Root canal treatment by means of electronic conductometry without radiographic trans-operative verification: a report of five cases

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ABSTRACT

Introduction: Determining the working length in root canal treatment is very important, since it allows clinical procedures to be performed within the anatomical limits of the canal. **Objective:** The aim of this article is to report five cases in which root canal treatment was performed by an electronic method without trans-operative radiographic verification. **Methods:** Three maxillary and two mandibular molars diagnosed with irreversible pulpitis or pulpal necrosis were treated at the Endodontic Clinic of the Military Regional Hospital of Guadalajara, Mexico. After obtaining patient's informed consent, the working length of the root canal was measured with Raypex 6 apex locator, without radiographic verification. All root canals were prepared with Reciproc system instrumentation and filled by means of Tagger hybrid technique. **Results:** Postoperative radiographic control revealed that the level of root canal filling in 12 out of 14 root canals was from 0 to 2 mm of the radiographic apical apex. **Conclusion:** Results suggest that electronic conductometry is a reliable method to determine the working length. Additionally, it reduces the number of radiographs taken during root canal treatment.

Keywords: Endodontics. Root canal preparation. Root canal filling. Root canal therapy.

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Introduction

One of the difficulties found during root canal treatment is to determine a working length that allows clinical procedures to be performed within the anatomical limits of the root canal.[1-4] Root canal length indicates the apical limit for the chemo-mechanical preparation and filling level; an improper setting can lead to instrumentation and filling beyond the apical foramen or short, which can hinder periapical healing.[3,5,6]

Conventionally, to obtain the working length, radiographic techniques are used; however, they have some limitations, including superimposed images of anatomical structures, twodimensional images of threedimensional objects, distortion of images, difficulty determining the position of the apical foramen and the quality of the film or sensor which can negatively affect image quality. Additionally, some clinical circumstances limit their use, such as patients with macroglossia and nausea, in addition to pediatric and pregnant patients.[1] Several authors[7-10] recommend the combined use of x-rays and electronic locators so as to obtain the correct working length.

In 1918, Custer[11] proposed the use of a device which recorded the electric current between two electrodes, one in the root canal and the other in the oral mucosa, in order to determine instrumentation apical limit. Studies by Suzuki[12] and Sunada[13] led to the development of the first apical locators. Over time, new instruments were developed based on impedance at single or multiple frequencies, which have overcome some problems found in the first models.[4,14]

Based on the reliability of modern electronic devices used to determine the working length,[10,15-18] it is worth investigating whether it is possible to reduce the number of trans-operative radiographs in order to decrease radiation dose and treatment time. This report presents five cases in which root canal treatment was performed by means of electronic conductometry, without trans-operative radiographic verification, with two radiographs for each case.

Clinical cases

In the Regional Military Hospital of Guadalajara, Mexico, four adult patients, aged between 20 and 40 years old, in good general healthy, but requiring root canal treatment, were treated. An informed consent form and the approval of the Bioethics Committee of the hospital were obtained.

Diagnoses were as follows:

» Cases 1 and 2: Pulp necrosis of mandibular right first molar (#46), and irreversible pulpitis of mandibular right second molar (#47).

» Case 3: Pulp necrosis of maxillary right first molar (#16).

» Case 4: Irreversible pulpitis of maxillary left first molar (#26).

» Case 5: Irreversible pulpitis of maxillary left second molar (#17).

Previous local anesthesia and clinical procedures were performed in all patients under rubber dam isolation (Nic-tone, MDC, Mexico). Endodontic access was performed with high-speed #3 carbide bur (SS White, USA). The pulp chamber was irrigated with 5 ml 2.5 % sodium hypochlorite (NaOCl) (Viarzoni-t-Viarden, Mexico). All procedures were carried out with sterile instruments. The root canals were explored with a # 15 K file (Dentsply-Maillefer, Ballaigues, Switzerland). Root canals orifices were enlarged with # 4 Gates-Glidden drills (Dentsply-Maillefer). The pulp chamber was flooded with NaOCl solution.

The working length was determined with Raypex 6 apex locator (VDW, Munich, Germany), following the manufacturer's instructions. The locator lip clip was placed on patient's lip. A #10 or #15 K file (Dentsply-Maillefer) was attached to Raypex 6, until the locator displayed a red bar indicating the location of the apical foramen. The position of the file was adjusted until the locator screen showed that the file was at the third green bar. The file remained at the same position for 30 seconds so as to stabilize the measurement. The length in millimeters from the coronal reference to the tip of the file was recorded, considering this measure as the working length for chemo-mechanical preparation and filling.

