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Neuroradiologist  
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Cardiologist

## Noninvasive Cardiac Imaging: Guide for Dummies - Concurrent Workshop Repeated

Friday, 16 August 2013

Start 2:00pm

Start 3:05pm

Duration: 55mins

Duration: 55mins

Pyramids

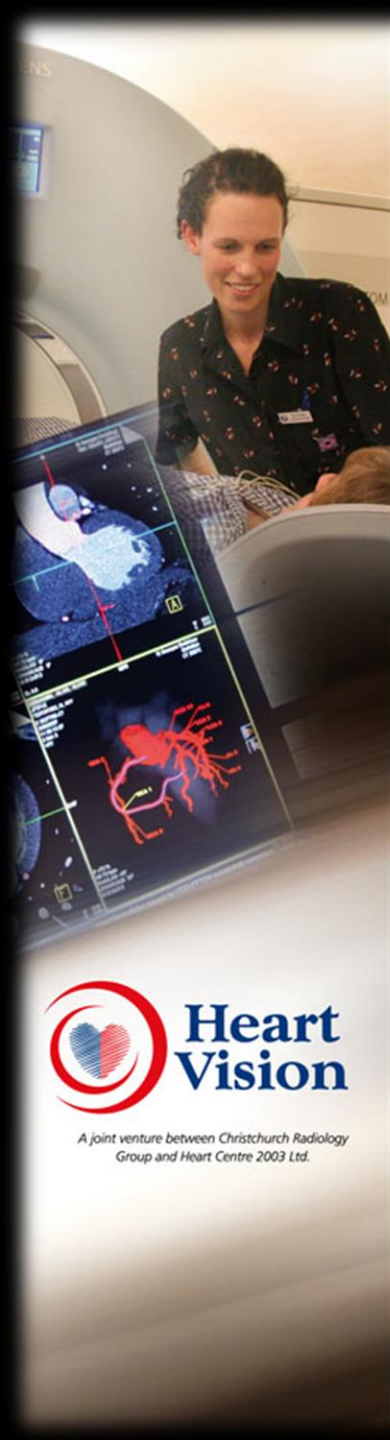
Pyramids



**South GP CME 2013**

General Practice Conference & Medical Exhibition

**15-18 August | Edgar Centre | Dunedin**



# Heart Vision

**“Non Invasive Cardiac Imaging – A Guide for Dummies”**

**Drs Clive Low (Cardiology)  
& Ross Keenan (Radiology)**

**GP CME, Dunedin 16 August 2013**

**Workshop, Friday 2-4pm Edgar Centre**



A joint venture between Christchurch Radiology  
Group and Heart Centre 2003 Ltd.

**HEART VISION Ltd.**

joint venture

**CHRISTCHURCH RADIOLOGY GROUP  
&  
HEART CENTRE (2003)**

**[www.heartvision.co.nz](http://www.heartvision.co.nz)**

# Non Invasive Cardiac Imaging

A Guide for Dummies

Dr Clive JS Low

Consultant Cardiologist



# CT Coronary Calcium Score

## An in-patient susceptibility study

The validation studies in Males aged 50 to 70 show us that little or no calcified plaque identifies low risk of IHD events in the patient

Studies demonstrate more accurate risk prediction For an individual patient by combining the Framingham Risk (NHF table) and CT calcium score

# CT Coronary Calcium Score

## An in-patient susceptibility study

A patient with high calcium score ( $\geq 300$  Agaston units) has the same IHD event rate as a patient who has had MI, CABG, PTCA, or abnormal coronary angiogram

# CT Coronary Angiogram

## An accurate test for diagnosis of IHD

|                                  |                 |
|----------------------------------|-----------------|
| Ex ECG                           | 75% accurate    |
| Stress Echo (and all the others) | 80ish% accurate |

For Obstructive IHD

|                       |              |
|-----------------------|--------------|
| CT Coronary Angiogram | 98% accurate |
|-----------------------|--------------|

For Significant coronary atheroma

(NB All quite operator dependant)

# CT Coronary Angiogram

## An accurate test for diagnosis of IHD

### Limitations

|                    |                       |
|--------------------|-----------------------|
| Radiation exposure | esp young and females |
| Contrast exposure  | allergy               |

|            |                                                                               |
|------------|-------------------------------------------------------------------------------|
| Arrhythmia | ectopic beats<br>atrial fibrillation<br>tachycardia<br>(NB ? $\beta$ Blocker) |
|------------|-------------------------------------------------------------------------------|

|                |                                     |
|----------------|-------------------------------------|
| Severe disease | high risk patients<br>calcium bloom |
|----------------|-------------------------------------|



CARDIAC CT

**St George's Radiology**

137 Leinster Rd, Christchurch

t • 03 355 6073 f • 03 3552173

[www.heartvision.co.nz](http://www.heartvision.co.nz)

Examination Required: ☐ CT CORONARY ANGIOGRAM ☐ CALCIUM SCORE

|                  |       |                           |
|------------------|-------|---------------------------|
| Patients Name    | D.O.B | Referrer Name / Signature |
| Address          | NHI   | Date                      |
|                  | Phone |                           |
| Clinical Details |       | Copy to                   |
|                  |       | Scan Urgency              |

**CLINICIAN CHECKLIST (COMPLETE FOR ALL PATIENTS)**

|                                                  |                     |              |
|--------------------------------------------------|---------------------|--------------|
| <input type="checkbox"/> Pacemaker or ICD        | Resting heart rate: | Age years:   |
| <input type="checkbox"/> AF or arrhythmia        | Height cm:          | Weight kg:   |
| <input type="checkbox"/> Coronary stents or CABG | GFR:                | Date of GFR: |

Details:

**APPROPRIATENESS CRITERIA (ONLY REQUIRED FOR SOUTHERN CROSS HEALTH INSURANCE)**

- ☐ Chest pain or other cardiac symptoms suggesting CAD, with a low or intermediate pre-test probability of CAD when exercise or pharmacologic stress testing is not possible or contraindicated.
- ☐ Recent exercise treadmill test for the investigation of suspected CAD symptoms with result that cannot be interpreted or is equivocal.
- ☐ Unequivocally negative exercise test with ongoing symptoms strongly suggestive of ischemia.
- ☐ Preoperative assessment of coronary arteries prior to elective cardiac valve or aortic aneurysm surgery.
- ☐ Suspected mass or other morphologic abnormality of the heart, pericardium or great vessels on echo.
- ☐ New onset heart failure or dilated cardiomyopathy previously evaluated by echo, where ischemia is suspected aetiology.
- ☐ Symptomatic (ischemic equivalent) or evidence of major silent ischemia following CABG. CTCA for evaluation of graft patency.
- ☐ Chronic total occlusion (CTO) for definitive intervention. CTCA to help determine the most appropriate therapeutic approach.
- ☐ Post revascularization following coronary angioplasty involving stent placement in the left main coronary artery. CTCA in lieu of an angiogram.

**PLEASE PRESCRIBE B-BLOCKER AND GTN TARGET HR IS < 70 BPM FOR CARDIAC CT BUT PLEASE REFER ALL PATIENTS**

☐ Patient not suitable for additional drugs to slow heart rate. (NB aorta for size can be performed without gating)

Is the patient taking a  $\beta$ -Blocker? ☐ Yes ☐ No Does patient use GTN spray? ☐ Yes ☐ No

Contraindication to  $\beta$ -Blocker? ☐ Yes ☐ No Contraindication to GTN spray? ☐ Yes ☐ No

|                                                                                                                                  |                          |                                 |
|----------------------------------------------------------------------------------------------------------------------------------|--------------------------|---------------------------------|
| Prescribed drugs will be administered by radiology staff on day of scan according to Cardiac CTA $\beta$ -blocker / GTN protocol |                          |                                 |
| Drug and Dose                                                                                                                    | Prescribing Dr signature | Radiology administration record |
| Metoprolol 100mg PO stat                                                                                                         |                          |                                 |
| Additional Metoprolol 50mg PO PRN                                                                                                |                          |                                 |
| GTN 1 spray S/L prior to scan                                                                                                    |                          |                                 |
| Prescribing Dr <i>print</i> surname                                                                                              |                          | Date of prescription:           |
| Prescribing Dr NZ MC Number                                                                                                      |                          |                                 |



# Heart Vision

[www.heartvision.co.nz](http://www.heartvision.co.nz)

1986

20th Century Fox



"Mr. Osbourne, may I be excused? My brain is full."

# Cardiac Imaging Team



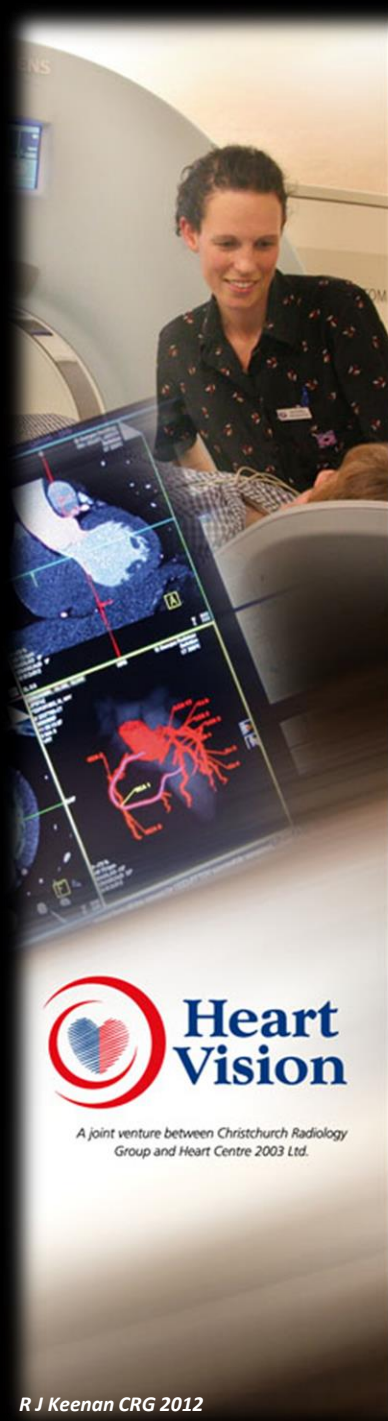
**Right to Left:** Amanda, Jo, Dr Latham Berry, Dr Sharyn Macdonald, Dr Ross Keenan, Jenny, Clare, Rachel

## Cardiac CT : Heart Vision

- based in St Georges Radiology CHC
- total CCTA patients ~ 1900pts
- CCTA v catheter ongoing audit
- continuous radiation dose audit
- health insurance coverage
  - CACS “screening” not covered
  - CCTA - SXHI criteria v others



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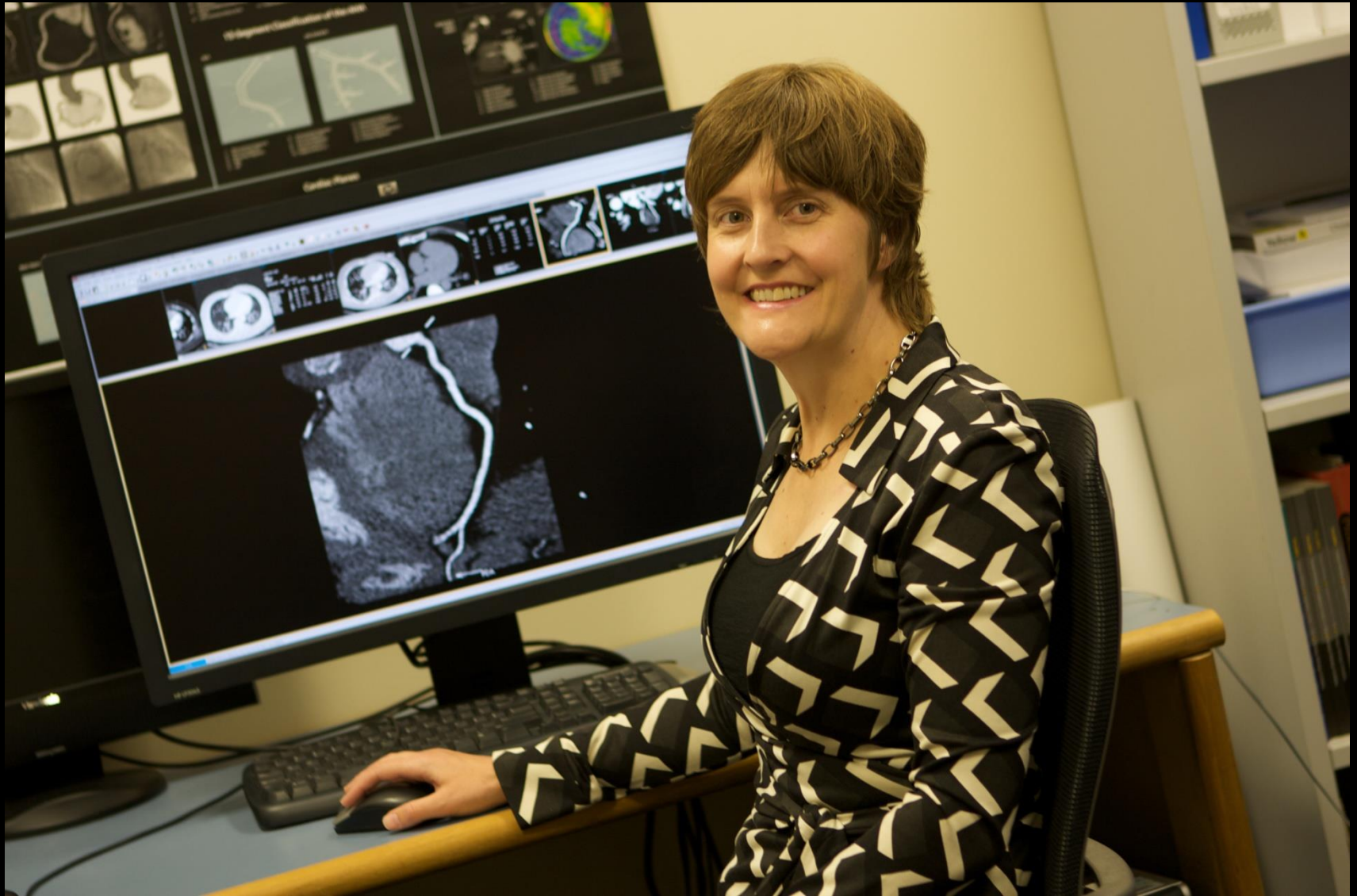


# Cardiac CT Imaging Systems



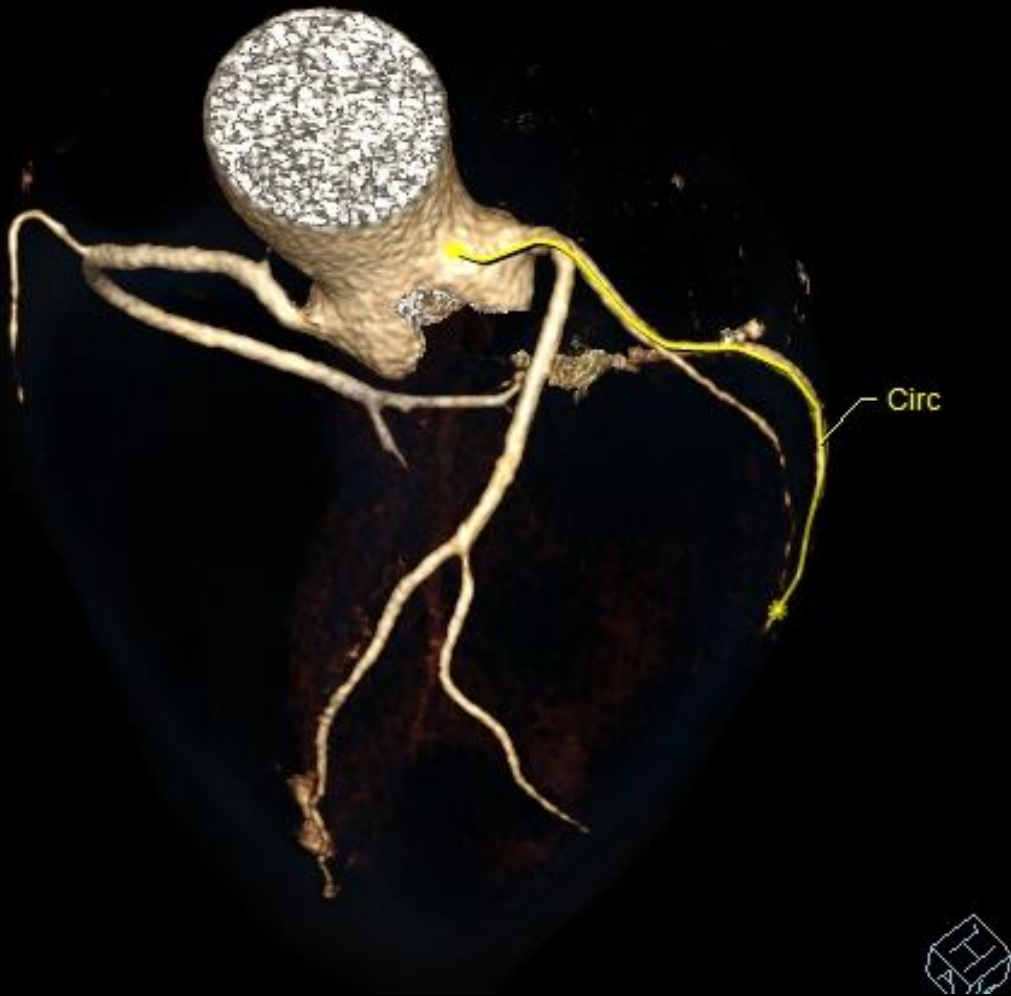
Siemens Dual Source CT: **Left:** Definition 2007 (St Georges), **Right:** Definition FLASH 2012 (Christchurch Hospital)

