Effectiveness of Root Zx Ii and Propex Pixi Apical Locators: A Bibliographic Review

Rómulo Guillermo López Torres[1], Diana Michelle Yumbopatín[2], Johanna Estefanía Moreta Criollo[3], Kerly Dayana Eugenio Álvarez[4]

[1]Departamento de Odontología, Universidad Autónoma Regional de los Andes, Ambato, Ecuador.
Email: ua.romulolopez@uniandes.edu.ec
ORCID: https://orcid.org/0000-0001-9315-3388
Email: oa.dianamyr80@uniandes.edu.ec
ORCID: https://orcid.org/0000-0003-4214-6190

[2]Departamento de Odontología, Universidad Autónoma Regional de los Andes, Ambato, Ecuador.
Email: oa.johannaemc82@uniandes.edu.ec
ORCID: https://orcid.org/0000-0002-0630-5708

[3]Departamento de Odontología, Universidad Autónoma Regional de los Andes, Ambato, Ecuador.
Email: oa.kerlydea19@uniandes.edu.ec
ORCID: https://orcid.org/0000-0003-2969-7334

[4]Departamento de Odontología, Universidad Autónoma Regional de los Andes, Ambato, Ecuador.

Abstract

In endodontics, the use of apical locators is of vital importance for a good dental treatment, if used correctly and a correct manipulation is acquired by the operator, it turns out to be a reliable method to detect the apical formen; therefore, these electronic devices perform the function of instrumenting the root canal system since they measure their impedance while they are entering, in addition, they quantify the frequency and resistance of the surrounding material to avoid accidents that harm the final result. **Objective:** The objective of this article is to determine, through a literature review, the accuracy reported between the ROOT ZX® II and PROPEX PIXI® locators, within the field of endodontics. **Materials and methods:** databases such as Google Scholar were investigated: PubMed, Scielo, Elsevier, between the years 2017 and 2022. The inclusion and exclusion criteria were taken into account, which influenced the selection of 12 articles destined for publication. the discussion of this research. **Results:** the Root ZX ® II apical locator was more efficient and reliable, showing 91.86%, being significantly higher compared to Propex Pixi®, which showed an efficacy of 88.67% according to the study articles that were collected and analyzed. with a discrepancy of only 3.19%. **Conclusion:** The handling of the Root ZX ® II apical locator is positively recommended due to its great efficiency in locating the real working length, thus guaranteeing a good professional treatment.

Keywords: endodontics locators; precision; working length.

1. Introduction

Within the field of endodontics the precise determination of the length of work plays a fundamental role for the success of the procedure, since, there are many errors during the instrumentation of the ducts, given by a bad anatomical reference at the time of obtaining the apparent length of the tooth, causing an overinstrumentation and consequent an overfilling, thus inducing the formation of periapical pathologies or aggravating the clinical diagnosis, because the cytotoxic components of the filling materials can cause postoperative pain and even the persistence of theinflammatory process. (1)

However, it is important to be aware of the meaning of the "working length" itself which is described as the distance between the incisal edge or the tip of the highest cusp to the CDC limit, determined radiographically or electronically, with the use of a K file that fits the diameter of the duct, Although, it must be borne in mind during the manual or mechanical conformation of the same, that most of these have a certain degree of curvature which increases the degree of complexity of the procedure conditioning theclinical success. (2)

While it is true, within the manual procedure, after introducing the file to a provisional length of the tooth, we proceed to take an x-ray which is called conductometry, to verify if the reference measurement is correct or not and start the instrumentation, this method is used by several professionals, since, It is positive to determine the length of the tooth through the use of instruments used inside the duct, although it is currently

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complemented by the electronic method of determining length. (3)

In the same way, the selection of the type of technique to be used in the endodontic procedure depends on the pathology presented by the patient, that is, in a biopulpectomy we proceed to instrumented with the apico-coronal technique and in a necropulpectomy with a corono-apical, each one has its effectiveness if it is performed properly according to its established protocol and if a logical order of the sequence of the files used during the instrumentation is carried out. (3)

