Effectiveness of three electronic apical locators in determining the apical foramen in single-rooted teeth in vitro

Paola Guadalupe Segovia Cáceres[1]*, Claudia Liliana Soto Godoy[2]

1. Facultad de Odontología de la Universidad Nacional de Caaguazú "Santo Tomás de Aquino" Coronel Oviedo. Paraguay. E-mail: paosegovia123@gmail.com – ORCID: 0000-0002-8118-6745. 2. Facultad de Odontología de la Universidad Nacional de Caaguazú "Santo Tomás de Aquino" Coronel Oviedo. Paraguay. E-mail: claudiasoto@odontounca.edu.py – ORCID: 0000-0002-1781-5244. *: correspondent author.

Financing: Facultad de Odontología de la Universidad Nacional de Caaguazú "Santo Tomás de Aquino".
The authors declare that they have no conflicts of interest related to the content of this work.

Receipt August 8, 2022; revised version receipt October 27, 2022; Accepted November 4, 2022.

Abstract
The success of Endodontics includes cleaning, disinfection and obturation of the canal system; being the value of the length of work determining for its scope. The electronic apical locator is an essential tool for endodontic treatment. The purpose of the study was to determine the efficacy of three commercial brands of electronic apical locators for finding the apical foramen arrangement in vitro. An experimental study was conducted with three groups of 14 teeth each randomly coded. The opening, permeability and measurement of the canal were carried out with a magnifying glass, transferring that length to an Angelus® millimeter ruler, thus obtaining the real length of the tooth, a parameter for measurements with locators. Measurements were made with each locator according to the manufacturer's instructions. Both measurements were compared with each other. Canal pro Apex Locator, had a mean of -0.036 with a standard deviation of 0.745. The I-Pex had a mean of 0.250 with a standard deviation of 0.379. And the E – PEX PRO a mean of -0.357 and a standard deviation of 0.744. In Canal Pro Apex Locator, the average is lower with a -0.036 therefore lower average in the measurement error. The I-Pex according to standard deviation obtained from 0.3798 is the most accurate. The Wilcoxon test yielded a (p = 0.639). The CanalPro Apex Locator obtained a lower average measurement error. The iPex, according to standard deviation, is slightly more accurate than the other locators used.
Key words: Endodontics Electronic Apex Locator, Working Length.

Endodontics is science and art, it includes the etiology, prevention, diagnosis, and treatment of pathological alterations of the dental pulp and its repercussions in the periapical region and therefore in the organism. In short, this specialty deals with the prevention and treatment of endodontics and the apical and periapical region (1). Its main objective is to prevent pulpal and periodontal injuries, and treat those already installed. The determination of the working length is one of the most important stages of endodontic treatment because the inaccuracies in this process can favor the occurrence of accidents and postoperative complications (2).

The success of root canal treatment depends on the cleaning, disinfection and three-dimensional filling of the root canal system. To achieve this, there are numerous aspects of utmost importance among them: the determination of the working length.

The glossary of terminology of the American Association of Endodontics defines the working length as "the distance from the coronary reference point to the point at which the preparation and filling of the root canal should end" (3).

Locating the proper position of the apex has always been a challenge in clinical endodontics. The dentin-cementum junction is where the pulp tissue changes into the apical tissue. It is the most ideal physiological apical limit of the working length (4). For this reason, a new alternative was created for determining the working length, the electronic apex locators (5-9).

Allowing precise location of the foramen to be carried out electronically and including advantages such as greater accuracy, dynamic conductometrics (verify the working length at each instrument change, or when in doubt, during the conformation of the canal), reduction in the number of radiographs and the exposure it represents (5-9).

In 1918, Custer pioneered the method of measuring root length by electronic means. It was later revised by Suzuki in 1942, who studied the flow of direct currents using dogs' teeth as samples. Later Sunada in 1962 took these principles and built a simple apparatus that used direct current to measure the length of the root canal. The apical locator has been modified over time, with a total of four well-documented generations (10).

There are several ways to determine the working length, the best known is through the conventional radiographic method, however this has several deficiencies, including its inaccuracy, considering that the apical foramen often does not coincide with the radiographic apex. It is of subjective interpretation, it provides images of superimposed planes, the quality of the film affects the image. In addition, certain circumstances limit its execution, such as: pregnant patients, patients with a gag reflex and macroglossics. Some factors such as root fractures, resorptions, incomplete apices can lead to interpretation errors (11).

The general objective was to determine the efficacy of three commercial brands of electronic apical locators for the location of the apical foramen in vitro in 2019. For this purpose, the in vitro efficacy of CanalPro Apex Locator (Coltene), iPex (NSK, Nakanishi Inc. Kakuma Tochigi, Japan and E–Pex Pro (Eighteeth), in the location of the apical foramen in single-rooted teeth, as well as the comparison of the effectiveness of the three apical locators with each other.

Methodology

This was an experimental research, carried out in the Pre Clinic and Clinic I Dr. Justo Balbuena of the Faculty of Dentistry of the National University of Caaguazú in the

months of September, October and November of the year 2019. 42 extracted single-rooted teeth with a single canal.

Inclusion criteria

— Teeth with formed apex
— Teeth with integral crown

Exclusion criteria

— Calcified teeth
— Obliterated teeth
— Fractured teeth at the apical level.

The collection of 42 inert single-rooted teeth from different departments and clinics was carried out, to then select them according to the inclusion criteria following the ethical patterns of extracted teeth established in the Helsinki principles of 2004 (12). Teeth selected for the sample were introduced and kept in physiological serum until the moment of their use.

Once the teeth to be used were identified, they were divided into three groups of 14 teeth each, randomly marking each tooth with a numerical code for better identification.

