RADIATION DOSE RISKS ESTIMATIONS ASSOCIATED WITH COMMON CT EXAMINATIONS OF CHEST IN SOME OF IRAQI GOVERNATES

Iskander Ali Aziz¹, Aysar Sabah Keiteb², Amal Faisal Jaffar³

¹Diyala Health Department / Radiology Unit / Diyala, Iraq
²Middle Technical University (MTU), College of Health and Medical Technology, Dept. Radiology Technology / Baghdad, Iraq
³Middle Technical University (MTU), Institute of Medical Technology - Baghdad

e-mail: draysaralnidawi@mtu.edu.iq

ABSTRACT

Purpose: To estimate how much radiation exposure can be associated with CT examinations of the chest. The study is associated with that most commonly performed in Bagdad, Diyala, and Babylon region hospitals, in order to assess the radiation dose and to determine, whether it is within the permissible levels set buy CT scan machine manufacturers, and to estimate variation across study types, patients, and Hospitals, and to find out the best type of CT device that gives the least dose exposure of radiation among the three used machines.

Methods: This study was conducted on 147 consecutive patients (75 males and 72 female) at an age ranged 2-90 years cases, were examined by three CT scan companies; (Toshiba, Siemens, and Philips) The examinations were conducted for the chest in each device. Dose information were taken from the protocols designated for each machine, which is the calculation of DLP, CTDI of each CT machine. And comparing it with global doses to know the dose for each device. Also, use the dosing meter to examine the dose directly for each patient, which is a type of Gama Scout. It was also compared to the global doses of Table 103 for the year 2007.

Results: The DLP was compared with each device data, after converting the recorded dose to millisieverts for each device to identify the average dose, the following values were obtained, The Toshiba, Philips and Siemens, 10.046 mSv, 9.814 mSv, 5.171mSv respectively.

Conclusions: The results of the study showed that; amount of radiation exposure was higher than the permissible limit according to the radiation protection law in 3 governorates for the chest examination, the study also found a disparity between the devices, and Siemens CT machines, found to be the lowest in terms of dose exposure limits.

Keywords: Computed tomography (CT)

I. INTRODUCTION

Computed tomography CT is more accurate and rapid than other imaging techniques, making it very suitable for detecting and excluding a medical condition. the application of its use has led to improved cancer, trauma, stroke, and cardiac diagnosis and treatment [1]. CT is now widely used in medical imaging because of these factors. The usage of CT scans has dramatically increased in the last three decades as a result of advances in this imaging technology [2]. [3][4].

With widespread adoption of CT scanning, there is an increased risk of increasing radiation exposure to patients. Despite the fact that natural radiation exposure has remained the same, the amount of radiation exposure to the general population has doubled over the last 30 years [5]. Based on data from various national surveys, CT provides a substantial portion of the collective dose from medical exposure, and exposure from this procedure causes substantial radiation exposure.
While several studies have focused on determining the increased risk of radiogenic cancer incidence due to the total effective doses from CT scans, more are needed to evaluate this risk accurately. Most of these reports have used CT dose index volume and dose length product; these values are preliminarily determined by the manufacturer using standardized 16- and 32-cm phantoms, and are usually displayed on the console when performing CT scans [6][7][8][9][10]. It has been shown that the dosage-indicating phantoms used in this study do not replicate real patient absorption since they are created using synthetic phantoms of equal attenuation, and their sizes are predetermined [6]. Additionally, the tissue composition of real human bodies is heterogeneous, and the cross-sectional diameter is highly variable. To estimate the risk of radiation effects from diagnostic CT scans in individual patients and evaluate the radiation risks appropriately, it is important to know the doses to individual organs in addition to the effective doses [11][12][13].

The CT dosimetry concept is important and is effectively communicated to both the public and hospital personnel alike by detailing the doses in CT [14].

Computed Tomography (CT) scans of the chest and abdomen and brain are important because they provide accurate information about the doses that affect the organ and consequently determine the radiation risk, which commonly results in cancer and other health effects[15].

