Assessment of Effective Dose by Indirect Method for Some CT Examinations in Medical Imaging Department

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Abstract: ***Purpose to assess the radiation doses, diagnostic reference level, dose length product (DLP) and effective doses for CT examinations in one of medical imaging department in Jeddah, SA. Materials and Methods. Dose diagnostic reference levels are calculated as the third quartile value of the distribution of the dose descriptors observed in patient dose surveys. Effective doses (E) for brain, sinuses and abdomen CT examination are estimated using DLP dose conversion Coefficients. Results The mean DRL (mGy), DLP (mGy.cm) and effective doses for brain, sinuses and abdomen examination are compared to surveys from international countries for 96 patients from king Abdullah medical complex, Jeddah. The mean (minimum-maximum) radiation doses were, as follows: for Brain examinations 49 (32-58) mGy, 508 (276-1133) mGy.cm and 1.17 mSv, respectively; for Sinuses examinations 3.5 (1.4-4) mGy, 89 (29-85) mGy.cm and 0.21 mSv, respectively and for Abdomen examinations 14 (7-10) mGy, 807 (263-1960) mGy.cm and 12.11mSv, respectively. These results are compared with diagnostic reference dose levels the European Commission are within diagnostic reference levels. Conclusion CT in the mentioned hospital in Saudi Arabia associated with relatively low radiation doses in third quartile, 75% of the patients size due to use radiation dose reduction software.***

Keywords: Computed tomography, diagnostic reference dose levels, length product, Effective doses.

1. Introduction

Computer tomogram modality contribute to a patients about 47% of the collective dose from diagnostic radiology (UK, 2003). It representing only 9% of all X-ray examinations (Suliman et al, 2011). It delivers radiation doses to patients that are higher than those from other radiological procedure. In addition to, International Atomic Energy Agency (IAEA, 2009) [1] have found the diagnostic reference level, (DRL) surveys of computed tomography in large medical centers delivered the highest radiation doses to patients from diagnostic radiology. The mean dosimetric reference levels, Computed Tomographic Dose Index, CTDI (mGy) patient doses and dose length product, DLP (mGy.cm) are defined as diagnostic reference levels (DRLs). A lot of authors established DRL(s) in some countries around the world such as (Mohamed et al, 2017) have recorded values of weighted CT dose index (CTDIw) and dose length product (DLP) for two groups of brain imaging using two scanners with 64-slice CT scanners. A recent publication of international Atomic Energy Agency (IAEA,2009)shows an increasing use of dose reduction techniques in routine clinical practice, particularly the use of automatic exposure control techniques . This study is aimed to assess effective doses for Brain, Sinuses, and Abdomen CT examinations using new GE 64 MDCT scanner in medical imaging department in one hospital in Makkah city, SA.

2. Material and Method

The study was approved by the King Abdullah Medical Complex, KAMC, Jeddah, KSA, Institution review board (IRB) number A 00575. Discovery CT750, 64 scanners (GE Medical Systems, LLC) with solid state detector at King Abdullah Medical Complex City scanner is used in this study. GE 64 MDCT scanner reconstructed kernel algorithm with Adaptive Statistical Iterative Reconstruction (ASIR) algorithm for enabling CT images with adequate image quality and diagnostic. value at significantly lower radiation dose. The ASIR-V algorithm enables dose reduction by intelligently reducing noise and has the capability to reduce low signal artifact. ASIR-V increases the detectability of low-contrast objects, thus offering the capability to reduce patient dose.

Data Collection

Data collection of patient parameters such as collected by a medical physicist at KAMC-Jeddah in Saudi Arabia via scan dose report. Patients demographic parameters such as age, gender, various weight, height for a sample of more than 90 computed tomography (CT) and physical scan parameters such as patient tube voltage (kV), reference and effective mill ampere-second (mAs), section collimation (CsL), rotation time (TI), scan length, number of slices, pitch factor is collected from a picture archiving and communication system (PACS). The data collected from PACS of general electric scanner in King Abdullah Medical Complex, KAMC, Jeddah, the mean patient doses of CTDIvol (my) and DLP (mGy.cm) for the selected hospital was comparable with another reference CTDIvol and DLP for 75th percentile of all patient size.

