Original Article

# The Effect of Irrigating Solutions on the Accuracy of the Raypex5 Apex Locator

Shiva Sadeghi*, Masoumeh Abolghasemi**

## ABSTRACT

***Background:*** It is of great importance for clinicians to have confidence in the accuracy of an electronic apex locator in the presence of an irrigant. The purpose of this study was to evaluate the effect of different irrigation solutions on the accuracy of the Raypex5 electronic apex locator.

***Methods:*** In this experimental *in vitro* study, 20 straight and single canals of extracted maxillary central teeth were used. Access cavities were prepared and actual working length was determined. Electronic working length by means of Raypex5 apex locator was measured in the presence of saline, 0.2% chlorhexidine, and 5.25% sodium hypochlorite. Data were analyzed by ANOVA with repeated measurements.

***Results:*** There was no significant difference between actual and electronic working length in the presence of different solutions (P = 0.533).

***Conclusion:*** Under the conditions of the present study, the accuracy of the Raypex5 was in an acceptable range in the presence of different irrigating solutions.

***Keywords:*** Electronic apex locator, irrigation, root canal therapy.

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## Introduction

Precise working length measurement is a prerequisite for a successful endodontic treatment.[1-5] Traditional methods for estimating working length include radiography, anatomical averages and knowledge of anatomy, tactile sensation and moisture on a paper point.[6] All of these methods have limitations and do not allow precise localization of apical constriction. The use of electronic apex locators (EAL) to determine working length (WL) has gained increasing popularity in recent years.[6] The first two generations of electronic apex locators were sensitive to the content of the canal and irrigants used during treatment.[7] However, the use of irrigants and their benefits in endodontics have been clearly proven, and most clinicians use irrigants for their antimicrobial and tissue-solving capabilities. Therefore, it is of great importance for the clinician to have confidence in the accuracy of an EAL in the presence of an irrigant. To overcome this shortcoming, several manufacturers have introduced EAL devices using advanced technology (the third and fourth generations). They claim that these devices allow root canal length measurements in a canal filled with different electrolytes, such as purulent exudates, blood and sodium hypochlorite. Several *in vivo* and *in vitro* experiments have been conducted to test the accuracy of different apex locators in the presence of irrigants.[8-14] To date, no published study has been conducted to evaluate the accuracy of the new apex locator, Raypex5 (VDW, Munich, Germany) in the presence of different intracanal irrigants. The manufacturer claims that based on the proven technology of the fourth generation device, Raypex4, this new apex locator presents additional features for optimal performance during root canal treatment. Raypex5 has a unique ergonomic design featuring a hinged front panel with large color graphic display, black light illumination and increased measurement precision.[15] The purpose of this study

* Assistant Professor, Department of Endodontics, School of Dentistry, Guilan University of Medical Sciences, Rasht, Iran.
**Dentist, Guilan University of Medical Sciences, Rasht, Iran
Correspondence to : Shiva Sadeghi, Assistant Professor, Department of Endodontics, School of Dentistry, Guilan University of Medical Sciences, Rasht, Iran. E-mail: Sadeghi _ DDS@ yahoo.com

was to examine the accuracy of the electronic apex locator Raypex5 in the presence of different intracanal irrigants in an *in vitro* model.

## Materials and Methods

In this experimental *in vitro* study, 20 straight and single canals of human extracted maxillary central teeth were selected. Roots with resorption, fractures, open apices or radiographically invisible canals were excluded from the study. Canal patency was evaluated using a size 10 K-file (Mani, Japan). The size of the apical foramen was determined using the largest file fitting at the apical foramen without any force or instrumentation. Maxillary central teeth with apical terminus size 30-35 file were chosen. The incisal edges were flattened to establish a level surface to serve as a stable and reproducible reference for all measurements. A standard access cavity was prepared; pulp chambers and canals were cleansed by irrigating with 5 ml of normal saline.

### *Actual working length determination*

The actual working length (AWL) was measured by inserting a small #10 K-file until the file tip was just visible at the apical foramen using ×3 magnifications. After adjusting the silicone stopper to the coronal reference, the file was removed from the canal and its length was measured using a digital caliper to the nearest 0.01 mm. According to Kuttler`s study, 0.5 mm was subtracted from this length and the new length was considered as the actual working length.[16]

### *Electronic working length determination*

Teeth were embedded in an alginate (Zhermack, Italy) model especially designed to demonstrate electronic working length (EWL) measurement.[10,17] Next to the teeth, a metal rod was also inserted to be attached with the lip clip of the Raypex5. All measurements were made within two hours of the model being prepared in order to ensure that the alginate was kept sufficiently humid.[6] A size 15 K-file (Mani, Japan) connected to the EAL was used in all cases. EWL measurements were taken with various irrigants in the canals:

- Saline (Darupakhash, Iran)
- Chlorhexidine 0.2% (Shahr Daru, Iran)
- Sodium hypochlorite 5.25% (Taj, Iran).

