

INTERFERENCE FROM MULTIBAND RADIOFREQUENCY COMMUNICATION DEVICE (850-1900MHZ) ON ACCURACY OF 3RD GENERATION ELECTRONIC APEX LOCATOR ROOT ZX: AN IN VITRO STUDY

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ABSTRACT

Objectives: To determine the effect of electromagnetic radiations (emitted by Xiaomi Redmi Note 9 Pro Device) on working length determination of 3rd generation Electronic Apex Locator (RootZx).

Materials and Methods: Twenty nine intact, non-carious, single-rooted teeth were decoronated at the cemento-enamel junction. Visually, working length was determined by using a #15 K-file and it was taken as standard length. The effect of cellular phones on electronic working length (EWL) was determined under 2 experimental settings: (1) in a closed room with poor signal strength and (2) in a polyclinic set up with good signal strength and 2 conditions: (a) electronically with cellular phone in standby mode (b) electronically, with mobile phone in physical contact with EAL and in calling mode for a period of 25 seconds. The EWL was measured 3 times per tooth under each condition. Stability of the readings was scored. The data was analyzed by using Microsoft Excel.

Results: The EWL measurements were not influenced by the presence of cellular phone and could be determined under all experimental conditions.

Conclusion: Within the limitations of this study, it can be concluded that mobile phones do not interfere with the EWL determination.

Keyword: working length, apex locator, root canal, endodontics

INTRODUCTION

Root Canal therapy depends on various factors among which correct working length estimation is a crucial step. Electronic apex locators (EALs) have been used worldwide for working length determination. These devices can help reduce treatment time and radiation dose to the patient¹. Various factors such as correct usage, Isolation, vital or necrotic pulp,

inflammatory exudate, and obturating materials in the root canal, contribute to the accuracy of EALs. Moreover, studies have shown that EALs provide working length estimation at par with radiographic method.²

It is known that electromagnetic radiation emitted from devices such as cellular phones, iPods, dental devices such as electronic pulp testers, electro surgery units, and ultrasonic scalers can interfere with the function of implanted cardiac pacemakers in patients with implanted cardiac devices. Electrical energy from these dental devices can travel down the lead wires and can induce ventricular or atrial fibrilla-

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tion and reprogram the cardiac device.³ Studies have reported that cellular phones can inhibit the function of a pacemaker, and this depends on the distance between the pacemaker and the electronic device, power output of the electronic device⁴. The use of cellular phones should be restricted in hospitals because electromagnetic interference (EMI) caused by them can interfere with functions of medical devices⁵. Allowing usage of cellular phones in non-patient areas, restrictions in clinical areas, cellular phone safe wards, and use of distance greater than 1m from all medical equipment are some precautions taken to prevent this interference.^{6,7}

A dental office has no such limitations for the use of cellular phones in dental operatory. Cellular phones are used by the dental surgeons, dental surgery assistants, and patients in close proximity to dental devices. The technical support documents of EALs such as Root ZX (J Morita Corp, Tokyo, Japan) state that EMI from portable and mobile radiofrequency communications equipment such as cellular phones can cause interference with accurate reading of the EAL and should not be used closed to any part of the EAL⁸. There is limited evidence that can help a dental practitioner come to a decision whether mobile phones can be used in close proximity to EALs and whether these devices can have any effect on the electronic working length (EWL) determination.

This in vitro study aimed to evaluate the reliability of EALs when placed in contact and in close proximity with a smart phone (Xiaomi Redmi Note 9 Pro) in different experimental conditions.

MATERIALS & METHODS

Dental Samples

Twenty Nine single-rooted teeth with 1 canal and mature apices were selected for this study. Roots were examined under magnification, and roots with carious lesions, fractures, resorptions, immature apices, or any other anatomic irregularities were excluded. The teeth were sectioned at cementoenamel junction for simplified access to root canal and to obtain a reproducible reference point. The sectioned teeth were stored in distilled water at 4 C for further use.

