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Estimation of Pediatric Patients' Radiation Dose during Computed Tomography Examinations

Rufida Elbushra Ahmed[1,2*], Suhaib Alameen[1], Mohamed E. M. Gar-Elnabi[1]

[1]Sudan University of Science and Technology. College of Medical Radiological Sciences P.O. Box 1908, Khartoum, Sudan
[2]Department of Radiological Sciences, Inaya Medical College, Riyadh, Saudi Arabia

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***Corresponding author:** Rufida E. Ahmed

Abstract **Original Research Article**

The important of this study comes from the increased number of CT procedure to pediatric as CT consider invasive investigation. Patient data for both male and female collected from four different hospital and centers in Khartoum which using different CT scanner modalities. comparing the demographic data and radiographic information for male and female patients from CT scan for pediatric during brain examinations, the demographic information the age for male was higher than female, while the body mass index for female was higher than male, for the demographic data the Ma, DLP and effective dose was higher for male while the CTDIvol for female was higher than male. comparing the demographic data and radiographic information for male and female patients from CT scan for pediatric during chest examinations, the demographic information the age for male was higher than female while the body mass index for female was higher than that for male, the demographic data the mA, DLP, CTDIvol and effective dose was higher for female. Comparing the dose parameters among the two exams for all hospitals for brain the CTDIvol, DLP and ED was 54.82 ± 18.82, 890.99 ± 451.73 and 7.83 ± 4.75 respectively, while for CT chest was 9.03 ± 5.54, 319.72 ± 243.54 and 8.19 ± 6.59 respectively. When compare the present studies with others in table 6. Found a huge different in the pediatric dose and this for mainly two reasons; first from the technologist because they are not well trainee and they are not separate between the adults and pediatric protocol, and the other reason from the medical engineering for didn't activate the AEC option for medical devices special the X-ray and CT machines.

Keywords: *CT, effective dose, Chest, Brain, Pediatric*.

INTRODUCTION

Estimation of radiation dose in computed radiography examinations consider as non-invasive using x-ray technology in medical imaging to present the human body or the imaged organ as slice [1], Imaging of different of human body parts such as bones, soft tissue and blood vessels using x-ray give superior details to the imaged organs, and attenuated of the energy resulting from absorbed by the organs it passes through [2]. Beginning of imaging by Computed Tomography start at 1970s and the developing of pediatric imaging protocols start with [3].

CT has become one of the most main source of medical exposure, reports show that the risk of developing malignant diseases due to radiation exposure from CT is significant [4]. Many factor contribute to CT burden such as CTDIvol witch indicate the dose output of CT unit to a standard-size object. It is also effective in characterizing CT system output for axial coverage protocols this will lead to fail in representing fully account for each patient attributes and protocols [5]. Another factor is DLP dose-length-product expressing the total radiation dose excess [6]. In CT procedure to improve clinical practices dose measurements for each patient is recommended although a high exposure per examination related with increasing the number of people who are exposed the risk of individual patient is low never the less it may have related to many cases off cancer resulting from exposing to radiation during CT procedure. Reputed CT examination, using of inappropriate exposure factor and increasing scan volume all this factor attributed to increase patient dose [7].

Children are more sensitive to ionizing radiation induce carcinogenic effect than adult, since they have more life expectancy there for more risk to cancer [8] a pediatric protocol should be used to minimize the delivered radiation dose (ALARA) [9], in

the model which had been used to estimate cancer risk pediatric has the highest risk for cancer compered to adult in CT procedure [10]. Justification in CT examinations and optimization's of patient's dose by scanning protocols. Furthermore, the must restricted the using of ionizing radiation of imaging to minimize the unnecessary dose [11].

MATERIAL AND METHODS

This study was designed to evaluate the patient doses and the radiation related factor, the collected data included, sex, and age, tube potential, tube current–time product settings, pitch, slice thickness and total slice number, in addition, I also recorded all scanning parameters, as well as the CT Dose Index volume (in milli sievert) and dose-length product (in milli sievert-centimeters). All these factors have a direct influence on radiation dose. The entire hospital was passed successfully the extensive quality control tests performed by Sudan atomic energy commission and met the criteria of this study. Four CT machines were used to collect data during this study. These machines are installed in four private radiological departments. All quality control tests were performed to the machine prior any data collection.

