Cardiac Diagnostic Imaging for the GP

Dr Julie O Brien
Beacon Limerick

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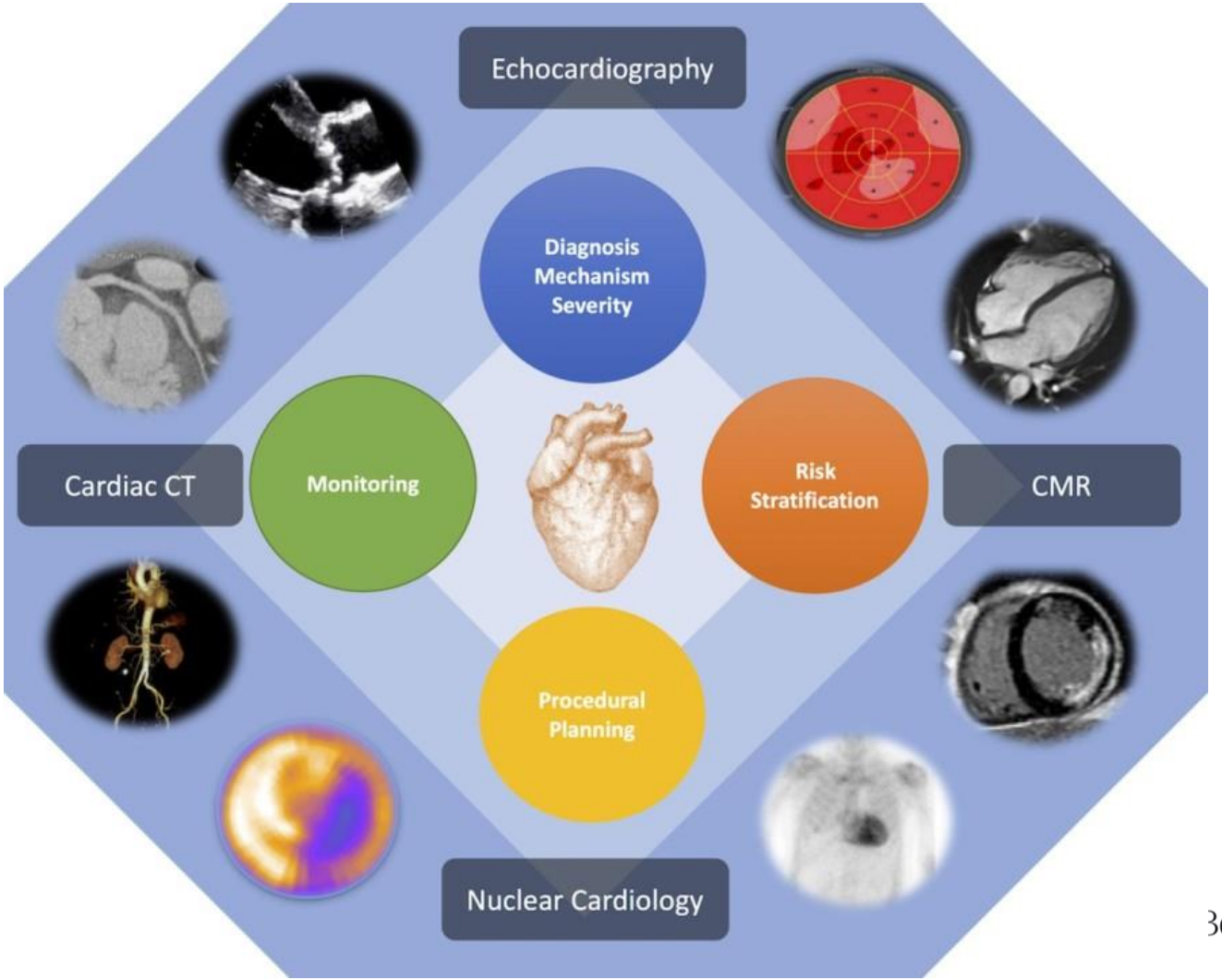
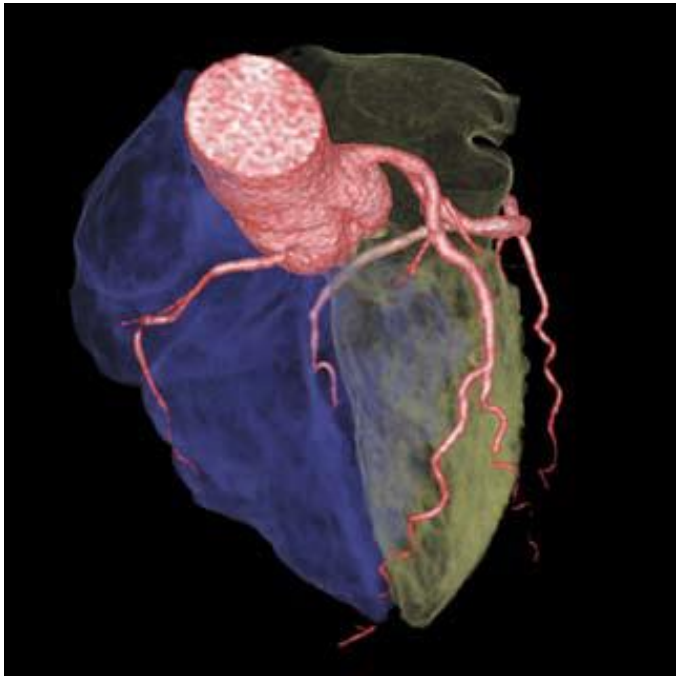
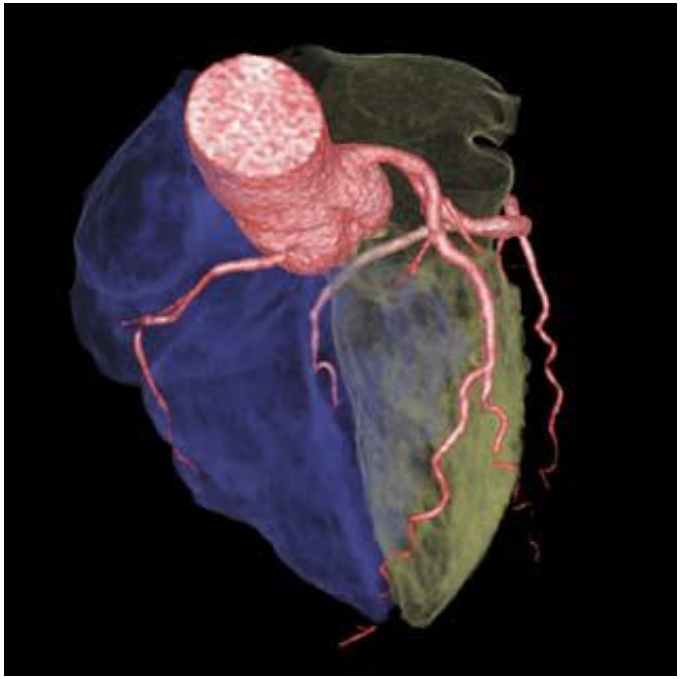

Echocardiography
Diagnosis
Mechanism
Severity
Cardiac CT
Monitoring
Risk
Stratification
CMR
Procedural
Planning
Nuclear Cardiology



Objectives

Background
Indications and Limitations
Acquisition and preparation
Interpretation of Report



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Background

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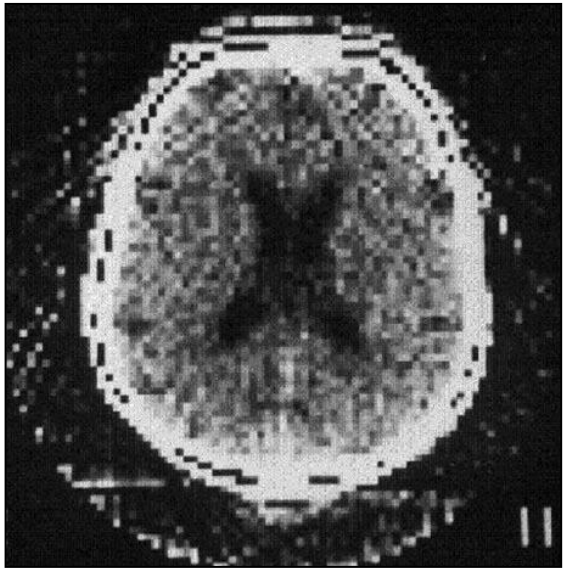
History of CT

October 1, 1971, Atkinson Morley Hospital in Wimbledon



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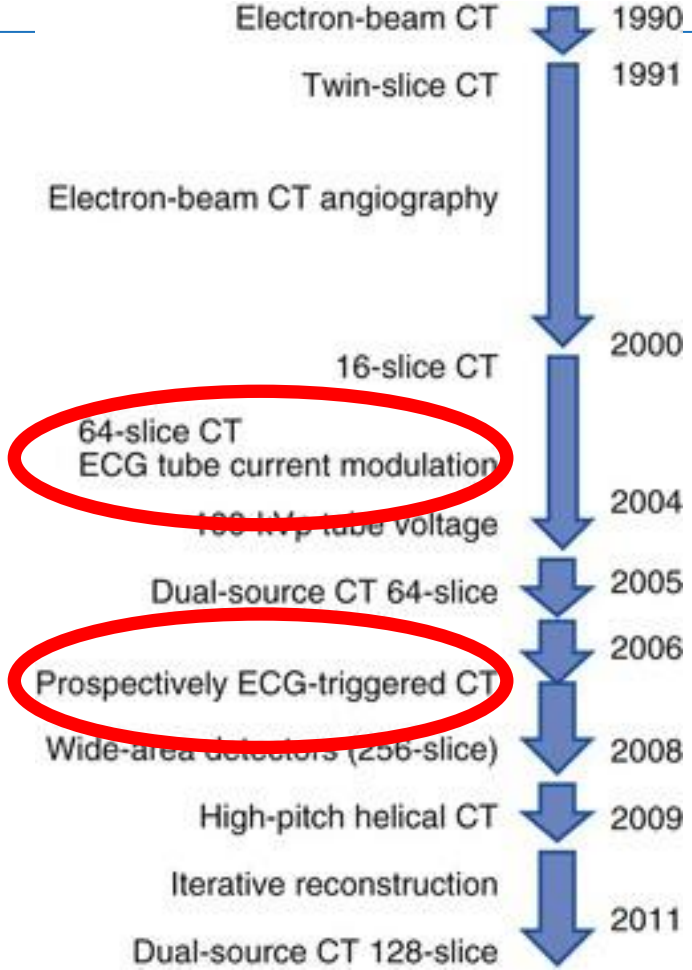
Timeline of technical advancement in CT



