Original Research Article

Comparative analysis of two electronic apex locators in working length determination at endodontic therapy – an in vitro study

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Abstract

Introduction: Endodontic treatment comprises individual steps that should be effectively performed in order to achieve therapeutic success. Among these steps is the determination of the real tooth length, which prevents damage to the periapical tissues during instrumentation and obturation, due to restrict the operator action, favoring tissue repair. Objective: The present study aimed to evaluate in vitro the reliability of two electronic apical locators (Root ZX II® and Propex II®) in working length determination, compared to direct visual measurement. Material and methods: Forty single-rooted human teeth were selected; the pulp chamber was accessed and a size 10 Kerr file was inserted into the canal until its tip was visible at the apical foramen with x8 magnification. At this point, a rubber stop was placed on the file, at the incisal edge, and this length was measured with an endodontic ruler, therefore, recording the real tooth length (RTL). Then, the teeth were embedded in a vegetable sponge (loofah) base, soaked in saline solution. Electronic measurements were carried out using Root ZX II® and Propex II® locators, until an “Apex” reading was observed. The measurements obtained
by the different methods were compared. **Results:** Root ZX II® apical locator showed 93% of correct readings, while Propex II® locator was correct in 90% of the measurements. No statistically significant difference was observed between the two apex locators tested (p = 0.05). **Conclusion:** Both apex locators showed an acceptable percentage of correct readings and, therefore, may be recommended for clinical use.

**Introduction**

Endodontic therapy comprises several steps, which when individually well-executed, contributes to its success. Odontometry is one of these steps, searching for the measurement of working length and limiting the operator’s action on shaping and filling procedures, avoiding damages to periapical tissues and favoring the area’s repair [20].

Apical constriction has been considered the ideal point for endodontic treatment’s shaping and filling [15, 16]. The development of reliable devices, regardless the type of the solution within root canal [17], was collaborated by a complete study comprising: the determination of oral mucosa’s electrical resistance, including the periodontal membrane; the relationship between the instrument tip and tooth apex, when the device showed this electrical resistance; the electrical resistance at the moment that the instrument tip was inside root canal; and the relationship between the electrical resistance and the position of the instrument tip at the apical portion and further from the apex [23].

Through initial studies, the development of electronic apex locators has been constant, becoming indispensable in the endodontic therapy [6, 11]. Odontometry is a dynamic process, mainly in curved root canals. The electronic method is capable of identifying the alteration in the working length during all root canal shaping, diminishing the number of radiographic exposures [4].

Because electronic localization is based on the impedance of the alternating current transit in dentine, it has been hypothesized that apex locators would more precisely operate in localizing the foramen. Therefore, the aim of this study is to elucidate such aforementioned hypothesis, through the use of two third-generation apex locators.

**Materials and methods**

The Ethical Committee in Research of the Dental Research Center of Sao Leopoldo Mandic, under protocol #06/385, approved the use of the specimens extracted due to several reasons and obtained at the tooth bank of the aforementioned institution.

Forty, single-rooted, human teeth with complete apexes were submersed into 2.5% sodium hypochlorite, for 6 hours, in order to eliminate the periodontal ligament remnants and other residues from the external root surface. Following, the teeth were kept in 0.9% sterile saline at 9ºC, until their usage. This was performed because saline is neutral and capable of keeping the tooth hydrated [3]. An incisal wear was executed at the tooth crowns in order to facilitate the rubber stop positioning during the length readings and to standardize the reference for both devices [5, 10]. Foramen patency was verified by the observation of a #10 Kerr file tip at the apical foramen exit, through an operative microscope (Alliance, Brazil), at x8 magnification. Manual measurement of the 40 specimens comprised the positioning of the rubber stop at the incisal plane when the #10 file tip was visible at the foramen, followed by the measurement of this length with a millimetric endodontic ruler (Angelus, Brazil). Next, the teeth were inserted in an experimental base (figure 3), composed of a glass recipient with vegetable sponge (loofah) (Terra Nossa, Brazil), generally used for making floral arrangements, soaked in 0.9% sodium chlorite (Aster, Brazil), in order that all root portion was kept submerse and stable. Root canals were then irrigated with 2.5% sodium hypochlorite (Pharma Terra, Brazil), and aspirated keeping them wet and the pulp chamber dry. After that, electronic measurement was performed:

