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Comparative Evaluation of Accuracy of Two Apex Locators with Different Irrigants: An In-Vitro Study.

Janus Raji[1] Himanshu Sood[2] Sunil Mlalhan[3] Gursandeep Kaur Sandhu[4] Jasleen Virk[5] Danish Prabhakar[6]

[1]*PG student (3rd Year), Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh*
[2]*Reader, Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh*
[3]*HOD, Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh*
[4]*Professor, Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh*
[5]*PG student (3rd Year), Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh*
[6]*PG student (3rd Year), Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh.*
Corresponding Author: *Janus raji, PG student (3rd Year), Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh*

ABSTRACT
Aim: *The aim of this in-vitro study will be to evaluate and compare the accuracy of two apex locators in the presence of various irrigants.*
Methods and Material: *The study will be conducted on 80 extracted straight, single-rooted permanent human teeth with mature apices. The teeth will be decoronated. Access cavity preparations will be done and working length will be established with 10 K file or 15 k-file into the canal until its tip emerged through the major apical foramen at ×10 magnification under a stereomicroscope. All the samples selected will be divided into four groups on the basis of irrigants used. Group 1 will be dry without irrigants, used as control, in Group 2 saline will be used as irrigant, in Group 3 sodium hypochlorite will be used as irrigant and in Group 4 chlorehexidine will be used as irrigant. Each group again will be subdivided into two groups on the basis of two different apex locators used (Root ZX Mini J. Morita) and CanalPro (Coltene). All the samples will be embedded in gelatin filled polyurethane bottles to simulate the periodontium.*
Statistical analysis used*: Subsequently, the data will be statistically analysed using one-way analysis of variance (ANOVA) and paired t-test.*
Results: *In this study, group 2 canal pro apex locator is accurate and sodium hypochlorite irrigant shows maximum variation.*
Conclusions: *Canalpro showed accurate values than Root ZX and sodium hypochlorite showed more variations.*
Key-words: *Apex locator, Decoronation, Irrigants, Stereomicroscope.*

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I. INTRODUCTION

For endodontic therapy to be successful, the physiological root apex's precise location must be known. It is imperative to completely clean and shape the canal in order to prevent irritation to the periapical tissues.[1] Establishing the working length at the apical constriction is considered ideal for endodontic treatment Electronic devices for assessing the root canal length have gained popularity and eliminate many of the problems associated with radiographic measurements. [2]

The Root ZX apex locator is used as the gold standard which newer Electronic Apex Locator (EAL).[3] The Root ZX mini, a 3rd-generation AL, is considered to be the gold standard and is based on the "ratio method" that uses dual frequency and proportional impedance.[4]

CanalPro (Coltene) is another newly introduced EAL that ascertains the mean square root values for two alternating frequencies. The manufacturers claim that this device exhibits superior accuracy as the readings for

each frequency are measured independently. The accurate apex location, virtual apex function, high-resolution graphic display, and user-friendliness of the CanalPro make it stand out.[5]

Irrigation has a central role in endodontic treatment. During and after the process of instrumentation, the irrigants administers the removal of microorganisms, tissue remnants, and dentin chips from the root canal through a flushing mechanism. Utilizing a blend of irrigants in the right grouping adds to a fruitful treatment outcome.[6]

Therefore, the purpose of this in vitro study is to compare and evaluate the accuracy of Root ZX mini and the CanalPro apex locator in determining the working length in presence of various irrigants.

II. MATERIALS AND METHODS

Eighty freshly extracted single rooted teeth with single canal were included in this invitro study which collected from department of oral and maxillofacial surgery, Desh Bhagat Dental College and Hospital, Mandi Gobindgarh.

Inclusion criteria includes:

- Teeth should be free of carious lesion.
- Teeth should have fully formed apices.
- There should be absence of any root filling.
- Teeth should not have any fracture.

Exclusion criteria includes:

- The presence of multiple canals.
- The presence of any type of internal resorption.
- The presence of any external resorption.
- The existence of root caries and cracks.
- Any calcification and open apices if present.

