SIR 36TH ANNUAL SCIENTIFIC MEETING

IR RISING:
LEADING IMAGE GUIDED MEDICINE

CHICAGO, ILLINOIS • MARCH 26-31, 2011

SOCIETY OF INTERVENTIONAL RADIOLOGY

Introduction to Coronary / Cardiac CTA

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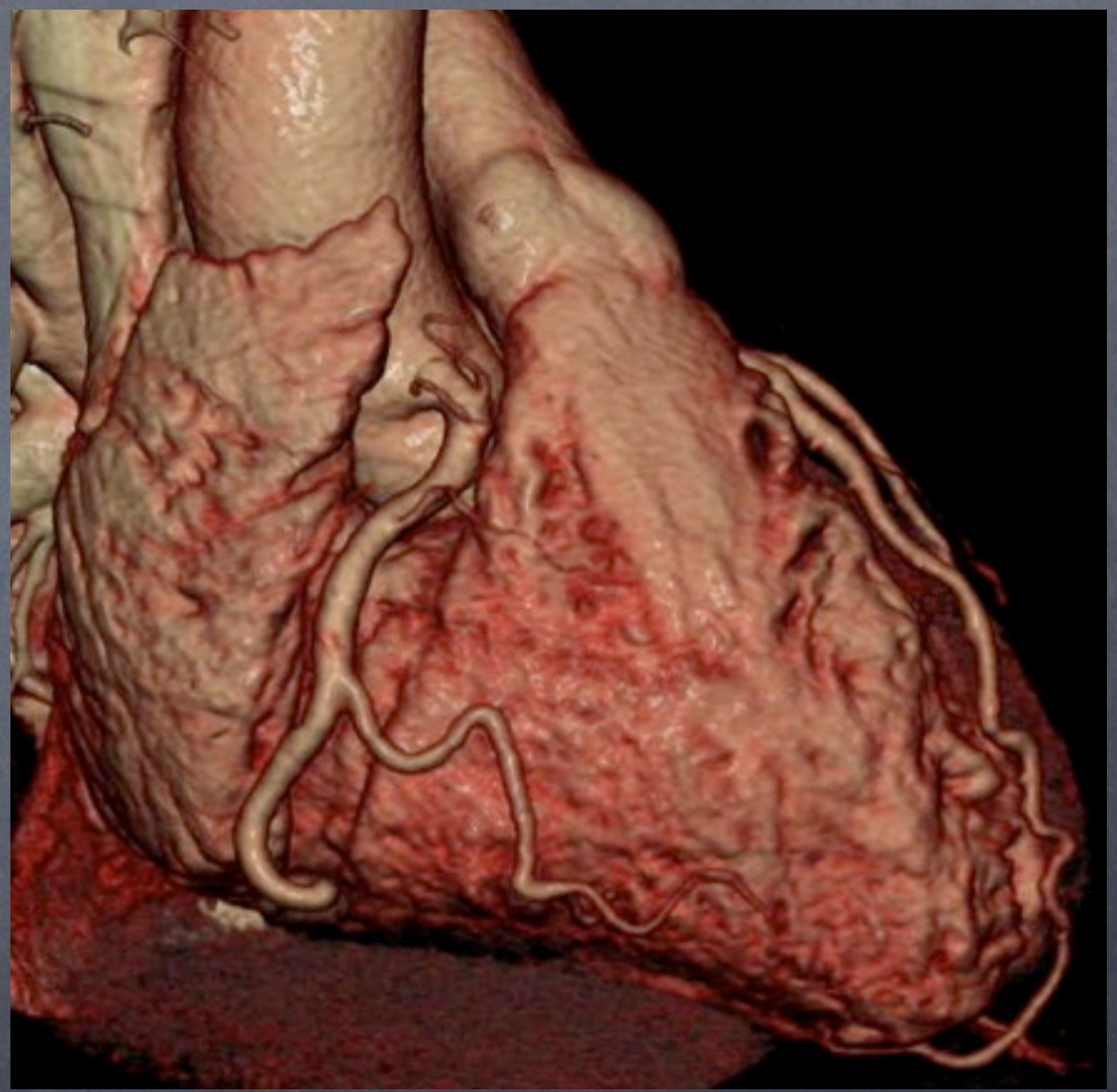
Disclosures: None

Handouts, more: http://stanford.edu/~hallett

Overview

- CCTA Technique
- Indications / Appropriateness
- Coronary Anatomy
- Cases



Handouts and more: http://stanford.edu/~hallett

More Information:

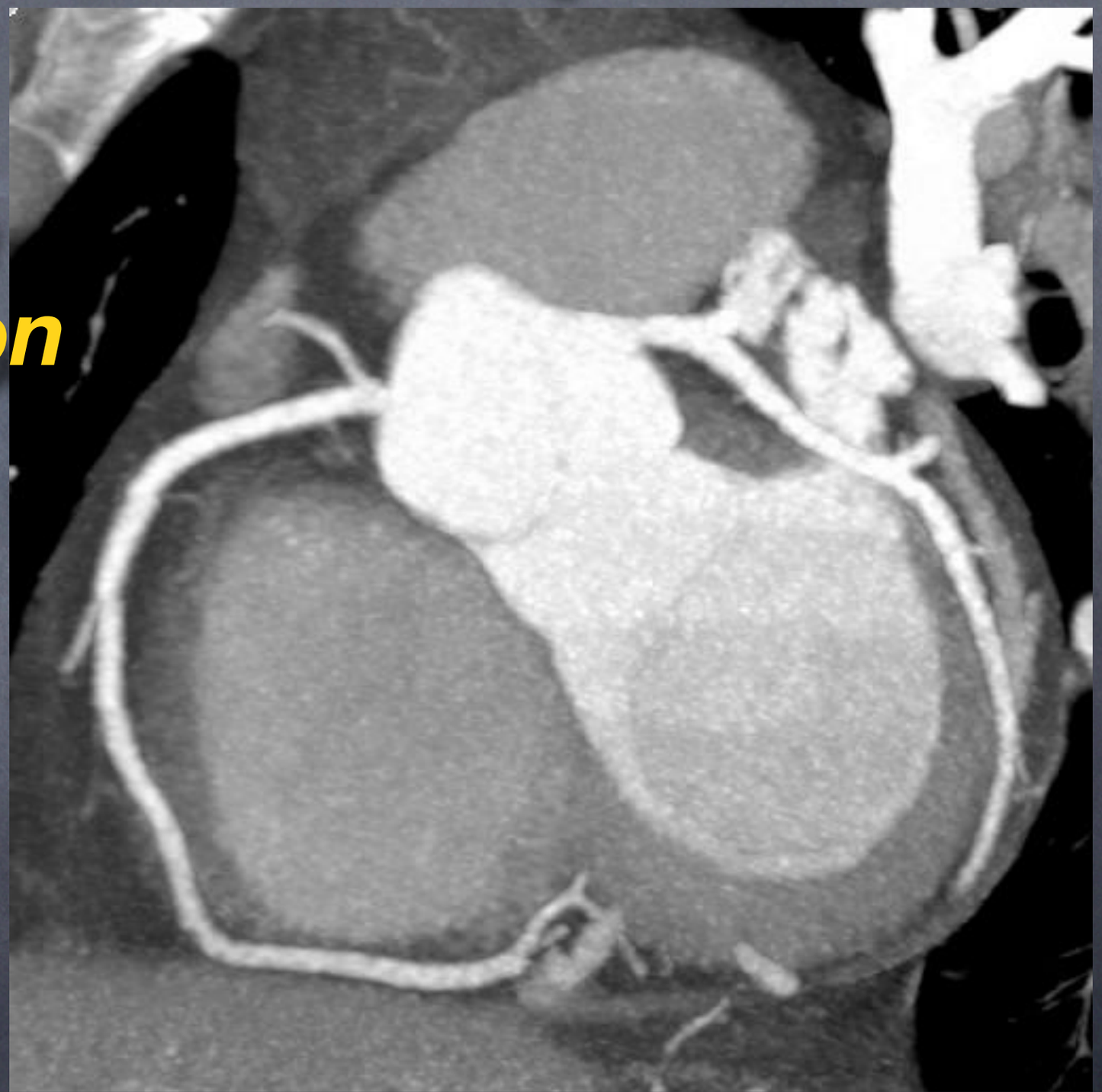
North American Society for Cardiovascular Imaging
http://www.nasci.org

Society of Cardiovascular Computed Tomography
http://www.scct.org

ACR Certificate of Added Proficiency (CoAP) in Cardiac CT
http://www.acr.org/secondarymainmenucategories/acr-education/coap.aspx

CCTA Technique

Patient Screening
Patient Preparation
Scan
Reconstruction
Interpretation



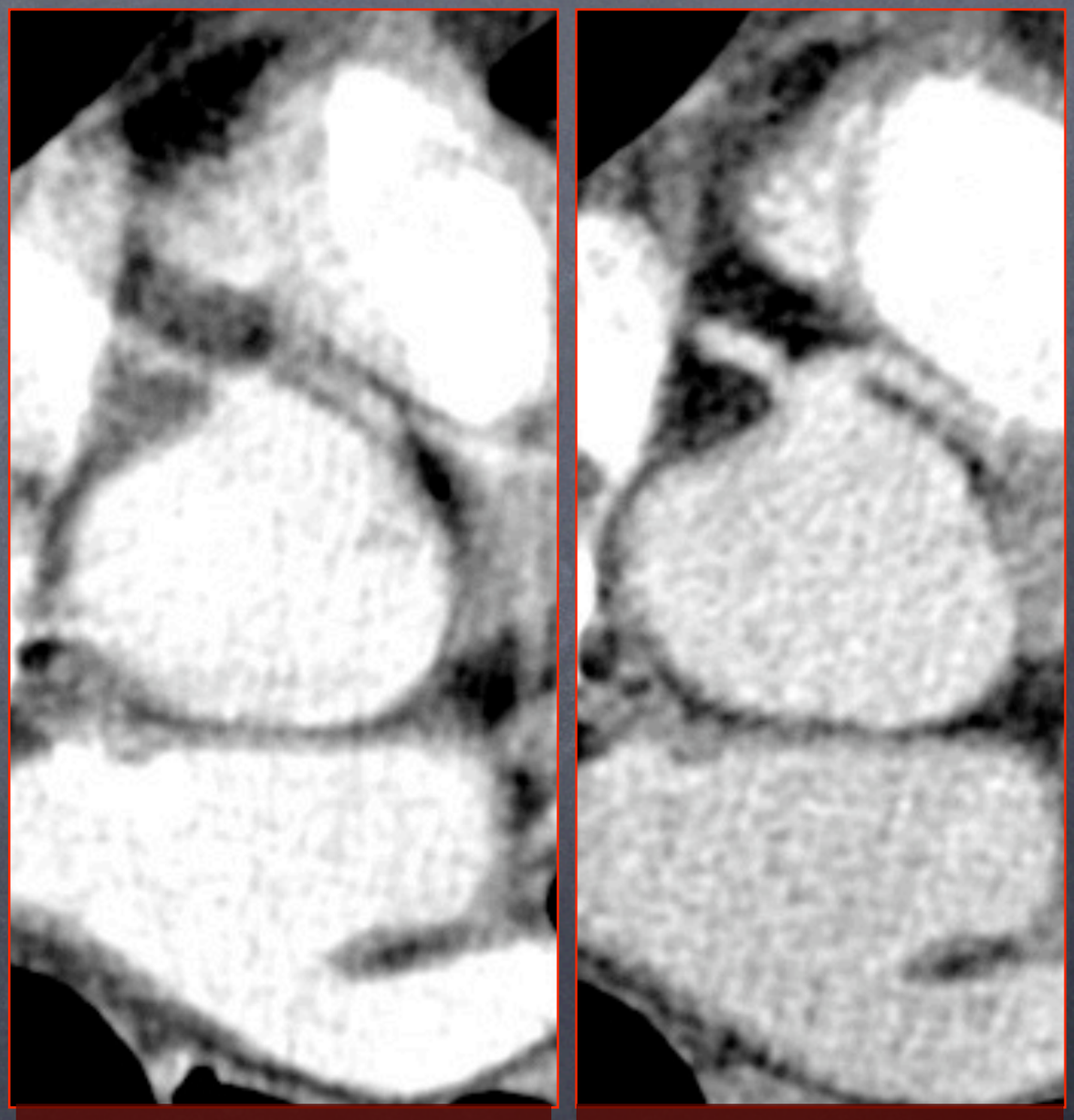
Pre-CCTA Screening

Medication	ß Blockers (ß1 selective Blocker) i.e. Atenolol, Metoprolol	CA Channel Blocker i.e. Verapamil, Diltiazem	Nitroglycerin
Heart			
Sick sinus syndrome	++	++	0
Severe bradycardia	++	++	0
2nd / 3rd degree heart block	++	++	0
Hypotension (systolic BP < 100 mm Hg)	++	++	++
Severe aortic stenosis	+	+	+
Early myocardial infarction	+	+	++
Obstructive cardiomyopathy	0	+	++
Contrictive pericarditis	+	+	+
High doses of other agents depressing SA and AV nodes (digoxin, anti-arrhythmica)	++	++	0
Lung			
Asthma	++	0	0
Bronchospams	++	0	0
Severe COPD	++	0	0
Other			
Severe anemia	0	0	++
Increased intracranial pressure	0	0	++
Migraine sensitive to nitrates			++
Peripheral arterial occlusive disease	+	0	0
Hypersensitivity	++	++	++
Erectile dysfunction treated with nitrate based medications i.e. Viagra ®, Sialis ®, Levitra ®			++
Pulmonary arterial hypertension treated with nitrate based medications, i.e. Viagra ®			++
Glaucoma			++

Note: ++ absolutely contraindicated; + relatively contraindicated; 0 not contraindicated

Patient Preparation

- Good IV (prefer RIGHT)
- 50 - 100 mg Metoprolol PO ~1 hr before CT
- 5-20 mg Metoprolol IV ~5 minutes before CT
- NTG on scanner ~ 3-5 minutes before contrast
- Calcium Score



82 bpm | 65 bpm

Ch. Becker, Munich, Germany

Scan Technique

- Test inject saline first
- Practice breathing instructions
- Double barrel injector
- 80 - 120 cc IV contrast
  - 30/70 chaser (R heart)
  - 30-50 mL saline chaser
- Bolus track / timing bolus

Reconstruction Technique

- Reconstructions:
  - ~ 1mm overlapping MPR
  - CPR, slice through display
  - Thin slab MIP
  - 0-90% R-R if retrospective (function)
- Review: 3D workstation, PACS

Post-CCTA Instructions

- Outpatients:
  - Observe ~30 min
  - No driving, etc. x 3 hr
- Inpatients:
  - Monitor on floor
- ED:
  - Disposition per ED rules

