International Journal Dental and Medical Sciences Research
Volume 3, Issue 5, Sep-Oct 2021 pp 876-880 www.ijdmsrjournal.com ISSN: 2582-6018

Estimation the Radiation Dose for Adults Patients during Computed Tomography Exanimations

Afaf M. A. Medani, Sharyfah S. S. Alasiri
Department of Radiological Sciences, College of Applied Medical Sciences, King Khalid University, Abha, Saudi Arabia

Submitted: 01-10-2021 Revised: 12-10-2021 Accepted: 15-10-2021

ABSTRACT:
The aim of this study to estimate the effective dose during common Computed Tomography exanimations in Khartoum state – Sudan,Total of 621 patients (364 female and 257 male) their age ranged from 19 till 99 years. The selected Computed Tomography scan was brain, chest, abdomen and pelvis.
The effective dose found 1.93 mSv for brain (1.98 mSv for male and 1.87 mSv for female), in CT Chest the effective dose was 3.58 mSv (3.57 mSv for male and 3.59 mSv for female), for abdomen was 5.69 mSv (5.25 mSv for male and 6.13 mSv for female) and for pelvis the E found 7.14 mSv (8.04 mSv for male and 6.23 mSv for female).
This study recommends that the CT technologist should well trainee to get the best strategies available for reducing radiation dose, and the patient’s Dose must be monitored regularly.
Keywords: CT dosimetry, computed tomography dose index, doselength product, effective dose

I. INTRODUCTION:

Computed tomography (CT) is one of the most heavily used diagnostic image procedures. Multidetector CT scanners have remarkably improved the throughput of the CT examinations, making CT examination readily accessible. Radiation exposure during a single CT examination is relatively high, compared with most of the other X-ray examinations. Consequently, CT has become the largest source of the radiation exposure to the patients. The risk of developing malignantdiseases related to CT imaging is reported to be significant with the current level of radiation exposure originated from CT examination [1].Major technological advances of CT over the last decade include the introduction of multidetector CT, dual-source CT scanners, and increased x-ray tube rotation speeds [2,3].With dual source CT systems, it is now possible to scan a complete adult chest with ectrocardiogram synchronization in less than 1 second (>40 cm/s) and achieve a temporal resolution of 75 ms for an individual CT image [4].

It is likely that technical advances in CT will continue to occur and that clinical applications will expand in the foreseeable future. There is little doubt that most patients benefit from the diagnostic information obtained from the clinical use of this imaging modality [4,5]. Marked improvements in diagnostic imaging performance of CT have been accompanied by increased concern regarding higher radiation doses and corresponding patient risks [6-8], Radiation doses in CT are markedly higher than in conventional radiography.

The first role in the principle of radiation protection for medical imaging is the need to balance between the benefit and risk of any patient exposure which called justification [9]. so, it is essential that, the technologist should understand the radiation risks associated with radiological examinations, and the relation between these risks and the patient’s information gender and age [10,11]. The main concerning is then due to the significant radiation dose delivered to the radiosensitive organs, thyroid, eye lens and breast because they will be irradiated during radiological procedures of the cervical spine, head and chest [12-14].

The effective dose is a radiation descriptor that may be used to characterize radiation exposures to patients undergoing computed tomographic (CT) examinations, where radiation levels are well below threshold doses required to induce deterministic effects. (The effective dose E, defined in publication 60 of the International Commission on Radiological Protection [15], and the effective dose equivalent H , defined in publication 26 of the International Commission of Radiological Protection [16], are conceptually identical but use different organ-weighting factors; E and H_E are interchangeable in this article.) The magnitude of the effective dose is related to the stochastic radiation risks of cancer induction and the production of genetic effects.

National and international organizations are using the effective dose to quantify exposures of patients to radiation in diagnostic radiology

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[17,18]. The aim of the study is to estimate the pediatric radiation dose during Computed Tomography Procedures.

