

THE ACCURACY OF WORKING LENGTH DETERMINATION DURING ENDODONTIC RETREATMENT

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Abstract:

Aim. Endodontic retreatment requires complete removal of contents from the root canal and the orthograde endodontical approach of the whole system. Restoring access to the entire length of the canal will allow the action of the irrigation solution and the intracanal medicaments, thus facilitating the success of this approach.

Methods. For this in vitro study were selected 30 maxillary anterior teeth, with fully formed apices, no root defects and intact crowns. The teeth were instrumented and filled by cold lateral condensation and then retreated, according to the protocol established for this experiment. After the endodontic retreatment the working length was determined using direct and electronic methods, the values being recorded and compared. Were used the following electronic apex locators: Root ZX(J. MoritaCorp.FGM, Kyoto, Japan), Element Diagnostic Unit(SybronEndo, SybronDental, Anaheim, CA, USA), ProPex(Dentsply MailleferSwitzerland), i-Pex(NSK, NakanishiInc., Japan).

Results. To validate the results, the measurements were recorded by two independent observers, all the values being placed in a statistical analysis program. The working lengths were analyzed aiming to evaluate the apex locators's performances, reported to the initials values and the specific endodontic retreatment implications. Accuracy of determinations was 96.6% (n29) for Morita, 93.3% (n28), 90% (n26) for Propex and 86.66% (n27) for I-pex.

Conclusions. The apex-locators can be used successfully to determine the working length in endodontic retreatment. Determinations were not influenced by root canal sealer or gutta-percha. The file used to determine the working length is preferable to have an ISO size closer to apical constriction diameter, in order to obtain an accurate determination. Desing's display and individual scale models may affect the accuracy of the results till the practitioner get used to an apex-locator.

Keywords: endodontic retreatment, maxillary anterior teeth, apex locators

INTRODUCTION

Endodontic retreatment requires complete removal of contents from the root canal and the orthograde endodontical approach of the whole system. Restoring access to the entire length of the canal will allow the action of the irrigation solution and the intracanal medicaments, thus facilitating the success of this approach. The first step towards a favorable prognosis is establishing the correct working length (WL) in both endodontic treatment and retreatment. Electronic methods for determining the working length (apex-locators) eliminate some of the errors caused by X-ray examination used to determine the working length.

These devices can measure the length of the canal until the apical foramen, not to the radiological apex and

the newer generations are intended to measure even the apical constriction. Our study aimed to determine the performances of four electronic apex locators during endodontic retreatment which may require the presence of remnants of sealer, gutta-percha fragments or dentinal debris.

METHODS

A total of 30 maxillary anterior teeth with fully formed apices, no root defects and intact crowns were selected for this study. In the phase I of the study, the 6th year dental students from Carol Davila University, Bucharest, prepared these teeth following the next protocol: Rx preoperatively radiographs, preparation of access cavities, removing the pulp tissue, establishing apical patency with a size 10 file, a radiograph with the initial file,

determining working length, the root canal instrumentation using different techniques (step-back, crown-down, manual version of ProTaper), filling by cold lateral

condensation using Endofill as a sealer, another radiograph after filling the root canals, retreatment and again the teeth were radiographed (Photo 1)



Photo 1. Phase I of the study.

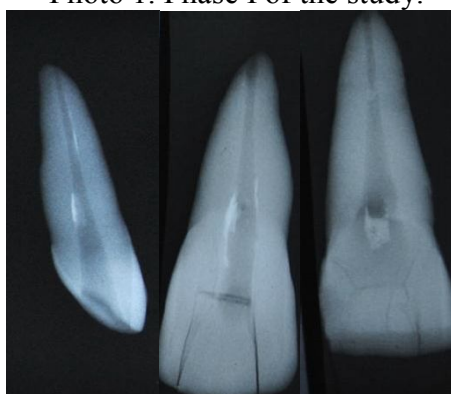


Photo 2. Residuum of root canal sealer or gutta-percha after retreatment.

Phase II - to establish the working length using an operative microscope with a magnification of 8.5 by observing the tip of a size 15 Kerr file touching the apical foramen, followed by a slow withdrawal. These values will be treated as a control group, real length (AL)

Phase III - four independent investigators who had no access to the data recorded in the previous stages, determined and measured the working length using the following electronic apex

locators: Root ZX II (J. Morita Corp. FGM, Kyoto, Japan), Element Diagnostic Unit (SybronEndo, Sybron Dental, Anaheim, CA, USA), ProPex (Dentslpy Maillefer Switzerland), I-Pex (NSK, Nakanishi Inc., Japan). Determination was done by setting the teeth in a device that reproduces the apical tissue emerged in a 0.9% saline solution. The root canal was irrigated with 0,1 ml of the same saline solution.



Photo 3. Element Diagnostic Unit (SybronEndo, Sybron Dental, Anaheim, CA, USA), I-Pex (NSK, Nakanishi Inc., Japan), Root ZX II (J. Morita Corp. FGM, Kyoto, Japan), ProPex (Dentslpy Maillefer Switzerland).

For an accurate determination we used the “double-blind” method, for each apex locator the measurements were obtained from two independent investigators until the “00” value, displayed on the screen, and their average was considered and recorded as a fair value. Was made with an file Kerr ISO 15.

RESULTS

The recorded data was statistically analyzed with one-way ANOVA and Tukey multiple range test nonparametric correlation among groups. Statistical significance was considered when $P < 0.05$.

