ORIGINAL ARTICLE

Frequency of Accurate Working Length Measurement Using Endo Motor Having Built in Apex Locator Compared to Periapical Radiograph

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OBJECTIVE: To determine the accuracy of apex locator in determination of working length of root canals during endodontics compared to periapical radiographs in cases with irreversible pulpitis.
METHODOLOGY: This cross-sectional study was conducted at Operative Dentistry Department of Ibn-e-Siena Hospital Multan over a period of 6-months from 1st January 2023 to 30th June 2023. Patients 12 - 35 years of age, either male or female gender presenting with irreversible pulpitis of maxillary anterior teeth and planned to undergo root canal treatment were consecutively included in the study. Pre-operative working length was determined through intraoral radiograph using standardized paralleling technique. Per operatively, the working length was taken with an endo-motor with built-in apex locator in dual mode using stainless steel K file # 10 or #15. Working length (in mm) was considered accurate if the apex locator reading lied 0-2mm short of the radiographic working length. Descriptive statistics were run, and stratified comparison were made using chi-square test at 5% significance level.
RESULTS: The mean age of the participants was 23.9 ± 6.8 years and 50.3% (n=79) were females. Incisors were involved in 64.3% (n=101) of patients. The mean working length on periapical radiograph and on apex locator was 21.5 ± 1.8 mm and 20.6 ± 1.5 mm respectively. The apex locator was 84.1% (n=132) accurate in measuring the working length compared to periapical radiograph.
CONCLUSION: Compared with periapical radiography, the apex locator demonstrated high accuracy not affected by age, gender of the patients and type of tooth involved.
KEYWORDS: Irreversible pulpitis, Apex locator, Periapical radiograph, Working length, Root canal treatment
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INTRODUCTION

The procedure of root canal management has success rate of around 86%.[1] If microbes and their byproducts are allowed to remain in the root canal, they may cause persistent infection. This may develop owing to poor cleaning and shaping or missed canal during therapy.[2] The area of the root canal with the smallest diameter is known as the apical constriction, and many clinicians use it as the apical reference point to complete cleaning, shaping, and filling.[3] The position of the apical constriction is highly varied and cannot be seen radiographically.[4]

An apex locator is an electronic device used in endodontics to determine the position of the apical foramen and establish the working length of the root canal. It operates by measuring the electrical impedance between the periodontal ligament and oral mucosa through the canal. Modern apex locators have shown high accuracy rates ranging from 85% to 95% in determining working length (WL). The idea of apex locators was first presented

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by Sunada in 1962 when he built a device that used direct current to determine canal length.[5] The impact of fluids or pulp tissue in the canal decreased the accuracy of first electronic apex locators (EALs).[6] Innovation has led to improvements in EALs that provide accurate readings even when electrolytes are present. Even though apex locators' accuracy has been evaluated in the literature, general dentistry still does not make extensive use of them. The most fascinating part of root canal therapy is figuring out the WL.[7] Radiographs have historically been used to measure working lengths. Researchers have examined the accuracy of EALs and demonstrated that they can reliably and efficiently find the apical foramen.[8,9,10]

In their analysis of 96 cases, Abidi SYA et al recorded the radiographic and electronic results of working length. If the endomotor reading fell between 0 and 2 mm short of the radiographic working length, accuracy was deemed to be positive. In 85 cases (88.5%), working length with X-Smart Dual was acceptable; in 11 cases (11.5%), it was unacceptable.[9] Ninety patients with 90 teeth with single canals were split into three groups in a study by Agarwal A et al. Group 1's WL was established by radiograph, group 2's by EAL, and group 3's by endomotor integrated apex locator). In groups 1, 2 and 3, the frequency of acceptable WL was 83.3%, 90%, and 93.3%, respectively.[10]

The radiographic apex, or the tip or end of the root as identified radiographically, is used to calculate radiological working length. The anatomic apex may or may not be in alignment with it. Therefore, considering radiographic apex as a reference point for working length is not ideal.

An apex locator with per-operative length determination is a device used during root canal treatment to electronically measure the working length of the root canal in real-time. It provides precise location of the apical constriction by detecting changes in electrical resistance, helping guide instrumentation and reduce reliance on radiographic estimates. This study has been planned to determine of accuracy of WL with EAL and radiography. The results will be helpful in highlighting the utilization of EAL along with radiography for better WL assessment. Practitioners will have the advantage of predictable treatment with a time-saving option. While numerous studies have evaluated apex locator accuracy in general or in necrotic cases, there is a paucity of focused research on their accuracy in irreversible pulpitis cases, where pulp vitality and inflammation may significantly affect electronic readings. The variation in canal moisture, presence of exudates, and tissue changes may influence the functioning of EALs differently than in other clinical conditions. Thus, a comparative study that directly evaluates the accuracy of EALs against periapical radiographs in irreversible pulpitis is essential.

