https://doi.org/10.333279/jkcd.v13i2.181

CHOICE OF IRRIGANT SOLUTION FOR ACCURATE MEASUREMENT OF ROOT CANAL WORKING LENGTH BY ELECTRONIC APEX LOCATOR IN EXTRACTED HUMAN TEETH

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ABSTRACT

Objectives: *To compare the mean working length (in terms of accurate length) with different intra-canal irrigant solutions in extracted teeth.*

Materials and Methods: *This experimental ex-vivo study was conducted in the Operative Dentistry Department at Rehman College of Dentistry Peshawar, from January 2019 to June 2019. Sample size of 120 extracted single-rooted human permanent teeth were selected. The Actual root canal lengths and electronic lengths were calculated in an ex-vivo model using alginate as a medium to replicate periodontal tissues in the presence of irrigants for each group. All readings were recorded in the Performa. Data was analysed using SPSS version 17 for descriptive statistics. One way ANOVA was used to compare the four groups for overall irrigant effect. For all comparisons, statiscal significance was considered at $p<0.05$.*

Results: *There was a statistically significant difference in the means of actual length and electronic lengths as determined by one-way ANOVA (P=0.001). In terms of accuracy, 2% CHX was most accurate showing a difference of -0.18 between actual and electronic lengths as compared to 17% EDTA -0.47, 5.25% NaOCl -0.53 and normal saline -0.53.*

Conclusion: *It can be concluded that Root ZX can be safely used to determine WL within $\pm$ 0.5mm of the actual length. Among irrigating solutions, Root ZX EAL gave best results with chlorhexidine gluconate.*

Key words: *Root canal treatment, Working length, Electronic apex locator, Irrigating solutions, Sodium hypochlorite, Chlorhexidine*

INTRODUCTION

Endodontic therapy is a sequence of treatment for infected/inflamed and necrotic pulp, that involves removal of infected/inflamed or necrotic pulp tissues, the subsequent shaping and decontamination of pulp space and ultimately the obturation (filling) of the decontaminated root canal system[1]. Establishment of correct working length (WL) is the key for successful root canal treatment[2,3]. Working length is the distance from coronal reference point to the apex at which root canal shaping and filling should terminate[4]. Endodontic therapy should take place inside the root canal system, thus preserving the apical periodontal tissues[5,6].

Traditional methods for WL estimation includes radiography, anatomical averages, tactile sensation and paper point method[7]. Radiographs are most commonly used for WL determination. They are advantageous as they determine the root canal anatomy, health of periapical tissues, restorability of tooth and aids in assessing the resorptive lesions and calcified

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canals[7].Electronic apex locators (EAL's) overcome problems related to the use of radiographic method. They are easy to operate, can help to identify the apical constriction area, decrease procedure time, and also reduce x-rays dose[8,9]. 3rd apex locator works on the principle of Comparative impedance[10].

The accuracy of the apex locators may, however, get influenced by dry or wet condition of the canal. In a study by Irfana et, al,[11] the electronic WL readings in the canals filled with chlorhexidine irrigant gave highest proportion of exact co-incidence (42.5%) to actual WL and lowest in the presence of sodium hypochlorite (0.00%) irrigant solution. These findings were similar to studies performed by Fan et, al[12] and Ozsezer et, al[13] respectively.

In contradict of the above-mentioned results, in a research study carried out by Ana laura et, al[2] the electronic readings were closer to the gold standard regardless of the irrigating solutions. A research study by Prasad et, al[14] showed similar results.

The rationale of the present study is to determine the effect of different root canal irrigant solutions on accuracy of electronic determination of WL. It will contribute to the literature on regional basis as scarce literature is available in our region regarding influence of different irrigant solutions on electronic measurement of working length. It will help the clinicians to focus on selection of intra-canal irrigants while recording the electronic measurement of root canals because correct working length is the key to successful endodontic treatment.

MATERIALS AND METHODS

This experimental ex-vivo study was conducted in the Operative dentistry department at Rehman College of Dentistry Peshawar, from January 2019 to June 2019 after seeking approval from ethical committee (EC Ref No:RCD-18-09-103).

Sample size was calculated using WHO sample size calculator V.2.0 (1.1) with 95 % confidence interval and 90 % power of study by using statistics of electronic WL of sodium hypochlorite (NaOCl) of 18.84+2.5313 and 19.33+2.50 for Chlorhexidine13. Non-probability sampling technique was used. Sample size of 120 single-rooted human permanent teeth which were scheduled for extraction, were selected. Teeth with mature/closed apices, assessed on peri-apical radiographs and teeth with no previous endodontic treatment, depicted on peri-apical radiographs were included in the study. Excluded cases were; teeth with root resorption, canal calcification, extensive peri-apical lesions, severe curvature of root canal evaluated on peri-apical radiographs and retreatment cases.

