Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2019;9:2s:256-263.

Comparison of Conventional Radiography and iPex Apex Locator in Working Length Determination of Primary Molars

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ABSTRACT

Background: The aim of present in-vivo study was to evaluate and compare the working length obtained by conventional radiography and electronic apex locator in primary molars.

Material and Method: 120 canals from 40 mandibular primary molars were selected and working length was estimated using radiographic and electronic apex locator (iPex) and compared for clinical accuracy between both the methods. The mean of working length of individual canal (mesiobuccal, mesiolingual and distal canal) of each mandibular primary molar was also compared. Data were statistically analyzed by using paired t test.

Result: The overall mean working length (13.02±1.25mm) determined by electronic apex locator method was slightly greater and accurate than determined by using conventional radiographic method (12.95±1.27mm)**.** When the mean of working length of individual (mesiobuccal, mesiolingual and distal) canals was compared, working length of the overlapped canals (mesiobuccal and mesiolingual) were found to be more accurate by electronic apex locator (iPex) than that of by radiographic method.

Conclusion: Though no statistical significant difference (p=0.28) was obtained between working length determined by electronic apex locator and radiographic method; working length determined by electronic apex locator was found to be more accurate.

Keywords: Working length, Electronic apex locator, Radiography.

INTRODUCTION

Preservation of primary teeth until the time of physiologic exfoliation is of utmost importance in clinical pediatric dentistry as their early exfoliation may lead to reduced tooth function, impaired mastication, space loss, crowding, malocclusion, speech problems and deleterious oral habits [1,2]. The endodontic therapy in children aids in overcoming these consequences by preserving the integrity and function of the teeth along with dental arches[3,4]. Importance of accurate working length determination cannot be neglected in successful endodontic therapy of primary teeth. The glossary of endodontic terms defines working length as "The distance from a coronal reference point to a point at which the canal preparation and obturation should terminate"[5]. The apical constriction indicates the

Received: Feb. 13, 2019**: Accepted**: Apr. 7, 2019
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pISSN 2278-0076
eISSN 2321-9270

apical limit for the termination of endodontic treatment [6]. Overfilling of root canal beyond apical limit causes foreign body reaction, necrosis of bone and cementum, enamel defects in permanent teeth and deviated path of permanent successor[7,8]. Underfilling of root canal may lead to inadequate debridement and retained pulp tissue which causes persistence of radicular infection leading to failure of endodontic therapy. Literature is vastly filled with various methods of working length determination like tactile sensation, conventional radiography, digital radiography and electronic apex locator.

Radiographic method acts as an initial guide for working length estimation along with the advantages, like direct observation of the anatomy of root canal system, number and curvature of roots and in addition acts as an initial guide for working length estimation[4]. Anatomical variations, angulations of machine and technical errors in projection can lead to errors[9]. There are radiation hazards both to the patient and the dental personnel but they can be efficiently managed by following the radiation protection protocol[10].

The use of electronic devices was first proposed by Custer[11] and first electronic apex locator was developed after Suzuki's investigation of electrical resistance properties of oral tissues[12]. The first generation electronic apex locator is resistance based whereas second generation electronic apex locator is based on impedance[13]. The main shortcoming of both generations of electronic apex locators (which corresponded to poor accuracy with electrolytes) was overcome by introduction of third generation electronic apex locator which involves the measurement of impedance values at two frequencies simultaneously and calculation of a quotient that expresses the position of file tip in the canal[14]. The fourth generation electronic apex locator measures capacitance and resistance simultaneously to determine the location of file tip in the canal[15].

The canal anatomy of primary molar is difficult to predict because of balance of physiologic resorption and hard tissue deposition. Physiologic resorption changes shape, dimension and position of root apex which makes locating exact position of apical foramen difficult[16]. For these reasons, clinically acceptable error tolerance for electronic apex locator is ± 1 mm or ± 0.5 mm[17].

Electronic apex locators are recommended to use in primary teeth as they are not only safe and painless but also offers the potential to reduce patient exposure to ionizing radiation and lessen the procedure time, both of which contribute to patient co-operation[3,18,19].

Currently, the NSK Company (Tokyo, Japan) has introduced an electronic apex locator device by name iPex. It is a fourth generation electronic apex locator[15,20,21]. iPex has been investigated in permanent teeth, but it has not yet had its precision evaluated in primary teeth[22]. Hence the present clinical study was designed and conducted to evaluate working length of root canals of primary molars by using conventional radiography and iPex electronic apex locator (fourth generation) and compared along with working length of individual root canals of primary molars.

