Analysis of annual radiation exposure due to CT in a single federal public hospital in Russia

Poster No.: C-1227  
Congress: ECR 2015  
Type: Scientific Exhibit  
Authors: E. Matkevich, V. Sinitsyn; Moscow/RU  
Keywords: Dosimetric comparison, Statistics, Health policy and practice, Dosimetry, CT, Radioprotection / Radiation dose, Professional issues  
DOI: 10.1594/ecr2015/C-1227
Aims and objectives

Radiation exposure due to CT is a major contributor to population dose from the medical sources [1]. Analysis of radiation exposure in an individual hospitals and comparison of these data with national and international dose reference levels are important tools for improvement of population radiation safety. In Russian Federation so far there are no national reference dose values have been analyzed and published.

The aims of this study were:

To estimate the total number and structure of examinations for the years 2012-2013 in a selected federal hospital;

To analyze the radiation exposure due to CT in the selected hospital and to study the values of effective doses according to anatomical areas and scanners settings;

To illustrate the feasibility of routine low-dose CT examinations.
Methods and materials

Data about number and types of CT-examinations in years 2012-2013 were extracted from the hospital's RIS.

A retrospective analysis was performed using electronic patient records and scan information randomly extracted from hospital's RIS and PACS from a single multiprofile hospital (Federal Center of Medicine and Rehabilitation of Russian Ministry of Health, Moscow, 450 beds). 1626 records were randomly selected for the further analysis. Patient population consisted of 794 men, and 832 women; age range 17-93 years. Patients were scanned with 3 CT systems (two 64-row systems and one 40-row scanner). The distribution of CT examinations according to anatomical regions scanned was as follows: brain (n=329), chest (n= 596), abdomen-pelvis (n=529), chest-abdomen-pelvis (n=172). Data regarding scanning parameters of each study were collected and analyzed, including volumetric CT dose index (CTDI) and dose-length product (DLP). Then the mean CTDI and mean DLP were defined. The effective dose (ED) was calculated using the normalized coefficients according to ICRP Guidelines [2].

On the final stage an analysis of image quality of low-dose CT-examinations of the heart and coronaries, chest and carotids was performed. Reduce of radiation exposure was achieved with use of decreased tube voltage (80-100 kV) and tube current in combination with the algorithm of iterative reconstruction (ASIR and MBIR).
Results

The total amount of CT examinations in our hospital was 11697 in year 2012 and 14089 - in 2013 (fig.1). The total number of CT scans increased by 20.4% from the year 2012 to 2013. CT of the brain, chest and abdomen composed the majority of the scans in this sample: in 2012 - 73.8%, in 2013 - 72.1% (fig.2).

The mean DLP (M±m) values (mGy*cm) with/without contrast medium, respectively, according to anatomical areas were as follows: 1021.8±12.44/1530.6±101.20, chest - 289.5±6.91/659.2±48.0, abdomen-pelvis - 594.9±23.71/2177.7±69.70, chest-abdomen-pelvis - 736.2±46.90/2110.6±106.90 (fig.3).

Some clinical cases of low-dose CT are given below:

Non-contrast CT of the lung (fig.4) was performed with decreased tube voltage (80 kV) which resulted with low DLP (259.7 mGy*cm). This value was lower than our mean DLP for chest by 9%. The image quality was rated as good.

Figure 5 demonstrates the image quality of chest CT achievable with the MBIR algorithm (low kV and mA settings). The obtained DLP was 94.23 mGy*cm, that is lower than the mean DLP for the chest (obtained in this study) by 67%. The sharpness of image was slightly reduced, but image quality was rated as good.

The contract-enhanced CT of carotids with tube voltage equal 80 kV (fig.6) was performed with total DLP of 210.2 mGy*cm. The image quality is absolutely adequate for clear definition of plaques in arteries and grading of the stenosis of left carotid artery.

One of the leading directions in CT angiography (CTA) is coronary and cardiac CTA. A lot of attention has been paid to decrease of radiation exposure in such types of examinations. Fig. 7 shows an example of low-dose coronary CTA in mid-aged woman with total DLP equal to 49.13 mGy*cm (respectively, ED was below 1 mSv). The image quality was sufficient to determine mixed plaque in the left anterior descending artery causing stenosis about 50%.

