ASSESSMENT OF RADIATION DOSE TO PATIENTS DURING HEAD COMPUTED TOMOGRAPHY SCAN IN SOME SELECTED TERTIARY HEALTHCARE CENTRES IN NIGERIA

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Abstract

Introduction: Computed Tomography scan has become the essential tools in diagnosis and treatment of patients with severe head injuries, even with the fact that it is the largest source of exposure to ionizing radiation in Medicine.

Objectives: The objective of study is to assess the amount of the radiation dose given to patients in the selected Hospitals and determine whether there is variation in radiation doses between CT scanners for the same procedures by comparing the local dose reference levels obtained with the established DRLs in the literature.

Materials and Methods: Dose report and scan parameters for Heads examination was surveyed during the study period in three CT center. Data on CT dose index ($CTDI_{vol}$) and Dose length produce (DLP) displayed on CT scanner console from three (3) selected hospitals was recorded for an average of 10 adult patients for each facility.

Results: The mean value for head extermination from center A, B, and C has $CTDI_{vol}$ were 51.8mGy, 49.8mGy and 44.0mGy respectively, while the DLP values were 1019.9mGy.cm, 1005.4mGy.cm and 822.5mGy.cm respectively. The data were analyses using SPSS version (21) statistical software. The third quartile values of the estimated LDRLs for CTDLvol were estimated as 61.0mGy, 50.0mGy and 44.0mGy respectively and DLP were estimated as 1210.0mGy.cm, 1063mGy.cm, 821.0mGy.cm for Centre A, B and C respectively. However, the study has established Local Diagnostic Reference Levels (LDRLs) for these three centres. The $CTDL_{vol}$ and DLP obtained were comparatively smaller compare to the 60mGy and 1000 mGy.cm reported by the European commission, 2014.

Conclusion: Although variation between the CT scan centres was noted. Dose optimization is there recommended for patient protection.

Keywords: **Exposure, Ionizing radiation, CT dose Index, Diagnostic Reference Levels.**

Introduction

Since the introduction of CT scan 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 diseased [7].

A CT scan, also called x-ray computed tomography (x-ray CT) or computerized axial tomography scan (CAT Scan), makes use of computer processed combinations of many x-ray images taken from different angles to produce cross-sectional (tomographic) images (virtual slices) of specific areas of a scanned object, allowing the user to see inside object without cutting. Computed Tomography (CT) is a non-invasive method of acquiring the images of

the inside of the human body without superimposition of distinct anatomical structures [6]. In CT, the x-ray tube rotates around the body, making multiple exposures at different angles that allow the computer to generate detailed images of the patient's anatomy [4].

As x-ray CT is the most common form of CT in medicine and various other contexts, other types exist (such as positron emission tomography (PET) and single-photon emission computed tomography (SPECT) [1].

The usages of computed tomography (CT) have increased dramatically over the last two decades in many countries. An estimated 72 million scans were performed in the United States in 2007 [2]. By nature, CT involves larger radiation doses than the more common conventional x-ray imaging procedures.

Materials and Method

This study adopted a retrospective and quantitative research design to determine the absorbed radiation dose to patients undergoing CT scan of the head in three selected centers in North Central Nigerian. A quantitative design was appropriate because the study involved the use of numerical data, and was conducted retrospectively to ensure more reliable and valid data acquired from the computer archive system, where the dose report and exposure parameters are stored [8].

The data was collected by the researcher assistant (The CT radiographers). The CT radiographers were well trained on how to collect the data. The data collection sheet used for the study was adopted from the IAEA survey form and has the following sections: participant demographic information, scan parameters and dose parameters. A sample size of (30) participant patients were recruited for head CT in the study. This was obtained through selection of 10 participants each that came for CT examination of the head in center A, B and C respectively.

Table 1: Detail of Facilities, Manufacturer, Brand, Configurations of Detector, Manufacture Year and Year of Installation

CT Center	Manufacturer	Brand/Model	CT Scanner Detector Configuration	Year of Manufacture	Year of Installation
Center A	Philips	Philips Brilliance CT	16-slice	2015	2015
Center B	Toshiba	Toshiba Acquilion	32-slice	2015	2015
Center C	General electric (GE)	Bright Speed	16-slice	2014	2014

Results and Discussions

In this study, the number of participated patients included for head CT are 10 each from center (A), (B) and (C). This contained 16 (53.3%) males and 14 (46.7%) females. The participants age range from 30 to 98 years. Therefore, thirty years of age is considered as an adult based on the hospital age classification in Nigeria.

i. Result of Selected Patient's Characteristics from the Three Study Centers

Analysis of patient's characteristics (Age & number of patient per each CT examination) is presented in Table 2 below

Table 2: Result of patient head Characteristics

CT Centers/Examination	No. of patients	Age (Years) (Mean ± SD)
Center A	10	60.4 ± 7.9
Center B	10	57.1 ± 10.8
Center C	10	63.1 ± 16.3

ii. Result of Measured CT Scan Exposure Parameters

Analysis of the scan parameters (kV, mAs, scan time & scan range) for the three study centers is presented in table 3 below.

