



PATIENT DOSE IN DIGITAL X-RAY RADIOGRAPHY

Medicine

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ABSTRACT

Patients are exposed to a significant radiation dose during digital radiography X-ray. In addition, these investigations are subjected to a repetition during patient management more than one time. Due to this irradiation, the sensitive organs (eye lens, thyroid and parathyroid glands) are exposed to a relative high dose which imposes a radiation risks to the patient. This study aim to measure the radiation dose in digital radiography-X-ray, evaluate the effective dose and patient dose risk. Methods: The study was conducted in Radiology department of Sawi Hospital, Doctors clinic Hospital. The study was obtained during the period spanned from Jan 2017 up to May 2017. By convenient sampling, 60 patients who were found to have Patient Dose were recruited and their DR X-ray findings were evaluated. Results: Among the 80 cases of patients with patient dose it was found to be: effective dose of chest .0774 uSv, knee .007935uSv, L/S .022uSv, C/S .008593uSv, Shoulder .005559Sv, Abdomen .246uSv and Thoracic.352uSv were found in 3cases. Conclusion: patient dose structured reports will improve dose managements in digital radiology.

KEYWORDS

Patient dose, X-ray, Dose area product (DAP), Effective Dose.

INTRODUCTION

Since the discovery of X-rays in 1895 by Wilhelm Conrad Roentgen, a professor at Wurzburg University, Germany. Medical imaging has contributed significantly to progress in medicine. Roentgen was exploring the path of electrical rays passing from an induction coil through a partially evacuated glass tube. Although the tube was covered in black paper and the room was completely dark, he noticed that a screen covered in fluorescent material was illuminated by the rays. [1]

Patients are exposed to a significant radiation dose during direct radiography X-ray. In addition, these investigations are subjected to a repetition during patient management more than one time. Due to this irradiation, the sensitive organs (eye lens, thyroid and parathyroid glands) are exposed to a relative high dose which imposes a radiation risks to the patient. Although the task is very important, few studies were published internationally and to our knowledge, no study was published in Sudan. Therefore, it is important to evaluate the patient dose and its related risks during direct radiography-X-ray imaging. [1]

Diagnostic x-ray radiology is a common diagnostic practice and there has been a substantial increase in the number of examinations recently [3]. In spite of the increasing hazard of diagnostic x-rays to human beings, studies aimed at achieving low patient doses with sufficient image quality have continued to be of interest in research [1]. All exposures to ionizing radiation needs to be justified and optimized in terms of the benefit and risks [1]

Patient doses in diagnostic x-ray examinations can be best estimated in terms of entrance surface dose (ESD) per radiograph or dose area product (DAP) for the complete examination [4]. While digital techniques in radiology have the potential to reduce patient doses, they also have the potential to significantly increase them. This is a technology that is advancing rapidly and will soon affect hundreds of millions of patients. If careful attention is not paid to the radiation protection issues of digital radiology, medical exposure of patients will increase significantly without concurrent benefit. [5]

Some EU countries require patient dose evaluation of a sample of patients of standard size for a standard procedure in all X-ray rooms on a yearly basis, as well as comparison of the results with the DRLs. If

DRLs are consistently exceeded, appropriate corrective action and investigation of the causes are required to reduce doses while maintaining suitable image quality. [6] so that higher exposure levels result in worse image quality. For those institutions that have goals for optimization of image quality and patient dose (typically given as "as low as reasonably achievable", or ALARA (7) , General Principles of "as Low as Reasonably Achievable" The guiding principles for radiation protection in medicine are: Justification: The examination must be medically indicated. Optimization. [16]

The examination must be performed using doses that are as low as reasonably achievable and use digital radiography, it has been necessary to find a way to determine optimal exposure techniques to prevent exposure creep. Then, having set ALARA targets for some exposure metric at an institution, a QC program can be established to monitor whether its X-ray imaging program has met those targets. [8] Radiation monitoring equipment was mounted on the rooftop of the building that housed the then Federal Radiation Protection Service (FRPS) to monitor the possible nuclear fallout from Sahara Desert test. Earlier attempt at measuring radiation dose imparted to the patients started at the turn of last millennium [9] Since radiation could lead to immediate and late effects, radiation dose measurement is required, and it is an essential component of quality control (QC) program. It is indicated in the document of ICRP Report 105 that, in the case of exposure from diagnostic and interventional medical procedures, the diagnostic reference levels (DRLs) have the optimization of protection as its objective. (10) Diagnostic reference level is an important tool for radiation dose management. It is a means to an end — optimization of protection. The concept of DRL was introduced as a tool that identifies the practices with abnormally high patient doses. These guidance levels are defined as dose levels for a typical examination for groups of standard-sized patients or standard phantom for broadly defined types of equipment. These levels are expected not to be exceeded for standard radiographic procedures when good and normal practices regarding diagnostic and technical performance are followed. (11,12) The LDRLs are based on the overall mean (of ESD/DAP) of all rooms. It is not expected that the LDRLs should exceed national diagnostic reference levels (NDRLs) if an organization is undertaking good practice. With the establishment of LDRLs within a geographical region, it is easier to compare the local performance of a particular hospital with the group of hospitals in a geographical setting expressed

in terms of regional diagnostic reference levels. A nation-wide dose measurement can also be carried out on standard-sized patients to determine national diagnostic reference levels (NDRLs). As a consequence of the fact that dose distribution in diagnostic radiology examinations is usually skewed with long tail at the higher dose end of the scale, it has been recommended that the 75th percentile of the dose distribution is an appropriate level for DRLs. (13)