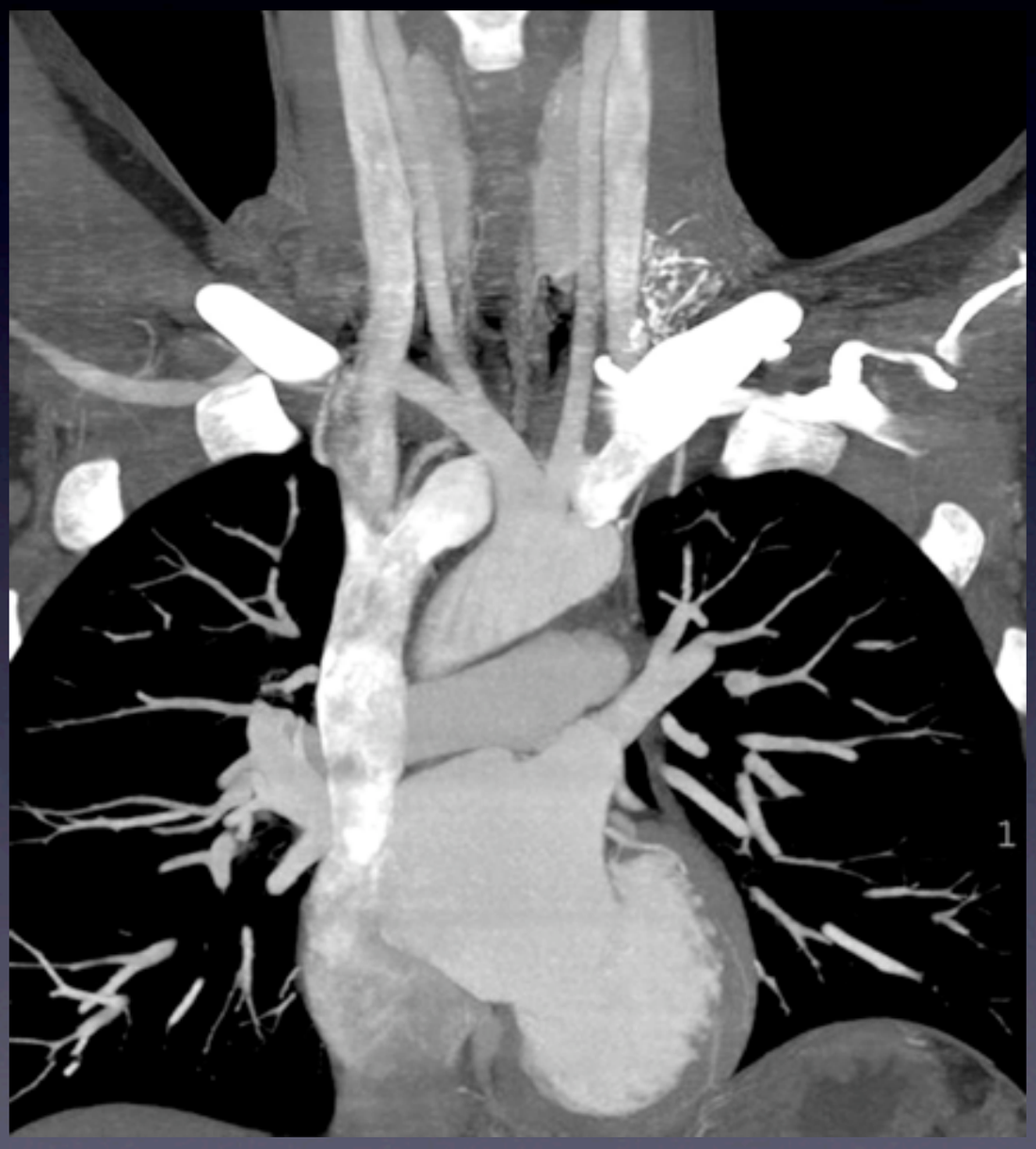
Modification: “Triple Rule Out”

PE

DSX

Coronaries

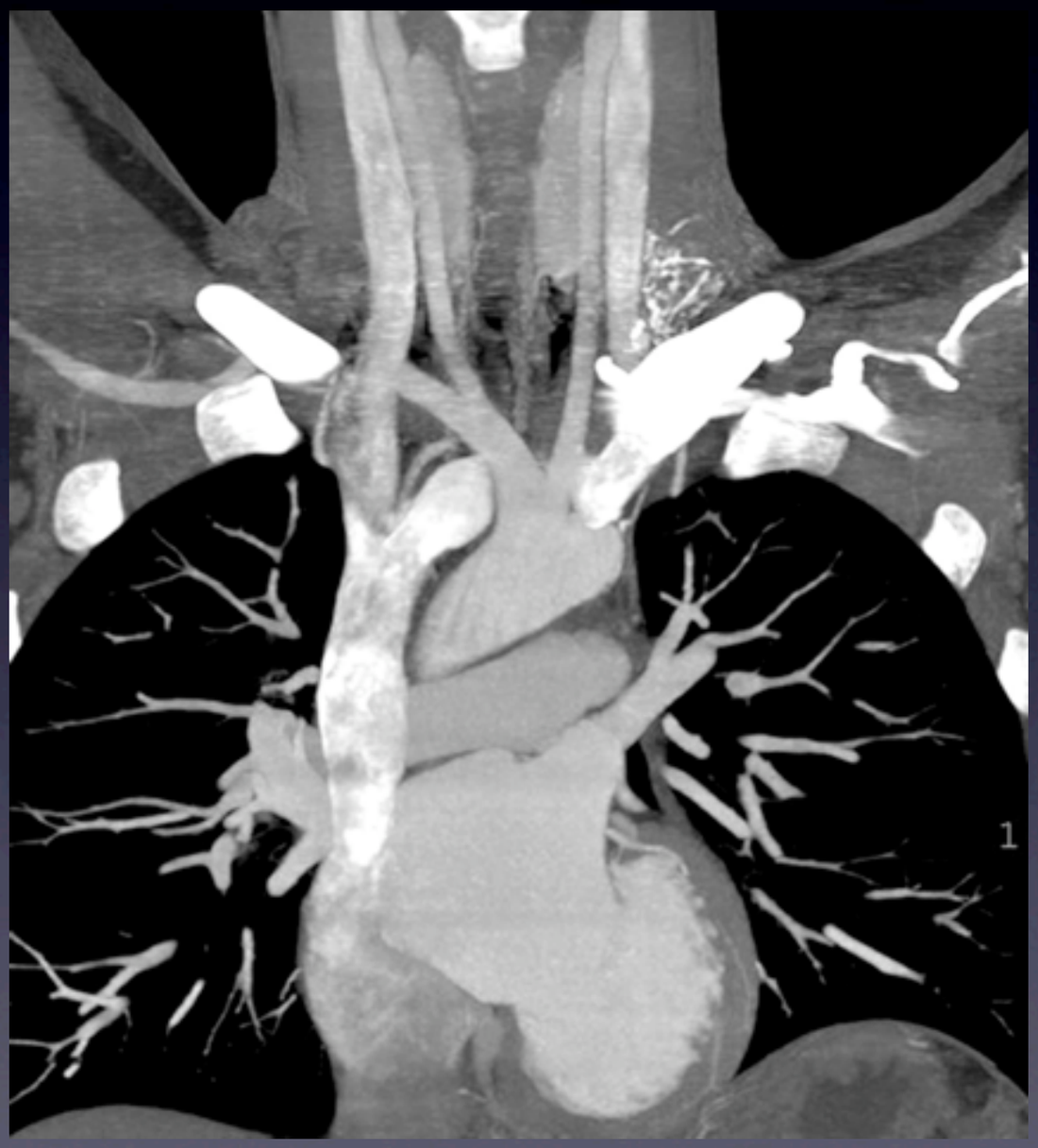
TRO: Patient Selection



Halpern E J Radiology 2009;252:332-345

- Clinical presentation: low to moderate risk of ACS
- Clinical presentation: non-ACS diagnosis considered
- Negative biomarkers (myoglobin and troponin-I)
- Normal ECG or nonspecific changes
- No history to suggest extensive coronary calcium
- Not recommended for patients with bypass or stents
- Patient able to tolerate CT and hold breath
- Cardiac rhythm acceptable for ECG-gated scan
- Adequate renal function

Triple Rule Out: Technique



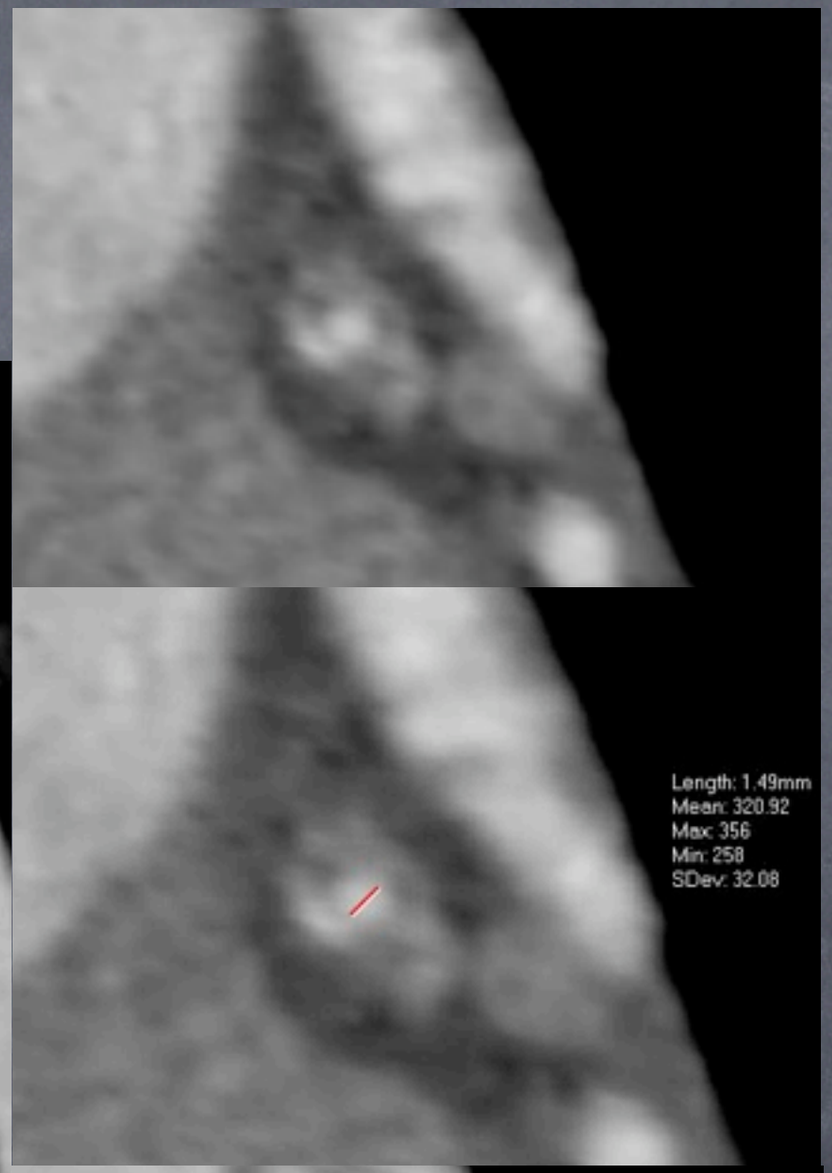
- Beta-blocker
- NTG
- Longer Acquisition
- Larger FOV
- A little more contrast
- A little more radiation

Halpern E J Radiology 2009;252:332-345

To Review

	Purpose Goal	Decrease HR and R-to-R variabiliy Steady heart rate of 50-65 beats per minute (bpm)	Alternatives
A	Questionnaire Obtain baseline HR & BP	rule out contraindications if HR ≤ 65 bpm --> [D] if HR > 65 bpm --> [B]	***CA Channel Blockers***
B	**Oral Atenolol (Tenormin®)**	100 mg p.o. 1-2 hour before cardiac CT if HR ≤ 65 bpm --> [D] if HR > 65 bpm --> [C]	Oral Diltiazem (Cardizem®, regular release): 30 mg p.o. or doubling oral dose for patients currently taking oral calcium channel blockers OR
C	**Intravenous Metoprolol (Lopressor®)** injection with patient on the scanner table wait 3-4 min	5 mg i.v. slow injection over 1 min if HR ≤ 65 bpm --> [D] if HR > 65 bpm --> repeat [C] up to two times at 3-4 min interval maximal dosis: 15 mg Metoprolol (Lopressor®) if HR ≤ 65 bpm --> [D] if HR > 65 bpm --> [D] regardless of HR	if systolic BP>100 and HR>60 Intravenous Diltiazem (Cardizem Monovial ®): 10 mg i.v. over 2 min repeat 10 mg i.v. in every 10 min to maximal dosis of 40 mg
	Purpose	coronary artery dilatation for better visualization	
D	Questionnaire **Sublingual nitroglycerin (NitroQuick ®)** wait 5 min	rule out contraindications 0.4 mg tablet --> [E]	Sublingual nitroglycerin spray (0.4 mg/L)
E	Scan	--> [F]	
F	Post scan monitoring HR & BP Recommendations	outpatients: for 30 min inpatients: on ward outpatients: 3h not operate machinery, i.e. driving car	

CCTA Results



Heart Rate

< 70: 97% sens, 95% NPV

≥ 70: 88% sens, 83% NPV

Calcium Score

≤ 100: 94% sens, 95% NPV

≥ 400: 93% sens, 67% NPV

Obesity

BMI ≤ 25: 100% sens, spec, PPV, NPV

BMI ≥ 30: 90% sens, 86% NPV

Appropriateness

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

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¶Official American College of Radiology Representative.
#Official North American Society for Cardiovascular Imaging Representative.
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‡‡Official American College of Emergency Physicians Representative.
§§Official Heart Rhythm Society Representative.
‖‖Official Health Plan Representative.
¶¶Official American College of Physicians Representative.

This document was approved by the American College of Cardiology Foundation Board of Trustees in June 2010; by the American College of Radiology, the American Society of Echocardiography, the American Society of Nuclear Cardiology, the Society for Cardiovascular Angiography and Interventions, the Society for Cardiovascular Magnetic Resonance, the Society of Cardiovascular Computed Tomography, and the American Heart Association in September 2010; and by the North American Society for Cardiovascular Imaging in November 2010.

The American Heart Association requests that this document be cited as follows: Taylor AJ, Cerqueira M, Hodgson JM, Mark D, Min J, O'Gara P, Rubin GD. 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. *Circulation*. 2010;122:e525–e555.

This article has been copublished in the *Journal of the American College of Cardiology* and the *Journal of Cardiovascular Computed Tomography*.

Copies: This document is available on the World Wide Web sites of the American College of Cardiology (www.cardiosource.org) and the American Heart Association (my.americanheart.org). A copy of the document is also available at http://www.americanheart.org/presenter.jhtml?identifier=3003999 by selecting either the "topic list" link or the "chronological list" link (No. KB-0105).

Expert peer review of AHA Scientific Statements is conducted at the AHA National Center. For more on AHA statements and guidelines development, visit http://www.americanheart.org/presenter.jhtml?identifier=3023366.

(*Circulation*. 2010;122:e525-e555)

Circulation is available at http://circ.ahajournals.org

DOI: 10.1161/CIR.0b013e3181fcae66

Appropriateness for CCTA: New Guidelines 2010

Previous: Hendel RC, et al. JACC 2006 48(7): 1475-97

Score 7 to 9
Appropriate test for specific indication

Score 4 to 6
Uncertain for specific indication (test **may** be generally acceptable and **may** be a reasonable approach for the indication).
May need more research

Score 1 to 3
Inappropriate test for specific indication

Taylor AJ, et al. Circulation 2010 vol. 122 (21) pp. e525-55

Symptomatic Patients

Detection of CAD in Symptomatic Patients Without Known Heart Disease Symptomatic—Nonacute Symptoms Possibly Representing an Ischemic Equivalent		
1.	• ECG interpretable AND • Able to exercise • Intermediate pretest probability of CAD	A (7)
2.	• ECG uninterpretable or unable to exercise • Low pretest probability of CAD	A (7)
2.	• ECG uninterpretable or unable to exercise • Intermediate pretest probability of CAD	A (8)

Detection of CAD in Symptomatic Patients Without Known Heart Disease Symptomatic—Acute Symptoms With Suspicion of ACS (Urgent Presentation)		
6.	• Normal ECG and cardiac biomarkers • Low pretest probability of CAD	A (7)
6.	• Normal ECG and cardiac biomarkers • Intermediate pretest probability of CAD	A (7)
7.	• ECG uninterpretable • Low pretest probability of CAD	A (7)
7.	• ECG uninterpretable • Intermediate pretest probability of CAD	A (7)
8.	• Nondiagnostic ECG or equivocal cardiac biomarkers • Low pretest probability of CAD	A (7)
8.	• Nondiagnostic ECG or equivocal cardiac biomarkers • Intermediate pretest probability of CAD	A (7)

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Detection of CAD in other scenarios

Detection of CAD in Other Clinical Scenarios—New-Onset or Newly Diagnosed Clinical HF and No Prior CAD		
13.	• Reduced left ventricular ejection fraction • Low pretest probability of CAD	A (7)
13.	• Reduced left ventricular ejection fraction • Intermediate pretest probability of CAD	A (7)
Detection of CAD in Other Clinical Scenarios—Preoperative Coronary Assessment Prior to Noncoronary Cardiac Surgery		
15.	• Coronary evaluation before noncoronary cardiac surgery • Intermediate pretest probability of CAD	A (7)
Use of CTA in the Setting of Prior Test Results—Prior ECG Exercise Testing		
20.	• Normal ECG exercise test • Continued symptoms	A (7)
21.	• Prior ECG exercise testing • Duke Treadmill Score—intermediate risk findings	A (7)
Use of CTA in the Setting of Prior Test Results—Sequential Testing After Stress Imaging Procedures		
22.	• Discordant ECG exercise and imaging results	A (8)
23.	• Stress imaging results: equivocal	A (8)

