



Comparative Evaluation of Accuracy of Newer Generation Apex Locator with Conventional Radiographic Method to Determine Working Length in Presence of Various Intracanal Irrigants – An *Invivo* Study

Dr. Saloni Sinha¹, Dr. B.S. Keshava Prasad², Dr. Murali H Rao³, Dr. Karanam Apoorva Prakash⁴

D A Pandu Memorial R V dental college, Bangalore

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ABSTRACT

Aim: The aim of the present study was to compare the accuracy of Canal Pro and Root ZX Mini with conventional radiographic method to determine working length in presence of 3% sodium hypochlorite, 17% Ethylenediaminetetraacetic acid (EDTA) and in dry condition.

Material and Method: For the investigation, 15 single-rooted teeth were chosen. Radiovisography (RVG) was used to determine the actual working length. With 3% NaOCl, 17% EDTA, and dry conditions, electronic working length measurements were made using Canal Pro and Root ZX Mini. Repeated Measures of ANOVA was used to compare the mean working length between RVG and 2 EAL with the use of EDTA and also with NaOCl. Paired student's t Test was used to compare mean working length determined by Canal Pro and Root ZX Mini based on irrigant and also based on the EAL for each irrigant used.

Result: The mean Working length determined by RVG was 20.47 ± 2.11 , by Canal Pro EAL with EDTA was 20.38 ± 2.06 & by Root Zx Mini with EDTA was 20.27 ± 2.22 . However, there was no significant difference in the mean working length between RVG & 2 EALs with use of EDTA.

Conclusion: There was no significant difference between working length in different dry and wet conditions between EAL's and radiographic method. Newer generation apex locator can be confidently used to determine working length in both dry and wet canals.

KEYWORDS: Canal Pro, Root ZX Mini, 3% sodium hypochlorite, 17% ethylenediaminetetraacetic acid, working length measurements

I. INTRODUCTION

The steps in root canal treatment are access opening, determining the working length, cleaning, shaping, and obturation. One of the main goals of endodontic therapy is to thoroughly clean

and shape the entire root canal system to create a space that promotes the healing of the periradicular tissues.¹

One of the most crucial aspects in ensuring the effectiveness of root canal therapy is determining the working length. According to one definition, working length is "the distance from a coronal reference point at which the canal preparation and obturation should terminate."¹ Incorrect working length can harm periradicular tissues and cause other procedural errors.² The most common and widely used way of determining the radiographic working length is diminished by the electronic method.²

Electronic Apex locators (EALs) have been found to be the most effective way for determining the intraoperative working length, according to recent studies. Due to their electrical contact with the periodontal ligament, 3 EALs can detect perforation and horizontal fractures. Consequently, anatomical difficulties including isthmuses, confluences, and accessory canals may compromise the precision of these electronic devices.³

A new EAL on the market, the CanalPro (Coltene-Endo, Cuyahoga Falls, OH), evaluates the mean square root values for two separate alternating frequencies. The third-generation apex locator Root ZX Mini is the gold standard for apex locators due to its lengthy history of clinical effectiveness.⁴

Sodium hypochlorite (NaOCl) is an endodontic irrigant with effective antimicrobial action and tissue-dissolving capability, but concerns have been raised regarding its toxicity to host tissue in higher concentration.⁴

The most common solution used to eliminate the inorganic residues, but not removed by NaOCl, is a Ph 7 solution of EDTA. Ethylenediaminetetraacetic acid (EDTA) has no antibacterial properties but can remove the smear layer deposited by the mechanical action of



instruments, making the canal walls accessible again to disinfects.⁶

The purpose of present study was to compare and evaluate the accuracy of 3rd generation and 6th generation apex locators with conventional radiographic method in determining the working length in present of various intracanal irrigants.

II. MATERIALS AND METHODS

This study was conducted in DA Pandu Memorial RV Dental College after ethical approval from the Institutional Review Committee. The criteria which were included in this study were teeth with single root and with <30 degree curvature, teeth without root fracture, teeth with completely formed root, teeth without caries or restoration. The criteria which were excluded in

this study were teeth with root caries, cracks or fracture, multi rooted teeth, open apices, dilacerated and calcified roots, metallic restored teeth, patients with cardiac pacemakers’.

In this investigation, 15 single-rooted teeth that were considered for endodontic treatment and had fully developed apices confirmed by periapical radiographs were employed. Each patient gave their informed consent. A high speed round diamond burs was used to prepare the access cavity while local anesthesia was given.