# Cardiac CT Imaging Systems

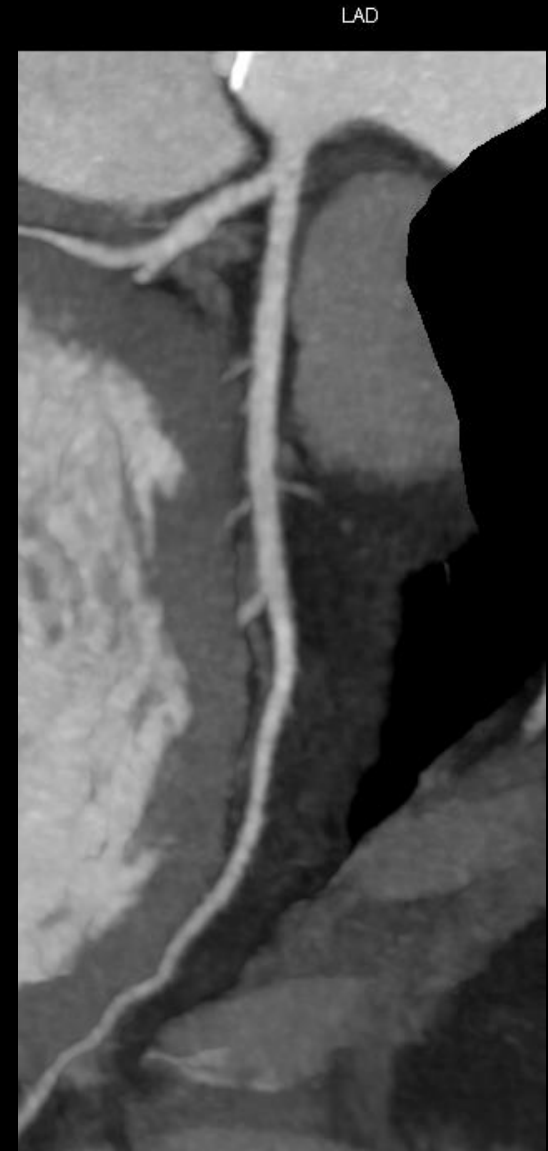


**Heart Vision** : Dr Sharyn Macdonald, Cardiac Radiologist: Siemens Dual Source Definition CT\_Circulation analysis

# Cardiac CT Imaging Systems



**Left:** CCTA Syngo via VR



**Right:** Syngo via curved MIP, normal LAD

# '5' learning points

- CT dose = low and decreasing to  $< 1\text{mSv}$
- CACS = CVD risk stratification - adjuvant
- CCTA = coronary stenosis imaging - exclude CAD
- cardiac MRI = function, myocardial, valvular disease
- **ROUTINE!**



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# Cardiac CT Radiation Dose



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# COUNTERTHINK



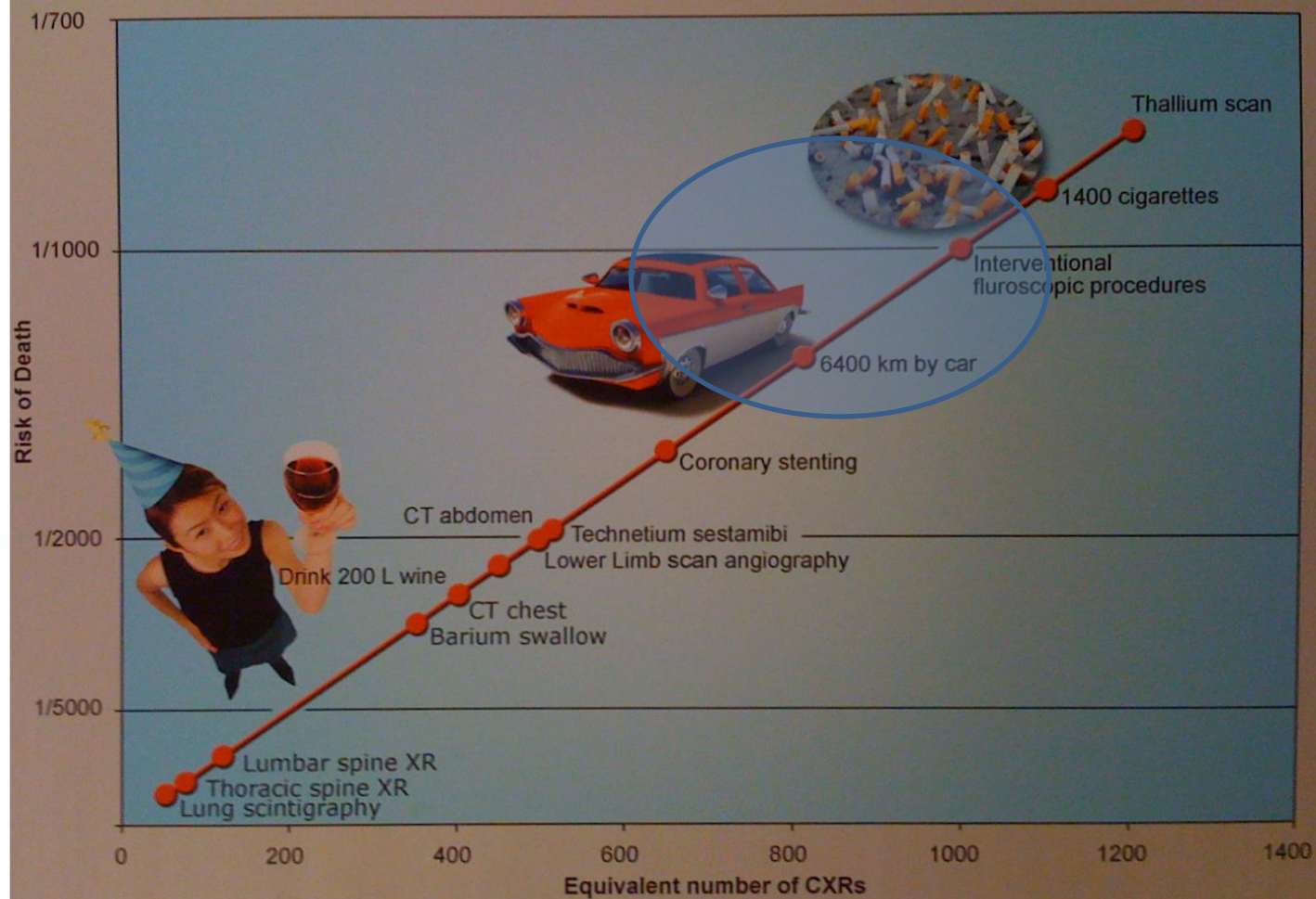
# Cardiac CT System

## Siemens Dual Source CT

- dedicated cardiac CT system
- dual source (2 XR tubes 1.5 tonne)
- rotation time = 280msec
- temporal resolution = 70msec
- detector = 40mm
- “FLASH” scanning, high pitch  $\sim 3.4$
- dual energy = 80 - 140kvp



## Cancer risk v Radiation dose



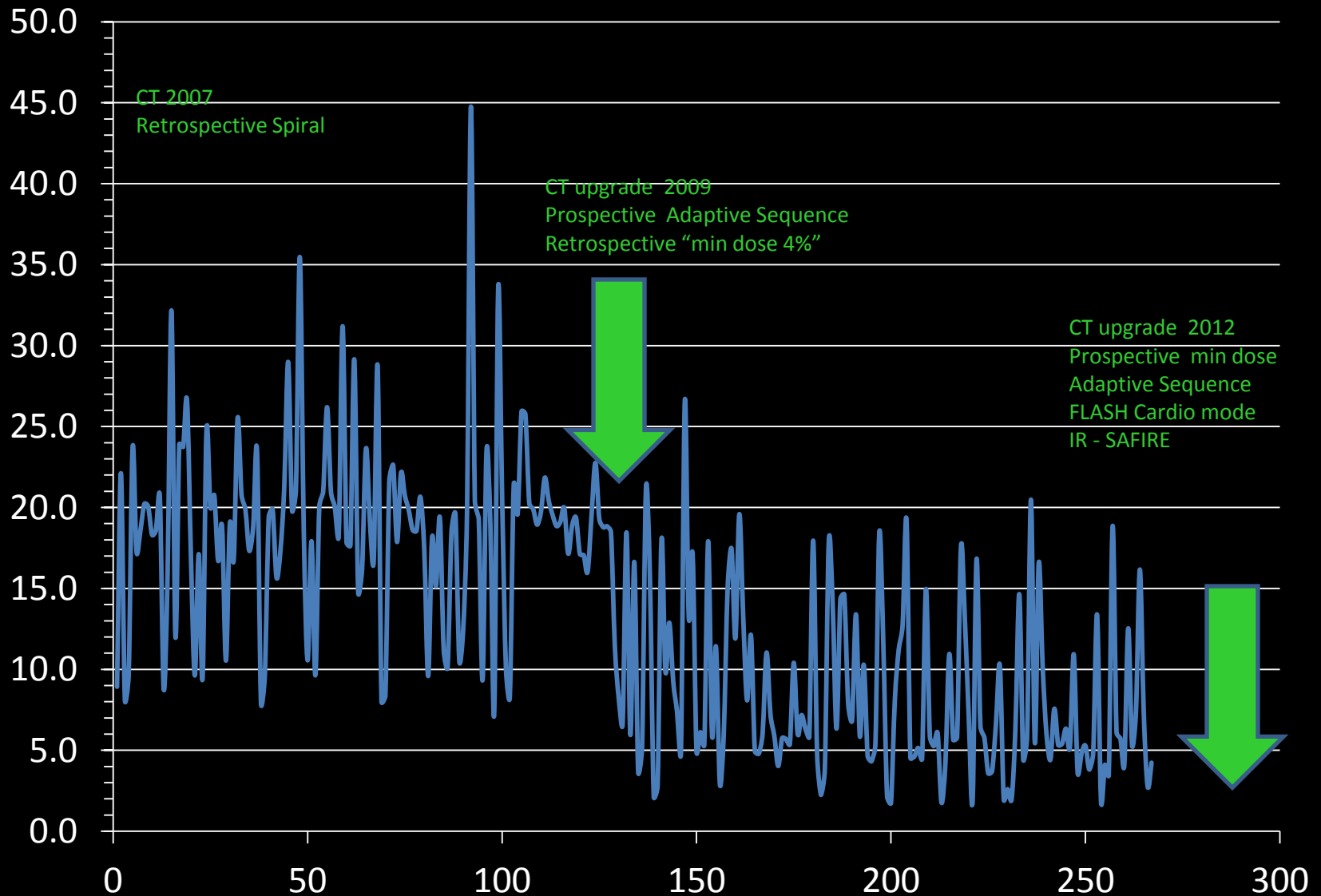
# CCTA Radiation Dose - 2009

| Technique                                   | Effective Dose pa         |
|---------------------------------------------|---------------------------|
| SPECT Thallium stress                       | 25mSv                     |
| SPECT Sestamibi stress                      | 12-18mSv                  |
| CT chest ungated helical                    | 5-7mSv                    |
| Retrospective mode CCTA                     | 14 mSv, (4.5-19) < 5-6mSv |
| Prospective mode CCTA                       | 5 mSv,(1.7-7.3) < 3-4mSv  |
| FLASH mode CCTA                             | < /= 1mSv                 |
| Diagnostic catheter angiogram               | 3-6 mSv, (3-30)           |
| CXR (PA/Lat)                                | 0.05 mSv                  |
| <b>Annual background radiation</b>          | <b>2-5mSv (~ 3mSv)</b>    |
| Additional background radiation at altitude | + 1.5mSv                  |
| USA East-West round trip flight             | + 0.03mSv                 |

## Reference:

Stolzmann P et al. Eur Radiol 2008; 18: 592-599

# CCTA Radiation Dose - 2009



# CCTA Radiation Dose - 2012

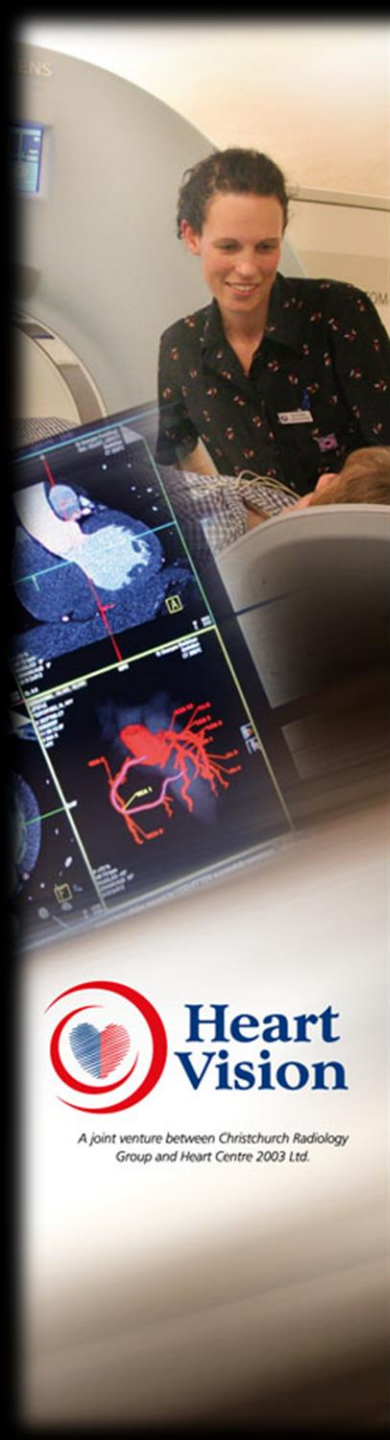
| Technique           | Mean Dose (mSv) |
|---------------------|-----------------|
| Retrospective gated | < 6mSv          |
| Prospective gated   | 0.8 - 4mSv      |
| Siemens FLASH mode  | << 2mSv         |
| CACS                | < 0.5mSv        |

## Reference:

Heart Vision Audit 2011:



"C'mon, c'mon — it's either one or the other."



