

A Comparative Evaluation of Radiographic and Electronic Technique for Endometrics in Endodontic Therapy: A Clinical Investigation

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Abstract

Introduction: An accurate working length determination is the key to successful endodontic therapy for it ensures complete cleaning of root canal system without overinstrumentation. Thus, it is essential to use reliable methods for endometrics during endodontic therapy.

Aim: The aim of this clinical investigation was to comparatively evaluate the radiographic and electronic methods for working length determinations in clinical setting.

Material and Method: Incisors, canines, premolars, and molars, 150 roots in total, were randomly selected for the study. The working lengths were recorded using the radiographic technique as well as the electronic method using an apex locator. The readings were compared and subjected to statistical analysis using Student's *t*-test and Levene's test for equality of variances.

Conclusion: The results showed no significant difference between the two techniques, thereby indicating both the techniques to be reliable for working length determination.

Keywords

- ▶ apex locator
- ▶ endodontics
- ▶ endometrics
- ▶ radiography
- ▶ working length

Introduction

An accurate and a reproducible working length is an important factor in root canal treatment. It establishes the apical limit of the canal preparation and demarcates the creation of an apical stop. It also enables thorough debridement of the canal, allowing it to be performed without overinstrumentation, trauma to the periapical tissues, or destruction of the anatomy of the root apex. It establishes the apical limit for obturator.^{1,2}

The success rate of conventional root canal treatment has been correlated with the length of the final root canal

filling.³ There are various methods of determining the working length. The use of conventional radiography remains the most common method of determining the working length. There are major disadvantages like the production of two-dimensional images, high radiation exposure, and a cumbersome technique in developing the films with this method.

In recent years, new imaging techniques have been developed with the aim of improving the clarity of the image while reducing the radiation dose. Among them is the radiovisiography, which has been gaining widespread popularity. The advantage of radiovisiography is that there is a 60% radiation

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dose reduction and production of an instant image which is enhanceable and modifiable.³⁻⁵

Efforts have been made to improve the technique to locate the apical constriction and to determine working length without the need to irradiate the patient and to get a near-accurate working length through newer methods like apex locators. However, they too, at times are considered as adjuncts to conventional radiography.

The present article compares the diagnostic efficacy of two methods, namely radiographic technique and electronic apex locator in determining the working length in root canal systems in vivo.

Materials and Methods

Eighty-five adult patients (29 females and 56 males) between 18 and 55 years of age having carious lesions and having history of pain in teeth were randomly selected for the study. In total, 150 roots of 10 incisors, 15 canines, 15 one-rooted premolars, 10 two-rooted premolars, 15 two-rooted molars, and 20 three-rooted molars were included in the study.

Visual examination, palpation, percussion, and vitality tests were performed for preliminary assessment. Preoperative radiographs were taken to confirm the diagnosis and determine the anatomy of the root canal system. Intraoral film holder tooth positioner and paralleling technique were used for standardization during exposure with radiography. A constant distance of 3 inches was maintained between the cone head of the radiograph unit and the tooth positioner during radiographical methods for all the samples.

This procedure minimizes magnification or shortening of tooth image, so all preoperative, intraoperative, and postoperative radiographs were taken by using same angulation to minimize differences in measuring working length of all the samples. Teeth with incompletely formed root apices, evident root fractures, dilacerated roots, and pulp calcifications were excluded from the study.

Each selected tooth was anesthetized with local anesthetic solution containing 4% articaine with 1:100,000 epinephrine (Ultracain D-S forte; Hoechst-Marion Roussel, Frankfurt, Germany).

Under rubber dam isolation, caries removal was done and the initial access form was accomplished with a sterile tungsten carbide bur using a high-speed hand-piece under abundant water spray. Any metal restoration, if present, was completely removed. The pulp chamber was accessed, root canals were located, the coronal part of each canal was flared with an SX Protaper file (Neolix), and then each canal was irrigated with 2.5% sodium hypochlorite solution (Norateks Chemical Industry, Istanbul, Turkey). The incisal or occlusal edges were ground lightly to create stable reference points for the rubber stops on the root canal files. An endodontic K-file corresponding to the size of the root canal was introduced until the apical constricture was felt by the investigator.

Thereafter, excess fluid was removed from the pulp chamber with gentle stream of an air syringe, but no attempt was made to dry the canal. The apex locator (C-Root III, China) was turned on, the file was attached to the file holder, and the lip clip was attached to patient's lip. The file was advanced till the device indicated that the apical constriction had been reached. Then, the working length was measured by apex locator till it reached 0.1 on the monitor. A plastic millimeter ruler was used to measure the length of the K-file from the base of the rubber stopper to the tip of the file, and the readings were again recorded.

Full instrumentation of root canal was done by chemo-mechanical preparation with size 15, 20, 25, and 30 ISO hand K-file (Perfect China) and then using Neolix rotary file (one file technique) corresponding to the size of the root canal, in a modified crown-down manner by using a gentle in-and-out motion, with continuous use of ethylenediaminetetraacetic acid gel. The canals were irrigated throughout with 2.5% sodium hypochlorite solution.

