Research Journal of Biological Sciences 5 (5): 400-403, 2010
ISSN: 1815-8846

Canal Length Measurement by Digital Radiography and Conventional Parallel Radiography

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Abstract: Radiographic techniques play a significant role in dentistry. Despite their developments, radiographic films have some problems in determining the root canal length. In recent years, digital radiography system has changed the dental radiology. The aim of this research was to compare the canal length of teeth by two techniques including digital parallel radiography and conventional parallel radiography. Sixty five single rooted human teeth were included in this study. The canal length was first determined *in vitro* by visual manner (clinical examination). Then, the measurements were carried out by digital parallel radiography and conventional parallel radiography technique. The means of calculated lengths were compared with ANOVA and Duncan's tests. The results showed that the mean canal length in conventional parallel radiographyl and digital parallel radiography methods and real length are 22.1462, 21.6031 and 22.1997, respectively. According to ANOVA test, there was a significant difference in canal length between three groups. Duncan test showed a significant difference between the real length and conventional parallel radiography as well as between the real length and digital parallel radiography ($p<0.05$) but there was no significant difference between conventional parallel radiography and digital parallel radiography ($p>0.05$). According to the results of this study, there is no difference between the two techniques. The accuracy of both techniques appeared to be the same and the measured tooth length with both methods were different to the real length. However because of advantages of digital parallel radiography, it is much more preferred to other systems.

Key words: Digital radiography, canal length, measurement, root canal, dentistry, Iran

INTRODUCTION

Radiographic techniques have a variety of applications in dentistry and play an important role in canal length measurement which is very important factor in endodontic treatment. The canal length is measured from the radiographic apex to a reference point on the crown (Walton, 1973). Studies of periapical healing after endodontic treatment have shown the importance of confining endodontic instrumentation and obturation within the root canal (Walton, 1973; Torabinejad *et al*., 1989).

Traditionally, endodontic file length adjustments have been measured with the use of conventional radiography techniques (Torabinejad *et al*., 1989; Swartz *et al*., 1983) which has the following advantage: imaging very small files within the canal (Val Cox *et al*., 1991).

A recently approved direct digital imaging system is Radiovisiography (RVG) (Horner *et al*., 1990; Moyen *et al*., 1969).

The digital radiography (RVG) unit consists of a conventional x-ray generator to expose a sensor with scintillation screen adjacent to a fiber optic bundle, there is a device called a charged coupled device. RVG has been reported to overcome some of disadvantages associated with conventional radiography (Voorde and Bjorndahi, 1969; White and Pharaoh, 2004).

The application of computer technology to radiography has allowed image acquisition (Teleradiography) to remote sites in a digital format. Potentially, one of the greatest advantages of digital imaging over film radiography is the possibility of image recording and display functions.

Digital techniques produce a dynamic rather than static image in which the visual characteristics of density and contrast can be manipulated after acquisition to meet specific diagnosis tasks or to correct errors in exposure techniques (Voorde and Bjorndahi, 1969; White and Pharaoh, 2004).

The capability of post acquisition manipulation provides the clinician with the possibility of obtaining more information from the images and would reduce the number of images needed to retake because of overexposure and underexposure (White and Pharaoh, 2004). The use of digital technology also results in a 50-95% reduction in patient's dose. Because of greater

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sensitivity to digital receptor, elimination of wet process and the need for dark room considerably reduces the time laps between image acquisition and display (Horner *et al*., 1990). Horner *et al.* (1990) used the RVG for canal length measurement.

They concluded that using digital radiography (RVG) would be useful to reduce the dose but there was not any significant difference between conventional radiography and digital radiography (RVG) in measuring the canal length (Shearer *et al*., 1991).

The purpose of this *in vitro* investigation was to determine whether accurate endodontic file length adjustment could be achieved using digital parallel images as compared with conventional parallel radiography.

MATERIALS AND METHODS

Sixty five extracted one rooted (mandibular canine and incisors) human teeth from clinics and dental offices were prepared. The teeth with severe curve, calcification, external resorption and internal resorption were excluded. They were disinfected by cetrimide C (Darou Pakhsh. Pharmaceutical Mfg. co. Iran). Also, they were disinfected by diluted sodium hypochlorite. Cavity and access were prepared and file number 15 (k file maillefer, dentsply, Switzerland) was put in the canal. The teeth were mounted on a human dried mandible. In a pilot study, 5 radiographs were taken to determine the best exposure time. We had seen the file at apex and then the reference point had designed on the crown.

The teeth with file put on the socket of dry mandible and then imaged. We prepared a place with wax for putting film and sensor in lingual side of mandible. One operator took the radiographs. Trophy radiographic unit (Trophy. Radiographic Inc. Vincennes, France), 70 kvp/08 s, 10 mA technique. Films were processed by Velopex processor and Champion processing solution (x-ray company, England).

