ISSN: 0067-2904

Entrance Surface Dose for patient`s undergoing X-ray examinations at Sebha medical center "Libya"

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Abstract

Diagnostic X-ray is one of the ionizing radiation that plays an important role in medical examination. Despite its great benefit, it is considered the largest source of artificial radiation exposure to public. The aim of the study is to measure the entrance surface dose (ESD) of patients undergoing chest, lumber spine and knee X-ray examination using TLD-100. The mean Entrance surface dose of chest (PA), lumber spine (AP, LAT) and knee (AP, LAT) are 1.3mGy, 8.57mGy, 21.5mGy and 0.49mGy, 0.48mGy respectively. The ESDs measured were found to be higher than the published work.

Keywords: Entrance surface dose, TLD-100, X-ray examinations.

الجرعة السطحية الداخلة للمرضى الذين يخضعون لفحوص الأشعة السينية في المركز الطبي سبها "ليبيا"

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الخلاصة

التشخيص بالأشعة السينية هو احد انواع الإشعاعات المؤينة التي تلعب دوراً هاما في الفحص الطبي. وعلى الرغم من فائدتها العظيمة إلا انها تعتبر من أكبر مصادر التعرض للإشعاع الاصطناعي للجمهور. تهدف الدراسة الى قياس الجرعة السطحية الداخلة (ESD) للمرضى الذين يخضعون لفحص الصدر والعمود الفقري و الركبة باستخدام كواشف TLD−100 . نتائج هذه الدراسة وضحت بأن متوسط الجرعة السطحية الداخلة لفحص الصدر لوضع PA ، و فحص العمود الفقري لوضع (AP، LAT) وفحص الركبة للوضع (AP، LAT) هي .1.3mGy، 8.57mGy، 21.5mGy، و 0.49mGy، و 0.48mGy على التوالي. وجد أن قيم ESDs المقاسة أعلى من المستويات المرجعية لبعض الدراسات المنشورة.

Introduction

The danger and risks associated with X-rays have been extensively researched during the last century, and it is apparent that governmental supervision of X-rays usage is necessary [1].

The need for radiation dose measurement of patients during diagnostic X-ray has been highlighted by increasing knowledge of the hazards of ionizing radiation. Explaining the variations of patient dose and their causes is a useful tool in investigating areas in need of dose reduction [2]. The X-ray is said

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to be the major contributor to the collective effective dose of the general public both in developed and developing countries [3].

Measurement and optimization of radiation doses received by patients are the most important tasks for radiation protection of patients in diagnostic radiology. The patient dose is usually dependent on radiographic procedures, technical and equipment factors, exposure parameters and the level of quality assurance in hospitals [1]. Therefore, the growing application of X-rays in medicine and the increasing hazards of radiation medical exposure have led to comprehensive efforts of different international committees and organizations involved radiation protection fields for issuing reference dose values as a guide to the levels of radiation protection of patients undergoing X-ray examinations. Patient's dose has often been described by the entrance surface dose (ESD) as measured in the center of the X-ray beam.

Because of the simplicity of its measurement, ESD is recommended as the most appropriate dosimetry quantity for X-ray projections, since it meets the three basic conditions set by the IAEA which is simple to measure. Permits direct measurement on patient during the examination, and is representative of the dose received by the patient. It is also recommended by the Commission of the European Communities (CEC) in the document on quality criteria for the most common radiographic images. Above all the measurement of ESD permits easy comparison with published diagnostic guidance or reference levels [4- 7].

Hence, the objective of this study is to measure the ESD of three common X-ray examinations" chest PA, Knee PA, LAT and Lumbar spine PA, LAT at Sebha medical center "Southern Libya".

