ELECTRICAL PROPERTIES OF ENDODONTIC FILES AS DETERMINANT OF ACCURATE MEASUREMENT IN PROCEDURES USING THIRD GENERATION ELECTRONIC APEX LOCATOR ROOTZX

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Abstract

Objective: *To determine the most compatible endodontic file with third generation electronic apex locator for working length determination in an ex vivo alginate model.*

Materials and Methods: *In this experimental in vitro study conducted at Sardar Begum Dental Hospital Peshawar, 60 extracted single rooted human permanent maxillary incisor teeth were selected and randomly divided into two groups (30 teeth each). A conventional access cavity was prepared in each tooth and patency of canal was determined with size 15 K-File. Anatomic Length was calculated with help of digital vernier caliper and magnification loupes. Electronic Lengths were calculated in an ex-vivo model using alginate as medium to replicate periodontal tissue in presence of irrigants for each group utilizing nickel titanium and stainless steel files. All readings were recorded on Performa. All electronically measured lengths were compared to anatomic lengths, readings exceeding anatomic lengths were recorded positive and those short of actual lengths were recorded negative. Data were analyzed using SPSS version 15.0 for descriptive statistics; Independent samples T test was used to compare the associated means of working lengths for each group. Cross-tabulation and Chi square test was used for selection of the most conducive file type based on categories of acceptability and safety. For all comparisons, statistical significance was considered at* $p \leq 0.05$.

Results: *Both endodontic file types showed similar effects with no significant differences in means of anatomic and electronic working lengths. For Nickel Titanium group Anatomic lengths* $M=11.6\pm1.1$, *Electronic lengths* $M=11.6\pm1.4$. *And Stainless Steel group Anatomic lengths* $M=10.92\pm1.07$, *Electronic lengths* $M=10.5\pm1.04$ *For final selection Stainless Steel files were considered most appropriate based on 93.3% values in the acceptable range compared to 60% of Nickel Titanium group (Table 3).*

Conclusion: *Under conditions of present study, both endodontic file types showed workable effects. Stainless Steel files were recognized as the most appropriate for use with RootZx based on its readings in acceptance range.*

Key Words: *Endodontics, Electronic Apex Locators, Working Length, Stainless Steel, Nickel Titanium*

Introduction

Precise judgment of working length is a central determinant that influences the outcome of endodontic therapy.[1] Perseverance of biological length of root canal system enhances optimal healing. 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.[2,3]

Ambiguities remained associated taking in account 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.5 since then, the electronic apex locator has made the assessment of 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 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

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both in vivo and ex vivo ranges from 85% to 94%.[6].

Numerous studies on apex locator have been performed, and generally they have used only small sized stainless-steel (SS) hand files for testing purposes. A literature search retrieved very few articles comparing stainless-steel (SS) hand files and Nikel Titanium (NiTi) hand files for the accuracy of Electronic Apex Locators in determination of working Lengths. Capacitance is affected by the electrical properties of the materials involved in the test system and by the system geometry itself. This implies that the accuracy of EALs might be affected by file alloy.

Given the widespread use of nickel-titanium files, a comparison of the accuracy in determining working length with an apex locator seems clinically relevant. Thus the purpose of this in vitro study was to investigate the accuracy of Root Zx using SS hand files, and to compare the findings with NiTi hand files, respectively.

Materials and Methods

In this experimental in vitro study conducted at Sardar Begum Dental College from October 2015 to April 2016, 60 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 same operator.

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

The Actual length of the canals was determined with a #15 file (with a silicon stop) until the tip of the file was visible at apical foramen under stereomicroscope at 10x magnification. The distance of silicon stop to file tip was measured with digital vernier calipers and 0.5 mm was subtracted from it and registered as (AL) Anatomic length.

In Vitro simulation was done using Kaufman et al model, all teeth were embedded in test apparatus. Alginate was poured in 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 prior to setting.

