

Original Research

Assessment of third generation versus fourth generation electronic apex locators in detecting apical constriction: A comparative study

Anuj Kumar Sharma¹, Priya Pundir², Prabhat Mandhotra³, Karma Sonam Bhutia⁴, Aman Abrol⁵

¹Endodontist, Dr. YSPGMC Medical College and Hospital, Nahan, distt Sirmour, Himachal Pradesh

²Senior Lecturer, Department of Conservative Dentistry and Endodontics, Seema dental college and hospital, Rishikesh, Uttarakhand

³Reader, Department of Conservative Dentistry and Endodontics, Himachal Dental College, Sunder Nagar, Himachal Pradesh;

⁴PG student, Department of Conservative Dentistry and Endodontics, Himachal Institute of dental sciences, Paonta sahib, Himachal Pradesh;

⁵Endodontist, RPGMC medical college and hospital, Tanda, distt Kangra, Himachal Pradesh

ABSTRACT:

Background: The success of root canal treatment depends on the removal of infected pulp tissue, necrotic material, and microorganisms from the root canal and achieves homogeneous filling of the entire canal. Therefore, determining an accurate working length (AWL) is one of the most important steps of endodontic therapy. **Material and method:** 40 single rooted completely formed freshly extracted teeth were used for this study. After administering local anesthesia access was opened and no 15 file was used to determine the working length with apex locators. The sequence of use of Raypex 5 and Root ZX was kept at random to remove bias. The file was sealed at this position using permanent dental cement and the excess coronal portion was cut off using an orthodontic cutter. This was followed by atraumatic tooth extraction and immersing in hypochlorite solution to remove organic debris. Apical 5 mm of the root apex was then shaved off with a bur under a microscope. The last layers were removed by a BP blade. This was followed by measuring the distance of the end of the file to the minor diameter under stereomicroscope at $\times 10$. **Results:** The mean distance between the instrument tip and the minor diameter was $+0.0001 \pm 0.2054$ mm for the Root ZX and $+0.042 \pm 0.229$ mm for the Raypex 5. The minor diameter was coinciding with the tip of the instrument in 9 cases when Root ZX was used and in 10 cases when Raypex was used. In 92.5% of cases tested with Root ZX the minor diameter was within the limit of ± 0.5 mm. In 95% of cases, minor diameter was within a limit of ± 0.5 mm with Raypex 5. No significant difference was seen between the results of Root ZX and Raypex 5 in determining the minor diameter. **Conclusion:** Root ZX and Raypex 5 were almost equally effective in determining the minor diameter of teeth.

Key words: Minor diameter, Raypex 5, Root ZX

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Corresponding author: Dr. Priya Pundir, Senior Lecturer, Department of Conservative Dentistry and Endodontics, Seema dental college and hospital, Rishikesh, Uttarakhand

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INTRODUCTION

The exact location of the physiological root apex is a prerequisite for the successful endodontic therapy. It is imperative to completely clean and shape the canal in order to prevent irritation to the periapical tissues. Failure to determine the proper working length can result in short working length with tissue being left in the canal or a long

working length, with possible sequelae of damage to the periradicular tissues. This can result in patient discomfort, reinfection and/or extrusion of irrigating solution beyond the confines of the canal¹⁻³. Working length (WL) is defined as 'the distance from a coronal reference point to the point at which canal preparation and filling should terminate⁴. The correct determination of the WL is a key

factor for successful root canal treatment, because it reduces the possibility of insufficient debridement of the canal or damage to the periapical tissues due to over-instrumentation⁵. Due to the pivotal role of WL determinations in root canal therapy, several methods have been introduced as follows; tactile sensation, the paper point method, apical periodontal sensitivity, and radiography. However, among all these methods, none of them was singly able to accurately determine the apical constriction. The radiographic method has long been the most commonly used for WL determination. The most obvious drawback to this method is that it is impossible to accurately determine the position of the apical constriction (AC) and the apical foramen (AF) on the basis of conventional radiographs alone⁶. Electronic apex locator (EAL) currently is being used to determine the working length and is an important adjunct to radiographs which has overcome its drawbacks⁷. This study was undertaken to assess and compare the third generation versus fourth generation electronic apex locators in detecting apical constriction.

