

Effects of Different Viewing Conditions on Radiographic Interpretation

Mahkameh Moshfeghi¹, Majid Shahbazian^{2*}, Soodabeh Sadat Sajadi³, Sepideh Sajadi⁴, Hossein Ansari⁵

¹Assistant Professor, Department of Oral and Maxillofacial Radiology, Dental School, Shahid Beheshti University of Medical Sciences, Tehran, Iran

²Dentist, Private Practice, Dental School, Shahid Beheshti University of Medical Sciences, Tehran, Iran

³Assistant Professor, Department of Orthodontics, Dental School, Arak University of Medical Sciences, Arak, Iran

⁴Assistant Professor, Department of Endodontics, Dental School, Arak University of Medical Sciences, Arak, Iran

⁵Assistant Professor, Health Promotion Research Center, Zahedan University of Medical Sciences, Zahedan, Iran

Abstract

Objectives: Optimum viewing conditions facilitate identification of radiographic details and decrease the need for retakes, patients' costs and radiation dose. This study sought to evaluate the effects of different viewing conditions on radiographic interpretation.

Materials and Methods: This diagnostic study was performed by evaluating radiograph of a 7mm-thick aluminum block, in which 10 holes with 2mm diameters were randomly drilled with depths ranging from 0.05 mm to 0.50mm. The radiograph was viewed by four oral radiologists independently under four viewing conditions, including a white light viewing light box in a lit room, yellow light viewing light box in a lit room, white light viewing light box in a dark room and yellow light viewing light box in a dark room. Number of circular shadows observed on the film was recorded. The data were analyzed by two-way ANOVA.

Results: The mean number of detected circular shadows was 6.75, 7.5, 7.25 and 7.75 in white light viewing light box in a lit room, white light viewing light box in a dark room, yellow light viewing light box in a lit room and yellow light viewing light box in a dark room, respectively. Although the surrounding illumination had statistically significant effect on the radiographic details ($P \leq 0.03$), the light color of the viewing light box had no significant effect on visibility of the radiographic details.

Conclusion: White and yellow light of the viewing light box had no significant effect on visibility of the radiographic details but more information was obtained in a dark room.

Keywords: Lighting; Radiography, Dental; Radiographic Image Interpretation

Journal of Dentistry, Tehran University of Medical Sciences, Tehran, Iran (2015; Vol. 12, No. 11)

* Corresponding author:
M. Shahbazian, Dental School,
Shahid Beheshti University of
Medical Sciences, Tehran, Iran

majidshahbazian122@gmail.com

Received: 26 June 2015

Accepted: 4 September 2015

INTRODUCTION

Radiography plays an important role in diagnosis of dental pathosis [1] and it is necessary for clinical and diagnostic assessments in dentistry [2]. Over 400 million radiographs per year are taken by dentists in the

Unites States [2]. Although the dosage of the X ray per exposure is low, the accumulative dosage may rise due to taking multiple shots [3]. Thus, the international committee for radiographic protection recommends that the received dosage and the number of individuals

exposed to the beams should be kept as low as possible [4].

Quality assurance techniques are among the most effective ways to reduce the exposure dose. These techniques focus on viewing conditions and interpretation of radiographs to achieve more diagnostic information [5]. It seems that optimum viewing condition of radiographs would facilitate finding minor changes and differences in the density of anatomical structures [6].

Viewing conditions and the way they affect radiographic details are still controversial topics [7-10].

Several reports have emphasized the value of using a viewing light box, magnification and masking of extraneous light when interpreting intraoral radiographs [1]. Limited information is available about the effect of viewing conditions on the accuracy of diagnosis of periapical lesions on intraoral radiographs [1]. Use of low ambient light and restricting light from the surroundings of the viewing light box significantly improve performance. In general, the less the amount of extraneous light, the higher the detection rate of details [11]. Important abnormalities on radiographs may go undetected when a light box is not used [12]. A viewing light box in a lit room provides optimal viewing condition for radiographic interpretation [4].

The use of enhancement accessories can have a more important, positive effect as well, especially when one is using a magnifying glass or an X-viewer [9].

Although the viewing light is effective for radiographic interpretation, not much attention is paid to mask ambient light in clinical practice, which would result in loss of some diagnostic information [4]. It is recommended to view radiographs in a semi-dark room by eliminating extraneous illumination and light passing only through the radiographs [13].