METHODOLOGY

We conducted this cross-sectional study at Department of Operative Dentistry Ibn-e-Siena Hospital Multan, over a period of 6-months form 1st January 2023 to 30th June 2023, after approval from the institutional ethics review committee (IRB# C-48-1005, Dated. 25-11-2022). Patients 12 - 35 years of age, either male or female gender presenting with irreversible pulpitis of maxillary teeth and planned to undergo root canal treatment were consecutively enrolled in the study after informed consent (from parents if < 18-years of age). Patients were excluded from the study if they had previous root canal treatment on same tooth, root resorption (on radiograph), electronic device e.g., pacemaker, open apex on pre-operative radiograph, metallics restorations and fractured teeth on radiograph.

We labelled irreversible pulpitis if there was pain (VAS > 3) persisting for > 10 seconds after the removal of cold stimulation. Patient characteristics like age, gender, type of the tooth i.e. canine or incisors were recorded. All the patients underwent a pre-operative E-speed calibrated intraoral radiograph using standardized paralleling technique (film is placed parallel to the long axes of teeth being radiographed) with an intra-oral film holder. All the root canal treatments were performed by the consultant dental surgeon as per hospital protocol.

Following anaesthesia and isolation with rubber dam, access cavity was prepared by using highspeed handpiece with water coolant using round diamond bur (no.3). After negotiating canal orifices and making Glide path by patency files #06 and #08, coronal flaring with G.G burs or orifice opener was done. The working length was taken with Endomotor built in apex locator in dual mode (Endo e plus) using stainless steel K file (#10 or #15). Working length was measured in mm using measuring gauge. After achieving tentative working length from pre-operative radiograph, 1-mm was subtracted from radiographic apex. A stainless-steel K file (#10 or #15) was placed in canal at this length and a radiograph was taken. Working length (in mm) was considered accurate if apex locator reading lied within 0-2mm of radiographic apex.

A minimum sample size of 157 patients with irreversible pulpitis was calculated taking 88.5%9 accuracy of endo-motor apex locator at 95% significance level and precision of 5%. The data was analysed through SPSS version 27. Descriptive statistics were run in the form of mean and standard deviation for numerical data and frequency and percentages for categorical data. Accuracy of apex locator among the stratified groups was compared through chi-square test and p-value < 0.05 was considered significant. The data is presented in the form of tables and figures.

RESULTS

The mean age of the participants was 23.9 ± 6.8 years and there were 50.3% (n=79) female patients. Most common tooth involved was incisors in 64.3% (n=101). The mean working length determined on periapical radiograph was 21.5 ± 1.8 mm and on apex locator was 20.6 ± 1.5 mm [Table 1]. The apex locator was 84.1% (n=132) accurate in measuring the working length compared to periapical radiograph [Fig.1]. Age, gender and tooth type did not affect the accuracy of apex locator in determining the working length among patients presenting with irreversible pulpitis [Table 2].

Table 1: Frequency of accurate working length measurement using endo motor having built in apex locator compared to periapical radiograph

Age (years) mean ± SD	**23.9 ± 6.8**
Gender	
Male	**78 (49.7)**
Female	**79 (50.3)**
Tooth type	
Incisor	**101 (64.3)**
Canine	**56 (35.7)**
Working length on radiograph (mm)	**21.5 ± 1.8**
Working length on Apex locator (mm)	**20.6 ± 1.5**

Figure 1: Accuracy of Apex locator for working length measurement compared to periapical radiograph

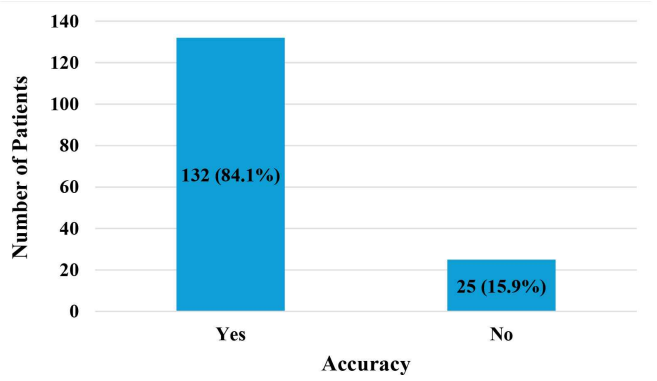

Table 2: Factors affecting the accuracy of apex locator in determining working length in patients presenting with irreversible pulpitis (N=157)

