RESEARCH ARTICLE

Accuracy of working length measurement with endo motor having built-in apex locator and comparison with periapical radiographs

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Abstract

Objective: To determine the accuracy of working length measurement with endomotor having built-in apex locator by comparing it with periapical radiographs.

Methods: The cross-sectional study was conducted at the Department of Operative Dentistry, Dr Ishrat-ul-Ibad Khan Institute of Oral Health Sciences, Dow University of Health Sciences, Karachi, from January to June 2014, and comprised permanent maxillary anterior teeth with mature apices. A pre-operative radiograph was taken by using standardised paralleling technique. The access cavity was prepared by a high speed water-cooled diamond bur. After doing initial filing and drying the canal, the working length was taken with an endomotor with built-in apex locator in dual mode using the Protaper Rotary File S1. The length was measured using a millimetre scale. After attaining tentative working length from the pre-operative radiograph, 1mm was subtracted from the radiographic apex. A stainless steel K-file was placed in the canal at this length and a radiograph was taken by paralleling technique using intraoral film holder. The electronic and radiographic findings were noted. Accuracy was considered positive if the endomotor reading was 0-2mm short of the radiographic working length. Data was analysed using SPSS 16.

Results: Of the 96 cases, working length with X-Smart Dual was acceptable in 85(88.5%) cases, and unacceptable in 11(11.5%) cases.

Conclusion: Accuracy of working length measurement with endomotor having built-in apex locator was found to be a better measuring tool compared to the conventional periapical radiographs.

Keywords: Working length, X-Smart Dual, Radiographs. (JPMA 70: 437; 2020).

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Introduction

The latest technological progress and its continuation from the previous decade have presumably re-invented dentistry.[1] Major innovations have been made during the previous decade to simplify the procedure and to build anticipation. The rate of success of root canal management has expanded to being about 86%, while 98% have ended up being an exceptionally dependable treatment alternative.[2,3] In the event that micro-organisms and their by-products are left in the root canal, they may prompt steady infection. This may happen due to insufficient cleaning and shaping or missed canal during treatment.[2,4] Insufficient debridement and improper filling of tooth at the apical level influences the treatment and result of roots having necrotic pulp or containing periapical lesions.[4,5] Therefore, procedure of root canal and its filling must not lengthen away from the level of the root and must not leave un-instrumented areas within the root canals.[4,5]

The first extensive investigation of apical root anatomy was done by Kuttler in 1955.[6] The framework of the apical part of root is quite complex in nature and contains three different anatomical and histological constituents; apical foramen, apical constriction and cemento-dentinal junction.[1,6] Apical constriction is the portion of the root canal having least diameter and is considered the apical reference point that is used by many clinicians to finish cleaning, shaping and filling. It is considered to be a perfect apical end-point for shaping and performing obturation on tooth.[6] Apical constriction is 0.5 to 1.5mm above the apical foramen.[6] The position of the apical

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constriction is highly variable and cannot be detected radiographically.[7]

Custer in 1918 presented the first electrical method of finding the apical foramen.[8] In 1948 Suzuki, a Japanese scientist, while doing research on dogs revealed that electrical resistances between the periodontal ligament and oral mucosa were always constant at 6.5k?, irrespective of the type and shape of teeth and the age of patient.[8] Sunada in 1962 introduced this principle into clinical practice and constructed a device that measured the canal length using direct current,[9] which is the base on which the principle of resistance-based apex locators work. Use of direct current may cause instability with measurement, and polarisation of file tip causes measurement to be altered. The accuracy of initial electronic apex locators (EALs) was reduced because of the effect of fluids or pulp tissue in the canal. Advances in innovation have prompted improvement of EALs that make precise readings even within the presence of electrolytes. In spite of the fact that the accuracy of apex locators has been assessed in literature, they are as yet not widely utilised as a part of general dental practice.[10]

The device X-smart Dual is an endodontic motor with an integrated EAL. Other than the length measurement function, these devices additionally have torque control and speed settings. As there are countless endodontic motor and EALs are available in the market, the inquiry emerges in the matter of whether these two stand-alone devices may be utilised in combination as an apex locating endodontic motor.[7,9,11]

The determination of working length is the most exciting step in root canal treatment.[12] Traditionally, the working lengths has been measured by radiographs. Radiographic working length is taken with reference to the radiographic apex which is the tip or end of the root as determined radiographically. It may or may not coincide with the anatomic apex. Also, anatomic apex coincides with apical foramen less than 50% of the time. Therefore, considering radiographic apex as a reference point for working length is not ideal. In a study conducted in New Zealand in 1980, 95% of general dental practitioners surveyed used a pre-operative radiograph and 83% considered it necessary to obtain a working length radiograph.[13] In 2009 Palmer et al. conducted a study on endodontic practice in England and found that 57.3% of practitioners continued to use radiographs as the only method for establishing the working length.[14] Errors and concern about radiographic exposure has led to the development of EALs.[2-4] The accuracy of EALs has been studied and it has been proved that they locate the apical foramen effectively and reproducibly".[13,14]

The current study was planned to determine the accuracy of working length measurement with endomotor having built-in apex locator by comparing it with periapical radiographs.