Master cone gutta-percha of same size as of the master apical file (inserted till it fit the working length measured by apex locator) was chosen, the extra length (incisally or occlusally) was cut by scissor according to the reference point chosen. A radiograph was then taken by using paralleling technique, the length was measured by the Vateck software, and the readings were recorded.

Results

The working length of individual root measured by the apex locator (group B) was compared with the working length obtained using radiograph (group A). Results were tabulated and subjected to statistical analysis using Student's *t*-test. The mean of group A (21.02) was found to be almost equal to the mean of group B (21.05) and the variation between groups having a very small difference (► **Table 1**).

Depending on the equal variance assumed, Levene's test for equality of variances revealed no significant difference between the two groups as the value of significance came as 0.889 (*t*-test) which was greater than $\alpha = 0.05$ (► **Table 2**).

Discussion

Endometrics is the science of measuring working length during endodontic therapy. This forms a crucial step in the

Table 1 Mean of group A and group B and the variation between groups

Group statistics					
Y		N	Mean	Standard deviation	Standard error of the mean
X	A	150	21.02	1.849	0.151
	B	150	21.05	1.854	0.151

Table 2 Independent samples test

		Levene's test for equality of variances		t-Test for equality of means						
		F	Significance	t	Degree of freedom (df)	Significance (two-tailed)	Mean difference	Standard error of difference	95% Confidence interval of the difference	
									Lower	Upper
X	Equal variances assumed	0.011	0.916	-0.140	298	0.889	-0.030	0.214	-0.451	0.391
	Equal variances not assumed			-0.140	297.998	0.889	-0.030	0.214	-0.451	0.391

Note: Levene's test for equality of variances revealing no significant difference between the two groups.

procedure of root canal treatment as it ensures the confinement of the instrument and irrigating solutions within the root canal system and ensures complete cleaning and shaping. In the present study, the methods that were used to determine working length were apex locator and radiography and both the techniques showed equal efficiency in determining accurate working length. Out of these two methods, the radiographic technique was closer to the accurate value but was not statistically significant than the other method.

The results of the present study are similar to some of the previous studies.⁶ However, few investigators observed reduced patient inconvenience with the use of electronic apex locator and concluded that the determination of working length using a combination of an electronic apex locator and radiography is more accurate than radiographs alone.⁷ Also, some studies reported that there is no significant difference between conventional methods and electronic apex locators in the accuracy of working length determination but electronic apex locators and digital radiographic methods were found to be beneficial from the perspective of radiation dose reduction.⁸

On the other hand, few studies stated that no individual technique is truly satisfactory in determining endodontic working length. The cementodentinal junction is a practical and anatomic termination point for the preparation and obturation of the root canal and this cannot be determined radiographically.⁹

Modern electronic apex locators can determine this position with accuracies of greater than 90% but may still have some limitations. Knowledge of apical anatomy, prudent use of radiographs, and the correct use of an electronic apex locator can certainly assist practitioners to achieve predictable results.

The current guidelines recommend a combination of electronic and radiographic methods for working length determination. This is in line with several studies which have recommended that an electronic apex locator reading should be radiographically confirmed, whenever in doubt, to reduce the chances of error.¹⁰

Some studies have shown that conflicts in the length measurements given by the two techniques existed. In one such study, the mean length given by the electronic apex locator was beyond the radiographic apex by 0.66 mm and measurements ranged from 2.13 mm short of radiographic apex to 3.14 mm beyond it.¹⁰

However, many studies are in the favor of using the combination method for achieving higher accuracy in working length determination. One such study demonstrated that electronic apex locator measurements were ± 0.5 mm from the apical constriction in 84% of the teeth and the combined method raised the accuracy to 96%.¹¹

So, it can be said that the accurate determination of working length will be dependent on the ability of the clinician to interpret radiographs, correct determination of apical constriction with the help of apex locator,¹² handling and using a combination of all methods, application of logic, knowledge of anatomy, and tactile sense.

The best prognosis for root canal treatment is adequate instrumentation and homogeneous obturation till the apical constriction. The worst prognosis for root canal treatment is under or overinstrumentation or filling short or beyond the apical constriction. So, proper usage of instruments along with the knowledge, skill, and experience of the operator will determine the outcome of each technique.

Conclusion

Accurate determination of the root canal working length is one of the most important steps in endodontic therapy. Conventional radiographs are needed before, during, and immediately after the endodontic treatment and then periodically to evaluate the success or failure of the therapy. The conventional radiograph, though accurate, has the disadvantages of increased radiation and being time consuming. The digital radiography overcomes these by reducing the radiation and time requirement and also eliminating processing variables. The apex locator, however, completely eliminates

radiation and has the advantage of time and convenient chairside access.

Thus, concluding the clinical significance of this study, which has revealed that both the radiographic and electronic methods to be equally reliable for working length determination. However, as a recommendation, a combination of the radiography and apex locator is ideal.

Irrespective of the technique, it is the skill, knowledge, and expertise of the clinician which seems to be assuming paramount importance in correctly understanding and utilizing these technological advances, so as to best determine the accurate working length, which forms the basis for successful endodontic therapy. The more diligently the clinician becomes adept with these techniques, the better the holistic success of the endodontic therapy.

Conflict of Interest

None declared.

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