

ASSESSMENT OF ACCURACY OF DIGITAL RADIOGRAPHY WITH DIFFERENT ENLARGEMENTS IN DETERMINING WORKING LENGTH OF ROOT CANAL

Razavi M,¹ Shirafkan S,² Kazemi P,³ Abdolalian F,⁴ Amin-Poor M⁵

1. Assistant Professor, Department of Oral & Maxillofacial Radiology, Faculty of Dentistry, Ahaz Jundishapur University of Medical Sciences, Ahvaz, IRAN.

2. Assistant Professor, Department of Oral & Maxillofacial Surgery, Faculty of Dentistry, Ahaz Jundishapur University of Medical Sciences, Ahvaz, IRAN.

3. Assistant Resident, Department of Orthodontics, Faculty of Dentistry, Ahaz Jundishapur University of Medical Sciences, Ahvaz, IRAN.

4. Assistant Professor, Department of Periodontology, Faculty of Dentistry, Ahaz Jundishapur University of Medical Sciences, Ahvaz, IRAN.

5. Faculty of Dentistry, Ahaz Jundishapur University of Medical Sciences, Ahvaz, IRAN.

ABSTRACT

Aim: One main problem in root treatment is correct measurement of canal working length because working length determines level of canal cleaning and shaping and it clarifies maximum level of root filling. This study aimed at assessing accuracy of digital radiography with different enlargements in determining working length of root canal and comparing it with standard method.

Materials & Method: This study was performed by experimental method on 30 extracted single rooted premolar teeth from both lower and upper jaws. After providing access hole, root canal was prepared. One file with 15 mm size was placed into canal to the point that its end was observable in canal apical pore. Firstly, canal length from reference point was measured based on millimeter and it was measured based on shortening the length for 0/5 millimeter by endometrium and it was calculated by 0.1 mm accuracy. Then teeth were mixed by green acrylic which has bone powder and mounted. Radiographic images of indirect digital periapical was provided for all samples by parallel method after preparing radiography by Scanora software, images were changed into conventional radiography film size and then they were saved by 2 and 3 times enlargements. Images were assessed separately by 2 maxillofacial radiologists with at least two years of experience in observing digital images.

Results: Accuracy of 1x, 2x and 3x enlargements of indirect digital radiography were 95/1%, 96/3% and 95/9% respectively.

Conclusion: Accuracy of 1x, 2x and 3x enlargements of indirect digital radiography for estimating root working length were very similar either in general status or in each observers and there was no significant difference in different enlargements.

Key words: Enlargement, Indirect Digital Radiography, Working Length of Canal.

Introduction

Success of root treatment is dependent on diagnosis, treatment plan, preparing access hole and canal cleaning, shaping and filling. One main point in root canal treatment is how to determine progress length of instrument in canal and length of prepared canal and end point of canal filling. Determining apical end accurately has been always an important clinical challenge for root canal treatment.¹

Today various radiographies are available in which reducing required ray level is important in order to achieve optimal stereotype.² Harmful effects of insufficient printing and verifying and impacts of problems related to maintaining chemical solutions of printing and verifying are effective on diagnosis quality of films in imaging conventional.³ Printing digital imaging revolved radiography. In this system, recovers transfer pictorial information to the computer which is represented immediately on screen and it is able to change image quality including contrast and density and saving and transferring it to other centers.⁴⁻⁶ Dentistry digital imaging is used since last decade and its use is growing permanently.⁷ So more companies are producing software's and hardware for digital imaging. Clearly, radiographic diagnosis of diseases needs accurate diagnosis of conventional anatomy and on the other hand influenceability diagnostic power, quality of data resource and method of applied image processing is undeniable.⁸

There are two digital radiography system:

- direct (Charge Coupled Devices) (CCD) and
- indirect (Photostimulable Phosphor Plates) (PSP).^{9,11}

In order to determining root canal length, technique including touch, radiographic methods or apex locators are used.¹² For many years, conventional radiographies are popular methods for determining canal working length.¹³ However, they have some disadvantages including resolution lower than conventional technic, high cost, and sensor sensitivity and high cost of their replacement.¹⁴⁻¹⁵

