Dual Energy CT Aortography:
Can We Reduce Iodine Dose??

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SCBTMR Annual Course
Boston,  October 10, 2012
Conflict of Interest Statement

• I administer an unrestricted grant from GE Healthcare which supports clinical investigation of advanced CT applications.
From: Silva AC et al, Radiographics 2011; 31: 1031
Ko JP et al, J Thoracic Imag 2012; 27:8
Should Every Body Case be DECT ??

- “CT can now be performed routinely in DE Mode without additional dose or compromise in image quality…” Invest Radiol 2010; 45: 347
- “Dual Energy CT is equivalent and can be used for routine diagnostic purposes…” AJNR 2011; 32:1994
- “Dual energy CT is now the routine for all my abdomen and pelvis studies…” Alec Megibow, 2011
• Can we use Dual Energy technique to markedly reduce the amount of iodine needed for a CT aortogram ??
“Because vasculopathy involves the whole body, many patients who need a CT aortogram have some compromise of renal function.... ”
“In CT, we harm more patients with iodine than we do with radiation....”
What has published peer-reviewed literature reported recently about iodine dose in CT aortography ??
Single Energy CT Aortography

- “Lower tube voltage reduces contrast material and radiation doses on 16-MDCT aortography”

- Nakayama Y, et al
- AJR; 187: 2006
Single Energy CT Aortography

- Compared 100 kVp aortography using 100 ml of iodinated contrast (3 ml/sec) to 90 kVp using 40 ml. (2 ml/sec)
- Mean attenuation aorta: same
- Subjective scoring of renal and celiac artery enhancement: same
Optimizing DE-CT Aortography

- “Single-Aquisition Dual-energy MDCT: Results: Vascular enhancement and post-processing for the thoracic aorta”
  - Godoy MCB, Naidich DP, et al
  - JCAT; 34: 2010
Optimizing DE-CT Aortography

- 40 patients had DECT thoracic aortography (40/60% weighting between 80 and 140 kVp)
  - 20 got 100-150 ml at 4.5 ml/sec
  - 20 got 50-60 ml at 3.0 ml/sec
Optimizing DE-CT Aortography

• Results:
  • At 80 kVp, image noise was higher but perceive image quality was same as 140 kVp.
  • At 80 kVp, aortic enhancement and image quality with low iodine contrast dose technique comparable to 140 kVp with higher iodine dose.
Single vs Dual Energy CT Aortography

- “Initial Experience with single-source dual-energy CT abdominal aortography...: Image quality, enhancement, dose”
- Pinho DF, Sahani DV, et al
- European Radiology, August, 2012
Single vs Dual Energy CT Aortography

- Virtual monochromatic spectral images from DECT depict how an object would look if the X-ray source produced only photons of a single energy (keV)
- Increased vessel iodine attenuation and CNR at lower keV, higher noise
Single vs Dual Energy CT Aortography

- 35 patients with repaired AAA had SECT of abdominal aortography followed within 6 months by DECT abdominal aortography
- Same volume of iodinated contrast and rate of injection given to both groups
- DECT-A post-processed to 50 and 70 keV
Single vs Dual Energy CT Aortography

• Results:
  • Subjective:
    • 70 keV best for image quality
    • 50 keV best for renal artery branches
    • Endoleaks best on 50 keV
Single vs Dual Energy CT Aortography

- Results:
  - Quantitative:
    - Mean aortic attenuation –
      - 50 keV = 800 HU
      - 70 keV = 375
      - 120 kVp = 297
Single vs Dual Energy CT Aortography

- Results:
  - Quantitative:
    - Aorta CNR
      - 50 keV = 26
      - 70 keV = 20
      - 120 kVp = 11
Single vs Dual Energy CT Aortography

• Conclusion:
  • Monochromatic (single keV) DECT images offer both higher aortic density and better image quality than SECT
  • Better depiction of small branch renal arteries and small endoleaks.
Optimizing DE-CT Aortography

- “Sweet Spot for endoleak detection: Optimizing CNR using low keV....DECT”
  - Maturen KE, Quint LE, Platt JF et al
  - JCAT; 36: 2012
Optimizing DE-CT Aortography

- The K – edge of iodine is 33.2 keV.
- Lower keV DECT closer to this K edge will make iodine brighter during aortography but also increases image noise.
- Is there a CNR “sweet spot”?
Optimizing DE-CT Aortography

- 2 blinded readers subjectively assessed endoleak detection, type, and conspicuity in 39 patients
- DECT data set postprocessed to
- 55 keV vs. 75 keV
Optimizing DE-CT Aortography

• Results:
  • Endoleak detection statistically higher at 55 than 75 keV (100% vs. 84%)
  • Endoleak conspicuity higher at 55 keV
  • Endoleak type characterization the same for both keV’s
CNR vs. keV
Half Dose of Iodine and DE GSI

W=1000, L=200
Single Energy, Full Dose Iodine

HU = 320

GSI DECT keV 60, Half-Dose Iodine

HU = 439
GSI DECT Aortogram, Half-Dose of Iodine

- keV 44
  - HU 960
- keV 60
  - HU 439
- keV 77
  - HU 252
## GSI DE Aortography with *Half-Dose of Iodine*

<table>
<thead>
<tr>
<th></th>
<th>40 keV</th>
<th>50 keV</th>
<th>70 keV</th>
<th>77 keV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aorta HU</strong></td>
<td>882</td>
<td>579</td>
<td>284</td>
<td>233</td>
</tr>
<tr>
<td><strong>HU&lt;250</strong></td>
<td>0%</td>
<td>7%</td>
<td>14%</td>
<td>61%</td>
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<tr>
<td><strong>Noise</strong></td>
<td>40.4</td>
<td>24.4</td>
<td>14.3</td>
<td>15.1</td>
</tr>
<tr>
<td><strong>CNR</strong></td>
<td>21.2</td>
<td><strong>22.1</strong></td>
<td>17.4</td>
<td>12.7</td>
</tr>
</tbody>
</table>
Conclusion:

- DECT aortography with 50% iodine dose reduction resulted in consistently dense enhancement of the abdominal aorta well above the threshold of 250 HU.

- The aorta CNR greatest at 50 keV.
DECT vs. SECT: Dose Comparison

- Dual energy abdominal CT
  - Univ. of WA. experience:
    - 2 years ago: DE 5 – 10% higher dose than our low-dose SE using NI = 36, ASIR 40%
    - Today: NI and iterative recon. in DE have increased, lower radiation dose is achievable (through selectable rotation time) than our low-dose SE.
Summary

• Patient radiation dose in dual energy CT currently is slightly lower than low-dose single energy CT.
  • A number of centers using DECT for all exams
  • Advanced iterative reconstruction

• DECT enables substantial reduction of iodine dose for angiograms or for tissue enhancement (50% or greater reduction)
  • Great for patients with renal compromise