Effective Dose Calculation

Effective dose was estimated multiplying CT air kerma-length product, mGy.cm by a corresponding normalized conversion coefficient that is defined as specific only to the anatomic region (k), mSv/mGy.cm for multiline CT imaging, 0.0028 for brain, 0.0023 for sinuses, and 0.015 for abdomen imaging [6] ; it wast stated by (ACR-2018, UK-2011).

3. Results

Mean ± standard deviation of patient demographic data and computer tomography acquisition parameters for the available routine brain. Sinuses and abdomen CT protocols in KAMC, Jeddah, SA is tabulated in (table 1).

Table 1: Patients demographic data and main CT acquisition parameters for some CT Protocol in KAMC, Jeddah, SA.

	Patient demographic data				CT acquisition parameters	
CT Protocol	No. of Patients	Age (year)	Weight (kg)	Kilo-Voltage, kV.	mAs	L(cm)
Brain	46	48 ± 20	68 ± 11	136 ± 7	150 ± 46	4.4
Sinuses	38	14 ± 14	68 ± 8 0	104 ± 00	74 ± 0 0	15.5
Abdomen	12	39 ± 19	70 ± 07	102 ± 10	76 ± 100	56

L: Scan length

CTDI vol, dose length product, DLP and effective dose for brain, sinuses and abdomen CT imaging for 75thpercentile of all patient size respectively for king Abdullah medical complex KAMC-Jeddah and comparison with other values reported by mentioned organization bodies presented as shown in Tables (2-3).

Table 2: The mean, minimum- maximum values for DLP (mGy.cm) for the brain, sinuses and abdomen examinations, at KAMC, Jeddah

Dosimetric data	CT examination	KAMC1	UK-2003	EC, 1999	Malizia, 2013
DLP	Brain	508 (276-1133)	930	1050	814
	Sinuses	89 (29-85)	930	360	106
	Abdomen	807(263-1960)	560	-	567

Table 3: The mean effectives dose (mSv) for the brain, sinuses and abdomen examinations, at KAMC, Jeddah

Dosimetric data	CT examination	KAMC1	Germany, 2003	EC, 2001	Netherland, 2013
E (mSv)	Brain	1.17	1.5	1.5	0.2
	Sinuses	0.21	0.2	0.2	1.5
	Abdomen	12.11	11.5	7.1	8

4. Discussion

The mean and standard deviation for DLP for brain, sinuses and abdomen for reference 75th percentile of all patient size was found to be 508 (276-1133) mGy.cm, 89 (29-85**)** mGy.cm and 807(263-1960) mGy.cm respectively as shown in table (2). The current DLP for the sinuses and brain are lower than values found by **(UK-2003)**, **(EC,1999)** and **(malizia-2003)** respectively and DLP for abdomen are higher than the that values found by **(UK-2003)**, **(EC,1999)** and **(malizia-2003)**respectively as presented in table (2) due to difference in scan length. The scan length for sinuses, brain and abdomen was 15.5 cm, 4.4 cm and 56 cm respectively as presented in table (2). The effective dose for the brain was slightly lower than that values obtained by **(Germany, 2003)**, European Commission **(EC, 2001)** and (Netherland,2013)*)* due to differences in scan length. the scan length of the current brain CT protocol was found lower than that value of 153 mm presented by **(Mohamed,** ***et al, 2011)***. The effective dose for sinuses for reference weights of 60 ± 10% was lower than values reported by (**Germany, 2003)**, European Commission **(EC, 2001)** and **(Netherland,2013)**, for the abdomen was lower than that values obtained European Commission for abdomen was lower than values obtained by Switzerland and European Commission **(EC, 2001)** and **(Netherland,2013)** *and was close to values obtained by* ***(Germany, 2003)****due* to difference in scan length and using new CT reduction software.

5. Conclusion

The effective dose for the sinuses, brain and abdomen was lower than the corresponding value of mentioned countries, **(UK-2003), (EC,1999) and (malizia-2003)** The variations were due to both to inherent differences between CT scanners and the corresponding techniques used. The dose delivered to sinuses, brain and abdomen in KAMC optimized by reduced CT acquisition parameters (kV and mAs) of GE 64 MDCT scanner that reconstructed kernel algorithm with Adaptive Statistical Iterative Reconstruction (ASIR) algorithm for enabling enables dose reduction.

6. Ethical Statements

This study is approved by Institution review board (IRB) number A 00575 from The King Abdullah Medical Complex, KAMC, Jeddah, KSA.

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