

AN IN VITRO EVALUATION OF ABILITY OF DENTAPORT ROOT ZX FOR CORRECT WORKING LENGTH DETERMINATION

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ABSTRACT

This study was performed to evaluate the ability of Dentaport Root ZX to determine the working length accurately. Apex locators are considered to be one of the latest innovations that have made the outcome of the endodontic treatment more predictable.

Seventy-two extracted teeth were used in present study and standard access cavities were prepared in all the teeth. Working length was first determined using direct method. The root canal length measured by direct method i.e. direct length (DL) showed a mean of 14.92 ± 1.107 mm and std.deviation of 1.107. For in vitro working of Dentaport Root ZX an apparatus was designed which used normal saline as the conducting medium to ensure free movement of ions between electrodes of electronic apex locator (EAL). Working length was then measured electronically using Dentaport Root ZX and noted as Electronic length (EL). EL showed a mean of 14.69 ± 1.137 mm and std.deviation of 1.137. Out of 72 extracted teeth that were used in present study the difference between DL and EL was insignificant (p -value < 0.05) which proves the accuracy of Dentaport Root ZX in determination of working length.

Key Words: Endodontics, working length, Electronic Apex Locators, Apical foramen, Dentaport Root ZX.

INTRODUCTION

Root canal treatment is considered to be an ideal option for treating necrotized tooth, tooth with irreversible pulpitis and traumatized teeth with Pulpal exposure. Irrespective of the reasons of undergoing it, endodontic therapy is regarded as a specialized procedure which not only requires complete knowledge of the subject but an appropriate armamentarium as well.¹

Determining the apical limit of canal preparation or determination of the working length, which is one of the important aspects of root canal treatment, has always been a challenge for all endodontists. Optimal rates of healing occur when instrumentation and filling are contained within the region of apical constriction.

Traditional methods for establishing working length such as radiographs, anatomical averages of canal

length, tactile sensation in both open and closed apices and moisture on a paper point have their limitations. Radiographs have many disadvantages when it comes to working length determination.^{2,3}

Even amongst experienced clinicians, the use of anatomical averages and tactile sensation has been shown to be unreliable and are subjected to marked intra-subject differences.

Despite of the short comings of this method, different studies are still directed to test the use of tactile sensation for determination of working length in teeth with open apices.⁴

The development of electronic apex locators (EALs) has helped in making the assessment of working length more accurate and predictable.^{5,6} In 1991 Kobayashi et al introduced the ratio method which subsequently led to the invention of self-calibrating Root ZX (J. Morita, Tokyo, Japan) that belonged to third generation of apex locators. The main shortcoming of first and second generation apex locators i.e. erroneous readings with electrolytes was overcome by this invention. This third generation apex locator i.e. Dentaport Root ZX (J. Mortia, Tokyo, Japan) was used in this study.

EALs have proved their efficiency in primary molars with difficult canal anatomy^{7,8}, in the presence of different irrigants within the canal^{9,10,11}, apical periodontitis,

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defibrillators¹³, in root canals with large periapical lesion or intracanal exudate¹⁴, in root canals with large apical foramen¹⁵ and in the presence of different solvents.¹⁶

METHODOLOGY

The study was conducted on 72 extracted maxillary and mandibular anterior teeth with single straight canal. Teeth with completely formed roots with no previous attempt for endodontic therapy were included in present study. Teeth with curved, resorbed roots, roots with open apices and previous endodontic therapy, calcified canals having pulp stones were excluded.

After obtaining an informed written consent from the patients teeth were extracted due to periodontal, orthodontic and/or prosthetic reason and ensuring that they cannot be saved by any mean. Every tooth was labelled with a number from 1 to 72 and to eliminate operator bias only one length was taken at a time so that the previously noted length was not known. The selected teeth were stored in 10% formalin and rinsed in saline solution before use. Incisal edges of all the teeth were reduced to produce a regular, flat reference point in such a way that each tooth was measuring in a range of 13mm to 18mm in length.

Data Collection

Standard access cavities were prepared.¹⁷ A 25mm #15 K file (Mani) was introduced into the tooth through the access cavity till the point where the file just started to appear at the cervical border of the major foramen under 2.5 x magnifications (keeler Super Vu Galilean loupe¹⁸, inches working distance). At this point stopper was adjusted against the reference point on the crown of the tooth and the length was noted from tip of the file till the stopper with the help of millimeter scale as direct length (DL) in millimeters.

A special apparatus was designed for in vitro working of Dentaport Root ZX. A plastic container was filled with saline soaked sponge. This sponge was used to support another perforated small plastic container and the tooth was mounted in the lid of this container at the CDJ so that its root was completely submerged in the solution.

The working length of the same tooth was then noted with the help of Dentaport Root ZX. Apical line indicator on the LED of the apex locator was adjusted at 0.5 position. The stopper was adjusted against the same reference point used for direct method of correct working length determination and the length was noted as electronic length (EL) from tip of the file till the stopper with the help of millimeter scale in millimeters.

