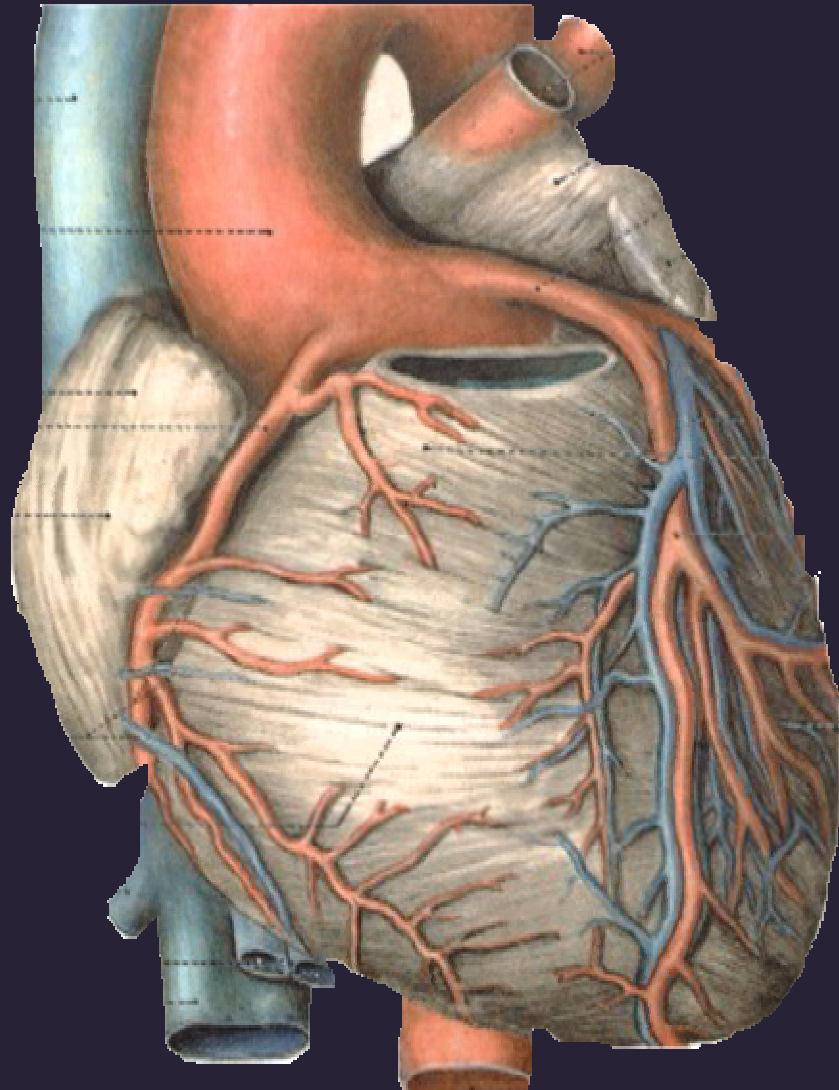


Coronary CT Angiography

Merits, Applications, Limitations,
Problems

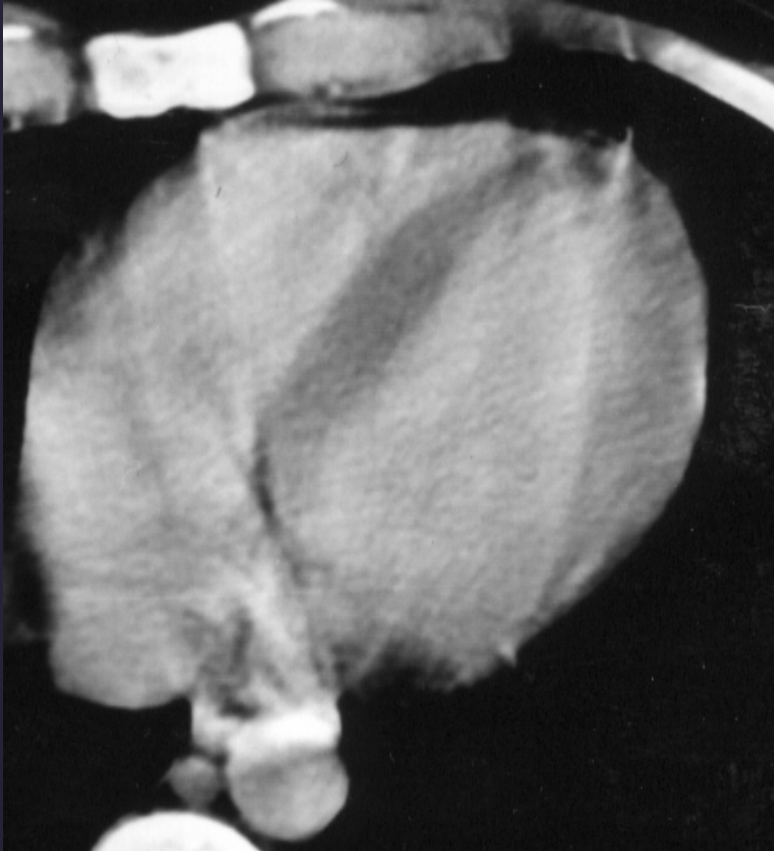


CORONARY IMAGING:

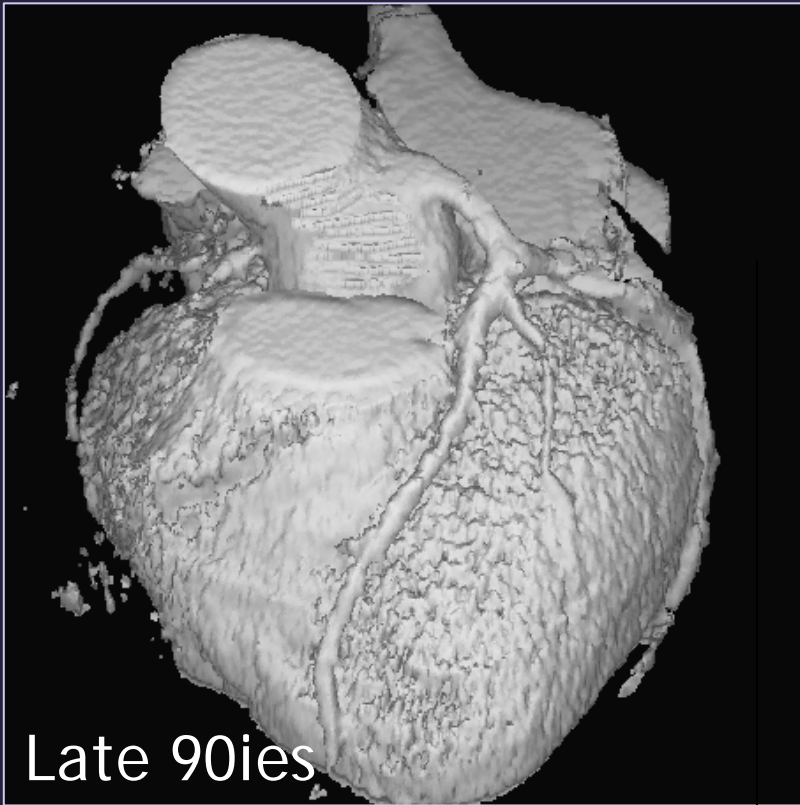
- Complex Anatomy**
- Small Dimensions**
- Rapid Movement**

CORONARY IMAGING:

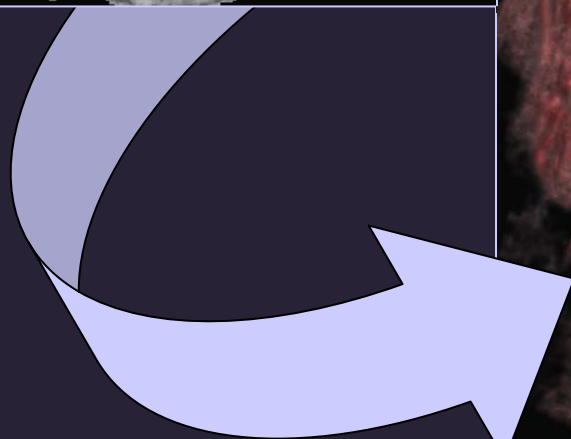
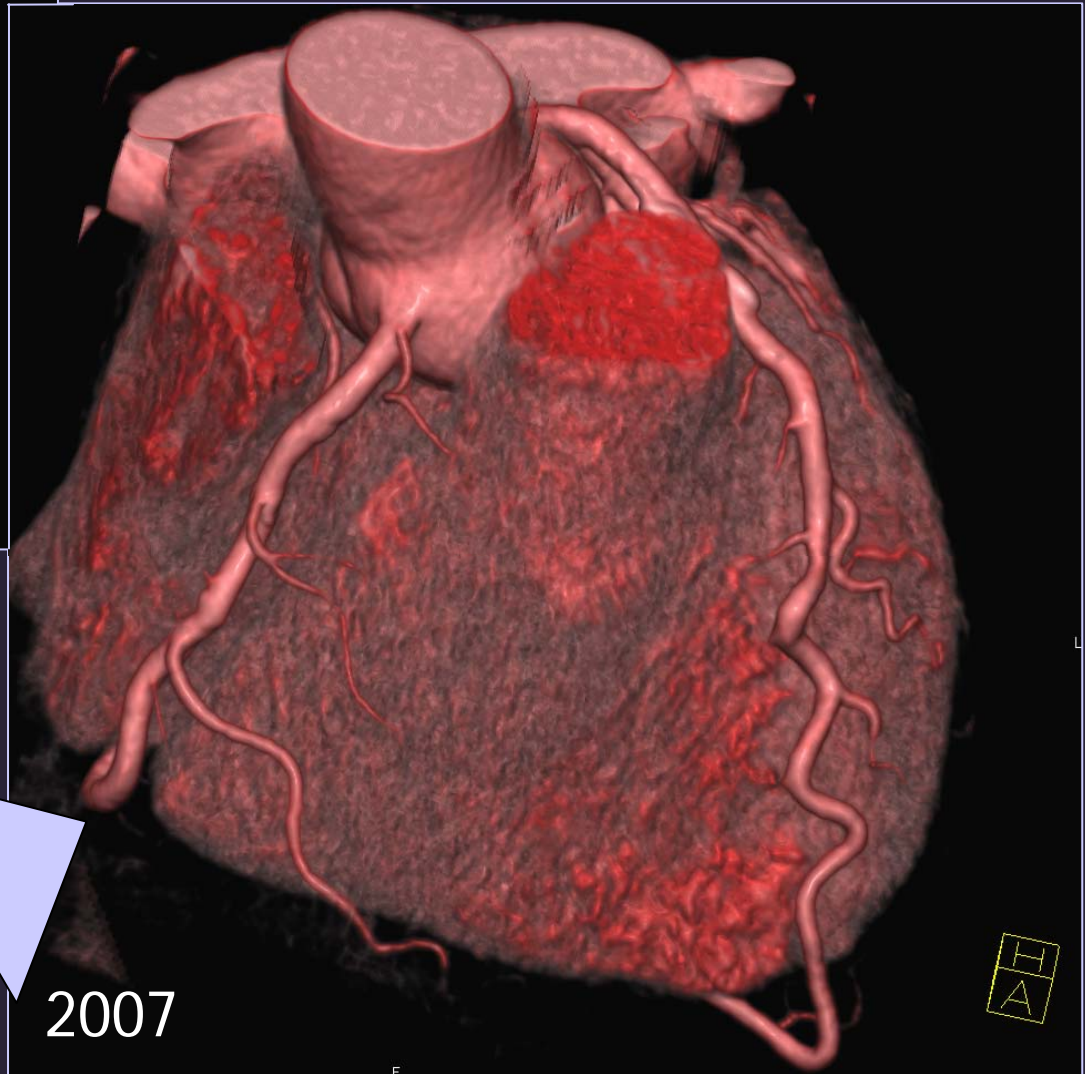
- Complex Anatomy**
- Small Dimensions**
- Rapid Movement**



1990: ~ 1 s/image



Late 90ies



High-resolution non-invasive coronary artery visualization



State of the Art:

16 - slice CT or more

< 500 ms rotation

Heart rate < 60-65/min (16/64)

Intravenous contrast (dual head)

Nitrates

Protocol:

1. Localization Scan

2. Contrast timing

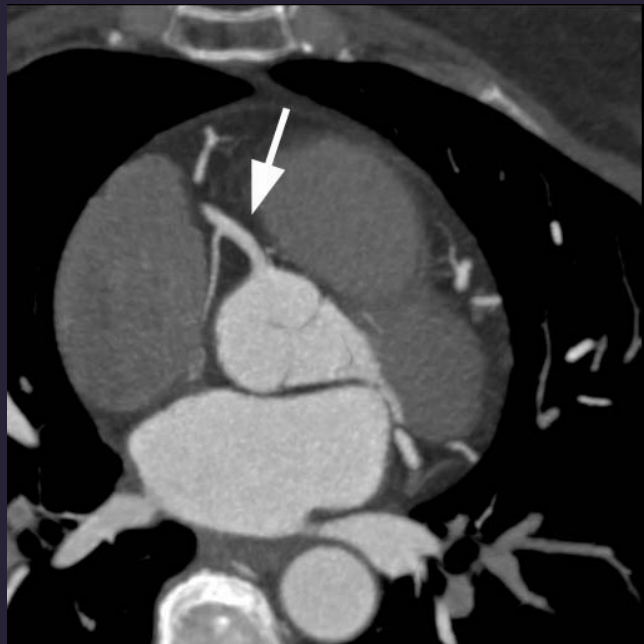
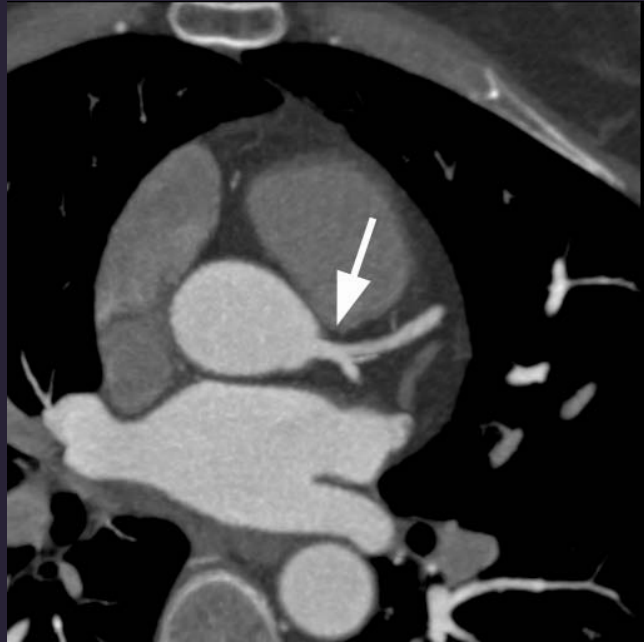
“Test Bolus”