Taylor AJ, et al. Circulation 2010 vol. 122 (21) pp. e525-55

Detection of CAD in other scenarios

Use of CTA in the Setting of Prior Test Results—Evaluation of New or Worsening Symptoms in the Setting of Past Stress Imaging Study		
29.	• Previous stress imaging study normal	A (8)

Risk Assessment Postrevascularization (PCI or CABG)—Symptomatic (Ischemic Equivalent)		
39.	• Evaluation of graft patency after CABG	A (8)

Risk Assessment Postrevascularization (PCI or CABG)—Asymptomatic—Prior Coronary Stenting		
43.	• Prior left main coronary stent with stent diameter ≥3 mm	A (7)

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Cardiac Structure and Function

	Evaluation of Cardiac Structure and Function—Adult Congenital Heart Disease	
46.	• Assessment of anomalies of coronary arterial and other thoracic arteriovenous vessels	A (9)
47.	• Assessment of complex adult congenital heart disease	A (8)

	Evaluation of Cardiac Structure and Function—Evaluation of Ventricular Morphology and Systolic Function	
49.	• Evaluation of left ventricular function • Following acute MI or in HF patients • Inadequate images from other noninvasive methods	A (7)
50.	• Quantitative evaluation of right ventricular function	A (7)
51.	• Assessment of right ventricular morphology • Suspected arrhythmogenic right ventricular dysplasia	A (7)

	Evaluation of Cardiac Structure and Function—Evaluation of Intra- and Extracardiac Structures	
53.	• Characterization of native cardiac valves • Suspected clinically significant valvular dysfunction • Inadequate images from other noninvasive methods	A (8)
54.	• Characterization of prosthetic cardiac valves • Suspected clinically significant valvular dysfunction • Inadequate images from other noninvasive methods	A (8)
56.	• Evaluation of cardiac mass (suspected tumor or thrombus) • Inadequate images from other noninvasive methods	A (8)
57.	• Evaluation of pericardial anatomy	A (8)
58	• Evaluation of pulmonary vein anatomy • Prior to radiofrequency ablation for atrial fibrillation	A (8)
59.	• Noninvasive coronary vein mapping • Prior to placement of biventricular pacemaker	A (8)
60.	• Localization of coronary bypass grafts and other retrosternal anatomy • Prior to reoperative chest or cardiac surgery	A (8)

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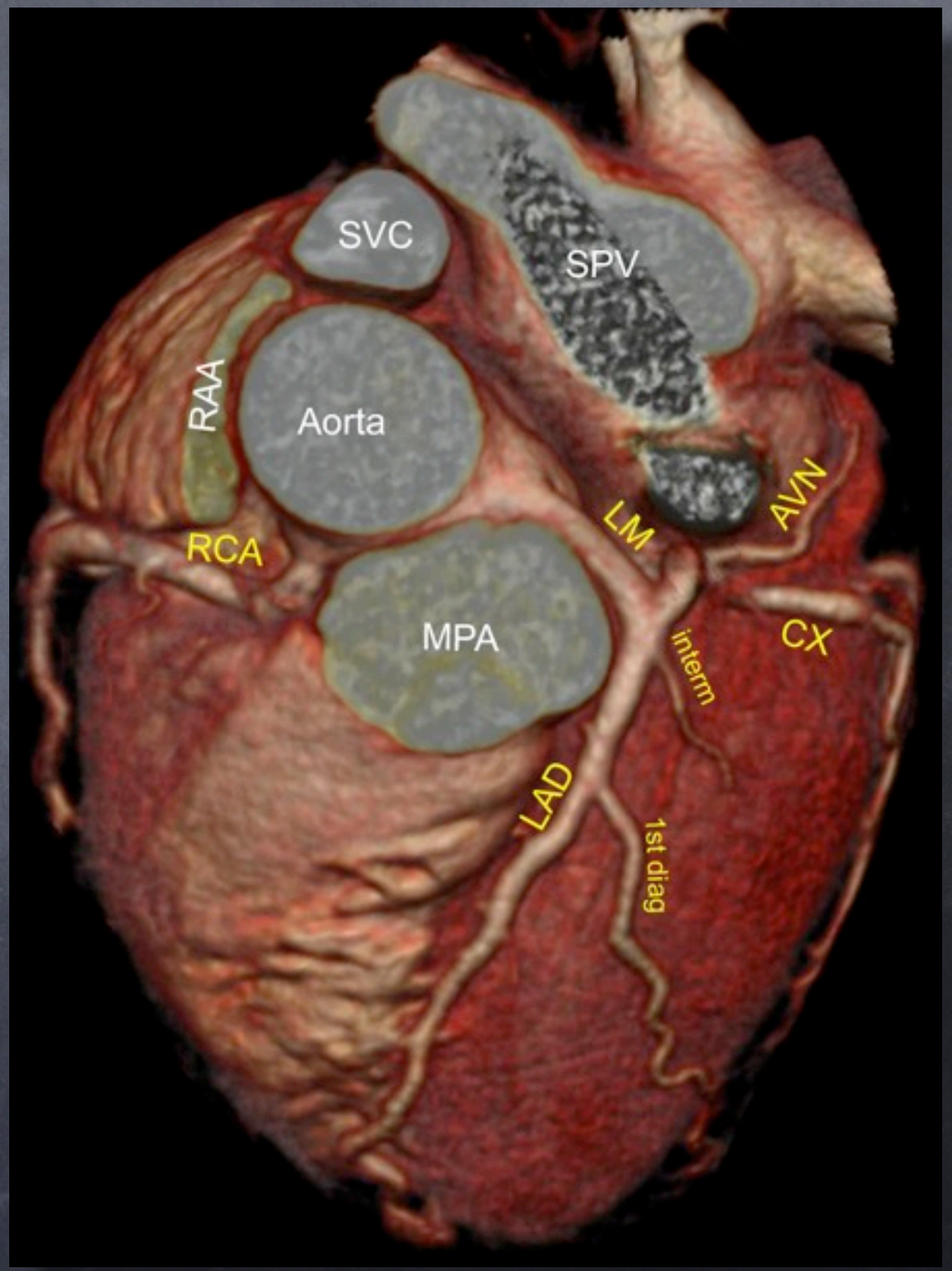
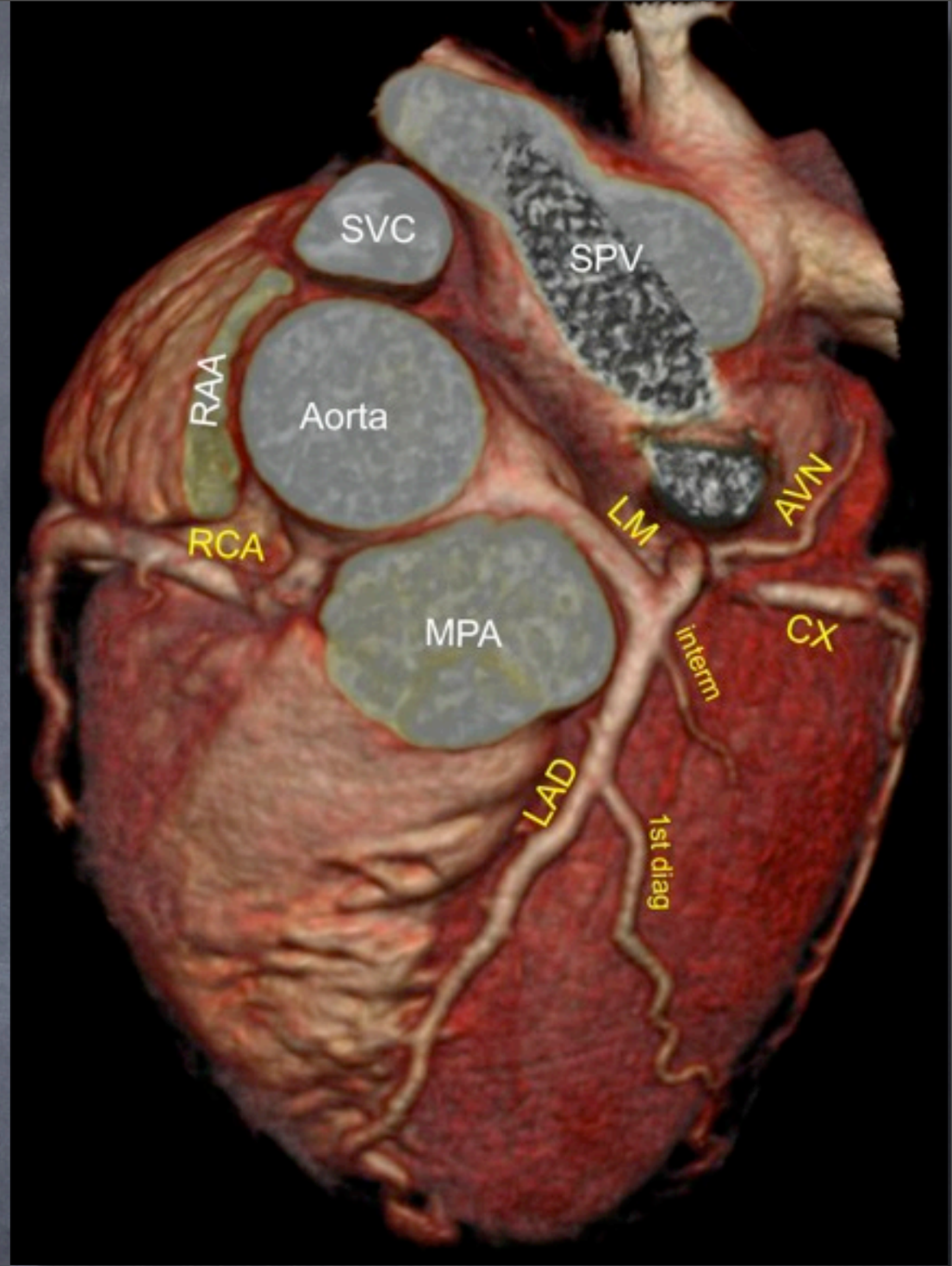
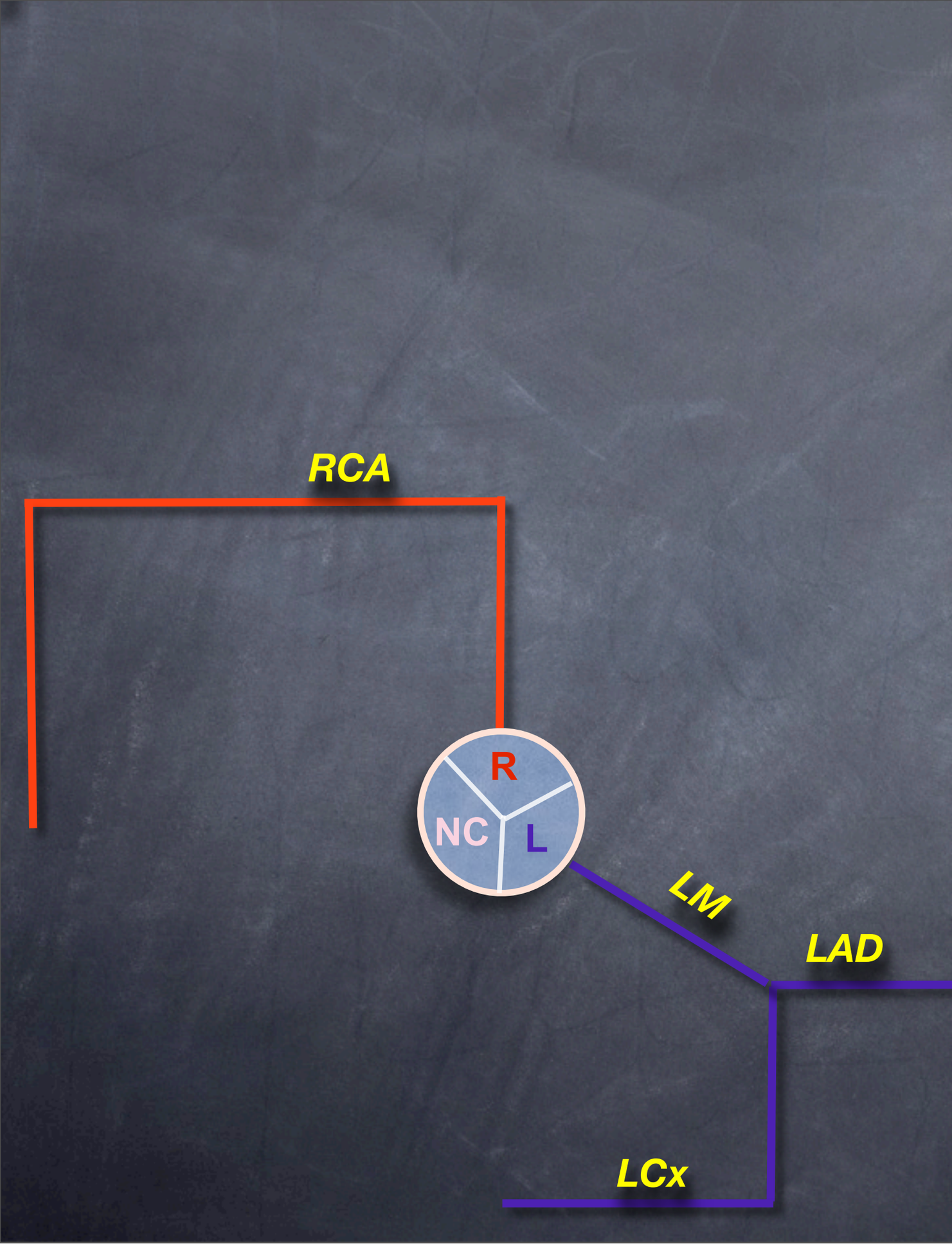
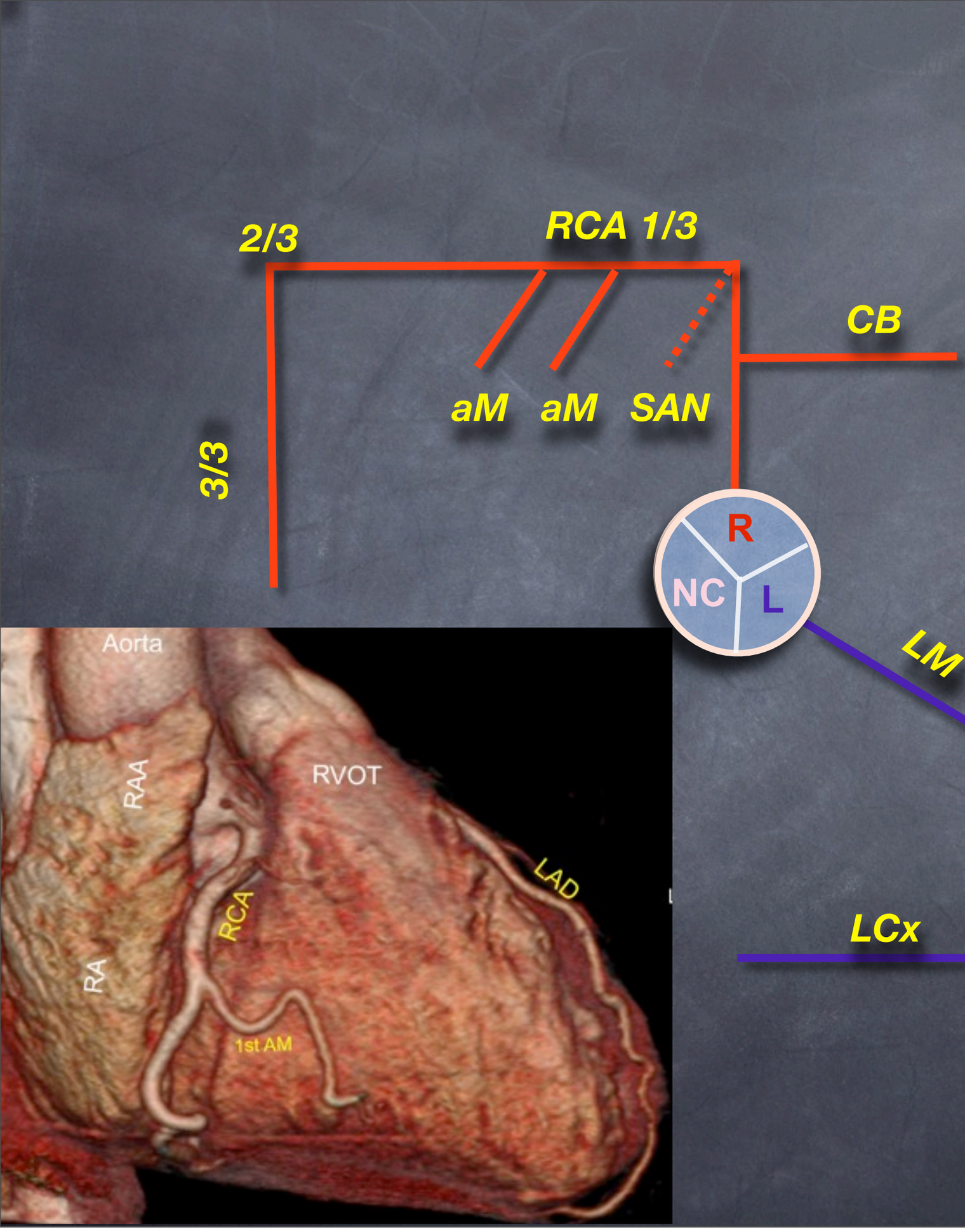
CORONARY ANATOMY

