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AINSHAMS DENTAL
JOURNAL

Print ISSN 1110-7642

Online ISSN 2735-5039

AIN SHAMS DENTAL JOURNAL

Official Publication of Ain Shams Dental School

December 2020 • Vol. XXIII

ACCURACY OF TWO ELECTRONIC APEX LOCATORS IN DETERMINING SIMULATED ROOT PERFORATION (IN VIRTO STUDY)

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Abstract

Objective: to evaluate the influence of sodium hypochlorite 5.25% NaOCl and chlorohexidine 2% CHX irrigants on the accuracy of Root ZX mini and SIROEndo pocket apex locators in locating cervical and apical simulated root perforation.

Materials and methods: Eighty recently extracted straight fully formed single rooted mandibular premolars, radiographically examined to confirm the presence of single patent canal. Using rotary diamond disc teeth will be decoronated below cemento-enamel junction to provide y access to the canal e and to obtain a constant reference point. The teeth specimens will be then divided into two groups (40 each) according to apex locators used (GROUP I): Root ZX mini apex locator (GROUP II): SIROEndo pocket apex locator Each group will be further classified into 2 subgroup (20 each) according to site of perforation: (Sub-group A): cervical perforation (Sub-group B): apical perforation. And each sub-group will be further classified into 2 subgroups (10 each) according to type of irrigant used: (Sub-group 1): NaOCl 5.25% (Sub-group 2): CHX 2%.

Results: It was found that regarding to site of perforation: detection of apical perforation was statistically significant in comparison to coronal one, regarding to type of irrigant :it was found that in presence CHX of was statistically significant in comparison to in the presence of NaOCl and regarding to the efficacy of EALs: Root ZX mini apex locator was not statistically significant in detection of perforation in comparison to SIROEndo pocket apex locator.

Conclusion: Both EALs were capable in detection of root perforation. Position of perforation affect the ease of its detection, Detection of perforation is more accurate in presence of CHX.

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Introduction

Root perforation is a non-anatomic mechanical or pathological communication between the root canal system and periodontal tissues. Although caries or resorptive processes may cause perforations, they are usually iatrogenically induced which occur approximately 2% to 12%, and they have a negative effect on the long-term prognosis of the tooth after root canal treatment. Root canal treatment perforations may occur at access opening, canal orifice search, excessive dentin removal in danger zone, misdirected files during canal negotiation, unsuccessful attempts to bypass separated instruments and misaligned instruments during post-space preparation. So clinical diagnosis of location of perforation is mandatory in order to minimize the probability of extruding of various irritating materials used during root canal treatment procedure and prevent instrumentation beyond perforation site (1, 2) EALs is useful and reliable method of detecting root perforation as latest generation of EALs measure alternating current impedance at 2 or multiple different frequencies and they can work in the presence of various intra-canal contents and irrigants. Root ZX mini® (Morita Co, Kyoto, Japan) and SIROEndo Pocket® (Sirona Dental System GmbH Co, Bensheim, Germany) are two modern EALs.

Evaluation the accuracy of Root ZX mini® and SIROEndo pocket ®devices in detecting simulated root perforations under various canal conditions seems to be of great interest.

Materials and Methods

Sample selection: Eighty recently extracted straight fully formed single rooted mandibular premolars were used. Roots with caries, internal or external resorption, fractures, or open apex were excluded from this study. Each tooth was radiographically examined to confirm the presence of single patent canal then were decoronated below cemento-enamel junction using rotary diamond disc, to provide easy access to the canal space and to obtain a constant reference point for all measurements. They were randomly divided into two equal groups (40 teeth each) according to apex locators used:

- GROUP I: Root ZX mini apex locator.
- GROUP II: SIROEndo pocket apex locator.

Each group was then randomly classified into two equal sub-group (20 teeth each) according to site of perforation:

- Sub-group A: cervical perforation.
- Sub-group B: apical perforation.

And each sub-group was further classified into two sub-divisions (10 teeth each) according to type of irrigant used:

- Sub-division (1): NaOCl 5.25%
- Sub-division (2): CHX 2%

Statistical analysis:

The obtained data were collected; tabulated and statistically analyzed. Values were presented as mean, standard deviation (SD) values and confidence interval. The significance level was set at $p \leq 0.05$.

