Advances in Imaging: Cardiac CT

Robb Romp, MD
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Disclosure Statement

I have no relevant financial relationships with any commercial interests to disclose.
Roadmap

CT Background

Techniques/Protocols

Clinical Indications

- Noncardiac anatomy
- Arch anomalies
- Venous anomalies
- Coronary anomalies
- Functional information

Strengths and Weaknesses
What is Computed Tomography?

Imaging technology using X-rays which are absorbed to varying degrees as they pass through the body.

CT data acquired with 360 degree rotations around body.
CT Scanner

Originally single detector

Multidetector (MDCT) scanners now have up to 256 detectors

X-ray tube and detectors rotate around pt within gantry
Helical Scanning

Helical scanning involves continuous imaging while patient advanced through rotating gantry.

Scan duration is determined by detector width (8 cm) and gantry rotation speed (0.32 sec/revolution).
Gating

EKG gating “eliminates” cardiac motion

Prospective gating (step and shoot)
- Imaging only during preset R-R %
- Significant radiation reduction
- No functional information
- Not forgiving of arrhythmias

Retrospective gating
- Imaging is continuous
- Maximum flexibility/sensitivity
- High radiation exposure
- Tube current modulation
Radiation

ALARA (As Low As Reasonable Achievable)

Radiation reduction achieved by
- Prospective gating
- Lower tube energy (80kV)
- Faster scan times
- Tube current modulation

Radiation dose dramatically decreased in past 5-10yrs

Effective radiation dose for cardiac CT
- Prospective scan <1 mSv
- Retrospective scan ~5 mSv
- Background radiation 3-6 mSv/yr (sea level)
Protocol

Philips Brilliance ICT 256 detector scanner
Optiray 320 nonionic contrast at 2 mL/kg
Hand inject for infants through 22g IV
Power inject through larger IV in older children
Bolus tracking triggers on area of interest
Post-processing

Post-processing permits 3D reconstructions

Voxels viewable using
- Unique cut planes
- Density templates
- Color labeling
- MOVING images
Situs - Airway

Bilateral left

Normal

Bilateral right
Situs - Abdomen

Transverse Liver
Right-sided stomach

Polysplenia
Situs - Atria

Bilateral L atrial appendages

Bilateral R atrial appendages
Mycotic Aneurysm
Mycotic Aneurysm
Coarctation
Coarctation
Coarctation
Interrupted Arch and VSD
Interrupted Arch and VSD
Double Aortic Arch

Virtual Bronch
Double Aortic Arch

Virtual Bronch
Aortic Dissection
Aortic Dissection
Pulmonary Sling
Tetralogy with MAPCA’s
Tetralogy with MAPCA’s
Systemic Vein Evaluation

First Pass

Second Pass (Venous Phase)
Systemic Vein Evaluation

First Pass

Second Pass (Venous Phase)
TAPVC
TAPVC
ALCAPA
Anomalous Aortic Origin of LCA
Anomalous Aortic Origin of LCA
Anomalous Aortic Origin of LCA
4D Cardiac CT

Adds time to volumetric imaging

Requires retrospective gating (increases radiation)

Allows volume and functional measurements
<table>
<thead>
<tr>
<th>Based on Heart Segmentation</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES Ventricular Volume (Phase 40%)</td>
<td>40.2 ml</td>
<td>77.0 ml</td>
</tr>
<tr>
<td>ED Ventricular Volume (Phase 0%)</td>
<td>119.8 ml</td>
<td>153.2 ml</td>
</tr>
<tr>
<td>Ventricular Stroke Volume</td>
<td>79.6 ml</td>
<td>76.2 ml</td>
</tr>
<tr>
<td>Ventricular Ejection Fraction</td>
<td>66 %</td>
<td>49 %</td>
</tr>
<tr>
<td>Ventricular Cardiac Output</td>
<td>6286.8 ml/min</td>
<td>6020.4 ml/min</td>
</tr>
<tr>
<td>LV Wall Muscle Mass</td>
<td>84.2 gr</td>
<td></td>
</tr>
<tr>
<td>HR (Mean)</td>
<td>79 bpm</td>
<td></td>
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</table>
Cardiac CTA Summary

Strengths

- Noninvasive and Fast
- Excellent spatial resolution
- Extensive extracardiac information
- Post-processing with 3D reconstructions

Weaknesses

- Radiation/contrast exposure
- Motion artifact (respiratory and cardiac)
- Low temporal resolution limits intracardiac imaging