II. METHODOLOGY:

CT scanners that participated in this study are helical CT scanners in five hospitals. All scanners displayed volume Computed Tomography Dose Index (CTDI) and Dose Length Product (DLP). The data were collected from each CT scanner. All quality control tests were performed to the machines prior to any data collection. All the data were within an accept.

Population of the study: Total of 621 patients (364 female and 257 male) their age ranged from 19 till 99 years.

CT dose measurements

Radiation dose indicators CTDIvol and DLP can be obtained from a dose summary page, which includes information about the CT exam. CTDIvol 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 [19]. DLP, an indicator of the dose imparted to the patient, is calculated by multiplying CTDIvol times the scan length. In addition to being affected by the issues associated with CTDIvol, DLP can be problematic in a limited scan range [20].

Calculation of Effective dose

CT scanners record the radiation exposure as a DLP in mGy.cm. the determination of external exposure to the patient is basically from the CT scan that generates the x-ray. As referred to ICRP publication 102 [21], external exposure will determine using the CT Dose Index (CTDI) and Dose Length Product (DLP) value which can have obtained direct from screen computer scan. The effective dose, E for external exposure was then calculated according to equation [21].

$E= k \times DLP$

where k is coefficient based on empirical weighting factor, which functional of the anatomical region scanned (mSv.mGy-1.cm-1) in ICRP 102 [21] and k=0.015 for trunk.

III. RESULTS:

Table 1. show demographic information for all patients:

Exam	Age years	High cm	Weight kg
Brain	45.83 ± 15.25 19-91	159.55± 9.30 118-190	67.05 ± 13.75 35-110
Chest	39.12 ± 11.20 20-89	164.55± 9.30 122-191	61.15 ± 10.82 30-95
Abdomen	47.25 ± 19.10 20-90	163.12 ± 9.30 123-189	63.10 ± 11.16 33-115
Pelvis	44.63 ± 16.25 22-91	159.55± 9.30 118-190	60.90 ± 11.64 30-114

Table 2. show dose parameter for all patients according to CT scan:

Exam	Tube Voltage	Tube Current	CTDIvol mGy	DLP mGy.cm
Brain	120.60±6.7 100-130	220±150 11-721	48.62±25.7 1.6-99.5	944.7±654 52-3049
Chest	120.3±6.4 100-130	127.17±96.12 17-350	8.2±6.6 0.6-31.3	256.8±260 10.9-1205.9
Abdomen	119.1±54.9 80-130	126.8±112.5 19-339	8.62±8.4 0.9-27.6	350.09±385.8 17-1508
Pelvis	120.29±6.7 110-130	146.5±144 15-490	13.79±20.7 1-75	536±940 1.3-4548.7

Table 3. show statistical parameters of effective dose for all patients:

Exam	Gender	Mean	STD	Median	Min	Max	3d Quartile
Brain	**Male**	1.98	1.37	1.42	0.11	6.40	3.28
	Female	1.87	1.26	1.36	0.02	5.14	2.99
Chest	**Male**	3.57	2.84	2.89	0.37	11.49	4.76
	Female	3.59	3.64	2.60	0.15	16.88	4.39
Abdomen	**Male**	5.25	5.79	2.70	0.03	22.63	6.52
	Female	6.13	6.26	3.34	0.59	21.71	6.48
Pelvis	**Male**	8.04	14.11	2.40	0.02	68.23	7.04
	Female	6.23	9.73	2.93	0.02	52.23	6.53