Electronic Lengths

Experimental Setting

The experiment was carried out in 2 different settings, one in a closed room (9* 9 feet) and the other in a dental polyclinic (26* 40 feet) with 2% Chlorhexadine as irrigation solution to record whether the EWL differed between the 2 settings:

1. In a closed room with weak signal strength
 - ✓ Phone placed in physical contact with EAL in standby mode
 - ✓ Phone placed in physical contact with EAL and in calling mode for a period of 25 seconds
2. In a dental polyclinic with good signal strength
 - ✓ Phone placed in physical contact with EAL in standby mode
 - ✓ Phone placed in physical contact with EAL and in calling mode for a period of 25 seconds

All the experiments were performed in the same place to ensure accurate replication of the results.

Length Determination under Magnification

After access opening and verification of canal patency, #10 K-file (Mani Inc, Tokyo, Japan) was used to prepare the glide path. Pulp tissue was removed from the canal by using #10 K-file and 2.6% NaOCl. A #15 file (Mani Inc) fitted with a rubber stop was inserted into the canal until the file tip was just visible at the apical foramen under magnification. The silicone stop was placed at the reference point. The distance from the base of the silicone stop to the file tip was measured with an endodontic ruler (Dentsply Maillefer USA, Tulsa, OK). The lengths were measured to an accuracy of 0.25 mm. The measurements followed a random sequence, each measurement was repeated 3 times, and the mean value was calculated.

In Vitro simulation

In Vitro simulation was done using Kaufman et al model, all teeth were embedded in test apparatus. Alginate was poured in plastic box, the teeth were embedded and the lip clip electrode of Root Zx (J. Morita Mfg Corp. Kyoto, Japan) apex locator was inserted in alginate prior to setting. 2% Chlorhexidine was used as irrigation solution during electronic working length determination.

RESULTS

Table 1 and Table 2 shows Descriptive statistics and Anova analysis where $df(4,140)=0.032$, $p<0.05$ the p value (0.999701) is greater than alpha (0.05) which means that there is no statistically significant difference in five groups. The data suggests that there is no significant difference between the observations made at every setting.

DISCUSSION

EMI between radiofrequency communication devices (phones) and medical devices generally occurs when the cellular phones are in proximity to the medical devices⁸. The results of this study show that there is no correlation between cellular phone use and electronic working length determination. Under all the experimental conditions the EAL showed reliability and stability. This study concluded that presence of cellular phone in close proximity or at a distance from the EAL does not influence the readings of EALs. Thus, cellular phones can be used in a dental operatory during root canal therapy without the risk of EMI between cellular phone and EAL.

In vitro studies have used alginate, agar agar, gelatin, and saline to simulate the root surrounding

tissues in EWL determination. Therefore, alginate model was used as electro-conductive material in this study. Teeth were horizontally sectioned at the cement-enamel junction for obtaining reproducible reference points and were mounted alginate model¹. Irrigants are used in endodontics for their antimicrobial, tissue dissolving, and lubrication properties. Studies have shown that Chlorhexidine can be safely used with EALs in working length determination. Hence, 2% chlorhexidine was used as a canal irrigant in this study⁹. Previous studies have reported that Propex II and Root Zx can accurately locate the major foramen in presence of irrigation solutions which is similar to the findings in our study.

Different experimental settings were used in this study. In experimental setting #1 a closed room was selected to prevent interference from other cellular phones. Furthermore, a poor signal strength was selected to induce the mobile phone to transmit at maximum power, thus increasing the risk of EMI because cellular phones control output power depending on the availability of the nearest cell base station. Experiment 2 was conducted in a polyclinic with good signal strength and the dental personnel carried cellular phones, mimicking a dental operatory

Table 1: Descriptive statistics for working Lengths measured under different conditions in presence of Radio Frequency Communication Device

No	Groups	Count	Sum	Average	Variance	
1	Standard Lengths Via Physical Measurements	29	379	13.069	7.995	2.828
2	Eal Length with phone on stand-by mode in closed room	29	373.5	12.879	8.172	2.859
3	Eal Length in closed room setting with phone in calling mode for 25 seconds	29	372	12.828	7.612	2.759
4	Eal Length in dental polyclinic with phone on stand-by mode	29	376	12.966	8.159	2.856
5	Eal Length in dental polyclinic with phone in calling mode for 25 seconds	29	373.5	12.879	8.940	2.990

Table 2: Shows output of Anova analysis which shows the five groups does not differ on measurements, $df(4,140)=0.032$, $p<0.05$ the p value (0.999701) is greater than alpha (0.05) which means that there is no statistically significant difference in five groups. The data suggests that there is no significant difference between the observations made at every setting.

