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ACCURACY OF TWO APEX LOCATORS IN CALCULATING WORKING LENGTH IN MOLAR PRIMARY TEETH: AN EX VIVO STUDY

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ABSTRACT

Aim: The purpose of this study is to compare the accuracy of Root ZX II and SIROEndo in calculating the working length (WL) in primary teeth.

Methods: Twenty primary molars teeth planned for extraction were used, after access cavity preparation the actual working length for each root canal was measured, All root canals were then measured by using both devices. Difference between the electronic and actual canal lengths were calculated.

Results: At the accuracy limit ± 0.5 mm showed there was no significant difference between both devices; the Root ZX II device showed accuracy 76.66% % while the SIROEndo Pocket showed accuracy 71.66%, when the difference was ± 1 mm. there was also no significant difference, the results were shown to be 98.33% for the Root ZX II device and 96.66% for the SIROEndo Pocket ($p < 0.05$).

Conclusion: Both electronic apex locators (EAL) devices can be used as a reliable tool in measuring working length in primary molar teeth.

INTRODUCTION

Successful root canal treatment depends on adequate cleaning, shaping and filing of the root canal system either in permanent or primary teeth. Accurate determination of the working length (WL) is a crucial step prior to pulpectomy in primary molars.

Due to limitations of radiographic interpretation and high possibility of over-instrumentation of the unevenly resorbed roots and subsequent overfilling, the application of electronic apex locators (EAL) is recommended regardless of the stage of root resorption[1]. In addition, radiographs are highly dependent on patient cooperation, especially

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in children patients. Radiographs lengthen appointment time, and most importantly, expose patients to ionizing radiation.

The first and second generation EALs were unable to give accurate measurements in the presence of irrigation solutions, blood, pus, and pulpal tissue either necrotic or vital [2]. However, recently developed EALs determine the working length by measuring the impedance with two or more different frequencies, and they can work in the presence of various electrolytes.

The Root ZX EAL (J. Morita Co., Kyoto, Japan) has been extensively tested in vivo and ex vivo and has become the gold standard to which new devices are compared. [3, 4] it is considered of the third generation which works by calculating the impedance ratio of two simultaneously produced frequencies (0.4 and 8 kHz). It has been tested in previous studies and has subsequently become a reference in WL evaluation [5, 6]

SIROEndo Pocket is a combined device which helps in root canal preparation while measuring WL, it uses dual frequencies, 0.047 kHz and 0.063 kHz.

Thus, the purpose of this study is to compare the accuracy of two electronic apex locators in calculating the working length in primary teeth.

MATERIALS AND METHODS

Teeth selection

Twenty primary maxillary & mandibular molars extracted from outpatients of the dental clinics of Alazhar dental college were selected for this study. The teeth used in this study were extracted either due to inability to restore it due to presence of extensive caries, or due to prolonged retention. All the teeth were extracted following signed consent from the children parents. Following extraction all the teeth were numbered and stored in 10% formaldehyde till use. The teeth were immersed in sodium hypochlorite 5.25% for 15 minutes to remove any organic fragments on the root surface.

Access cavity preparation was performed in using # 2 carbide round bur and the pulp was extirpated using pulp broach and canal patency was confirmed using # 10 K file. For complete debridement all canals were irrigated using 3 ml 6% NaOCl followed by 3 ml sterile saline then the pulp chamber was dried using cotton pellets.

To create flat reference point; the occlusal surface was ground using wheel stone bur perpendicular to the long axis of the tooth, the reference point was marked using paint marker to allow repeatable positioning of the silicone stopper of the K-file. All the teeth were placed to the level of cemento-enamel junction in freshly mixed alginate poured in plastic blocks dimension 2 x 4 cm.

Electronic determination of the working length

Electronic measurements were taken for each canal of the selected molars using Root ZX II, SIROEndo pocket. Lip Electrode was attached to the alginate via metal rod while the file clip was attached to K file # 15.

The WL were determined according to manufacturer instructions in both devices, for the Root ZX II the file was advanced in the canal till the signal on the display screen appear showing the end of the green bars at the word Apex then withdrawn 0.5 mm, as for the SIROEndo pocket the file was advanced till reaching the letter A then the file was withdrawn 0.5 mm. After adjusting the silicone stopper to the reference point the file was withdrawn out of the canal and the distance between the tip of the file and the rubber stopper was measured using 0.5 mm precision digital caliper with 0.01-mm resolution (Tiny Deal, china). The measurements were taken by two observers three different for each canal and the average measures were recorded.

Actual determination of the working length

K- File with silicone stopper #15 was inserted passively in the canal till the tip of the file was visible using loupes with magnification 2.5 x at the apical foramen then it was withdrawn 0.5 mm coronally. The silicone stopper was placed flat on the previously marked reference point, then the file was removed out of the canal and the working length was measured using the same endodontic ruler.

All of the obtained data from both EALs and direct measurements were calculated and tabulated in Excel spreadsheets.

RESULTS

All of the calculated values were grouped as stated below:

- Between –1 and –0.51 mm
- Between –0.5 mm and +0.50 mm
- Between +0.51 mm and +1 mm

Mean and standard deviations of anatomical and electronic means were also calculated for each group.

The frequent distribution of the electronic EALs measurements at different distances from the apical foramen are shown in table (1) the difference between both devices was calculated by chi square test.

When the accuracy limit was (–1 and –0.51) mm:

Root-ZX II group revealed an accuracy of 8.3 % in all canal. Meanwhile SIROEndo group revealed an accuracy 11.6 % in all canal. The difference between both devices was non-significant as indicated by chi square test (p=0.543>0.05).

