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COMPARISON OF RADIOVISIOGRAPHY AND APEX LOCATOR WITH THE CONVENTIONAL METHOD IN ROOT CANAL LENGTH DETERMINATION OF PRIMARY TEETH

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Abstract:

Purpose: The purpose of this study was to assess whether Radiovisiography and Apex locator can be used as an alternative to Conventional method of radiography for determination of working length in pulpectomy of primary molars.

Methods: This in vivo study was conducted on 50 primary teeth indicated for pulpectomy. A standardized periapical radiograph was taken using conventional method by paralleling technique and E speed film. Measurement from digital radiography was obtained by modifying the method to minimize overprediction. Fourth generation apex locator, Ipex was used for the estimation of working length. The measurements were then compared with the conventional method of root canal measurement technique for accuracy.

Results: The mean values between Radiovisiography and conventional method showed non-significant p value of 0.851. The pearson correlation between Radiovisiography and conventional method (0.911) was more than correlation between apex locator and conventional method (0.862). RVG showed over prediction of working length while Apex locator showed shortest working length among the three methods.

Conclusion: Radiovisiography showed more correlation with conventional method than apex locator. Inspite of giving short working length, apex locator is recommended in pediatric endodontics because of the presence of physiologic resorption. Therefore, apex locator can be recommended in conjunction with RVG to accurately determine the working length in primary teeth.

Keywords: Radiovisiography, Apex Locator, Conventional Method, Root Canal Length Determination, primary teeth.

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 objectives of pulp treatment.[1] The main differences between deciduous and permanent teeth are that deciduous teeth are smaller in all dimensions than permanent teeth, and the mesiodistal / buccolingual crown ratio in deciduous teeth is larger than in permanent teeth. Their general aspect is more globulous. Furthermore, the cervical thirds of the buccal and lingual walls are more curved than in permanent teeth and they present a narrowing at the CEJ level, and the buccal and lingual coronal

walls converge occlusally, which reduces the width of the occlusal table.[2]

Root canal length or working length determination is an important step in root canal therapy. These terms are used interchangeably and according to the Endodontic Glossary refer to "the distance from the coronal reference point to the point at which canal preparation and obturation should terminate." Correct working length determination is one of the main factors leading to success in root canal treatment. Endodontic anatomy of primary teeth, in particular of molars is difficult to predict because of the resorption, shape, dimension and position of the root apex are often continuously altered. This is the reason that makes it difficult to determine the exact location of the actual apex. To minimize periapical injury and possible damage to the succedaneous tooth, the root length should be carefully determined without exceeding the apex.[1]

Radiographic method described by Ingle is one of the most common and reliable method used in determining the working length, however accuracy is difficult to achieve because of the variables in techniques, distorted image due to angulation and exposure and observer's bias which lead to error. The observers' bias in radiographic interpretation may also lead to errors.[1] Radiographic scan is often difficult in pediatric dentistry, due to the children's behavior, as they may move their heads, legs and arms. Anatomical variations and the superposition of images, such as the permanent tooth germs overlapping the roots of deciduous teeth, can make the location of the radicular apex difficult, leading to misleading results, particularly in cases where resorption is present. Therefore, endodontic treatment in children can be challenging for the professional. Technique errors may result in an increased risk of over-instrumentation and/or overfilling, which can damage the permanent tooth germ.[3]

Technological advances have led to the introduction of digital radiology (DR), which has many potential benefits in endodontic practice. It allowed a substantial reduction in the duration of endodontic procedures, because it effectively eliminated the film processing time. In the same way, the zoom function had the potential to improve the diagnostic performance by magnifying areas such as the apical zone. Digital imaging incorporates computer technology in the capture, display, enhancement, and storage of direct radiographic images.[4]

An electronic method for root length determination was first investigated by Custer (1918). The idea was revisited by Suzuki in 1942 who studied the flow of direct current through the teeth of dogs. Sunada (1962) took these principles and constructed a simple device that used direct current to measure the canal length. It worked on the principle that the electrical resistance of the mucous membrane and the periodontium registered 6.0 KΩ in any part of the periodontium regardless of the persons age or the shape and type of teeth.[5] It has mainly three parts: 1) labial electrode, 2) electrode attached to the endodontic file in the root canal, 3) the device itself with display that shows the movement of the file to the apical foramen.[6] Their advantages include equal or higher accuracy compared with the radiographic method, continuous monitoring of the working length in combination with intelligent rotary systems, discriminating between impenetrable and penetrable canals, and reducing the total needed radiographs and radiographic exposure as a result.[7] 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. Artificial perforations can be recognized and radiation to the patient can be reduced.[1]

