

In Vivo Comparative Evaluation of Three Methods to Determine Working Length – Conventional Radiograph, Electronic Apex Locator and Histological Section

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Abstract

Aim: To compare the precision of working length determination using conventional radiograph and sixth generation electronic apex locator with the actual working length.

Methodology: A total of sixty mandibular first premolars from thirty patients who were scheduled for orthodontic extraction were used in the study. Working length measurement was done using a sixth generation electronic apex locator followed by conventional radiography in the patient’s mouth. The teeth were then extracted and histological sectioning was done to determine the actual working length.

The data so obtained were statistically analysed using ANOVA test and Students’ t-test, with a p-value of 0.05.

Results: Mean values of working length were 19.90 ± 1.21 for conventional radiography, 20.90 ± 1.11 for apex locator and the actual working length was 21.35 ± 1.19 . The mean distance between the file tip and the apical foramen compared with the actual length was 1.45 ± 0.98 for conventional radiograph and 0.40 ± 0.31 for apex locator. It was also found that the precision level was 92.61% for conventional radiograph whereas for EAL it was 96.1%.

Conclusion: electronic apex locator was found to be more reliable and accurate within 1mm of apical constriction when compared with conventional radiographic method.

Key words: conventional radiograph , histological section, sixth generation apex locator, working length

Introduction

One of the prerequisites for successful endodontic therapy is the determination of the correct working length (WL). It is important, as both over- or under-filling can increase the failure rate. (1)

Working length is defined as “the distance from a coronal reference point to a point at which canal preparation and obturation should terminate.” – American Academy of Endodontists 2003.

There are several methods of working length determination which maybe broadly classified as radiographic and non radiographic techniques.

Radiographic measurement is the most common technique for working length determination. However, it has limitations such as image distortion, inability to detect the minor constriction, subjective estimation and also overlapping of canals in multi rooted teeth. (2)

Electronic apex locators (EAL) have also been incorporated in day to day practice. Although apex locators are a useful adjunct in locating the terminus of the root canal during

endodontic therapy, the ability of apex locators to accurately locate the apex varies from 55 to 95% (Fouad et.al 1990, McDonald 1990). (3,4)

Currently, the sixth generation apex locators have incorporated the ability to detect multiple frequencies and also can adapt to both dry and wet environments in the root canals.

Aim

To compare the precision of working length determination using conventional radiograph and electronic apex locator with the actual working length.

Objectives

➤ To measure the working length using conventional radiograph (Acteon, India), sixth generation electronic apex locator (Canal pro, Coltene).

- To measure the actual working length by histological examination under stereomicroscope (Labomed)
- To compare the accuracy of conventional radiograph and electronic apex locator with the actual working length.

Materials And Methods

Institutional ethical clearance was obtained for the study. Thirty healthy patients, who were scheduled to have teeth extracted for orthodontic reasons participated in this study. Informed written consent was obtained from each patient. Sixty mandibular first premolar with single canal and mature apices were used in this study. Grossly carious premolars with structural deformity, patients allergic to local anesthesia, teeth where rubber dam isolation was not possible and teeth with immature apices or root resorption were excluded from this study. The sample size calculation was done using G*Power version 3.0.10. The alpha-type error of 0.05 at a beta power of 0.80 were also stipulated. A total of 60 samples was indicated as the best size required for observing important changes.

Measurement of working length using conventional radiograph

A preoperative diagnostic intra oral periapical radiograph was taken following which 2% lignocaine and 1:80,000 adrenaline was administered using inferior alveolar nerve block. The experimental teeth were isolated using a rubber dam. The cusps were flattened to create a reference point using a high speed handpiece with a tapered fissure bur. Endodontic access using Endo access bur (Dentsply Maillefer) was made and the canal was negotiated using a # 15 k file. The silicon stopper of the # 15 k file was adjusted to the length pre-determined by the diagnostic radiograph. Using an E speed film and a Rinn XCP film holder, a working length measurement radiograph was taken. The length was adjusted by subtracting 0.5mm from the radiographic apex and was noted down.

The file measurements of the radiographic images were made by two different observers who were blinded to the true length of the files. The measurements were made at intervals of 5mins and 10 mins and the observations were recorded.

Measurement of working length using electronic apex locator

The canals were irrigated with 3% sodium hypochlorite and dried with paper points. Canal pro (Coltene) was used for the measuring the working length electronically.

The lip clip was attached to the patient’s lip. The #15 K file was advanced up to the “apex” mark followed by retraction till “0.0” mark was visible on the display screen. The stopper of the file was adjusted at this length. The file was withdrawn, and the length was measured using digital caliper.

