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Assessment of Radiation Exposure in Chest And Abdomen: X-Ray Examination at Federal Teaching Hospital Gombe, Nigeria

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ABSTRACT

Exposures from diagnostic medical x-rays are the most important artificial source of exposure to ionizing radiation in several countries. Even though, data on medical exposure of diagnostic x-rays is dispersed into international legislative strategies. In Federal Teaching Hospital Gombe, there is a conventional radiography in daily routine of diagnostic medical examinations. In this research, the mean ESD were calculated as 12.24 mSv for Chest and 3.35 mSv for Abdomen respectively. This indicates that the necessary need for optimizing the patient's dose to the acceptable levels recommended by the international commission on radiological protection (ICRP) from risk of higher exposure to diagnostic x-rays is needed also comparative chart between chest and abdomen, shows that patients with chest ailment are mostly common compared to the abdomen. It is therefore important to look and address factors leading to chest ailment.

Keywords:
Abdomen,
Chest,
Diagnostic,
Entrance Skin Dose,
X-ray.

INTRODUCTION

The data used in this research were gotten from Federal Teaching Hospital Gombe after obtaining an ethical clearance. In diagnostic medical imaging, the major risk is the excess exposure of patients to radiation. This problem may be due lack of technical knowledge on the operation of radiography equipment. The exposure to x-rays diagnostic must be justified and enhanced, taking into regard its benefits and harms to the patients (Decourchelle *et al.,* 2000). In x-ray examination, as a requirement of radiation protection, the physical parameters and the radiation dosage transmitted to the patient must be justified. Entrance Skin Dose (ESD) is referred to the quantity of radiation dose that is absorbed in air at the spot of overlap of the X-ray radiation axis with the access superficies of the patient, containing backscatter (Dietze *et al.,* 2005). The gate way flat dose is one of the important quantities for determining the patient dosage and to determine the ideal dose for the patient.

The radiation protection of patients undergoing medical x-ray examinations is governed by principle of justification and optimization. It is concerned with the control of the manner in which sources of ionizing radiation are used so that in the use of the sources, members of the public are not irradiated above acceptable levels (ICRP,1996; European Commission,1999). Hence, good radiographic technique is necessary to reduce level of exposure and risks from diagnostic procedure. In order to achieve appropriate radiographic techniques, the Commission of European Communities is used the "European Guidelines on Quality Criteria for Diagnostic Radiographic Images" a publication which includes examples of good radiographic techniques for a number of common x-ray examinations; should demonstrate good compliance with image and dose criteria (CEC, 1996).

In Nigeria to promote the optimization principles, it is necessary for x-ray departments to examine their work practices, assess the level of adherence to CEC guidelines, identify areas where less than optimal techniques exist and implement recommendations. Radiation can cause damage to human tissue (Abuzaidetal., 2019). The doses delivered by radiological examinations are substantially lower than the threshold needed to cause an immediate harmful effect. For example, radiation sickness, skin burn or eye damage can occur only when prolonged or repeated radiation exposure exceeds 1-2 gray (Gy) (Feyler et al., 2002). Fetus irradiation during pregnancy, when exceeding 100-200 mGy, could have adverse effects, such as mental retardation and malformation. However, even low doses can increase the probability of cancer occurrence due to changes in cell DNA (Valuckiene et al., 2016).

Radiographers play a major role in this aspect (Dietz et al., 2005; ICRP, 2009). They are considered as key to performing clinical radiological examinations and supporting radiation exposure; Thus, their practice should always be optimized according to the ALARA principle as Studies in Ireland, England, Germany, Greece and Sudan have shown that a number of x-ray departments are not using optimum techniques (Brennan & Johnson, 2002; Saure, 1995; Neil et al., 1995; Suliman et al., 2006). The chest x-ray is often the starting point for evaluation of respiratory complaints and is therefore encountered daily by many healthcare providers (Gans *et al.,* 2012). In an era of increasingly imaging-intensive medical practice, a thorough understanding of chest radiographic interpretation is a key skill that may aid practitioners in determining appropriate intervention, while lessening their dependence on expensive chest computed tomography (Suliman et al., 2006; Kothan, 2018).

In Nigeria, the Nigerian Nuclear Regulatory Authority (NNRA) is charged with the full responsibility of nuclear safety and radiation protection. This national regulatory body is empowered to categorize and monitor activities involving the use and processing of ionizing radiation from nuclear and medical practices in Nigeria. In this regard, the NNRA in her document made provision for minimum requirements for equipment maintenance in line with international regulatory policies (NNRA, 2015). The Nigerian Nuclear Regulatory Authority is responsible for the monitoring of the radiation exposure resulting from nuclear and medical practices in Nigeria. From many studies, varying level of adherence to guidelines were evident, with no hospitals demonstrating 100% compliance with the use of x-ray in Nigeria without knowing the possible harm. The radiation can cause harm to the human body with consequent effects to their general health and wellbeing (Oluwafisoye et al., 2010).