Decoronation of teeth was carried out at the level cemento-enamel junction (CEJ). The actual lengths were measured by use of the dental loupes (magnification level 3.5X), a 10 K file was inserted into the root canal till it reach the apex and a rubber stop was positioned at coronal reference point (CEJ). The distance between base of silicone rubber-stop and tip of the file was measured on calliper. The WL was then be established 0.5mm shorter than the measured distance. Coronal pre-flaring was accomplished using #1, # 2 and # 3 gates-glidden drills. Subsequently, in a plastic container, alginate was poured and teeth were embedded into the alginate at room temperature. Third generation apex locator i.e. Root ZX was used. Initially the electronic measurement was recorded in dry state of canal. # 15k file with clip of the apex locator was inserted inside the canal until the EAL shows 0.00 readout. The file was then retrieved to the 0.5 mark on the readout, silicone rubber stop was adjusted on reference point. The distance between base of silicone rubber stop and tip of the file was measured on calliper and recorded in millimetres. Electronic measurements were repeated as mentioned above, by filling the canals with following irrigation solutions: 0.5 % saline 5.25% sodium hypochlorite, 17 % EDTA and 2% chlorhexidine gluconate solution. One trained examiner carried out this procedure to avoid inter-examiner variability.

Data was analysed using SPSS ver 17. Mean and standard deviation of actual length and electronic measurements in the presence of different irrigation solutions was calculated. Comparison of mean actual and electronic lengths of the four irrigants solutions was carried out using one-way ANOVA test. P-value < 0.05 was considered significant.

RESULT

Sample size of 120 single-rooted extracted human permanent teeth were selected. Statistical analysis was compiled. Mean and standard deviation of actual length and electronic measurements in the presence of four different irrigating solutions

is shown in Table 1. In terms of accuracy, 2% CHX was most accurate showing a difference of -0.18 between actual and electronic lengths as compared to 17% EDTA -0.47, 5.25% NaOCl -0.53 and normal saline -0.53. (Table.2). There was statistically significant difference in the means of actual length and electronic measurements in the presence of all the four irrigants as determined by one-way ANOVA (p=0.001) (Table. 3).

Table 1: Mean and standard deviation of actual length and electronic measurements in the presence of different irrigation solutions

	N	Mean	Std.Deviation
Actual_length	120	9.63	1.28
Saline	120	9.09	1.28
NAOCL	120	9.09	1.33
EDTA	120	9.15	1.41
CHX	120	9.44	1.37
Valid N (listwise)	120		

DISCUSSION

Working length is important in the root canal treatment and greatly affect success rate[15]. The present study utilized Root ZX, a 3rd generation EAL based on the principle of two different frequencies to find WL. It has been claimed that Root ZX requires no calibration, its readings remain unaffected by either dry or moist condition of canals and measurements are more precise. Considering these facts, this device was chosen to be used in the present study.

Complete debridement of the root canal system is considered impossible without chemically active irrigant solutions[16]. Different studies using advanced modalities such as Micro-CT have shown that the major portion of the root canal system remain untouched and uncleaned by the instruments and can be accessed only by irrigant solutions for thorough debridement. This has resulted in the use of variety of irrigants with variable electroconduction[17]. In present study, irrigation solutions that are contemporarily recommended are used.

Table 2: Paired Sample T-test

Paired Differences									
					95% Confidence Interval of the Difference				
		Mean	Std.Deviation	Std.Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Saline-Actual length	-0.53	0.35	0.32	0.59	-0.47	-16.53	119	0.01
Pair 2	NAOCL-Actual length	-0.53	0.35	0.32	0.59	-0.47	-16.18	119	0.02
Pair 3	EDTA-Actual length	-0.47	0.36	0.33	0.54	-0.41	-14.45	119	0.03
Pair 4	CHX-Actual length	-0.18	0.28	0.26	0.23	-0.13	-7.12	119	0.01

Table 3: ANOVA

		df	Mean Square	F	Sig.
Saline	Between Groups	5	36.11	285	0.01
	Within Groups	114	0.127		
	Total	119			
NAOCL	Between Groups	5	39.72	326.6	0.02
	Within Groups	114	0.122		
	Total	119			
EDTA	Between Groups	5	44.31	354.4	0.01
	Within Groups	114	0.12		
	Total	119			
CHX	Between Groups	5	42.82	541.94	0.01
	Within Groups	114	0.79		
	Total	119			

