Prospective vs. Retrospective CTA

A quick look at patient dose and image quality

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Introduction

- Hospital A has been carrying out CT Angiograms for > 12 months on a Siemens Definition AS+ scanner
- Hospital B has been carrying out CTAs for < 6 months on a Siemens Definition AS+ scanner
- The aim of this study was to assess patient doses for both prospective and retrospective CTAs at both hospitals, with a view to optimise protocols
- Image quality was briefly assessed at Hospital B (where we had access to PACS)
Method

- Patient protocol data was collected from each scanner.
- DLP, CTDI$_{vol}$, pitch, kV, and rotation time were collected.
- No patient specific data (height/weight/heart rate) was collected.
- Mean CT number and standard deviation were measured in the contrasted artery of CTA images at hospital B to calculate the signal to noise ratio (SNR).
- Effective dose (D$_{eff}$) and breast equivalent dose (BED) were calculated using the ImPACT CT Dose calculator v1.0 which includes the ICRP 103 tissue weighting factors.
Data collected

- Hospital A: 28 retrospective CTAs
- Hospital B: 14 retrospective and 17 prospective CTAs

Protocol information:

- 100 – 120 kV
- Rotation time 0.23 – 0.5 s
- Pitch 0.18 – 0.30
- CTDI$_{vol}$ 4.85 – 42.32 mGy
- DLP 50 – 642 mGy.cm
Hospital A

Retrospective CTA
Median
• DLP = 274 mGy.cm
• Deff = 7.4 mSv
• BED = 24 mGy

75th percentile (DRL)
• DLP = 372 mGy.cm
• Deff = 9.9 mSv
• BED = 32 mGy

No access to PACS for IQ analysis

Multiplication factor = 27 µGy(mGy.cm)^{-1}
Hospital B

Retrospective CTA
Median
• DLP = 263 mGy.cm
• Deff = 7.25 mSv
• BED = 23 mGy
• SNR = 17.6

Prospective CTA
Median
• DLP = 137 mGy.cm
• Deff = 3.45 mSv
• BED = 11 mGy
• SNR = 14.1

Multiplication factor = 27 µGy(mGy.cm)$^{-1}$
Hospital Comparison

- Median and third quartile doses for retrospective CTA are equivalent at both hospitals.
- Both dose distributions are skewed, with maximum doses far greater than the median.
- Maximum doses of 16-17 mSv are too high and must be investigated further.
Literature Review

CTA Doses
- Hausleiter et al (2009): Median effective dose 9 mSv for prospective CTA on Siemens 64 slice scanner
- Huda et al (2010): Calculated a factor of $26.2 \mu \text{Sv} (\text{mGy.cm})^{-1}$ for CTA on Siemens Definition AS+

CTA Dose and IQ
- Feng et al (2010)
  - Study of effective doses, SNR and CNR for prospective and retrospective CTA
  - Mean effective dose 2.7 mSv for prospective CTA on Siemens Definition AS
  - Found significant difference between effective doses
  - Found no significant difference in SNR
  - Found an increase in CNR for prospective CTA
Literature Comparison

- Doses for prospective and retrospective CTA consistent with literature (below)
- Multiplication factor is consistent with Huda *et al* (2010)
- No significant difference in SNR, consistent with Feng *et al* (2010)

<table>
<thead>
<tr>
<th>Site/Study</th>
<th>Mean Effective Doses (mSv)</th>
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<tbody>
<tr>
<td></td>
<td>Prospective</td>
<td>Retrospective</td>
<td></td>
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<tr>
<td>Hospital A</td>
<td>-</td>
<td>8.3 ± 3.1</td>
<td></td>
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<tr>
<td>Hausleiter <em>et al</em> (2009)</td>
<td>-</td>
<td>*9 (7-14)</td>
<td></td>
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<tr>
<td>Hospital B</td>
<td>3.2 ± 1.3</td>
<td>7.9 ± 3.8</td>
<td></td>
</tr>
<tr>
<td>Feng <em>et al</em> (2010)</td>
<td>2.71 ± 0.67</td>
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</table>

*Median (interquartile range)
Conclusions

Hospital A

- doing mainly retrospective CTA and therefore doses are high
- should encourage them to do more prospective if possible

Hospital B

- doing 50:50 prospective and retrospective CTA
- doses for prospective are around 50% less
- no significant difference in average SNR despite drop in dose
- a few retro and prospective studies had very poor SNR (~5)
Conclusions

- Breast doses are high but cannot use Bi filter since CAREDOSE works real-time and would increase mA accordingly.
- Effective doses are comparable with literature and are generally low compared with other manufacturers.
- However further work is required to investigate the cases with very high dose and the cases with very poor SNR.
- Once more data is available for Hospital B we would like to extend the study and include patient data to optimise protocols.
- CNR could also be measured as a further measure of IQ.
Optimisation methods

• Use prospective gating where possible
• Reduce kV for smaller patients
  – 100kV<85kg gives 39% $D_{\text{eff}}$ reduction for same IQ [Pflederer et al (2009)]
• Increase kV for larger patients?
• Optimise mA / modify level of CAREDOSE
• Reduce number of phases
• Check pitch
References

• Feng et al 2010 Prospective ECG triggering versus low-dose retrospective ECG-gated 128-channel CT coronary angiography: comparison of image quality and radiation dose Clin Radiol. 65(10) 809-14

• Hausleiter et al 2009 Estimated Radiation Dose Associated With Cardiac CT Angiography JAMA. 301(5) 500-507