“Bolus Tracking”

3. Volume Data Set

Highest Temporal and Spatial Resolution

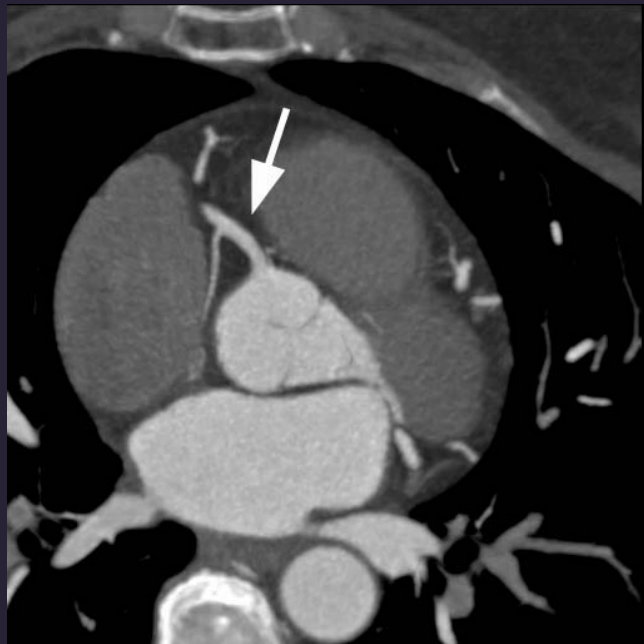
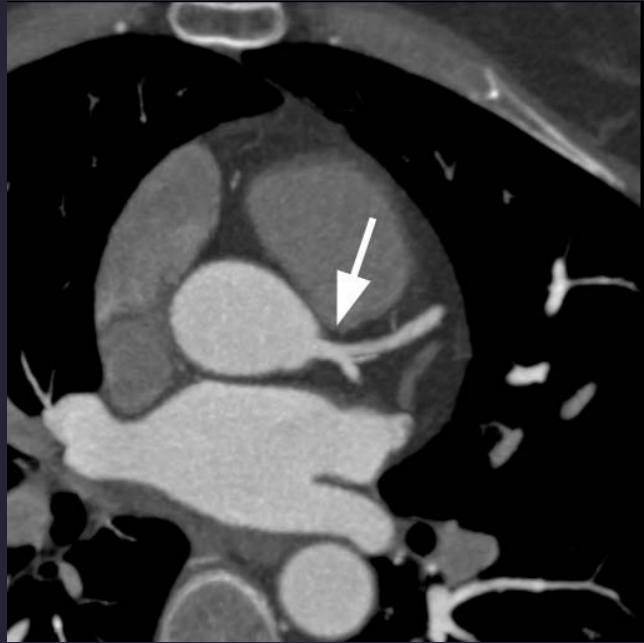
~ 60 - 120 ml contrast agent, ~ 5-15 mSv

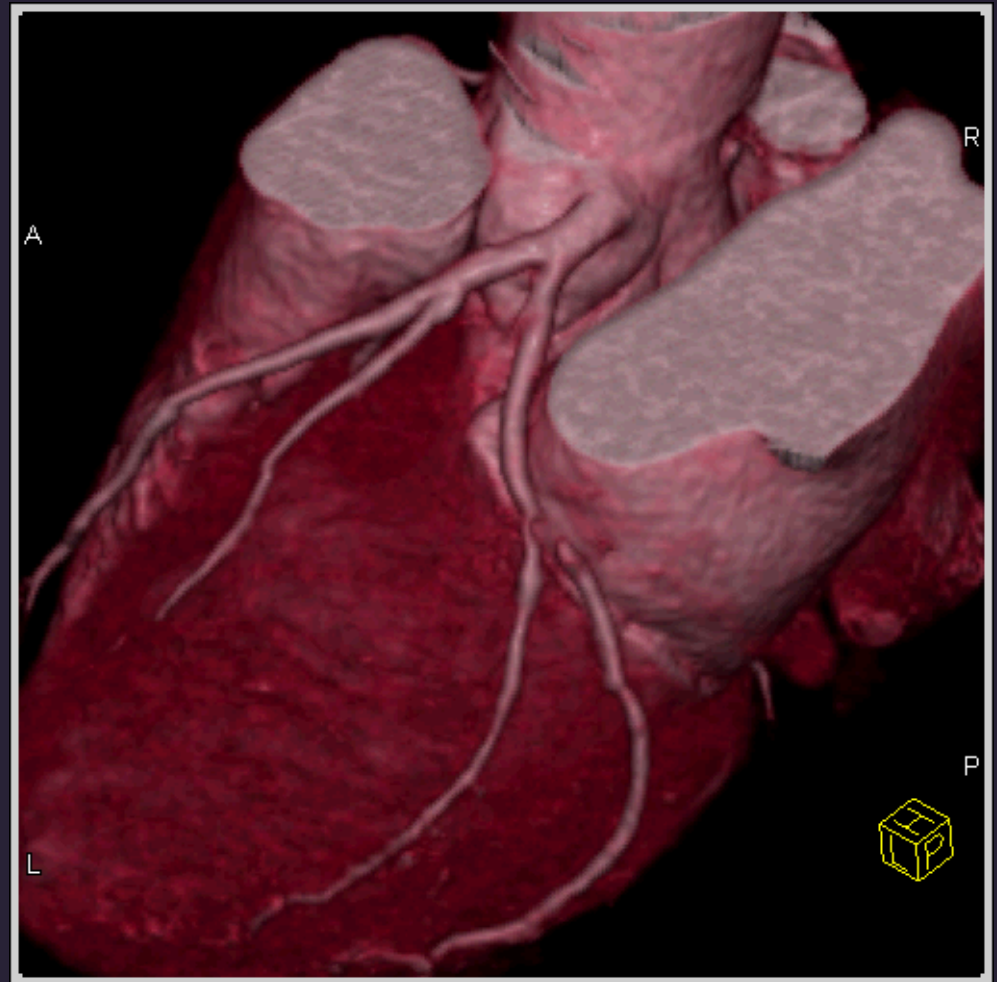


Coronary CTA Volume Data Set:

~ 250 - 350 axial images

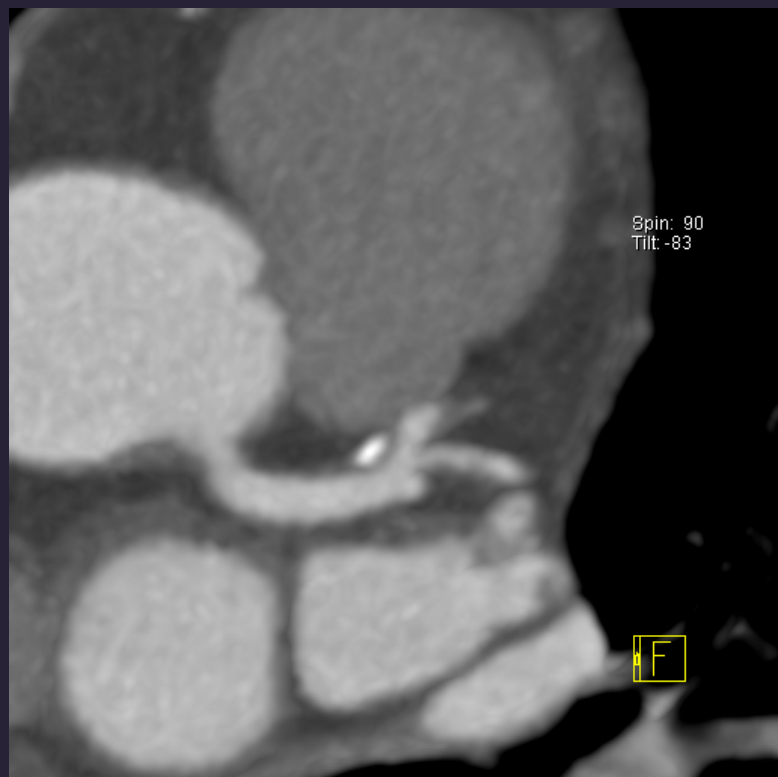
~ 0.5 - 0.75 mm slice thickness

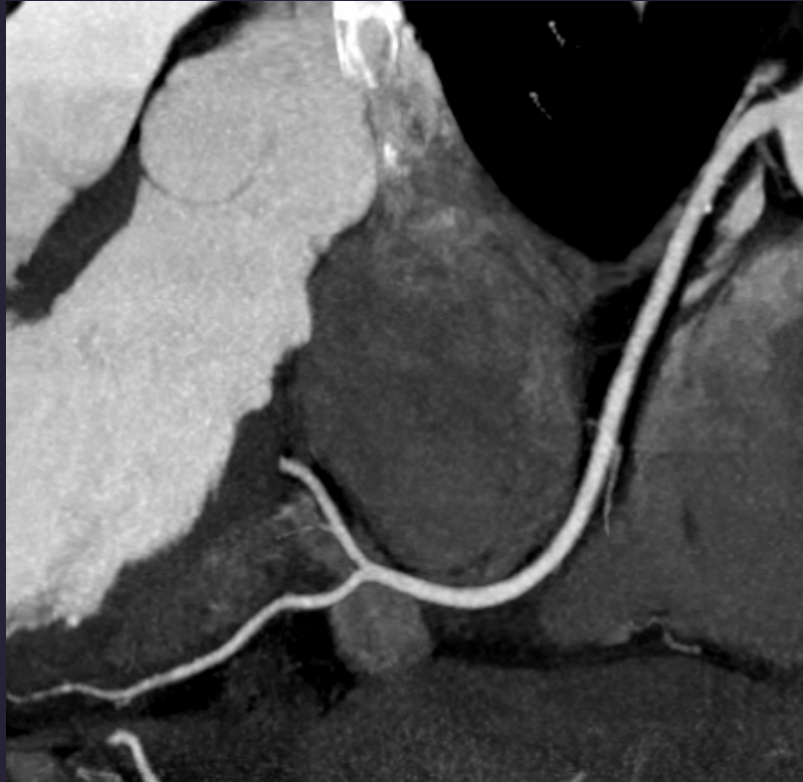












Multi-Detector CT

0.4 mm spatial resolution
~80-200 ms temporal resolution
i.v. contrast



Coronary Angiography

0.2 mm spatial resolution
8 ms temporal resolution
intracoronary contrast

Main Limitation:

Temporal resolution

=> Routine beta blockade (except DSCT)



Stenosis Detection MDCT vs. Cardiac Cath

		n	Sens.	Spec.	unevaluable
16-slice					
Mollet	JACC 2005	51	95%	98%	--
Kuettner	Heart 2005	72	85%	98%	7%
Hoffmann	JAMA 2005	103	95%	98%	6%
Achenbach	Eur Heart J 2005	50	93%	95%	5%
Morgan-Hughes	Heart 2005	57	89%	98%	--
Garcia	JAMA 2006	187	85%	91%	29%
Dewey	AIM 2006	129	83%	86%	9%
40-slice					
Lim	Clin Radiol 2006	30	99%	98%	--
64-slice					
Leschka	Eur Heart J 2005	57	94%	97%	--
Raff	JACC 2005	70	86%	95%	12%
Leber	JACC 2005	59	87%	98%	--
Ropers	AJC 2006	82	95%	93%	4%
Mollet	Circulation 2005	52	99%	95%	2%
Fine	AJC 2006	66	95%	96%	6%
Nikolaou	AJR 2006	72	86%	95%	10%

Stenosis Detection MDCT vs. Cardiac Cath

		n	Sens.	Spec.	unevaluable
Dual Source CT					
Ropers	AHA 2006	40	90%	95%	3%
Weustink	AHA 2006	30	92%	96%	--
Leber	AHA 2006	40	94%	98%	--
256 Slice CT					
Kurata	AHA 2006	9	100%	95%	17%

Stenosis Detection MDCT vs. Cardiac Cath

		n	Sens.	Spec.	unevaluable
Dual Source CT					
Ropers	AHA 2006	40	90%	95%	3%
Weustink	AHA 2006	30	92%	96%	--
Leber	AHA 2006	40	94%	98%	--

No β -blockers used

256 Slice CT

Kurata	AHA 2006	9	100%	95%	17%
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1.5 s data acquisition

Stenosis Detection MDCT vs. Cardiac Cath

Per-Patient Analysis: 16- and 64-slice MDCT

Author	n	Scanner Type	Sens.	Spec.	NPV
Mollet	51	16x0.75/375 ms	100%	100%	100%
Hoffmann	103	16x0.75/420 ms	95%	97%	94%
Achenbach	50	16x0.75/375 ms	100%	83%	100%
Garcia	187	16x0.75/420 ms	98%	54%	99%
Leschka	53	64x0.6/375 ms	100%	100%	100%
Raff	70	64x0.6/330 ms	95%	90%	93%
Leber	59	64x0.6/330 ms	94%	--	--
Mollet	52	64x0.6/330 ms	100%	92%	100%
Ropers	82	64x0.6/330 ms	96%	91%	98%
Nikolaou	72	64x0.6/330 ms	97%	92%	95%