After initial exploration of canals with #15k-file, pulp was extirpated with #15k-file followed by through irrigation of the canal with 0.9% saline. Finally, the access was thoroughly dried with cotton pellet. The working length was determined using both EAL and radiographically.





MEASUREMENT OF ACTUAL WORKING LENGTH (AL)

To calculate the actual working length, RVG was used. Buccolingual to mesiodistal angle was used for the capture. The estimated length was placed on file number 15, and the working length was taken. It was measured and noted how far the radiography apex was from the file's reference point.

ELECTRONIC LENGTH MEASUREMENT

Working length was carried out by both electronic apex locators in dry condition and various wet conditions.

Between measurements with different irrigants, the canal was irrigated with distilled

water and dried with paper points. A lip clip from an apex locator was used to secure the patient's lip, and a #15k-file was then attached to the file and put into the canal until the apex locator indicated the "apex" reading.

The file was slightly retracted until the apex locator indicated a reading of "0.5". The silicon stop was adjusted, and the file tip was measured to the nearest 0.5 mm using a vernier calliper.

This length was deducted by 0.5 mm, and the result was noted as actual length (AL). When a measurement remains steady for at least five seconds, it is deemed to be accurate. Two separate apex locators CanalPro and Root ZX Mini were employed to gather electronic measurements.



III. STATISTICAL ANALYSIS

Using the GPower program version 3.1.9.7 [(Franz Faul, Universität Kiel, Germany)], the sample size was calculated.

The required sample size was 14, which will be rounded up to 15. This is because the effect size to be measured (f) is 30% for 6 repeated measurements (2 solutions x 3 techniques), the study's power is 80%, and the alpha error is 5%.



Therefore, 15 patients were included in the current study.

Repeated Measures of ANOVA Test was used to compare the mean Working length (in mm) between RVG & 2 EAL with use of EDTA & also with NaOCl. Student Paired t Test was used to

compare the mean Working Length (in mm) determined by Canal Pro & Root Zx Mini based on Irrigant & also based on the EAL for each Irrigant used.

The level of significance was set at $P < 0.05$.

IV. RESULTS

Comparison of mean Working length (in mm) between RVG & 2 EAL with use of EDTA using Repeated Measures of ANOVA Test

Method	N	Mean	SD	Min	Max	p-value
RVG	15	20.47	2.11	17.7	25.5	0.10
Canal Pro	15	20.38	2.06	17.8	25.2	
Root Zx Mini	15	20.27	2.22	17.5	25.8	

The mean Working length determined by RVG was 20.47 ± 2.11 , by Canal Pro EAL with EDTA was 20.38 ± 2.06 & by Root Zx Mini with

EDTA was 20.27 ± 2.22 . However, there was no significant difference in the mean working length between RVG & 2 EALs with use of EDTA.

Comparison of mean Working length (in mm) between RVG & 2 EAL with use of NaOCl using Repeated Measures of ANOVA Test

Method	N	Mean	SD	Min	Max	p-value
RVG	15	20.47	2.11	17.7	25.5	0.10
Canal Pro	15	20.38	2.06	17.8	25.2	
Root Zx Mini	15	20.27	2.22	17.5	25.8	

The mean Working length determined by RVG was 20.47 ± 2.11 , by Canal Pro EAL with NaOCl was 20.38 ± 2.06 & by Root Zx Mini with

NaOCl was 20.27 ± 2.22 . However, there was no significant difference in the mean working length between RVG & 2 EALs with use of NaOCl.

Distribution of Error Distance of Canal Pro & Root Zx Mini in comparison to RVG readings

Variable	Category	n	%
Error Distance (in mm)	-1.0 to -0.5 mm	7	46.7%
	0.1 to 0.5 mm	7	46.7%
	0.6 to 1.0 mm	1	6.6%

Majority of the Error Distance was observed in the range of -1 to -0.5 mm [46.7%] & 0.1 to 0.5 mm [46.7%] irrespective of the EAL

used. Only few percentage [6.6%] was observed with an error distance of 0.6 to 1.0 mm.



