



COMPARATIVE ACCURACY OF APEX LOCATORS IN DETECTING LATERAL CANALS, EXTENT OF PERFORATING INTERNAL ROOT RESORPTION AND OPEN APEX- AN EX-VIVO STUDY

Dental Science

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ABSTRACT

Aim: This study compared the accuracy of Root ZX mini and CanalPro in determination of working length in open apex, location of lateral canals at different levels and determination of extent of perforating internal root resorption.

Methods: Hundred decoronated single rooted teeth with single canal were divided into three groups- simulated lateral canals at 3, 5 and 8 mm from the apex, simulated perforating internal root resorption and simulated open apex. Actual length was measured by visual method and electronic length of samples embedded in alginate model.

Results: The accuracy of both the apex locators in EL determination was significantly higher in apical lateral canals compared to middle and coronal canals and in apical extent of internal resorption as compared to coronal extent ($P < 0.05$). The accuracy of both apex locators was more at ± 1 mm when compared to ± 0.5 mm.

Conclusion: Both EAL's are accurate in working length determination in simulated clinical scenarios.

KEYWORDS

Apex locators, Lateral canals, Open apex, perforating internal root resorption

INTRODUCTION:

Proper working length (WL) determination is a precursor for success in root canal treatment. An adequate apical limit ensures shaping procedures to be confined within the canal limits without injuries to periapical tissues.^[1] The Root ZX mini a fifth generation electronic apex locator (EAL) calculates the root canal length by ratio method.^[2] Sixth generation apex locator CanalPro (Coltene-Whaledent) which uses multiple frequencies which are alternated, thus eliminating noise and the need for signal filtering.

Teeth often present themselves with complex root canal anatomies, characterized by the presence of fins, curvatures, deltas, accessory and lateral canals.^[3] Ebrahim et al^[4] in his study showed that the accuracy of EALs is reduced slightly by the presence of accessory canals. This study has been designed to compare the accuracy of CanalPro and Root ZX mini in WL determination in open apex, in location of lateral canals at different levels and location and determination of extent of perforating internal root resorption.

MATERIAL AND METHODS:

Hundred freshly extracted human teeth with single root and single canal, extracted due to periodontal reasons, were chosen for the study. Samples with incomplete root development, fractures or root resorption were excluded. Access opening was performed with round bur #06 (SS White burs Inc., New Jersey, USA). Preflaring of the canals was done with ProTaper Sx and S1 (Dentsply Maillefer, Ballaigues, Switzerland). The samples were then randomly divided into three groups with 20 samples each.

1. In group O (n=20), immature open apices were simulated by resecting the apical 3 mm of the roots using double diamond disc and creating irregular differences between dentinal-wall lengths of 2-3 mm. Enlargement of root canals was done to a size #80 K file followed by instrumentation using Peeso reamers sequentially

from #1 to #3, with each Peeso reamer passing 1 mm beyond the apex to increase the apical width to 1.3 mm in diameter.

2. In group L (n=20), simulation of lateral canals was done by subjecting the samples to tooth decalcification procedure by suspending the samples in nitric acid (5%) for 24h which it was washed under running tap water for three min. Lateral canals were then created under 8 X magnification by #06 to #15 K file.
3. In group I (n=20), artificial internal resorptive cavities were created by sectioning the root horizontally from the apex at 7 mm with a diamond disk. Semi-circular cavities with a diameter of 2 mm were formed around the root canal space periphery of each section forming a communication of 1 mm with external surface of root. Then the root halves were repositioned using minimal amount of cyanoacrylate glue on the dentine surface around the cavities. Canal patency was maintained by introducing a #15 K file into the root canal which prevented glue from flowing in the canal.

The actual length (AL) in all the samples was measured by direct visual examination under operating microscope and use of digital Vernier Caliper. The samples were subsequently embedded in an alginate model and electronic length (EL) was determined. Values were acknowledged only if the reading was stable for at least 5 seconds. The procedure was repeated three times for each tooth. The mean value was calculated and recorded for each sample.

Statistical Analysis:

The tabulated data was subjected to "t" test using statistical package for social sciences (SPSS Inc., Chicago, IL, USA) version 24 for windows. $P < 0.05$ was considered statistically significant.

RESULTS:

No statistically significant difference was observed between CanalPro and Root ZX mini ($P = 0.05$) in all the groups in Table 1.

