The Influence of Newly Developed and Conventional Irrigants on the Accuracy of Three Electronic Apex Locators

Ersan Çiçek, Emre Bodrumlu

Bülent Ecevit University, Faculty of Dentistry, Depertmant of Endodontics, Zonguldak/Turkey

Abstract

Background: The aim of this study was to compare the accuracy of different electronic apex locators in the precence of irrigants.
Materials and Methods: 180 single-rooted teeth were used in the study. 2.5% NaOCl, 2% chlorhexidine, MTAD, Ozonate Water and a mixture of Streptokinase, Tween 80 and Barium sulphate (SBT) were used.The roots and labial clip were embedded in freshly mixed alginate. Accuracy was determined based on stable measurements between 0.0 mm and +0.5 mm. Statistical data were analyzed by using the McNemar test, and comparisons were made according to the Kruskal-Wallis test.
Results: The percentages of accuracy of Root ZX mini, Propex II and Raypex 5 were found to be 90.5%, 89.4% and 82.6%, respectively. The differences in the accuracies of the apex locators produced by the irrigants tested in this experiment were not statistically significant ($p>0.05$).
Conclusions: The reliability of the apex locators were more accurately reliable when the 2% CHX irrigant were used, in comparison to the other irrigants.

Key Words: Working length, Apex locator, Root ZX mini, Popex II, Raypex 5

Introduction

Biomechanical preparation is one of the most important steps in root canal treatment (RCT) and should terminate at the apical constriction (minor foramina) (AC) [1-3]. For endodontic therapy, the ideal working length (WL) is the distance from a coronal reference point to the AC in the root canal system (RCS) [3]. Having the narrowest diameter of the RCS the AC, in which the least blood build up, constitutes a border between pulpal and periodontal tissues [3,4].

For many years, the radiographic apex has been the accepted location for the WL to terminate. However, as the radiograph provides a 2-dimensional image of a 3-dimensional structure, and the foramen commonly does not coincide with the apex, it does not consistently reveal the end point of the RCS [4-7]. In the beginning of the twentieth century, the idea of defining the WL electronically was introduced [8]. Since then, the electronic apex locator (EAL) has been developed over several generations [4,6].

Irrigation, which serves for a number of purposes including antibacterial effects, tissue dissolution, cleaning and chelating, is an essential step during RCT. Irrigation should be used as a component of biomechanic preparation during the RCT. For this purpose, various irrigation agents are employed in clinical contexts.

The newly developed irrigation solution examined in this study includes Streptokinase, Tween 80 and Barium Sulphate. Streptokinase is capable of dissolving organic tissue, which leds us to hypothesize that it might be especially well-suited for eliminating infected tissue in the lateral canals of the RCS. Tween 80, as a surfactant and barium sulphate, as a radio opac substance are added to the solution. In this solution, Tween 80 reduces the surface tension, and Barium sulphate serves to image the RCS by using a radiograph.

The aim of the present in-vitro study was to compare the accuracy of different electronic apex locators (Propex II, Raypex 5, Root ZX mini) in the presence of the newly-developed and of conventional irrigation solutions.

Materials and Methods

For the present study, 180 single-rooted teeth with mature apices were selected. This study was approved by the Ondokuz Mayis University Ethics Committee (OMU.TEAK-2010/186). Tooth suitability was determined by visual inspection by using a microscope (×10 magnification) and radiographs. Just after extraction, all teeth were kept in 10% buffered formalin till the duration of testing. Prior to testing, they were also placed in a 5.25% sodium hypochlorite solution (NaOCl) (Wizard, Rehber Chemistry, Istanbul, Turkey) for 2 hours to remove organic residue. The remaining tissues were removed from the external root surfaces using a periodontal scaling instrument. The teeth were numbered and rinsed in tap water. Moreover the incisal and occlusal edges were ground lightly to create a flat surface. Standard access preparation was carried out by using a high-speed diamond fissure bur (SWS Rotary-SWS Dental, Izmir, Turkey) under water coolant, and the remaining pulp tissue was removed with a barbed broach (Vereinigte Dentalwerke GmbH & Co. KG, München, Germany), without any attempt to enlarge the canal. The canals were irrigated with 5 mL of 1% NaOCl, and the actual canal length (AL) was determined by introducing a size 10 file (Dentsply-Maillefer, Baillagues,Switzerland) into the canal until its tip became visible at the major apical foramen under a microscope at x10 magnification. A rubber stop was then carefully adjusted to the reference level and the distance between the rubber stop and the file tip was measured with a digital calliper (Sankin, Mitutoyo Co., Kanagawa, Japan) to the nearest 0.1 mm and recorded. The WL was calculated by subtracting 0.5 mm from the AL. Additionally, radiographs were used to control the WL.