Materials & Methods

This *in vivo* study was conducted on 50 primary teeth, indicated for pulpectomy in patients of age group of 5-12 years in the Department of Pediatric and Preventive Dentistry, Modern Dental College & Research Centre, Indore. Total of 50 primary teeth were used which included 8 maxillary first molars, 6 maxillary second molars, 16 mandibular first molars and 20 mandibular second molars. For the estimation of working length 157 canals were used in the study. Children were selected according to the inclusion criteria after obtaining consent from the parents. All teeth had adequate remaining tooth structure for rubber dam isolation and radiographically visible canals and endodontic treatment was required due to irreversible pulpitis, pulp necrosis or dentoalveolar abscess. Duration of the study was 1 year. A standardized intraoral periapical radiograph of the tooth was taken using conventional method by paralleling technique and E speed film was used. The distance between the source and the tooth; and, the tooth and the films, was standardized using X-ray positioning device. X-ray machine used operated at 70KVp, 8mA and exposure time was 0.20 seconds. Tooth was anaesthetized locally with 2% lignocaine with

adrenaline (1:80,000) and then 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 and normal saline. The pulp chamber was dried using sterile cotton pellets. Measurement of the root canal length was estimated from the preoperative radiographs. With these measurements, keeping them 0.5 mm short of the root apex, the files were inserted into the canal and a conventional radiograph was taken using the same measurement, the files were then again placed in the canals, and an intraoral digital radiograph was taken with exposure time 0.04 seconds. There was difficulty in the measurement of working length by digital radiography as there was lack of a reference point on the occlusal surface of the teeth from which measurements were made because of the overlapping by rubber dam clamp. To get correct working length by digital radiography, measurement was taken from CEJ to apex and to this crown length was added. Crown length was obtained from conventional radiograph by subtracting CEJ to apex length from its full working length. The images were stored in JPEG format. The dimension of image was 576×466 pixel.

The root canal length was clinically determined with the help of an electronic apex locator. Fourth generation electronic apex locater, Ipex is used according to the manufactures instructions to measure the working length. 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 with an audible sound that the apical constriction had been reached. The rubber marker of the file is kept at that length and the working length is measured. 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, pearson correlation test and Tukey test.

Results

Working length of the canals determined by apex locators and Radiovisiography was compared with conventional radiography in vivo.

The average mean root canal length value with apex locator, conventional radiography and with radiovisiography is shown in Table-1. ANOVA test (p= 0.007) showed significant different in between the three groups.

Intercomparison by Tukey test (table-2) showed significant difference between apex locator and conventional method (p= 0.039); and between apex locator and Radiovisiography (p= 0.008). The mean values between Radiovisiography and conventional method showed non-significant difference (p= 0.851)

The pearson correlation between apex locator and conventional method showed positive correlation (0.862) (table-3, figure-2), Radiovisiography and conventional method showed strong positive correlation (0.911) (table-3, figure-3).

Therefore, Radiovisiography showed more correlation with conventional method than apex locator (figure-4).

Discussion

In primary teeth, it is important to estimate the exact root canal length during endodontic therapy to avoid injury to the succedaneous tooth bud. Although pulpectomy is an important treatment option in primary teeth with infected pulps, various factors must be borne in mind before starting treatment. Long appointments may be tiring for young patients and the diagnostic procedures which require a child's cooperation (e.g. vitality testing) are less reliable compared with adult patients. There are also specific problems which are characteristic of primary teeth: root canal walls are often thin and instrumentation of the canal may result in perforation or root fractures. In addition, the primary roots get resorbed during eruption of their permanent successors. A technique to be used in determining the root canal length must give précise and reproducible results.[8] The radiological diagnostic techniques used in the present study were chosen to reflect current interests in comparing the performances of digital and conventional radiology, and assessing their applicability to root canal measurements. Intraoral digital radiography has provided approximately 60% reduction in radiation dosage in comparison with conventional radiography.[1]

Fourth generation apex locator (Ipex), used in present study measures two components of impedence i.e. capacitance

and resistance seperately to accurately determine the location of the file tip in the canal. The accuracy of the electronic measurements with the Ipex was found similar to that reported by other authors using various Electronic apex locators in primary teeth and the excellent results have supported their indication for clinical use in children.[9,10]

Paralleling technique, 10 & 15 no. file size were used in the study to make radiographs more reproducible as suggested by many authors previously.[11,12] In the present study RVG showed more correlation with the conventional method than apex locator and same correlation was found by Shearer et al[13] and Mehdizadeh et al.[14]

However, in the present study RVG showed 0.82% of over prediction which is in accordance with the study conducted by I E Neena et al[1], they[1] found overprediction of 1.86% by RVG. They explained might be due to the magnification errors caused by positioning of the sensor inspite of using position indicating devices and due to the lack of correct reference point. Reference point is sometimes not clear in the digital image as it is overlapped by the rubber dam clamp and the smaller size RVG sensor used for primary teeth. We tried to minimize this bias by modifying the method for measuring the working length in RVG as described in materials and methods section. Our study showed less overprediction which might be because of the modified method used. The improved results by RVG system could also be because of better resolution. Resolution for radiographs often is judged by line pairs per millimeter (lp/mm), which measures clarity of an image. The Suni sensor has been rated at 22 lp/mm as compared to standard x-ray film at 8-11 lp/mm.