Comparison of mean Working Length (in mm) determined by Canal Pro & Root Zx Mini based on Irrigant using Student Paired t Test						
EAL	Irrigant	N	Mean	SD	Mean Diff	p-value
Canal Pro	EDTA	15	20.38	2.06	0.00	..
	NaOCl	15	20.38	2.06		
Root Zx Mini	EDTA	15	20.27	2.22	0.00	..
	NaOCl	15	20.27	2.22		

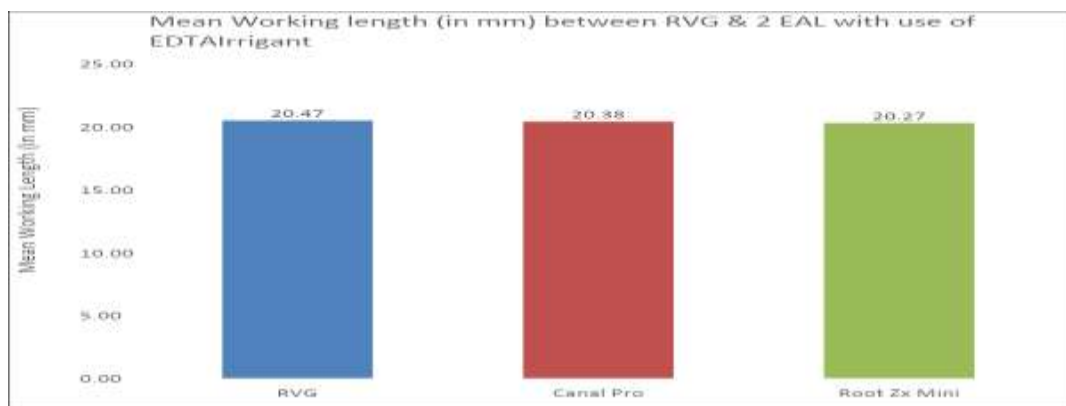
The mean working length determined using Canal Pro EAL using EDTA Irrigant was 20.38 ± 2.06 and with NaOCl Irrigant was 20.38 ± 2.06 . However, no significant difference was observed in the mean working length between 2 Irrigants when used with Canal Pro EAL.