On each radiograph, the canal length was measured by grid on film. We used a wire as grid on film and by this way we knew the magnification rate so we measured more accurate. The real file length was also measured.

In canal length measurement by digital parallel radiography, the techniques were similar to that of conventional parallel radiography, the only difference was using a sensor (Schick Technologies, Long Island, NY) instead of film.

Femet (Sorodex, Finland) digital radiography and plan Mecca x-ray unit (Planmecca, Finland), 60 kvp, 10 mA with wire sensor was used. For digital unit calibration, a 20 mm metal wire was used (five images were prepared for pilot study. Best time of exposure agreed 0.02 sec for digital parallel radiography. The canal length was determined on digitally produced image by computer from the apex to the reference point by radiologist and endodontist.

No adjustment of contrast and brightness was performed by rates. Statistical analyses consisted ANOVA and Duncan test carried out by SPSS computer software (SPSS Inc, Chicago, IL).

Differences between areas under curves were assessed using repeated measures analysis of variance (ANOVA). Pearson's correlation coefficient was used to measure interpreter reliability and Kendall's coefficient of concordance was used to measure interpreter reliability.

RESULTS AND DISCUSSION

Table 1 showed the canal length measured by three methods. According to ANOVA test there was a significant difference in canal length between three groups. Duncan test showed a significant difference between the real length and Conventional Parallel Radiography (CPR) as well as between the Real Length (RL) and Digital Parallel Radiography (DPR) ($p<0.05$) but there was no significant difference between conventional parallel radiography and digital parallel radiography ($p>0.05$). Radiography is an important stage in endodontic treatments and so is the canal length measurement. A good image can help for better treatment (Torabinejad *et al*., 1989).

In this study, a good accuracy was achieved by using digital parallel radiography while we had other advantages such as the reduction in dose, faster processing, information saving and no need for wet processing (White and Pharaoh, 2004). Shearer *et al.* (1991) used digital parallel radiography for the measurement of canal length. They concluded that there was no significant difference between conventional radiography and digital radiography. But using digital radiography in endodontic was very useful.

Lamus *et al.* (2001) carried out the same study as the investigation. He concluded that digital radiography had more accuracy than conventional radiography and there was an agreement between observers in canal length measurement.

Lanzano *et al.* (2002) compared digital radiography and conventional radiography for *in vitro* measurement of the canal length. He used file number 8, 10 and 15. He concluded that apex was better observed in conventional radiography. So conventional radiography was reported to be the first choice for file number 15. The accuracy of two systems was the same. Ledy *et al.* (1994) chose the first and second mandibular molar and compared the two

Table 1: Comparison of canal length measured by three methods

Modality	Mean±SD
DPR*	22.1997±2.4133
CPR**	22.1462±2.4169
RL***	21.6031±2.3074

*DPR: Digital Parallel Radiography; **CPR: Conventional Parallel Radiography; ***Real Lentgh

imaging systems. There was no significant difference between two systems. Moyen *et al.* (1969) concluded that digital radiography was useful in diagnosis of periapical lesions. Digital radiography is useful for showing lesions because both contrast and density can be modified (Stavropoulos and Wenzel, 2006; Wenzol *et al.*, 2002).

We concluded that there is no significant difference between digital radiography and conventional parallel radiography and there is an agreement between us and some others (Shearer *et al.*, 1991; Lanzano *et al.*, 2002; Stavropoulos and Wenzel, 2006; Gundappa *et al.*, 2006; Ledy *et al.*, 1994). But digital radiography is a more rapid imaging system that can produce clinically acceptable periapical images at lower radiation dose than conventional parallel radiography (Lamus *et al.*, 2001).

Measurement of working length especially in curved canals is a great importance in endodontic treatments. In this field, there have been extensive studies and numerous methods investigated in both the anatomy of apical area to determine the measurement of working length of the canal in endodontic treatment (Subramanian *et al.*, 2005; Pour *et al.*, 2008). Moreover, there have been various studies to compare the results of conventional parallel radiography and digital methods of radiography in dental radiology.

It is believed that digital parallel radiography would result in a significant development in measurement of working length in dental radiography (Subramanian *et al.*, 2005; Pour *et al.*, 2008).

CONCLUSION

According to the results of this study, the accuracy of both techniques appeared to be the same and the measured tooth length with both methods was different to the real length.

However because of advantages of digital parallel radiography, it is much more preferred to other systems. Further studies of the modified and new systems because of rapid technological improvement are needed.

ACKNOWLEDGEMENTS

We are grateful to Department of Oral Radiology and Department of Endodontics of Isfahan Dental School, Iran. This research was supported by Isfahan University of Medical Sciences (grant#82227).

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