Generally main aim of root treatments is removing anti genes from root canal in order to repaired and regenerate periapical tissues by immune system.^{16,17} For cleaning process, exact length of canal needs to be specified thus determining ending point of treatment is the main stage in root canal treatment and it is very effective on success and failure of the treatment.^{18,19}

Main aim of the study is assessing accuracy of digital radiography with different enlargements in determining root canal working length. So accuracy of working length of root canal in indirect digital radiography images of PSP with 1x, 2x and 3x enlargements are determined and accuracy of working length of root canal in indirect digital radiography images of PSP with 1x, 2x and 3x enlargements are compared.

Results of this study is used for recommending appropriate enlargement to dentists for determining correct diagnostic canal length.

Materials & Method

Data & Variables

Sample group was provided from indirect digital stereotypes from 30 single root maxillary and mandibular premolar teeth. Statistical population included 30 single root maxillary and mandibular premolar tooth. Based on information from similar researches by Javidi *et al*,¹⁵ in 2007, 30 teeth were determined thus 90 digital images were studied. Criteria of the sampling of single root maxillary and mandibular premolar tooth was their extraction due to Orthodontics or periodontal with no break, decay, crack or repair. This study has two independent variables including indirect digital radiography (PSP) and enlargement level of digital image with 1x, 2x and 3x enlargements of images. Scale of both variables is nominal. Digital imaging technic were obtained indirectly after processing by the machine. Dependent variable of the research is working length of root canal which is obtained through measuring by digital ruler based on millimeter.

Method of Performing

This study is performed by experimental method on single root extracted premolar teeth 30 single root premolar tooth with direct roots based on inclusion criteria. Teeth were sterilized in hypochlorite sodium. After providing access hole, root canal was prepared. One file with 15 mm size was placed into canal to the point that its end was observable in canal apical pore. Firstly, canal length was measured from reference point in terms of millimeter and it was measured based on shortening the length 0/5 millimeter by endometrium and it was calculated by 0.1mm accuracy. This size was considered as standard length. Then teeth were mixed by green acrylic which has bone powder and mounted and the ratio was 1 to 4. [Figure 1]



Figure 1: Sample from teeth mound in green acrylic mixed with bone powder

All samples of radiographic images of indirect digital periapical were provided for all samples by parallel method by radiography machine (X Genius, De Gotzen, Italy). After preparing radiography by Scanora software, images were changed into conventional radiography film size and then they were saved by 2 and 3 times enlargement. Finally, 3 copies were provided for each image which was measured by digital ruler with 0/1 millimeter accuracy based on distance of reference point to 0.5 millimeter of apical end. Images were assessed separately by 2 maxillofacial radiologists with at least two years of experience in observing digital images. Observers were not aware of distribution and type of samples so this is considered as one-way study. There was no time limit for observers. Indirect digital images (PSP) were observed in gloomy room on common monitor. Before diagnosis of radiographic images of the study, an example of images assessment was provided and they received required instruction. Finally, variance analysis was used for comparing accuracy of different enlargements and level of significance was considered as $p \leq 0.05$.

It should be mentioned that since this study is performed on extracted teeth experimentally there was no need to consent. And there was no ethical considerations except maintaining people against ray during performing radiographic technics. Main limitation of the study was finding healthy single root premolar teeth which were extracted due to periodontal and orthodontia.

Results

Data were analyzed in three categories; general status (agreement between first and second observers), first observer and second observer.

