Reversed Original Research Article

Abdominal 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 abdomen 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 12.7 mGy and 560 mGy*cm. The mean CTDIw obtained are lower to the reported data from the European Commission of 35 mGy. The mean DLP are comparably lower than all the reported value from the European commission of 780 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

Computed tomography of the abdomen and pelvisis an application of computed tomography (CT) and is a sensitive method for diagnosis of abdominal diseases [1]. It is used frequently to determine stage of cancer and to follow progress [2]. It is also a useful test to investigate acute abdominal pain (especially of the lower quadrants, whereas ultrasound is the preferred first line investigation for right upper quadrant pain) [3]. Renal Stones, appendicitis, pancreatitis, diverticulitis, abdominal aortic aneurysm, and bowel obstruction are conditions that are readily diagnosed and assessed with CT [4]. CT is also the first line for detecting solid organ injury after trauma [5]. CT is an accurate technique for diagnosis of abdominal diseases [6]. Its uses include diagnosis and staging of cancer, as well as follow up after cancer treatment to assess response [7]. There are several advantages that CT has over traditional 2D medical radiography. First, CT completely eliminates the superimposition of images of structures outside the area of interest. Second, because of the inherent high-contrast resolution of CT, differences between tissues that differ in physical density by less than 1% can be distinguished. Finally, data from a single CT imaging procedure consisting of either multiple contiguous or one helical scan can be viewed as images in the axial, coronal, or sagittal planes, depending on the diagnostic task. This is referred to as multiplanar reformatted imaging [8]. CT is regarded as a moderate- to high-radiation diagnostic technique [9]. The improved resolution of CT has permitted the development of new investigations, which may have advantages; compared to conventional radiography, for example, CT angiography avoids the invasive insertion of a catheter [10]. CT colonography (also known as virtual colonoscopy or VC for short) is far more accurate than a barium enema for detection of tumors, and uses a lower radiation dose [11]. CT Virtual Colonoscopy is increasingly being used in the UK and US as a screening test for colon polyps and colon cancer and can negate the need

for a colonoscopy in some cases. The radiation dose for a particular study depends on multiple factors: volume scanned, patient build, number and type of scan sequences, and desired resolution and image quality [12]. In addition, two helical CT scanning parameters that can be adjusted easily and that have a profound effect on radiation dose are tube current and pitch. Computed tomography (CT) scan has been shown to be more accurate than radiographs in evaluating anterior interbody fusion but may still over-read the extent of fusion [13].The radiation used in CT scans can damage body cells, including DNA molecules, which can lead to radiation-induced cancer [14]. The radiation doses received from CT scans is variable. Compared to the lowest dose x-ray techniques, CT scans can have 100 to 1,000 time's higher dose than conventional X-rays [15]. However, a lumbar spine x-ray has a similar dose as a head CT [16].Articles in the media often exaggerates the relative dose of CT by comparing the lowest-dose x-ray techniques (chest x-ray) with the highest-dose CT techniques. In general, the radiation dose associated with a routine abdominal CT has a radiation dose similar to three years average background radiation [17].Some experts noted that CT scans are known to be "overused," and "there is distressingly little evidence of better health outcomes associated with the current high rate of scans" [18].Early estimates of harm from CT are partly based on similar radiation exposures experienced by those present during the atomic bomb explosions in Japan after the Second World War and those of nuclear industry workers [19]. Some experts project that in the future, between three and five percent of all cancers would result from medical imaging [20].An Australian study of 10.9 million people reported that the increased incidence of cancer after CT scan exposure in this cohort was mostly due to irradiation [21]. In this group, one in every 1,800 CT scans was followed by an excess cancer. If the lifetime risk of developing cancer is 40% then the absolute risk rises to 40.05% after a CT [22].Some studies have shown that publications indicating an increased risk of cancer from typical doses of body CT scans are plagued with serious methodological limitations and several highly improbable results [23]. Concluding that no evidence indicates such low doses cause any long-term harm [24].A person's age plays a significant role in the subsequent risk of cancer [25]. Estimated lifetime cancer mortality risks from an abdominal CT of a one-year-old are 0.1% or 1:1000 scans [26]. The risk for 40 years old patient is half that of 20 years old patient with substantially less risk in future [27].

