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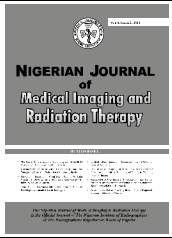

ESTIMATED RELATIVE RISK ASSOCIATED WITH PATIENTS' DOSES FROM COMPUTED TOMOGRAPHY OF THORAX IN A RADIOLOGY FACILITY IN IMO STATE, NIGERIA.

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ABSTRACT

Introduction: Computed tomography (CT) is very efficient in medical imaging and the procedure exposes the patients to a high radiation dose and risk that could result to deleterious effects which might in turn increase the patient's cancer risk.

Objective: To estimate the individual organ doses and whole body effective dose administered to patients from thorax CT procedure and estimate the relative cancer incidence and mortality risk associated with the procedure.

Materials and Method: A retrospective study was carried out from August 2014 to September 2015 in a radiological facility in Imo state; Nigeria. A total of 133 patients were investigated. Eighty one (60.9 %) patients investigated were male adults while 52 (39.1%) were female adults, .The Patients' organ doses and whole body effective doses were evaluated using impact dosimetry software (3.0 version 27/05/2015). The estimated relative risk and life time attributed risk were also calculated using BEIR VII ERR MODEL.

Result: The exposure factors used ranged from (kVp = 120.00 ± 0.00 and mAs = 142.08 ± 19.09) and (kVp = 120.00 ± 0.00 and mAs = 109.84 ± 28.79) for male and female respectively. The maximum organ dose and minimum organ dose from thorax CT in the center for lungs were (male = 2018.18 ± 91.92 and female = 1588.57 ± 83.44) × 10^{-3} mSv and bladder (male = 0.39 ± 0.38 and female = 0.36 ± 0.28) × 10^{-3} mSv respectively. The estimated risk and mortality rate is less than one person in every 1000 persons exposed.

Conclusion: There were variations in induced doses for different organs so there is need for greater standardization across CT institutions even though the estimated relative risk and mortality rate were low.

INTRODUCTION

Since the invention of CT procedure, it has experience tremendous improvement in medicine [1] and also contributes a lot to both diagnostic and Therapeutic medicine [2],[3]. In modern days, the use of radiation to access human tissues and also treat them has been of great benefit to medicine and humanity [3],[8],[13],[14]. CT imaging provides a wonderful structured image with true information about the tissue in consideration. This makes it so effective for patients' tissue management but the procedure is associated with high radiation exposure [7],[8],[9],[10],[11].

Despite the benefits drawn from radiation for medicine, there might be associated negative effects; to patients. This can be seen immediately after a high Radiation exposure (Deterministic effect) or long period effect after low radiation

exposure (Scholastic effect) [15],[16],[17]. In view of safety and protection, thorax CT procedure can expose a patient to a high radiation dose that might be too high to ignore [4],[5],[6],[7]. In medicine today, C T procedure is most often used but due to constant repeated exposure during the procedure, there is a tendency that patient might receive a radiation dose value quite greater than the recommended reference value [10],[13]. Some values of radiation reported in previous studies are within the documented value for cancer risk and genetic malformation [12].

In modern medicine, Radiology involves a variety of imaging procedures, such as projection radiography, Ultrasound, Computed tomography (CT), nuclear medicine, positron emission tomography (PET) and Magnetic Resonance Imaging (MRI). CT produces a cross sectional image for diagnoses [17]. It uses x-ray in conjunction with computing algorithm to image body structures [15],[18]. In CT, an ionization chamber using high cadmium tungstate or scintillation dictator is used as the x-ray detector elements [19].

BEIR VII ERR MODE is a model that allows one to estimate the incidence, mortality rate and life time attributed cancer risk resulting from any specified dose of ionizing radiation [7], [8].

Reports from previous studies have shown that patients' exposure to radiation may cause negative effect that is too risky to be ignored; This might cause tissue damage or long term deformation depending on the duration of the exposure, part of body exposed, rate of exposure, and type of radiation involved [13],[17],[20]. The idea of overexposure or under exposure of patients by radiation has been the main limitation to the regular use of CT as a diagnostic tool in medicine [12]. In Nigeria, it has been recorded that most CT facilities are old, and has no quality control implementation, and even patient's radiation dose monitoring. This might give rise to over dosed or under dosed radiation exposure. This study covers the CT procedure on the thorax region, so the dose to vital organs may be quite significant to ignore [3],[14], so it aimed at estimation of relative cancer risk associated with patients' radiation doses from Thorax CT procedure, by evaluation of individual organ doses and whole body effective doses administered to patients investigated.

MATERIALS AND METHODS

This study was conducted in a radiology department of a Hospital located in Owerri, in the South east region of Nigeria, from August 2014 – Sept 2015. One hundred and thirty three(133) patients' parameters were collected from the CT facility DICOM and were investigated. Patients' parameters collected includes patients' body thickness (mass per height) age, gender, exposure factors (tube voltage, tube current) were collected and documented in a well-structured estimation form. Radiation dose indicators such as computed tomography dose index (CTDI) and Dose length product (DLP) were calculated using the impact dosimetry software (3.0 version 27/05/2015). It was also used to estimate the individual organ doses and whole body effective doses. All varying scanning parameters such as gender, age, body thickness, kVp and mAs were taking care of during the calculation by the impact dosimetry software [12]. The individual organ doses and estimated whole body effective doses from this study was compared with other related studies using a statistical tool (t-test) [21]. The estimated relative risk and life time attributed risk were also calculated using BEIR VII ERR MODEL.