MATERIALS AND METHODS

The present study was cross-sectional clinical trial which was conducted at Outpatient Department of Pedodontics and Preventive Dentistry of Maitri college of Dentistry and Research Centre, Durg after obtaining ethical clearance. Subjects were allocated in the present study by purposive sampling technique. The study was carried out on 40 mandibular primary molars of the healthy children aged between 4 to 8 years. A total of 120 root canals were assessed for measuring working length first by conventional radiographic method and then by electronic apex locator.

Inclusion criteria

Clinical criteria:

1. The child having decayed teeth with history of pain suggestive of irreversible type of pulp disease requiring partial pulpectomy.
2. Abscess teeth with sinus which are not indicated for extraction.
3. The children with no history of systemic disease.

Radiologic criteria:

1. Decayed teeth showing radiolucency extending from enamel, dentin and pulp involving coronal & radicular pulp indicated for partial pulpectomy procedure.
2. Teeth showing with no or one third root resorption, not more than that.

Exclusion criteria

Clinical criteria:

1. Un-cooperative patients.
2. Teeth with non-restorable crown.
3. Teeth which had previously undergone endodontic treatment.
4. Medically compromised children.
5. Abscess teeth with sinus or fistula indicated for extraction.

Radiologic criteria:

1. Calcified root canals.
2. More than one third of root resorption.
3. Teeth with internal root resorption.
4. Teeth showing furcation involvement of tooth.

After administering local anesthesia and ensuring rubber dam isolation, endodontic access cavity was completed by using straight fissure diamond bur (TF-21; Mani) in a high-speed handpiece (NSK). Straight line access to root canal was established. Coronal pulp extirpation was done using round diamond bur (BR-46; Mani) and standardized spoon excavator. Root canal orifices were located with endodontic explorer and pulp tissue extirpated with smooth broach followed by irrigation with sodium hypochlorite (2.5%) and normal saline (0.9% w/v).

After establishing a stable coronal reference point on the tooth; the file was advanced till the approximated working length. Radiograph was taken by X-ray equipment operating at 8mA and 65-70 Kvp using paralleling technique and then processed manually. Film holder (Endoray II, DentsPly, Japan) was used with E speed film and parallelism was maintained. The working length was adjusted and calculated 0.5 mm short of radiographic apex by digital vernier caliper (Aerospace). Two examiners did the recording procedure of working length of selected primary mandibular molars. Intra examiner reliability of the recorded working length determined by either method (Radiographic method and electronic apex locator) was assessed after every five patients. Inter examiner reliability was assessed by the second examiner (supervisor) by re-recording working length of same patients determined by examiner one (investigator).

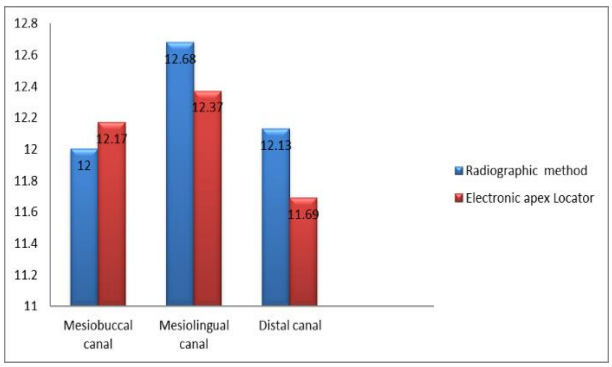
Electronic apex locators were used in accordance with manufacturer's instruction. Once the dryness of canal is assured by using absorbent paper points (DentsPly), one head of the electrode of electronic apex locator (lip clip) was attached to lip commissure contralateral to the respective tooth and the other one (file holder) was attached to the endodontic file. Working length was calculated when file reached to 0.5 mm mark (5 sections) on LCD monitor and the readings were considered valid if the instrument remained stable for at least 5 seconds. At this time a rubber stop was set on the coronal reference point and file was removed. The distance between rubber stop and tip of the file was measured by digital vernier caliper. The readings recorded were tabulated. The collected data was evaluated and analyzed statistically by using paired t test.