The present study was conducted to evaluate the effect of ambient light and the viewing box light on radiographic interpretation.

MATERIALS AND METHODS

This study was performed to determine the optimal radiographic viewing conditions. A 7mm thick rectangular block of aluminum was used in which, 10 holes of 2mm diameter were randomly drilled. The depth of the shallowest hole was 0.05mm, with 0.05mm increments in depth of the next ones; the deepest hole was 0.50mm deep. A radiograph was obtained of the aluminum block utilizing an X ray unit (Planmeca, Helsinki, Finland) and an occlusal film (DF-50 #4 Occlusal X-Ray Film, Kodak, Ohio, USA), which was then processed by an automatic film processor (Clarimat 300@ Gendex, London, UK). The radiograph was taken with the exposure settings of focal size= 0.7mm, 50-70 kVp, 8mA, total filtration (min.2 mm all equivalent at 70 Kv), tube-film distance of 10cm and intimate contact of film and aluminum block to reduce shadowing as much as possible. The tube was oriented so that the central beam passed through the center of the film and aluminum block. Four oral and maxillofacial radiologists interpreted the radiograph independently under four different viewing conditions including:

- 1) White light viewing light box in a lit room (LW)
- 2) White light viewing light box in a dark room (DW)
- 3) Yellow light viewing light box in a lit room (LY)
- 4) Yellow light viewing light box in a dark room (DY)

Observers separately reported the number of holes they detected on the radiograph under the mentioned viewing conditions. The data were analyzed by repeated measures ANOVA with two within factors. Inter- observer reliability was measured by the Kendall's coefficient of concordance.

RESULTS

The mean number of detected holes in the lit and dark rooms was 7 ± 0.53 and 7.625 ± 0.51 , respectively.

On the other hand, the mean number of detected holes using white light and yellow light color was 7.125 ± 0.64 and 7.5 ± 0.53 , respectively (Table 1). Statistical analysis revealed that the ambient light had a statistically significant effect on detection of details on radiographs ($P=0.042$); whereas light color of the viewing light box had no significant effect ($P=0.094$) on detection of details on radiographs. High level of agreement (0.842) was found between the observers.

DISCUSSION

The present study evaluated the effects of ambient light and light color of viewing light box on the ability of the radiologists to detect holes drilled in an aluminum block on radiographs. The results revealed that yellow light viewing light box in a dark room provided optimum viewing conditions for radiographic interpretation; whereas minimal details were detected in a lit room on a white light viewing light box. The results showed that ambient light significantly affected radiographic interpretation but the light color of the viewing light box had no such effect.

Achieving as much diagnostic information as possible from dental radiographs would prevent repetition of X ray exposure and reduce health care costs.

Table 1. Mean number of detected holes on the radiograph by the four observers under four different viewing conditions.

	LW	DW	LY	DY
First Observer	7	8	8	8
Second Observer	7	7	7	7
Third Observer	6	7	7	8
Fourth Observer	7	8	7	8
Mean	6.75	7.5	7.25	7.75
Total	7.125		7.5	

LW: White light in a lit room

DW: White light in a dark room

LY: Yellow light in a lit room

DY: Yellow light in a dark room

Utilizing optimal viewing conditions would provide more accurate diagnostic information. In this study, an optimally exposed radiograph was evaluated; it should be noted that different results could have been obtained if different exposure settings had been used in the present study. Espelid in 1987 examined radiographs under two viewing conditions: ceiling light in a room without a window, and X-ray viewer ($\times 2$ magnification) with two alternative light sources. For dark radiographs, the X-ray viewer improved diagnostic quality compared to viewing under ceiling illumination; however, room illumination provided the best viewing conditions when light radiographs were examined. Most of these differences were not statistically significant [8]. However Hill et al. demonstrated that low ambient light and restricted lighting from surrounding view boxes significantly improved low-contrast detection performance on films with a density of approximately 2.00. Clearly using low ambient lighting is required to detect low-contrast details [14]. In a study by Kawai et al, [4] masking the viewing box in a lit room increased the detectability on underexposed, optimally exposed and overexposed radiographs by 8%, 14%, and 25%–47%, respectively, compared with the unmasked condition; with masking of the viewing box in a dark room, the detectability on underexposed radiographs remained unchanged, while the detectability on optimally and overexposed radiographs increased by 8% and 24%–54%, respectively, compared with that in the unmasked condition in a lit room [4].

