CHOICE OF IRRIGATION SOLUTION FOR ACCURATE MEASUREMENTS IN ENDODONTIC PROCEDURES USING THIRD GENERATION APEX LOCATOR (ROOT ZX)

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Abstract

Objectives: *(1). To measure overall variance in working lengths utilizing Root Zx in an ex vivo model using 5.25% Sodium hypochlorite, 2% Chlorhexidine, 17% EDTA and 0.9% Normal saline irrigation solutions. (2). To measure the difference in electronic and actual lengths within the same groups. (3). To identify optimal irrigation solution based on readings in an acceptable range.*

Materials & Methods: *In this experimental in vitro study conducted at Sardar Begum Dental Hospital Peshawar, 120 extracted single-rooted human permanent maxillary incisor teeth were selected and randomly divided into four groups (30 teeth each). A conventional access cavity was prepared in each tooth and potency of canal was determined. After coronal laring, Actual Lengths were calculated with the help of digital vernier calliper and magnification lopes. Electronic Lengths were calculated in an ex-vivo model using alginate as a medium to replicate periodontal tissue in the presence of irrigants for each group. All readings were recorded on Performa. All electronically measured lengths were compared to actual lengths, readings exceeding actual lengths were recorded positive, and those short of actual lengths were recorded negative. Data were analyzed using SPSS version 15.0 for descriptive statistics; one way ANOVA was used to compare the four groups for overall irrigant effect; the paired samples T-test was used to determine the accuracy of using different irrigants based on actual and electronic lengths. Cross-tabulation and Chi-square test was used for selection of the optimal irrigant based on categories of acceptability and safety. For all comparisons, statistical significance was considered at $p \leq 0.05$.*

Results: *All the four irrigants showed similar effects with no significant difference between the means of actual and electronic lengths (p=0.787). In terms of accuracy, 17% EDTA was most accurate showing a deference of -0.37mm between the actual and electronic lengths (p=0.052) 2% Chlorhexidine was considered the most appropriate based on 40% acceptable values*

Conclusion: *All four irrigation solutions showed workable effects; 2% Chlorhexidine was considered the most appropriate irrigant based on its readings in the acceptance range.*

Key Words: *Endodontics; Electronic Apex Locator, Irrigation Solutions, EDTA, Sodium Hypochlorite; Chlorhexidine.*

Introduction

The precise judgment of working length is a central determinant that influence the outcome of endodontic therapy[1]. Perseverance of biological length of root canal system enhances optimal healing. A major controversy and subject of debate for decades were where to end root canal therapy,

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in clinical practice consensus is on major apical foramen as a more consistent anatomical factor [2]. Different methods have been employed to determine the location; these included digital, tactile senses, average working length charts, and the paper point technique. All these methods had limitations. They have been reported to be unreliable and subject to marked intra-subject differences[3].

Challenges remained associated with the limitations of two-dimensional radiographic length determination. Radiographs are subject to distortion, magnification, interpretation variability, and lack of three-dimensional representation. If the major foramen deviates in the lingual or buccal plane, it is difficult to locate its position using radiographs, even with multi-plane angles[4].

Electronic apex locators evolved to overcome these shortcomings. First electronic apex locator was introduced in 1918 by Custer et al. His ideas were reinstituted by Suzuki and Sunada .5since then, the electronic apex locator has assessed working length more accurate and predictable. Root Zx (J. Morita Mfg Corp. Kyoto, Japan) is 3rd generation electronic apex locator; it works on the principle of impedance ratio method, that is a significant increase in capacitance and consequent decrease in impedance at apical foramen and expressing it in terms of files position. The accuracy of these Root Zx (J. Morita Mfg Corp. Kyoto, Japan) apex locators both in vivo and ex vivo ranges from 85% to 94%[6].

However, it has not been clarified whether the accuracy of the electronic apex locator would be influenced by the presence of irrigants. This question is particularly relevant to situations where the working length is monitored and verified by Electronic Apex Locators (EAL) periodically. It has been shown that root canal instrumentation leads to changes in working length (WL) by straightening of the canal during the treatment. Davies et al. recommended validating the WL after early coronal laring, late coronal laring, and before definitive instrumentation of the apical segment of the root[7].

The effect of irrigants on the accuracy of electronic apex locators is controversial. Doubt exists in the mind of operators as there is a lack of consistent and strong evidence that declares the role of irrigants (with different electro conductivities) on the accuracy and reliability of electronic apex locators. The true effects of various solutions are still debatable. Present evidence suggests a selection of EAL-specific irrigants for accurate outcomes. Therefore to bridge the gap of evidence the present study was conducted to ascertain the best irrigation solution to be used with Root ZX (J. Morita Mfg. Corp. Kyoto, Japan)and determine the efect of diferent electro-conductive solutions on its accuracy.