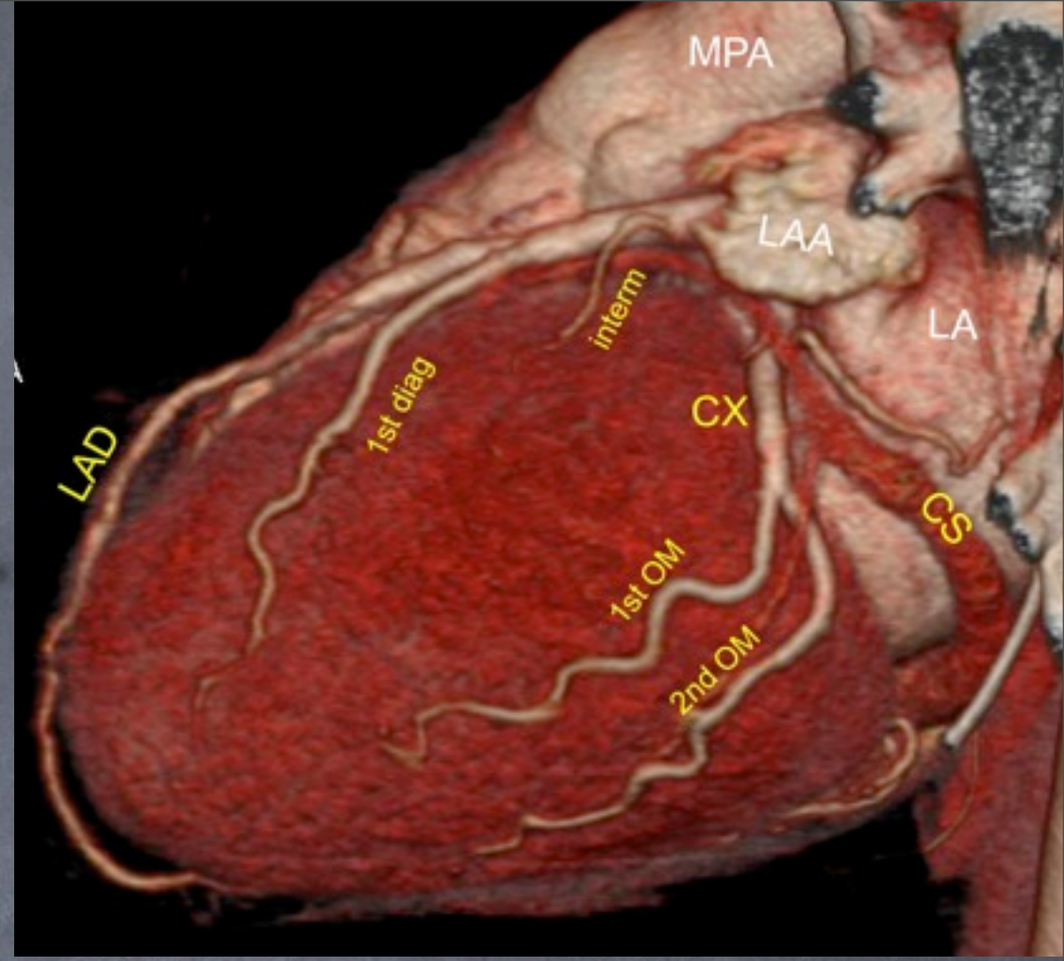


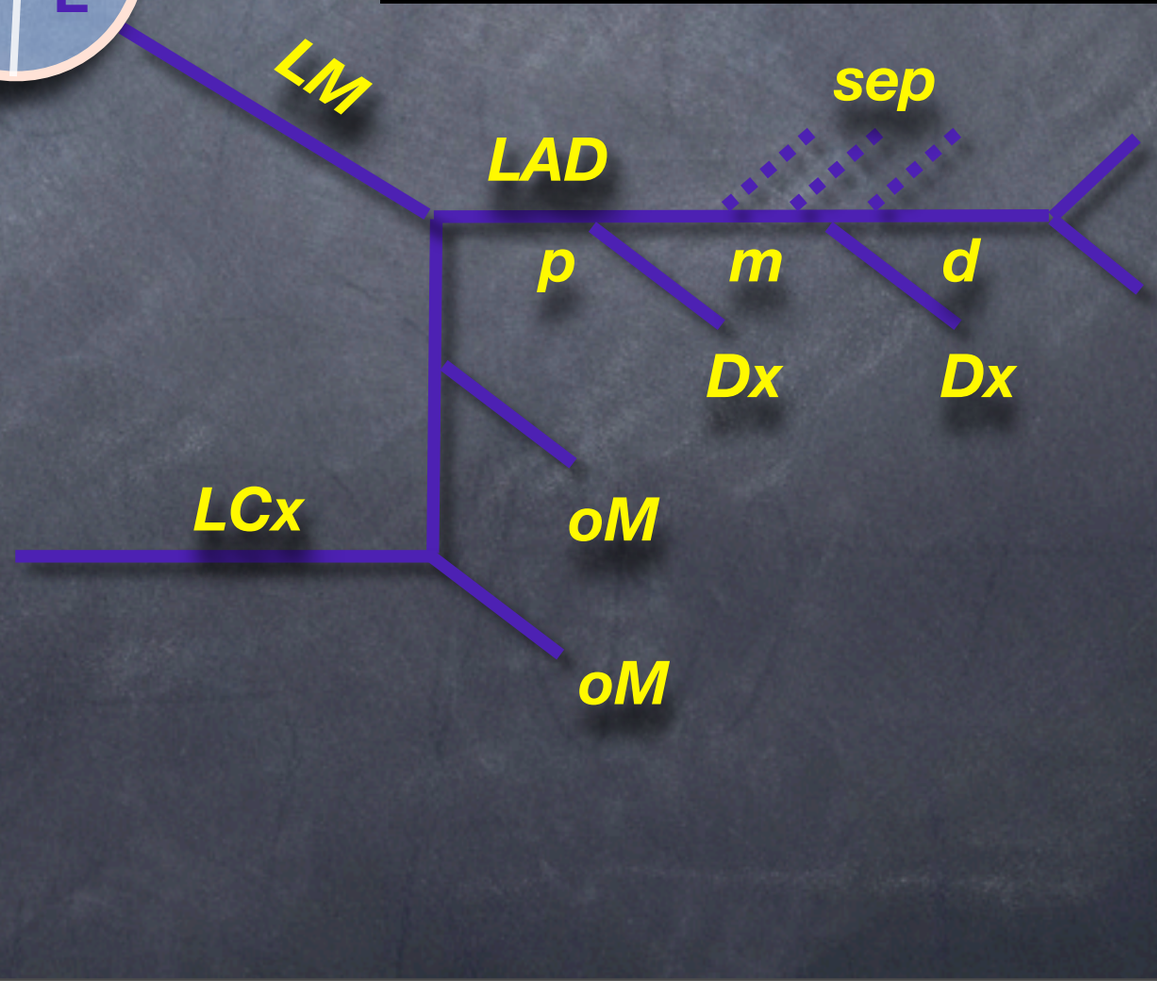


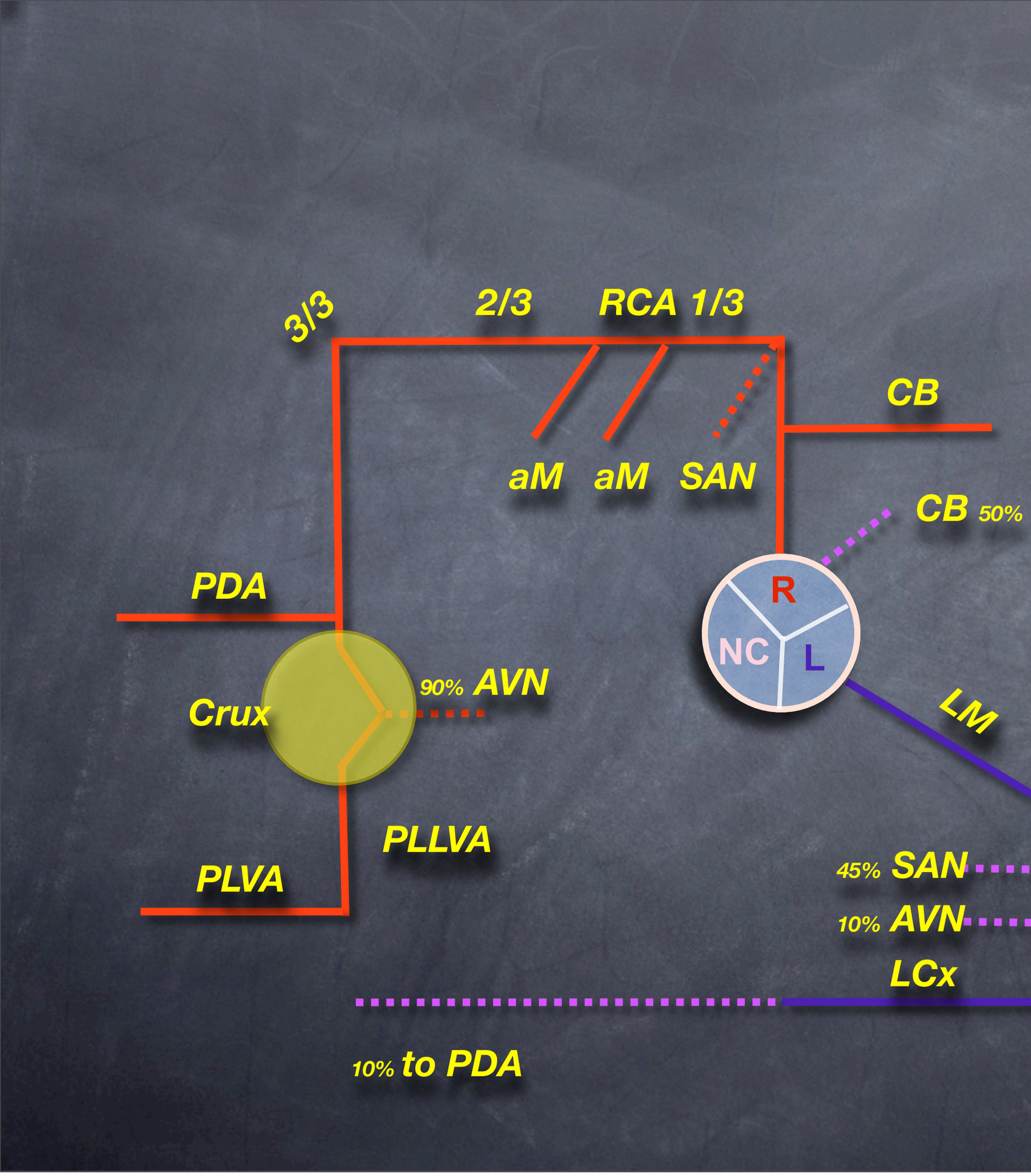


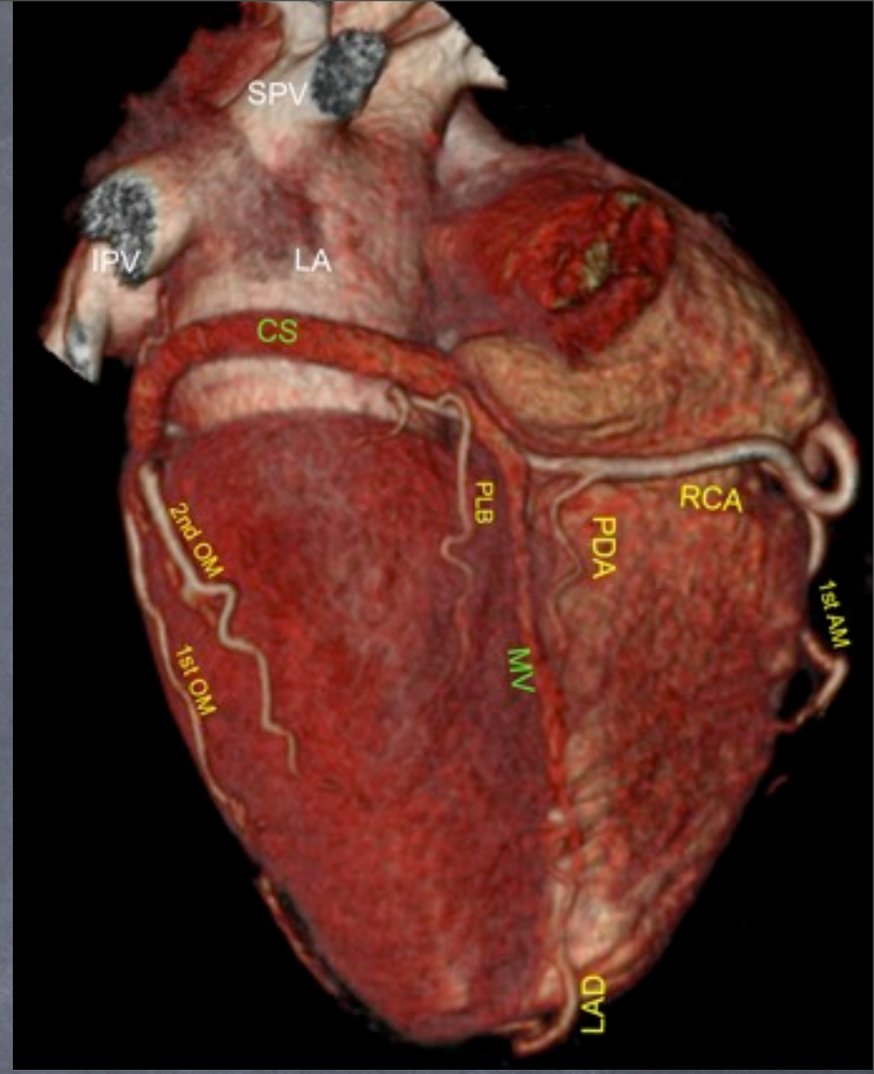
Courtesy of
Humberto Wong, MD


2/3
RCA 1/3
CB
aM
aM
SAN
3/3
R
NC
L
Aorta
RAA
RVOT
LAD
RCA
RA
1st AM

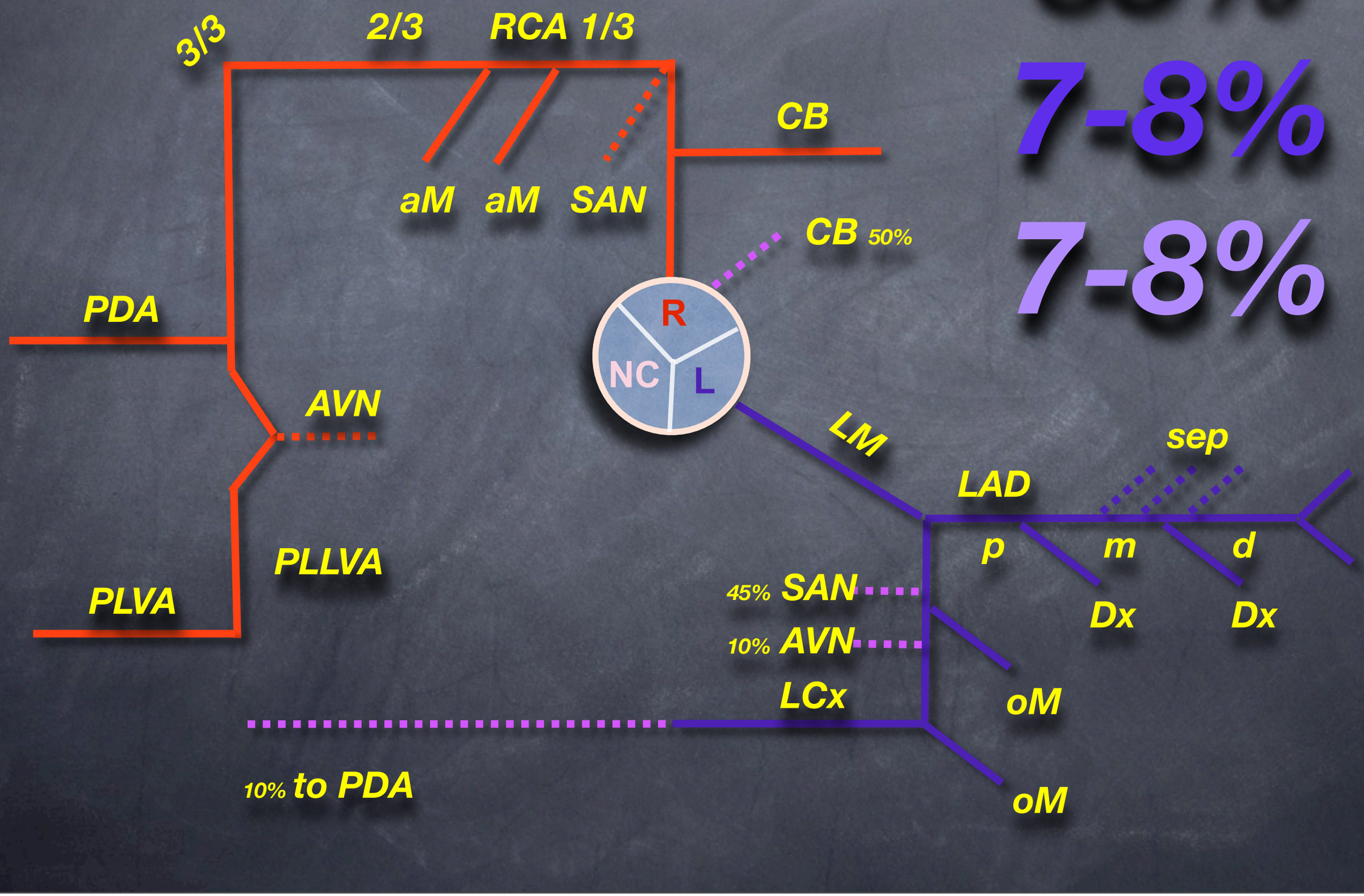

MPA
LAA
LA
interm
1st diag
CX
LAD
CS
1st OM
2nd OM


LM
sep
LAD
p
m
d
Dx
Dx
LCx
oM
oM

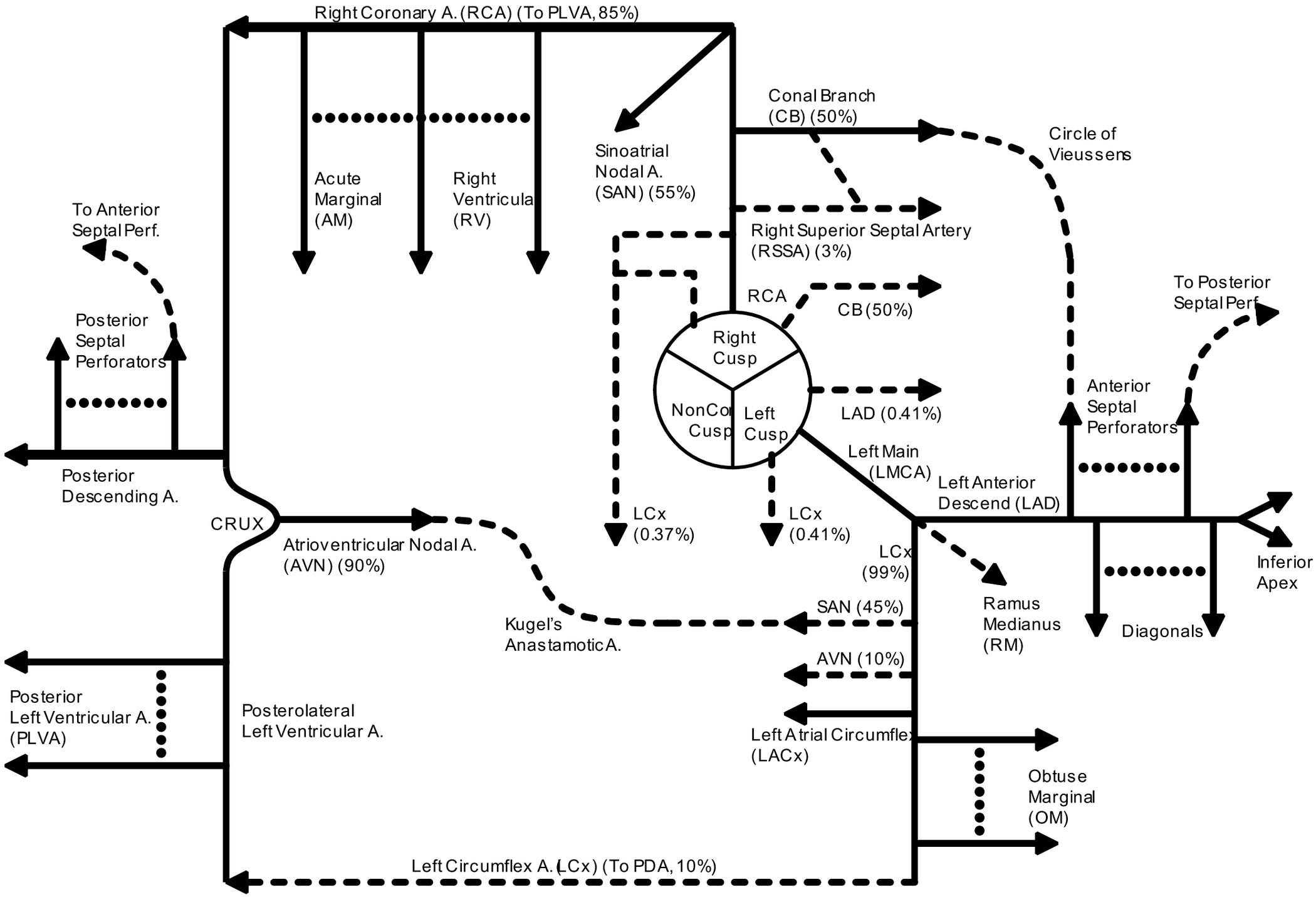

3/3
2/3
RCA 1/3
CB
aM
aM
SAN
CB 50%
PDA
R
NC
L
90% AVN
Crux
LM
sep
LAD
p
m
d
PLLVA
PLVA
45% SAN
10% AVN
Dx
Dx
LCx
oM
oM
10% to PDA


SPV
IPV
LA
CS
PLB
PDA
RCA
2nd OM
1st OM
MV
1st AM
LAD

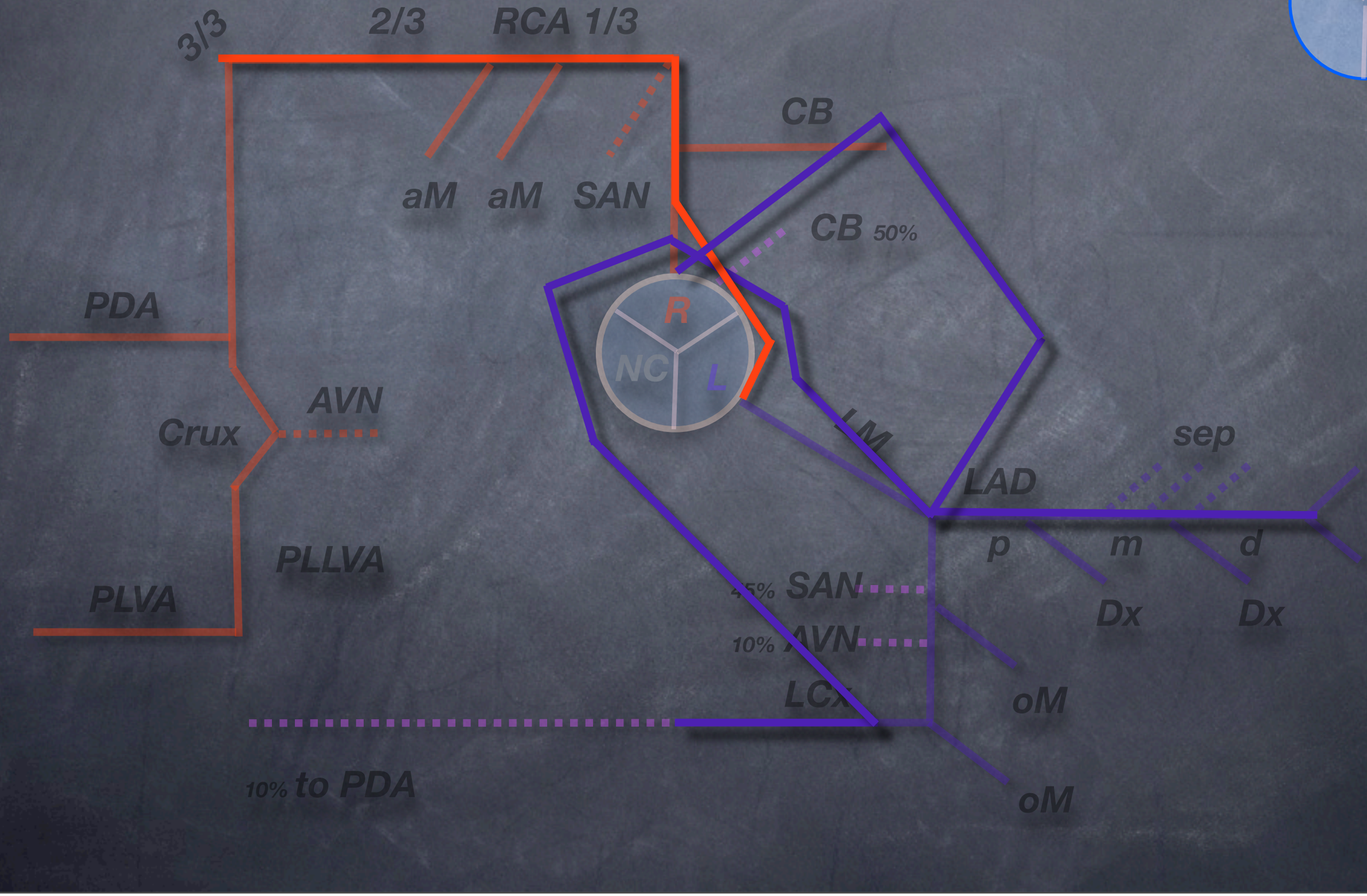
Dominance


85%
7-8%
7-8%
3/3
2/3
RCA 1/3
CB
aM
aM
SAN
CB 50%
PDA
R
NC
L
AVN
LM
sep
LAD
p
m
d
PLLVA
PLVA
45% SAN
10% AVN
LCx
Dx
Dx
oM
oM
10% to PDA