[28]. The International Commission on Radiological Protection estimates that the risk to a fetus being exposed to 10 mGy (a unit of radiation exposure) increases the rate of cancer before 20 years of age from 0.03% to 0.04% (for reference a CT pulmonary angiogram exposes a fetus to 4 mGy)[27]. A 2012 review did not find an association between medical radiation and cancer risk in children noting however the existence of limitations in the evidences over which the review is based [29].CT scans can be performed with different settings for lower exposure in children with most manufacturers of CT scans as of 2007 having this function built in [30]. Furthermore, certain conditions can require children to be exposed to multiple CT scans [31,32]. This study assess Abdominal CT Dose Examination for Adult Patient in Abuja and Keffi, Hospitals in Nigerian

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

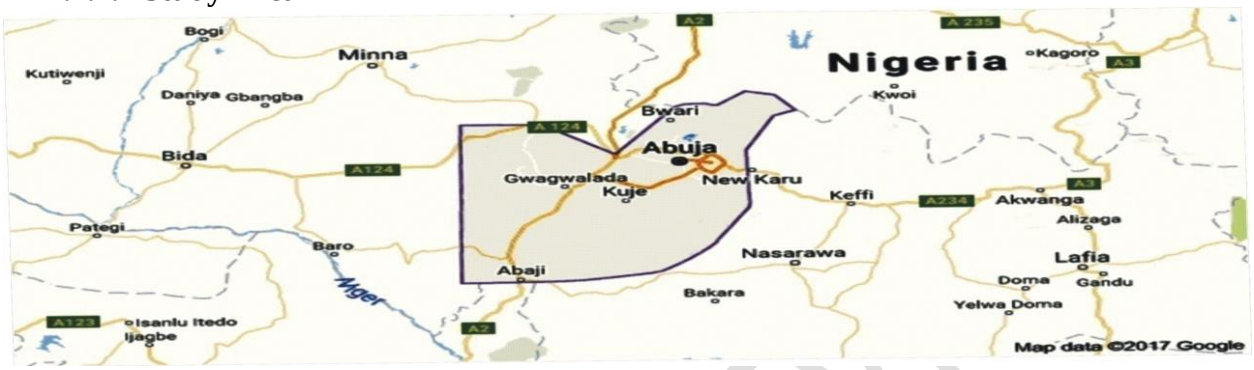

Fig. 1: Map of FederalcapitalTerritory(FCT) Abuja, Showing the Study Area

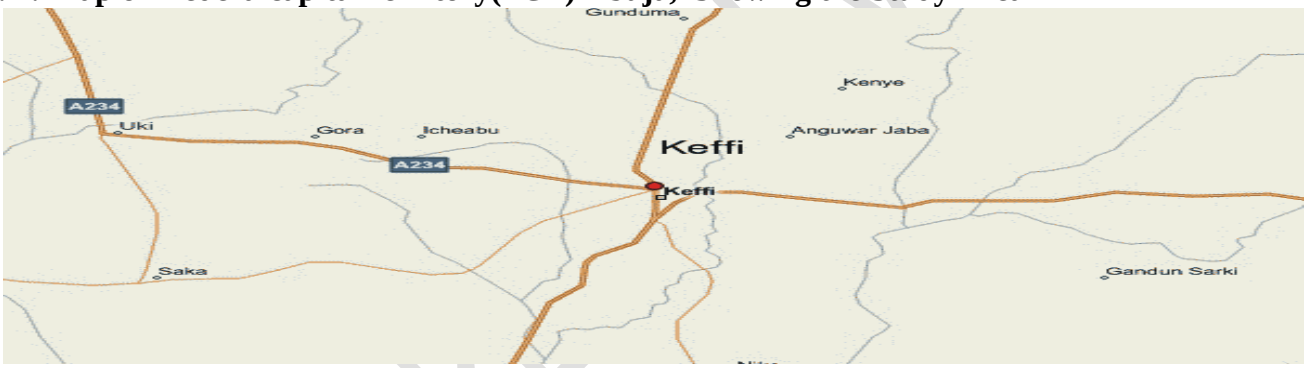

Fig. 2: Map of Keffi Showing the Study Area

2.2.Methods

The study adopted a retrospective and quantitative design to determine the absorbed radiation dose to patient undergoing CT scan of the abdomen. 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 abdomen. A simple size (45) participant patient was recruited for abdominal CT in the study. This was obtained through selection of 15 participants from centre A, 20 participants from centre B and 10 participants from centre C that come for CT examination on abdomen in center A, B and C respectively.