Ogata et al, in 2005 expressed that viewing conditions appear to be less important for interpreting high contrast compared to low contrast objects such as dental caries. There did not seem to be any advantage in viewing box masking or use of magnification for measuring the distance between the tip of an endodontic file and the root apex in maxillary incisors [15]. Deep and Petropoulos in 2003 stated that controlled darkroom viewing conditions did

not have any clinical benefit for radiographic identification of interproximal carious lesions [16]. Cederberg et al, in 1998 indicated that background lighting did not appear to affect the ability to detect artificial approximal lesions [10]. In contrast, the results of Orafi et al. are in agreement with the national and European guidelines, which recommend the use of a viewing box, magnification and masking for radiographic interpretation [17].

Kawai et al, in 2005 indicated that masking the viewing box in a lit room increased the detectability on radiographs compared with that in unmasked condition. On the other hand, by masking the viewing box in a dark room, the detectability on underexposed radiographs remained unchanged, while it increased for optimally and overexposed radiographs, compared with that in unmasked condition in a lit room [4].

The current study demonstrated that more diagnostic information was detected in a dark room than in a lit room. By using yellow light viewing light box, more information was obtained compared to the use of white light viewing light box; however, this improvement was not statistically significant. According to the results of the current study, it is recommended to interpret radiographs in dark rooms on a viewing light box with either white or yellow light. Reduced light intensity, as in viewing films under ambient lighting, causes a subjective reduction in image contrast and an increase in average density. When viewing a small film like a periapical radiograph on a larger viewing box, the eyes are affected by the light from the surrounding environment. This subjectively increases film blackening and reduces the perceived contrast. By eliminating extraneous light and complete masking, the perceived contrast can be increased [1]. It has also been stated that radiographic interpretation is best done in a room with reduced overhead lighting and with the use of a mask to block the excess light from the viewing box around the radiograph. As the eyes adapt to increased

luminance, the pupil size decreases, which reduces the ability to perceive structures with low image contrast [14]. Secondary sources of illumination (i.e., light other than that originating from the viewing box), such as overhead indoor light or natural outdoor light, can reduce the radiographic contrast and may therefore affect the viewer's ability to extract diagnostic information [16].

Kawai et al, in 2005 revealed that the detectability on radiographs improved in a dark room, considering that observers evaluated the radiographs 2-3 minutes after the eyes adapted to darkness [4]. Adaptation time seems to be impractical from the clinical point of view. In the current study, no time was considered for eye adaptation to darkness. It is important to know what happens in the eyes under different viewing conditions. The rods and cones of the retina are found over its entire surface apart from the fovea, where only cones are present. Cones are primarily used for color vision while rods only interpret information as black, white or shades of grey. Upon exposure to bright light, the visual pigment migrates between the cones, stopping the spread of light from one cone to another. This improves visual acuity (the ability to differentiate between two objects with a minimum distance between them). When exposed to dim light, visual acuity is decreased because the visual pigment remains within the rods and cones allowing light to spread between them. While this increases the sensitivity, it reduces acuity. As the light becomes dimmer, the cones stop functioning and the rods take over, leading to further reduction in acuity [1]. As discussed by Lanning et al, in 2006, inaccuracies and inconsistencies in radiographic viewing conditions among clinical instructors may be particularly problematic in a dental school setting, where patients are assessed and treated by multiple clinicians. This can lead to errors in diagnosis and prognosis, over- or under-treatment and increased treatment time and cost. Inaccuracies and inconsistencies among clinical instructors

may also be problematic in the instruction of radiographic interpretation [18].

It should be mentioned that in our study, in neither of the viewing conditions radiologists detected all the holes in the aluminum block. Arnold in 1987 showed that modification of illumination conditions had only a slight negative influence on diagnostic quality compared to standard conditions. The observer, however, proved to be the most important variable with respect to the diagnostic quality of radiographs [9]. Patel et al, in 2000 supported the guidelines, which recommend the use of a viewing box, magnification and masking for interpretation of intraoral radiographs. They also stated that observers' experience influenced performance in interpretation of periapical pathosis [1].