All the data was entered and analyzed using Statistical Package for Social Sciences (SPSS version 10). Descriptive statistics were used. Mean $\pm$ standard

deviation was calculated for root canal length measurement (in millimeters) by direct method. Independent sample t-test was applied to compare means of different qualitative variables (Root canal lengths measured by different methods). p-value less than 0.05 was taken as significant.

RESULTS

The root canal length measured by direct method i.e. DL showed that the minimum length was 13mm and maximum length was 18mm with a mean of 14.92 $\pm$ 1.107mm and std. deviation of 1.107. The distribution of measurement of root canal length measured by EAL i.e. EL is given in (Table 1). To find out the difference in root canal length the measurements taken as EL were subtracted from measurements taken as DL. The difference of EL and DL is given in (Table 2) which revealed that the mean difference was -0.2083 $\pm$ 0.5291 within a range of -1.5 and 1.5 mm.

The negative sign shows that the root canal length measured by EL is smaller than measured by DL. The negative mean value showed that the root canal length measurement is smaller by EL as compared with DL method in most of the teeth. Comparison of root canal lengths measured by two different methods i.e. DL and EL showed no statistically significant difference. (Table 3)

TABLE 1: DISTRIBUTION OF ROOT CANAL LENGTH MEASURED BY EAL (EL)

	N	Min- imum	Max- imum	Mean	Std. De- viation
EL (mm)	72	12	18	14.69	1.137

TABLE 2: DISTRIBUTION OF DIFFERENCE BETWEEN EL AND DL

	N	Min- imum	Max- imum	Mean	Std. De- viation
EL-DL	72	-1.50	1.50	-0.2083	.5291

TABLE 3: COMPARISON OF ROOT CANAL LENGTH (MM) MEASURED BY DL AND EL

	Method	N	Mean	Std. De- viation	P- value
Root Canal Length	DL	72	14.9167	1.1069	0.222
	EL	72	14.6875	1.1366	

DISCUSSION

Present study was conducted on 72 extracted maxillary and mandibular anterior teeth. Comparisons with other studies in terms of sample size revealed that in studies conducted by Barthelemy, Jabckodson¹⁸

and Atenburger¹⁹ the sample size was 45, 24, 65 and 60 extracted teeth respectively with a mean sample size of 48.5 per study. EALs have proven accuracy in determining the working length under different clinical conditions^{20,21,22}, and working environments.^{23,24,25}

In present study for eliminating variable of tooth length and to obtain a flat reference point the incisal surfaces of all the teeth were prepared so that every tooth should measure between a range of 13mm to 18mm. The electronic length (EL) was measured with the apical line indicator on the LED of the EAL so adjusted to detect the major foramen. Major foramen is used as a reference point because it can be determined by direct inspection which eliminates the requirement of the tooth to be grinded to visualize the tip of the instrument used for working length determination.

The difference of ± 0.5 mm was considered as negligible to accommodate the following variations that can occur during the working length determination:

- 1 Accurate adjustment of the rubber stop along the reference point.
- 2 Accurate adjustment of the length determining file along the ruler.
- 3 Minor errors that may or may not be present in the ruler that is used for measuring the file length.
- 4 Correct visualization of the tip of the length determining file is not possible because of variations in the shape of major foramen when it reaches its cervical border.

Findings of present study are in agreement with the findings of an in vitro study conducted by Alves.²⁶ However a study conducted by Plotino²⁷ on extracted teeth in which he compared Root ZX, Elements diagnostic Unit and Apex Locator and ProPex for their ability of determining the root canal terminus found a mean difference of $-0.157\text{mm} \pm 0.228\text{mm}$ (where negative sign shows measurement short of the actual length) between the length determined by the direct method and Root ZX. According to this study there was a significant difference ($P < 0.001$) when the length was determined by these two different methods i.e. direct method and by Root ZX.

Root ZX was found to be more accurate when it was compared with different types of EALs available. Another in vitro study conducted by Bernardes²⁸, found that the accuracy of Root ZX for determining the root canal length is more than 95% when compared with other types of apex locators such as Romi APEX D-30, Elements Diagnostic Unit and Mini Apex locator. Measurements that were obtained from EAL i.e. EL which were found to be shorter than the ones obtained

by DL method can be attributed to dentin debris that accumulates apically due to the cutting action of the file on the walls of the root canal. In none of the 72 teeth which were used for this study EL was greater than DL (as shown in Table 2). This finding is very encouraging as this will help in avoiding damage to the periapical tissues by over instrumentation, transportation of the canal constituents into the periapical area by repeated mechanical movement of the file and change in the position of minor foramen.

CONCLUSION

This study proved that the difference in length determined by Dentaport Root ZX and the one determined by direct method is statistically insignificant ($p > 0.05$). Hence Dentaport Root ZX can be used to determine the working length accurately in teeth with single canal.

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CONTRIBUTIONS BY AUTHORS

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| 1 Adil Shahnawaz: | Conducted the entire research, performed procedures and collected data |
| 2 Alia Ahmed: | Supervised the entire research |
| 3 Muhammad Qasim Javed: | Helped in biostatistics and data analysis of the research |