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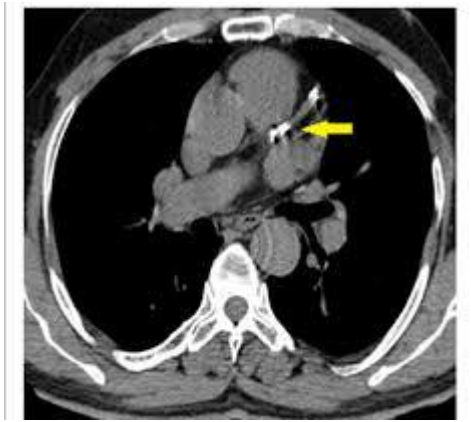
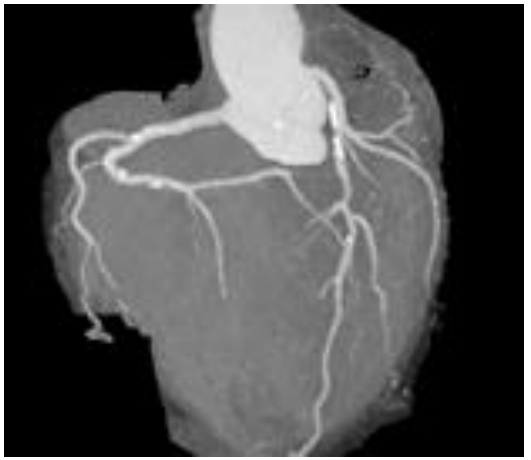
Types of Cardiac CT



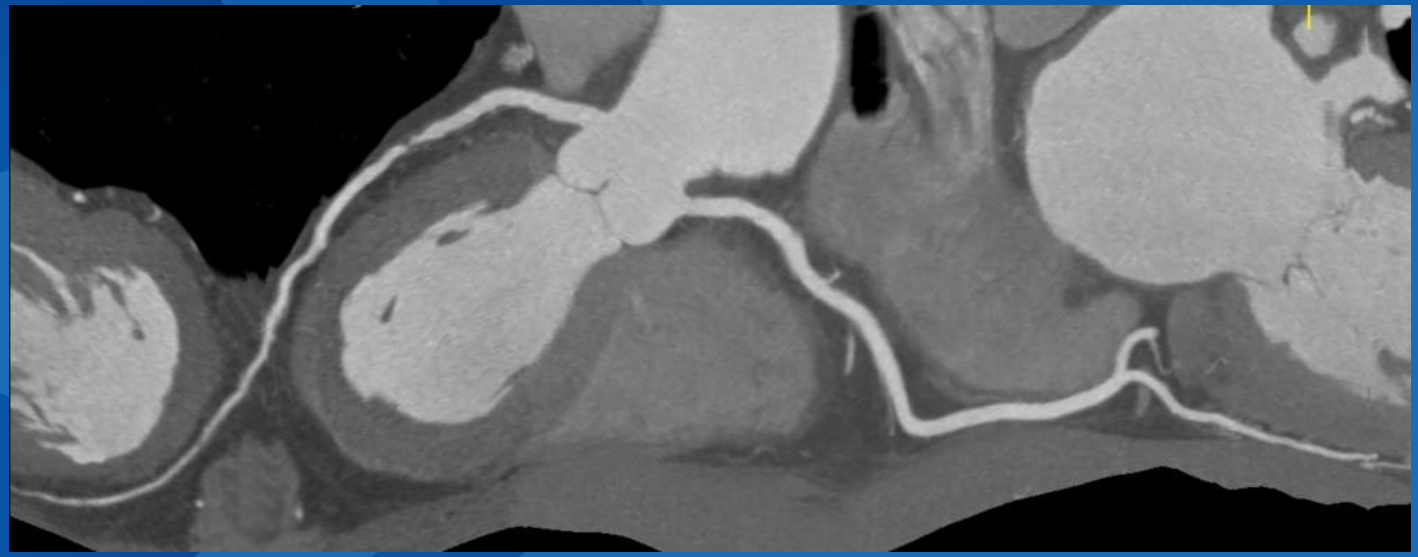
- **Coronary calcium**
- Gated
- No contrast

- **Aortic angiography**
- Gated
- IV contrast



- **Coronary angiography**
- Gated
- IV contrast
- Rate control/nitrate

How accurate is Coronary CT angiography ?



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Diagnostic Accuracy of CCTA

Table 2. Diagnostic Performance of 64-Slice CCTA According to Baseline Patient Risk

Pretest probability of CAD	n	Sensitivity	Specificity	PPV	NPV
High	105	98%	74%	93%	89%
Intermediate	83	100%	84%	80%	100%
Low	66	100%	93%	75%	100%

CAD indicates coronary artery disease; CCTA, coronary computed tomography angiography; NPV, negative predictive value; and PPV, positive predictive value. Adapted from Meijboom et al[8] with permission of the publisher. Copyright ©2008, Elsevier.

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Accuracy of CCTA

- NPV 99 - 100%
- If reported as ‘negative’ it is ‘negative’ 99-100%
- Play to your strengths;

CCTA in patients with low or intermediate probability of CAD

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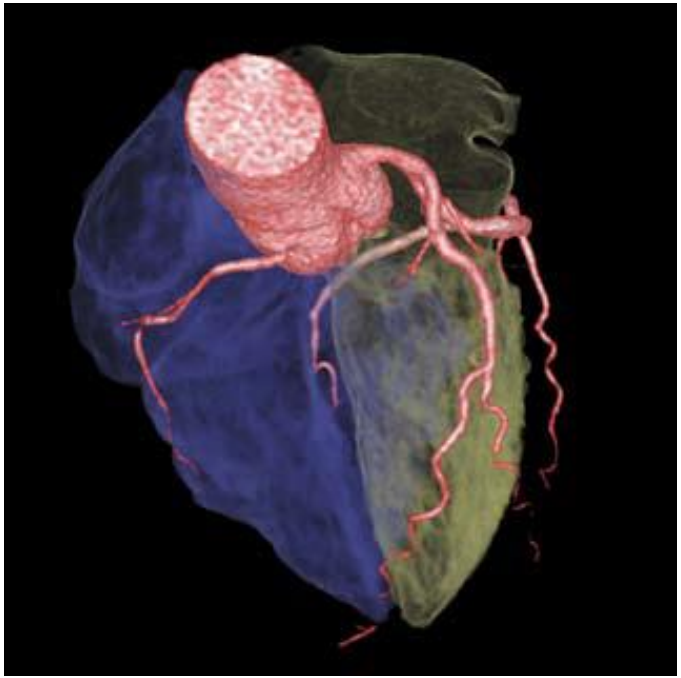

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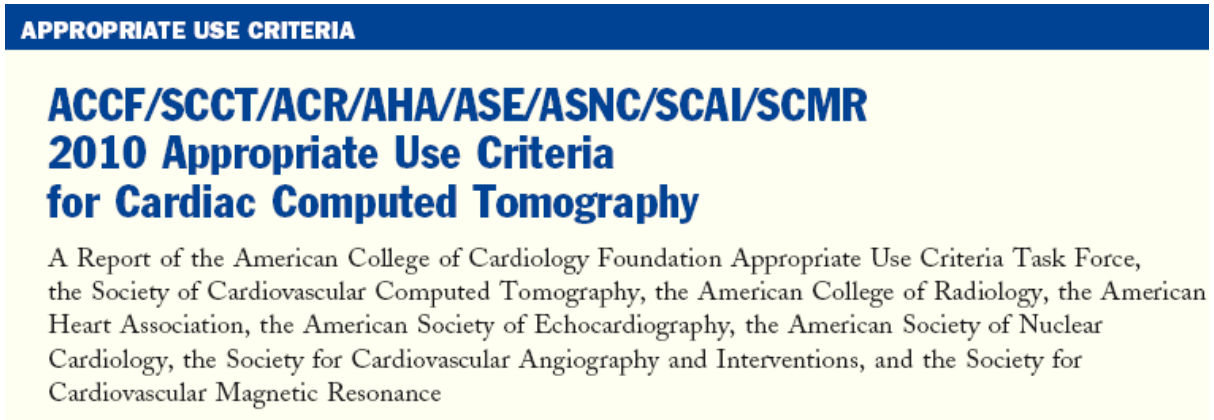
Indications for CCTA


APPROPRIATE USE CRITERIA

ACCF/SCCT/ACR/AHA/ASE/ASNC/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 Society for Cardiovascular Angiography and Interventions, and the Society for Cardiovascular Magnetic Resonance

Stable chest pain

Bypass Graft patency

Stent imaging >3mm

Coronary anomalies

The Updated NICE Guidelines: Cardiac CT as the First-Line Test for Coronary Artery Disease

Alastair J. Moss,[1] Michelle C. Williams,[1] David E. Newby,[1] and Edward D. Nicol[2]

▸ Author information ▸ Copyright and License information PMC Disclaimer

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Cardiac CT: Suggestions who **NOT** to refer?