Results:

It was found that regarding to site of perforation: detection of apical perforation was statistically significant in comparison to coronal one, regarding to type of irrigant :it was found that in presence CHX of was

statistically significant in comparison to in the presence of NaOCl and regarding to the efficacy of EALs: Root ZX mini apex Table 1 Comparison difference between actual and electronic length showing the effect of irrigation on apical perforation

locator was not statistically significant in detection of perforation in comparison to SIROEndo pocket apex locator.as seen in table and graph.

Table1: Comparison difference between actual and electronic length showing the effect of devices

		Root ZX mini apex locator	SIROEndo pocket apex locator	p-value
Apical	NaOCl	0.95±0.50	1.00±0.41	0.809ns
	CHX	0.85±0.34	0.65±0.53	0.327ns
Cervical	NaOCl	0.25±0.35	0.30±0.42	0.777ns
	CHX	0.40±0.39	0.35±0.34	0.305ns

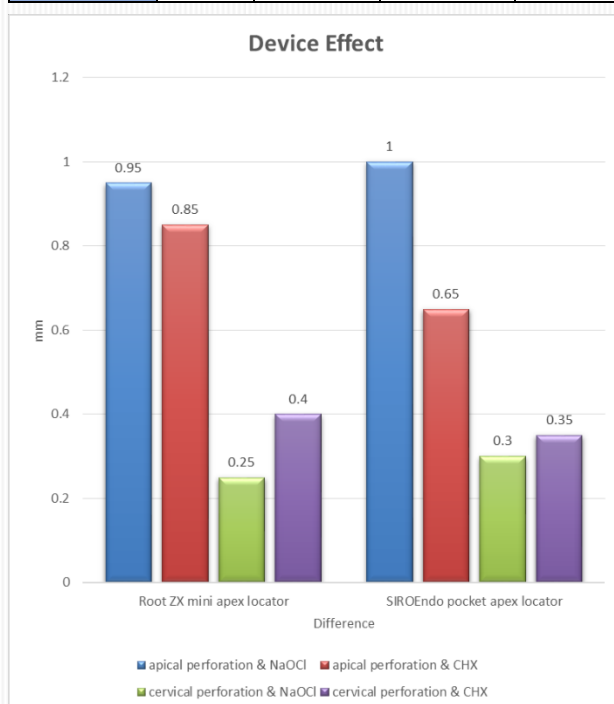


Table 2 Comparison difference between actual and electronic length showing the effect of irrigation on apical perforation

	NaOCl	CHX	p- value
Root ZX mini apex locator	0.95±0.50	1.00±0.41	0.605ns
SIROEndo pocket apex locator	0.85±.34	0.65±.53	0.115 ns

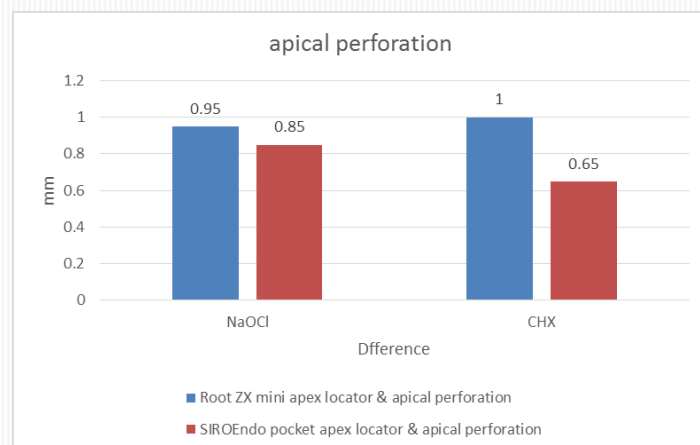


Table 3 Comparison difference between actual and electronic length showing the effect of irrigation on cervical

	NaOCl	CHX	p- value
ROOT ZX apex locator	0.25±0.35	0.40±0.39	0.382ns
SIROEndo pocket apex locator	0.30±0.42	0.35±0.34	0.773 ns