**Group 1 – Apical foramen localization by Root ZXII® (JMorita, Japan):** the device was switched on (figure 1), and the labial clip was inserted in the base close to the tooth to be evaluated; an endodontic file with diameter compatible to root canal’s anatomic diameter (diameter between #15 and #30) was attached to the connector and inserted into root canal with oscillatory motion up to apical foramen’s location, which is represented by the last green bar in the device’s display. Then, using
dental tweezers, the rubber stop was positioned in the incisal reference. This length was measured with a millimetric endodontic ruler. The obtained values were recorded and stored.

**Group 2** – The apex foramen was localized by Propex II® (Dentsply, Switzerland): the same aforementioned procedures were repeated with this device. T test for paired samples were used for comparison of the values obtained by each device to values obtained by the direct method, for the 40 teeth.

**Results**

After all the specimen assessments, the values obtained by the electronic method were recorded and evaluated comparatively to those by visual method, through t test for paired samples (p = 0.05). Root ZXII® results were coincident in 93.0% of the teeth; while Propex II® results were in 90.0%, without statistically significant differences (graph 1).

**Discussion**

The term “electronic apex locator” is seen in all the studies verified, however, the best accuracy indexes occur when the foramen position is used as reference [8,21].

In endodontic therapy, the exact obtaining of the root canal’s working length is necessary
to achieve a correct shaping and filling. Although its mensuration is difficult to reach, because of the several variations in root morphology [15], several techniques have been studied, comprising from the radiographs to the appearance of apex locators [23].

Either the partial or complete removal of the tooth crown was performed in some studies [2, 18], with the same objective. However, in our study, tooth crown maintenance aimed to reproduce the clinical conditions.

Compensatory wear and root canal's medium and cervical thirds preparation was carried out [1, 3, 10] by using Gates-Glidden burs (#4, #3, #2) in order to improve the efficacy of the apex locators and to enhance the possibility of employing a larger instrument close to the anatomical diameter of the apical foramen, optimizing these devices usage [13].

Root canals were irrigated with 2.5% sodium hypochlorite, removing all pulp chamber’s excess by aspiration; notwithstanding, root canals were kept wet in order to facilitate the devices’ readings [3, 17].

The use of electronic apex locators in determining apical foramen position have substantially increased. Some authors investigated their accuracy by in vivo and in vitro studies, and found results between 62.6% [9] and 100% [24], regardless of the pulp conditions, with or without the presence of exudates and irrigants [7, 17], and foramen diameter variations [18, 19].

Most current studies compared the devices’ accuracy among each other, without using the comparison to the radiographic method as reference, because of the superiority of the electronic system [3].

The importance of the evidential radiograph shot of the electronic measurement was cited as relevant [22], as well as the reduction of patient exposure to radiation, when only the electronic method is employed for odontometry [10].

Teeth presenting larger apexes showed a greater difficulty of obtaining the working length by the electronic method, displaying smaller measurements than the real ones [14, 19]. Therefore, we recommend the use of instruments with diameters most possibly close to the foramen diameter.

The employment of apex locators was also verified in cases of endodontic retreatment, presenting a reliability index of 80 to 100%, since foramen’s patency is reached, without interference of gutta-percha point or endodontic cement [10].

Third-generation electronic apex locators mostly show a reliability index above the mean values obtained by the radiographic method (approximately 50.6%) and the digital radiograph (about 61.4%), becoming an indispensable tool for current Endodontics.

The results obtained by this study did not differ from the searched literature and reached values similar to those finding by other authors: 89.64% [8], 85% [6], 97.5% [11], with ± 0.5 mm of tolerance. Thus, endodontists can trust in these devices for use in endodontic routine. Some researchers obtained values greater (100%) [9, 12, 24], but a tolerance of ± 1.0 mm was set.

Conclusion

Based on the results and according to this study’s limitations, it can be concluded that there are no statistical differences between the measurements of the devices testes, when compared to the visual method (93% for Root ZXII® and 90% for Propex II®). Such indexes were considered as acceptable for clinical application.

References


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