Subsequently, the chamber opening was performed with a round diamond bur, to then perform the permeability of the canal (passage of a low caliber endodontic file through the root canal to keep it free and permeable) to each tooth by introducing a Nro 10 file. K-Flexofile®, thus ruling out teeth with calcified or obstructed canals. Then, with a Nro 15 K-Flexofile® file, it was introduced to the apical foramen, observing with a magnifying glass for greater precision, once it was verified that it had reached the apical foramen, the rubber stop was adjusted by removing it and transferring that length to a ruler. Angelus® millimeter gauge, thus obtaining the real length of the tooth and whose measurement served as a parameter for the measurements with the locators. Each canal was irrigated with 5.25% NaOCl, removing excess irrigant from the pulp chamber using an endodontic ejector. An alginate model (13) was then used, in which the teeth were mounted in models in order to carry out the electronic measurement.

Finally, the measurements were made on the teeth with each locator according to the manufacturer's instructions, and according to the group assigned to each one, for the three devices, the lip clip was submerged in the alginate and the electrode connected to a file Nro 15 K-Flexofile®, and finally the real length of the tooth and those obtained by electronic devices were compared. All these data obtained were loaded into an Excel® spreadsheet for later analysis.

Results

In this table we can see the mean and standard deviation obtained, yielding the following results: for the locator 1 Canalpro Apex Locator (Coltene), a mean of -0.036 with a standard deviation of 0.745 is observed.

Table 1. Numerical and percentage distribution regarding the difference and precision of the three types of apical locators in single-rooted teeth in vitro in 2019. n=42

Locators	Media	Standar deviation	N
CANALPRO APEX LOCATOR (COLTENE)	-0.036	0.745	14
IPEX (NSK)	0.250	0.379	14
E–PEX PRO (EIGHTEETH),	-0.357	0.744	14
Total	**-0.048**	**0.679**	**42**

For the I-Pex locator 2 (NSK), a mean of 0.250 with a standard deviation of 0.379 was observed. And for locator 3, a mean of -0.357 and a standard deviation of 0.744 are observed.

However, it can be seen that the localizer 1 CanalPro Apex Locator (Coltene), the mean is lower with -0.036, therefore lower average measurement error. And the iPex locator 2 (NSK, Nakanishi Inc. Kakuma Tochigi, Japan) according to its obtained standard deviation of 0.3798 is the most accurate.

Using Wilcoxon test, the real measurements were compared with the electronic ones and there was no statistically significant difference between them (p=0.639). In this test, the significance of the results obtained can be observed, with 0.639 there is no evidence to prove that there are statistically significant differences between the actual measurement of the tooth and the measurement obtained with the apical locator. With a confidence level of 95%.

According to the results of the Kruskall-Wallis test, the locators compared showed a median of 0.054 greater than p=0.05 is observed. No statistically significant differences were found between them (p=0.054), therefore the null hypothesis is not rejected and there is no evidence to prove that there are statistically significant differences between the actual measurement of the tooth and the measurement obtained with the apical locator. With a confidence level of 95%.

Conclusions

The null hypothesis is not rejected, since it was not found that there are statistically significant differences obtained between each locator and the measurements of each tooth. However, the locator 1 CanalPro Apex Locator (Coltene), obtained an average of -0.036 lower than the other results, therefore, a lower average measurement error. The iPex locator 2 (NSK, Nakanishi Inc. Kakuma Tochigi, Japan) according to its obtained standard deviation of 0.379 is slightly more precise than the other locators used.

References

1. Leonard, MR. Endodontic root canal treatment. Technical and biological principles. Medical Arts Publisher. Page 9. 2005.
2. Rodríguez C, Oporto G. Determination of Working Length in Endodontics: Clinical Implications of Radicular Anatomy and the Root Canal System. Int. J. Odontostomat.; 8(2): 177-183.) 2014
3. Basrani E, Blank AJ and Cañete M. Radiology in endodontics. Publisher Amolca. 1st edition, Chap.18: 247-251. 2003.
4. Kim E, Lee S.J. Electronic apex locator. Dent Clin N Am;48; 35-54. 2004
5. Kqiku L, Städtler P. Radiographic versus electronic root canal working length determination. Indian J Dent Res. Nov-Dec;22(6):777-80. 2011
6. Martos J, Lubian C, Silveira LF, Suita LA Ferrer CM. Morphologic Analysis of the Root Apex in Human Teeth. J Endod;36:664–667. 2010
7. Lime, ME. Endodontics, from Biology to Technique. Publisher Amolca. 2009.
8. Leonardo MR, Silva LA, Nelson-Filho P, Silva RA, Raffaini MS. Ex vivo evaluation of the accuracy of two electronic apex locators during root canal length determination in primary teeth. Int Endod J. Apr;41(4):317-21. 2008.
9. Tosun G, Erdemir A, Eldeniz AU, Sermet U, Sener Y. Accuracy of two electronic apex locators in primary teeth with and without apical resorption: a laboratory study. Int Endod J. May;41(5):436-41. 2008
10. Gordon, M. and Chandler, N. Electronic apex loeators. International Endodontic Journal. 2004(37\:425437. 2004
11. Hilú R et al. Root ZX Electronic Apical Locator. An in vivo study. RAOA 94 (2): 109-13.2006
12. Moreno GN, Guevara JO, Morales R, Feres HN, Marcio A, Miranda MdG. Use of human teeth in dental education. Ethical, legal and biosafety aspects. Acta odontol venez; 50(2). 2012
13. Tinaz AC, Alacan T, Topuz O. A simple model to demonstrate the electronic apexlocator. Int Endod J;35:940-5. 2002