FIGURE 1 : TOOTH SAMPLE

TABLE 1: ARMAMENTARIUM

S.NO	ARMANENTARIUM	BRANDNAME
1	Root ZX Mini Apex locator	J Morita Corp. USA
2	Canalpro	Coltene, USA
3	Electronic Digital Caliber	
4	K- files	Mani Inc, Japan
5	Diamond Disk	Microdont Discodiamantado
6	Normal saline 0.9%	Euro life healthcare pvt Ltd, Chennai, India
7	Sodium Hypochlorite 5.25%	Pyrex, New Delhi
8.	Chlorhexidine	Ammdent, New Delhi.
9	High speed dental turbine handpiece	Sicher holding Ltd, United Kingdom
10	5ml syringe with 27G needle	Dispovan, India
11	High speed hand airotor	Appledent, India
12	Stereomicroscope	Trinocular Sterezoom Microscope, India.

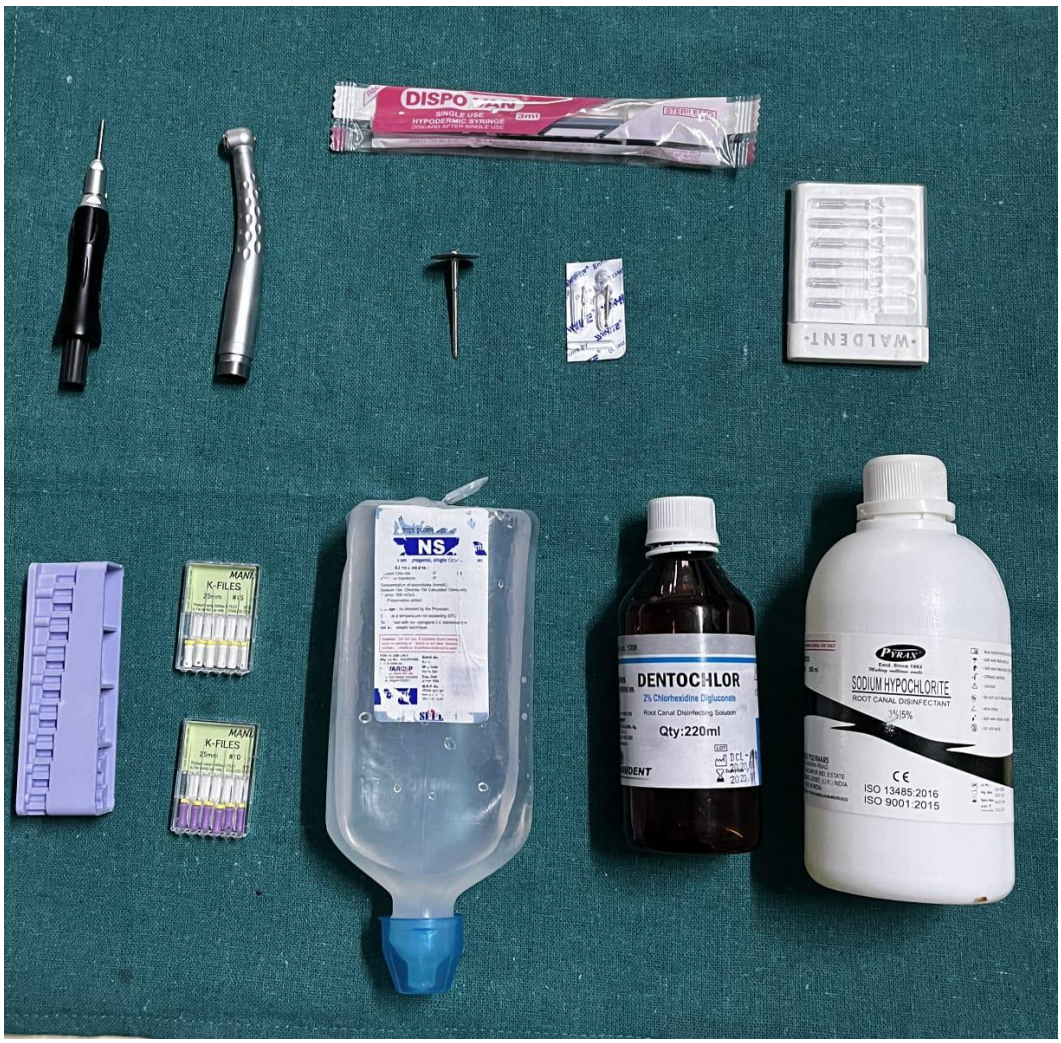


FIGURE 2 – ARMAMENTARIUM USED

III. METHODOLOGY

A total of eighty freshly extracted human single rooted teeth were used as study samples. These teeth were cleaned with hand scaler and soaked in sodium hypochlorite. The teeth were then decoronated uniformly at cement-enamel junction using diamond disk. Access cavity was prepared, and canal patency checked with no.10k file in each tooth.

Initial Endodontic Treatment: After access cavity preparation, apical patency was confirmed. In order to gain access to the root canal and to create a reliable reference point for all measurements, the teeth were decoronated at the cementoenamel junction using a diamond disc. Teeth were numbered 1–80 and the actual length was determined by introducing a size 10 or 15 k-file into the canal until its tip emerged through the major apical foramen at ×10 magnification under a stereomicroscope. The long axis of the tooth was placed perpendicular to the line of sight and the tip of the file was positioned tangential to the major apical foramen. The file was removed from the root canal and the distance between the silicone stopper and file tip was measured after the silicone stopper was carefully adjusted to the reference position. (Table 1. & Figure 1,2)