Materials and Methods

In this experimental in vitro study conducted at Sardar Begum Dental College from June 2015 to December 2015, 120 permanent, non-carious teeth with mature apices and single canals extracted due to periodontal reasons were selected.

Preparation: Teeth were stored in 10% formalin and 3% sodium hypochlorite solution for two weeks to clean the extraneous tissues and calculus, then were transferred to 0.9% saline solution before the test. All teeth were treated by the same operator.

The cusps and the incisal edges of the teeth were lattened with diamond burs to obtain a stable reference point for all the measurements. A standard access cavity was formed with the high-speed handpiece and a tapered issure bur (NSK, JAPAN) the pulp tissue was removed with barbed broaches. The canal orifices were identified, and a cervical third of each canal was lared with gates Glidden burs in a sequential manner to improve the access.

The Actual length of the canals was determined with a #15 ile (with a silicon stop) until the tip of the ile was visible at apical foramen under a ste - reomicroscope at 10x magnification. The distance of silicon stop to ile tip was measured with digital vernier callipers, and 0.5 mm was subtracted from it and registered as (AL) actual length.

In Vitro simulation was done using Kaufman et al[10]. Model, all teeth were embedded in the test apparatus. Alginate was poured in a plastic box, the teeth were embedded, and the lip clip electrode of Root Zx (J. Morita Mfg Corp. Kyoto, Japan) apex locator was inserted in alginate before setting.

For electronic measurements teeth were divided into four groups:

A. 5.25% Sodium Hypochlorite

B. 17% EDTA

C. 0.9% Normal Saline

D. 2% Chlorhexidine

The root canal of each tooth was illed by the respective irrigating solution. The excess solution was wiped dry with a cotton swab from the external surface of the teeth. The readings were taken by advancing 15 k-Flexoile till it read 0.0 on the electronic apex locator with a clear confirmatory beep sound. The root canal lengths of all teeth were recorded in the same manner and recorded on a Performa.

All measurements were then to be compared to actual canal length as the reference standard.

Results

All the four irrigants showed similar effects with no significant difference in the means of actual and electronic lengths p=0.787 (Table 1). In terms of accuracy, 17% EDTA group was most accurate showing a difference of -0.37mm between the actual and electronic lengths p=0.052, compared to 2% Chlorhexidine group-0.47, p<0.001, 0.9% Normal Saline group -0.49, p=0.008, and 5.25% Sodium hypochlorite group -0.67, p<0.001. (Table 2) For inal selection, 2% Chlorhexidine was considered the most appropriate based on 40% acceptable values, followed by 5.25% Sodium hypochlorite 16.7% acceptable values, 17% EDTA 13.3% acceptable values, and 0.9% Normal Saline 10.0% acceptable values. (Table 3)

Table 1: Anova

The diference in Length (Actual Length - EAL Length)	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.674	3	.225	.353	.787
Within Groups	73.925	116	.637		

The Sum of Squares between groups was 0.674, within the groups 73.925 and the total sum of squares was 74.599. F value is .353, comparing it with a p-value (level of significance) 0.05. Therefore, the difference between the groups was insignificant.

Table 2: Paired Sample T-Test

Irrigation Solution Used	Mean	Paired Diferences				t	df	Sig. (2-tailed)
		Std. Deviation	Std. Error Mean	95% Conidence Interval of the Difer - ence				
				Lower	Upper			
5.25 % Sodium Hypochlorite Pair 1 EAL'S Length - Actual Length of the Tooth	-.67333	.72060	.13156	-.94241	-.40426	-5.118	29	0.000
17 % EDTA Pair 1 EAL'S Length - Actual Length of the Tooth	-.37000	1.00074	.18271	-.74368	.00368	-2.025	29	0.052
2% Chlorhexidine Pair1 EAL'S Length - Actual Length of the Tooth	-.47333	.57472	.10493	-.68794	-.25873	-4.511	29	0.000
0.9% Normal Saline Pair 1 EAL'S Length - Actual Length of the Tooth	-.49000	.94736	.17296	-.84375	-.13625	-2.833	29	0.008

Two-tailed significance values 0.00, 0.00 and 0.08 which is less than alpha value of 0.05 shows the presence of sodium hypochlorite, chlorhexidine and normal saline groups had no statistically significant effects on electronically measured readings. EDTA group has two-tailed significance values of 0.05 which shows statistical significance.

Table 3: Irrigant Used * Diference categories Crosstabulation

Irrigants Used	Count /% within Irrigants Used	Diference Categories			
		-1.00 to 0.00	-1.01 and below	0.01 and above	Total
5.25 % Sodium Hypochlrite	Count	5	0	25	30
	% withinIrrigants Used	16.7%	.0%	83.3%	100.0%
17 % EDTA	Count	4	2	24	30
	% withinIrrigants Used	13.3%	6.7%	80.0%	100.0%
0.9% Normal Saline	Count	3	0	27	30
	% withinIrrigants Used	10.0%	.0%	90.0%	100.0%
2% Chlorhexdine	Count	12	0	18	30
	% withinIrrigants Used	40.0%	.0%	60.0%	100.0%
Total		24	2	94	120
		20.0%	1.7%	78.3%	100.0%

The frequency and percentage of readings within only the selected interval under different conditions are listed
Three intervals were selected, and the interval of -1.00 to 0.00 range was set as desired.