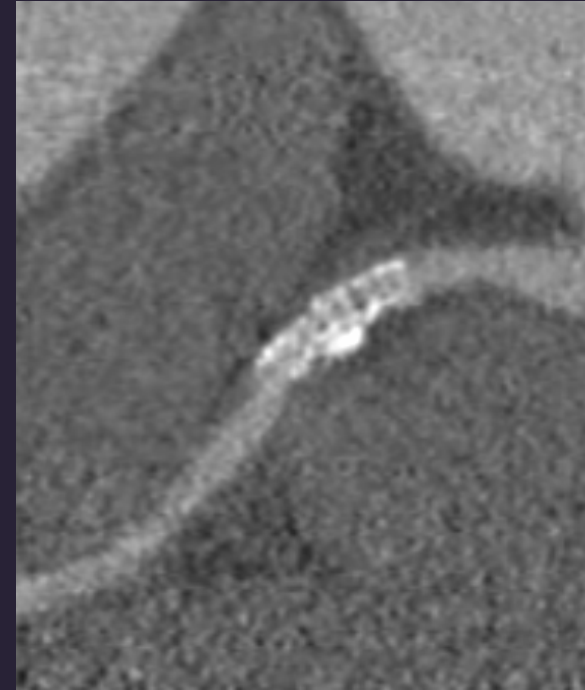
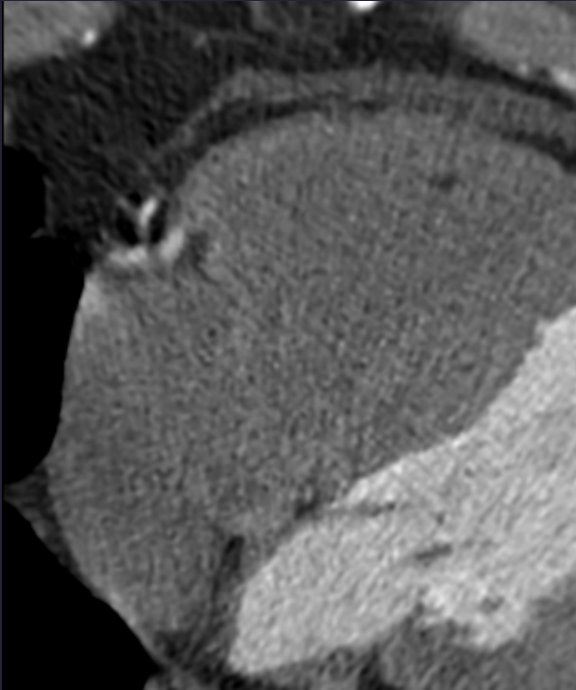
Stenosis Detection MDCT vs. Cardiac Cath

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Leschka	53	64x0.6/375 ms	100%	100%	100%
Raff	70	64x0.6/330 ms	95%	90%	93%
Leber	59	64x0.6/330 ms	94%	--	--
Mollet	52	64x0.6/330 ms	100%	92%	100%
Ropers	82	64x0.6/330 ms	96%	91%	98%
Nikolaou	72	64x0.6/330 ms	97%	92%	95%



LIMITATIONS



Motion (High Heart Rates)
Calcium
Stents
Arrhythmias
Contrast

Limitations

Calcium, Motion

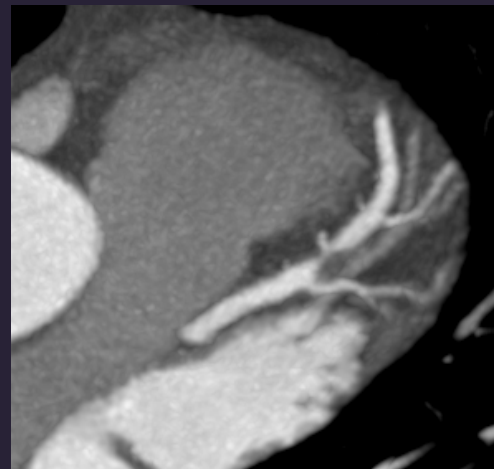
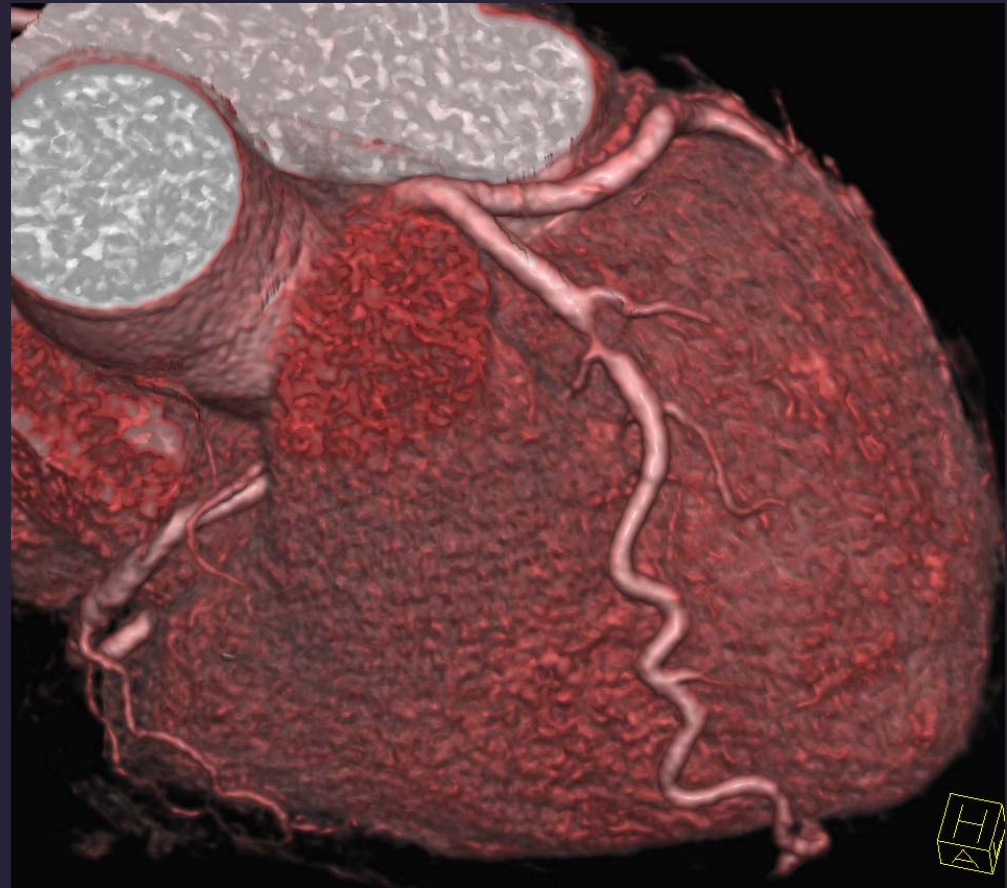
Sinus rhythm

Contrast

Purely diagnostic

No intervention

Not in clinical settings with
high likelihood of stenoses



In somewhat selected patients:

- High negative predictive value to
- rule out coronary stenoses



In somewhat selected patients:

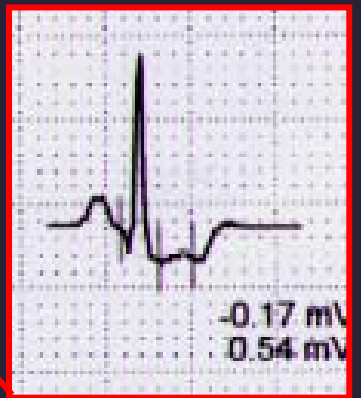
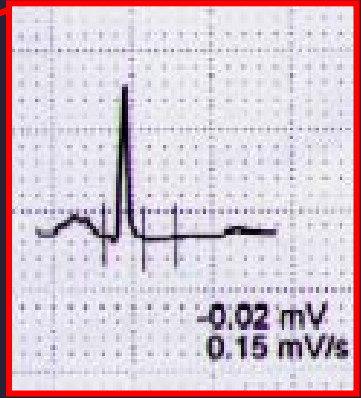
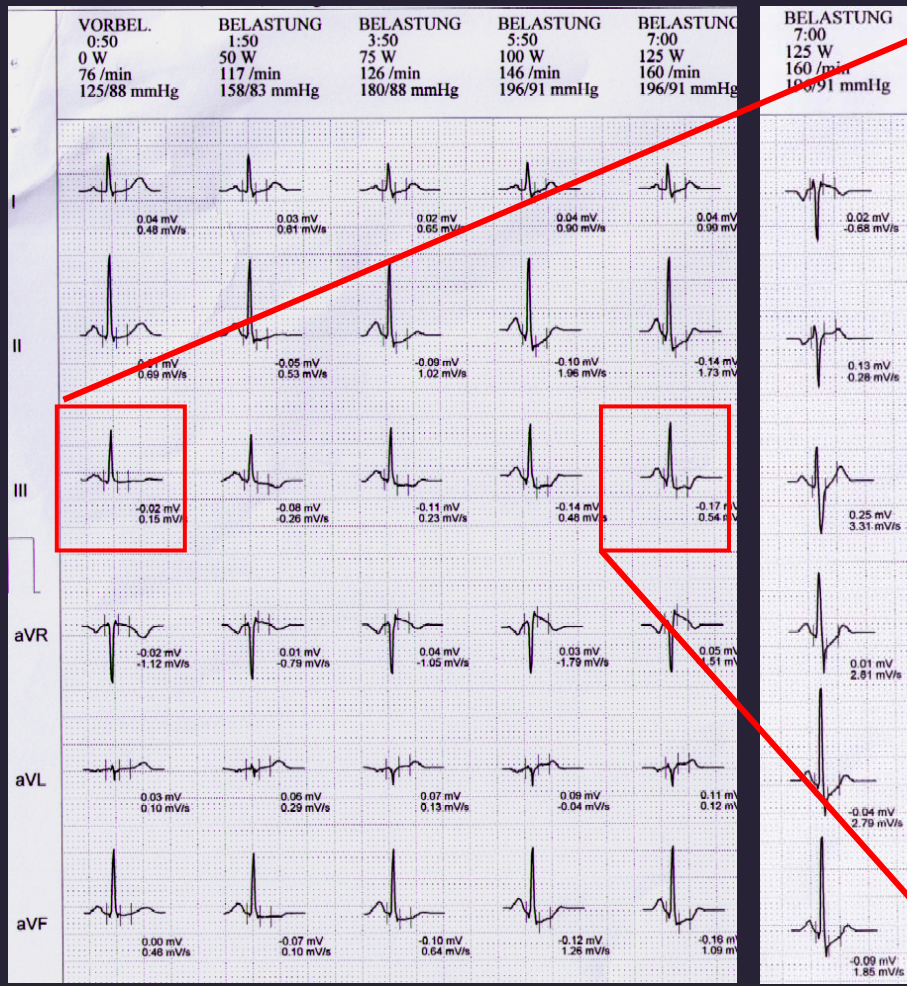
- High negative predictive value to
- rule out coronary stenoses

„Is this a patient who does NOT need a cath?“

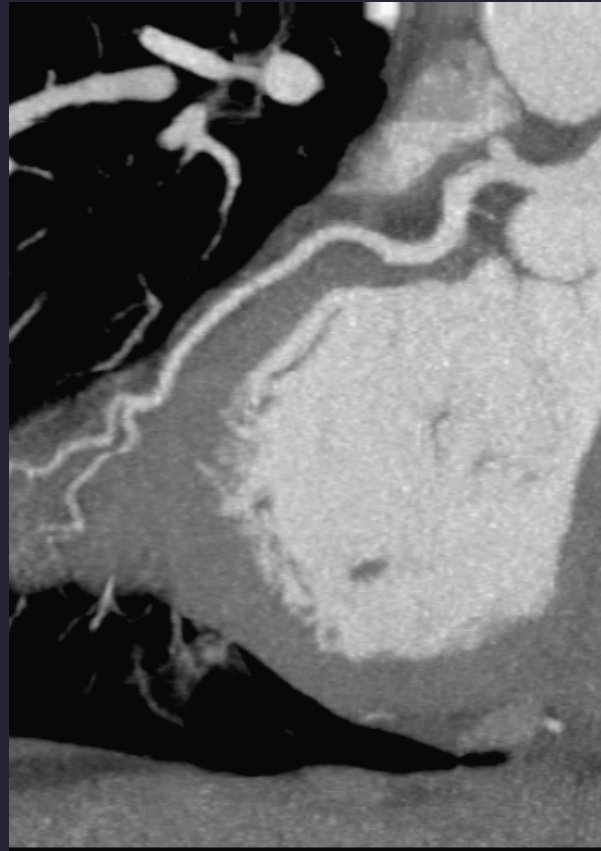
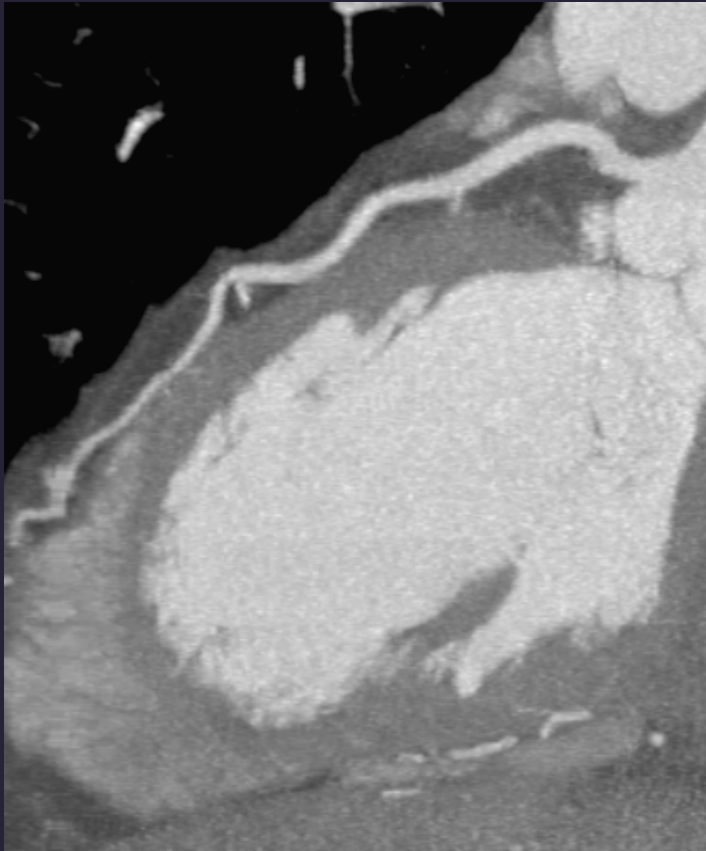