REVIEW.....

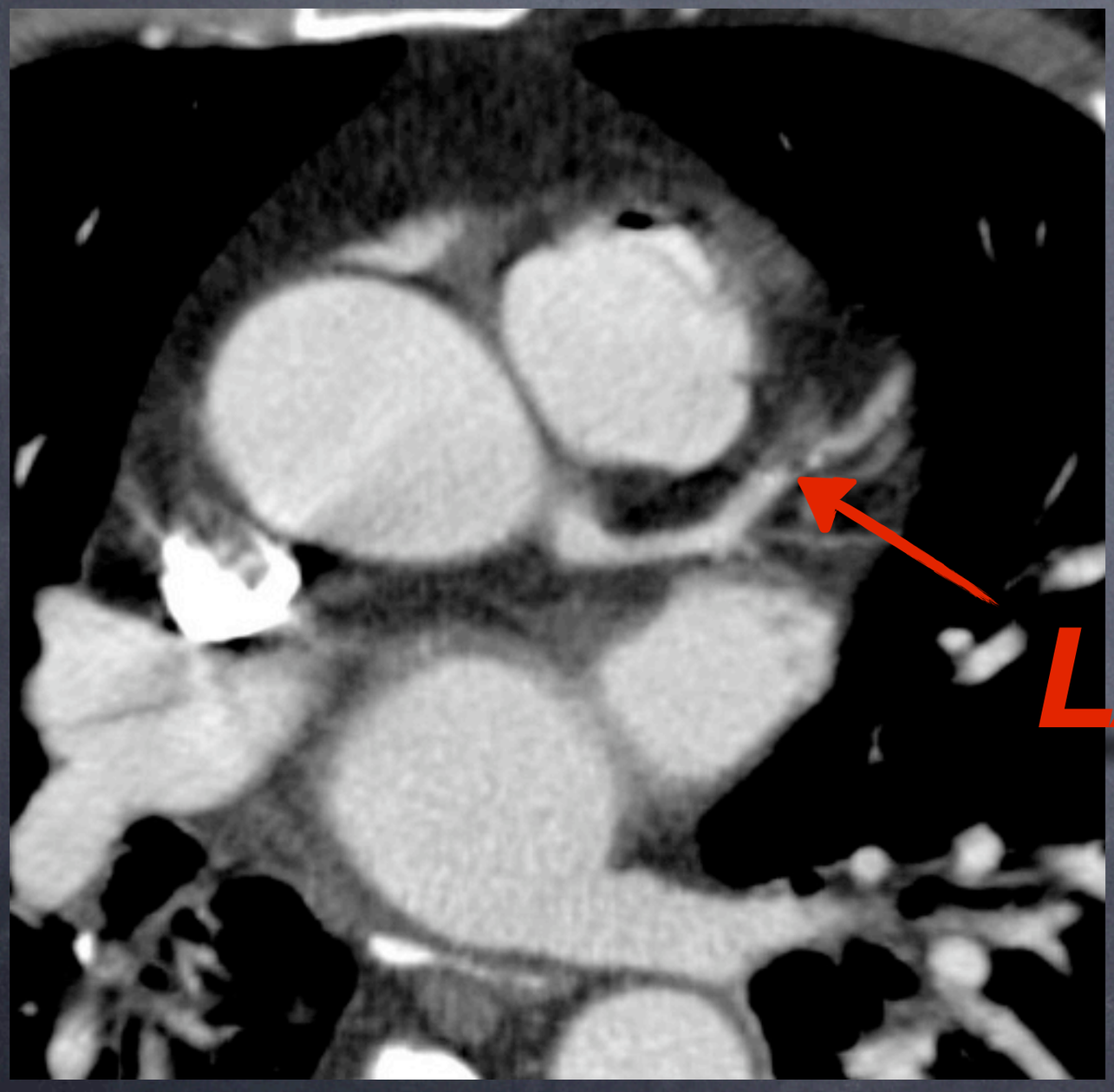

Right Coronary A. (RCA) (To PLVA, 85%)
Acute Marginal (AM)
Right Ventricular (RV)
Sinoatrial Nodal A. (SAN) (55%)
Conal Branch (CB) (50%)
Circle of Vieussens
To Anterior Septal Perf.
Right Superior Septal Artery (RSSA) (3%)
RCA
CB (50%)
Right Cusp
NonCoronary Cusp
Left Cusp
LAD (0.41%)
To Posterior Septal Perf.
Anterior Septal Perforators
Posterior Septal Perforators
Left Main (LMCA)
Left Anterior Descend (LAD)
Posterior Descending A.
CRUX
LCx (0.37%)
LCx (0.41%)
LCx (99%)
Inferior Apex
Atrioventricular Nodal A. (AVN) (90%)
Ramus Medianus (RM)
SAN (45%)
Diagonals
Kugel's Anastamotic A.
AVN (10%)
Posterior Left Ventricular A. (PLVA)
Posterolateral Left Ventricular A.
Left Atrial Circumflex (LACx)
Obtuse Marginal (OM)
Left Circumflex A. (LCx) (To PDA, 10%)

