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ORIGINAL ARTICLE

Initial Local Diagnostic Reference Level for Computed Tomography of the Abdomen

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ABSTRACT

AIM: The aim of this work was to examin the diagnostic reference levels (DRLs) for the abdomen-pelvis computed tomography (CT) examinations performed at our medical institution. Another aim was to compare our data with the national and international values for the same examination as starting point on the way of establishing a regional DRLs and to contribute to the national DRLs project.

MATERIALS AND METHODS: Dosimetric indexes were collected for the abdominal pelvic examination for 180 patients and results are analysed using Matlab (R2016b) statistics and machine learning toolbox.

RESULTS: The results are within and below the international reported levels for abdomen-pelvis CT in several countries and slightly higher than our published national reference level.

CONCLUSION: Continuous monitoring of the radiation doses received by the patients in computed tomography is continuous and ongoing process in order to ensure compliance and to optimize clinical imaging protocols. More extensive data acquisition and analysis are required to allow better understanding of the contributing factors leading to less patient radiation dose while preserving the

Key words: Computed Tomography; Abdomen CT; Diagnostic Reference Levels; Dose Monitoring

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INTRODUCTION

The abdomen–pelvis CT exaninations are one of the most practiced world wide in diagnostic radiology , it is the most common CT examination in the united states[1]. the advantages of establishing local DRls are numerous, first to benchmark your practice against the international standards, to document the patient safety program, to verify the efficiency of the quality assurance program and to provide data for the radiology quality management program. All of these are important and required by accreditation organisations in helath care today.

In general, the CT dose index (CTDI) and related measurement indexes were used for X-ray CT dose evaluation. Although CTDI is useful for predicting X-ray exposure during CT examination, it cannot retrieve the dose delivered to patients. In addition, CTDI is calculated based on measurements obtained from phantoms with diameters of 16 and 32 cm for adult heads and bodies, respectively[2].

Conversion to effective dose (ED) from dose length product (DLP) is feasible using population-based conversion factors (k) that take the averaged radiosensitivity in defined anatomic regions into account[3].

Both $CTDI_{vol}$ and DLP are essential tools for radiation dose

optimization while they do not represednt the actual radiation dose received by the patient during CT examination. They are called dose index. Such index is useful also in comparing radiation output from different scanners.

A number of coutries in Europe have started to perform DRL based on clinical indications[4-5].

The aim of this work was to examin the diagnostic reference levels (DRLs) for abdominal computed tomography (CT) examinations performed at our medical institution.

METHODS

Data have been retrieved from the modality work station, and from the Radiology picture archiving and communication system (PACS). These data were used to gather information on the dose length product (DLP) and the volumetric computed tomography dose index ($CTDI_{vol}$) to be included in this analysis.

Percentiles of the abdomen CT examinations are presented in the table 1 and in figure 1; comparing our data with the national published data for abdominal CT was done.

When comparing our data with the published American reference levels it was revelaed that we are slightly lower. further study aiming at identifying the factors that affect the radiation dose levels obtained during abdominal CT examinations is warranted and already have been undertaken.

All statistical analysis were conducted using the Matlab Statistical and Machine Learning Toolbox (R2016b).

RESULTS

the following are the results of the data analyzed in this work. The next boxplot shows the dose length product for the abdomen-pelvis CT scans analysed. Our national DRL for abdomino- pelvis CT is 634 [mGy.cm], the ACR DIR is 781 [mGy.cm], and the EU is 800 [mGy.cm].[1] we have obtained slightly higher dose reference levels of 701 [mGy.cm] than the national reference levels and lower that the American and european reference levels.

The CT scanner used in this study is equipped with automatic exposure control and iterative reconstruction algorithm. The use of both features allows radiation dose reduction and maintains good clinical images quality.

DISCUSSION

DLP data permit facilities to compare the amounts of radiation used to perform similar examinations [6]. To perform such comparison there is a need to specify the patient size because most CT scanners use automatic exposure control to adjust the amount of radiation and this latter feature is based on patient size and shape[7-8].

The diffrence in radiation doses are mainly due to the diffrences in patient's size (weight and height), the exposure parametres, the scan length, the number of acquisition series and the scanner model.

Scanners have evolved over time and automatic exposure control techniques play a major role in todays' sacnners in order to reduce the radiation dose received by the patients while maintaining acceptable image quality.

Using the world largest database of CT dose information from actual patient examinations in the world; multivariate regression analysis showed that water equivalent diameter and lateral thickness were significant predictors of dose indexes. Therefore, taking patients' size into account is important factor to consider in future studies related to developing DRLs in CT, size based DRLs is the future direction in CT DRLs[1].

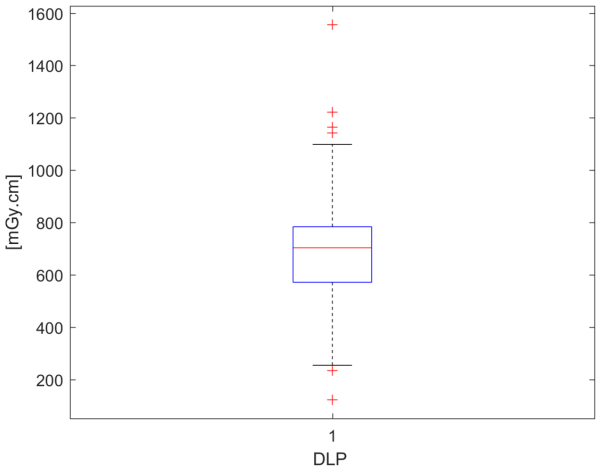

Figure 1 Boxplot of the abdomen pelvis CT scans analysed in this work n=180 patients.

Table 1 Resultas of DRLs for abdoem pelvis CT exams performend in this work.

	Percentile		
Variable	0.25	0.5	0.75
DLPs [mGy.cm]	561	686	701
CTDIvol [mGy]	11.14	13.74	14.86
SSDE [mGy]	15.85	17.97	19.87

The current trend In the use and application of DRls in CT are based on clinical indication (DRL_{ci}), since more than one indication maybe present for one anatomical area. The chest for example , different scan protocols can be applied depending on the purpose of the requested CT scan. In the abdomen pelvis area for example the performed CT can be for kidney stone, Appendicitis or Liver cancer which requires diffrent levels of image quality and hence scan parameters and also scan length leading to different radiation dose at bthe end of the scan. Therefore DRLs should be classified based on clinical indication and not on anatomical area [9].

The current DRL_{ci} for abdomino-pelvis CT are five clinical indications: abscess/lymphadenopathy, virtual colonoscopy (VC)/ polyps/tumor, CT for abdominal aortic aneurysms (AAA), colic and occlusion [10].

The lack of focus on actual scanning protocols has produced estimates that do not reflect the range and complexity of modern CT practice. To allow clinicians, patients and policy makers to make informed risk versus benefit decisions the individual and population level risks associated with modern CT practices are essential [11].

CONCLUSIONS

DRLs are a good optimization tool in diagnostic radiology, a continuous evaluation of the DRL in CT applications are very important since there is room for optimization in that area. The use of DRL based on clinical indications is required in order to reduce patient's radiation dose. Standardizing CT aquisation protocols is warranted at the local, national and international levels. Clinicians should be aware of this current optmisation strategy undertaken by a number of countries around the world.

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