Cath Lab Technician, 56 years

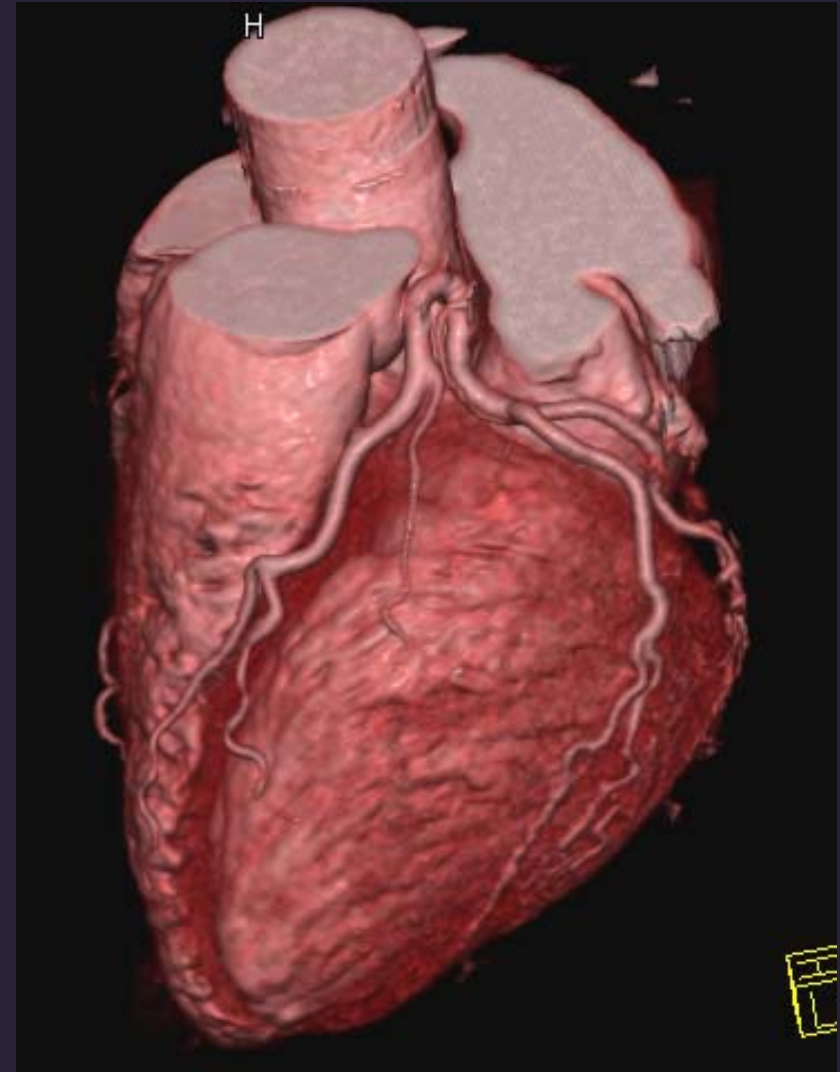
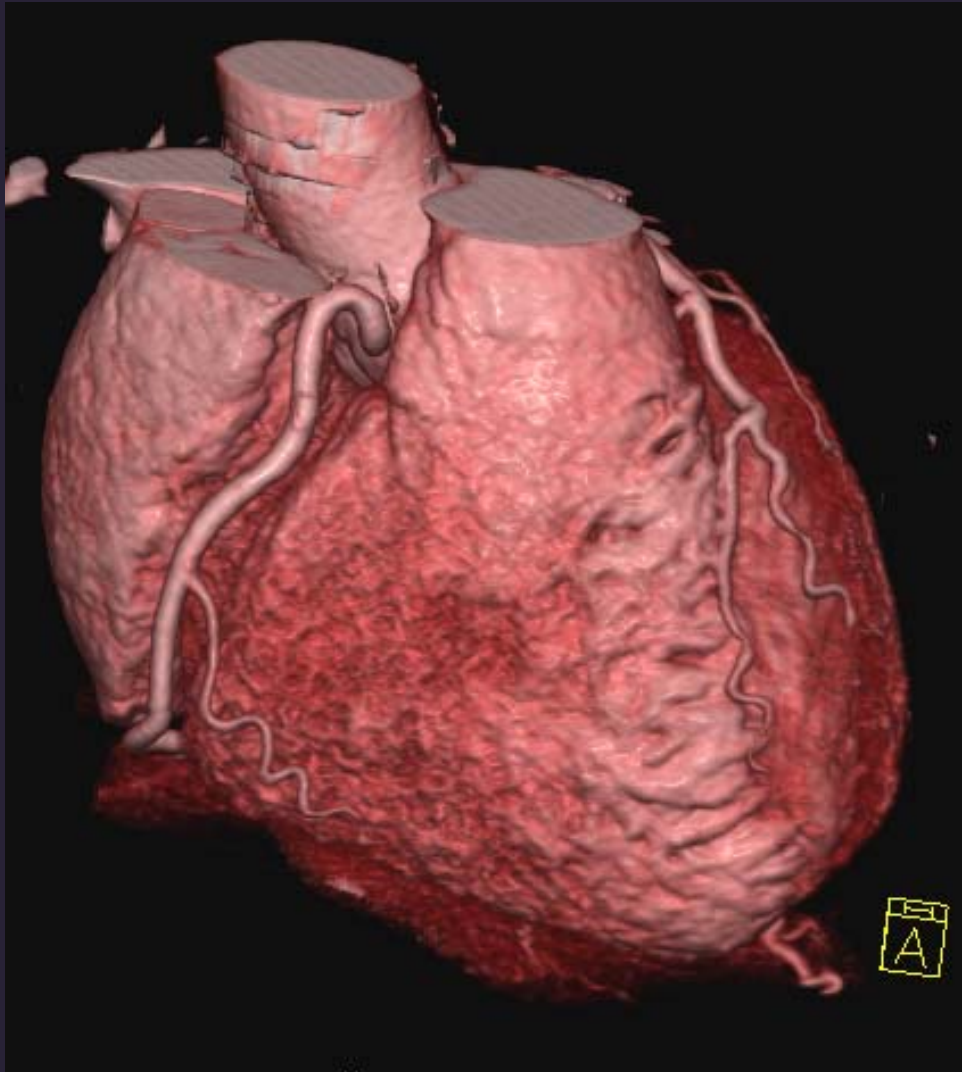
Chest Pain



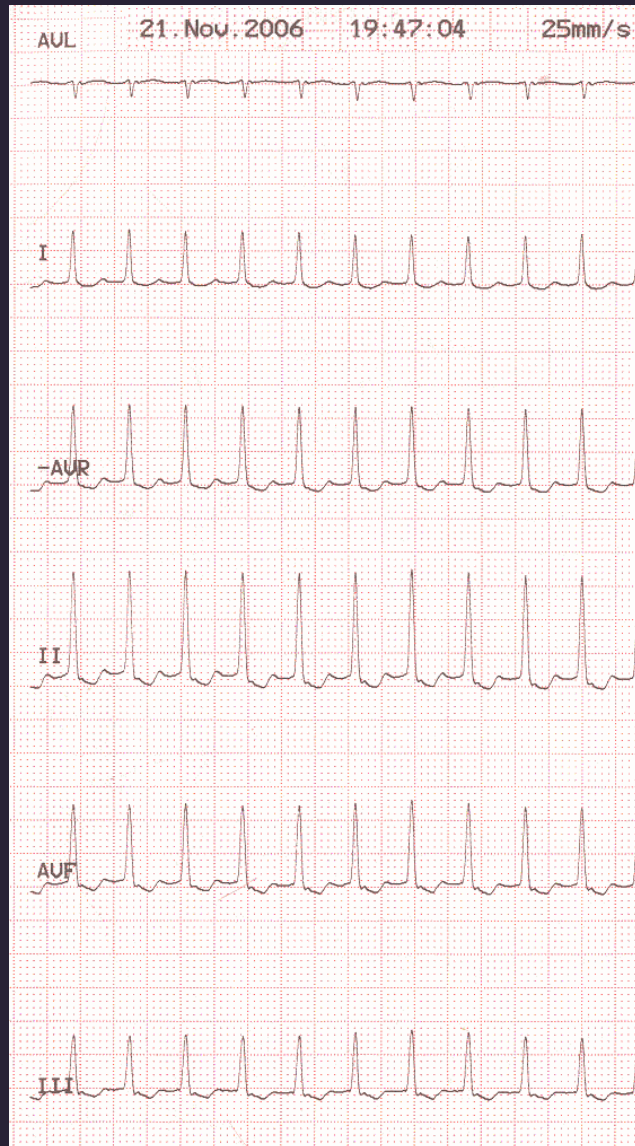
Cath Lab Technician, 56 years
Chest Pain



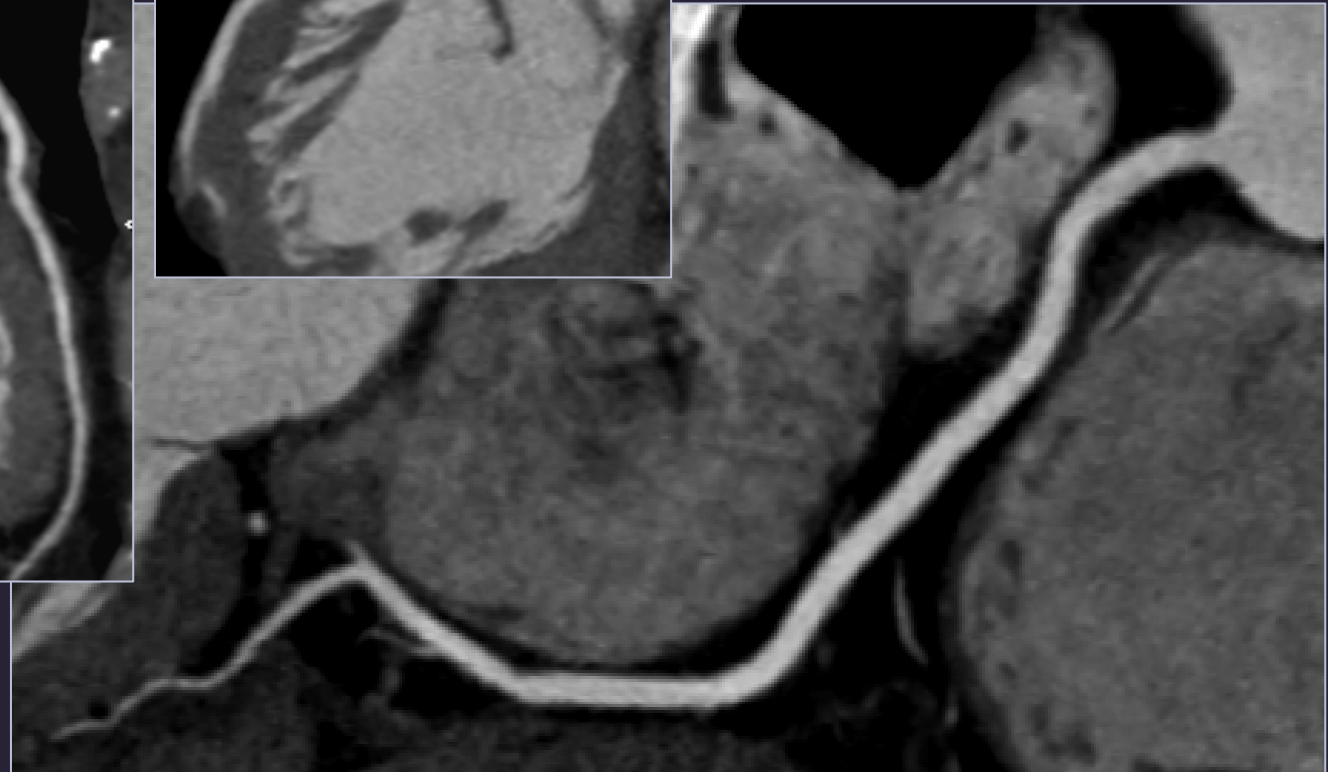
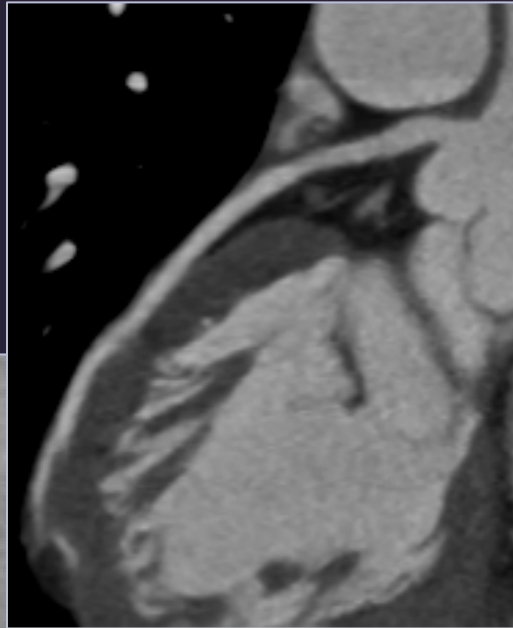
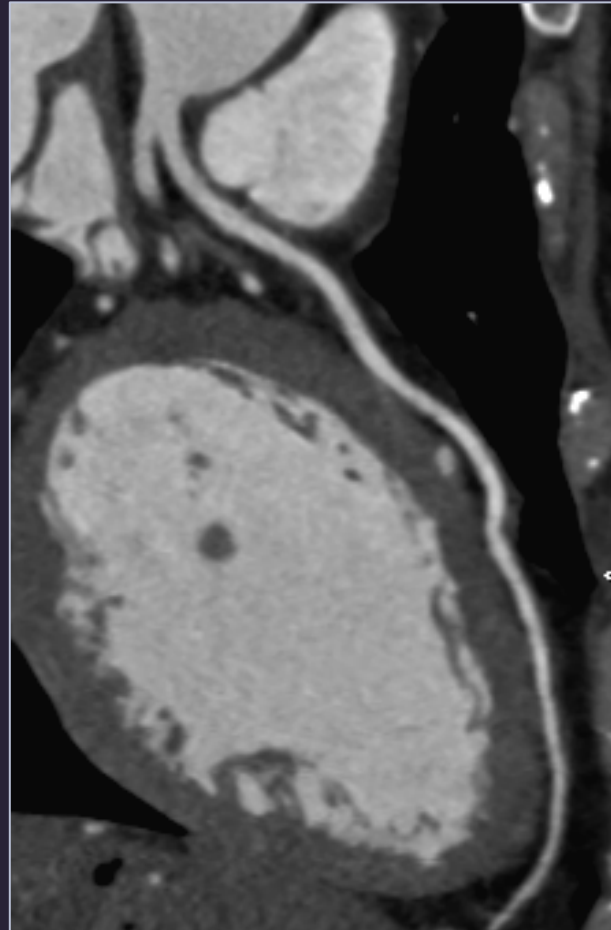
Cath Lab Technician, 56 years
Chest Pain



