Available Online at http://www.journalajst.com

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 08, Issue, 06, pp.4978-4980, June, 2017

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

RESEARCH ARTICLE

ESTIMATION OF RADIATION DOSE FOR PEDIATRIC PATIENTS UNDERGOING X-RAY EXAMINATIONS OF THE CHEST AND ABDOMEN

[1]Mahmoud Hyder, [2]Mohammed A. Alkreem and [1,*] Ahmed Abukonna

[1]College of Medical Radiologic Science, Sudan University of Science and Technology, Sudan
[2]Radiation and Isotopes Center, Khartoum (RICK), Sudan

ARTICLE INFO

Article History:
Received 20th March, 2017
Received in revised form
22nd April, 2017
Accepted 10th May, 2017
Published online 30th June, 2017

Key words:
ESD, Pediatric,
Chest, Abdomen.

ABSTRACT

Pediatric radiography is a challenging procedure from the perspective of radiation dosage. Children are approximately ten times more sensitive to radiation-induced cancer than middle-aged adults and three times more sensitive than the population average. A total of 100 patients were enrolled in this study. ESDs were evaluated for the chest posterio-anterior (PA) projection and abdomen anterio-posterior (AP) projection. For each studied examination, the patient anthropometrical data (sex, age, weight and height) and technical parameters used (kVp, mAs and FSD) were collected at the time of the examination on a self-designed data collection sheet. The ESD was assessed by indirect method, with the data on the radiation output of the X-ray tube and exposure factors (kVp, mAs and FSD). The result of the study revealed that the (mean ± SD) for ESDs were found to be (0.11 ± 0.03mGy),(0.41 ± 0.15mGy) for PA chest and abdomen consequently. The maximum ESD for abdomen (0.723 mGy) observed at maximum kV_p (62 kV_p) which emphases the significant correlation between kVp and ESD, no correlation was found between patient age or weight and ESD. The study is considered as an attempt to evaluate the ESDs received by digital radiographic x-ray machine for children aged between 1 - 8 years old, taking into considerations number of other variables. The mean ESD values obtained are found to be within the standard reference. The data obtained may add to the available information in national records for general use. It may provide guidance on where efforts on dose reduction will need to be directed to fulfill the requirements of the optimization process and serve as a reference for future researches.

INTRODUCTION

Pediatric radiography is a challenging procedure from the perspective of radiation dosage. Because, it is well-known that the dose of radiation is an extremely important issue in children, who are significantly more radiosensitive and more likely to manifest radiation-induced changes over their lifetimes (Guo *et al*., 2013). Children are approximately ten times more sensitive to radiation-induced cancer than middle-aged adults and three times more sensitive than the population average(Brenner *et al*., 2001). More people are exposed to ionizing radiation for medical practice than any other human activity, and in many cases, individual doses are highest. Exposure to radiation in medicine involve people undergo diagnostic radiographic, interventional procedures or radiation therapy. Diagnostic radiology examinations lead to higher risks per unit dose of radiation to cancer in infants and children compared with adults.

Corresponding author: Ahmed Abukonna,
College of Medical Radiologic Science, Sudan University of Science and Technology, Sudan.

The International Commission on Radiological Protection (ICRP) asserted that the use of effective dose is actually not recommended for assessing the risks of stochastic effects in retrospective situations for exposures in patients, however this quantity can be of value for comparing the use of similar technologies and procedures in different hospitals and countries as well as the use of different technologies for the same medical examination (2007). The Entrance Skin Dose (ESD) is defined as the absorbed dose to air where the X-ray beam intersects the skin surface of the patient including the backscatter(Alm-Carlsson *et al*., 2007).The reasons for evaluating ESD is that; the physical parameter recommended for monitoring the Diagnostic Reference Levels (DRLs) in conventional radiography was the ESD and the dose is greatest at the surface where radiation enters the body of the patient therefore the skin is the main organ for which there is a possibility of deterministic effect i.e., skin burn (Sharifat and Oyeleke, 2009)another reason the organs equivalent dose can be estimate from the ESD and that very important especial in case where the part of the body undergoing to be imaged contain sensitive organ to the effect of radiation. This study was aimed to estimate the ESD for pediatric patients undergoing diagnostic X-ray examinations of the chest and abdomen in pediatric hospital in Khartoum, Sudan to help in applying optimization of radiation protection of the patients.