RESULTS

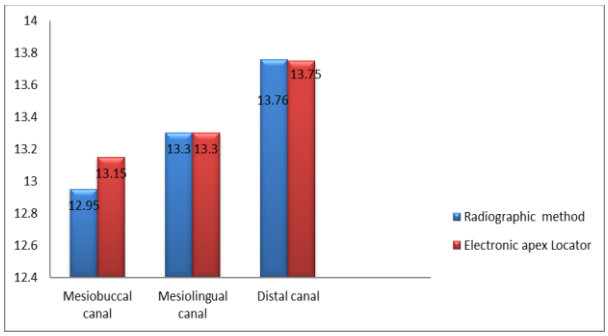
In the present research, a total of 40 mandibular primary molars were selected for estimation of working length out of which 3 were mandibular left primary first molars , 10 mandibular left primary second molars, 7 mandibular right primary first molars and 20 mandibular right primary second molars. A total of 120 root canals were selected for estimation of working length by using conventional radiography of which 9 canals were from mandibular left primary first molars, 30 canals of were mandibular left primary second molars, 21 canals of were mandibular right primary first molars and 60 were mandibular right primary second molars. The working lengths of same root canals were assessed by using electronic apex locator (iPex). In our study we found that overall mean working length (13.02±1.25mm) determined by electronic apex locator method was slightly greater and accurate than determined by using conventional radiographic method (12.95± 1.27mm) but the difference between the mean working length determined by radiography and electronic apex locator (iPex) was statistically not significant (p=0.28) (Table no.1).

Table 1: Comparison between overall mean of working length (mm) of mandibular primary molars determined by Conventional radiography and Electronic apex locator (iPex).

Teeth selected	Method				Test	p Value	Significance
	Conventional radiography		Electronic apex locator				
	Mean	SD	Mean	SD			
Mandibular primary molars	12.95	±1.27	13.02	±1.25	Paired t test	0.28	Not Significant



Graph 1: Comparison of mean of root canal length (in mm) of mesiobuccal, mesiolingual and distal canal of primary first molars by radiography and electronic apex locator (iPex).



Graph 2: Comparison of mean of root canal length(in mm) of mesiobuccal, mesiolingual and distal canal of primary second molars by radiography and electronic apex locator (iPex).

In the present study the comparison of mean of working length of individual (mesiobuccal, mesiolingual and distal) canals of mandibular primary first and second molars determined by conventional radiographic method and electronic apex locator was done (Graph no. 1 and 2). It was observed that the working length of the overlapped canals (mesiobuccal and mesiolingual) were more accurate by electronic apex locator (iPex) than that of by radiographic method.

DISCUSSION

The success of an endodontic therapy depends on straight line access to all the canals present, accurate determination of the working length, thorough cleaning, disinfection, shaping and hermetic sealing of all the portal of communication between the periapical area and the tooth [2,3,23].

According to Ricucci and Langeland[24] the apical constriction creates the smallest wound site and best healing condition. Root canal preparation techniques should ideally attempt to use minor constriction as the apical limit for canal preparation.

Radiography is one of most commonly used traditional method for the determination of the working length[1,24]. It favors the evaluation of furcation and/or periapical area to obtain an estimate of the radicular behavior. But the accuracy of radiographic method is questionable especially in the cases where the primary teeth are undergoing resorption in the facio-lingual planes[25]. But still this method is most commonly used.

Radiographic method described by Ingle is mostly used which is based on the proposition that the apical constriction is located between 0.5 and 1 mm from the radiographic apex and working length is determined 0.5 mm to 1 mm short of radiographic apex [26,27].

The use of electronic means of working length determination has increased considerably in recent years, not only in the permanent but also in the primary dentition[1,17]. However, information regarding the accuracy of electronic root canal length measuring devices in the primary dentition is

limited both in vitro and clinical studies[13,28]. It was observed that studies carried out by Soruri M et al.[1], Nelson-Filho P et al.[22], and Paludo L et al.[21] found iPex electronic apex locator as a reliable tool for measuring working length. The sample of 4-8 years of age were selected in the present study as the primary molars in this age group usually have non resorbed roots or at least two third of their root intact and this was also the most common age group of patients reporting for the endodontic treatment .

There is a radiation protection protocol given by International commission on radiologic protection[10]. In the present study lead apron and thyroid collar was used for all the subjects to minimize exposure to radiation. Paralleling technique was considered as gold standard because it was found to be more common and has high accuracy for determination of canal length[1]. Various investigators had used paralleling radiographic technique for determination of working length in primary teeth[1,23]. Kazzi D et al.[29] found that percentages of inaccurate radiographs with paralleling technique are less than the percentage of inaccurate radiographs with bisecting angle technique. Group E speed films require about half the exposure of ultra-speed (Group D) films [10]. In the present study Group E speed films were used as it is the most common used films and also decreases the exposure to radiation.

