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Effect of cell phone radiation on determination of exact working length with two different generations of electronic apex locator"- an in-vivo study

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Abstract

Introduction: Electronic apex locators (EALs) are now being used for accurate working length measurements but it can be affected by electromagnetic waves. The aim of the study was to evaluate and compare the cell phone radiation effect on determination of exact working length with two different generations of electronic apex locators.

Materials and methodology: Thirty-two single rooted mandibular premolars (Vertucci's Type I) were selected. After pre-op and working length IOPA, working length was measured with two electronic apex locators (Root ZX; third generation and Propex II; fifth generation). Smart phone (Samsung galaxy Note Edge) was used to evaluate the interference. Electronic working length was determined under four different conditions; Group I -No mobile present within 2 feet radius of the dental chair, Group II- mobile placed next to EAL with Wi-Fi and Bluetooth activation Group III - mobile placed next to EAL in standby mode, and Group IV - mobile placed next to EAL activated by calling mode for 25 sec, in a closed room (9 feet × 9 feet).

Result: Intergroup and intragroup comparison had no statistically significant difference when the above-mentioned groups were compared.

Conclusion: Apex locators worked efficiently even in the presence of cell phone.

Keywords: Working length, Apex locator, Wifi.

INTRODUCTION

Root canal treatment (RCT) is an integral part of dental practice.1 The most crucial step for the success of endodontic treatment is the correct determination of working length.2,3

Working length, according to Glossary of Endodontic Terms, is defined as a distance from the coronal reference point to a point at which canal preparation and obturation should terminate.4

Various methods are there for determining working length and are grouped broadly under non-radiographic and radiographic methods, popular being radiographic method. Radiographic method has many disadvantages like radiation hazard, image superimposition, image distortion and observer bias which further leads to radiographic interpretation error.5

Electronic Apex Locator is an electronic device used in endodontic procedures for determining the length of the root canal space as well as the position of the apical constriction. The concept of determining the working length via electric current was first conceived by Dr. Levitt Ellsworth Custer in 1918 and was not implemented until it was revisited by Suzuki in 1962. Sunada in 1962 constructed a device to measure canal length by using direct current.6 As the root apex has a specific resistance to electric current so, the apex locator uses a pair of electrodes usually clipped onto the lip and attached to the endodontic file.7

EAL can be used when apical part of the canal is superimposed by any anatomic structure, can be safely used in pregnant patients as it has higher accuracy, reduced radiation dose and reduced treatment time.8,9 However, there are few contraindications like root fractures, perforations, root resorption, swelling and hemorrhage.10 Hence, electronic apex locator (EAL) is a useful adjunct in endodontics to determine the exact working length.3

One of the major concerns regarding EALs is it's possibility of inaccurate readings due to the electromagnetic interference (EMI) provided by different electronic devices, including smartphones.11

Thus, the purpose of this in-vivo study was to determine the stability and reliability of two different generations of electronic apex locators (Root ZX [J Morita Corporation, Tokyo , Japan] and The Propex II (Dentsply Maillefer, Ballaigues, Switzerland) in presence or absence of a smart phone (Samsung galaxy Note Edge) .

MATERIALS AND METHODS

Thirty-two mandibular premolar (single rooted teeth with Vertucci type I and mature apex) requiring root canal treatment were selected from the Department of Conservative Dentistry & Endodontics for the study. The age of patient ranged from 18 to 70 years. The exclusion criteria included patients having cardiac pacemaker, fractured root, perforations, immature apex, haemorrhage, root resorption, swelling, heavy metallic filling, any severe root canal curvatures or previously treated tooth. Informed written consent was taken from all the patients and approval for conducting the study was granted by the Institutional Ethical Committee. (IEC No.-1611).

Intra-oral periapical radiograph was taken pre-opratively. After administration of local anesthesia (2% lignocaine,1:80,000), the tooth was isolated under rubber dam (Hygenic Corp, Coltene Whaledent). The occlusal surface was flattened using 201 flat end tapered fissure diamond point (Shofu, Kyoto, Japan.) in a high-speed handpiece and water spray which allowed easy pulp chamber accessibility and a stable reference point for working length determination. Access cavity was prepared using round diamond bur (Dentsply Maillefer, Ballaigues, Switzerland) and refined with an Endo-Z bur (Dentsply Maillefer). Pulp was extirpated with barbed broach (Dentsply Maillefer) and 2.5% sodium hypochlorite solution (Venson's India) as an irrigant. The radiograph of working length with 15 K-file (Dentsply Maillefer) within the canal was done with modified Ingle's method.6 Evaluation of discrepancies within 0.5 mm - 1mm was done which was later confirmed with electronic apex locator) and reading was adjusted till the display revealed "0".

