ORIGINAL ARTICLE

Determination of Mean Distance of Obturation from Radiographic Apex by Using Electronic Method of Working Length Measurement

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ABSTRACT

Objective: The aim of the study was to determine the mean distance of obturation from the radiographic apex, in maxillary and mandibular teeth, using electronic apex locator for working length measurement.

Study Design: Cross sectional study.

Place and Duration of Study: The study was conducted in the Department of Operative Dentistry, at Islamic International Dental Hospital, Riphah International University from September 1st, 2016 to March 15th, 2017.

Materials and Methods: The mean distance of obturation from radiographic apex was evaluated in 97 canals of 43 patients, between 14 to 55 years of age. Working length was determined by using Dentaport ZX apex locator. Canals were prepared by using step back technique and obturated by cold lateral condensation technique. Postoperative radiographs were taken by using paralleling technique and the results were evaluated in SPSS version 24.

Results: The mean distance of obturation from radiographic apex was found to be -0.52mm with standard deviation (SD) of + 0.57.No statistically significant difference was found between the apical limit of canal filling on the basis of tooth vitality and tooth type. (P-value > 0.05).

Conclusion: This study suggested that appropriate use of apex locator can decrease the required number of radiographs during endodontic treatment and can be used reliably with no statistically significant difference in mean distance of obturation from radiographic apex when used in maxillary and mandibular teeth.

Key Words: *Electronic Apex Locator, Obturation, Working Length Determination.*

Introduction

An accurate working length determination is one of the critical steps in the endodontic "Triad of success" thorough microbial disinfection, ideal canal preparation and hermetic seal. It determines how far the canal preparation and later on obturation should be extended.[1,2] Inaccurate working length determination can lead to iatrogenic errors, patient discomfort and possible infection. It is generally agreed upon that canal preparation and root canal filling should end at or short of apical constriction.[3] Moreover, optimal healing occurs when instrumentation and filling is contained within the region of apical constriction. Conventional methods used for working length determination are use of anatomical averages and knowledge of anatomy, tactile sensation, moisture on paper point and radiography.[4]

Radiographic method is the most common method for working length determination, however, this method has limitations.[5] Radiographic method, provides an estimation of the apical constriction which is histological landmark. Although clinically beneficial, averages utilized to define the radiographic apex from apical constriction could result in over filling or under filling of canal.[6] Additionally, radiation hazard both to patients and dental personnel is one of limitations of radiography.[2] This led to the development of electronic apex locators (EALs), which has helped in making the assessment of working length more accurate and predictable.[7] Most electronic apex locators are based on the theory of Sunada.[8]

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Dentaport ZX (J.Morita Corp, Tokyo, Japan) is an impedance type locator[7,9] and has proved effective in working length determination even in the presence of different electrolytes, blood and irrigant solutions in the canals[10,11] Moreover, electronic apex locators have demonstrated efficiency in teeth with difficult canal morphology[12], intracanal exudate[13], large apical foramen[14] or periapical lesion.[13]

Current literature suggests that apex locators should be considered as useful adjunct to the radiographic method, not its replacement, and it improves the accuracy of working length determination.[7,15] Additionally, use of EALs could possibly decrease the quantity of radiographs taken for the determination of working length.[2] Even though new generations of apex locators give accurate reading, current practice is to confirm electronic reading, radiographically.[2] On the other hand, completing endodontic treatment without the need for a working length radiograph would not only save the time and cost of root canal treatment but will also significantly reduce the radiation exposure of the patients. The current study helped to ascertain, how the use of EALs alone for working length determination affect the extent of root canal filling. The objective of the study was to determine the mean distance of obturation from the radiographic apex, in maxillary and mandibular teeth, using electronic apex locator (Dentaport ZX) for working length measurement.

Materials and Methods

The cross-sectional study was conducted in the Department of Operative Dentistry, at Islamic International Dental Hospital (IIDH), Riphah International University from 1st September, 2016 to 15th March, 2017. Sample size was calculated using World Health Organization sample size calculator with confidence interval=95% .Estimated population mean was 0.5, estimated standard deviation was 0.5^2 and absolute precision required was 0.1. Sample (n) was comprised of 97 canals of 43 teeth. Non-probability consecutive sampling technique was used. The study was approved by ethical review board of IIDH. All teeth requiring endodontic treatment with completely formed roots were included in the study. Teeth with resorbed roots/open apices, previously endodontically treated, calcified canals and patients with heart pacemaker were excluded. In the present in vivo, ex vivo study 97 canals of 43 patients, between the age group of 14 to 55 years were studied. Both male and female requiring root canal treatment of single and multi-rooted teeth were treated by following the procedure as mentioned below. An informed written consent of the patient was obtained. A standardized data collection proforma was used for recording the required details. A preoperative periapical radiograph placed in a film holder (Hawe X-Ray Film Holder System) was taken by paralleling technique.[16] After administration of local anesthesia standard access cavity was prepared.[17] Tooth was isolated by rubber dam and vitality was assessed on the basis of bleeding on initial instrumentation of canal. The irrigation of the pulp chamber was carried out by 2.5% sodium hypochlorite solution and chamber was dried by performing aspiration.