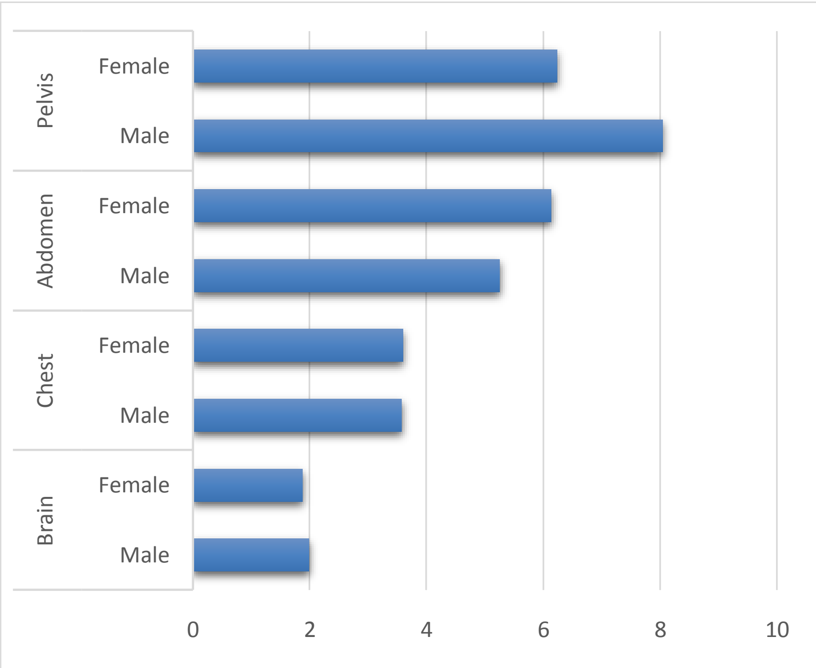

Fig. 1. show compare of effective dose for all CT scan with patients' gender

IV. DISCUSSION:

CT examinations in adult patients have contributed greatlyto the diagnosis of different diseases; however, the radiationexposure to the patient is significantly higher compared with

other radiologic examinations.Table 1. show demographic information for all patients where the data presented as mean, standard deviation minimum and maximum, for patients age, high and weight to the four CT exam brain, chest, abdomen and pelvis. For CT brain the mean ± STD for age was 45.83 ± 15.25, for patients high 159.55± 9.30 and for patients' weight was 67.05 ± 13.75. for CT chest the age was 39.12 ± 11.20, for high 164.55± 9.30 and for patients' weight 61.15 ± 10.82. for CT abdomen the mean was 47.25 ± 19.10, the patients high was 163.12 ± 9.30 and patients' weight 63.10 ± 11.16. for CT pelvis for patients age 44.63 ± 16.25 year, high 159.55± 9.30 cm and for patients' weight was 60.90 ± 11.64 kg.

Table 2. show information of dose parameters for all patients per exam, where the dose parameters were tube voltage, tube current, CTDIvol and dose length product. For CT brain the tube voltage was 120.60 ± 6.7, tube current 220 ± 150, CTDIvol 48.62 ± 25.7 and for DLP was 944.7 ± 654. For CT chest the tube voltage was 120.3±6.4, tube current 127.17±96.12, CTDIvol 8.2±6.6 and for DLP was 256.8±260. For CT abdomen the tube voltage was 119.1±54.9, tube current 126.8±112.5, CTDIvol 8.62±8.4 and for DLP was 350.09±385.8. For CT pelvis the tube voltage was 120.29±6.7, tube current 146.5±144, CTDIvol 13.79±20.7

and for DLP was 536±940.

The effective dose considers the important unit of patient's dose, here we present the statical

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parameters for effective dose shown as mean, median, standard deviation, minimum, maximum and third quartile for all patients and for male and female patients separately in table 4. The effective dose found 1.93 mSv for brain (1.98 mSv for male and 1.87 mSv for female), in CT Chest the effective dose was 3.58 mSv (3.57 mSv for male and 3.59 mSv for female), for abdomen was 5.69 mSv (5.25 mSv for male and 6.13 mSv for female) and for pelvis the E found 7.14 mSv (8.04 mSv for male and 6.23 mSv for female). As shown in table 3. And fig1.

V. CONCLUSION:

CT examinations in adult patients have contributed greatlyto the diagnosis of different diseases; however, the radiationexposure to the patient is significantly higher compared with

other radiologic examinations.the demographic information for all patients where the data presented as mean, standard deviation minimum and maximum, for patients age, high and weight to the four CT exam brain, chest, abdomen and pelvis

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