Demographic Factors		Accuracy of Apex Locator		p-value*
		Yes	No	
Age (year)	12 – 18	39 (88.6)	5 (11.4)	0.330
	19 - 35	93 (82.3)	20 (17.7)	
Gender	Male	65 (83.3)	13 (16.7)	0.800
	Female	67 (84.8)	12 (15.2)	
Tooth Type	Incisors	89 (88.1)	12 (11.9)	0.063
	Canine	43 (76.8)	13 (23.2)	

**chi-square test*

DISCUSSION

Several techniques have been used to electronically measure length of root canals.[11,12] EALs have been compared with radiographic methods, clinically as well as by actually measuring of root canal length.[13] These devices have also been tested using research laboratory models, however these cannot replicate in vivo settings.[14] Thus, working length measured with an endomotor was compared to that on radiographs in this in vivo investigation.

In our study, the apex locator was 84.1% accurate in measuring the working length compared to periapical radiograph. When comparing radiographs and apex locators, it has been found that EALs were more accurate.[15] To determine the working length, Hassanien et al found that radiographs were more accurate than the Root ZX apex locator.[16] Similar to our study, Hoer and Attin in 2004 reported in their in vivo investigation that there was no significant difference between endomotor WL and radiograph WL measurements.[17] Abidi SYA conducted a study where they observed that working length with X Smart Dual, when compared with that on radiography, was found to be acceptable in 88.5% cases.[9] This is aligned closely to our results.

In contrast to our results, Siu C et al discovered that the Root ZX II, Apex NRG XFR, and Mini Apex Locator had 50%, 46.43%, and 39.29% accuracy, respectively, in detecting the minor diameter within +/-0.5 mm.[18] Our study's accuracy was significantly higher than the 76.6% found in another earlier study that focused on anterior teeth. Post-operative pain results from the introduction of several irritants into the peri-apical region when an instrument penetrates beyond the apical foramen.[19]

There have been overestimations ranging from 8.33% to 41.67% in other investigations on endomotors with integrated apex locators.[20] An in vitro investigation on mandibular premolars discovered that using apex locators to measure working length led to overestimation in 21% of cases, which is significantly higher than the current study.[20] According to a study by Ehsan S, radiography had an accuracy of 50.4%, while the Root ZX had 94.1% accuracy to within 0.5mm of the apical constriction.[21]

Research indicates that in younger age groups, EAL

precision decreases as apical foramen diameter grows.[9,22] Age, however, had no effect on the apex locator's accuracy in estimating the working length in our investigation. Nevertheless, there are currently few studies that consider how the apical foramen diameter affects the accuracy of commercially available EALs.

Positive accuracy was found to be 51.8% for central incisors, 24.7% for lateral incisors, and 23.5% for canines by Abidi SYA et al.[9] There was no statistical significance in this comparison. We also found no statistically significant difference regarding type of tooth (incisor accuracy of 88.1% and canine accuracy of 76.8%, p=0.063).

By achieving the proper working length, the root canal system is thoroughly cleaned, shaped, and obturated, avoiding damage to the periapical tissues and procedural accidents.[23] Despite being widely used, traditional radiographs have limitations in reliably identifying the apical constriction (AC), which can result in inaccuracies due to picture distortion and variances in technique.[24] Electronic Apex Locators have become more significant as a result, providing accurate measurements by identifying the file position inside the canal.

Further research on endomotors with built-in apex locators is necessary. Although endomotors with built-in apex locators are a helpful supplement to endodontic therapy, it's crucial to realise that they can't fully replace radiographs in treatment.

Data from the current study cannot be extrapolated to posterior teeth because it was conducted just on anterior teeth. Endomotor was contrasted with radiographs, which are a two-dimensional representation of a three-dimensional object and have their own drawbacks. Endomotor should therefore be the subject of more in vivo and ex vivo research, as well as comparison with other electronic apex locators.

CONCLUSION

Continuous control of apical preparation during endodontics is made possible by modern endomotors with built-in apex locators. These along with radiographs give practitioners a predictable treatment choice that saves time.

CONFLICT OF INTEREST

None to declare

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