After that Dentaport ZX, third generation apex locator was used on EMR Mode (electronic measurement of root canal mode). The size 15 k file (Mani) was advanced into the canal and apical line indicator on the LED of the apex locator was adjusted at 0.5 position. The rapid tone was noted with the illumination of LED green light at 0.5 position. After that silicone stopper was adjusted against reference point. The distance from file tip and silicone stopper was then measured and registered as working length. Cleaning and shaping was done using k files size 15-40 (Mani) using a step back technique. During cleaning and shaping, sodium hypochlorite was used as an irrigant in 2.5% concentration. Subsequently, paper points were used to dry the canal prior to obturation. Obturation was performed by utilizing gutta percha and endomethasone sealer with cold lateral compaction technique. A postoperative periapical radiograph was taken by paralleling technique. Endodontic treatment was completed within 1 to 3 visits depending on pathological status, patient's cooperation, time available and difficulty of case. Post obturation periapical radiographs were evaluated on radiograph illuminator by using 2.5x magnifying loupes (keeler SuperVu Galilean loupe, 18 inches working distance). Distances were measured in millimeters from the end of obturation to radiographic apex of tooth to an accuracy of 0.5 mm twice, at two separate occasions. The mean of two readings was calculated and recorded. A negative sign (-ve) was used if obturation was short

of apex and positive (+ve) sign was used if obturation extended beyond the apex. All the collected data was analyzed using Statistical Package for Social Sciences (SPSS version 24). Descriptive statistics were used. Mean and standard deviation was calculated for obturation length measurements (in millimeters). Frequency and percentages were calculated for gender, age, status and type of tooth. Independent sample t-test was utilized to determine the difference between mean distance from tip of root canal filling to radiographic apex in vital and non-vital teeth and for calculating the p-value. ANOVA test was used to determine the difference between mean distance from tip of root canal filling to radiographic apex in anterior, premolar and molar teeth.

Results

The total number of patients who were assessed for eligibility was 70, out of which 25 patients were excluded as they did not meet the inclusion criteria. Of the 45 patients enrolled for the study 2 patients were excluded from the study one because of instrument breakage during canal preparation and other because of inability of an instrument to reach the apical foramen, resulting in 43 teeth with 97 canals for the outcome analysis. The age of the patients ranged between 14 years and 55 years as shown in fig 1.

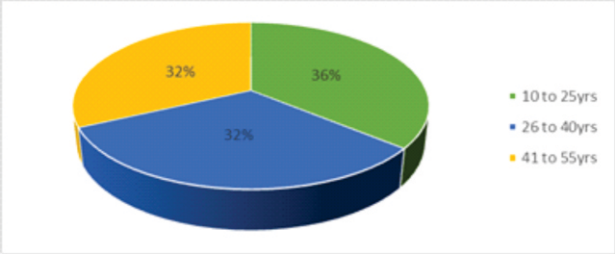

Fig 1: Age Distribution

The mean age was found to be 33.83 years with the standard deviation of 13.93. Out of 97 patients, 61 were males and 36 were females. Canals of molar teeth were comparatively more, 74 in number, followed by anteriors and premolars which were found to be 12 and 11 in numbers, respectively. The distance of obturation from radiographic apex was calculated at two different occasions and their means were calculated for all 97 canals. The mean of two readings was entered in SPSS version 24 and the mean of all 97 readings was found to be -0.52mm and standard deviation was found to be ± 0.57mm.

Table I: Comparison between Mean Distances of Obturation from Radiographic Apex in Vital and Non-Vital Teeth

Distance from radiographic apex	Tooth Status	N (%)	Mean	SD	P-value
	Vital	47 (48.5%)	-0.43	± 0.47	0.135
	Non vital	50 (51.5%)	-0.60	±0.64	

Using independent t-test it was found that there was no statistically significant difference between mean distance from tip of root canal filling to radiographic apex in vital and non-vital teeth (p value > 0.05) , as shown in the table I.

Table II: Comparison between Mean Distances of Obturation from Radiographic Apex in Different Teeth Type

Tooth type	n (%)	Minimum	Maximum	Mean	SD	P-value
Anteriors	12 (12.4%)	0.00	1.5	-0.52	±0.43	0.202
Premolars	11 (11.3%)	0.00	0.60	-0.23	±0.21	
Molars	74 (76.3%)	0.00	3.00	-0.56	±0.62	
Total	97 (100%)	0.00	3.00	-0.52	±0.57	

The mean distance from the radiographic apex to the tip of root canal filling was found to be -0.52 mm, -0.23 mm and -0.56 mm for anteriors, premolars and molars, respectively. Using ANOVA test, it was found that there was no statistically significant difference between mean distance from tip of root canal filling to radiographic apex in anterior, premolar and molar teeth (p-value=0.202), as shown in the table II. The mean distance from tip of root canal filling to radiographic apex was found to be - 0.49 mm for maxillary teeth and -0.55 mm for mandibular teeth with standard deviation of ±0.56 and ±0.59, respectively. Using independent t-test it was found that there was no statistically significant difference between mean distance from tip of root canal filling to radiographic apex in maxillary and mandibular teeth (p value > 0.05) , as shown in the table III.

