<u>Original Research Article</u>

Chest CT Dose Examination for Adult Patient in Abuja and Keffi, Hospitals in Nigerian

Abstract

This study has established local diagnostic reference levels (LDRLs). Dose report and scan parameters for chest was assessed during the period of seven months at the three study centres. Data on CT Dose index (CTDIw) and dose length product (DLP) available and achieved on CT scanner control console was recorded for a minimum of 10 average sized patients for each facility to established a local Diagnostic reference level (LDRLs) and radiation dose optimization Data was collected using a purposive sampling technique, from 131 adult patients weighing 70±3kg) from Philip brilliance, Toshiba Alexion and General Electric (GE) CT scanners for this study. Third quartile values of the estimated LDRLs for CTDIw and DLP was determined as 10.9 mGy and 432.8 mCy*cm. The mean CTDIw obtained are lower to the reported data from the European Commission of 30 mGy. The mean DLP are comparably lower than all the reported value from the European commission of 650 mGy/cm. Therefore, there is no any clinical implication and hence CT dose optimization is recommended.

Keywords: Radiation Dose, MSCT, VGA, CTDIv, CTDIw, DLP, LDRL.

1. Introduction

The term "computed tomography" (CT) is often used to refer to X-ray CT, because it is the most commonly known form. But, many other types of CT exist, such as positron emission tomography (PET) and single-photon emission computed tomography (SPECT). X-ray tomography, a predecessor of CT, is one form of radiography, along with many other forms of tomographic and non-tomographic radiography. CT produces data that can be manipulated in order to demonstrate various bodily structures based on their ability to absorb the X-ray beam. Use of CT has increased dramatically over the last two decades in many countries [1]. Lower radiation doses are often used in many areas, such as in the investigation of renal colic [2]. Side effects from intravenous contrast used in some types of studies include the possibility of exacerbating kidney problems in the setting of pre-existing kidney disease [3].

Since its introduction in the 1970s, CT has become an important tool in medical imaging to supplement X-rays and medical ultra sonography. It has more recently been used for preventive medicine or screening for disease, for example CT colonography for people with a high risk of colon cancer, or full-motion heart scans for people with high risk of heart disease. A number of institutions offer full-body scans for the general population although this practice goes against the advice and official position of many professional organizations in the field primarily due to the radiation dose applied [4]. The radiation dose reported in the gray or mGy unit is proportional to the amount of energy that the irradiated body part is expected to absorb, and the physical effect (such as DNA double strand breaks) on the cells' chemical bonds by X-ray radiation is proportional to that energy [5]. The sievert unit is used in the report of the effective dose. The sievert unit, in the context of CT scans, does not correspond to the actual radiation dose that the scanned body part absorbs but to another radiation dose of another scenario, the whole body absorbing the other radiation dose and the other radiation dose being of a magnitude, estimated to have the same probability to induce cancer as the CT scan [6] Thus, the actual radiation that is absorbed by a scanned body part is often much larger than the effective dose suggests. A specific measure, termed the computed tomography dose index (CTDI), is commonly used as an estimate of the radiation absorbed dose for tissue within the scan region, and is automatically computed by medical CT scanners [7]. The thorax or chest is a part of the anatomy of humans and various other animals located between the neck and the abdomen [8]. The thorax includes the thoracic cavity and the thoracic wall. It contains organs including the heart, lungs, and thymus gland, as well as muscles and various other internal structures. Many diseases may affect the chest, and one of the most common symptoms is chest pain [9]. In humans and other hominids, the thorax is the chest region of the body between the neck and the abdomen, along with its internal organs and other contents [10]. It is mostly protected and supported by the rib cage, spine, and shoulder girdle. In the human body, the region of the thorax between the neck and diaphragm in the front of the body is called the chest [11]. The corresponding area in an animal can also be referred to as the chest. The shape of the chest does not correspond to that part of the thoracic skeleton that encloses the heart and lungs [12]. All the breadth of the shoulders is due to the shoulder girdle, and contains the axillae and the heads of the humeri [13]. In the middle line the suprasternal notch is seen above, while about three fingers' breadth below it a transverse ridge can be felt, which is known as the sternal angle and this marks the junction between the manubrium and body of the sternum [13]. Level with this line the second ribs join the sternum, and when these are found the lower ribs can often be counted [13]. At the lower part of the sternum, where the seventh or last true ribs join it, the ensiform cartilage begins, and above this there is often a depression known as the pit of the stomach [14].