When the accuracy limit was (+0.5 and +1) mm

Root-ZX II group revealed an accuracy of 13.3% in all canal. Meanwhile SIROEndo group revealed an accuracy of 15 % for all canal. The difference between both devices was non-significant as indicated by chi square test (p=0.793>0.05)

When the accuracy limit was (± 0.5) mm

Root ZX II show 76.66% accuracy, while SIROEndo show 71.66% of all root canals. There was no statistically significant difference as indicated by chi square test (p = 0.408 >0.05).

When the accuracy limit was at (± 1) mm

Root ZX II show 98.33%accuracy while SIROEndo show 96.66% of all root canals. There was no statistically significant difference as indicated by chi square test (p = 0.558 >0.05).

Mean differences between all groups (Root-ZX II group, Siroendo, Anatomical) were shown in table (2). The difference in working length measurement mean± SD between groups was statistically non-significant as revealed by ANOVA test (F=0.0270, p=.9733>0.05)

TABLE (1): Frequent distribution of the electronic apex locator's measurements at different distances from the apical foramen. Positive values are within the canal whereas the negative values are beyond apical foramen or resorption.

Electronic apex locator	Interval in mm (n (%))				
	≥ -1	–1 to –0.51	–0.5 to +0.50	+0.51 to +1	≤ 1
Root-ZX II	1 (1.6 %)	5 (8.3 %)	45 (75 %)	8 (13.3 %)	0
Siroendo	2 (3.3 %)	7 (11.6 %)	41 (68.3 %)	9 (15 %)	0
P value	0.288 ns	0.543 ns	0.408 ns	0.793 ns	

TABLE (2) Working length measurement results showing mean differences between anatomical and electronic apex locator groups.

Group	Mean ± SD	Mean difference	ANOVA
Anatomical	11.6525±1.601	----	P value
Root-ZX II	11.6297±1.592	-0.02283±0.1692	.9733 ns
SIROEndo	11.7395±1.560	-0.0875±0.252	

DISCUSSION

The determination of the accurate WL is a very important step in the endodontic treatment of deciduous teeth and should take great concerns of clinicians to provide efficient disinfection of root canals and at same time protect periradicular tissues and the tooth germ of the successor by preventing the passage of obturation material or instruments through the apex. Inappropriate manipulation of primary tooth apex may compromise and damage of the permanent tooth buds, in order to prevent that the working length has to be considered shorter than the radiographic apex.

Many conducted studies used different methods to evaluate the accuracy of EALs as its comparison with radiographic technique and, or using clinically and the actual lengths of canals were measured following extraction. In this study the electronic working length was measured by EALs and visually as used by **Angwaravong and Panitvisai**[7].

Commonly, dentists use Radiography for working length determination. However, the widespread of EALs to determine WL has progressed substantially and gained increasing popularity in recent years as it overcomes many problems as limited mouth opening, poor child cooperation, root resorption, hard tissue deposition and superposition of images, in addition to elimination of radiation risks [8,9].

EAL devices function by completing an electrical circuit through the body. One side of the circuit is connected to a root canal file, while the other end is connected to a lip clip, in this study the lip clip was attached to alginate medium which provide electro conductivity, firmness, stability and simulate periodontium for the teeth as was reported by **Tinaz et al** [10].

The apical constriction of the primary teeth roots is always subjected to resorption either physiologic or pathologic; that why some authors consider the acceptable measurement to be ±0.5 mm between the working lengths obtained directly and that those obtained electronically [11, 12], whereas others considered ± 1 mm to be accepted in primary teeth[13].

Modern apex locators have the ability to determine the area between the minor and major apical foramina by measuring the impedance between the tip of the file and the canal with different frequencies and enables tooth length measurements in the presence of electrical conductive media in the root canals **Kobayashi**[11].

In our study the results at the accuracy limit ± 0.5 mm showed there was no significant difference between both devices; the Root ZX II device showed accuracy 76.66% % while the SIROEndo Pocket showed accuracy 71.66%, meanwhile, when the difference was ± 1 mm there was also no significant difference, the results were shown to be 98.33% for the Root ZX II device and 96.66% for the SIROEndo Pocket.

In the literature variations were found regarding the accuracy of Root ZX in primary teeth as **Guimarães etal**[14] found the accuracy to be 53.3%, 100%, while **Beltrame etal**[15] 69%, 92%, **Goldberg etal**[16] 64%, 94 at ±0.5mm, ±1 mm difference respectively, the variations in the results could be explained by the test conditions as presence or absence of root resorption, root canal irrigants, the methods of evaluation. While **Bahroloomi etal** [17] reported the accuracy to be 86% at ±0.5mm when compared to radiography.

Our findings explain why the Root ZX has become the benchmark for testing other EALs as it comes in accordance with previous results of **Tosun etal**[18] 83.3, 98.5% at ±0.5mm, ±1 mm as they compared the Root ZX to the Tri Auto ZX, While **Welk etal**[19] reported accuracy of 90.7% ±0.5mm when comparing it to the Endo Analyzer.

Our results detected there was no statistically significant difference between both the Root ZX II, SIROEndo Pocket either at ±0.5mm or ±1 mm, this comes in variation with **Altunbaş etal**[20] reported that DentaPort ZX was more accurate than SIROEndo Pocket using the clearing technique±0.5mm or ±1 mm .

CONCLUSIONS

Both Root ZX II, SIROEndo were effective in determination of working length in primary teeth. Therefore, using both devices as an adjunct is recommended for root canal length measurements in primary anterior teeth.

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