

I piani tomografici del cuore in Eco-2D, TC e RM

*... per renderci conto di quanto siamo
naturalmente vicini a queste metodiche*

Arturo Raisaro

Ecocardiochirurgia Milano 2009

ECOCARDIOGRAFIA

- 2D echo con doppler rimane la principale metodica non invasiva di imaging in ambito cardiovascolare
- Versatile e cost effective
- Facilmente eseguibile al letto del paziente
- La disponibilità di ecografi compatti (ultraportatili) è ora disponibile con tutte le tecnologie di base per una corretta accuratezza diagnostica

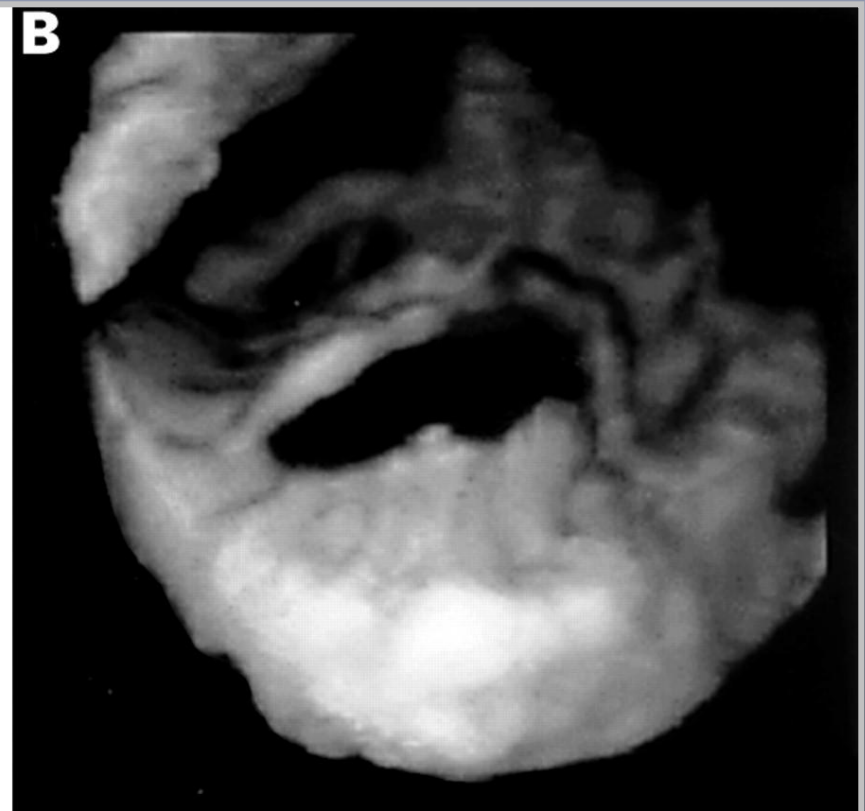
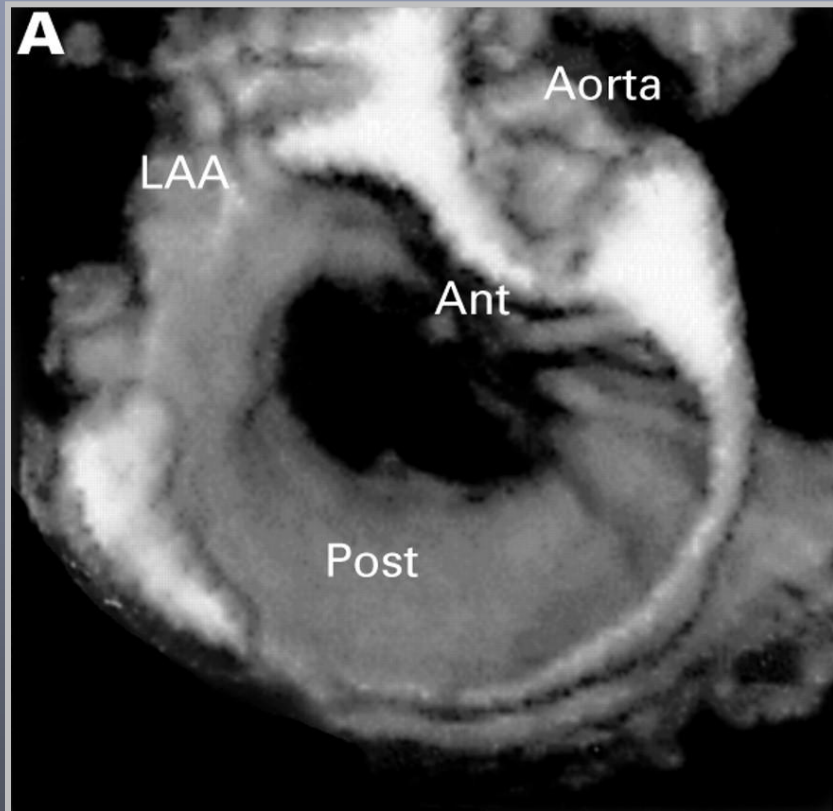
Le nuove metodiche in Ecocardiografia