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. Inclusion Criteria

i. Only adult patients weighing in the range of 67 to 73kg were included in the study [33].

ii. Only adult patients that attended for routine CT scans of abdominal CT scan examination was considered.
iii. Data was acquired on a CT scanner that was calibrated by the Nigeria Nuclear Regulatory Authority (NNRA) 2009, 2015 and 2014 for centre A, B and C respectively.

2.2.4. 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 [34].
iii. CT scanner that was not calibrated by the Nigeria Nuclear Regulatory Authority (NNRA) 2009, 2015 and 2014 for centre A, B and C respectively..

2.3. Data Analysis

According to [35], the MSAD for non-spiral scans can be estimated from the CTDI by the equation:

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

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 [36], the MSAD for spiral scans can be expressed as:

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

$CTDI_{Vol}$

According to [37], $CTDI_{Vol}$ 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	Av. Age (years)	Av. Weight (Kg)	No. of Male	No. of Female	Total No. of Patients
A	49.3±12.7	71.6±20.9	6	10	16
B	50.3±11.3	81.7±27.6	6	14	20
C	50.3±9.6	52.6±11.6	6	9	15

Table 3. Scan Parameters for all Centres

Scan parameters	kV	mA	mAs	Scan Range	CTDIw (mGy)	DLP (mGy*cm)

Centres						
A	120	NA	212.5±9.7	418.3±18.8	15.1±0.60	689.6±43.98
B	100	NA	76.9±43.0	433.0±63.0	7.3±4.67	356.7±248.15
C	120	268.9±113.5	NA	385.9±35.5	11.7±3.95	491.7±134.77
Mean					**11.0±3.6**	**500.9±173.5**

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.

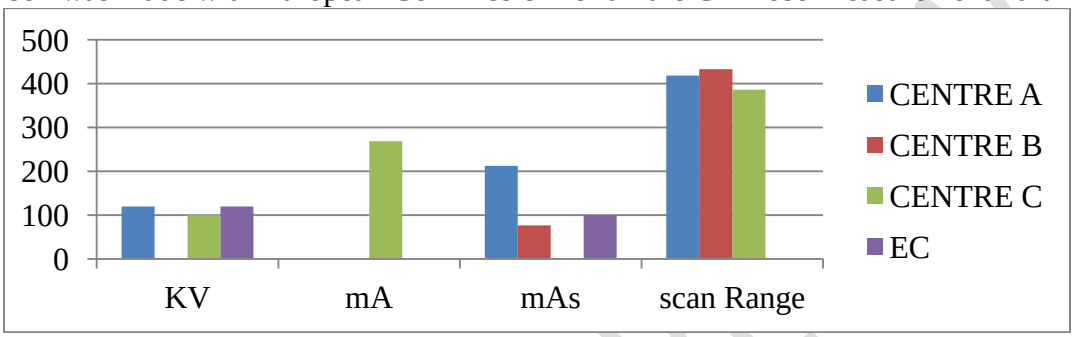

Fig 3: Comparison of Abdominal CT Scans Parameters between the Study Centres.

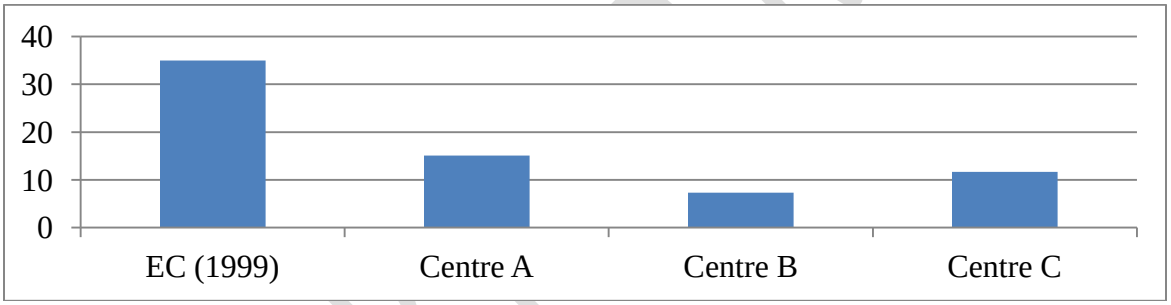

Fig 4: Comparison of Abdominal CTDIw (mGy) with European Commission for the study centres

