Effect of Working Length Measurement by Electronic Apex Locator or Digital Radiography on Postoperative Pain: A Randomized Clinical Trial

Aysun Kara Tuncer, DDS, PhD, and Müzeyyen Gerek, PhD†*

Abstract

Introduction: The aim of this study was to evaluate the effect of working length determination methods, electronic apex locator and digital radiography, on postoperative pain. **Methods:** Two hundred twenty patients with asymptomatic single-rooted vital teeth were randomly assigned to 2 groups according to the method used for working length determination, the radiographic group and the electronic apex locator group. After working length determination, chemomechanical preparation was performed in a crown-down technique with ProTaper instruments. A master cone radiograph was taken. Canals were obturated with gutta-percha and sealer by using a lateral compaction technique. Postoperative pain was assessed after 4, 6, 12, 24, and 48 hours by using a 4-point pain intensity scale. In addition, patients were asked to record the number of days necessary to achieve complete pain resolution. **Results:** Postoperative pain during the 4-hour to 48-hour interval studied was not significantly different ($P > .05$) between groups. The mean times for pain dissipation in the radiographic and electronic apex locator groups were 3.37 ± 2.79 and 3.88 ± 3.34 days, respectively. The difference between groups was not statistically significant ($P > .05$). **Conclusions:** There is no difference in postoperative pain between working length measurement methods by using an electronic apex locator or digital radiography. The reduced exposure to radiation by using apex locator may be a factor that influences a dentist's decision to choose the electronic apex locator over radiography. *(J Endod 2014;40:38–41)*

Key Words

Digital radiography, electronic apex locators, postoperative pain, root canal treatment, working length determination

From the *Department of Endodontics, Faculty of Dentistry, Bezmialem Vakif University, and †Private Practice, Istanbul, Turkey.

Address requests for reprints to Dr Aysun Kara Tuncer, Department of Endodontics, Faculty of Dentistry, Bezmialem Vakif University, Istanbul, Turkey. E-mail address: aysunkara80@gmail.com

0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2013.08.004

It is important to determine and maintain an accurate working length during endodontic treatment. The working length is defined as the distance from a coronal reference point on the tooth to the point at which canal preparation and obturation should terminate (1). The apical constriction is accepted as the physiological apical limit for ending endodontic instrumentation and obturation (2). The apical constriction, also defined as a minor diameter, represents the histologic point of transition between the pulpal and the periodontal tissue at the cementodentinal junction (3).

Conventional measurement methods for working length determination are periapical radiographs and electronic apex locators. Recently, cone-beam computed tomography scans have been promoted for use with endodontic working length measurements (4), but this is not a common approach. Periapical radiography is the more frequently used method for working length determination, and it has advantages as well as disadvantages. The advantages include having information about the periapical status of teeth, root canal anatomy, and the proximity of adjacent anatomic structures. However, the limitation of radiography is superimposition caused by producing a two-dimensional representation of a three-dimensional object (5). An electronic method for working length determination was first investigated by Custer in 1918. The idea was revisited by Suzuki in 1942, which was based on a constant electrical resistance value of 6.5 kΩ between the periodontal ligament and oral mucosa (3). The first-generation development of this method did not function properly in the presence of fluids or pulp tissue in the root canal. Owing to these shortcomings, new apex locators have been developed to provide accurate readings regardless of the fluid electrolytes in the root canal.

Postoperative pain is a frequent complication of endodontic treatment, with an incidence ranging from 3%–58% (6). Many factors can cause postoperative pain, including mechanical, chemical, and/or microbial injury of the pulp or periradicular tissues. Irritation of periradicular tissues during root canal therapy causes an acute inflammatory reaction, which leads to release of chemical mediators and changes in local adaptation and periapical tissue pressure (7). Accurate determination of working length has been shown to have an effect on postoperative pain (8). A working length established beyond the minor diameter may cause apical perforation and overfilling of the root canal system. This may increase postoperative pain and delay or prevent healing. A working length established short of the minor diameter may lead to inadequate debridement and underfilling of the canal. Retained pulp tissue may cause prolonged pain (3).

Various studies have evaluated the relationship of preoperative pulpal diagnosis (9), number of treatment visits (10), instrumentation methods (11, 12), irrigation solution and devices (13), intracanal medicaments (14), and occlusal reduction (15) on postoperative pain. However, to the best of our knowledge, there is no information as to whether determination of working length with an apex locator, rather than the periapical radiographic method, causes more or less postoperative pain. The aim of this study was to compare the incidence of postoperative pain with the 2 different working length determination methods. We hypothesized that determination of working length with the apex locator, rather than the periapical radiographic method, would result in less irritation on periradicular tissues.

Materials and Methods

In this clinical study, we recruited 220 volunteer patients between the ages of 20 and 60 years with no systemic diseases, no history of taking analgesics 12 hours before root canal treatment, and women who were not pregnant. Only single-rooted teeth with vital pulp and 1 straight root canal with a diagnosis of either asymptomatic irreversible pulpitis caused by carious exposures or normal pulp treated for prosthetic reasons were selected. The medical and dental history of each patient was obtained, and pulpal/periapical status was examined via periapical radiographs, periodontal evaluation, palpation, percussion, electric pulp tester, and thermal tests. Age, gender, tooth location, and the vitality of teeth were recorded. All patients were treated by a single endodontist in a single visit.

