Assessment of Entrance Surface Dose for the Patients from Common Radiology Examinations in Sudan

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Abstract: Medical X-ray exposures are the largest man-made source of population exposure to ionising radiation in many countries. Although information on medical exposure is already incorporated into national legislative documents, in Isfahan there is no data on the assessment of patient's entrance surface dose (ESD) and the health risk from conventional radiography in daily clinical practice. In this study, Entrance Surface dose (ESD) were estimated for adults patients undergoing common X- ray examinations in two Hospitals in Khartoum, namely Khartoum teaching hospital and academy teaching hospital. the study was performed in four X-ray machines. A total of 191 patients were included in this study. Patient's data such as (age and weight) and exposure parameters (kV and mAs) were recorded. The results of ESD have been obtained with the use of the Dose Cal software which developed by the radiological protection center in saint gorges hospital London. The results showed that the mean values for chest, abdomen and limbs were 0.31 mGy, 2.6 mGy, 0.05 mGy respectively. the results obtained in this work, range from (10.3) for lumbosacral lat to (0.004) for Elbow, was not exceeding the reference value and also the values obtained by Previous studies. But When comparison made between the four machines using some selected tests, the mean dose value at Khartoum teaching hospital by (shimadzu (1)) was found to be higher than other machines. This may be due the fact that the machine is old one and also it is output is greater than outputs of other machines, but in general the competency of technicians in Khartoum teaching hospital is less than in the academy teaching hospital, and also the number of patients in this hospital is more than academy hospital.
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1. Introduction

Dose area product (DAP) is a product of surface area of patient that exposed to radiation at the skin entrance multiplied by the radiation dose at this surface. Measurement of dose area product is suitable for achieving optimum degree of safety during radiological examination of patient. DAP is a valuable radiation dose descriptor because radiation-induced bio-effectiveness is directly related to both the magnitude of the radiation dose and the total amount of tissue that is irradiated (Nickoloff et al. 2008)

Also, DAP is useful for continuous quality assurance, as well as analysis of performance of X-ray machines.

Dose area product could be measured by two methods, namely:

(i) Direct measurement through the use of a transmission ionization chamber at the surface of the X-ray tube collimator; and

(ii) By mathematical approach (indirect). The mathematical approach involves the product of irradiated area of the patient and radiation dose incident at the surface. In conventional diagnostic procedure, the entrance surface dose is considered a useful first approach in measurement of radiation exposure to patients (Broese and Geleijns. 1998).

This is because the amount of radiation dose delivered to the skin of the patient determines both the stochastic and deterministic risks. The measurement of entrance surface dose with thermoluminescence dosimeter (TLD) has been shown to be laborious, capital intensive, and potentially intrusive,(McParland, 1998), especially when large numbers of patients are involved in the survey. This made dosimeter-based entrance surface dose measurement in routine X-ray examination quite expensive for centers with limited resources. The adoption of a mathematical method for dose determination provides an avenue for greater output with respect to patient dose information. A study by (McParland, 1998).

has shown that entrance skin dose can be estimated from dose area product with an accuracy of 30%–40%. Apart from being useful for estimating entrance skin dose in routine X-ray examination, knowledge of DAP, as well as location and projection of X-ray beam, can also be used to estimate effective dose, a quantity mostly used to assess stochastic risk from nonhomogeneous irradiation (I C RP. 1990).

DAP is easier to measure than entrance skin dose (ESD) and effective dose, especially in routine X-ray examinations. Among several indirect methods employed for practical estimation of effective dose in conventional radiology and fluoroscopy is dose area product (Le Heron. 1992 and Theocharopoulos et al 2002).

In sudan, most of the studies on patient dosimetry in routine X-ray examinations are usually dosimeter-based measurement of either ESD or effective dose (Ogundar et al. 2004, Ogunseyinde et al 2002, Ajayi and Akinwumiju 2000).

. However, the dose area product received by patients during the examination procedure is not known.

This present study is aimed at measuring dose area product received by patients undergoing common radiological examinations in some diagnostic centers in Sudan. It is anticipated that the results from this study would provide useful means of estimating DAP and effective dose received by patients during routine X-ray examination, thereby providing easy and timely patient dosimetry in diagnostic radiology.

This study aimed to measurement entrance skin dose for the patients who are exposed to radiation during different cases of X-ray examination. Moreover, to compare this dose with the international literature.

2. Material and Methods

To calculate the entrance surface doses (ESD) for patients undergoing common x-ray examination by using the Dose Cal software. The ESD is defined as the absorbed dose measured in air on the x-ray beam axis at the point where the x-ray beam enters the patient.

Dose calculation is a software system designed to calculate and report entrance surface dose manually the tube out put data and exposure factors entered.

The exposure factors were fed in excel program and then the mean, standard and also minimum and maximum values for kV, mAs, age and weigh were decided (in tables).

The ESD was calculated in the present work using the following relation:

$$\mathbf{ESD = OP \times \left(\frac{kV}{80}\right)^2 \times mAs \times \left(\frac{100}{FSD}\right)^2 \times BSF}$$

Where (OP) is the tube output per mAs measured at a distance of 100 cm from the tube focus along the beam axis. kV is peak tube voltage recorded for any given examination. mAs is the tube current and time product, FSD is the focus-to-patient entrance surface distance and BSF is the backscatter factor, with a value of 1.35 in this study.

