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EFFECT OF CELL PHONE RADIATION ON ELECTRONIC APEX LOCATOR

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ABSTRACT

Establishment of accurate working length is very crucial for the success of endodontic therapy. With the advent of electronic apex locators, working length determination can be done without exposing the patient for X-ray radiation. These electronic apex locators can be affected by generation of electromagnetic interference by the cell phones radiation. Hence, the present study was conducted to evaluate the effect of cell phone radiation on electronic apex locator. A total no. of 30 patients with single rooted teeth with Type I anatomy indicated for root canal treatment were selected. Preoperative and a working length determination intraoral radiographs are taken, reconfirmed with an apex locator, with the operators, assistants and patients cell phone placed next to it under four different conditions. The conditions were grouped into, Group I: No cell phone within one metre radius of the dental chair; Group II, II and IV cell phone in standby mode, with Bluetooth and Wi-fi activated and in ringing mode respectively. This study concluded that apex locators can be interfered when cell phones are closer to them and activated by a callbut not interfered when cell phones are in standby mode or activated by Bluetooth and Wi-fi.

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INTRODUCTION

One of the major problems in endodontic treatment has always been identification and maintenance of the biological length of the root canal system. The determination of accurate working length is one of the most critical steps in the endodontic therapy. In endodontic, the working length is defined as the distance from a coronal reference point to the point at which canal preparation and obscuration should terminate (Glossary of Endodontic terms). The cleaning, shaping and obscuration cannot be accomplished accurately unless the working length is determined precisely. Thus the predictable endodontic success demands an accurate working length determination of the root canal system. There are various methods of calculating working length broadly grouped under radiographic and Non-radiographic methods. Radiographic methods, traditionally the most popular and trusted way for length measurement in the field of Endodontic has many advantages, like direct observation of the anatomy of root canal system, number and curvature of roots and in addition acts as an initial guide for working length estimation (Olson, 1991). It is impossible to locate the Cemento-Dentinal Junction (CDJ) clinically and that the radiographic apex is the only reproducible site available in this area. There are, however a number of disadvantages like radiation hazard both to the patient and dental personnel, image distortion, superimposition, cannot appreciate buckle or lingual curvatures and observer's bias in radiographic interpretation which may lead to errors (Bramante C.M., Berbert, 1974). The development of electronic devices for locating the canal terminus have been major innovations in working length determination. An electronic method for root length determination was first conceived by Custer (1918) and the idea was revisited by Suzuki (1942); but it was Sunada, who in 1962 constructed a simple device that used direct current to measure the canal length. The advantages of using electronic apex locators are that it can be used when apical portion of canal system is obscured by certain anatomic structures. It can be safely used in pregnant patients and patients with cardiac pace makers (Raphael R. Garofalo,

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2002). In addition, electronic apex locators help to reduce the treatment time and radiation dose, which may be higher with conventional radiographic measurements.(Pascon, 2009). The main disadvantages of electronic apex locators are that it cannot be used in patients with cardiac pacemakers, perforations; fractures of root and their accuracy in cases of immature apex, root resorption, hemorrhage and swelling are also questionable (Hoer D, Attin T, 2004; Tinaz, 2002).

Cell phones have become an inevitable part of our lives. In 2014, there is an estimated 6.9 billion subscriptions globally. Mobile phones communicate by transmitting radio waves through a network of fixed antennas called base stations. Radiofrequency waves are electromagnetic fields, and unlike ionizing radiation such as X-rays or gamma rays, can neither break chemical bonds nor cause ionization in the human body. These radiofrequency waves can generate an Electromagnetic interference (EMI), also called radio-frequency interference (RFI), affecting the conduction circuit established by electronic apex locator. This disturbance may degrade the performance of the circuit or even stop it from functioning. Justine Hurstel and Herve Tassery studied the effect of cell phones on establishing electronic working length and found out that neither the cell phone type nor the Electronic Apex Locator affected the measurements, *in vitro* (Justin Husrtel, Herve Tassery, 2015). *Tang et al* studied on interfering capability of 2G and 3G mobile systems on medical equipment's and showed that medical equipment's were more sensitive to 2G systems than 3G systems. (Kti-Tang, 2009).Thus the present study was aimed to evaluate the effect of cell phone radiation on working length determination through electronic apex locators, (SybronEndo Apex ID Digital Electronic Foramen Locator) *in-vivo*.

MATERIALS AND METHODS

30 patients with single rooted having Type I internal anatomy with mature apex indicated for root canal treatment of were included in the study. Patients with cardiac pacemakers, perforations, fractures of root, cases of immature apex, root resorption, haemorrhage and swelling were excluded from the study. Pre-operativeIntra Oral Periapical (IOPA) radiograph was taken prior to access opening. Access cavity preparationwas done after securing local anaesthesia, under rubber dam. After extirpation of pulp, working length radiograph was taken with 20 size K-file (3M ESPE, Denstply) using modified Ingle's technique. Discrepancies within 0.5mm to 1mm were noted and evaluated. It was then confirmed using electronic apex locator (SybronEndo Apex ID Digital Electronic Foramen Locator) and adjusted till the reading in the display showed "0". Discrepancies from radiographic working length were noted. Working length was then determined with three cell phones placed next to it under four conditions and a set of four readings recorded for every patient:-

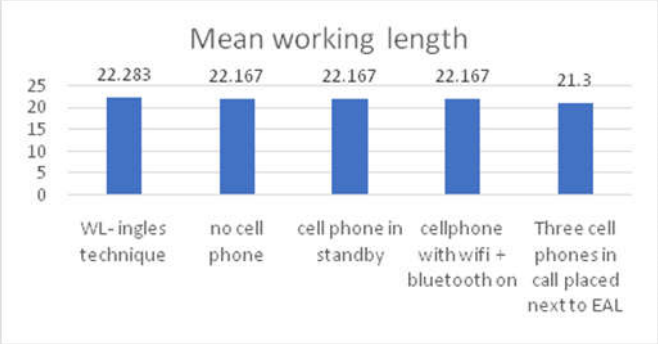
Group I: No cell phone present within 1 metre radius of the dental chair
Group II: Threecell phones placed next to EAL with Wi-Fi and Bluetooth activated,
Group III: Threecell phones placed next to EAL in standby mode,
Group IV: Threecell phones placed next to EAL activated by ringing.

