



Clinical evaluation of two working length determination methods in primary molars: An *in vivo* study

Dr. Kanithi Saujanya, Dr. M.Ghanashyam Prasad, Dr. Vasa Aron Arun Kumar, Dr. Suzan Sahana, Dr. Mamidi Deepika, Dr. Gaddam Divya

^{1,5}Assistant professor, ²Professor and Head, ^{3,4}Professor, ⁵Reader

¹Department of Pedodontics and Preventive Dentistry, Government Dental College and Hospital, Kadapa

^{2,3,4,6}Department of Pedodontics, St.Joseph Dental College, Eluru

⁵Department of Pedodontics, Sree sai Dental College Srikakulam

***Corresponding Author:**

Dr. Kanithi Saujanya

Assistant professor, Department of Pedodontics and Preventive Dentistry, Government Dental College and Hospital Kadapa

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Abstract

Introduction: The determination of working length and its maintenance during cleaning and shaping procedures are key factors for successful endodontic treatment. Owing to the physiologic resorption of roots of primary molars, the exact location of the actual apex remains a puzzle to the clinician. The procedure for the establishment of the working length of these teeth should be performed with skill, using techniques that have been proven to give accurate and valuable results. To eliminate these problems associated with conventional and Digital radiography, electronic root canal length measuring devices, the so-called Electronic Apex Locators (EAL's) have been introduced.

Objectives: To compare the accuracy of Multiple Frequency Apex Locator and Radiovisiography (RVG) with Ingle's conventional Radiographic method to determine working length in primary molars.

Method: The study includes 238 maxillary and mandibular primary molars, with a minimum of 2/3rd root remaining and indicated for pulpectomy selected from children in the age range of four to ten years. After administration of local anesthesia and isolation under rubber dam, standard access cavity preparation was done, pulpal tissue was extirpated and the canals were irrigated using sodium hypochlorite solution. The working length was determined by Ingle's method, Radiovisiography and Apex locator.

Results: A significant correlation was found between apex locator and Ingle's method ($r=0.8891$), when compared to Radiovisiography and Ingle's method ($r=0.8879$) and Radiovisiography and Apex locator ($r=0.8843$).

Conclusion: The apex locator yielded similar measurements to Ingle's method than RVG

Keywords: Electronic apex locator, Ingle's method, primary molars, Radiovisiography, working length

INTRODUCTION

The determination of working length and its maintenance during cleaning and shaping procedures are key factors for successful endodontic treatment.¹ To minimize periapical injury and possible damage to the succedaneous tooth, the root length

should be carefully determined in primary teeth without exceeding the apex.²

To eliminate these problems associated with conventional and Digital radiography, electronic root canal length measuring devices, the so-called

Electronic Apex Locators (EAL's) have been introduced by Sunada in 1962.³

Numerous studies have tested the accuracy of EALs in permanent teeth, but very few have been reported in primary teeth. Hence, the purpose of the study is to compare the working length determination in primary molars using Digital Radiography and Apex locator, with that of the conventional radiographic method.

MATERIALS AND METHODS

A cross-sectional study was performed on a selected group of children who were indicated for undergoing pulpectomy in relation to primary molars. Clinically healthy children aged 5–10 years, attending the outpatient department of pediatric dentistry were included. About 238 maxillary and mandibular primary molars indicated for pulpectomy with a minimum of 2/3rd root and an adequate remaining tooth structure for rubber dam isolation and radiographically visible canals have been included. Teeth with calcified root canals and radiographic evidence of more than 2/3rd root resorption or bone loss were excluded. To confirm the selection criteria, an initial intraoral periapical radiograph was taken. Ethical clearance was obtained from the Institutional Ethical Committee and informed consent was taken

from the parent or guardian of the children who were included in the study.

After administration of local anesthesia and isolation under rubber dam, standard access cavity preparation was done using a round diamond bur under abundant water coolant. The pulpal tissue was extirpated and the canals were irrigated using sodium hypochlorite solution. The working length was determined by Ingle's method, RVG, and apex locator via the following procedures.