Table-1: show specification of computed tomography machines in the all hospitals:

Hospitals	Manufacture	Model	Detected Type
Hospital A	GE Healthcare	Light Speed 8	8 slice
Hospital B	Toshiba	Aquilion 64	64 slice
Hospital C	Toshiba	Aquilion 64	64 slice
Hospital D	Siemens	Sensation	16 slice

CT dose measurement

Radiation dose indicators $CTDI_{vol}$ and DLP can be obtained from a dose summary page, which includes information about the CT exam. $CTDI_{vol}$ does allow the comparison of scan protocols or scanners and is useful for obtaining benchmark data to compare techniques, but it's not so good for estimating patient dose. DLP, an indicator of the dose imparted to the patient, is calculated by multiplying $CTDI_{vol}$ times the scan length. In addition to being affected by the issues associated with $CTDI_{vol}$, DLP can be problematic in a limited scan range [12].

Calculation of Effective dose

CT scanners record the radiation exposure as a DLP in mGy.cm. and by Multiply this by Conversion Factor (CF) to convert it to effective dose in mSv.

RESULTS

CT scanning has been recognized as a high radiation dose modality, when compared to other diagnostic X-ray techniques, since its launch into clinical practice more than 30 years ago. Over that time, as scanner technology has developed and its use has become more widespread, concerns over patient radiation doses from CT have grown [13]. The following statistical methods were used: mean, median, STD, minimum, maximum and 3rd quartile.

Table-2: Show the demographic data and radiographic information for all patients from CT scan for brain examinations:

Variables	Mean	Median	STD	Min	Max	3d Quartile
Age	3.19	4	1.60	1	5	5
BMI	16.06	15.76	1.47	13.60	20.82	17.16
Ma	158.93	125	68.82	27	313.5	223.5
DLP mGy.cm	890.99	626.03	451.73	282	2196	1318.85
CTDIv mGy	54.82	46.05	18.82	22.8	80.8	72.2
ED mSv	7.83	6.42	4.75	1.86	24.16	10.63

kV=120

Table-3: Show comparing the demographic data and radiographic information for male and female patients from CT scan for pediatric during brain examinations

Variables	*Male*					*Female*				
	Mean	*STD*	*Min*	*Max*	*3d Quartile*	*Mean*	*STD*	*Min*	*Max*	*3d Quartile*
Age	3.38	4	1.65	1	5	2.91	2	1.51	1	5
BMI	15.84	15.77	1.09	14	18.71	16.39	15.68	1.88	13.60	20.82
mA	167.92	174.2	69.23	27	313.	145.44	125	67.01	38	233.5
DLP mGy.cm	956.09	621.7	02.39	282	2196	793.36	646.61	347.79	282.3	1366
CTDIv mGy	54.17	38.86	18.94	22	75	55.80	59.03	18.91	22.80	80.80
ED mSv	8.21	5.98	5.26	1.87	24.16	7.27	6.53	3.86	1.87	15.03

kV=120

Table-4: show the demographic data and radiographic information for all patients from CT scan for from Chest examinations

Variables	*Mean*	*Median*	*STD*	*Min*	*Max*	*3d Quartile*
Age	3.42	4	1.55	1	5	5
BMI	16.23	16.53	1.61	13.67	20.58	17.11
Ma	246.92	138	384.92	80	2015	188.75
DLP mGy.cm	319.72	214.2	243.54	103.47	1250.8	409.48
CTDIv mGy	9.03	10.04	4.54	2.90	18	12.15
ED mSv	8.19	5.46	6.59	1.86	32.52	10.027

kV=120

Table-5: show comparing the demographic data and radiographic information for male and female patients from CT scan for from brain examinations

	Male					*Female*				
Variables	*Mean*	*STD*	*Min*	*Max*	*3d Quartile*	*Mean*	*STD*	*Min*	*Max*	*3d Quartile*
Age	3.44	4	1.67	1	5	3.40	3.50	1.43	1	5
BMI	16.08	16.45	1.69	13.80	20.58	16.46	16.91	1.52	13.67	18.31
mA	169.50	138	144.84	80	529	370.80	155	390.67	80	2015
DLP mGy.cm	259.17	204.62	156.16	103.47	652	416.59	305.57	327.37	186.9	1250.8
CTDIv mGy	8.56	6.20	4.73	2.90	17	9.79	10.04	4.35	2.90	18
ED mSv	6.37	5.24	4.04	1.86	16.95	11.10	7.36	8.84	3.73	32.52