MATERIALS AND METHODS

A total of 100 patients were enrolled in this study. ESDs were evaluated for the chest posterio-anterior (PA) projection and abdomen anterio-posterior (AP) projection. The patients were randomly selected from pediatric patients of both sexes attending medical investigation sat Jafar ibn Auf Hospital for children. For each studied examination, the patient anthropometrical data (sex, age, weight and height) and technical parameters used (kVp, mAs and FSD) were collected at the time of the examination on a self-designed data collection sheet (see table 1 and 2). The standard FFD of 180 cm for the chest PA and 100 cm for the abdomen AP were used as routine. The available machine specific data such as type, model, filtration, focal spot size, year of manufacture were recorded from the manufacturer information written on the machine (see Table 3). The ESD was assessed by indirect method, with the data on the radiation output of the X-ray tube and exposure factors (kVp, mAs and FSD) using Equation (1) which used by(Ofori *et al*., 2012)

$$\text{ESD} = \text{Tube ouput} \times \text{mAs} \times \left(\frac{100}{\text{FSD}}\right)^2 \times \text{BSF} \quad \text{.............. (1)}$$

Where Tube output in (mGy/mAs), mAs is the product of the tube current (mA) and the exposure time in seconds, FSD is the focus-to-skin distance, BSF is the backscatter factor, the backscatter factor was 1.35 suggested in European guidelines (EC, 1996) and used by (Sharifat and Oyeleke, 2009) and (A.Alkreem and Abukonna, 2017).

$$\text{FSD} = \text{FFD} - \text{T} \quad \text{.............................. (2)}$$

Where FFD is the focus film distance, T is AP chest separation Ggenerator output airkerma values (in mGy/mAs) at different kVp settings from (40 to 80) kVp and constant mAs were first measured using the DIAVOLT universal (Model T43014-01292). The detector was placed on top of the table at one meter focus detector distance. The relationship between X-ray Air Kerma X-ray tube and applied tube voltages kVp was plotted using Microsoft Excel Worksheet as shown in figure 1and expressed by the fitting Equation (3)

$$y = 0.0224x - 0.7938 \quad \text{.......................... (3)}$$

Where Y-axis: X-ray Air Kerma in mGy/mAs and X-axis: applied tube voltage in kV

The distribution of the minimum, maximum, mean and standard deviation values of (ESD) for individual patient exposures was shown as in Table 4.

RESULTS

Table 1. The patient anthropometrical data

		Sex		Age (year)	Weight (Kg)	Height (cm)	FSD (cm)
		Male	Female				
Chest	Minimum	47	26	1	8	62	168
	Maximum			8	27	121	178
	Mean			3.5	14.3	83.5	172.4
	Std. Deviation			2	4.7	12	2.88
Abdomen	Minimum	10	17	1	8	48	88
	Maximum			10	28	134	93
	Mean			3.5	13	77	90.8
	Std. Deviation			2.4	5.9	18.8	1.8

Table 2. Exposure parameters

		Minimum	Maximum	Mean	Std. Deviation
Chest	Kv	48	62	53.9	3.7
	mAs	2	7	4.7	1.01
Abdomen	Kv	46	62	52.7	5.1
	mAs	3	6	4.5	1.19

Table 3. Specification of x-ray machine

Manufacturer	Shimadzu Corporation
Model	P18DE-85
Focal spot size	0.6/1.2
Total filtration	2.5 mm AL at 75 kV_P
Generator Manufacturer	Shimadzu Corporation
CR reader	Fujifilm FCR PRIMA 35✕43cm 14✕17Inch

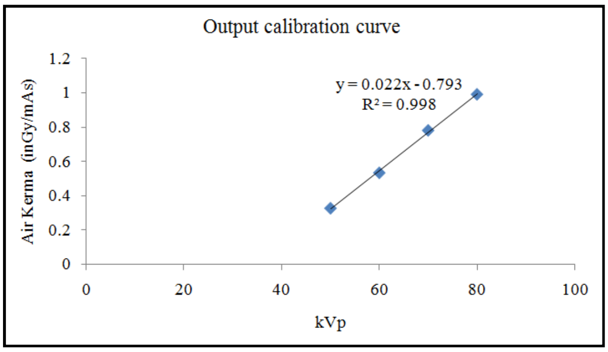

Figure 1. The relationship between X-ray Air Kerma X-ray tube and applied tube voltages kV_p

Table 4. The ESD (in mGy)

ESD (mGy)	Minimum	Maximum	Mean	Std. Deviation
Chest	0.049	0.202	0.11	0.03
Abdomen	0.215	0.723	0.414	0.15

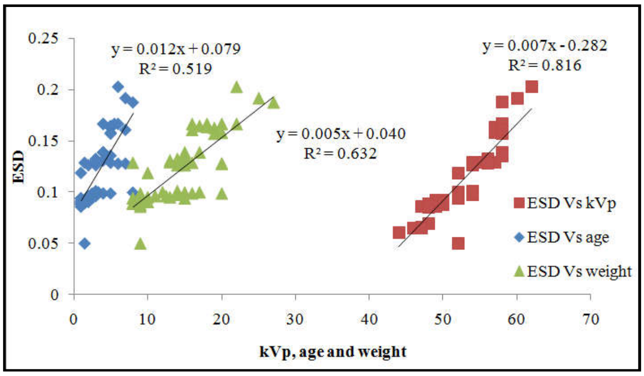

Figure 2. The correlation between kVp, age, weight and ESD for chest PA

Table 5. Comparison with previous studies

	This study	(Eljak et al., 2015)	(European Commission 1999)
Chest	0.12	0.16	0.1
Abdomen	0.37	0.46	1

