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"Comparison of Digital Radiography and Apex Locator with the Conventional Method in Working Length Determination of Primary teeth: An in Vivo Study"

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ABSTRACT:
Aim: *To compare the working length in primary teeth using Intraoral digital Radiovisiography and Apex locator with conventional method.*
Materials and Method: *30 primary teeth which were indicated for pulpectomy in the patients of the age group of 3-9 years. Endodontic treatment was required due to irreversible pulpitis or pulp necrosis. A standardized pre-operative intraoral periapical radiograph of the tooth was taken using conventional method. After this, the pulpectomy procedure was initiated, during the procedure the working length was firstly determined by IOPAR method, simultaneously with digital radiography, and then working length determination was done by Electronic apex locator. The measurements were then compared with the conventional method of root canal measurement technique.*
Results: *From the results obtained we concluded that mean value of working length calculated by various methods from IOPA was 15.2870, digital radiography was 15.1853 and 14.4857 with 5th generation electronic apex locator. It was noticed that there was no significant difference in the working length obtained from the three techniques (P > 0.05).*
Conclusion: *No statistically significant differences found between the three techniques, so all the three methods of working length estimation were reliable. Hence, both the techniques digital radiography & electronic apex locator can be safely used as alternatives to conventional radiographic methods in determining working length in primary teeth.*
Key words: *Apex locator, conventional radiography, digital radiography, primary teeth, working length*

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I. Introduction

Pediatric endodontics deals with the management of pulpally involved primary and young permanent teeth in children. Maintaining the integrity and health of the oral tissues is the primary objective of pulp treatment. In permanent teeth, definitive rules for successful endodontic therapy have been established such as compact obturation and apical/coronal seal. In contrast, in pediatric endodontics, because of open apices, there are difficulties in estimating the exact root canal length, and hence, there are no definitive rules for successful endodontic therapy.[1]

Pulpectomy is defined as the removal of necrotic pulp tissue followed by filling the root canals with resorbable cement.[2] Maintaining the integrity of the primary dentition until physiologic exfoliation is a major goal when treating young patients. The removal of all pulp tissue, necrotic material and microorganisms from the root canal is essential for endodontic success. This can only be achieved if the length of the tooth and the root canal is determined with accuracy. The root canal anatomy of primary molars is difficult to predict because of the balance of resorption and hard tissue deposition.[3-2]

The working length determination is a critical step during root canal treatment in primary teeth due to possible damage to the permanent successor tooth germ. The anatomic apex is the tip end or end of root determined morphologically, where as the radiographic apex is the tip or end of root determined radiographically. In clinical practice, radiography has been the method of choice for determination of working length.[4] However; radiographic assessment has limitations due to anatomic variations of the canal system, interference of adjacent anatomic structures or technical errors in projection. In addition, there is a radiation hazard, both, to the patient and the dental personnel. The observers' bias in radiographic interpretation may lead to errors.[5]

Technological advances have led to the introduction of digital radiology (DR), which has many potential benefits in endodontic practice. In dentistry, the first commercial integrated digital imaging system was

radiovisiography, involving the use of an intraoral sensor instead of the conventional X-ray film. The radiovisiography allowed a substantial reduction in the duration of endodontic procedures, because it effectively eliminated the film processing time. It also offers some distinct advantages over the conventional film; however, like any emerging technology, it presents new and different challenges for the practitioner to overcome.[6] Digital

Radiographic method having some disadvantages sensor size which cannot be used comfortably in a child's small mouth. Secondly, there is radiation exposure. So a method that could minimize the need for exposing children to radiation during this part of root canal treatment is preferred. All factors together have stimulated the development of electronic root canal measuring devices, also known as electronic apex locators (EALs).[6]

Apex locator was introduced by Sunada in 1962 to locate the root apex for measuring the root canal length. Main advantages of apex locators are that these measure the root canal length to apical foramen, not the radiographic apex. They are easy and fast to operate, and have a good accuracy. The present article compares the diagnostic efficacy of three methods, namely apex locator, conventional radiography and radiovisiography in determining the working length in primary root canal systems *in vivo*.[7]

