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COMPARISON IN WORKING LENGTH DETERMINATION BETWEEN DIFFERENT USED METHODS TO EVALUATE THE EFFICIENCY OF CBCT IN WORKING LENGTH DETERMINATION

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ABSTRACT

Aim: This study was conducted to evaluate the routinely used methods for working length determination of root canals and comparing them to the working length obtained from the cone beam computed tomography -CBCT- to assess its efficiency in working length determination through both in-vivo and in-vitro measurements.

Methodology: A total number of 47 root canals of 47single rooted human anterior teeth – 12 upper central incisors, 10 upper lateral incisors, 13 upper canines and 12 lower canines that were diagnosed to be extracted due to grade III mobility.

The sample was collected from 10 patients – 6 males and 4 females. CBCT were taken preoperatively. Access cavity was prepared and the working length was determined using apex locator. Then, same teeth were extracted to determine the actual working length (in-vitro).

The working length were recorded and compared to the actual working length of the teeth.

Results: Working length measurements using the preoperative CBCT when compared to the actual working length after teeth extraction were considered to be accurate with the mean value difference between the CBCT and the actual working length 0.5<mm.

Conclusion: Under the circumstances of this study, it was concluded that CBCT is considered to be a reliable and accurate method for working length determination with negligible difference from the actual working length of the teeth that was measured in vitro after extraction.

KEYWORDS: Apex Locator, Cone Beam Computed Tomography, Working Length Determination, root canal treatment.

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INTRODUCTION

Accurate determination of working length in endodontic treatment is one of the most important clinical procedures that directly affect the success of endodontic therapy.

To retain the biological potential of the periapical area and achieve a full disinfection of the root canal system where the mechanical preparation and chemical irrigation is limited to, it is significantly crucial to accurately determine the working length of the canal [1].

The endpoint of an endodontic treatment must be located at the cemento-dentinal junction which is directly affecting the prognosis of the endodontic therapy, where any deviation from the right working length will directly affect the treatment. Determining the working length precisely is therefore essential to successful endodontic therapy [2].

Clinicians usually use various methods and techniques for working length determination however, it has always been challenging to precisely determine the proper apical position in clinical endodontics. Therefore, in adjunct to the periapical radiography, the electronic apex locator is often used to measure the working length of the canals. Which significantly reduces the treatment time as well as the radiation dose received by the patient [3]

Whatever the chosen method is, the canal terminal must be precisely detected during canal preparation in order to achieve successful endodontic treatment, and this working length must be carefully controlled all throughout the procedure of mechanical and chemical canal preparation [4].

In radiographic working length determination, it has been found that 3D measurements are more precise when compared to 2D measurements although both are still considered to be reliable - taking in consideration that all parameters are accurately adjusted and the radiographs are free form errors - especially in anterior teeth with single canals, both had shown negligible difference [5]

Clinicians may prefer to combine two or more techniques to ensure the accurate determination of the working length -whether conventional CBCT software or 3D endo radiographs- provides the clinician with reliable working length determination however, using the electronic apex locator with the previously mentioned methods will increase the accuracy of locating the apical foramen [6].

The ideal method with the ultimate accuracy and least drawbacks is still unleashed. However, most endodontists prefer the combination of periapical radiographs together with the electronic apex locator to achieve more accurate readings instead of dependence on one technique only [7].

Recently, the CBCT had shown many promising results in various dental fields including the endodontic treatments, with less drawbacks and more ease of the clinical process of endodontic therapy compared to the other routinely used methods [8].

This study aims to compare the recent technology of the CBCT radiographs in the determination of the root canal working length and evaluate its efficiency to be reliably used during root canal treatments [9]

The null hypothesis was that there is non-significant difference between the actual working length determined after tooth extraction and that obtained from the preoperative CBCT.

Accuracy of working length determination has been always one of the most critical factors which significantly affect the success of root canal treatment, where any deviation from the proper working length will accordingly affect the prognosis of the root canal treatment [10].

Although different methods are being used every day for working length determination and all are of relatively reliable accuracy such as periapical radiographs and electronic apex locators, cone beam computed tomography – CBCT – has recently introduced in dental field showing promising clinical significance and increased accuracy

compared to the traditional radiography [11] The aim of this study is to compare the working length determined from the preoperative CBCT radiograph to that obtained by the electronic apex locator and the 2d preoperative periapical radiograph using the working length determined by the manual file after tooth extraction as the gold standard, to evaluate the CBCT efficiency as a reliable method for working length determination [12]

MATERIALS AND METHODS

Sample selection:

Study sample was selected carefully of a total number of 47 sound human anterior teeth with typical root configuration (upper centrals , upper laterals and upper and lower canines) -collected from total number of 10 patients- that were diagnosed to be extracted as a result of excessive mobility, surrounding bone resorption and aggressive periodontitis

Case preparation

CBCT radiographs using Sidexis dental imaging software from Dentsply Sirona – to be used for teeth examination and working length determination.

