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Head 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 HAA managed the analyses of the study. Authors UR, IU and LKS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study has established local diagnostic reference levels (LDRLs). Dose report and scan parameters for the head was assessed during 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 establish 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. The collected data were analyzed using SPPSS version (20) statistical software. Third quartile values

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of the estimated LDRLs for CTDIw and DLP was determined as 49.8 mGy and 9639 mGy. The mean CTDIw obtained are lower to the reported data from the European Commission of 60mGy. The mean DLP are comparably lower than all the reported value from the European commission of 1050 mGy. Therefore, CT dose optimization is recommended.

Keywords: Radiation dose; MSCT; VGA; CTDIv; CTDIw; DLP; LDRL.

1. INTRODUCTION

CT scanning of the head is typically used to detect infarction, tumours, calcifications, haemorrhage, and bone trauma. Of the above, hypodense (dark) structures can indicate oedema and infarction, hyperdense (bright) structures indicate calcifications and haemorrhage and bone trauma can be seen as disjunction in bone windows. Tumours can be detected by the swelling and anatomical distortion they cause, or by surrounding oedema. Ambulances equipped with small bore multi-slice CT scanners respond to cases involving stroke or head trauma. CT scanning of the head is also used in CT-guided stereotactic surgery and radiosurgery for treatment of intracranial tumours, arteriovenous malformations, and other surgically treatable conditions using a device known as the N-localizer [1-6].

2. MATERIALS AND METHODS

2.1 Materials

The materials requirements for the conduct of this research were included [7].

i. Computer tomography scanner machines located at the study centres.
ii. Data Collection Sheet
iii. SPSS version (20) software for data analysis

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 & 2.

2.2 Methods

The study adopted a retrospective and quantitative design to determine the absorbed radiation dose to the patient undergoing a CT scan of the head [8]. 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 the head.

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 sample size (60) participant patient was recruited for head CT in the study. This was obtained through the selection of 20 participants each that come for CT examination on the head in centre A, B and C respectively.

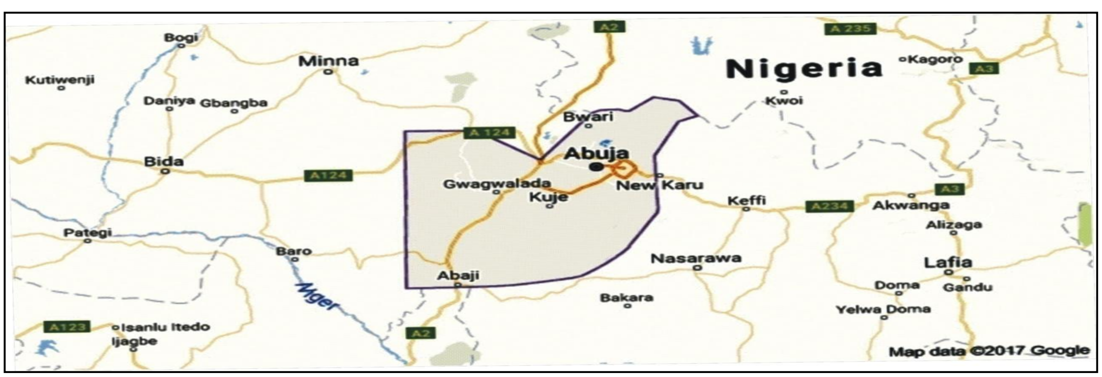

Fig. 1. Map of Federal Capital Territory (FCT) Abuja, showing the study area

Fig. 2. Map of Keffi Showing the Study Area

2.2.4 Inclusion criteria

i. Only adult patients weighing in the range of 67 to 73 kg were included in the study [8].
ii. Only adult patients that attended for routine CT scans of brain 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. The patient that attended for non-routine CT procedure such as CT angiography, CT colonography.
ii. Patients with weight above or below the specified limit [9,10].
iii. CT scanner that was not calibrated by the Nigeria Nuclear Regulatory Authority (NNRA).

