

Comparison of Tentative Radiographic Working Length with and without grid Versus Electronic Apex Locator

Abstract

The apical termination of obturation is the most important factor influencing the success of root canal treatment (RCT). Working length (WL) is the key element in achieving this. **Aim:** The aim of this study is to compare and evaluate the preoperative estimated WL with conventional radiograph and with grid radiograph, with reference to electronic apex locator (EAL) in single-rooted teeth. **Settings and Design:** Thirty permanent anterior teeth with complete root formation indicated for RCT were included in this study. **Materials and Methods:** Conventional radiograph (Group 1) and conventional radiograph with external grid (Group 2) were made before access opening. WL with EAL (Group 3) was determined after access opening. **Statistical Analysis:** The statistical package for the social sciences (SPSS) version 16.0 (SPSS Inc., Chicago, IL, USA) was used to compare the WLs of three groups, and the statistical significance was considered to be $P \leq 0.05$. ANOVA, *post hoc* test were made to measure the intergroup comparison, and Pearson correlation values were obtained. **Results and Conclusion:** The results of the study showed a higher correlation between grid WL and apex locator WL than conventional WL and apex locator WL. Preoperative metrics with radiographic grid along with the apex locator is a better measuring tool compared to the conventional radiographic WL in a single-rooted tooth.

Keywords: Apical constriction, electronic apex locator, radiographic grid, working length determination

Introduction

By means of pulpal necrosis, bacteria and their by-products, as well as infected dentinal debris may remain in the most apical portion of the canal; these irritants may jeopardize apical healing.^[1] One of the key concerns in the root canal treatment (RCT) is working length (WL) determination, i.e., to determine how far the working instrument should be advanced within the root canal along with the point of termination for the preparation and obturation. Anatomically, the apical constriction (AC), is a logical location for WL since it often coincides with the narrowest diameter of the root canal. Location of the cementodentinal junction is widely accepted as being 0.50–0.75 mm coronal to the apical foramen.^[2] Accurate determination of WL is a challenge because of the complex apical anatomy.

Radiographic method of determining the WL is one of the most commonly used method.^[3] However, it has limitations such as distortion, shortening and elongation,

and interpretation variability.^[4] One way of minimizing these distortions is by the use of paralleling technique with film holders. However, elongation of images was found to be approximately 5% even with this technique.^[5] Hence, the accurate determination of the WL with radiographic method still remains a challenging task.

Electronic apex locators (EALs) determine the WL with better accuracy in complement or in assistance with radiographic methods.^[6] It was shown that the WL of root canals can be accurately determined with the help of modern EAL irrespective of the canal contents.^[7] The age old radiographic grid method is no more in practice but still has its role in determining the WL. Till date, there is limited literature available regarding the usage of grids to overcome the disadvantage of conventional radiographs in endodontic practice.^[8] Hence, a study was planned to compare and evaluate the preoperative estimated WL with conventional radiograph and that with grid radiograph, with reference to EAL in single-rooted teeth.

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Materials and Methods

This *in vivo* study included 30 permanent single-rooted teeth, indicated for RCT for various reasons in patients between the age group of 18 and 60 years. Teeth with open apex, calcifications, internal resorptions, external resorptions, and perforations were excluded from the study. Institutional ethical committee clearance was obtained for the study. Informed written consent was obtained from the patients. A conventional radiograph and grid radiograph [Figure 1] were made for each tooth before access opening and the tentative WLs obtained by them were considered as Group 1 and Group 2, respectively.

After access opening and pulpectomy, root canal was irrigated using 3% sodium hypochlorite (Prime Dental) and was aspirated but no attempt was made to dry the canals completely. The AC was located with the Root ZX apex locator according to the manufacturer's instructions (J. Morita Corp. 2005). The size 10 K-file was advanced apically into the canal until the beep sound was heard and the light-emitting diode (LED) marked APEX on the panel began to glow, indicating that the tip of the file had reached the anatomical end of the canal. The file was withdrawn with a slow counterclockwise turn until the red LED APEX light turned off and green LED light illuminated and a rapid tone was heard, suggesting that the tip of the file was at the predetermined length of the AC. The distance from the file tip to the incisal edge was then measured and registered as final WL and it was considered as Group 3.

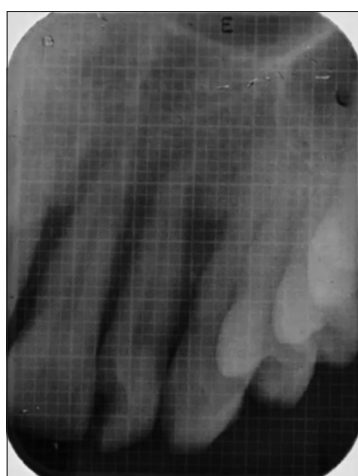


Figure 1: Radiograph with grid over maxillary anterior tooth

Results

Statistical analysis was performed using the statistical package for the social sciences (SPSS) version 16.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was considered to be $P \leq 0.05$. The observations were subjected to Tukey *post hoc* test, and the results were as shown in Table 1. The results showed a statistically significant difference between the groups.

On pair-wise comparison, there was statistically significant difference between Group 1 and 2, Group 1 and 3, whereas this difference was not observed in Group 2 and 3. On comparing Group 1 and 2 with Group 3, Group 2 has shown closer values in WL determination than that of Group 1. Pearson correlation value of 0.990 that is 99% correlation was observed between Group 2 and 3 whereas 95% correlation was observed between Group 1 and 3 [Table 2].

