Accuracy of an Intraoral Digital System for File Length Measurement

Original Article

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Received: Sep 30, 2015
Accepted: Dec 30, 2015

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Abstract

Introdouction:
Canal length measurement is essential for proper endodontic treatment. Any error or miscalculation in working length determination, particularly in curved canals, can result in complications during or after root canal therapy. Digital radiography has enabled accurate measurement of curved canal length. In this study, we evaluated the accuracy of calibration of a complementary metal oxide semiconductor (CMOS) digital system for file length measurement

Materials and methods:
In this in vitro study, 45extracted molar teeth were divided into three groups of 15 with respect to the angle and radius of canal curvature. A 5-mm piece of orthodontic wire was placed on the lateral surface of the roots. Digital radiographs were taken after insertion of the endodontic file by the CMOS digital system. Two observers measured the file length with and without using the calibration tool of digital measurement software. The correlation between observers was evaluated and data were analyzed using the paired t-test with 95% confidence interval.

Results:
The overall agreement between the observers was satisfactory. There was no significant difference between the mean values of calibrated measurement and true file length with respect to canal curvature ($P>0.05$). However, there was a significant difference between the mean values of uncalibrated measurement and true file length with respect to canal curvature ($P<0.05$).

Conclusion:
The calibrated measurement of file length was more accurate than the uncalibrated file length measurement.

Key words:
•Digital Dental Radiography •Root Canal Therapy •Calibration.

Introduction

Correct determination of working length is an important step in achieving clinical excellence in endodontics.[1]

Traditionally, endodontic file length is measured on conventional radiographs.[2] The most important limitation of conventional radiography is its lack of precision in measurement of the length of curved canals; this inaccuracy increases with increased curvature of the canal.[2,3] However, with recent advances in digital radiography, a suitable alternative to conventional radiography is now available.[4] In addition to several advantages of digital radiography, it enables accurate distance measurement. Numerous studies have evaluated direct measurement tools of digital software programs for the determination of the working length of root canals.[2,3,5-11] However, they did not evaluate the accuracy of the calibration feature of the measuring tool. Loushin et al.[4] found that calibrated measurements were more accurate than uncalibrated file length measurements. In their study, teeth with single roots and relatively straight canal systems were selected.

The aim of this study was to assess the accuracy of calibration for the measurementof working length in curved canals.

Materials and Methods

A total of 80 extracted mandibular first molars with various degrees of mesial root curvature were collected.There was no caries or root resorption in the mesial roots.Radiographs were taken from the teeth, and tracings were made on the projected images of mesiobuccal canals. The curvature radius was defined as the length of the line connecting the beginning point of the curve and the end point of the canal. The curvature angle was determined using Schneider's method.[12] Finally,45 teeth were selected and divided into three groups of slightly curved (group I) for curves ranging from 0° to 15° and curvature radius of 11.76–18.42 mm, moderately curved (groupII) for curves ranging from 15° to 30° and radius of 7.29–10.13 mm, and severely curved (group III) for curves greater than 30° and curvature radius of 7.03–4.66 mm.[3]

The crowns of the teeth were cut using a bur with a high-speed handpiece at the level of the cemento-enamel junction. A 5-mm piece of orthodontic wire was placed and secured by sticky wax vertically on the lateral surface of the coronal third of the mesial roots to avoid superimposition over the projected file. The wire was used for calibration control. A small occlusal reference point was marked on each tooth with a 557 bur. A #15 K-file (Mani , Japan) with a rubber stopper was introduced into the mesiobuccal canal and advanced until the file tip was visible at the apical foramen. At this moment, the stopper was adjusted to the occlusal reference point, the file was removed, and a millimeter ruler was used to measure the file length. One mm was subtracted from the measured value to obtain the actual working length. The file was then introduced into the canal and fixed in place with a self-cure composite resin. An apparatus was made to allow for a constant spatial relationship between the x-ray source, the teeth, and the receptor. The distance from the source to the sensor was 40 cm. A 0.5-cm thick glass plate was used to simulate x-ray absorption and scatter properties of the soft tissue cheek. The specimens were radiographed using complementary metal oxide semiconductor (CMOS) sensor (Schick, Long Island, NY, USA). The teeth were exposed to x-rays generated by Soredex X-ray unit (Minray, Helsinki, Finland) at 65 kVp and 6mA. The estimated canal length was then measured by a maxillofacial radiologist and an endodontist with more than 7 years of professional work experience. They used the distance measurement tool of CMOS digital sensor. Two separate measurements were made on each digital image. The first measurement was estimation of canal length with two clicks for the slightly curved group (first click at the occlusal reference point and a second click at the file tip) and three clicks for moderately curved and severely curved groups (first click at the occlusal reference point,second click at the tip of the angle, and third click at the file tip).