General Status (Agreement between first and second observers)

In this study, it was clarified that canal length mean in general standard and in standard status is 20.91 ± 0.15 , in 1x enlargement of digital radiography is 21.06 ± 0.14 , in 2x enlargement of digital radiography is 21.022 ± 0.15 and in 1x enlargement of digital radiography is 21.027 ± 0.15 . Accuracy of 1x, 2x and 3x enlargements of indirect digital radiographies are 95.1%, 96.3% and 95.9% respectively. In statistical studies it was illustrated that there is no significant difference between three different enlargements of indirect digital radiography. [Table 1]

	Mean Square	Degree of Freedom	Mean Square	F	Significance
In Groups	0.694	3	0.231	0.168	0.918

Table 1: Accuracy of 1x, 2x, and 3x enlargements of indirect digital radiographies by ANOVA in general status

In studied carried out by ANOVA method and by (Tukey test (HSD)) it was illustrated that there is no significant difference between three different enlargements of indirect digital radiography ($p \geq 0.05$). [Table 2]

(I) Status	(J) Status	Mean Difference (I-J)	Standard Error	Sig.	Confidence Level 95%	
					Low Band	High Band
Standard	1x	-0.1433	0.2145	0.909	-0.698	0.412
	2x	-0.1050	0.2145	0.961	-0.660	0.450
	3x	-0.1100	0.2145	0.956	-0.665	0.445
1x	Standard	0.1433	0.2145	0.909	-0.412	0.698
	2x	0.0383	0.2145	0.998	-0.517	0.593
	3x	0.0333	0.2145	0.999	-0.522	0.588
2x	Standard	0.1050	0.2145	0.961	-0.450	0.660
	1x	-0.0383	0.2145	0.998	-0.593	0.517
	3x	-0.0050	0.2145	1.000	-0.560	0.550
3x	Standard	0.1100	0.2145	0.956	-0.445	0.665
	1x	-0.0333	0.2145	0.999	-0.588	0.522
	2x	0.0050	0.2145	1.000	-0.550	0.560

Table 2: Accuracy of 3 different enlargement of indirect digital radiography rather than each other and real size in general status.

First Observer

In this study, it was clarified that canal length mean in general standard is 20.91±0.22 in first observer, in 1x enlargement of digital radiography is 21.12±0.20, in 2x enlargement of digital radiography is 21.022±0.22 and in 3x enlargement of digital radiography is 21.04±0.22. Accuracy of 1x, 2x and 3x enlargements of indirect digital radiographies are 93.8%, 96.7% and 95.8% respectively. In statistical studies it was illustrated that there is no significant difference between three different enlargements of indirect digital radiography (p=0.927). [Table 3]

	Mean Square	Degree of Freedom	Mean Square	F	Significance
In Groups	0.672	3	0.224	0.154	0.927

Table 3: Accuracy of 1x, 2x and 3x enlargements of indirect digital radiographies by ANOVA in first observer.

In studied carried out by ANOVA method and by (Tukey test (HSD)) it was illustrated that there is no significant difference between three different enlargements of indirect digital radiography (p≥0.05). [Table 4]

(I) Status	(J) Status	Mean Difference (I-J)	Standard Error	Sig.	Confidence Level 95%	
					Low Band	High Band
Standard	1x	-0.2100	0.3114	0.907	-1.022	0.602
	2x	-0.1067	0.3114	0.986	-0.918	0.705
	3x	-0.1267	0.3114	0.977	-0.938	0.685
1x	Standard	0.2100	0.3114	0.907	-0.602	1.022
	2x	0.1033	0.3114	0.987	-0.708	0.915
	3x	0.0833	0.3114	0.993	-0.728	0.895
2x	Standard	0.1067	0.3114	0.986	-0.705	0.918
	1x	-0.1033	0.3114	0.987	-0.915	0.708
	3x	-0.0200	0.3114	1.000	-0.832	0.792
3x	Standard	0.1267	0.3114	0.977	-0.685	0.938
	1x	-0.0833	0.3114	0.993	-0.895	0.728
	2x	0.0200	0.3114	1.000	-0.792	0.832

Table 4: Accuracy of 3 different enlargement of indirect digital radiography rather than each other and real size in first observer.

Second Observer

In this study, it was clarified that canal length mean in general standard is 20.91±0.22 in second observer, in 1x enlargement of digital radiography is 20.99±0.20, in 2x enlargement of digital radiography is 21.02±0.20 and in 3x enlargement of digital radiography is 21.01±0.21. Accuracy of 1x, 2x and 3x enlargements of indirect digital radiographies are 96.7%, 96.1% and 96.2% respectively.