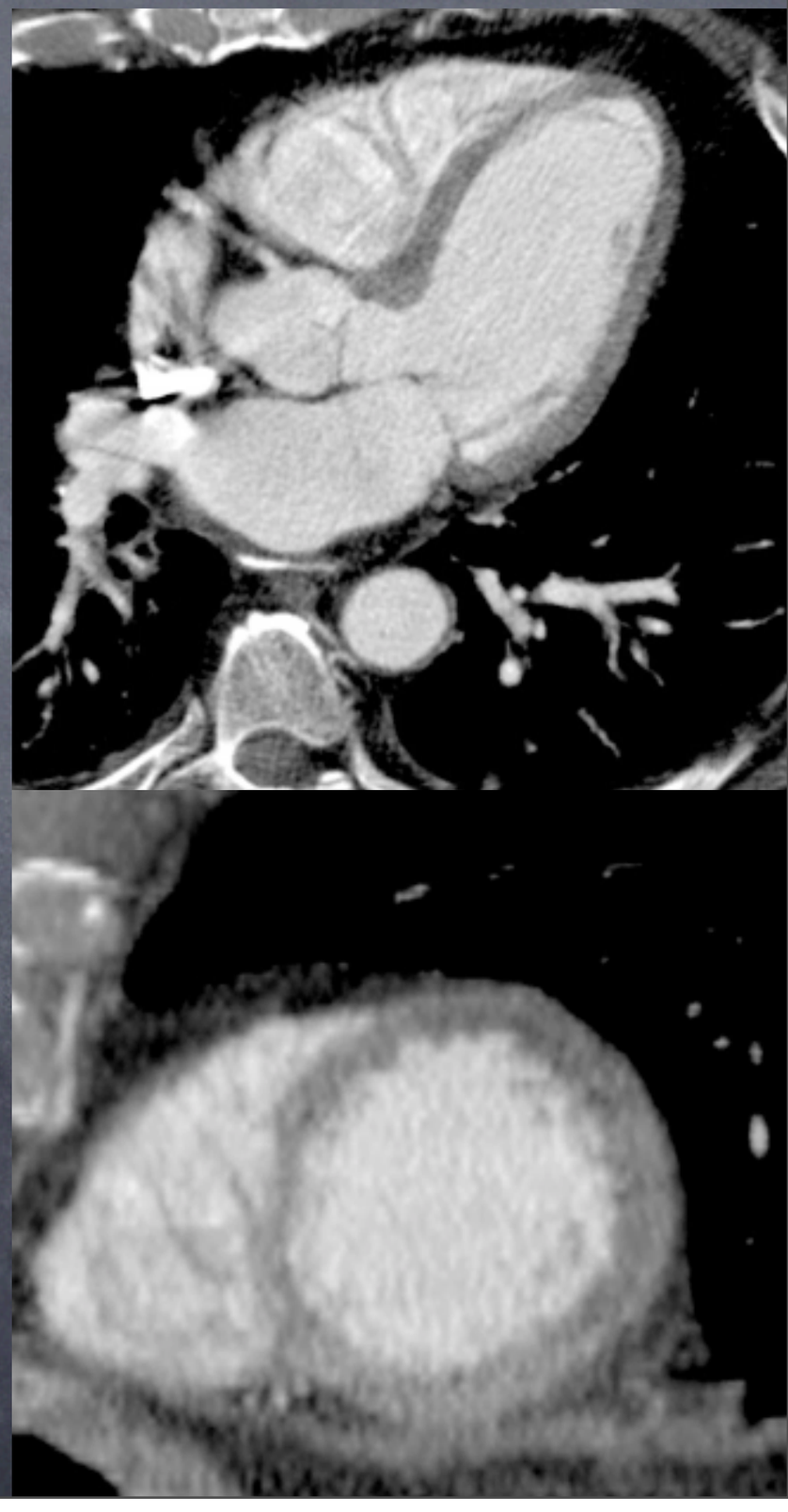
Anomalous Coronaries



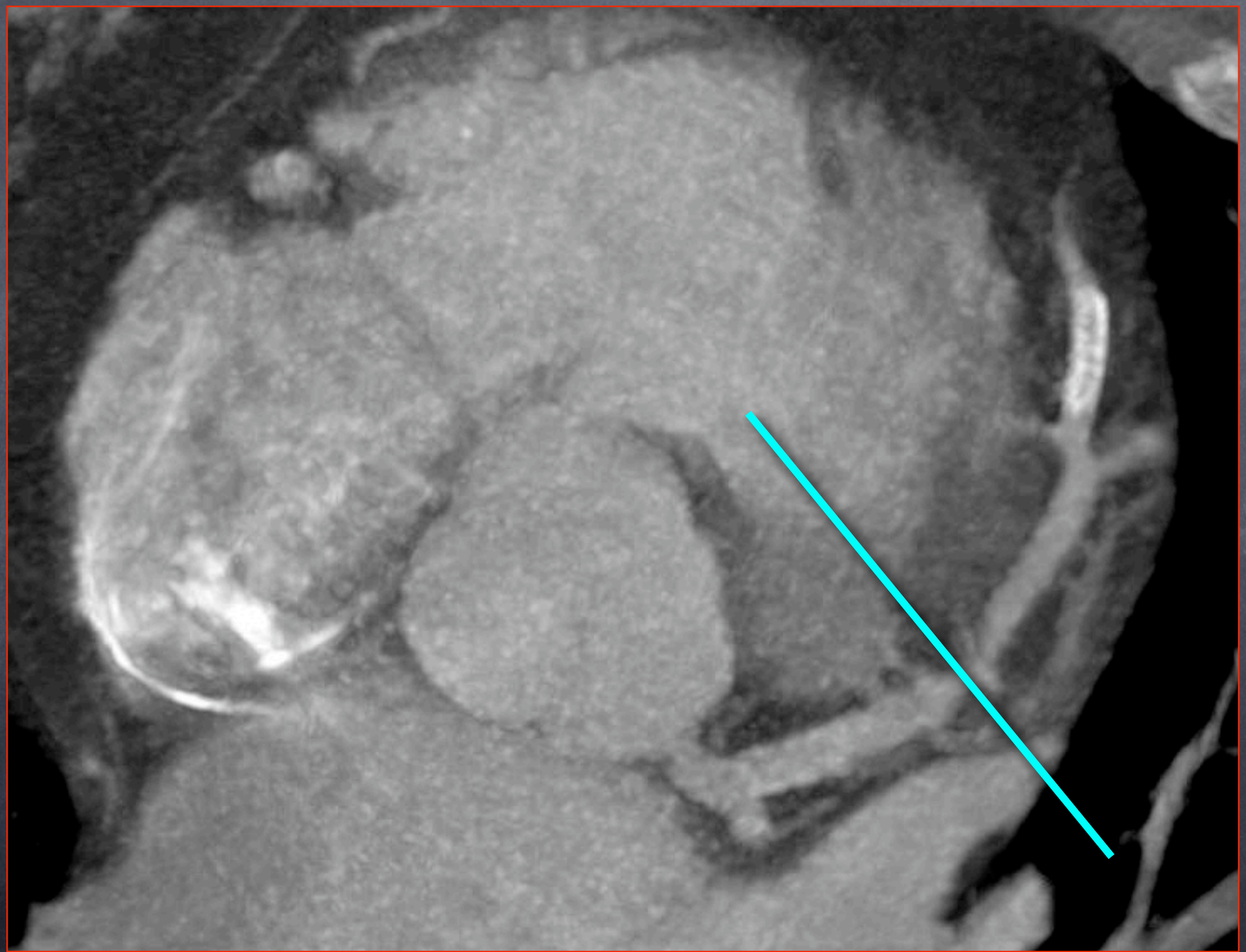
Examples:
CAD

ED - Chest pain

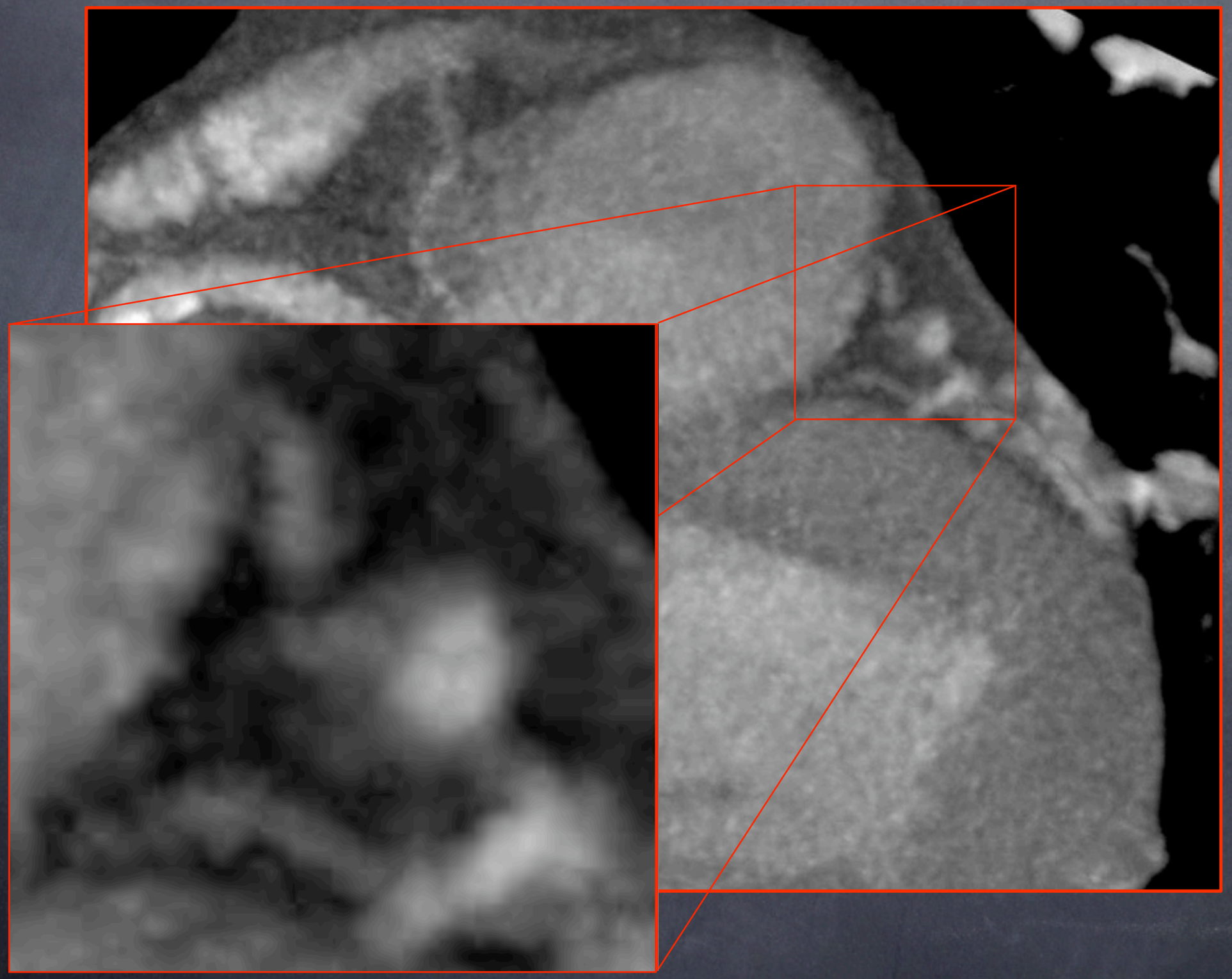




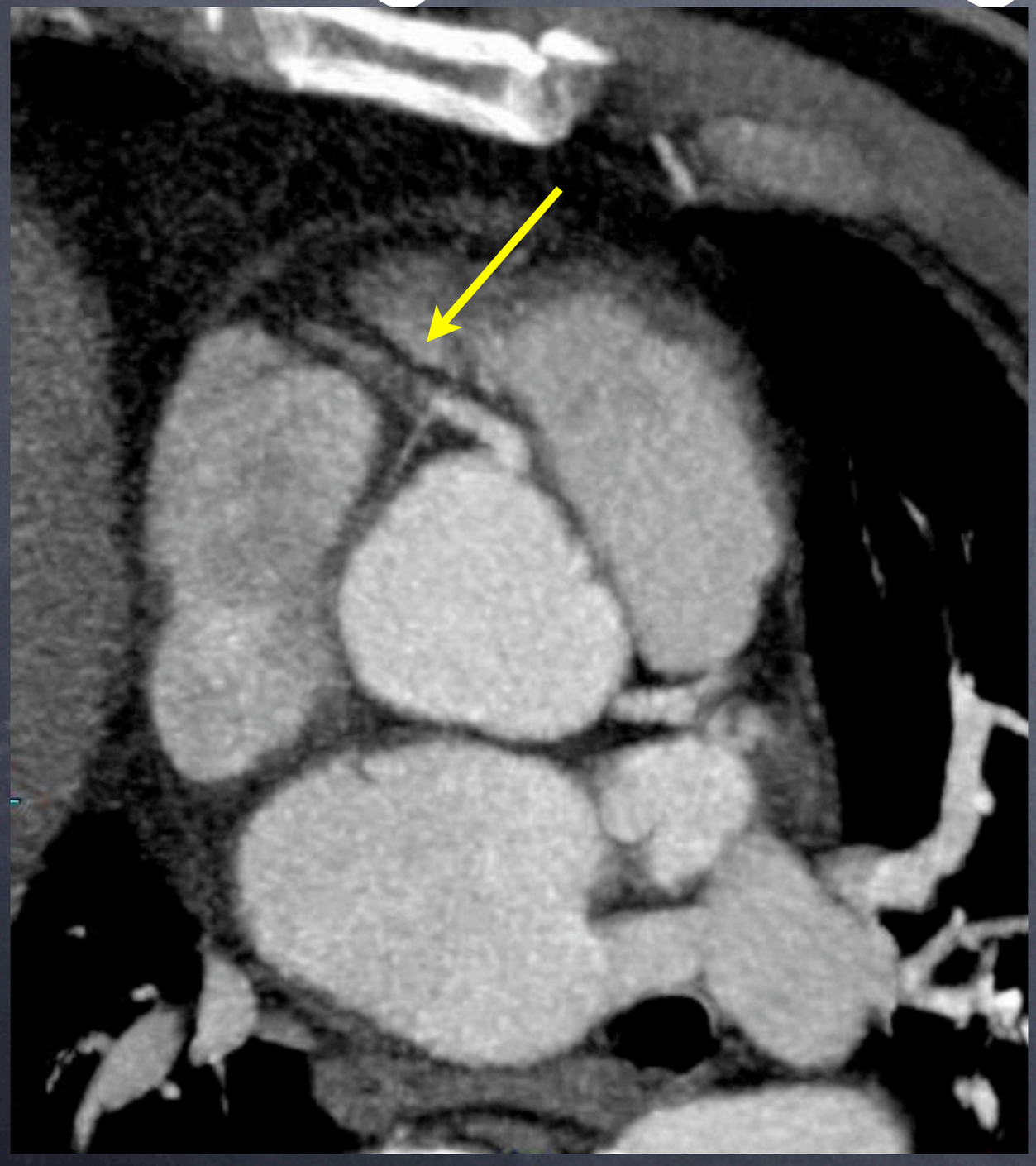
38 yo post LAD stent

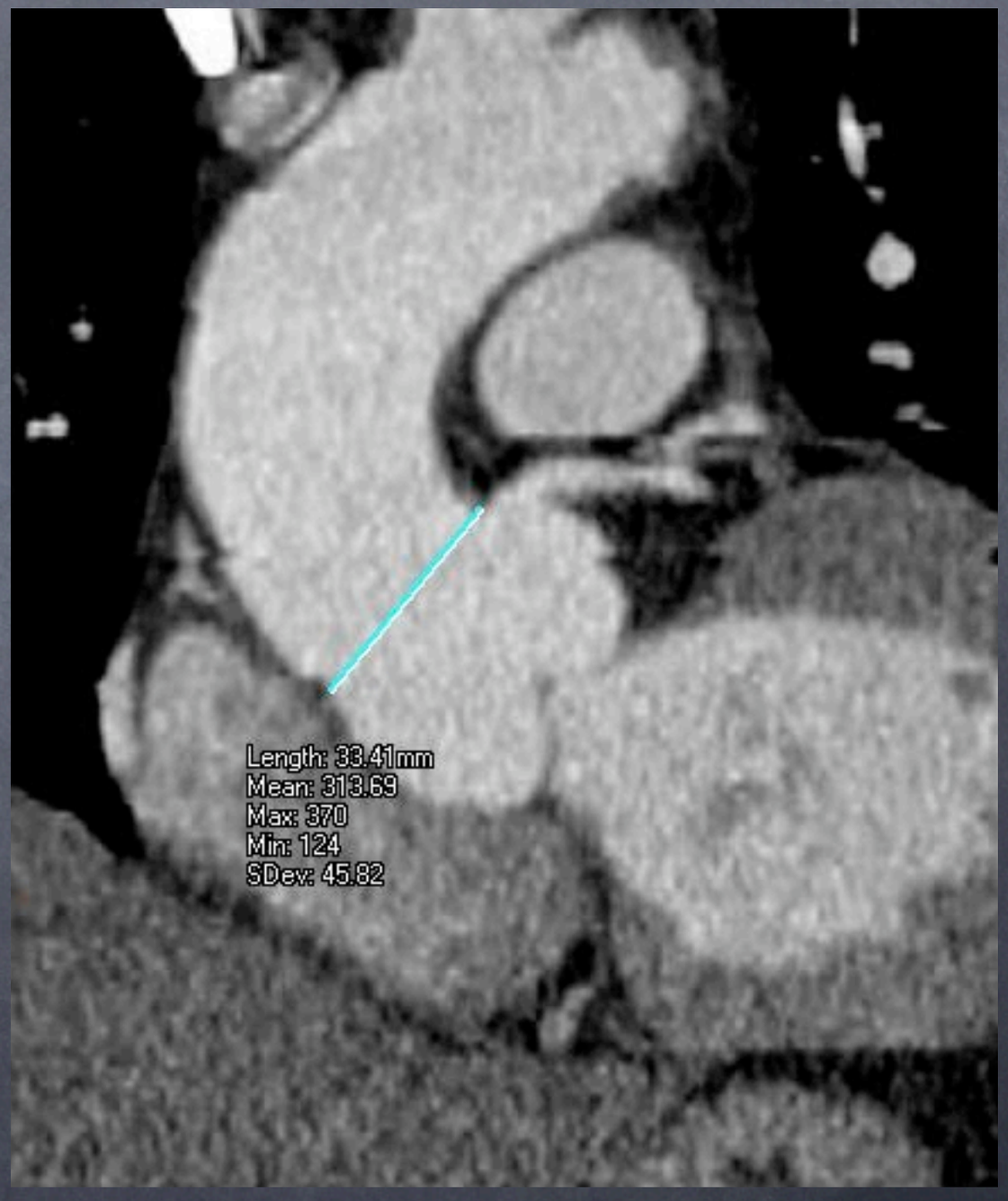


Soft Plaque in LAD (~ 40% stenosis)



