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The Radiation Dose and Scattered Radiation in Paediatric Patients Undergoing Computed Tomography Examination at Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria

[1]Aborisade C.A., [2]Famurewa O. C., [3]Ibitoye F. I., [4]BalogunF.A.

[1]Department of Physics and Engineering Physics, Obafemi Awolowo University, Ile-Ife, Nigeria
[2]Department of Radiology, Obafemi Awolowo University, Ile-Ife, Nigeria
[3]Center for Energy Research and Development, Obafemi Awolowo University, Ile-Ife, Nigeria

***Abstract* - This research work measured radiation doses (RD) and the variation of scattered radiation (SR) from the incident radiation to the critical organs such as chest, abdomen, skull and pelvic for commonly performed paediatric patients undergoing Computerized Tomography (CT) examinations using well calibrated thermoluminescent dosimeters (LiF-100) attached to the skin in the path of the primary X-ray beam. Two hundred and fifty eight (258) paediatric patients were studied. The values of the equivalent dose for abdominal CT scan ranged from 23.49 - 55. 26mSv; skill CT scan ranged from 10.07 – 69.94mSv and chest CT scan ranged from 8.60 – 31.94mSv. The chest has the highest SR dose of 37.31 mSv when the incident radiation dose to the pelvic is 38.61 mSv. Pelvic has the least SR dose of 0.21 mSv when the skull has corresponding incident RD of 69.94 mSv. The work showed that the choice of exposure parameter should be reviewed.**

Keywords: Radiation dose, CT, Scattered dose and paediatric.

I. INTRODUCTION

The medical use of X-ray in the hospital has a lot of implications, there is need to know the amount of dose patients are being exposed to at the hospitals. Because the use of Computer Tomography (CT) has improved resolution and faster scans acquisitions, consequently; these has made the use of CT in diagnostic procedures, responsible for a larger proportion of medical radiation exposure to patients. Patient is the major source of scattered radiation during x-ray examination and most of the technologist's occupational exposure comes from scatter radiation; therefore knowing the magnitude of the scattered radiation will assist in using safety measures against scatter radiation which will effectively lower a technologists occupational exposure. Most of the medical imaging systems have a considerable number of variables that must be selected by the operator in order to optimize the image produced.

Exposure of paediatric patients during radiological examination attracts particular interest because there is substantial evidence to suggest that children are more susceptible to the effects of ionizing radiation than adults [1,2]. Likewise, the probability that there may be late radiation effects is also higher. Firstly, children are more much radiosensitive than adults [3]. A 1–year-old infant is 10-15 times as likely as 50-year-old adult to develop a malignancy from the same dose of radiation, according to International Commission on Radiological Protection. Secondly, for a given procedure, the effective dose is larger in a small infant than in an adult, because the effective dose decreases with age, [4]. The reasons for dose variation are multi factorial: patient weight, exposure factors, radiological technique and equipment type. Therefore, reducing the incident radiation will lead to reduction in scattered radiation form the incident radiation. Scatter measurements and predictions of staff doses have been performed in the past [5-8]. Marshall et. al. also measured and predicted the scattered radiation dose to staff in diagnostic radiology is particularly important, owing to the increased use and complexity of interventional radiology [9]. The effective doses to paediatric patients undergoing body CT examinations were computed by Walter Huda et. al. They used scaling factors that accounted for scan length, mAs, patient weight and relative energy imparted. [10].The typical organ doses and the corresponding effective doses to adult and paediatric patients undergoing a single CT examination were determined by Walter et. al. [11]. Kennedy et. al. investigated whether lead shielding can be used to decrease the radiation dose to the foetus during CT scans for the diagnosis of pulmonary embolism during early sage pregnancy. They found that the fatal radiation dose from

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a CT scan following a pulmonary embolism protocol can be effectively reduced by the use of lead shielding. [12]. The determination of typical organ dosed and the corresponding effective doses to adult and paediatric patients undergoing a single CT examination were carried out by Walter et. al. they concluded that organ absorbed doses in CT are substantially lower that threshold doses for the induction of deterministic effects and effective doses are comparable to annual doses from natural background radiation [13].In Nigeria, Justina A. Achukaet. al. condemned the recommendation of chest radiography for school admission and employment purposes because of the risks of radiation especially cancer induction [14]. Aborisade et. al. also measured the variation in the Entrance Skin Dose (ESD) and scattered radiation of importance to radiation protection in paediatric patients for commonly performed X-ray examinations such as chest, abdomen, skull and pelvic and scattered radiation in three Nigerian tertiary health institutions, it was concluded that the choice of exposure parameters and ESD are known to vary inter and intra institutions and that there is need for the establishment of reference values. [15]. Patient-Specific radiation dose and cancer risk in CT examinations in Ondo state of Nigeria was carried out by Olaniyan et. al. and concluded that effective dose and patient-specific dose varied with and across the CT examinations [16]. This work used thermoluminescent dosimeters (TLDs) to measure the radiation dose and the scattered radiation during radiological examinations to paediatric patients in three Nigerian teaching hospitals and computed the effective.