For the preparation of the root canal within the endodontic treatment, knowing how to correctly establish the length of the tooth in which we are going to work, is considered as the most important part of the whole procedure that is going to be carried out, since it is the starting point of the protocol, for the aforementioned, several techniques have been carried out, within which we have radiographic, manual and electronic. (3)

Now, with the advancement of technology there are new methods that help strengthen precision when reaching the anatomical point at which the instrumentation must end, which is the apical constriction, one of them are the apical locators, these devices being very useful, because they allow to respect to a greater degree the biological principles of endodontics and therefore a better recovery post treatment. (4)

Similarly, we know that apical locators help predict the success of endodontic therapy, through obtaining the working length in a simpler way, although normally in the daily clinic where this electronic device is not available, this distance is taken between a coronal and an apical reference point, It must be adequate to avoid tissue damage and thus do not interfere duringhealing. (5)

Within the wide commercial market of these devices, we have the Root ZX® II (J. Morita MFG Corp., Kyoto, Japan) this was the first pen locator of the third generation, being one of the most popular and frequently tested, so it does not require any adjustment or calibration, therefore, its greatest advantage is that it can be used in both wet and dry ducts, Being something fruitful for the professional, in the same way, according to several studies it has a combined accuracy of approximately 90% in the detection of apical foramen. (6)

The Root ZX® II (J. Morita MFG Corp., Kyoto, Japan) is considered the Gold standard of apical locators from 2003 to 2013, based on the study of several authors who evaluated it in various conditions in order to see how efficient it is, resulting in an accuracy of 82% to 90% regarding the distance of 0.5mm with respect to the apical foramen, In addition, it is not altered by being in contact with sodium hypochlorite, which corresponds to an irrigating substance for the relevant disinfection of dental canals. (7)

Similarly, the Root ZX® II (J. Morita MFG Corp., Kyoto, Japan) has a different characteristic, due to the fact that it simultaneously measures two impedance values at two different frequencies (8 and 0.4 Hz) within the duct, that is, it measures the degree of opposition to the passage of current, on the other hand, these locators have inside a microprocessor that calculates the relationship between the two impedances and its coefficient is represented in a liquid crystal display in which the progressive advance of the file in the interior of the duct can be detected visually and acoustically. (8)

On the other hand, with reference to the apical electronic locator (LEA) Propex Pixi® (Dentsply Maillefer, Ballaigues, Switzerland) of fifth generation, which is also within the range of the best apical locators in endodontics, this device ensures us to detect the minor apical foramen related to reading 0.0, based on an analysis of electrical properties of various tissues inside the root canal system, achieving a high degree of reliability in obtaining the length of work compared to conventional methods. (9).

Propex Pixi® apart from providing comfort for the user also provides high reliability on the part of its magnificent apical detector, offering a multifrequency technology that leads to correct operation in any duct that has moisture or liquid, such as blood, purulent liquid, irrigators or saliva, without varying its result or effectiveness. In this type of locator it is not necessary to fix or calibrate the conductometry between patients since the calibration is automatic. (10).

That is why, it is convenient to use this device because it has a color led screen, has a characteristic limited size that allows access to transport and store anywhere, also provides an easy analysis, so it provides a system of lines of different color every time the file is approaching the apex of the tooth is indicating according to the stripes that become colorful, The ideal is to mark up to 0.5, therefore, if we continue advancing this will turn red and will begin to resonate intensely when it has exceeded the recommended limit. (10).

As for the advantages of Propex Pixi® (Dentsply Maillefer, Ballaigues, Switzerland), it reduces the use of x-rays; the working time, so that it has a good accuracy in contact with different liquids that may exist inside the duct; It is easy to use, analyze, and store, also reduces x-ray exposure for both patient and operator, and has good visibility with RSPto its reading (10).