Proximal RCA Occlusion, High LM origin (at STJ)



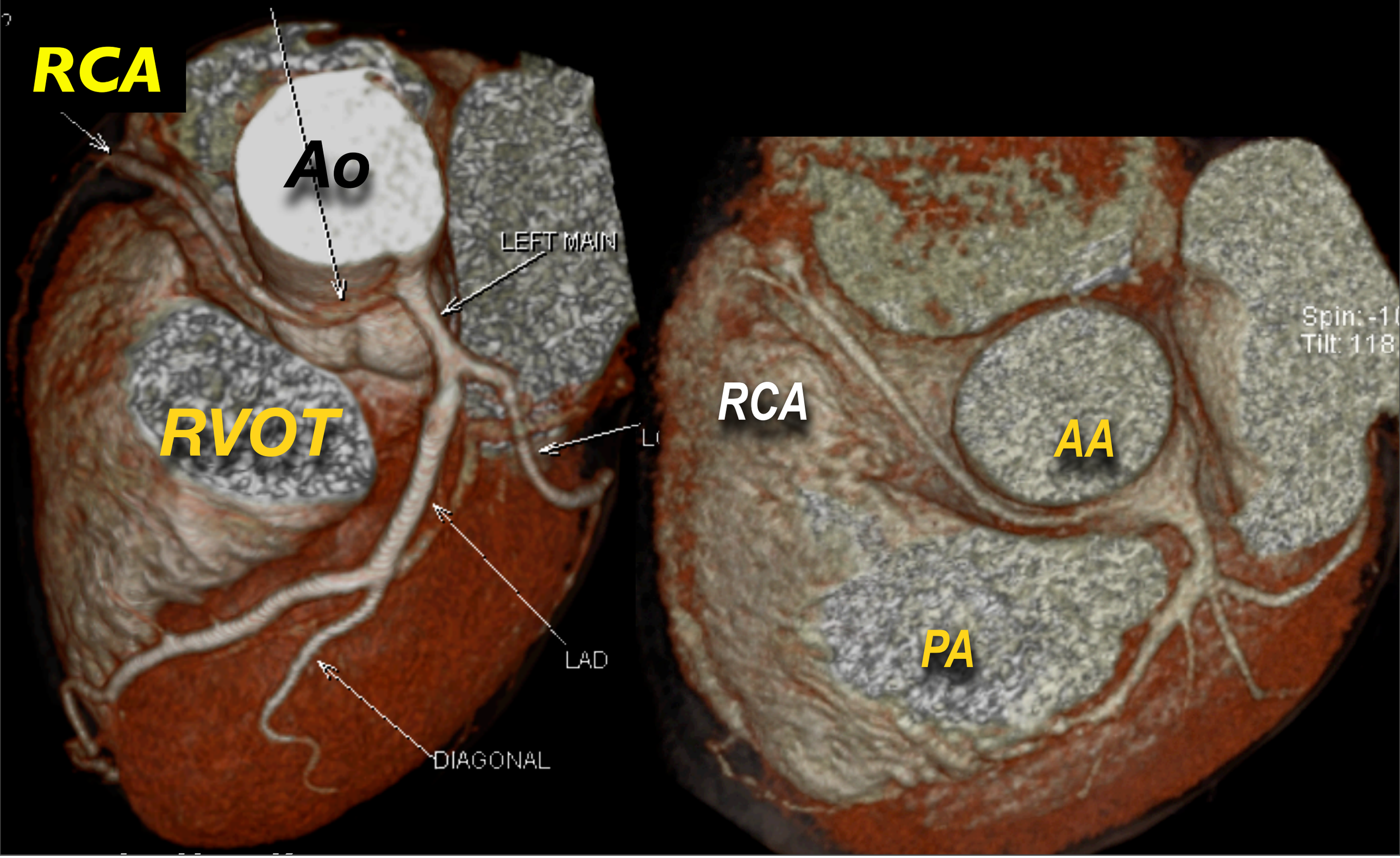


SVG to RCA, native PDA disease

BPG Aneurysm

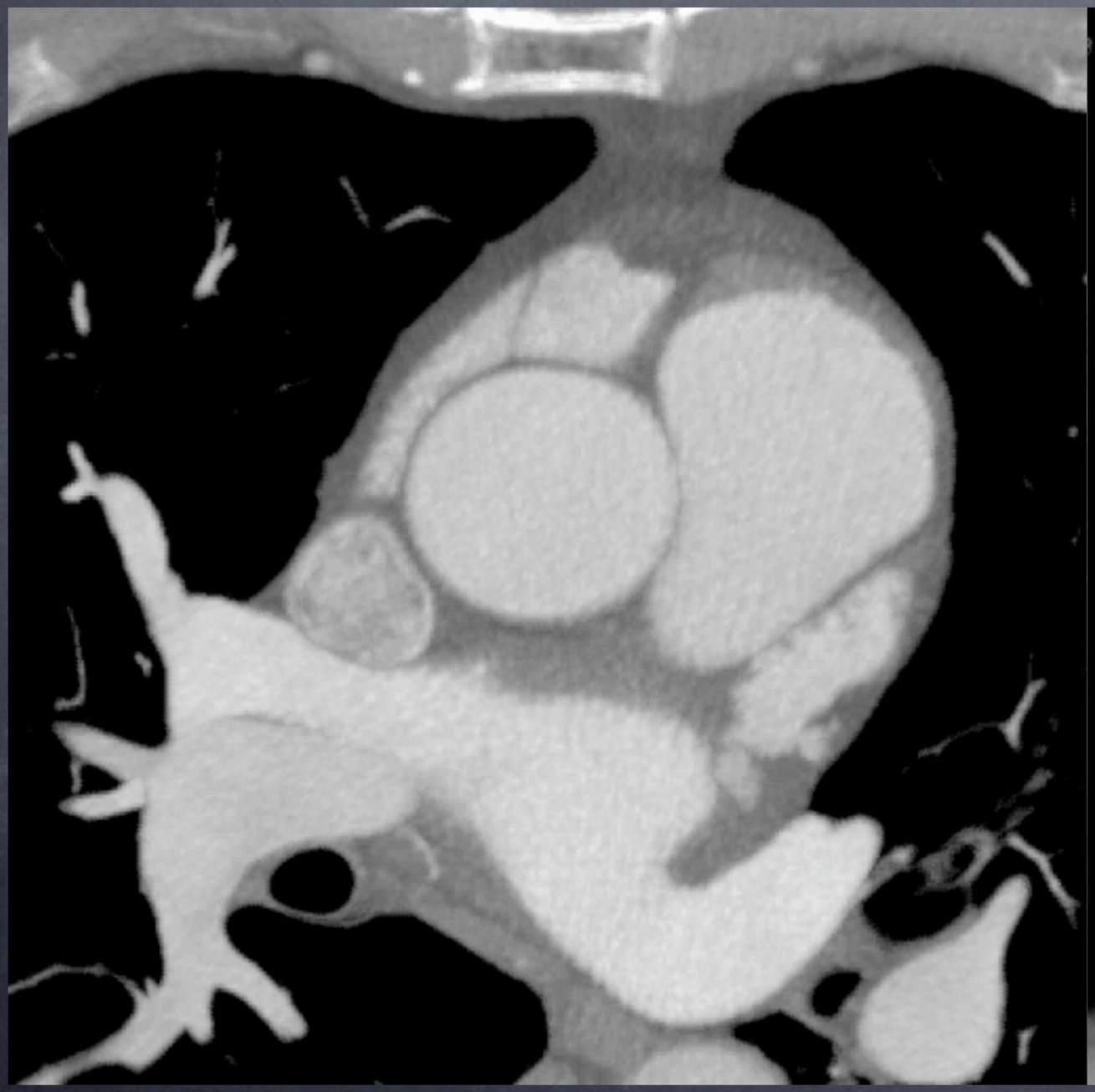
Examples:
Coronary Anomalies

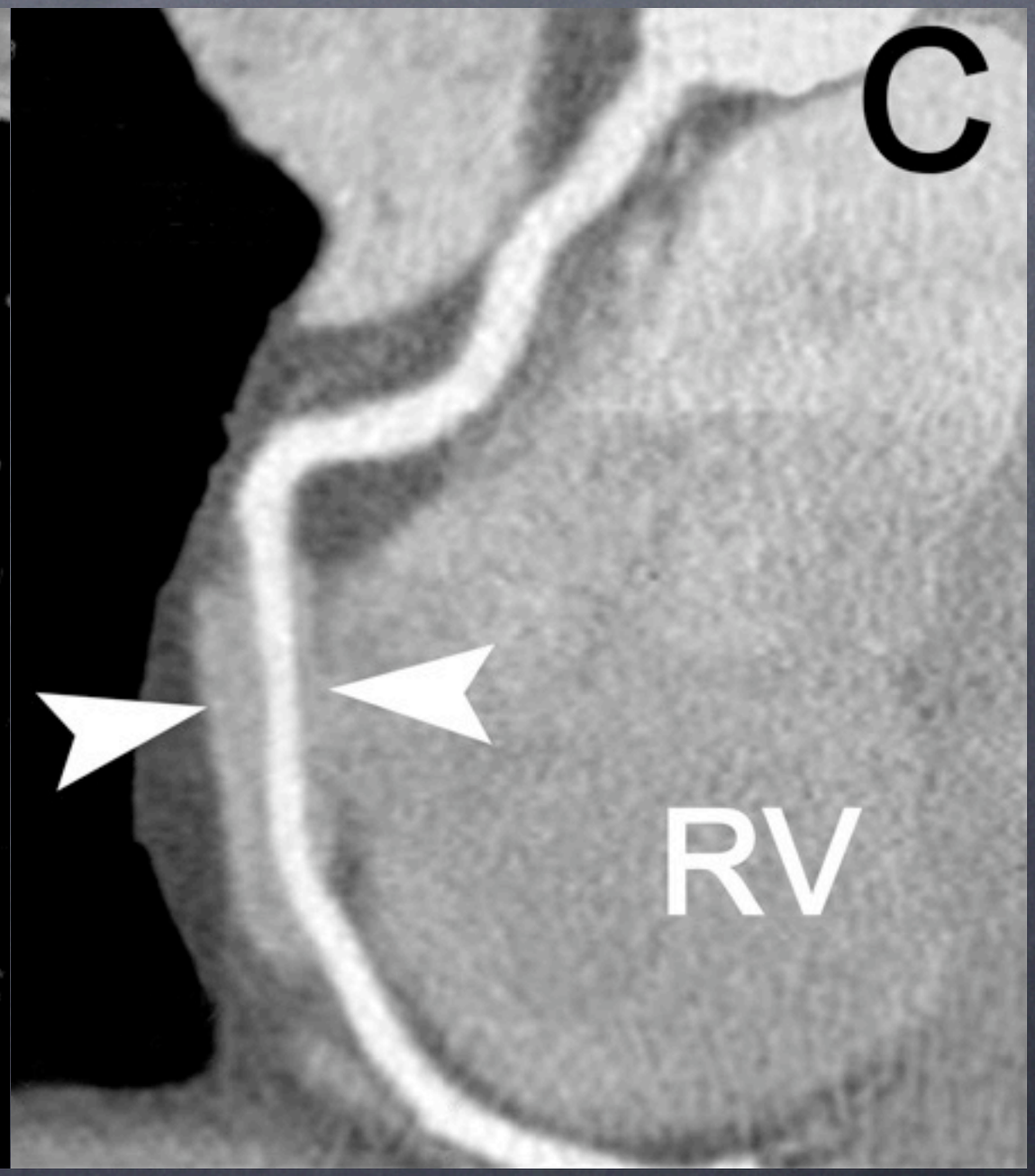
Anomalous RCA



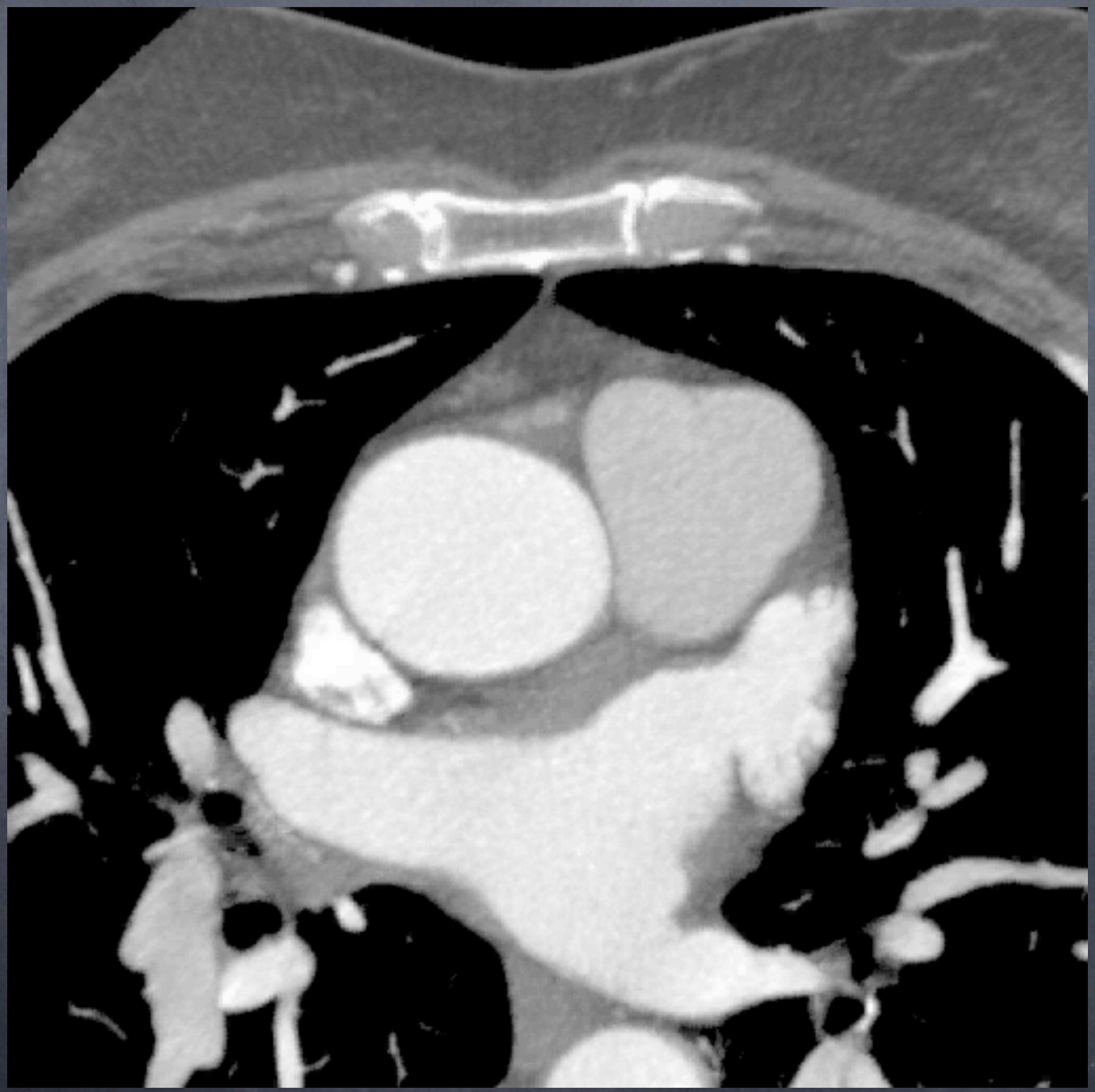
Anomalous RCA
(malignant anatomy)