II. MATERIALS AND METHODS

a) Materials

The scanner located in the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife is the Bright Speed Series manufactured in 2007 and installed in 2010. Lithium fluoride (LiF) TLD-100 is one of the most commonly used thermoluminescent (TL) materials for the measurement of radiation and scattered dose in diagnostic radiology. A set of three hundred and fifty (350) well calibrated chips were used for the work. All exposures for calibration of reader and dosimeter chips were done in the secondary standards dosimetry laboratory which maintains radiation protection standards for Nigeria and is housed at the National Institute of Radiation Protection and Research (NIRPR), University of Ibadan. The NIRPR serves as the custodian of the national secondary standards traceable with traceability to the IAEA standard laboratory in Vienna. The dosimeter chips were read at the NIRPR using HARSHAW Reader (model 4500).

b) Methods

After the annealing process of the calibrated dosimeter chips, each of the thermoluminescent dosimeters (TLDs) was enclosed in a black cellophane bag with different identification number. Radiation doses to typical CT examinations such as chest, abdomen and skull/pelvic were measured with three (3) of this TLD chips the average reading was taken to the radiation dose for that examination. Also, three (3) of the calibrated TLD chips were placed near various critical organs such as the gonad/pelvic, chest and the head depending of the type of the examination, in order to monitor the scattered radiation from the incident radiation to the critical organ situated in the head such as eye and brain and the gonad where the sensitive reproductive organ resides the average of the readings was taken to the the scattered radiation dose for that examination. CT radiographic examinations were evaluated for two hundred and fifty eight (258) children at the Obafemi Awolowo University Teaching Hospital Complex, (OAUTHC), Ile-Ife.

The chips were taken to NIRPR at UI for reading. The chips were removed from their bags and placed the planchet of the Harshaw Model 4500 TLD Reader with the help of the tweezer one after another. During the reading of the field dosimeter (TLD) the glow curve is generated on the computer that was connected with the reader. The reading of the dosimeter was done in a dark room with a red light because photoelectric effect will not take place with red light, thus, red light will not have any effect on the expose dose.

An important aspect of this research work is to compute the effective dose from the equivalent dose obtained from the hospital using the thermoluminescent dosimeters (TLD) placed on the patient during CT examination. Because the resulting biological effects of different types of radiation having the same energy dose varies, there is need for biological weighting of the energy dose to do the computation. This was done using the so-called equivalent dose. In ICRP paper no. 60, 1991 (ICRP 1991) an equivalent dose (H) for a certain organ or tissue is defined as

$$H = \sum W_R \times D \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1)$$

Where D represents the dose applied to the organ, W represents the radiation weighting factor and for X-ray W = 1 (ICRP, 1991). Also, because of the varying radio sensitivity of different organs and tissues, a tissue weighting factor, W, has been introduced, which leads to effective dose E (as opposed to the equivalent dose HT).

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III. RESULTS AND DISCUSSIONS

The results showed that CT scanning of the skull has the highest radiation dose (69.94 mSv) followed by pelvic/abdomen (66.26 mSv) while chest has the least dose of 31.94 mSv.

The results of the incident radiation and scattered radiation from the incident radiation to the critical organs are presented in Figures 1, 2 and 3.