RESULTS

One hundred and thirty three (133) adult patients were investigated. The patients age ranged from 25 – 50 years, with average (33.8) years. The mean body thickness of all patients investigated is (7.5) kgm^{-1}. The illustrative statistics of the exposure factors (kVp and mAs), organ doses with their ERR and whole body effective doses with their ERR values from thorax CT in this unit were highlighted in table 1, 2 and 3 respectively. The maximum organ doses were found in lungs with (Male = 2018.18 $\pm$ 91.92 and Female =1588.57 83.44) $\times 10^{-3}$mSv while the minimum organ doses were found in bladder with (Male = 0.39 $\pm$ 0.38 and Female = 0.36 $\pm$ 0.28) $\times 10^{-3}$mSv respectively. The average estimated relative risk and mortality rate calculated from the whole body effective dose is (incidence = 2.03 and Mortality = 1.42) for male and (incidence = 2.78 and mortality = 2.29) for female respectively in every 10,000 persons exposed.

Table 1 : Indicator factors of thorax CT procedure

Patients gender	kVp		mAs	
	Range	Mean	Range	Mean
Male	120.00 -120.00	120.00	130.00-157.00	142.08
Female	120.00 -120.00	120.00	91.00- 160.00	109.84

Table 2: Average organ dose and ERR for CT examination of the thorax.

Organ	(Mean organ dose (mSv) and associated estimated relative risk) $\times 10^{-3}$			
	Male		Female	
	Mean effective dose	Estimated relative risk	Mean effective dose	Estimated relative risk
Gonad	1.25	0.34	1.20	0.54
B/Marrow	494.55	133.53	385.71	263.57
Colon	13.15	8.54	10.10	4.55
Lung	2018.18	645.82	1588.57	508.34
Stomach	239.09	50.21	182.29	87.50
Bladder	0.39	0.20	0.36	0.59
Breast	1800.00	486.00	1392.86	709.92
Esophagus	822.73	222.14	578.71	260.42
Thyroid	52.73	27.95	23.97	25.17
Skin	27.45	7.41	23.54	10.59
Bone surface	76.64	20.69	56.00	25.20

Table 3: Whole body average effective dose, with incidence and mortality ERR.

Examination procedure	EFFECTIVE DOSE (MSV) INCIDENCE AND MORTALITY ESTIMATED RISK (PER 10,000 PERSONS)					
	MALE			FEMALE		
	MEAN	ERR (INCIDENCE)	ERR (MOTARLITY)	MEAN	INCIDENCE	MORTALITY
Thorax	6.17	2.03	1.42	4.87	2.78	2.29

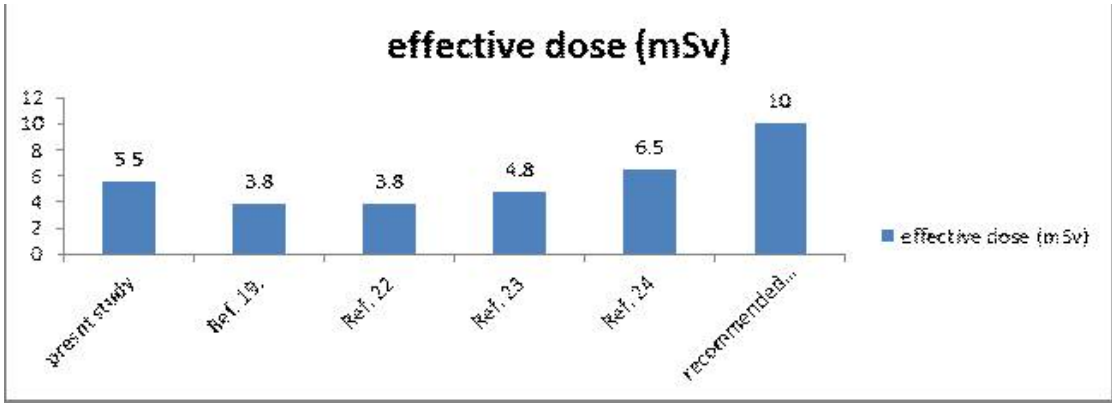

Fig.1. Mean effective dose compared to the result of other related CT studies.

DISCUSSION

In this dose investigation, the average effective dose from thorax CT procedure is (6.17 ± 1.30 and 4.87 ± 1.30) mSv for male and female respectively. The mean effective dose obtained is within results obtained from other related studies; as shown in the fig 1. It is also below the radiation safety recommended effective dose value of 10mSv. There is no significant difference ($p > 0.05$) in effective dose estimated in this study to other studies compared [10],[25]. Organs that receive high radiation doses include lungs, breast and esophagus with lungs having the highest dose. In other to maximize the image quality and avoiding over or under radiation exposure on patients during CT procedure there is a need for procedure protocol, quality control and radiation dose monitoring. The estimated relative risk calculated shows an approximate mortality rate of 1 in every 7,050 male exposures and 4400 female exposures, which is less than 1 person in every 1,000 persons exposed both for male and female. The estimated

organ risk has maximum value on the female breast (709.92×10^{-3}), even though it is not the organ that receives the maximum dose. This could be as a result variation in organ risk factor (β).

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CONCLUSION

This study has shown that the average effective dose on patients that underwent thorax CT in the center is moderate (< 10 msv). Impact dosimetry software version 3.0 27/5/2015 is good for the estimation of organ doses and whole body effective dose. Effective doses obtained are in line when compared to results of previous studies of thorax CT in Nigeria with lungs having the maximum organ dose. The ERR calculated also shows that the mortality rate is within the safety range, but due to the variation in doses estimated, a further standardization in CT thorax procedure is of great necessity.

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Conflict of Interest: Nil

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