Discussion

The present study utilized a third-generation Electronic apex locator Root ZX (J. Morita Mfg. Corp. Kyoto, Japan) a dual-frequency based apex locator based on the principles of multiple frequencies to determine root canal length. The claimed distinguishing characteristic of Root ZX (J. Morita Mfg Corp., Kyoto, Japan) is that it requires no calibration,8,9and that measurements are more precise by virtue of determining a sudden change in the dominant characteristic (capacitive or resistive) of the impedance. It has also been asserted to be unaffected by the either dry or moist condition of canals. Considering these facts, this device was scrutinized in the present study.

Exclusion of human periodontium makes in vitro studies problematic. To minimize drawbacks, several materials were considered; that included alginate, agar, saline, and gelatin. Alginate has proved to be a good medium to establish the necessary electric circuit for electronic apex locator measurements, as it mimics the electric impedance of the human periodontium. Kaufman et al. (1993) developed an experimental model, and it has been found that using alginate with Kaufman's model provided the most coherent results[10].

Chemo-Mechanical debridement is deemed impossible without chemically active irrigation solutions. Several studies using advanced techniques such as micro-computed tomographic scanning have demonstrated that proportionally large areas of the main root-canal wall remain untouched by instruments and are accessed only by irrigation solutions. This has led to increased use of various irrigation solutions with variable electro conductivities[11]. In present study irrigation solutions that are contemporarily recommended were used.

Sodium hypochlorite (NaOCl 0.5% to 6%) is the most popular irrigating solution[12]. It is the only root-canal irrigant that dissolves necrotic as well as vital tissue and is a potent antimicrobial agent that kills most bacteria instantly on direct contact[13]. It is difficult to imagine successful irrigation of the root canal without hypochlorite. NaOCl ionizes in water into Na and the hypochlorite ion, OCl, establishing equilibrium with hypochlorous acid (HOCl). Hypochlorous acid is responsible for the antibacterial activity. Wrbas et al. in an in vivo study with 1% NaOCl found the accuracy of Root ZX within ±0.5 mm to be 75%,[14] whereas Weiger et al. in an in vitro study found this to be 95.7% within ±1 mm[15]. The diferent results obtained in previous studies is partly because of the nature of the teeth and partly because of the difference of concentration of irrigant used in those studies. In the present study 5 out of 30 readings fell

within the acceptable range which is due to higher concentration of NaOCl that is 5.25% and the error tolerance range of the study that was 0 and -1 mm.

EDTA is a chelating agent and is used for the removal of the inorganic portion of the smear layer. Alone it has a little or no anti-microbial effect; it is used as an adjunct to sodium hypochlorite. Electronic devices can give short readings for canals that are illed with strong electrolytes as only minimal chang - es occur in electrical impedance when the foramen is approached and passed.11 EDTA readings reaching up to -1.1 mm short of the target range in two cases were seen in this study.

Chlorhexidine gluconate (CHX) is a broad spectrum anti-microbial agent with low toxicity (AAE). It lacks foul smell and bad taste, but it cannot dissolve organic substance present in the root canal system[11, 12]. It is marketed as a water-based solution or gel in concentrations of 0.2–2% and is considered toxicologically safe. Shin et al. found Chlorhexidine to be the best irrigant to be used with newer generations of electronic apex locators[16]. This is because of lower electro-conductivity of Chlorhexidine. Khattak et al. found 100% of readings were in acceptable range when Chlorhexidine is used as irrigant with Root Zx[17], whereas GhadaElhilalyMohemad and Abdul Waheed found 66% of readings were in acceptable range with 2%Chlorhexidine being used[18]. In the present study, 12/30 readings fell along the accepted level of tolerance. Comparatively, Chlorhexidine proved to be a better irrigating solution in our study, which is in accordance with work done by previous researchers. Low conductivity of chlorhexidine has allowed better detection of the impedance changes at the apical foramen. The use of Chlorhexidine gave the highest frequency within the target interval. Therefore, it seems to be the irrigant of choice when using Root ZX.

Conclusion

This study shows that the burden of arrhyth - mias is quite high in our population and judicious management and referral of patients in primary and tertiary care centers to electrophysiologists will help cure most of the arrhythmias. This will decrease the burden of the disease and reduce the, in turn, decrease the injudicious use of antiarrhythmic medications.

This data may serve as a support for planning the allocation of human and material resources, as well as for establishing indicators for health care quality, designing continuing education activities or devising training programs for new specialists.

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