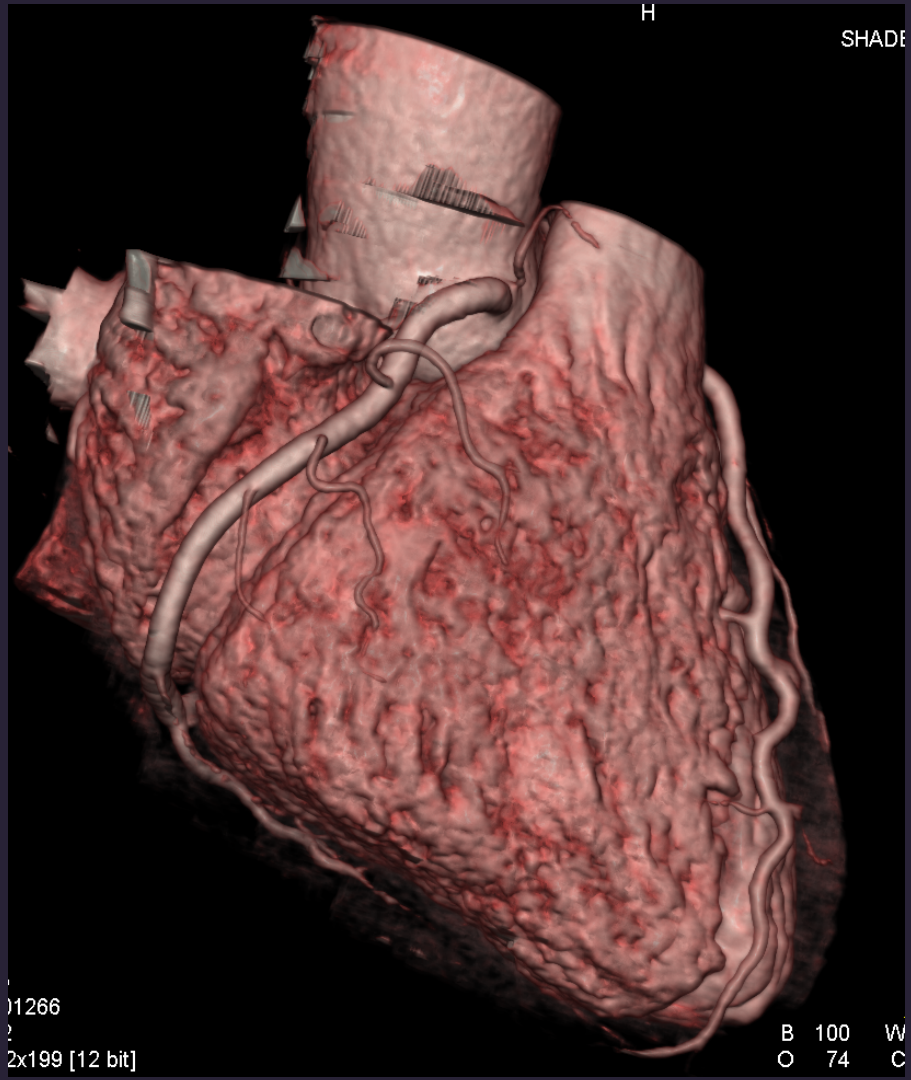
53 years, repeated episodes of tachycardia and chest pain
Troponin 2.0



53 years, repeated episodes of tachycardia and chest pain
Troponin 2.0

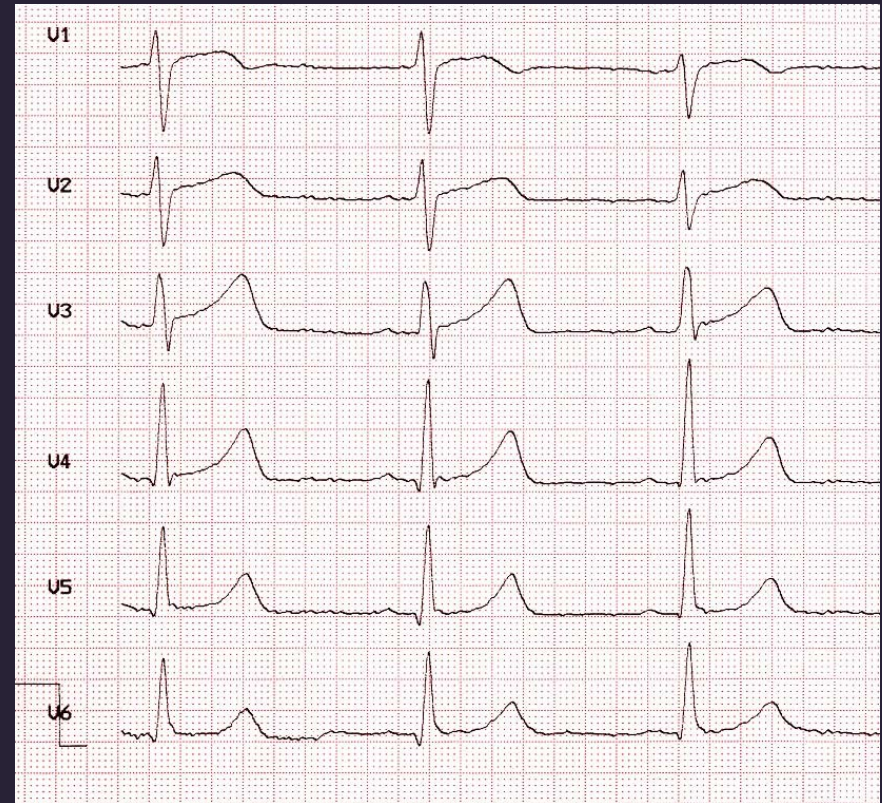
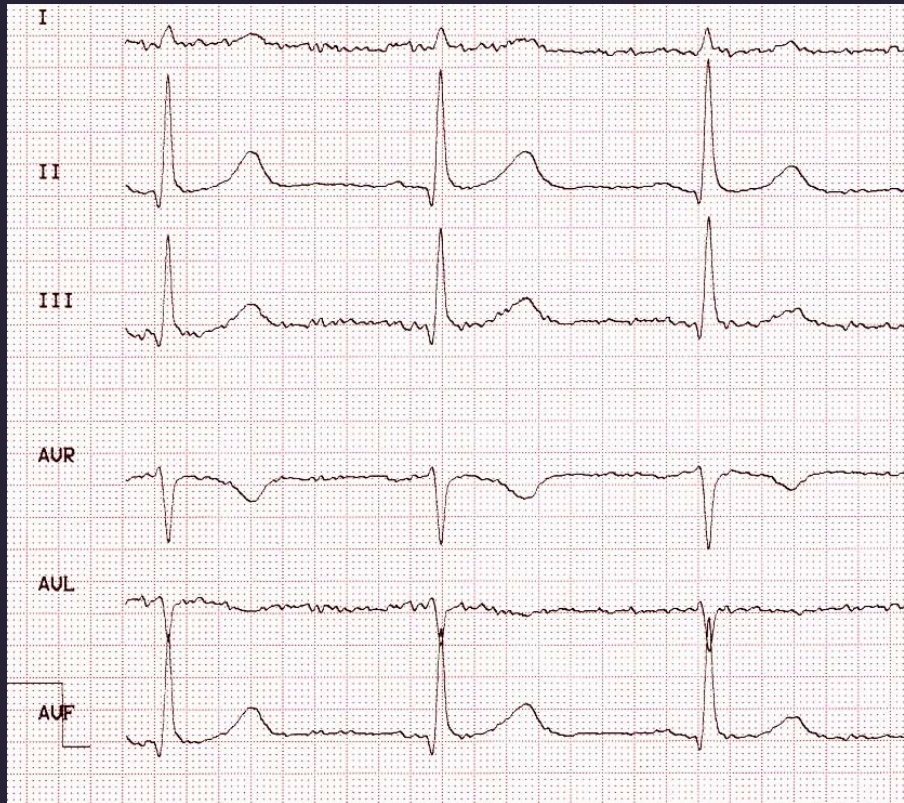


53 years, repeated episodes of tachycardia and chest pain
Troponin 2.0



66 years, chest pain at rest, no enzymes, echo normal. CAD?

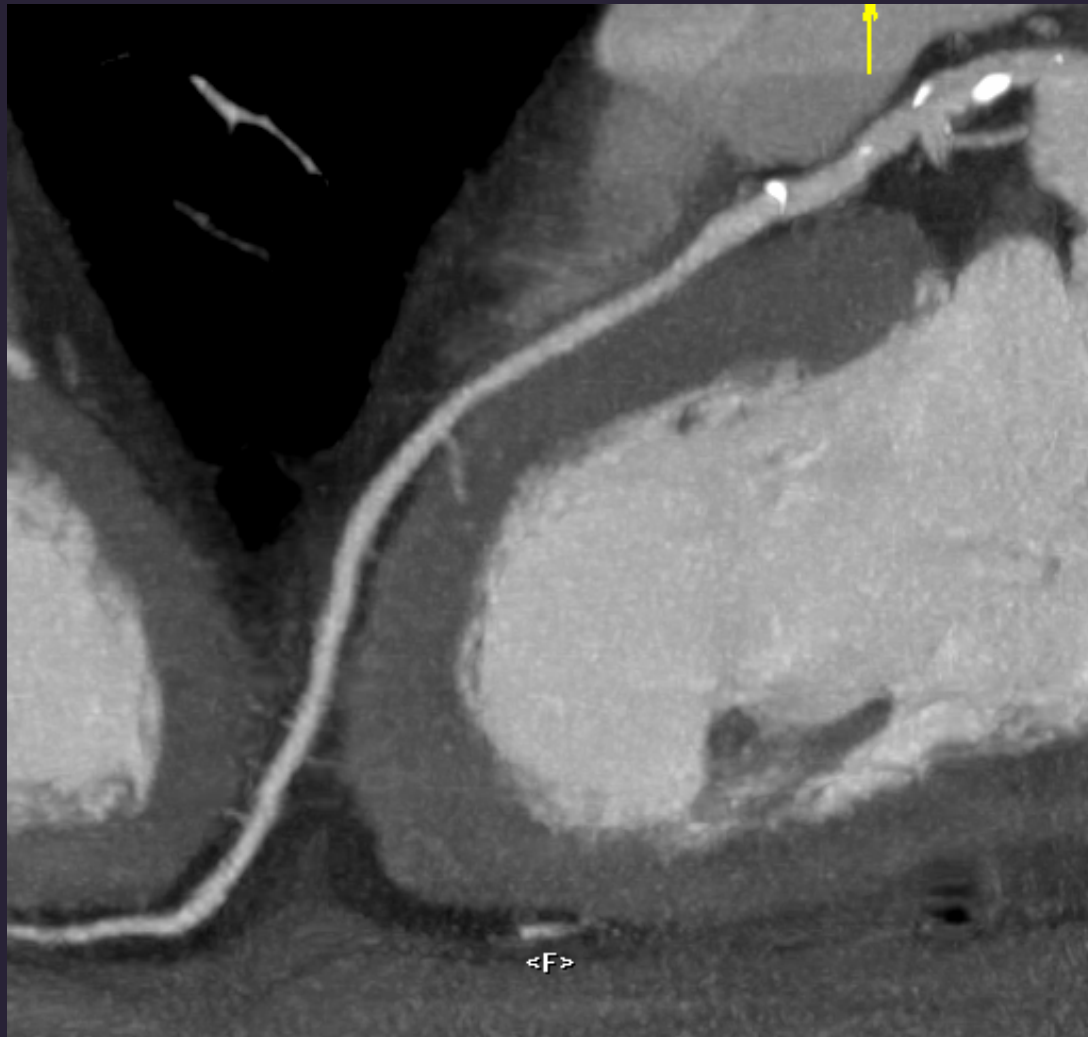
66 years, chest pain at rest, no enzymes, echo normal. CAD?



66 years, chest pain at rest, no enzymes, echo normal. CAD?



66 years, chest pain at rest, no enzymes, echo normal. CAD?



66 years, chest pain at rest, no enzymes, echo normal. CAD?



