CT Coronary Angiography
Dr Rodney Wu
Scanning technique
Patient preparation
Physiologic basis
Normal Coronary artery anatomy
Calcium Score
Indications for Coronary CT Angiography
Screening of Asymptomatic patients
Examination of Symptomatic patients
Specialised applications
Scanning technique
16 row MDCT
1 cm detector
20 SEC SCAN

64 row MDCT
4 cm detector
4-8 SEC SCAN

128 row MDCT
8 cm detector
2-4 SEC SCAN

320 row MDCT
16 cm detector
1-3 SEC SCAN
Patient Preparation

- No solids
- Hydration with clear fluids
- No caffeine products
- Abstinence from Erectile dysfunction meds 24-48hr as may interact with nitrates to cause severe hypotension
- Beta blocker HR<70bpm preferably <60bpm
- Calcium score
- Triphasic IV contrast
- Timing bolus
Physiologic basis

- Heart is mobile around its axis
- Volume varies between systole/diastole
- Coronary artery filling easier in diastole
- On ECG diastole begins later than R-wave and lasts until Q-wave
- On the ECG the centre of diastole is at 70% of an R-R complex
- Retrospective gating
- Prospective ECG gating
- ASIR (Adaptive statistical IR)
Normal Coronary Artery Anatomy
Left Coronary Artery

- LMA
- LAD
- Diagonals
- Circumflex
- Obtuse Marginals
LMA
LAD
Diagonals
Circumflex
Obtuse Marginals
- LMA
- LAD
- Diagonals
- Circumflex
- Obtuse Marginal
- LMA
- LAD
- Diagonals
- Circumflex
- Obtuse Marginals
Right Coronary Artery

- Right Coronary Artery
- Posterior Descending Artery
- Posterolateral Artery
Calcium Score
Calcium Score

0 - 0:
No identifiable atherosclerotic plaque

1 - 10:
Minimal plaque burden - Low CVD risk

11 - 100:
Mild plaque burden - Moderate CVD risk

101 - 400:
Moderate plaque burden - High CVD risk

Greater than 401:
Extensive plaque burden - Very high CVD risk

Score Summary
Your total calcium score is 728.

Ranking Guide
Your score of 728 places you in the 75th percentile rank.
That means 25 percent of the male at the ages from 66 to 70 will have a higher calcium score than you.

Category Table

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Extensive plaque burden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Interpretation</td>
<td>High likelihood of at least one &quot;significant&quot; coronary stenosis (&gt;50% diameter)</td>
</tr>
<tr>
<td>Gender and Age Issues</td>
<td>Greater clinical significance when score is above 75th percentile for age and sex, or if calcium present in 2 or more vessels</td>
</tr>
<tr>
<td>Recommended Clinical Action</td>
<td>Very aggressive risk factor modification using NCEP guidelines as for established CAD. Consider invasive stress test to rule out ischemia</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CORONARY</th>
<th>AJ-139</th>
<th>Mean</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIMA (Left Main Artery)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>LAD (Left Anterior Descending)</td>
<td>250</td>
<td>22</td>
<td>38</td>
</tr>
<tr>
<td>LCX (Left Circumflex)</td>
<td>97</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>RCA (Right Coronary Artery)</td>
<td>223</td>
<td>43</td>
<td>103</td>
</tr>
<tr>
<td>PD (Posterior Descending Artery)</td>
<td>13</td>
<td>4</td>
<td>28</td>
</tr>
<tr>
<td>D1</td>
<td>14</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>4</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>O1</td>
<td>54</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>728</td>
<td>188</td>
<td>365</td>
</tr>
<tr>
<td>Total (without additional vessels)</td>
<td>284</td>
<td>51</td>
<td>284</td>
</tr>
</tbody>
</table>

Calibration Factor (CIF): 0.74

*Presence of chest pain, or multiple risk factors, or younger age subject to female gender may yet - asymptomatic should encourage a more aggressive approach to the therapy/maintenance of the patient.*
High calcium scores in patients with a low Framingham risk of cardiovascular (CVS) disease: implications for more accurate CVS risk assessment in New Zealand

Chris J Ellis, Malcolm E Legget, Colin Edwards, Niels Van Pelt, Jolan A Omiston, Jonathan Christiansen, Helen Winch, Mark Osborne, Greg Gamble

Abstract

Aims New Zealand (NZ) patients are recommended to undergo an ‘adjusted’ Framingham score to assess their cardiovascular (CVS) risk. The current (2009) NZ CVS Risk Guideline does not recommend the use of a ‘calcium score’ as an additional risk tool, although it has been shown to be powerfully predictive of CVS events above the predictive power of traditional Framingham risk factors. Calcium scores of >400 are very strongly predictive of a future CVS event and give direct evidence of atheromatous disease in the coronary circulation. Identification of people with advanced, premature coronary atheroma would allow early treatment of those who may benefit from more vigorous preventative strategies, including statin therapy.

