ORIGINAL ARTICLE

QUALITY ASSURANCE AUDIT OF INTRA-ORAL PERIAPICAL RADIOGRAPHS AT THE UNDERGRADUATE DENTAL SCHOOL

Anum Khan, Muhammad Qasim Javed*, Rida Iqbal, Fareeha Khan, Syed Rashid Habib**

College of Dentistry, Riphah International University, Islamabad-Pakistan, *Department of Conservative Dental Sciences and Endodontics, Qassim University-Saudi Arabia, **Department of Prosthetic Dental Sciences, College of Dentistry, King Saud University, Riyadh-Saudi Arabia

Background The three fundamental principles of radiation protection are justification, dose optimization or limitation and subsequently following the As Low as Reasonably Practicable-(ALARP) principle. Quality assurance (QA) program for dental radiography is important in order to yield results with maximum diagnostic value, minimize errors, aid in interpretation, avoid unnecessary repetition of radiographs and therefore, additional radiation exposure. **Methods** This standard based audit was conducted at an undergraduate and postgraduate teaching hospital. One thousand and sixty four intra oral periapical radiographs were graded according to the set standards by NRPB by 3 examiners. Data were analyzed with SPSS-24. **Results** Out of the 532 conventional periapical radiographs, 313 radiographs were Grade 1, 177 radiographs were Grade 2 and 42 radiographs were Grade 3, requiring a repeat radiograph. For 532 digitally taken periapical radiographs, 255 radiographs were Grade 1, 192 radiographs were Grade 2 and 85 radiographs were Grade 3 and diagnostically unacceptable. Considering the aforementioned results, the findings of the first cycle did not meet the standards. **Conclusion** According to the results of the quality assurance audit, the radiographs were below the standards set by NRPB. Recommendations were made for improvement measures in the radiology department and plan to re-audit after six months.

Keywords: Radiographs, Quality Assurance; Audit

Citation: Khan A, Javed MQ, Iqbal R, Khan F, Habib SR. Quality assurance audit of intra-oral periapical radiographs at the undergraduate dental school J Ayub Med Coll Abbottabad 2020;32(3):327–30.

INTRODUCTION

One of the primary diagnostic tools in dentistry that is an essential component of dental diagnosis is radiographic examination. Dental radiographs (intaoral and extraoral) are not only important for diagnosis but also aid in treatment planning, monitoring progress of the disease and evaluating treatment outcomes. However, exposure to ionizing radiation is not without potential harmful effects. Considering this, the need for every radiograph advised must be justified and included in the patient record. Also, it is well known amongst medical personnel and in recent times, laymen as well, that the radiation dose can have hazardous effects.[1]

The 'Ionizing Radiations Regulations 1999' (IRR 99)[2] and the 'Ionizing Radiations (Medical Exposure) Regulations (IR (ME) R 2017)[3] emphasize on the introduction of quality assurance (QA) programs for dental radiographs. Quality assurance program in a dental practice is imperative, the purpose of which is to optimize the diagnostic value of the radiographs, minimize errors, aid in interpretation, avoid unnecessary repetition of radiographs and therefore, additional radiation exposure. Good quality radiographs are also time and cost effective.[4,5] Efforts in achieving consistent and diligent diagnostic results also account to radiation protection. The three fundamental principles of radiation protection are justification, dose optimization and limitation. The objective of an acceptable radiographic examination is to achieve maximum diagnostic efficacy while restricting the dose exposure to a minimum.[6] The dose should be As Low as Reasonably Practicable-(ALARP) to reduce the exposure of patient and dental staff to harmful radiation.[7] Some of the measures to achieve this include lead lined walls of the room, lead aprons for patients and staff members, and the use of rectangular collimation.[8] Another aspect of looking at the same issue would be to reduce the number of radiographs altogether or to take diagnostic radiographs to minimize/completely eliminate the need for repeats. Ideally, a periapical radiograph should be a sharp image and should include the tooth in question and at least one tooth on either side of it. Each of these teeth should have their crowns, roots and 3 mm of the periapical area completely visible. This audit aims at assessing the quality of conventional and digital intra oral periapical radiographs taken at the Undergraduate Dental School in Islamabad, Pakistan.

