MDJ

Indirect Digital Radiography versus Conventional Radiography for Estimation of Root Canal Length

Dr. Ahmed S. Mustafa, B.D.S., M. Sc.*
Dr. Salah S. Mustafa, B.S.C., M.Sc., Ph.D.**

Abstract

The aim of this study was to evaluate the accuracy of Indirect Digital Radiography (IDR) for setting working length with the aid of new software additions program. The root canal length was measured using two estimation methods: conventional D-speed film radiograph, IDR using 2 clicks, 3 clicks, 4 clicks, and 6 clicks of measuring tools. Twenty seven extracted human lower molar teeth with different canal curvatures were examined. True canal length was measured using a millimeter rule. Non-significant differences were found in canal length estimation between IDR, conventional radiograph, and true canal length, also there was non-significant difference in measurement using 2, 3, 4, or 6 clicks.

Introduction

Nonsurgical root canal therapy relies on the establishment of an accurate and reproducible working length. The working length establishes the apical extent of the canal preparation and apical stop. Accuracy of this determined length is essential if damage to the root apices and periapical tissues during instrumentation and obturation procedures is to be avoided.(1)

In clinical practice the location of the end of the file in relation to the dental apex should be verified with the use of radiological, xero-radiographic, or digital image. Progress in computer technology has allowed the computer of digital system to measure the distance between two points selected on a digital image. In principal if the end of the file and the base of the rubber stop are chosen as reference points we will achieve an estimation of the working length that is free of human error. (2)

There are two sorts of receptors capable of registering and digitalizing a radiographic image: an intraoral sensor, which forms part of a digital radiographic system; this method called "Direct Digital Radiography"(DDR), and a video camera or similar light sensitive device that records and forms digital image form conventional radiograph; which is called "Indirect digital Radiography" (IDR)(3). however, phosphore plate systems are also called direct systems, because of the direct acquisition of the digital image, other authors call phosphor plate systems indirect systems because of the extra action that need to be done to scan the plate in the laser scanner, again others have found a compromise in the term "semi direct systems". (4)

*Assistant lecturer in department of conservative dentistry, college of dentistry, Al-Mustansiria University.
**Assistant Professor, College of Computer, Al-Anbar University.

To represent these images on a computer monitor, the intensity of each pixel must be quantified. The vale of a pixel corresponds to a level of gray on a graduated scale from white to black. [5]

The purpose of this study was to evaluate the accuracy of IDR for setting working length, and to evaluate weather increasing the number of clicks of the measurement tool enhances the accuracy of length estimation in curved canals over a straight-line two-click measurement, with the aid of new software additions program.

Materials and Methods

Forty-five extracted adult human lower posterior teeth with varying root curvatures were obtained. The mesiobuccal canals were considered only for the present study. Standard endodontic access opening was prepared in each tooth and the mesiobuccal cusp tip was selected as an occlusal reference point, which is flattened with a fissure bur.

Canal patency was verified with a size 10 k-file. A size 20 k-file with rubber stopper was inserted in the canal and advanced until the file tip was visualized at the foramen then pulled 0.5 mm. The rubber stop was set at the occlusal reference point, and the file was removed. True canal length (CL_{True}) was determined for each tooth using a millimeter Endodontic ruler. Measurement was read to the nearest 0.5mm the file was than returned to the canal and fixed in place with alight-cured composite resin. The teeth were then mounted in stone material, using a nice cube tray as abase mold, then the specimens were imaged using conventional radiographic technique. Conventional radiographs were obtained using D-speed film (Eastman Kodak Company, Rochester, NY). Atrophy model x-ray system at 70 KUCP and 8ma was used for exposures. The standard geometric configuration was fixed at 10-cm source-to-object distance, and the object close to the film. Zero degrees vertical and horizontal angulations of the x-ray beam.

We fix two points on each radiograph, then the radiographs scanned (Genus 48-bit superior color scanner) processed, and viewed on a conventional color monitor (cathode ray tube). Examiners were able to adjust the contrast, color and magnification that are not possible if the conventional x-rays are viewed directly. We enter the value of the distance between the fixed two points to the software program as a standardization of our measurements.

