Cardiac CT

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Pretty Pictures Are Nice…

Courtesy Tom Kracus
Kettering Medical Center
Basic Protocol for 64 slice Coronary MDCT

• Heart rate <65
  – Administer atenolol or metoprolol po
  – Administer metoprolol IV prn (5-10mg)
• Nitroglycerin just before injection
• Test bolus (10cc) – track intensity in aorta to determine optimal time for imaging (about 20 seconds)
• Bolus contrast (70-120cc) with breath hold coordinated during image acquisition
Sequential vs Helical CT scan

Braunwald 7th ed
Resolution

• Current scanners can acquire a slice in about 0.3 seconds
• Spatial resolution among scanners varies
  – 0.4mm x 0.4mm x 0.4mm for example
Planar vs Tomographic images

Figure 1  Planar versus tomographic imaging

Schoenhagen
Image Acquisition
Angiography vs CTA

Figure 2  Image acquisition time

Schoenhagen
EKG gating

Figure 9  Volume coverage

Schoenhagen
Data sets at different points along the R-R interval can give different results
Vessel motion during cardiac Cycle
Arrhythmia distorts image
Image Reconstruction Techniques

- MPR – Multiplaner Reconstruction
- MIP – Maximal Intensity Projection
- CPR – Curved Planar Reformation
- VR – Volume Rendering
Axial vs MPR images
Maximal Intensity Projection

• Thicker slice than MPR (10mm)
• Takes the brightest spot (voxel) within the slice and emphasizes that point
• Good for general visualization and layout of vessel
Curved Plane Reformation

Figure 1: Principle of the CPR visualization
Axial Endovascular VR of Aorta

Figure 27  Perspective volume rendering

Schoenhagen
Radiation dose from various sources

<table>
<thead>
<tr>
<th>Examination</th>
<th>Effective dose (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head CT</td>
<td>1–2</td>
</tr>
<tr>
<td>Chest CT</td>
<td>5–7</td>
</tr>
<tr>
<td>Abdomen and pelvis CT</td>
<td>8–11</td>
</tr>
<tr>
<td>Selective coronary angiogram</td>
<td>3–5</td>
</tr>
<tr>
<td>PA and lateral chest X-ray</td>
<td>0.04–0.06</td>
</tr>
<tr>
<td>Average annual background radiation in the US</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Abbreviations: CT, computed tomography; PA, posteroanterior.

Data from Morin RL, Gerber TC, McCollough CH. Radiation dose in computed tomography of the heart. Circulation 2003;107:917–22; with permission.
How good is 64 slice coronary MDCT?

### TABLE 2. Diagnostic Performance and Predictive Value of 64-Slice CT Coronary Angiography for the Detection of ≥50% Stenoses on QCA