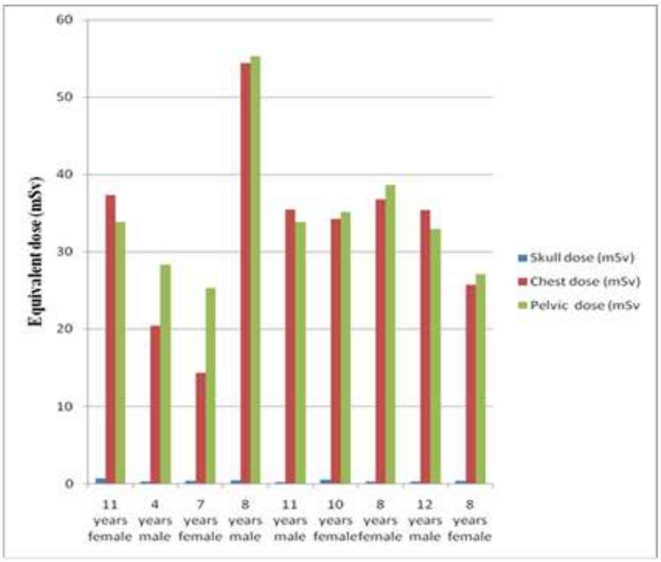

Figure 1: Comparison between Doses Received at Skull, Chest and Pelvic for Patients who had Pelvic CT scan

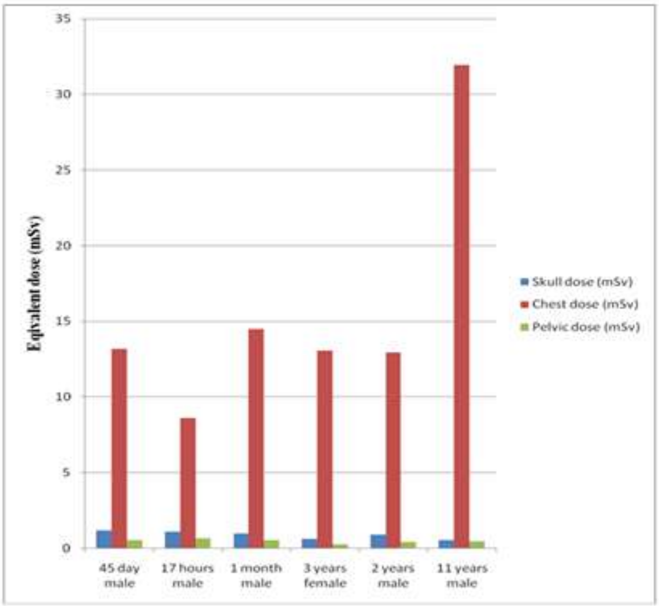

Figure 2: Comparison of Dose between Head, Chest and Pelvic for Patients who had Chest CT scan

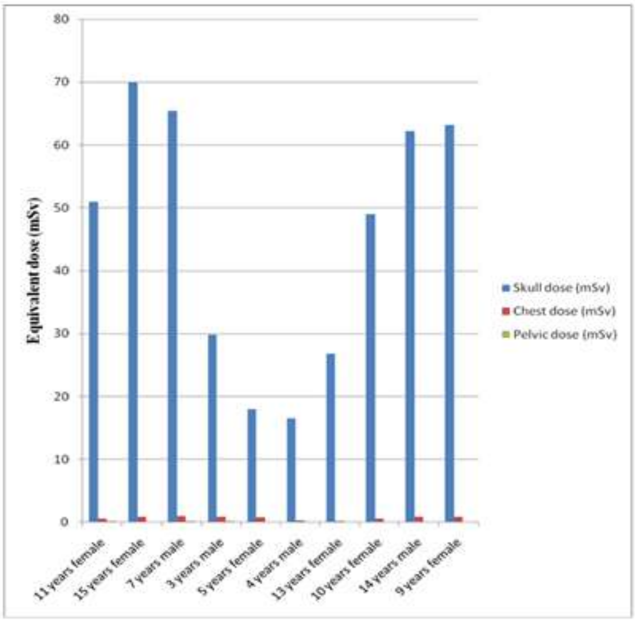

Figure 3: Comparison of Dose between Head, Chest and Pelvic for Patients who had Head CT scan

The radiation doses to the paediatric patients in this work is higher that the result obtained by Walter et. al. [11] with the skull has the highest dose of 69.94 mSv. Many of the CT examinations performed on paediatric in this hospital were performed at 120 kV and 300 mAs which may account for the higher doses. Paediatric doses will be much larger than those of adults if same radiographic techniques (mAs) are used for all examinations [11]. There is need for the use of lower kV values which will leads to substantial dose reduction without losing the diagnostic information [17-19]. The aim of radiation protection is to keep the radiation to the exposed area as low as reasonable achievable (ALARA), while reducing the radiation scattered to the other areas which are not part of the examination. The result presented in figure 1 showed that for those paediatric that did pelvic CT scan the collimated area was extended to cover chest and this led to the sizable amount of incident radiation dose that got to the chest but the small fraction of the scattered radiation got to the head. Even in some examinations the dose to the chest is even higher than the pelvic. Figure 2, showed the radiation dose and scattered dose distribution to the paediatric that did chest CT examination. The distribution pattern showed that the scattered radiations to the head and pelvic are small compared to the incident dose. The fraction of the scattered radiation dose that got to the head is a little bit higher than that of the abdomen; this is because the distance from the head to the chest is smaller than from chest to the pelvic. Figure 3, showed that the fraction of scattered radiation to the chest and pelvic is small compared with the incident radiation that got to the skull. The fraction that got to the pelvic is smaller than

