

CORRELATION OF ENTRANCE SKIN DOSE WITH BODY MASS INDEX OF PATIENT UNDERGOING ROUTING X-RAY EXAMINATION AT FEDERAL TEACHING HOSPITAL GOMBE, NORTH-EASTERN NIGERIA

Abstract

A study was conducted to confirm the amount of dose received by patient undergoing routing x-ray examination at Federal Teaching Hospital, Gombe in Gombe state, Nigeria. Entrance skin doses (ESDs) for different kinds of x-ray procedures, include Posterior Anterior (PA) and Lateral (Lat) chest, Anterior Posterior (AP) Abdomen, AP pelvis, AP and Lat lumbar spine and PA and Lat skull. The sum of eighty (80) data were obtained from patients who were being exposed to diagnostic X-ray during their regular X-ray examinations. The patient's age falls between 1 to 80 years, while the weight is between 20kg to 100kg and height of these patients fallen between 95.0cm to 171cm. The skin dose of each patient were evaluated using a formula, which is based on the radiographic exposure parameters of kVp, mAS, SSD, the X-ray tube and the total filtration of the beams. The enumerated mean entrance skin dose falls between 0.016 mGy to 3.168 mGy. Eventually, the ESDs measured for this type of x-ray procedures were found to be below the maximum permissible limits set by Nigeria Basic Ionizing Radiation Regulation [8] and all the examinations conducted shows that there is a good correlation between the entrance skin doses with body mass index during diagnostic X-ray examination. This shows that patients with higher body mass index will received more dose than the patients with low body mass index.

Key words: Skin dose, Body Mass Index, X-Ray Examination, Teaching hospital, Gombe

Introduction

The main purpose of x-ray examination diagnosis is to generate patient's images with important and adequate image quality in order to serve as a guide for practitioner to carry out an effective and efficient examination and treatment of different bad health conditions. Due to the danger related to the exposure of patients to x-ray while undergoing x-ray examinations, it is recommended that images of adequate quality for accurate examination are produced without any need for repetition [1].

Although, patients would definitely obtain great advantage from diagnostic x-ray examinations, but their use is not completely without risks. As a result of this, every exposure to diagnostic x-rays need to be justified and optimized in terms of risk and benefit [3]. One of the major ways of assessing radiation dose received in diagnostic and therapeutic radiography is monitoring of patients during the examination [4].

Diagnostic X-rays are used for identifying diseases and other problems during medical examinations. The objective of any diagnostic X-ray examination is to produce images of patients with essential details and sufficient image quality so as to guide practitioners for effective and efficient diagnosis and treatment of various disease conditions. Because of the risks associated with the

exposure of the patients to X-rays during the diagnostic X-ray examinations,[6] suggested that, there would be a need for improvement in producing an image containing all the necessary information required for accurate diagnosis which should lead to minimum dose exposure to the patient.

Materials and Method

The method of surveying in this work was based on the guideline established by the International Atomic Energy Agency (IAEA) protocols. This study comprises of eight most common performed diagnostic x-ray examinations, which are Posterior Anterior (PA) and Lateral (LAT) chest, Anterior Posterior (AP) Abdomen, AP pelvis, AP and LAT lumber spine and PA and LAT skull. The age range/interval considered were: 1-10, 11-20, 21-30, 31-40, 41-50, 51-60, 61-70 and 71-80 years. If the patient age is > 10 than it was put in range 11-20, >20 in 21-30, >30 in 31-40, >40 in 41-50, >50 in 51-60, >60 in 61-70, >70 in 71-80. These intervals were chosen since results in literature follows the protocol [7]. Automatic exposure control (AEC) was positioned between the patient being x-rayed and the x-ray film cassette. X-rays passing through the patient also pass through this "AEC detector" before they strike the x-ray film. Back Scatter Factor (BSF) was determined using 30cmx30cmx15cm phantom and conversion coefficients in term of surface dose. It depends on the type of the x-ray machine, the x-ray machine in the Federal Teaching Hospital was estimated as 2.9mmAl, that is the value for the BSF were determined to be 1.24gray/sievert

For each patient; age, sex, weight, height and chest thickness were recorded and corresponding technical parameters of exposures kV, mAs and Focus to Skin Distance (FSD) were also recorded. Although the National Radiological Protection Board [9] recommended that measurement of patients' dose be directly measured on Thermo-Luminescent Dosimeters (TLDs), free-air measurement of a tube's radiation output together with the calculation of Entrance Skin Dose using standard factors can also be employed in appropriate circumstances. [5]. In this work, we employed calculation of Entrance Skin Dose (ESD) based on standard exposure data due to unready availability of TLD chips and TLD reader equipment in the hospitals. The mean ESD was determined by evaluation from the x-ray tube parameters and exposure radiographic parameters using mathematical equation by [10] for calculating ESD.

$$ESD = BSF \times T \times OP \times \left(\frac{FFD}{FSD} \right)^2 \times mAs \quad (1)$$

Where: OP = the output in mGy/mAs of the x-ray tube at 80 KV at a focus distance of 1m normalized to 10mAs

mAs= product of the tube current (in mA) and the exposure time (s).