Statistical analysis

Working lengths of the four groups were then assessed for inter group variability and also compared against radiographically determined value. Data was analysed using SPSS version 17. P value will be kept at < 0.001. One way ANOVA was be used for evaluation of inter group variance.

RESULTS

66% (n=20) of working length determined by radiographs needed adjustment within range of 0.5 mm and 13% (n=5) till 1 mm. When compared with Electronic Apex locator (without the presence of Cell phone within 1 metre radius) only 50% (n=15) of the true working length was determined radiographically.17% (n=5) of the readings showed "0" (indicating at the apex) on the digital display when the cell phones were ringing whereas 83% (n=25) of the readings showed "01". The difference was statistically significant indicated by P value < 0.001. (Table 1) Also we observed a reduction in the mean average working length when EAL were placed next to three cell phones in ringing mode. (Graph 1)However, no difference in the reading was observed when there was no cell phone within 1 metre radius, Cell phone with Wi-Fi and Bluetooth activated, or Cell phone in standby mode



Graph 1. Average working lengths through different methods and cell phone modes

DISCUSSION

Cell phones have become an inevitable part of our life globally. T. Buczkowski *et al*, proved that GSM mobile phone electromagnetic radiation influences the ECG recordings and that the distance between two electronic devices is a parameter that can influence EMI. Selcuk Helhel *et al,* studied the effect of different medical equipment's and concluded that mobile phone usage closer then approaching distance/critical distance of 1.25 meter can cause interference on ECG and EEG equipments. The present study was therefore conducted to study the effect of cell phone radiation on apex locators. A direct contact between the phone and the EAL has been also been used in the present study to determine the working length in the worst case scenario maximizing the chance of detecting EMI. Three cell phones were used in this study to simulate a clinical situation where a patient, a doctor and an assistant will have their cell phones placed closed to the dental operatory and monitoring systems. Hoer D and Attain in 2004 demonstrated higher accuracy of apex locators when combined with peril apical radiographs. The combined method raised the accuracy to 96%.

Table 1. One way ANOVA showing difference in mean between different group

		N	Mean	Std. Deviation	Paired Differences		t	df	P VALUE
					Mean Difference	Std. Deviation			
Pair 1	WL-ingles technique	30	22.283	1.5068	0.1167	0.5676	1.126	29	0.269
	no cell phone	30	22.167	1.5162					
Pair 2	WL-ingles technique	30	22.283	1.5068	0.1167	0.5676	1.126	29	0.269
	cell phone in standby	30	22.167	1.5162					
Pair 3	WL-ingles technique	30	22.283	1.5068	0.1167	0.5676	1.126	29	0.269
	cellphone with wifi + bluetooth on	30	22.167	1.5162					
Pair 4	WL-ingles technique	30	22.283	1.5068	0.9833	0.5943	9.063	29	<0.001
	Three cell phones in call placed next to EAL	30	21.3	1.512					
Pair 5	no cell phone	30	22.167a	1.5162					
	cell phone in standby	30	22.167a	1.5162					
Pair 6	no cell phone	30	22.167a	1.5162					
	cellphone with wifi + bluetooth on	30	22.167a	1.5162					
Pair 7	no cell phone	30	22.167	1.5162	0.8667	0.5241	9.057	29	<0.001
	Three cell phones in call placed next to EAL	30	21.3	1.512					
Pair 8	cell phone in standby	30	22.167a	1.5162					
	cellphone with wifi + bluetooth on	30	22.167a	1.5162					
Pair 9	cell phone in standby	30	22.167	1.5162	0.8667	0.5241	9.057	29	<0.001
	Three cell phones in call placed next to EAL	30	21.3	1.512					
Pair 10	cellphone with wifi + bluetooth on	30	22.167	1.5162	0.8667	0.5241	9.057	29	<0.001
	Three cell phones in call placed next to EAL	30	21.3	1.512					

a The correlation and t cannot be computed because the standard error of the difference is 0.

To overcome the shortcomings of traditional radiographic working length determination a combined method has been used along with apex locators in the present study. In the present study, Cell phone in ringing mode was seen to interfere with the readings of the apex locator when placed next to it (P <0.001). Cell phones release electromagnetic interference, which might disturb electronic working length measurements. The results were contradicted by Stephen Cohen who found no significant difference in the electronic working length recorded in the presence of smart phones. His study also showed that there were no obvious signs of EMI between cell phones and Electronic apex locators under all conditions. Indeed, the two EALs used in his study worked correctly with good reliability and stability even in physical contact with a cell phone in standby or call mode. *Silva et al*, studied the effect of smartphones on two EALs (Novapex and Root ZX II) under two different conditions: no smartphone in the operatory room (control group); and smartphones with Wi-Fi and Bluetooth setting activated and placed in physical contact with the EAL to maximize the chance of detecting EMI. The EWL was measured three times per tooth under each condition. No significant differences (P > 0.05) were found for EWL measurements in the presence or absence of smartphones for the two tested EALs. The probable reason could be that

Conclusion

Cell phones radiation interferes with the working length determination of electronic apex locators when placed next to it. Therefore it is advised to keep all cell phones in standby mode during root canal treatment especially when electronic dental equipments are in use.

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