- Tissue Doppler and 2D strain
 - Valutazione della contrattilità miocardica durante il ciclo cardiaco
 - Migliore valutazione della disfunzione diastolica
- 3D echocardiography
- Ecocardiografia con contrasto (studi di perfusione)

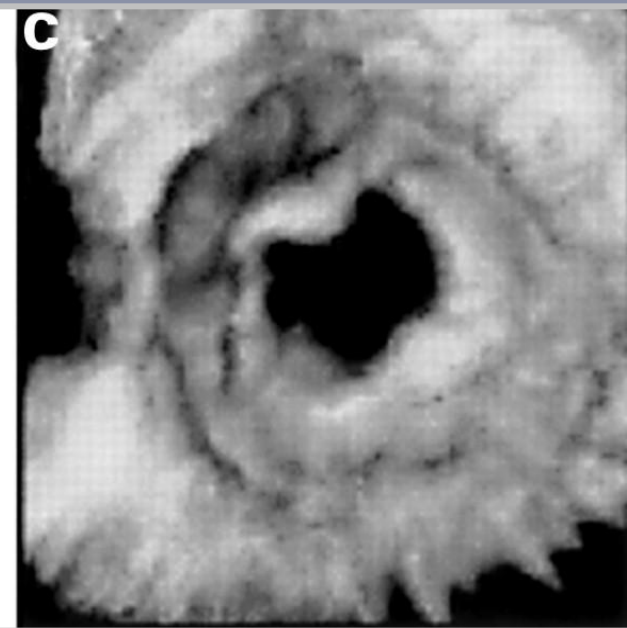
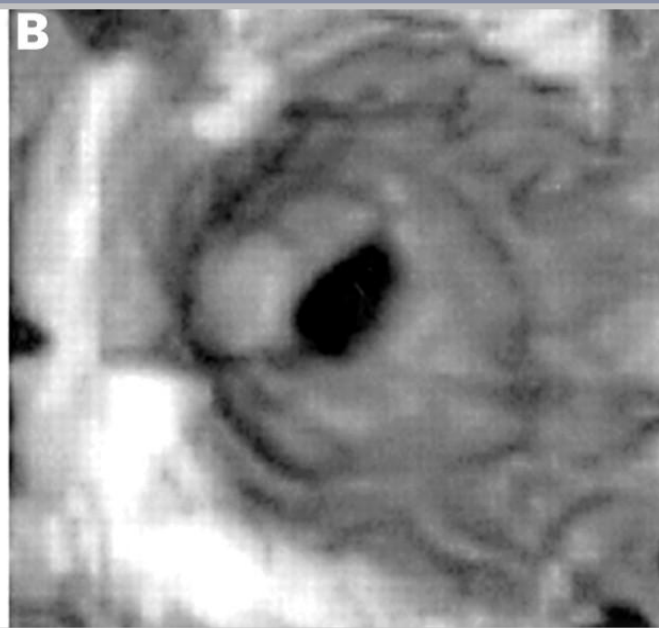
3D Echocardiography

- Accurata valutazione dei volumi ventricolari e della FE%
- Ricostruzione 3D delle valvole cardiache
- Migliore definizione of della cinetica segmentaria
- Valutazione della sissincronia del VS prima e dopo impianto di PM biventricolare (CRT)
- Tecnologia e applicazioni in evoluzione