66 years, chest pain at rest, no enzymes, echo normal. CAD?



CTA in the Emergency Department

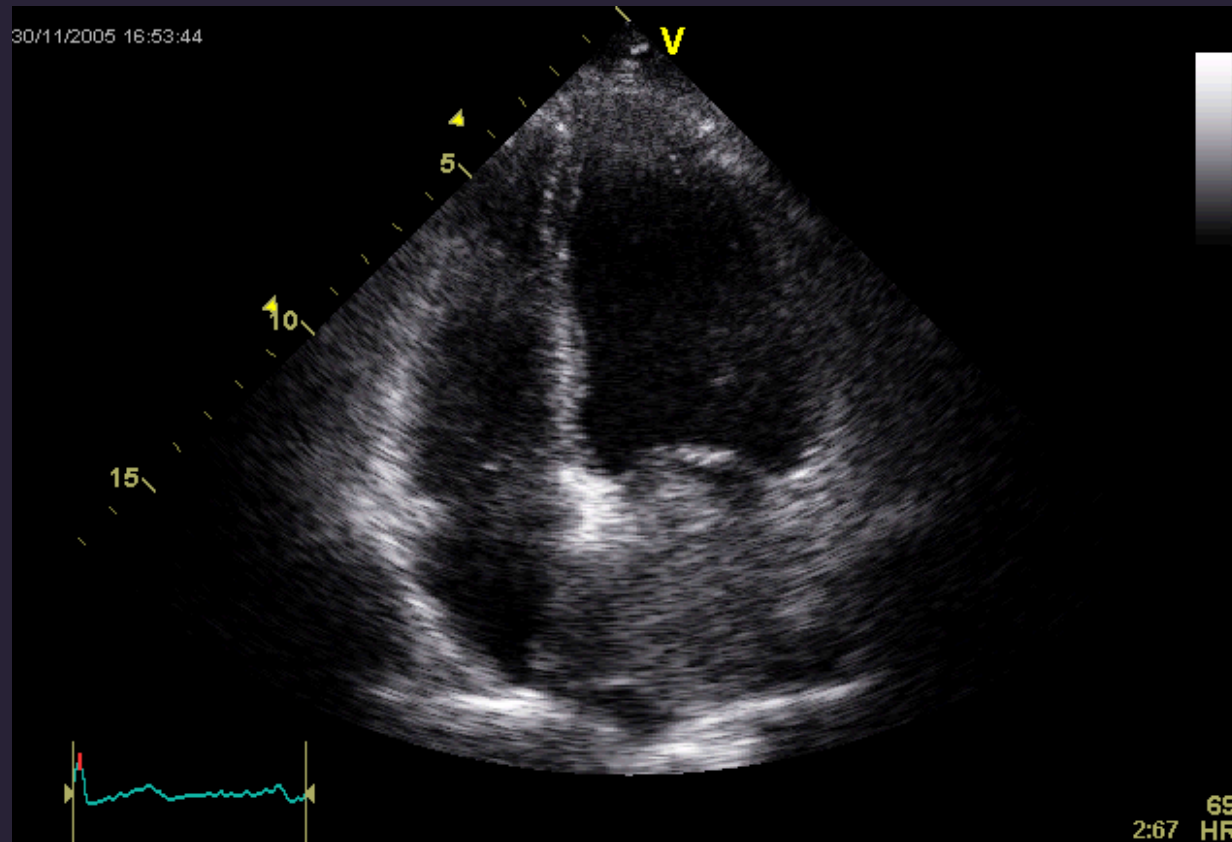
Hoffmann et al, Circulation 2006

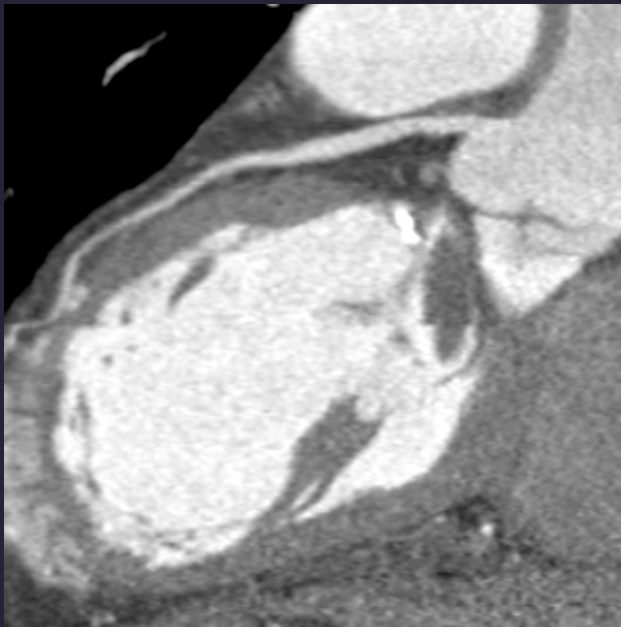
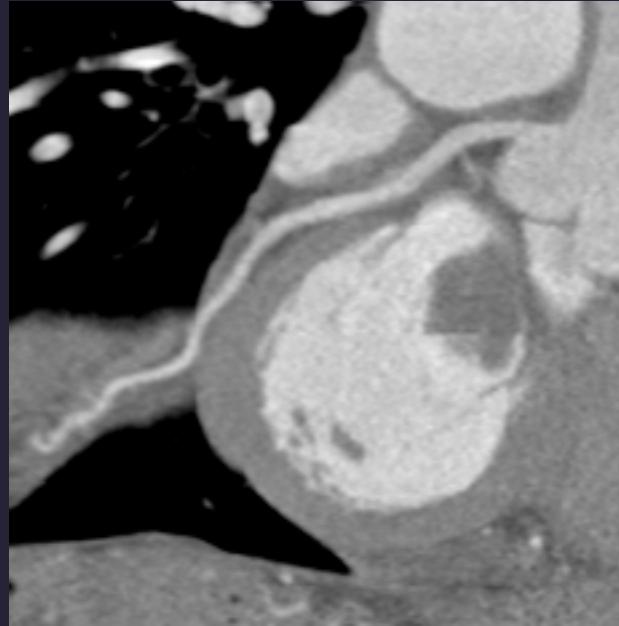
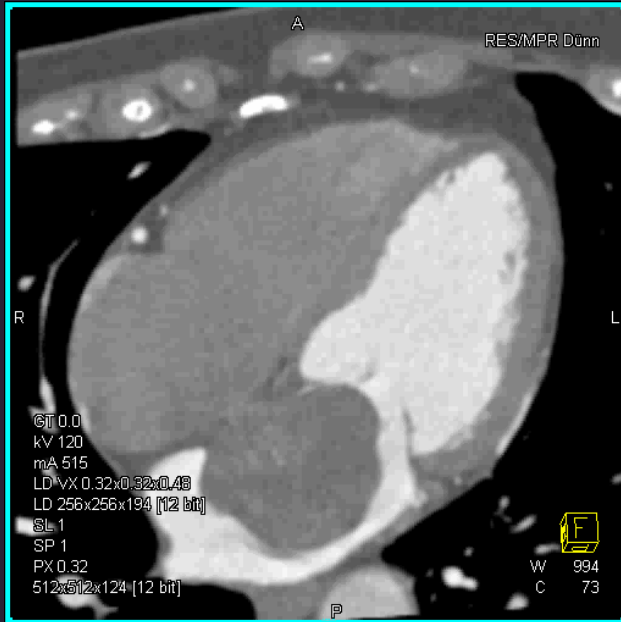
305 pts screened

104 pts with ACS included(no enzymes, no ECG)

14/14 patients with coronary stenoses detected
(sensitivity 100%, specificity 82%)

Female, 73 years, with left atrial myxoma
Pre-operative evaluation to rule out CAD





CTA before valve surgery

Meijboom et al, J Am Coll Cardiol 2006: 64 slice CT

105 pts with aortic valve stenosis

35 excluded (26 arrhythmias, 5 renal failure, 4 allergy)

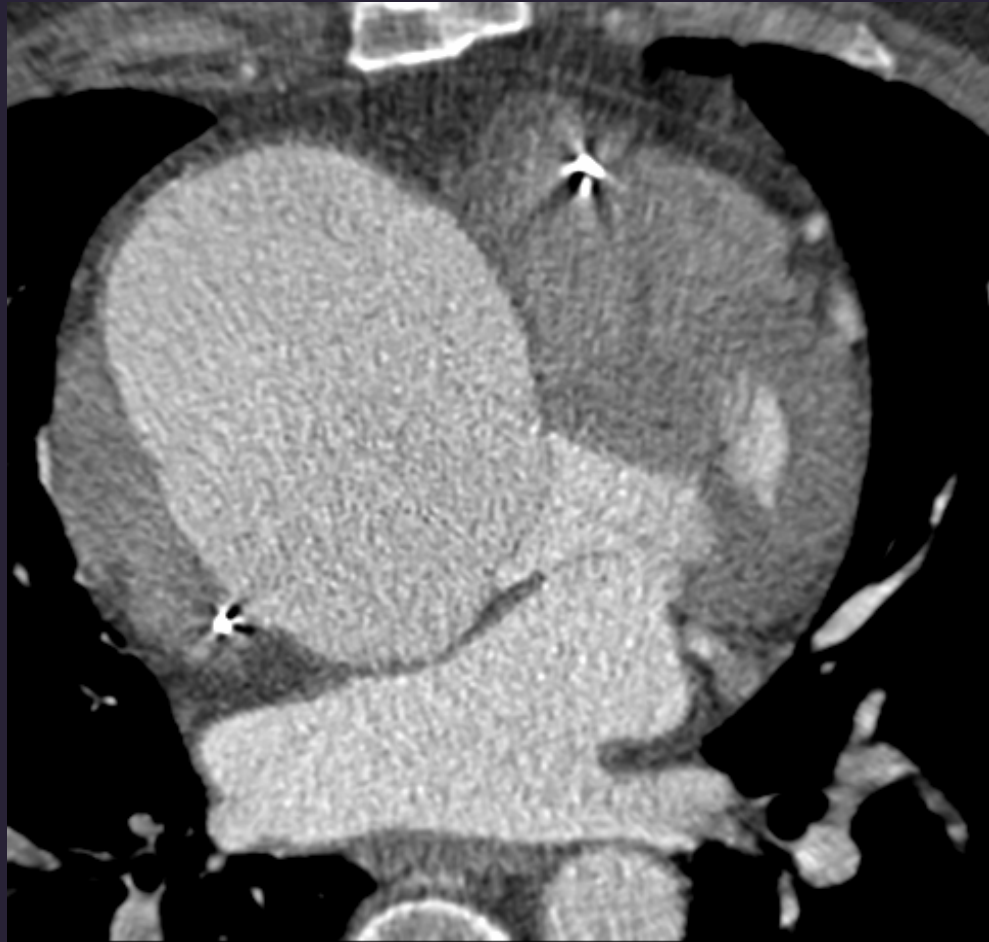
Sensitivity 100% (18/18)

Specificity 92% (48/52)

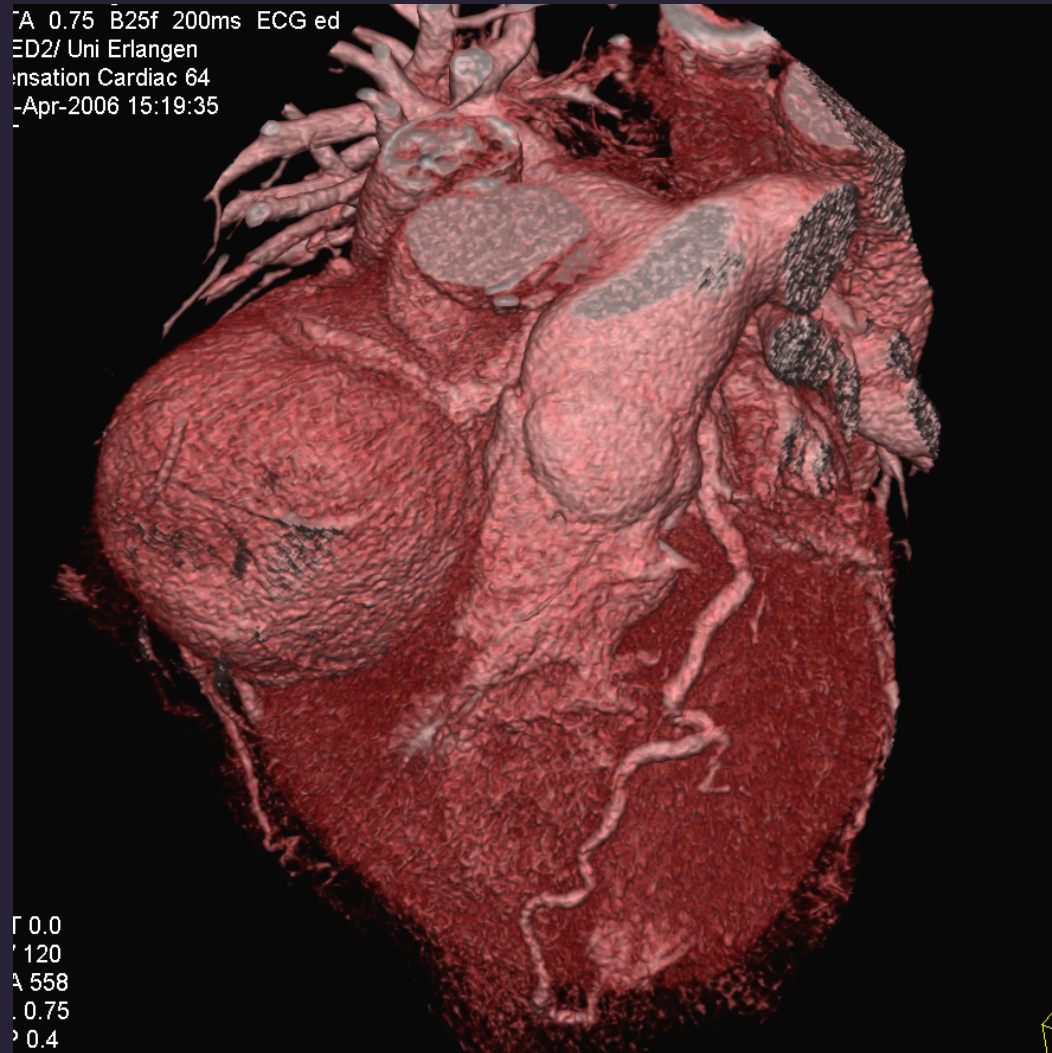
53 years, aortic root aneurysm.

