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Establishment of Local Diagnostic Reference Levels for Patients Undergoing Brain Computed Tomography Scan in Sokoto

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ABSTRACT
Brain Computed Tomography examination has become most procedures at Computed tomography unit in both public and private diagnostic hospital and other centers in Sokoto. An investigation shows that brain Computed Tomography present 58% and 64% in all the total procedures attained at CT unit of Usmanu Danfodio University teaching hospital Sokoto between 2019 and 2020 respectively, equally 66% of the total procedure attained in 2020 at CT unit in Caliphate clinical and diagnostic centre Sokoto. As such rapid increase of patient undergoing brain computed tomography scan in Sokoto patient audit and optimization is required to keep patient safe from unnecessary radiation exposure. The aim of this research is to estimate the local dose reference values for patient undergoing brain computed tomography in Sokoto and compare the values with Nigeria published literature and other established European DRLs to see if patient in Sokoto are at no risk to radiation exposure and this serve as baseline in establishing national DRLs in Nigeria. The study was conducted in two different centres in Sokoto, 86 consenting adult participants data was collected from two different center with CT machine model of GE 4-slice and Phillips 16-slice from February to April 2021. Patient information, exposure factors, volume computed tomography dose index (CTDIvol) and dose length product (DLP) values were recorded. The data were analyzed using SPSS version (16) statistical software. The mean, standard deviation and 75th percentile values of the CTDIvol and DLP were calculated. An inter comparison of the measured 75th percentile reference dose values from the two research centers was conducted and compared with the Nigerian published work and international DRL values. The established local diagnostic reference values reported in 75th percentile values of CTDIvol and DLP are 64 mGy and 1282 mGy.cm for centre A and 34 mGy and 684 mGy.cm for centre B. The study shows that the CTDIvol values are relatively higher to those reported in established work by the European Commission. However, the DLP values are comparably higher than those of the European Commission. This revealed that there is need for robust and sustained optimization program so as to reduce patient doses without affecting diagnostic image quality.

Keywords: Brain CT, CTDIvol, DLP, LDRL and 75th percentile.

I. INTRODUCTION

Brain Computed tomography examination is an X-ray imaging test used to obtained a detailed three dimensional picture of the brain, the beam of X-ray produce by scanner penetrate the brain at different levels and resulting image are picked up on the computer screen to form three dimensional picture of the brain (Brenner 2007). Brain computed tomography usually it is used to detect the abnormalities in the brain and its surrounding tissue; it's also used to detect the disorder in blood circulation and provide accurate image of the specified area in the brain. Sokoto is one of the developing states in Nigeria where the technology of CT is not widespread compared to developed state like the Legos, Kano, Ibadan, Kaduna and Federal capital territory Abuja. This is because, with a population 662000 million only 2 CT machines are actively working based on the Nigeria

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Nuclear Regulatory Authority 2009 report (Garba 2014). Also awareness of the clinical applications of CT is rather poor among general physicians and other healthcare providers (Garba 2014). Despite the limited number of CT scanners, according to a study conducted by Adeyekun and Obi-Egbedi-Ejakpovi (2013), CT is referred to as the first line investigative modality of choice for patients with severe head injury. And there is propagated population of patient undergoing brain computed tomography

II. MATERIALS AND METHOD

A prospective quantitative methodology is choice for this study to establishment of local reference values for patient undergoing brain computed tomography in sokoto.

III. DATA COLLECTION

A total of 86 patient data was collected from two different center with CT machine model of GE 4-slice and Phillips 16-slice from January to March 2021. Both the centers were chosen because they met the eligibility criteria for the study; having all the imaging modalities for the study and Nigerian Nuclear Regulatory Authority's Requirement for Authorization and Practice (Licensing) involving ionizing radiation. Ethical approval for the study was obtained on 9 Feb 2021 from the Research and Ethical committee of the two centers with coded NHREC/30/012/2019.

IV. DATA ANALYSIS

The data collected were analyzed using a recommended statistical software SPSS version 16.0. Mean standard deviation (SD) and 75% percentile of CTDIvol and DLP was calculated. Were 75% value is chosen as an appropriate investigation level on the grounds (Abdullahi 2009).

V. RESULT

The summary of scan and measured parameters used and recorded by the two centers under study is presented in the table 1 and 2 for brain CT scan examination.

Result of Scan Parameters

A summary of scan parameters such as kV, mA, Scan length and pitch is presented in Table 1 for brain CT scan examination for both centres.

Table 1: Mean, SD and 75th percentile of Scan Parameter

Centres	No. of patient	kV	mA (mA)	Scan length (cm)	Pitch (cm)
Centre A Mean ±SD 75th Percentile	46	136±8 .97 140	238±29 250	18.8±2.20 20	1.5±0 1.5
Centre B Mean ±SD 75th Percentile	40	120±0 .0 120	76±15 85	18.8±2.2 20	1.5±0 1.5

The summary of the scan parameters shows that centre A have the most higher scan parameters used.

Result of Measured Parameters

Table 2: Mean, SD and 75th percentile of the measured parameters

Centres	No. of patient	CTDIvol (mGy)	DLP (mGy.cm)
Centre A Mean±SD 75th Percentile	46	58±14.0 64.25	1011±267 1282
Centre B Mean±SD 75th Percentile	40	32±12.3 34.10	602±216 684

The summary of measured parameters for brain CT scan shows that centre A have the highest values in both CTDIvol (mGy) and DLP (mGy.cm) and this may likely be the result from the highest scan parameters used during the examination.

