

Influence of the instrument used for cervical preflaring on the precision of 2 Electronic Apex Locators

Influência do instrumento utilizado no preparo cervical na precisão de 2 localizadores apicais eletrônicos

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ABSTRACT

Objective

This study was aimed at evaluating the influence of cervical preflaring using LA-Axxes No. 1 bur (SybronEndo, Glendora, USA) or S1 and SX ProTaper files (Dentsply Maillefer, Ballaigues, Switzerland) on the accuracy of the Electronic Apex Locators (EALs): Root ZX mini (J. Morita Corporation, Tokyo, Japan), and Joypex 5 (Denjoy, Changsha, China).

Methods

Thirty mandibular incisors were accessed, and the root canal length (RCL) was determined with a K-file #15, with the aid of a stereo microscope. Afterwards, the specimens were divided into 2 groups (n = 15) referring to the cervical preflaring with LA-Axxes or ProTaper files. The teeth were embedded in alginate and the RCL was determined by the EALs before and after preflaring. Data were classified into: accurate, if the difference in RCL measurement were ≤ 0.05 mm; and inaccurate, if the difference were >0.5 mm or beyond the RCL.

Results

McNemar's test ($\alpha < 0.05$) was used to detect differences in the accuracy of the EALs before and after each preflaring with different instruments, and to detect difference in accuracy among devices. No differences were found concerning the accuracy of the EALs ($P > 0.05$) after the cervical preflaring, regardless of the used instrument.

Conclusion

The preflaring procedure increased the number of accurate measurements for both EALs, with statistical difference for Joypex 5 when the preflaring was performed with LA-Axxes. However, after the cervical preflaring, the EALs showed similar accuracy, regardless of the used instrument.

Indexing terms: Dental instruments. Endodontics. Odontometry.

RESUMO

Objetivo

Avaliar a influência do preparo cervical utilizando a broca LA-Axxess nº 1 (SybronEndo, Glendora, EUA) ou os instrumentos ProTaper S1 e SX (Dentsply Maillefer, Ballaigues, Suíça) na precisão dos Localizadores Apicais Eletrônicos (LAEs): Root ZX mini (J. Morita Corporation, Tóquio, Japão) e Joypex 5 (Denjoy, Changsha, China).

Métodos

Trinta incisivos inferiores foram acessados e o comprimento do canal radicular (CCR) determinado com uma lima K #15 com o auxílio de um estereomicroscópio. Em seguida, os dentes foram distribuídos em dois grupos (n=15) referentes ao preparo cervical com LA-Axxess ou instrumentos ProTaper. Os dentes foram incluídos em alginato e o CCR determinado pelos LAEs antes e após o preparo cervical. Os dados foram classificados em: precisos, se a diferença na medida do CCR era $\leq 0,05$ mm; e imprecisos, se a diferença era $>0,5$ mm ou estava além do CCR.

Resultados

O teste de McNemar ($\alpha < 0.05$) foi utilizado para detectar diferenças na precisão dos LAEs antes e após o preparo com os diversos instrumentos, e para detectar diferenças na precisão entre os aparelhos. Não foram identificadas diferenças na precisão entre os dois LAEs ($P > 0,05$) após o preparo cervical, indiferente do instrumento utilizado.

Conclusão

O preparo cervical aumentou o número de medições precisas dos LAEs, com diferença estatística para Joypex 5 após o uso da LA-Axxess, contudo os aparelhos apresentaram precisão similar após o preparo cervical, indiferente do instrumento utilizado.

Termos de indexação: Instrumentos odontológicos. Endodontia. Odontometria.

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INTRODUCTION

The determination and maintenance of apical limit during root canal preparation has a fundamental importance to obtain a safe and efficient endodontic instrumentation¹. The recommended reference point to determine the working length (WL), ideal depth for instrumentation and endodontic obturation, is the apical portion of the root canal, which offers greater constriction and can be found at 0.5-1.0mm short of the major apical foramen². However, obtaining WL using conventional radiographic method is hindered by the limitations related to this technique, such as image distortion, and variations and interference of anatomical structures, which can reduce the reliability of the obtained measurement¹⁻⁵.

Electronic Apex Locators (EALs) have been introduced in Endodontics with the goal of making the determination of the WL, or apical constriction, of the root canal more accurate and reliable⁶. These devices have been constantly changed since they were invented. The changes, which were related to their operating principle, have been made in order to achieve more accurate measurements. Therefore, EALs have gained popularity in endodontics⁷. The latest EALs use the principle of alternating current impedance with the processing of two or more different frequencies⁸⁻¹⁰. Currently, one of the EALs which has presented satisfactory results is the Mini Root ZX (J. Morita Corp., Tokyo, Japan)¹¹, a modified version of Root ZX from the same manufacturer¹⁰, which measures the impedance of two frequencies simultaneously¹². Due to its high cost, some professionals are purchasing EALs that are more financially viable, such as Joypex 5 (Denjoy, Changsha, China), which uses multiple frequencies, though there are few studies verifying their efficiency, especially when associated with cervical enlargement.