When recording and reporting data, care must be taken to ensure that the 'measured' value and 'uncertainty' should be presented with the same significant number. This practice ensures the precision of the data. In practice, experimental data should be approximated to either one or two decimal places [3]. There is however no penalty if someone decides to report the data with more than two decimal places. The recorded data in this study for the exposure parameters was recorded to one-decimal places.

Table 3: Result of Measured CT exposure parameters for organ dose measurements

CT Center/Examination	kV	mAs	Scan Time (Sec)	Scan Range (mm)
Center A	120	350.6 ± 63.7	27.8	182.8 ± 6.2
Center B	120	155.0 ± 15.0	2.8	175.9 ± 13.3
Center C	120	236.5 ± 32.0	0.98	126.6 ± 11.6

The mean kV values for head CT in center (A), (B) and (C) are all the same. The scan time for centre A, B and C were 27.8sec, 2.8sec and 0.98sec respectively.

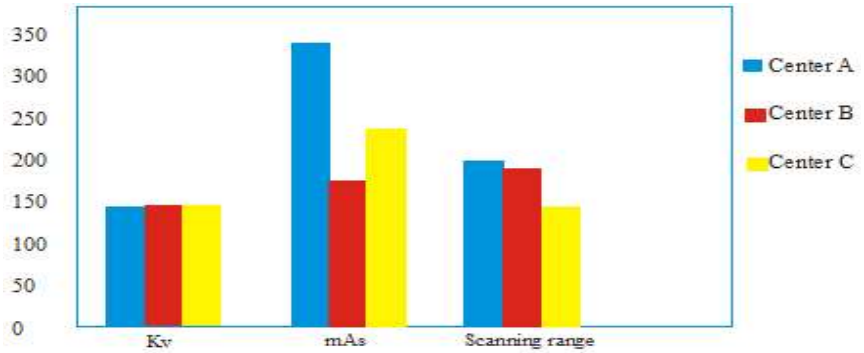

Figure 1: Comparison of Head CT scan parameters for the study centers

iii. Measured CTDI and DLP from the Study Centers

The summary statistics for the measured dose parameters such as CTDI and DLP with their mean, standard deviation and 75th percentile is presented in table 4 below. The 75th percentile value was described as third (3rd) quartile value for establishing the diagnostic reference level (DRLs).

Table 4: Measured $CTDI_{vol}$ (mGy) and DLP (mGy*cm) values from the study centers

Centers	Region	CTDI (mGy) Mean ±SD	DLP (mGy*cm) Mean ±SD	75th Percentile (Third Quartile)
Center A		51.8 ± 9.5	1019.9 ± 201.1	61 1210
Center B		49.8 ± 0.0	1005.4 ± 60.0	50 1063
Center C		44.0 ± 4.2	822.5 ± 221.9	44 821

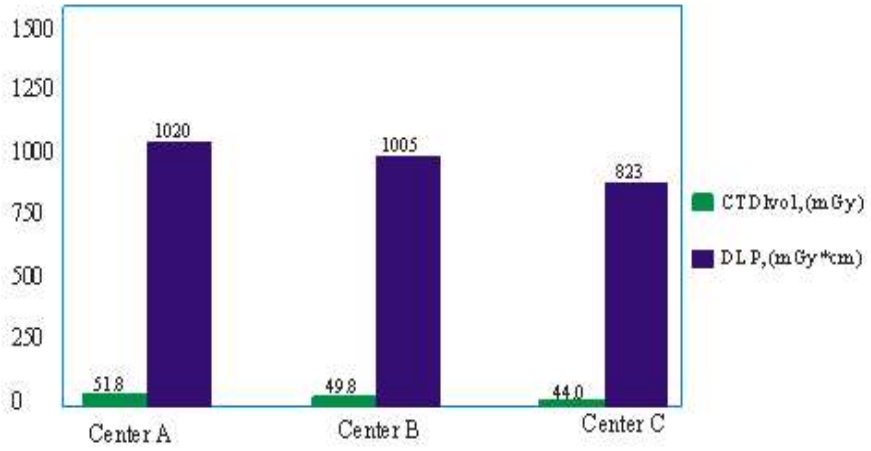

Figure 2: Measured head $CTDI_{vol}$ (mGy) and DLP (mGy*cm) values from the study centres.