2. Materials and Methods

2.1. Materials

The materials requirements for the conduct of this research were included;

i. Computer tomography scanner machines located at the study centers.
ii. Data Collection Sheet
iii. SPSS version (20) software for data analysis
iv. Ethical clearance from the participated hospital that allowed this research to be conducted.

2.1.1. Study Area

Fig. 1: Map of Federal capital Territory (FCT) Abuja, Showing the Study Area

Fig. 2: Map of Keffi Showing the Study Area

2.2.Methods

The study adopted a retrospective and quantitative design to determine the absorbed radiation dose to patient undergoing CT scan of the chest. A quantitative design was appropriated because the study involved the uses of numerical data.

2.2.1. Study Population

The study consisted of all adult patients that attended for CT scans examinations of chest.

2.2.2. Data Collection

The data was collected with the assistant of the CT radiographers who are well trained on how to collect the data.

2.2.3. Sample Size

A simple size (26) participant patient was recruited for chest CT in the study. This was obtained through selection of 16 participants from centre A, 10 participants from centre C and zero participants from centre B that come for CT examination on the chest in center A, B and C respectively.

2.2.4. Inclusion Criteria

i. Only adult patients weighing in the range of 67 to 73kg were included in the study [15].
ii. Only adult patients that attended for routine CT scans of chest CT scan examination was considered.
iii. Data was acquired on a CT scanner that was calibrated by the Nigeria Nuclear Regulatory Authority (NNRA).

2.2.5. Exclusion Criteria

i. Patient that attended for non-routine CT procedure such as CT angiography, CT colonography.
ii. Patients with weight above or below the specified limit [16].
iii. CT scanner that was not calibrated by the Nigeria Nuclear Regulatory Authority (NNRA).

2.3. Data Analysis

According to [17], the MSAD for non-spiral scans can be estimated from the CTDI by the equation:

$$\text{MSAD} = \frac{NXT}{I}(CTDI) \qquad 1$$

Where N is the number of scans, T is the nominal scan with (mm), and I is the distance between scans (mm). For MSCT system, N X T is the total nominal scan width, and I correspond to the patient table movement during 1 gantry rotation. According to the work of [18], the MSAD for spiral scans can be expressed as:

$$\text{MSAD} = \frac{I}{Pitch}(CTDI) \quad 2$$

$CTDI_{Vol}$

According to [17,18], $CTDI_{Vol}$ for single-Slice scanners is defined as:

$$CTDI_{vol} = \frac{NXT}{I}(CTDIw) \quad 3$$

When N is the number of scans, T is the nominal scan width (mm) and I is the distance between scans (AAPS). Also, $CTDI_{vol}$ for MSCT is defined as:

$$CTDIvol = \frac{I}{Pitch}(CTDIw) \quad 4$$

3. Results and Discussion

3.1. Result

Table 1. Description of the Scanners for all Centres

Centres	Scanner	Model	Number of Slides	Manufactured Year	Installed Year
A	Phillip	Brilliance	16	2008	2009
B	Simen	Alexion	32	2015	2015
C	General Electric	Bright Speed	16	2008	2014

Table 2. Patients Description

Centres	Average Age (years)	Average Weight (Kg)	Number of Male	Number of Female	Total Number of Patients
A	54.0±11.5	75.4±19.5	NA	NA	NA
B	NA	63.3±5.4	5	5	10
C	60.8±11.7	NA	6	10	16

Table 3. Scan Parameters for all Centres

Scan parameters / Centres	kV	mA	mAs	Scan Range	CTDIw (mGy)	DLP (mGy*cm)
A	120	NA	153.3±12.5	362.7±38.6	10.8±0.87	431.0±91.96
B	NA	NA	NA	NA	NA	NA
C	100	108.2±38.1	NA	342±35.6	10.7±2.58	442.6±139.81
Mean					**10.8±1.8**	**435.6±113.6**

3.2. Result Analysis

In order to analyze the results obtained and presented in Table 1, charts were plotted and comparison was made with European Commission for all the CT Dose Measurement Parameters.