Root canal preparation was performed in all teeth by means of the Reciproc system (VDW, Germany). Mesial and buccal canals were enlarged up to R25, while palatal and distal canals were enlarged up to R40. Only one palatal canal with pronounced curvature was enlarged up to R25. Root canals were irrigated with 3 ml NaOCl, on every change of instrument,

with a 27 gauge needle (Bayer, Mexico). After chemomechanical preparation, the canals were irrigated with 5 ml of saline solution (KabiPac, Mexico). Each root canal was then flooded with 1 ml EDTA solution (MD-Cleanser, Meta Biomed, Korea) left for 5 minutes and rinsed with 5 ml of saline solution.

Root canals of both molars diagnosed with pulp necrosis were dried with sterile paper points R25 and R40 (VDW, Germany) and filled with calcium hydroxide paste (Viarden, Mexico) mixed with distilled water. The procedure was carried with a #30 lentulo bur (Dentsply-Maillefer) at 20,000 rpm. The walls of the pulp chamber were cleaned and temporarily sealed with Cavit G (3M ESPE, Germany). The following appointment was scheduled 8 days later. At this occasion, under local anesthesia and absolute isolation, the coronary seal was removed with a # 3 bur. Calcium hydroxide paste was manually removed with the last file used, and irrigation was performed with 10 ml NaOCl. After the paste was removed, the canal was irrigated with EDTA and saline solution for 5 minutes.

Root canals were dried with sterile paper points R25 or R40 and filled with gutta-percha cones (VDW, Germany), with the same size of each apical preparation (25 or 40), with MTA Fill-Apex (Angelus, Londrina, Brazil) sealer. With #30 finger spreaders (Dentsply-Maillefer), lateral condensation was performed and two fine-fine coated sealant accessory points (Hygenic-Coltene, USA) were inserted. A #40 rotary file (Miltex, USA) was inserted at 20,000 rpm to plasticize and condensate gutta-percha. Excess gutta-percha was removed with a hot Glick spatula. Endodontic access was temporarily sealed with Cavit G (3M-ESPE, México), rubber dam was removed and a final radiograph was taken (Kodak, Mexico).

Out of 14 treated root canals, ten had filling between 1 and 2 mm short of the root apex (Fig 1A), two had filling material overflow, and two canals had slight overfilling (Fig 1B). A second mandibular molar had only two canals (mesial and distal). In a first maxillary molar, two canals were located in the mesiobuccal root (MB), in which MB-2 canal merged to the middle third of MB canal. In this root, only one canal was counted, since there was only one apical third (Fig 1C).