From the result obtained above, Brain CT at center (A) has the higher $CTDI_{vol}$, value of 51.8 mGy followed by center (B) and (C) with 49.8 mGy and 44.0 mGy respectively. Meanwhile, the highest DLP values were noted at center (A) follow by centre (B) then centre (C) with the values as 1019.9 mGy*cm, 1005.4 mGy*cm and 822.5 mGy*cm respectively.

iv. Analysis for establishing Diagnosis Reference Levels (DRLs)

To establish DRLs, only routine procedures ought to have been

included [3]. Analysis of the absorbed dose in $CTDI_{vol}$ and DLP for head CT acquired with scanning mode was carried out. Mean and third quartile values of the measured doses in $CTDI_{vol}$, and DLP are shown in Table (6). A bar charts of third quartiles absorbed dose in $CTDI_{vol}$ and DLP for brain CT across all centers with third quartile values of $CTDI_{vol}$ (49.8 mGy) and DLP (1087.8 mGy*cm) for brain CT examination.

Table 5: Measure $CTDI_{vol}$ (mGy) and DLP (mGy*cm) with 75th Percentile values

Region	$CTDI_{vol}$ (mGy) Mean ± SD	DLP (mGy*cm) Mean ± SD	75th Percentile (Third Quartile)
Head	48.5 ± 7.9	949.0 ± 176.3	49.8 1087.8

v. Comparison of DRLs in terms of CTDI and DLP with the international values

The comparison of the new DRLs obtained with the established reference levels from the European countries as well as other countries is presented from Table 6 and 7 below. This would determine the possibility of radiation does variance between the CT scanners and show the causes of that radiation dose variation in CT procedures.

Table 6: Comparison of DRLs in terms of $CTDI_{vol}$ (mGy) with the International Values

Region	This Study 2017	European Commission	Portugal	Slovenia	Australia
Author	Musa 2017	European Union, 2014	Santos *et al.,* 2014	Dejan, 2014	ARPANSA 2013
Head	48.5	60	75	62	47

Table 7: Comparison of DRLs in terms of DLP (mGy*cm) with the International Values

Region	This Study 2017	European Commission	Portugal	Slovenia	Australia
Author	Musa 2017	European Union, 2014	Santos *et al.,* 2014	Dejan, 2014	ARPANSA 2013
Head	949	1000	1010	1040	527

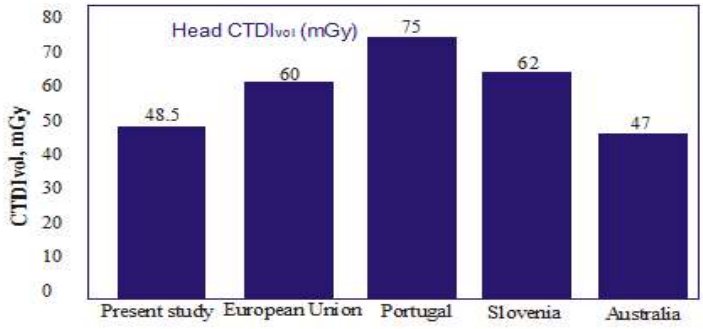

Figure 3: Comparison of Head DRLs in terms of $CTDI_{vol}$ (mGy) with international values

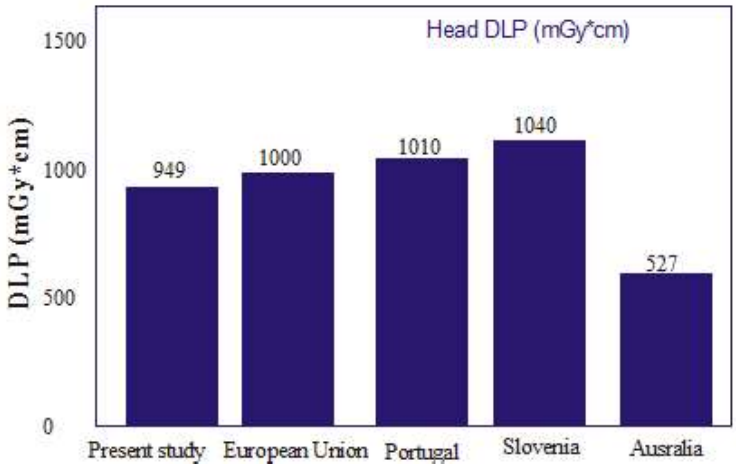

Figure 4: Comparison of DRLs for CG head in terms of DLP (mGy*cm) with the international values

Conclusion

Diagnostic reference levels were primarily introduced to avoid situations of high patient absorbed radiation dose. However the doses received for head CT in this study is low compared to those obtained internationally.

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