Do Cell Phones Affect Establishing Electronic Working Length?

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Abstract

Introduction: Patients often keep their cell phones on and nearby during root canal therapy. Cell phones release electromagnetic interference, which might disturb electronic working length measurements. The purpose of this *ex vivo* study was to determine the effect of a cell phone (Apple iPhone 5 [Apple, Cupertino, CA] or KP100 [LG, Seoul, Korea]) placed into direct contact with an electronic apex locator (EAL) (Dentaport Root ZX module [J Morita Corp, Tokyo, Japan] or Propex II [Dentsply Maillefer, Ballaigues, Switzerland]) on working length determination. **Methods:** Twenty-six human premolars without fractures or carious lesions were used; previously cleaned; and observed under magnification (×15) in order to check for the presence of only 1 apical foramen, the absence of apical resorption, an "open" apex, and accessory canals. The working length measurement was performed with a #15 K-file in the presence of 2.6% sodium hypochlorite under 4 conditions: (1) visually, under the microscope until the file tip reached the canal terminus; (2) electronically, without the cell phone in proximity; (3) electronically, with the cell phone in standby mode placed in physical contact with the EAL; and (4) electronically, with the cell phone activated by a call in the same position. The experimental model for electronic working length determination was a screw top plastic container filled with a saline solution. The measurements were repeated 3 times per canal under each condition. Scores of 1 to 3 categorized the stability of the readings as follows: (1) good stability; (2) unstable reading with minor difficulties determining the working length; and (3) major difficulties or impossible to determine the working length. A 2-way repeated measures analysis of variance (way 1: cell phone type and way 2: EAL model) was performed, and a second repeated measures analysis of variance was performed to seek a difference among the 4 working length determination conditions. **Results:** Neither the cell phone type nor the EAL affected the measurements (not significant). The electronic working length measurements gave the same results as the visual examination, and this length was not influenced by direct contact with a cell phone (not significant). It was also possible to determine the electronic working length under all the experimental conditions. **Conclusions:** Within the limitations of the present study, it can be concluded that patients can keep their cell phones on during root canal therapy without any adverse effect on electronic working length determination. *(J Endod 2015;41:943–946)*

Key Words

Cell phone, electromagnetic interference, electronic apex locator, working length

The use of an electronic apex locator (EAL) is a useful adjunct in endodontics to determine the working length. The accuracy of these devices depends on their correct usage (1, 2); this has been well documented *in vitro* and *in vivo* (3–5). It has been reported (6) that the reliability of EAL is better than digital radiography or cone-beam computed tomographic assessment.

EAL allows the practitioner to save time and reduce the radiation dose to which the patient is subjected (7). There is a general agreement that EAL is contraindicated for patients who have a pacemaker or an implantable cardioverter-defibrillator because of potential electromagnetic interference (EMI). However, the major life-threatening side effects are rare (8–10); this depends on the kind of pacemaker, the patient's health condition, and the distance between the 2 devices (9). The same kind of problem is frequently mentioned between pacemakers or defibrillators and cell phones and depends on many parameters like the device model, distance, and power output (11). However, the literature about the link between effectiveness, transmission problems, and measurements of electromagnetic fields is minimal.

Cell phone frequencies, used for transmission and reception, depend on the type of connection and the network provider; they also differ on other continents. Because cell phones can release EMI (eg, hyperfrequencies or microwaves), their usage is commonly forbidden in many hospitals to prevent potential interferences with medical devices; this precaution remains controversial (12) because the evidence supporting this claim is weak. In fact, from a distance of 1 m to sensitive medical equipment, cell phones can be used safely in all hospital areas (13).

If practical procedures to prevent EMI with electronic medical equipment have been suggested in the hospital environment (14), the latter are rarely applied in private dental offices. Moreover, patients often keep their own cell phones switched on and nearby during root canal therapy. However, to the best of our knowledge, there is no peer-reviewed publication discussing the possibility of EMI between a cell phone

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and an EAL. In different EAL technical support documents (eg, Propex II; Dentsply Maillefer, Ballaigues, Switzerland, or Root ZX; J Morita Corp, Tokyo, Japan), it is clearly written that inaccurate or incorrect readings from EMI could be triggered by the presence of different electronic devices, including cell phones nearby. These kinds of suspected phenomena might explain some problems, especially clinical difficulties in electronic working length (EWL) determination because of the EAL's lack of stability.