Methods Using a prospectively acquired, comprehensive database we audited the first 1000 patients (7 August 2006 to 28 November 2006) to undergo a 64-slice computed tomographic (CT) cardiac angiogram (GE Light Speed), which included a scan for a ‘calcium score’, at the Mercy Hospital, Auckland. We excluded 58 patients who had experienced one or more of a previous myocardial infarction (MI) (n=21), coronary artery bypass graft (CABG) surgery (n=15), percutaneous coronary intervention (PCI) (n=13) or stroke (n=21) and who therefore already had definite evidence of vascular disease and would be automatically placed in a high risk strata. We calculated each patient’s Framingham risk from the original ‘Anderson’ equation, used by the 1996 NZ CVS risk Guideline, and the ‘adjusted’ Framingham 5-year CVS risk using the NZ Guidelines Group 2003/2009 recommendations, and then compared this with the observed calcium scores.

Results The mean patient age was 56 (SD 9) years; 364 (39%) patients were female, 82% patients were Caucasian. 41% were current (4.6%) or previous (36%) cigarette smokers, 35% had a history of hypertension, 44% hyperlipidaemia and 5.6% had diabetes mellitus. The percentage of patients at ‘low’ 5-Year CVS risk (0-10% 5-year risk), using the 1996 and 2003/2009 guideline methods, was 78% and 58% respectively. Of patients in those Framingham ‘low-risk’ groups, 10% and 8.8% had a calcium score of >400 Agatston units, indicating that they were actually at very high CVS risk, and 203 (28%) and 147 (27%) respectively had a calcium score of >100 Agatston units, indicating that they were actually at ‘high risk’ and not ‘low risk’.

Conclusion Approximately 10% to 27% of patients with a low CVS risk as assessed by the established Framingham equation have a markedly increased calcium score and hence a significantly increased risk of a CVS event. Currently promoted methods of risk assessment may be inadvertently, falsely re-assuring these patients. Clinicians
Indications for Coronary CT Angiography

- Screening of Asymptomatic patients
- Examination of symptomatic patients
- Specialised applications
Screening of Asymptomatic patients
- The presence of coronary atherosclerosis and the subsequent manifestations of coronary disease exist on a continuum.
- High plaque burden may exist yet remain asymptomatic and undetectable at conventional testing.
DANGEROUS RUPTURES
Cholesterol in the blood can enter arterial walls, causing plaque to form. Tiny pockets of plaque accumulate in a process called atherosclerosis. Plaque can build up for decades and suddenly rupture into the bloodstream with deadly consequences.

THE PROCESS
1. Cholesterol in the bloodstream infiltrates the arterial wall.
2. Immune system dispatches macrophages to consume cholesterol. The bloated macrophages become foam cells.
3. Foam cells accumulate and become a major component of plaque.
4. To keep the arterial wall slick, smooth muscle cells form a cap.
5. Foam cells in the plaque secrete chemicals that weaken the cap.
6. Heart attack: If the cap cracks, plaque snaps into the bloodstream, and a clot forms that can block blood flow.

Most heart attacks are triggered in arteries where blood flow is less than 50 percent blocked and where plaques and caps are soft and more likely to rupture.

GENETIC CLUES
The gene apoE4 is involved in arterial inflammation, and some scientists suspect that a mutation of the gene MEF2A affects the likelihood of a rupture.

DEATH FROM HEART ATTACK
U.S., 2003

<table>
<thead>
<tr>
<th>Age</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-19</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>20-29</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>30-39</td>
<td>51</td>
<td>110</td>
</tr>
<tr>
<td>40-49</td>
<td>163</td>
<td>426</td>
</tr>
<tr>
<td>50-59</td>
<td>1,657</td>
<td>11,240</td>
</tr>
<tr>
<td>60-69</td>
<td>7,089</td>
<td>16,117</td>
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<tr>
<td>70-79</td>
<td>7,997</td>
<td>24,082</td>
</tr>
<tr>
<td>80+</td>
<td>49,294</td>
<td>32,262</td>
</tr>
</tbody>
</table>

TOTAL: 81,047

SOURCE: RICHARD A. LANGE, JOHN HOPKINS HOSPITAL, PETER LIBBY, BOSTON AND WOMEN'S HEALTH STUDY, UNIVERSITY OF CALIFORNIA, SAN FRANCISCO.