Using a 15-gauge needle, the irrigant was inserted into the canal. The 15 or 20 K-file was inserted into the canal and fastened to the file holder based on the canal's dimensions. A blinking bar denoted the 0.5 mm reading for Root ZX, which was used for electrical measurements and was set between the factory default of "1" and "APEX." The file was carefully put into the root canal of each device until the "APEX" signal appeared. Next, the file was carefully withdrawn until the display displayed a flashing picture of the root canal along with a flashing bar for Root ZX between APEX and 1 (0.5 reading), indicating that "0.5" was "on" for CanalPro. The file's silicone stopper was carefully adjusted to a reference position, and then the file was removed in order to measure, to the closest 0.5 mm, the distance between the silicone stopper and the file tip. This was noted as the canal length as determined by electronic means. The electronically measured canal length was noted as this. The accuracy of the two EALs was assessed using AL±0.5 mm, which was the difference between the median electronically measured length (EL) and the actual length (AL) for each tooth for all irrigants.

EXPERIMENTAL GROUPS

The 80 samples were evaluated under two groups and four subgroups:

GROUP I - Root ZX Mini

Root ZX (J. Morita, Japan) is a third-generation ERCLMD that uses dual frequency and comparative impedance principle is based on the "ratio method" for measuring canal length. This method simultaneously measures the impedance values at two frequencies and calculates a quotient of impedances.