Fig.8 sums up radiation dose data from some sources on national radiation registries (non-enhanced CT-examinations) in comparison with our results. It shows that average radiation exposure from different types of CT examinations in a Russian hospital are comparable with reference levels indicated in the European Guidelines [2] and the mean DLPs published for different countries [3-5].
Fig. 1: Number of CT-examinations for the years 2012-2013 in the national hospital.

© "Radiology Department, Federal Center of Treatment and Rehabilitation, Moscow. 2014"

Fig. 2: Structure of CT-examinations in the year 2012 and 2013 in the national hospital.
Fig. 3: Mean DLP on one patient during one CT-examination, M±m.

Fig. 4: Non-contrast CT of the lung with decreasing of tube voltage to 80 kV.
**Fig. 5:** Non-contrast CT of the lung reconstructing with MBIR.

© "Radiology Department, Federal Center of Treatment and Rehabilitation, Moscow. 2013"

**Fig. 6:** Contrast-enhanced CT of carotids with tube voltage equal 80 kV.

© "Radiology Department, Federal Center of Treatment and Rehabilitation, Moscow. 2013"
**Fig. 7:** Tomographic image from low-dose coronary CTA, showing the mixed plaque in the left anterior descending artery.

© "Radiology Department, Federal Center of Treatment and Rehabilitation, Moscow. 2013"
<table>
<thead>
<tr>
<th></th>
<th>European DRLs DLP (mGy*cm) [2]</th>
<th>Australian National DRL DLP (mGy*cm) [3]</th>
<th>UK DRLs DLP (mGy*cm) [3]</th>
<th>NSRD 2010 DLP (mGy*cm) [4]</th>
<th>Canada DLP (mGy*cm) [5]</th>
<th>Greece DLP (mGy*cm) [5]</th>
<th>India DLP (mGy*cm) [5]</th>
<th>Poland DLP (mGy*cm) [5]</th>
<th>Thailand DLP (mGy*cm) [5]</th>
<th>UK DLP (mGy*cm) [5]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brain</strong></td>
<td>1021.8/1530.6</td>
<td>1050</td>
<td>1000</td>
<td>930</td>
<td>813.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chest</strong></td>
<td>289.5/659.2</td>
<td>650</td>
<td>450</td>
<td>580</td>
<td>320.0</td>
<td>294</td>
<td>540</td>
<td>355</td>
<td>447</td>
<td>247</td>
</tr>
<tr>
<td><strong>Abdomen</strong></td>
<td>780</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdomen-pelvis</td>
<td>594.9/2177.7</td>
<td>570*</td>
<td>700</td>
<td>560</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest-Abdomen-Pelvis</td>
<td>736.2/2110.6</td>
<td>1100</td>
<td>940</td>
<td></td>
<td>813.8**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*only for pelvis; **only for chest-abdomen.

**Fig. 8:** Comparison of radiation dose data (DLP, mGy*cm).

© "Radiology Department, Federal Center of Treatment and Rehabilitation, Moscow. 2015"
Conclusion

Our statistics data of examination’s number (fig.1) matched the global trends showing the total growth of CT-examinations all over the world. It leads to increase of population dose from medical sources and, consequently, to potential risk of radiation-induced cancers and other diseases.

Dose results of this single-center represent an example of CT dose values and distribution in a multiprofile hospital. This experience should be expanded for creation of the National reference dose values for CT and for co-operation with international initiatives (e.g. EuroSafe project).

For this purpose, our next step will be to determine the standard dose for standard patient with average weight (e.g. of 70 kg or 80 kg) or body surface area (BSA). This approach is important for comparison of radiation exposure dose levels between different hospitals.

New trend in CT is usage of iterative image reconstruction, which leads to significant reduction in radiation dose to the patient with preserved image quality. Taking into consideration this fact, one can expect that in the coming years the CT reference doses would substantially decrease.
Personal information

Elena Matkevich, MD, radiologist, Radiology Department, Federal Center of Treatment and Rehabilitation, Moscow

Valentin Sinitsyn, MD, PhD, Professor, Head of Radiology Department, Federal Center of Treatment and Rehabilitation, Moscow
References