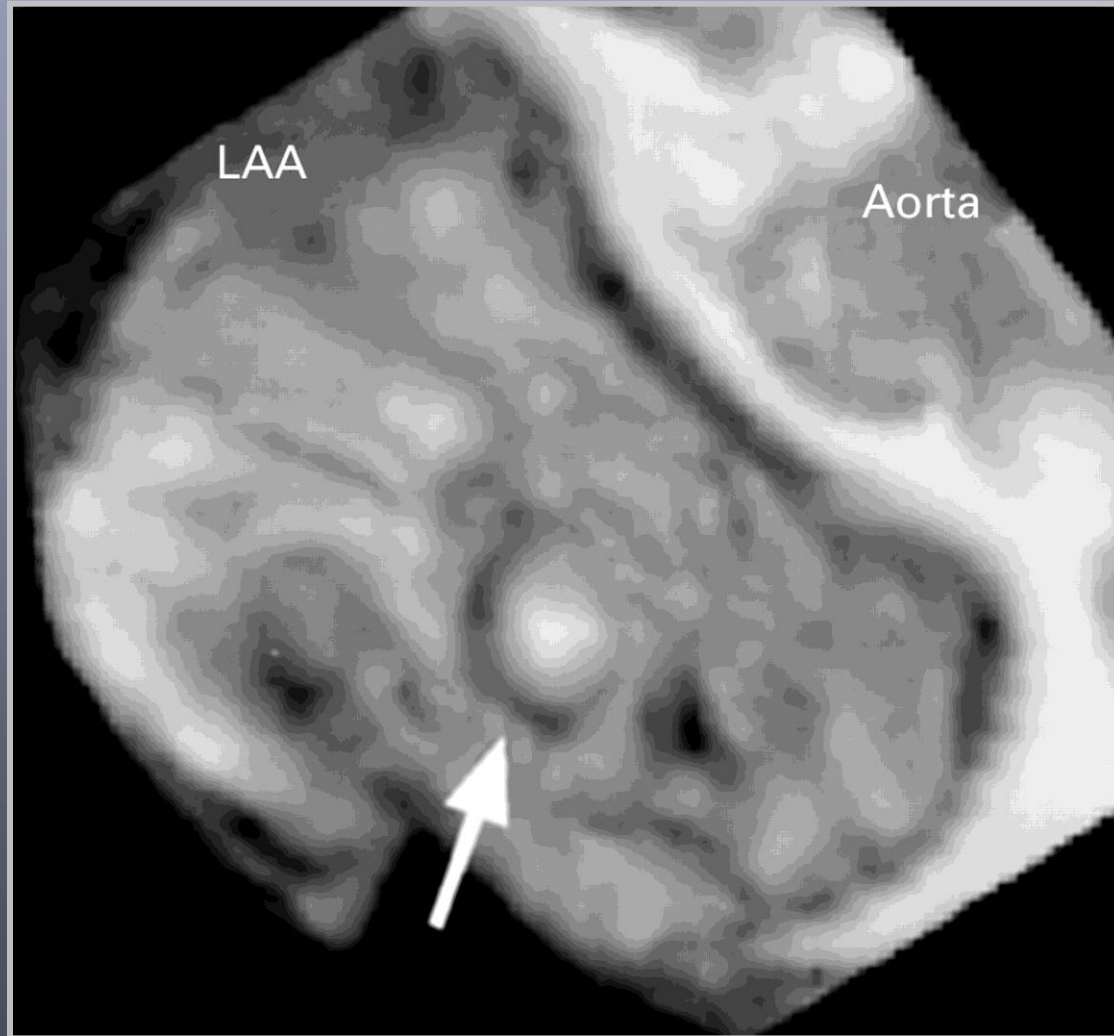
3 D ECHOCARDIOGRAPHY OF NORMAL MITRAL VALVE