- Known obstructive CAD
- Advanced age (Calcium burden)
- High pre test probability patients
- Afib/confused/poor comprehension
- Patients whom discovering non obstructive plaque would cause excessive anxiety

Coronary Calcium Score

American Journal of Preventive Cardiology 11 (2022) 100365

Contents lists available at ScienceDirect

American Journal of Preventive Cardiology

journal homepage: www.journals.elsevier.com/american-journal-of-preventive-cardiology

Commentary

Preventive cardiology advances in the 2021 AHA/ACC chest pain guideline

- Predictor of coronary artery disease
- **Asymptomatic patients**
- CAC provides a quantitative assessment of the atherosclerotic plaque burden, a risk stratification tool for future cardiovascular events, which is significantly **more predictive than risk factors alone**
- May inform need for further testing or identify an opportunity to initiate or intensify guideline-directed medical therapy

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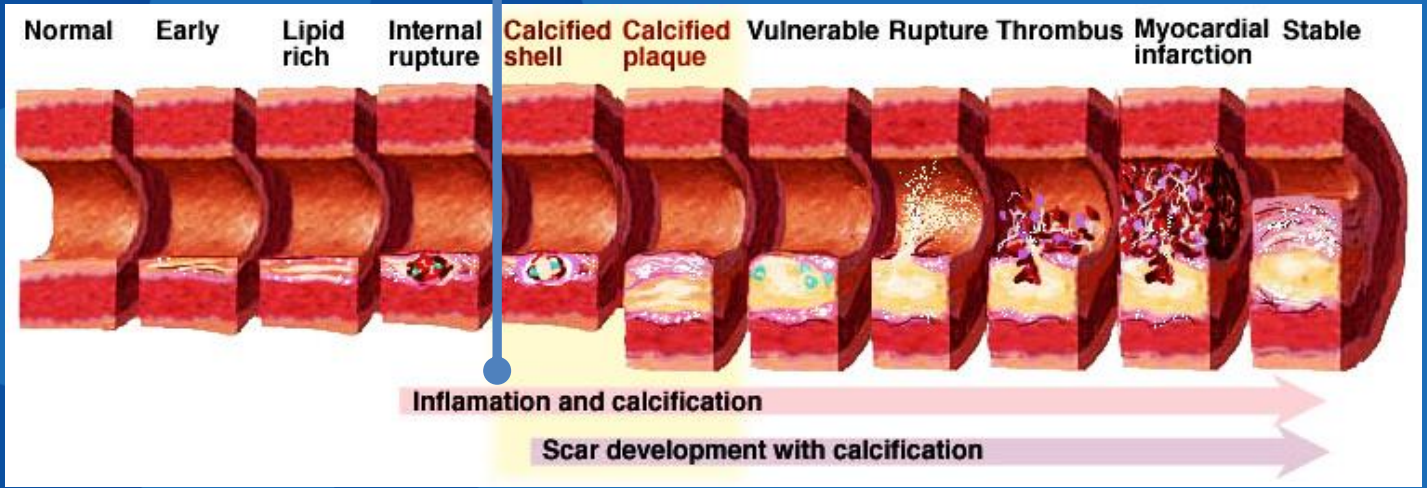
What are the limitations of CCTA?

- High heart rate
- Irregular heart rhythm
- Inability to sustain a breath hold
- Severe coronary calcification or the presence of coronary artery stents
- Segments with a diameter <1.5 mm

Coronary disease progression

Plaque Detected by CT



Role for CCTA

>60% stenosis (+) stress/imaging

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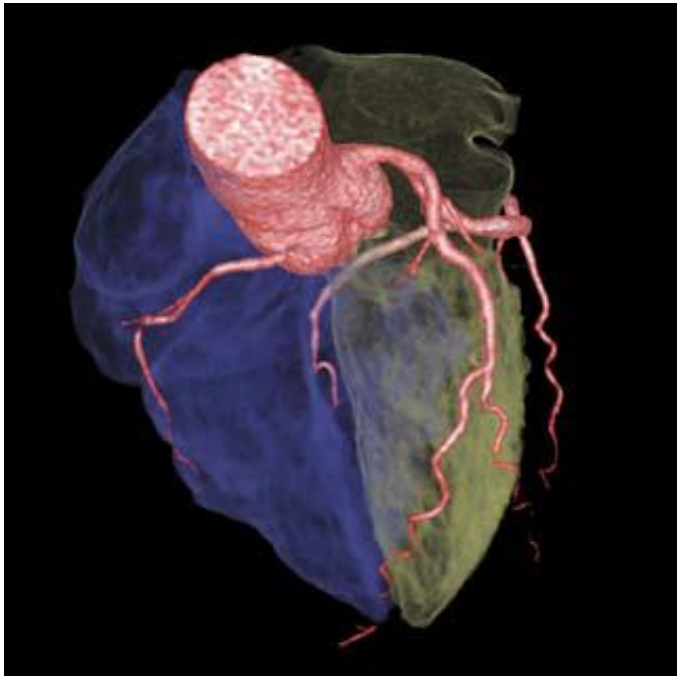

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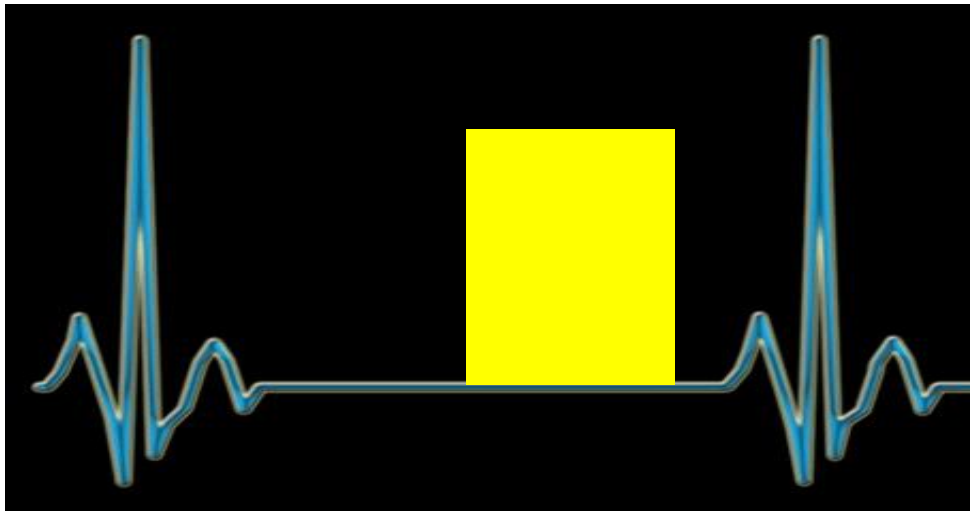
ECG synchronisation

ECG monitoring used to trigger the CT imaging

Images performed during the phase of the least cardiac motion



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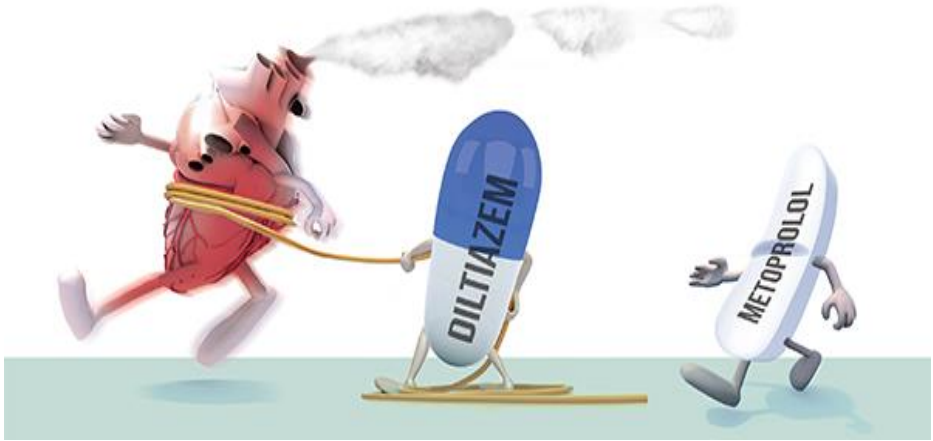
Rate control

- Aim: stable slow heart rate
- Optimal <65bpm on standard 128 CT
- Conservative measures
  - Avoid caffeine
  - Smoking
  - exercise
- Beta blocker eg metoprolol
- Verapamil or diltiazem if C/I



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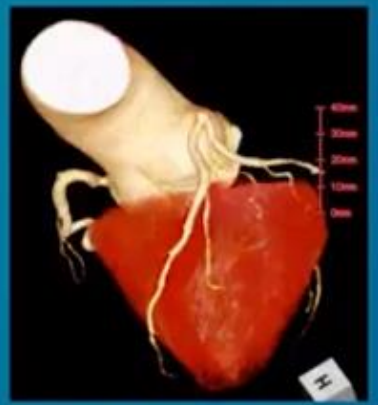
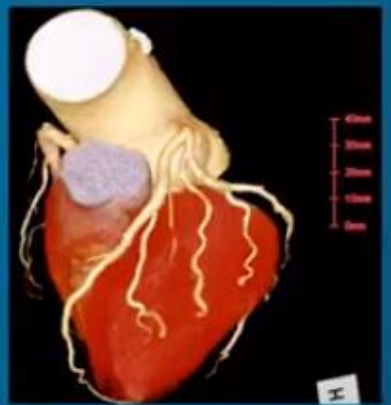
Nitrates

Effect on Vasculature

- Direct vasodilators
- Induce smooth muscle relaxation
- Cause dilation of the coronary arteries



Prior to Sublingual Nitrate administration



5 min after Sublingual Nitrate administration

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What about Artifacts ?