# CACS

Coronary Artery Calcium Scoring

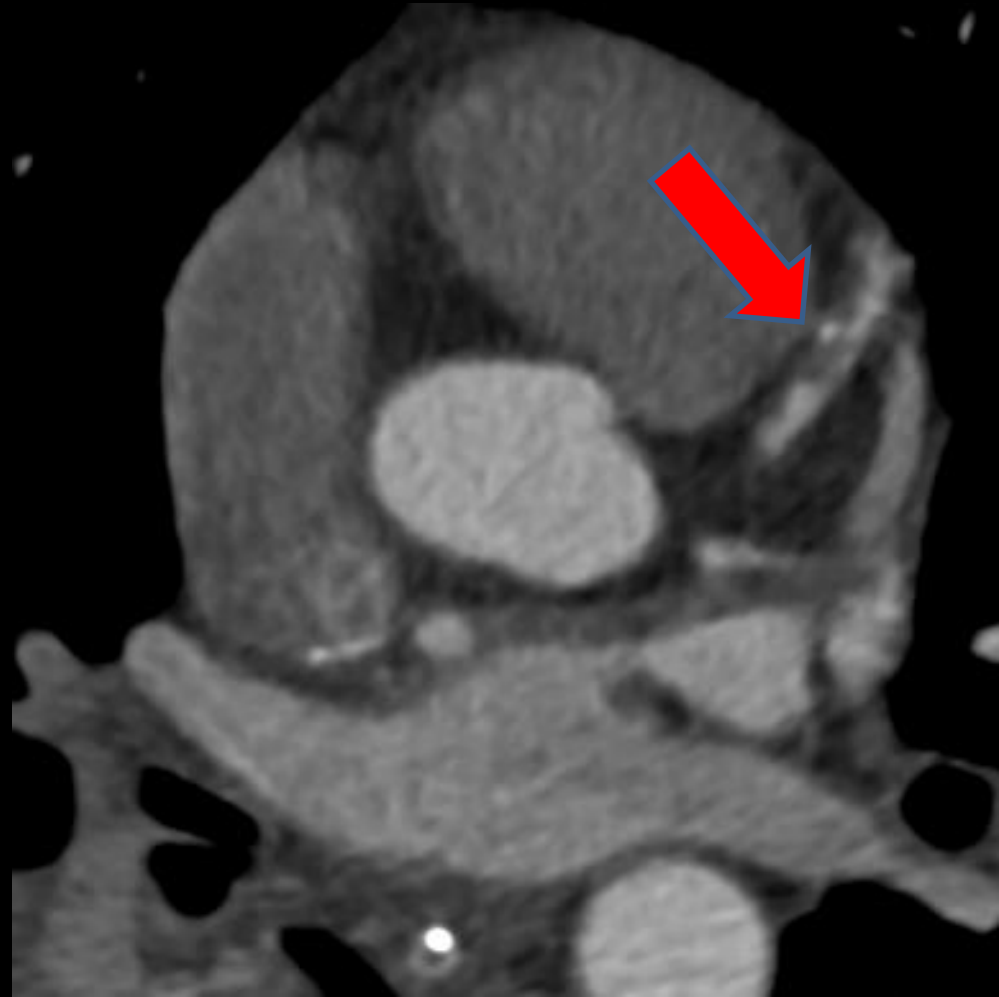


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# CACS



Non-contrast CACS



Contrast CCTA

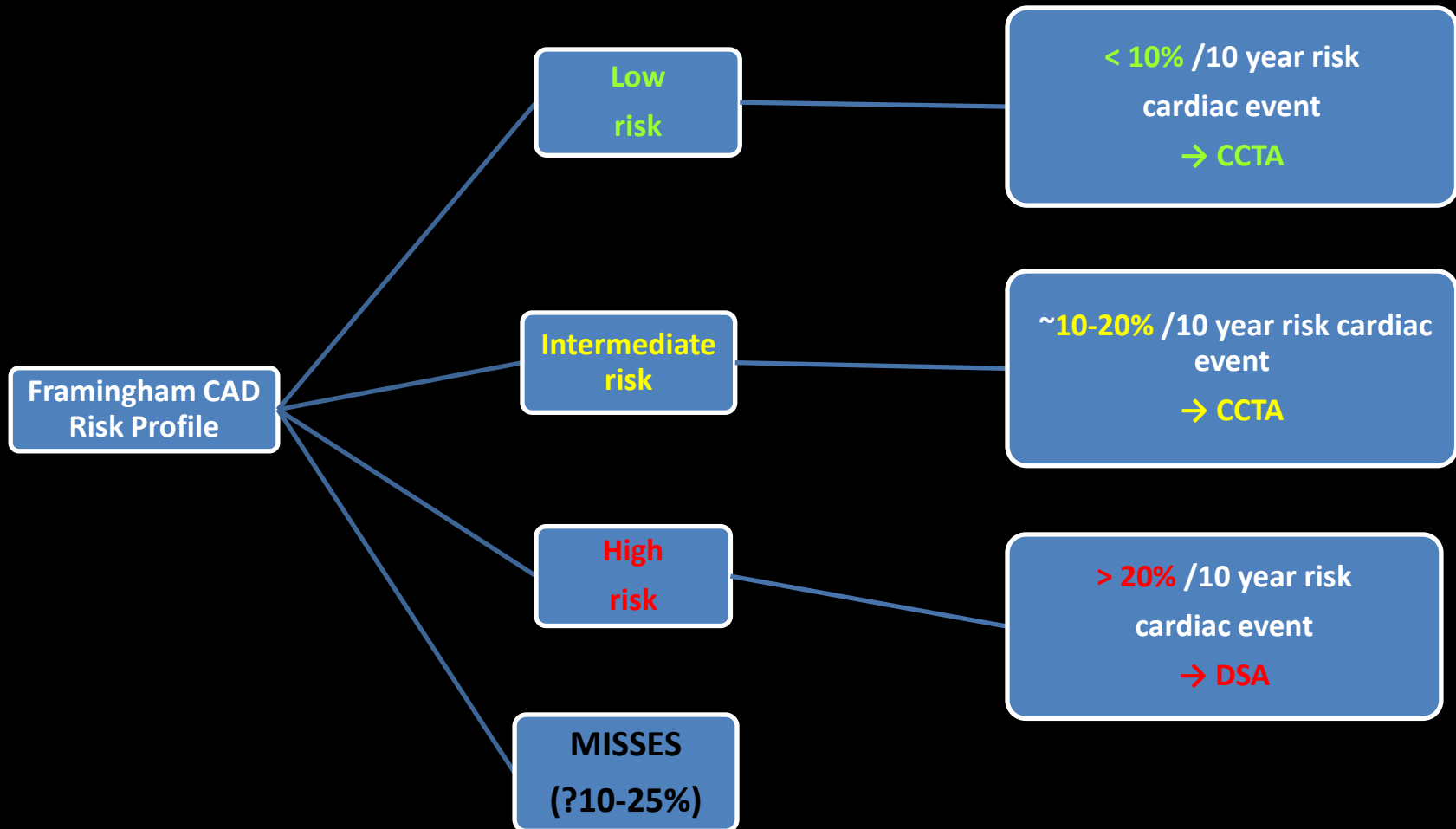
# CACS

- CT scan - ECG gated prospective low dose ( $< 0.5\text{mSv}$ )
- CVD risk stratification tool (Agatston 1990)
- CACS quantifies calcified plaque
- CACS scores plaques with peak density  $>130\text{HU}$
- Total CACS score ranked against population standards
- MESA = Multiethnic Study in Atherosclerosis

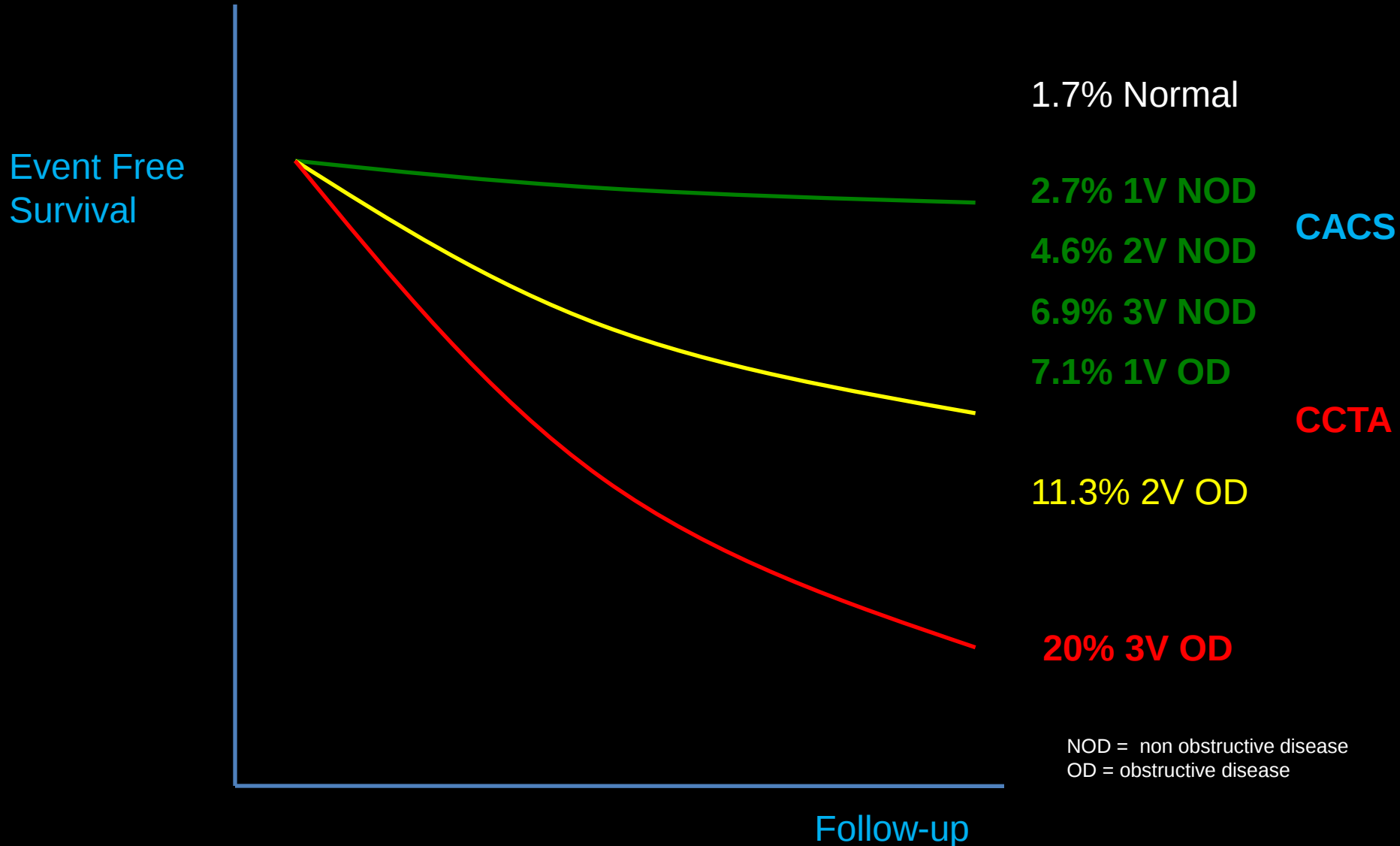


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# CAD Risk Stratification: definitions



# CVD Risk Stratification



# CACS - Interpretation

| CACS Score (Agatston) | Plaque burden | Obstructive CAD Risk                | CVD Risk        | Guidelines                                                                                                                                             |
|-----------------------|---------------|-------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0                     | none          | < 5%                                | very low        | • reassuring                                                                                                                                           |
| 1-10                  | minimal       | < 10%                               | low             | • discuss 1 <sup>o</sup> prevention                                                                                                                    |
| 10-100                | mild          | mild stenoses                       | moderate        | • 1 <sup>o</sup> risk modification                                                                                                                     |
| 100-400               | moderate      | NOCAD highly likely                 | moderately high | <ul style="list-style-type: none"> <li>• 1<sup>o</sup> + 2<sup>o</sup> risk modification</li> <li>• aspirin</li> <li>• consider stress test</li> </ul> |
| > 400                 | severe        | > 90% risk of OCAD<br>>= 1 stenosis | high            | <ul style="list-style-type: none"> <li>• aggressive risk modification</li> <li>• aspirin</li> <li>• stress test</li> </ul>                             |

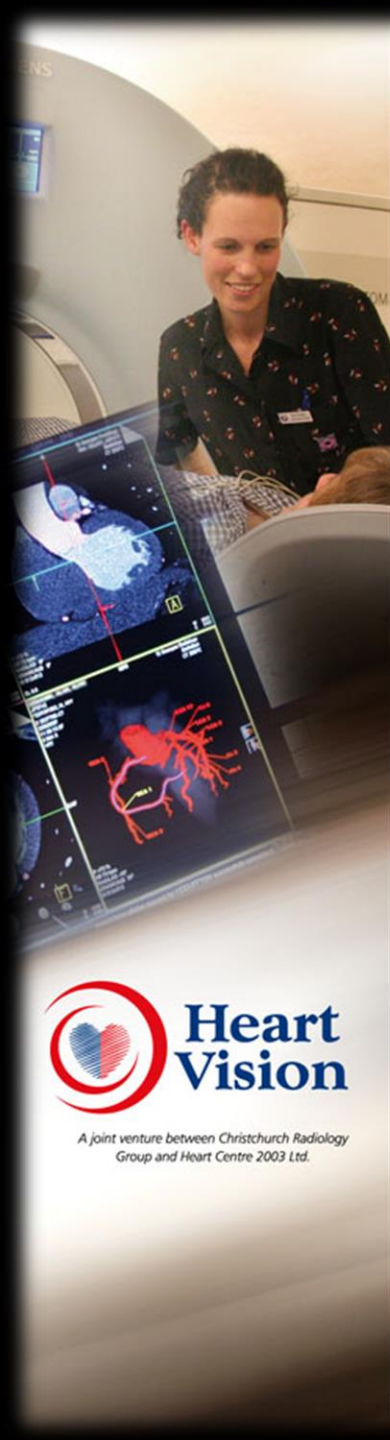
Reference: Rumberger 1999

# CACS

- result = ranked Agatston score
- calcification = biomarker of CAD burden
- CVD risk assessment in low-medium risk patients
- ↑ score = ↑ CVD risk
- extensive evidence base
- routinely incorporated in CCTA studies (2012)



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# CCTA

## Coronary CT Angiography



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# CCTA - Techniques

## Retrospective Gating

- original technique
- higher dose

## Prospective Gating

- newer ~ move and shoot
- low radiation dose

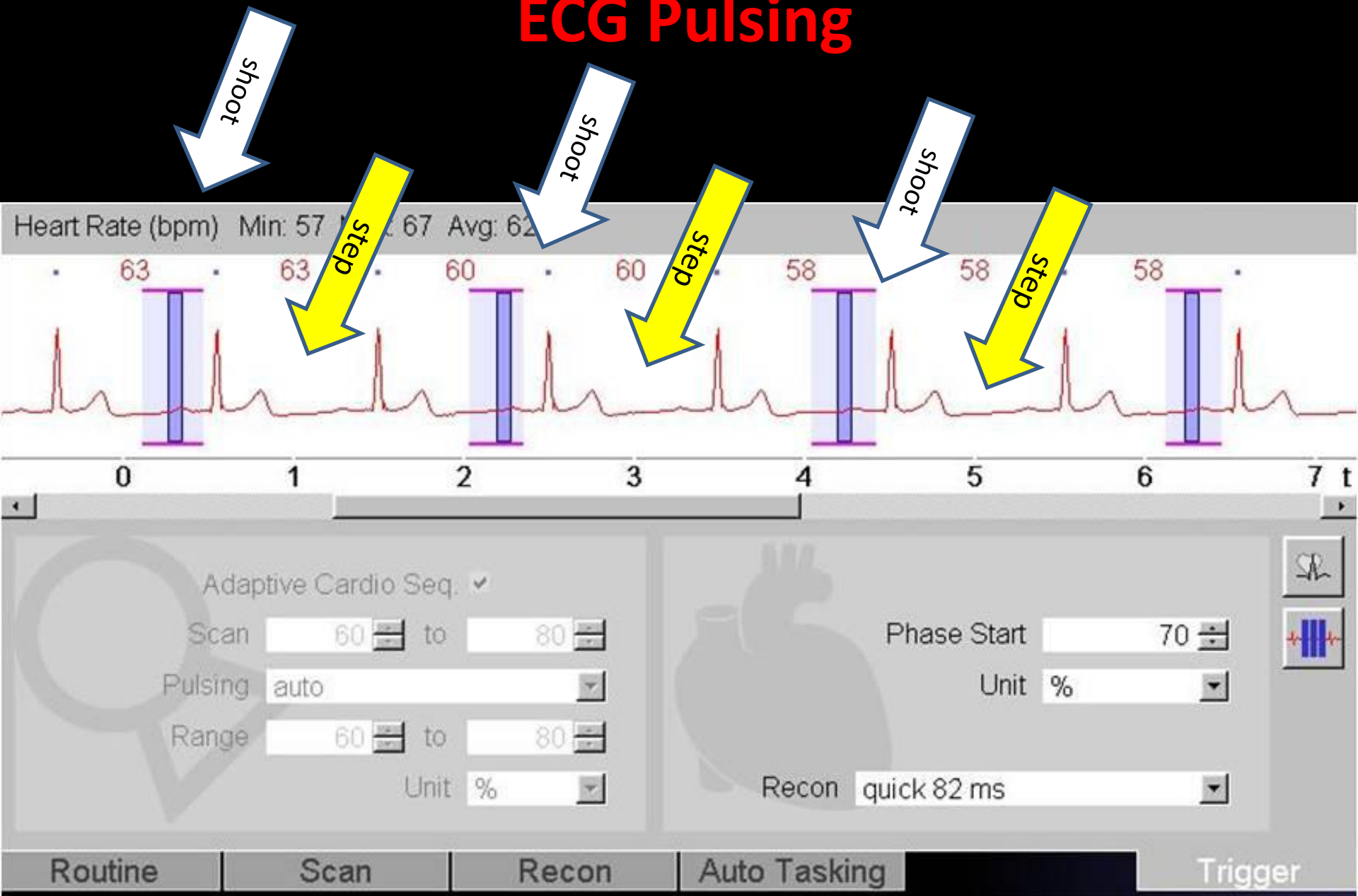
## FLASH Scan

- Siemens DSCT, 1 diastolic RR ~ 400msec
- ultralow dose <1mSv

# CCTA Technique

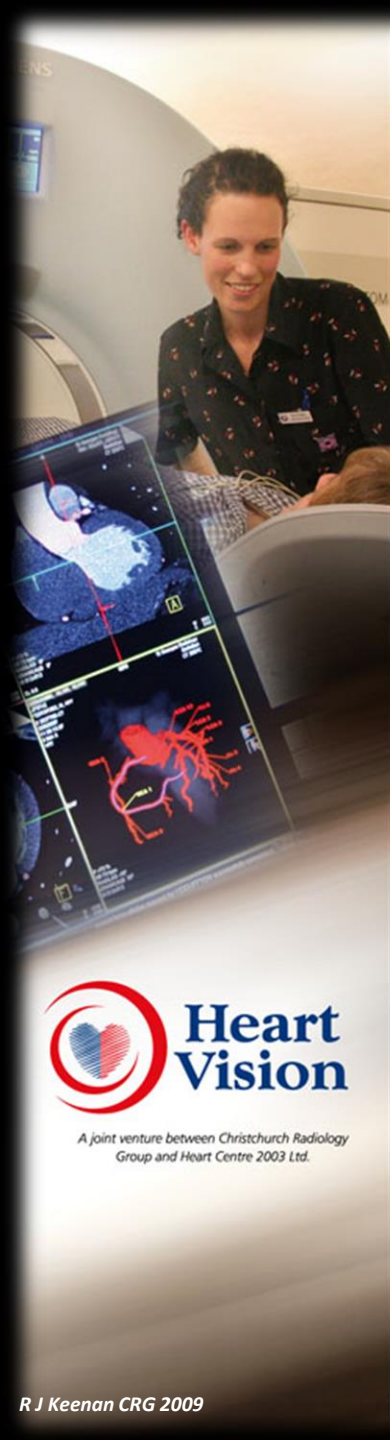
- sinus rhythm, heart rate control critical
- +/-  $\beta$  blocker (**Metoprolol**) 100-150 mg po routinely pre scan
- **CACS** scan during acquisition range planning
- sublingual **GTN** spray 2-3 minutes pre scan
- iv right antecubital , Iopamiro 360 @ 60ml 6ml/sec + saline flush

# ECG Pulsing





"And this report just in. ... Apparently, the grass is greener on the other side."