Surgery planned.

53 years, aortic root aneurysm.
Surgery planned.



53 years, aortic root aneurysm.
Surgery planned.



Useful for the Cardiologist:

Reliably rule out the presence of significant coronary artery stenosis

Stable patients - -
acute chest pain

Accurate grading of lesion severity not so important.



Anomalous Coronary Arteries



Anomalous Coronary Arteries

Ropers D et al, *AJC* 2001

Deibler AR et al, *Mayo Clin Proc* 2004

Datta J et al, *Radiology* 2005

van Ooijen PM et al, *Eur Radiol* 2004

Memisoglu et al, *Cath Card Interv* 2005

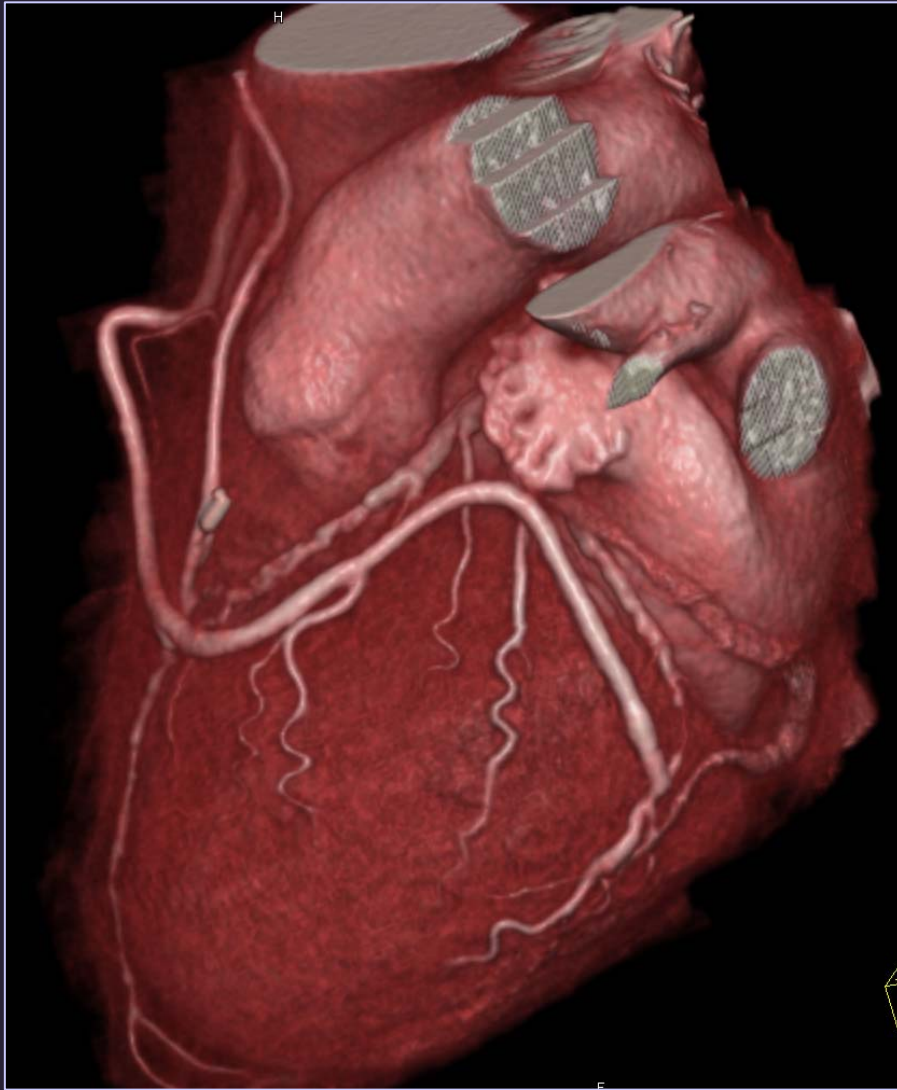
Manghat NE et al, *Heart* 2005

Schmid M et al, *Int J Cardiol* 2006

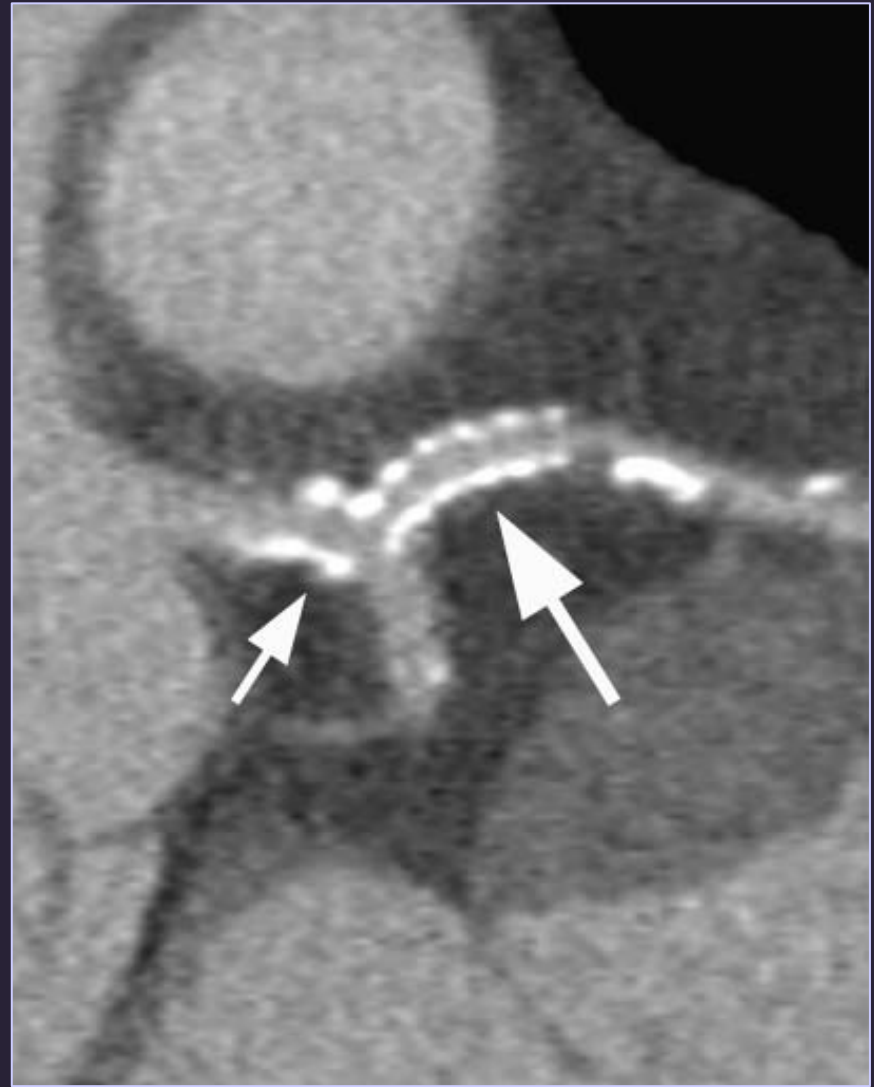
... and many case reports



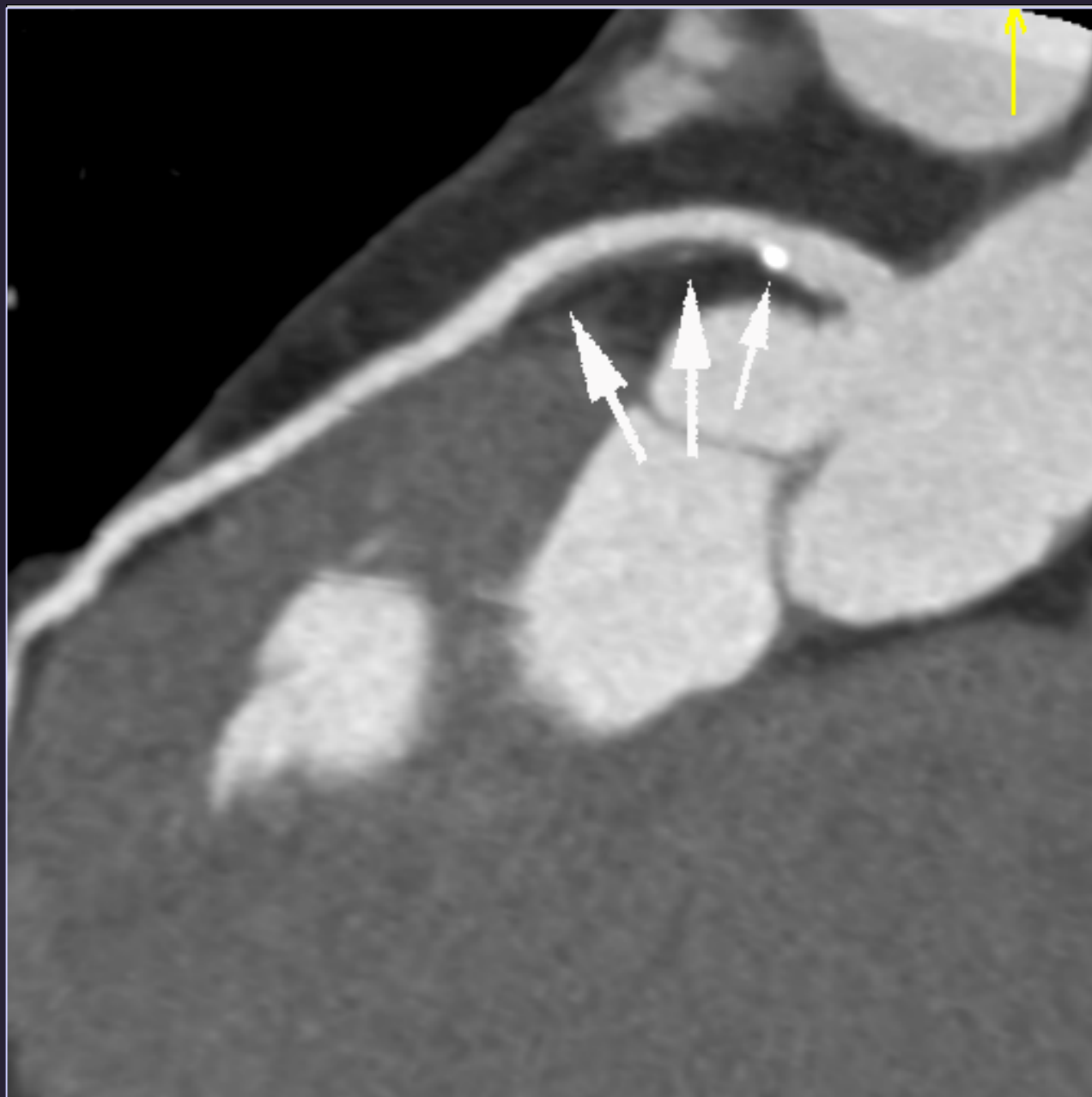
Bypass Grafts



Coronary Stents



Plaque



CT for Pre-interventional Assessment?

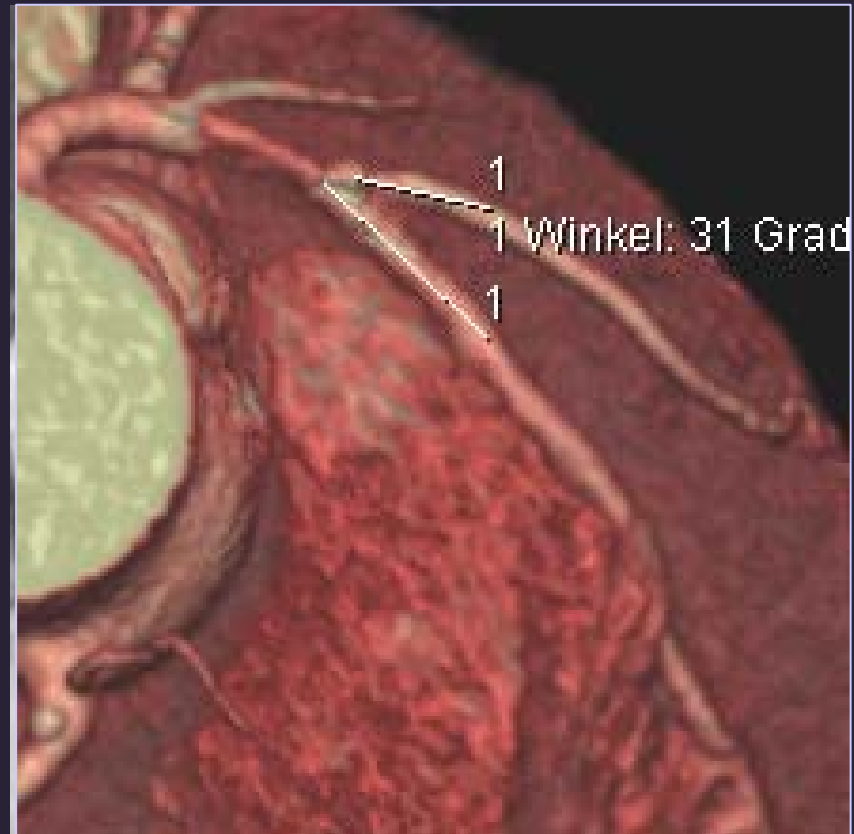
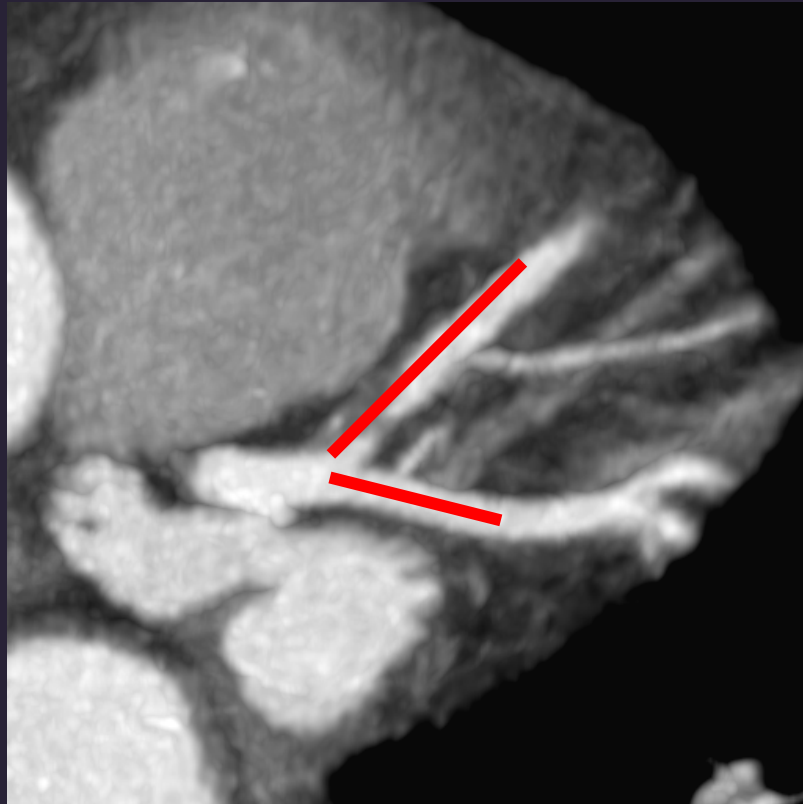
Plaque Distribution/Extent