The second measurement was similar as above, except that the image was first calibrated to the known length(5mm)of the orthodontic wire using the calibration tool of the measurement program. This tool enables the measurement of pixel numbers for the known length, after which the measurements will be calibrated using the ratio of the actual length to the radiographed length.The correlation between the observ-

ers was evaluated by Pearson's correlation test (Table 1). All the measurements were then compared with the actual file length with respect to the root curvatures. The paired t-test with 95% CI was used to analyze the results.

Results

No significant difference was found between the observers (Table1).No statistically significant differences were noted between the calibrated measurements and the true file length (P>0.05), but there were significant differences between the uncalibrated measurements and true file length (P<0.05).

Table1. Correlation between observers in measurement of file length with and without using the calibration tool

		Tooth group		
		I	II	III
Correlation between observers%	Calibrated	99	99	99
	Uncalibrated	98	98	99

Significant differences were also detected between calibrated and uncalibrated measurements (P=0.0001) (Table2).

Table2. Comparison of measurements with actual values

Tooth group	Actual	Observers	Calibrated	P-value	Uncalibrated	P-value
I	13.15±1.67	1	13.57±1.70	0.14	14.20±1/12	0.0001
		2	13.63±1.67	0.16	14.32±1.77	0.0001
II	15.16±1.55	1	15.55±1.56	0.21	15.95±1.80	0.0001
		2	15.53±1.49	0.23	16.12±1.16	0.0001
III	15.36±1.36	1	15.40±1.53	0.17	16.12±1.16	0.0001
		2	15.44±1.52	0.12	16.20±1.11	0.0001

Discussion

Radiography is essential for a successful endodontic treatmentand plays an important role in achieving accurate and reproducible measurements.Digital radiography provides rapid image acquisition, eliminates the image processing steps, and allows for the manipulation of image quality via digital enhancement software programs.[3,6] Thus, digital radiography has become increasingly popular in endodontics[6], enabling accurate measurement of the length of curved canals.[3] The distance measurement function in the Schick computed dental radiography software package allows for calibration of measurements.This feature determines the number of pixels for the known length and then uses this ratio to calculate the measured on-screen file length. Our results indicated that the calibrated measurements were statistically more accurate than the uncalibrated measurements. This finding was consistent with the results of Lushine et al.[4] However, in their study, the curvature of canals was not considered and only teeth with relatively straight canal systems were selected. On the other hand,in our study, the accuracy of file measurement was evaluated with respect to canal curvature,and all measurements were longer than actual file lengths. This result is also similar to that of Lushine et al.[4] The distance measurement function in the Schick CDR software package allows for straight line and multiple-line measurements.In our study, straight line measurement was used for slight curves and multiple line measurement was applied for medium and severe curves. Lushine et al.[4] and burger et al.[9] compared the two methods and showed that there were no significant differences between the two measurement methods.

Conclusion

The authors are thankful to the staff of Oral and Maxillofacial Radiology Department of Guilan Dental School.

References

1.Radel RT, Goodell GG, McClanahan SB, Cohen ME. In-vitro radiographic determination of distances from working length files to root ends comparing Kodak RVG 6000, Schick CDR, and Kodak insight film. J Endod 2006; 32(6): 566-568.

2.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(1): 88-91.

3.Goodarzi Pour D, Razmi H, JabedarMaralani S, Zeighami S. Newsoftware: comparison between three software programs for root canal length measurement. Dentomaxillofac Radiol 2008; 37(4): 228-231.

4.Loushine RJ, Weller RN, Kimbrough F, Potter BJ. Measurement of endodontic file length: calibrated versus uncalibrated digital images. J Endod2001;27(12): 779-781.

5.Avinash M, Kamath PM. Canal length estimation in curved root canals:a comparison between conventional and direct digital radiography. Endodontology 2002; 14, 52-60.

6.Brito-Ju'nior M, Santos LA, Baleeiro EN, et al. Linear measurements to determine working length of curved canals with fine files: conventional versus digital radiography. J Oral Science 2009; 51(4): 559-564.

7.Cederberg RA, Tidwell E, Frederiksen 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(3): 325-328.

8.Lamus F, Katz JO, Glaros AG. Evaluation of a digital measurement tool to estimate working length in endodontics. J Contemp Dent Pract2001; 2(1):24-30.

9.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(4): 260-263.

10.Woolhiser GA, Brand JW, Hoen MM, et al. Accuracy of film-based, digital, and enhanced digital images for endodontic length determination. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005; 99(4): 499-504.

11.Krajczár K, Marada G, Gyulai G, Tóth V. Comparison of radiographic and electronical working length determination on palatal and mesio-buccal root canals of extracted upper molars. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008; 106(2): e90-e93.

12.Schneider SW. A comparison of canal preparations in straight and curved root canals. Oral Surg Oral Med Oral Pathol 1971; 32(2): 271-275.