

ISSN 0970-9290

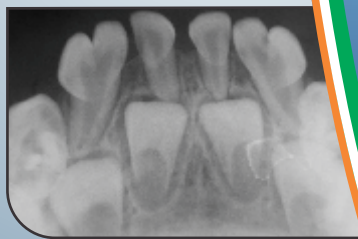
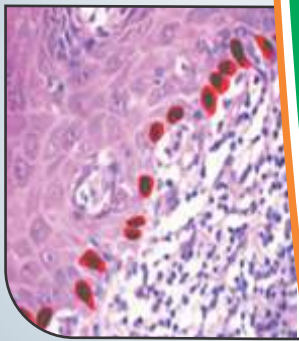


Indian Journal of Dental Research

Volume 24

Issue 2

March-April 2013



<http://www.ijdr.in>

*Official Publication of
Indian Society of Dental Research*

 Wolters Kluwer
Health

Medknow

A comparison between conventional and digital radiography in root canal working length determination

Abesi Farida, Ehsani Maryam¹, Mirzapour Ali², Moudi Ehsan, Yousefi Sajad³, Khafri Soraya⁴

Departments of Oral and Maxillofacial Radiology, and ¹Endodontics, Dental Materials Research Center, ²Student Research Center of Babol Dental Faculty, ³Departments of Oral and Maxillofacial Radiology, ⁴Social Medical and Health, Babol University of Medical Science, Babol, Iran

ABSTRACT

Aim and Objectives: Obtaining a correct working length is necessary for successful root canal treatment. The aim of this study was to compare conventional and digital radiography in measuring root canal working length.

Materials and Methods: In this *in vitro* study 20 mesio buccal canal from maxillary first molars with moderate and severe curvature and 20 canal form anterior teeth with mild curvature were chosen and their working length were measured with number 15 k file (Maillefer, DENTSPLY, Germany). Then for each canal five radiographies were taken, three conventional radiographies using three methods of processing: Manual, automatic, and monobath solution; in addition to two other digital radiographies using CCD and PSP receptors. Two independent observers measured working length in each technique. Finally, the mean of working length in each group was compared with real working length using a paired T-test. Also a one-way ANOVA test was used for comparing the two groups. The level of statistical significance was $P < 0.05$.

Results: The results have shown that there was a high interobserver agreement on the measurements of the working length in conventional and digital radiography ($P \leq 0.001$). Also there was no significant difference between conventional and digital radiography in measuring working length ($P > 0.05$).

Conclusion: Therefore it was concluded that the accuracy of digital radiography is comparable with conventional radiography in measuring working length, so considering the advantages of the digital radiography, it can be used for working length determination.

Key words: Conventional radiography, digital radiography, working length

Received : 18-05-12
Review completed : 12-07-12
Accepted : 10-09-12

Definition of location, structure, and anatomy of root canal is very important in determining prognosis, treatment plan, and method of retaining teeth in the long term.^[1-3]

Exact measurement of the working length is an important factor for cleaning and effective filling of the canal. The best technique for measuring the working length of the canal is radiography.^[2]

Of course this is not the only way to determine the length. Clinically working length determination is also done by using a electronic apex locator.

By improving diagnostic imaging and introducing digital imaging these methods of imaging have many applications in medicine and in dentistry their use are increasing. The main advantages of digital radiography over conventional radiography are elimination of film and chemical procedure of processing, decreasing radiation dose, quick access to image for display, and the ability to transfer and save, and image processing with computer programs.^[4]

Generally there are two types of digital image receptors for intraoral radiography:

- Solid-state receptor.
- photo-stimulable phosphor plates receptor (PSP).

In solid-state image receptors like charge-couple device (CCD) it is possible to have digital image output in computer without an external device. However, in PSP image receptors, a latent image is constructed and should be scanned.

According to the previous studies, it seems that intraoral digital radiography is similar to conventional radiography in common diagnostic tasks.^[4,5]

Address for correspondence:

Dr. Ehsani Maryam
E-mail: ehsanimaryam@yahoo.com

Access this article online	
Quick Response Code:	Website: www.ijdr.in
	DOI: 10.4103/0970-9290.116693

Mentes *et al.*^[6] evaluated the accuracy of conventional and digital radiography methods for measuring canal length in curved canals. The results indicated no significant difference between two radiography methods in measuring the length of the canal. In both methods measurement of the canal length was more than that of the real length. They also concluded that digital radiography can be used for measuring the curved canal length. Eikenberg *et al.*^[7] declared that in comparison of the CCD digital method with conventional method using manual processing and self-developing film, the error rate is significantly lower in the digital method upon conventional imaging ($P \leq 0.001$). Javidi *et al.*^[8] and Cederberg *et al.*^[9] recommended digital radiography as a more accurate method for measuring the working length. Therefore, the aim of this study was to compare the accuracy of conventional radiography (using different methods of processing) with digital radiography in measuring the working length of the root canal.