The purpose of this *ex vivo* study was to determine the reliability and stability of the EALs (Dentaport Root ZX module [J Morita Corp] and Propex II) when placed in direct contact with a smart phone (iPhone 5; Apple, Cupertino, CA) or a Global System for Mobile Communications (GSM) phone (KP100; LG, Seoul, Korea).

Materials and Methods

Dental Samples

Twenty-six human mandibular premolars (1 canal/tooth) without fracture or carious lesions were thoroughly cleaned before the experiment and then observed under magnification (×15) to check for the presence of a mature apex, a single apical foramen, and the absence of apical resorption. The teeth were sectioned at the cementoenamel junction and stored in distilled water at 4°C until usage to maintain their hydration.

EALs

Two different models of EALs available on the market were tested:

1. The Dentaport Root ZX module, a third-generation EAL and dual-frequency device (0.4 and 8.0 kHz), based on the "quotient method" principle (ie, calculating the canal impedance by the ratio of the 2 frequencies simultaneously); the quotient of the impedances decreases quickly as the apical constriction is reached (2)
2. The Propex II (Dentsply Maillefer, Ballaigues, Switzerland), which records the signals of 2 alternating currents (0.5 and 8.0 kHz) and calculates the mean square root of impedances in 2 frequencies

Cell Phones

Two cell phones were used in this study:

1. An Apple iPhone 5, a recent smart phone, used with the network provider Free mobile (Paris, France) at a frequency of 2100 MHz (with a 3G/Universal Mobile Telecommunications System connection)
2. An LG KP100, which is a GSM phone used with the network provider Bouygues Telecom (Issy-Les-Moulineaux, France) at a frequency of 900–1800 MHz (dual-band GSM).

During all the experiments, Wi-Fi and Bluetooth connections were inactivated, and no other cell phone was present in the room. All EWL determinations were performed in the same place to ensure that the signal intensity of the cell phone reception was stable. A dental office in a hospital building with a weak incoming signal was selected for conducting the experiments.

Visual Observation under the Microscope

After identifying the root canal orifice, a glide path was prepared with a precurved #10 K-file, and canal patency was confirmed; teeth with canal obstructions (eg, calcifications) were excluded. Pulp tissues were carefully removed using 2.6% sodium hypochlorite (NaOCl) and a #10 K-file. The #10 K-file was used to slightly enlarge the root canal. After rinsing with 2 mL NaOCl, a #15 K-file fitted with a rubber stop was inserted until visible at the apical foramen using an operating microscope (×15). After removing the #15 K-file from the root canal, its penetration depth was recorded with an endodontic ruler (mm). The measurements were performed to an accuracy of 0.25 mm as a base unit of length. This experiment was repeated 3 times per tooth (78 measurements), and the results were kept blinded for the remainder of the study.

Experimental Model Used for EWL Determination

A screw top plastic container was filled with 0.9% NaCl solution; the tooth and the lip clip of the EAL were inserted through the screw top (Fig. 1) perforated with 2 self-made holes. The tooth position was adjusted until the apical and middle third of the root were immersed into 0.9% NaCl solution. For each experimental condition, the EWL was determined with 2.6% NaOCl in the root canal and just beyond the "0" indicated on the display (apical patency). Then, the #15 K-file was carefully withdrawn until it reached the "0" position. The EWL was confirmed by the audible signal from the EAL. For further validation of the EWL, we required the audible signal from the EAL to be steady for 5 seconds. The silicone stop was then adjusted on the specimen, and the penetration depth was recorded.

Conditions for EWL Assessment

For each canal, the EWL was performed under 3 different conditions:

1. No cell phone in the room (control group)
2. Cell phone in standby mode placed in physical contact with the EAL to maximize the chance of detecting EMI
3. Cell phone activated with a call under the same conditions

Wi-Fi and Bluetooth settings were inactivated for both phones and experiments.

Three EWL measurements were recorded per canal (78 measurements) and each condition (10 groups), which led to a total of 780 electronic measurements for further statistical analysis.

Figure 1. A screw top plastic container was filled with 0.9% NaCl solution; the tooth and the lip clip of the EAL were inserted through the screw top by 2 self-made holes.

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