Working length determination using Radiographic method (Ingle's method) (Figure1 a&b)

A size 15 or 20 K- file with a length 1mm shorter (safety factor) than the tooth length as noted from the pre-operative radiograph was placed in the root canal from a standard reference point established on the tooth crown and a radiograph was taken. On the radiograph, the difference between the end of the file and the apex was measured. This amount was added/subtracted to the original measured length. From this adjusted length of tooth, 1 mm was subtracted to confirm with the cementodentinal junction. This value was registered as "radiographic working length".



Figure 1(a & b): Working length determination using Ingle's method

Working Length Determination by Radiovisiography (RVG) (Figure 2(a&b))

Measurements from the pre-operative radiographs were made using 15 or 20 number K- files with rubber markers, keeping them 0.5 mm short of the root apex. With these measurements the files were inserted into the canal and an intraoral digital radiograph was taken. The file length was measured on the RVG screen using measurement tools and calibration. The examiner was able to adjust the contrast of RVG to achieve the best possible image. The estimated canal length was then measured as the distance from the occlusal reference point to the most apical extent of the file visualized. This value was registered as "digital radiographic working length".

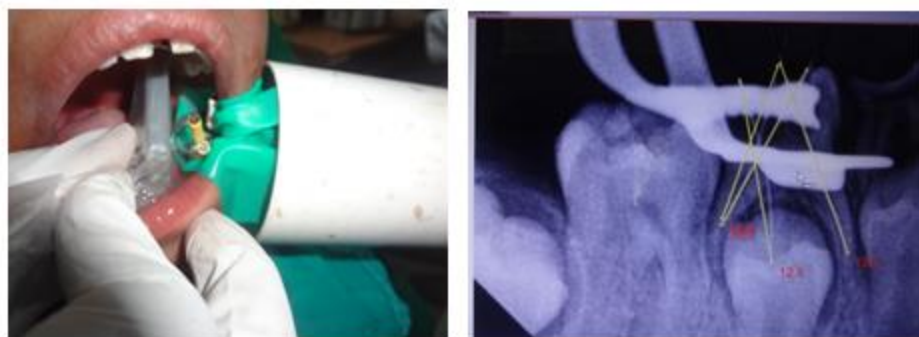


Figure 2(a&b) : Working length determination using RVG

Working length determination by Apex Locator (Figure 3 a&b)

The root canal length was clinically determined with the help of Electronic Apex Locator, Apex NRG blue (medic NRG Ltd, Tel Aviv, Israel). The Apex locator was used according to the instruction manual and the manufacturer's recommendations by a single operator. A No. 15 or 20 K-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 rubber stop was adjusted on the file in such a way that it touches the reference point. The instrument was carefully withdrawn and the distance from the tip of the instrument to the rubber stop was measured using a graduated metal scale. The value was noted down and registered as "electronic working length".



Figure 3(a&b) : Working length determination using Apex locator

The root lengths estimated from Intraoral Digital Radiography and Apex Locator were compared with the conventional method of root canal measurements for accuracy. Measurements were subjected to statistical analysis using Analysis of Variance (ANOVA) and Correlation or reliability between three methods was assessed by Karl Pearson's correlation coefficient.

RESULTS

The mean value of working length determined by Radiovisiography (RVG) was found to be 13.26 ± 1.28 , whereas the mean value of apex locator was

13.13 ± 1.22 and that of Ingle's method was 12.82 ± 1.26 (Table 1)

In comparison, of three methods (Radiovisiography, Apex locator and Ingle's method) with respect to working length it was found to be significant at the 5% level of significance.

In comparing the correlation or reliability between the three methods with respect to working length by Karl Pearson's correlation coefficient method, a significant correlation ($P < 0.01$) was found between apex locator and Ingle's method ($r = 0.8843$), when compared to Radiovisiography and Ingle's method ($r = 0.8815$) and

Radiovisiography and Apex locator ($r=0.8768$) (Table 2).