MATERIALS AND METHODS

A total of 40 teeth (20 teeth with single straight root and 20 teeth with curved mesiobuccal root of maxillary first molar) were extracted for orthodontic or periodontal reasons and the teeth which were studied were obtained from different sources with or without crown caries. They were kept in normal saline and %1 Thymole.

The inclusion criteria were as follows:

- Anterior tooth with straight root and curvature $\leq 5^\circ$.
- Maxillary first molar with mesiobuccal (MB) root curvature $\geq 20^\circ$.
- Tooth with at least two healthy enamel walls.
- Tooth with mature and complete apex without fracture and resorption.

The exclusion criteria were as follows:

- Tooth with calcified canal.
- Tooth with extensive caries.
- Tooth with external root resorption.

Level of curvature was measured according to the Schneider method (1971).^[3,10] First a line was drawn along the longitudinal axis of canal from the orifice and where the canal deviated from this line; the location was called spot "A"; and then the second line was drawn from apical foramen to spot "A." The angle between these two lines was the curvature angle and was measured by conveyor (Rottring, Germany) and the results are documented.

Access cavity preparation was carried out using a round diamond bur and for attaining a reference point on teeth, the incisal or occlusal edge was flattened using diamond bur. The number 15 K file was inserted in the canal and the real working length was measured by observing the end point of the file and reducing 1 mm from the length. Then, the teeth

were fixed in resin block and each block was radiographed using a DC intraoral Xray unit (Minray, Soredex, Finland) under the standardized condition: 60 kvp, 8 MA, and 0.2 s with E-speed film (Eastman Kodak, Rochester, NY). Blocks of resin and film were stabilized on a positioning jig to provide central beam orientation, 10 mm tooth-receptor distance and 30 cm target-to-receptor distance. A 24 mm plexy-glass plate was placed between the tube extension and the teeth to simulate the soft tissue.

Then films were processed in three different methods as follows:

First method

Films were processed with automatic method (Hope-Dental Max, USA) using a Tetenal processing solution according to instructions provided by the manufacturing company.

Second method

Manual method using a Monobath processing solution (USA, Kodak) according to the manufacturing company's instructions.

Third method

Films were processed manually using a Teifsaz fresh processing solution (Teifsaz Company, Iran).

For the next step digital radiography was done for the teeth using a CCD sensor (DIXi3) (Planmeca, Finland) with 19 μm pixel size and 26 LP/mm resolution, and PSP receptor (Digora PCT, Soredex, Finland) with 85-167 μm pixel size and 6 LP/mm resolution.

It should be mentioned that all the adjustment conditions for teeth and radiography apparatus were the same as previous; only exposure time was reduced by about 0.1 second. In the CCD receptor, the image is displayed in the computer directly, but in PSP receptors images are scanned, processed, and saved in the computer and finally all digital images are coded randomly.

Assessment of radiography

Each of the digital and conventional radiographic images was allocated a code. One oral and maxillofacial radiologist and one endodontist acted as observers. The observers were allowed to use the image enhancement facilities as they pleased. First, the images provided by conventional radiography were observed in a quite dark room on the view box. Then digital images were examined one by one in a predetermined random order on a DFX 17-inch monitor (Samsung and Syncmaster 1793) with high resolution and no time limitation in a quiet, semidark room. Measurement of the canal length was done by two observers (one radiologist and one endodontist) using Digital rulers software with 0.25 accuracy. In tooth and radiography film, the working length was measured via an endodontic

ruler with 0.25 mm accuracy (to simulate clinic situations). It must be noted that in conventional radiographies observers could use lenses if it was necessary.

For anterior teeth measurement was done with two clicks: The first click on the coronal reference point and the second click on the end point of the file; and for posterior teeth with moderate and severe curvature three clicks were done: The first click on the coronal reference point, the second click on the vertex of curvature angle along the axis of root canal, and the third click on top of file. The second observation was done after 2 weeks. Then data were collected and analyzed using SPSS V.17 software and paired T-test and one-way ANOVA.