Coronary CT angiography is impressively accurate – but there are challenges from artifacts

Motion

Misalignment

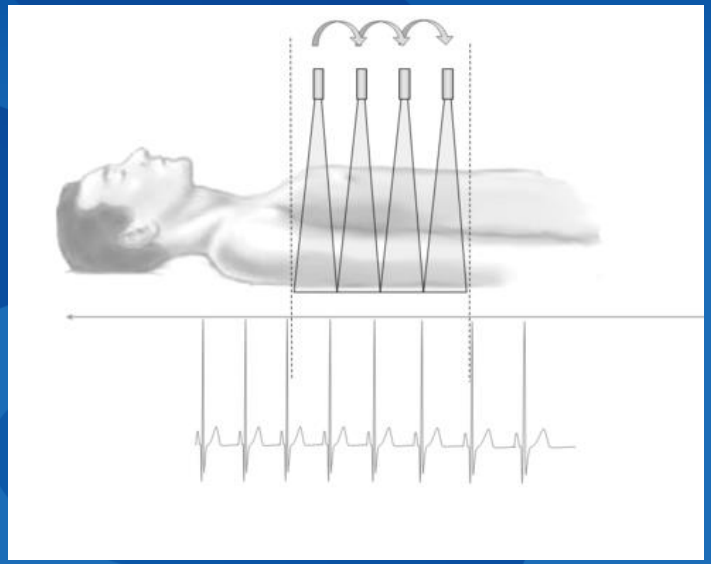
Cardiac Motion

Blooming Artifact

Calcium

Stents

Misalignment



Breathing

Arrhythmia

Inconsistent heart beats

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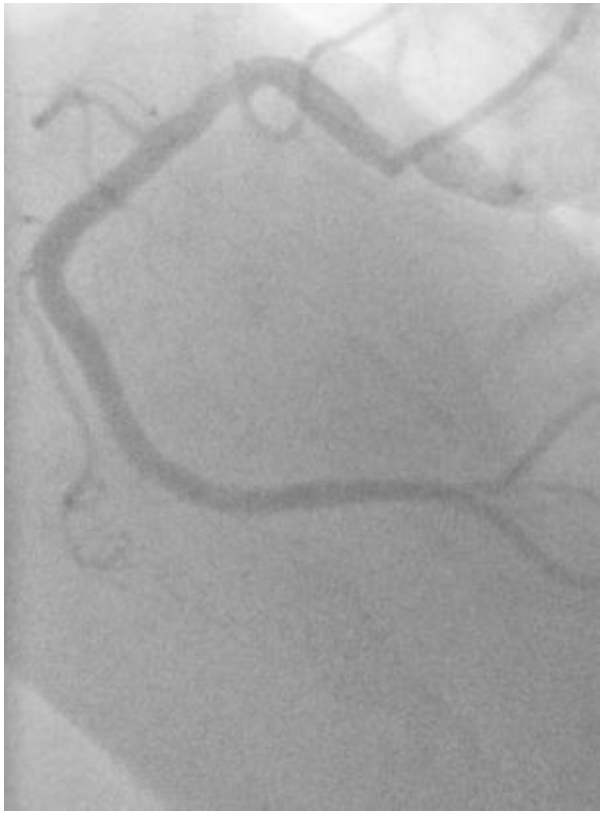
Misalignment



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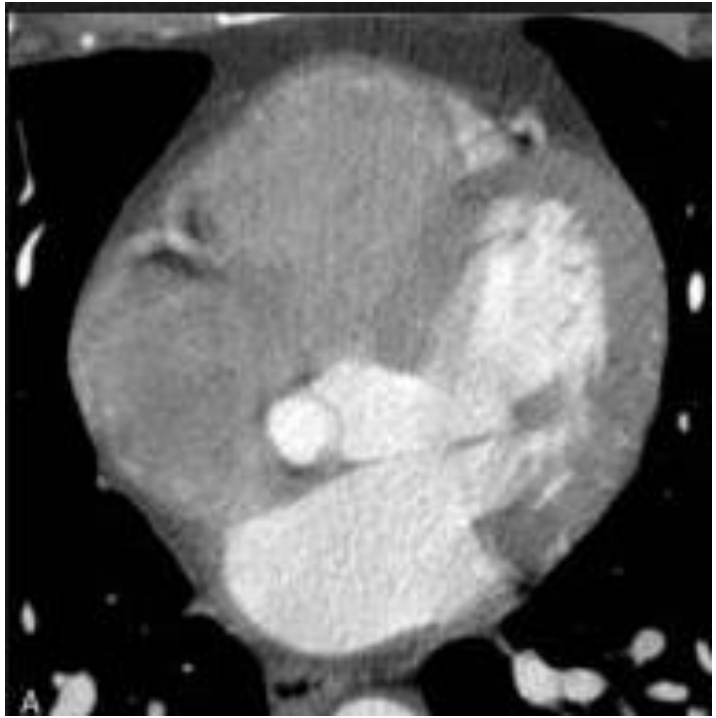
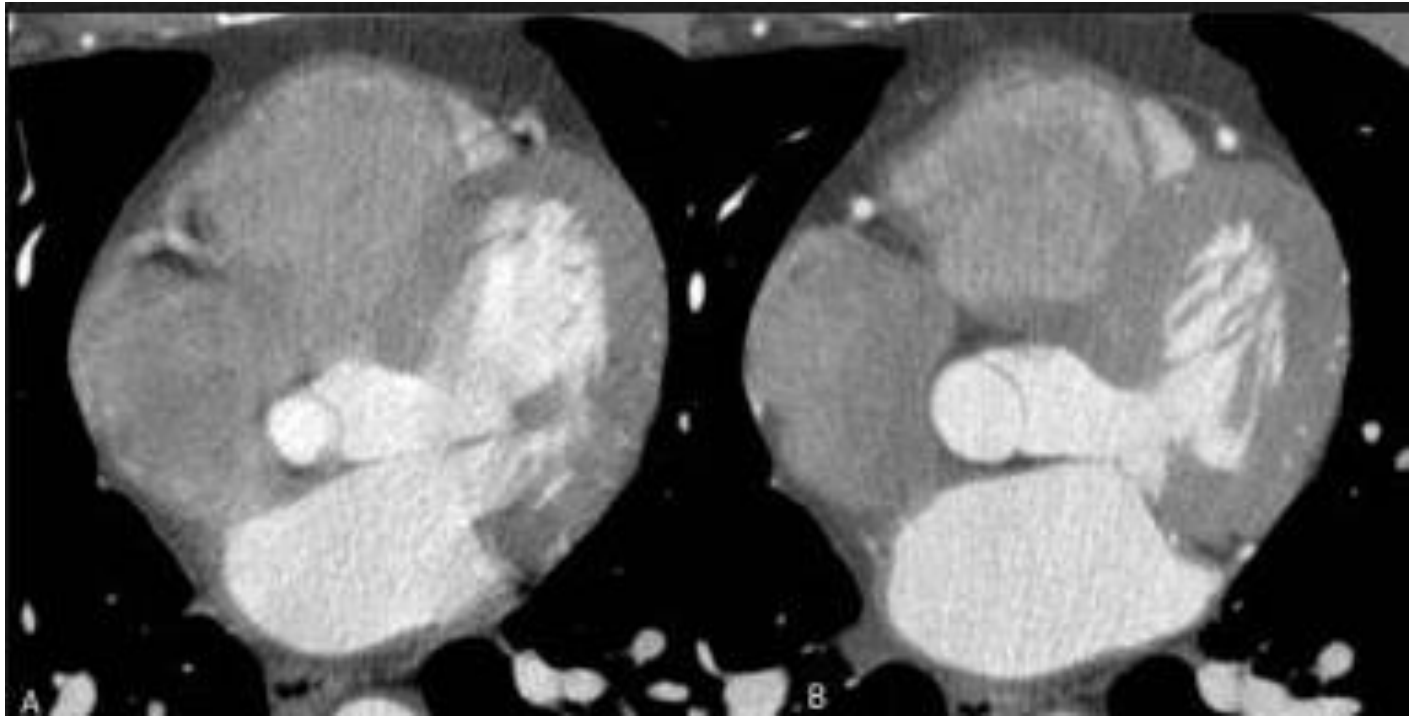
Motion



Motion



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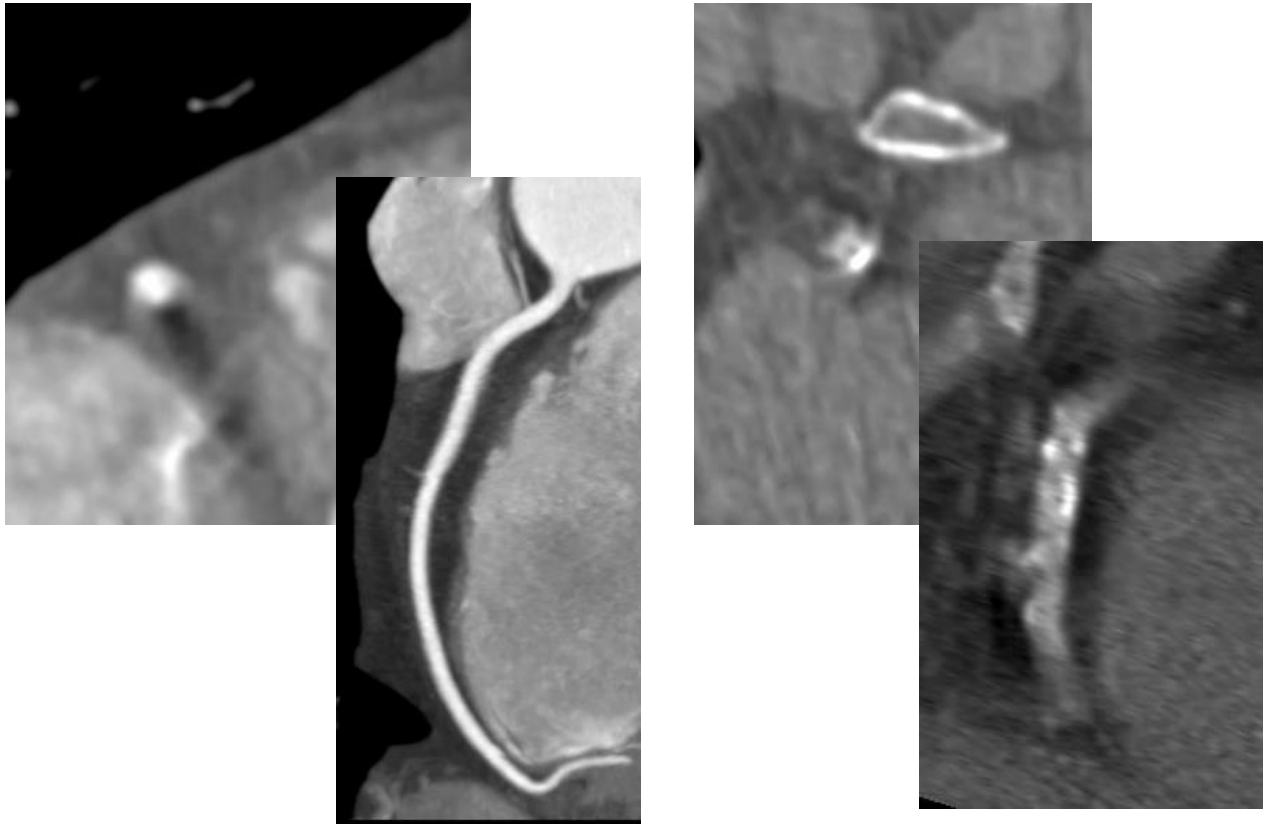
Motion



