CARDIAC CT: Calcium Score and CT-angiogram

Maroussa Douskou
Radiologist
"BIOIATRIKI" Medical Center
• Cardiovascular diseases remain the leading cause of morbidity and mortality in industrialized nations.

• Invasive coronary angiography (ICA) has been the standard of reference for diagnosis of CAD.

• Non invasive techniques (EBCT, MSCT, MRI) and their role are still being debated.
Types of Coronary CT imaging

• Coronary Calcium Scoring

• MSCT (multislice CT) : A new form of cardiac imaging. This is a way to measure obstruction similar to a cardiac catheterization. It is NOT a functional test.
Coronary Calcium Scoring

• Calcium scoring for risk assessment.

• This is for asymptomatic patients and is not yet recommended as a routine screen.

• CCS can be normal in 5% of patients who have myocardial infarcts
Coronary Calcium Scoring

- Agatston Score: based on maximum CT numbers
- Calcium Mass Score: amount of calcium
- Volume Score: volume of a plaque
Calcium Volume Scoring

<table>
<thead>
<tr>
<th>Hn x-factor</th>
<th>Score</th>
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<tr>
<td>130-199</td>
<td>1</td>
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<tr>
<td>200-299</td>
<td>2</td>
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<td>300-399</td>
<td>3</td>
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<td>&gt;400</td>
<td>4</td>
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Area = 15 mm²
Peak CT = 450
Score = 15 x 4 = 60

Area = 8 mm²
Peak CT = 290
Score = 8 x 2 = 16

Coronary Calcium Scoring
The calcium scale is a linear scale with 4 calcium score categories:

- 0: none
- 1–99: mild
- 100–400: moderate
- >400: severe

*Calcium score correlates with risk of events and likelihood of obstructive CAD*
Coronary Calcium Scoring

• Initial ACC/AHA guidelines “may be useful in selected patients”…
• Added prognostic power to conventional risk stratification tools (Framingham)
• Revised guidelines (and reimbursement for service) likely forthcoming
MSCT Coronary Angiography

First whole-body CT cross-section through a human thorax, generated by Ledley et al in 1974 (Science 1974;186:207)
Initial studies 5-10 years ago used 4-slice MSCT. Then came 16-slice (we still use these in some centers) and now 64-slice MSCT is arriving in just the last few years.

The 64-slice CT is the current standard (approved in 2004).

Dual head 64-Slice CT. (can handle faster heart rates)

256-slice CT angiograms are just starting to be evaluated.
MSCT Coronary Angiography

- Patient preparation
- Data acquisition
- Image reconstruction
Clinical Indications for MSCT

• Non-invasive coronary angiography (CTA) in the symptomatic low-risk patient or asymptomatic intermediate-risk patient

*A negative test (normal CTA) has a 98% chance of revealing normal coronary arteries on invasive angiography*
When to Consider MSCT

- Equivocal stress test or persistent symptoms despite negative stress test
- Prior to non-coronary cardiac surgery (valve or congenital repair)
- Patients with difficult access or on therapeutic warfarin
- Suspected coronary anomalies
When to Consider MSCT

- Idiopathic dilated cardiomyopathy
- Cardiac transplant evaluation
- Patients to undergo electrophysiologic intervention (AF ablation, BiV pacing)
- Selected patients pre- and post-bypass surgery (aortic pathology, graft patency)
Soft Plaque Visualization
Pulmonary Vein Stenosis

The Great Promise of MSCT

The “Triple Rule-Out”
CTA Limitations

- Rapid (>80 bpm) and irregular HR
- High calcium scores (>800-1000)
- Stents
- Contrast requirements (Cr > 2.0 mg/dl)
- Small vessels (<1.5 mm) and collaterals
- Obese and uncooperative patients
- RADIATION EXPOSURE
Radiation Risks

• Exact quantification of harmful effects of radiation difficult to ascertain
• For a child under age 15, the risk of cancer death from a single CT scan is approximately 1 in 500
• For a 45 year old adult, the risk of death from cancer from a single CT exam is about 1 in 1,250

Effective Radiation Doses for Various Tests

- Bone Density: 0.01 mSv
- CXR: 0.02 mSv
- Mammogram: 0.7 mSv
- CT of the head: 2 mSv
- CT colonoscopy: 5 mSv
- CT of the abdomen: 10 mSv
- Stress Gated Myocardial Perfusion Scan SPECT: 10-11 mSv
- CT chest: 13 mSv
- MSCT angiogram: 15 mSv (MEN) 21 mSv (w)
  - Can be reduced 40% if ECG controlled X-ray tube current modulation is used.
- Coronary angiography: 6-30 mSv
- CT chest/abd/pelvis: 35 mSv
- Dose allowed for radiological personnel: 20 mSv/year
Radiation Dose Reduction

• STEP AND SHOOT MODE (SAS)
  acquisition of data only in predefined phases of the R-R interval
• Heart rate <70 bpm
• BMI<30
• Radiation dose <6mSv
MSCT Coronary Angiography Accuracy

- Accuracy of testing:
  - For 64 slice CTA: (for clinically significant occlusions, >50%)
    - **Sensitivity**: 89%
      - (If cardiac cath positive (gold standard), CTA will be positive 89% of the time)
    - **Specificity**: 96%
      - (if cath negative, the CTA will not find it 96% of the time.)
    - **Negative Predictive Value**: 99%
      - (if negative CTA, cath is negative 99% of time)
    - **Positive Predictive Value**: 78%
      - (if positive CTA patient has positive cath 78% of the time)

» *Clinical Cardiology* vol. 30, 9/07
Multi-slice CT (MSCT) not likely to replace conventional angiography

Post-processing of images for MSCT angiography time & labor intensive

Major strength of CTA is its high negative predictive value

CMR to become the preferred cardiac imaging modality in the future
Which Test for Which Patient?

• All modalities are improving
• No single modality fits all applications and all patients
• Choice of initial test depends on the specific clinical question in individual patient
Conclusions and future perspectives

- Improved diagnostic accuracy
- Combined evaluation of anatomy and cardiac function (MSCT-PET-SPECT) coronary tree-perfusion scan-cardiac metabolism and function
- Coregistered MRI viability mapping and MSCT optimize surgical revascularization planning
Conclusions and future perspectives

• Detection of pulmonary embolism
• Aortic dissection
• Wider use in emergency rooms

"Triple Rule Out"

in patients with chest pain
Thank you for your attention