3D ECHOCARDIOGRAPHY OF RHEUMATIC MITRAL STENOSIS

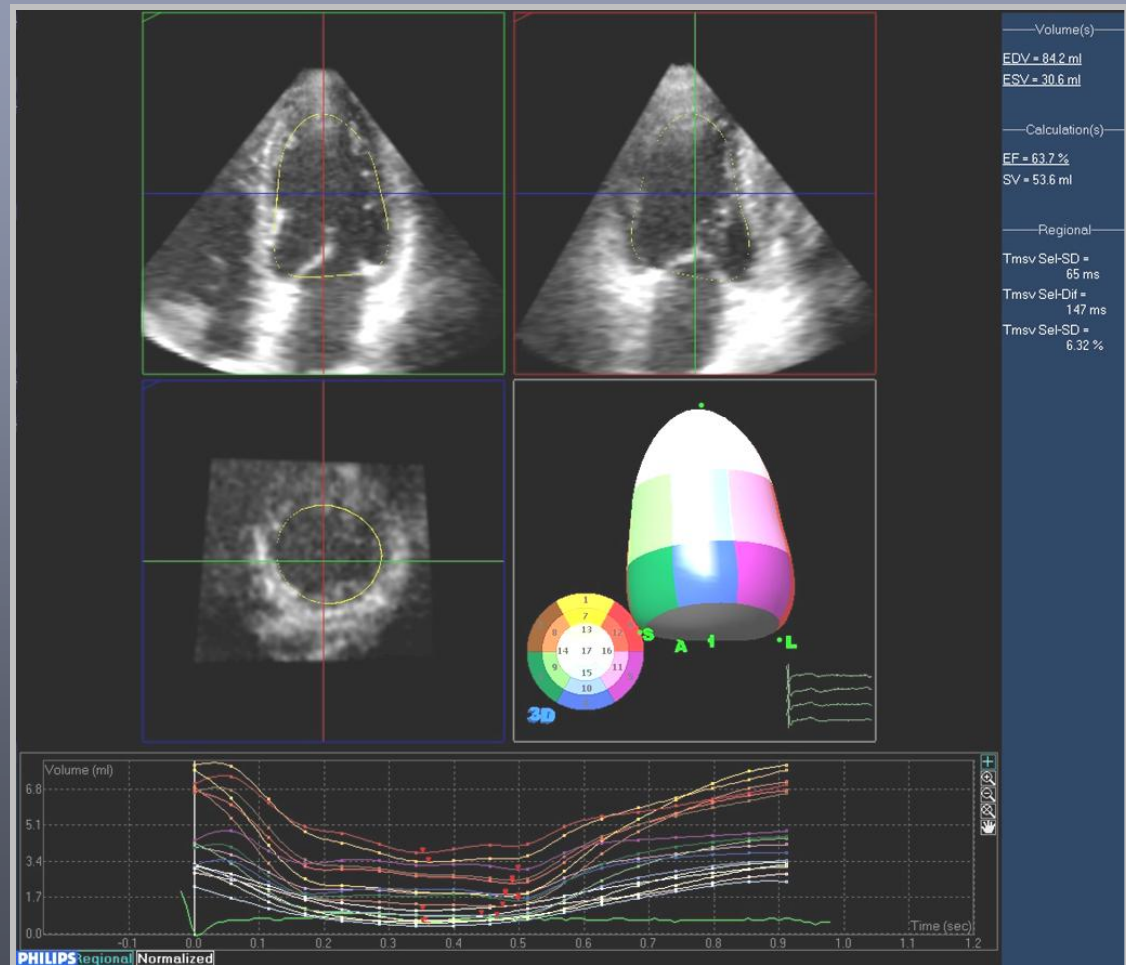


3D ECHOCARDIOGRAPHY OF MITRAL VALVE PROLAPSE



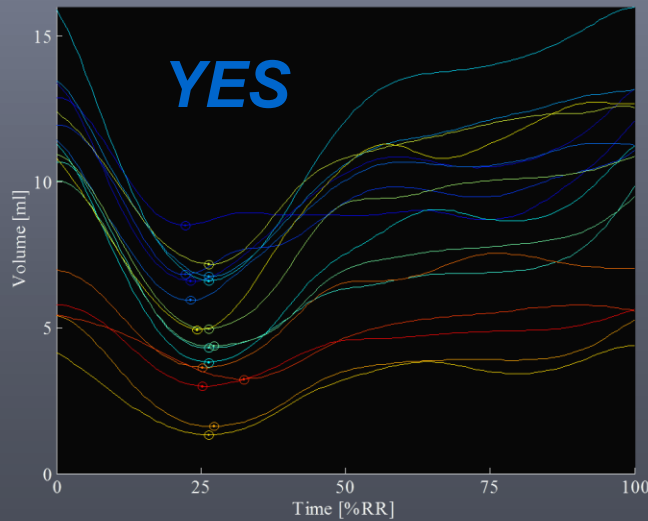
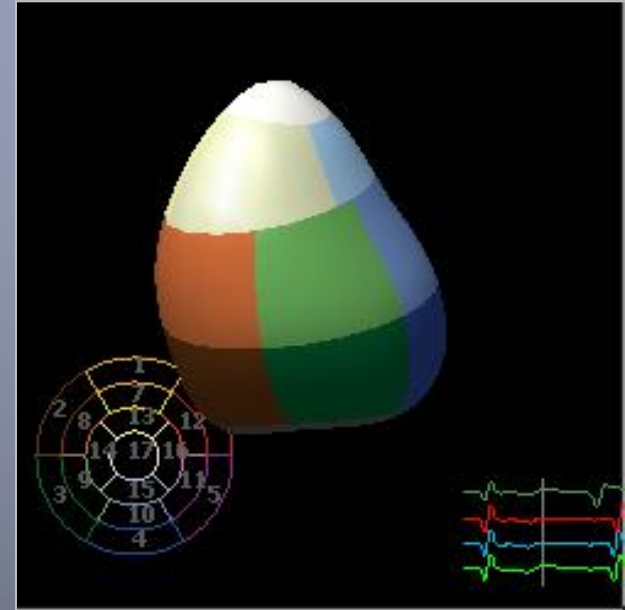
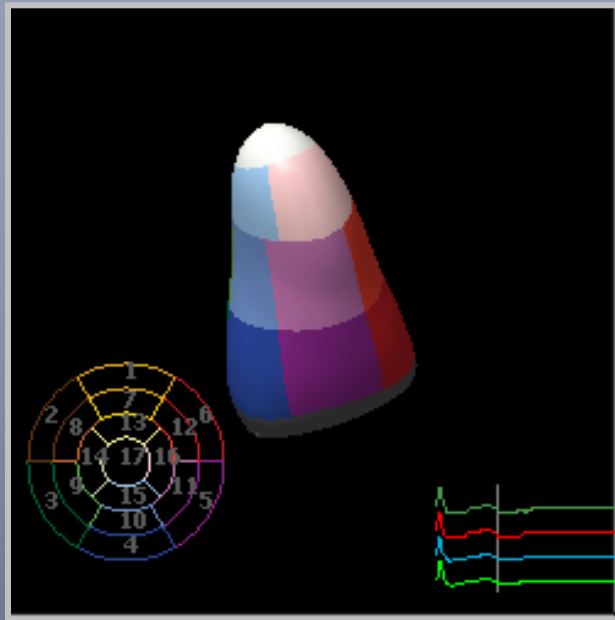
CRT and 3D Echo Analysis

