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Assessment of Radiation Dose from Computed Tomography in Erbil City, Kurdistan Region: A Comparison with National Diagnostic Reference Levels

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Abstract

The diagnostic reference levels (DRLs) are important operational agents for improvement of patient protection from radiation doses in radiological imaging. It advised by the International Commission on Radiological Protection (ICRP) as an advisory measure to optimization of patient protection by determining high patient dose levels which might not be necessary on the basis of image quality needs, so one of the main goals of this study was protection of patients from radiation doses during CT examination, evaluate radiation doses received by patients from CT examination that conducting in three medical imaging centres, Department of radiology in PAR Hospital, Hawler Hospital, and Cardiac Centre, in Erbil.

Compare the results with National Reference levels. The patients with total sample of 335 patients that undergoing various CT examinations including head, chest, and abdomen were collected. The data collected included age, gender, region examined, length, weight. Simulation software, CT Expo (Ver.2. 3. 1 Germany) were used for each examinations, radiation doses from CT that received by patients, and presented in terms of weighted Computed Tomography dose index (CTDI), dose length product (DLP). The results show that the mean values of CTDIw, DLP ranged from 6.7 ± 5.8 to 60 ± 1.7 mGy, 156 ± 88.5 to 884 ± 182.2, respectively. It is important to aware and optimizes the high radiation dose of CT equipment.

Keywords: CT-scan; Radiation dose; Weighted CT dose index; Dose length product; National Reference levels; Volume CT dose index; Body mass index

Introduction

Since Rontgen has taken the first image of his wife's hand on 22nd December 1895, the X-ray radiology system has developed continuously [1]. The Computed Tomography (CT) in 1972 is the greatest developments in medical imaging, it is generally accepted that radiation doses from Computed Tomography is significantly very high compared to X-ray due to continuous output along z-axis during scanning [2].

Radiation protection of patients has been fundamental responsibilities in medical community since have been discovering CT scan, to ensure that radiation dose in line with the concept of The guiding principle of radiation safety is ALARA (As Low As Reasonably Achievable) [3]. Efforts directed towards, accurate reference levels for CT radiation dose [4], for each examination significantly, with multi detector CT (MDCT), which have been recognized as high radiation dose, compare with other imaging techniques [5].

There are three different quantities of CT scan radiation dose, weighted computed tomography dose index (CTDIw), dose length (DLP). These values is used for characterizing radiation output of scanner [6,7], to protect the patients from the risk of ionizing radiation, that need to manage the dose levels in order to reflected the essential process of optimization the technical parameters, which effect doses of CT scan [8]. This study conduct in three medical imaging centres to compare the current radiation doses in Erbil city with other relevant literatures.

The quantities of radiation are significantly high and vary through different scanner and anatomical region. Therefore, the operators should justify, and optimize the amount of ionizing radiation doses of CT scan unnecessary to the patient [9].

Material and Methods

This study was conducted in three medical imaging centres, Department of radiology in PAR Hospital, Hawler Hospital, and Cardiac Centre, in Erbil.

The data contain characteristics of patients, who performed CT scan procedure in these hospitals, age, weight, height and body mass index (BMI).

The technical factors of CT equipment was record for each patient tube-potential (Kv), tube current (mAs), slice thickness, and scan range. Radiation output include volume computed tomography Dose Index (CTDIv) or weighted computed tomography Dose Index (CTDIw), dose length product (DLP).

The information obtained for 335 patients that undergoing various CT examinations including head, chest, and abdomen were collected. Volume CT dose index CTDI vol is a measure of amount of energy

deposited per unit mass, proportional to absorbed dose; unit is the Gray (Gy). DLP takes into account scan length; it is the product of the CTDIvol . Scan length (in centimetres), unit of DLP is mGy.cm.

Radiation doses of CT system were calculated in the program CT-EXPO (Version 2.3.1, Germany), this program provide as with CTDIw and dose length product (DLP) automatically, by scanning parameters as input, which including patient age, weight, height and body mass index (BMI), the results were collected in Microsoft Excel and analysis [10].

Results

The aim of this work was to compare radiation doses from CT scanner in Erbil hospitals with other literatures. There were three CT scanners procedures included in this data are used for diagnostic procedures. CT Expo-software calculated CTDIw, and DLP. The data were in regards to 335 of CT underwent head scanning, chest and abdomen, 120 who underwent head CT scan, 80 who underwent chest, and 140 abdomen CT examinations (Table 1).

Hospital	Region of examination	No patients	Age (year)	Weight (k)	Height (m)
PAR	Head	40	65 ± 2.5	70 ± 10.2	1.68 ± 2.15
	Chest	20	38 ± 5.8	75 ± 13.6	1.65 ± 1.47
	Abdomen	50	55 ± 3.7	75 ± 6.9	1.61 ± 2.28
Hawler	Head	30	63 ± 7.2	72 ± 7.8	1.65 ± 1.33
	Chest	30	38 ± 8.6	75 ± 8.5	1.73 ± 2.12
	Abdomen	40	53 ± 9.8	68 ± 3.2	1.62 ± 3.05
Cardic center	Head	50	56 ± 7.8	72 ± 7.6	1.63 ± 3.1
	Chest	30	48 ± 6.2	71 ± 10.2	1.66 ± 1.27
	Abdomen	45	53 ± 2.9	73 ± 9.3	1.62 ± 1.36

Table 1: Patients Characteristics.