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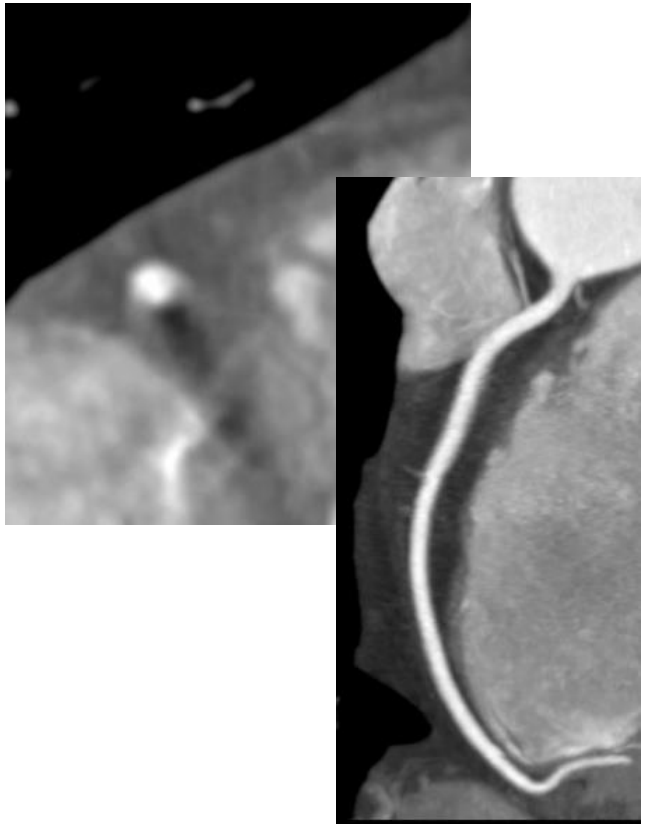
Motion



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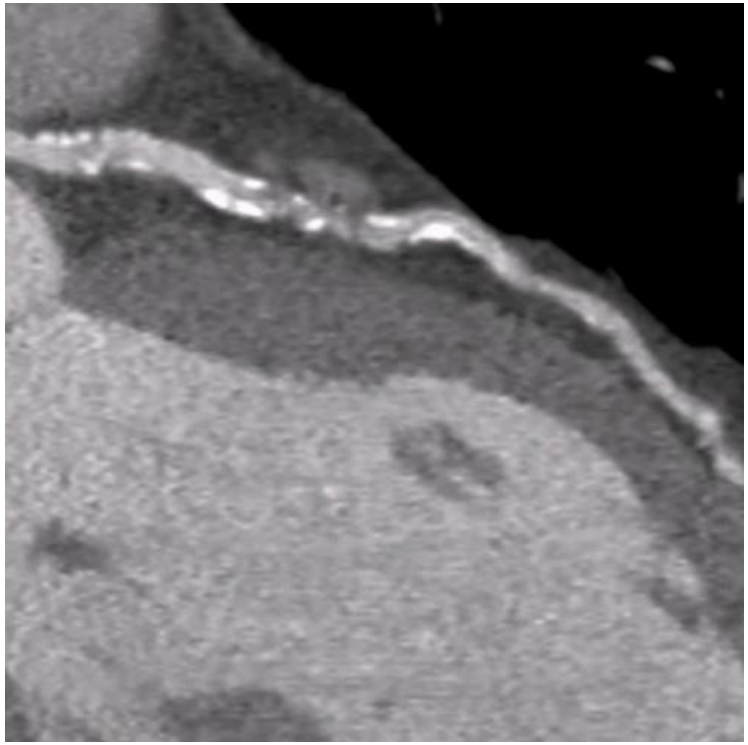
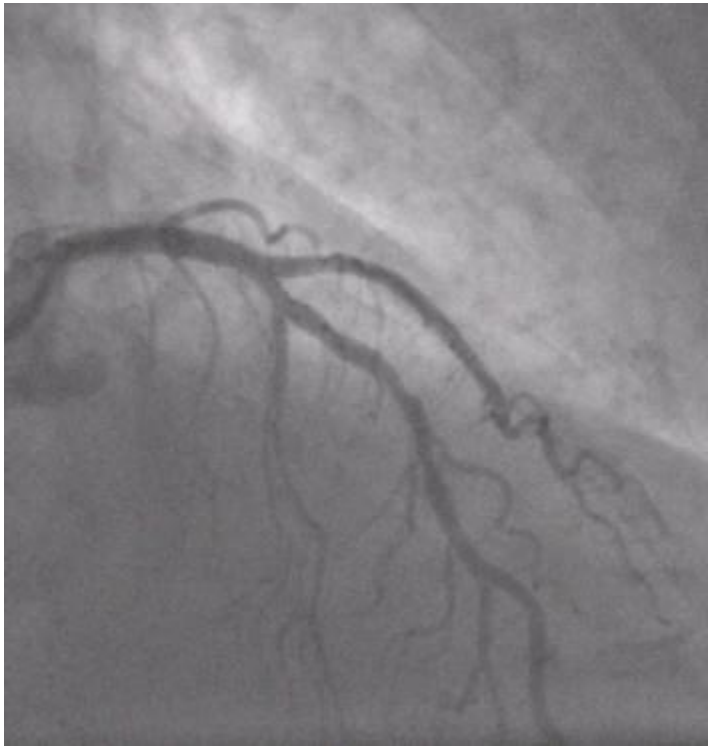
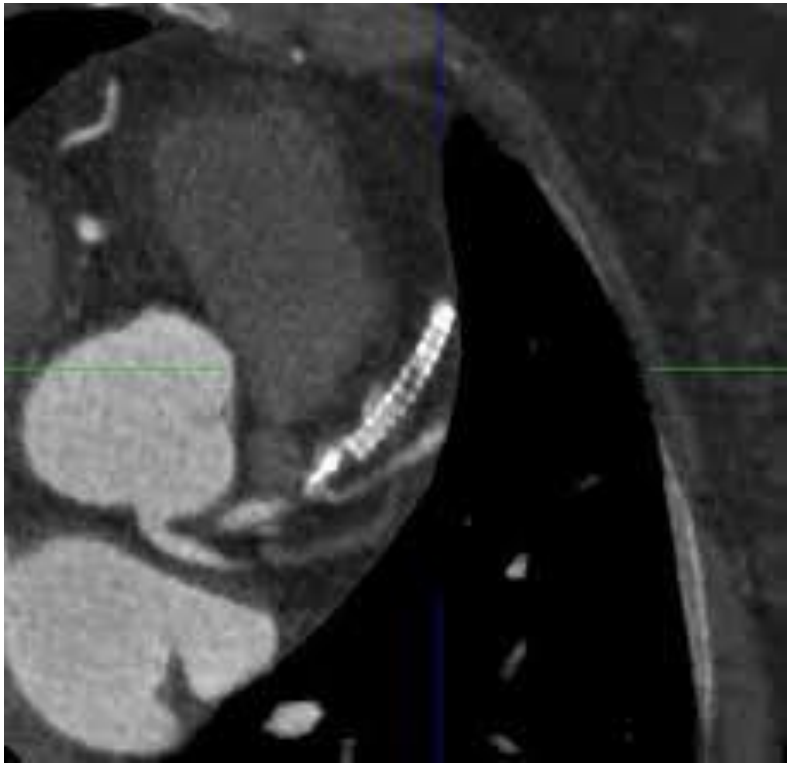
Calcium

This causes overestimation of stenosis

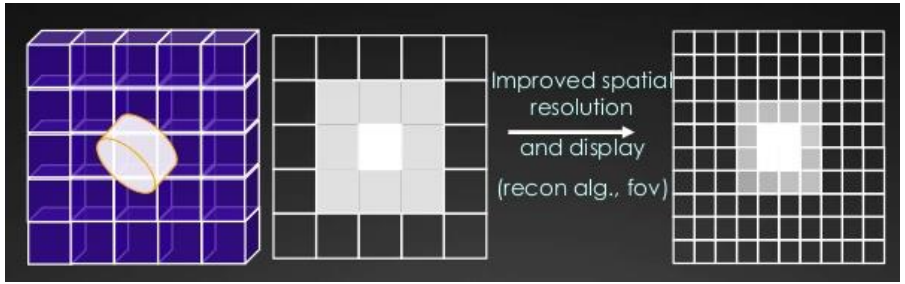




Stent Imaging



>3mm



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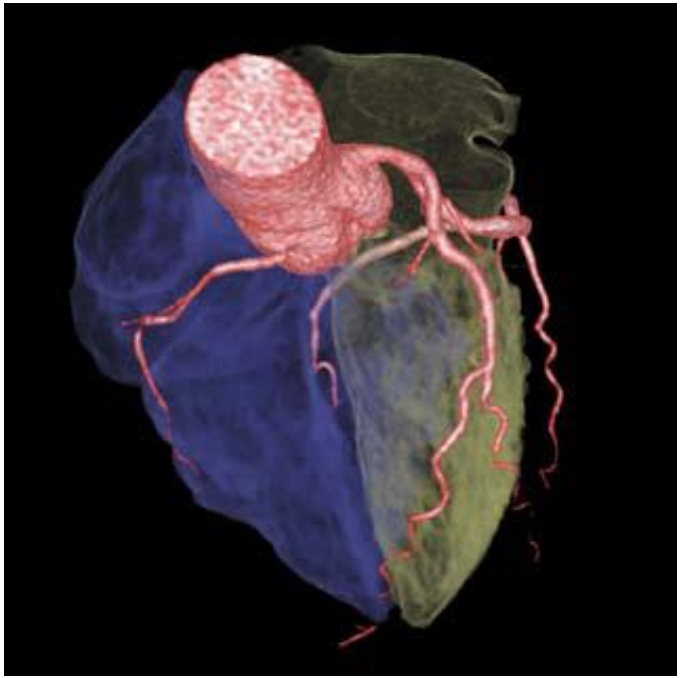