In the present study, 5.25% NaOCl (Wizard, Rehber Chemistry, Istanbul, Turkey), 2% chlorhexidine (CHX) (Klorhex-drogsan, Ankara, Turkey), MTAD (a mixture of tetracycline, acid and Tween 80) (Biopure- Dentsply,

Corresponding author: Ersan ÇİÇEK, DDs, PhD, Bülent Ecevit University, Faculty of Dentistry, Depertmant of Endodontics, Zonguldak/Turkey; Tel: +903722613413; Fax: +0903722613403; e-mail: ersancicek@beun.edu.tr

Washington, USA), Ozonate Water and the newly developed irrigation solution (a mixture of Streptokinase, Tween 80 and Barium sulphate) (SBT) were used to evaluate the accuracy of three apex locators (Root ZX mini, Propex II and Raypex 5). The teeth were randomly divided into three main groups (n=60) according to the apex locator used.

The roots were embedded up to the cementoenamel junction in freshly mixed alginate (Hydrogum; Zhemarck, Rovigo, Italy) and for electronic measurement, the metal lip clip was embedded into the alginate and stabilized with transparent adhesive tape. The solutions were carried into the root canals by 27 gauge irrigation needles and the pulp chamber was gently dried with air. Sterile cotton pellets were used to dry the tooth surface and eliminate excess irrigation solution, without any attempt to dry the canal. Within 2 hours of preparing the model, all canals were individually measured with the three EALs by one operator who was blind to the preliminary measurements. For electronic measurement, a size 15 K-File was attached to the EALs used in each group.

While using the Root ZX mini (J.Morita Corp, Tokyo, Japan), the file was advanced into the canal to just above the foramen, until it indicates '0.0' on the LCD display. The file was then withdrawn until the reading of the EAL showed a consistent '0.0' with the corresponding symbol and audible signal indicating that the root canal constriction had been reached.

While using the ProPex II (Dentsply Maillefer, Ballaigues, Switzerland), the file was advanced into the canal to just beyond the foramen, until it indicates the red light and warning signal. The file was then withdrawn until the reading of the EAL showed a consistent '0.0' on the LCD display and a solid tone indicated that the apex had been reached.

While using the Raypex 5 (VDW, Munich, Germany), the file was advanced to the apical foramen (red bar on the LCD display) (0.0) and measurements at these points were regarded as AC.

Each measurement with each apex locator was performed one by one in the precence of all the irrigation solutions.

When the EAL exhibited the specified reading, the silicone stop was adjusted to the coronal surface, the file was removed, and the distance from the stop to the file tip was measured with digital calipper to the nearest 0.1 mm. A mean value of 3 measurements was recorded for each canal as the electronic working length.

For each reading, the error in measurement was calculated as the absolute difference, in millimeters, between electronic working length and real working length. Positive or negative values were recorded when the tip was detected beyond or behind of the real working length, respectively. Accuracy was determined based on stable measurements between 0.0 mm and +0.5 mm.

Statistical Analysis

Data were analyzed by using the SPSS 18 program (SPSS Inc, Chicago, IL, USA) by the McNemar test, which is a comparison method. With this method of analysis, the accurancy of different apex locators were compared in the presence of both the same and different solutions. The data were analyzed as to whether or not they fell in the normal range. It was observed that the data were not within normal range according to Kolmogorov-Smirnov test. Therefore, comparisons were provided according to the Kruskal-Wallis test (p<0.0001).

Results

The data obtained in this study are shown in Table 1. The measurements between 0.0 and +0.5 mm was evaluated as acceptable. The percentages of accuracy for Root ZX mini, Propex II and Raypex 5 were 90.21%, 89.02% and 82.60%, respectively.

Table 1. The percentage of accuracy of apex locators presence of irrigation solutions.

		Root ZX mini		Propex II		Raypex 5	
	Distance (mm)	n=60	%	n=60	%	n=60	%
NaOCl	>0.6	6	10	7	11.6	11	18.3
	0.41-0.6	30	50	29	48.3	26	43.3
	0.01-0.4	22	36.6	20	33.3	20	33.3
	-0.1	2	3.3	4	6.6	3	5
	0.0-0.6	54	89.9	53	88.2	49	81.6
CHX	>0.6	5	8.3	6	10	10	16.6
	0.41-0.6	20	33.3	19	31.6	19	31.6
	0.01-0.4	32	53.3	30	50	27	45
	-0.1	3	5	5	8.3	4	6.6
	0.0-0.6	55	91.6	54	89.9	50	83.2
MTAD	>0.6	6	10	6	10	10	16.6
	0.41-0.6	26	43.3	25	41.6	23	38.3
	0.01-0.4	24	40	23	38.3	21	35
	-0.1	4	6.6	6	10	6	10
	0.0-0.6	54	89.3	54	89.9	50	83.3
Ozonate Water	>0.6	7	11.6	7	11.6	11	18.33
	0.41-0.6	31	51.6	28	46.6	25	41.6
	0.01-0.4	19	31.6	23	38.3	21	35
	-0.1	3	5	2	3.3	3	5
	0.0-0.6	43	88.2	53	88.2	49	81.6
SBT	>0.6	5	8.3	6	10	10	6
	0.41-0.6	26	43.3	27	45	24	40
	0.01-0.4	24	40	23	38.3	24	40
	-0.1	5	8.3	4	6.6	2	3.3
	0.0-0.6	55	91.6	54	89.9	50	83.3
Mean total (%)		90.21		89.02		82.6	