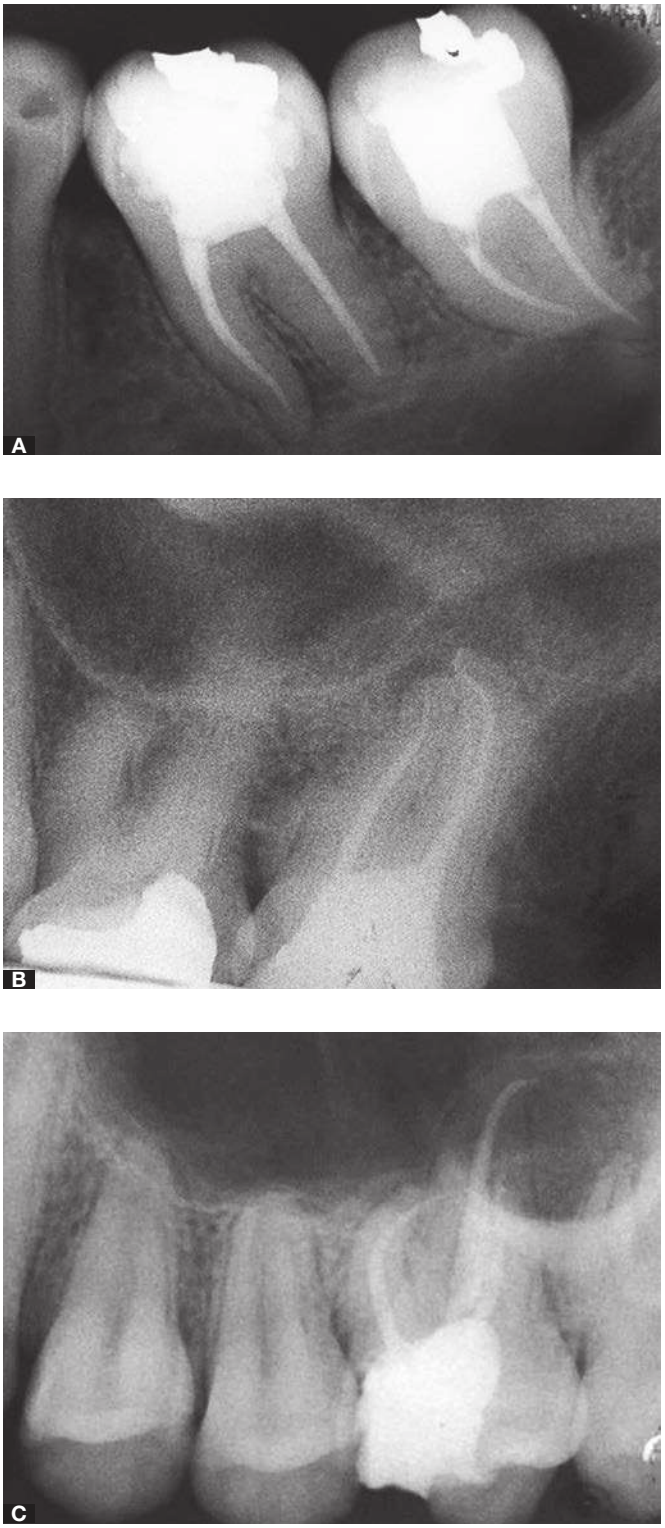

Figure 1. A) Right mandibular first molar in which curvature is observed in the form of an "S" in the mesial root. In the second molar, filling is observed within the canal. **B**) Left maxillary second molar. Filling of the buccal canal is located at 1 to 2 mm shorter the radiographic apex, while the palatal one shows slight overfilling. **C**) Maxillary right first molar in its mesiobuccal and palatal root curvature is observed at distal. Filling of the three canals has an acceptable level.

Ibuprofen 600 mg (every 8 hours) was prescribed in case of postoperative sensitivity. Patients were seen 10 days later for clinical and radiographic control. All cases were asymptomatic and referred to prosthetic rehabilitation.

Discussion

The cement-dentine junction is the anatomical region suggested as the limit for preparation and filling of the root canal.[1,3,19] Nevertheless, there are difficulties for its radiographic determination.[4] With the fourth generation of electronic apex locators, it is possible to determine the location of this anatomical area with a precision level above 90%,[7] despite certain clinical limitations, such as roots with cracks or resorptions.[17]

This report of five cases shows that, under certain conditions, it is possible to perform root canal treatment using electronic conductometry without trans-operative radiographic verification. When compared to other radiographic methods used to determine the working length,[10,20,21] electronic apex locators yield similar or even higher and more accurate[8,22,23,24,25,26] results for conductometry. One reason why the working length determined by means of radiographic methods may be imprecise is because it is based on the interpretation of twodimensional images of a threedimensional object, in which the radiographic apex is considered the limit, whereas in the electronic method, the reference point is the apical foramen which is radiographically imperceptible.[26]

Although the working length can be obtained electronically, radiographs are still used during clinical testing of gutta-percha points or condensation.[10] In this report, the five cases were treated with the exclusive use of electronic conductometry, without trans-operative radiographic verification and with only two periapical radiographs (initial and final).

In 12 out of 14 canals, endodontic filling assessed by means of the final radiograph was located at 0 to 2 mm from the apical apex. Sjögren et al[5] state that this length of filling allows the highest rate of periapical healing.

The use of electronic apex locators can reduce the risk of overinstrumentation, as well as filling shorter or beyond the root canal.[7,24,25] In addition, it minimizes the need for additional radiographs.[10,26,27] With this protocol, the use of trans-operative radiographs is eliminated or reduced; hence, exposure to radiation is also reduced and so are the time dedicated to the examination, the handling of chemicals and the costs involved in endodontic treatment. However, with the use of locators, a margin of error might still occur,[28] which may be caused by the presence of metal restorations, tooth decay, instruments in a secondary canal or saliva contamination.[7]

This report included cases of pulp necrosis treated within two sessions, and cases of irreversible pulpitis treated within one session. In both conditions, similar results were obtained for the apical limit, a finding consistent with Piasecki et al[17] who reported that the reliability of the electronic apex locator does not rely on the presence or absence of apical periodontitis.

Due to the limited number of cases presented in this study, further *in vivo* and *ex vivo* studies, conducted to determine root canal length without radiographic verification, are warrented; however, the observed results suggest that electronic radiograph is a reliable method. Knowledge about root anatomy of periapical pathologies, the prudent use of radiographs and the technology of electronic apex locators can help the clinician to achieve good results in the accurate determination of root canal length.[9,10,15,16]

Conclusion

Raypex 6 is a reliable method to determine working length which, in turn, establishes the limit of root canal treatment without radiographic verification. It also reduces radiation dose during root canal treatment.

