



RESEARCH ARTICLE

EFFECTIVENESS OF THE iPex II NSK® APEX LOCATOR IN PATIENTS WITH SYMPTOMATIC IRREVERSIBLE PULPITIS DIAGNOSTICS AND ASYTOTOMATIC AP

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ABSTRACT

Background: Root canal treatment is a procedure that allows to preserve the dental organs, even when they have presented infectious processes due to the direct or indirect presence of microorganisms in the oral environment. For this reason, multiple technologies have been developed that allow endodontists to establish diagnoses and develop treatments with better results. Foramen locators are equipment that allows the identification of the location of the file introduced to the root canal, in relation to the anatomical structures of the apex such as: the constriction and the apical foramen (the apical constriction corresponds to the place where it must be instrumented for shaping the apical stop). Multiple studies have been carried out to identify the effectiveness of these devices, with a predominance in “ex vivo” studies, which leads to the question: What is the effectiveness of the iPex II NSK® foramen locator in patients who attend the endodontic consultation of the CEMENAV in the period: July - December 2019 with diagnoses of symptomatic irreversible pulpitis and asymptomatic apical periodontitis in the distal root of the lower first molar? **Objective:** To determine the effectiveness of the iPex II NSK® foramen locator in patients with diagnoses of symptomatic irreversible pulpitis and asymptomatic apical periodontitis in the distal root of the lower first molar. **Material and methods:** Measurements of the distal root of the first lower molars of patients who came with a diagnosis of symptomatic irreversible pulpitis and acute apical periodontitis were performed. Subsequently, radiographic taking was carried out with the Morita® Root ZX II foramen locator (gold standard) and subsequently the measurement with the iPex II NSK® foramen locator. **Results:** After six months of measurements (68 cases), it was possible to identify an effectiveness of 85.29% in the measurements, due to obtaining 58 coincidences and 10 discrepancies that correspond to: 34 measurements with 100% effectiveness in the cases with a diagnosis of Symptomatic irreversible pulpitis and 34 measurements with 70.58% effectiveness (only 24 coincidences), in cases with asymptomatic apical periodontitis. **Conclusions:** Due to the results obtained and the methodological sequencing used, it is possible to identify the effectiveness of the iPex II NSK® foramen locator in patients with diagnoses of symptomatic irreversible pulpitis and not in patients with asymptomatic apical periodontitis in the measurements made in the distal root of the former. lower molars that were part of the study.

INTRODUCTION

The American Association of Endodontists defines the specialty in Endodontics as the branch of dentistry that deals with the morphology, physiology, and pathology of the dental pulp and periradicular tissues (1). Root canal treatment is a procedure that allows to preserve the dental organs, even when they have presented infectious processes due to the direct or

indirect presence of microorganisms in the oral environment. (2,3) The fundamental objectives of root canal system treatment are to eliminate or prevent the entry of microorganisms into the root canal system to prevent reinfection after filling, to achieve sealing of the apical third and the rest of the canal, and obtain a long-term biological closure. (4)

In order to reach, multiple technological equipment has been developed that allow specialists in this branch of dentistry to establish diagnoses and develop treatments with better results according to recent studies. Many of these technologies represent in the clinical practice of endodontics, operative tools that provide certainty in their measurements, taking as reference the studies carried out by their manufacturers and operators at an international level (5). However, it is necessary to give them continuity and constantly monitor more recent results and studies that allow operators to carry out their professional practice with greater safety, obtaining higher success rates; which is directly reflected in the quality of service standards by meeting the expectations of patients.

MATERIALS AND METHODS

The objective of this study was to measure the effectiveness of the iPex II NSK® foramen locator, taking as a reference the diagnoses of symptomatic irreversible pulpitis (PIS) and asymptomatic apical periodontitis (APA). The reason why these diagnoses were chosen is considering the histological and cellular characteristics present in each lesion; in the case of PIS, the pulp tissue is still vital without changes in the periapice, while in PAA the pulp is necrotic and there are changes in the periapical tissues that could influence the correct measurement of the locator. In order to reach, the measurement to be evaluated was established taking as a reference the distal root of the first lower molar, using two different locators; the Morita® Root ZX II foramen locator, considered as the mandatory confirmatory parameter and the NSK® iPex II foramen locator, which is the study equipment based on, due to being the equipment that naval health establishments have acquired the most in Mexico (see figures 1 and 2).