According to Schneinder technique[6], canal curvature was measured utilizing this software packages through determining four points, first point (A) at the coronal third of the file, second point (B) at straight line with the first point, third point (C) at a point were the file begin to curve, and the fourth point (D) at the apical foramen. The software will analyze this points into two lines (a line parallel to the long axis of the canal in the coronal third, and a second line from the apical foramen to intersect with the point where the first line left the long axis of the canal) and measure the intersection of these lines, two reading were taken for each measurement, and the average was obtained (Fig.1)

Collectively, canal curvature ranges from 1^0 to 44^0. Teeth were then divided into three groups according to their canal curvature as stated by Burger (1999);

- Group I slight (CL_{SLIGHT}) for curvatures $\leq 20^0$,

- Group II moderate ($CL_{MODERATE}$) for curvatures $>20^0$and $<36^0$,
- Group III severe (CL_{SEVERE}) for curvatures ≥ 36

Accordingly the teeth are distributed each in the fitting group. The measurement results revealed that in-group I there was 18 teeth, 15 teeth in-group II and 12 teeth in-group III. 9 teeth from each curvature grouping were randomly chosen to be included in the present study.

The film images were viewed on a view box in a darkened room. All film images were examined within 5min of processing to simulate clinical conditions. Tracing of the canals was made, a magnifying glass and an endodontic ruler were used to make the measurements. This allowed measurements with a precision of 0.5mm for conventional working length (WL_{CON}).

The estimated canal length was then measured as a distance from the occlusal reference point to the most apical extent of the file visualized to the 0.001 of a millimeter as IDR method using:

(A)Two clicks ($CL_{2\ click}$), one click at the reference point and the final click at the file tip.

(B) Three clicks ($CL_{3\ click}$), starting, ending, and one intermediate at the most curvature point.

(C) Four clicks ($CL_{4\ click}$), starting, ending, and two intermediate.

(D) Six clicks ($CL_{6\ click}$), starting, ending, and four intermediate (Fig 2).

Four readings were taken for each measurement then the average is obtained.

Results

The average measurement for each of the specimens compared with the true canal length according to T-test found there is no statistically significant difference (P=0.05). The average canal length is found in table 1.

Although there is non-significant difference in the measurement using different number of clicks, but measurements with 6 click method are the nearest one to the true length, and by comparing the average total canal length using 6 clicks and the conventional method with the true canal length, although its difference is non-significant but 6 click method is the nearest one to the gold measurement (Average CL_{True}), Fig. 3.

Discussion

The effect of radiographic magnification error must be taken into consideration whenever a radiographic technique is used to determine canal length. This software packages will allow the practitioner to calibrate the measurement tool before canal measurement, thus negating this magnification error.

IDR as DDR techniques do allow the clinician to adjust contrast, color, and magnification of the radiographic image to allow for optimal image evaluation.

The less variation will be seen with 6 clicks method as compared with methods utilizing other number of clicks from one side and with the conventional method from other side. Although it is non-significant but it is important to enhance the success of root canal treatment, this difference may be due to the precision of the measurement in increments 0.001 mm by using this system.

Amelia et al. (1997) in their study to evaluate the digital radiography to

estimate working length. As indirect methods, measurement will be taken from conventional x-ray with calipers and with a digital radiographical measurement system. No statistically significant differences were obtained between the direct and indirect methods.

Steven and Robert (2000) show in comparison of digital dental x-ray system with self-developing film and manual processing for endodontic file length determination, that the measurement error was significantly less for the digital images than for the film based images.

Carrie Burger et al. (1999) Will estimate canal length in curved canals using direct digital radiography versus conventional radiography. It was found that use of multiple measurement points did not result in significantly more accurate measurements of estimated canal length than use of only a starting and ending point regardless of canal curvature.

In this study, with the using of this software additions program, it was found that, there was no significant difference between canal length estimation using IDR and conventional radiographic techniques; and increasing the numbers of clicks will enhance the accuracy of the estimated canal length over a straight-line two-click measurement but it is not significant.

References

1- Ingle JI, Bakland LK, Peters DL, Buchanan SL, Mullaney TP; Endodontics. 4th ed. Baltimore: Williams & Wilkins, 1994: 191-4.
2- Amelia A.G, Leopoldo F.N, Vicente U.C, & Rafael M.L. Evaluation of digital radiography to estimate working length. J Endodon 1997; 23: 363-5.
3- Thomas F. & Gail F.; Current oral & maxillofacial imaging. Williamson, 1st ed. 1996: 6-9.
4- Erwin Berkhout. Implementation of digital dental radiography, user aspect, radiation dose and diagnostic effects. Ph.D thesis. Department of oral radiology. Academic Center for Dentistry in Amsterdam; 2007:20-21.
5- Benz C, Mouyen F. Radiovisiographie system for film free intraoral radiographs, Dtsch Zahnarzt IZ 1989; 44:177-179.
6- Philip J. Hankins, & Mahmoud E. ElDeeb. An evaluation of the canal master, balanced-force, and step-back techniques. Journal of Endodontics 1996; Vol.22, No.3.
7- Steven E. & Robert V. Comparison of digital dental x-ray systems with self-developing film and manual processing for endodontic file length determination. J Endodon 2000; 26: 65-67.
8- Carrie Burger et al., Direct digital radiography versus conventional radiography for estimation of canal length in curved canals. J Endodon 1999;25:260-263.