A computerized axial tomography (CAT) scan is a technique of acquiring images of the body utilizing rotating x-ray equipment and a digital computer. CT imaging may be used to generate cross-sectional images of internal organs and tissues. Despite the fact that there are a variety of imaging techniques available, CT imaging is unique in that it can provide crisp images of a wide range of issues. CT imaging can provide pictures of soft tissue, bone, muscle, and blood arteries without sacrificing resolution. Other imaging methods are considerably more restricted in terms of the kinds of pictures they can produce. Consider ahead x-ray to better grasp the differences between CT imaging and other methods. The bone structures of the skull may be seen using simple x-ray methods. Blood vessels and soft tissue may be seen using magnetic resonance imaging (MRI), but good, detailed pictures of skeletal structures are not possible. X-ray angiography, on the other hand, may reveal the blood arteries of the skull but not soft tissue. CT imaging of the skull may show not just soft tissue but also bones and blood arteries in detail. CT imaging is often utilized in diagnostic procedures. It is, in fact, a primary imaging technique for detecting a number of malignancies, including those of the lungs, pancreas, and liver. Physicians may use CT imaging to not only confirm the presence of tumors, but also to identify their sites, precisely quantify tumor size, and detect whether cancers have migrated to adjacent tissues. CT imaging is used for planning and delivering radiation cancer treatments, as well as arranging some kinds of operations, in addition to diagnosing specific malignancies. CT imaging is a useful tool for the diagnosis and treatment of musculoskeletal diseases and accidents because it provides excellent pictures of bone, muscle, and blood vessels. It's often used to assess the bone mineral density and identify internal organ damage. CT imaging is also utilized for the detection and treatment of certain vascular disorders that, if left untreated, may lead to renal failure, stroke, or death. CT scanning is a painless procedure. Some people, on the other hand, maybe bothered by the need to lay motionless for an extended length of time. A well-trained CT technician usually performs the operation. [16].

The present study has been carried out in Iraqi hospital for the X-Ray Institute in the medical City Complex in Baghdad and Diyala and Babylon Hospitals.

Chest CT

The patient is exposed to a total of thirty to four hundred chest X-rays when the CT scan is focused on the chest. An additional 5,300 cases of lung and breast cancer may develop during the next two to three decades as a consequence of the increased use of chest CTs and CT angiography. Some additional models estimate that as many as 1 in 150 young women who have a chest CT angiogram, and 1 in 270 women (total) who undergo the procedure, will be diagnosed with breast cancer. It is worth noting that a variety of studies have shown evidence of malignant tumor development in women who have been exposed to high doses of ionizing radiation. Frequent fluoroscopy, as well as radiation exposure, was associated with an increased risk of breast cancer.

Therefore, it was discovered that breast tissue had a high susceptibility to radiation. This is shown in the updated radiation tissue risk factors recommended by the International Commission on Radiation Protection (ICRP). Their weight factor for the breast was increased from 0.05 to 0.12 in the most recent ICRP report. Although it is a
rare occurrence, it is possible to have the breast included in the scan region of diagnostic thoracic computed tomography (CT).

Given the sensitivity of the glandular tissue to radiation and the fact that the breast is not a target for imaging, it is possible that damage may occur. The estimated CT chest scan average glandular dose is about 5cGy.[17].

**Radiation Risk during CT Chest**

Many patients have indeed benefitted from CT’s quick diagnosis as well as from its use in monitoring chronic illness. There are, however, growing worries regarding the danger of excessive radiation exposure. Due to both the deterministic and stochastic nature of radiation, it is widely accepted as a hazardous chemical that may have both deterministic and stochastic consequences. Hair loss, skin bumps, and cell death are dose-dependent deterministic consequences, which occur when a dosage is reached. The dosage at which this effect begins is somewhere between 150 and 200 mSv. The average estimated Dose of CT imaging is between 2-10 mSv, making deterministic consequences unlikely. Cancer is unpredictable (stochastic) when it comes to the impact of radiation, rather than deterministic. Another way of saying the same thing is that increased radiation doses are connected with an increased risk of Carcinogenesis, but even low amounts of radiation may cause Carcinogenesis, making it more difficult to determine a safe radiation dosage. [17].

**II. PATIENTS AND METHODS**

**Patient selection**

From October 1, 2020 to April 15, 2021, an exploratory study was conducted on 147 consecutive patients being examined by a CT scan divided into 3 CT devices, namely Toshiba, Siemens, and Philips, and it was distributed over three governorates in Iraq: Baghdad, the Radiology Institute, Baghdad Teaching Hospital, and Medina Medicine: Oncology Hospital, Diyala Governorate, Baquba Teaching Hospital, Specialized Surgery Hospital in Baquba General Hospital, Babil Governorate, Al-Hashmiyat General Hospital, and Al-Qissem Hospital to detect the radiation risks they are exposed to during the examination by CT scan of the above devices, three areas of the body were taken, which are the most common in the examination, they are, the head, the chest, and the abdominal area. And the devices had the same type of specifications, namely,

1. MDCT Philips Brilliance, 64 slice, 2009, Holland, Installation date 2011.
2. MDCT SIEMENS SOMATOM Definition AS, 64 slice, 2009, Germany, Installation date 2010.
3. MDCT TOSHIBA Aquilion, 64 slice, 2009, Japan, Installation date 2009.
4. Dosimeter GAMMA SCOUT, the leading device to measure radiation, Germany, 2014.