Figure 1. Morita® Root ZX II foramen locator

The study was conducted in patients who attended the outpatient clinic of the endodontic specialty (at the Naval Medical Center "CEMENA", which is a High Specialty Hospital of the Secretariat of the Mexican Navy), with any of the diagnoses mentioned in the first lower molar, taking the distal root as a reference. Subsequently, a radiographic was taken using the Morita® Root ZX II foramen locator and later the measurement with the iPex II NSK® foramen locator and the records were made taking as reference the following specifications: Measurement unit: millimeter, Variance: measurement greater than 0.1 mm = long measurement and measurement less than 0.1 mm = short measurement and coincidence when there is no discrepancy.



Figure 2. NSK® iPex II Foramen Locator

The foregoing was carried out under the informed consent of the patients with the mentioned diagnostic conditions, in the period July - December 2019. The measurements made with the iPex II NSK® were contrasted with the first measurement, which was made with the Morita® Root ZX II foramen locator, which is considered by the current scientific literature as a confirmatory parameter or standard goal (current reference) in terms of foramen locators.

RESULTS

After six months of measurements, in 68 cases, it was possible to identify an effectiveness of 85.29% in the measurements, due to obtaining 58 coincidences and 10 discrepancies. According to the diagnosis, the measurements were classified into: 34 measurements with 100% effectiveness in cases with a diagnosis of symptomatic irreversible pulpitis and 34 measurements with 70.58% effectiveness (only 24 coincidences), in cases with asymptomatic apical periodontitis (see tables 1, 2, 3 and 4).

A statistical analysis was developed through a Fisher's exact test, which allowed to identify the existing association between the effectiveness of the equipment and the patient's condition. In this way, it is possible to conclude that the iPex II NSK® foramen locator has statistically significant measurements in its effectiveness according to the disease and, for this reason, its reliability is not recommended in patients with asymptomatic apical periodontitis (see tables 5 and 6). The present statistical development allows identifying the existing association between the effectiveness of the equipment and the patient's condition. In this way, it is possible to conclude that the iPex II NSK® foramen locator has statistically significant measurements in its effectiveness according to the disease and its reliability is not recommended for this reason in patients with asymptomatic apical periodontitis.

Table 01. Results: coincidences and discrepancies detected.

Number of measurements	Coincidences	Discrepancies	Percent of effectiveness
68	58	10	85.29%

Table 02. Results of the short and long measurements detected.

Number of measurements	Discrepancies (short and long)	Measurements short	Measurements long
68 (100%)	10 (14.70%)	8 (11.76%)	2 (2.94%)

Table 03. Distribution of results by pathology: PIS and PAA.

Number Of Measurements	Symptomatic Irreversible Pulpitis	Asytomatic Apical Periodontitis
68 (100%)	34 (50%)	34 (50%)

Table 04. Results for correct and incorrect measurements and detected effectiveness

Symptomatic Irreversible Pulpitis	34 = 100% (34 Measurements Effective)	None	100%
Asytomatic Apical PeriodontitiS	34 = 100 % (24 Measurements Effective)	10 = 29.41% (10 Measurements Ineffectivity)	70.58%

DISCUSSION

Endodontic treatment is a procedure that for its effectiveness requires multiple aspects both for its correct performance and ideal results. Therefore, in the specialty of endodontics, as in the rest of the different areas of medicine and health sciences, different tools and technological equipment have been implemented as diagnostic aids to optimize treatments, ranging from reducing operating times, until tissue damage or trauma is minimized. The technologies incorporated into the endodontic specialty have been modified and improved over the years, through the different versions and models that manufacturers adapt to the needs expressed by those who operate them and because, like any technological tool, they usually have failures or defects in its mechanisms that can originate from various causes such as: inadequate use (non-adherence to the manufacturer's specifications), life time and aspects of its manufacture. (6).

Due to the importance of the efficient operation of the technologies applied or intended for the different treatments for the preservation of human health, it is essential to continuously develop studies that allow identifying aspects that could question their effectiveness or, aspects not considered by the manufacturers. For this, it is necessary to take into account various application scenarios and the aspects that its creators stipulate for its ideal use. (7.8). The manufacturers of different foramen locators, as is the case of the equipment studied in this investigation, report that their effectiveness does not vary according to the diagnosis in which the dental organ to be treated is found. However, in the specifications for its correct use, certain aspects are mentioned that may influence its effectiveness that are not necessarily related to the diagnosis of the dental organ. (9.10). In the different studies that have been carried out in the last two decades aimed at the effectiveness or efficiency of these equipment, there is a notorious predominance of methodologies developed *ex vivo* that do not allow to establish, due to the characteristics of the tissues, elements to guarantee the results in patients (in living tissues). (eleven). On the other hand, the studies carried out in living tissues show a clear tendency to determine the effectiveness or efficiency of foramen locators, taking into account variables other than the diagnosis in which they are presented, which leads to the development of studies like this are direct contribution to a specialized union focused on clinical practice.

