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Comparison of the Accuracy of Propex II Electronic Apex Locator and Conventional Radiography for Working Length Determination in Primary Anterior Teeth

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Abstract:

Background: To assess the accuracy of multi-frequency based fifth generation apex locator Propex II (Dentsply, Maillefer) in primary anterior teeth, in comparison with a conventional radiography and an actual working length (AWL) obtained through direct measurement.

Materials and Methods: The study was conducted on 60 retained primary anterior teeth in 7-9 years old children. Following endodontic access cavity preparation, working length was measured by the conventional radiography using Ingle's method, new generation electronic apex locator (EAL) (Propex II) and compared with AWL measured by direct observation after extraction. The results were analyzed statistically by analysis of variance.

Results: There was no significant difference in the working length determined by the radiographic method, EAL, and the AWL ($P > 0.05$).

Conclusion: An accuracy of Propex II apex locator is comparable to conventional radiograph for the determination of the working length in primary teeth.

Key Words: Apex locator, apical constriction, radiography, working length

Introduction

Accurate working length determination is a crucial factor that influences the success of endodontic treatment.[1] Despite several limitations, conventional radiography is the commonly used technique for working length determination. With advancement in technology, electronic apex locator (EAL) was introduced which determines the working length accurately by identifying the apical constriction. Propex II is a modern fifth generation EAL, which uses multi-frequency technology.[2] However, their clinical validity in working length determination of the primary dentition is limited. This study was designed to evaluate the accuracy of Propex II, in comparison with conventional radiography and the actual working length (AWL) in primary anterior teeth.

Materials and Methods

This study was conducted on 60 retained primary anterior teeth in 7-9 years old children. These teeth were indicated for an extraction. The children in the study were subjected to standardized intraoral periapical radiograph of the retained primary anterior tooth using the paralleling technique to assess the resorption status of roots. Teeth with more than 1/3rd apical root resorption were excluded from the study. An informed written consent was obtained from the parents.

After administration of local anesthesia, standard access cavity was prepared using high-speed diamond round bur for each tooth. The incisal edge of the teeth was flattened with a tapered diamond bur to obtain a smooth surface, and this served as a stable reference point for all measurements. Following this, extirpation of pulp tissue was done using 15 size barbed broach. The root canals were irrigated with sodium hypochlorite and sterile saline.

Radiographic working length (RWL) determination was performed with Ingle's method. Pre-operative radiograph was used to determine the RWL. A 15 size K-file with a length 1 mm less (safety allowance) than the length as measured on the pre-operative radiograph was inserted into the prepared root canal. This 1 mm was to allow for possible image magnifications and distortions. Following this, another diagnostic radiograph was obtained using the paralleling technique. The distance between the tip of the file and the apical foramen was measured, and this was added or subtracted to the initial length determined on the pre-operative radiograph. Following this, 1 mm was subtracted (safety factor to conform to the apical termination of the root canal at the apical constriction) from this adjusted working length to yield the radiographic working length.

To determine the electronic working length (EWL), Propex II (Dentsply Maillefer, Ballaigues, Switzerland) apex

locator was used. The canals were dried with absorbent points. The lip clip was attached to the patient's lower lip and the file holder was attached to the K-file of size 15. The K-file was advanced apically into the canal until the display pointed out "Apex." If the reading was stable for 5 s, a silicone stopper was then shifted to the coronal reference point and EWL was measured using a 0.5 mm precision endodontic ruler.

After determining the working length by the above two methods, the teeth were extracted and a 21 mm long 15 size K-file with the rubber stopper touching the coronal reference point was passively introduced into the root canal until its tip was visible at either the apical foramen or the apical resorption level. Then, the file was retracted carefully and the distance from the rubber stopper to the file tip was measured with a metallic endodontic ruler of 0.5 mm precision. This measure minus 1 mm was recorded as working length gold standard. To control the visualization errors, each tooth was measured thrice, and the mean value was calculated. This reading was registered as AWL.

The electronically and radiographically measured working lengths were compared with the AWL for accuracy. The working length readings obtained by the different methods were tabulated, and a statistical analysis was performed using analysis of variance (ANOVA).

Table 1: Descriptive statistics of working length (mm) obtained using conventional radiography, electronic apex locator and actual length of extracted tooth.

Groups	*N*	Mean±standard deviation	Minimum	Maximum
Conventional radiography (RWL)	60	12.100±2.1625	9.5	17.0
Electronic apex locator (EWL)	60	11.902±1.7977	9.5	16.0
AWL of extracted teeth	60	11.992±2.0200	9.5	16.5

RWL: Radiographic working length, EWL: Electronic working length, AWL: Actual working length

Table 2: Analysis of variance.