Ibrahim MF et al.[30] noticed that radiographs taken by Endoray II (receptor holding device) resulted in lower unacceptability (retake) rates which is always desirable in young children. Endoray II was selected purely because of its availability and design. Duran-Sindreu F et al.[31] reported that 2.5% concentration of sodium hypochlorite had no influence on the accuracy of iPex electronic apex locator under in vivo conditions**.** So it was preferred in our study.

Apical end point of root canals in primary teeth is often uncertain because of root resorption. Some authors declared that ±0.5 mm is acceptable from radiographic apex whereas some declared ±1 mm from radiographic apex is acceptable[16,32,33]. When overall mean of working length of mandibular primary molars was compared by using conventional radiographic method (12.95±1.27 mm) and electronic apex locator (13.02±1.25 mm), we found statistically non-significant difference (Graph no.1). It might be attributed to the observer bias while recording working length, secondly the smaller sample size used to compare working length by radiographic and electronic apex locator method.

Oznurhan F et al.[18] in their study found insignificant difference when working length of radiographic method (13.23±1.92 mm) was compared with electronic apex locator (13.08±1.77mm). Soruri M et al.[1] found insignificant difference in working length estimation by radiographic (14.43±2.19mm) and electronic apex locator (14.42±2.24mm) methods in their study. These findings were similar with results of present study and this might be due to use of similar methodological criteria and use of digital Vernier caliper which was used in our study.

Results of our study were in contrast with studies conducted by few authors in the past[9,25]. Pinheiro SL et al.[9] found significant difference in working length determination between radiographic (11.83±1.97mm) and electronic apex locator (10.91±1.31mm) methods. The reason can be attributed to that their study was not influenced by behavior and co-operation issues of the child. Furthermore; they had determined actual working length by extracting the tooth. Suneja B et al.[25] in their study found significant difference in determining working length by using radiographic technique(11.32±1.72mm) and fifth generation electronic apex locator(10.32±1.97mm). Use of millimeter ruler, bisecting angle technique and advanced generation electronic apex locator for determination of working length might account for reason behind these significant differences which they found in their study.

In present study mean of working length of the individual canal (mesiobuccal, mesiolingual and distal canal) of each mandibular primary molars was also compared. In the present study the comparison between the mean of working length of mesiobuccal, mesiolingual and distal canal of mandibular first primary molars determined by conventional radiographic method (12.00±0.82 mm;12.68±1.45mm,12.13±0.95mm) and electronic apex locator (12.17±0.8 mm,12.37± 1.28mm,11.69±1.16mm) respectively was found to

be statistically non-significant (Graph no.1). In current study statistically non-significant differences were also observed in mandibular second primary molars when the comparison was made by using conventional radiographic method (12.95±1.05mm; 13.3±0.93mm,13.67±1.26mm) and electronic apex locator(13.15±0.95mm, 13.3±0.89mm,13.75±1.27mm) for mesiobuccal, mesiolingual and distal canals respectively (Graph no.2). This might be attributed to using more accurate isolation and radiographic technique to record working length in our study, still while working on children it was always difficult for the operator to have control on child's tongue movement and also to stabilize the instruments in oral cavity which could result in variation of working length estimated than that actually.

Further studies are required with more number of sample sizes, more advanced generation electronic apex locators, histological analysis, digital radiography, cone beam computed tomography, stereomicroscope and other digital methods; to confirm the accuracy of various methods of working length determination.

Electronic apex locator reduces the number of radiographs required and thereby minimizes radiation exposure and furthermore also assists where radiographic methods create difficulty. Combinations of methods are always recommended for proper estimation of root canal length. It has been found that the use of an electronic apex locator in combination with the radiograph has greater precision in the determination of working length.

CONCLUSION

In our study no statistical significant difference was obtained between working length determined by radiographic method and electronic apex locator neither in the overall mean nor in the individual canals of primary molars but it was observed that working length determined by electronic apex locator was more accurate. Hence it was highlighted that the radiographs along with electronic apex locators not only aids in accurate working length determination but also enhance the success of endodontic therapy.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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