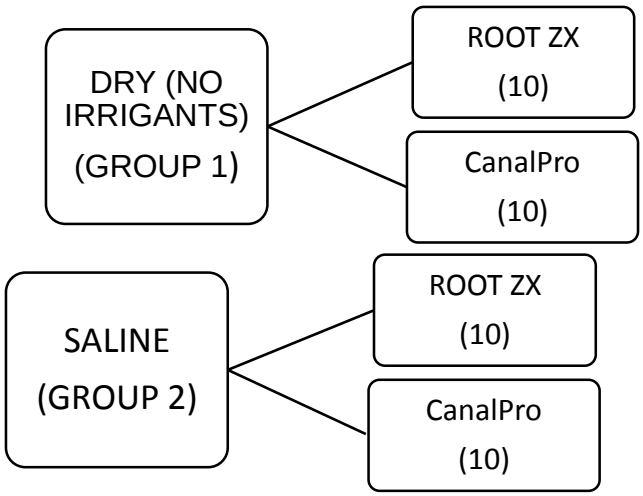
GROUP II – Canalpro

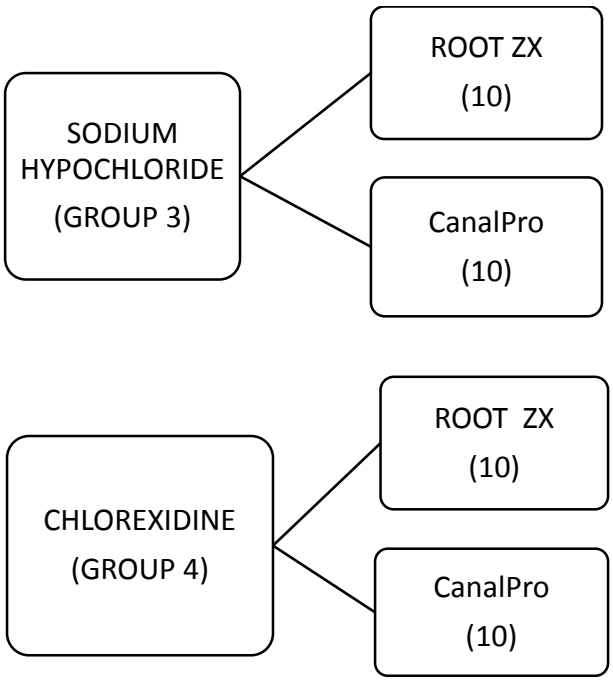
CanalPro is a sixth-generation Electronic Apex locator that uses two measurement frequencies that are alternated, not blended, which eliminates noise and the need for signal filtering. Due to its mechanism of measuring two frequencies that are alternated and not mixed, thus cancelling the need for signal filtering and eliminating the noise caused by non-ideal filters.

The subgroups are

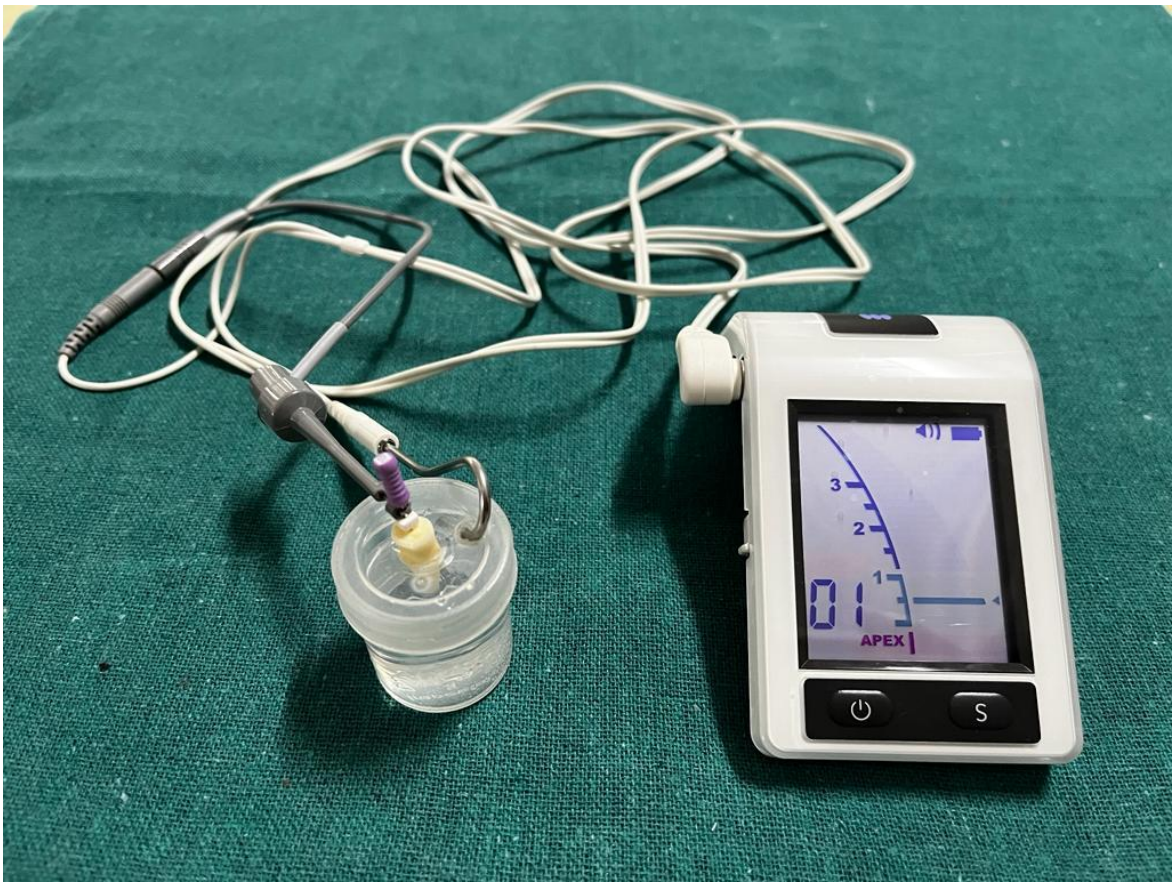
SUBGROUP A- DRY CANAL (Control)
SUBGROUP B- NORMAL SALINE
SUBGROUP C- SODIUM HYPOCHLORITE 5.25%
SUBGROUP D- CHLORHEXIDINE