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that of chest this is also because the chest is closer to the head than the pelvic. The result cannot be compare with any literature because no known work has ever been reported to best of our knowledge.

The effective doses can be computed from the results of this work. Hence, patient radiation risk can be estimated from the effective doses. According to Huda et. al. patient doses in CT are broadly comparable to annual doses from natural background and any risk for a single CT scan should be comparable to those from background doses delivered to every inhabitant of our planet each year [11].

IV. CONCLUSION

From the results it is better to collimate the radiation to the area of interest because the larger the amount of tissue the beam is allowed to irradiate the more scatter radiation produced. Using high kVp and low mAs techniques produces less scatter. The use of protective equipment such as lead lined walls or a lead apron when one is be involve in an exam is advisable. During mobile exams stand at least 6 feet away and if possible at a 90 degree angle from the radiation source (the patient) because the scattered radiation form CT examinations will be negligible. There is need for training/workshop for the technologies' at this centre.

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REFERENCES

[1] Berrington de Gonzalez A, Darby S. (2004) Risk of cancer from diagnostic X-rays: estimates for the UK and14 other countries. *Lancet* 363:345-351.

[2] Appleton M B and Stephen C R. Radiation protection in a neonatal intensive care unit: a practical approach, *Radiography* 1984; 50:137–41.

[3] ICRP-International Commission on Radiological Protection. 1990 Recommendations of the International Commission on Radiological Protection. *ICRP Publication 60. Annals of the ICRP* 1991; 21 (1-3).

[4] Ware D E, Huda W, Mergo P J., (1999) Radiation effective doses to patients undergoing abdominal CT examinations. Radiology 210: 645–650.

[5] Faulkner, K. &Moores, B. M., (1982). An assessment of the radiation dose received by staff using fluoroscopic equipment. *British Journal of Radiology*, 55, 272-276.

[6] Jeans, S. P., Faulkner, K., Love, H. G. &Bardsley, R. A.,(1985). An investigation of the radiation dose to staff during cardiac radiological studies. *British Journal of Radiology*, 58,419-428.

[7] LAW, J., (1985). Doses to head and arms of radiologists during fluoroscopy. *British Journal of Radiology*, 58, 187-188.

[8] PALMER, K. E. & WRIGHT, I. H., (1985). Eye dose limits and the use of over couch and under couch X-ray image intensifier systems. *British Journal of Radiology*, 58, 1221-1223.

[9] N. W. Marshall and K. Faulkner; (1992), The dependence of the scattered radiation dose to personnel on technique factors in diagnostic radiology. *British Journal of Radiology*. 65, 44-49.

[10] Walter Juda, Kent M. Ogden; (2008), Computing effective doses to pediatric patients undergoing body CT examinations. *Pediart.Radiol*.38:415-423.

[11] Walter Huda and Awais Vance; (2007), Patient radiation doses from adult and pediatric CT. *AJR*, 188540-546.

[12] Kennedy E. V., Iball G. R., and Brettle D. S.; (2007), investigation into the effects of lead shielding for fetal dose reduction in CT pulmonary angiograpy. *The British journal of radioody*, 80, 631-638.

AUTHOR'S BIOGRAPHIES

C. A. Aborisade (Ph.D)	Lecturer and Researcher at Department of Physics and Engineering Physics, Obafemi Awolowo University, (OAU) Ile-Ife. Nigeria.
O. C. Famurewa(FWACS)	Associate professor, Lecturer, Radiologist and Researcher at Department of Radiology, Obafemi Awolowo University, Ile-Ife. Nigeria.
F. I. Ibitoye (Ph.D)	Associate Professor, Lecturer and Researcher at Center for Energy Research and Development, Obafemi Awolowo University, Ile-Ife. Nigeria.
F. A. Balogun (Ph.D)	Professor, Lecturer and Researcher at Obafemi Awolowo University, Ile-Ife. Nigeria.

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