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## CCTA - Reporting Triage

### Stenosis Grade:

- normal
- minimal  $< 25\%$
- mild 25 - 49%

borderline  $\sim 50\%$

- moderate 50 - 69%
- severe  $\geq 70\%$
- occlusion  $\sim 100\%$



“significant” stenosis  $> 50\%$



“severe” stenosis  $> 70\%$

# CCTA - Indications 1

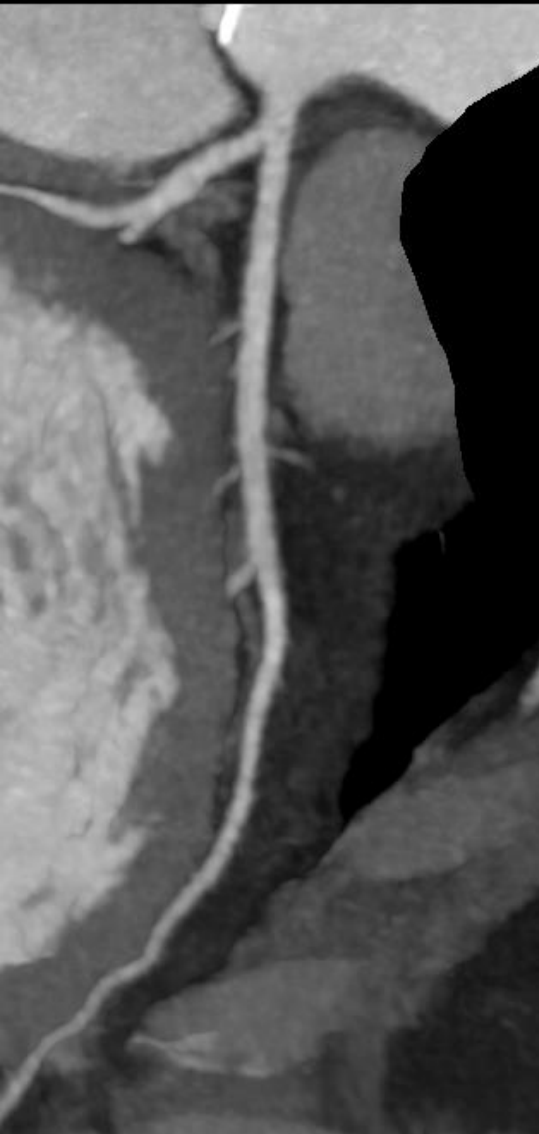
## Major

- Chest **pain** – low/intermediate pretest probability CAD
- Chest **pain** - uninterpretable or equivocal ETT/imaging
- Evaluation **acute CP** (ED) – intermediate risk CAD/normal ECG-enzymes
- Pre-op **exclusion CAD** prior to valve-aneurysm surgery
- Suspected coronary **anomalies**
- **CHF or DCM** on echo - new onset for exclusion CAD

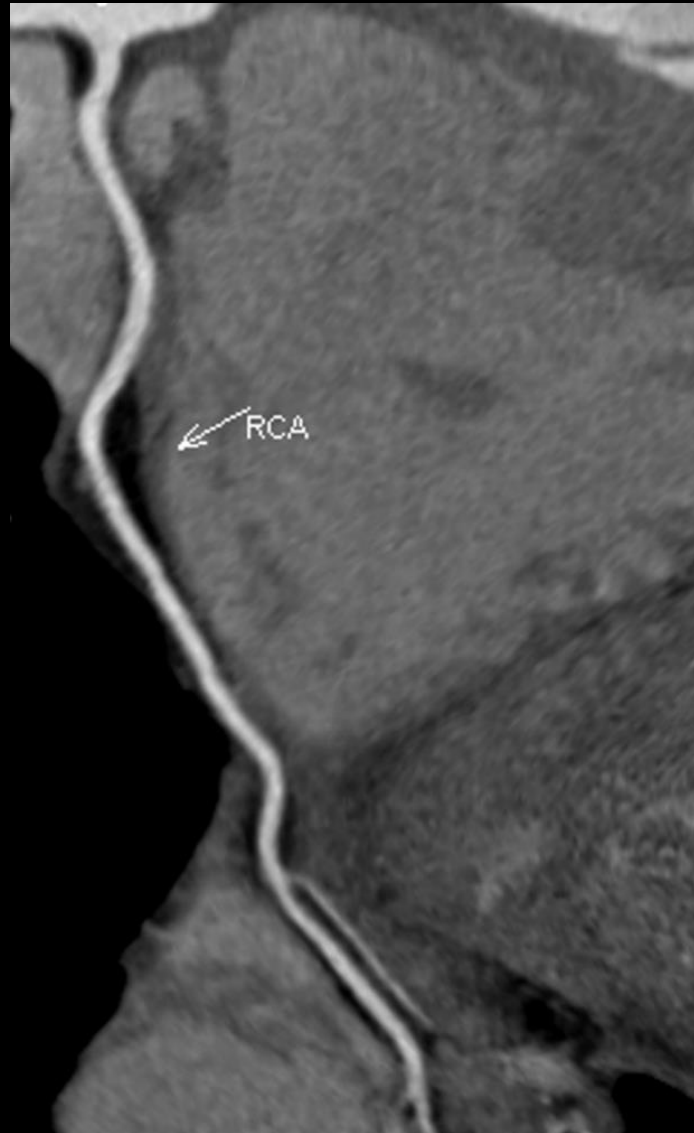
**Reference:** CSANZ November 2010

# CCTA

LAD



RCA



Circ



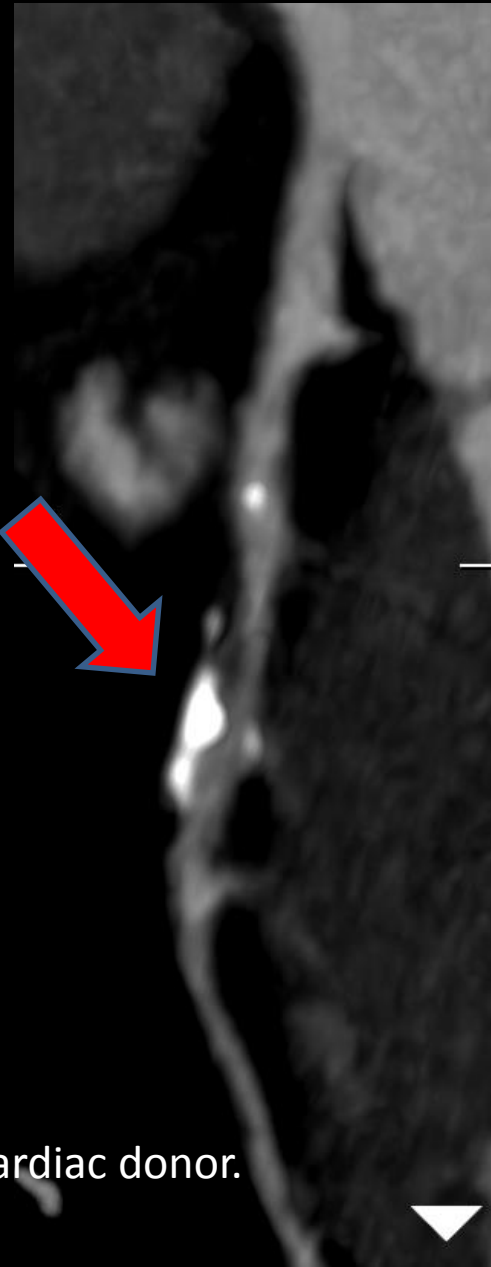
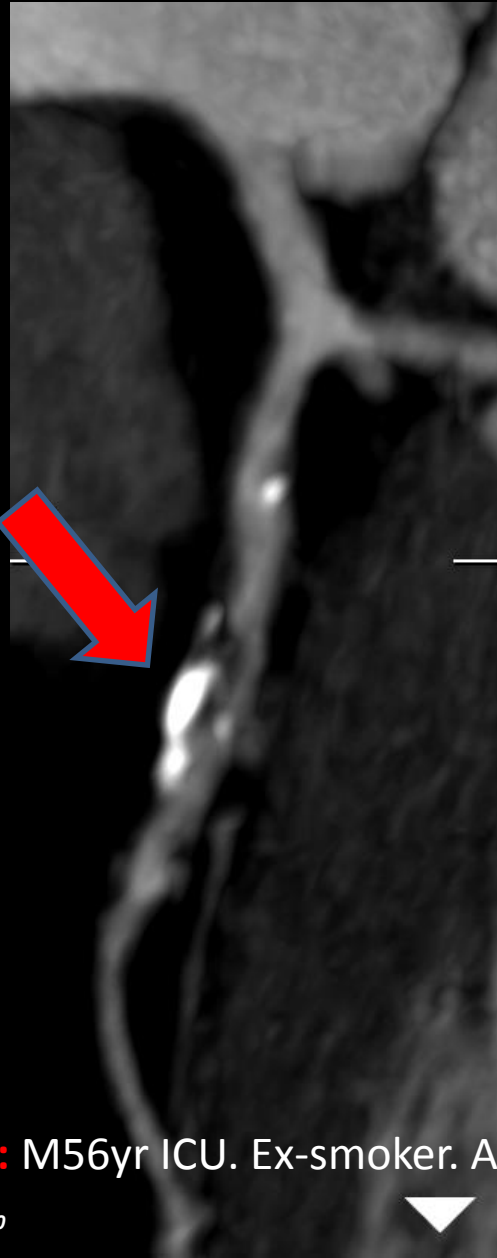
M55yr. Atypical CP. Severe Framingham risk factors. PETT.

# CCTA



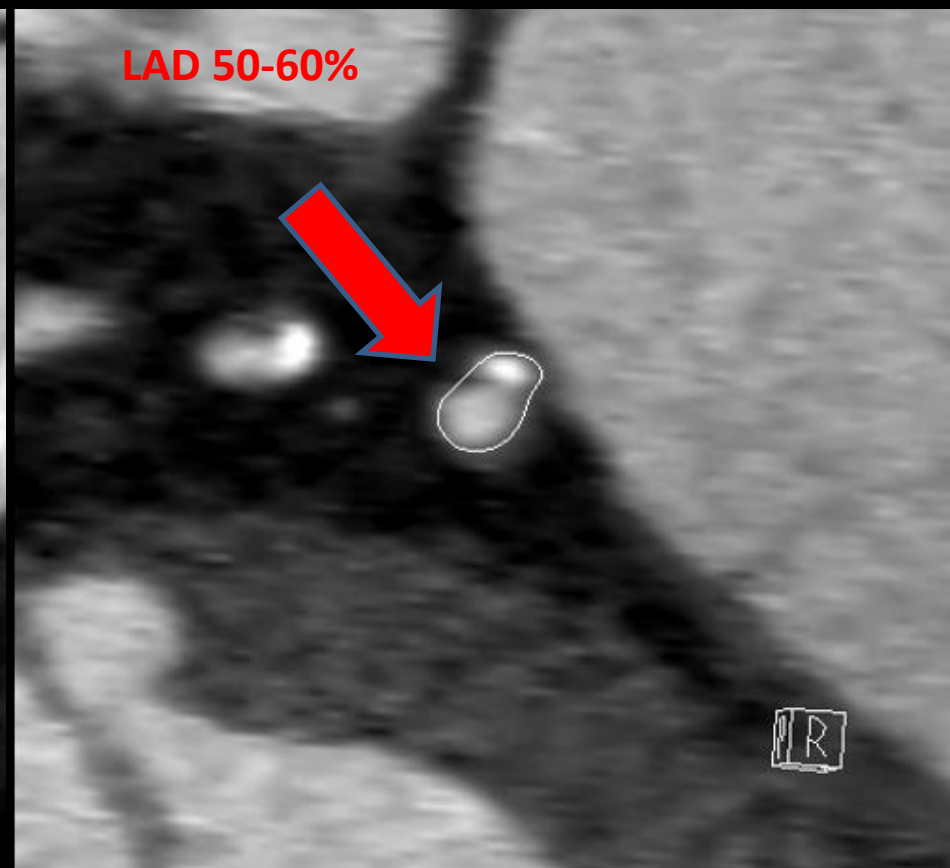
M36yr Atypical CP. No Framingham risk factors. NETT.

# CCTA



**FPH6911:** M56yr ICU. Ex-smoker. Assess suitability as cardiac donor.

# CCTA

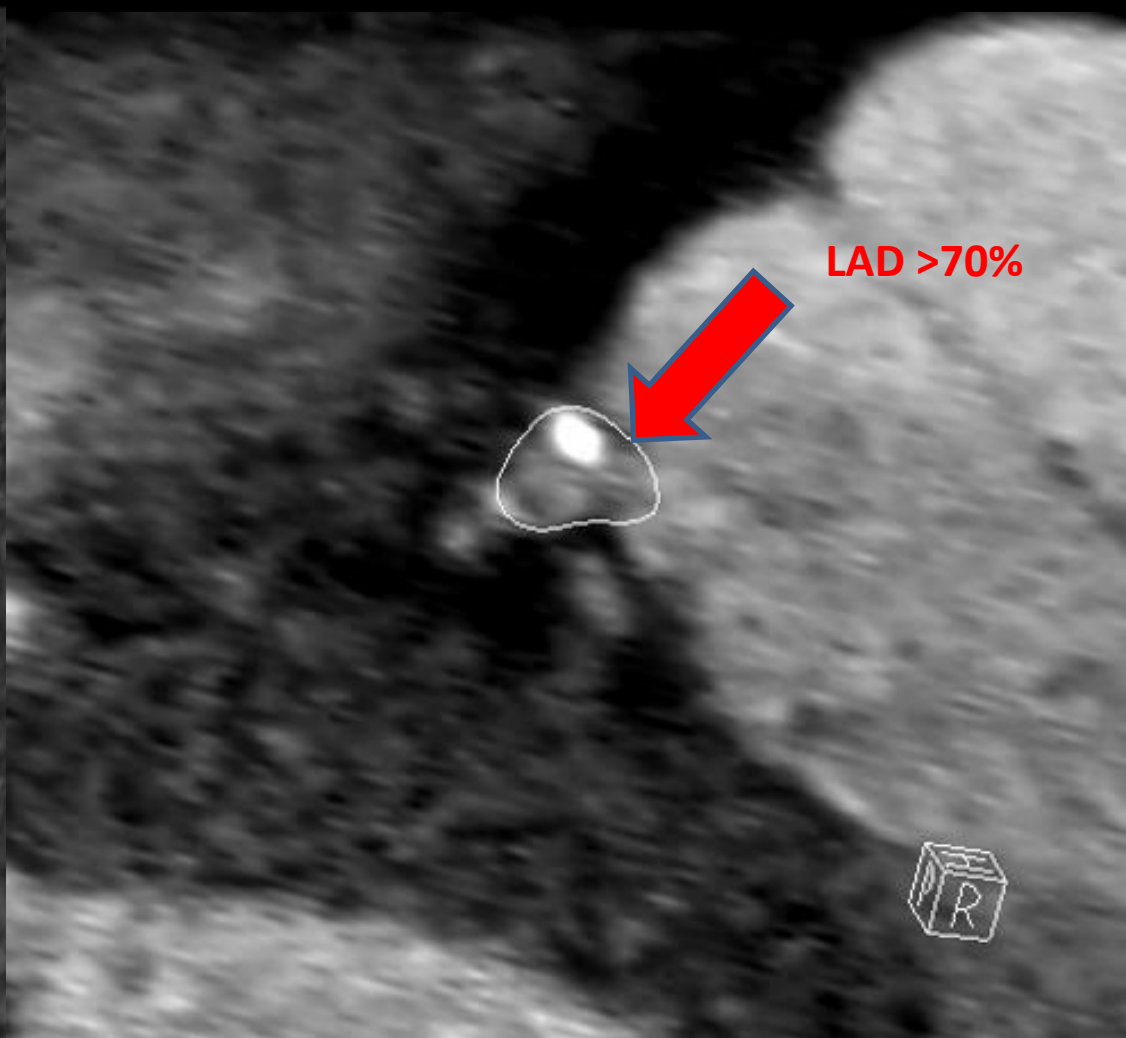
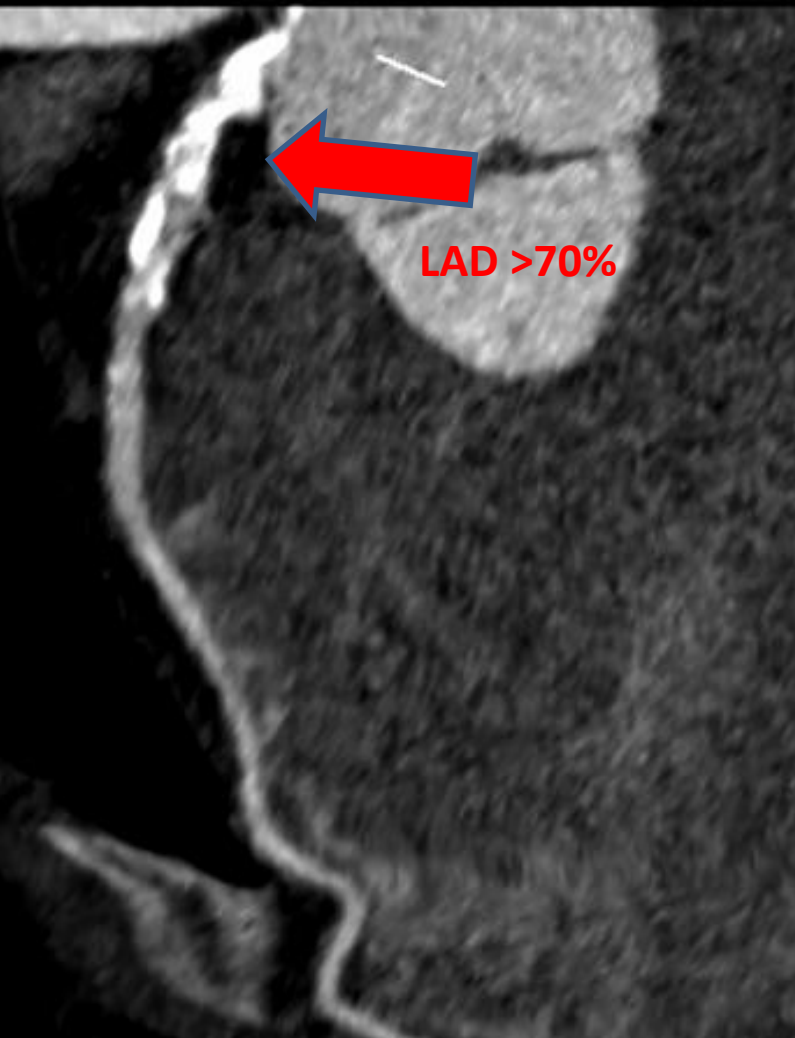