RESULTS

In this study 40 extracted human teeth including 20 anterior teeth and 20 posterior teeth were evaluated by two observers for estimating the length of the root canal.

The correlation between the observers was assessed using a Pearson correlation test. There was a significant correlation between observers in conventional radiography ($P \leq 0.001$) and digital radiography ($P \leq 0.001$).

Totally, interobserver's correlation in measuring the canal length equals 0.963 ($P \leq 0.001$). Also intraobserver's correlation in measuring the canal length was 0.968 ($P \leq 0.001$). The mean length of 20 anterior teeth was $20.15 \text{ mm} \pm 1.86$ and for posterior teeth the mean length was 20.20 ± 1.61 . Then the mean measurements by two observers were evaluated.

The real and measured lengths using various methods were analyzed by a paired T-test. In anterior teeth there was a significant difference between the mean real working length and measured working length using conventional radiography ($P \leq 0.001$) and in posterior teeth there was a significant difference between the mean real working length and measured working length using conventional radiography ($P \leq 0.001$). Also in digital radiography this difference between measured and real working lengths in anterior teeth ($P \leq 0.001$) and in posterior teeth ($P \leq 0.001$) was significant [Tables 1-3].

Table 2 showed that CCD was more accurate in measuring the working length, in comparison with PSP, because of lower error rate in using CCD. Also in Table 3 it was seen that the least error in conventional radiography was for the automatic method; however there was no significant difference between methods.

DISCUSSION

Working length measurement is one of the most important steps in endodontic treatments, so exact measurement will

Table 1: Working length measured by digital and conventional radiography, and error rate

Method	Mean and standard deviation of the diagnostic working length	Mean and standard deviation of the real working length	Error rate
Digital radiography	20.96±1.74	20.18±1.73	0.78±0.74
Conventional radiography	20.85±1.73	20.18±1.73	0.68±0.47
P value	0.681	1.000	0.269

Table 2: Anterior and posterior working length, and error rate

Location of tooth	Mean and standard deviation of the diagnostic working length	Mean and standard deviation of the real working length	Error rate
Anterior	20.73±1.91	20.15±1.86	0.58±0.49
Posterior	21.07±1.52	20.20±1.60	0.87±0.74
P value	0.165	0.839	0.001

Table 3: Comparison between digital and conventional radiography in the working length error rate

Method		Mean and standard deviation of the diagnostic working length	Mean and standard deviation of the real working length	Error rate
Digital	CCD	20.67±1.74	20.18±1.72	0.49±0.97
	PSP	21.25±1.72	20.18±1.73	1.07±0.55
	P value	0.138	1.000	0.02
Conventional	Manual	20.89±1.77	20.18±1.73	0.71±0.55
	Automatic	20.75±1.70	20.18±1.73	0.58±0.40
	Monobath	20.92±1.75	20.18±1.73	0.75±0.43
	P value	0.903	1.000	0.25

PSP=Photo-stimulable phosphor plates, CCD=Charge-couple device

lead to a complete treatment in the root canal area.^[11-15] In clinical studies multiple factors are effective in measuring the working length such as direction of radiation, exposure time, image receptors type, duration of processing, condition of image display, location and position of apical foramen, and clinical position of tooth.^[9] In this *in vitro* study we evaluated some of these factors affecting the measurement of the working length. Results of this study showed no significant difference in measuring the working length between observers, so we analyzed the mean of measurements.

According to the results there was a significant difference between the mean real working length and measured working length by digital radiography and also conventional radiography so that this difference tends to overestimation. These findings were in accordance with Javidi's study,^[8] MohtaviPour,^[15] and Mentis.^[6] In this study as mentioned before, we used special instruments in a geometrically standardized to make the study replicable. Furthermore in this study radiographies were taken parallel in order to have the least distortion for images. Of course magnification was somehow predictable which was seen in the results of

