

Comparison between Three Different Generations of Electronic Apex Locators in Determining Working Length of Single-Rooted Teeth - An in Vitro Study

Mohammed Ahmed Alqarni¹, Mohammed Jaber Alwadee², Fahad Ahmed Alajmah³, Yahya Mazyad Awaji⁴, Mohammed Abdelkhalig Iesa⁵, Mohammed Sulaiman Alaenazi⁶, Sarah Albaiti⁷, Raghad Albeshri⁸, Nouf Alqurashi⁹, Bader Mohammed Alharbi¹⁰

¹Senior Registrar of Endodontist, Armed Forces Hospital Southern Region. Khamis Mushayt. Aseer – KSA
Email: dr.mohammed.a.alqarni[at]hotmail.com
Mobile: +966560775160

²Senior Registrar of Prosthodontist, Armed Forces Hospital Southern Region. Khamis Mushayt. Aseer-KSA

³Senior Registrar of Endodontist, Head of Endodontic Department. King Abdulaziz Hospital. Mekkah-KSA

⁴Specialist Endodontic Dentist, Jazan Dental Center. Jazan-KSA

⁵Specialist Endodontic Dentist, Arar Dental Specialist Center. Arar-KSA

⁶Specialist Endodontic Dentist, Arar Dental Specialist Center. Arar-KSA

⁷General Dental Practitioner, Jeddah-KSA.

⁸General Dental Practitioner, Jeddah-KSA.

⁹General Dental Practitioner, Jeddah-KSA

¹⁰General Dental Practitioner, Alsulaimaneyya Polyclinic-East Jeddah Hospital, Jeddah-KSA

Abstract: *The aim of the present study was to evaluate the accuracy of three different electronic apex locators in single-rooted teeth. Materials and methods were Sixty extracted human single-rooted permanent teeth were selected for this study. The actual working length was measured with visual technique by placing a size #15 k-file under magnification. Then, the canal lengths were measured electronically with RAYPEX 6, ROOT ZX II and using Propex II™ electronic apex locators within ± 0.5 and ± 1 mm. The three readings were obtained by different observers for each sample by reinserting the No.15 K-file, and measurements were obtained with the three Electronic Apex Locators. Results: The mean value of working length for RAYPEX 6 was 23.11 mm while Propex II and ROOT ZX II were 20.98 mm and 21.33 mm respectively. Conclusion: The Raypex 6 electronic apex locator is most reliable in the determination of working length, followed by the Propex II electronic apex locator and the Root ZX II electronic apex locator.*

Keywords: Electronic apex locator, RAYPEX 6, Root-ZX, Propex II

1. Introduction

Three main criteria required for obtain a Successful root canal therapy: a proper access cavity, cleaning and shaping, and three-dimensional obturation of the root canal system. The last two prerequisites can be accomplished only if the WL is determined precisely (1). The Accurate determining working length in root canal therapy improve the treatment prognosis. (2).

Working length is the distance between a coronal reference point and the point at which canal preparation and obturation should terminate (3). Many studies have been proofed a different histological result after root canal treatment and have shown superior results when the instrumentation and obturation are performed to the apical constriction (apical foramen). Thus, the determination of the accurate working

length by locating the minor apical constriction is very important for successful root canal treatment (4).

As the apical constriction is the narrowest area of the canal, many studies have suggested this area as the apical reference and because of the smallest blood supply diameter in this region, healing can be desirable and the wound to the periapical tissues is supposed to be minimum (5). Many methods are available for determining the working length however the method of using an electronic apex locator is reliable and accurate in determining working length (6). Electronic apex locators use the human body to produce an electrical circuit. They have two sides: one is attached to the endodontic file in the root canal, and the other side is attached to the patient's lip. The electrical circuit will be completed when the tip of the endodontic file reaches the periodontal tissue. These devices are particularly useful for

patients whom suffering from gag reflex problems or whom cannot tolerate radiography films or sensors (7). The aim of this study was to evaluate the accuracy of three different electronic apex locators in single-rooted teeth.

2. Methods and Materials

Thirty extracted human permanent single-rooted teeth with completely formed apices were used in this study. After extraction, all teeth were immersed in 5.25% sodium hypochlorite to remove the periodontal ligament. Hand scalers and curettes used to remove any stains and calculus found in the samples then stored in a container containing 2% thymol crystals in distilled water until the time needed for the study. Access opening was done with burs using a high-speed hand piece. The actual working length were analyzed with the aid of a stereo microscope under 40x magnification by multiple observers, with a mean value of three different observers set as the actual working length. A size 15 K-file (Maillefer, Dentsply) was inserted into each sample to access the root canal working length then each sample was placed properly on the tray of the stereo microscope so that the complete working length was analyzed.

The apical exit of the inserted endodontic file was observed and the file was removed 0.5mm from the canal without changing the location of the rubber stopper then the working length was measured by using an endo gauge. The procedure was repeated for each sample 3 times by each observer and the mean value as actual working length was set. The thirty extracted teeth were then divided into three groups.

Each tooth was placed in a container poured with alginate which mixed with a saline liquid to replicate the conduction of electricity to simulate an oral environment. The lip clip was placed inside the alginate, and the wire from the apex locator was attached to the file.

