
Occurrence of no-function of two electronic apex locators: an in vivo study

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Objectives. This in vivo study was aimed at quantifying the electronic no-function rate of 2 electronic apex locators, ApexPointer and Novapex, and evaluating whether their operation is affected by the type of applied treatment, patient's age, and the type of tooth.

Study design. A total of 209 root canals were included in this study. For each canal, the electronic length was determined and verified by radiography. Whenever the electronic device failed to provide a value, it was recorded as an electronic no-function. Experimental data were statistically tested with chi-squared through Statview.

Results. For both apex locators, the no-function rate remained around 15% and did not seem to be affected by the age of patients. A statistically significant relationship was found between no-function rate and retreatment ($P < .05$). The type of tooth had no influence on the no-function rate.

Conclusions. Under the conditions of this assessment in vivo, the 2 apex locators proved to give no value in about 15% of the cases. Further investigations are necessary to clear up the links between no-function and retreatment or age. (*Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009;108:e61-e65)

There is a consensus in the endodontic community about the importance of an accurate determination of working length in the success of endodontic treatment,¹ despite the difficulty of making such a measurement under clinical conditions.² This essential step can be performed by the radiographic method or the electronic one. Radiography is traditionally employed to determine the location of the root apex. Most authors agree that the apical canal constriction is a natural barrier between the root canal and the apical tissues³ and that this anatomic limit should be the end of root canal preparation. According to histologic studies, this apical constriction is often at some distance (0-2 mm) from the radiographic apex.⁴ In fact, in more than 90% of the cases, the apical foramen is positioned at 0.5 mm from the anatomic apex and at 1 mm from the radiographic apex.⁵ However, one should be aware that the determination of canal length by radiography can be inaccurate^{6,7} for several reasons, e.g., possible superimposi-

tion of anatomic structures and misinterpretation of 2-dimensional radiographic images.^{8,9}

These limitations have led to the design of an alternative device dedicated to the measurement of root canal length through application of an electronic principle and further developments.¹⁰ Numerous electronic apex locators have been introduced in the market. Their advantages have proven to be numerous,¹¹ including radioprotection, ergonomics, shorter operating time, enhanced accuracy, and minimization of the risk incurred by over- or underinstrumentation.¹² However, one of the recurrent problems of these electronic devices is the fact that sometimes either the apex locators are unable to provide a length through a visual or auditory signal, or the bar scales display great instability even when the file is at rest. In the present study, these events are considered to be an electronic no-function. Few investigations have studied this phenomenon,¹³⁻¹⁶ which has been described as inconsistency or unstable results. Here, 2 locators of the fourth generation, Novapex (Dentsply, York, PA) and ApexPointer (MicroMega, Besançon, France), were tested to evaluate the rate of no-function. To our knowledge, these apex locators are reliable for clinical use. For example, Novapex accuracy was compared to that of Root ZX.¹⁷⁻¹⁹ Those studies showed that there were no statistical significant differences between Novapex and Root ZX, and that both are accurate in the determination of apical foramen location. ApexPointer has also been reliable.²⁰

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Received for publication Jul 15, 2009; accepted for publication Jul 23, 2009.

1079-2104/\$ - see front matter

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doi:10.1016/j.tripleo.2009.07.042

These considerations led us to conduct the present *in vivo* study under clinical conditions to quantify the rate of electronic no-function, a parameter poorly documented in the literature. This study was also aimed at assessing the influence of type of treatment, patient age, and type of tooth on the function of the apex locator.

MATERIALS AND METHODS

This 6-month study was carried out at the Brest University teaching hospital and involved 100 patients, 49 male and 51 female. All patients had given their informed consent. This study was performed under the regulations of the local ethical committee. The investigations involved 209 canals from 100 teeth. Deciduous teeth and permanent teeth with resorption, immature roots, apical resection, root fracture, and/or perforation were excluded. No selection was made regarding the type of tooth to maintain normal clinical conditions. In all cases, an endodontic treatment had been planned before our investigations. The age of the patient, the type of root canal treatment (initial treatment on either vital pulp or necrotic pulp or retreatment), and the type of tooth were recorded. For all patients, a crown-down preparation was performed by a single operator.

The access cavity was prepared under rubber dam and after anesthesia when required. The tooth vitality was assessed by thermal tests and clinical considerations. It was recorded as either vital, in the case of coronal bleeding from the cavity, or necrotic, in the case of lack of bleeding in initial treatment. The coronal third of each canal was prepared with Gates-Glidden drillings or with EndoFlare (MicroMega). The debris and remnants of pulp tissue were removed with hand K-files of sizes 8, 10, and 15. The root canal was irrigated with 2.5% sodium hypochlorite. For each canal, the working length was determined by insertion of a size 15 K-file with a silicone stop.

The measurements were made by the same operator, who had 2 years of experience with both apex locators. For each root canal, the 2 electronic apex locators, ApexPointer and Novapex, were used successively according to the manufacturer's instructions. For each of them, the measuring file was introduced in the root canal up to reaching the values of 0.5 on the bar scale, corresponding to the apical constriction. The electronic length was obtained by removing the file from the canal and holding it next to a ruler (Maillefer, Ballaigues, Switzerland). To assess the repeatability, each measurement was made with each electronic device in triplicate, and the mean value was calculated and recorded as the length with the electronic apex locator. It sometimes happened that either the electronic device was unable to provide a length through a visual or auditory signal, or the bar scale displayed a great instability even

when the file was at rest. These events were considered to be electronic no-function and recorded.

After insertion of a K-file in the root canal, set to the electronic length, a digital radiograph with Digora Optime (Soredex, Tuusula, Finland) was taken on using the paralleling technique with Endoray II (Dentsply) as film holder and according to paralleling-principle. Numeric radiographies were treated (contrast improvement, magnification by a factor 2) using Digora for Windows software (Soredex). Two examiners assessed independently the position of the file tip as follows: 1) "acceptable" when the file tip lay within 0 and 2 mm from the radiographic apex; 2) "underinstrumentation" when it was >2 mm short of the radiographic apex; and 3) "overinstrumentation" when it was beyond the radiographic apex.

The statistical recording and analysis of the data were made with Excel (Microsoft, Redmond, WA) and Statview (SAS Institute, Cary, NC) softwares, respectively. To gain more insight into the reliability of both locators, the distributions of acceptable measurements produced by each of them were compared through use of linear regression. Moreover, the significance of their respective no-function rate was assessed by chi-squared test. These tests were also performed to highlight a possible correlation between no-function and different parameters, such as type of tooth, type of treatment, and age of patient.

RESULTS

Study population

The investigations included 209 root canals from 100 teeth, set in 15 incisors, 9 canines, 29 premolars, and 47 molars; 182 canals were primary treatment cases: 131 canals had vital pulp and 51 had necrotic pulp; 27 root canals were retreated.

The age of the patients included in the study ranged from 11 to 79 years (mean age 33 ± 0.8 years). The population was well distributed, except for the patients between 60 and 69 years and especially for the patients between 70 and 79 years, who were underrepresented compared with the other age groups (Fig. 1).

Acceptable measurements of locators regarding radiography

The function rate was 86.6% with Apex Pointer and 82.8% with Novapex. In the cases where the apex locators worked well, the rates of "radiographically" acceptable measurements were 93.9% and 91.3% with Apex Pointer and Novapex, respectively.

Figure 2 illustrates the results of the linear regression test (a 95% confidence interval) between acceptable measurements by the two locators.

Figure 2 demonstrates the lack of a significant statistical difference between ApexPointer and Novapex

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