this study. Also in the digital technique there is an option for estimating magnification that was not considered to adjust the conventional method. In all cases we used a cursor attached to the computer mouse for digital systems and an endodontic ruler for conventional films, that according to Scarf *et al.*^[16] was the most accurate and valid method. In Mohtavipour.^[15] and Burger.^[17] studies there was no significant difference between radiographic measured (conventional and digital) and real measurements, that can be caused by using a CMOS digital system and F speed films in their studies. Of course in their studies the canals were categorized into three categories (0-15, 15-30, ≥ 30) according to the amount of curvature, where just in the first category there was some overestimation. And finally there was no significant difference between the mean radiographic measurement and real length according to curvature. In this study there was no significant difference between digital and conventional radiography in measuring the working length that was in consistence with Mohtavipour.^[15] and Mentés^[6] study results. However Javidi^[8] and Cederberg.^[9] suggested that digital radiography was a more accurate method for measuring the working length. Javidi used an E speed film and manual processing and CCD digital system. He considered digital system utilities for adjusting contrast and image brightness for better observation of file tip, and finally stated that the digital method was more accurate for measuring the working length than conventional radiography. Of course in Javidi's study the canal curvature was not considered and also their study was done on skull and only mandibular teeth. In this study in conventional radiography we used three methods for processing including manual, automatic, and Monobath that there was no significant difference, although the priority was with automatic process. Bernstein^[18] worked on quality of radiographic images and there was no significant difference between quality of rapid processing and manual processing images. Also Syriopoulos^[19] reported no significant difference between manual and automatic processing in measuring the working length. Kaffe^[20] compared D and E speed films using four types of solution in rapid processing. He concluded that it can be used in emergency situations and endodontic treatment. These results were in accordance with this study in some way. Monobath solution is a kind of rapid processing solution that contains processing materials and water in one solution, which based on the manufacturer's recommendations can be used in emergency situations like surgical and endodontic treatments. In this study there was no significant difference in estimating the working length, between three methods of processing. Although the error rate was fewer in automatic method, it was not significant statistically.

In the digital method there was no significant difference between PSP and CCD type in measuring the working length of the canal. But the CCD system was more accurate in measuring the working length. Further there

was a significant difference in error rate between the two methods. The error rate for the PSP method was more than that for CCD method that can be for higher resolution of the CCD system than PSP system. Anas *et al.*^[13] 2010 compared digital images of PSP plates (DenOptix) and CCD plates (Gendex) for estimating the canal length in mandible molar teeth, and indicated that for canal length measuring Gendex makes more trustable images than DenOptix; and this error rate was connected to the type of digital receptor. In CCD receptors a digital image is formed and saved directly and without any medium, but in PSP receptors an analog image is made and then convert into the digital image. Anas *et al.*^[14] 2008 compared three types of digital image receptors for measuring the radiographic working length of canal and evaluated DenOptix (PSP), Gendex (CCD), and Schick (CDR/Wireless) receptors. DenOptix had the most error rate in measuring the working length and then Gendex and Schick. The result of this study confirms the findings of Anas's study. As CCD images are more accurate in comparison with PSP in measuring the working length. Also CCD had the least error rate in measuring the canal length, among all studied methods. Cederberg^[9] studied the accuracy of conventional and digital radiography for measuring the working length of canal in endodontic treatments. In this study the accuracy of digital radiography was more than conventional for measuring the working length; although no significant difference was reported. Also in this study similar to Cederberg's study, CCD had the least error rate. It is mentioned that by going from anterior teeth (with straight canal) toward posterior teeth (with curved canal) error rate is increased and this difference is significant. Of course in this study the curvature of posterior teeth was more than 20°, according to the Schneider method. But in anterior teeth the curvature of canal is lower than 5°.

Anyway, in the digital method each observer was authorized to use three clicks for measuring canal. Obviously in curved canals as the number of the clicks increased, it could cause defects or benefits. It could cause better adaptation of measuring lines drawn by a cursor, and on the other hand it could cause estimation error because of discontinuity that occurs in drawing lines.

However in this study there was no significant difference between digital and conventional methods in measuring the working length in curved and straight canals, but the error rate in curved canal was significantly more than straight canal so that these findings are in accordance with Burger,^[17] Mentés,^[6] Ezoddini.^[11] Conventional radiography is a common procedure due to accuracy, cheap price, availability everywhere (accessibility) and easy usage, but digital radiography is recommended because of priorities such as decreased exposure time, ability of changing density, contrast, color, size of image, no need of dark room, and processing equipment.

CONCLUSION

This study indicated that the accuracy of conventional and digital radiography in the evaluation of the working length was comparable. Furthermore a CCD digital image receptor is more efficient than PSP receptors for measuring the working length of the canal.