FIGURE 3 - APEX LOCATORS USED IN THE STUDY.





The electronic working length was measured in the dry canal and in the presence of Normal Saline, Sodium Hypochlorite 5.25% and Chlorhexidine. The file with stabilized stopper was measured using electronic digital caliper and were recorded and measured under stereomicroscope. The recorded readings were subjected to statistical analysis.



Statistical analysis:

A paired t-test was employed to statistically analyze the significance of mean difference between Electronically measured length and Actual Length .One-way ANOVA was employed to assess the difference among various irrigants in their estimations of the canal length.

IV. RESULTS

TABLE 2: DESCRIPTIVE STATISTICS OF VARIOUS PARAMETERS OF THE ROOT ZX GROUP

Parameter	GP	N	Mean	Std. Deviation	Std. Error Mean
Actual root length	control	10	17.350	1.4347	.4537
	saline	10	22.000	1.1304	.3575
	chlohexine	10	19.800	1.6865	.5333
	naocl	10	22.050	.9846	.3114
Electronic apex locator values	control	10	17.350	1.3954	.4413
	saline	10	21.920	1.1033	.3489
	chlorhexidine	10	19.750	1.6568	.5239
	naocl	10	21.840	1.1404	.3606
Difference	control	10	.100	.2108	.0667
	saline	10	.080	.1687	.0533
	chlorhexidine	10	.050	.1080	.0342
	Naocl	10	.210	.2283	.0722

*statistically significant ** statistically non- significant

TABLE 3: DESCRIPTIVE STATISTICS OF VARIOUS PARAMETERS OF THE CANAL PRO GROUPS

Parameter	GP	N	Mean	Std. Deviation	Std. Error Mean
Actual length	control	10	16.400	1.9408	.6137
	saline	10	21.000	1.6330	.5164
	chlorhexidine	10	20.8000	1.61933	.51208
	Naocl	10	22.1000	.99443	.31447
Electronic apex locator values	control	10	16.350	1.9444	.6149
	saline	10	20.920	1.6950	.5360
	chlorhexidine	10	20.800	1.6193	.5121
	Naocl	10	21.920	.8270	.2615
Difference	control	10	.050	.1581	.0500
	saline	10	.080	.1687	.0533
	chlorhexidine	10	.000	.0000	.0000
	naocl	10	.180	.2348	.0742

The objective of this study was to evaluate the accuracy of Root ZX and canal pro apex locator with different root canal irrigants. The materials most often used are alginate, agar, saline and gelatin for resembling the peridontium.[7]