**DNC3450:** M68yr CP. BETT. LBBB



MR stress test -ve Rx medical

# CCTA

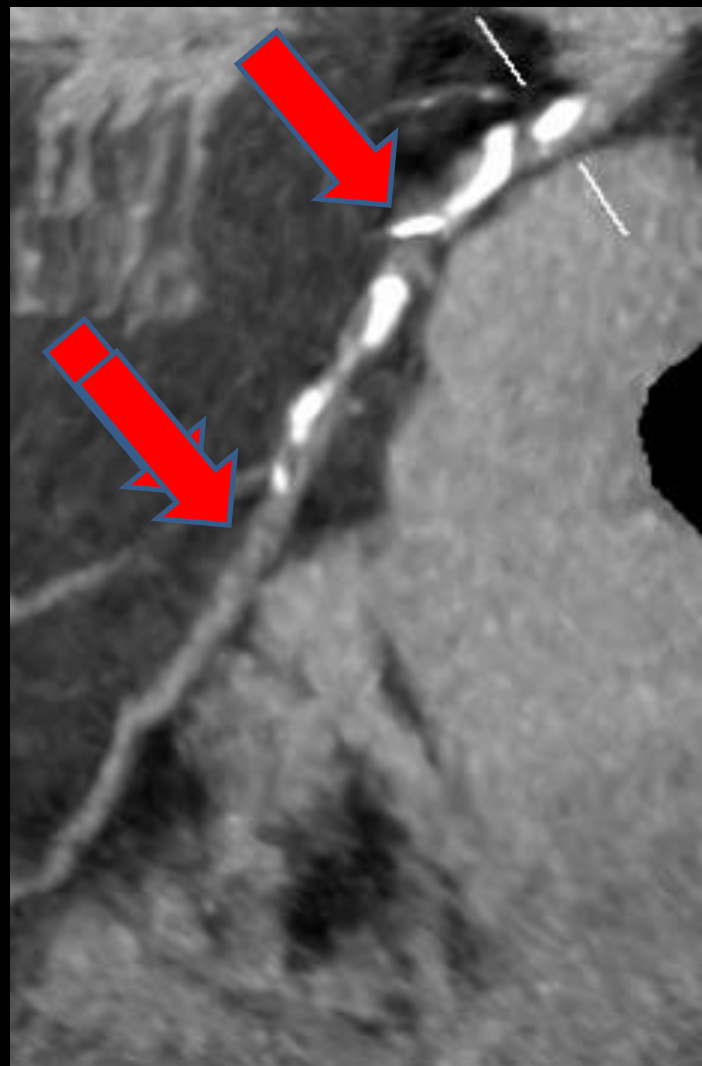
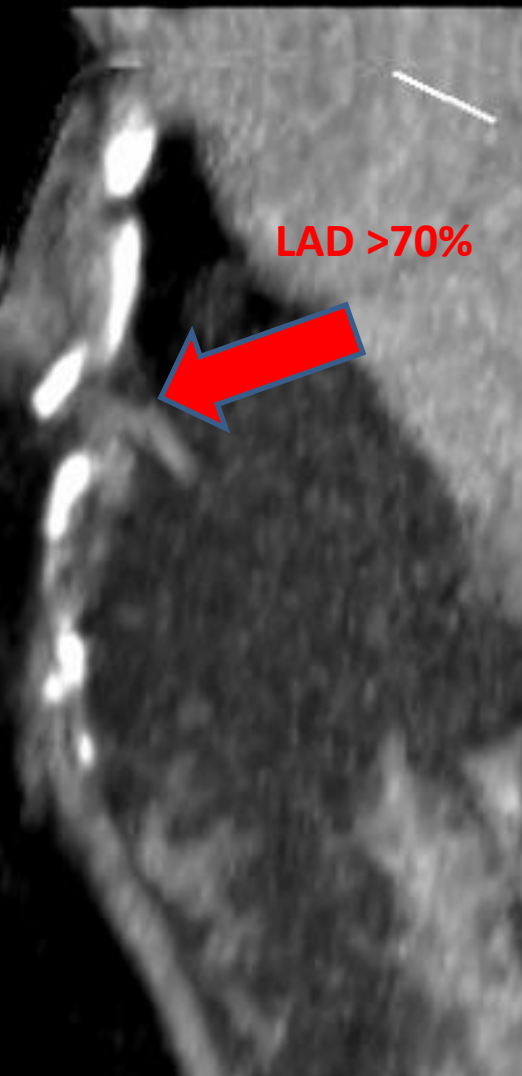


**LPG8917:** M74yr Previous MVR. CT. BETT



catheter + PCI

# CCTA



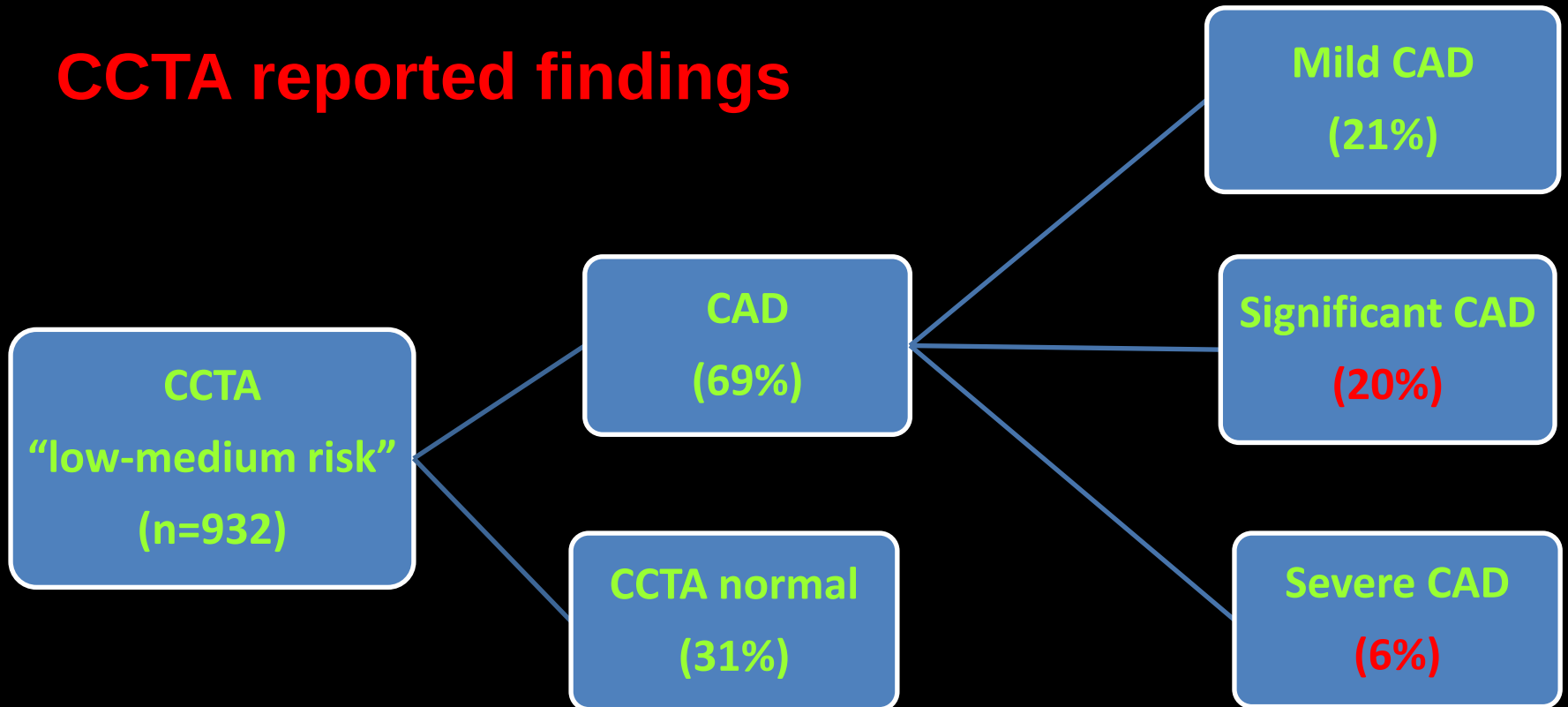
**AYD4723:** M62yr CT. BETT. AF. FHx IHD



catheter

# HV Audit (2) 2008 - 2011

## CCTA reported findings

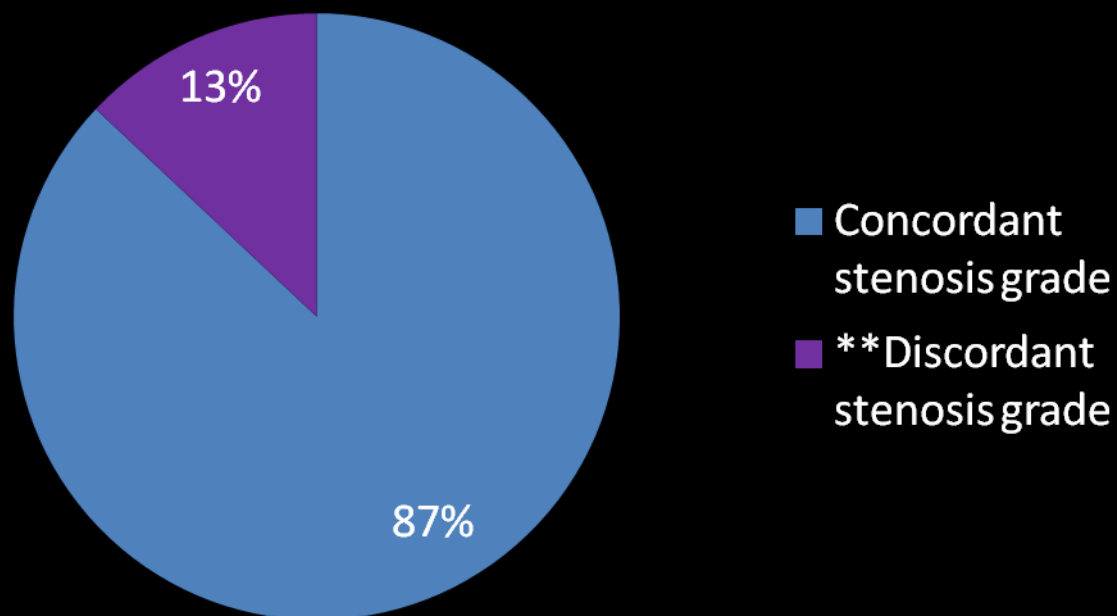


### Reference:

CCTA report analysis, HV Audit 2, Paula England  
June 2008 – August 2011 (n = 1002)

## CCTA v Catheter Concordance - Audit (2)

Patient analysis – CCTA v catheter



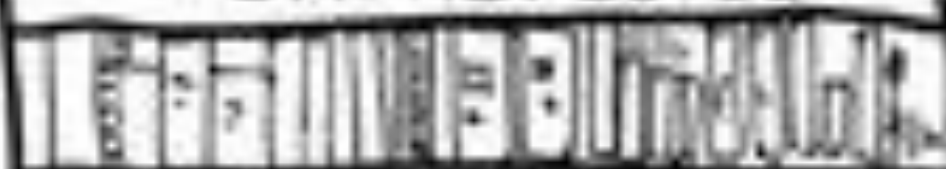
**\*\*discordant stenosis grade  $\neq$  missed lesion**



**Heart Vision**

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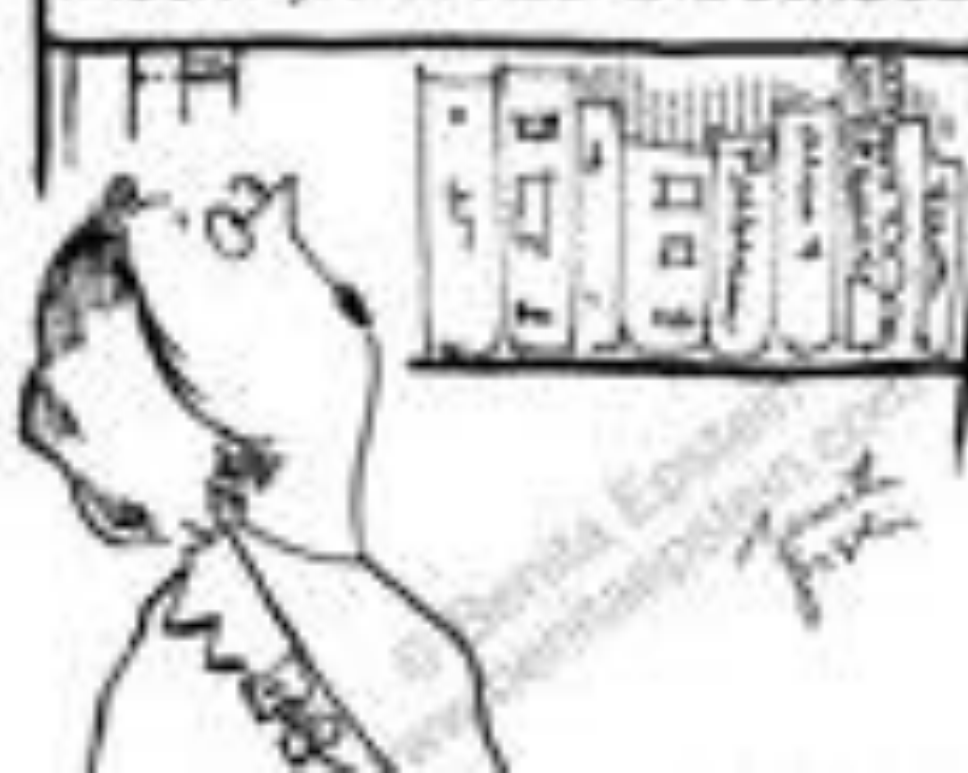
## ORTHOPEDICS



## PEDIATRICS



STUFF THEY NEVER  
TAUGHT YOU IN MEDICAL SCHOOL



# “Negative” CCTA - Prognosis

- “negative CCTA” = absent or “non-significant” CAD
- long term data accumulating - follow-up > 5 years available
- consistent results
- negative CCTA **NPV 96-100%** (< 5yrs)
- negative CCTA **confidently rules out** significant CAD
- negative “non-obstructive” CCTA **predicts very low rate** of major CVD events over the longer term (5yrs)



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# Case Examples

- **Case 1:** SR, 49yr white male

Normal CACS & CTCA

- **Case 2:** KN, 63yr white male

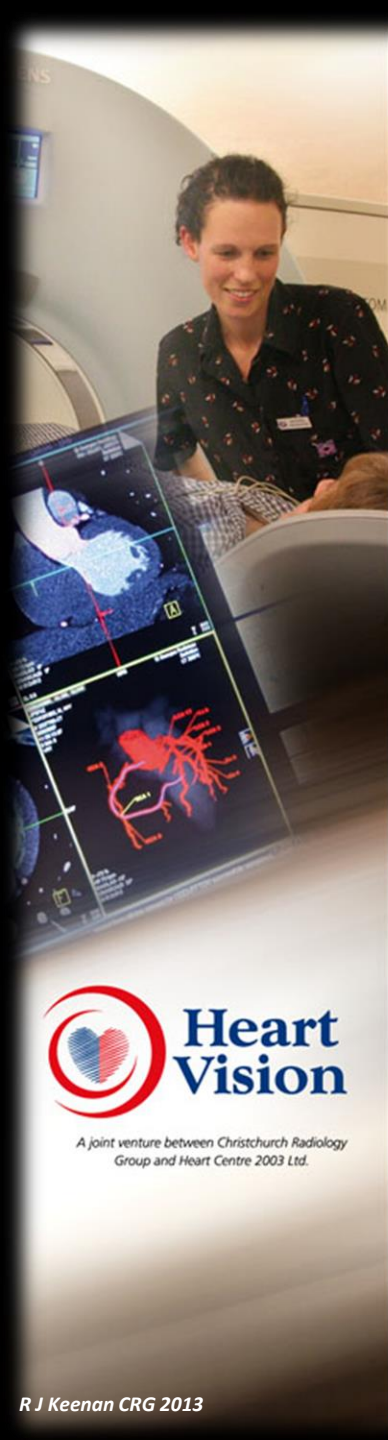
CACS 98<sup>th</sup> centile, CTCA severe plaque

- **Case 3:** DD, M53yr white male

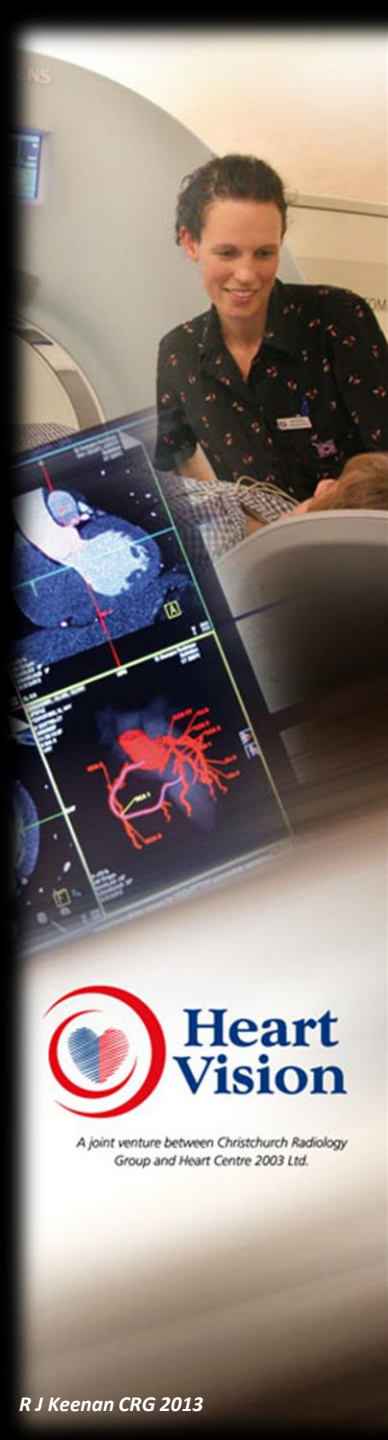
CACS 96<sup>th</sup> centile, CTCA moderate-severe obstructive disease