After topical anesthetic application, the teeth were anesthetized with local anesthetic solution containing 4% articaine with 1:100,000 epinephrine (Ultracaine DS fort; Hoechst-Marion Roussel, Frankfurt, Germany). Each tooth was isolated with a rubber dam, which had been disinfected with 30% hydrogen peroxide. All surfaces were then coated with tincture of iodine and allowed to dry. Caries removal and the initial access form were accomplished with sterile high-speed and low-speed burs. The rubber dam and surrounding tooth structure were disinfected again with iodine tincture before continuing access with another sterile bur by using a surface disinfection protocol described by Wang et al (16). The cavity access preparation was completed, pulp tissue was removed, and the canal orifices were localized easily. The incisal or occlusal edges were ground lightly to create stable reference points for the rubber stops on the root canal files. The canal patency was determined with a sterile stainless steel K-file (Dentsply Maillefer, Ballaigues, Switzerland) size #10 (ISO). The coronal part of each canal was flared with an SX Protaper file (Maillefer), and then each canal was irrigated with 2.5% NaOCl solution (Norateks Chemical Industry, Istanbul, Turkey). Excess fluid was removed from the pulp chamber with an air syringe, but no attempt was made to dry the canal. Afterward, patients were randomly assigned to 1 of 2 groups according to the method used for working length determination, the radiographic group and the electronic apex locator group.

Working Length Measurements

In the radiographic group, the working length was determined according to the method of Ingle and Bakland (17). The K-file #15 was placed into the root canal up to 1 mm less (safety factor) than the estimated tooth length, which was obtained from the preoperative radiograph, and then periapical radiographs were taken by digital radiography (Kodak RVG 5100; Eastman Kodak Company, Rochester, NY) with parallel technique by using a Schick CDR-holder (Schick Technologies Inc, Long Island City, NY). The difference between the end of the file and the apex was measured on the radiograph. If the end of the file was shorter than the apex, this amount was added to the original measured length. From this adjusted length of the tooth, a 1-mm safety factor was subtracted to estimate the apical termination of the root canal at the apical constriction. A radiograph was taken again to confirm that the end of the file was placed 1 mm short of radiographic apex.

In the electronic apex locator group, the working length was determined by using the Root ZX apex locator (J. Morita Co, Tustin, CA), according to the manufacturer's instructions. First, the clip was attached to the patient's lip, and the electrode was connected to a K-file size #15. The file was advanced within the root canal to a point just beyond the major foramen, as indicated by the flashing "APEX" bar on the liquid crystal display. The file was then withdrawn until the liquid crystal display showed a flashing bar between "APEX" and "1." Measurements were considered correct if the instrument remained stable for at least 5 seconds.

Root Canal Treatment

Chemomechanical preparation was performed with ProTaper instruments. ProTaper (Maillefer) instruments were used in a modified crown-down manner by using a gentle in-and-out motion. The coronal part of each canal was flared with an SX ProTaper file, and then each canal was irrigated with 2.5% NaOCl solution by using a 30-gauge side-vented irrigation needle (KerrHawe Irrigation Probe; KerrHawe SA, Biggio, Switzerland). After coronal flaring, working length was determined by using either an electronic apex locator or radiography as described above. ProTaper S1 and S2 instruments were used to the working length minus 1 mm; then F1, F2, and F3 were used to the full instrumentation length. After each instrument change, 1 mL 2.5% NaOCl was used as irrigant. A 30-gauge side-vented irrigation needle (KerrHawe Irrigation Probe) was placed as deep as possible into the canal without binding to the canal wall but not deeper than the predetermined working length minus 1 mm.

Depending on the individual tooth, apical preparation was completed with 3 sizes up from the first file to bind at the apex. Final preparation ended with ProTaper F2, F3, F4, or F5. A master cone radiograph was taken. Canals were dried with paper points and were filled with ProTaper universal gutta-percha (Dentsply Maillefer) and AH plus sealer (Dentsply DeTrey GmbH, Konstanz, Germany) by using a lateral compaction technique and restored with temporary restorative material Caviton (GC Corporation, Tokyo, Japan).

Patient Questionnaire

A questionnaire was given to the participants to note the intensity of pain and the frequency of analgesic use postoperatively at 4, 6, 12, 24, and 48 hours after the endodontic treatment was completed. Each patient was given a prescription for 100 mg flurbiprofen, with instructions to take only if needed for pain. In addition, patients were asked to record the number of days necessary to achieve complete pain resolution. Postoperative pain was measured by using a 4-point pain intensity scale (18). The 4 pain categories were as follows: 1, no pain; 2, slight pain (mild discomfort, need no treatment); 3, moderate pain (pain relieved by analgesics); and 4, severe pain (pain and/or swelling not relieved by simple analgesics and required unscheduled visit).

One week after obturation, all the patients returned to the clinic with the forms and reported their postoperative pain.

Statistical Analysis

The Fisher exact test and χ^2 analysis were used for qualitative data (sex, tooth type, jaw, analgesic use). The Mann–Whitney *U* test was used to evaluate postoperative pain scores between the 2 groups, and the Friedman test was used to find significant differences within each group. The level of statistical significance was set at $P < .05$. All statistical analyses were performed by using the Statistical Package for Social Sciences for Windows 15.0 software package (SPSS Inc, Chicago, IL).

Results

Of the 220 patients, 121 (55%) were men, and 99 (45%) were women. The age range was 20–60 years. For 114 patients (51.8%), maxillary teeth were treated, and for 106 (48.2%), mandibular teeth were treated. The percentages of endodontic treatment because of dental caries and prosthetic reasons were 71% and 29%, respectively. Postoperative pain intensity distribution is shown in Figure 1. No patient reported severe pain at any time interval in the questionnaire. Postoperative pain prevalence is shown in Figure 2. For both groups, the