2. General Objective

To determine, through a literature review, the accuracy reported between the ROOT ZX® II and PROPEX PIXI® locators, within the field of endodontics.

3. Materials And Methods

For the realization of this article, an exhaustive search

was carried out on the topic "Effectiveness of the apical locators ROOT ZX® II and PROPEX PIXI, ® based on the quality of the articles thus substantiating the established objective. To comply with the above, databases such as PubMed, Scielo, Elsevier and Google Scholar were investigated.

In terms of information collection, search keywords were taken into account, such as:locators; endodontics; precision; conductometry; length of work, and their respective English translations: apex locators; endodontics; precision; working length.

Inclusion criteria

1. Articles published in the last 5 years.
2. English and Spanish language
3. Impact event magazines
4. Studies addressing the efficacy of locators including those mentioned in this research.
5. Clinical cases

Exclusion criteria

1. Texts included prior to 2017
2. Other languages that were not established
3. Monographs, theses, blogs
4. Clinical cases without scientific support to support them
5. Other types of locator brands

Of a total of 21 articles found for the execution of this research, 12 were selected for discussion, with the aim of evaluating the quality of the articles, placing them according to their content, thus obtaining a logical and updated sequence of information.

4. Results

The percentages collected based on a literature review on the effectiveness of electronic apical locators were examined and described in a table and diagram that allow a better understanding of the results obtained. These values were tabulated and processed in the Excel program (Microsoft) which allows to obtain a much more accurate statistical percentage. Using 8 experimental in vitro articles and 4 in vivo articles that determine the proportion of accuracy of both the brand Root ZX ® II (J. Morita MFG Corp., Kyoto, Japan) and Propex Pixi® (Dentsply Maillefer, Ballaigues, Switzerland).

Table 1. Comparison chart of the efficiency of the Root ZX ® II and Propex Pixi® electronic locators

Comparison of the effectiveness of electronic locators Root ZX ® II y Propex Pixi®				
Author	Type of study	Propex Pixi®	Root ZX ® II	% Effectiveness
Andrade Rojas & Guillén Guillén	In vitro		X	99.4%
Luna Roa & Peñaherrera	In vitro	X		98.76%
Gay Orten & Serrano Nranas	In vitro		X	93%
Reinaldo Freight	In vivo		X	95%
Astocaza Reátegui	In vitro	X		95%
Mansilla	In vitro	X		92%
Nepomuceno Oliveira, Vivacqua Gomes, Affonso Bernardes, Ricci Vivan, & Carvalho Vasconcelos	In vitro	X	X	Root Zx II 93%. Propex Pixi 93%. *In setbacks* Root Zx II 93%. Propex Pixi 83%
Serna Peña , and others	In vivo	X		83,3%
Tufenkci & Kalaycı	In vitro	X	X	*In retreatments* Root Zx II 83.4%. Propex Pixi 80%
Wong Gan, Anita, and Jannett Jasmin Mellado Saucedo.	In Vivo	X	X	97% Root Zx II 88% Propex Pixi
Bertoli, F. M. P., Bruzamolin, C. D., Baratto Filho, F., Silva, D. A. D., Tomazinho, F. F. S., Gonzaga, C. C., & Souza, J. F. D.	In Vitro	X	X	90% Root Zx II 85% Propex Pixi
Piasecki, L., Carneiro, E., Fariniuk, L. F., Westphalen, V. P. D., Fiorentin, M. A., & da Silva Neto, U. X.	In vivo		X	83%

