Computed Tomography and the Cardiac Cath Laboratory

Thomas Smith, MD FACC
University of California, Davis
Director Adult Echocardiography

May 2, 2015
Disclosures

• I have no financial or professional disclosures pertaining to this topic or presentation.

• There are no cat videos within this presentation.
Cardiac CT – When is it useful?

- Chest pain syndrome
  - Exclude CAD (99% NPV)
  - CP in ER
- Equivocal stress test
- Non-coronary artery cardiac surgery
  - Exclude CAD
- Prior bypass surgery
  - Patency of grafts (not great for severe native disease)
- Congenital anomalies of the coronary circulation
- Structural heart disease
- Procedure planning
Outline

• CT Basics
• Ischemia
• Structural heart disease
• Procedural planning
  – Valves
  – Electrophysiology
CT Basics
Cardiac Computed Tomography

• Advantages
  – Anatomic
  – High resolution coronary artery angiography
  – Rapid
  – Pacemakers/ICDs are safe

• Disadvantages
  – Radiation
  – Follow breathing instructions (CT and MRI)
  – Arrhythmias
  – Post-processing
  – Renal risk
  – Does not assess flow (yet...)

UC DAVIS
HEALTH SYSTEM
Third Generation CT

- Arc of detector elements
- Wider fan beam
- Translation of tube and detector
- Faster scan speed
More coverage with larger detectors

64 x 0.625 = 40mm
128 x 0.625 = 80mm
320 x 0.625 = 200mm
More coverage with larger detectors

64 x 0.625 = 40mm
128 x 0.625 = 80mm
320 x 0.625 = 200mm
More coverage with larger detectors

64 x 0.625 = 40mm
128 x 0.625 = 80mm
320 x 0.625 = 200mm
Scanning Modes: Helical

- Continuous table movement
- Tube on throughout
  - May fluctuate current
- Table movement through when data acquired
- Helix of data produced
- Virtual “axial” slices are created with interpolation.

Table movement
Scanning Mode: Sequential/Prospective

- Stepwise table movement
- Tube off and on
- ECG triggers the acquisition
  - Approx 70% of the RR cycle
- All data used
- X-ray dose much lower
- No functional data

Table movement
8 second breath hold. 80-100 cc of contrast at 4-6 ml/second.
High Pitch Coronary CT Scanning
Male patient (183 cm, 78 kg, heart rate 54 b.p.m.).


0.89 mSv
The average person in the U.S. receives an effective background dose of about 2.5 – 3 mSv per year.

### Relative Radiation Dose
Real World Results Vary Widely

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Relative Dose (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest X-ray</td>
<td>0.02</td>
</tr>
<tr>
<td>Calcium Score</td>
<td>1.5</td>
</tr>
<tr>
<td>Lower GI Barium Enema</td>
<td>2-6</td>
</tr>
<tr>
<td>Upper GI Barium Enema</td>
<td>2.5</td>
</tr>
<tr>
<td>Tech 99m</td>
<td>3</td>
</tr>
<tr>
<td>Chest CT</td>
<td>7</td>
</tr>
<tr>
<td>Abd CT</td>
<td>8</td>
</tr>
<tr>
<td>Thallium Tech + Thallium</td>
<td>9</td>
</tr>
<tr>
<td>Tech + Thallium</td>
<td>10</td>
</tr>
<tr>
<td>Cath low</td>
<td>10</td>
</tr>
<tr>
<td>Cath High CCTA</td>
<td>6-15</td>
</tr>
<tr>
<td>Cath High CCTA + Thallium</td>
<td>12-26</td>
</tr>
</tbody>
</table>
Prospective vs. Retrospective Gating

Prospective

Retrospective

kv 120  mA 550
4.4 mSv

kv 120  mA 695
25.5 mSv
Beta-blocker
Nitroglycerin
Gated with contrast

RCA

LM

LAD

RCA

Left circumflex
Plaque visualization
Acute Chest Pain Syndrome in the ED

• Challenging strain on delivery system
  – 8 million visits annually in the US
  – ACS diagnosis is made in only 10-15% of these patients
  • $10 billion annual cost

• Three recent randomized trials
  – CT vs usual care in the ED in CP patients
  – Low to intermediate risk patients
The CT-STAT (Coronary Computed Tomographic Angiography for Systematic Triage of Acute Chest Pain Patients to Treatment) Trial

The NEW ENGLAND JOURNAL of MEDICINE

Coronary CT Angiography versus Standard Evaluation in Acute Chest Pain


CT Angiography for Safe Discharge of Patients with Possible Acute Coronary Syndromes

Harold I. Litt, M.D., Ph.D., Constantine Gatsonis, Ph.D., Brad Snyder, M.S., Harjit Singh, M.D., Chadwick D. Miller, M.D., Daniel W. Entrikin, M.D., James M. Learning, M.D., Laurence J. Gavin, M.D., Charissa B. Pacella, M.D., and Judd E. Hollander, M.D.
What the studies demonstrated

- CTCA in low-to-intermediate risk patients is safe with similar patient outcomes when compared to currently available testing.
- CTCA use results in faster triage in ED.
  - Faster discharge/faster diagnosis/faster admit.
- ER costs are reduced.
  - although no significant overall savings.
- Does not apply to intermediate or high risk patients.
- Safe and quick at about the same cost.
The future of coronary CT?

From: Diagnostic Accuracy of Fractional Flow Reserve From Anatomic CT Angiography

A Study patient with ischemia
Multiplanar reformat of CT angiogram

Fractional flow reserve computed from CT (FFR<sub>CT</sub>)

Invasive coronary angiogram

B Study patient without ischemia
Multiplanar reformat of CT angiogram

Fractional flow reserve computed from CT (FFR<sub>CT</sub>)

Invasive coronary angiogram
STRUCTURAL HEART DISEASE
Structural heart disease
Structural heart disease
Structural heart disease

ASD

RA

CS

LA

ASD occluder

filling defect

TERARECON
Structural heart disease

Aorta

ASD

LV
VALVES
Single breath-hold. Mechanical valve assessment
TAVR
Cardiac Gated CT – Coronary height
Avg. Diameter: 10.5 mm
Min. Diameter: 8.28 mm
Max. Diameter: 12.4 mm
Area: 86.5 mm²
Deployment angle lining up all the cusps
LAO 15, CAUDAL 20
Matching up C-arm angle – reducing contrast and radiation in the cath lab
C-ARM AND CT INTEGRATION
iGuide refers to current C-arm geometry.
CT in the EP Lab
Only the smart moves enable fast image acquisitions...
CT in the Cath Lab – Wrapping it up

- Pre-procedure planning
  - Ischemia
  - EP
  - Structural heart
- Procedural integration
  - EP
  - Valves
- Procedural guidance
  - Structural heart
Questions?