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The Report

- Coronary anatomy
- Plaque description
- Stenosis severity
- +-/- Calcium score
- Extra cardiac findings

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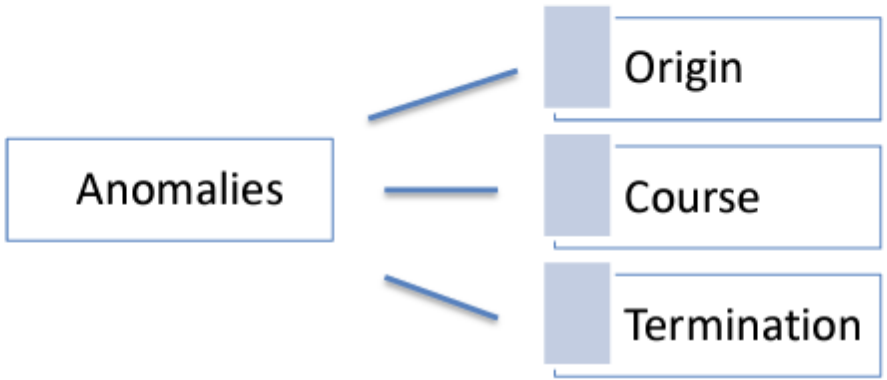
Coronary Anomalies

Prevalence 1-2%

Clinical presentation is variable; may remain occult or have life threatening consequences

Even if asymptomatic, knowledge of their presence is important at cardiac surgery



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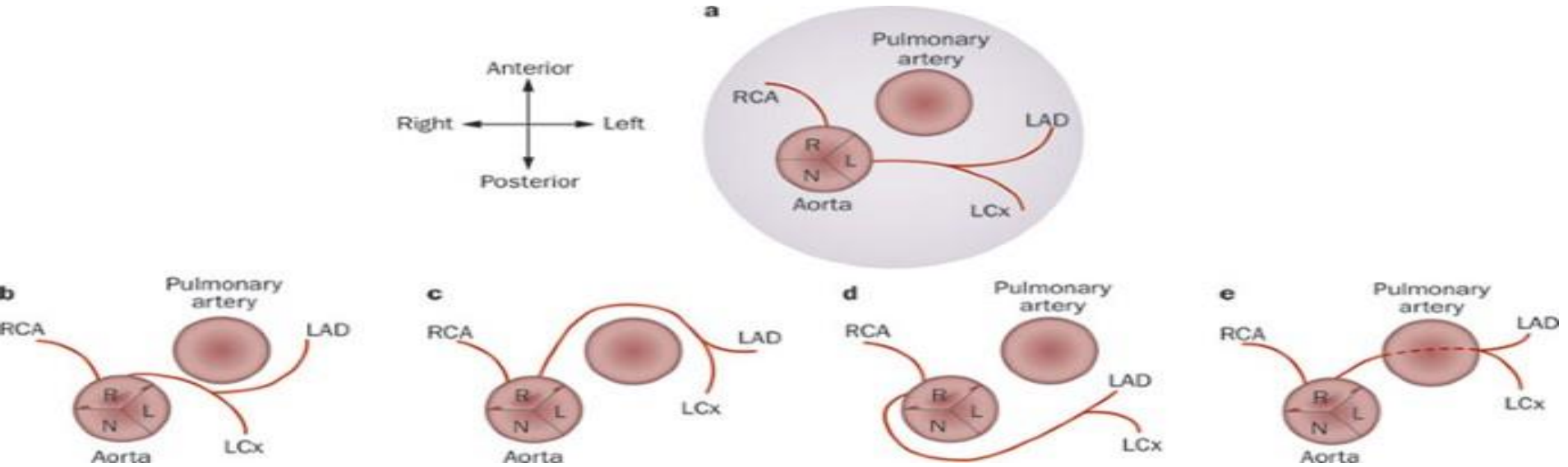
Anomalous origin

- **Coronary artery arises from the opposite sinus and takes one of four paths**



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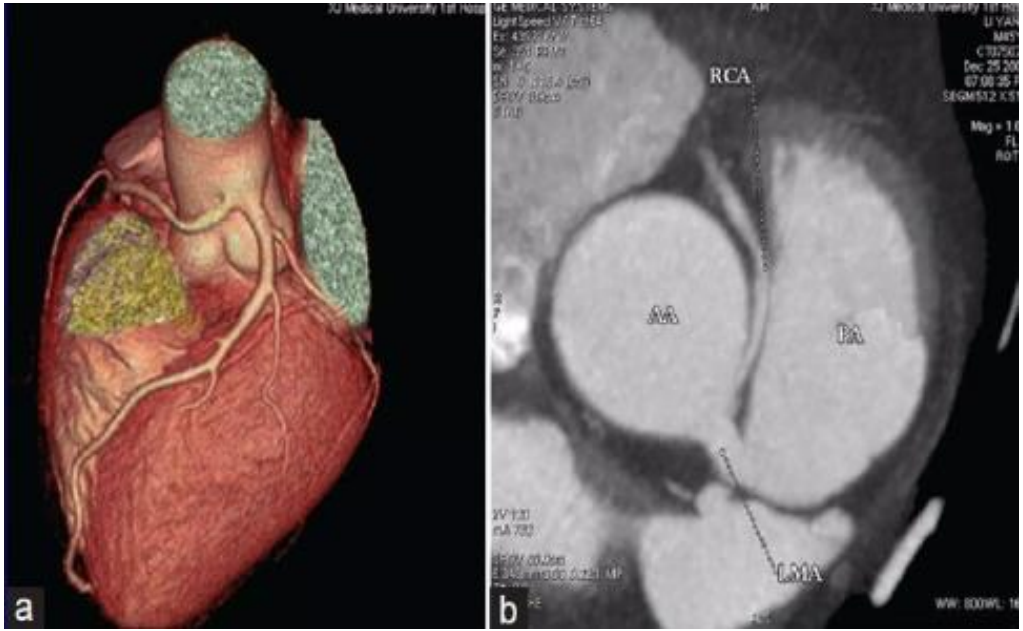
Inter-arterial course

- **Carries a risk of sudden cardiac death**
  - Narrow slit-like orifice
  - Acute angle of the ostium with tangential course
  - Intra-mural course



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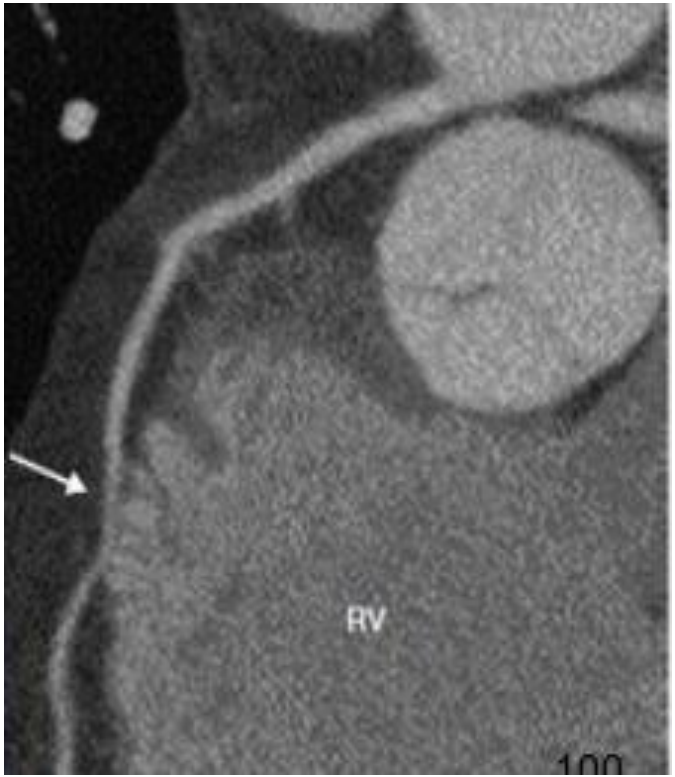
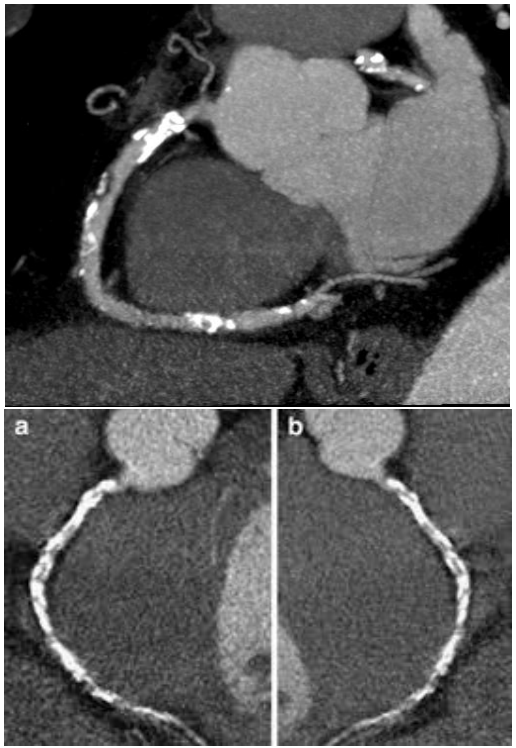
Myocardial Bridging

- Vessels normally epicardial
- Segment of a coronary artery takes a “tunnelled” intramuscular course under a “bridge” of overlying myocardium
- Atherosclerosis sparing
- Infrequently associated with symptoms