- **Case 4:** ES, F54yr white female

Normal CACS & CTCA



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# Case 1

## SR



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# \*SR\*Intermediate Risk and SOB (known asthma)

- Male 49
- PHx Sarcoidosis, Mild Asthma
- TC 6, HDL 1, LDL 4
- FHx IHD Father MI 60, Uncle Stents 55

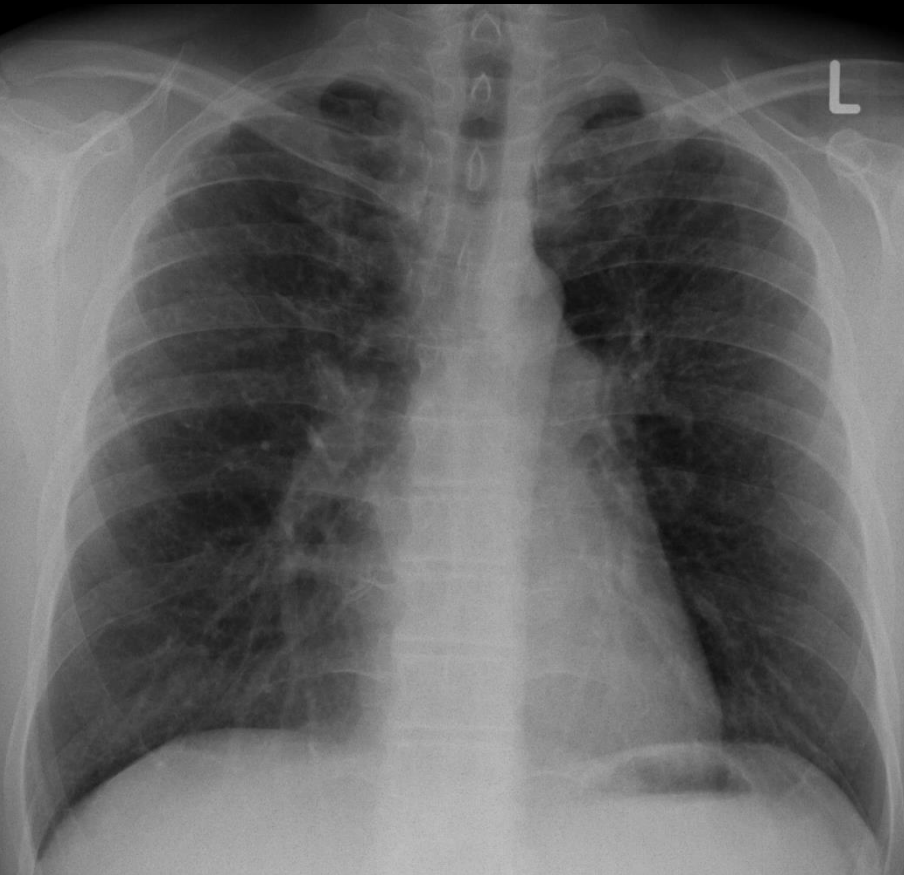
# Intermediate Risk and SOB

- Male 49
- Ex ECG
  - Limited by dyspnoea
  - Moderately reduced Ex capacity
  - Borderline ST changes

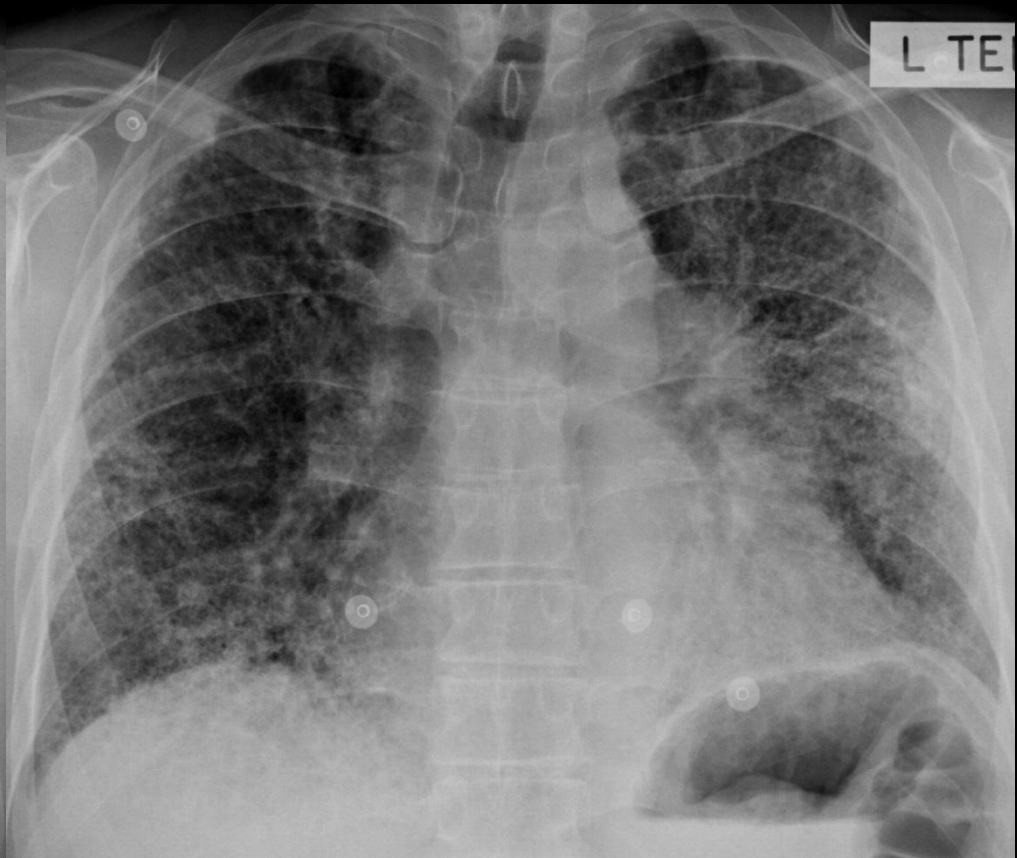
# Intermediate Risk and SOB

- Male 49
- What to do?

# Case 1



**CXR 2006**



**CXR 2011**

# Case 1



CT 2011

# Case 1



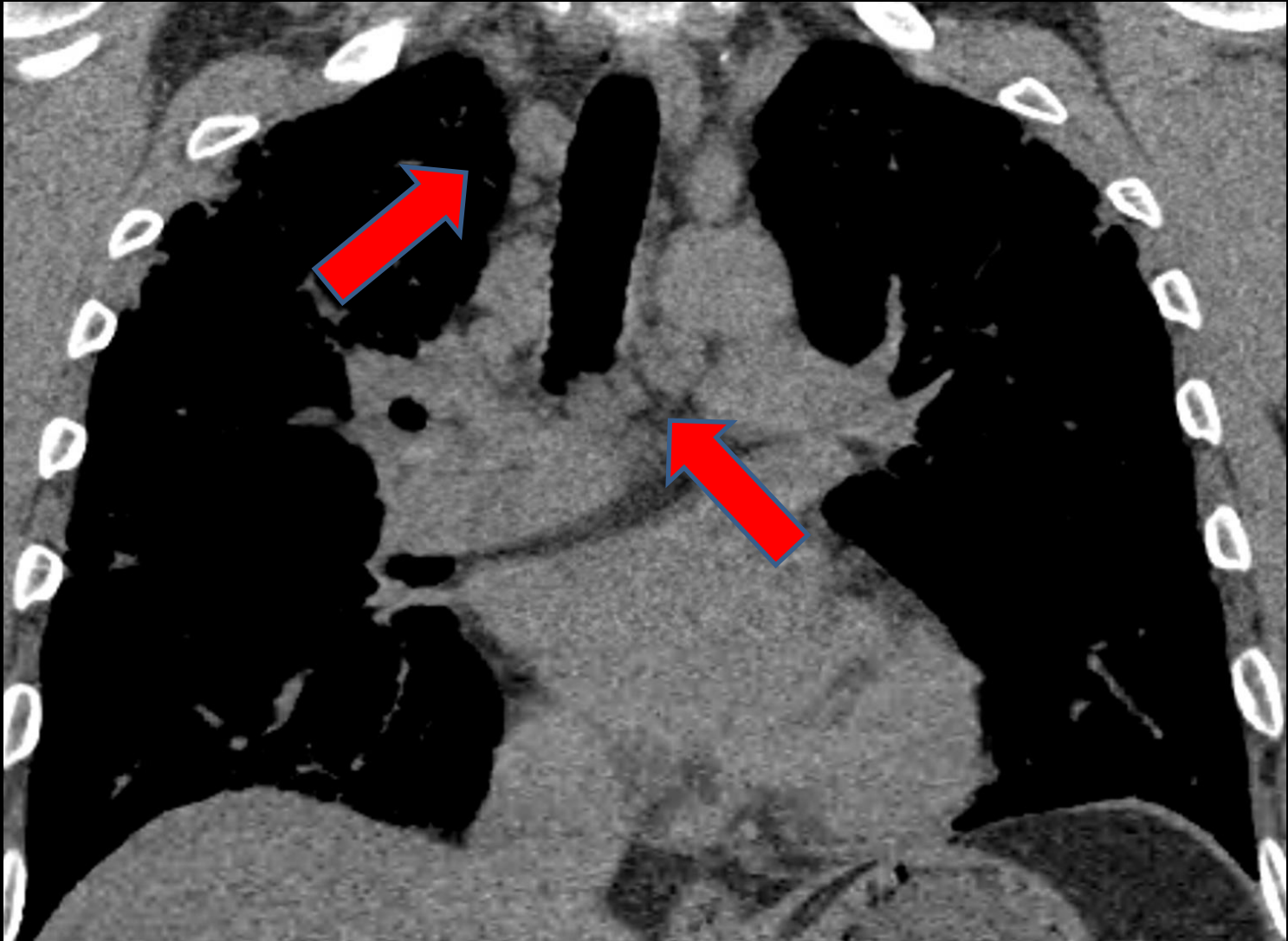
CT 2011

# Case 1



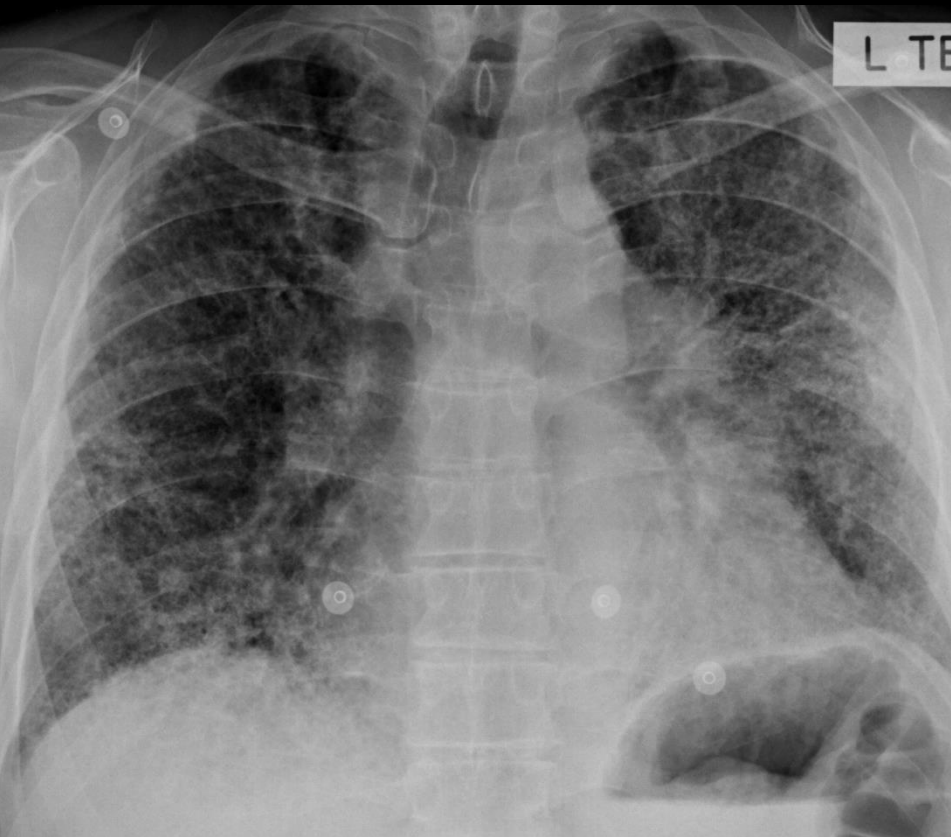
CT 2011

# Case 1

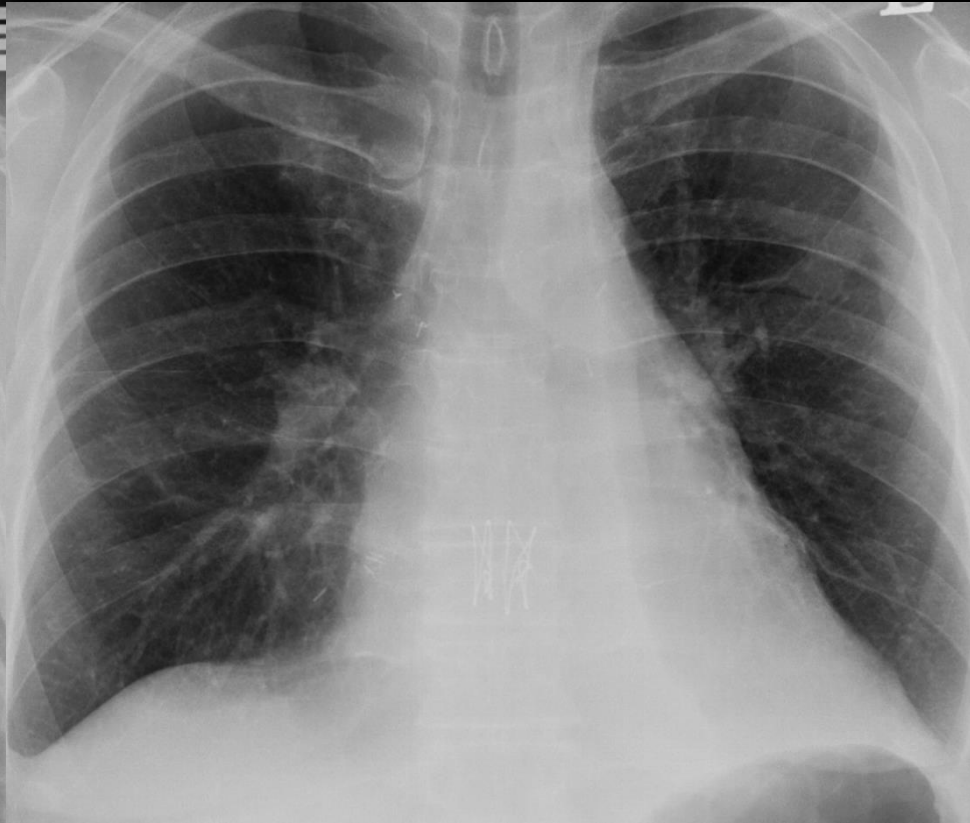


CT 2011

# Case 1



**CXR 2011 preop**



**CXR 2011 post lung transplant**

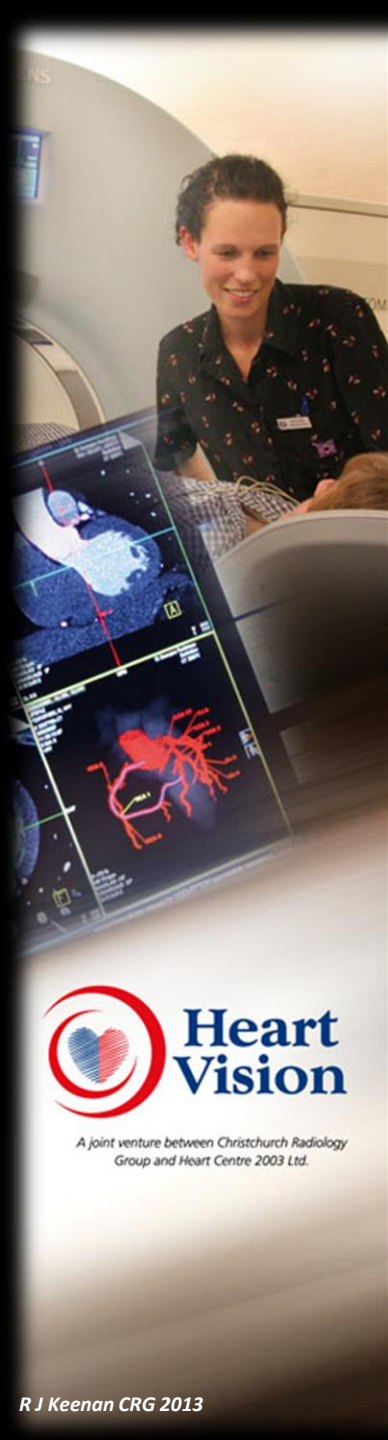
# Case 1

- SR, M48yr, FCY8681
- Phx sarcoidosis, mild asthma
- TC 6, HDL 1, LDL 4
- Fhx paternal MI age 60yr, uncle stented 55yr
- Ex ECG SOB limited, moderately ↓ exercise capacity
- serial CXR parenchymal deterioration 2006 - 2011
- CT chest
  - chronic DILD, reticulonodular, GGO, nodules
  - honeycombing, bronchiectasis, mediastinal L/N↑

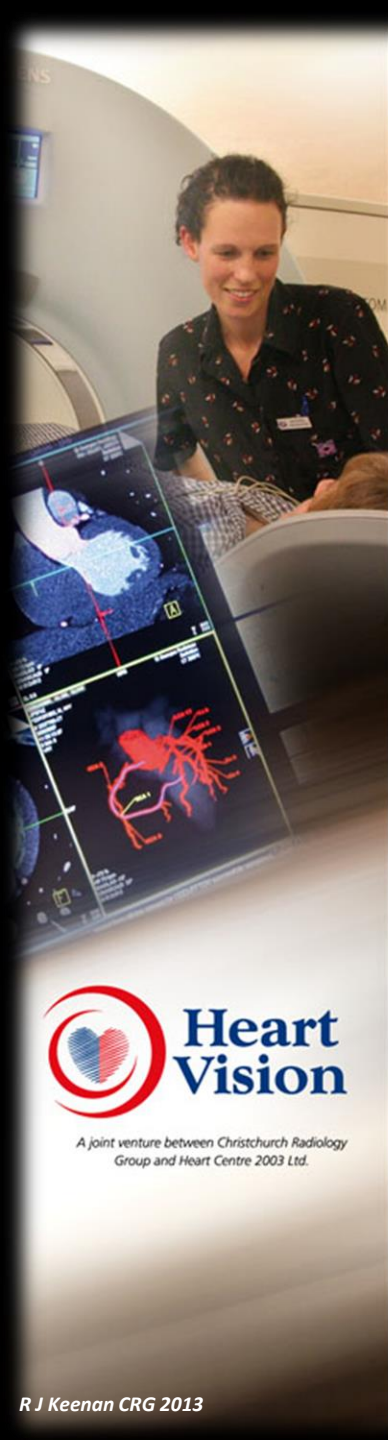
Δ. Transbronchial biopsy = sarcoidosis.

