Cardiac CT: Current Guidelines, Appropriateness Criteria and Potential Future Applications

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Disclosures

I do not have an affiliation, financial or otherwise, with a pharmaceutical company, medical device or communications organization.

I will not discuss or describe in my presentation the investigational or unlabeled ("off-label") use of a medical device, product, or pharmaceutical that is classified by Health Canada as investigational for the intended use.
Objectives

• Basic appropriateness principles
• Review specific guidelines
• Potential future applications
What makes a test useful?

- Diagnostic accuracy
- Effect on post test probability
- Implications for management decisions
- Prognostic value
- Risk/Benefit ratio (and vs. other tests)
Diagnostic Accuracy: Normal Coronaries
Diagnostic Accuracy: Severe ulcerated LAD
Diagnostic Accuracy:
Severe ulcerated LAD
Diagnostic Accuracy:
Severe ulcerated LAD
Diagnostic Accuracy: Overcall LAD disease
Diagnostic Accuracy
Patient Factors

• Calcium
• Stents
• Heart Rate
• Rhythm
• Obesity
## Diagnostic Accuracy: Multicentre Trials S64

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<tr>
<th>Trial</th>
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Likelihood Ratio CCTA

- Very low –ve LR
  - Test good at discriminating patients without the disease vs. patients with the disease

- Variable moderately high +ve LR
  - Reasonably good at discriminating those with the disease vs. those without the disease
Likelihood Ratio: Pre-test and Post-test Probability

- Nomogram
- Apply LR to the pre-test probability
- Gives post-test probability

- Very high or very low pre-test will not be sufficiently altered by test

- Use on intermediate pre-test patients
Bottom Line

• CCTA better at excluding obstructive disease than at confirming disease

• Findings alter diagnosis most in intermediate pre-test patients
Management Decisions

Investigation pointless if it does not

Change management
and/or
Add prognostic information
Risks
CCTA vs. ICA

• ICA
  – Mortality 0.11%*
  – Morbidity 1.5%*

• Contrast Media
  – Similar

• Radiation
  – Similar (or CCTA < ICA)

Specific Guidelines

Coronary CTA
The ‘what, when, where, who and how?’ of cardiac computed tomography in 2009: Guidelines for the clinician

Primary Panel: Benjamin JW Chow MD FRCPC, FACC FASNC (Chair)1,2, Eric Larose DVM MD FRCPC FAHA3, Sylvie Bilodeau MD FRCPC2, Mary Lou Ellis MD FRCPC4, Paul Galiwango MD FRCPC3, Malek Kais MD FRCPC, Tej Sheth MD FRCPC6

Secondary Panel: Davinder S Jaisal MD FRCPC5, Iain DC Katzpatrick MD FRCPC5, GB John Mancini MD FRCPC5, John Mayo MD FRCPC9, Arun Abraham MBBBS FRCPC3, James White MD FRCPC11

Key Words: Coronary artery disease; Coronary artery calcium; Detection; Computed tomography angiography; CT; Coronary angiography; Multidetector CT; MDCT; CARD; Guidelines; Standards
SCCT Guidelines 2010

ACCF/SCCT/ACR/AHA/ASE/ASNC/NASCI/SCAI/SCMR
2010 Appropriate Use Criteria
for Cardiac Computed Tomography

A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the Society of Cardiovascular Computed Tomography, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the American Society of Nuclear Cardiology, the North American Society for Cardiovascular Imaging, the Society for Cardiovascular Angiography and Interventions, and the Society for Cardiovascular Magnetic Resonance

Cardiac Computed Tomography Writing Group

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†Official American Society of Nuclear Cardiology Representative;
‡Official Society for Cardiovascular Angiography and Interventions Representative;
§Official Society of Cardiovascular Computed Tomography Representative;
||Official American Heart Association Representative;
###Official North American Society for Cardiovascular Imaging Representative
Symptomatic patients without known CAD: Non-Acute

- Pre-test probability CAD LOW or INTERMEDIATE
  And one of the following:
  - ECG uninterpretable or not able to exercise
  - Continued symptoms after normal ECG exercise test
  - Intermediate risk ECG exercise test
  - Discordant ECG exercise and imaging results
  - Equivocal stress imaging
Non-Acute: Normal Coronaries
Non-Acute: Minimal LAD
Symptomatic Patients without known CAD: Acute Symptoms

- Pre-test probability of CAD LOW or INTERMEDIATE
  And BOTH of the following:
  - ECG normal, non-diagnostic or uninterpretable
  - Biomarkers normal or equivocal
Acute Dom RCA

CT straight to cath and PCI
Asymptomatic Patients

• New diagnosis of heart failure with reduced ejection fraction and Pre-test probability of CAD LOW or INTERMEDIATE

