

## Clinical Comparison Of Two Electronic Apex Locators In Working Length Determination As Compared To Conventional Radiography In Primary Molars

Research Article

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### Abstract

**Aim:** The aim of this study was to evaluate the effectiveness of two different types of electronic apex locators and conventional radiography for working length determination in primary teeth.

**Materials and methods:** A total of 50 primary teeth indicated for pulpectomy in children aged 4 to 9 years were randomly selected and subjected to working length determination using two varieties of electronic apex locators and conventional radiography. The data were then subjected to statistical analysis.

**Results:** The values obtained using the 2 electronic apex locators were similar but the values were not statistically significant in comparison to the conventional radiographic values. Children showed more positive behaviour on usage of electronic apex locators as compared to conventional radiography and was statistically significant.

**Conclusion:** conventional radiography and apex locators are equally effective in determining working length in primary teeth. The electronic apex locators were far better accepted by children than conventional radiography.

**Keywords:** Electronic Apex Locators; Conventional Radiography, Pulpectomy; Working Length.

### Introduction

Pulpectomy of primary teeth is indicated when the radicular pulp tissue is necrotic.[1] Failure to determine the proper root canal working length during root canal treatment may compromise the treatment result.[2] The lack of patient's cooperation, limited access, anatomical variations, and complex anatomy of the primary roots defines the complex nature of endodontic treatment in young children [3, 4]. Constant resorption and hard tissue deposition combined with the tortuous and peculiar morphology of primary molar root canal systems,[5] the size of the root canals, location of the apical foramina is continually altered making it difficult to determine the exact position of apical foramen [6, 7]. One of the most important but still overlooked detail would be the possibility of overinstrumentation leading to periapical injury and in rare cases damage to the permanent successor germ [8, 9].

Behavior of the child is one of the most important factors de-

terminating the success of the treatment. And increase in treatment duration most often leads to decrease in cooperative ability of the child. Moreover, having an anxiety free, relaxed child not only leads to an uneventful treatment procedure but also improves operator efficiency [10].

Conventional radiographic techniques have been used for decades to obtain information about root canal anatomy, working length and the surrounding soft tissues. Radiographic method described by Ingle is one of the most common and reliable methods used in determining the working length. The accurate determination of root canal length radiographically is hindered because of the anatomical variations, interference of anatomical structures or errors in projection [8]. Moreover, it is difficult to obtain a diagnostic radiograph in children because of poor patient cooperation and limited access to the mouth [8, 11]. In addition, there is a radiation hazard, both, to the patient and the dental personnel. The observers' bias in radiographic interpretation may lead to errors [12].

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Use of an electronic apex locator for determining WL has reduced radiation dosage and time [8]. In 1918, Custer was the first to develop the idea that root canal length could be estimated by the use of an electrical current. The electrical resistance between the periodontal ligament and oral mucosa has a constant value that could be measured using electronic apex locator [13].

Electronic apex locators (EAL) have been used in endodontic treatment for many years, especially in permanent teeth, and five generations of apex locators have been produced by manufacturers [14, 15]. The use of EAL in primary teeth, however, is not universally accepted [16]. The literature does not indicate the differences when using the EAL in permanent and primary teeth [8], but it was concluded that electronic apex locators are safe, painless, and useful because they avoid unnecessary radiation [4].

A significant disadvantage of the previous generation devices is that they need to perform in relatively dry or in partially dried canals. In some cases, this necessitates additional drying. Also in heavy exudates or blood it becomes inapplicable [8, 17-19]. Both R SMART PLUS and the ProPexPixi Apex Locator (Dentsply-Sirona, Maillefer) are 5th generation apex locator that uses multi frequency technology to locate the apical foramen. Some new generation endo motors also come with the electronic apex locators attached and this further reduces the instrumentation time and thereby improves the patient cooperation.

To cope with the problems associated with previous generations of apex locators the 5th generation device uses a new measuring method that has been developed based on comparison of the data taken from the electrical characteristics of the canal and additional mathematical processing. It measures the capacitance and resistance of the circuit separately and is supplied with an inbuilt diagnostic table that includes statistics of the file. They have the best accuracy in any root canal condition (dry, wet, bleeding, saline, EDTA, NaOCl) [20, 21]. Hence even in mild resorption cases the reading will be accurate [22]. It is claimed to be less affected by electrical noises affecting other physical parameters, such as amplitude or phase of electrical signal [23]. However, *in vivo* studies to evaluate their accuracy in the primary dentition are limited.

