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ESTIMATION OF ABDOMEN RADIATION DOSE AND EFFECTIVE DOSE FOR CT SCAN IN KHARTOUM STATE HOSPITALS

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ABSTRACT

This study is aimed to evaluate radiation dose to patients from Computed Tomography (CT) Abdomen examination in Many hospitals in Khartoum State and defining Effective Dose. A total of 502 patients (290 females and 212 males) were examined in this study. The data collected from 5 radiology department in Khartoum state. Patient doses showed wide variation due to patient clinical indication.

INTRODUCTION

Computed tomography (CT) is an imaging technique which produces a digital topographic image from diagnostic X-ray. The basic principle of CT involve digitizing an image received from a slit scan projection of the patient's body and then back-projecting the image through mathematical algorithms .[1] Since 1970s, computed tomography (CT) has played a tremendously important role in diagnosing diseases as compared with other radiological procedures though it imparts high radiation doses to patients. While the benefits of CT are well known in diagnosing diseases, these benefits should far outweigh the radiation risk involved therein. Technological developments have improved the speed of the procedure and quality of the images, leading to encouragement of the use of CT worldwide. [2]

Nowadays CT scan plays an important role to the diagnosis of the diseases. Sectional images of the body are obtained based on the measurement of the attenuation coefficient of the passing radiation beam in different angles around the patient. X-ray beam passes through patient at different angles and is detected in opposite side by detector, and then sectional images are reconstructed by using of the various algorithms. [3-4] Better spatial and contrast resolution of the CT images were enabled by advances in CT scanners manufacture technology, so that dynamic imaging of the moving tissues such as heart is possible by newer CT scanners such as 64 rows detector CT scan. [5-6] The proportion of CT scan to the patient's diagnostic absorbed dose has increased due to increasing use of the new CT examinations such as coronary CT angiography, extremities angiography and four dimensional CT. [7] Despite advances in the manufacture technology of the new CT scanners used for the mentioned above new examinations, absorbed dose to the patients has increased, for example absorbed dose from coronary CT angiography is higher than conventional angiography. [8]

In a recent regional survey on CT scanners in India, it was found that there has been an increase of 35% in the number of multi slice CT (MSCT) scanners compared to single-slice CT scanners since the year 2000. [9] Radiation dose from CT is of concern due to the increase in number of examinations performed each day. Though CT imparts a substantial amount of manmade radiation to the human population, the clinical benefits with the use of this modality far exceed the risk involved therein. [9-10].

Evaluation of the absorbed does in CT examinations and using dose reduction strategies are important from radiation protection aspect. Survey and determination of the diagnostic reference level is one way to investigate the absorbed dose to the patients. [11-12] Diagnostic reference level determines the expected radiation dose for the different CT examination while considering image optimization principle. Based on the diagnostic reference levels, extra dose in one examination must be evaluated to prevent patient from receiving unnecessary radiation dose. [13] The diagnostic reference levels (DRLs) can be derived from the observed distributions of patient doses in a certain area, conducted over a certain period of time. DRLs then are not an individual measure but derived from a representative sample of dose indicators associated with a standard patient size. The DRL must be set at approximately the level of the third quartile in the dose distribution. The third quartile value is chosen as an appropriate investigation level on the grounds that if 75% of X-ray departments can operate satisfactorily below this dose level, then the remaining 25% should be made aware of their considerably less than optimal performance and hence should be encouraged to alter their radiographic equipment or techniques to bring their doses in line with the majority. At the same time adherence to the Diagnostic Requirements for each scan series will ensure that diagnostic effectiveness does not suffer from any dose reduction (European Commission 1998). The DRL in general is the rounded third quartile distribution of mean values of CTDIW and DLP measured for a particular examination on a patient group.[14] The ideal standard patients' size as recorded by EC (European Commission 1996) is 20 cm AP trunk thickness and 70 kg weight, with an average weight, that is 70±3 kg. Similarly, the UK has adopted the criteria that the mean weight of the sample should lie in the range 65 to 75 kg for the mean dose to be indicative of the typical dose to an average (70kg) patient. [1] However, if there is no average patient available, the measurement period of all patients and the average of the dose result can be calculated as the outcome for a standards patient. [1] The purpose of this study was to determine the diagnostic reference levels for CT examination to make supervision on the patient absorbed dose.

MATERIAL AND METHOD

Material

The data used in this study were collected from five diagnostic radiology departments at Khartoum state during 12 month. Data technical parameters used in CT procedures was collected after informed consents were obtained from all patients prior to the procedure. Ethics and research committee was approved this study according to the declaration of Helsinki on medical protocol.

PATIENTS DATA:

A total of 502 patients (290 females and 212 males) Underwent CT study for Abdomen¸ for different clinical problems was selected and recorded their anthropometrical data (Age, sex,…..) with CT protocol technical data (kv, mAs , DIP ,$CTDI_{vol}$) and slice thickness.