MATERIAL AND METHODS

Study was conducted at two hospitals in Khartoum State; Omer Sawi Hospital and Clinic Doctor Hospital obtained during the period spanned from Jan to March 2017. Sample consisted from 80 patients, all of them were examined with a DR X-ray. Patients data were registered: including (age, gender, type of Examination, Kvp, MA, mAs, DAP and FFD).

DRACQUISITION

The higher The KHU means the more consecutive exposures we can do using the X-Ray tube without over heating the tube (Not that in X-ray beam generation a lot of heat energy is being generated too which is cooled down by the oil inside the tube. Focal Spot: The below X-ray tubes are all dual focal spot which means we can provide 0.6 mm small focus (used for good sharp details images like extremities) and 1.2 mm as large focus (used for short and high current exposures) to minimize the effect on involuntary motion), TOSHIBA 400k HU 4" Radiographic X-ray tube 1.2/0.6mm focal spot sizes 150 kVp, High/standard speed rotor, 12° anode target angle automatic exposure control (AEC) systems are designed to adjust ma, or exposure time in order to obtain an image of diagnostic quality (while fixing KV). These systems sense the amount of radiation immediately in front of the image detector and adjust the dose or dose rate by driving the cut off dose (ma and exposure time) to the patient in order to assure sufficient photons are reaching the image receptor.

IMAGE INTERPRETATION

Dose were reviewed on machine. Measured effective dose. Each study was interpreted by one DR X-RAY Screen... Additional features, defined by typical DAP (Dose area product) of the Dose were used. This method was also been used in other previous studies. [3,7]

STATISTICAL ANALYSES

All data obtained in this study was documented and analyzed using SPSS program version 16. Descriptive statistics, including frequency and percentage were used. Measurement of the dose area product and effective dose was calculated respectively.

ETHICAL CONSIDERATIONS

Special consideration was given to the right of the confidentiality and anonymity for all participants. Anonymity was achieved by using number for each participant to provide link between the collected information and the participants. Justice and human dignity was considered by teaching the selected participant equally when offering them an opportunity to participate in the research. Permission for conducting the study was obtained from head of the radiology department at Khartoum hospitals.

RESULTS

TABLE – 1 GENDER DISTRIBUTION AMONG STUDY SAMPLE (n=100)

Gender	No of patients	%
Male	54	55%
Female	46	45%
Total	100	100%

TABLE – 2 AGE GROUP DISTRIBUTION AMONG STUDY SAMPLE (n=100)

Age	No of patients	%
Less than 20 y	18	18.7%
20-40 y	48	41.2%
40-60 y	34	40%
Total	80	100%

TABLE – 3 DAP AND FFD VALUE. (n=100)

DAP Absorbed dose / Area	FFD
73.42796	14.5833

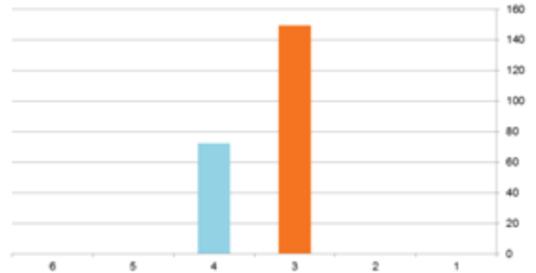


Figure 1: DAP and FFD distribution

TABLE – 4 EFFECTIVE DOSE

Body Part	Equivalent Dose
Chest	0.0764 uSV
Knee	0.007735 uSV
Lumbosacral	0.021 uSV
c/spine	0.008573 uSV
Shoulder	0.005539 uSV
Abdomen	0.246uSV