This study is hence aimed at clinically comparing the two electronic apex locators in working length determination as compared to conventional radiography in primary molars.

## Materials And Methods

This randomized clinical trial was conducted in children aged between 4 and 9 years with mandibular primary second molars scheduled for pulpectomy and accompanying their parents to the department of pediatric and preventive dentistry.

### Ethical approval

The study was registered with the Institutional Review Board of the Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India. Ethical approval was obtained from the Institutional Review Board of the SIMATS. Informed consent was obtained from all parents of the children before including them in the study. Informed consent was obtained from the par-

ents/guardians of participating children prior to the treatment.

### Source of participants

Children aged between 4 and 9 years were included. Mandibular primary second molars with nonrestorable crown structure, intracanal calcifications, extensive periapical/furcation radiolucency, mobility, twothird of the root resorption, and children with any underlying systemic disorders were excluded from the study. A preoperative radiograph was taken using bisecting technique to confirm the selection criteria.

### Clinical procedure

After administration of local anesthesia the tooth was isolated with rubber dam. Access cavity was prepared and the coronal pulp tissue was removed using spoon excavator. Barbed broaches and K files were used to extirpate the pulp tissue from each root canal followed by rotary instrumentation. Care was taken not to penetrate the apex. The root canals were then irrigated with 1% sodium hypochlorite followed by sterile saline solution. The pulp chamber was dried using sterile cotton pellets.

Working length was then determined by conventional radiography and EALs in all the selected teeth.

### Working length determination by radiographic method

Measurements were made from the preoperative radiograph using ISO 15 size files with rubber stoppers. With these measurements, files were inserted into the canals. In case of more than one canal on the same side different types of files were inserted in each canal for easy identification. Conventional intraoral periapical radiograph was taken using the bisecting angle technique. Cusp adjacent to the canal was taken as the occlusal reference. The files were removed and file length was determined using an endogauge. Ingle's method was followed for working length determination (file 1 mm shorter than the radiographic apex).

### Working length determination using electronic apex locators

Working length was determined clinically using PropexPixi (DentsplyMaillefer, Ballaigues, Switzerland) and R SMART PLUS apex locators as per the manufacturer's instructions. Both the EAL were used but first was chosen randomly.

### Working length determination using electronic apex locator

The same K-file used in the radiographic method was attached to the file holder and the ground electrode was secured to the patient's labial commissure. The pulp chamber was dried using sterile cotton pellets. The file was advanced into the canal till the PropexPixi showed the 0.5 marking, indicating that the file was in the apical zone. The rubber stopper was adjusted at the same occlusal reference point as the radiographic method. The file was carefully withdrawn from the canal and the measurement was recorded using an endogauge. This procedure was followed for each canal.

### Assessment of behaviour

Frankl's behaviour rating scale was used to check for the behavior of the child while using apex locators or using conventional radiography.

Pulpectomy treatment was completed in subsequent appointments.

**Statistical methods**

The data collected were statistically analyzed using the SPSS version 18.0 software (SPSS Inc., Chicago, IL, USA). One-way analyses of variance were used to test the difference between the EALs (PropexPixi and R SMART PLUS) and conventional radiography groups. Pearson correlation coefficient test was used to determine whether there was any correlation between the three measurements. The behavioral responses of the children to the three methods of working length determination were assessed using the Chi-square test. In all the above tests, P< 0.05 was taken to be statistically significant.

**Results**

A total of 50 teeth with 150 canals were evaluated in this study. 11 mandibular primary second molars included for working length determination were in 4–5-year-old children, 17 in 5–6-year-old children, 18 in 6–7-year-old children, 4 in 7–8-year-old children. Table 1 shows the means of working length obtained by conventional radiography and PropexPixi and R SMART PLUS apex locators. No statistically significant difference was detected between the three methods (P> 0.05). Children showed more positive

behaviour on usage of electronic apex locators as compared to conventional radiography and values were statistically significant.