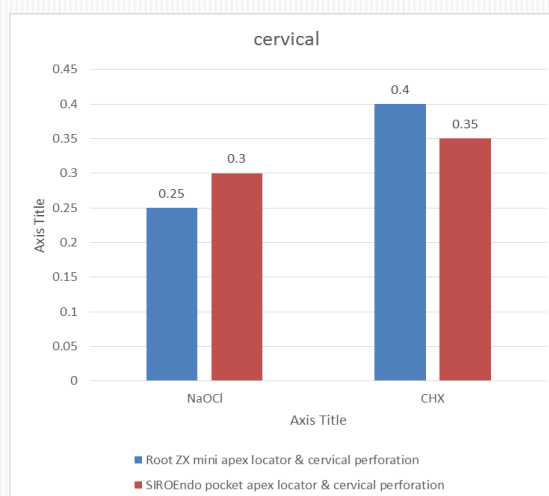


Table 4 Comparison difference between actual and electronic length showing the effect of perforation site on NaOCl irrigation

	Apical perforation	Cervical perforation	P value
Root ZX mini apex locator	0.95±0.50	0.25±0.35	0.002*
SIROEndo pocket apex locator	1.00±0.41.	0.30±0.42	0.001*

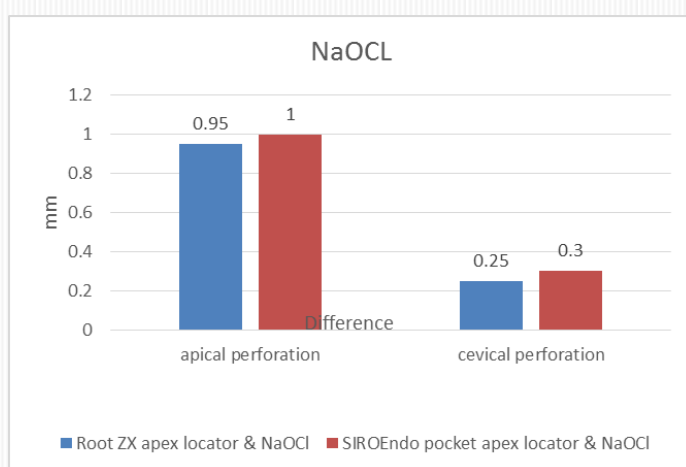
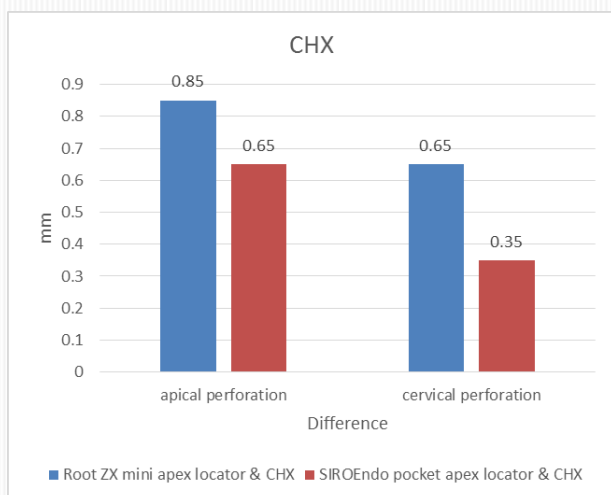


Table 5 Comparison difference between actual and electronic length showing the effect of perforation site on CHX irrigation

	Apical perforation	Cervical perforation	P value
Root ZX mini apex locator	0.85±0.34	0.40±0.39	0.013*
SIROEndo pocket apex locator	0.65±.53	0.35±.34	0.148 ns



Discussion:

Diagnosis and treatment of root perforations is one of the most important and difficult problems. Proper diagnosis is critical to distinguish a perforation complication from clinical manifestations of periodontal and endodontic disease. Detection of root perforation along root surface is essential for successful treatment.

