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EVALUATION OF THE USE OF AN ELECTRONIC APEX LOCATOR AND BEHAVIORAL ANALYSIS IN CHILD PATIENTS

***[1]Elizandra Silva da Penha, [2]Luana Bento Herculano, [3]Ana Karina Almeida Rolim, [2]Mariana Gil Gomes Medeiros de Araújo, [3]Carlus Alberto Oliveira dos Santos, [1]Camila Helena Machado da Costa Figueiredo and [1]Gymenna Maria Tenório Guênes**

[1]Professor of Dentistry, Department of Biological Sciences. Federal University of Campina Grande, Patos, Paraíba, Brazil
[2]Dental Surgeon, Federal University of Campina Grande, Patos, Paraíba, Brazil
[3]Master Student, Department of Dentistry. State University of Paraíba, Paraíba, Brazil

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****Corresponding author:***
Elizandra Silva da Penha

ABSTRACT

This study aimed to compare *in vivo* the measures of working length found with the electronic apex locator Joypex 5 (Denjoy®, China) with those of conventional radiography, in addition to analyzing the behavior of the child during both techniques. The sample included 30 deciduous molar conduits of patients cared for in the Dentistry Teaching Clinic of the Universidade Federal de Campina Grande (UFCG). After the access was prepared, the conduits were irrigated with sodium hypochlorite 2.5% and sterile serum. Two methods for measuring the length of the root canal (electronic and radiographic) were compared to measure their efficacy. The samples were characterized as "Acceptable", "Short", and "Long", depending on the evaluation standards. The modified Frankl Behavior Scale was applied to evaluate the behavior of patients. The results were analyzed using Student's t test, with a 95% confidence interval ($p<0.05$). No statistically significant difference was observed between the measures found by the different methods evaluated ($p = 0.45$). There was an 80% positive behavior during LAE measuring, while there was only 50% for the radiographic method. The electronic apex locator is a safe deciduous teeth odontometric tool to determine the working length, diminishing the exposure to ionizing radiation, as well as the negative behavior during endodontic treatments.

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INTRODUCTION

Endodontic treatments are often required in Pediatric Dentistry Clinics to deal with deciduous teeth with problems related to tooth decay or traumatic lesions that reach the pulp. However, the quality of the endodontic technique in deciduous teeth is often made more difficult due to the challenging behavior of children and by internal anatomic characteristics, such as the form, size, and position of the root apex, which is continuously altered by the physiological root resorption (MOURA *et al*., 2013). Traditionally, radiography is used to find information about the root canal anatomy and working length. However, the radiographic image is bi-dimensional, and the peri-radicular and dental structures are tri-dimensional, meaning there might be distortions and errors in the evaluation of the working length through the radiographic image (PISHIPATI, 2013).

Determining the actual working length is an extremely important stage of the endodontic treatment, particularly when it comes to deciduous teeth, since it helps minimizing possible damage to the peri-apical and root regions, thus avoiding damage to the succedaneous permanent teeth germ (OZNURHAN *et al*., 2015). However, determining the root canal length with precision is challenging due to the many anatomic variations, to the superposition of anatomic structures, mistakes in techniques, or in the projection (COUTINHO-FILHO *et al*., 2012). The presence of permanent teeth germs, in close proximity to the apex of deciduous teeth, may also make it more difficult to locate the apical limits of the roots (LUCISANO *et al*., 2009). These factors encourage the development of electronic instruments that measure the root canal length, which can locate the position of apex construction with higher precision (LUCISANO *et al*., 2009). These instruments are called Electronic Apex Locators (EALs)

(MAACHAR *et al*., 2008) and have been undergoing changes in order to improve their efficacy and precision. Using EALs in deciduous teeth odontometrics may make this procedure painless, faster, and more precise. Most devices of the type can be exact in elements of this type of teeth, finding any communication between the interior of the root canal and the peri-apical tissues (SARITHA *et al*., 2012). This diminishes the chance of causing damage to tissues, especially to the germ of the succedaneous permanent tooth (MAACHAR *et al*., 2008). The physiological root reabsorption, which is a feature of this type of teeth, is not a contraindication of the use of EALs. An *in vivo* study carried out using the Root ZX II in deciduous maxillary incisors alleged that EALs are safe, painless, and avoid unnecessary exposure to radiation, being recommended for use in deciduous incisors (SARITHA *et al*., 2012). Lately, with the recommendation of locators as paramount auxiliary resources in endodontic therapies, new models were made available. However, the lack of *in vivo* investigations on the efficacy of these is worrying (ODABAS *et al*., 2011; CHITA *et al*., 2012). Another challenging feature of pediatric dentistry clinic is the behavior of the children. During dental treatment. Pediatric dentists should be able to notice specific situations or factors that may be causing changes in the behavior of the patient. It is important to recognize the predictors of children behavior, since, in addition to making the routine of attention easier, it allows the professionals to deal more easily with adverse situations. Therefore, the observation of child behavior and the knowledge of possible factors associated with it are extremely important in pediatric dentistry (MELO, 2015). Therefore, it is because of these needs of child patients that this study, in addition to evaluating the precision of the EAL in deciduous teeth, is a useful instrument to analyze how children behave with each odontometrics technique, determining which type of behavior is the most helpful for success in the endodontic treatment, using the already established Frankl Scale (FRANKL *et al*., 1962).