**Discussion**

The accuracy of apex locators is higher when compared with that of the radiographic methods. Modern apex locators can locate not only the apical foramen but also, in contrast to radiographic methods, the apical constriction, which is an optimal endpoint for root canal preparation and filling [24]. In the present study, fifth generation apex locator was used which works on dual frequency type, and is considered best in any root canal condition. It provides the reader with a digital read out, graphic illustration and an audible signal. But it is also emphasized that the use of apex locator alone without the preoperative and postoperative radiographs is not a recommended practice due to the large number of variations in the tooth morphology, and medico legal record keeping requirements [25].

Kobayashi and Fan et al [26, 27] reported that the electroconductive solutions present inside the canal greatly reduce the impedance and therefore resulted in a tendency toward shorter measurements, whereas longer measurements were detected in the lower electroconductive solution. This is in agreement with other studies in which the accuracy of different brands of apex locators were evaluated in the presence of different irrigants, and a greater deviation from the actual WL was obtained with NaOCl [28].

Working length radiograph was taken using bisecting angle technique as it is the most common radiographic technique and the presence of a rubber dam, rubber dam clamp, and the root canal

**Table 1.**

Root canal	WL determination method	n	mean	p
Mesio buccal	Conventional radiography	50	13.71	0.801
	propexPixi	25	13.45	
	R Smart Plus	25	13.99	
Mesio lingual	Conventional radiography	50	12.45	0.677
	propexPixi	25	12.33	
	R Smart Plus	25	12.79	
Distal	Conventional radiography	50	13.23	0.594
	propexPixi	25	13.87	
	R Smart Plus	25	13.64	

**Table 2.**

Age (years)	N	Working length determination method	Frankl's behavior rating scale				P - value
			--	-	+	++	
4-5 years	11	Conventional method	3	4	3	1	0.01
	5	Propexpixi	0	0	3	2	
	6	R Smart plus	0	0	4	2	
5-6 years	17	Conventional method	5	7	2	3	0.001
	8	Propexpixi	0	0	5	3	
	9	R Smart plus	0	0	7	2	
6-7years	18	Conventional method	2	6	9	1	0.001
	9	Propexpixi	0	0	5	4	
	9	R Smart plus	0	0	3	6	
7-8 years	4	Conventional method	0	1	3	0	0.012
	2	Propexpixi	0	0	2	0	
	2	R Smart plus	0	0	1	1	

instruments may complicate by impairing proper receptor positioning and aiming cylinder angulations with paralleling technique [29]. The radiographic working length produced by both parallel and bisecting angle technique has been compared and concluded that comparable working lengths and the slightly better performance of the former would be clinically irrelevant [30].

Palatal and mesiobuccal roots of maxillary molars were associated with the highest incidence of inaccurate radiographic working length compared with other roots in vitro and in vivo [31, 32]. Hence only mandibular 1st and 2nd molars were included in the study.

In a previous study D'Assuncao evaluated 2 apex locators and found that they are reliable in finding the apical foramen [33]. Sadeghi in another study compared apex locators with conventional radiography in straight and curved canals and found apex locators are reliable in determining working length regardless of the curvature of the canals [34].

The behaviour of the child greatly affects the outcome of the treatment. It was found that children found the electronic apex locators to be more comfortable as compared to the conventional radiographic methods. The placement of the film positioner was problematic in children with small mouth openings which could attribute to them finding the procedure uncomfortable and to some extent the negative behaviors [6].

Within the limits of this study, both electronic apex locators were able to determine the minor diameter within  $\pm 0.5$  mm therefore likely to provide clinically acceptable measurements. The R SMART PLUS is moreover a new instrument that has yet to be described in the literature. We find that this apex locator shows similar results and also poses a slight advantage over PropexPixi as the apex locator is attached to the endo motor thereby drastically reducing the working time.

## Conclusion

Both the apex locators were as accurate as conventional radiography in determining working length in primary teeth; with no statistically significant difference between R Smart Plus and Propex-Pixi. R Smart Plus posed a slightly better advantage in children as the apex locator was built in with the endomotor. The electronic apex locators were far better accepted by children than conventional radiography.

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