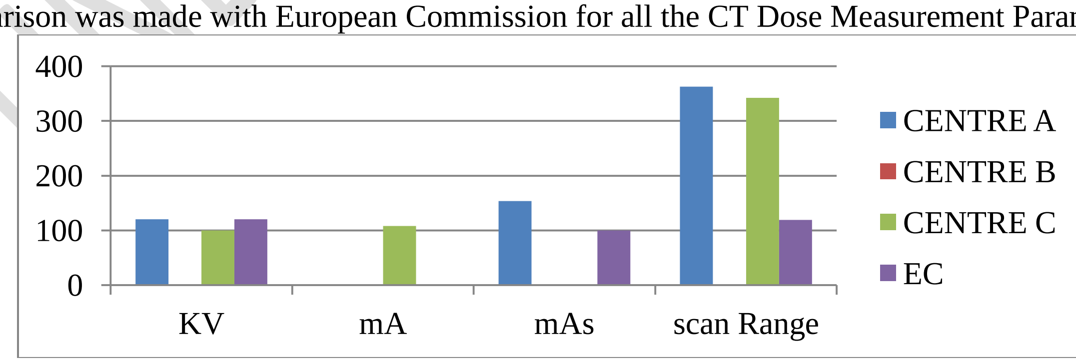

Fig 3: Comparison of Chest CT Scans Parameters between the Study Centres.

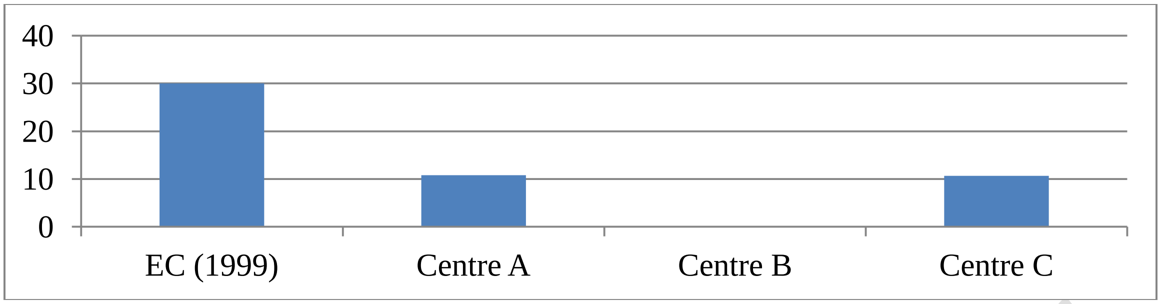

Fig 4: Comparison of Chest CTDIw (mGy) with European Commission for the study centres

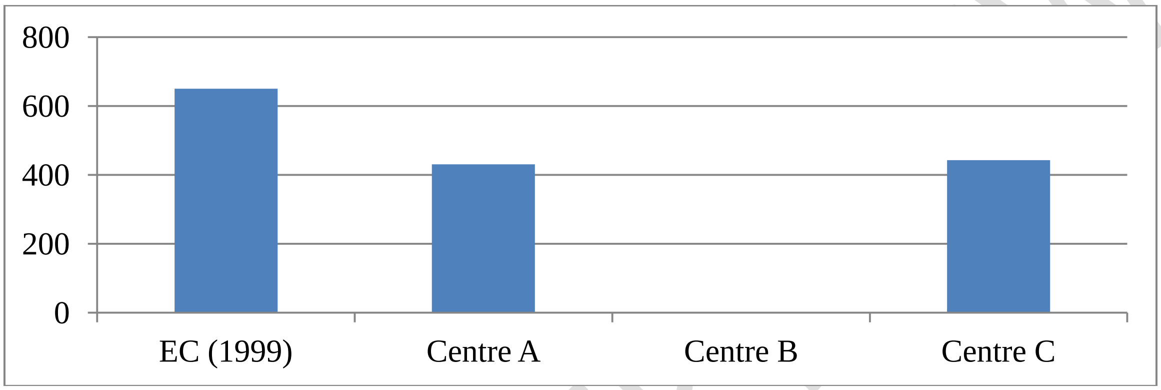

Fig 5: Comparison of Chest DLP (mGy*cm) with European Commission for the study centres.