Sodium hypochlorite (0.5 % to 6%) is the widely used irrigant in root canal therapy. It dissolves necrotic as well as vital tissue and is a potent antimicrobial agent[18]. Successful irrigation without the use of sodium hypochlorite is not possible. In a study by Weiger et al[19], accuracy of Root ZX was demonstrated to be 95.7 % within + 1mm in the presence of 1% NaOCl. In our study, 5.25% NaOCl was used, there was mean difference -0.53 between actual lengths and electronic measurements. This difference in the result of previous study is due to use of different type of teeth and strength of the irrigant. In our study, recordings matched less precisely to actual WL in the presence of sodium hypochlorite. This was in accordance to the study carried out by Shin et al[20]. This could be explained on the basis that the presence of conductive fluids in the canals decreased the accuracy of apex locators. According to Reynoso et al.[21] NaOCl had higher conductivity than CHX. In another study by Pilot and Pitts[22] in 1997, in which conductivity testing of some irrigants was done found out that NaOCl was the most conducting endodontic solution. The conductivity of root canal irrigants from most to least are as following. 5.25% NaOCl solution, 17% EDTA solution, 2% chlorhexidine, normal saline and finally RC prep, and 70% isopropyl alcohol[23].

Chlorhexidine gluconate is a broad-spectrum antimicrobial agent. It does not have any bad taste, but it is unable to dissolve organic matter in the pulp space. In our study, the EAL measurements in the presence of 2% CHX showed best results as compared to other irrigants; giving a mean difference of -0.18 from the actual lengths. In an in-vitro study, Khatak et al[24] found 100% readings were in acceptable range when 2% CHX is used as an irrigant, which coincides with the result of our study. In another study by Padmanabh et al[25], the least effect on the accuracy of EAL was seen with 2% chlorhexidine followed by 17% EDTA, 3% NaOCl, and the highest effect was seen with 5% NaOCl, which is in accordance with the results of our study. This is because of lower electro-conductivity of CHX. However, a study conducted by Ghada et al[26] reported that 66% of the readings were in acceptable range with 2% CHX, which contradicts our results.

EDTA is used as an adjunct to NaOCl, to remove inorganic component of the smear layer. EAL can give short readings for canals containing strong electrolytes because only minimal changes occur in electrical impedance when the apical foramen is reached[27]. An vitro study conducted by Gilani S.D el al[28] showed that 17% EDTA was most accurate among other irrigants, showing a mean difference of -0.37 between actual lengths and electronic measurements. Our findings showed that electronic measurements in the presence of 17% EDTA resulted in a difference of -0.47 from the actual lengths. This difference in results could be due to different type of teeth and generation of EAL used in the studies.

CONCLUSION

On the basis of this study, it can be concluded that Root ZX can be safely used to determine WL within $\pm$ 0.5mm of the actual length, in the presence of chlorhexidine gluconate, EDTA, sodium hypochlorite and saline. Among irrigating solutions, Root ZX EAL showed best results in the presence of chlorhexidine gluconate, however recordings with saline and NaOCl matched less precisely with the actual length measurements. The alginate model was a suitable method for testing electronic apex locator in ex-vivo.

REFERENCES

1. Stallaert KM, Sigal MJ, Titley KC, Andrews PB. A retrospective study of root canal therapy in non-vital primary molars. Eur J Paediatr Dent 2016 Dec;17(4): 295-300.
2. Carvalho AP, Moura-Netto C, Albuquerque A,Marques MM, Davidioicz H. Accuracy of three electronic apex locators in the presence of different irrigating solutions. Braz Oral Res 2010, Oct-Dec;24(4):394-8.
3. Jain S, Kapur R. Comparative evaluation of accuracy of two different electronic apex locators in the presence of various irrigants: An vitro study. Contemp Clin Dent 2012 Sep;3 (2):140-5.
4. Eleazer PD, Glickman GN, McClanhan SB. Glossary of Endodontic Terms. 8th ed. Chicago: American Association of Endodontists; 2012. p.51.
5. Briseno-Marquin B, Frajlich S, Goldberg F, Willerhausen B. Influence of different instrument size on the accuracy of different apex locators: an in vitro study. J Endo 2008 Jun;34 (6):698-702.
6. Sui C, Marshall JG, Baumgartner JC. An in-vivo comparison of the Root ZX II, the Apex NRG XFR and Mini Apex locator by using rotary nickel titanium files. J Endod 2009 Jul;35 (7): 962-5.
7. Nayak G, Shetty S. Comparison between conventional radiography and radiovisiography with Raypex 5 apex locator for imaging root canal length. Int J Indian Dent

Assoc 2011;11:38-43.