• Pre-op assessment before non-coronary cardiac surgery with Pre-test probability of CAD INTERMEDIATE

• NB no role as screening tool
45yr Male Aortic Stenosis
Normal Coronaries
Prior Revascularization

- Symptomatic
  - Yes: CABG patency (NB run-off vessels)
  - Uncertain: Stent > 3mm
  - No: Stent < 3mm

- Asymptomatic
  - Not indicated
Grafts: LIMA to LAD
Grafts: SVG sequential
Coronary Stents: Not if <3mm

Prox LAD

D1
Notable “Uncertainties”

- “Triple Rule Out”
  - Technical factors
  - Indication creep and pre-test probability
- NSVT or syncope
- Post transplant coronary assessment
- CCTA when CCS >400
Structure and Function

- Anomalous vascular anatomy
- Complex congenital cardiac disease
- Pericardial abnormality
- RV structure and function

- LV function and valves
  - Only failing other modalities
Anomalous Left Main
Congenital Disease

DORV, PA Atresia, Fontan
VSD D-Transposition
Patent Fontan
Pre-test Probability

- Multiple algorithms
- Guidelines do not specify which to use
- In general:
  Want to appropriately classify intermediate
  Use method that was:
  Designed for your patient population
  Predicts presence of coronary disease
Chest pain and Coronary disease at ICA

• Diamond Forrester
  – Pain type, gender, age

• CASS registry
  – Pain type, gender, age

• Duke Clinical Score
  – Pain type, gender, age + RFs + ECG

• Morise
  – Pain type, gender, age + RFs
Others

- TIMI: Symptomatic. 14 day MACE
- Framingham: Asymptomatic. 10y CV event
- PROCAM: Asymptomatic. 10y coronary event
- SCORE: Asymptomatic. 10y CV death
Which to use?

- Addition of RF’s refines prediction
- Less patients categorized as intermediate
- More to do for referring clinician
- Is it really worthwhile?
Future Applications
CT Myocardial Perfusion Anatomy and Physiology

CT Myocardial Perfusion Challenges

- Radiation dose
- Beam hardening artifact
- Contrast resolution
- Temporal resolution at high heart rates
- Z axis coverage
Radiation Dose

• Essentially double the dose of the CTA

• Range 10.1mSv to 18.7mSv*
  – (Prospective and/or retrospective)

• Ultra high pitch 2.5mSv (+/- 2.1mSv)**

• Remember …
  Tc99 SPECT MPI dose 12-15mSv***

** Feutchner et al. Circ Cardiovasc Imaging 2011;4:540-549
Core 320 Trial

• Multicentre international trial
  – 16 centres, 8 countries
• 381 patients
• CTA + stress CT MPI vs. ICA + SPECT MPI

• Diagnostic Accuracy for Stenosis >50%:
  • 0.81 (CTA), 0.87 (CTA + CT MPI) (p<0.001)
• Median Dose CT + CT MPI 8.4mSv
Ischemia:
Functional Flow Reserve

• CCTA – tends to overestimate stenosis
• Stenosis over (and under) estimates ischemia
• FFR gold standard for ischemia
  – PCI guided by FFR improved outcomes (FAME*)

FFRCT

- Image based modeling of myocardium and coronary tree
- Computational fluid dynamics
- VR 3D model of coronary tree with complete spacial distribution of FFR
FFRCT Evidence

• Multicenter trials
  • DISCOVER –FLOW*
  • DE FACTO**

• CCTA vs FFRCT vs ICA and FFR
• FFRCT improved prediction of ischemic lesions vs CCTA alone
• Good correlation with FFR

**Min et al. JAMA. 2012;26:1-9
**FFRCT Evidence**

<table>
<thead>
<tr>
<th></th>
<th>CCTA stenosis &gt; 50%</th>
<th>FFRCT ≤ 0.80</th>
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<tr>
<td>DISCOVER-FLOW*</td>
<td>61</td>
<td>87</td>
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<td>DEFACTO**</td>
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Table: Accuracy of FFRCT vs CTA for determination of FFR proven flow limiting lesions (per patient)

- Effect still evident in poorer quality CTA studies
- Effect greater in intermediate grade lesions
- Identified ICA +ve, FFR –ve lesions

**Min et al. JAMA. 2012;26:1-9
Atheroma imaging: Beyond obstructive disease

- Prognosis and primary prevention
  - CONFIRM registry:
    non obstructive plaque – increased mortality

- Identification of the vulnerable plaque
  - Low attenuation
  - +ve remodelling
  - Ring attenuation
Positive Remodeling
Atheroma imaging: Beyond obstructive disease

• Turn observations into improved outcome

• Robust identification of at risk lesions

• Intervention
  – What
  – When
  – Demonstrate net benefit
Objectives

• Basic appropriateness principles
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Thank you

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