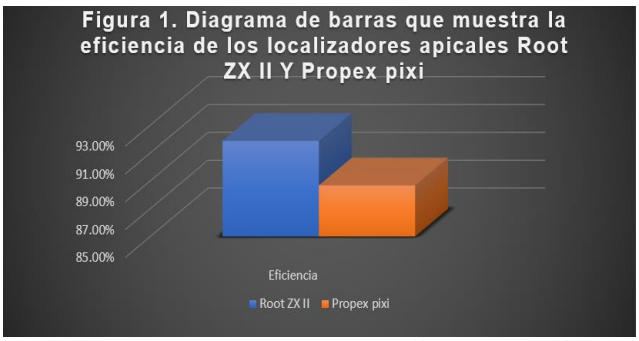

Figure 1. Bar diagram showing the effectiveness of Root ZX® II and Propex Pixi® apical locators

When comparing the percentages obtained from the electronic apical locators Root ZX II (J. Morita MFG Corp., Kyoto, Japan) and Propex Pixi (Dentsply Maillefer, Ballaigues, Switzerland) it was determined that the Root ZX ® ® II LOCATOR (J. Morita MFG Corp., Kyoto, Japan) has a 91.86% efficiency compared to the Propex Pixi®® (Dentsply Maillefer, Ballaigues, Switzerland) which showed an efficiency of 88.67% according to the articles studied.

To carry out this study, 12 articles were considered, of which 8 represent 66.6% of analyzed studies of the brand Root ZX ® II (J. Morita MFG Corp., Kyoto,

Japan) with an efficiency of 91.86% proving to be accurate and reliable when obtaining the working length, compared to the Propex Pixi® locator (Dentsply Maillefer, Ballaigues, Switzerland) which has the same percentage of items, resulting in 88.67% efficiency.

Therefore, the authors of this article recommend the use of the electronic localization of the brand Root ZX ® II (J. Morita MFG Corp., Kyoto, Japan), because when compared with the brand Propex Pixi® (Dentsply Maillefer, Ballaigues, Switzerland) yields a difference of 3.19%, so it is not considered statistically significant. Therefore, the result of Root ZX ® II (J. Morita MFG Corp., Kyoto, Japan) is estimated to be the gold standard for an endodontic treatment when finding the actual working length, guaranteeing the success of the procedure performed by the professional.

5. Discussion

The Root ZX ® II (J. Morita MFG Corp., Kyoto, Japan) provides accurate and reliable results in the measurement of ducts regardless of whether there is fluid present at the time of irrigation or blood in the root canal. According to the study conducted by Andrade Rojas & Guillén, 2017, (7) they pointed out that the Root ZX ® II apex locator (J. Morita MFG Corp., Kyoto, Japan) has a reliability of 99.4% when measuring the duct, in the study the irrigating substance was used that does not affect the time of measuring the working length compared to the locator with Propex Pixi® (Dentsply Maillefer, Ballaigues, Switzerland). The authors Luna Roa & Peñaherrera, 2017, (11) mention in their study the comparison of working lengths of ducts in an in vitro study highlighting that 120 dental organs were used, inaddition they mention that the duct must be kept dry to measure the ducts. Theefficiency of the locator is 98.76% being thus effective in the oral cavity. In conclusion, from the two in vitro studies analyzed, it is considered that in the Propex Pixi® locator (Dentsply Maillefer, Ballaigues, Switzerland) the duct must be kept dry to obtain the actual measurement while in the Root ZX ® II LOCATOR (J. Morita MFG Corp., Kyoto, Japan) it can be used wet or dry.

According to Gay Ortíz & Serrano Navas, 2018, (12) demonstrated in its in vitro study that locating Root ZX ® II (J. Morita MFG Corp., Kyoto, Japan) has a minimum of error with irrigating substances, this locator does not require any calibration and the diameter of the file does not produce any alteration during the taking of the length of the root canal this locator has an efficiency of 93% being thus an excellent work tool in endodontics. Similarly, Reinaldo Fretes et al., 2019, (13) mentioned in their in vivo study that the Root ZX II LOCATOR (J. Morita MFG Corp., Kyoto, Japan) was compared with other current locators where the use of the Root ZX ® ® II LOCATOR (J. Morita MFG Corp., Kyoto, Japan) in intraduct treatments was favorably resulted. Also, he mentioned that it does not require calibration at the time of obtaining the actual length, in the study it is emphasized that a larger diameter file was used in the ducts, but it should be emphasized that the same file was used with the other locators, the efficiency of this locator is 95% success. In this way it is distinguished that when using a manual instrument, it is advisable to use a file for each procedure because when handling the file several times it suffers wear that can affect when making the actual measurement.