8. Deepak BS, Subash TS, Narmatha VJ, Anamika T, Snehil TK, Nandini DB. Imaging technique in Endodontics. an overview. J Clin Imaging Sci 2012;2:13.
9. Nawab S, Ahmad-Rana MZ, Yar A. Comparative evaluation of working length with digital radiography and third generation apex locator. Pak Oral Dent J 2016;36(2):308-11.
10. Ali R, Okenchukn NC, Brunton P, Nattress B. An overview of electronic apex locators: part 2. Br Dent J 2013;214:227-31.
11. Khursheed I, Bansal R, Reddy KJ. A comparative evaluation of working length with digital radiography abd third generation apex locator (Propex) in the presence of various intra-canal irrigants: An in-vivo/ex-vivo study. Dent Rest J 2014 Jan-Feb;11(1):56-60.
12. Fan W, Fan B, Gutman JL, Bian Z, Fan MW. Evaluation of the accuracy of three electronic apex locators using glass tubules. Int Endod J 2006;39:127-35.
13. Osezer E, Inan U, Aydin U. an in-vivo evaluation of propex electronic apex locator. J Endod 2007;33:974-7.
14. Prasad AB, Harshit S, Aastha SA, Deepak R. An in-vitro evaluation of the accuracy of two electronic apex locators to determine working length in the presence of various irrigants. Ethiop J Health Sci 2016 Sep;26(5):457-62.
15. Kang JA, Kim SK. Accuracies of seven different apex locators under various conditions. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008 Oct; 106(4):e57-62.
16. Kaufman AY, Katz A. Reliability of Root ZX apex locator tested by an in-vitro model. Journal of Endodontics 1993, 19; 201.
17. Haapasalo M, Shen Y, Qian W and Gao Y. Irrigation in endodontics. Dental clinics of North America 2010; 54(2): 291-312.
18. Wrbas KT, Ziegler AA, Altengurger MJ, Schrimester JF. In vivo comparison of working length determination with two electronic apex locators. Int Endod J 2007; 40: 133-8.
19. Rocas IN, Siquerin JF. Comparison of the in vivo antimicrobial effectiveness of sodium hypochlorite and chlorhexidine used as root canal irrigants: a molecular microbiology study. Journal of endodontics. 2011; 37(2):143-150.
20. Weiger R, John C, Geige H, Lost C. an in vitro comparison of two modern apex locators. J Endod 1999; 25:765-8.
21. Shin HS, YangWK, Kim MR, Ko HJ, Cho KM, Park SH, et al. Accuracy of root ZX in teeth with simulated root perforation in the presence of gel or liquid type endodontic irrigant. Restor Dent Endod 2012; 37:149 54.
22. Reynoso RF, Nazario RN, Rodriguez J, Bittencourt BF, Dominguez JA. Influence of irrigant solutions and apex locators in working length determination. J Oral Health Dent Sci 2017;1:103.
23. Pilot TF, Pitts DL. Determination of impedance changes at varying frequencies in relation to root canal file position and irrigant. J Endod 1997;23:719 24.
24. Biradar B, Biradar S, Tandan M, Godara N, Arvind MS, Byakod P. Evaluation of influence of instrument size on the accuracy of three different apex locators in the presence of different irrigation solution in vital teeth: An in vivo study. Int J Sci Res 2020;9:75 8.
25. Khattak O. A comparative assessment of accuracy of electronic apex locators Root ZX in the presence of commonly used irrigating solutions. J ClinExp Dent 2014; 6:41-6.
26. Padmanabh Jha, Vineeta Nikhil, Shalya Raj, Rohit Ravinder, Preeti Mishra. Accuracy of electronic apex locator in the presence of different irrigating solutions. J Endodontology 2021;33(4): 233-6.
27. GhadaEM, Nagla AW. In vivo effect of different irrigants on the electronic determination of working length using a new vector based apex locators. Cairo Dental Journal 2008; 24:37-47.
28. Haapasalo M, Shen Y, Qian, Gao Y. Irrigation in endodontics. Dental clinics of North America. 2010; 54(2): 291-312.
29. Gilani SD, Kakakhel M.S, Khattak Y, Khattak S.R. Choice of irrigating solution for accurate measurements in endodontic procedures using a third generation apex locator (Root ZX). JKCD 2018; 8(3):7-12.