Table -6: Compare the present study with other studies worldwide:

	Effective Dose mSv
Present study 2019	*8.01*
D. L. Miglioretti et al 2013 – USA[14]	*3.5*
Ataç, et al 2015- turkey[15]	*1.5*
Thomas KE et al 2008 – USA[16]	*1.5*
Shrimpton PC et al 2006 – UK[17]	*1.5*

DISCUSSIONS

The important of this study comes from the increased number of CT procedure to pediatric as CT consider invasive investigation. Patient data for both male and female collected from four different hospital and centers in Khartoum which using different CT scanner modalities. Table2. shows the demographic data and radiographic information for all patients from CT scan for brain examinations were the data presented as mean ± STD for the demographic information the age and body mass index was 3.19 ± 1.60 years and 16.06 ± 1.47 kg/cm2 respectively, and for the radiographic data the kV was 120 for all patients and the mA, DLP, CTDIvol and ED was 890.99 ± 451.73, 54.82 ± 18.82 and 7.83 ± 4.75 respectively.

Comparing the demographic data and radiographic information for male and female patients from CT scan for pediatric during brain examinations, the demographic information the age for male was higher 3.38 ± 4 and for female 2.91 ± 2, but the body mass index for female was higher than that for male 16.39 ± 15.68 and 15.84 ±15.77, for the demographic data the Ma, DLP and effective dose was higher for male 167.92 ± 174.2, 96.09 ± 621.7 and 8.21 ± .98 for female was 145.444 ± 125, 793.36 ± 646.61 and 7.27 ± 6.53 respectively, while the CTDIvol for female was higher the male 55.80 ± 59.03 for male was 54.17 ± 38.86 as shown in table 3.

Table 4. shows the demographic data and radiographic information for all patients from CT scan for chest examinations were the data presented as mean ± STD for the demographic information the age and body mass index was 3.42 ± 1.55 years and 16.23 ± 1.61 kg/cm2 respectively, and for the radiographic data the kV was 120 for all patients and the mA, DLP, CTDIvol and ED was 246.92 ± 384.92, 319.72 ± 243.54, 9.03 ± 4.54 and 8.19 ± 6.59 respectively. Comparing the demographic data and radiographic information for male and female patients from CT scan for pediatric during chest examinations, the demographic information the age for male was higher 3.44 ± 4 and for female 3.40 ± 3.50, but the body mass index for female was higher than that for male 16.46 ± 16.91 and for male 16.08 ± 16.45, for the demographic data the mA, DLP, CTDIvol and effective dose was higher for female 370.80 ± 155, 305.57 ± 327.37, 10.04 ± 4.35 and 11.10 ± 7.36 respectively and for male was 169.50 ± 138, 259.17 ± 204.62, 8.56 ± 6.20 and 6.37 ± 5.24 respectively as shown in table 5. Comparing the dose parameters among the two exams for all hospitals for brain the CTDIvol, DLP and ED was 54.82 ± 18.82, 890.99 ± 451.73 and 7.83 ± 4.75 respectively, while for CT chest was 9.03 ± 5.54, 319.72 ± 243.54 and 8.19 ± 6.59 respectively.

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and this for mainly two reasons; first from the technologist because they are not well trainee and they are not separate between the adults and pediatric protocol, and the other reason from the medical engineering for didn't activate the AEC option for medical devices special the X-ray and CT machines.

CONCLUSION

The important of this study comes from the increased number of CT procedure to pediatric as CT consider invasive investigation. Patient data for both male and female collected from four different hospital and centers in Khartoum which using different CT scanner modalities, comparing the demographic data and radiographic information for male and female patients from CT scan for pediatric during brain examinations, the demographic information the age for male was higher than female, while the body mass index for female was higher than male, for the demographic data the Ma, DLP and effective dose was higher for male while the CTD Ivol for female was higher than male. comparing the demographic data and radiographic information for male and female patients from CT scan for pediatric during chest examinations, the demographic information the age for male was higher than female while the body mass index for female was higher than that for male, the demographic data the mA, DLP, CTD Ivol and effective dose was higher for female. When compare the present studies with others in table 6. Found a huge different in the pediatric dose and this for mainly two reasons; first from the technologist because they are not well trainee and they are not separate between the adults and pediatric protocol, and the other reason from the medical engineering for didn't activate the AEC option for medical devices special the X-ray and CT machines.

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