MATERIAL AND METHODS

This 1st cycle of prospective clinical audit was carried out at the Oral Radiology Department of the Undergraduate Dental School in Islamabad, Pakistan. The ethical approval was obtained from the institutional ethical review committee. The process of assessment of the quality of periapical radiographs was comprised of grading of each film by utilizing the grading system set

by the National Radiological Protection Board (NRPB) and the British Dental Association (BDA).[9,10] as shown in Figure-1. Additionally, the errors in the radiographic images were identified. The current standards at the school were compared with those set by NRPB[9,10] and recommendations are given to enhance the standards for improving the quality of periapical radiographs.

The audit was comprised of a random selection of conventional and digital periapical radiographs over a period of three months, October to December, 2018. To eliminate inter-examiner bias, before the grading of periapical radiographs calibration of the examiners was done. Subsequently, 3 examiners with 5 years of experience analyzed each periapical radiograph separately according to NRPB grading criteria (Figure-1).

Grade 1 radiographs exhibit clear distinction between the enamel, dentin and pulp of a tooth completely visible along with 3 mm apical area included, show the periodontal ligament (PDL) space and successfully help in the diagnosis of caries, periapical radiolucency and any other iatrogenic and pathological changes.

The data collection was carried out by utilizing the standardized data collection sheet. The grading of radiographic images and recording of errors was done. Errors noted were positioning errors including angulation, conning off, image cut, elongation/ foreshortening of image, blurring of image and overlap, processing errors including poor contrast, light/dark image and post processing errors in the work bench area comprising of splashes/stains.

Data were analyzed with SPSS-24 Software using simple descriptive statistics.

RESULTS

A sample of 1064 periapical radiographs were evaluated, 532 of which were manually radiographed and processed while 532 were digitally taken. Out of the 532 conventional periapical radiographs, 313 radiographs were Grade 1, 177 radiographs were Grade 2 and 42 radiographs were Grade 3, requiring a repeat radiograph. For 532 digitally taken periapical radiographs, 255 radiographs were Grade 1, 192 radiographs were Grade 2 and 85 radiographs were Grade 3 and diagnostically unacceptable. Considering the aforementioned results, the findings of the first cycle did not meet the standards, as shown in table-1.

The most prevailing error for the digital radiograph was that of exposure, consequently producing an image with poor contrast (83 radiographs). The second most common error was the cutting of the image because of improper positioning (67 radiographs). Figure-2 shows the results for the digital radiograph errors that resulted in a Grade 2 or Grade-3.

For manually taken and processed periapical radiographs, conning off was the error that occurred most frequently (83 radiographs). Following this were the processing errors, resulting in an image that was either too light (30 radiographs) or too dark (30 radiographs). Figure-3 shows the results for the manual radiograph errors that resulted in a Grade-2 or Grade-3.

Table-1: Results of the first cycle of data collection for the manual and digital radiographs, as compared to the target percentages

	Percentage % (n)		
Grading	**NRPB Standard**	**Manual Radiographs**	**Digital Radiographs**
Grade 1	70%	58.83 % (313)	47.93% (255)
Grade 2	20%	33.27% (177)	36.09% (192)
Grade 3	10%	7.9 % (42)	15.97% (85)

Rating	Quality control	Target
1	Excellent- no errors of processing or positioning or exposure	Not less than 70%
2	Acceptable- some processing errors, exposure or positioning but which still allow diagnostic information to be obtained	Not greater than 20%
3	Unacceptable- errors render the film diagnostically useless	Not greater than 10%

Figure-1: The grading system set by the National Radiographic Protection Board (NRPB) and the British Dental Association (BDA)

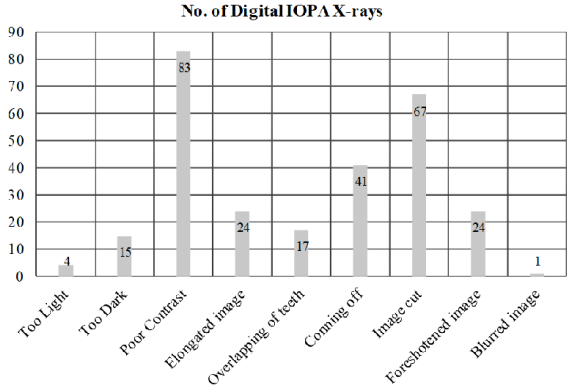

Figure-2: Bar chart showing the number of Grade 2 or 3 digital periapical radiographs for each individual error