For electronic measurements teeth were divided in two groups:

A. Stainless-Steel (SS) hand files

B. Nickel Titanium (NiTi) Files

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

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

Results

Both endodontic file types showed similar effects with no significant differences in means of anatomic and electronic working lengths. For Nickel Titanium group Anatomic lengths (M=11.6, SD=1.1), Electronic lengths (M=11.6, SD=1.4) conditions; $t\ (.58) = 1.68$, $p = .86$. And Stainless Steel group Anatomic lengths (M=10.92, SD=1.07), Electronic lengths (M=10.5, SD=1.04) conditions; $t\ (.58) = 1.37$, $p = .174$. For final selection Stainless Steel files were considered most appropriate based on 93.3% values in the acceptable range compared to 60% of Nickel Titanium group.

Discussion

The evolution of electronic apex locators have led to their increased utility for working length determination. Latest generation EALs are considerably less sensitive to the influence of external factors. The present study utilized a third generation Electronic apex locator Root ZX (J. Morita Mfg Corp. Kyoto, Japan) a dual-frequency apex locator which is 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 and its measurements are more precise by virtue of determining a sudden change in the dominant characteristic (capacitive or resistive) of the impedance.[7] It has also been asserted to be unaffected by either dry or moist condition of canals. Considering these facts this device was scrutinized in present study.

Exclusion of human periodontium makes in vitro studies problematic. To minimize drawbacks, a number of 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, it is simple and remains stable for hours. Kaufman et al (1997) developed an experimental model and it has been found that using alginate with Kaufman's model provided the most coherent results.[8]

Chemo-Mechanical debridement is deemed impossible without chemically active irrigation solutions which has led to increased use of various irrigation solutions with variable electro conductivities.[10] According to Pilot and Pitts, with more conducting solutions, minimal changes in the electrical characteristics are noted as the foramen is approached and passed through. In the present study 2% Chlorhexidine was used as an irrigant.[7].

Capacitance is affected by the electrical properties of the materials involved in the test system and thus the type of instrument and its composition may also have an impact on the accuracy of the electronic measurements. The instruments used in endodontic treatment are made of various materials, including high quality stainless steel, carbon steel, chromium and nickel alloys, and nickel titanium alloys.[9] The utility of SS and NiTi files is mainly because both the materials are characterized by endurance, good cutting abilities, and resistance to bio fluids of the oral cavity as well as chemical and physical factors occurring in the process of sterilization/disinfection. The current study used hand NiTi files and Stainless Steel files to evaluate the accuracy of Root ZX (J. Morita Mfg Corp. Kyoto, Japan) in working length determination.

Dental stainless steel is an alloy that contains 73% iron, 9% nickel, and 18% chromium. Thomas et al first investigated the effect of type of alloy on the accuracy of EALs using SS files and NiTi files. They found both SS and NiTi files resulted in accurate readings, suggesting these files could be used interchangeably. The accuracy of Electronic working lengths determination with SS files in various study ranges from 70%–100%.[11] In the present study 93.3% of the times measurements were in acceptable range which is in agreement with previously reported studies the differences in results reported by Thomas et al may be attributed to the size of file used and the irrigant used while determining electronic lengths.[12]

Nickel titanium is an alloy consisting of 54% nickel and 46% titanium which is characterized by shape memory, high flexibility, and resistance to fracture. Nickel titanium instruments additionally show increased flexibility; they have better cutting ability and shape memory. Moreover, they are more economical, and can be utilized 2-3 times longer. Thomas et al has reported cent percent accuracy with both NiTi and SS files[12], where as other studies have reported the accuracy using NiTi files to be between 39%–94%.[13] In the present study 60% of the results were in acceptable range. The variations of results between this and other studies may be due to differences in operator sensitivity, study design

Under conditions of present study, both endodontic file types showed workable effects. Stainless Steel files were recognized as the most appropriate for use with Root Zx based on its readings in acceptance range. The results should be interpreted within the limitations of this study and other clinical conditions should be considered for WL determination.