On comparing the correlation or reliability between the three methods with respect to working length by

Karl Pearson's correlation coefficient method, a significant correlation ($P < 0.05$) was found between apex locator and Ingle's method ($r = 0.8843$), when compared to RVG and Ingle's method ($r = 0.8815$) and RVG and apex locator ($r = 0.8768$) [Graphs 1-3].

Table 1: Mean, SD, SE and coefficient of variation of working length (mm) in three methods.

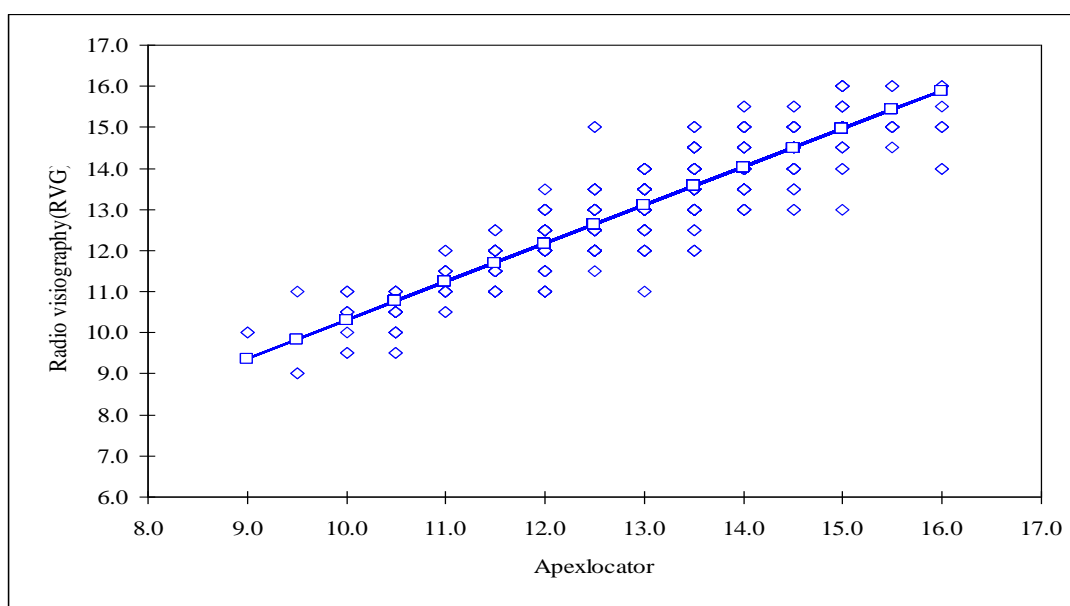
| Method | N | Mean | SD | SE | CV |
|-------------------------|------|-------|------|------|------|
| Radio visiography (RVG) | 631 | 13.26 | 1.28 | 0.05 | 9.61 |
| Apex locator | 631 | 13.13 | 1.22 | 0.05 | 9.27 |
| Ingles method | 631 | 12.82 | 1.26 | 0.05 | 9.79 |
| Total | 1893 | 13.07 | 1.26 | 0.03 | 9.66 |