Our results showed significant difference between RVG and apex locator. Subramaniam P. et al[15] found contradictory results showing high reliability coefficient between the RVG and apex locator measurements were best related to actual tooth canal length.

In the present study apex locator gave the shortest working length among the three methods which is in accordance with the studies by Kielbassa A M et al[16] and by S. Saritha et al. [17] According to Kielbassa A M et al[16], 100% of the apex locator measurements were short or equal to the working length in primary molars while only 2% measurements exceeded the working length in incisors. Nonetheless, apex locator can be determined as a reliable means for working length determination in primary root canals as it tends to measure shorter working length and thus includes prevention of injury to periapical tissues and succedaneous tooth germ,reduced radiation dosage and chairside usability.

The exact location of the apical foramen remains difficult to determine in primary teeth[18] due to the presence of resorption, larger impedence difference detected by the apex locator before apex.

Conclusion

Within the limitations of our study, following conclusions could be drawn:

- RVG showed strong correlation with conventional radiography, hence can be applied clinically.
- Apex locator showed weaker correlation with conventional radiography. Therefore, it can be applied clinically in association with RVG only.
- RVG showed over prediction of working length which was not significant.
- Apex locator showed shortest working length among the three methods.
- The over prediction of working length in RVG was minimized by modifying the method of measurement (Cementoenamel junction to apex by digital ruler + crown length by conventional radiography).

Therefore, apex locator should be used in conjunction with RVG to accurately determine the working length in primary teeth.

Table – 1: Mean values of the working length using three methods

Working Length	Mean	SD	SE	95% Confidence Interval for Mean		Min	Max
Apex Locator N= 157	12.95	1.64	0.13	12.69	13.21	8.00	16.00
Conventional N= 157	13.42	1.69	0.13	13.16	13.69	9.00	17.00
RVG N= 157	13.53	1.83	0.15	13.24	13.82	9.00	18.00

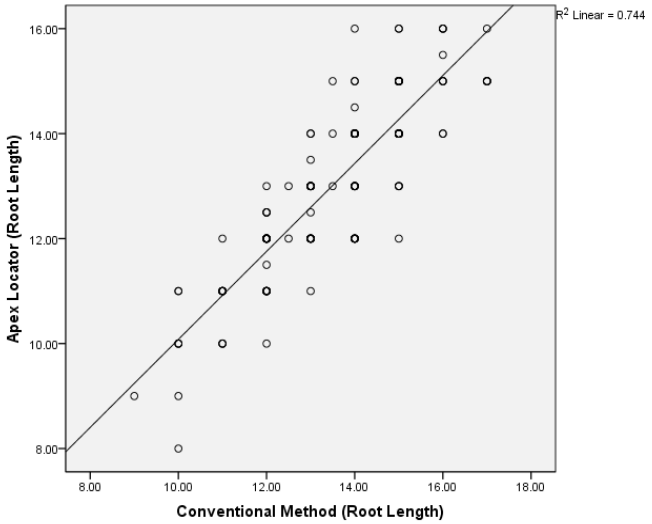
ANOVA p = 0.007

Table – 2: Intercomparison between groups

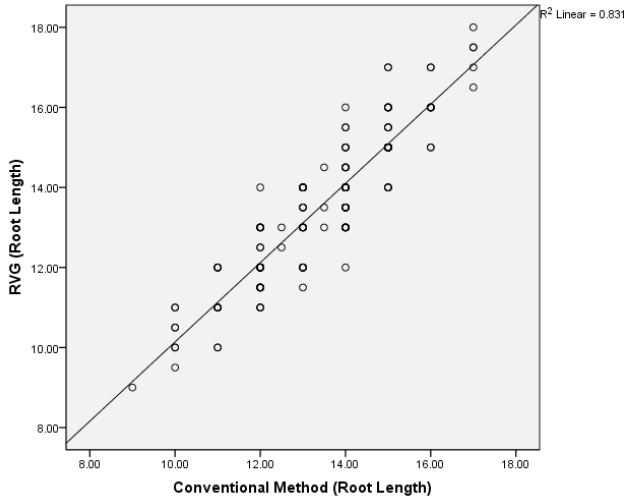
Method	Compared to	Tukey Test
Apex Locator	Conventional	.039
	RVG	.008
\Conventional	Apex Locator	.039
	RVG	.851 NS*
RVG	Apex Locator	.008
	Conventional	.851 NS*

NS* - Non Significant

Figure – 2: Correlation between Root length by Apex locator and Conventional Radiography



Figure–3: Correlation between Root length by Radiovisiography and Conventional Radiography



Table–3: Correlation of Root length by Apex locator and Radiovisiography with Conventional method

Conventional Method (Root Length)	Apex Locator (Root Length)	RVG (Root Length)
Pearson Correlation	0.862	0.911
	Strong Positive Correlation	Strong Positive Correlation
Sig. (2-tailed)	.000	.000
	Significant	Significant
N	157	157

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