The irrigation solutions did not significantly affect the accuracy of the apex locators (p>0.05). However, in the

presence of CHX, the apex locators determined the WL more accurately than the other solutions. Although no significant difference was statistically found between the Root ZX and Propex II ($p>0.05$), both of these were found to be superior to the Raypex 5 in terms of accuracy ($p<0.05$).

Discussion

Traditionally, WL has been determined with radiographs. Although the radiographic image is two dimensional, it has limitations to measure the AC. Various studies showed that the AC is above about 0.3-3.80 mm from the radiographic apex [9,10]. Besides, the radiograph is used for evaluation of accuracy of EALs to determine the WL or AC [10-14].

Several research studies stated that the AC was approximately 0.5-0.7 mm shorter than the anatomic apex [3,4,15]. Many of the studies accepted EALs showing 0.0 point as the correct measurement [15,16]. Similarly in this study, measurements of EALs at 0.0 mm were regarded as correct for the WL.

Generally, studies evaluating the EALs have been performed on human teeth in vitro [16,17]. The teeth were embedded into agar-agar [18], alginate [19], gelatine [17] or saline [20] which act as the periodonsium. Alginate blocks were prefered in our study because they act as a better periodonsium and allow us to test many teeth at the same time.

Krajczar [20] compared the WL determination with apex locator and radiographic methods in the maxillary molar teeth. He concluded that the apex locator is more reliable than radiographic methods since the roots can possess anatomic variations. Therefore, teeth with one root and root canal were selected for this study in order to provide standardization and to avoid anatomic variations.

In the literature, many studies used NaOCl and CHX to determine the working length, but MTAD is usually used only for final irrigation. In this study, however, MTAD was used as the initial irrigant for determining the WL. In addition, the effect of irragants on the accuracy of EALs was evaluated. Additionally, MTAD, ozonate water and SBT were used for this purpose firstly. Therefore, this study aimed to contribute to the literature.

Stoll [21] reported that the accuracy of the Root ZX mini was 95.0 % and 93.4% and the accuracy of the Raypex 5 was 82.4% and 87.2% by using a #10 and #15 K File, respectively. They also reported that there was significant difference between the apex locators tested. Akisue et al. [22] compared the accuracies of several apex locators in teeth which were enlarged to different apical sizes and they statistically found no difference between Root ZX II and Propex II at the apical size of #25. However, the Root ZX II was found quite reliable compared to Popex II at the apical size of #45 or #70. Our findings mostly match up with the previously mentioned studies' results, though they disagree with Duran-Sindreu et al. [23] 's findings. They found that the accuracy of Root ZX changed from 46.4 % to 82.1 %. The difference may occure, since their study was applied in-vivo. On the other hand, one study applied in-vivo similar to the study above showed that the difference between the accuracy of Raypex 5 and Propex II was not found statistically significant [24].

Briseno-Marroquin [18] and Wrbas [13], respectively, reported that the accuracy of the Raypex 5 at 0.5 mm was 85.59 % and 80 %. These results were similar to our result (82.6 %). Gomes et al. [25] reported that the accuracy of Raypex 5 in various irrigants changed from 36 % to 73 % at 0.0-1 mm. Sadeghi and Abolghsemi [26] stated that the accuracy of the Raypex 5 was 70 % and 95 % at 0.0-0.5 mm and 0.5-1 mm, respectively. Miguita [27] and Paul [28], respectively, reported that the accuracy of Propex II was 90 % and 82.1 % on 0.5-1 mm. Briseno-Marroquin [18] reported that the accuracy of Propex II was from 83.45 % to 91.41% at 0.5 mm. These results were quite similar to our result (89.02 %).

Several studies have shown that this kind of irrigation solution does not have an effect on the accuracy of the EALs [25,29-32], though Joshi and Ponnappa [32] stated that the accuracy of the apex locator was more reliable in the presence of CHX than the other solutions used in the present study. However, this difference was not statistically significant. Similarly, the irrigation solutions used in our study, did not have any statisitically signficiant effect on the accuracy of the EALs. Additionally, there was no significant difference beween the Root ZX mini and the Propex II in terms of accuracy, though these apex locators were both superior to the Raypex 5.

Conclusions

The present study concluded that irrigation solutions have no effect on the accuracy of EALs. Therefore, the accuracy of tested apex locators was regarded as reliable for clinic usage.

Conflicts of Interest

The authors do not have any financial interest in the companies whose materials are included in this article.

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