La valutazione 3D della cinetica regionale del VS e l'analisi dei tempi di contrazione può essere utilizzata nella selezione dei pazienti candidati alla resincronizzazione, nella valutazione dell'estensione della dissincronica e nella valutazione dei risultati.

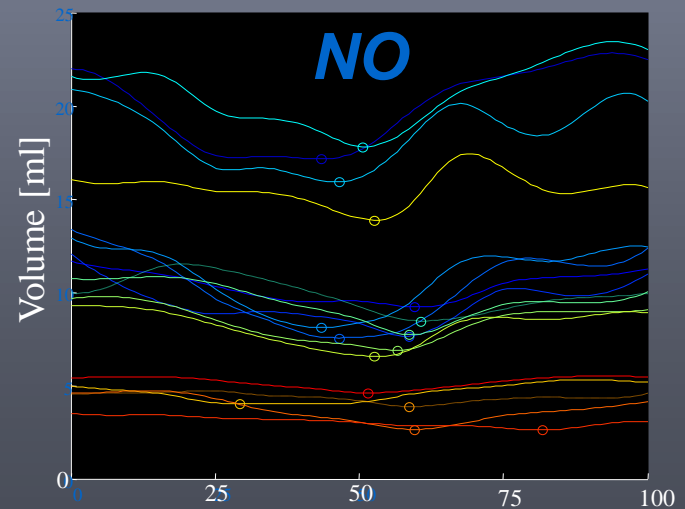


What is LV dyssynchrony?

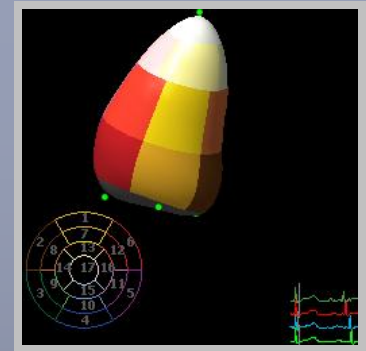
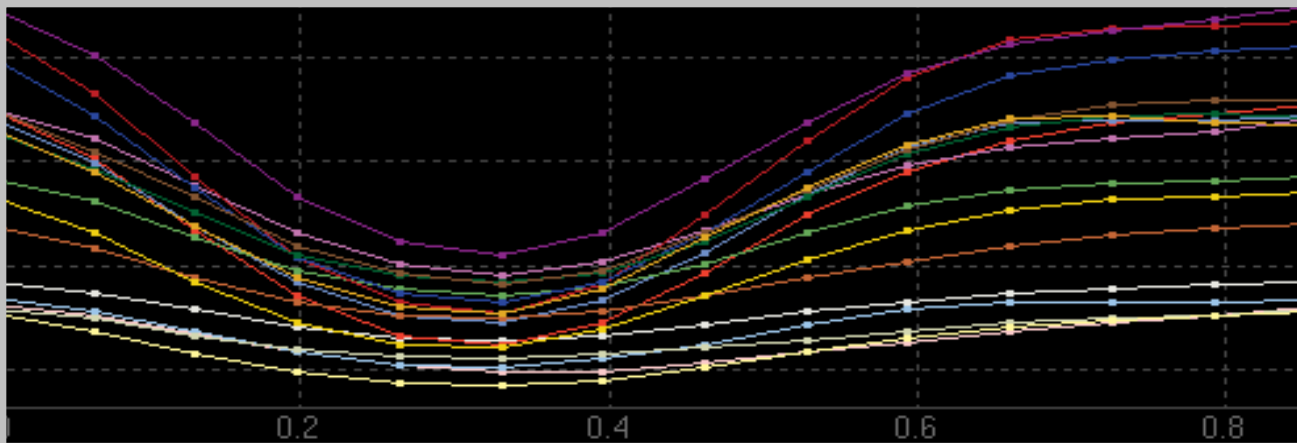
Does LV contract together ?