Hospitals	Region of Examination	Tube Curren (mAs)	SliceThickness (mm)	Scan Range (cm)
PAR	Head	418.5 ± 42.8	3	12.5 ± 1.4
	Chest	156.3 ± 23.1	5	44.1 ± 3.1
	Abdomen	200 ± 39.5	5	43.4 ± 9.3
Hawler	Head	275 ± 8.6	3	60.1 ± 8.6
	Chest	75.1 ± 11.7	5	7.2 ± 1.7
	Abdomen	85.0 ± 0.22	5	6.3 ± 1.5
Cardic center	Head	288	5	63.4 ± 1.3
	Chest	108	5	12.6 ± 6.8
	Abdomen	80	5	13.1 ± 3.4

Table 2: CT scan equipment's parameters.

Hospitals	Region Examined	CTDIvol	CTDIw	DLP
PAR	Head	60.2 ± 1.4	60 ± 1.7	795.9 ± 115.8
	Chest	6.2 ± 4.3	8.6 ± 2.6	388.5 ± 156.1
	Abdomen	11.9 ± 8.8	9.8 ± 3.1	632.8 ± 378.3
Hawler	Head	47.7 ± 3.4	48.6 ± 1.3	652 ± 55.4
	Chest	3.5 ± 2.1	7.6 ± 1.7	156 ± 88.5
	Abdomen	4.8 ± 1.9	9.8 ± 3.5	248.7 ± 95.8
Cardic Center	Head	61.1 ± 7.4	57.3 ± 10.5	884 ± 182.2
	Chest	10.2 ± 5.1	8.4 ± 2.2	575.5 ± 246.1
	Abdomen	9.2 ± 7.36	6.7 ± 5.8	385.8 ± 172.4

Table 3: CT-dose index volume, CT-dose index weight, and dose length product measurements.

The mean age for the patients, who participated in this study ranged from 38 to 68 years old. While the mean values for weight ranged from 68 to 75 kg, and from 1.61 to 1.70 m for height respectively.

The slice thickness for patients was ranged between 4.0 to 10.0 mm thicknesses, voltage CT equipment between 110 to 120 Kv for all patients examinations (Tables 2 and 3).

Table 4 describe the comparison between the values of radiation doses in Erbil hospitals CTDIvol, CTDIw, and DLP with other literatures. The values of CT head, chest, and abdomen in lower level doses than Malaysia and United Kingdom.

Study	Region	CTDIvol	CTDIw	DLP
This study	Head	58	55	780
United Kingdom		56	57	690
Malaysia		63	46.8	1050
This study	Chest	7	8	373
United Kingdom		10	14	400
Malysia		15	19.9	600
This study	Abdomen	9	8.7	
United Kingdom		12	16	350
Malysia		17	12.8	450

Table 4: Comparison of CT scans doses with other literatures.

Discussion

The radiation dose of Computed Tomography, is higher than other diagnostic imaging equipment, CT technique parameters including tube potential (Kvp), current product (mAs), scan length (DLP), pitch (the shift per rotation ratio), which CT dose depended on these factors [11]. The mean doses in this study and CT parameters among radiology department of each hospital, the scanner doses are in agreement with other literatures from previous study, and with National reference measurements (NDR) [12]. Significant variation

was shown in tables [13,14] for head, chest, and abdomen radiation doses. Highest dose index was founding head imaging, with value of about 65.9 mGy, whereas the lowest value of 3.5 mGy was recorded for chest examination [15,16]. Variation between these examinations may be due to the use non-optimised exposure factors that deepened on adjusting mAs, or poor knowledge of protocols of scanner procedures, that would increase the risk of cancer to patients examined by CT scan [17,18]. It has been noted that necessary to monitoring the ionizing radiation in medical imaging centres in Erbil the dose must be according to age, weight, and body mass index of the patients. CT doses to recognize that invaluable diagnostic system to protect patients from that amount of radiation should be considered safe [19,20]. This study is a basis in the optimisation techniques particularly for Multi-slice modern CT scan units, dosage levels from scanners, and number of CT examinations.

Conclusion

The CTDIvol, CTDIw, and DLP for CT scan in Erbil hospitals; these presented doses were lower compared with other literatures. Radiation dose is good estimating by used of CT-Expo software, which is a useful tool for these measurements. Body mass index of patient play important role in radiation dose. Finally, it is awareness that voltage KVp) and pitch may have been affected patient dose. Dose as Low as Reasonably (ALARA), while maintaining the patient outweigh the risk.

Ethical Approval

Ethical approval was obtained from the Research Ethics Committee of the College of Medicine, Hawler Medical University, meeting Code: 8, Paper Code: 11, Date 13/10/2019.

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