Table III: Comparison between Mean Distances of Obturation from Radiographic Apex in Maxillary and Mandibular Teeth

Distance from radiographic apex	Arch	N(%)	mean	Std Dev	p-value
	Maxilla	47 (48.5%)	-0.49	±0.56	0.618
	Mandible	50 (51.5%)	-0.55	±0.59	

Discussion

The utilization of electronic apex locators for determination of working length has increased substantially in the current years[2] and they have been increasingly incorporated into the modern practice of endodontics.[18] The purpose of the present study was to determine the mean distance of canal filling from the radiographic apex, using electronic apex locator (Dentaport ZX) for working length measurement.

Several researchers in the past have worked to evaluate the accuracy of apex locators. Researchers utilized teeth which were to be extracted for comparing the electronically determined length to various reference points, such as radiographic apex, apical foramen and apical constriction in different in vivo studies[19,20,21] On the other hand, electro conductive material like saline was used for simulating the clinical conditions in the in vitro studies.[22] Contrary to the aforementioned studies, the present clinical study is true representative of what occurs during typical endodontic treatment, thereby, incorporating errors that might occur in the oral cavity.[2]

In the present study the mean distance of obturation from radiographic apex was found to be -0.52 mm. The findings were in line with the results of the study conducted by L Smadi et al[2] who found the mean distance of obturation from radiographic apex as -0.5mm when only EAL was used for working length determination. Obturation length found in the present study was within acceptable clinical limit as concluded by Fouad and Reid.[15] Fouad and Reid[15] deemed root canal filling as acceptable when it was found to be 0 to 2mm short of radiographic apex. Likewise, Ravanshad et al[23] in their research concluded that there was no difference in the radiographic length measurement of root canal filling of two groups, when working length was determined by EAL only and Radiograph only.

Overfilling of canals was not noted in the current study. The results are clinically acceptable as they are supported by the meta-analysis by Schaeffer et al[24] in which it was found that most successful endodontic treatments are those in which obturation is within 1mm of radiographic apex followed by those which ends within 1 to 3 mm and both were found superior to obturation beyond the apex in terms of success. Likewise, Swartz and colleagues[25] in their study concluded that the chances of failure of root canal treatment increases to four times when canal is overfilled as compared to under filled canal. However, Halse et al[26] studied canals, which were slightly overfilled radiographically, 10 to 17 years after obturation and gave the conclusion that obturation with filling material in slight excess generally results in successful endodontic treatment. Contrary to this, Kojima et al[27] and Wu et al[28] found higher success rates when obturation was close to or at the radiographic apex.

In the current study, the preoperative pulpal status did not seem to influence the functionality of the Root Zx apex locator. Therefore, the difference in the apical limit of canal filling in the teeth with vital and non-vital pulp was found to be statistically insignificant. Similar findings were reported in previous studies.[2,19,21] Conversely, Pommer and colleagues[29] noted higher accuracy of apex locators in the teeth canals with vital pulp tissue. However, recent meta-analysis[30] concluded that vitality of the pulp have no influence on the accurate functioning of electronic apex locators.

The results of the present study suggest that apex locator can reliably be used as a method of working length determination and in future can replace radiographic method as a mean of working length determination. This suggestion would adhere to As Low As Reasonably Achievable principle[31] (ALARA) in relation to radiographic exposure at one end and greater accuracy of modern apex locators as concluded in other studies[19,23] at the other end. This suggestion, however, is not in keeping with the suggestion of Hoer and Attin[32] who suggested that apex locators should always be used in combination with radiographs. Alternatively, Saad and al-Nazhan[33] argued that it is possible to perform successful endodontic treatment by utilizing only apex locator for working length determination.

The small sample size of 97 canals is one of the limitations of this study. This sample size did not allow detailed analyses of results. Increasing the number of teeth will give more valid and reliable statistical data. The other limitation is that this is single arm study and comparison is not made by using the gold standard method .i.e. radiographic method as a method of working length

determination to evaluate the difference between two methods. Lastly, only one brand of apex locator (Root Zx) was used in the current study; therefore, the results cannot be generalized to all the apex locators. Further studies, with larger sample size and multiple brands of electronic apex locators under varying clinical conditions, are suggested to verify the results of current research

Conclusion

The routine practice of utilizing apex locator for working length determination is reliable and appropriate with no statistically significant difference of the apical extent of root canal filling in the teeth with vital or non-vital pulp. Within the clinical setting of the current study, it is proposed that accurate use of electronic apex locator alone can limit the need of taking diagnostic radiographs for measurement of working length. Subsequently, it will also reduce the radiation exposure of patients.

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