A comparison of radiation doses between multi-slice computed tomography coronary angiography and invasive diagnostic coronary angiography using the latest ICRP tissue weighting factors

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Purpose

• The radiation dose from cardiac MDCT (Multi-detector computed tomography) is a common subject in the literature.
• Comparisons have been made with conventional invasive coronary angiography (ICA)².
• An effective dose (mSv) is used to compare the radiation dose between different imaging modalities. The sensitivity of a particular tissue to ionising radiation is accounted for by the application of a tissue weighting factor.
• The aim of this audit was to compare the radiation doses between ICA (invasive coronary angiography) and prospectively gated cardiac MDCT using computer based anthropomorphic models and the latest ICRP (International commission on radiological Protection) tissue weighting factors.
• Previous comparisons have based the effective dose calculation on conversion factors which were derived from the ICRP 60 (1991) tissue weighting factors; these were updated in 2007 (ICRP 103)³ and may not reflect the contemporary effective dose.

Methods

ICA

• The DAP (dose area product) field size, projection angle, kV, exposure duration and frame rate were recorded for each acquisition performed on a state of the art Allura (Phillips).
• This information was applied to a computer based anthropomorphic model (PCXMC - figure 1) to calculate the effective dose for each examination based on the ICRP 103 (2007) tissue weighting factors
• A hospital specific conversion factor was then applied to the total DAP for 94 consecutive patients (0.24 mSv/Gy cm²).

CTCA

• The effective dose for cardiac MDCT was calculated with the ImPACT computer based simulator (figure 2) utilising the ICRP 103 (2007) tissue weighting factors.
• For each CTCA protocol the radiation in air was measured with a 100mm ionisation chamber within the scanner bore. This data along with the kV, mA, scan filter and volume was entered into the model for 84 patients.
• The study included patients under primary investigation for coronary artery disease.
• All scans were performed with prospective ECG gating on a Lightspeed VCT (GE Healthcare) using commercially available scan protocols (snapshot pulse).
• BMI range 20-35 kg/m².

<table>
<thead>
<tr>
<th>Angiographic Type (No)</th>
<th>Age (SD)</th>
<th>BMI (SD)</th>
<th>DLP/DAP (SD)</th>
<th>kV (SD)</th>
<th>mA (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTCA (84)</td>
<td>59 (11)</td>
<td>27 (3.8)</td>
<td>159 (47)</td>
<td>113 (16)</td>
<td>638 (SD)</td>
</tr>
<tr>
<td>ICA (94)</td>
<td>66 (10)</td>
<td>27 (3.6)</td>
<td>27.2 (12)</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Figure 1 – screen shot of the PCXMC computer based model.
Figure 2 – Reproduced from the ImPACT calculator with permission from the Health Protection Agency and the ImPACT Group.

Results

• The median effective dose for ICA was 6.3 mSv (inter-quartile range 4.2-8.2).
• The median effective dose for MDCT was 5.4 mSv (inter-quartile range 3.5-5.9).

Conclusions

• The radiation dosed from prospectively gated cardiac MDCT is comparable to the dose received at invasive coronary angiography even when the doses are calculated with computer based anthropomorphic models incorporating the latest ICRP tissue weighting.
• Further CTCA dose reduction is possible with the use of iterative reconstruction – median effective dose 2.5 mSv⁴.

References & Acknowledgements


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