References

1. Dummer PHM, McGinn JH, Ress DG. The position and topography of the apical canal constriction and apical foramen. Int Endod J. 1984;17:192-8.
2. Ricucci D. Apical limit of root canal instrumentation and obturation, part 1. Literature review. Int Endod J. 1998;31:384-93.
3. Ricucci D, Langeland K. Apical limit of root canal instrumentation and obturation, part 2. A histological study. Int Endod J. 1998;31:394-409.
4. Ramos CAS, Bramante CM. Odontometria fundamentos e técnicas. São Paulo: Ed. Santos; 2005.
5. Sjögren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990;16(10):498-504.
6. Alves AMH, Felippe MCS, Felippe WT, Rocha MJC. Ex vivo evaluation of the capacity of the Tri-Auto ZX to locate the apical foramen during root canal retreatment. Int Endod J. 2005;38:718-24.
7. Gordon MPJ, Chandler NP. Electronic apex locators. Int Endod J. 2004;37:425-37.
8. Cianconi L, Angotti V, Felici R, Conte G, Mancini M. Accuracy of three electronic apex locators compared with digital radiography: an ex vivo study. J Endod. 2010;36:2003-7.
9. Wrbas KT, Ziegler AA, Altenburger MJ, Schirrmeister JF. In vivo comparison of working length determination with two electronic apex locators. Int Endod J. 2007;40:133-8.
10. Ravanshad S, Alireza A, Anvar J. Effect of working length measurement by electronic apex locator or radiography on the accuracy of working final length: a randomized clinical trial. J Endod. 2010;36:1753-6.
11. Custer LE. Exact methods of locating the apical foramen. J Natl Dent Assoc. 1918;5:815-9.
12. Suzuki K. Experimental study of iontoforesis. Japanese J Stomatol. 1942;16:411-29.
13. Sunada I. New method for measuring the length of the root canal. J Dent Res. 1962;41:375-87.
14. Fan W, Fan B, Gutmann JL, Bian Z, Fan MW. Evaluation of the accuracy of three apex locators using glass tubules. Int Endod J. 2006;39:127-35.
15. Stöber EK, Duran-Sindreu F, Mercadé F, Vera J, Bueno, Roig M. An evaluation of root ZX and iPex apex locators: an in vivo study. J Endod. 2011;37:608-10.
16. Stöber EK, Ribot J, Mercadé M, Vera J, Bueno R, Roig M, Duran-Sindreu F. Evaluation of the Raypex 5 and the mini apex locator: an in vivo study. J Endod. 2011;37:1349-52.
17. Piasecki L, Carneiro E, Fariniuk LF, Westphalen VPD, Fiorentin MA, Silva Neto UX. Accuracy of Root ZX II in locating foramen in teeth with apical periodontitis: an in vivo study. J Endod. 2011;37:1213-6.
18. Duran-Sindreu F, Stöber EK, Mercadé M, Vera J, Garcia M, Bueno R, Roig M. Comparison of in vivo and in vitro readings when testing the accuracy of the Root ZX apex locator. J Endod. 2012;38:236-9.
19. Simon JHS. The apex: how critical is it? Gen Dent. 1994;42:330-4.
20. Williams CB, Joyce AP, Roberts S. A comparison between in vivo radiographic working length determination and measurement after extraction. J Endod. 2006;32(7):624-7.
21. Renner D, Grazziotin-Soares R, Gavini G, Barletta FB. Influence of pulp conditions on the accuracy of an electronic foramen locator in posterior teeth: an in vivo study. Braz Oral Res. 2012;26(2):106-11.
22. Pratten DH, McDonald NJ. Comparison of radiographic and electronic working lengths. J Endod. 1996;22(4):173-6.
23. Venturi M, Breschi L. A comparison between two electronic apex locators: an in vivo investigation. Int Endod J. 2005;38(1):36-45.
24. Usun O, Topuz O, Tinaz AC. Accuracy of the apex locating function of TCM Endo V in simulated conditions: a comparison study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;103(3):e73-6.
25. Usun O, Topuz O, Tinaz C. Accuracy of two root canal length measurement devices integrated into rotary endodontic motors when removing gutta-percha from root-filled teeth. Int Endod J. 2008;41:725-32.
26. Vieyra JP, Acosta J, Mondaca JM. Comparison of working length determination with radiographs and two electronic apex locators. Int Endod J. 2010;43:16-20.
27. Stoll R, Urban-Klein B, Roggendorf MJ, Jablonski-Momeni A, Strauch K, Frankenberger R. Effectiveness of four electronic apex locators to determine distance from the apical foramen. Int Endod J. 2010;43:808-17.
28. Thomas AS, Hartwell GR, Moon PC. The accuracy of the Root ZX electronic apex locator using stainless-steel and nickel-titanium files. J Endod. 2003;29(10):662-3.