Plaque characterisation

Calcified



Non-calcified

Partially calcified

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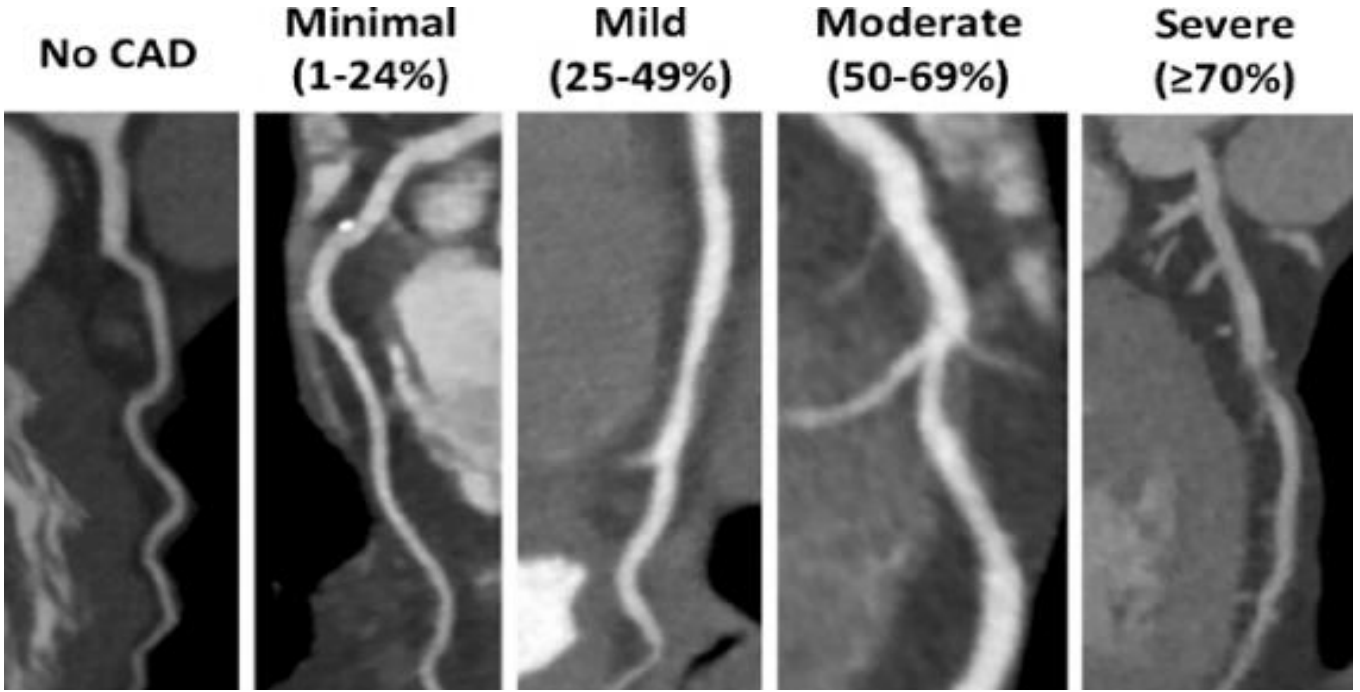
Grading stenosis



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Coronary calcium

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):

Gender: female

Race/Ethnicity: black

Observed Agatston Calcium Score (optional):

Calculate

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MESA The Multi-Ethnic Study of Atherosclerosis

The estimated probability of a non-zero calcium score for a white male of age 46 is 28 %.

Percentiles and Calcium Scores for: white male of age 46

25th	50th	75th	90th
0	0	3	48

The observed calcium score of 0.6 is at percentile 72

for subjects of the same age, gender, and race/ethnicity who are free of clinical cardiovascular disease and treated diabetes.

25th	50th	75th	90th
0	0	3	48

The observed calcium score of 0.6 is at percentile 72

for subjects of the same age, gender, and race/ethnicity who are free of clinical cardiovascular disease and treated diabetes.

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The role of Calcium Scoring (CAC)

Risk assessment to guide therapies in asymptomatic patients

CAC is a surrogate marker of burden of sub-clinical coronary atherosclerosis

Positive CAC scores indicate incremental risk

Alters therapeutic goals

Improve Compliance

Coronary artery calcium scoring does NOT:

Predict if you will have an MI

Provide detail of coronary artery stenosis

Serve as a substitute for a coronary angiogram or stress test

Not identify non calcified plaque

Extra cardiac findings

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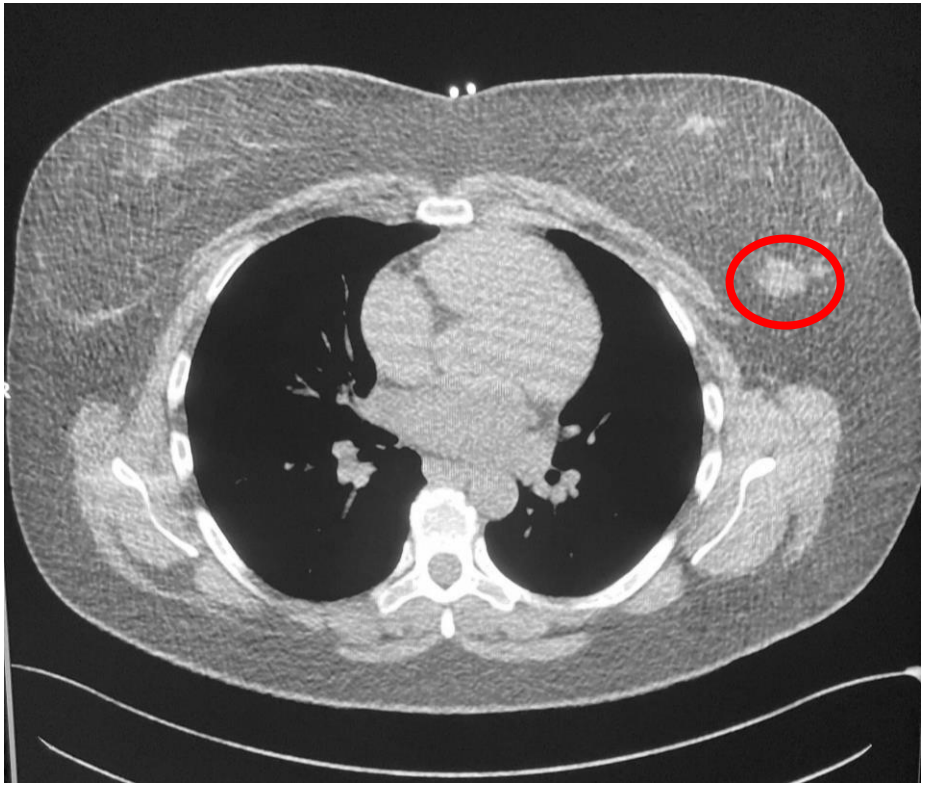
52 yr old atypical chest pain



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Pulmonary nodules

Solid	Size	Follow up		
	< 6 mm (<100mm^3)	Single	Low risk	No routine follow
			High risk	Optional CT at 12 months
		Multiple	Low risk	No routine follow
			High risk	Optional CT at 12 months
	6-8 mm (100-250mm^3)	Single	Low risk	CT at 6-12 mo, then consider CT at 18-24
			High risk	CT at 6-12 mo, then CT at 18-24
		Multiple	Low risk	CT at 3-6 mo, then consider CT at 18-24
			High risk	CT at 3-6 mo, then CT at 18-24
	> 8 mm (> 250mm^3)	Single	All	Consider CT at 3 mo, PET/CT or Biopsy
		Multiple	Low risk	CT at 3-6 mo, then consider CT at 18-24
			High risk	CT at 3-6 mo, then CT at 18-24