Materials and Methods

The entrance surface dose (ESD) of the patients undergoing chest, Knee and lumbar spine imaging are measured using thermoluminescence dosimeter TLD -100 (Lif : Mg; Ti). The TLD-100 are annealed at 400 ^{o}C for 1h, and the irradiated TLDs are then read on a Harshow model 3500 TLD- Reader. Time temperature profile (TTP) is set on initial preheat temperature of 50 ^{0}C and an acquire temperature rate 12 ^{0}C/sec for an acquisition time $33\frac{1}{3}$sec Two X-ray machine (RADspeed MF , Duo Diagnostic Philips) were used in this study located in radiology department at Sebha medical center. X-ray machine setting such as kV_p, mAs , and FSD values for each examination are taken. The ESD of 147 adult patients was measured in this study, 48 patients for chest examination, 56 for knee examination, and 44 for lumbar spine examination. Patients of both sexes are randomly selected, for each patient the following parameters are recorded, sex, age, weight, height and body mass index (BMI). The average of these parameters with X-ray machine parameters are shown in Table-1.

Three TLD chips are attached to patients' skin for every measurement. The average of the three reading after correction is converted to dose in mGy using equation (1).

$$ESD(mGy) = \frac{TL(output)(nC)}{CF(nC/mGy)} \quad -----(1)$$

Where TL output is the average reading of three TLDs attached to patients – background reading of the control TLDs, and CF is the calibration factor of the TLDs.

Results and Discussion

The mean values of kV_p, mAs and FSD along with their range for each type of radiographic examination obtained are shown in Table-1. The body mass index calculated by weight/ (height)^2 is an indication of the patient size and shape [8]. The descriptive statistics of ESD i.e the minimum, first quartile, third quartile, maximum, mean and median are shown in Table-2. This study shows that there is a wide range of variations in patient dose for the same type of X-ray examination as shown in Table-2. This variation is due to the exposure factors, patient size, and radiographic technique

Table 1-shows patients information and X-ray parameters.

Examination projection		No. of patient	Age (y)	Height cm	Weight Kg	BMI	Kv_p	mAs	FSD
Chest	PA	48	(7-80) 42	(110-185) 160	(48-102) 71	27	(60-86) 76	(18-45) 31	(100-150) 127
Knee	PA	33	(13-85) 42	(120-195) 164	(58-130) 82	30	(50-77) 58	(7-32) 12	(40-100) 65
	LAT	23	(13-70) 43	(140-165) 166	(58-130) 82	29	(50-77) 58	(7.4-18) 11.9	(30-100) 64
Lumbar spine	AP	13	(10-75) 49	(95-180) 160	(48-115) 78	30	(10-110) 80	(20.8-182) 84.8	(30-80) 65
	LAT	30	(10-80) 43	(95-198) 165	(48-120) 80	29	(74-133) 95.5	(36-316) 181.9	(25-120) 58

Table 2-ESD for three common types of X-ray examinations at Sebha medical center.

Examination projection		No. of patient	Min mGy	1st quartile	Median	Mean mGy	3rd quartile	Max mGy
Chest	PA	48	0.41	0.86	1.2	1.3	1.58	2.9
Knee	PA	33	0.15	0.27	0.35	0.49	0.51	1.8
	LAT	23	0.19	0.29	0.36	0.48	0.57	1.2
Lumbar spine	AP	13	1.23	2.94	6.83	8.57	14.16	27.5
	LAT	30	2.7	9.65	18.65	21.5	33.5	47.9

Table 3-shows the comparison of kV_p and mAs for Chest, Knee, and Lumbar spine used in this work and other published studies.

	Taiwan [9]	Malaysia [8]	Portugal [10]	UK [11]	Malaysia [12]	Saudi Arabia [13]	Iran (14)	Ireland [2]	This study
Chest PA									
kVp	77	79	76	76	-----	------	-----	--------	76
mAs	16	9	12	8	-----	------	-----	--------	31
Lumbar spine AP									
kVp	----	------	-------	------	73	75	69	-----	80
mAs	-----	------	------	------	35	24	22	------	84.8
Lumbar spine LAT									
kVp	---	------	------	-----	85	86	82	72-117	95.5
mAs	-----	-------	--------	------	52	55	40	10.9-400	181.9
Knee PA									
kVp	----	------	------	-----	------	64	-----	------	58
mAs	-----	-----	------	-----	-------	8	-----	-------	12
Knee LAT									
kVp	------	-------	-------	------	------	64	-----	------	58
mAs	------	------	-------	------	-------	7	----	------	11.9

Table 4-Shows the ESD from this study compared with other published work.

