Doses in Computed Tomography

W. Ślusarczyk-Kacprzyk, W. Skrzyński

Medical Physics Department, Maria Skłodowska-Curie Memorial Cancer Centre and Institute of Oncology, ul. Roentgena 5, 02-781 Warszawa

Abstract

In this study we analyzed doses for a group of 484 patients who underwent an examination on a GE HiSpeed CT scanner in Centre of Oncology in Warsaw. Patient doses (CTDI_w and DLP) have been compared against reference values published by the Polish Ministry of Health. We found that typical patient doses do not exceed reference values. As reference dose levels are defined only for a standard-sized patient, sometimes they may be exceeded for a properly done examination. Polish reference dose levels are not based on up-to-date data.

Keywords: CTDI, DLP, doses for diagnostic patient, doses for planning patient

Introduction

Patient dose in an X-ray examination should always be kept as low as achievable while maintaining acceptable image quality. This rule is extremely important in computed tomography, which gives a major contribution to collective dose from medical X-rays (i.e. 47% in UK, [1]).

Several dosimetric quantities are used in computed tomography, measurement methods are well-established [2]. CTDI (Computed Tomography Dose Index) is defined as an integral of dose distribution profile (measured along a line parallel to the axis of rotation of the lamp) divided by the nominal slice thickness, it is usually measured with a dedicated “pencil” ionization chamber. Other dosimetric quantities in wide use are DLP (Dose Length Product), CTDI_w (Weighted Computed Tomography Dose Index). It is recommended that dosimetric information for an examination is displayed on a CT console [3].

Decree on safe use of ionizing radiation in healthcare issued by the Polish Ministry of Health [4] provides a clear guidance on the doses in CT. Values of CTDI_w and DLP should not exceed reference dose levels, which are set for several regions of body. Polish reference dose levels have been adapted from guidelines published by the European Commission [2]. Originally they were set at the third quartile values of the distributions of mean doses observed for a large number of CT scanners in survey in UK [5]. This work presents patient doses for a CT scanner installed in Centre of Oncology in Warsaw. The doses are compared with the reference dose values.

Experimental procedures

In this study we investigated doses for a group of 484 patients who underwent an examination on a single slice GE HiSpeed CT scanner in Centre of Oncology in Warsaw. Patients have been divided into 9 groups depending on the examined region of body (Table 1). As the scanner serves radiotherapy department, each group includes both diagnostic examinations and examinations for radiotherapy treatment planning.

Data collected for each patient included: X-ray beam parameters (kVp, mA), scan time, nominal slice thickness, slice interval or pitch, CTDI_w value displayed on the console. DLP values have also been calculated for each patient.

Measurements of CTDI_w have been performed for selected examination protocols. We used PTW Unidos dosimeter, ionization chamber PTW 77336 (calibrated in Secondary Standard Dosimetry Laboratory in Centre of Oncology in Warsaw) and phantoms constructed in workshops of Centre of Oncology in Warsaw. Measured
doses have been compared with values displayed on the CT console. Collected dosimetric data for each region of body have been analyzed, mean and maximum values of CTDI<sub>w</sub> and DLP have been compared against Polish reference dose values.

**Results**

The values of CTDI<sub>w</sub> displayed on the CT scanner console agree with results of the measurements within ±10% tolerance. Table 1 presents observed values of CTDI<sub>w</sub> and DLP compared against the reference levels.

We compared average DLP values for patients that had diagnostic examination and patients that had examination for radiotherapy treatment planning. Doses in diagnostic examinations are generally higher, the difference of average DLP ranges from 5 to 37%. The largest differences of mean DLP was noted for groups: "stomach" and "thigh", but these groups are the least numerous, so the result might be not representative. In more numerous groups differences do not exceed 12%.

**Discussion of results**

Average CTDI<sub>w</sub> and DLP values do not exceed reference values in any region of body. Reference values for CTDI<sub>w</sub> have not been exceeded. However, in a few cases CTDI<sub>w</sub> was significantly higher than needed for high quality image. In this cases CT operators have not optimized exposure parameters (kV, mA). Reference values for DLP have been exceeded for a few patients. We found that all of them significantly exceeded standard dimensions of 70kg and 170cm, for which reference values are defined. In each of the cases the examination parameters have been chosen properly.

It should be stressed that the Polish reference values are based on the data published in 1999 (results of the UK survey [5]). During last 15 years typical patient doses for single slice CT scanners have significantly decreased. Recently a new CT dose survey has been performed in UK and, consequently, new British reference dose levels have been set (separately for single-slice and multi-slice scanners) [6]. If we compare CTDI<sub>w</sub> for two unites types Siemens Somatom DRH (was an axial-only scanner, it was replaced by the GE HiSpeed scanner in 2000) and GE HiSpeed we can see how much the doses are less. For brain region 46,3 for Siemens, 19,2 for GE (chest: 25 – Siemens, 10,7 – GE; abdomen: 25 – Siemens, 8,8 – GE). This is why in UK the new reference dose levels was established. The new British reference levels seem to be more appropriate in this case.

**Conclusions**

Typical patient doses for a GE HiSpeed scanner in the Centre of Oncology in Warsaw do not exceed reference values.

Reference dose levels are defined only for a standard-sized patient, therefore sometimes they are exceeded for a properly done examination. Polish reference dose levels are not based on up-to-date data, their revision should be considered.

**References**


<table>
<thead>
<tr>
<th>Region of body</th>
<th>Number of patients</th>
<th>CTDI&lt;sub&gt;w&lt;/sub&gt; (mGy)</th>
<th>DLP (mGy x cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>brain</td>
<td>57</td>
<td>5.3</td>
<td>26.8</td>
</tr>
<tr>
<td>head/neck</td>
<td>47</td>
<td>6.9</td>
<td>28.5</td>
</tr>
<tr>
<td>chest</td>
<td>107</td>
<td>4.4</td>
<td>14.4</td>
</tr>
<tr>
<td>breast</td>
<td>43</td>
<td>4.1</td>
<td>9.1</td>
</tr>
<tr>
<td>abdomen</td>
<td>26</td>
<td>5.9</td>
<td>11</td>
</tr>
<tr>
<td>stomach</td>
<td>14</td>
<td>4.4</td>
<td>9.1</td>
</tr>
<tr>
<td>pelvis</td>
<td>62</td>
<td>6.8</td>
<td>17.8</td>
</tr>
<tr>
<td>prostate</td>
<td>113</td>
<td>7.1</td>
<td>9.5</td>
</tr>
<tr>
<td>thigh</td>
<td>15</td>
<td>9.1</td>
<td>14.4</td>
</tr>
</tbody>
</table>