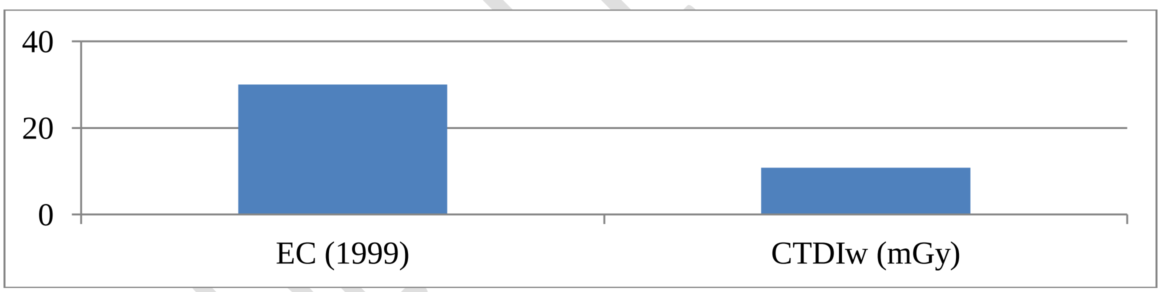

Fig 6: Comparison of Mean Chest CTDIw (mGy) with European Commission

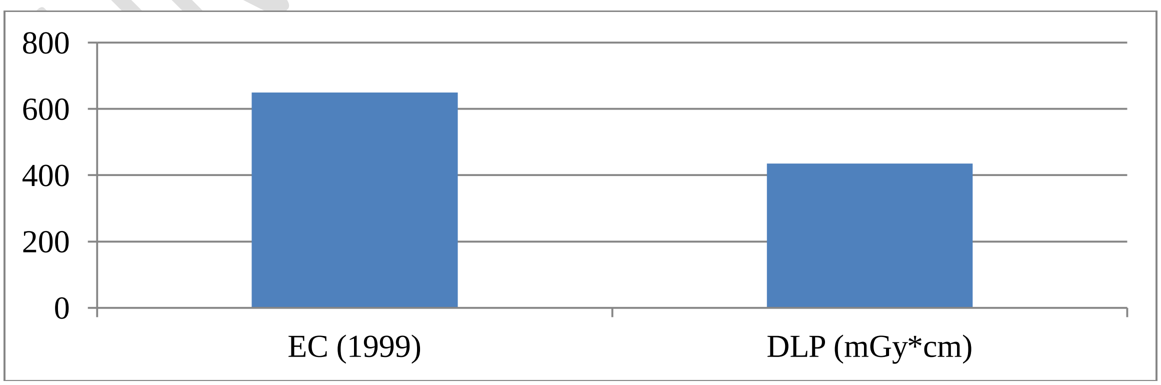

Fig 7: Comparison of Mean Chest DLP (mGy*cm) with European Commission

3.3. Discussion.

This study determined the CTDIw and DLP for adult pertinent undergoing routine chest CT scan in three Nigerian hospitals one located in Keffi, Nasarawa State while the other two are located in Abuja Federal Capital territory (FCT). Potential Local diagnostic reference levels were established.

From the result obtained above, Chest CT at centre (A & B) has the higher and same CTDIw value followed by centre (B) respectively. Meanwhile, the highest DLP values were noted at centre (C) then Centre (A) and finally, centre (C) respectively.

In comparison with the European Commission values, it can be seen clearly from Fig 4 and 5 that all the CTDI and DLP values are lower than the EC values.

Since the mean in Fig 6 and 7 shows that the values for both CTDI and DLP are lower than the European Commission values, it can be concluded that the CTDI and the DLP in most of the study centres are within or below the values in the European Commission Report. Therefore, there is no serious clinical implication on the participants in the study centres. Hence, CT dose optimization is recommended.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

4. References

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