In statistical studies it was illustrated that there is no significant difference between three different enlargements of indirect digital radiography (p=0.986) [Table 5]

	Mean Square	Degree of Freedom	Mean Square	F	Significance
In Groups	0.198	3	0.066	0.049	0.986

Table 5: Accuracy of 1x, 2x and 3x enlargements of indirect digital radiographies by ANOVA in second observer

In studied carried out by ANOVA method and by (Tukey test (HSD)) it was illustrated that there is no significant difference between three different enlargements of indirect digital radiography (p≥0.05) [Table 6]

(I) Status	(J) Status	Mean Difference (I-J)	Standard Error	Sig.	Confidence Level 95%	
					Low Band	High Band
Standard	1x	-0.0767	0.3000	0.994	-0.859	0.705
	2x	-0.1033	0.3000	0.986	-0.885	0.679
	3x	-0.0933	0.3000	0.990	-0.875	0.689
1x	Standard	0.0767	0.3000	0.994	-0.705	0.859
	2x	-0.0267	0.3000	1.000	-0.809	0.755
	3x	-0.0167	0.3000	1.000	-0.799	0.765
2x	Standard	0.1033	0.3000	0.986	-0.679	0.885
	1x	0.0267	0.3000	1.000	-0.755	0.809
	3x	0.0100	0.3000	1.000	-0.772	0.792
3x	Standard	0.0933	0.3000	0.990	-0.689	0.875
	1x	0.0167	0.3000	1.000	-0.765	0.799
	2x	-0.0100	0.3000	1.000	-0.792	0.772

Table 6: Accuracy of 3 different enlargement of indirect digital radiography rather than each other and real size in second observer.

Discussion

According to advantages of digital radiography technic such as simplicity of providing images, it is attempted to improve quality of this machine by accessory software including a software with enlargement ability such as viewing box and microscope during root treatment and reading therapeutical stereotypes. This study aimed at assessing accuracy of digital radiography with different enlargements in determining root canal length function. Results indicated that there is no significant difference between three different enlargements however accuracy of 1x was lower than 2x and 3x.

Different studies are performed on canal length measurement by conventional radiography and digital radiography. Although there is no study on different enlargements as accurate as our study, they all studied and

compared capacities of digital radiographies and compare it with norma radiography and they all could not achieve results approving advantages of these capacities. Abbasi *et al* studies,⁹ Mohtavapour *et al*,²⁰ Mehdi-Zadeh *et al*,²¹ Mostafa *et al*,²² are studies similar to our field.

Lozan *et al*,²³ performed similar studies and did not find any difference in accuracy of canal length determination in conventional images taken by digital radiography. In addition in another study by Morais *et al* on diagnosis of periodontal lesion and bone defects and they found no difference in accuracy of digital radiography and enlarged images.²⁴

Results of the study is similar to Javidi *et al* article,¹⁵ and they concluded that there is no significant difference between different enlargements in determining working length. In our study although there is no significant difference, accuracy of measurement in 1x was lower than 2x and 3x enlargements, probably because larger sight shows apex position better and they are more easier to use and see the details. This result was not compatible with Javidi *et al*,¹⁵ article in which higher enlargement reduces measurement accuracy. Maybe it is due to our different method they used three different sizes (long-short-proper) which was different without method and all files places in conventional length in tooth.

Therefore, using enlargement capacity, although observer is more convenient, based on no significance difference, it is not valuable in analyzing working length.

Conclusion

Accuracy of 1x, 2x and 3x enlargements of indirect digital radiographies were 95.1%, 96.3% and 95.9% respectively.