X-ray projection	This study ESD (mGy)	Germany [15]	Malaysia [8]	Slovenia [7]	IAEA [16]	Malaysia [12]	Ireland [2]	Iran [17]	UK [18]	CEC [19]
Chest PA	1.3	0.3	0.28 mGy	0.29 mGy	0.4 mGy	0.18 mGy	0.218 mGy	----	0.15	0.3
Lumbar spine AP	8.57	10	10.56 mGy	6.06 mGy	10 mGy	5.74 mGy	6.42 mGy	3.92 mGy	5	10

Lumbar spine LAT	21.52	30	18.6 mGy	15.52 mGy	30 mGy	11.36 mGy	16.87 mGy	6.84 mGy	11	30
Knee AP	0.49	---	--	---	----	-----	----	----	---	--
Knee LAT	0.48	---	---	---	----	----	-----	----	---	---

A total of 147 dose measurements on chest, lumbar, and knee examinations are recorded during this study. The radiographic technique parameters recorded in this study show that there are variations in the technique factors when compared with other work [2, 8, 9,10,12, 14]. Varying radiographic voltage, reduced FSD and increasing mAs were used in this study. These factors have an adverse influence on the amount of dose received by patients, and this problem is common in other developing countries

Table-3 shows the radiographic parameters, and the range of applied tube potential for chest x-ray is 76 kV_p which are in the same range as the corresponding value in other studies. But the average mAs were higher than those used in other established studies. The optimal tube potential in chest radiography has received a considerable amount of discussion in the radiological literature [20, 21]. It has been estimated that increasing the tube potential from 60 kV_p to 90 kV_p will result in an ESD saving of 60% [20]. In a pilot research programmer coordinated by the IAEA, conducted in seven developing countries, it was reported that only one out of 21 X-ray rooms dedicated to chest radiography used a high tube potential technique [7]. This explains why the ESD values measured were higher than the international reference values. In case of Lumbar spine AP, the Kv_p used in this study around 80 Kv_p which is slightly higher than other studies, where the mAs is much higher than the other studies. The same for LAT projection the kV_p is higher and mAs is 181.9 mAs which is much higher than the other studies [12, 14]. Martin et al [22] found that increasing tube potential by 8 -13 kV in lumbar and thoracic spine examinations resulted in a dose reduction of 26 -36 %.

The mean entrance surface dose (ESD) obtained for chest PA, knee, PA / LAT, and Lumbar spine AP/LAT are 1.3 mGy, 0.49 mGy, 0.48mGy, 8.57mGy, and 21.5mGy respectively as shown in Table-4. These values are below the international accepted reference values except the chest PA which is above the international accepted reference values. There is no national diagnostic reference levels (NDRLs) in Libya to compare the results of this study. However, a comparison of the results in this study with some published work as shown in Tables-(3, 4). This study confirms that patients who have chest, Knee, X-ray examinations receive high radiation dose compared to other published data [2, 16, 19]. Higher ESD than the reference ESD values for a particular types of X-ray procedure in general represent an unnecessary over exposure to the patient whereas low ESD values may lead to poor diagnosis and unnecessary repetition of the X-ray procedure. In both cases the chance of increasing radiation exposure to the patient increases. The reason for higher ESD in this study is due to excessive exposure parameters such high mAs, and short FSD compared with other studies [9, 16]. In general, the use of low tube potential and high mAs values is common in high dose. In addition, there is no regular quality control and radiation protection program at Sebha medical center. This affects the performance of the X-ray machine and increase the patients' radiation dose.

Conclusions and recommendations

The results show that patients undergoing Chest X-ray at Sebha medical center are being over exposed to radiation as their ESD is higher than recommended values. The results also show that the Lumbar spine AP/ LAT ESD are below the international reference value but slightly higher than other published work. This is essentially attributed to poorly selected exposure parameters. Thus, certain measures need to be adopted to reduce the hazard of radiation (1) using the proper radiological parameters such as high kV_p, and low tube current and large distance between patient and X-ray tube. (2) The ALARA principle should be used by the technician. (3) Training programmers to radiographer. (4) Implementing quality Assurance program in the X-ray department reduce un necessary high patients' radiation dose.

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