Measurement of working length using histological sectioning

The 15 no. K file was luted to each tooth with sticky wax. The teeth along with the luted file was extracted. The teeth were stored in 5.25% NaOCl for 10 mins and washed with distilled water.

Each tooth was sectioned longitudinally using a diamond disc just until the canal was viewed.

The teeth were viewed under stereomicroscope (Luxeo 2S, Labomed) under 2x and 4x magnification. Distance between the file tip and the apical constriction was measured by calibration software (Motic Images Plus Software, USA)

Results and Statistical Analysis

Statistical Analysis was performed with the help of Epi Info (TM) 3.5.3. EPI INFO is a trademark of the Centers for Disease Control and Prevention (CDC), India. The data so obtained were subjected to statistical analysis using ANOVA test and Students’ t-test, with a p-value of 0.05.

Table 1: Mean values of working length assessed by different methods

	Conventional radiography	Apex locator	Actual length as seen histologically
Mean value (mm)	19.90	20.95	21.35
Standard deviation (mm)	1.21	1.11	1.19

Table 2: One way analysis of variance

Source of variation	Degree of freedom	Sum of square	Mean square	Standard deviation	P value
Between groups	2	20.45	10.22		
Within groups	97	119.55	1.37	1.25	<0.001
Total	89	140			

Table 3: Comparison of mean distance in mm between the file tip and apical foramen compared with the actual length in both techniques

	Conventional radiography	Apex locator
Mean (mm)	1.45	0.40
Standard deviation (mm)	0.98	0.31

Table 4: Precision level in % with minimum and maximum value range in mm between two methods and actual length

	Conventional radiography	Apex locator	Actual length as seen histologically
Value range	17-22	19-23	19-23
Level of precision (%)	92.61	96.1	

Table 5: Total % of deviated apical foramen

	Centrally placed apical foramen	Laterally opening apical foramen
No. of teeth	9	6
% of teeth	60%	40%

Discussion

Correct WL determination is critical to achieve clinical success, allowing to clean, shape, and fill the canal system as close as possible to the apical constriction. The maximum endodontic success rate is obtained when canal obturation lies within 2 mm of the radiographic apex. (5) With the development of EALs, assessment of WL has become more predictable and has helped in overcoming some of the shortcomings of conventional radiographs.

In the current study, it was found that the distance between the file tip and the apical foramen was more in conventional radiography than in EAL. When the anatomic apex and apical foramen do not coincide, radiographic estimation of working length becomes more questionable, making other methods of working length determination more important. The larger the difference between these two points, the more difficult it is to make a clinical judgement regarding working length. This fact may be more significant when treating premolars and molars where there is a higher probability of inconsistency in foramen position. (6)

In the present study, it was found that the foramen was located centrally in 60% of the specimens and laterally in 40% of the specimens.

In previous literature it has been demonstrated that the apical foramen is located laterally in 78 to 93% of posterior teeth. (7,8)

A smaller distance between these two points, as may be the case in anterior teeth, results in a smaller discrepancy between radiographic estimation and microscopic

measurement. This makes radiographic check film much more reliable in anterior teeth than in posterior teeth. (9)

Radiographic method of working length determination has been used over the years and is still used but the use of apex locator has gained a lot of attention while determining working length of canals during endodontic treatment. Although the term ‘‘apex locator’’ is commonly used and has become accepted terminology, it is a misnomer. Some authors have used other terms to be more precise such as Electronic Root Canal Length Measuring Instruments or Electronic Canal Length Measuring Devices.(10,11)

In the present study, Canal pro apex locator was used, which is a multi-frequency based sixth generation apex locator to determine root canal length.

However, to establish the actual length with respect to CDJ, histological method has been recommended. (12) In the present study, samples were sectioned for histological approach in order to compare with the actual length. Martínez-Lozano et al. 2001(13) and Muthu et al. 2007 (14) stated that histological method is the best approach to establish actual working length, i.e., by removing cementum and dentin. Apical foramen was considered to be standardized reference.

In the present study, apex locator showed higher accuracy with 96.1% as compared to digital radiography 92.6%. These results are comparable with results reported in the range of 85% and 98% respectively. (15,16)

This high accuracy could be attributed to its mechanism of measuring two frequencies that are alternated and not mixed, thus cancelling the need for signal filtering. Signal intensity is used to calculate the file tip position thus eliminating electromagnetic interferences and improving its accuracy. (17,18)

Conclusion

Within the limitations of this in vivo study, electronic apex locator was found to be more reliable and accurate within 1mm of apical constriction when compared with conventional radiographic method.

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