



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

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Authors' contributions

This work was carried out in collaboration among all authors. Author UR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors UR, GCO and IU managed the analyses of the study. Authors UR, LKS and HAA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

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). This study was carried out in the north central part of Nigeria which includes Abuja and Keffi (Nasarawa State). This study has established local diagnostic reference levels (LDRLs). Dose report and scan parameters for chest was assessed during the period (January – July, 2016) of seven months at the three study centres (A, B and C in which two are located in Abuja and the other one (C) located in Keffi. Data on CT Dose index (CTDI_w) 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 establish a local Diagnostic reference level (LDRLs) and radiation dose optimization Data was collected using

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a purposive sampling technique, from 131 adult patients weighing $70\pm 3\text{kg}$) 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 30mGy. The mean DLP are comparably lower than all the reported value from the European commission of 650mGy/cm. Therefore, there is no any clinical implication and hence CT dose optimization is recommended.

Keywords: Radiation dose; MSCT; VGA(Video Graphic Array); 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 ultrasonography. 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

This section described exactly where the study centers were located, two of the study centers were located in Abuja and the remaining one located in Keffi as shown in Figs. 1 and 2.

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. It was collected by the use data sheet which was used to record the data and Video Graphic Array which was use to display the result.

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

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

Where N is the number of scans, T is the nominal scan width (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:

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

CTDI_{Vol}

According Morin [17,18], CTDI_{Vol} for Single-Slice scanners is defined as:

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

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:

$$CTDI_{vol} = \frac{I}{Pitch} (CTDI_w) \quad (4)$$

3. RESULTS AND DISCUSSION

3.1 Results

In order to compute the result for the Chest CT Dose Examination for Adult Patient in Abuja and