Two EALs were used in the study:

1. Third generation, Root ZX, (J. Morita Mfg. Corp., Kyoto, Japan), a dual frequency device, operates based on the quotient method principle, which calculates the canal impedance by the ratio of the two frequencies 0.4 and 8.0 kHz

2. Fifth generation, Propex II (Dentsply Maillefer, Ballaigues, Switzerland), a multifrequency-based EAL that records the signals of 2 alternating currents of 0.5 kHz and 8.0 kHz

Cellphone that was used to evaluate EMI:

Samsung Galaxy Note Edge, a 4G LTE (Long-Term Evolution) multiband android smart phone used.

Experimental setting: The whole experiment was carried out in a closed room (9 feet × 9 feet).

Working length was measured using no. 15 K-file under the following conditions for each EAL:

Group I: No cell phone present within 2 feet radius of the dental chair.

Group II: EAL placed next to cell phone with Wi-Fi and Bluetooth activation.

Group III: EAL placed next to cell phone in standby mode.

Group IV: EAL next to cell phone activated by calling mode for 25 sec.

If the obtained reading remained stable for at least 5 s, measurements were considered valid. If the scale bars on the display of the EALs jumped from one point to the other, then it is recognized as unstable measurements. The silicon stopper was adjusted, and the distance was measured with a 0.1 mm precision digital caliper (Mitutoyo Digimatic Caliper, Mitutoyo, Kawasaki, Japan) between the silicon stopper and the file tip. During the experiment, no other smartphone was present in the room. All EWL determinations were performed in the same place to ensure that the signal intensity of the smartphone reception was stable.

Statistical analysis

Statistical analysis was analysed by SPSS (statistical package for the social sciences) version 21 and significant level was set less than 0.05. Test mainly used are unpaired t test and ANOVA.

Results:

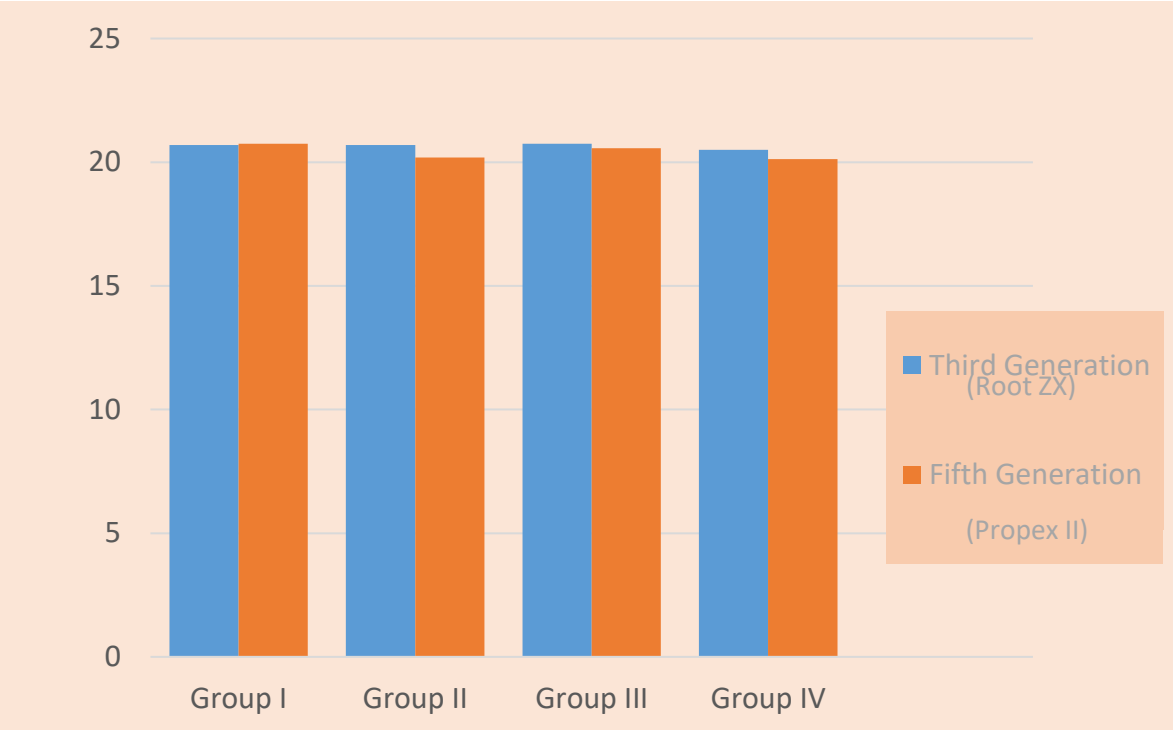
Three readings were taken for each tooth, and averages of the readings were tabulated and compared for mean and standard deviation under the different conditions.

