CARDIAC CT: Calcium Score and CT-angiogram

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- 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



The Calcium Scale

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 (<u>Science</u> 1974;186:207)

MSCT Coronary Angiography

- 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 intermediaterisk 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)







kv 120 mA Mod. Rot 0.35s/CH 8.8mm/rot 0.6mm 0.22:1/0.3sp 0.3/MP 20:00 20

LightSpeed VCT BIOIATPIKH /vct

> SP: mm ST: mm W 256 C 128





LightSpeed VCT BIOIATPIKH /vct

SP: mm ST: mm W: 255 C: 128



26/9/2008

Soft Plaque Visualization







26/9/1974/rc Senes: Southing Descending Artery Angle: 221.0 |

DFOV 20.0 cm STND/C2 Ph:75% (No Filt.)

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kv 120 mA 671 MH 8/1 Rot 0.35s/CH 8.8mm/rot 0.6mm 0.22:1/0.6sp 0.4/MIP SRJmm-0.0 ST2:008mm PM ₩.256 60028 = 240

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M 65 CARDIAC Senes: 197 Angle: -27.0 DoB; Sep 14 1943 Ex: Det 20 2008

DFOV 13.5 cm STND/02 Ph:75% (No Filt,)

kv 120 mA 741 Rot 0.35s/CH 8.8mm/rot 0.6mm 0.22:1/0.3sp 0.3/MIP SPJmm 0.0 ST9:038mm AM W: 256-69428 = 382 137/

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Senes: 137 mg: 132

DFOV 16.4 cm STND/C2 Ph:75% (No Filt.)

kv 120 mA 741 Rot 0.35s/CH 8.8mm/rot 0.6mm 0.22:1/0.3sp 0.3/MLP SPLINT 0.0 ST3:03mM AN W. 256 Cl 128 = 251 LIMA TO LAD

137/32

14/9/19482 *** Sehigs:1970;Mg:argy Artery Angle: -302.0

DFOV 12.9 cm STND/C2 Ph:75% (No Filt.)

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8.8mm/rot ′0.3sp 0.3/MIP

328



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DFOV 10.4 cm STND/C2 Ph:75% (No Filt.)

kv <u>120</u> mA 741

Rot 0.35s/CH 8.8mm/rot 0.6mm 0.22:1/0.3sp 0.3/MIP SPUmm 0.0 ST9:03mm AM W: 256 C?128 = 328

Pulmonary Vein Stenosis





Vasamreddy et al. *Heart Rhythm* (2004) 1, 78-81.

The Great Promise of MSCT The "Triple Rule-Out"





0.6mm 0.22:1/0.6sp SP: mm

IFLE

ST: 0.6mm W: 256²6⁰928 = 233



Ex: Dec 18 2007

18/12/2007

[PRF]



p.r.a10/48/2008 DDO. . 5 M CARDTIDS DoB: Ex: Oct 10 2008 Artery 0.0 Angl 654/1 THEODO. 4/MIP







F 74 ANGIDGRAPHY DoB: Jan 01 1934 Ex: Dct 16 2008







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

Brenner et al. Radiology, 231(2):440-445.

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 (мем) |
| | 21 mSv (w) | |
| | – Can be reduced 40% if ECG controlled X-ray tube current modulation is used. | |
| • | Coronary angiography: | 6-30mSv |
| • | 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.)
 - <u>Negative Predictive Value</u>: 99%
 - (if negative CTA, cath is negative 99% of time)
 - <u>Positive Predictive Value</u>: 78%
 - (if positive CTA patient has positive cath 78% of the time)
 - » Clinical Cardiology vol. 30, 9/07

Summary

Cardiovascular Imaging

- Multi-slice CT (MSCT) <u>not</u> 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