Probably one of the fields of greatest study in equipment used in this discipline corresponds to foramen locators. However, the studies that have been carried out in this line of research correspond to “*ex vivo*” studies, that is, in extracted teeth. (11.12). Echevarría I., (2016). in their study of the *in vitro* efficacy of two foraminal locators: Easy Apex and Mini apex in locating the cementum-dentin junction (U.C.D) in uniradicular lower premolars, Arequipa, 2016”. The present research aimed to compare the precision of electronic measurements between two fourth generation electronic locators. (13). This study made possible to identify that no significant differences have been demonstrated between the fourth generation and sixth generation apex locators, when these are handled correctly by the operator, they achieve results of approximately 88% for the Raypex 6 and 90% for the Root ZX II, in determining the working length. (14). From the diverse range of articles published today related to form locators, it is possible to obtain an overview of how the processes of determining the effectiveness of a foramen locator are carried out, which allowed the researcher to take guidelines or references for an *in vivo* study methodology with accurate results on the electronic working length measurements by the iPex II NSK®, as well as determining its effectiveness with the diagnoses of symptomatic irreversible pulpitis and asymptomatic apical periodontitis.

Based on the elements that favor or oppose the development of this type of research (discussion), the question arises as: why carry out this type of study? The answer is based on consideration of the following aspects:

- Duct treatments require an efficient operation of the technological equipment that helps in the realization of these, so the continuous evaluation of said equipment is essential to analyze the effectiveness of said technologies in the various scenarios that usually occur in the daily professional practice is considered a necessary scientific act. (fifteen)
- The development of studies that guide health personnel is considered a highly relevant factor, based on increasing quality standards by permanently seeking a health service that solves the conditions and / or diseases of this discipline. (16)
- At present, the use of foramen locators in root canal treatment has become an element that broadens the objectivity with which this procedure is carried out, leading endodontic specialists to trust the effectiveness of the equipment without have elements that allow verifying the possibility of variants or discrepancies that could compromise its efficiency, therefore the study will provide guidelines to corroborate whether it can be certain with the use of this equipment. (17, 18)
 - Documenting the efficiency of a team that is used in naval health establishments for conducting treatments, allowed to corroborate a correct phase of the protocol to follow in order to obtain optimal results from said procedure.
- According to the results, it was possible to corroborate the efficiency of this equipment, which would directly represent the Naval Medical Center a determinant of future investment, considering that it is an equipment that is used within the establishment by its personnel.

Table 5. Fisher's exact test.

	Effectives	Not effectives	Totals
Pathology 1. Symptomatic Irreversible Pulpitis (PIS).	34 Measurements (100%)	0 None (0%)	Total P1 34 =100%
Pathology 2. Asyptomatic Apical Periodontitis (PAA).	24 Measurements (70.58%)	10 Measurements (29.41%)	Total P2 34=100%
Totals:	58 Measurements Effective (85.29%)	10 Measurements Not Effectives (14.70%)	Totales: 68=100% Total Effectives 85.29% Total Not Effectives 14.70%

Source: self made.

Table 6. Information clearance for Fisher's exact test

	EFFECTIVES	NOT EFFECTIVES	TOTALS
Pathology 1.	34	0	34
Pathology 1.	24	10	34
TOTALS	58	10	68

Confidence level: 95% Source: own elaboration. Significance level: 0.05%

		$(A+B)! (C+D)! (A+C)! (B+D)!$		$(34+0)! (24+10)! (34+24)! (0+10)!$
Statistical formula:	p=	$N! A! B! C! D!$	p=	$68! 34! 0! 24! 10!$

$34! 34! 58! 10!$		$(77.4347E+161)$	
$P= 68! 34! 0! 24! 10!$	p=	$(1.6485E+165)$	p=0,000451

- The Naval Medical Center, headquarters of this study, has infrastructure that allowed the researcher, after having the authorization of the corresponding authorities, to carry out the investigation with a low cost implication (it has state-of-the-art dental equipment that includes one of the two foramen locators to be used in this study), which made this research project a feasible procedure.
- As all the elements and criteria were available to the researcher (once its performance was approved), it was considered a viable research.
- The study of this team has been delimited and with it, the reduction of variables, measuring the distal root of the lower first molar, presenting a diagnosis of symptomatic irreversible pulpitis or asymptomatic apical periodontitis. Most of the studies carried out to determine the efficacy of foramen locators are carried out in anterior or uniradicular teeth in consideration of factors such as the patient's mouth opening and the anatomical variant of the canals that predisposes to a straight morphology of greater frequency. For this reason, the selection of the first lower molar, which, in turn, is the molar that is most frequently presented to said service according to current statistics. In the same way, it was decided to delimit it to the distal root of said dental organ, consequently, the low percentage of anatomical variants, which according to the literature has a straight morphology. (19)