Fig. 1. Map of Federal Capital Territory (FCT) Abuja, showing the study area

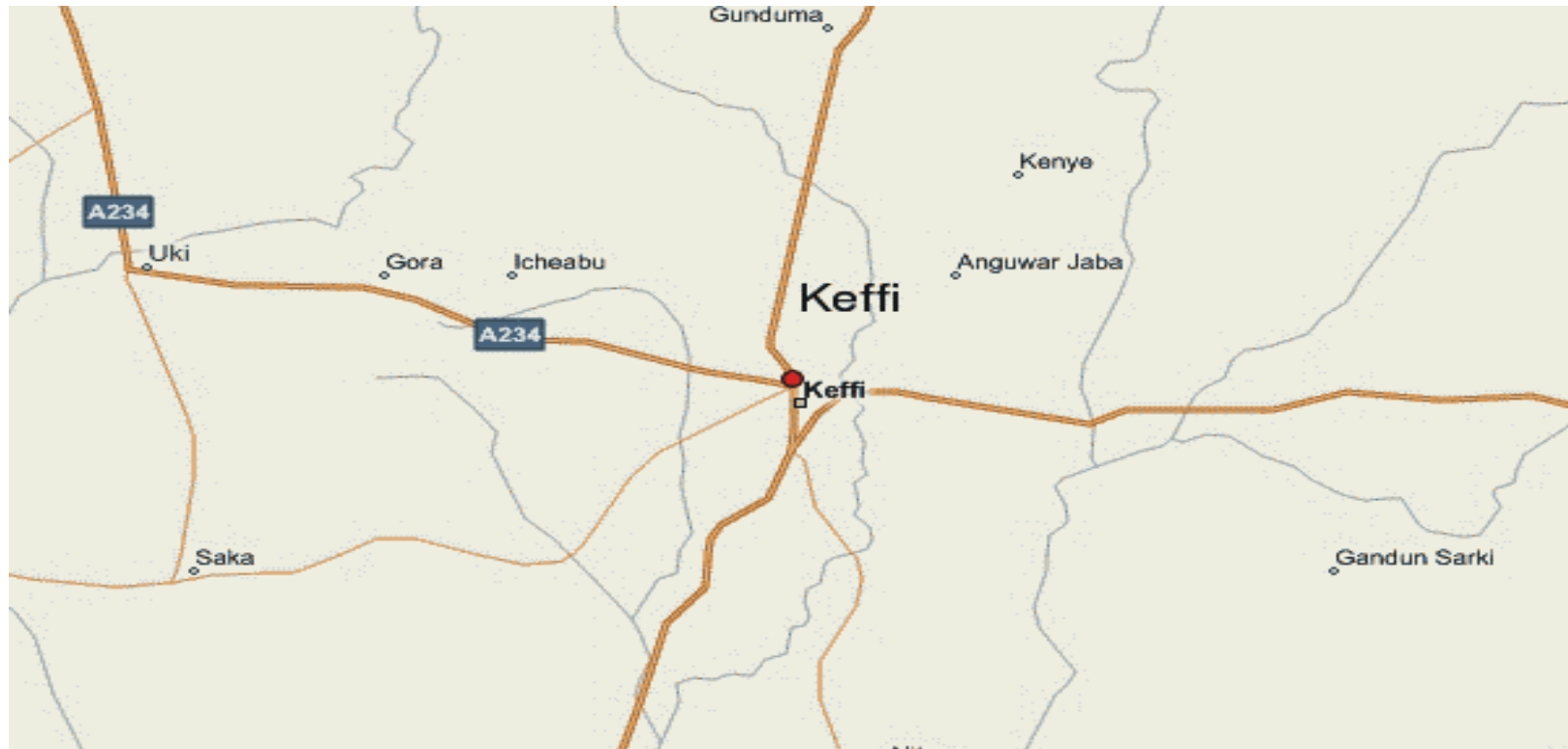


Fig. 2. Map of Keffi showing the study area

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	kV	mA	mAs	Scan range	CTDIw (mGy)	DLP (mGy*cm)
Centres						
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

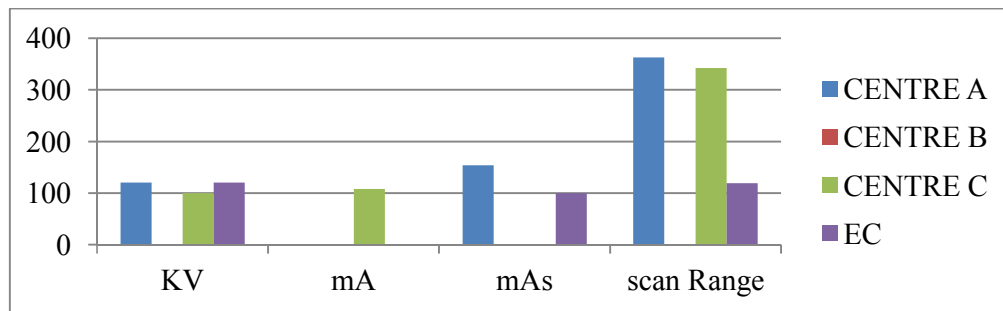


Fig. 3. Comparison of chest CT scans parameters between the study centres

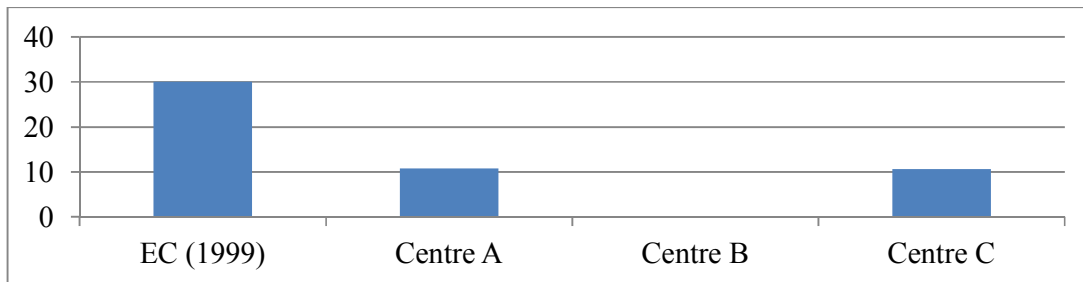


Fig. 4. Comparison of chest CTDIw (mGy) with European Commission for the study centres

Keffi, Hospitals in Nigerian, scanner type, model, number of slides, manufactured year and installed year were gathered from Abuja and

Keffi, Hospitals and presented in Table 1. Also, average age (years) and weight (Kg), number of males and females as well as total number of

patients whom attended chest CT examination within January to July, 2016 in Abuja and Keffi, Hospitals were recorded and presented in Table 2. Lastly, the scan parameters like kV, mA, mAs, Scan Range, CTDI and DLP were calculated and presented in Table 3.

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.