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>PPV, %</th>
<th>NPV, %</th>
<th>+LR</th>
<th>-LR</th>
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</thead>
<tbody>
<tr>
<td><strong>Segment-based analysis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>All segments</td>
<td>725</td>
<td>99 (94–98)</td>
<td>95 (93–96)</td>
<td>76 (67–89)</td>
<td>100 (99–100)</td>
<td>20.81</td>
<td>0.01</td>
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<tr>
<td>Proximal segments</td>
<td>204</td>
<td>100 (89–100)</td>
<td>97 (93–98)</td>
<td>83 (67–97)</td>
<td>100 (97–100)</td>
<td>29.00</td>
<td>0.00</td>
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<tr>
<td>Mid segments</td>
<td>142</td>
<td>97 (83–99)</td>
<td>94 (83–97)</td>
<td>81 (63–96)</td>
<td>99 (94–99)</td>
<td>15.47</td>
<td>0.04</td>
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<td>Distal segments</td>
<td>121</td>
<td>100 (68–100)</td>
<td>97 (92–99)</td>
<td>73 (69–98)</td>
<td>100 (96–100)</td>
<td>37.87</td>
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<tr>
<td>Side branches</td>
<td>258</td>
<td>100 (87–100)</td>
<td>94 (90–95)</td>
<td>65 (48–85)</td>
<td>100 (98–100)</td>
<td>16.57</td>
<td>0.00</td>
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<tr>
<td>LM</td>
<td>51</td>
<td>100 (21–100)</td>
<td>100 (93–100)</td>
<td>100 (92–100)</td>
<td>100 (2–100)</td>
<td>$\infty$</td>
<td>0.00</td>
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<tr>
<td>LAD</td>
<td>230</td>
<td>97 (85–100)</td>
<td>92 (68–95)</td>
<td>69 (53–86)</td>
<td>99 (96–99)</td>
<td>12.68</td>
<td>0.03</td>
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<td>LCx</td>
<td>235</td>
<td>100 (88–100)</td>
<td>97 (94–99)</td>
<td>83 (66–97)</td>
<td>100 (98–100)</td>
<td>34.33</td>
<td>0.00</td>
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<tr>
<td>RCA</td>
<td>209</td>
<td>100 (89–100)</td>
<td>95 (91–97)</td>
<td>77 (60–95)</td>
<td>100 (97–100)</td>
<td>19.89</td>
<td>0.00</td>
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<tr>
<td><strong>Patient-based analysis</strong></td>
<td>51</td>
<td>100 (91–100)</td>
<td>92 (67–99)</td>
<td>97 (66–99)</td>
<td>100 (73–100)</td>
<td>13.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

PPV indicates positive predictive value; NPV, negative predictive value; +LR, positive likelihood ratio; −LR, negative likelihood ratio; LM, left main coronary artery; LCx, circumflex coronary artery; and RCA, right coronary artery. For segment-based analysis, analysis of 725 segments visualized on the conventional angiogram and classified according to a 17-segment modified AHA classification was performed. Segments were further classified on the basis of their location within the coronary tree (proximal, mid, or distal segments of the main coronary artery arteries or side branches) and their location within a single vessel (LM, LAD, LCx, or RCA). For patient-based analysis, analysis of 51 patients was performed. Values in parentheses represent 95% CIs.

Mollet et al., 2005
Orientation to Anatomy – Axial MPR
VR graft anatomy
Axial images
Examine axial images

Notice Calcium in LAD and D1
MIP View of Left Coronary
Notice misregistration of distal LAD raw Axial Slices
MIP View of RCA
CPR of LAD – artifact mid LAD
CPR of OM and RCA

OM CPR

RCA CPR
VR MIP of Coronary Tree
You can also see valves...
Another patient

There is Misregistration Artifact

You will see some VR reconstruction
LAD MIP – 10 mm
RCA MIP – 10mm
Cx MIP – 10mm
Cx MPR – 1mm
CPR of Cx
RAO slices
LAO slices
Moving on to another patient

Bad Bolus timing (images too late)

Misregistration artifact
Raw Axial Slices
MIP axial slices
Another patient
LAD mid aneurysm and stenosis
LAD MIP – 10 mm
LAD – MPR 1mm
Cx MIP – 10mm
RCA MIP – 10mm
MPR of Anuerysm
CPR of LAD

Length: 658mm
Mean: 255.04
Max: 365
Min: 79
Stdev: 6314
Not all patients have good images.
VR heart from obese patient
Next patient has grafts
Axial raw slices
LAD and Cx MIP – 10mm
RCA MIP – 10mm
VR heart with grafts
Next patient with Calcium in RCA and LAD
Left Coronary MIP – 10mm
RCA MIP – 10mm
CPR RCA
VR Heart
VR RCA Ostium
Aortic Arch Calcification
Mitral Valve Calcification
Left Main from Right coronary cusp

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Courtesy Tom Kracus
Kettering Medical Center
RCA stenosis VR
Left Circumflex graft VR

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Courtesy Tom Kracus
Kettering Medical Center
Cardiac Mass
References