Theory

Absorbed dose by the patients is referred to the absorbed radiation dose by the patient's dose by the patients for each examination. It described the amount of energy absorbed per unit mass (John and Cunningham, 1983). The absorbed dose in organ or tissue is measured in gray were

1Gy = 11 $Gy = 1\ JKg^{-1}$ and it is expressed as

$$\Delta T = \frac{dE}{dM} \quad (1)$$

Where dE is the mean energy imported by ionizing radiation and dM is the mass of the tissue or organ.

Exposure is the measure of radiation that is needed to ionize the air in a medium given as

$$X = \frac{dQ}{dM} \quad (2)$$

According to European Commission Guidelines Entrance Skin dose (ESD) (CEC,1996) Suggested several methods of estimating entrance skin dose. These include the use of thermo luminescent dosimeter (TLD) and use of exposure parameter such as KVP, MAS, FSD which measured directly.

MATERIALS AND METHODS

The materials that were used in carrying out this research are:

i. Conventional X-ray Machine
ii. ii Thermoluminescence Dosimeter (TLD) Chips
iii. Measuring tape

The study was conducted in the X-ray unit of the Federal Teaching hospital Gombe. For each patient undergoing the routine examinations, the following parameters were recorded: sex, age, Focus-to-Film Distance (FFD), Focus-to-Skin Distance (FSD), tube potential (kVp), and electrical factor (mA). The TLD chips were fixed for each projection required for the examinations. Immediately after irradiating the patient, the chips were removed for each case to avoid excess radiation exposure while waiting for the next patient. After exposing all the chips, they were taken to Centre for Energy Research and Training (CERT) Zaria for analysis.

All x-ray examinations and measurement were carried out with a conventional X-ray machine in the radiology unit of Federal Teaching Hospital Gombe.

The population of the study includes all the patients that came for Chest and Abdomen X-ray examinations.

A total of twenty (15) patients comprising of both male and female adults referred to x-ray departments were investigated.

Method of Measuring ESD

Entrance Skin Dose (ESD) were measured directly by using calibrated TLD chips placed on the patient's body (Focus to Skin Distance).

Method of Analysis of Results

Dosimetry results were analysed from the TLD chips at the Centre of Energy Research and training (CERT) Zaria as in table 3.

RESULTS AND DISCUSSION

Table 1: Exposure parameters and individual ESDs (mSv) for Chest (AP) X-ray examination

S/N	Examination	Age	kVp	mAs	FFD (cm)
1	A P	38	70	10	150
2	A P	26	72	10	150
3	A P	39	70	12	150
4	A P	45	70	11	150
5	A P	40	70	12	150
6	A P	50	70	10	150
7	A P	38	72	13	150
8	A P	42	74	12	150
9	A P	50	72	10	150
10	A P	52	70	11	150

kVp range: (70-85)
mAs range: (10-16)

Table 2: Exposure parameters and individual ESDs (mSv) for abdomen (AP) X-ray examination

S/N	Examination	Age	kVp	mAs	FFD(cm)
1	AP	32	81	20	100
2	AP	51	89	25	100
3	AP	46	85	26	100
4	AP	45	82	32	100
5	AP	38	85	32	100

Data Presentation and Analysis

Table 3: Analyzed result for patient's ESD (mSv) for Chest and Abdomen x-ray examinations by the Centre for Energy Research and Training (CERT)Zaria

S/N	Chest AP (mSv)	Abdomen AP (mSv)
1	106.2	2.35
2	4.40	2.43
3	4.96	4.39
4	4.21.	4.64
5	1.68	2.95
6	4.28.	
7	2.39	
8	5.06	
9	2.10	
10	3.65	

Mean ESD for Chest (AP) x-ray examination = 12.24 mSv and Mean ESD for Abdomen (AP) x-ray examination = 3.35 mSv