MATERIALS AND METHODS

This is an observational, cross-sectional, and analytical study. The sample was made up of 30 deciduous molar conduits from child patients attended at the Teaching Dentistry Clinic at the Universidade Federal de Campina Grande (UFCG), in the campus of the city of Patos, who were treated in the subject Child Clinic II. The research project was approved by the Committee for the Ethics in Researches with Human Beings, under Certificate of Submission to Ethical Appreciation n. 42764615.4.0000.5181. The conduits were submitted to two methods for measuring the length of the root canal (electronic and radiographic), which were compared to measure their efficacy. The Free and Informed Consent Form (FICF) was explained and given to the tutor of the patient. A Consent Form (CF) was read for the child explaining it according to their level of understanding. After conditions were accepted and both forms were signed, a signed copy of each form was delivered to the tutor of the child. To start the procedure, a radiography was conducted to check whether the patient was within the inclusion criteria of the research. If that was the case, the patient went through both methods of measuring and, later, received an endodontic treatment in the same session. Patients who were not in accordance to the inclusion criteria also received treatment for their needs in the same session. This research included participants who: were children from both genders; with or without the presence of the succedaneous permanent teeth germ; requiring endodontic treatment in a deciduous tooth; with less than 1/3 root reabsorption; with a pulp presenting signs of irreversible pulpitis or pulp necrosis; pulp exposure due to tooth decay or trauma; absence of cracks and/or extensive fractures of the pulp chamber; absence of lesions that break the crypt of the germ of the permanent; teeth in conditions that could be restored; and the possibility of carrying out complete isolation. Patients who were sensible to sodium hypochlorite and those whose behavior made it impossible to carry out the measuring techniques were excluded.

The tooth to be treated was radiographed, using the most adequate technique according to the region and the cooperation of the patient. It was rinsed with a 0.12% chlorhexidine solution and prophylaxis was made using pumice. Then, a topical anesthetic was applied in the adequate location and lidocaine 2% was used as a local anesthetic. The anesthetic technique was chosen according to the location of the tooth and the age of the child. In anterior teeth, infiltrative techniques were used, while in posterior teeth, depending on the age of the patient, the blockage of the inferior alveolar nerve or of the superior posterior alveolar nerve were carried out. The anesthetic dosage was calculated according to the weight of the patient. Only the tooth being treated suffered an absolute conventional isolation. When necessary, a gingival barrier was used. When the tooth being treated had decayed tissue, it was removed using round dental burrs. The Endo Z burr was used to remove the ceiling of the pulp chamber. After the access was prepared, the conduits were irrigated with sodium hypochlorite 2.5% and sterile serum. The electronic apex locator Joypex 5 (Denjoy®, China) was used to measure the length of the conduit according to the protocol recommended by the manufacturer, by a trained observer. A lip hook and a 21 mm type K file (Maillefer), with the diameter that fit the best to the internal walls, were put in the file support. The instrument was slowly inserted into the root canal, until the device emitted a sound indicating the location of the working length of the conduit. Then, a silicon stop was brought to the incisal/occlusal reference point of the dental element, and the file was removed and measured with a calibrator rule (Dentsply Maillefer), to record the electronic working length (EWL). The file was once again inserted in the conduit, according to the measure observed by the electronic register, and a new radiography was taken and brought to the light box, to register the radiographic working length (RWL), according to Oznhurhan.[3] The values were written down in a form specifically elaborated for the research to be compared. After this evaluation, the samples were classified in groups according to the following criteria: Group 1: "Acceptable", indicating that the length of the tip of the file was 0-1mm shorter when compared to the radiographic apex; Group 2: "Short", indicating that the length of the tip of the file was > 1mm below the radiographic apex; and Group 3: "Long", indicating that the tip of the file was beyond the apex found by the radiography. During the measuring of electronic and radiographic working lengths, the same trained observer used the Frankl Behavior Scale to define how the child reacted to the two different measuring techniques. Behavior was defined according to the parameters: Definitely Positive (good relations with the dentist, no sign of fear, interested in the procedures, making appropriate verbal contact), Positive (careful acceptance of treatment, some reluctance, many questions or delay tactics, moderately willing to consent with the dentist, sometimes with reservations, and a similar