Canals were irrigated with each irrigant using a blunt needle placed as deep as possible without obstructing the canal. The pulp chamber was then gently dried with a cotton pellet. Using the Raypex5 according to the manufacturer's instruction, a #15 K-file was advanced within the root canal to the region of the apical constriction, as indicated by the linear high-resolution scale of the APEX ZOOM with its three green segments. The silicone stop was then adjusted and the distance from the base of the silicone stop to the file tip was measured with a digital caliper to the nearest 0.01 mm. One experienced operator performed all measurements. Finally, collected data was analyzed by ANOVA with repeated measurements at a significant level of $P < 0.05$.

## Results

The mean and standard deviation of the difference between actual working length and the electronic canal length measurements obtained with different irrigants are illustrated in Table 1.

**Table 1.** Mean difference between actual and electronic working length (mm).

| Irrigants | Mean ± SD (mm) |
|---|---|
| Normal saline | -0.004 ± 0.79 |
| NaOCl 5.25% | -0.176 ± 0.79 |
| Chlorhexidine 0.2% | -0.073 ± 0.82 |

The frequencies of canal measurements are presented in Table 2. Negative measuring results were obtained in three samples in the presence of NaOCl 5.25%. For each canal, the difference between AWL and EWL was calculated. Positive values indicated that the file was in a position past the apical constriction; negative values indicated that the file tip was short of the apical foramen, and zero values indicated that the file tip was flush to the apical constriction. ANOVA with repeated measurements showed no significant difference between AWL and EWL in the presence of different irrigant solutions ($P = 0.533$). Table 2 shows the frequency of EWL measurements within ± 0.5 mm and ± 1 mm of the AWL for chlorhexidine 0.2% (75%, 85%), for NaOCl 5.25% (47.2%, 88.8%) and for normal saline (70%, 95%).

**Table 2.** Frequency of electronic working length measurements.

| Distance from actual length (mm)[a] | Normal saline | | NaoCl 5.25% | | Chlorhexidine 0.2% | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| > 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 01.0 to 0.5 | 2 | 10 | 3 | 17.7 | 2 | 10 |
| 0.5 to 0.01 | 11 | 55 | 5 | 29.5 | 6 | 30 |
| 0.0 | 0 | 0 | 0 | 0 | 5 | 25 |
| -0.5 to - 0.01 | 3 | 15 | 3 | 17.7 | 4 | 20 |
| -1 to -0.5 | 3 | 15 | 4 | 23.6 | 0 | 0 |
| > -1 | 1 | 5 | 2 | 11.8 | 2 | 10 |

[a] Negative value indicates measurements short of the AWL

## Discussion

In this *in vitro* study, we used an alginate mould and extracted human teeth because it is simple, inexpensive, and stable for hours, and the root apices can not be seen. The relative stiffness of the alginate mould prevented fluid movement inside the canal that is responsible for premature electronic readings registered with previous models.[9,17,18] Electronic apex locators were frequently used with a small size 15 stainless-steel endodontic hand file. Numerous apex locator studies have used this file for testing purposes without considering the apical terminus size of the canals. In the present study, a size 15 K-file connected to the EAL was used in all cases. Electronic working length determination is influenced by the size of the canal at the apical terminus.[10,18,19] Maxillary central teeth with apical terminus size 30-35 file were chosen to control this parameter. The range of ± 0.5 mm to the foramen range measurement has been considered as the strictest acceptable range.[9,20] Thus, measurements attained within this tolerance are considered highly accurate. On the other hand, root canals do not always end with an apical constriction, a clear minor and major diameter or an apical foramen at the exact base of the cemental cone. This is why some authors prefer the range of ± 1 mm as the acceptable range.[21,22] There was no significant difference between AWL and EWL in the presence of different irrigant solutions. In another words, the irrigating solutions had no effect on the accuracy of Raypex5. The results of this study should be evaluated by further research because a literature review failed to reveal any studies that compared the effect of irrigating solutions on the accuracy of Raypex5. However, according to the result of this study, Raypex5 showed negative measuring results in three samples in the presence of 5.25% hypochlorite sodium solution. This finding is in accordance with the reports of Jenkins et al.[12] They showed that the greatest deviation from actual canal length was obtained with 5.25% hypochlorite sodium solution using the Root ZX apex locator. Given the widespread utility of NaOCl as an intracanal irrigant, further research is essential to understand the reason for these results. The result of this *in vitro* study needs to be verified in an *in vivo* study. Clinically, a higher variation of measurements is expected, because in contrast to *in vitro* studies, favorable circumstances for precise measurements are not available.

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