Reference

1. Raghu KN, Daniel JG, Razvi S, Vinaychandra R, Kini A, Nandakishore KJ. In vivo evaluation of the accuracy of working length determination using an electronic apex locator IPEX (NSK) on vital uninfected teeth and teeth with radiographic evidence of periapical lesions. *J Int Soc Prev Community Dent* 2014;4(3):204-8.
2. Wang A, Monsoar PA, Moule AJ, Basford KE. A comparison of Kodak ultraspeed and Ektaspeed plus dental x-ray films for detection of dental caries. *Aust Dent J* 2002;47(1):27-29.
3. Razmus TF, Williamson GF. Current oral and maxillofacial imaging. 1st Ed Philadelphia:
4. Whites SC, Pharoah MJ. Oral radiology principle and interpretation. 4th Ed. St Louis: 2000. 223-227. W.C SANDERS. 1996; 6-184.
5. Ruddle CJ, Cohen S, Burns RC. Pathways of the pulp. 8th Ed. Philadelphia: St Louis; 2002.115-128.
6. Seltzer S: Endodontology. 2nd Ed. Philadelphia: Lea & Febiger;1998.149-156.
7. Wenzel A, Moystad A. Experience of Norwegian genereal dental practitioner with solid state and

- storage phosphor detectors. *Dentomaxillofac Radiol* 2001;30(4):203-8.
8. Gijbels F, de Meyer AM, Bou Serhal C, van Den Bossche C, declerck J, Persoons M, *et al*. The subjective image quality of direct digital and conventional panoramic radiography. *Clin Oral Investig* 2000;4(3):162-7
9. 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(2):229-33.
10. Nishikawa K, Ooguro T, Kuroyanagi K. Comparisons of physical imaging properties among three kinds of imaging plates used in photostimulable phosphor systems for dental radiography. *Bull Tokyo Dent Coll* 2002;43(1):23-30.
11. Bakland LK. Root Resorption. *Dent Clin North Am*. 1992;36(2):491-507.
12. Kqiku L, Städtler P. Radiographic versus electronic root canal working length determination. *Indian J Dent Res* 2011;22(6):777-80.
13. Orosco FA, Bernardineli N, Garcia RB, Bramante CM, Duarte MA, Moraes IG. In vivo accuracy of conventional and digital radiographic methods in confirming root canal working length determination by Root ZX. *J Appl Oral Sci* 2012;20(5):522-
14. Salemi F, Saati S, Falah-Kooshki S. A comparative study of the conventional and digital intraoral radiography methods for root canal length measurement. *Brazilian Dent Sci* 2014:34-9.
15. Javidi M, NejadNasrollah F, Esmaili E. A comparison of accuracy of determining the root canal working length by different magnifications of digital radiography. *Mashhad J Dent Univ* 2007;31:17-24.
16. Walton RE, Torabinejad M. Principles and practice of endodontics. 3rd ed. Philadelphia: W.B. Saunders Co; 2002, 156-172.
17. McDonald NJ. The electronic determination of working length. *Dent Clin North Am* 1992;36(2):293-307.
18. Zarabian M, Nekoofar MH, Marashi MS. A comparative investigation on the accuracy of Neosono Ultima EZ instrument, radiography and an experimental apex locator in root canal working length measurement. *Journal of Dentistry*. Tehran University of Medical Sciences (Vol. 16; No.4; 2004)
19. Griffiths BM. Comparison of three techniques for assessing endodontic working length. *Int Endod J* 1992;25(6):279.
20. 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(1):7-10.
21. Mahdizadeh M, Khademi AA, Nasr N. Canal length measurement by digital radiography and conventional

- parallel radiography. *Bio Sci J Res.* 2010;5(5):400-403.
22. Mustafa AS, Mustafa SS. Indirect digital radiography versus conventional radiography for estimation of root canal length. *MDJ* 2008;5(2):132-6.
 23. Lozano A, Forner L, Llena C. In vitro comparison of root canal measurements with conventional and digital radiology. *Int Endod J* 2002;35: 542.
 24. Morais JA, Sakakura CE, Loffredo LC, Scaf G. Accuracy of zoomed digital image in the detection of periodontal bone defect: In vitro study. *Dentomaxillofac Radiol* 2006;35(3):139-42.

Corresponding Author

Dr. Parisa Kazemi

Assistant Resident,
Department of Orthodontics,
Faculty of Dentistry,
Ahvaz Jundishapur University of Medical Sciences,
Ahvaz, IRAN.
Email Id: - parisa-kazemi69@yahoo.com