disposition to follow instructions), Negative (lower negativity or resistance susceptible to the techniques of treatment and minimum to moderate reserve, fear, nervousness or crying) or Definitely Negative (refusal of treatment, evident hostility and resistance, strong fear, vigorous crying, moving away and/or isolating themselves). It was noted in a table created to this end and later analyzed. After collected and categorized, data was submitted to descriptive univariate analysis, including the use of frequency distribution for the variables. For the bivariate analysis, Student's t test was used, with a 95% confidence interval ($p<0.05$). Statistical analysis was carried out using the software Statistical Package for the Social Sciences (SPSS), version 20.0.

RESULTS

The participants of the research were 10 patients from 5-9 years old (6.8 ± 1.2 years). The sample was the result of the evaluation of 11 deciduous molar teeth referred to endodontic treatment due to extended tooth decay lesions with pulp involvement. Six were superior molars, and five were inferior. The research included 30 conduits from these elements. The calibrations were tabulated and included in the groups according to the evaluation criteria. Group 1 includes 43.3% (n=13) of the conduits analyzed, meaning their measurement was found to be "Acceptable", that is, the length of the tip of the file was from 0 to 1mm shorter than the result of the radiography apex, a result which is clinically tolerable.

Table 1. Distribution of conduits according to evaluation criteria

GROUPS	FREQUENCY	PERCENTAGE
Acceptable	13	43.3
Short	11	36.7
Long	6	20.0
Total	30	100.0

The radiographic measurement (RM) of the conduits analyzed had a mean result of 12.88 ± 3.74 mm, while the electronic measurement found a result of 12.18 ± 3.49 (CTE). Through the use of Student's t test, it was possible to notice that there was no significant difference between the measurements found by each method evaluated ($p=0.45$).

Table 2. Mean and standard deviation of radiographic and electronic measurements

MEASUREMENTS	N	Mean ± SD (mm)
Radiographic	30	12.88 ± 3.74[a]
Electronic	30	12.18 ± 3.49[b]

[a-b] Statistical difference found ($p=0.45$)

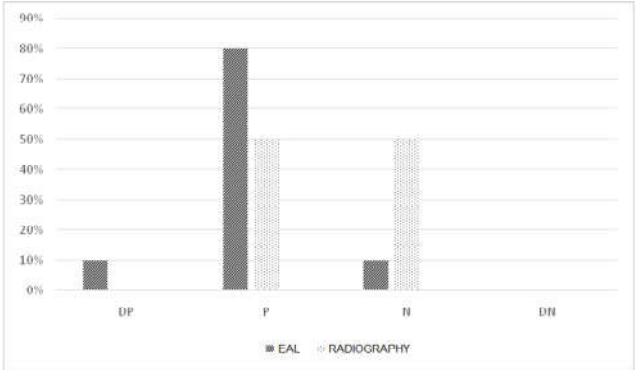

Image 2. Percentage behavior distribution according to the Modified Frankl Behavior Scale during the use of EAL and of conventional radiography

During the measurements carried out using the techniques analyzed in the research, the modified Frankl scale was applied, finding that 80% of patients had a positive behavior during EAL measurements, while only 50% had a behavior considered to be positive during the radiographic method (Image 2).

DISCUSSION

Determining the working length (WL) during the endodontic treatment of deciduous teeth is a crucial step for the success of the technique, necessary to carry out the complete disinfection of the conduit, with no possible damage to the germ of the succedaneous tooth (MELLO-MOURA *et al*., 2010). The precision of electronic apex locators greatly improved over the years, and this measuring method has been increasingly used due to its precision and reliability, in addition to diminishing the clinical time and the exposure to radiation, making it useful to overcome some shortcomings of the radiographic exam (MARTIN *et al*., 2014; MOSLEH *et al*., 2014). The anatomy of conduits and deciduous teeth is constantly altered by physiological resorption, which makes it so the radiographic measurement technique is not adequate, since its image is limited to detect the place where the resorption bezel is (KIELBASSA *et al*., 2003). A study carried out using the ROOT ZX, the standard comparative device, had a 62.7% precision in the determination of the working length in teeth with apex resorption in the cases of clinical tolerance ± 0.5mm (GOLDBERG *et al*., 2002). Many devices are available, but since this is a research carried out in a public service, the chosen device was the Joypex 5, which won the public bidding process to be used in the Institution.