II. Materials And Method

This *in vivo* study was conducted on 30 primary teeth which were indicated for pulpectomy in the patients of the age group of 3-9 years in the Department of Pedodontics and Preventive Dentistry, Himachal Institute of Dental Sciences, Paonta Sahib; Sirmour H.P. Children were selected according to the inclusion criteria after obtaining consent from the parents. All experimental teeth had adequate remaining tooth structure for rubber dam isolation and radiographically visible canals. Endodontic treatment was required due to irreversible pulpitis or pulp necrosis. A standardized intraoral periapical radiograph of the tooth was taken using conventional method. After administration of block with Lignocaine local anesthesia tooth was isolated with rubber dam. Access cavity preparation was done using a round diamond bur under abundant water spray. Pulpal tissue of each tooth was extirpated using a barbed broach, and the root canals were irrigated using sodium hypochlorite solution. The pulp chamber was dried using sterile cotton pellets. Measurements from the preoperative radiographs were made using ISO 15-20 number files with rubber markers, keeping them 0.5mm short of the root apex. With these measurements, the files were inserted into the canal and a conventional radiograph was taken. Simultaneously, an intraoral digital radiograph was taken. Then root canal length was clinically determined with the help of an electronic apex locator. The file was attached to the file holder and the lip clip was attached to patients lip. The file was advanced till the device indicated that the apical constriction had been reached. The root lengths estimated from intraoral digital radiography and apex locator were compared with the conventional method of root canal measurements. Measurements were then statistically analyzed for the result with one way Anova & Pearson's correlation.

III. Result

The mean value of working length calculated by various methods was 15.2870 with IOPA, 15.1853 with Digital; radiography and 14.4857 with 5th generation electronic apex locator[Table 1]. In this study it was noticed that there was no significant difference in the working length obtained from the three techniques ($P>0.05$) as shown in the [Table 2] the mean difference between IOPA and RVG (.10172) is comparatively low as compared to the RVG and EAL (.69961) and followed by IOPA & EAL (.80133) and it was found that no statistically mean significant difference between these three methods ($P>0.05$) [Table 3]. The Pearson's correlation is found maximum in working length recorded with IOPA & RVG i.e.0.937 followed by working length recorded with RVG & EAL (Electronic apex locator) i.e. 0.911 and IOPA & EAL i.e. 0.867 [Table 4]. Hence it was observed that working length recorded with RVG is closer with IOPAR method as compared to working length recorded with Electronic apex locator [Graph 1, Graph 2].

TABLE 1: Working length value (in mm) of all three techniques.

CASE NO	WL WITH IOPA	WL WITH RVG	WL WITH EAL
1	18	18	18
2	18	17	17
3	18.5	17.5	17.5
4	17	18	17
5	15	14.5	13
6	14	13	11.5
7	14 13 15	15 11 15	13 11 14
8	13.5 13.5 14.5	13.5 13.5 14.5	13.5 13 13
9	14	14	13.5
10	15	14.5	13.5
11	18	18.5	17
12	15 15 14.5	14 15 14.5	13.5 13.5 14
13	15 15 13.5 14	15.5 14.5 13.5 13	14 14 13.5 13

14	17 16 16	16.5 16 16	14 14 15
15	15 14 14	15 15 16	15 15 16
16	16 16 15	16 16 15	15 15 14
17	16 16.5 15 15	15 16 14 14	16 16 15 15
18	17 17 17.5	16 17 17	15 16 14
19	13.5 15 13.5 15	13 16 13 15.5	13 14 13.5 13
20	13 13 13	14 13 13	14 13 13
21	17 17 17	17 16 17	15 15 16
22	15.5 16 17	15 16 17	14 15 16
23	14 15 13	14.5 15 14	14 15 14
24	14.5 14.5 14	15 15 14	14 14.5 14.5
25	15 14 16	14 14 15	14 15 16
26	15 15	15 15	14 13
	15	15	15
27	15.5 15 14	15 16 14.5	14 14 13.5
28	14 15 14	14 15 13	13 13.5 13.5
29	13.5 13.5 12.5	14 14.5 13	13 13 13
30	14 14 13	14 14 13	14 13.5 13

Table 2 Mean working length recorded by conventional technique, digital radiovisiography and electronic apex locator.

The mean value was calculated. The individual observations of each technique were first added then divided by the number of canals.

$$\bar{X} = \frac{\sum X_i}{n}$$

Technique	Mean difference
IOPA &RVG	.10172
RVG & EAL	.69961

X = Mean ΣX_i = Sum of Observations n = number of canals

	N	Mean	Std. Deviation	Sig
WL WITH IOPA	75	15.2870	1.54436	.094 (P>0.05)
WL WITH RVG	75	15.1853	1.49521	
WL WITH EAL	75	14.4857	1.56300	

TABLE 3 Intergroup comparisons for mean difference of working length measured by the three techniques with each other.