MATERIAL AND METHOD

This study was undertaken to assess and compare the third generation versus fourth generation electronic apex locators in detecting apical constriction. 40 single rooted completely formed freshly extracted teeth were used for this study. After administering local anesthesia access was opened and no 15 file was used to determine the working length with apex locators. The sequence of use of Raypex 5 and Root ZX was kept at random to remove bias. The file was sealed at this position using a permanent dental cement and the excess coronal portion was cut off using an orthodontic cutter. This was followed by atraumatic tooth extraction and immersing in hypochlorite solution to remove organic debris. Apical 5 mm of the root apex was then shaved off with a bur under a microscope. The last layers were removed by a BP blade. This was followed by measuring

the distance of the end of the file to the minor diameter under stereomicroscope at ×10. Entire data was recorded in the Microsoft excel sheets. SPSS software was used for statistical analysis. Chi square test and student T test were used to compare the variables. P-value of less than 0.05 was considered significant.

RESULTS

In the current study the minor diameter was determined in all the teeth. The distance of the file tips from the minor diameters as calculated by EALs are given in table 1. The mean distance between the instrument tip and the minor diameter was $+0.0001 \pm 0.2054$ mm for the Root ZX and $+0.042 \pm 0.229$ mm for the Raypex 5 (table 1).

The minor diameter was coinciding with the tip of the instrument in 9 cases when Root ZX was used and in 10 cases when Raypex was used. In 92.5% of cases tested with Root ZX the minor diameter was within the limit of ± 0.5 mm. In 95% of cases, minor diameter was within a limit of ± 0.5 mm with Raypex 5 (table 1).

In the current study no precise distinction was found between the results of the two EALs. The paired sample *t*-test showed that there was no significant difference between the results of Root ZX and Raypex 5 in determining the minor diameter ($P < 0.416$).{table 2}

DISCUSSION

Since the introduction of first electronic apex locator by Sunada, it has undergone lot of improvements. This has led to a greater precision, fewer procedural errors, less discomfort to the patient and faster case completion⁸. Although many generations of EAL's are available for use in clinical practice, Root ZX has become the benchmark to which other apex locators are compared. Root ZX has been exhaustively tested for accuracy in vivo and in vitro. Root ZX has shown 90-100% accuracy in determining the minor apical foramen⁹.

Table 1: Distance from file tip to minor diameter.

Number of teeth	1	2	3	4	5	6	7	8	9	10
Root ZX(mm)	-0.4	0.6	0.1	0.0	-0.2	-0.3	0.0	0.2	-0.3	0.1
Raypex 5(mm)	0.5	0.5	0.1	0.0	0.1	0.0	-0.2	0.2	0.4	0.3
Number of teeth	11	12	13	14	15	16	17	18	19	20
Root ZX(mm)	0.2	0.3	0.1	-0.1	0.0	-0.1	0.1	0.2	0.0	0.0
Raypex 5(mm)	-0.1	0.0	-0.2	-0.1	0.0	-0.2	0.1	0.2	-0.3	0.0
Number of teeth	21	22	23	24	25	26	27	28	29	30
Root ZX(mm)	-0.4	0.6	0.1	0.0	-0.2	-0.3	0.0	0.2	-0.3	0.1
Raypex 5(mm)	0.5	0.6	0.1	0.0	0.1	0.0	-0.2	0.2	0.4	0.3
Number of teeth	31	32	33	34	35	36	37	38	39	40
Root ZX(mm)	-0.4	0.6	0.1	0.0	-0.2	-0.3	0.0	0.2	-0.3	0.1
Raypex 5(mm)	0.0	0.5	0.1	0.0	0.6	0.0	-0.2	0.2	0.4	0.3

Table 2: Statistical comparison between the two apex locators

EAL	Mean	Standard deviation	P-value
Root ZX(mm)	.0001	.2054	.416
Raypex 5(mm)	.0427	.2294	

The electronic apex locators (EALs) have been presented as valid instruments for identifying the AC and determining WL alternatively to the radiographic method. Their advantages include higher accuracy in estimation of the WL compared with the radiographic method as shown by previous studies¹⁰⁻¹¹, continuous monitoring of the WL in combination with intelligent rotary systems, and reducing the total needed radiographs and radiographic exposure as a result¹².