ART BY BRIAN CHRISTIE
Standard Framingham risk factors help identify groups at low, high and intermediate risk for future cardiac events.

- Low risk: likelihood of cardiac events of <10% per 5 years
- High risk: likelihood of cardiac events of >20% over a 5 year period considered to be at high risk.
Asymptomatic low risk patient according to Framingham criteria is less likely to gain further benefits from additional cardiac testing.

Low risk patients are most likely to have false-positive results owing to a low pretest likelihood of disease.

Asymptomatic intermediate risk group most likely to benefit from further risk stratification.

40% population belong in intermediate risk group.
40m Asymptomatic FHx
40M Asymptomatic FHx
Mild stenosis LAD, LCX and RCA
Mild stenosis LAD, LCX and RCA
53M Asymptomatic, +ve family hx
50% LAD stenosis confirmed on angio with pressure wire indicating obstructive. Pt went to CABG.
50% LAD stenosis confirmed on angio with pressure wire indicating obstructive. Pt went to CABG.
51M Asymptomatic, abnormal stress test
- Soft and calcified plaque LAD <50%
- LCX 30% stenosis
- RCA small plaques
Examination of Symptomatic patients
Atypical chest pain

- Patients with atypical chest pain with low to intermediate risk would benefit from a non-invasive test with a high negative predictive value.
- A normal CT angiogram and negative calcium score could avoid invasive cardiac catheterization in a substantial % of patients.
- CT also helpful when other tests are negative or equivocal.
Typical chest pain

- CT is not recommended for patients with Acute Coronary Syndrome and high risk factors.
- CT can reveal non cardiac causes of chest pain.
- The use of CT in evaluation of chest pain in ED is currently being explored. The “Triple rule out” to evaluate aortic dissection, PE and acute coronary syndrome. Not currently recommended.
72F borderline ETT. No chest pain
72F borderline ETT. No chest pain
64M atypical chest pain, smoker
LAD 70% stenosis x2
2nd OM 70% stenosis
Occluded RCA
Confirmed on ANGIOGRAM went onto CABG
Confirmed on ANGIOGRAM went onto CABG
65M chest pain with exercise, +ve fam hx
Prox LAD 70% + stenosis
Distal RCA >50% stenosis
67F angina, HT
75% distal LMA stenosis
Confirmed on angiogram, went onto CABG
71m symptomatic aortic stenosis
71m symptomatic aortic stenosis
LMA and LAD 50%, RCA 70% stenosis
Specialised applications
- CT can be used to evaluate bypass grafts and stents.
- Evaluation of patients undergoing valve surgery but unlikely to have coronary artery disease.
- Pre cardiac catheter planning
57M for redo AVR
68F aortic valve vegetation
47M chest pain
67M LAD aneurysms preop planning
Vein graft aneurysm

lima to lad

vein graft to om
Pre cardiac cath planning

- 51 M
- Occluded mid RCA
- Stents mid LAD and OM1
- Severe stenosis mid LAD
Stents LAD/OM1
Soft plaque occluding RCA
Collaterals from the LCX with retrograde filling of PLA
66M Cardiologists unable to demonstrate RCA at angiography
66M Cardiologists unable to demonstrate RCA at angiography
Conclusion

- CT angiography allows visualization of the coronary arteries which previously required invasive cardiac catheterization.
- It should not be directly compared with cardiac cath as it offers different information non-invasively. It directly identifies early stages of plaque formation before it can be seen on cardiac angiography.
- Patients who have undergone revascularization procedures including stenting and bypass can now be imaged non-invasively.
Advantages

- Quick and non-invasive
- 3D modality
- Accurate and unique info
- Most sensitive test in detection of coronary artery disease other than IVUS
- Can see other vessels and structures in chest

Disadvantages

- Involves radiation (down to <1msv with prospective gating)
- Difficult in fast or irregular heartbeats
- Requires contrast and beta blockers
- Can be difficult and occasionally impossible to quantify stenosis in heavily calcified or small vessels.
KEEP CALM AND X-Ray ON
RADILOGIC TECHNOLOGIST

WARNING
TO AVOID INJURY,
DON’T TELL ME
HOW TO DO MY JOB