Discussion

Accurate determination of the WL is one of the most important steps in endodontic success.^[9] Radiograph is one of the most commonly practiced and age-old methods for the determination of the WL; however, it is difficult to achieve as the AC cannot be identified accurately due to variables in the technique, angulations, exposure which can distort the image and lead to errors. A paralleling technique exposed with a conventional film holder reproduced the distance between the apex and the tip of a root canal instrument with a very low degree of error. The frequency of deviations was considerably higher when a bisecting-angle technique was used.^[10] The deviations most often consisted of the root canal instrument being projected shorter on the radiograph with the bisecting-angle technique than compared with the paralleling technique. To overcome the above-mentioned errors, electronic methods for WL determination has progressed substantially and has gained popularity in modern endodontic treatment. This method provides more accurate results than with the conventional radiographs.^[11]

In a stereomicroscopic study done by Kqikuand Stadler, the electronically determined WL did not significantly differ from the radiographic WL determination. They concluded that the WL measured with EALs was within ± 0.5 mm of the apical foramen in 74.8% of cases and within ± 0.5 mm of the radiological control length in 90% of all cases.^[12] It

Table 1: Mean comparison between the groups

Equipments	Mean \pm SD	Difference in mean \pm SD	Percentage of mean difference (\pm)	P
Radiograph (Group 1)	23.35 \pm 2.83	2.90 \pm 0.20	14.2	0.001 (significant)
Grid WL (Group 2)	20.45 \pm 2.63			
Radiograph (Group 1)	23.35 \pm 2.83	3.00 \pm 0.24	14.7	0.001 (significant)
Final WL (Group 3)	20.35 \pm 2.59			
Grid WL (Group 2)	20.45 \pm 2.63	0.10 \pm 0.04	0.5	0.988 (not significant)
Final WL (Group 3)	20.35 \pm 2.59			

Statistical analysis: Tukey *post hoc* test. Statistically significant if $P < 0.05$. SD: Standard deviation; WL: Working length

Table 2: Karl Pearson's correlation between the variables

	Correlations		
	Radiograph (Group 1)	Grid WL (Group 2)	Final WL (Group 3)
Radiograph (Group 1)			
Pearson correlation	1	0.960*	0.952*
P		0.001	0.001
Grid WL (Group 2)			
Pearson correlation	0.960*	1	0.990*
P	0.001		0.001
Final WL (Group 3)			
Pearson correlation	0.952*	0.990*	1
P	0.001	0.001	

*Correlation is significant at the 0.05 level (2-tailed). WL: Working length

is suggested that the use of an apex locator alone could not prevent the need for further radiographs for determination of WL since it has been reported that the electronic method for WL determination was satisfactory in 67.8% of cases, versus 50.6% and 61.4% for the conventional and digital radiological methods, respectively.^[13]

Root ZX is capable of performing accurately even in the presence of sodium hypochlorite, blood, water, local anesthetic solution, and pulpal tissues in clinical conditions. Root ZX was found to be accurate to ± 0.5 mm in more than 95% of teeth and was able to consistently determine the location of the AC (within approximately ± 0.4 mm) in the presence of any of the tested irrigants. The advantages of the Root ZX over the others are that it requires no adjustment or calibration and can be used when the canal is filled with strong electrolyte or when the canal is "empty" and moist. A number of *in vitro* and *in vivo* studies on the accuracy and reliability of the Root ZX have been reported, which gave precise and accurate measurements; however, this is not superior to digital radiographic methods when used alone.^[7,14]

Nevertheless, it was emphasized that the use of EAL alone without a preoperative radiograph is not a recommended practice due to the large variation in root canal morphology; open apices, calcifications, perforation, and resorptions.^[15]

Hence, the proper use of the EAL, in conjunction with a well-exposed and properly angled pre-operative radiograph, will result in the most accurate and reproducible means of determining the WL. Ideally, this will lead to more predictable and efficient treatment outcomes to maximize both patient comfort and success of RCT.

Digital radiographic method produces images using a sensor instead of a radiographic film. The digital X-ray has some advantages over the conventional method, which include a speedier image acquisition, a much lower radiation dose, and image editing ability to clearly study the details. The possibility of image manipulation using the resources

offered for the DIGORA system and other digital systems has an advantage over the conventional method, namely, the adjustment of low-quality images that would avoid repetitions and consequently reduce exposing the patient to radiation. However, the sensor is not as flexible as the conventional film, often making it difficult to position in the patient's mouth for the radiograph and also radiographic noise is less with conventional radiographs when compared to digital radiography. Hence, the conventional radiograph was used in the present study to determine the WL.^[16]

Hence, the methods to minimize shortening and elongation of radiographs were considered, among which the parallel placement of radiographic film with film holders is one. However, even when the paralleling technique is used, elongation of images has been found in approximately 5% of the cases.^[17] Therefore, in spite of all the above-mentioned techniques, accurate determination of WL during RCT is a challenging task. Hence, an alternative for the conventional radiographic method, radiographic grid was developed. Everett and Fixot were the first to use metallic grids for WL determination.^[18] The grid should be attached to the film on the tube side, and the film should be exposed. Thus, if the film is elongated, the grid lines also elongate; however, the distance between the two grid lines is 1 mm which is constant.^[8]

A 99% Pearson correlation was observed between grid preoperative WL and EWL which was clinically significant when compared to radiographic preoperative WL and EWL with 95% correlation. Considering the results of the present study, when the three groups were compared, there was a statistically significant difference between radiographic WL and grid WL, EAL WL and radiographic WL. There was no difference observed in between EAL WL and grid WL.

Conclusion

Preoperative metrics with radiographic grid along with apex locator is a better WL measuring tool compared to the conventional radiographic WL in single-rooted teeth, thus preventing a confirmation radiograph at final WL and can be useful in patients who need not to be exposed to repeated radiation because of mental, medical, or oral conditions.

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Conflicts of interest

There are no conflicts of interest.

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