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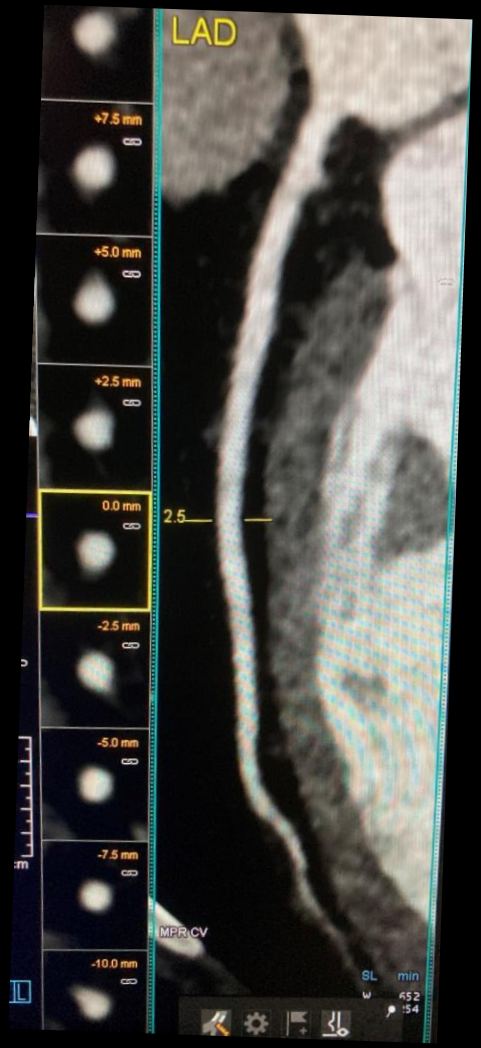
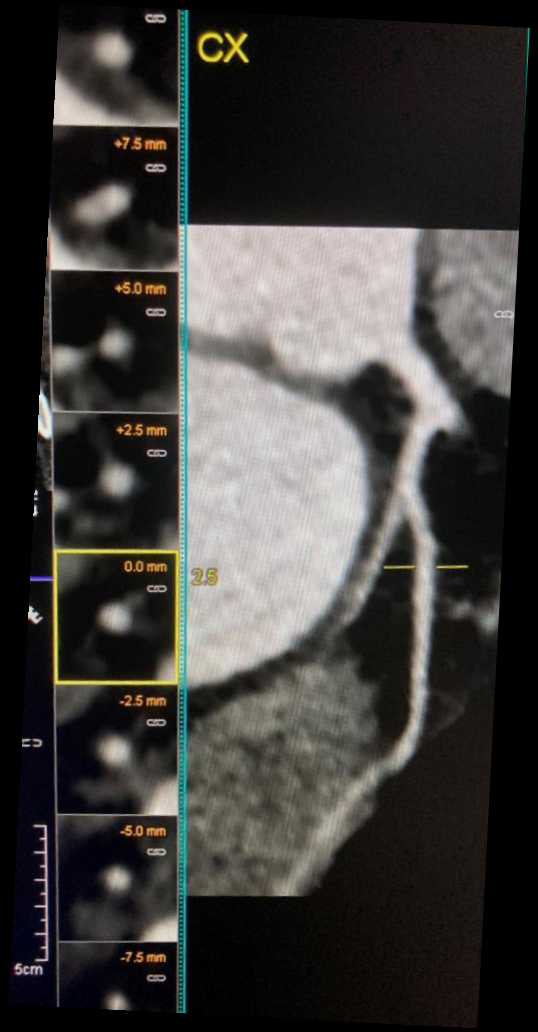
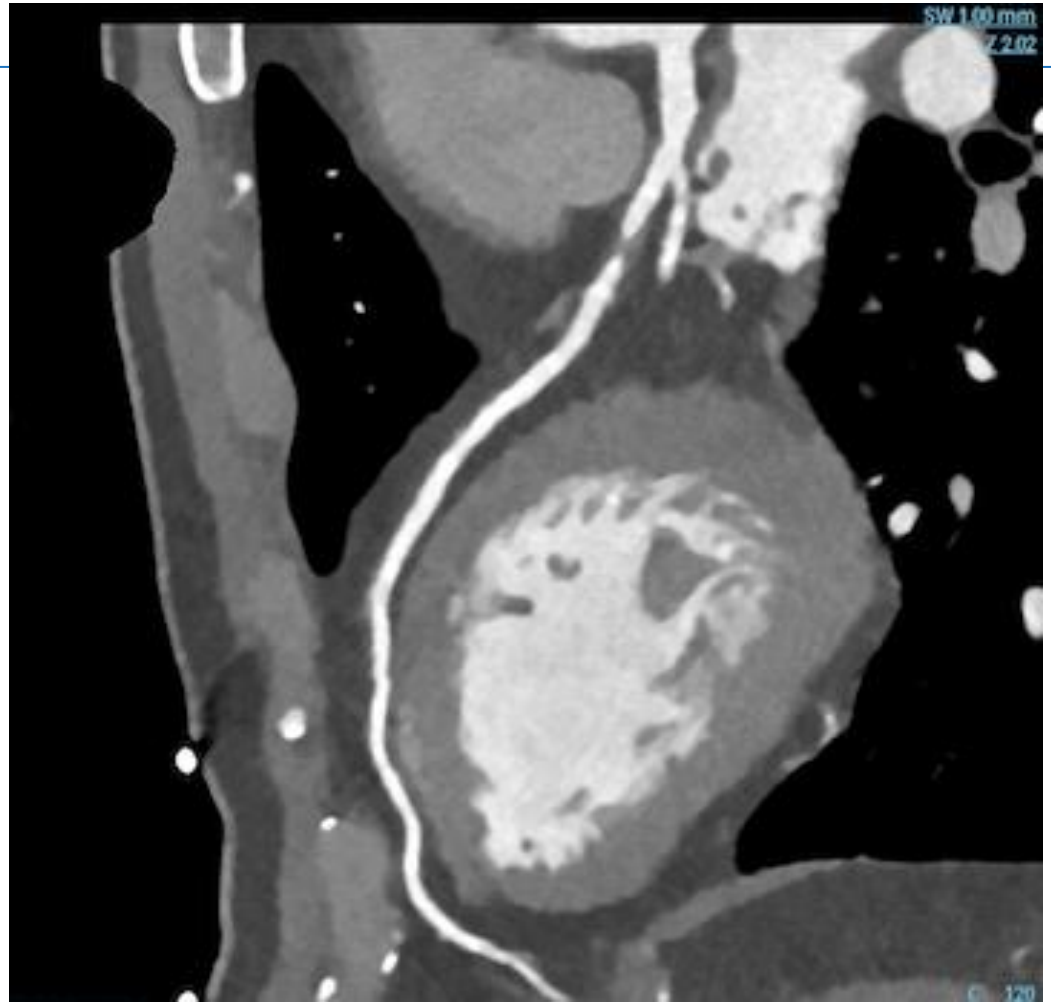

LAD
+7.5 mm
+5.0 mm
+2.5 mm
0.0 mm
-2.5 mm
-5.0 mm
-7.5 mm
-10.0 mm
2.5
MPR CV
SL
min


CX
+7.5 mm
+5.0 mm
+2.5 mm
0.0 mm
-2.5 mm
-5.0 mm
-7.5 mm
2.5
5cm


RCA_2
+7.5 mm
+5.0 mm
+2.5 mm
0.0 mm
-2.5 mm
-5.0 mm
-7.5 mm
-10.0 mm
2.5
MPR CV



Calcium score zero

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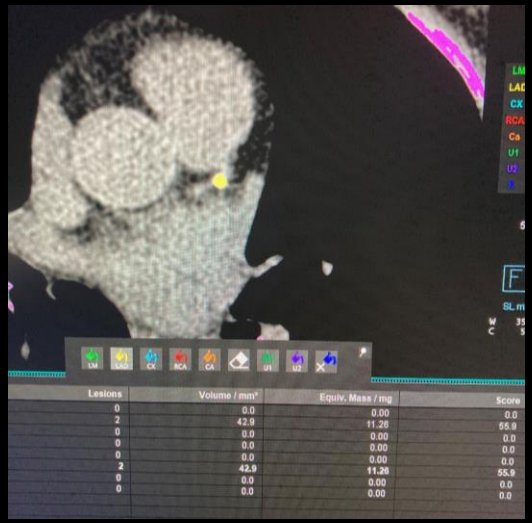
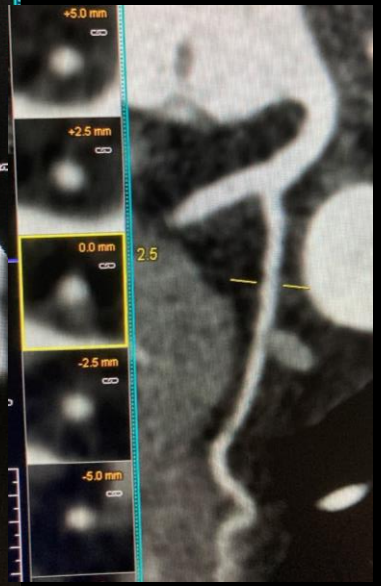
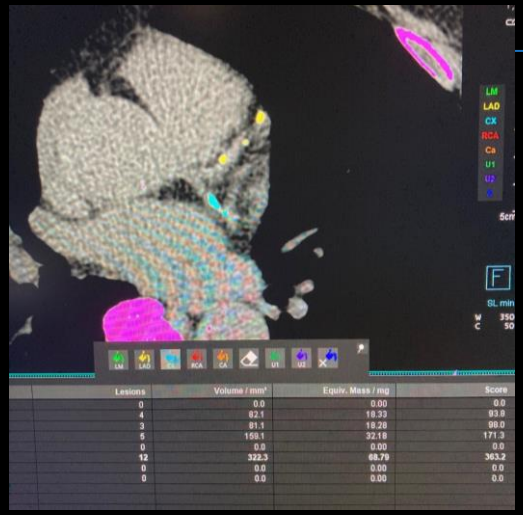
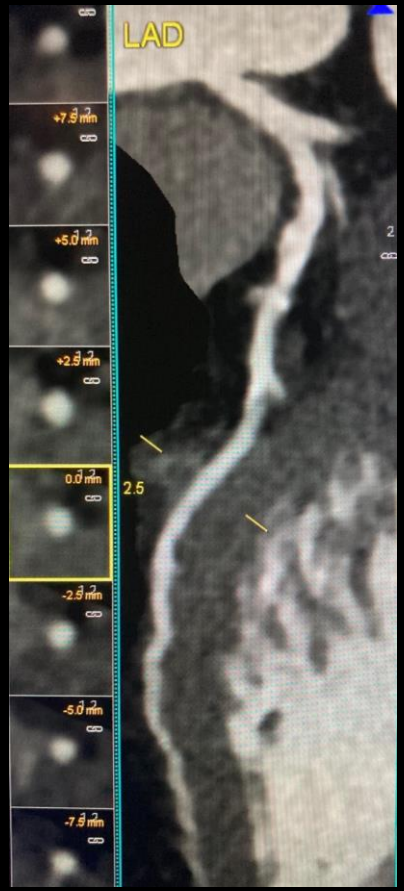
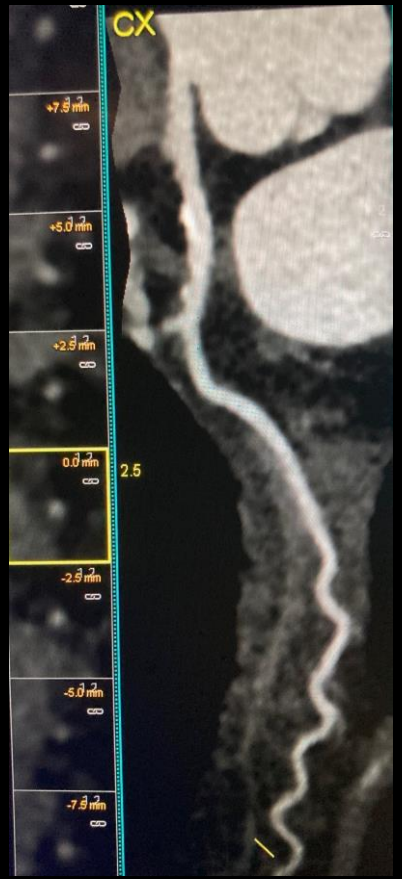


55 yr old ex smoker
Ca 55.9
92nd centile









Ca score 363.2

Cardiac CT: Key points

- CTCA quality and dose have improved significantly in recent years
- CTCA is evidence based and increasing becoming preferred pathway for low to medium risk patients
- Value of CTCA is in **negative** predictive strength
- Most effective in young (<65) with stable HR and rhythm
- Ca score is being increasing used to inform risk modification strategy/therapeutic goals in asymptomatic patients

Thank you

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