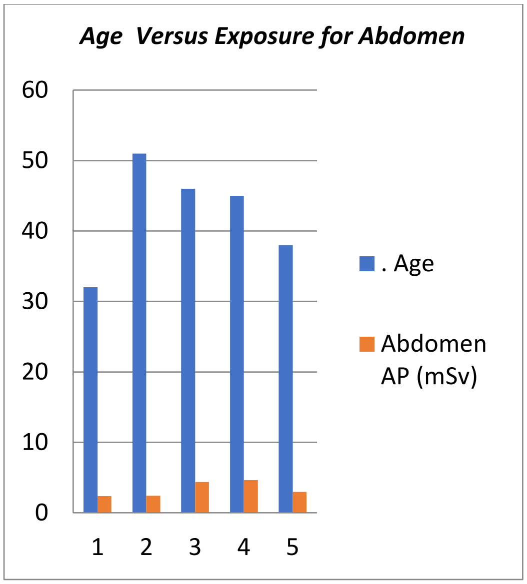

Figure 1: Range of Age undergoes Abdomen Exposure

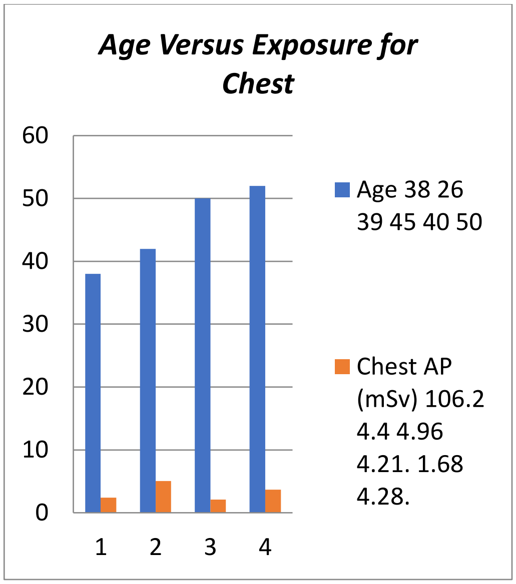

Figure 2: Age Range Undergoes Chest Exposure

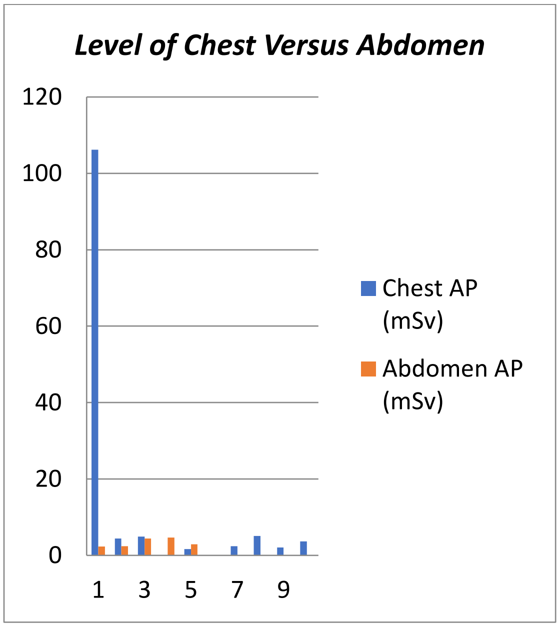

Figure 3: Difference between chest and Abdomen Exposure

Discussion

Table 1 and 2 shows that the exposure parameters used in carrying out the chest and abdomen x-ray examination, according to their age and elevation/projections. The data obtained clearly depicted that those patients with age ranges from 38,46 and 48 are mostly vulnerable to abdomen x-rays examination also, patients with age of 32 and 50 are less vulnerable to abdomen x-ray exposure while patients with ages of 42 and 52 are mostly undergoes chest x-rays examination and patients with age of 38 and 50 are less vulnerable to chest x-rays exposure. Table 3 shows the analyzed results of individual patient exposure (EDD) in mSv that participates in chest and abdomen x-ray diagnostic examinations for this research. Figure 1 and 2 indicate the age against the exposure of abdomen and chest x-ray diagnostic examination for this research. It was seen that each of them had an intense peak at different threshold. The highest exposures according to the ages are the age of 46 and 48 for abdomen while the lowest is the age of 50. Also, the orientation that was having the highest exposure according to the ages is the age of 42 for the chest and the lowest is the age of 50 also. Figure 3 shows the level of chest exposure against abdomen which according to this research. The chest x-ray examination has the highest exposure of about 106.2

mSv and also the lowest exposure falls in the chest x-ray examination of about 1.68 mSv. In comparison, the standard average effective radiation dose administered for adult in both chest and abdomen is 0.1 mSv and 0.7 mSv compared to our results, it is underestimated.

CONCLUSION

This research was conducted using calibrated thermo luminescence Dosimeter (TLD) chips. The Entrance Skin Doses (ESD) results were analyzed at the Centre for Energy Research and Training (CERT), Zaria, Nigeria. The use of personal devices where very low at the hospital (FTHG). It will be highly beneficial to optimize this practice in the hospital (FTHG) so as to avert the onward effect of ionizing radiation. It is therefore observed that none of these investigations was set up to the standard value and hence conclusively the personnel working in the radiology unit and the occupants around the vicinity of the diagnostic Centre of the hospital (FTHG) were safe from radiation effects. The patients' projections were taken in accordance with the requirements for the examinations and observation depicted those patients with age ranges from 38,46 and 48 are mostly exposed to abdomen x-rays examination also, patients with age of 32 and 50 are less vulnerable to abdomen x-ray exposure while patients with ages of 42 and 52 are mostly undergoes chest x-rays examination and patients with age of 38 and 50 are less vulnerable to chest x-rays exposure. In comparative chart between chest and abdomen given in figure 3, shows that patients with chest ailment are mostly common compared to the abdomen. It is therefore important to look and address factors leading to chest ailment. Government and relevant non-Governmental health Agency to look into the need to remedy member of public from factors leading to chest and abdomen ailment. In Gombe and it environ.

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