Cervical preparations are intended to facilitate the insertion of the instruments up to the apical third of the root canal¹³⁻¹⁵, and reduce the amount of microorganisms that can be pushed to the periapical zone¹⁶. This procedure can be performed using manual or mechanical techniques¹⁷, with the aid of different instruments, such as Hedstroem files, IT-Axxess and Gates-Glidden drills, and rotational instruments, such as the S1 and Sx by ProTaper system^{16,18,19}. Studies have shown that when the determination of WL was performed without prior cervical enlargement, there was a higher incidence of cases where the file stopped short of or beyond the apical limit of the root canal^{14,16}. To date, few studies that evaluated the

influence of cervical preparation on measurements by EALs suggest that the accuracy of some devices was increased after cervical preparation^{15,20-21}.

Although numerous studies indicate an increase in the accuracy concerning the determination of the WL by different EALs^{5,7,22-24}, the fact that prior cervical preparation of root canals performed with different instruments might affect the accuracy of these devices has not yet been proved. Thus, this study was aimed at evaluating the influence of cervical preparation, using LA-Axxess (SybronEndo) and S1 and Sx ProTaper (Dentsply Maillefer), on the accuracy of Root ZX mini and Joypex 5.

METHODS

This study was approved by the Ethics Committee in Research (report #165.371).

Selection and preparation of the samples

Thirty mandibular incisor teeth with a single root canal, extracted due to clinical indication and donated to this research with the prior consent of the patient, were selected for this study after radiographic examination. The selected teeth presented their root and coronary structures preserved, completely formed apex, root canal of type I of Vertucci²⁵, and no evidence of calcification, resorption, fractures, endodontic treatment and metal restorations. Tissues and debris were removed from the root surface by manual curettes. The teeth were kept in saline solution at 5°C until the time they were going to be used.

The incisal edges were flattened using a polishing machine under refrigeration (APL-4; Arotec, Cotia, SP, Brazil) to obtain a fixed and stable reference point to assist future measurements of the root canal. Crown access was performed with diamond burs # 1012 (S.S. White Dental products, Rio de Janeiro, RJ, Brazil) at high speed. Debris present in the pulp chamber and remnants of pulp tissue were removed with K file #10 (Dentsply Maillefer, Ballaige, Switzerland) under irrigation with sodium hypochlorite solution 1% (NaOCL) using a disposable plastic syringe attached to a 23 gauge needle.

The length of the root canal (LRC) up to the apical foramen was determined by the introduction of a K file #10 (Dentsply Maillefer, Ballaige, Switzerland) inside the canal up to the point where its tip reached the apical foramen, and then, the silicon cursor was adjusted to the tooth incisal edge. This procedure was carried out with

the aid of a stereo microscope (Carl Zeiss, Jena, Germany) with a magnification of 50x.

The file was removed and the LRC was determined using a ruler with a precision of 0.5 mm (ARCH, Tokyo, Japan). All the measurements that were needed in this study were performed three times and the average was used as the final LRC.

Electronic determination of the root canal length

The teeth were divided into two groups (n=15), according to the cervical preparation to be performed:

Group 1 (G1): preparation with S1 and Sx by ProTaper system, using the electric motor X-Smart (Dentsply Maillefer, Ballaige, Switzerland) at 300 rpm and torque of 3N. The instrument S1 was introduced in the canal up to 3 mm short of the LRC; afterwards, the instrument Sx was used up to 5 mm short of the LRC.

Group 2 (G2): preparation with drill LA-Axxess (SybronEndo, California, USA) No. 1 (20.06) at low speed, up to 5 mm short of the LRC.

Before the cervical preparation, the teeth were immersed into a plastic recipient containing freshly mixed alginate (Jeltrate II, Dentsply, Petropolis, RJ, Brazil) to enable the electronic measurement of the LRC by the EALs Mini Root ZX (j. Morita Corp., Tokyo, Japan) and Joypex 5 (Denjoy, Changsha, China). The labial electrode was inserted into the alginate and laterally to the tooth. The root canals were irrigated with the 1% NaOCl solution and its excess was removed from the pulp chamber. A K-type file was connected to the other electrode and slowly inserted in the root canal until the display showed "0.0" or "APEX". The measurements obtained were considered to be correct if the readings remained stable for at least 5 s. Afterwards, the silicone cursor was carefully adjusted according to the reference

point and the distance between the cursor and the end of the file was measured. After measurement of each canal was performed 3 times by the EALs evaluated, cervical enlargement was performed in each group, as previously described, and new measurements of LRC were obtained with the EALs.

The accuracy of the EALs was classified as: accurate, if the difference in measurement up to the apical foramen was ≤ 0.5 mm; and inaccurate, if the difference in measurement was > 0.5 mm or beyond the LRC.

McNemar's Chi-square test was used to detect differences in the accuracy between the samples before and after the cervical preparation with the different instruments, and to detect differences in accuracy between the EALs tested under the same conditions, before and after cervical preparation. The level of significance was established at P< 0.05.