Comparing the results of this work with current studies on the subject, it is possible to identify that the diagnostic variable had not been considered as a determining element in their effectiveness. This could be considered one of the most relevant aspects. From the above, the question arises as to why before one diagnosis a lower percentage of effectiveness was identified than another, which leads to the hypothesis that, in chronic lesions, due to the presence of clastic cells (osteoclasts),

that have destroyed periapical bone, as well as led to root resorption, may influence the correct functioning of the apex locators. Starting from the level of effectiveness that was identified in chronic lesions, which was 70.58%, compared to that found in pulpitis, which was 100%, it is possible to consider a statistically significant percentage of ineffectiveness in chronic lesions. Regarding the 10 cases in which ineffectiveness was detected, it was possible to observe the short measurements more frequently, thereby generating the hypothesis described in the previous paragraph.

Conclusion

After having carried out the measurements in the established period of six months, the specific objectives of the study were achieved, starting with:

Through a systematic review of the literature, it was possible to know the parameters established for the correct use of the iPex II NSK® foramen locator in accordance with the manufacturer. Based on the above, it was possible to apply the parameters established by the manufacturer for the correct use of the iPex II NSK® foramen locator in the cases selected for this study. Finally, it was possible to analyze whether the selected diagnoses affect the effectiveness of the iPex II NSK® foramen locator according to the conditions in which the present study was carried out. In response to the general objective, it was possible to determine the effectiveness of the iPex II NSK® foramen locator in patients attending the CEMENAV endodontic clinic in the period: July - December 2019 with diagnoses of symptomatic irreversible pulpitis and asymptomatic apical periodontitis in the distal root of the lower first molar that was 85.29% (based on 68 measurements), due to obtaining 58 coincidences and 10 discrepancies that correspond to: the 34 measurements with 100% effectiveness in cases with a diagnosis of symptomatic irreversible pulpitis and 24 of the 34 measurements with 70.58% effectiveness (10 results did not coincide), in the cases with asymptomatic apical

periodontitis. The results obtained and the methodological sequencing used make it possible to identify the effectiveness of the iPex II NSK® foramen locator in patients with diagnoses of symptomatic irreversible pulpitis and not in patients with asymptomatic apical periodontitis in the measurements made in the distal root of the lower first molars that you were part of the study.

RECOGNITION

To professors for their valuable contributions made to my training and their intervention in the development of this manuscript.

DECLARATION OF CONFLICT OF INTEREST

In accordance with the provisions of the Federal Law on Administrative Responsibilities of Public Servants and article 37 of the Organic Law of the Federal Public Administration, in force by virtue of the second transitory decree of the reform Decree to this Law, published in the Official Gazette of the Federation on January 2, 2013, it corresponds to the Ministry of Public Function to know and investigate behaviors of public servants of the Federal Government that, where appropriate, could constitute administrative responsibilities. Considering all laws or regulations of the Secretary of the Navy - Mexican Navy that interfere with ethical aspects in the investigation, we hereby declare NOT TO HAVE ANY POTENTIAL CONFLICT OF INTEREST WITH THE STUDY: "Effectiveness of the iPex II NSK® foramen locator in patients with diagnoses of symptomatic irreversible pulpitis and asymptomatic apical periodontitis ", carried out in 2019 as a thesis work to obtain the degree of specialist in endodontics.

The person in charge of the study and all the participating professors (co-authors of the article), declare and sign hereby stating that there is no potential conflict of interest related to this research.

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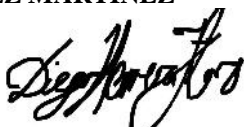


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GLOSSARY OF ABBREVIATIONS	
ABBREVIATION	MEANING
AAE	American Association of Endodontics
C	Duct
CDC	Conduit Dentin Cement
CEMENA	Naval Medical Center
ESCPO	Postgraduate School in Naval Health
LEFs	Electronic Foramen Locators.
OD	Dental Organ
PAA	Asymptomatic Apical Periodontitis
PIS	Symptomatic Irreversible Pulpitis
SEMAR	Secretariat of the Navy
UCD	Union Cement Dentin.
UNINAV	Naval University

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