Intra-cavitary RCA



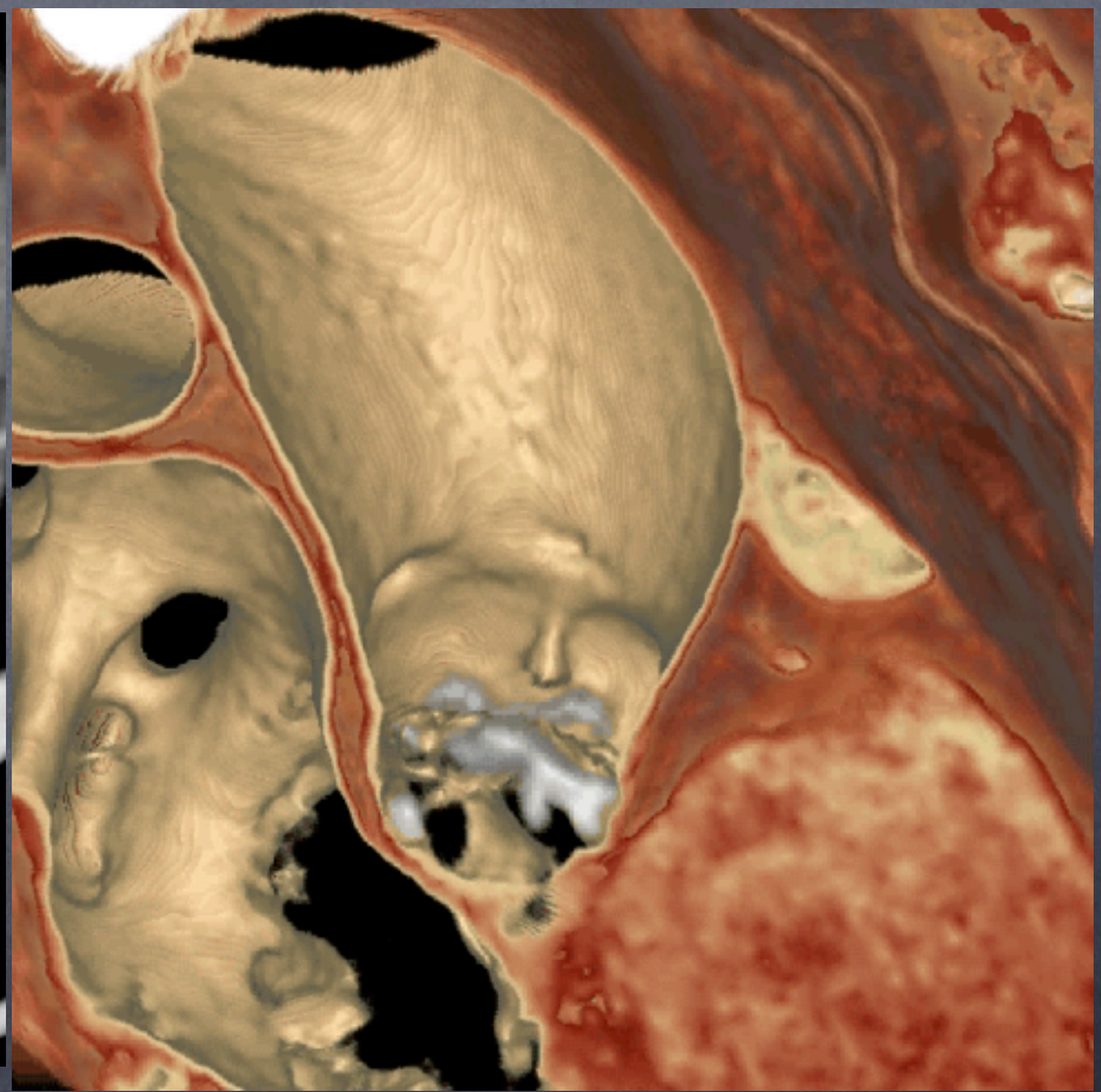


Anomalous Left Main

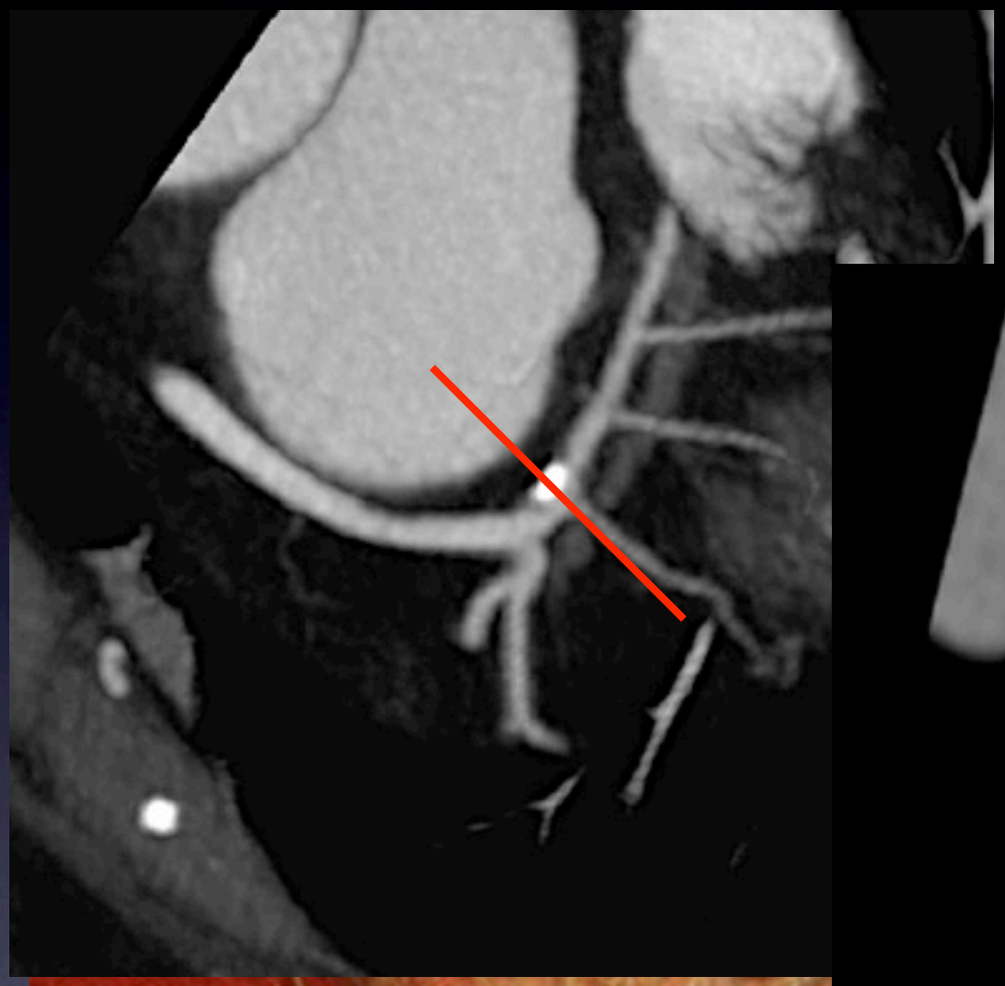


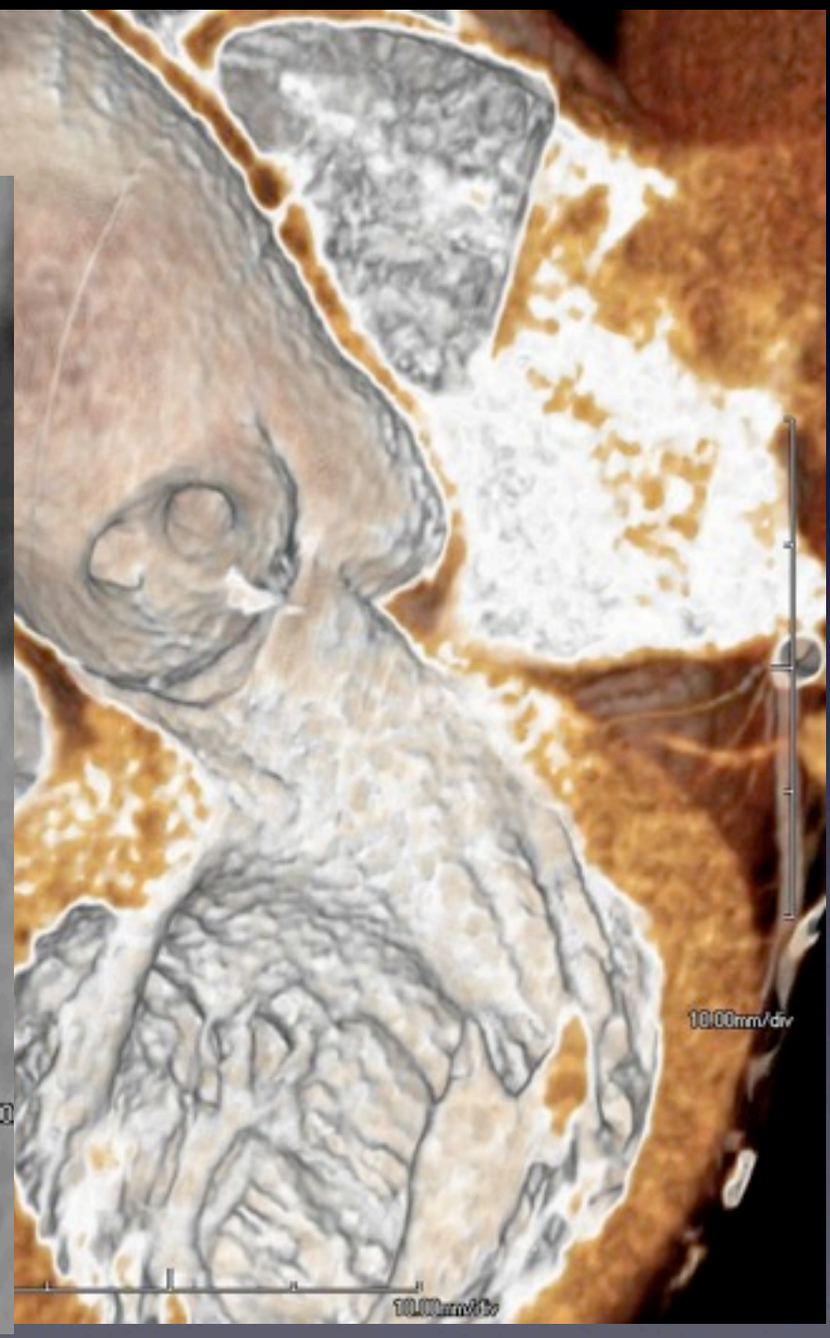
Anomalous LM from R, septal course

Anomalous RCA above fused RL cusps in BAV

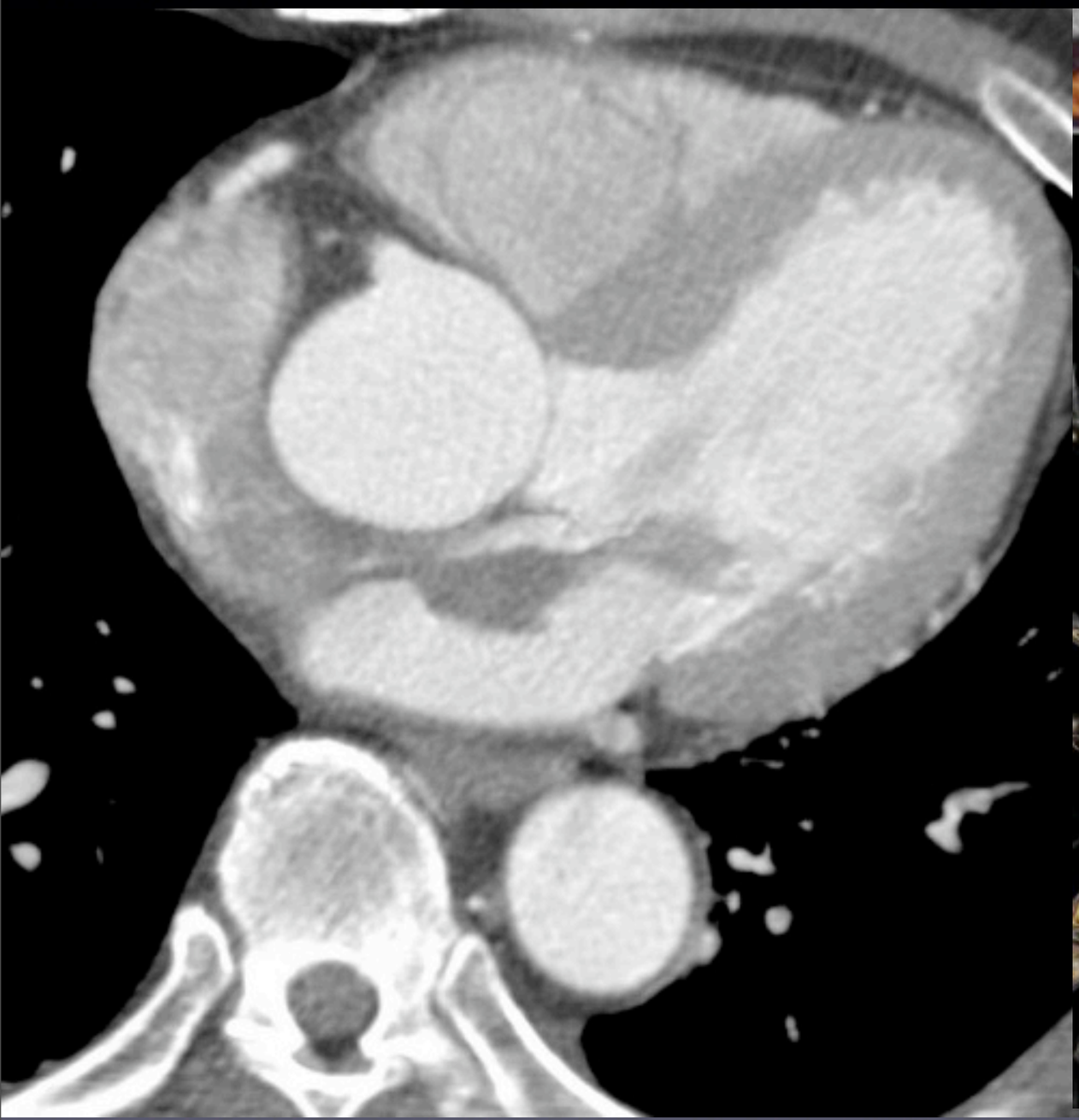


A “Benign” Coronary Anomaly (?)





Example: Cardiac Tumor



LA Myxoma

Conclusions

- CCTA / TRO are technically dependent exams
- Coronary CTA can be a robust technique for selected ED and outpatients at low - intermediate risk by FRS
- High NPV of TRO / CCTA exams can be leveraged to save resources
- Useful for wide range of congenital / acquired pathology

Handouts and more: http://stanford.edu/~hallett

More Information:

North American Society for Cardiovascular Imaging
http://www.nasci.org

Society of Cardiovascular Computed Tomography
http://www.scct.org

ACR Certificate of Added Proficiency (CoAP) in Cardiac CT
http://www.acr.org/secondarymainmenucategories/acr-education/coap.aspx

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