In the current study the minor diameter was determined in all the teeth. The distance of the file tips from the minor diameters as calculated by EALs are given in table 1. The mean distance between the instrument tip and the minor diameter was $+0.0001 \pm 0.2054$ mm for the Root ZX and $+0.042 \pm 0.229$ mm for the Raypex 5 (table 1). [DV Swapna](#) et al compared the accuracy of Root ZX and Raypex 5 in detecting minor diameter in human permanent single-rooted teeth. Thirty-one patients with completely formed single-rooted permanent teeth indicated for extraction were selected for the study. Crown was flattened for stable reference point and access cavity prepared. Working length was determined with both apex locators. A 15 K file adjusted to that reading was placed in the root canal and stabilized with cement. The tooth was then extracted atraumatically. Following extraction apical 4 mm of root was shaved. The position of the minor diameter in relation to the anatomic apex was recorded for each tooth under stereomicroscope at $\times 10$. The efficiency of two electronic apex locators to determine the minor diameter was statistically analyzed using paired sample *t*-test. The minor diameter was located within the limits of ± 0.5 mm in 96.6% of the samples with the Root ZX and 93.2% of the samples with Raypex 5. The paired sample *t*-test showed no significant difference. On analyzing the results of our study it can be concluded that Raypex 5 was as effective as Root ZX in determining the minor diameter¹³.

In this study the minor diameter was coinciding with the tip of the instrument in 9 cases when Root ZX was used and in 10 cases when Raypex was used. In 92.5% of cases tested with Root ZX the minor diameter was within the limit of ± 0.5 mm. In 95% of cases, minor diameter was within a limit of ± 0.5 mm with Raypex 5 (table 1). Mehmet Yolagiden et al compared the accuracy of four different electronic apex locators (EALs) in detecting a position 0.5 mm short of the major foramen. The actual working length of thirty-five extracted human teeth was determined visually as 0.5 mm short of the apical foramen. After actual working length measurements, electronic working length was measured with four different EALs (Apex Pointer+, Raypex 5, Apex ID, and Raypex 6). Measurements were

repeated three times by different operators. The data were analyzed using the intraclass correlation coefficient (ICC), the repeated measure analysis of variance (rANOVA) and Bonferroni post hoc tests. The significance level was set at $p \leq 0.05$. The mean differences between electronic and actual working length were -0.305 mm, 0.098 mm, 0.037 , and 0.144 mm for the Apex Pointer+, the Raypex 5, the Apex ID, and the Raypex 6, respectively. Multiple paired comparisons (Bonferroni test) also showed the Apex Pointer+ is significantly different from the Raypex 5, Apex ID and Raypex 6 ($p = 0.000$, $p = 0.001$, and $p = 0.001$ respectively). All EALs showed an acceptable determination of the working length between the ranges of ± 0.5 mm except for the Apex Pointer+ device, which had the lowest accuracy. Further studies may be beneficial especially to better evaluate the accuracy of the Apex Pointer+¹⁴.

In the current study no precise distinction was found between the results of the two EALs. The paired sample *t*-test showed that there was no significant difference between the results of Root ZX and Raypex 5 in determining the minor diameter ($P < 0.416$).{table 2} [Hamid Mosleh](#) et al compared electronic apex locators (EAL) with others root canal determination techniques and evaluate other usage of this devices. "Tooth apex," "Dental instrument," "Odontometry," "Electronic medical," and "Electronic apex locator" were searched as primary identifiers via Medline/PubMed, Cochrane library, and Scopus data base up to 30 July 2013. Original articles that fulfilled the inclusion criteria were selected and reviewed. Out of 402 relevant studies, 183 were selected based on the inclusion criteria. In this part, 108 studies are presented. Under the same conditions, no significant differences could be seen between different EALs of one generation. The application of EALs can result in lower patient radiation exposure, exact diagnosing of fractures, less perforation, and better retreatment. EALs were more accurate than other techniques in root canal length determination¹⁵.

CONCLUSION

From the above study the author concluded that both root ZX and Raypex 5 were almost equally effective in determining the minor diameter of teeth. Further studies are recommended.

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