ACKNOWLEDGMENT

The authors would like to thank Dr. Moghimi for donating PSP Digora-PCT to Babol University of Medical Sciences. This article was the result of the thesis of Dr. Ali mirzapour which was supported by Dental Material Research Center and Deputy of Babol University of Medical Sciences.

REFERENCES

- Lamus F, Katz JO, Glaros AG. Evaluation of a digital measurement tool to estimate working length in endodontics. *J Contemp Dent Pract* 2001;2:24-30.
- Friedlander LT, Love R, Chandler NP. A comparison of phosphor plate digital images with conventional radiographs for the perceived clarity of fine endodontic files and periapical lesions. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002;93:321-7.
- Schilder H. Cleaning and shaping the root canal. *Dent Clin North Am* 1974;18:269-96.
- White SC, Pharoah MJ. *Oral radiology: Principle and interpretation*. 6th ed. St. Louis: Mosby; 2009. p. 78-99.
- Lozano A, Forner L, Liena C. *In vitro* comparison of root canal measurements with conventional and digital radiology. *Int Endod J* 2002;35:542-50.
- Mentes A, Gencoglu N. Canal length evaluation of curved canals by direct digital or conventional radiography. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002;93:88-91.
- Eikenberg S, Vandre R. Comparison of digital dental X-ray systems with self-developing film and manual processing for endodontic file length determination. *J Endod* 2000;26:65-7.
- Javidi M, Shoja Razavi, Esmaili H. A comparison between conventional and digital radiography in estimating the working length of root canal. *Journal of Dentistry, Mashhad Univ Med Sci* 2006;30:33-40. (In Persian).
- Cederberg R, Tidwell E, Frederikson NL, Benson BW. Endodontic working length assessment: Comparison of storage phosphor digital imaging and radiographic film. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1998;85:325-8.
- Abesi F, Ehsani M. Radiographic evaluation of maxillary anterior teeth canal curvatures in an Iranian population. *Iran Endod J* 2011;6:25-8.
- Ezoddini Ardakani F, Goodarzi Pour D, Soltani Mohammadabady M. Comparison of the accuracy of digital and conventional radiography in evaluation of curved canals lengths. *Journal of Dentistry, Tehran Univ Med Sci* 2005;18:66-74. (In Persian).
- Goga R, Chandler NP, Love RM. Clarity and diagnostic quality of digitized conventional intraoral radiographs. *Dentomaxillofac Radiol* 2004;33:103-7.
- Anas A, Asaad J, Tarboush K. A comparison of intra oral digital imaging modalities: Charged couple device versus storage phosphor plate. *Int Health Sci (Qassim)* 2010;4:156-67.
- Athar A, Angelopoulos C, Katz JO, Williams KB, Spencer P. Radiographic endodontic working length estimation: Comparison of three digital image receptors. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;106:604-8.
- Mohtavipour ST, Dalili Z, Azar NG. Direct digital radiography versus conventional radiography for estimation of canal length in curved canals. *Imaging Sci Dent* 2011;41:7-10.
- Scarf WC, Norton S, Farman AG. Measurement accuracy: A comparison of two intra oral digital radiographic systems, Radiovisiography-S and Flash dent with analog film. *Dentomaxillofac Radiol* 1995;24:215-20.
- Burger CL, Mork TO, Hutter JW, Nicoll B. Direct digital radiography versus conventional radiography for estimation of canal length in curved canals. *J Endod* 1999;25:260-3.
- Bernstein DI, Clark SJ, Scheetz JP, Farman AG, Rosenson B. Perceived quality of radiographic images after rapid processing of D- and F-speed direct exposure intra oral X-ray films. *Oral Surg, Oral Med, Oral Pathol Oral Radiol Endod* 2003;96:486-91.
- Syriopoulos K, Velders XL, Sanderink GC, van Der Stelt PF. Sensitometric and clinical evaluation of a new F-speed dental X-ray film. *Dentomaxillofac Radiol* 2001;30:40-4.
- Kaffe I, Gratt BM. E-speed dental films processed with rapid chemistry: A comparison with D-speed film. *Oral Surg Oral Med Oral Pathol* 1987;64:367-72.

How to cite this article: Farida A, Maryam E, Ali M, Ehsan M, Sajad Y, Soraya K. A comparison between conventional and digital radiography in root canal working length determination. *Indian J Dent Res* 2013;24:229-33.

Source of Support: Nil, **Conflict of Interest:** None declared.