Group I: 10 extracted anterior single rooted teeth which working length was taken by using RAYPEX 6 electronic apex locator (VDW, Munich, Germany).

Group 2: 10 extracted anterior single rooted teeth which working length was taken by using ROOT ZX II electronic apex locator (J. Morita Corp., Osaka and Tokyo, Japan; J. Morita USA, Inc., Irvine, California).

Group 3: 10 extracted single-rooted teeth which working length was taken by using Propex II™ electronic apex locator (Dentsply Sirona, York, Pennsylvania).

The three readings were then recorded by the observers for each sample through reinserting the No.15 K-file and measurements were obtained with the three Electronic Apex Locators: Root-ZX II, Propex II and Raypex 6. The values were then compared with the actual working lengths that previously obtained.

All the statistical analysis was performed by using SPSS version 18 and MedCalc Version 14. The p-value of < 0.05 was considered to be statistically significant.

Statistical analysis was performed by using paired t-test and Kruskal Wallis ANOVA with post-hoc Conover test.

Statistical readings were considered to be significant when $p < 0.001$.

3. Results

The mean value of working length for group 1 was 23.12 mm, and the standard deviation was 1.87 as measured with the microscope. The mean value of this group's working length with the apex locator was 22.73 mm, and the standard deviation was 1.8.

The mean value of working length of group 2 was 20.99 mm, and the standard deviation was 1.77 as measured with the microscope. The mean value of working length for group 2 was 20.20 mm, and the standard deviation was 1.48 with the apex locator reading.

The mean value of working length of group 3 was 21.34 mm, and the standard deviation was 2.46 as measured with the microscope. The mean value of working length of group 3 was 20.53 mm, and the standard deviation was 2.22 in apex locator reading.

The absolute agreement about the readings of the three apex locators was checked by intra-class correlation coefficient (0.93). The absolute agreement about the three microscope readings was checked by intra-class correlation coefficient (0.92).

Table 1: Intragroup comparison of apex locator and microscope working length

	Apex Locator		Microscope		P-value
	Mean	SD	Mean	SD	
Group1	22.73	1.88	23.12	1.87	< 0.001; Sig
Group2	20.20	1.48	20.99	1.77	< 0.001; Sig
Group3	20.53	2.22	21.34	2.46	< 0.001; Sig

Table 2: intragroup comparison of apex locator and microscope working length

	Difference of microscope — apex locator working length		p – value	Post hoc test
	Mean	SD		
Group1	0.37	0.22	0.015	Group 2, 3 >1
Group2	0.78	0.51		
Group3	0.82	0.77		

4. Discussion

Accurate working length determination is the main factor leading to success in endodontic treatment. Many studies have shown the histological results after root canal treatment to be superior when the instrumentation and obturation are limited to the apical foramen and not beyond this anatomical landmark. Therefore, accurate determination of the location of the apical constriction is a key factor in successful endodontic therapy (8).

Custer in 1918 was the first to report the use of an electric current to determine working length while in 1962, Sunada reported that there is a constant value (6.5k%) of electrical resistance between the mucous membrane and the periodontium and stated which it is possible to use this value of resistance in the estimation of root canal length.

Additionally, he stated that if an endodontic instrument is connected to an ohm meter introduced into the canal and advanced till the ohm meter shows the value of 40 Ω. The device utilized by Sunada became the basis for electronic apex locators (8).

In the presented study, three different electronic apex locators were used (Root ZX II, Propex II, and Raypex 6) whose electronic working length was compared to the actual root length using a stereo microscope to determine the actual working length. The results stated that the accuracy of the Raypex 6 EAL was more accurate than the Root ZX II electronic apex locators, that is similar to a study demonstrated by Samadi, et al (9). Additionally, the Propex II was not as accurate as the Raypex II as conducted by Demiriz, et al (10). The data collected in this study found a statistically significant difference between the Raypex 6 and the other two units evaluated by up to 1 mm between the all samples studied. Comparison of accuracy between the Root ZX II and Propex II demonstrated near equal accuracy between these two electronic apex locators.

Another study evaluates several apex locators and showed that the Root ZX II was more reliable among the apex locators (11). Haffner, et al. also stated a study comparing electronic apex locators with a microscope and confirmed that electronic apex locators are very reliable in determining working length (12). Another comparison was done in compared apex locators with the conventional radiographic method in straight and curved root canals and confirmed that apex locators are reliable in determining working length, regardless of the curvature or lack of curvature of the root (13).

Many studies also have been stated that the use of an electronic apex locator for determination working length is a much easier method and more accurate than taking the working length by using a radiograph with a file within the canal which minimize the radiation exposure to the patient. Thus, we can conclude that the electronic apex locators are more accurate than alternative methods to determine working length, saving time, and decreasing patient radiation exposure.

5. Conclusions

The use of an electronic apex locator is more reliable and accurate method in working length determination. The Raypex 6 electronic apex locator is most reliable in determination of working length, followed by the Propex II and the Root ZX II electronic apex locator.

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Conflicts of interest:

There are no conflicts of interest.

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