V. Discussion:

In our study Group 1 Root ZX is designed to be easily portable and also emphasized that they are less sensitive to intracanal contents. This EAL also features automated calibration, shock resistance, and three programmed memory settings.[8]

Group 2 the CanalPro, belonging to the 5th generation, which uses two measurement frequencies that are alternated, eliminates noise, and the need for signal filtering, and makes it unaffected by electromagnetic interferences. The CanalPro stands out due to its precise apex location, virtual apex function, high-resolution graphic display, and user friendly. The highest accuracy of Canal Pro Apex Locator in could be due to its mechanism of measuring two frequencies that are alternated and not mixed, thus cancelling the need for signal filtering and eliminating the noise caused by non-ideal filters which makes the measurement much more immune to various kinds of electromagnetic noises. Canal Pro is another newly introduced EAL that ascertains the mean square root values for two alternating frequencies.[9]

In this study canal pro and Root zx shows same accuracy with control group (dry canal) and with irrigants canalpro showed more accurate values than Root ZX.

The irrigants used here are saline, chlorhexidine, sodium hypochlorite and dry group as control.

Sub group – 1 dry canal is used to measure the accuracy of Root ZX and canal pro. The values obtained are accurate to the radiographic measurement. The mean difference between the actual working length (17.30) and electronic apex locator values (17.31) in dry canal with Root Zx is 0.01 while the mean difference between the actual working length (16.35) and electronic apex locator values(16.40) in dry canal with Canal Pro is 0.05 .The difference in measurement shown by both the apex locators are insignificant.

Sub group - 2 Saline is used as irrigant to compare the accuracy of both the apex locators. The mean difference between the actual working length(22.00) and electronic apex locator values (21.920) with saline as irrigant in Root Zx is .080 while the mean difference between the actual working length(21.00) and electronic apex locator values (20.920) with saline as irrigant in Canal Pro is 0.008 The values obtained in both apex locators are similar and difference is insignificant.

Sub group – 3 Sodium hypochlorite (NaOCl) is used, which the most popular irrigating solution. In our present study sodium hypochlorite shows variation in measurements when used with Root Zx and Canal pro as an irrigant. The mean difference between the actual working length(20.50) and electronic apex locator values (21.840) with sodium hypochlorite as irrigant in Root Zx is 0.210 while the mean difference between the actual working length(22.1) and electronic apex locator values (21.920) with sodium hypochlorite as irrigant in Canal Pro is 0.180 .The values obtained in both apex locators are similar and difference is significant.

Sub group- 4 Chlorhexidine is used as an adjunct to the NaOCl during endodontic treatment. The difference in measurement shown by the Root ZX and canal pro apex locators are insignificant, when chlorhexidine is used as an irrigant in our present study. The mean difference between the actual working length (19.800) and electronic apex locator values (19.750) with chlorhexidine as irrigant in Root Zx is .050 while the mean difference between the actual working length(20.80) and electronic apex locator values (20.80) with saline as irrigant in Canal Pro is 0.0 The difference in measurement shown by both the apex locators are insignificant.

In this study Sodium hypochlorite showed significant variations between Actual working length and electronic apex locator values with both Root zx and Canal pro apex locator.

NaOCl ionizes in water into Na and the hypochlorite ion, establishing an equilibrium with hypochlorous acid (HOCl). Hypochlorous acid is responsible for the antibacterial activity. NaOCl is commonly used in concentrations between 0.5% and 6%.[10]This solution was selected because it is a strong electrolyte (Conductivity of 88 miliSiemens) and can influence the readings of an apex locator.[11]

Several benefits of CHX include its broad antibacterial spectrum, low toxicity, efficacy against Candida albicans and Enterococcus faecalis, substantivity, acceptable taste and odor, and nonbleaching qualities. The most conductive endodontic solution is NaOCl[12]. The following list shows the conductivity of root canal irrigants, going from most to least. Dry canal, normal saline, chlorhexidine, and NaOCl solution.

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