The working length was then determined on the CBCT (cross-sectional and labio-lingual cuts) using the measurement tool on the software, and were recorded.

Local anesthesia was administrated to the field and access cavity was made using medium sized round bur with coolant, proper deroofing was done using endoZ bur (safe-ended), canal patency was checked using manual stainless-steel k-file #10 and the working length were determined in vivo using k-file # 15 with rubber stopper together with an electronic apex locator and the same reference points - incisal edges and cusp tips- were considered.

The file was then withdrawn and the distance from the file stopper to the tip of the file was measured using metal endo ruler (millimeter ruler).

The file was then inserted back to the canal with the stopper adjusted to the working length predetermined by the electronic apex locator and periapical radiographs were taken using digital sensor with standardized parameters and paralleling technique.

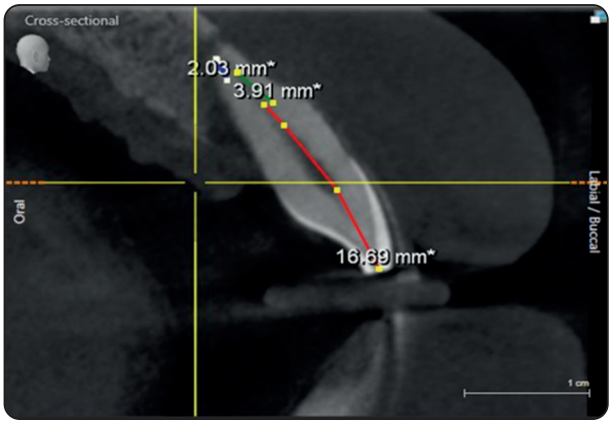

Fig. (1) Showing working length determination on the preoperative cbct radiograph on the upper left lateral incisor

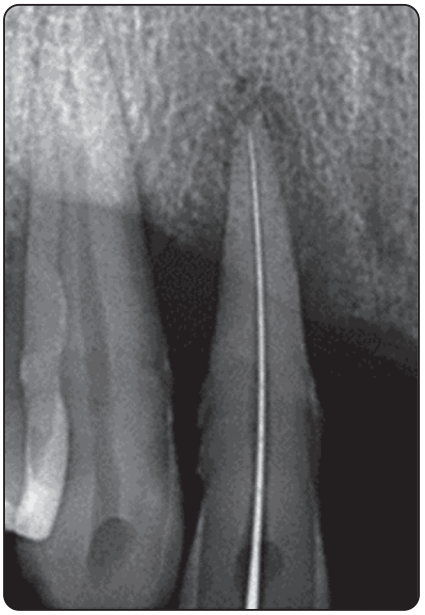

Fig. (2) Showing working length determination on the periapical radiograph with the k-file inserted to the working length predetermined by the apex locator on the upper left lateral incisor

Fig. (3) Showing working length determination after tooth extraction

The teeth were then extracted, soaked in sodium hypochlorite for 30 seconds and the working length was determined extra-orally using endodontic file #15 and the millimeter ruler, those measurements were then recorded to be considered as the gold standard for this study.

All working length measurements were collected and compared to the measurements obtained from the preoperatively taken CBCT radiographs. The mean and the standard deviation of all measurements were calculated.

RESULTS

The mean value of the working length determined by the electronic apex locator and the cone beam computed tomography images together with actual measurements after tooth extraction were collected and statistically compared to evaluate the difference between each of them to the gold standard working length (in-vitro)

The results were plotted using regression analysis and T- test with unequal variance

No statistically significant differences were found between the two methods (P>0.05) with the CBCT showing higher accuracy when compared with apex locator method versus the actual working length. However, the statistical difference remains nonsignificant.

TABLE (1) showing regression statistics

Regression Statistics	
Multiple R	0.999173919
R Square	0.99834852
Adjusted R Square	0.998275121
Standard Error	0.097224025
Observations	48

TABLE (2) Showing the study anova

ANOVA					
	df	SS	MS	F	Significance F
Regression	2	257.1394287	128.5697143	13601.64662	2.52434E-63
Residual	45	0.425362995	0.009452511		
Total	47	257.5647917			

TABLE (3) Showing the intercept of the two methods.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.013685861	0.202039585	5.017263634	8.68502E-06	0.606757249	1.420614473	0.606757249	1.420614473
Apex locator	9.701476257	0.247935516	2.405340523	1.33221E-12	1.90597276	2.904708287	1.90597276	2.904708287
CBCT	-1.404209526	0.247927122	-5.663799565	9.82654E-07	-1.903560383	-0.904858669	-1.903560383	-0.904858669