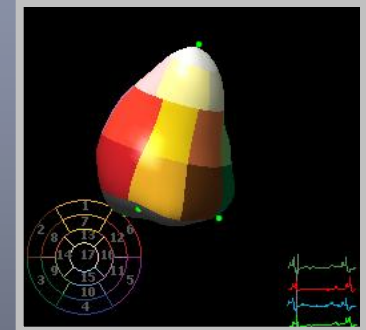
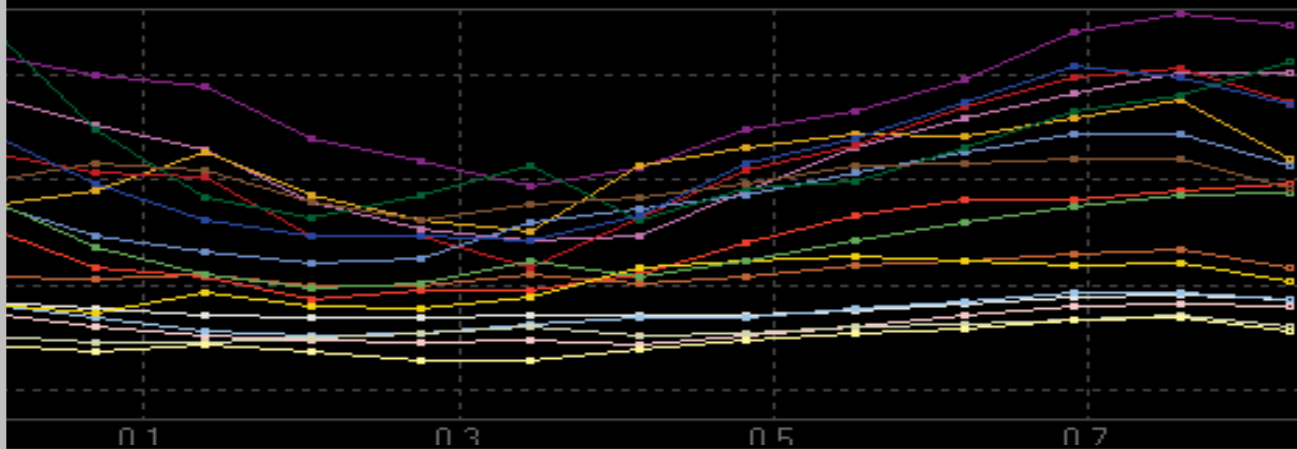
(EF=50%)
Asynchrony index: 2.3%



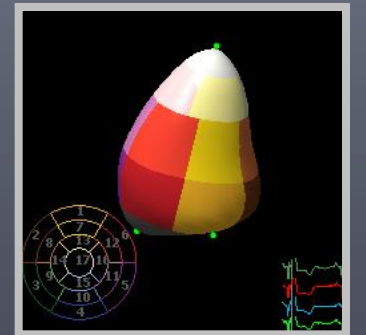
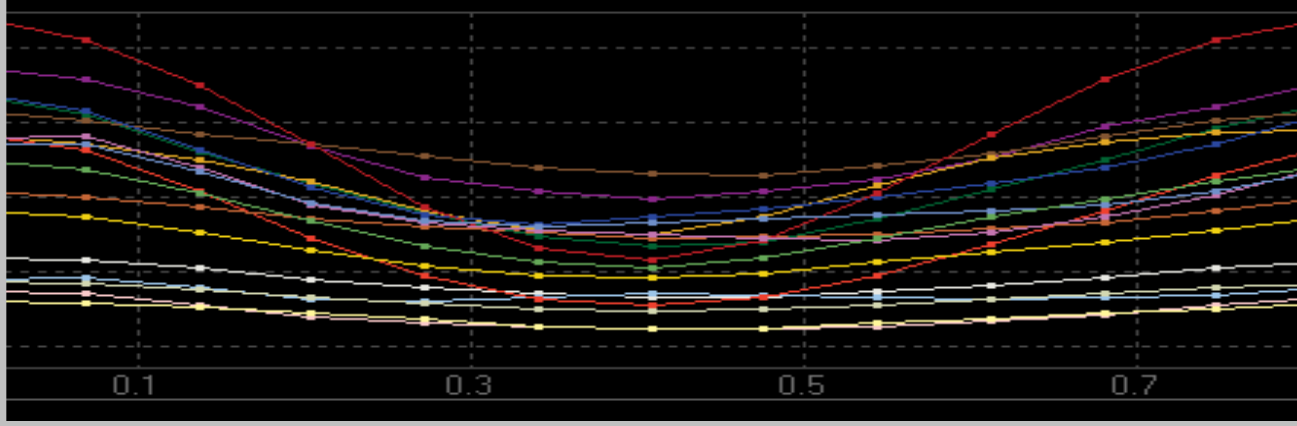
(EF=24%)
Asynchrony index: 11.4%