The software used in this work was specially developed for the evaluation of ESD dose. It was developed by the radiological protection center of saint georges hospital London.

It is computer based system by which by patient doses can be determined from exposure factors recorded at the time of the examination.

The use of software program to perform patient doses is modern resource in dosimetery and is being widely used in hospital.

Tools and method

Four x-ray machines were involved in this work. They are all digital. The x-ray equipments used were (2) Toshiba + (1) shimiadzu (in Khartoum teaching hospital) and (1) shimadzu (in academy teaching hospital) with total number of 191 patients.

At the beginning, the patient's anthropometrical data (the age, weight) was recorded and then the patient was centered by technician to record the parameters such as peak tube voltage (kv_p), exposure current and time product (mAs) and focus to surface distance (FSD) at the time of the examination for each patient undergoing the specified diagnostic procedure.

The kV and mAs was changed according to the type of examination and patient age and Weight.

The data was analyzed using excel program and then the tables followed in the coming pages were created.

3. Results

This work was carried out in two major hospitals in Khartoum; four x-ray units were included in this study. The results obtained were recorded in tables and figures shown below. The results included the mean, the stander deviation, the minimum and the maximum for (kv, mAs, age, weight and dose) for all different cases in the four units. The results included procedures involving different positioning such as, antero-posterior (AP), postero-anterior (PA) and Lateral (LAT). Shimadzu (1) indicator to shimadzu at Khartoum teaching hospital and shimadzu (2) indicator to shimadzu at academy teaching hospital.

The outputs were measured for the four machines by Unfors Xi digital dosimeter at (FSD) of 100cm. The results of these outputs are shown in figs (1 to 3.4). Fig (5) represents mean surface dose for different examinations in Khartoum Hospital. Fig (6) shows comparison of the mean surface dose for different examinations in the two hospitals.

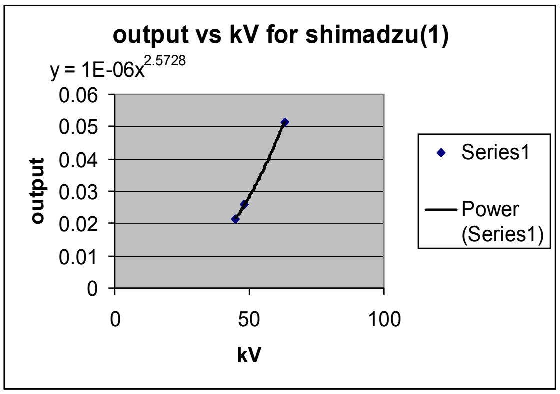

Fig (1) Outputs vs kVs for shimadzu (1)

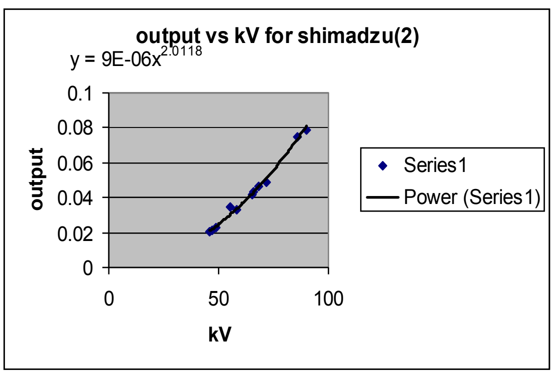

Fig (2) Output vs kV for shimadzu (2)

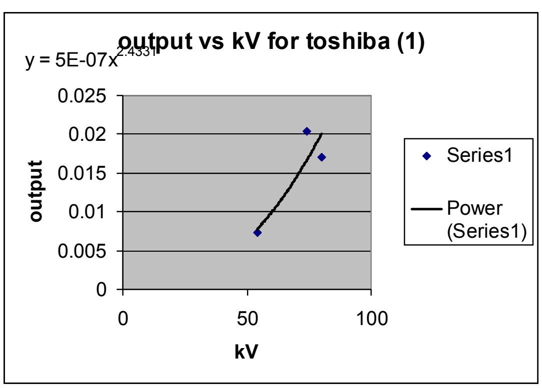

Fig (3) Output vs kV for Toshipa (1)

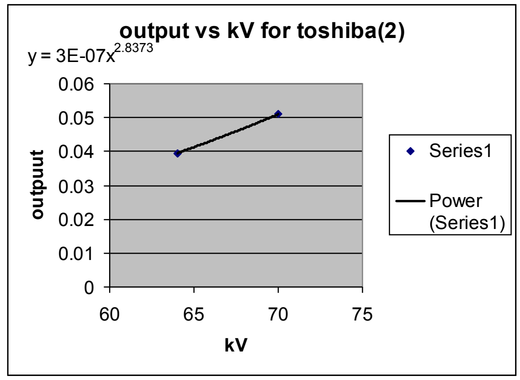

Fig (4) Output vs kV for Toshipa (2)