FSD= focus to skin distance (in cm)

FFD = focus to film distance

BSF= the back scatter factor ranging from 1.2 to 1.4 for x-ray spectra

The body mass index (BMI) is then calculated by dividing the subject's weight by the square of his/her height.

$$BMI = Weight(Kg) \div (Height)^2 m^2 \quad (2)$$

While effective dose is evaluated using the equation:

$$H = \sum_T (W_T \times ESD_T) \quad (3)$$

Where W_T is the weighting factor and ESD_T is the entrance skin dose of the respective tissue

Results and Discussion

Table 1 shows the distribution of biographical data of the patients, based on different age group and some machine parameters were also recorded. The determined mean for tube potential (KV), tube current and exposure time (mAs), output of x-ray (OP) and focus distance surface for chest LAT, pelvis AP, skull LAT, abdomen AP and lumber spine LAT were recorded.

Table1: patients' information and exposure parameters for x-ray examinations. (Ranges in parenthesis)

Age Range (Years)	Examination	Projection	Number of Patients	Weight (Kg)	Mean Kvp (Kv)	MEAN mAs (mAs)	Mean Dose (mGy)	Height (m)	BMI (Kg/m ²)	FSD (Cm)	O P (mGy/mAs)
1-10	Chest	LAT	2	23	30	12	0.027	0.96	24.96	60.0	0.0023
	Pelvis	AP	3	24	35	12	0.080	1.00	24.00	56.0	0.0067
	Skull	LAT	4	20	30	10	0.146	0.97	21.26	59.0	0.0146
	Abdomen	AP	0	0	0	0	0.005	0.00	0.00	0.0	0.0000
	Lumber Spine	LAT	1	25	30	12	0.061	0.95	27.70	56.0	0.0051

11-20	Chest	LAT	1	36	45	12	0.053	1.22	24.91	62.0	0.0044
	Pelvis	AP	0	0	0	0	0.005	0.00	0.00	0.0	0.0000
	Skull	LAT	3	45	50	12	0.241	1.38	23.63	71.0	0.0201
	Abdomen	AP	2	37	45	10	0.871	1.24	24.96	68.0	0.0871
	Lumber Spine	AP	4	38	50	10	0.274	1.21	25.95	61.0	0.0274
21-30	Chest	LAT	2	70	50	20	0.341	1.51	24.31	113.0	0.0171
	Pelvis	AP	2	58	56	20	0.590	1.51	25.44	91.0	0.0295
	Skull	PA	2	56	61	20	0.563	1.42	30.25	57.0	0.0282
	Abdomen	AP	2	61	63	22	0.509	1.44	30.38	63.0	0.0231
	Lumber Spine	AP	2	55	56	22	0.299	1.49	25.22	76.0	0.0136
31-40	Chest	PA	3	74	76	22	0.429	1.62	28.20	121.0	0.0195
	Pelvis	AP	3	76	75	28	0.501	1.55	31.63	87.0	0.0178
	Skull	LAT	0	0	0	0	0.005	0.00	0.00	0.0	0.0000
	Abdomen	AP	1	67	75	28	0.752	1.67	24.02	79.0	0.0269
	Lumber Spine	AP	3	80	77	32	0.718	1.66	29.03	84.0	0.0224
41-50	Chest	LAT	1	86	60	34	0.379	1.65	31.59	103.0	0.0111
	Pelvis	AP	1	80	74	38	0.812	1.70	27.68	63.0	0.0214
	Skull	PA	2	75	60	38	0.794	1.58	30.04	57.0	0.0209
	Abdomen	AP	4	70	56	41	0.976	1.69	24.51	67.0	0.0238
	Lumber Spine	AP	2	67	84	42	0.971	1.66	30.48	87.0	0.0231
51-60	Chest	LAT	4	89	76	42	0.871	1.71	30.44	123.0	0.0207
	Pelvis	AP	4	90	80	42	0.608	1.69	31.51	91.0	0.0145

	Skull	PA	1	82	66	42	0.894	1.61	31.63	88.0	0.0213
	Abdomen	AP	0	0	0	0	0.005	0.00	0.00	0.0	0.0000
	Lumber Spine	LAT	1	77	50	26	0.987	1.68	27.28	92.0	0.0340
61-70	Chest	PA	5	89	60	28	0.773	1.61	34.34	132.0	0.0276
	Pelvis	AP	1	99	72	26	0.654	1.59	39.16	73.0	0.0252
	Skull	LAT	1	88	68	38	0.456	1.68	31.18	76.0	0.0120
	Abdomen	AP	2	71	60	32	1.912	1.69	24.86	96.0	0.0598
	Lumber Spine	AP	1	79	56	30	1.543	1.68	27.99	67.0	0.0514
71-80	Chest	PA	2	100	85	30	0.820	1.71	34.20	114.0	0.0273
	Pelvis	AP	2	97	85	30	0.890	1.69	33.96	67.0	0.2967
	Skull	PA	2	87	80	32	0.609	1.68	30.82	78.0	0.0190
	Abdomen	AP	2	79	50	20	1.998	1.61	30.48	67.0	0.0999
	Lumber Spine	LAT	2	85	78	30	2.996	1.57	34.48	87.0	0.0999