TABLE 1. *Mean Values of Working Length for Each Condition*

Groups	Apex locator	Mean score Working length (mm)	Std. Deviation (±)	t	p value
Group I	Root ZX	20.6875	1.36113	0.089	0.930
	Popex II	20.7500	1.43925		
Group II	Root ZX	20.6875	1.41263	0.702	0.494
	Popex II	20.1875	1.43769		
Group III	Root ZX	20.7500	1.43925	0.279	0.784
	Popex II	20.5625	1.23744		
Group IV	Root ZX	20.5000	1.38873	0.552	0.590
	Popex II	20.1250	1.32961		

*No statistically significant difference was recorded amongst the different groups

GRAPH I- *Mean Values of Working Length for Each Condition*



It was found that in a closed room, there is no significant change in readings of electronic apex locator when placed in vicinity of mobile phone in different conditions. (p value < 0.05). (Table I). Inter group comparison among two different apex locator showed no statistically significant differences. (Graph I).

Discussion:

Cell phones have become an indispensable part of our life. Cell phones work through radio waves transmission via network of fixed antennas. Radio frequency waves are electromagnetic fields that can generate Electromagnetic interference (EMI). Electromagnetic interference (EMI) can affect the conduction circuit of various devices.12

Certain studies have reported that EMI emitted from these devices influence the ECG recordings and is influenced by the distance between two electronic devices as one of the parameters.13 Selcuk Helhel et al. inferred that usage of mobile phone can interfere with EEG and ECG equipments within a critical distance of 1.25 meter.6

In dental operatory mobile phones are often used in proximity of dental devices like Electronic Apex locators (EALs). The user manuals of EALs also emphasize that devices like cellphone, transceivers, remote controls should be turned off while using EAL.1 However, there is limited literature regarding the influence of EMI generated by cell phones on the EWL determination. Hence the purpose of the present study was to determine the effective functioning of EALs due to the interference by EMI generated by such devices.

For a Global System for Mobile Communication (GSM), the recommended safety distance between a cellular phone and medical device is 70 cm for 900 MHz cellular phone and for a GSM 1800 MHz cellular phone the safety distance is 5 cm, whereas a safety distance of 1 m is recommended between the cellular phones and medical devices for GPRS cellular phones. Samsung Galaxy Note Edge can be considered a GSM 900 MHz multiband phone and can transmit network frequencies of 900 MHz and 1800 MHz. For the present study, GPRS was activated along with the existing GSM network.14

As the distance between two electronic devices can influence EMI15,16 ,2 feet distance was

kept in this study to simulate the exact clinical scenario. Since, the wave emission is intense during the calling mode of a cell phone, the calling mode was used in the study to maximize the chances of detecting EMI.

This study showed that there were no obvious signs of EMI interference between cell phones and EALs under all conditions. Therefore, the 2 EALs (Root ZX and Propex II) used in this study worked correctly with good reliability and stability even in close contact with a cell phone in standby or calling mode.

Premolars with single canal were selected as samples to avoid any interference of anatomical variations as seen in multiple canals during working length estimation. It is reported that interference between cardiac pacemakers and cellphones is not dependent on time.15 Therefore, a 25s stimulus was considered satisfactory for this study purpose. Also, in this in-vivo study the experiments were performed by turning off Wi-Fi and Bluetooth networks of the department to prevent any other electronic interference. The experiments were carried out in the same room to ensure a stable intensity of the signal to permit a reliable comparison between the measurements.