3.3 Discussion

This study determined the CTDIw and DLP for adult pertinent undergoing routine chestCT 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.

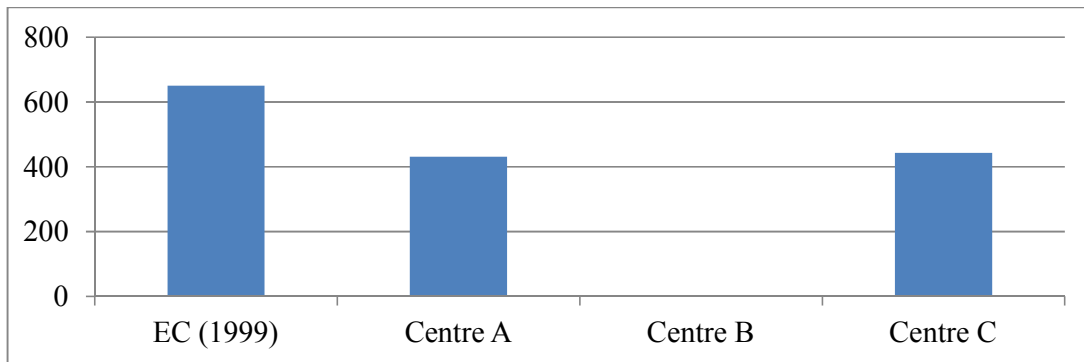


Fig. 5. Comparison of ChestDLP (mGy*cm) with European Commission for the study centres

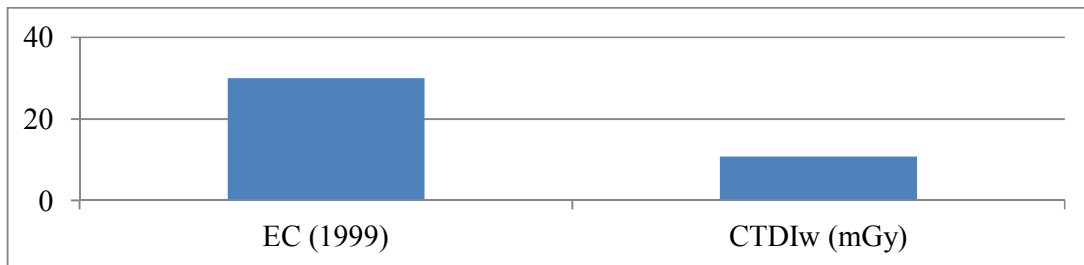


Fig. 6. Comparison of mean ChestCTDIw (mGy) with European Commission

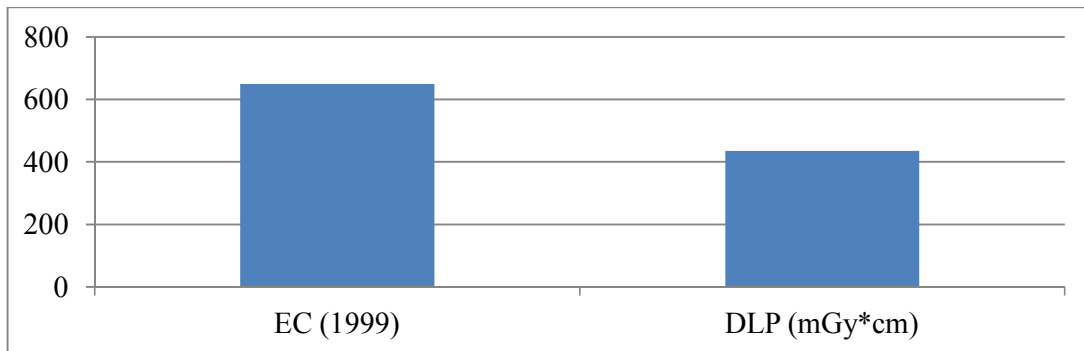


Fig. 7. Comparison of mean chest DLP (mGy*cm) with European Commission

From the result obtained above, Chest CT at centre (A& B) has the higher and same CTDIwvalue 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 Figs. 4 and 5 that all the CTDI and DLP values are lower than the EC values.

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusions

Since the mean in Figs. 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.

4.2 Recommendation

CT dose optimization is recommended.

DISCLAIMER

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.

CONSENT

As per international standard or university standard written patient consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical clearance from the participated hospital that allowed this research to be conducted.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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