**Inclusion criteria**

The patients were distributed according to the examination of chest for each apparatus.

The chest area in the Philips device was 69 patients, the Siemens device was 37 patients, and the Toshiba device had 41 patients.

All preparations protocols were taken for the devices in terms of doses, as well as taking the dose meter readings for each patient in each type of device, Standard doses were taken for patients without Contrast media.

**Exclusion criteria**

1- Six patients aged less than 15 years were excluded because they were not included in the dose-for-weight principle (BMI).

2- Patients who required additional doses were excluded by giving them Contrast media.
Figure Error! No text of specified style in document. 1A: Explain the phillips device.

Figure 1B: protocol of the phillips device.

Error! No text of specified style in document. 2A: Explain the Siemens device.

Figure 2 B: protocol of the Siemens device.
III. RESULT

Doses were evaluated for each device depending on the protocol used for each device, which is DLP. The CT DI was compared with each device as well as the DLP, and after converting the dose to millisieverts for each device to know the average dose, the following was found: the results of Toshiba for the chest were (10.04 msv), while the dosing results for the Philips device for the chest region (9.8 msv). While the results of the Siemens device were, (5.16 msv) for the chest region.

Radiation dose analysis

Results have been compared to International Commission on Radiological Protection (ICRP103, from 2007). CT head = mean (1.7 msv), (Min–max) (0.9–2.6). CT chest = mean (7 msv), (Min–max) (4.6–10.1).

Figure 1: show distribution of DLP in Philips device with body mass index (BMI), for normal or underweight DLP (409.94 mGy*cm), with percentage of (14%), for overweight, DLP (484.55 mGy*cm), with percentage of (56.2%), for obese, DLP (559.18 mGy*cm). with percentage of (29.6%). The mean differences of DLP according to body mass index (PHILIPS). (P=0.001 *)
Figure 2: show distribution of DLP in SIEMENS device with body mass index (BMI), for normal or underweight DLP (247.85 mGy*cm), with percentage of (21.6%), for overweight, DLP (243.41 mGy*cm), with percentage of (52.7%), for obese, DLP (295.91 mGy*cm) with percentage of (27.7%). The mean differences of DLP according to body mass index (SIEMENS).

Figure 3: show distribution of DLP in TOSHIBA device with body mass index (BMI), in green column the DLP (482.42 mGy*cm), with percentage of 25%), for overweight, DLP (456.85 mGy*cm), with percentage of (47.5%), for obese, DLP (600.65 mGy*cm). with percentage of (27.5%). The mean differences of DLP according to body mass index (TOSHIBA).

(P=0.005*)

Table 1: The mean volume computed tomography dose index CTDIvol Values in chest CT, for Toshiba 17.02±2.05mGy, and DLP 502.31±123.28mGy*cm, the mean effective dose values 10.046mSv, Dosimeter Reading 7.29mSv .While in Siemens device the CTDIvol Values 8.53±2.99mSv , DLP 258.56±91.50 mGy*cm, the mean effective dose values 5.171 mSv , Dosimeter Reading 7.28 mSv, and in Philips device the CTDIvol Values 14.16±3.18mSv, DLP 490.74±114.68mGy*cm, the mean effective dose values 9.814 mSv, Dosimeter Reading 10.45mSv.
Data of radiation dose from 3 device in CT scan of chest, where the study shows the lowest dose of Siemens device.

IV. DISCUSSION

As a result of the widespread use of multi-detector CT epidemic radiation dose is a concern in CT and the overall radiation burden on the population is increasing. Most importantly, tomography of the chest, head and abdomen entails irradiation of the breast tissue, the thyroid gland which is one of the most sensitive organs of the body to radiation.

Data of radiation dose from 3 device in CT scan of the chest. The mean volume computed tomography dose index CTDIvol Values in chest CT, for Toshiba 17.02±2.05mGy, and DLP 502.31±123.28mGy.cm, the mean effective dose values 10.046mSv. While in Siemens device the CTDIvol Values 8.53±2.99mSv, Toshiba 7.29 mSv, DLP 258.56±91.50 mGy.cm, the mean effective dose values 5.171 mSv. Reading 7.28 mSv, and in Philips device the CTDIvol Values 14.16±3.18mSv, DLP 490.74±114.68mGy.cm, the mean effective dose values 9.814 mSv. Reading 10.45mSv. The study was similar with [18] in Korea, In terms of the Siemens and Philips device, as for the Toshiba device, it is completely different, as the dose was much higher than the Korean study. The results of our study showed that the lowest dose was represented by the Siemens device Also, our study showed a procedure for the first time taken, which is to measure the effective radiation directly from the device by means of the Kama-Scott device. This study is new and it was also conducted for 3 devices with the same steps.

REFERENCE