NORMAL

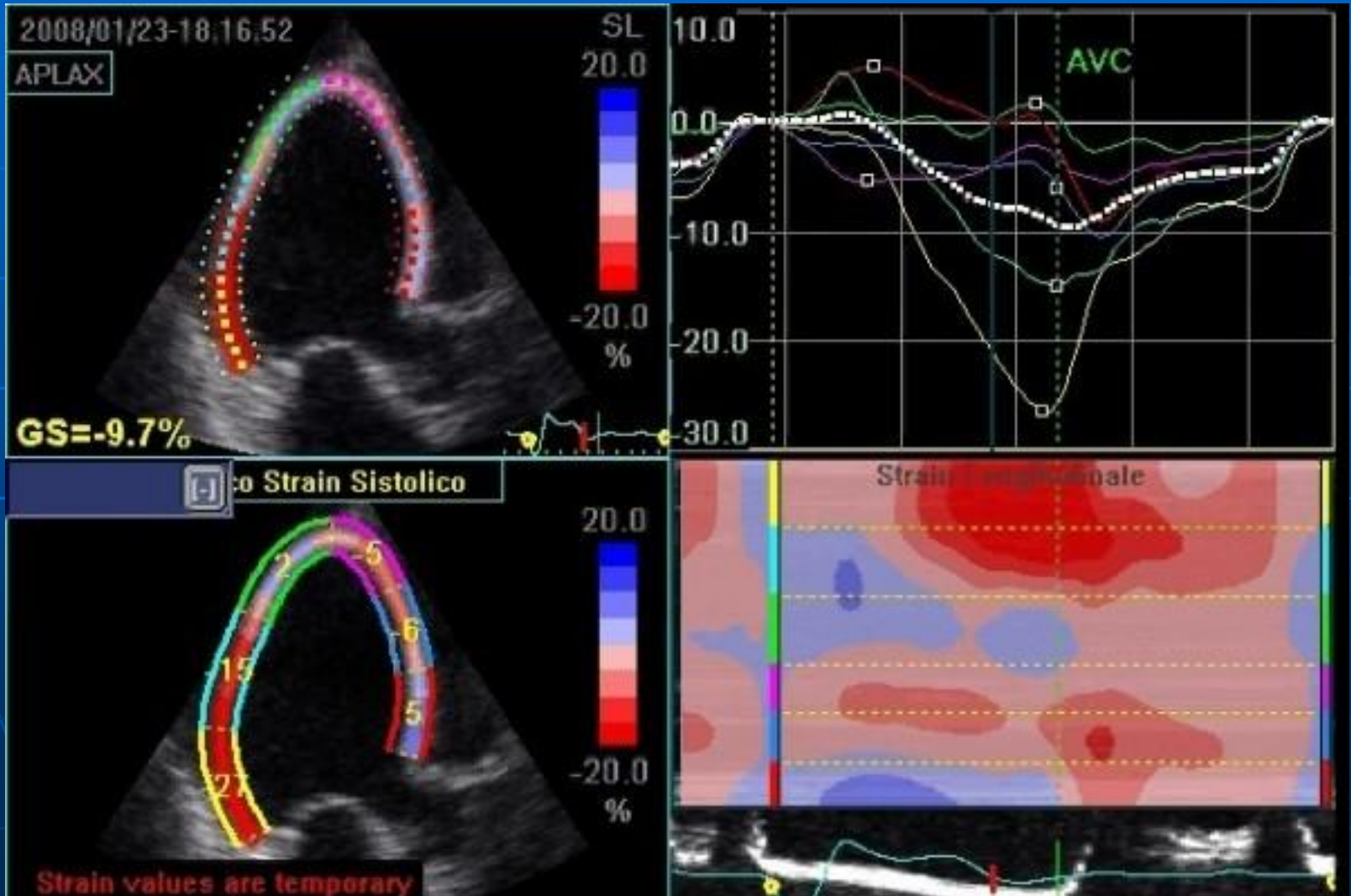


DYSSYNCHRONY