Successful treatment of root perforations depends on the location and size of the defect, the time between perforation and treatment, an accurate determination of the location and the sealing of the perforation site⁽¹⁾. Even for well-trained endodontists, root perforations in the buccal or lingual aspect of the root surface are difficult to diagnose radiographically⁽²⁾

the efficacy of apex locators as an aid in pinpointing root perforations has been tested experimentally in previous studies; the results have shown that EAL is an acceptable method for detecting root perforations under in vitro conditions^(3,7,14,15).

Moreover, radiographic method is subjected to interpretation bias (due to two-dimensional nature of the image and variation in apical extent of root in case of teeth with open apex or resorption) and shows anatomic noise (overlapping of various

anatomic structures like zygomatic arch, maxillary sinus etc.⁽¹⁶⁾

The root canal treatment depends mainly on chemical cleansing of root canal system with different irrigant solutions. The most common irrigant used is NaOCl with different concentrations. Also CHX is recommended as root canal irrigant. WL measurements tended to be slightly shorter in solutions of higher electrical conductivity, such as NaOCl and CHX solutions.

In present study, we used both irrigants -as for NaOCl- we used full concentration 5.25% -meanwhile for CHX – 2% concentration was used. In present study presence of NaOCl showed no significant effect on the accuracy of EALs in detection the root perforation as done in several previous studies. It is believed that the least significant impact is achieved when using the NaOCl solution regardless of its concentration. It comes from the fact that it is a solution characterized by high electrical conductivity and with the potential to penetrate into dentinal tubules and decrease electrical impedance of the root canal walls as well as generate better electrical contact with periapical tissues^(13,18) Recent studies reported that some physico-chemical properties of root dentin can be affected by sodium hypochlorite solution. Hence, it is possible that such change has influenced the

accuracies of the devices in present study⁽¹⁹⁻²¹⁾. Hence, NaOCl was used in different roots rather than those of CHX in order to avoid its effect on root dentin.

In present study, the presence of CHX irrigant showed no significant difference that may attributed to that CHX is liquid type endodontic irrigants which show good flow to reach the outer proximal root surface with higher accuracy in locating root perforation that present in proximal root plane. This means that the CHX solution resulted in the least variability in the performance of the devices as done in previous studies^(6,22) Which indicate that the electronic measurement in the presence of chlorhexidine can be performed safely.

Various electroconductive materials have been used such as agar-agar, alginate, gelatin, and a saline solution for in vitro evaluation of EALs in perforated teeth^(6-7,14). In this study, alginate was selected as the embedding medium to simulate the periodontium because it is easy to handle, rigid, has firm consistency that prevent intrusion of the material into perforation, remains around the root, simulates the periodontal ligament with its colloidal consistency, and presents suitable electroconductivity⁽²³⁾. The rigid alginate firmly supported the teeth and permitted experiment to be performed with the roots embedded.

In present study, the results showed that both EALs had no significant difference in detection of both perforations which is consistent with previous studies tested the same idea. Root ZX mini demonstrates consistent and accurate reading of root canal length and determination of apical constriction in presence of NaOCl and CHX^(4,5,6,7,9,10,11,14,15,23,24); in addition the presence of 2% Chlorhexidine in the root canal did not affect the accuracy of both EALs used in this study.

The precision of the electronic devices is based on the fact that the double-frequency devices possess a calibration that allows the indication of the variation of impedance relative values (quotient or difference) from the apical region, permitting the location of the instrument tip near 1 mm of the apical foramen, which is near to the apical constriction⁽¹⁰⁾

Many studies used an error range of ± 0.5 or ± 1.0 mm to assess the accuracy of the EAL Measurements obtained within this tolerance are considered highly accurate^(25,26) One reason cited for accepting a margin of error is the wide range seen in the shape of the apical zone.^(10,27) Moreover, average values within these tolerances were considered accurate and clinically acceptable because the relation between the rubber stop and the reference point, the rubber stop and the caliper, or the

file tip and the caliper was difficult to control visually. Additionally, it was challenging to visualize the exact point where the tip of the file reached the coronal border of the perforation site, even with magnification