2.3 Data Analysis

According to Karthikeyan and Chegu [11], 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 the 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 [12], the MSAD for spiral scans can be expressed as:

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

CTDI_{Vol}

According to Seeram [12] and Ling [13], CTDI_{Vol} for single-slice scanners is defined as:

$$\text{CTDI}_{vol} = \frac{NXT}{I}(\text{CTDI}w) \quad (3)$$

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:

$$\text{CTDI}vol = \frac{I}{Pitch}(\text{CTDI}w) \quad (4)$$

Effective Dose

According to several authors [14,15,16], the effective dose is expressed as:

$$E = E_{DLP} \text{ X DLP} \quad (5)$$

Where

E= Effective dose
E_{DLP} = Normalized effective dose
DLP=Dose Length product

3. RESULTS AND DISCUSSION

3.1 Results

This section presents the data collected from the respective study centers as well as further evaluations for effective interpretations.

3.2 Result Analysis

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

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 males	Number of females	Total number of patients
A	57.5±10.7	64.4±15.9	12	8	20
B	55.3±11.5	77.2±25.0	13	7	20
C	60.3±14.3	62.4±16.1	13	7	20

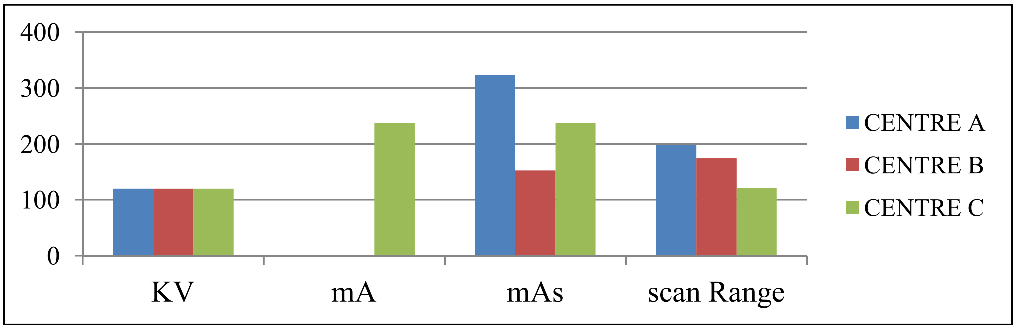

Fig. 3. Comparison of head CT scans parameters between the study centres

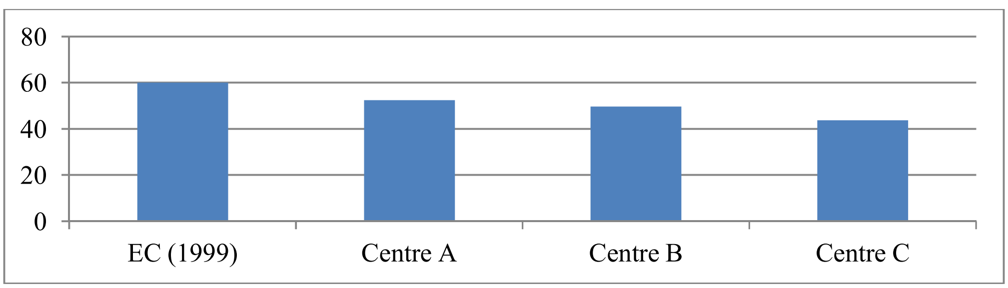

Fig. 4. Comparison of head CTDIw (mGy) with the European Commission for the study centres