CT MACHINES USED

Centers	Company	Installation date	Modality(number of slice/detectors)
A	Siemens	2005	16
B	Toshiba	2012	16
C	Neosoft	2014	128
D	Philips	2012	64
E	Philips	2010	2

METHOD

Patient dose were determine by using the volume CTDI ($CTDI_{vol}$) expressed in mGy the $CTDI_{vol}$ is represents the average absorbed radiation dose over the *x* and *y* directions at the center of the scan. And dose length product (DLP) in mGy cm, the DLP is usually used to describe total energy released in the scan volume. The DLP was calculated by using scan length and volume CTDI. The effective doses in mSv were estimated by multiplying the DLP values by normalized coefficients found in the European guidelines on quality criteria of CT.[15] This quantity of effective dose that reflects the risk of a non-uniform exposure in terms of an equivalent whole-body exposure [16].

RESULTS

A total of 502 CT abdomen (routine) procedures were performed over 12 month in five different hospitals with different detector CT modality. Table1 presented patient data.

Table 1 Show gender distribution

Gender	Number	Percentage
Male	212	42.231%
Female	290	57.769%
Total	502	100%

Table 2 Show Age distribution for gender according to Center

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Variables	Centers		No	Mean	Maximum	Minimum
Age	A	Male	51	41.626	88	22
		Female	50	46.457	70	19
	B	Male	56	42.164	60	26
		Female	64	48.318	70	18
	C	Male	28	59.786	69	32
		Female	91	57.659	80	26
	D	Male	57	52.544	76	27
		Female	39	49.867	64	23
	E	Male	20	43.133	72	20
		Female	46	47.522	75	21

Table 3,4,5,6 Show Values of Variables (mAs, Kvp, DLP, $CTDI_{vol}$) according to Center.

Table 3 Show Values of mAs according to Center					
Variables	Centers	No	Mean	Maximum	Minimum
mAs	A	101	90.7	180	44
	B	120	10	10	10
	C	119	114.197	301.5	29.9
	D	96	225.6	299	200
	E	66	90	160	60

Table 4 Show Values of Kvp according to Center					
Variables	Centers	No	Mean	Maximum	Minimum
Kvp	A	101	110	120	100
	B	120	120	120	120
	C	119	120	120	120
	D	96	110.625	120	100
	E	66	120	120	120

Table 5 Show Values of DLP according to Center					
Variables	Centers	No	Mean	Maximum	Minimum
DLP (mGy.cm)	A	101	418.736	722.51	152.53
	B	120	444.136	762.43	8.28
	C	119	776.786	1569.4	1.8
	D	96	486.372	1148.4	33.5
	E	66	312.78	719.65	12.7

Table 6 Show Values of $CTDI_{vol}$ according to Center					
Variables	Centers	No	Mean	Maximum	Minimum
$CTDI_{vol}$ (mGy)	A	101	8.278	12.7	4.37
	B	120	12.431	21.65	5.79
	C	119	14.531	62.8	3.7
	D	96	23.463	65.4	1.2
	E	66	7.615	12.5	2.13

Table 7 Show Values of $CTDI_{vol}$, DLP and Effective dose according to Center.
The mean effective doses for computerized topographic scans of the, abdomen, in five different hospitals were consistent with those of previous investigations.

Table 7 Show Values of $CTDI_{vol}$, DLP and Effective dose according to Center			
Center	$CTDI_{vol}$ (mGy)	DLP (mGy.cm)	Effective dose(mSv)
A	8.278	418.736	6.196
B	12.431	444.136	6.408
C	14.531	776.786	10.341
D	23.463	486.372	6.828
E	7.615	312.78	38.113

DISCUSSION

A total of 502 patients (290 females and 212 males) underwent abdominal CT scanning exams .The CT abdomen procedures were performed with dual some slice CT machines Table 1 Show patient distribution according to gender and age so the percentage of males is 42.231%and the percentage of females is 57.769%, the age of female ranged between (18 – 80) year and the age male ranged between (20 – 88) year, Table 3,4,5,6 Show Values of Variables (mAs, Kvp, DLP, $CTDI_{vol}$) according to Center. The minimum value of mAs for all centers is found to be 10 in center A, whereas the maximum is 301.5 in center B. Minimum value of Kvp is 100 in center A, D but maximum is 120 in all centers.

Table 7 Shows the results of mean of the variables (DLP , CTDIvol and Effective dose) according to Hospital there are found the maximum values of DLP is1569.4 in center C, the minimum values of DLP is1.8in center C also, the maximum values of CTDIvol is 65.4 in center D, the minimum values of CTDIvol is 1.2 in center D.

The mean values of (DLP, CTDIvol and Effective dose) is 487.762 mGy.cm,13.264 mGy , 13.577 mSv .

CONCLUSION

Results of this study demonstrated large scales of dose for the same examination among different centers. For all examinations, respectively were consistent with those of previous investigations. The highest mean effective doses were recorded for studies evaluate.

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