Moreover, the site of perforation showed significant difference statistically in the results of this study. This was shown in presence of both irrigants with Root ZX mini groups and in presence of NaOCl in SIROEndo pocket group. This may be, in part, explained by that- at the apical perforation- root canal wall thickness is reduced during instrumentation, thereby decreasing the impedance^(28,30). Also it may be explained by that the canal was irrigated with NaOCl, which is highly electro-conductive and infiltrates into dentinal tubules resulting in reduction of electrical impedance of the root canal wall. Electro-conductive solutions may allow better electrical contact with the apical tissues⁽¹³⁾

Simulated perforations, which were created iatrogenically by a 1-mm diameter round bur, were considered unrealistic in 1 study⁽⁶⁾ and mentioned that when the diameter of the perforation was ≥ 0.8 mm, the EALs may be not accurate⁽³¹⁾ However, large defects on the root surface may occur as a result of resorption and the usage of coronal shapers or large files; they may also

arise during various intra-canal procedures for post -placement.

Conclusion:

Under the conditions of the study, the following was concluded:

1. Both EALs were capable in detection of root perforation.
2. Position of perforation affect the ease of its detection
3. Detection of perforation is more accurate in presence of CHX

References:

1. Estrela C, Decurcio D de A, Rossi-Fedele G, et al. Root perforations: A review of diagnosis, prognosis and materials. *Braz Oral Res.* 2018;32:133–46.
2. Gorni FG, Andreano A, Ambrogi F, et al.. Patient and Clinical Characteristics Associated with Primary Healing of Iatrogenic Perforations after Root Canal Treatment: Results of a Long-term Italian Study. *J Endod.* 2016;42:211–5.
3. Takeshita WM, Chicarelli M, Iwaki LCV. Comparison of diagnostic accuracy of root perforation, external resorption and fractures using cone-beam computed tomography, panoramic radiography and conventional & digital periapical radiography. *Indian J Dent Res.* 2015;26:619.
4. Khojastepour L, Moazami F, Babaei M, et al.. Assessment of Root Perforation within Simulated Internal Resorption Cavities Using Cone-beam Computed Tomography. *J Endod.* 2015;41:1520–3.
5. Piasecki L, Carneiro E, da Silva Neto UX, et al. The Use of Micro-Computed Tomography to Determine the Accuracy of 2 EALs and Anatomic Variations Affecting Their Precision. *J Endod.* 2016;42:1263–7.
6. Custer LE. Exact methods of locating the apical foramen. *J Natl Dent Assoc.* 1918;5:815–9.
7. Sunada I. New method for measuring the length of the root canal. *J Dent Res.* 1962;41:375–87.
8. Gordon MPJ, Chandler NP. EALs. *Int Endod J.* 2004;37:425–37.
9. Nekoofar MH, Ghandi MM, Hayes SJ, et al. The fundamental operating principles of electronic root canal length measurement devices. *Int Endod J.* 2006;39:595–609.
10. Stoll R, Urban-Klein B, Roggendorf MJ, J et al. Effectiveness of four EALs to determine distance from the apical foramen. *Int Endod J.* 2010;43:808–17.
11. Berenice R, Norberto J, Claudia A, Andaracua G. Accuracy of Root ZX mini and Raypex 6 in locating the apical foramen of molars: radiographic and microscopic evaluation. *RSBO Rev Sul-Brasileira Odontol.* 2015;12(3):239–46.
12. Duran-Sindreu F, Gomes S, Stöber E, Mercadé M, Jané L, Roig M. In vivo evaluation of the iPex and Root ZX electronic apex locators using various irrigants. *Int Endod J.* 2013;46(8):769–74.
13. Meares WA, Steiman HR. The influence of sodium hypochlorite irrigation on the accuracy of the Root ZX electronic apex locator. *J Endod.* 2002;28(8):595–8.
14. Ebrahim AK, Yoshioka T, Kobayashi C, Suda H. The effects of file size, sodium hypochlorite and blood on the accuracy of Root ZX apex locator in enlarged root canals: An in vitro study. *Aust Dent J.* 2006;51(2):153–7.
15. Zmener O, Grimberg F, Banegas G, Chiacchio L. Detection and