The Propex Pixi® electronic locator (Dentsply Maillefer, Ballaigues, Switzerland) offers control when detecting the smallest apical diameter of the duct. According to Astocaza Reátegui et al., 2021, (14) mentions in its in vitro study that it made a comparison between the real means of the ducts of 32 teeth, resulting in 95% effectiveness at the time of obtaining the real length. Similarly, Mansilla, 2018, (15) mentions in his in vitro study the comparison of the actual length of the canal with the accuracy of the locator at the time of obtaining the actual length of 30 dental organs providing an efficiency of 92%. Therefore, in the 2021 study he mentions that by using the LEA we can obtain the measurement of the root canal effectively while in the 2018 study he mentions that there is a difference between the actual measurement of the root canal with the measurement provided by the locator, although the difference is not so significant it must be taken into consideration.

The use of electronic apical locators is essential and effective when performing a pulp treatment compared to any other technique, which is why the study by Oliveira et al., 2017, (16) who used 30 extracted mandibular premolars placed in fresh alginate with irrigated ducts was carefully examined. The Root ZX® II locator (J. Morita MFG Corp., Kyoto, Japan) and Propex Pixi® (Dentsply Maillefer, Ballaigues, Switzerland) when introducing manual files to the apex region at a length of (0.0) have an accuracy percentage of 93%, which indicates that both are a favorable option when it comes to specifying the real dimension of work to be instrumented. On the other hand, in the study carried out by Serna Peña, and others(17) analyzed 30 vital dental organs in which the marked working dimension of (0.0) was recorded with the Propex Pixi® locator (Dentsply Maillefer, Ballaigues, Switzerland) and then proceeded to its extraction for orthodontic, prosthetic and periodontal reasons, the length of work was redetermined and reflected a percentage of accuracy of 83.3%, which shows a Decrease in effectiveness that is justified because this study presents greater validity when first analyzed in vital teeth and then extracted, compared to an experimentation carried out on alginate.

In the article mentioned above by Oliveira et al., 2017, (16) shows a significant decrease in accuracy when using Propex Pixi® (Dentsply Maillefer, Ballaigues, Switzerland) with a percentage of 87%, when the file is introduced exceeding the apical foramen and after that receding it, since when performing this action, the initial adjustment

between the file and the walls of the file will be lost. duct in the area of the root apex generating minimal wear and resulting in an alteration in the perception of length, proving that the ideal device is the Root ZX® II (J. Morita MFG Corp., Kyoto, Japan) for retaining its accuracy of 93% tol perform setbacks at the apical level, patenting a minimum margin of error that It will allow an efficient healing of the periapical tissues.

As for teeth that have been endodontic and have failed, there is a high degree of difficulty in retreatingthem since the removal of the filling material could represent a great challenge for the stomatologist, according to Tufenkci & Kalaycı, 2020,(18) analyzed that the efficiency of an apical locator is impaired by the presence of remains of material such as cement, Guta-percha, intracanal medications or substances that allow the gutta-percha to be dissolved. Regarding this condition, the authors observed an accuracy of 83.4% for the Root ZX® II locator (J. Morita MFG Corp., Kyoto, Japan) and a percentage of 80% for Propex Pixi® (Dentsply Maillefer, Ballaigues, Switzerland) which shows a certain degree of involvement when a complete removal of material remains has not been carried out, but this does not mean that they are obsolete for these cases, It allows the dentist to verify the deep cleaning of the duct.