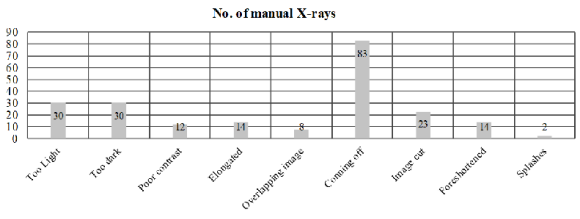

Figure-3: Bar chart showing the number of Grade 2 or 3 conventional periapical radiographs for each individual error

DISCUSSION

The results of this clinical audit show that the radiographs being taken currently (both conventional and digital) are below the standard set by NRPB and improvement needs to be made to yield the highest quality of information in an intraoral periapical radiograph. Moreover, digital radiographs were of poor quality, more than half of them being grade-2 and 3 as compared to conventional radiographs. The findings of the current audit coincide with the results of Chong and colleagues[11], who compared and concluded that digital radiographs were of inferior quality as compared to conventional radiographs. The findings of the current study suggest that the majority of errors were due to wrong positioning (incorrect tube/beam angle), that resulted in the conning off or the image cut on the periapical radiographs. Image elongation and foreshortening are a result of the vertical beam angle being too shallow or steep, respectively. Similarly, an incorrect horizontal beam angulation, results in an overlapping image. Patient movement during the process of x-ray taking causes blurring of the image. This results in missing important structures that are relevant for diagnosis and the diagnostic value of the image is affected. Various audits conducted in the past have shown similar results due to the incorrect x-ray tube, film or patient positioning.[12,13] It is therefore essential to introduce and train the students/staff to use film holders and beam aiming devices for proper film positioning as recommended by Salami et al[13] who conducted an audit of digital intraoral periapical and bitewing radiographs at a pediatric dental setting. Additionally, the operating individual should be sufficiently trained to be able to use variety of radiographic techniques (paralleling technique and bisecting angle technique).[14]

The other most common factor leading to faulty radiographs was errors in exposure more so in digital radiographs than conventional. This is comparable with a study by Jabbari and associates[6] which accounted correct exposure setting for excellent image quality with higher resolution. Poor contrast due to exposure being set on too high was one of the short comings observed in a large number of radiographs taken, particularly the digital. Digital radiographs require specific exposure settings for each quadrant and tooth and these instructions need to be followed for ideal outcome. To produce a radiographic image that is diagnostically acceptable, the exposure should be set at 60–70 kV for intraoral radiographs.[15,16] Exposure settings that have been set higher than required produce a darker image while a lower setting creates a paler image. The students and staff need to be given detailed training sessions to be able to eliminate this error and identify the required exposure for each individual patient.

Images being too light or too dark can also be the consequence of miscalculations during the processing procedure for conventional radiographs. Processing requires a dark room with no light leaks or a daylight loader with tightly sealed arm holes to ensure light proofing. The overall temperature of the room needs to be about 17 degrees which is optimum for processing the films. The developing solution weakens overtime and needs to be changed after a maximum of 10–14 days. Similarly, films that have been stored for prolonged times expire and produce dark, foggy images. Films require proper handling and storage in a dry area and away from the radiation zone. The equipment for processing radiographs manually includes three tanks (one for the developer, one for the fixer and one for water), a thermometer, a timer, film hangers and a drying rack.

At the institute where the current study was conducted, many conventional radiographs resulted in an image that is either lighter or darker than an ideal one. Similar results were found in a study by Edeh and colleagues[17] due to procedural and equipment defects. As advocated in this research, this could be improved significantly if certain simple measures are taken. Training needs to be greatly emphasized upon and the students/staff need to be taught about the processing timings and procedure as well as frequent equipment checks. The daylight loader being currently used has tears in the arm holes, resulting in light leaks. It needs to be replaced immediately. Also, the solution tanks are not cleaned regularly. Additionally, sometimes the films are left in the developer or fixer for either too long or too short time period, resulting in a dark or light image. Two of the manually processed films had splashes on them and to prevent this from happening, the work area needs to be kept clean and the drying rack kept at a distance from the tanks.

The findings of the current audit are communicated at the college council meeting and the following new recommendations are given (a) Regular use of film holders, beam aiming devices and rectangular collimation (b) Training staff on a regular basis to be competent in radiological practices and protection (c) Changing developing and fixing solutions regularly according to manufacturer's recommendation (d) Proper film storage (e) Clear patient instructions (f) Adjustment of exposure, processing time and temperature (g) Darkroom and

daylight loader integrity should be checked and maintained (h) Regular audits should be carried out.