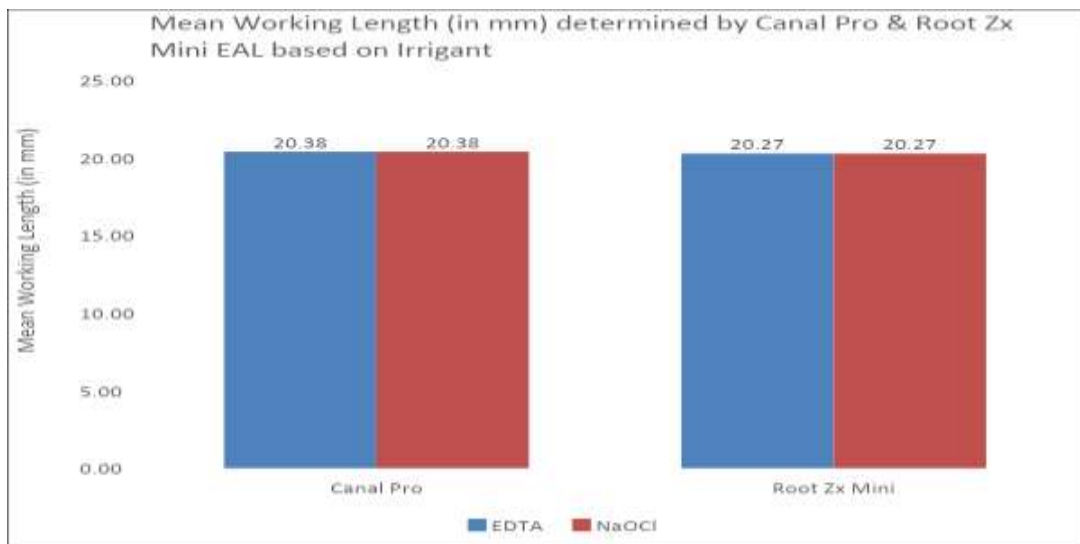
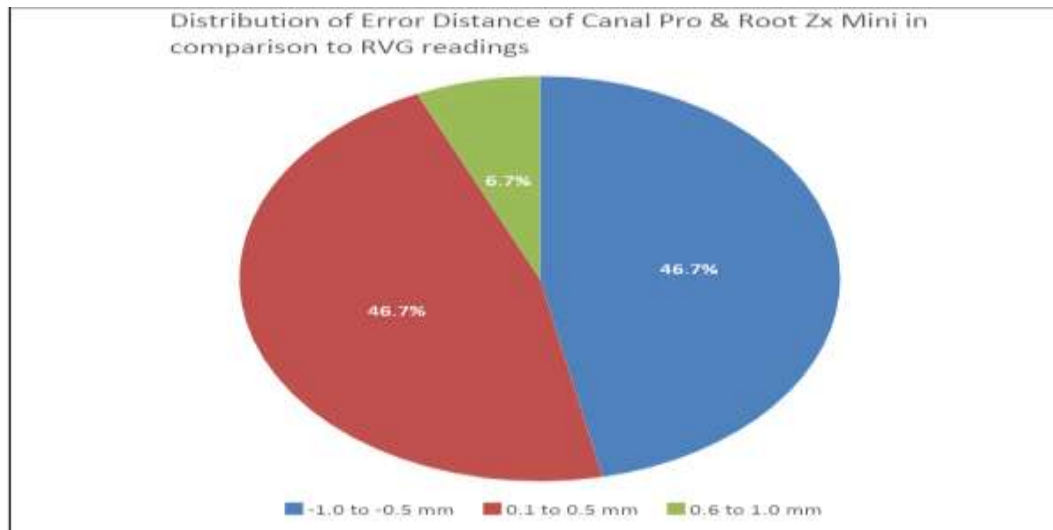
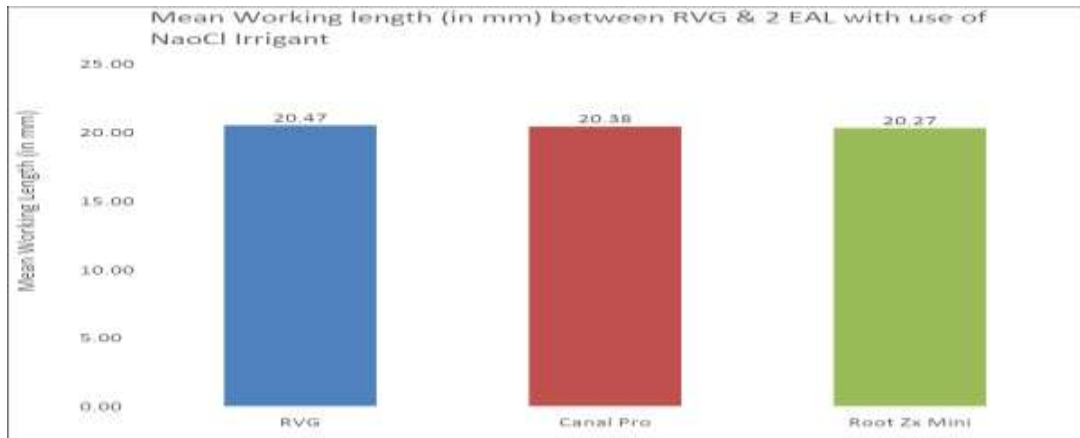
The mean working length determined using Root Zx Mini EAL using EDTA Irrigant was 20.27 ± 2.22 and with NaOCl Irrigant was 20.27 ± 2.22 . However, no significant difference was observed in the mean working length between 2 Irrigants when used with Root Zx Mini EAL.