Conclusion

Stainless Steel files were recognized as the most appropriate for use with Root Zx based on its readings in acceptance range.

References

1. Saraswathi.V , Kedia A , Purayil T.P, Ballal.V, and Saini. A.Comparative evaluation of the accuracy of two electronic apex locators in determining the working length in teeth with simulated apical root resorption: An in vitro study. J Conserv Dent. 2016 Sep-Oct; 19(5): 402–405.

2. Guise GM, Goodell GG, Imamura GM. In vitro comparison of three electronic apex locators. J Endod. 2010;36:279–81.

3. Cox V.S., Brown JR. C.E., Bricker S.L. Newton C.W. Radiographic interpretation of endodontic file length. Oral Surg Oral Med Oral Pathol.1991; 72: 340-344.

4. Muir JD. ALARA British Dental journal. 1989:6;166(9):318.

5. Kim E., Lee S.J. "Electronic apex locator". DCNA, 2004; 48:35-54.

6. Martins JN, Marques D, Mata A, Caramês J. Clinical efficacy of electronic apex locators: systematic review. J Endod. 2014 Jun;40(6):759-77

7. 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.

8. Kaufman AY, Katz A. Reliability of Root ZX apex locator tested by an in vitro model. Journal of Endodontics1993.19, 201

9. https://doi.org/10.1016/j.jrmge.2013.07.003

10. Haapasalo M, Shen Y, Qian W and Gao Y. Irrigation in endodontics. Dentalclinics of North America.2010; 54(2): 291–312.

11. Gehlot, P. M., Manjunath, V., & Manjunath, M. K. (2016). An in vitro evaluation of the accuracy of four electronic apex locators using stainless-steel and nickel-titanium hand files. Restorative dentistry & endodontics, 41(1), 6-11.

12. Thomas, A. S., Hartwell, G. R., & Moon, P. C. (2003). The accuracy of the Root ZX electronic apex locator using stainless-steel and nickel-titanium files. Journal of endodontics, 29(10), 662-663.

13. DOI: 10.2147/CCIDE.S158882

Table 1: Age distribution for plate removal

Nickel Titanium AL and EL	Levene's Test for Equality of Variances		t-test for Equality of Means						
	f	Sig.	t	df	Sig (2 tailed)	Mean difference	Std. Error Difference	95% Confidence Interval of the Difference	
								lower	upper
Equal variances assumed	1.39	.243	.168	.58	.867	.0566	.337	-.619	.732
Equal variances not assumed			.168	.53	.867	.0566	.337	-.620	.734

There was no significant difference in the actual lengths M=11.6±1.1 and Electronic Lengths M=11.6±1.4) conditions; t (.58) =1.68, p =.86.

Table 2: Independent Samples Test (Stainless Steel group)

Stainless Steel AL and EL	Levene's Test for Equality of Variances		t-test for Equality of Means						
	f	Sig.	t	df	Sig (2 tailed)	Mean difference	Std. Error Difference	95% Confidence Interval of the Difference	
								lower	upper
Equal variances assumed	.022	.883	1.376	.58	.174	.375	.272	-.170	.921
Equal variances not assumed			1.376	.58	.174	.375	.272	-.170	.921

There was no significant difference in the anatomic lengths M=10.92±1.07 and Electronic Lengths S/S FILES M=10.5±1.04 conditions; t (.58) =1.37, p = .174.

Table 3: Cross Tabulation

File Type Used	Count /% within file type Used	Difference Categories			
		-1.00 to 0.00	-1.01 and below	0.01 and above	Total
Stainless Steel S/S	Count	28	1	1	30
	% with in type of file used	93.33%	3.33%	3.33%	100.0%
Nickel Titanium NiTi	Count	18	2	10	30
	% with in type of file used	60%	6.66%	33.33%	100.0%
Total		46	3	11	60
		76.6%	5%	18.3%	100.0%