ANOVA						
Source of Variation	Sum of Squares	df	Mean square	f	p-value	F critical
Between Groups	1.044827586	4	0.261	0.032	0.99801	2.42363
Within Group	1144.62069	140	8.176			
Total	1145.665517	144				

in a realistic scenario.

The wave emission is intense during the calling mode of the cellular phone^{10,11,12}. The calling mode was used to maximize the chances of detecting EMI. The interference between cardiac pace-makers and cellular phones is not time-dependent. A stimulus either does or does not interfere with the pacemaker.¹¹ Therefore, a stimulus of 25 seconds (phone in calling mode) was deemed satisfactory for the purpose of this study.

According to Gomez et al, EALs can interfere with the function of pacemakers if the EAL is placed close to the tip of the pacemaker electrode¹². This may also explain the absence of EMI between cellular phones and EALs.¹⁰ Also, the findings of this study does not support the claim in the user manuals of EALs that EMI from portable and mobile radiofrequency communications equipment such as cellular phones can cause interference with accurate readings of electronic apex locators.

CONCLUSION

The present study revealed that EWL determination by apex locators is not influenced by the presence of cellular phones. Cellular phones can be used in the dental operatory without the fear of causing Electromagnetic Interference in Electronic working length determination during root canal therapy. Further studies with different parameters may be beneficial to confirm the results of the present study.

REFERENCES

1. Gilani.S.S.D, Khattak.Y , Awais.S.M , Rasheed.S , Irfanullah.K and Asma.H. Electrical properties of endodontic files as Determinant of accurate measurement in Procedures using third generation Electronic apex locator RootZx. Journal of Khyber College of Dentistry ;2019, Vol. 09, No. 01.
2. Khursheed I, Bansal R, Bansal T, et al. A comparative evaluation of working length with digital radiography and third generation apex locator (ProPex) in the presence of various intra canal irrigants: an in vivo/ex vivo study. Dent Res J (Isfahan) 2014; 11:56–60.
3. Patel MB, Thaker JP, Punnam S, et al. Pacemaker interference with an iPod. Heart Rhythm 2007;4:781–4.
4. Hayes DL, Wang PJ, Reynolds DW, et al. Interference with cardiac pacemakers by cellular telephones. N Engl J Med 1997;336:1473–9.
5. Tandogan I, Temizhan A, Yetkin E, et al. The effects of mobile phones on pacemaker function. Int J Cardiol 2005;103:51–8.
6. Baranchuk A, Kang J, Shaw C, et al. Electromagnetic interference of communication devices on ECG machines. Clin Cardiol 2009;32:588–92.
7. Hietanen M, Sibakov V. Electromagnetic interference from GSM and TETRA phones with life-support medical devices. Ann Ist Super Sanita 2007;43:204–7.
8. https://www.morita.com/cms/files/ROOT_ZX_II_Operation_20160921_en.pdf?download=1
9. Gilani.S.S.D, Khattak.Y , Shakeel ur Rehman.K , Shafqat.A.S Choice of irrigation solution for accurate measurements in endodontic procedures using third generation Electronic apex locator RootZx. Journal of Khyber College of Dentistry Sep ;2018, Vol. 08, No. 03.
10. Klein AA,Djaiani.G.N,Mobile phones in hospitals past present and future. Anesthesia2003;58:353-7.
11. Ettelt S, Nolte E, McKee M, et al. Evidence-based policy? The use of mobile phones in hospital. J Public Health (Oxf) 2006;28:299–303.26.
12. Pommergaard HC, Burcharth J, Rosenberg J. Use of mobile phones in hospitals do not jeopardise the safety of the patients. Ugeskr Laeger 2013;25(175):876–80.
13. Gomez G, Duran-Sindreu F, Jara Clemente F, et al. The effects of six electronic apexlocators on pacemaker function: an in vitro study. Int Endod J 2013;46:399–405.