CONCLUSION

According to the results of the quality assurance audit, the radiographs were below the standards set by NRPB. It cannot be emphasized enough that the errors noted need to be reviewed and eliminated promptly. The issue requires immediate attention to prevent unnecessary radiation exposure for the patient and staff as a result of retakes. Strict measures should be implemented to help reach the required standards. The dissemination of the audit results will help to raise the awareness of quality issues. However, to see the extent of improvement, the second audit will be carried out in 6 months after the necessary measures for improvement have been taken.

AUTHORS' CONTRIBUTION

AK: Literature search, conceptualization of study design. MQJ: Literature search, write-up. RI, FK: Data collection and data analysis. SRH: Proof reading

REFERENCES

1. Council on Dental Materials, Instruments, and Equipment. Biological Effects of Radiation from Dental Radiography. J Am Dent Assoc 1982;105(2):275–81.
2. Government of UK. The Ionising Radiations Regulations 1999. [Internet].1999. [Cited 2018 Dec 20]. Available from: http://www.legislation.gov.uk/uksi/1999/3232/pdfs/uksi_19993232_en.pdf
3. Government of UK. The Ionising Radiation (Medical Exposure) Regulations 2017. [Internet].2017. [Cited 2018 Dec 20]. Available from: http://www.legislation.gov.uk/uksi/2017/1322/pdfs/uksi_20171322_en.pdf
4. WHO. Quality assurance in diagnostic radiology. [Internet]. World Health Organization 1980. [cited 2018 Dec 20]. Available from: http://apps.who.int/iris/bitstream/10665/39095/1/9241541644 .pdf
5. Ngoye WM, Motto JA, Muhogora WE. Quality Control Measures in Tanzania: Is it Done? J Med Imaging Radiat Sci 2015;46(3):S23–30.
6. Jabbari N, Zeinali A, Rahmatnezhad L. Patient dose from radiographic rejects/repeats in radiology centers of Urmia University of Medical Sciences, Iran. Health 2012;4(2):94–100.
7. Lindell B, Dunster HJ, Valentin J. International Commission on Radiological Protection: History, Policies and Procedures. [Internet]. Swedish Radiation Protection Institute, SE. 1998; 171:16. [cited 2018 Dec 20]. Available from: http://www.icrp.org/docs/histpol.pdf
8. European Commission. European Guidelines on radiation protection in dental radiology, Radiation Protection 136. [Internet]. 2004. [Cited 2018 Dec 20]. Available from: https://ec.europa.eu/energy/sites/ener/files/documents/136.pdf
9. Hirschmann PN. Guidelines on radiology standards for primary dental care: a resumé. Royal College of Radiologists and the National Radiological Protection Board. Br Dent J 1995;178(5):165–67.
10. Rout J, Brown J. Ionizing radiation regulations and the dental practitioner: 3. quality assurance in dental radiography. Dent Update 2012;39(5):334–9.
11. Chong BS, Miller J, Sidhu S. The quality of radiographs accompanying endodontic referrals to a health authority clinic. Br Dent J 2015;219(2):69–72.
12. Emanuel RJ, Hussain N, O'Sullivan M. A retrospective audit of radiograph quality: completing the audit cycle. Qual Prim Care 2005;13(3):149–52.
13. Salami A, Al Halabi M, Hussein I, Kowash M. An Audit on the Quality of Intra-Oral Digital Radiographs Taken in a Postgraduate Paediatric Dentistry Setting. Oral Health Dent Manag 2017;16(1):1–4.
14. Tatapudi R, Myla S, UpendraGurugubelli J, Meenakshi K, SravaniBandru R. Comparison between the commonly used radiographic techniques for intra oral imaging in dentistry-A questionnaire study. Int J Dent Res 2017;5(2):157–62.
15. Ali S.A, Hussain M, Shahzad M, Irfan F. Quality Analysis of Periapical Radiographs Taken by Dental Assistants. J Liaquat Univ Med Health Sci 2018;17(4):260–4.
16. Okano T, Sur J. Radiation dose and protection in dentistry. Japanese Dent Sci Rev 2010;46(2):112–21.
17. Mallya S, Lam E. White and Pharoah's Oral Radiology: Principles and Interpretation. Mosby; 2019.

Submitted: July 13, 2019	Revised: July 25, 2019	Accepted: October 15, 2019

Address for Correspondence:

Muhammad Qasim Javed, Department of Conservative Dental Sciences and Endodontics, Qassim University-Saudi Arabia

Email: qasim_javed83@yahoo.com