Evaluation of Interference of Cellular Phones on Electronic Apex Locators: An *In Vitro* Study

Preena Sidhu, MDS, Swapnil Shankargouda, MDS,[†] Daniel DevaPrakash Dicksit, MPH,* Haydar Majeed Mahdey, MDS,* Danish Muzaffar, MDS,* and Shelly Arora, MDS**

Abstract

Introduction: Use of mobile phone has been prohibited in many hospitals to prevent interference with medical devices. Electromagnetic radiation emitted from cellular phones might interfere with electronic working length determination. The purpose of this *in vitro* study was to evaluate the effect of a smart phone (Samsung Galaxy Note Edge) on working length determination of electronic apex locators (EALs) Propex II and Rootor. **Methods:** Fifteen intact, non-carious single-rooted teeth were decoronated at the cementoenamel junction. Visually, working length was determined by using a #15 K-file under stereomicroscope (×20). 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 5 conditions: (1) electronically, without cellular phone in room; (2) electronically, with cellular phone in physical contact with EAL; (3) electronically, with mobile phone in physical contact with EAL and in calling mode for a period of 25 seconds; (4) electronically, mobile phone placed at a distance of 40 cm from the EAL; and (5) electronically, mobile phone placed at a distance of 40 cm 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 from 1 to 3: (1) good stability, (2) stable reading after 1 attempt, and (3) stable reading after 2 attempts. The data were compared by using analysis of variance. **Results:** The EWL measurements were not influenced by the presence of cellular phone and could be determined under all experimental conditions. **Conclusions:** Within the limitations of this study, it can be concluded that mobile phones do not interfere with the EWL determination. *(J Endod 2016;42:622–625)*

Key Words

Cellular phone, electromagnetic interference, electronic apex locator, working length determination

Root canal therapy is an integral part of dental practice. The success of 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 patient (1). Various factors such as correct usage, presence of irrigants, vital or necrotic pulp, inflammatory exudate, and obturating material (2–7) in the root canal, contribute to the accuracy of EALs. Moreover, studies have shown that EALs provide accurate working length estimation when compared with the radiographic method (6).

It is known that electromagnetic radiation emitted from devices such as cellular phones, iPods, dental devices such as electronic pulp testers, electrosurgery units, and ultrasonic scalers can interfere with the function of implanted cardiac pacemakers in patients with implanted cardiac devices (8–10). Electrical energy from these dental devices can travel down the lead wires and can induce ventricular or atrial fibrillation and reprogram the cardiac device (11). 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 device, type of pacemaker, age of pacemaker, and model of the cellular phone (12–14). It is suggested that the use of cellular phones should be restricted in hospitals because electromagnetic interference (EMI) caused by cellular phones can interfere with functions of medical devices (15). Allowing usage of cellular phones in non-patient areas, restrictions in clinical areas, cellular phone safe wards, and use of distance greater than 1 m from all medical equipment are some precautions taken to prevent this interference (15, 16).

A dental office has no such limitations for the use of cellular phones in dental operatory. Cellular phones are used by the dentist, 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), Propex II (Dentsply Maillefer, Ballaigues, Switzerland), and Rootor (Meta Biomed, Cheongwon-gun, Korea) 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 close to any part of the EAL. There is limited evidence base 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 (Propex II and Rootor) when placed in contact and in close proximity with a smart phone (Samsung Galaxy Note Edge; Samsung Electronics, Suwon, Korea) in different experimental conditions.

From the *Faculty of Dentistry, SEGi University, Jalan Teknologi, Kota Damansara, Selangor, Malaysia; and [†]KLE University VK Institute of Dental Sciences, Jawaharlal Nehru Medical College Campus, Karnataka, India.

Address requests for reprints to Dr Preena Sidhu, Faculty of Dentistry, SEGi University, Jalan Teknologi, Kota Damansara, 47810 Petaling Jaya, Selengor, Kuala Lumpur, Malaysia. E-mail address: sidhu.preena@gmail.com
0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2015.12.027

Materials and Methods

Dental Samples

Fifteen single-rooted teeth with 1 canal and mature apices were selected for this study. Roots were examined under magnification (Leica Microsystems, Wetzlar, Germany) with a magnification of ×20, 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.