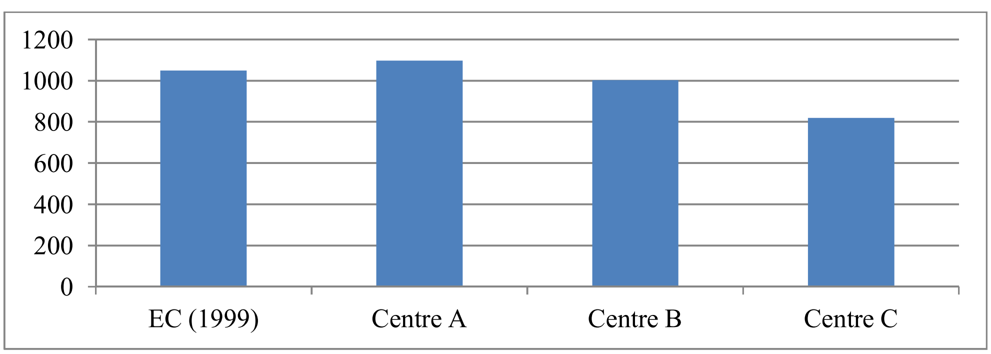

Fig. 5. Comparison of head DLP (mGy*cm) with the European Commission for the study centres

Table 3. Scan parameters for all centres

Scan Parameters / Centres	kV	mA	mAs	Scan range	CTDIw (mGy)	DLP (mGy*cm)
A	120	NR	324.2±75.7	198.2±42.5	52.5±96	1098.0±475.12
B	120	NR	152.5±10.9	174.1±16.1	49.8±00	1003.1±77.37
C	120	237.7±29.6	237.7±29.6	121.3±14.9	43.7±3.59	820.1±173.32
Mean					48.7±3.91	973.7±295.6

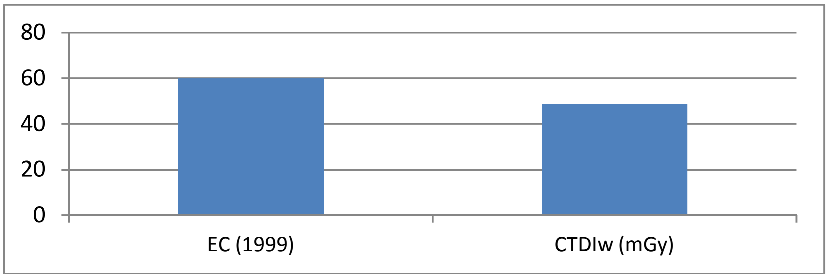

Fig. 6. Comparison of mean head CTDIw (mGy) with European Commission

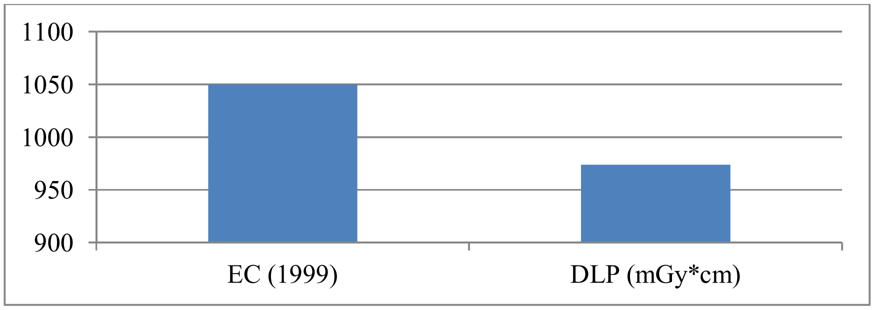

Fig. 7. Comparison of mean head DLP (mGy*cm) with European Commission

4. DISCUSSION

This study determined the CTDIw and DLP for adult pertinent undergoing routine brain 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, Brain CT at the centre (A) has a higher CTDIw value followed by the centre (B) and (C) respectively. Meanwhile, the highest DLP values were noted at the centre (A) then Centre (B) and (C) respectively.

In comparison with the European Commission values, it can be seen clearly from Fig. 4 that all the CTDI values are lower than the EC values. On the DLP, all values are lower except for centre A according to Fig. 5.

Since the mean in Figs. 6 and 7 shows that the values for both CTDI and DLP are lower than the European Commission values.

5. CONCLUSION

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, CT dose optimization is recommended.

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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