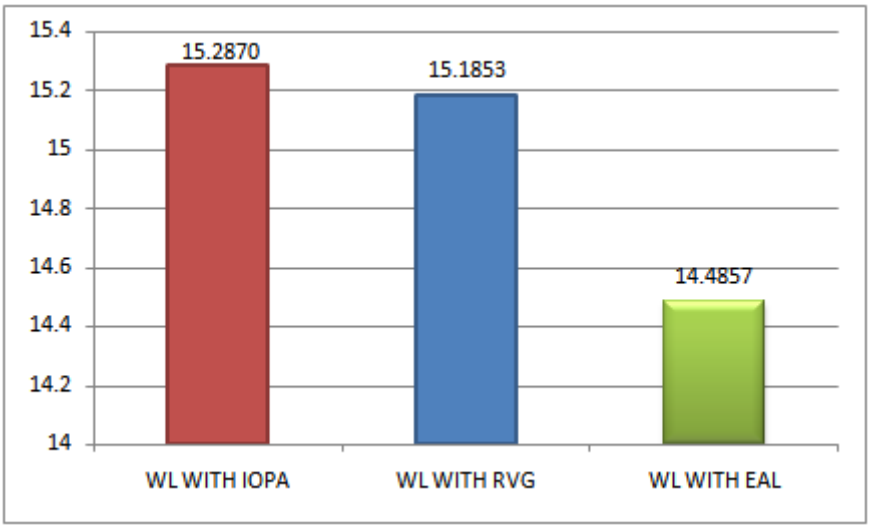
IOPA & EAL	.80133

TABLE 4 Pearson's correlation of digital radiography and apex locator with the conventional method in root length determination in primary teeth.

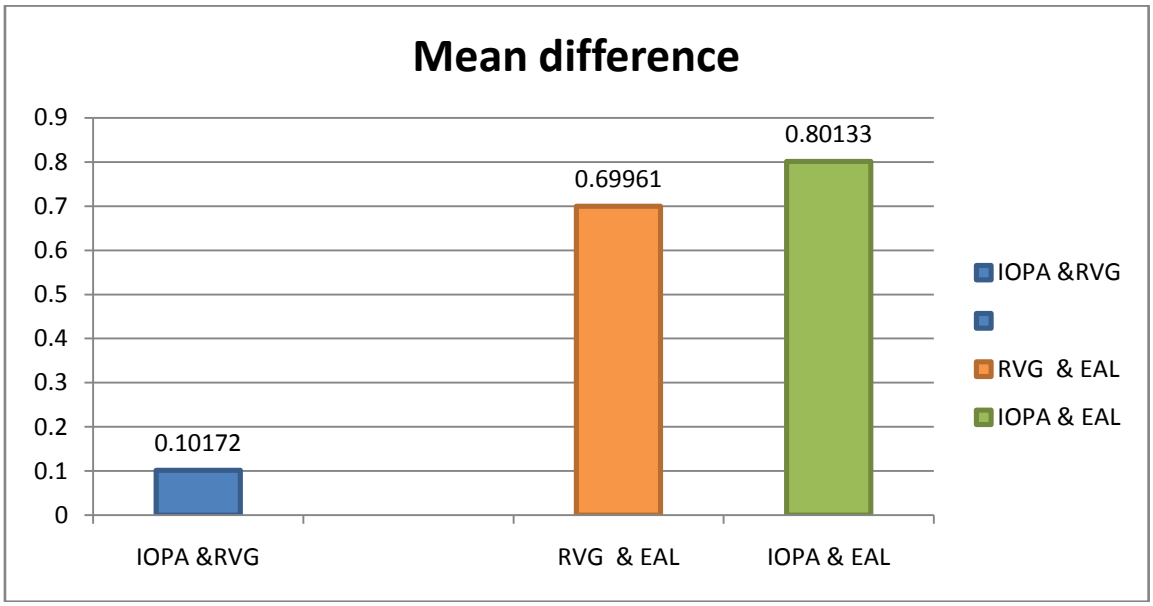
PEARSON'S CORRELATIONS

		WL WITH IOPA	WL WITH RVG	WL WITH EAL
WL WITH IOPA		1	.937(**)	.867(**)
			.000	.000
		75	75	75
WL WITH RVG		.937(**)	1	.911(**)
		.000		.000
		75	75	75

**** Correlation is significant at the 0.01 level (2-tailed).**



Graph 1: Shows the mean value of working length recorded with IOPA is more than working length recorded with RVG and EAL.