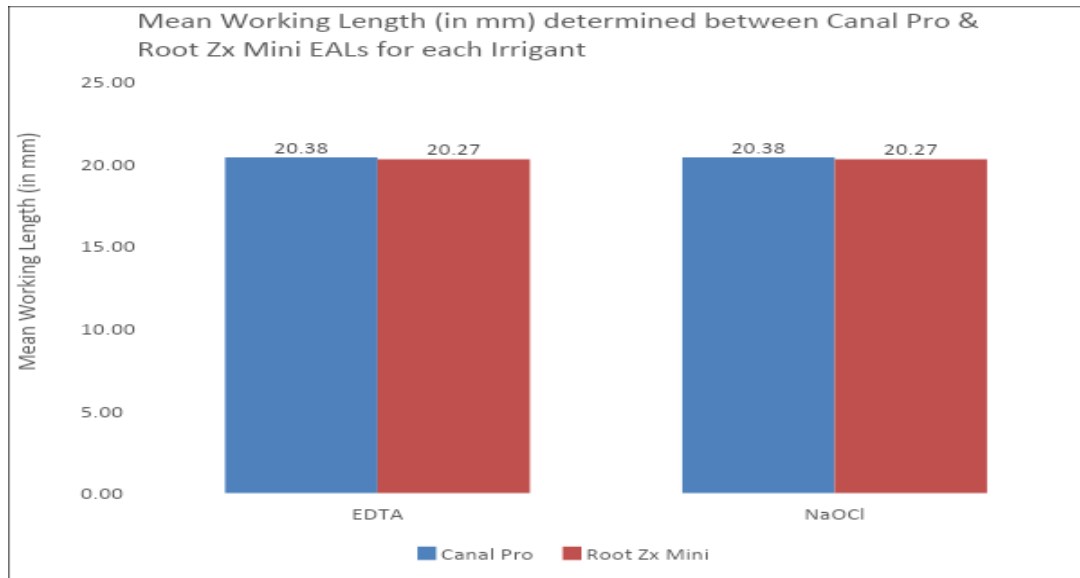
Comparison of mean Working Length (in mm) between Canal Pro & Root Zx Mini for each Irrigant using Student Paired t Test						
EAL	Irrigant	N	Mean	SD	Mean Diff	p-value
EDTA	Canal Pro	15	20.38	2.06	0.11	0.19
	Root Zx Mini	15	20.27	2.22		
NaOCl	Canal Pro	15	20.38	2.06	0.11	0.19
	Root Zx Mini	15	20.27	2.22		

The mean working length determined using Canal Pro EAL with EDTA Irrigant was 20.38 ± 2.06 and with Root Zx Mini with EDTA Irrigant was 20.27 ± 2.22 . However, no significant difference was observed in the mean working length between EALs when used with EDTA.

The mean working length determined using Canal Pro EAL with NaOCl Irrigant was 20.38 ± 2.06 and with Root Zx Mini with NaOCl Irrigant was 20.27 ± 2.22 . However, no significant difference was observed in the mean working length between EALs when used with NaOCl.







V. DISCUSSION

The root canal therapy treatment outcome is determined by the correct WL, which guarantees removal of the root canal system's contents followed by filling the prepared root canal space up to the WL without under or over-extending the final filling material.

The goal of this study was to test and assess the efficacy of Root ZX Mini (EAL) and CanalPro in two different irrigating solutions under in-vivo circumstances.

This study used the Root ZX Mini apex locator since it has been shown in numerous in vitro and in vivo investigations to be the most accurate and is regarded as the gold standard in accuracy. It is a third-generation EAL with a 74%–97.37% accuracy range. The "quotient method" is the main working principle of this apex locator, which involves simultaneously calculating the impedance by two frequency ratios.⁷

The 6th generation apex locator, called the CanalPro, uses two measurement frequencies that are alternated, not blended, which eliminates noise and the need for signal filtering. Since signal strength is employed to determine file tip position, electromagnetic interference cannot affect the measurement.

Because they are the most often utilized irrigants, 3% NaOCl and 17% EDTA were used in the current investigation.

EDTA is an inorganic solvent. For inorganic divalent cations, such as calcium ions, EDTA acts as a chelating agent to create calcium chelates.⁸

Since NaOCl is a common irrigant, it was used in this investigation. The advantages of using

NaOCl in this investigation included its capacity to disintegrate tissues and its antimicrobial properties. During endodontic procedures, the root canal is frequently irrigated with NaOCl, a halogenated substance. Sodium hypochlorite ionizes to Na and OCl in water, where it has an antibacterial effect. Between pH values 4 and 7, the chlorine ion manifests as hypochlorous acid (HClO), while OCl predominates at pH values greater than 9.⁹ Because oxidative phosphorylation and other membrane-related processes can be disrupted, HClO has a higher antibacterial effect than OCl. HClO also inhibits DNA synthesis and mitochondrial function in bacteria rapidly.

VI. CONCLUSION

In order to measure working length in vivo, the newer generation apex locator was compared to the traditional radiographic method in the current investigation.

Dentistry is not an exception to how the digital revolution is affecting the globe. We must keep up with modern trends and technological advancements.

The study's findings revealed that the working length values for the newer generation apex locators and the radiography approach were comparable.

Therefore, it can be inferred from the current study that the working length in both dry and wet canals can be accurately determined using the newer generation apex locators.

In addition to saving the clinician time, this can lower the patient's exposure to radiation.



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