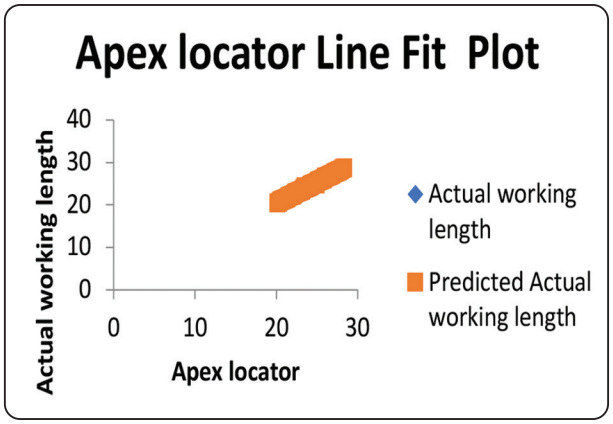

Fig. (4) Showing apex locator line fit plot

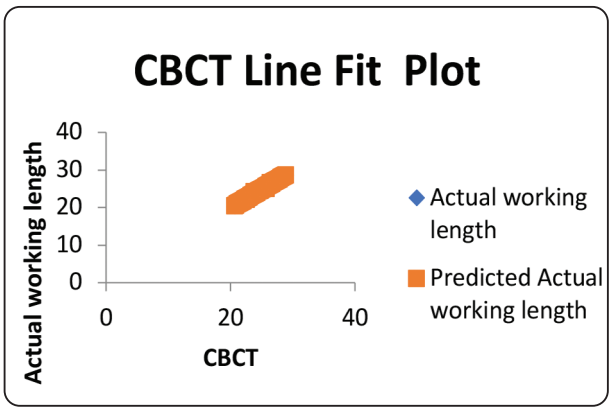

Fig. (5) Showing the CBCT line fit plot

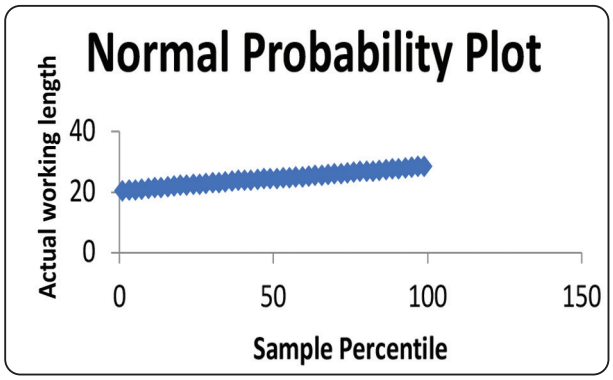

Fig. (6) Showing the normal probability plot

DISCUSSION

Different methods had been used for long time for locating the apical foramen of the root and for measuring the accurate working length at which the root canal filling has to be terminated.

the periapical radiographs are the most commonly used method however, multiple drawbacks can affect their accuracy such as distortion of image (elongation or shortening) due to improper angulation or difficulty to maintain parallelism between the cone and the intraoral film [13] it is also known that the accepted end point of endodontic filling is 0.5-1 mm from the radiographic apex and this may lead to inaccuracies due to difference in the reference point of the tooth from radiographs and intra-orally [14].

Other innovations such as the electronic apex locator had shown promising results as they are considered reliable methods for working length determination depending on the idea that the electrical conductivity of the periapical tissues differs from that of the intracanal pulp tissue, however some limitations are still present [15].

This study aimed to evaluate the reliability of the CBCT images not only in diagnosis of periapical pathology but also its contribution in increasing the success rates of endodontic treatment and increasing the accuracy of working length determination which is considered the cornerstone of dental pulp therapy [16]

The accuracy and reliability of CBCT in working length measurement shown in this study had also been reported in other different reports stated and

analyzed to consider the CBCT one of the reliable methods for working length determination that makes endodontic treatment more accurate and less stressful for the clinicians by reducing the operating time and increasing patient satisfaction of the experience [17].

Moreover, other studies such as Sherrard *et al*. stated that CBCT scans are at least as accurate and reliable as periapical radiographs for determining root length [18].

Others as Shabahang *et al*. stated in his own studies that Root ZX apex locator has an accuracy rate of 96.2% in determining the working length.

The CBCT tend to show higher readings than apex locator which were closer to the actual working length when compared to the readings of the apex locator.

These results came out in agreeance with the research of **de Morais AL etal**, in which the CBCT was shown higher accuracy very close to the actual working length when compared to the electronic apex locator or other periapical radiographs.

It has been proved that CBCT is a very reliable method for working length determination as it is not the only way in measuring the length but it helps in detection of curve direction, identification of the radius of the root curve and detection of intra-canal pathosis, for instance, internal resorption. Accordingly, CBCT gives endodontists 3D information about the shape and curve of internal canal anatomy for proper diagnosis and better canal shaping for better treatment prognosis.

CONCLUSION

When comparing the different available methods of working length determination in root canal treatment, CBCT can be considered an accurate and reliable method for proper working length determination which have great influence on the long-term success of endodontic treatment.

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