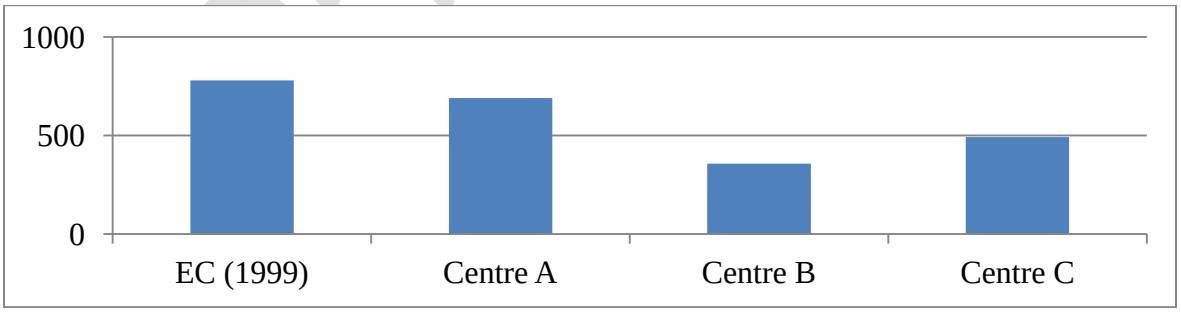

Fig 5: Comparison of AbdominalDLP (mGy*cm) with European Commission for the study centres.

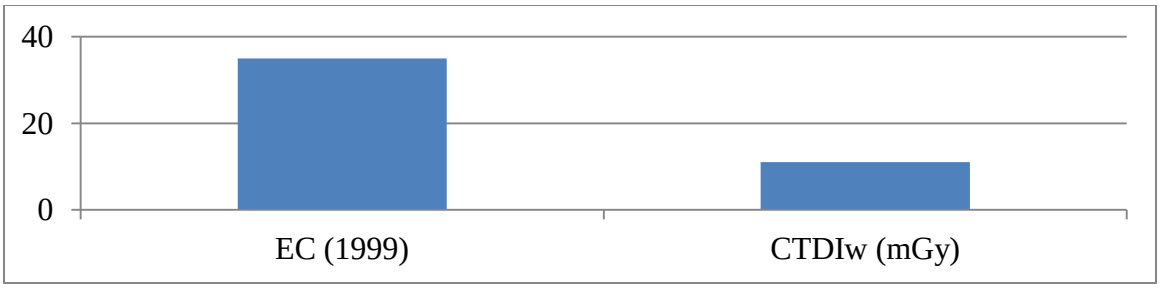

Fig 6: Comparison of Mean Abdominal CTDIw (mGy) with European Commission

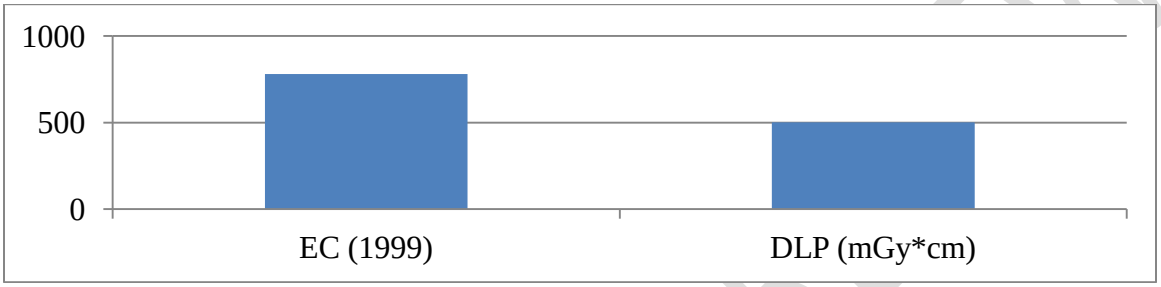

Fig 7: Comparison of Mean AbdominalDLP (mGy*cm) with European Commission

3.3. Discussion.

This study determined the CTDIw and DLP for adult pertinent undergoing routine AbdominalCT 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, Abdominal CT at centre (A& B) has the higherCTDIwabd DLP value followed by centre (C) then centre (B)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 (European Commission) 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.

4. Conclusion and Recommendation

4.1. Conclusion

From this study, 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 may not be serious clinical implication on the participants in the study centres.

4.2. Recommendation

CT dose optimization and further researches 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.

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