EAL

Two different EALs were used in this study:

1. The 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
2. The Rootor (Meta Biomed, Cheongwon-gun, Korea), a multiple frequency EAL that uses 2 frequencies of 0.5 kHz and 5 kHz

Cellular Phone

Samsung Galaxy Note Edge, a 4G LTE (Long-Term Evolution) multiband android smart phone used with a network provider Maxis Communications (Berhad, Malaysia), was used in this study.

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) in a university setting that has cubicles (9 × 9 feet), to record whether the EWL differed between the 2 settings:

1. In a closed room with weak signal strength and where Bluetooth, Wi-Fi, and General Packet Radio Service (GPRS) were inactivated:
   - No phone in the room (control group)
   - 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
   - Phone placed at a distance of 40 cm from the EAL in standby mode
   - Phone placed at a distance of 40 cm and in calling mode for a period of 25 seconds
2. In a dental polyclinic with cubicles with good signal strength where Bluetooth, Wi-Fi, and GPRS were activated:
   - Dental students and personnel carrying cellular phones with them in standby mode in vicinity of the cubicle (control group)
   - 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
   - Phone placed at a distance of 40 cm from the EAL in standby mode
   - Phone placed at a distance of 40 cm 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 Microscope

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 the stereomicroscope (Leica Microsystems) with a magnification of ×20. 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.

Determination of EWL

The EWL was established by using an experimental model described by Hurstel et al (17). Two holes were perforated in the screw cap of a plastic container, and the tooth along with the lip clip of the EAL was inserted through the screw cap (Fig. 1). The plastic container was filled with 0.9% NaCL solution, and the apical and middle thirds of the tooth were inserted into it. The tooth was irrigated with 2.5% NaOCl, and EWL was calculated in the experimental settings described above. The file tip with the previously calculated length was inserted into the tooth, and the file clip was attached. The file was pushed beyond the 0 reading on the EAL display and withdrawn slightly until the 0 reading was displayed indicating apical patency. This reading was confirmed by the audible signal emitted from the EAL. The file stop was adjusted, and this length was recorded as EWL.

A total of 945 measurements were recorded and tabulated, and results were compared for statistical significance.

To determine the stability of EWL reading, the following scores were used:

1. Immediate and clear audible signal emitted from EAL for a period of 5 seconds
2. Audible signal emitted from EAL for a period of 5 seconds but after 1 attempt
3. Audible signal emitted from EAL for a period of 5 seconds but after 2 attempts

Background noise (sign of interference) between the devices was also noted.

Statistical Analysis

Data were analyzed by using two-way repeated-measures analysis of variance followed by Bonferroni multiple post hoc procedure. The statistical significance was set at 5% level of significance ($P < .05$).

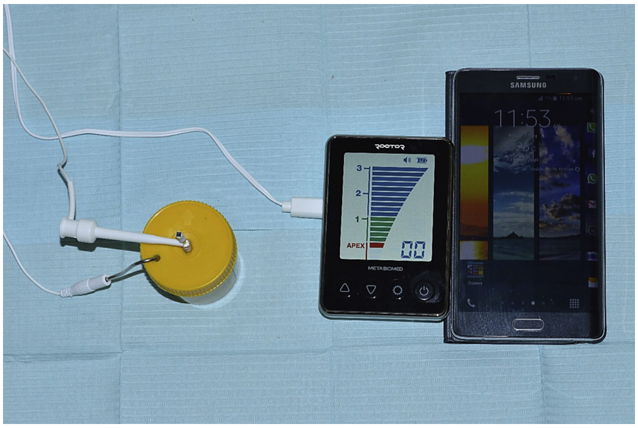

Figure 1. Experimental model connected to the electronic apex locator with cellular phone placed in physical contact with the electronic apex locator.