

A Comparative Evaluation of the Accuracy of Two Electronic Apex Locators and Radiovisiography to Determine the Working Length

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ABSTRACT

Aim: The purpose of this study was to compare the working length in primary teeth using intraoral digital radiovisiography and two apex locators for accuracy.

Materials and methods: This is an *in vivo* study done in 30 primary teeth which are indicated for pulpectomy in children aged 5–9 years. All the teeth selected for the study had adequate remaining tooth structure for rubber dam isolation and radiographically visible canals. During the pulpectomy procedure, the working length was determined by digital radiovisiography and apex locator. The teeth were divided into three groups: group I—radiovisiography, group II—apex locator-I (Root ZX mini), and group III—apex locator-II (i-ROOT). The measurements were then compared for accuracy.

Results: There is no significant difference in the mean root length measurements from the three techniques.

Conclusion: The study concludes that electronic method for determining the working length of root canal was found to be more accurate than the radiographic method.

Clinical significance: The clinical correlation can be interpreted from the fact that the more the machine can work in extreme environments the more accurate it is, and the better it is for the dental professionals.

Keywords: Apex locator, Radiovisiography, Working length.

World Journal of Dentistry (2019); 10.5005/jp-journals-10015-1671

INTRODUCTION

Pediatric endodontics is an expanding part of pediatric dental practice where emphasis is centered on the retention of primary teeth until the normal exfoliation time utilizing indirect pulp therapy, pulpotomy, pulpectomy, and root canal fillings. In primary teeth, it is not necessary to determine the exact length of the root canal, because of their open apices, but inaccurate working length determination may lead to overinstrumentation and overfilling which may traumatize the underlying permanent tooth structure.¹ In permanent teeth, definitive rules for successful endodontic therapy have been established, such as compact obturation and apical/coronal seal. In pediatric endodontics, because of open apices, it is difficult to estimate the exact root canal length, and hence, there are no definitive rules for successful endodontic therapy.²

Complete debridement and disinfection of the root canal without traumatizing the periapical tissues is the most crucial step for a successful root canal therapy that cannot be accomplished unless an accurate working length is determined.³ Working length is defined as, “the distance from a coronal reference point to the point at which canal preparation and obturation should terminate.” Apical constriction is recommended as the point up to which all instrumentation and obturation must terminate.⁴

Many methods are available for determining the working length, of which the traditional methods includes tactile sensation, radiographic interpretation, paper point determination, etc. Digital radiovisiography is the technological advancement in radiographic imaging in dentistry which utilizes computer technology and radiation-sensitive detectors to enhance the image which is once acquired to conveniently store, access, print, or transmit. One of the

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How to cite this article: Balaji K, Pravallika TS. A Comparative Evaluation of the Accuracy of Two Electronic Apex Locators and Radiovisiography to Determine the Working Length. *World J Dent* 2019;10(5):393–395.

Source of support: Nil

Conflict of interest: None

most commonly cited positive features are radiation dose reduction which reduces patient radiation exposure and also eliminates the need for the darkroom and chemical processing that makes it advantageous over conventional film. In addition, certain features of intraoral sensors make them less desirable in terms of infection control and difficulty in placement inside the mouth of children.⁵ As all these methods are not accurate enough and are also associated with limitations, electronic apex locators have evolved. The advent of electronic determination of the working length allowed to locate the apical foramen and undoubtedly enhanced the accuracy of the clinical procedure along with advantages such as elimination of radiographic obstacles.⁶

The purpose of this study was to compare the working length in primary teeth using intraoral digital radiovisiography and two apex locators, i.e., apex locator-I (i-ROOT) and apex locator-II (Root ZX mini) for accuracy.

The Root ZX mini (J. Morita Corporation) is also a fifth-generation apex locator that uses the "ratio method" to calculate the root canal length.⁷

i-ROOT is the fifth-generation apex locator by dual frequency and is developed and upgraded based on the technology of e-magic Finder (EMF 100 Series) apex locator.