DISCUSSION

Pediatric imaging techniques vary greatly due to the extremely large differences in patient size and weight. Therefore, different parameter settings may be necessary to gain optimal results for the same anatomical regions, according to the child's age. The result of this study showed that, for chest PA the age rang (1-8) years with mean age 3.5 years and weight range (8-27) kg with mean 14.3 kg and for abdomen AP the age rang (1-10) years with mean age 3.5 year and weight range (8-28) kg with mean 13 kg. Table 4 showed that, the maximum ESD (0.202 mGy) for chest PA observed for the maximum kV_p (62 kV_p) and the maximum ESD for abdomen (0.723 mGy) also observed for maximum kV_p(62 kV_p) that emphase the significant correlation coefficient between kVp and ESD and no correlation coefficient was found between patient age or weight and ESD as shown in figure 3, this result was in line with the previous study (Suliman *et al.*, 2007). The ESDs values compared with the (Rosenstein, 2008)and other study in the Sudan (Suliman *et al.*, 2007) and other country (Eljak *et al.*, 2015), the results showed that; all estimated ESDs values lower than the values of (Protection, 1999) and some previous studies.

Correlations between Entrance Skin Dose (ESD) and exposure parameters was performed and showed significant correlation (Figure 2). Many authors stated that the absorbed dose in skin is directly proportional to tube current; the length of exposure, and the square of peak kilovolt age (Parry *et al.*, 1999). The justification was that the digital imaging X-ray machine may allow for use of a lower tube current or a shorter exposure, thus reducing the dose to the patient as mentioned previously (Parry *et al.*, 1999) and where the image quality controlled automatically because the using of automatic exposure control as well as the presence of aluminum filter of 2.0 mm. The data obtained may add to the available information in national records for general use. It will provide guidance on where efforts on dose reduction need to be directed to fulfill the requirements of the optimization process and serve as a reference for future researches in pediatrics radiography.

REFERENCES

Alkreem, A., M. and Abukonna, A. 2017. Estimation of Radiation Dose for Adult Patients Undergoing Diagnostic X-ray Examinations of the Skull and Cervical Spine. IOSR *Journal of Applied Physics* 9, 33-36.

Alm-Carlsson, G., Dance, D., Dewerd, L., Kramer, H., NG, K., PERNICKA, F. and ORTIZ-LOPEZ, P. 2007. Dosimetry in diagnostic radiology: an International code of practice. *International Atomic Energy Agency Technical Reports Series.*

Brenner, D., Elliston, C., Hall, E. and Berdon, W. 2001. Estimated risks of radiation-induced fatal cancer from pediatric CT. *AJR Am J Roentgenol*, 176, 289-96.

Eljak, S. N. A., Ayad, C. E. and Abdalla, E. A. 2015. Evaluation of Entrance Skin Radiation Exposure Dose for Pediatrics Examined by Digital Radiography at Asser Central Hospital-KSA. Open Journal of Radiology, 5, 125.

Guo, H., Liu, W. Y., He, X. Y., Zhou, X. S., Zeng, Q. L. and LI, B. Y. 2013. Optimizing imaging quality and radiation dose by the age-dependent setting of tube voltage in pediatric chest digital radiography. *Korean J Radiol, 14*, 126-31.

Ofori, E. K., Antwi, W. K., Scutt, D. N. and Ward, M. 2012. Optimization of patient radiation protection in pelvic X-ray examination in Ghana. J Appl Clin Med Phys, 13, 3719.

Parry, R. A., Glaze, S. A. and Archer, B. R. 1999. The AAPM/RSNA Physics Tutorial for Residents: Typical Patient Radiation Doses in Diagnostic Radiology 1. Radiographics, 19, 1289-1302.

Protection, R. 1999. 109: Guidance on diagnostic reference levels (DRLs) for Medical Exposures. Luxembourg: European Communities.

ROSENSTEIN, M. 2008. Diagnostic reference levels for medical exposure of patients: ICRP guidance and related ICRU quantities. Health Phys, 95, 528-34.

Sharifat, I. and Oyeleke, O. 2009. Patient entrance skin doses at Minna and Ibadan for common diagnostic radiological examinations. *Bayero Journal of Pure and Applied Sciences*, 2, 1-5.

Suliman, II, Abbas, N. and Habbani, F. I. 2007. Entrance surface doses to patients undergoing selected diagnostic X-ray examinations in Sudan. *Radiat Prot Dosimetry*, 123, 209-14.

****