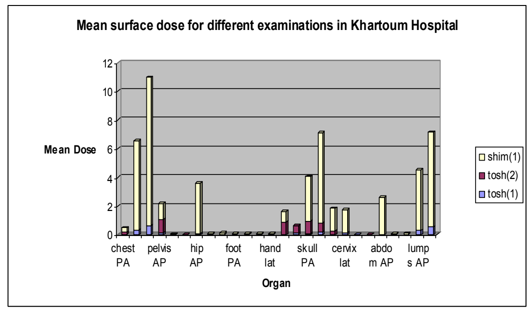

Fig (5) Mean surface dose for different examinations in Khartoum Hospital

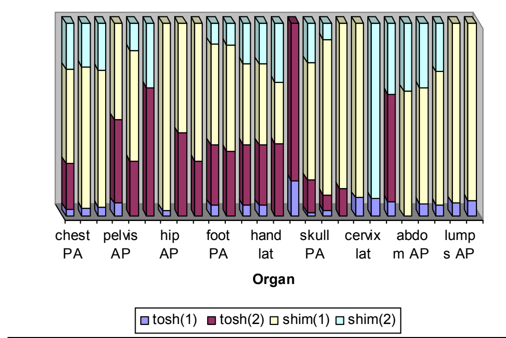

Fig (6) comparison of the Mean surface dose for different examinations in the two hospitals

4. Discussions

This study intended to evaluate the radiation doses for patients undergoing some common diagnostic x-ray examinations in Sudan. It was anticipated that the study would help in the optimization of radiation protection of the patient.

A total number of 191 radiographs were included in this study. The data were collected from two major hospitals in Khartoum.

The highest kV was used to image lumbo-sacral (Lat) applied by shimadzu (1) in Khartoum hospital and the lowest value of kV is used to image foot, also using shimadzu (1) in Khartoum hospital. In the other hand, the highest mAs was used to image lumbosacral (Lat) by shimadzu (1) in Khartoum hospital and the lowest value kV used to image foot PA using Toshiba (1) in Khartoum hospital.

The estimated ESDs ranged from 0.02 – 0.31 mGy for chest (PA), 0.06-0.23 mGy for chest (AP), 0.08 – 3.1 mGy for Skull (OF), 0.20 – 2 mGy for skull (LAT), 1.4 – 2.6 mGy for abdomen, 0.14 – 1.1 mGy for Pelvis, 0.31 – 4.2 mGy for Lumbar spine (AP) and 0.54 – 6.6 mGy for Lumbar spine (LAT).

Table (1) shows a comparison between the present studies with the literature. NR: not reported

Examination	This study	Suleiman et al (2007)	Halato et al (2008)	IAEA (1996)	DRL (2005)	EU Reference dose(ESD) 1996
Chest PA	(0.02-0.31)	NR	(0.18-1.05)	0.4	0.2	0.3
Chest AP	(0.14 -0.23)	(0.17-0.27)	NR	NR	NR	NR
Skull PA	(0.08-3.1)	(1.04-2.26)	NR	5	3	5
Skull LAT	(0.20-4)	(0.83-1.32)	(0.66-2.75)	3	1.5	3
Abdomen AP	(1.4-2.6)	NR	(1.22-4.35)	10	6	NR
Lumper spine AP	(0.31-4.2)	(1.46-3.33)	(1.52-5.01)	10	6	10
Lumper spine LAT	(0.54-6.6)	(2.9-9.9)	(2.48-10.41)	30	14	30
Pelvis AP	(0.14-1.1)	(1.31-1.189)	(1.18-5.75)	10	4	10

When comparing these values with reference levels and with previous studies, table (1) performed in Sudan the mean ESDs evaluated by this work were found relatively less than previous studies and reference levels, but mean ESD for Lat skull is greater than previous studies and reference levels.

The maximum dose value (10.3 mGy) in this study applied by Shimiadzu (1) in Khartoum hospital with case of lumbo-sacral (LAT) while the minimum dose value (0.004 mGy) applied by Toshiba (1) in Khartoum hospital with case of Elbow (AP&LAT).

When comparison made between the four machines using some selected tests, the mean dose value at Khartoum teaching hospital for (shimadzu (1)) was found to be higher than other machines. That is due to its long working age. Furthermore, its output is greater than outputs of other machines. But in general, the competency of technicians in Khartoum teaching hospital is less than in the academy teaching hospital. The number of patients in this hospital is also more than in academy hospital.

ESDs were estimated in this study for adult patients undergoing common x-ray examinations in some major Sudanese hospitals include four x-ray machines and a total number of patients 191.

The results in this study was found to be not exceeding the reference values and they are expected to encourage further dose surveys in the area of diagnostic radiology that will eventually lead to possible establishment of DRLs.

It is the interest of quality control programmers in medical radiological equipment, dark room and the materials use for film processing to decrease the radiation risks for patients and workers. Raising the competency of technologists through training improves the image quality, so as to avoid repeating the dose for patients. Continuity of such as these studies to cover all hospitals in Sudan, and all age group of even pediatric or adults.

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