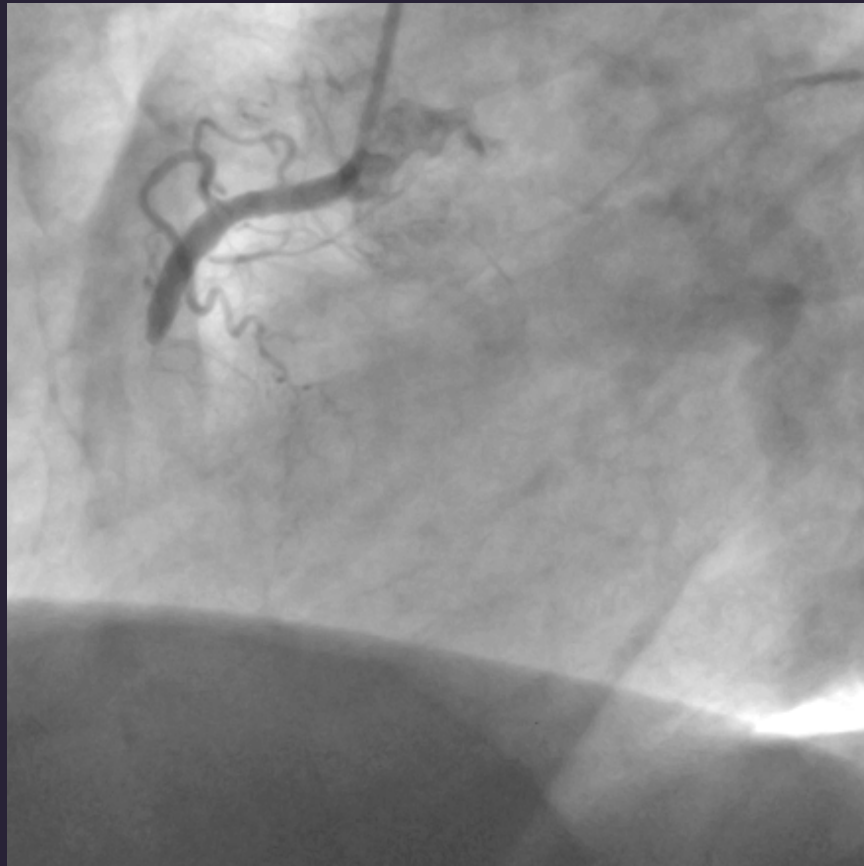
Ostial and Bifurcation Lesions



Ostial and Bifurcation Lesions



Chronic Total Occlusions



Main role to rule out coronary stenoses

AHA Scientific Statement

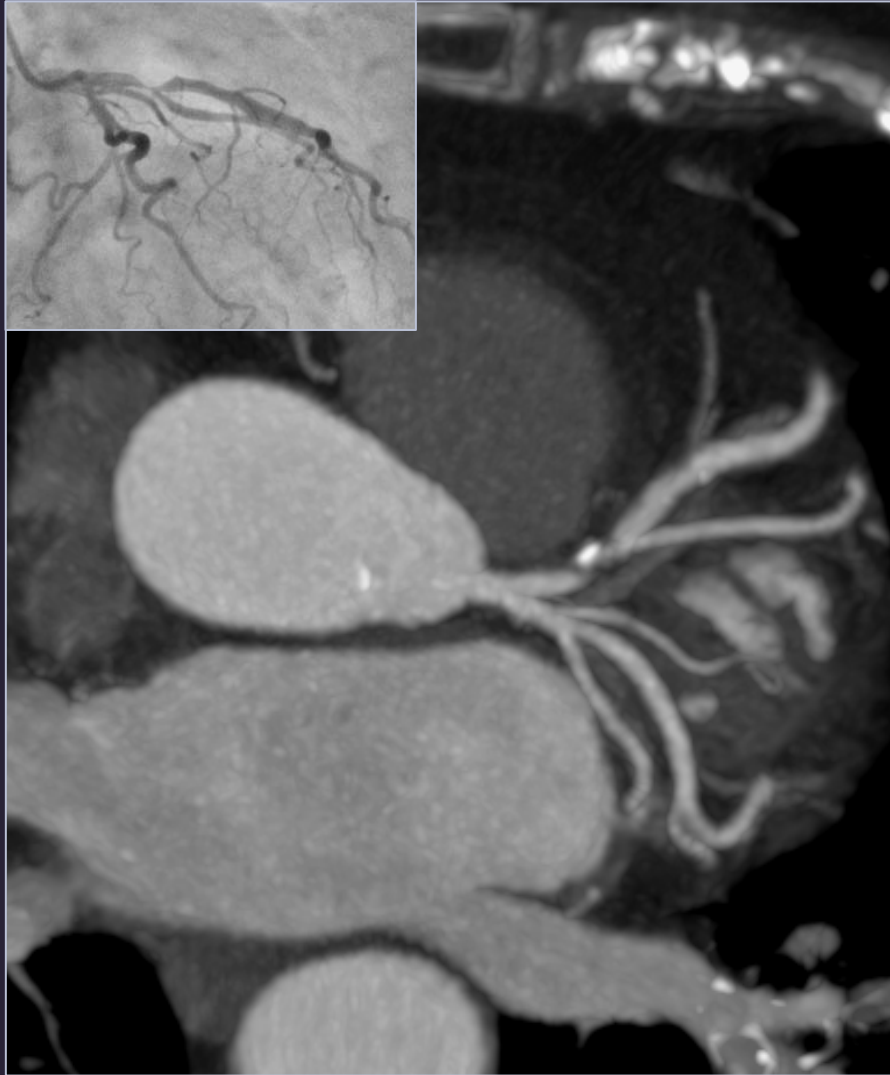
Assessment of Coronary Artery Disease by Cardiac Computed Tomography

Especially in the context of ruling out stenosis in patients with low to intermediate pretest likelihood of disease, CT coronary angiography may develop into a clinically useful tool. CT coronary angiography is reasonable for the assessment of obstructive disease in symptomatic patients (**Class IIa, Level of Evidence: B**).

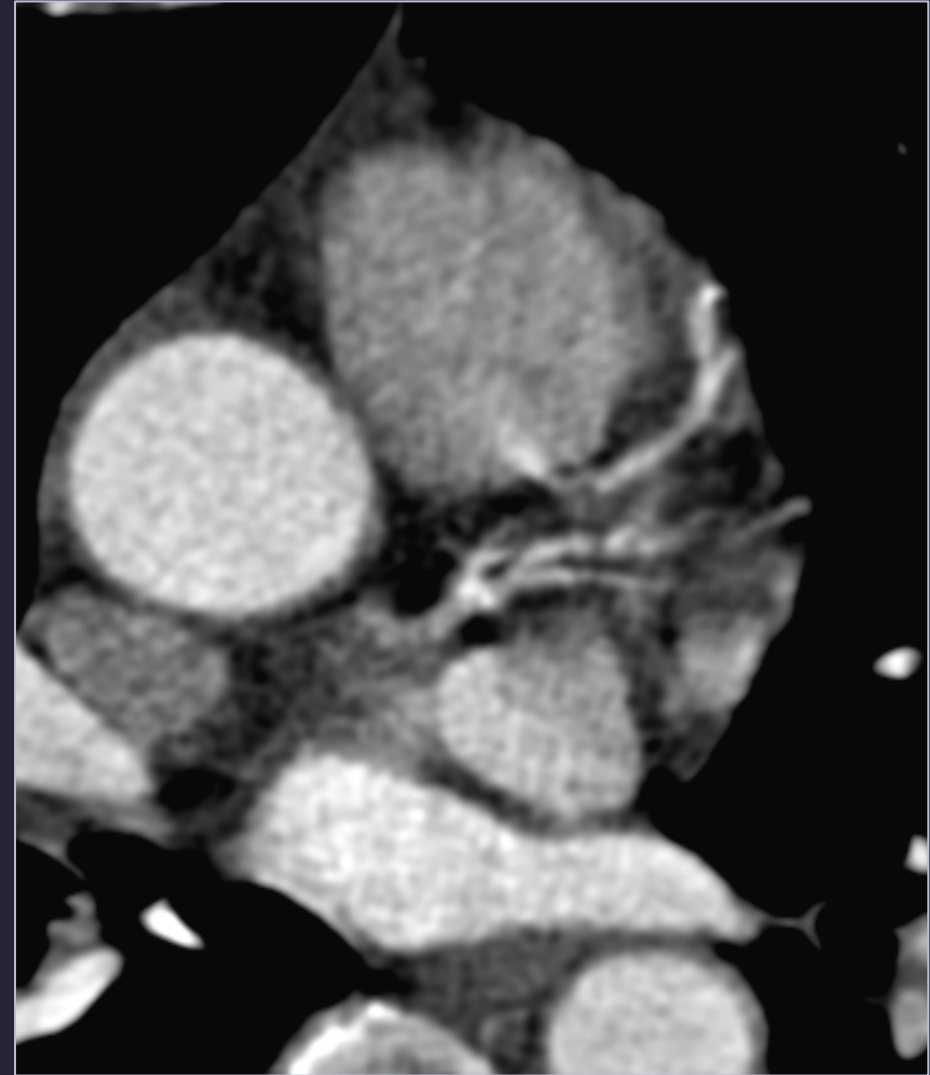
(*Circulation*. 2006;114:1761-1791.)



INDICATION	SCORE	
Detection of CAD With Prior Test Results - Evaluation of Chest Pain Syndrome (CT Angiogram) Uninterpretable or equivocal stress test result (exercise, perfusion, or stress echo)	8	
Detection of CAD: Symptomatic - Evaluation of Chest Pain Syndrome (CT Angiogram) Intermediate pre-test probability of CAD, ECG uninterpretable or unable to exercise	7	
Detection of CAD: Symptomatic - Acute Chest Pain (CT Angiogram) Intermediate pre-test probability of CAD, No ECG changes and serial enzymes negative	7	
Structure and Function - Morphology (Use of CT Angiogram) Evaluation of coronary arteries in patients with new onset heart failure to assess etiology	7	
Detection of CAD: Symptomatic - Evaluation of Intra-Cardiac Structures (CT Angiogram) Evaluation of suspected coronary anomalies	9	
Structure and Function - Morphology (Use of CT Angiogram) Assessment of complex congenital heart disease including anomalies of coronary circulation, great vessels, and cardiac chambers and valves	7	
Structure and Function - Evaluation of Intra- and Extra-cardiac Structures (Use of cardiac CT) Evaluation of cardiac mass (suspected tumor or thrombus), Patients with technically limited images from echocardiogram, MRI, or TEE	8	
Structure and Function - Evaluation of Intra- and Extra-cardiac Structures (Use of Cardiac CT) Evaluation of pulmonary vein anatomy prior to invasive radiofrequency ablation for atrial fibrillation	8	
Structure and Function - Evaluation of Intra- and Extra-cardiac Structures (Use of Cardiac CT) Noninvasive coronary vein mapping prior to placement of biventricular pacemaker	8	
Structure and Function - Evaluation of Intra- and Extra-cardiac Structures (Use of Cardiac CT) Noninvasive coronary arterial mapping, including internal mammary artery, prior to repeat cardiac surgical revascularization	8	
ACCF/ACR/SCCT/SCMR/ ASNC/NASCI/SCAI/SIR Appropriateness Criteria for Cardiac Computed Tomography and Cardiac Magnetic Resonance Imaging*	Pulmonary Disease (Use of CT Angiogram*) aneurysm	9
	Pulmonary Disease (Use of CT Angiogram*)	9



Experience in and Dedication to



Data Acquisition
Data Interpretation
Clinical Assessment

Coronary CT Angiography

Highly reliable to rule out
coronary stenosis if expertly performed

“Is this a patient who does not need a cardiac cath?”

Especially in situations of
low or intermediate pre-test
likelihood (stable or acute)

Bypass ~ Stent ~ Plaque ~ Peri-intervention