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Established Local Diagnostic Reference values

Table 3: the summary of the established Local Diagnostic Reference values

Centres	No. of patient	CTDIvol (mGy)	DLP (mGy.cm)
Centre A 75th Percentile	46	64	1282
Centre B 75th Percentile	40	34	684
Total A+B 75th percentile	86	64	1025

Table 3 shows the estimated established local diagnostic reference level in sokoto which show that centre A have the higher values than centre B.

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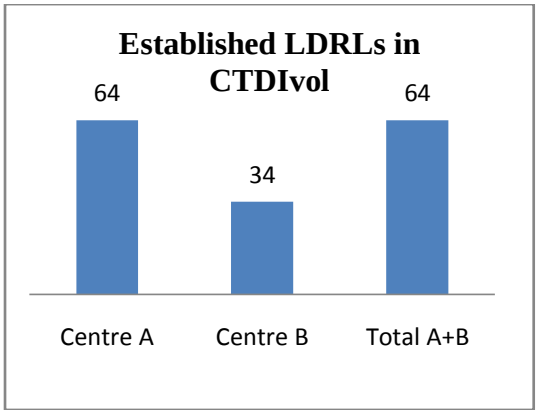

Figure 1: present the local diagnostic reference levels in CTDIvol with 75% value

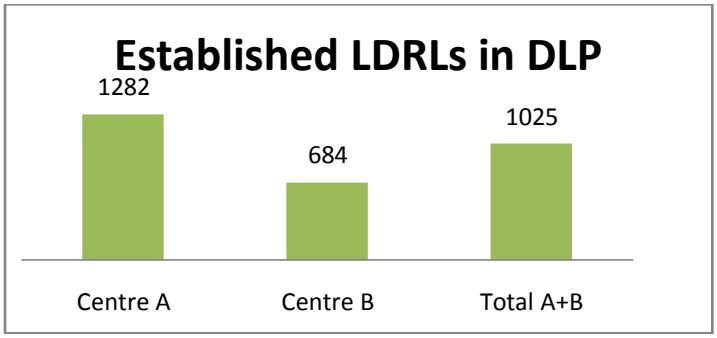

Figure 2: present the established local diagnostic reference levels in DLP with 75% value

Comparison of the LDRL with the Nigerian and EC

Table 4: Comparison of LDRL values in 75th % with some published Nigerian work values

Research Study	CTDIvol (mGy)	DLP (mGy.cm)
Centre A	64	1282
Centre B	34	684
Abdullahi A. 2009	62.5	2946
Garba I. 2014	76	789
Ogbole & Obed 2014	74	1898

Table 4, present the comparison of the established local diagnostic reference levels values with some Nigerian published work which shows that centre A is higher than one and less than two in CTDIvol and also

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higher than one published work and less than two in DLP values, while centre B also is less than all published work in both CTDIvol and DLP values.

Table 5: Comparison of LDRL values in 75th % with some international values

Research Study	CTDIvol (mGy)	DLP (mGy.cm)
Centre A	64	1282
Centre B	34	684
European Union 2014	60	1000
Portugal (Santos et al. 2014)	75	1010
Australia (ARPANSA 2013)	47	527

Table 5 present the comparison of established local diagnostic reference levels values with international values which shows that centre A is higher than two reported values and less than one in term of CTDIvol and almost higher than all the reported values in DLP. While centre B also less than all reported international DRLs in CTDIvol and higher than one and less than two reported values in DLP.

VI. DISCUSSION

The established local diagnostic reference level for brain computed tomography scan in 75th percentile values for the two centres in CTDIvol and DLP are 64 mGy and 1282 mGy.cm for centre A and 34 mGy and 684 mGy.cm for centre B.

When compare the CTDIvol and DLP values of the two centre's with Nigerian published work Centre A, CTDIvol's and DLP's are higher than the two reported published work and less than one, while centre B, CTDIvol and DLP is less than all reported published Nigerian work. In comparing with international established DRL values, centre A values of CTDIvol's and DLP's is also higher than all reported established DRL values and less than one in CTDIvol values, and centre B recorded values in CTDIvol is less than all the reported established international DRLs values and less than one in DLP.

The higher dose reference values in this study may be likely attributed to the variation in technical parameters, clinical complexity of patients and untimely quality control program in most of the hospital. The CT systems included in the current study differ in technology and model, with the number of slices per rotation ranging from 4 to 16. The reconstruction algorithms also differ across scanners, and may have contributed to dose variations. Literature shows that the lower CT models such as GE (4 slices) generated higher CTDIvol and DLP compared to 16 slice scanners, with the doses showing a downward trend as the technology improved, and also there is evidence that helical compared to axial scanning is associated with a 3%–14% dose reduction Garba (2014). Most of the data included in this study were acquired in axial modes thus.

other contributory factors and trigger optimization strategies.

VII. CONCLUSION

The established diagnostic reference level values in 75th percentile of CTDIvol and DLP was 64 mGy and 1282 mGy.cm for centre A and 34 mGy and 684 mGy.cm for centre B. there is variation of doses between the two centres and this may likely be the differences scan parameters used between the centres and the difference in model of the machine and technology. This suggests that there are opportunities for optimization of CT examinations through appropriate selection of technical and exposure parameters. This It should be noted that the 75th percentile dose values reported in this study are not threshold doses or punitive limits, but to provide benchmark to enable centers compare their dose values to the national standard. Such comparisons may enable centers with dose outliers assess their practice to uncover

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