On the other hand, the author Wong Gan, 2019 (19) conducted an In Vivo study on the degree of coincidence of the working length with the electrical apical locators Root Zx II (J. Morita MFG Corp., Kyoto, Japan) and Propex pixi ® (Dentsply Maillefer, Ballaigues, Switzerland) 89 root canals were investigated, where the authors selected the locator Root Zx II® ® (J. Morita MFG Corp., Kyoto, Japan) as the gold standard, since, it has an accuracy of 97% for Root Zx and 88% for the Propex Pix locator. In comparison with the study conducted by Bertoli, 2017, (20) with the same apical locators in vitro 25 deciduous teeth were used that were divided into 2 groups. The first group without root resorption and the second group with root resorption. These 2 types of apical locatorss despite the fact that the pieces presented root resorptions proved to have 90% accuracy with the use of the apical locator Root Zx II® (J. Morita MFG Corp., Kyoto, Japan) the results for the first group had a high performance compared to the Propex Pixi ® (Dentsply Maillefer, Ballaigues, Switzerland) which was at a lower level with a percentage of 85% because it presented difficulty at the time of entering root resorption presente. The 2 authors mentioned indicate that no significant differences were found between the apical locators analyzed, therefore, these apical locators are a reliable method (21-25).

While the invivo study of the author Piasecki, 2017, (26) analyzes 27 unirradicular teeth to determine the location of the apical hole in teeth with apical periodontitis with the electrical locator Root Zx II® (J. Morita MFG Corp., Kyoto, Japan) in which 83% accuracy was obtained, knowing that the analyzed teeth presented apical periodontitis, the results have a good Prognosis becoming the selected for endodontic procedures when the pieces present apical periodontitis.

The use of electronic apex locators has become a crucial aspect of root canal treatment, aiding clinicians in determining the precise working length and ensuring successful outcomes. Two commonly used apex locators are the Root ZX II and Propex Pixi. In a recent study, researchers compared the effectiveness of these two devices in accurately determining the apical constriction.According to the study conducted by Rodríguez-Benítez et al., both the Root ZX II and Propex Pixi demonstrated high accuracy rates in locating the apical constriction. However, the Root ZX II showed slightly higher accuracy compared to the Propex Pixi. The study concluded that both devices are highly effective in determining the working length, but the Root ZX II may have a slight advantage in terms of accuracy.Another study by Gündüz et al. compared the efficacy of the Root ZX II and Propex Pixi in terms of preparation time and accuracy. The results showed that both devices were highly accurate, with the Root ZX II demonstrating a shorter preparation time. The study also emphasized the importance of proper technique and training in achieving accurate measurements with apex locators.In conclusion, the Root ZX II and Propex Pixi are both highly effective electronic apex locators, with the Root ZX II potentially having a slight advantage in terms of accuracy and preparation time. However, the accuracy of both devices is highly dependent on proper technique and training of the clinician. These studies provide valuable insight into the effectiveness of apex locators in root canal treatment and can aid clinicians in selecting the appropriate device for their practice (27-31)

6. Conclusion

- The most efficient apical locator within the field of endodontics is the Root Zx II®, because it has an accuracy percentage of 91.86%, this being relatively higher, unlike the Propex Pixi® with 88.67% establishing this statement based on the statistical results obtained after a thorough investigation in articles with experimental studies both in vivo and in vitro.
- Although there is no significantly greater difference between the two percentages of effectiveness of apical locators, because there is a variation of only 3.19%, the effectiveness and accuracy of Root Zx II® continues to stand out in any situation of comparison with other instruments, since several authors affirm it based on their studies.
- In addition, it was corroborated that the Root Zx II®, has excellent accuracy when determining the distance that exists towards the apical foramen, without influencing the state of the radiculaduct r, that is, this dry or wet, along with countless advantages which help the endodontic procedure

obtain positive results after the completion of the established treatment, This being something fruitful for both the patient and the operator.

References

Pamela Aguilera, M. A. (2018). endodontics performed using the technique of rotational instrumentationI mechanized corono apical in the UAA. Journal, 1, 16.