Materials and Methods

The cross-sectional study was conducted at the Department of Operative Dentistry, Dr Ishrat-ul-Ibad Khan Institute of Oral Health Sciences, Dow University of Health Sciences (DUHS), Karachi, from January to June 2014. Patients included were those coming for root canal treatment with signs and symptoms of irreversible pulpitis of either gender aged 12-30 years as the apex matures at this age. The teeth examined were maxillary incisors and canines. Patients excluded were those requiring treatment for molars and premolars, or teeth showing root resorption as apex locators may give an erroneous reading, or with metallic restoration which may interfere with the apex locator function. Re-root canal cases and fractured teeth were also excluded.

After getting approval from the institutional ethics committee and consent from the subjects, permanent single-rooted maxillary anterior teeth with mature apices were selected. A pre-operative E-speed calibrated intra-oral radiograph was taken using standardised paralleling technique with an intra-oral film holder (Endo-Ray II, Dentsply). Following anaesthesia and isolation with a rubber dam, access cavity was prepared by using a high-speed water-cooled diamond bur (No. 3 round bur, Midwest-Dentsply). After completing the initial filing and drying the canal, the working length was taken with an endomotor with built-in apex locator (X Smart Dual, Dentsply-Maillefer) in a dual mode using the Protaper Rotary File S1 (Dentsply Maillefer). The length was measured using a millimetre scale. After achieving the tentative working length from a pre-operative radiograph, 1mm was subtracted from the radiographic apex. A stainless steel K-file (Mani Inc., Japan) was placed in the canal at this length and a radiograph was taken by paralleling technique using intra-oral film holder (Endo-Ray II, Dentsply-Maillefer). The electronic and radiographic findings were entered in a proforma. When the endomotor reading was 0-2mm short of the

radiographic working length(RWL) , accuracy was considered positive. If electronic working length (EWL) exceeded RWL or was >2mm short, accuracy was recorded as negative.

Data was analysed using SPSS 16. Mean and standard deviations were calculated for age of the patient, working length on endomotor and periapical radiographs. Frequency and percentages were calculated for gender, type of tooth and accuracy. Stratification was done with regards to age, gender and type of tooth to control effect modifiers.

Result

Of the 96 subjects, 44(45.8%) were males and 52(54.2%) were females. The overall mean age was 20.12±6.04 years. Also, 49(51%) teeth were central incisors, 26(27.1%) were lateral incisors and 21(21.9%) were canines. The mean RWL was 20.83±1.71mm (95% confidence interval [CI]: 20.48; 21.17) and mean EWL was 20.48±1.80mm (95% CI: 20.11; 20.85). Working length with the device was acceptable in 85(88.5%)and unacceptable in 11(11.5%) cases (Figure).

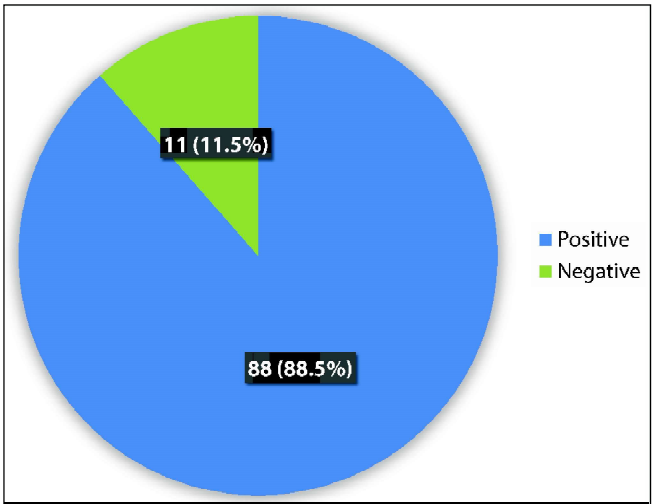

Figure: Accuracy of the working length.

Table: Stratification of accuracy of working length with respect to age, gender and type of tooth.