The result of the present study was in accordance with the study of Hurstel et al. and Sidhu et al who recorded no significant difference in determining electronic working length in smart phone presence.2,14 In other study, Silvia et al determined the effect on two EALs, Root ZX and Novapex, in presence and absence of smart phone in different conditions and found no statistical difference. Gohil et al in an in-vivo study concluded that active signals of cellphone do not interfere with electronic apex locator (ProPex Pixi and Root ZX Mini) in working length determination of a root canal in a dental clinic.12

Additionally, the results of this study do not support the claim of the user manuals of EALs that EMI from portable and mobile radiofrequency communications equipment such as cellular phones can cause interference with accurate reading of the apex locator.17

Conclusion:

Within the limitations of the present study, the following can be concluded:

1. The reliability and stability of the EALs (Root ZX and Propex II) were not influenced when placed in direct contact with a smart phone.

2. Patients or dentists can keep their cell phones in the treatment room during endodontic therapy with no effect on determination of working length.

References

[1] Jain AS, Asrani H, Singhal AC, Asrani A, Desmukh P, Jain D. Do mobile phones cause interference on electronic apex locators? An in vitro study. Endodontology 2017; 29:142-5.

[2] Hurstel J, Guivarc'h M, Pommel L, Camps J, Tassery H, Cohen S, et al. Do cell phones affect establishing electronic working length? J Endod 2015;41:943-6.

[3] Patel S, Attur K, Bagda K, Desai D, Kubavat R. Evaluation of electromagnetic interference of smartphone on apex locators: an in vivo study.Int Jour Res Rev. 2020; 7(2): 192-200

[4] Glossary of endodontic terms. AAE 10th ed 2020.

[5] Mohan GM, Anand VS. Accuracy of different methods of working length. determination in endodontics. IOSR J Dent Med Sci 2013; 12:25-38.

[6] Ali R, Okechukwu NC, Brunton P, Nattress B. An overview of electronic apex locators: part 1. Br Dent Jour.2013; 214: 155-158.

[7] Sarkar MD, Kundabala M. Shetty N. Effect of cell phone radiation on electronic apex locator. Int.Jour.Dev.Res. 2018;8(2):19056-19058.

[8] Pascon EA, Marrelli M, Congi O, Ciancio R, Miceli F, Versiani MA. An ex vivo comparison of working length determination by 3 electronic apex locators. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009; 108:147–51.

[9] Trivedi S, Chhabra S, Bansal A, et al. Evaluation of Sealing Ability of Three

Root Canal Sealers: An In Vitro Study. J Contemp Dent Pract 2020;21(3):291–295
[10] Hoer D, Attin T. The accuracy of electronic working length. Int Endod J.2004;37(2):125-131.
[11] Hussein HM, Saeed NA, Kudhair MS. The effect of Wi-Fi signals on the measurement accuracy of electronic apex locator during root canal therapy. MDJ 2017;14(1):8-15.
[12] T Buczkowski et al. Influence of Mobile Phones on the Quality of ECG Signal Acquired by Medical Devices. Meas Sci Rev. 2013;13(5):231-236
[13] Silva, Emmanuel & Muniz, Brenda & Carvalho, Nancy & Sassone, Luciana & Neves, Aline. Electromagnetic interference of smartphones on apex locators: An in vivo study. Endodontic practice.2016; 10. 161-165.
[14] Sidhu P, Shankargouda S, Dicksit DD, Mahdey HM, Muzaffar D, Arora S. Evaluation of interference of cellular phones on electronic apex locators: An in vitro study. J Endod 2016;42:622-5.
[15] Gomez G, Duran-Sindreu F, Jara Clemente F, et al. The effects of six electronic apex locators on pacemaker function: an in vitro study. Int Endod J 2013;46:399–405
[16] Garofalo RR, Ede EN, Dorn SO, Kuttler S. Effect of electronic apex locators on cardiac pacemaker function. J Endod 2002;28:831-3
[17] Sriman N, Prabhakar V, Bhuvaneswaran JS, Subha N. Interference of apex locator, pulp tester and diathermy on pacemaker function. J Conserv Dent 2015;18:15-9.