Marina Tolomei Sandoval Cury, A. M. (2021). Accuracy of Root ZXII, E-PEX and FIND apice locators on teeth with vital pulp: an in vivo study. Scielo, 35, 6.

Estrada, M. (2017). Rotary instrumentation in endodontics.What type of file or procedure is the most indicated? Scielo, 33(4), 10.

Pelin Tufenkci, A. K. (2020). Evaluation of the accuracy of different apice locators to determine the length of work during root canal retreatment. Dent Clin Dent Prospects, 14(2).

María León López, D. C.-B.-Q. (July 2021). Influence of coronal prewidening on the accuracy of electronic determination of working length: systematic review and meta-analysis. Journal, 10(13), 7.

S. Sarita, K. U. (2017). Clinical evaluation of the Root ZX II electronic apical locator in primary teeth. Eur Arch Paediatr Dent, 8.

Andrade Rojas, BM, & Guillén Guillén, RE (2017). Apical locators: comparative analysis of the accuracy of the working length between the apical locator I-ROOT (META BIOMED) and the ROOT ZX II (MORITA). Mastery of Sciences, 3(2), 841–862.

Rakesh Reddy Chukka, M. D. (2020). Efficiency of an integrated apex locator to determine the working length in various irrigation solutions: an in vivo study. Journal, 12(1).

Ferreira, I., (2019), The Precision of Propex Pixi with Different Instruments and Coronal Preflaring Procedures, PubMed Central, NIH, Eur Endod J., V.4.

Padilla, F., (2021), Conductometry accuracy with the electronic apical locator Propex pixi in in vitro premolar teeth, National University of the Peruvian Amazon.

(Luna Roa & Peñaherrera, 2017) Luna Roa, Á. M., & Peñaherrera, M. S. (2017). Efficiency of conductometry by applying three types of third-generation apical locators. Mastery of Science, 3(1), 21–34.

Gay Ortiz, MM & Serrano Navas, OG (2018). LApical Occalizers in Endodontics. Ustasalud , 2 (1), 33.

Vicente Reinaldo Fretes, A. P. (September 2019). Preliminary study on the in vivo repeatability of three electronic apical locators. Scielo, 56(3).

Astocaza Reátegui, TF, Ayarza Flórez, LR, & García Rupaya, CR (2021). Comparison of the accuracy of two apical electronic locators in teeth with simulated perforations. Revista científica odontológica, 9 (2), e055.

Mansilla, MCV (2018). Eficacia invitro de dos pagadores electrónico apicales wood pex iii and propex pixi en piezas uniradiculares - cusco 2018. Dental Vision, 5(2), 34–40.

Nepomuceno Oliveira, T., Vivacqua Gomes, N., Affonso Bernardes, R., Ricci Vivan, R., & Carvalho Vasconcelos, B. (2017). Determination of the Accuracy of 5 Electronic Apex Locators in the Function of Different Employment Protocols. American Association of Endodontists, 1-5.

Serna-Peña, G., Gomes-Azevedo, S., Flores-Treviño, J., Madla-Cruz, E., Rodríguez-Delgado, I., & Martínez-González, G. (2020). In vivo evaluation of 3 electronic apex locators: Root ZX mini, apex ID, and Propex Pixi. Journal of Endodontics, 46(2), 158–161.

Tufenkci, P., & Kalaycı, A. (2020). Evaluation of the accuracy of different apex locators in determining the working length during root canal retreatment. Journal of Dental Research, Dental Clinics, Dental Prospects, 14(2), 125–129.

Wong Gan, A. &. (2019). In vivo comparison of the determination of the working length of the electronic apical locators Root Zx, Propex Pixi and digital radiography in patients attended by students of the fourth year of the Faculty of Stomatology of the University. Edu.pe.