The current study revealed that ambient light significantly affected radiographic interpretation; whereas, the light color of the viewing light box had no significant effect on radiographic reading. Yellow light viewing light box in a dark room was proven to be the most optimal viewing condition for radiographs. Future studies on radiographs of dental structures and observers with a wide range of experience would be helpful to further evaluate the effects of viewing conditions on radiographic interpretation.

CONCLUSION

White and yellow light of the viewing light box had no significant effect on visibility of the radiographic details but more information was obtained in a dark room.

REFERENCES

- 1- Patel N, Rushton VE, Macfarlane TV, Horner K. The influence of viewing conditions on radiological diagnosis of periapical inflammation. *Br Dent J.* 2000 Jul 8;189(1): 40-2.
- 2- Carranza FA, Teki HH. Radiographic aids in the diagnosis of periodontal disease. In: Newman MG, Takei HH, Carranza FA, editors.

Carranza's clinical periodontology. Philadelphia, WB Saunders Co., 2002:454-468.

- 3- Hatzioannou K, Psarouli E, Papanastassiou E, Bousbouras P, Kodona H, Kimoundri O, et al. Quality control and diagnostic reference levels in intraoral dental radiographic facilities. *Dentomaxillofac Radiol.* 2005 Sep;34(5):304-7.

- 4- Kawai T, Sato K, Yosue T. Effects of viewing conditions on the detection of contrast details on intraoral radiographs. *Oral Radiol* 2005 Jun;21(1):23-9.

- 5- Kutcher MJ, Kalathingal S, Ludlow JB, Abreu Jr M, Platin E. The effect of lighting conditions on caries interpretation with a laptop computer in a clinical setting. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2006 Oct;102(4):537-43.

- 6- White SC, Pharoah MJ. Oral radiology principles and interpretation. 5th Ed., St. Louis, Mosby Co., 2004: 282.

- 7- Welander U, McDavid WD, Higgins NM, Morris CR. The effect of viewing conditions on the perceptibility of radiographic details. *Oral Surg Oral Med Oral Pathol.* 1983 Dec;56(6): 651-4.

- 8- Espelid I. The influence of viewing conditions on observer performance in dental radiology. *Acta Odontol Scand.* 1987 Jun; 45(3):153-61.

- 9- Arnold LV. The radiographic detection of initial carious lesions on the proximal surfaces of teeth. Part II. The influence of viewing conditions. *Oral Surg Oral Med Oral Pathol.* 1987 Aug; 64(2):221-31.

- 10- Cederberg RA, Frederiksen NL, Benson BW, Shulman JD. Effect of different background lighting conditions on diagnostic performances of digital and film images. *Dentomaxillofac Radiol.* 1998 Sep;27(5): 293-7.

- 11- Alter AJ, Kargas GA, Kargas SA, Cameron JR, McDermott JC. The influence of ambient and viewbox light upon visual detection of low-contrast targets in a radiograph. *Invest Radiol.* 1982 Jul-Aug;17(4):402-6.

- 12- Makdissi J. Interpretation of dental and maxillofacial radiographs: a comparative study using an x-ray viewing box and window. *J Ir Dent Assoc.* 2002;48(4):123-4.
- 13- White SC, Pharoah MJ. Oral radiology principles and interpretation. 6th Ed., St. Louis, Mosby Co., 2009:40.
- 14- Hill SJ, Faulkner K, Law J, Starritt HC. Film viewing conditions in mammography. *Br J Radiol.* 1997 Apr;70(832):409-11.
- 15- Ogata M, Loffredo Lde C, Kuga MC, Scaf G. Efficacy of three conditions of radiographic interpretation for assessment of root canal length. *J Appl Oral Sci.* 2005 Mar;13(1):83-6.
- 16- Deep P, Petropoulos D. Effect of Illumination on the Accuracy of Identifying Interproximal Carious Lesions on Bitewing Radiographs. *J Can Dent Assoc.* 2003 Jul-Aug;69(7):444-6.
- 17- Orafi I, Worthington HV, Qualtrough AJ, Rushton VE. The impact of different viewing conditions on radiological file and working length measurement. *Int Endod J.* 2010 Jul;43(7):600-7.
- 18- Lanning SK, Best AM, Temple HJ, Richards PS, Carey A, McCauley LK. Accuracy and consistency of radiographic interpretation among clinical instructors using two viewing systems. *J Dent Educ.* 2006 Feb;70(2):149-59.