- measurement of endodontic root perforations using a newly designed apex-locating handpiece. *Dent Traumatol.* 1999;15(4):182–5.
16. KAUFMAN AY, FUSS Z, KEILA S, WAXENBERG S. Reliability of different electronic apex locators to detect root perforations in vitro. *Int Endod J.* 1997;30(6):403–7.
 17. Jadhav GR, Mittal P, Patil V, Kandekar P, Kulkarni A, Shinde S, et al. ORIGINAL ARTICLE , DENTAL MEDICINE Accuracy of Different Apex Locators in Teeth with Simulated Apical Root Resorption : an In Vitro Study. 2018;60(4):624–31.
 18. Jenkins JA, Walker WA, Schindler WG, Flores CM. An in vitro evaluation of the accuracy of the root ZX in the presence of various irrigants. *J Endod.* 2001;27(3):209–11.
 19. Janeczek M, Kosior P, Piesiak-Pańczyszyn D, Dudek K, Chrószcz A, Czajczyńska-Waszkiewicz A, et al. The Effect of File Size and Type and Irrigation Solutions on the Accuracy of Electronic Apex Locators: An in Vitro Study on Canine Teeth. *Biomed Res Int.* 2016;2016.
 20. Sayin TC, Serper A, Cehreli ZC, Otlı HG. The effect of EDTA, EGTA, EDTAC, and tetracycline-HCl with and without subsequent NaOCl treatment on the microhardness of root canal dentin. *Oral Surgery, Oral Med Oral Pathol Oral Radiol Endodontology.* 2007;104(3):418–24.
 21. Dogan Buzoglu H, Calt S, Gümüsderelioglu M. Evaluation of the surface free energy on root canal dentine walls treated with chelating agents and NaOCl. *Int Endod J.* 2007;40(1):18–24.
 22. Marending M, Luder HU, Brunner TJ, Knecht S, Stark WJ, Zehnder M. Effect of sodium hypochlorite on human root dentine - Mechanical, chemical and structural evaluation. *Int Endod J.* 2007;40(10):786–93.
 23. Marek E, Łagocka R, Kot K, Woźniak K, Lipski M. The influence of two forms of chlorhexidine on the accuracy of contemporary electronic apex locators. *BMC Oral Health.* 2019;20(1):1–8.
 24. Ebrahim AK, Wadachi R, Suda H. Ex vivo evaluation of the ability of four different electronic apex locators to determine the working length in teeth with various foramen diameters. *Aust Dent J.* 2006;51(3):258–62.
 25. Ikhar Y, Gade V, Patil S, Gade J. The Influence of Various Irrigants on The Accuracy of Third Generation Apex Locator And Fifth Generation Apex Locators In Locating Simulated Root Perforation: An In Vitro Study. *IOSR J Dent Med Sci e-ISSN [Internet].* 2019;18(7):86–91. Available from: www.iosrjournals.org
 26. Dunlap CA, Remeikis NA, Begole EA, Rauschenberger CR. An in vivo evaluation of an electronic apex locator that uses the ratio method in vital and necrotic canals. *J Endod.* 1998;24(1):48–50.
 27. Pagavino G. A SEM study of in vivo accuracy of the root ZX electronic apex locator. *J Endod.* 1998;24(6):438–41.
 28. Shabahang S, Goon WWY, Gluskin AH. An in vivo evaluation of root ZX electronic apex locator. *J Endod.* 1996;22(11):616–8.
 29. Orosco FA, da Silva GF, Weckwerth PH, Lopes MTM, Garcia AMR, Duarte MAH, et al. Influence of different sized files on the accuracy of two electronic apex locators. *Aust Endod J.* 2018;44(3):251–4.
 30. Iizuka H. on Electric Method for Measuring by Root Canal Length As a fundamental study on the electric method for measuring root canal length , the various factors which affect the measured impedance were

investigated using a wide range of frequencies . 1) The imp. 1987;1–8.

31. Herrera M, Ábalos C, Lucena C, Jiménez-Planas A, Llamas R. Critical diameter of apical foramen and of file size using the root ZX apex locator: An in vitro study. J Endod. 2011;37(9):1306–9.



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