Source of variation	Sum of squares	Degree of freedom	Mean square	*F*	*P* value
Between groups	1.183	2	0.592	0.148	0.862
Within groups	707.316	177	3.996		
Total	708.499	179			

P>0.05: Not significant

Results

Table 1 shows the mean and standard deviation of the measurements obtained with conventional radiography, EAL, and actual length of extracted tooth. The mean working length measurements obtained with conventional radiography (RWL) and apex locator (EWL) were 12.100 and 11.902, respectively. Mean measurements of AWL of extracted tooth was 11.992.

Table 2 represents the results of ANOVA, which was performed to determine the differences between the measurements of conventional radiography, EAL and AWL. There was no statistically significant difference between the groups in the determination of working length in the primary teeth ($P > 0.05$). This implies that the measuring accuracy of Propex II EAL and conventional radiography were similar. Although there were no statistically significant differences between the three groups, the EWL measurements were the closest to the AWL.

Discussion

An accurate root canal length (working length) determination is one among the most important factors for successful endodontic treatment in both permanent and primary teeth.[3] The conventional radiography is the widely used technique for working length determination. However, radiographic determination of canal lengths especially in children is subject to several problems. Poor cooperation and limited access to the mouth of the young children makes it difficult to take a radiograph of acceptable diagnostic value.[4] Some technical disadvantages including inappropriate placement of film and incorrect angle of X-ray beam may cause inappropriate images which, in turn, will require repetition of radiography and increased exposure to radiation.[5] Above all, radiography merely provides a two-dimensional image of a three-dimensional structure, so small areas of resorption are difficult to assess[6] which may increase the risk of overinstrumentation. This overinstrumentation of primary tooth can damage the underlying permanent successor tooth.[7]

All these limitations together led to the shift of choice toward the development of electronic devices, the so-called EALs which locate the apical constriction (minor apical foramen), the end point of the root canal preparation more precisely. Minor apical foramen is the border line between the dental pulp and periodontal area and is approximately 0.5-1 mm from the anatomic apex.[8]

Some of the earlier studies[9,10] reported that the EAL measurements appear to be less accurate when the apical foramen is immature or large. This means that primary teeth which constantly undergo physiologic root resorption might influence electronic measurements of working length. However, the efficacy of EALs has been proven even in the presence of root resorption.[7,11-14] This has been attributed to decreasing taper toward the defect in the primary teeth[15] and also root length more than 7 mm were associated with round, regular apices, and apical diameters <0.3 mm.[16]

The generally accepted criteria for pulpectomy in primary teeth are that root resorption should not exceed one-third of root length.[17] Hence, in the current study, 60 primary teeth that did not show resorption of more than 1/3rd of the root length were

included. We did not find any significant difference between the EWL and AWL, indicating that the Propex II was accurate enough in measuring the working length of primary teeth with or without root resorption.

In this study, working length determination was done using the conventional radiographic method and Propex II EAL, which were then compared with the AWL obtained from extracted teeth. There was no significant difference among EAL and conventional radiography when compared with the AWL, which implies that both the techniques were equally accurate in the determination of the working length in primary teeth.

These results were in agreement with the previous studies[18-20] which have also reported no significant difference when EAL and conventional radiography were compared with AWL in primary teeth.

In this study, though there was no statistically significant difference, the least magnitude of deviation from the AWL was noticed in the EAL measurements when compared with conventional radiography.

In this study, Propex II apex locator was used as some of the earlier studies in permanent teeth have found it to be better when compared with other apex locators[21] and radiographic methods.[2,22] In addition, Propex II operating system calculations are based on the energy of the signal while the other apex locators usually use the amplitude of the signal. Hence, Propex II is reportedly less affected by potential interferences in the root canal.[23]

This study was limited to primary anterior teeth since it was difficult to obtain retained deciduous molars with sufficient root length. However, the results of the current study are comparable to Topaloglu-Ak *et al.*[24] who had also used Propex II in primary molars (*ex vivo*) and reported both EAL and digital radiography showed comparable performance as compared to stereomicroscopic measurements.

When performing endodontic treatment in young children, the procedure and duration are very important in maintaining patient cooperation. EALs reduce the number of radiographs required, detect root canal perforations, and can detect cases where the apical foramen is away from the radiographic apex. EALs used in isolation will not be able to provide information about the curvature and direction of root canal. EAL when used in combination with radiographs will give much greater accuracy of working length and can reduce the number of radiographs required.

Conclusion

In this study, conventional radiography and Propex II EAL showed no statistically significant difference in the determination of working length in primary anterior teeth with or without root resorption. Therefore, this device can be used as an adjunct for working length determination.

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