Dist. from AL (mm)	E.D.U.A.L. n(30)	Root ZX II n(30)	i-Pex n (30)	ProPex n(30)
-1 < -0.5	1	0	1	2
-0.5 > 0	10	19	15	17
0 > 0.5	18	10	11	10
0.5 > 1	1	1	3	1

Table #1. The determination accuracy

Descriptive Statistics

	Sample Size	Mean	Standard Deviation	SE of Mean
E.D.U.A.L	30	0.2816	0.60964	0.08622
Root ZX II	30	0.1461	1.24918	0.17666
i-Pex	30	0.31	1.34062	0.18959
ProPex	30	0.1161	0.92831	0.13128

Table #2. The mean and standard deviation from the actual length (AL)

Tukey Test

	MeanDiff	SEM	q Value	Prob	Alpha	Sig	LCL	UCL
Root ZXII Edual	-0.1355	0.21427	0.89432	0.92149	0.05	0	-0.69071	0.41971
i-Pex Edual	0.0284	0.21427	0.18745	0.99917	0.05	0	-0.52681	0.58361
i-Pex Root ZX II	0.1639	0.21427	1.08177	0.87013	0.05	0	-0.39131	0.71911
Propex Edual	-0.1655	0.21427	1.09233	0.86684	0.05	0	-0.72071	0.38971
ProPex RootZXII	-0.03	0.21427	0.19801	0.99902	0.05	0	-0.58521	0.52521
ProPex i- Pex	-0.1939	0.21427	1.27978	0.80223	0.05	0	-0.74911	0.35131

Table #3. The comparative statistics for the four analyzed apex-locators.

The accuracy of the measurements was determined from the established length using a microscope (AL) 0 ± 0.5 mm (Table #1) and was of 96,6% (n29) for Root ZX II, 93,3% (n28)

E.D.U.A.L, 90% (n26) ProPex and 86.66% (n27) i-Pex.

The mean of the recorded values was 0.1416 (SD-1.249) for Root ZX II, 0.2816(SD-0.609) for E.D.U.A.L, .1161

(SD- 0.928) for Propex and 0.31 (SD- 1.340) for i-Pex (table #2).

The comparative statistics for the four analyzed apex-locators is in table #3.

DISCUSSIONS

The apical constriction is the ideal and recommended end-point for instrumentation and canal filling. It is located about 0.5–1 mm from the major foramen. The foramen does not coincide with the anatomical apex; it might be located laterally and in a distance of up to 3 mm from the anatomical apex (Dummer 1984).

Recently developed electronic apex locators are based on the measurement of alternating current impedance. For that, two or more different frequencies are used and processed using different mathematical algorithms (11).

Modern apex locators are able to determine an area between the minor and major apical foramina by measuring the impedance between the file tip and the canal with different frequencies and enables tooth length measurements in the presence of electrical conductive media in the root canals.

Root ZX (J. Morita, Tokyo, Japan) works on the principle that two electric currents with different sine wave frequencies will have measurable impedances that can be measured and compared as a ratio regardless of the type of electrolyte in the canal. The capacitance of a root canal increases significantly at the apical constriction, and the quotient of the impedances reduces rapidly as the apical constriction is reached. Root ZX II is the latest model of Morita Company. There are many researches ex vivo and in vivo that prove the accuracy of this machine. In our research, the accuracy ± 0.5 from the AL 96.6%. The performance of RootZX have been appreciated at 97.37% (4,6,9,10) and 96,2-82,3% (12).

Elements Diagnostic Unit and Apex Locator (SybronEndo, Anaheim,CA,

USA). The device does not process the impedance information as a mathematical algorithm, but instead takes the resistance and capacitance measurements and compares them with a database to determine the distance to the apex of the root canal. A literature search revealed ex vivo studies evaluating the accuracy of the Elements Diagnostic Unit and Apex Locator 94.28% (8) and 96,2%- 82.3% (5). Our results for Elements Diagnostic Unit and Apex Locator are 93,3% ± 0.5 from the AL.

ProPex (Dentsply Maillefer, Ballaigues, Switzerland) is a multi-frequency based apex locator which is based on the same principles of the other modern devices which use multiple frequencies to determine root canal length. One important characteristic of ProPex is that the calculation is based on the energy of the signal where the other apex locators usually use the amplitude of signal. There aren't many studies on ProPex, but we have found the accuracy being 90%. Yet, W. Fan (7) reported the accuracy 75-100% and Plotino (8) registered 35.9% of the measurements within 0.5 mm short of the AL and 64.1% within 0.5 mm long of the AL.

By de Vasconcelos (3) in an in vivo study the rapport the accuracy 98.28% for i-Pex. Our ex vivo study discovered an accuracy of 86,66% for i-Pex ± 0.5 from AL.

CONCLUSIONS

Modern apex locators are able to determine an area between the minor and major apical foramina by measuring the impedance between the file tip and the canal with different frequencies and enables tooth length measurements in the presence of electrical conductive media in the root canals.

The apex-locators can be successfully used to determine the working length in endodontic retreatment. Determinations were not influenced by

root canal sealer or gutta-percha. The file used to determine the working length is preferable to be an ISO size closer to apical constriction diameter, in order to obtain an accurate determination.

Desingn's display and individual scale models may affect the accuracy of the results till the practitioner get used to an apex-locator.

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