DISCUSSION

In this study, the data was collected from the two Khartoum hospitals, Sawi hospital and clinic doctor in, Sudan. The data were collected randomly according to the availability. Therefore, these sample is not present any data regarding the incidence of a disease (Table 4.1). show gender 55% of the patients were males while the rest are 45 %female. No criteria were used to select the patients. In study by Estimation of adult patient doses for selected X-ray shows the patients' characteristics and the technical parameters for the various examinations for the three (3) public hospitals selected for the study. It shows the total number of patients with approximately 56% being males with the rest being females. (15) (Table 4.2). The mean age of the patients was ranged between 17 years to 60 years. It is important to note that pediatric patients are more sensitive to radiation up to four times higher than the adults. Therefore, radiation dose measurement and protection of this group should be mandatory (The table (4-3) shows the DAP and FFD value When FFD increase the DAP decrease , In study by Estimation of adult patient doses for selected X-ray The means for the ranges of ages, kVp, mAs and FDD for all the seven examinations have calculated and reported. For all examinations, the ages ranged from the minimum of 25 years to the maximum of 79 years. For the kVp, from the least of 60 kV to the highest of 95 kV. For the mAs, from the least of 12.5 mAs to the highest of 60 mAs and for the FDD, from least of 90 cm to the maximum of 180 cm. The mean ranges for the ages kVp, mAs, FDD were 38.4–60.2 yrs, 72.2–85.9 kV, 23.2–42.5 mAs and 105.5–138.6 cm respectively. The wide ranges of the kVp, mAs, FDD were as a result of various patient weights, heights, thicknesses and radiographic techniques employed by operators. (15) The table (4-4) shows the effective dose in each organ chest 0.0774usv knee 0.007935usv L/S 0.022usv c/s 0.008593usv shoulder 0.005559usv abdomen 0.246usv Thoracic 0.0352usv. In study by, Evaluation of dose-area product of common radiographic examinations the dose-area product (DAP) action levels (AL) for chest PA, pelvis AP, skull AP, lumbar AP, and abdomen AP obtained are: 0.14 Gy cm2, 0.50 Gy cm2, 0.83 Gy cm2, 0.25 Gy cm2, 1.21 Gy cm2, respectively (14)

CONCLUSION

The results presented in this study provided the the effective dose in each organ Digital radiology is low dose than conventional x-ray has great advantages for imaging and patient dose management dose reports online systems and the MPPS DICOM service are good tools to optimize procedures and to manage patient dosimeters data. The implementation of the ongoing IEC-DICOM standard for patient dose structured reports will improve dose managements in digital radiology. Keywords Digital radiography patient dose, DICOM header audit, quality assurance.

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REFERENCES

[1] International Commission on Radiological Protection. 1990 Recommendations of the International Commission on Radiological Protection (Report 60). Annals of the ICRP.

- 1991;21(1-3).
- [2] International Commission on Radiological Protection. Radiological Protection and Safety in Medicine (Report 73). Annals of the ICRP. 1996;26(2):1-31.
- [3] Bushong, 2001 S.C. Bushong Radiologic science for technologists 0-323-01337-Mosby, St. Louis (2001).
- [4] European Commission, 1996 European Commission European guidelines on quality criteria for diagnostic radiographic images (1996) EUR 16260 EN. Brussel.
- [5] International Commission on Radiological Protection. Managing Patient Dose in Digital Radiology. Vol. 34. Ann ICRP, 2004: 1-74 (ICRP Publication; 93). [PubMed]
- [6] European Commission. European Commission. European guidelines on quality criteria for diagnostic radiographic images. Report EUR 16260. L-2985 Luxembourg: Office for the Official Publications of the European Communities, 1996.
- [7] Willis CE and Slovis TL. The ALARA concept in pediatric CR and DR: dose reduction in pediatric exams — a white paper conference executive summary. Radiology. 2005; 234(2):343–44. CrossRef | Web of Science® Times Cited: 8
- [8] Jones AK, Heintz P, Geiser W, et al. Ongoing quality control in digital radiography: Report of AAPM Imaging Physics Committee Task Group 151. Med Phys. 2015; 42(11):6658–70. Wiley Online Library | PubMed | Web of Science® Times Cited: 1.
- [9] Ajayi IR and Akinwumiju A. Measurement of entrance skin doses to patients in four common diagnostic examinations by thermoluminescence dosimetry in Nigeria. Radiat Prot Dosimetry. 2000;87(3):217–20. CrossRef | Web of Science® Times Cited: 8.
- [10] Charnock P, Moores BM, Wilde R. Establishing local and regional DRLs by means of electronic radiographical X-ray examination records. Radiat Prot Dosimetry. 2013; 157(1). CrossRef | PubMed | Web of Science® Times Cited: 52004.
- [11] ICRP. Radiological protection in medicine. ICRP Publication 105. Ann ICRP. 2007; 37(6)
- [12] European Community. Council Directive 97/43: Euratom on health protection of individual against the danger of ionizing radiation in relation to medical exposure. L180 40. Luxembourg: European Community; 1997.
- [13] EC. Guidance on diagnostic reference levels (DRLs) for medical exposure. Radiation Protection 109. Brussels: The European Commission; 1999.
- [14] establishing a preliminary diagnostic reference levels (PDRLs) in Southwestern Nigeria Authors Nnamdi N. Jibiri, Christopher J. Olowookere First published: 8 November 2016 Full publication history DOI: 10.1120/jacmp.v17i6.6011 View/save citation
- [15] journal of Radiation Research and Applied Sciences Author links open overlay panel Kofi Ofori Samuel W. Gordon Emmanuel Akrobortu Adriana A. Ampene Emmanuel O. Darko Show more <https://doi.org/10.1016/j.jrras.2014.08.003> Get rights and content Open Access funded by The Egyptian Society of Radiation Sciences and Applications Under a Creative Commons license
- [16] Wadah M. Ali, Mogahid M. A. Zidan, "Assessment of Radiation Dose Reduction when using AEC of MSC T in Sudan", International Journal of Science and Research (IJSR), Volume 5 Issue 11, November 2016, 1399 - 1402, DOI: 10.21275/ART20163020