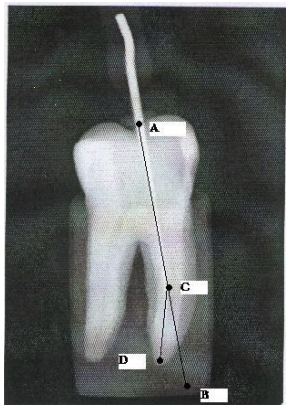
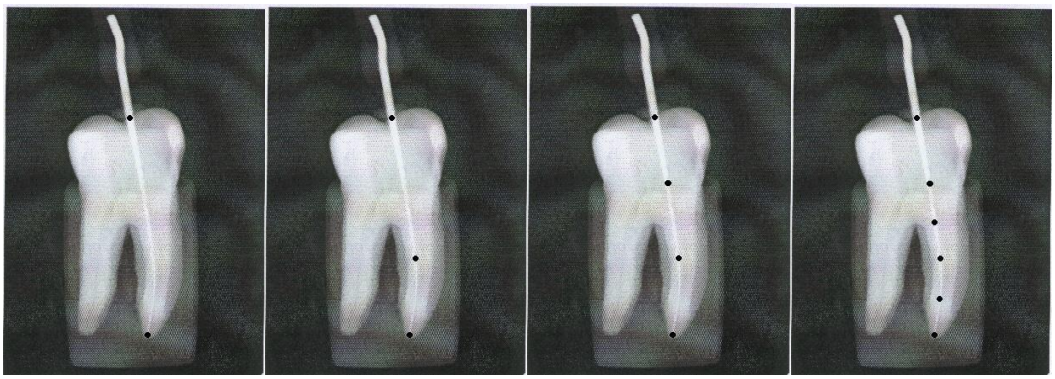


Fig 1. Canal curvature measurement



(A) (B) (C) (D)

Fig 2. IDR using (A), 2 clicks. (B), 3 clicks. (C), 4 clicks. (D), 6 clicks.

Table 1. Average canal length

	CL True	CL 2 click	CL 3 click	CL 4 click	CL 6 click	CL conv.
Average CL SLIGHT	20.5	20.19411	20.29789	20.29456	20.31678	20.66667
Average CL MODERATE	21.33333	21.03044	21.50156	21.47078	21.45711	20.94444
Average CL SEVERE	19.22222	17.71067	18.63044	18.78489	18.88433	18.44444
Average CL TOTAL	20.35185	19.64507	20.1433	20.18341	20.21941	20.01852

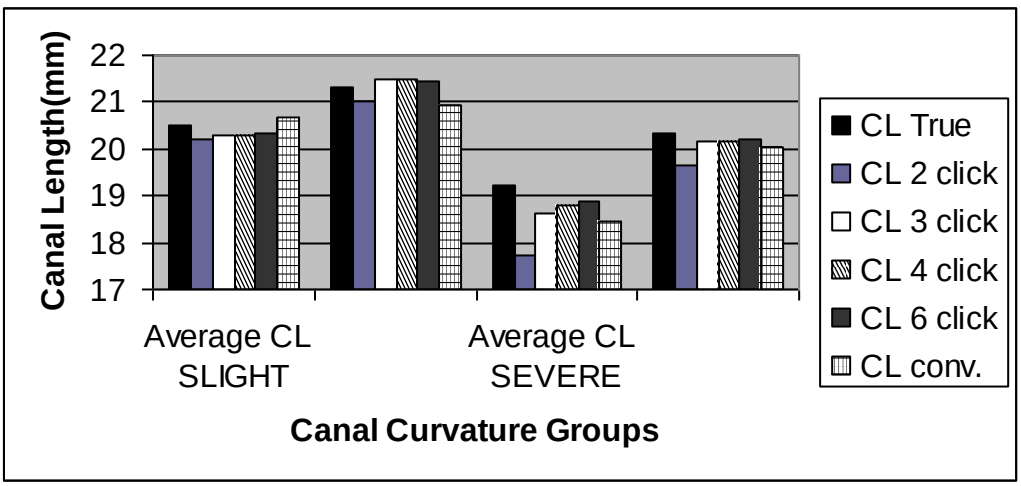


Fig 3. True canal length compared with estimated values. There are no significant differences among radiographic measurements.