Previous researches evaluated the way an EAL determined the working length in deciduous molars extracted with or without root resorption. The measurements were tabled and compared, and no statistically significant difference was found between the lengths. These results corroborate the use of this method in cases of physiological resorption in deciduous multi-root teeth, generating precise measures in this type of teeth (NELSON-FILHO *et al*., 2011; ODABAS *et al*., 2011). In this study, the evaluation was carried out *in vivo*, in multi-root teeth with or without resorption, which was appropriate since the electronic method does not depend on root resorption. *In vivo* analyses, despite not generating results as fast as *in vitro* ones, are complete and allow for a global assessment, while also making possible for the research to be extrapolated to predict clinical behavior (PENIDO *et al*., 2008). This study, involving deciduous molars, resulting from tooth decay lesions with pulp involvement, emphasized that neither the type of the tooth (incisor or molar), neither the state of the pulp, nor partial physiological root resorptions influence in determining the working length (ANGWARAVONG; PANITVISAI, 2009). Using the electronic measuring method, exposure to radiation diminishes, the comfort of the patient increases, and the need for the child to behave is not as relevant. In addition, it is more precise in the location of the apex limit, diminishing the subjectivity of radiography and optimizing the treatment in case of children who do not behave. The fact that not much cooperation from the patients' behavior is required during the use of the EAL explains why the child accepts better this method as it is used (KIELBASSA *et al*., 2003; SUBRAMANIAN *et al*., 2005). During the evaluation of the IPEX locator in determining working length in 20 deciduous molars, with no apex constriction defined, in a total of 33

conduits, it was possible to find with precision the apex foramen, or the location of the apex aperture, and measure the working length (NELSON-FILHO *et al*., 2011). These results indicate that, even when the apex constriction of this teeth is not defined, the EAL can measure the working length, with a tolerance of 1 mm below the apex, a measure that is considered to be clinically acceptable due to the variations in form, diameter, and internal anatomy of the apical zone (NELSON-FILHO, 2010). The results found in this study are in accordance to those found by other researchers, who, when analyzing the conduits of deciduous teeth, found results with 80.2% accuracy, within the parameter 0 - 1mm, using the Endomaster EAL in 96 conduits (OZNURHAN *et al*, 2015). Another author found values of 87.33% for Raypex and 81.33% for the IPEX (DANDEMPALLY *et al*., 2013). With the EAL ROOT ZX II the precision found was 70% (SARITHA *et al*., 2012). Another analysis involving 100 conduits found a precision of 92% within +0.5 mm and of 100% within +1 mm (KRISHNAN; SREEDHARAN, 2012). The precision analysis of this work also found a more expressive percentage of precision within ±1 mm, in which 13 conduits (43.3%) of the 30 conduits analyzed belonged in the clinically acceptable group.

However, another study finds that a 2-3 mm tolerance below the radiographic apex is acceptable, due to the changes in the apex caused by the intermittent and irregular resorption process (SARITHA *et al*., 2012). If this tolerance was accounted for in this study, 24 out of 30 conduits would be a part of this acceptable group, generating a global success rate of 80%. Another study using the same EAL (Joypex 5) *in vitro*, in 30 permanent uniradicular permanent teeth also did not find any statistically significant differences ($p>0.05$) between the measures carried out with Joypex 5 and the radiographic CT. Based on the results of said analysis, it was possible to say that this EAL was precise in determining the working length of permanent teeth (COUTINHO-FILHO *et al*., 2012). Similarly, this research also did not show statistically significantly differences between the measurements found by the methods evaluated ($p=0.45$), a result that is reflective of the efficiency of this apex locator in deciduous elements. When analyzing the behavior of the patients in this research, throughout the use of the locator and of the radiographic procedure, they were found to act in a more positive way (80%) during the use of the locator as opposed to the use of the radiographic method (50%). A research used the Frankl Behavior Scale, comparing the behavior of children from 7-13 years old in two moments: the first and second consultation, finding positive behavior results in, respectively, 74.8% and 78.4%. The observation of the child behavior and the knowledge of possible factors associated to this behavior are extremely important in Pediatric Dentistry. This broader understanding enables professionals to more clearly identify situations that can cause stress in the child during care, and to manage their behavior during treatment (MELO *et al*., 2015).

Conclusion

There was no statistically significant difference between the measures found by the electronic apex locator and by conventional radiography, but the behavior of the child was better during the measurements carried out with the electronic apex locator.

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