RESULTS

The number of canals with accurate and inaccurate measurements, and the percentage of accurate values for each EAL, before and after cervical preparation are shown in Table 1.

A significant increase in accuracy performed by Joypex 5 was observed after cervical preparation with drill LA-Axxes (P = 0.01).

Both EALs presented accuracy concerning all canals that were measured after cervical preparation with the S1 and Sx by ProTaper system, without statistical difference between them.

When comparing the EALs evaluated under the same conditions, before and after the cervical preparation with the different instruments, there was no significant difference between them (P > 0.05).

Table 1. Number of canals (n = 15) with accurate (≤ 0.5 mm) and inaccurate measurements (> 0.05 mm) and percentage (%) of accurate results for each EAL, before and after the cervical preparation with the drill LA-Axxess n° 1 and S1 and SX by Pro-Taper instruments.

Measurements	LA-Axxess n° 1				ProTaper S1 e SX			
	Before Preparation		After Preparation		Before Preparation		After Preparation	
	JYP ^B	RZM	JYP ^A	RZM	JYP	RZM	JYP	RZM
≤0.5 mm	7	9	14	13	12	12	15	15
> 0.5 mm	8	6	1	2	3	3	0	0
% of accurate results	46.6%	60%	93.3%	86.6%	80%	80%	100%	100%

Note: JYP = Joypex5; RZM = mini Root ZX; Intragroup comparisons: McNemar's test, P <. 01. Different capital letters indicate significant differences regarding the same locator, before and after each type of cervical preparation; intergroup Comparisons: McNemar's test, P >0.05.

DISCUSSION

Cervical preparation is an essential step during endodontic treatment because it facilitates the reach and the action of instruments in the apical third¹⁴⁻¹⁶. However, whether enlargement of the cervical third and the type of instrument that is used to accomplish this task are able to significantly affect the precision of the EALs is not yet clear in the literature.

According to the results obtained in this study, it was possible to observe that the use of the drill LA-Axxess in cervical preparation significantly increased the number of accurate measurements for Joypex 5 (Table 1). This increase is similar to those found in previous studies that used other EALs^{15,20-21}. This result can be due to a better adjustment of the file to the apical third²⁶, promoting less exposure of metallic surface to the surrounding electrolyte and allowing the impedance reading in that region to be more effective¹⁰.

The cervical preparation performed by the mechanical instruments S1 and Sx by ProTaper system promoted 100% accuracy in the measurements performed with the evaluated EALs; however, there was no statistically significant difference between them and the control group.

In order to be classified as accurate, the required difference between the real and the electronic measurement must be ≤ 0.5 mm; this method was considered to be highly accurate in previous studies^{22,27}. According to the results obtained in this study, and also according to other similar studies, the tolerance range was adopted and allowed to observe that after cervical preparation the devices used were highly effective^{21,27}. In addition, no cases of over extension were observed, which was similar to the results found by Brito Junior et al.²¹.

The option to assess the accuracy of the EALs at major foramen level (0.0 mm) was based on studies that obtained satisfactory results using that limit, since the chances of obtaining diverging LRC measurements are higher as there is an increase in the distance between the tip of the file and this limit^{12,22}. In order to avoid a distortion in the measurement, it is recommended to use the EAL until its display shows "APEX" or 0.0 mm. Afterwards, 1 mm should be subtracted from the obtained

measurement before beginning endodontic treatment⁵.

The experimental models used in ex vivo research aimed at evaluating the accuracy of EALs must simulate clinical situations to reproduce the impedance values in human tissue²¹. For this reason, the material that is commonly used is 1% agar, saline solution, alginate, gelatin or sponge soaked in saline solution^{10,24}. In this study, the teeth were embedded in alginate to perform the measurements, as this Protocol facilitates samples preparation, provides high degree of stability, and leads to accurate measurements^{20,22}. Furthermore, it is reported to be the most reliable and reproducible method²⁴. Alginate is able to simulate the periodontal ligament due its relative rigidity, favorable electrical conduction properties and jelly-like consistency, which together allow the circulation of the ions²⁴.

The results were obtained by a single operator. This was the chosen protocol based on previous studies, which reported significant differences regarding LRC measurements when they were carried out by more than one operator, possibly leading to false results⁷. The difference between operators may be related to their ability and experience in using EALs or to limitations of the electronic device itself⁷.

CONCLUSION

Cervical preparation performed with the drill LA-Axxes increased the accuracy of the Electronic Apex Locator Joypex 5. Both EALs presented similar precision after cervical preparation, regardless of the instrument used.

Collaborators

BM GUIMARÃES and MAH DUARTE have substantial contributions to the design of the study and its approval by the Committee for Ethics in Research, data acquisition and interpretation of data, and wrote the paper. T TARTARI performed statistical analysis. SL FERNANDES was also responsible for interpretation of data and wrote the paper. DF ODA contributed to the design of the study and its approval by the Committee for Ethics in Research and interpretation of data. CM BRAMANTE performed the study design and and revised the final version to be published.

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