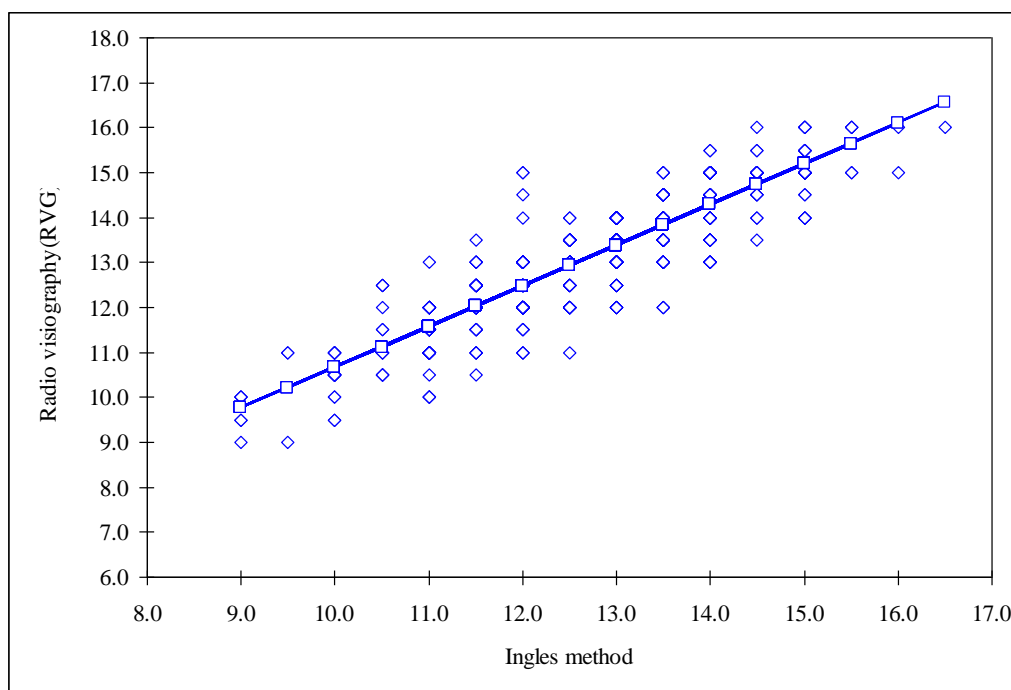
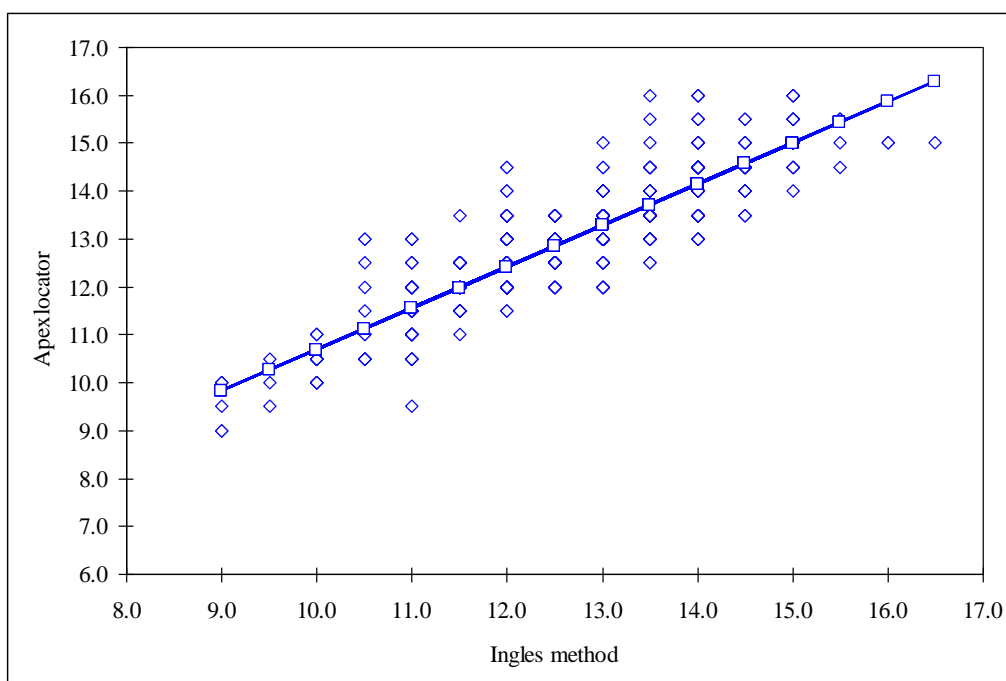
Table 2: Correlation or reliability between three methods with respect to working length (mm) by Karl Pearson's correlation coefficient method

| Methods | Radio visiography (RVG) | Apex locator | Ingles method |
|-------------------------|-------------------------|--------------|---------------|
| Radio visiography (RVG) | 1.0000 | | |
| Apex locator | 0.8768* | 1.0000 | |
| Ingles method | 0.8843* | 0.8815* | 1.0000 |

