Comparison of accuracy of digital and conventional radiographies in determining endodontic working length.

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ABSTRACT

Introduction: Determination of the length of the root canal is a critical step in endodontic therapy. Recently, digital radiography has been introduced for this purpose because it may have advantages over conventional radiographic methods. This study aimed to compare the accuracy of digital and conventional radiographic techniques in the determination of the endodontic working length (WL)

Materials and methods: Sixty single-rooted premolar human teeth were selected for this study. The teeth were randomly divided into two groups. The WL determination in groups 1 and 2 was carried out using, respectively, digital and conventional radiographic techniques. The procedure was performed by a single operator on two separate occasions, two weeks apart.

Results: The differences in WL measured at the two intra observer intervals was statistically significant neither in digital nor in conventional radiography method (P>0.05). The analysis of the data using a X2 test revealed that there were no significant differences in WL measurements between digital and conventional radiographic methods at any interval (P>0.05).

Conclusion: Based on the findings of this study, it may be assumed that the digital and conventional radiographic techniques have similar accuracies in the determination of WL.

Keywords: conventional radiography, digital radiography, endodontic working length.

INTRODUCTION

A successful root canal treatment depends on finding all root canals and subsequently on a highly efficient removal of both non pathologic and pathologic bacteria. To achieve this goal, it is necessary to accurately determine the endodontic working length, a measurement also required for the next phase of treatment. Infection in the canal or periapical irritation would otherwise occur due to the improper length of the completed root canal filling.[1] Accurate determination of working length (WL) prevents under-instrumentation and failure to remove infected tissues and microorganisms in the apical region, or over-instrumentation which could cause patient discomfort, damage to periapical tissue, or potentially cause an infection or cyst development from the placement of toxic materials beyond the apex.[2] Traditionally, the technique of choice for determining WL has been using conventional radiography. However, that technique offered some challenges, including superimposition of anatomical structures (mostly the location of the apical foramen in relationship with the apex), and the time required for processing of the film.[3] Due to advancing developments in science and modern technology, digital radiographic systems use a sensor instead of conventional radiographic film on which images are recorded. The advantages of the digital x-ray technique in comparison with the conventional technique include: faster images, the use of a low radiation dose, and a high capacity in demonstrating the details.[4,5] This study aimed to evaluate and compare the accuracies of digital and conventional radiographies in endodontic WL determination.

ACRONYM

WL: working length

MATERIALS AND METHODS

Sixty single-rooted premolar human teeth were selected for this study (α = 0.05, power = 80%).6 Teeth with apical root resorption and with apical foramina situated laterally to the longitudinal axis of the root were excluded. For disinfection, the freshly extracted teeth were stored in sodium hypochlorite) 2.5%) for 10 min (NACLO). Firstly, radiographs were taken to confirm patency of the canals and cavity preparation was done on all teeth. The working length was determined for each specimen. A number 15

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K-file (DentsplyMaillefer, Ballaigues, Switzerland) with a silicon stop was inserted into the root canal of premolars (without utilizing any lubrication) until the tip of the file was observable at the apical anatomical apex. The distance from the tip of the file to the silicon stop, adjusted so that it just touched the top of the buccal cusps of the tooth, was measured using an endodontic ruler. Finally, one mm was subtracted from the measured distance. To create laboratory conditions similar to the oral cavity, the teeth were inserted in an acrylic replica, and each tooth was then mounted in acrylic resin. The teeth were randomly divided into two groups of 30 teeth each. Conventional radiographic images were captured in Group 1 by F Speed (AgfaDentus M2) and Philips (Philips,US) systems with exposure settings of 0.08 Sec (60kVp and 7mA) used in the paralleling technique. In the digital group (Group 2), radiographic images were captured with a charge-coupled device sensor (Kodak, NY, Japan) and the images were observed using Kodak software (Kodak, NY, Japan). The procedures were performed by a single operator, repeated after a two-week interval, to increase the accuracy of the study. The investigator observed the images on a viewing box in a procedure room and in each case determined the distance between the radiographic apex and the image of the file tip. The results were analyzed using the chi-square test (X2) and McNemar's test by SPSS 16.0 (P< 0.05).

Table 1: Comparison of endodontic WL calculated with conventional and digital radiographic images

	Conventional radiography (n= 30)		Digital radiography (n=30)	
	Two weeks later	Baseline	Two weeks later	Baseline
Correct WL	24(80%)	24(80%)	24(80%)	22(73.3%)
D* > 1mm	2(6.7%)	2(6.7%)	4(13.3%)	4(13.3%)
D < 1mm	4(13.3%)	4(13.3%)	2(6.7%)	4(13.3%)

*D: distance between tip of the file and the radiographic apex

RESULTS

The endodontic WL's determined by measurements on the conventional and digital radiographic images are indicated in Table 1. Correct lengths were determined in 22 teeth (73% of Group One) by the conventional radiography method at the first set of measurements and in 24 teeth (80% of Group One)) when the measurements were repeated two weeks later. The Group in which digital radiography had been used showed a slightly increased accuracy with 24 of the Group (80%) recording correct lengths. In both Groups a small number of teeth recorded lengths which were either less than or more than one mm in error. According to the McNemar's test, there were no significant differences between the original recorded WL measurements and those repeated two weeks later by either technique (P>0.05). Further, the analysis of the Chi squared (X2) test revealed that the differences between conventional and digital radiographic techniques in WL determination were not statistically significant at either time period (χ^2= 0.75, P= 0.68, χ^2=1.33, P= 0.51, respectively).

DISCUSSION

Accurate WL is a most relevant factor to consider for effective endodontic treatment. Several studies have confirmed the importance of precise WL on the prognosis of endodontic treatments. Apical constriction is the tightest place of the root canal as is obvious on the images that are used for determination of WL. A study by Green demonstrated that the distance between apical constriction and external foramen is 0.5 to 1 mm.[7] In that study, the accuracy of WL determination by digital and conventional radiography were evaluated and compared. The authors found that the differences between two methods were not statistically significant and further that the operator could not affect the result of WL determination.

Diwanji *et al*. evaluated the diagnostic efficacy of various methods to determine WL of the root canals and concluded that the use of the apex locator was more reliable and precise than the digital radiography.[8]

In another study, Ehsan correlated the measurements of radiographic and electronic methods of WL determination with the directly observed visual lengths of root canals and evaluated the data. The Root ZX*apex (J.Morita, USA) apex locator was utilized to determine the root canal length. This instrument could calculate the length to within 0.5 mm of the apical constriction at 94.1% accuracy in comparison with the 50.4% accuracy possible when using digital radiographs.[9] Similar findings were obtained by Singh *et al*. validating the opinion that the electronic method for measuring the WL of root canals was more accurate compared with the conventional radiographic technique.[10] Jeger *et al*. in a prospective, controlled clinical study concluded that partial cone-beam computed tomography (CBCT) scans can be utilized for endodontic WL measurements.[11] The determination of WL was carried out in several other studies, several completing comparisons.[12-25] However, the application of the digital radiography technique was preferred as it reduced the duration of endodontic procedures through decreasing the film-processing phase. The computer system provided the zoom function which enhanced the diagnostic process by enlarging regions like the apical zone. A further benefit of digital radiography is the 22% reduction of radiation dose to patients compared with the use of f speed film and the 77% reduction of dose compared with the use of D speed film.[26]

CONCLUSION

Based on the findings of this study, the accuracy of digital and conventional radiography techniques were similar in determination of WL. Digital radiography confers advantages for patients and dentist compared with conventional radiography, and it is proposed as a more effective method for the endodontic WL determination.

Conflict of Interest: None declared.

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