Graph 2: Shows the mean difference between IOPA and RVG is far less than followed by RVG and EAL group and IOPA and EAL group.

IV. Discussion

While all methods were equally effective, the skill, knowledge and expertise of the clinician assumes 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.[8]

Conventional radiography as a method of determining the working length has shortcomings in that it depends on the child's co-operation as well as the operator's proficiency. In addition to this, minor degrees of resorption may not be visible, and overlapping by adjacent anatomical structures can obscure the clarity of the image (Priya et al 2005).[9]

The above problems associated with conventional radiographs were overcome with the introduction of intra oral digital radiograph. It has been reported that intraoral digital radiography has provided approximately 60% reduction in radiation dosage in comparison with conventional radiography.[10] It also permits immediate

display of image, image enhancement, storage, retrieval and transmission.. It also reduces the need for a dark room, films, mounts and processing equipment. Studies have shown that intra oral digital radiograph can be safely used in measurements of root length in root canal treatment. Main disadvantage of intraoral digital radiography includes the cost of the equipment. Similar to conventional radiography, placement of sensor in the child's mouth is a difficult task. Another possibility is the magnification of the actual images, in the images obtained by intraoral digital radiography.[6-10]

In the present study, fifth generation apex locator was used which works on dual frequency type, and is considered best in any root canal condition. It provides the reader with a digital read out, graphic illustration and an audible signal. Main advantage of apex locators is that they measure the root canal length to the apical foramen, not to the radiographic apex. They are easy and fast to operate and give good accurate results.[11]

In this study, 30 primary teeth were taken and patients selected were in the age group of 3-9 years as they would be having 2/3rd of the root length. Files selected to measure working length were in of the number 15-20, similar to the study conducted by Ssu-Kuang Chen *et al where* they have used files of 15-20 size. This is because the tips of the No 10K files were not identifiable as the tip diameter is less than 120micron meter required.[12]

Various studies have been carried out where there have been numerous technique employed in working length determination including radiography, apex locator, tactile perception, average tooth length and paper points; however, reliability and reproducibility of conventional films have made them gold standard by which all imaging systems arecompared.[13]

There are many published reports on the accuracy of determination of the WL with apex locators in permanent teeth but the information on primary teeth is limited. Most of the investigations are focused on *in vitro* evaluation but very few on clinical patients. The methods for determining the root canal length of the primary tooth should yield accurate and reproducible results. In vitro studies show some limitations, which do not allow their findings to be directly transferred to a clinical situation.[14]

In our study 3-9 years of age group was taken into consideration as the teeth at this age have more radiographically visible canals and show no signs of root resorption. Beyond this age group initiation of physiologic root resorption begins.

A study conducted by Neena I E *et al (2011)*, S Thillainayagam et al (2016) which is in accordance with the present study results that there was no significant difference found in working length measurement between RVG, IOPAR and EAL. On contrary, S Vijay singh et al (2014) showed that there was significant difference in the working length measurement between radiographic and electronic apex locator ($P<0.05$).

Sherif B (2012), Musab Hamed Saeed (2012) have reported that digital radiography were more accurate, and a reliable method for determining the working length. Also, Sander and Scarfe (2015) reported that digital radiography was as good as compared to conventional method.

However, even with the availability of all these techniques and results from the various studies, it still remains a dilemma to solely rely on a single technique to accurately estimate the working length. To sum up all this it can say that, the radiographic method to determine the working length has been in use since times immemorial because of its obvious advantages discussed earlier. But, presently with the advent of modern technology revolutionizing the Endodontic practice, the Digital radiography & Electronic apex locator as an adjunct to the traditional radiographic techniques as well as electronic apex locator forms a strong component of the Endodontic armamentarium for working length estimation. From the results obtained, we can conclude that intraoral digital radiography and apex locator methods of determining the root canal length in primary teeth can be considered as reliable and safe methods in the endodontic treatment of children.

V. Conclusion

The following conclusions were drawn from this present study.

- Digital Radiography is comparable to conventional radiograph in determining the working length without radiation in the primary teeth.
- Digital radiography is the safest method in determining the working length with significant reduction in radiation exposure.
- Hence, both Digital radiography and Electronic apex locator can be safely used as alternatives to conventional radiographic methods in determining working length in primary teeth.

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