MATERIALS AND METHODS

This *in vivo* study included 30 primary teeth which were indicated for pulpectomy in the patients of age-group 5–8 years, in the Department of Pediatric and Preventive Dentistry, MNR Dental College, Telangana. Children with primary molars indicated for pulpectomy, with three canals and more than two third of the root length remaining were included in the study. Ethical Committee clearance was obtained from the Institutional Review Board of MNR Dental College Sangareddy, and informed consent in full accordance with ethical principles was obtained from the parents as the age-group of the patients was 5–8 years. All procedures were carried out under rubber dam isolation. Before determining the definitive working length, the coronal access to the pulp chamber was prepared, pulpal tissue of each tooth was extirpated using a barbed broach, and the root canals were irrigated using sodium hypochlorite solution. The pulp chamber was dried using sterile cotton pellets. The working length in all cases was determined using three methods: group I (GI)—digital radiovisiography, group II (GII)—Root ZX mini, and group III (GIII)—i-ROOT. Measurements from the preoperative radiographs were made using ISO 15–20 number files with rubber markers, keeping them 0.5 mm short of the root apex. With these measurements, the files were inserted into the canal and intraoral sensor was then positioned in same position as an intraoral periapical radiograph (IOPA) is kept against the tooth and the sensor was exposed to radiation for 0.3 seconds. The equipment then digitizes processes and stores the image. The working length is then measured using the calibration tool available in the software and the working length readings were recorded. Root ZX mini (J. Morita Co., Tokyo and Japan) and i-ROOT were used according to the manufacturer's instructions. The clip was applied to the patients lip and no. 15 K-file is connected to the electrode of the device. The file was advanced with a slow clockwise turn until "APEX" begins to flash on the display monitor. The file was then withdrawn counterclockwise and the length of the file is measured and the value was recorded. The working length measurements was compiled, tabulated, and subjected to statistical analysis using the SPSS package (version 21.0).

RESULTS

The present study showed that the mean of root lengths measured by digital radiovisiography was 12.29, Root ZX mini 12.33, and i-ROOT 12.32 as shown in (Table 1).

The analysis of variance table shows the sum of squares between groups as 0.096, within group 232.144, and the degree of freedom between group II and within group 267. From Table 2 we notice that there is no significant difference in the mean root length measurements from the three techniques ($p > 0.05$).

Table 2: Analysis of variance root length (mm)

	Sum of squares	df	Mean square	F	Sig.
Between groups	0.096	2	0.048	0.055	0.946
Within groups	232.144	267	0.869		
Total	232.241	269			

DISCUSSION

In primary teeth, it is important to estimate the exact working length during pediatric endodontic therapy to avoid injury to the succedaneous tooth bud. Although pulpectomy is an important treatment aspect in primary teeth with infected pulps, various factors must be considered before starting the treatment. Long appointments may be tiring for young patients and they require child's cooperation which is less reliable compared with adult patients. There are also specific problems that are characteristic of primary teeth like root canal walls are often thin, and instrumentation of the canal may result in perforation or root fractures. In addition, the primary teeth roots get resorbed during eruption of their permanent successors. A technique to be used in determining the working length must give precise and reproducible results.⁸ The radiological diagnostic technique used in the present study was chosen to reflect current interest in comparing the performance among digital radiovisiography and electronic apex locators. The radiovisiographic images appear instantly on the monitor screen and can be used for patient education directly, whereas the major disadvantages of digital radiovisiography include the cost of the systems and their setup. However, studies have shown that intraoral digital radiograph can be safely used in measurements of root length.⁹

With the introduction of the latest generation of apex locators, determination of the working length has become extensive and has helped in overcoming problems associated with intraoral digital radiographs.¹⁰ They have an advantage that they can be used in both, wet and dry environments, and the latter are extremely useful in children who gag during radiography.¹¹ However, the accuracy of these apex locators is a major concern among the clinicians. Therefore, the purpose of this *in vivo* study was to compare and evaluate the accuracy of digital radiovisiography and electronic apex locators.

In the present study, files selected to measure working length were of the number 15–20, similar to the study conducted by Ssu-Kuang Chen et al.¹² This is because the tips of the no. 10 K files were not identifiable as the tip diameter is less than 120 μ M required. The results of the present study showed no statistical significant difference between digital radiovisiography and the two apex locators used in working length determination of primary molars. Electronic apex locators were found to be more accurate (significance) when compared to the radiographs and thus significant result may be obtained by increasing the sample size. The study by Abdullah et al. has shown that the latest generation electronic apex locator accurately determined the working length

Table 1: Descriptive statistics of root length (mm)

Groups	n	Mean	Std. deviation	Minimum	Maximum
Group I (GI) RVG	90	12.29	1.019	10	14
Group II (GII) Root ZX mini	90	12.33	0.912	10	14
Group III (GIII) i-ROOT	90	12.32	0.859	10	14

when compared with that of the digital radiovisiography, and the present study corresponds with their study.¹³

In the present study no statistically significant difference was observed in measuring accuracy among the apex locators, which was in contrast to the study by Saraf et al. where significant difference was observed among the two apex locators used.¹⁴ Electronic apex locators are more useful than the other radiographic methods because it avoids unnecessary radiation and is accurate, safe, and painless at use.¹⁵

CONCLUSION

Intraoral digital radiovisiography is the safest method in determining the working length, with significant reduction in radiation exposure than the conventional radiograph; but to overcome the few disadvantages it was seen that electronic apex locators were also accurate. With the advances in apex locators, the newer generations have now overcome the limitations of earlier generations and are better in efficacy and accuracy.

CLINICAL SIGNIFICANCE

According to the present study, clinical correlation can be interpreted from the fact that apex locators can work in extreme environments and are more accurate, which benefits the dental professionals.

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