Table 2 shows the evaluated entrance skin dose (mGy) for each range of age examination with corresponding values of Body Mass Index were 0.064, 0.213, 0.312, 0.481, 0.556, 0.511, 0.824, 1.428 (mGy) and 24.48, 24.48, 27.12, 28.22, 28.86, 30.22, 31.51 and 32.79 kg/m² respectively. Comparative account on the mean entrance skin dose received by different age groups with corresponding body mass index values are presented numerically in **table 2** and **figure 1**. The mean entrance skin dose received by patient belonging to age groups of 0–10 years and 11–20 years, respectively, ranged from 0.064 to 0.213 mGy and body mass index 24.48 kg/m². Likewise patients between (21–30 years age group) and 31 – 40 years were found to receive an mean entrance skin dose ranging between 0.460 and 0.481 mGy and 21.07–22.58 kg/m² respectively. The table have clearly shown that a patient with high Body Mass Index received high Entrance Skin Dose that is, if the Body Mass Index decrease Entrance Skin Dose also decreases (that is, Body Mass Index is directly proportional to Entrance Skin Dose).

Table 2: Mean ESD and BMI corresponding to the age range

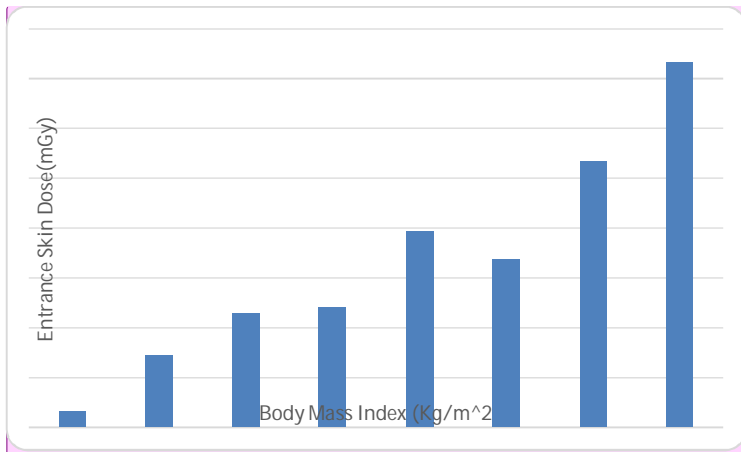
Age Range/ Interval	BMI (kg/m ²)	Mean Entrance Skin Dose (mGy)
1-10	19.58	0.064
11-20	19.89	0.289
21-30	21.07	0.460
31-40	22.58	0.481
41-50	28.86	0.786
51-60	24.17	0.673
61-70	31.51	1.068
71-80	32.79	1.463

Table 3 shows the estimated values entrance skin dose values compared with international established diagnostic reference levels and published works. The obtained values were below the international established diagnostic reference level.

Table 3: Comparison of mean Entrance Skin Dose (mGy) with others published and established radiographic procedures

Examination Type	Present study	Reference [10]	Reference [11]	Reference [2]
Chest PA and LAT	0.46	0.43	0.31	0.99
Abdomen AP	0.88	-	-	2.01
Pelvis AP	0.52	1.31	-	1.76
Lumber AP and LAT	0.98	3.25	5.95	2.18

Skull PA and LAT 0.46 - - 1.91



Comment [SV1]: re-write this graph as this figure 1, in x axis and y axis no numbers or range or percentages given, so add relevant data.

Figure 1: Chart showing Entrance Skin Dose against Body Mass Index

It is clearly shown from figure 1, that a patient with high Body Mass Index received high Entrance Skin Dose that is, if the Body Mass Index decrease Entrance Skin Dose also decreases (that is, Body Mass Index is directly proportional to Entrance Skin Dose).

In addition, the results of this study showed that the ESD of patients at federal teaching hospital, Gombe was compared to the results previously presented in the study made by Akbar A, and his team in Kashan, Iran [2]., and also those reported by Ofori EK and his associates study [10], UNSCEAR Foundation's 2000 A.D concluded study [11] all yielded only similar results as to the present study, which we carried out in Gombe, Nigeria.

Conclusion

At this work, the results of entrance skin dose (ESD) of patient undergoing routing x-ray examination at federal teaching hospital correlated with body mass index are presented, hence we conclude that, the amount of entrance dose is directly proportional to the body mass index, (i.e; the higher the BMI, the higher the amount of entrance skin dose received by the patient). So, the values of ESD obtained in this study were found to be lower than that of already established and published references.

Comment [SV2]: There is no need for Reference mention in Conclusion part, so, i reviewer edited it, and mentioned those references in under Discussion heading.

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