Table 1: Inter and intracomparison between CanalPro and Root ZX mini for different groups

Groups	Mean $\pm$ SD (Difference B/W Canal pro & ROOT ZX MINI)	p value (Intra-comparison)
Open Group	.04 $\pm$.43	0.94
L C Group	-.15 $\pm$.39	0.59
L M Group	.27 $\pm$.39	0.17
L A Group	.07 $\pm$.46	0.79
I C Group	-.10 $\pm$.50	0.69

I A Group	-.04±.51	0.88
Pair of Groups	Canal PRO (p value: Inter-comparison)	Root ZX MINI. (p value: Inter-comparison)
LA & LC	0.003*	<0.01*
LA & LM	0.001*	0.09
LC & LM	0.003*	0.002*
IA & IC	0.003*	<0.01*

*: statistically significant

The percentage of accuracy in both apex locators decreased at ± 0.5 mm tolerance level when compared to ± 1 mm tolerance level in all the groups. The accuracy of both the apex locators in EL determination of perforating internal root resorption was significantly higher in apical extent as compared to coronal extent ($P < 0.05$) as shown in Table 2.

Table 2: Accuracy of CanalPro and Root ZX mini at ± 0.5 and ± 1 mm tolerances

Apex Locator		± 0.5 mm tolerances					
		O	LA	LM	LC	IA	IC
CanalPro	Accurate	1 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Long	1 (5%)	4 (20%)	3 (15%)	10 (50%)	0 (0%)	5 (25%)
	Short	12 (60%)	14 (70%)	6 (30%)	3 (15%)	12 (60%)	1 (5%)
	Total	14 (70%)	18 (90%)	9 (45%)	13 (65%)	12 (60%)	6 (30%)
Root ZX mini	Accurate	1 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Long	0 (0%)	3 (15%)	0 (0%)	8 (40%)	0 (0%)	5 (25%)
	Short	12 (60%)	12 (60%)	9 (45%)	3 (15%)	8 (40%)	1 (5%)
	Total	13 (65%)	15 (75%)	9 (45%)	11 (55%)	8 (40%)	6 (30%)
		± 1 mm tolerances					
		O	LA	LM	LC	IA	IC
CanalPro	Accurate	1 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Long	1 (5%)	5 (25%)	7 (35%)	17 (85%)	0 (0%)	17 (85%)
	Short	18 (90%)	15 (75%)	12 (60%)	3 (15%)	19 (95%)	1 (5%)
	Total	20 (100%)	20 (100%)	19 (95%)	20 (100%)	19 (95%)	18 (90%)
Root ZX mini	Accurate	1 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Long	0 (0%)	3 (15%)	5 (25%)	19 (95%)	0 (0%)	16 (80%)
	Short	19 (95%)	17 (85%)	13 (65%)	0 (15%)	19 (95%)	1 (5%)
	Total	20 (100%)	20 (100%)	18 (90%)	19 (95%)	19 (95%)	17 (85%)

DISCUSSION:

In this study, we used two ranges ± 0.5 and ± 1 mm as latitude of acceptable error by EAL. No statistically significant difference was observed between the two apex locators in all groups which show that both EAL have equal accuracy for all the conditions evaluated in this study. The results are in contrast with study by **Taneja et al**^[5] in which CanalPro showed higher accuracy than Root ZX mini however, the clinical conditions for which the apex locators were tested was different from this study.

The percentage of accuracy at ± 1 mm tolerance limit was more as compared to ± 0.5 mm. This was expected since it is a fact that irrespective of the clinical condition evaluated, as we increase the clinically acceptable tolerance level, the number of samples showing accuracy would increase. **Santhosh et al**^[6] found that Root ZX gave 100% accuracy at ± 1 mm tolerance limit as compared to ± 0.5 mm which was found to be 80% accurate. In a study by **Alothmani et al**^[7], 95% samples showed a negative mean value of difference between AL and EL indicating EWL being short of the apical foramen.

Our study shows 100% accuracy at ± 1 mm tolerance in open apex however at ± 0.5 mm, it is lesser when compared to mature apex. **ElAyouti et al**^[8] found that the accuracy of Root ZX and Raypex reduced with increasing apical diameter. **Aydin et al**^[9] found Root ZX presented with an accuracy of 50% (within ± 0.5 mm) and 85% (within ± 1 mm) in teeth with immature apices, both the values being lower than in our study.

The results show that both the EAL's can be used reliably to predict the apical and coronal extent of perforating IRR (at tolerance level of ± 1 mm). There was a statistically significant difference between location of apical and coronal extent of IRR by both the apex locators. The reason may be the relative level of perforation with respect to apical and coronal extent and also due to preflaring by greater taper instruments, which leads to better adaptation of the file at the apical extent thus forming a better contact with dentinal wall and a better accuracy of apex locator.

Accuracy in EL determination was significantly more at apical third than middle third and coronal third (only at ± 0.5 mm tolerance level). Due to the preflaring of root canal with greater taper instruments, the initial file will have a better adaptation at apical third wall of root canal.

CONCLUSION:

It can be concluded from the results of the present study that the

percentage of accuracy in both EAL's increases with ± 1 mm tolerance level when compared to ± 0.5 mm tolerance level. CanalPro and Root ZX mini are able to determine apical extent of perforating IRR significantly better as compared to coronal extent and locate lateral canals at apical third significantly better than middle and coronal third of root canal.

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