* $p < 0.05$

Graph 1: Correlation or reliability between Radiovisiography (RVG) and Apexlocator methods with respect to working length (mm)



Graph 2: Correlation or reliability between Radiovisiography (RVG) and Ingles methods with respect to working length (mm)**Graph 3: Correlation or reliability between Apexlocator and Ingles methods with respect to working length (mm)**

DISCUSSION

To maximize the success of the endodontic treatment in primary teeth, the evaluation of root morphology is a factor of concern. The root canal anatomy of primary teeth is difficult to predict because of the balance of resorption and hard tissue deposition. In addition, pulp

and periodontal inflammation may lead to pathological root resorption and further complicate root canal anatomy.⁴ Thus, the exact location of the apical foramen remains difficult to determine in primary teeth.⁵

Radiographic method described by Ingle is one of the most common and reliable methods used in determining the working length. It has numerous shortcomings in that it depends on child's co-operation, as well as the operator's proficiency. The other problem associated with intra oral periapical radiograph is developing, fixing, drying and storage of the film.²

Technological advances have led to the introduction of Digital Radiography, with many potential benefits in endodontic practice. Digital imaging system utilizes an intra oral sensor in place of the radiographic film.⁶ The advantages of RVG over conventional radiograph are, computers can enhance the brightness and contrast of the image, store and transmit the image. The decreased exposure time also allows lower radiation dosage.⁷ However, it also has certain disadvantages such as it provides only two-dimensional image and assessment of small areas of resorption is difficult.⁵

Recently, the use of electronic devices became popular and numerous devices have been introduced. The advantages of electronic apex locators include reduction in radiation dosage and procedure time, both of which aid in maintaining patient cooperation.⁸

The study included 238 maxillary and mandibular primary molars (total 631 root canals) indicated for Pulpectomy selected from a group of children in the age range of four to ten years. The children below 10 years were selected to minimize the possibility of physiologic root resorption and to obtain a maximum of 2/3rd root length for working length determination. Working length was determined for a total of 631 root canals using Ingle's method, RVG and Apex locator.

For radiographic working length determination, E speed films were used because they have shown to produce a good quality of radiographic images, even under reduced exposure times when compared to D speed films.⁹ Files selected to measure working length were in about the number 15-20. This is because the tips of the No. 10K files were not detectable as the tip diameter is less than 120-micron meter required.²

In the present study, a third-generation apex locator was used as the technology of this was based on Digital Signal Processing (DSP) and uses square multi-frequency currents. This apex locator was found to be reliable, accurate and equally effective in both

dry and wet canals in vitro.¹⁰ Hence this study has been undertaken to evaluate its in vivo accuracy in primary molars.

The traditional method of determining root canal working length is to place a file 0.5 mm short of the radiographic apex in permanent teeth. However, in primary teeth without a well-defined apical constriction, a tolerance of 1mm short of apical constriction is regarded as clinically acceptable.¹¹ Hence in the present study, deviation of 0.5 mm has been considered clinically acceptable (Faud et al. 1990, Ricard et al. 1991, Kim and Lee, 2004)

In comparing the correlation or reliability between the three methods with respect to working length, a significant correlation was found between apex locator and Ingle's method ($r=0.8843$), when compared to Radiovisiography and Ingle's method ($r=0.8815$) and Radiovisiography and Apex Locator ($r=0.8768$).