Variables	Accuracy		*p*-value
	Positive	Negative	
Age groups			0.318
12-18 years	33(38.8%)	6(54.4%)	
19-30 years	52(61.2%)	5(45.5%)	
Gender			0.979
Male	39(45.9%)	5(45.5%)	
Female	46(54.1%)	6(54.5%)	
Type of tooth			0.279
Central incisor 49	44(51.8%)	5(45.5%)	
Lateral incisor 26	21(24.7%)	5(45.5%)	
Canine 21	20(23.5%)	1(9.1%)	

In univariate analysis, association of the accuracy of the working length measurement with age groups, gender and types of tooth was compared and found to be statistically non-significant (Table).

Discussion

Several methods have been utilised to evaluate electronic root canal length measuring devices.[9,10] EALs have been compared with radiographic methods in some clinical studies, whereas other studies used instruments to assess canal length clinically and then measured the actual lengths of the canals.[15,16] Research laboratory models have also been used to test these devices, but these are unable to simulate conditions in vivo.[17]

Therefore, in this in vivo study working length taken with X Smart Dual was compared with that on radiographs. The units were precise within ±0.5 mm which is 83-93% of the time[15] and that is in harmony with a study which reported an accuracy of 88.5%, with the exception that this study was done on an apex locator combined with an endomotor using rotary files. Radiographs have been compared to apex locators with most studies reporting EALs to be more accurate.[18] However, Hassanien et al. established that radiographs were more reliable for determining the working length than using the Root ZX apex locator. Hoer and Attin in 2004 carried out in vivo study which found no major variance concerning EWL and RWL measurements, which is in accordance with our study.[19,20]

A good prognosis of endodontic treatment is observed with fillings which are up to 0-2 mm short of the radiographic apex.[14,21] In this study, working length with X Smart Dual, when compared with that on radiograph, was found to be acceptable in 88.5% cases. This is in contrast with a study by Siu et al.[12] In another previous study,[22] also focussing on anterior teeth, reported accuracy as 76.6%, which is much smaller than this study. When an instrument passes beyond the apical foramen, it introduces many irritants into the peri-apical area causing post-operative pain.[23] In an in vitro study on mandibular premolars it was found that measuring working length with apex locators resulted in overestimation in 21% of the cases which is much higher

than the current study.[7] Other studies on endomotors with built-in apex locators have reported overestimation ranging from 8.33% to 41.67%.[7] In a study by Ehsan S., the Root ZX was 94.1% accurate to within 0.5mm of the apical constriction compared to 50.4% accuracy given by radiographs.[24]

In this study, 12-18 year age group had 38.8% positive accuracy and 19-30 year group had 61.2% positive accuracy. However, this comparison was not statistically significant. The reason behind decreased accuracy in the younger age group could be due to enlarged apical foramina in younger teeth. Studies show that EAL precision declines when diameter of the apical foramen increases.[25] Literature stresses that the lower accuracy is due to difficulty in recognising the slimmest diameter of the canal with these devices.[23] Foramen diameter did not affect the accuracy of MiniApex, Root ZXII, and Elements Apex Locator whereas iPex and Propex II exhibited reduced accuracy as foramen size increased.[25] Regardless of these findings, studies considering the effect of apical foramen diameter on the precision of commercially available EALs are still limited. Central incisors had 51.8%, lateral incisors had 24.7% and canines had 23.5% positive accuracy. This comparison was statistically non-significant. A study by Sadaf D et al. found consistency of EAL in 97.6% of distobuccal canals, 91.1% in palatal canals, 73.7% in mesiolingual canals, 83.3% in mesiobuccal and 80.2% in distal canals. Accuracy of EAL was 91.4% in mesiolingual canal, 92% in mesiobuccal, and 90.2% in palatal and 93.2% in distal canal. However, no significant association was found between other clinical variables with the consistency and accuracy of EAL.[26]

More studies should be carried out on endomotors with built-in apex locator. Endomotors with built-in apex locators are a useful adjunct to endodontic therapy and it is also important to understand that they cannot replace the radiographs completely in treatment. The current study was carried out on anterior teeth alone, and, therefore, data cannot be extrapolated to posterior teeth. Endomotor was compared with radiographs which also have their own limitations representing a two-dimensional image of a three-dimensional object. Thus, more in vivo and ex vivo studies should be carried out on X Smart Dual and it should also be compared with other electronic apex locators.

Conclusion

Modern endomotors with built-in apex locators allow for continuous control of apical preparation during endodontics. Radiographs combined with use of endomotor with built-in apex locator provided the practitioners predictable treatment with a time-saving option.

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