Δ. Open lung bx = UIP

Rx → lung transplantation



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# Case 2

## KN



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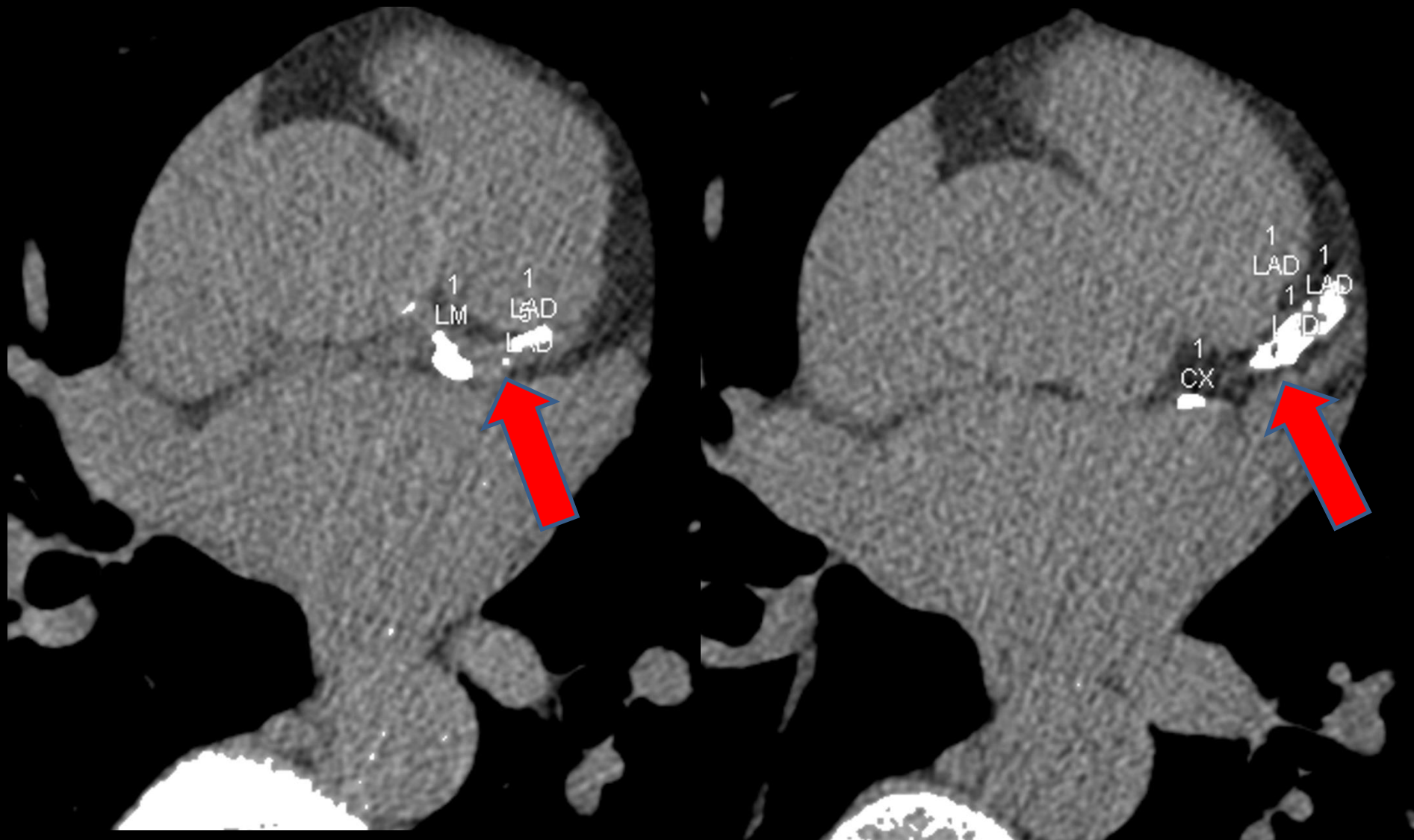
## \*KN\*Strong FHx severe IHD

- Male 63
- Lean, non smoker, regular walker
- HDL 1.53 LDL 3.6
- Normal Exercise ECG, Ex capacity 40%> predicted

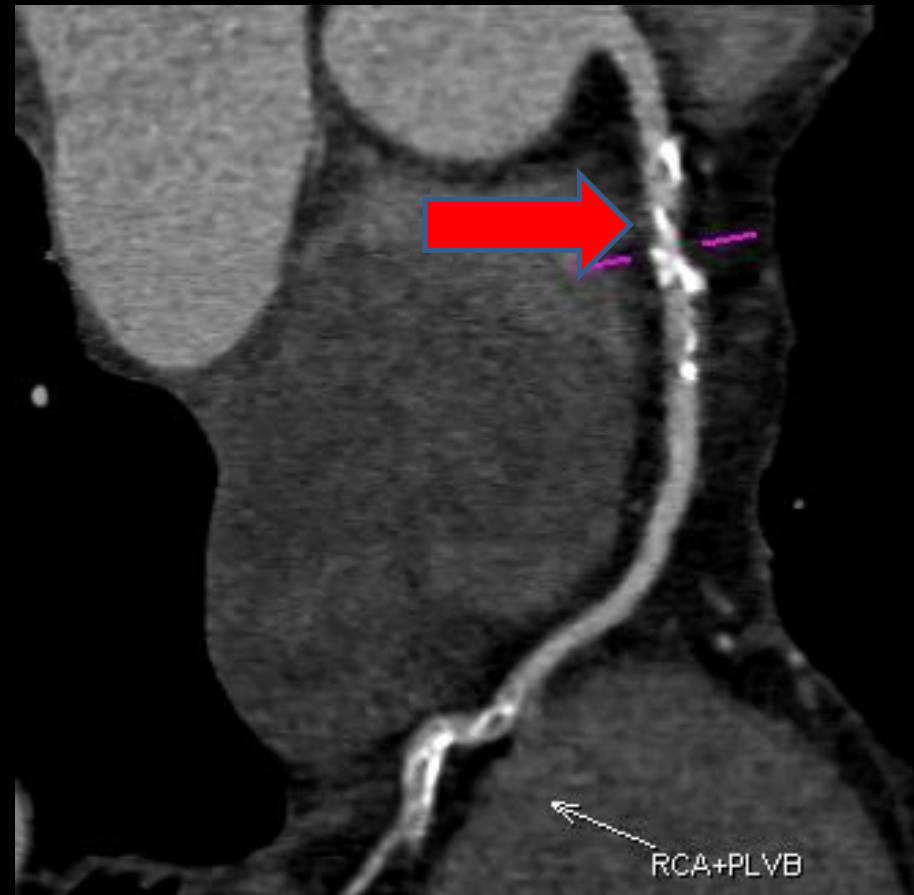
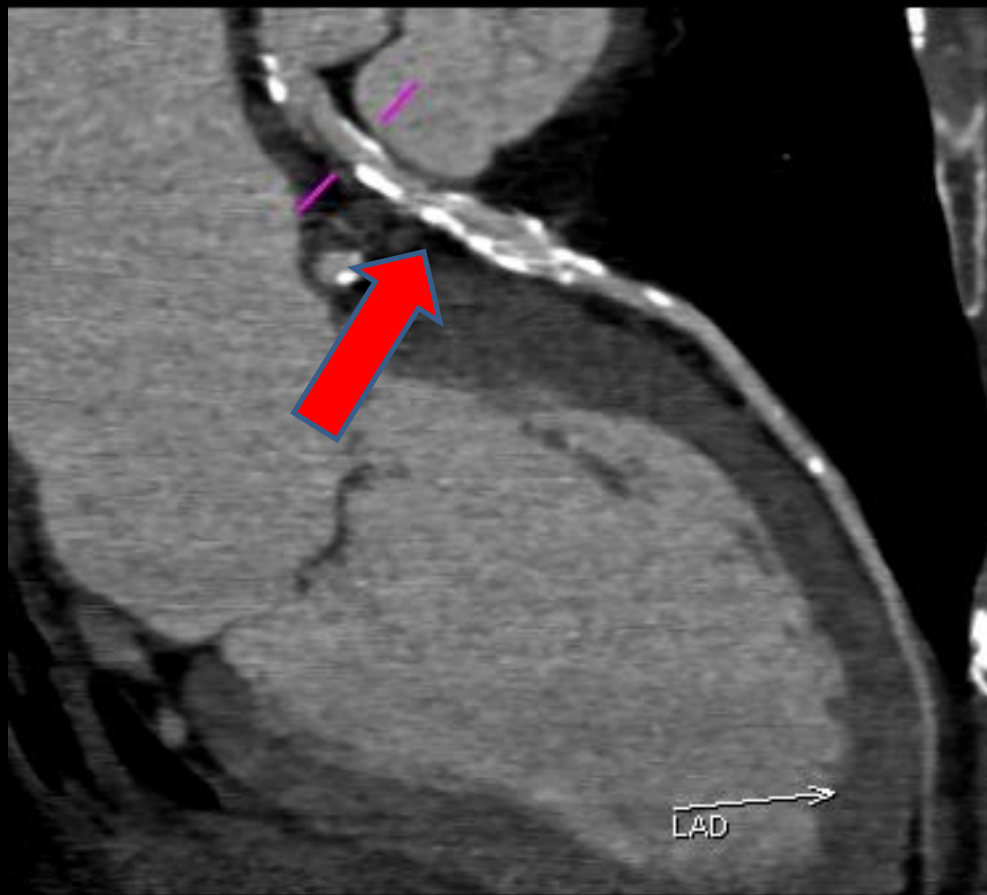
## \*KN\*Strong FHx severe IHD

- Male 63
- NHF risk 5 – 7.5%/5yr
- What does Ct Calcium score add

# Case 2



## Case 2



# Case 2



The Multi-Ethnic Study of Atherosclerosis

[Back to MESA CAC](#)

Input your age, select your gender and race/ethnicity, input (optionally) your observed calcium score and click "Calculate".

Age (45-84): 63

Gender: male

Race/Ethnicity: white

Observed Agatston Calcium Score (optional): 2247.7

[Calculate](#)

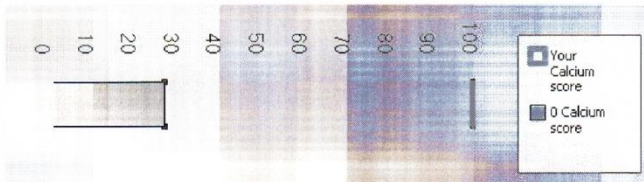
The estimated probability of a non-zero calcium score for a white male of age 63 is 74 %.

Percentiles and Calcium Scores for: white male of age 63

| 25th | 50th | 75th | 90th |
|------|------|------|------|
| 0    | 51   | 235  | 641  |

The observed calcium score of 2247.7 is at percentile 98 for subjects of the same age, gender, and race/ethnicity who are free of clinical cardiovascular disease and treated diabetes.

Chart 1: Percentiles



Heart Vision

@ St George's Radiology

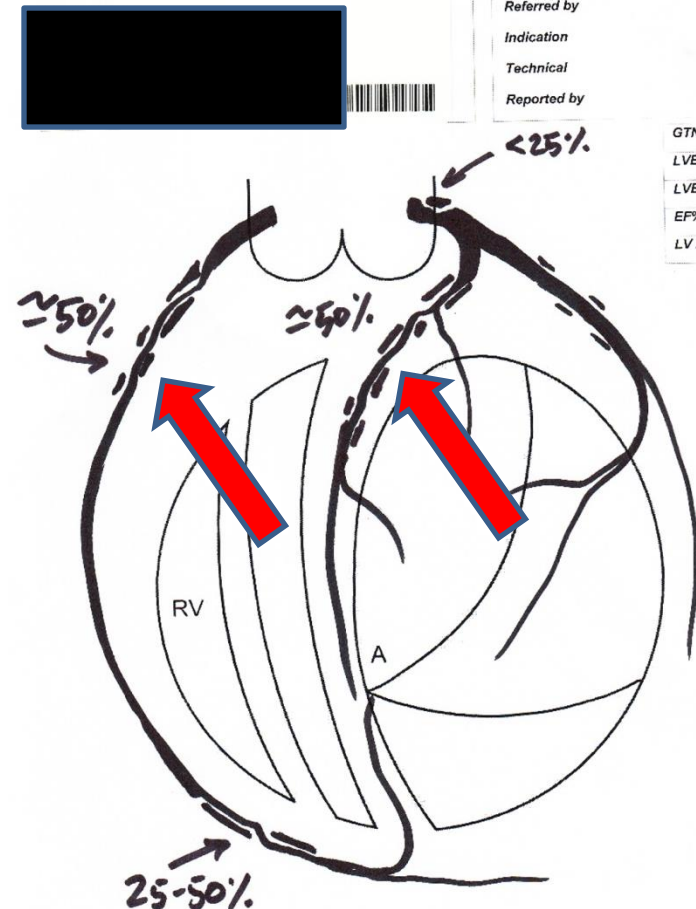
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## CT CORONARY ANGIOGRAM WORKSHEET

Please refer to the accompanying text report for full details of chest and cardiac findings.

Referred by  
Indication  
Technical  
Reported by

GTN  
LVEDV  
LVESV  
EF%  
LV Mass



## \*KN\*Strong FHx severe IHD

- Male 63
- NHF risk 5 – 7.5%/5yr
- Ct Calcium score >300
  - 30% 5yr risk !!
  - Risk is the same as previous IHD/2 prevention

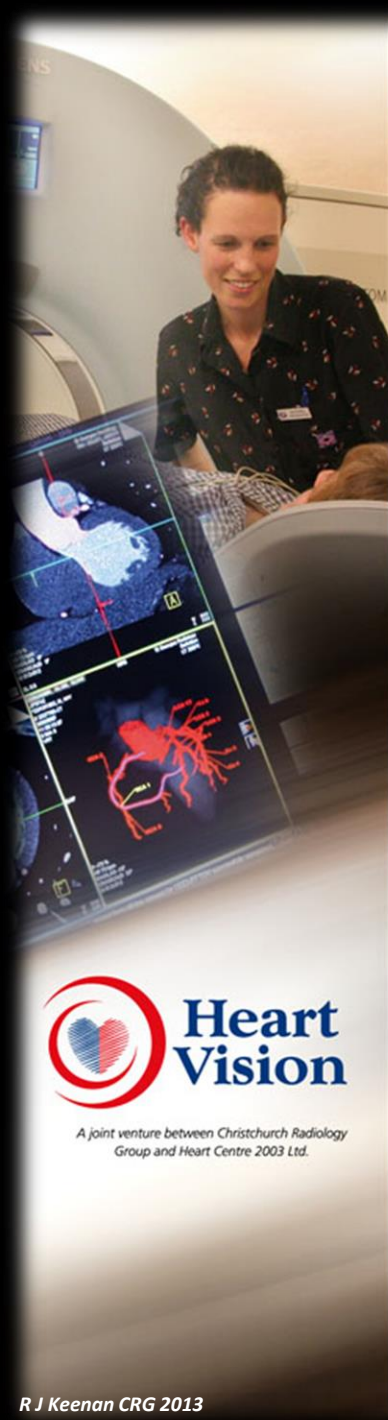
# \*KN\*Strong FHx severe IHD

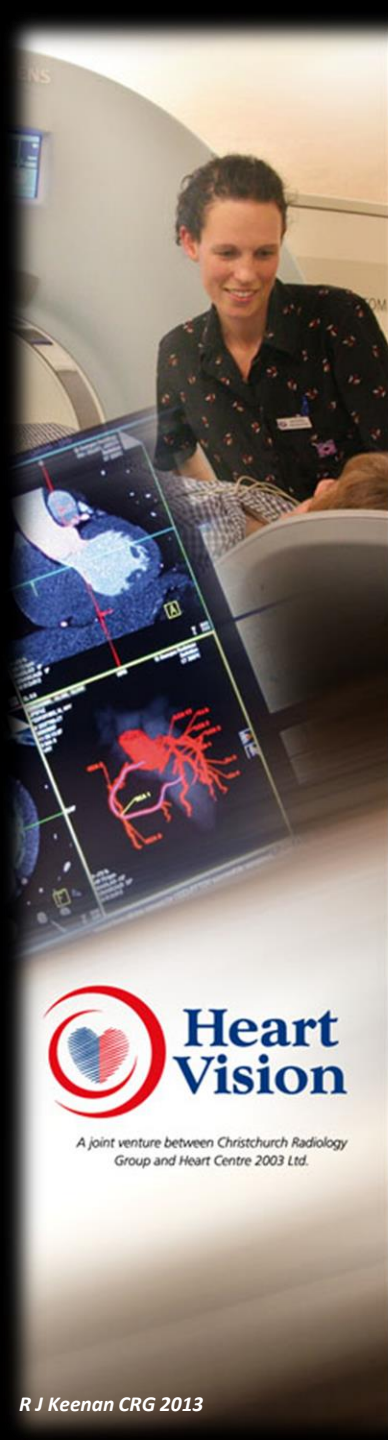
- Practice point

- If coronary calcification for on CT chest, or vascular calcification demonstrated during imaging for other causes (eg posterior tibial artery in ankle xray) patient may be at high coronary risk (>30%/5yr) and should be screened

## Case 2

- KN, M63yr white male
- Lean, non-smoker, regular walker
- HDL 1.53, LDL 3.6
- Ex ECG normal. Exercise capacity 40% > predicted
- NHF risk – 7.5%/5yr
- CACS = 2247 Agatston units (98<sup>th</sup> centile)
- CTCA – extensive plaque, mild-moderate multivessel obstructive disease max 50%





# Case 3

## DD



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# \*DD\* Treated LDL, knee pain and SOB

- Male 53
- Treated hyperlipidaemia 15 yrs. LDL on Rx 2.6
- Strong FHx IHD. Father died 76.
  - 3xCABG, 32(!!) Angiogram/plasties
  - 4 uncles CABG

# \*DD\* Treated LDL, knee pain and SOB

- Male 53
- Recent exertional dyspnoea (mild) – 3/12
- Regular gym based exercise. Jogging until knee injury 6/12 ago. Unable to run on treadmill @ gym.