Bertoli, F. M. (2017). Performance in vitro of apex locators in determining root length in primary molars. RGO. Obtenido de Revista Gaúcha de Odontologia, 64(3), 244–249.

Vázquez MYL, Cevallos REH, Piza IAC, Teruel KP. Análisis de las causas del consumo de drogas mediante aprendizaje automático. Universidad y Sociedad. 2021;13(S3):392-399.

Peñafiel Palacios AJ, Estupiñán Ricardo J, Cruz Piza IAC, España Herrería ME. Phenomenological hermeneutical method and neutrosophic cognitive maps in the causal analysis of transgressions against the homeless. Neutrosophic sets and systems. 2021;44(1):18.

Romero Fernández AJ, Alfonso González I, Álvarez Gómez GA, Latorre Tapia LF. La investigación y su contribución desarrollo de la sociedad ecuatoriana: perspectiva de Uniandes-Ecuador. Revista Universidad y Sociedad. 2022;14(6):165-175.

Ricardo JE, Vázquez MYL, Hernández NB. Impacto de la investigación jurídica a los problemas sociales postpandemia en Ecuador. Universidad y Sociedad. 2022;14(S5):542-551.

Ramos Argilagos M, Valencia Herrera A, Vayas Valdiviezo W. Evaluation of Nutritional Education Strategies in Schools in Ecuador Using Neutrosophic TOPSIS. International Journal of Neutrosophic Science. 2022;18(3):208-217. doi: https://doi.org/10.54216/IJNS.1803018

Piasecki, L. C. (2017). Accuracy of Root ZX II in Locating Foramen in Teeth with Apical Periodontitis: An In Vivo Study. Journal of Endodontics, 37(9), 1213–1216.

Suárez López A, Fong Betancourt MI, Jordán Fiallos DL. Use of Neutrosophy in the Evaluation of a Health Education Program for Undergraduate Medical Students. Neutrosophic Sets and Systems. 2022; 52: 249-254. doi: 10.5281/zenodo.7374303

Cobo Álvarez DA, Jami Carrera JE, Medina Ramírez GE. Neutrosophic Study on the Levels of Physical

Activity in Undergraduate Medical Students. Neutrosophic Sets and Systems. 2022; 52: 255-260. doi: 10.5281/zenodo.7374313
Cobo Álvarez DA, Hurtado Serrano KI, Bermúdez del Sol A, Llerena Cepeda MdL. Neutrosophic Linguistic Scale for Self-Assessment of Knowledge about Non-Communicable Diseases in Medical Students. Neutrosophic Sets and Systems. 2022; 52: 261-266. doi: 10.5281/zenodo.7374316
Lara Jacome AG, Guamán Guamán MI, Peñafiel Jaramillo KM, Suaste Pazmiño KV. Neutrosophic Study of Knowledge about Hemiplegia. Neutrosophic Sets and Systems. 2022; 52: 267-272. doi: 10.5281/zenodo.7374329
Balarezo García MG, Jami Carrera JE, Moina Veloz ÁP. Neutrosophic Analysis of the Self-Assessment of Pharmacology Knowledge in Medical Students. Neutrosophic Sets and Systems. 2022; 52: 273-278. doi: 10.5281/zenodo.7374338

Author Data

Romulo Guillermo Lopez Torres. Specialist in Endodontics. Professor at the Universidad Regional Autónoma de los Andes, Ecuador. Email: ua.romulolopez@uniandes.edu.ec
Diana Michelle Yumbopatin Ramos. Student at the Universidad Regional Autónoma de los Andes, Ecuador. Email: ora.dianamyr80@uniandes.edu.ec
Johanna Estefanía Moreta Criollo. Student at the Universidad Regional Autónoma de los Andes, Ecuador. Email: oa.johannaemc82@uniandes.edu.ec
Kerly Dayana Eugenio Alvarez. Student at the Universidad Regional Autónoma de los Andes, Ecuador. Email: oa.kerlydea19@uniandes.edu.ec