The apex locator yielded similar measurements to the standard conventional Ingle's method. These findings are similar to the previous in-vivo study conducted by **Neena et al.**² in primary molars.

The Digital Radiography has shown slight over prediction of working length when compared to that of Ingle's method and Apex locator. This can be seen in other studies where direct digital radiograph has shown over prediction of working length. One possible explanation may have been the lack of a reference point on the occlusal surfaces of the teeth from where the measurements were made.²

The correlation between RVG and apex locator was ($r=0.8843$). Similar finding was observed by **Saritha S et al.**¹², who have evaluated the accuracy of Root ZX II Electronic Apex Locator in root canal working length determination of primary maxillary incisor teeth using digital radiography and concluded that there was a high correlation ($r= +0.82$, $p< 0.001$) among these two methods.

Various studies have been conducted to test the accuracy of apex locators. They differ in the brand of apex locator used, the methods used to compare the device and the parameters for comparison. Most results indicate that the electronic method was 80-94% accurate, depending on the method of comparison.¹

Neena et al.², Thomas AA⁷ evaluated the in vivo accuracy and reliability of conventional radiography, RVG and Apex locators in primary molars and concluded that, all three methods were found to be reliable and both RVG and Apex locators can be used as alternatives to conventional Radiographic methods in determining working length.

CONCLUSION

Among the three methods utilizes for measuring working length (Ingle's method, Radiovisiography and Apex NRG Blue EAL) following conclusions were drawn from the study:

□ Apex NRG Blue was found to be adequately reliable and accurate in determining working length in multirooted primary teeth, as the measurements obtained by this were similar to the standard Ingle's method.

□ Radiovisiography has shown slight over prediction of working length when compared to the other two and can be used as an alternative to conventional radiography owing to its significant reduction in radiation dosage.

REFERENCES

1. Shanmugaraj M, Nivedha R, Mathan R, Balagopal S. Evaluation of working length determination methods: an in vivo/ex vivo study. Indian J Dent Res 2007; 18:60-2.
2. Neena IE, Ananthraj A, Praveen P, Karthik V, Rani P. Comparison of digital radiography and apex locator with the conventional method in root length determination of primary teeth. J Indian Soc Pedod Prev Dent 2011; 29:300-4.
3. Mull JP, Manjunath V, Manjunath MK. Comparison of accuracy of two electronic apex locators in the presence of various irrigants: an in vitro study. J Conserv Dent 2012; 15:178-82.
4. Rimondini L, Baroni C. Morphological criteria for root canal treatment of primary molars undergoing resorption. Endod Dent Traumatol 1995; 11:136-41.
5. Mente J, Seidel J, Buchalla W, Koch MJ. Electronic determination of root canal length in primary teeth with and without root resorption. Int Endod J 2002; 35:447-52.
6. Lozano A, Forner L, Llena C. In vitro comparison of root canal measurements with conventional and digital radiology. Int Endod J 2002; 35:542-50.
7. Thomas AA, Tandon S. Comparison of Root ZX, RVG and Conventional Radiography to determine working length in roots of primary molars. Ind J Odonto Stomatol Jan-March 2013;1(1):2-12.
8. Kocak S, Kocak MM, Saglam BC. Efficiency of two electronic apex locators on working length determination: A clinical study. J Conserv Dent 2013; 16:229-32.
9. Powell AW, Pitford TR. The use of E speed film for root canal length determination. Int Endod J 1993; 26:268-72.
10. Wang C, Krishnaprasad P. Accuracy of a new apex locator Apex NRG Blue: an in vitro study. Annals and Essences of Dentistry 2010; 2:1-3.
11. Gordon MPJ, Chandler NP. Electronic apex locators. Int Endod J 2004; 37:425-37.
12. Saritha S, Uloopi KS, Vinay C, Chandrasekhar R, Rao VV. Clinical evaluation of Root ZX II electronic apex locator in primary teeth. Eur Arch Pediatr Dent 2012;13(1):32-5.