# \*DD\* Treated LDL, knee pain and SOB

- Male 53
- What to do?

# Case 3



# Case 3

**MESA** The Multi-Ethnic Study of Atherosclerosis

[Back to MESA CAC](#)

Input your age, select your gender and race/ethnicity, input (optionally) your observed calcium score and click "Calculate".

Age (45-84): 53

Gender: male

Race/Ethnicity: white

Observed Agatston Calcium Score (optional): 425.5

**Calculate**

The estimated probability of a non-zero calcium score for a white male of age 53 is 50 %.

Percentiles and Calcium Scores for: white male of age 53

| 25th | 50th | 75th | 90th |
|------|------|------|------|
| 0    | 1    | 46   | 180  |

The observed calcium score of 425.5 is at percentile 96 for subjects of the same age, gender, and race/ethnicity who are free of clinical cardiovascular disease and treated diabetes.

Chart 1: Percentiles

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**CT CORONARY ANGIOGRAM WORKSHEET**

Please refer to the accompanying text report for full details of chest and cardiac findings

Referred by: [Redacted]

Indication: [Redacted]

Technical: [Redacted]

Reported by: [Redacted]

Noncalcified plaque no significant stenosis. LM.

Calcified plaque 30% stenosis.

Mixed plaque 70-90% stenosis. LCA

Calcified plaque 30-50% stenosis. LCA

Calcified plaque proximal LAD ~30% stenosis

Calcified plaque 30-50% stenosis D1 + D2.

LAD calcified plaque ~30% stenosis.

RV

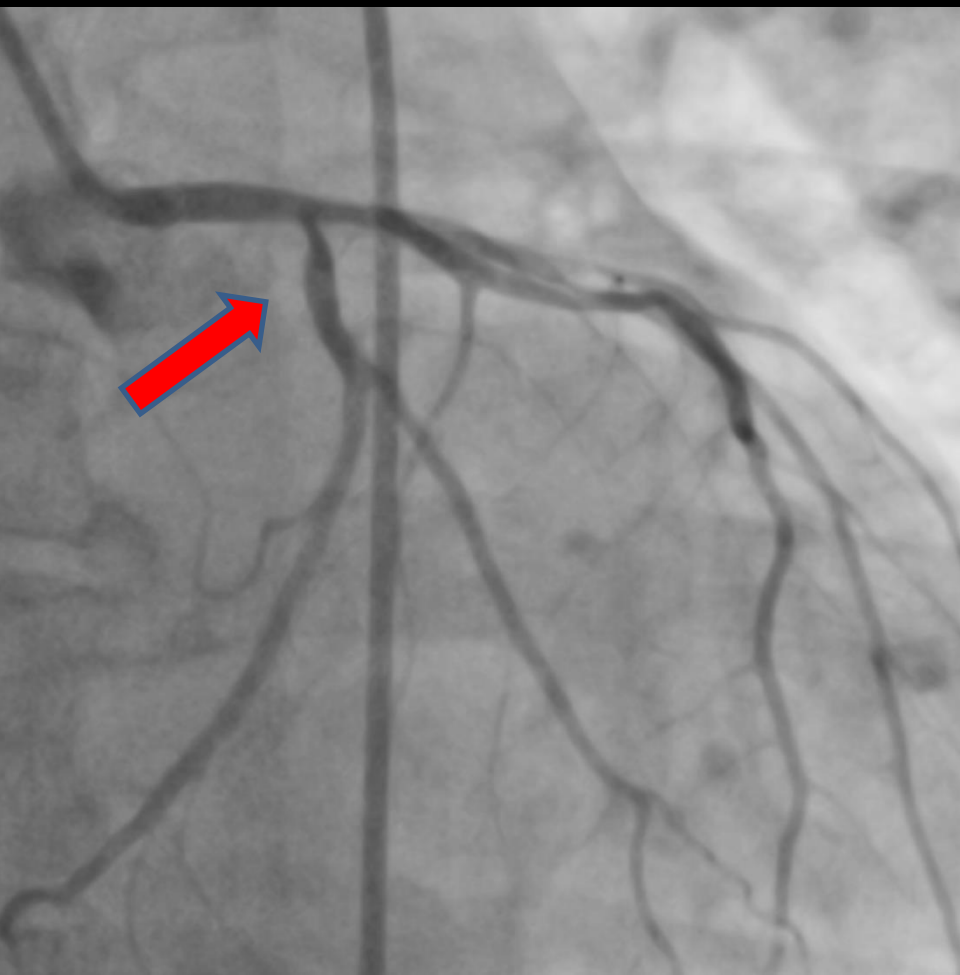
A

LM

LAD

Circumflex

# Case 3

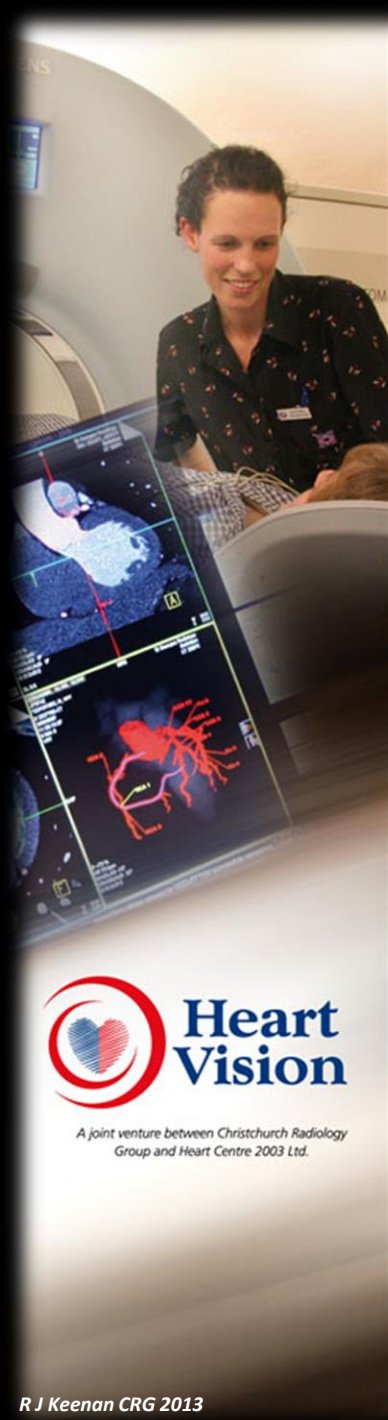


# Case 3

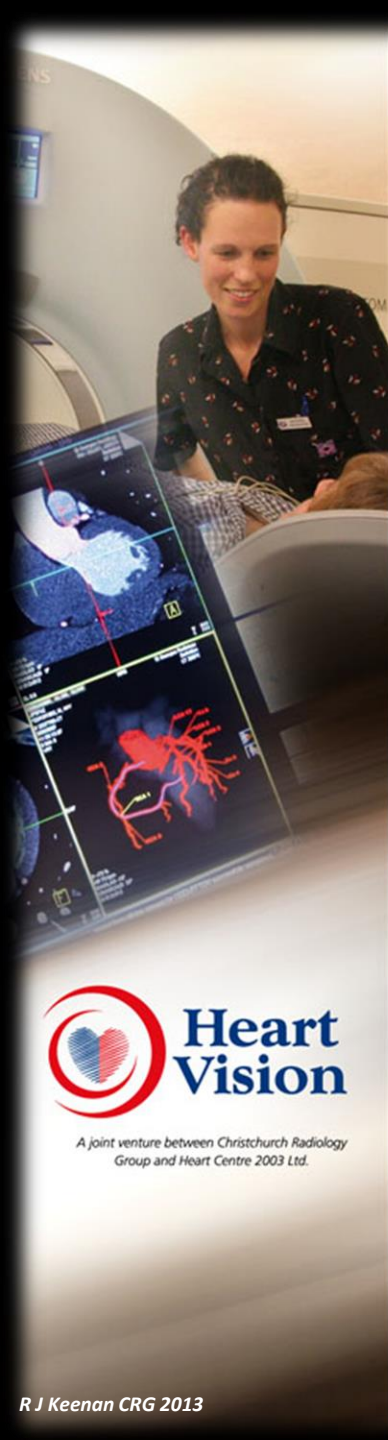


# Case 3

- DD, M53yr white male, DTS7446
- Treated hyperlipidaemia 15yrs. LDL on Rx 2.6
- Strong Fhx. Father +76yrs. x3 CABG 32yrs. x 4 uncle CABGs
- Recent mild exertional SOBOE 3/12
- Regular gym exercise.
- Jogging until knee injury, unable to run or perform ETT
- CACS = 425 Agatston units (96<sup>th</sup> centile)
- CTCA – extensive plaque, severe obstructive disease → catheter



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# Case 4

# ES



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# \*ES\* Treated LDL, knee pain and SOB

- Female 50
- Typical exertional angina 1/12
- Treated hypertension 20 yrs
- HDL 1.6 LDL 4.0g
- FHx IHD Father MI 65

# \*ES\* Treated LDL, knee pain and SOB

- Female 50
- Ex ECG
  - typical angina
  - 1mm inferolateral ST depression
- Stress Echo
  - typical angina
  - no wall motion defect

# \*ES\* Treated LDL, knee pain and SOB

- Female 50
- What to do?

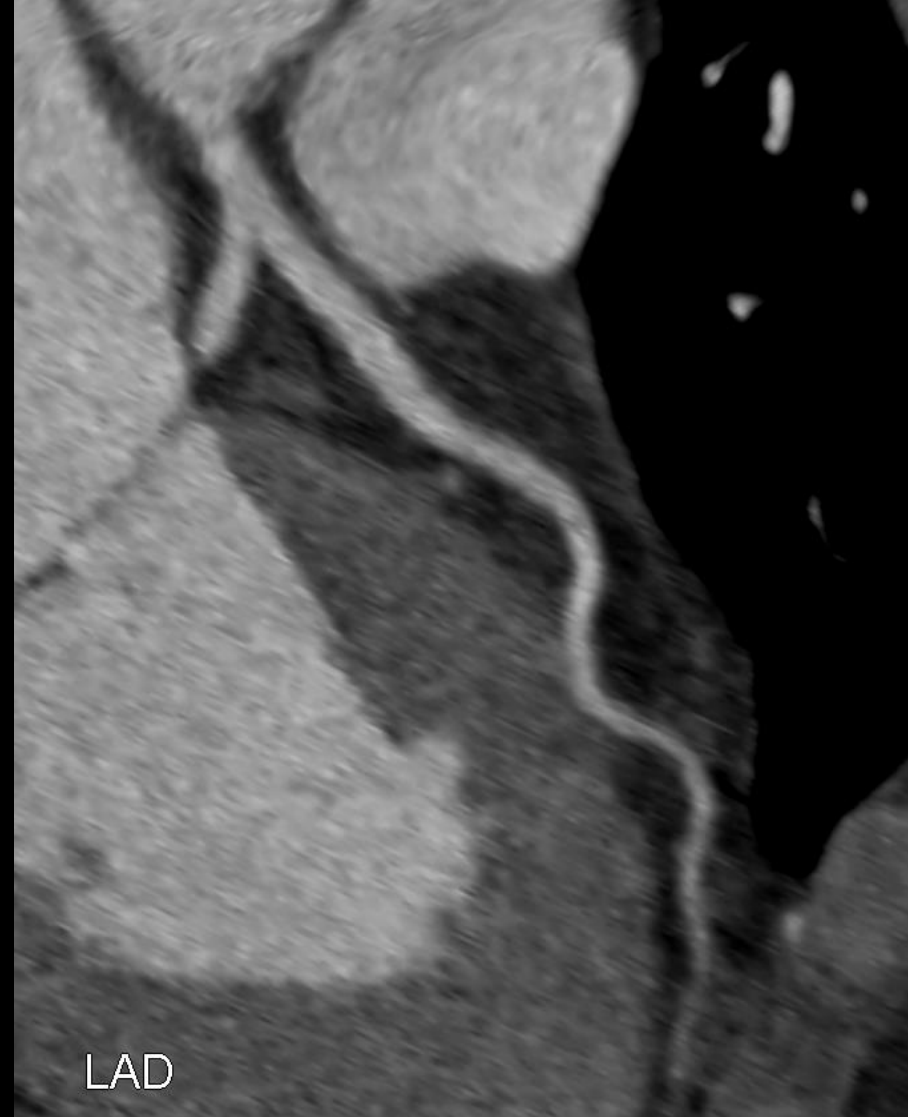
# Case 4

Threshold = 130 HU  
(103.2 mg/cm<sup>3</sup> CaHA)

| Artery | Number of Lesions<br>(1) | Volume<br>[mm <sup>3</sup> ]<br>(3) | Equiv. Mass<br>[mg CaHA]<br>(4) | Calcium<br>Score<br>(2) |
|--------|--------------------------|-------------------------------------|---------------------------------|-------------------------|
| LM     | 0                        | 0.0                                 | 0.00                            | 0.0                     |
| LAD    | 0                        | 0.0                                 | 0.00                            | 0.0                     |
| CX     | 0                        | 0.0                                 | 0.00                            | 0.0                     |
| RCA    | 0                        | 0.0                                 | 0.00                            | 0.0                     |
| Total  | 0                        | 0.0                                 | 0.00                            | 0.0                     |

- (1) Lesion is volume based
- (2) Agatston score
- (3) Isotropic interpolated volume
- (4) Calibration Factor: 0.794

# Case 4

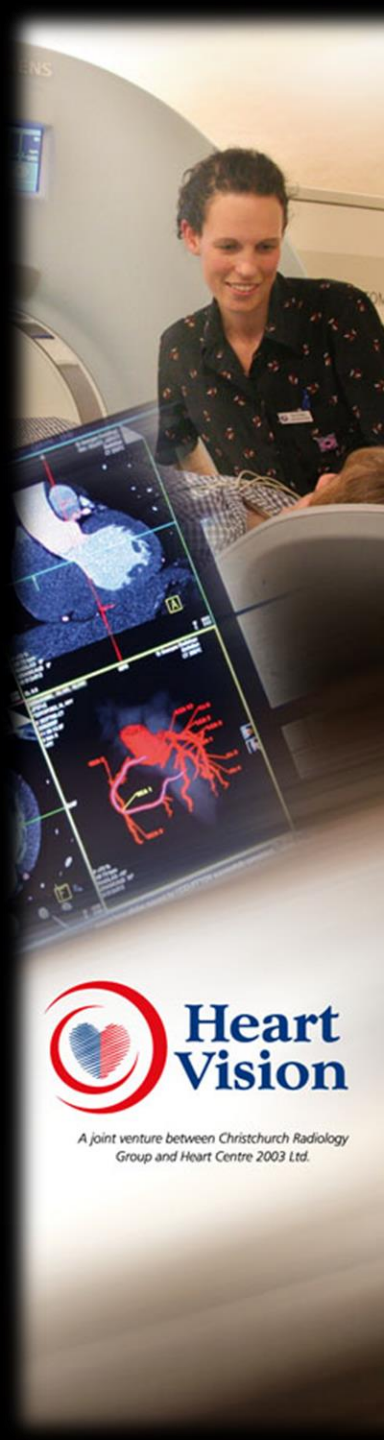


# Case 4

- ES, F54yr white female
- Typical exertional angina 1/12
- Rx hypertension 20yrs.
- HDL 1.6, LDL 4.0
- Ex ECG – angina, 1mm inferolateral ST depression
- Stress echo – typical angina, no RWMA
- CACS = 0 Agatston units
- CTCA – normal



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# Heart Vision

“Non Invasive Cardiac Imaging – A Guide for Dummies”

Drs Clive Low (Cardiology)  
& Ross Keenan (Radiology)



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# Questions

**END**