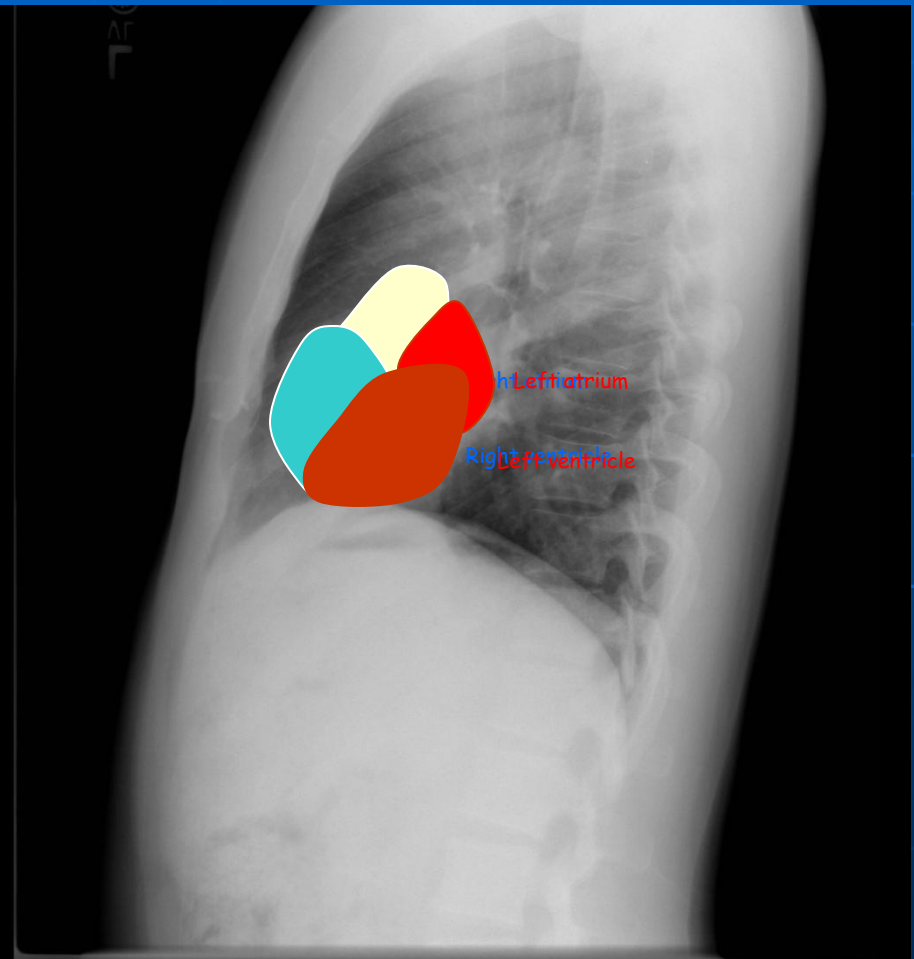
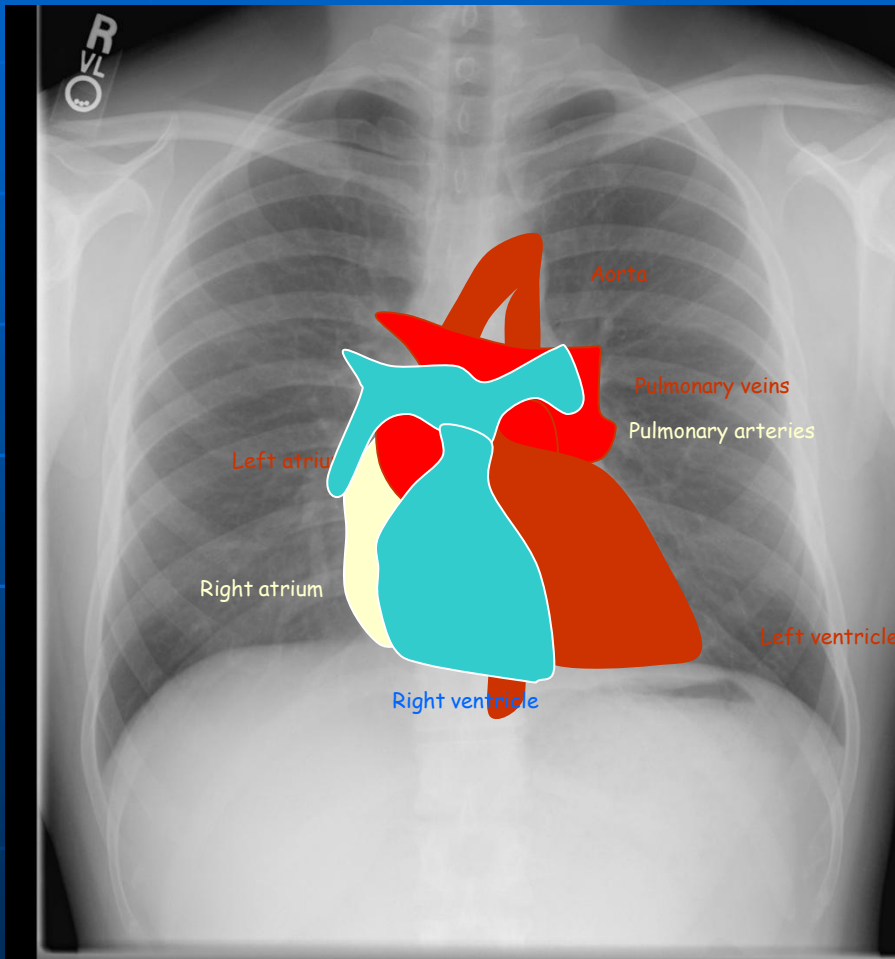


Post BiV pacer

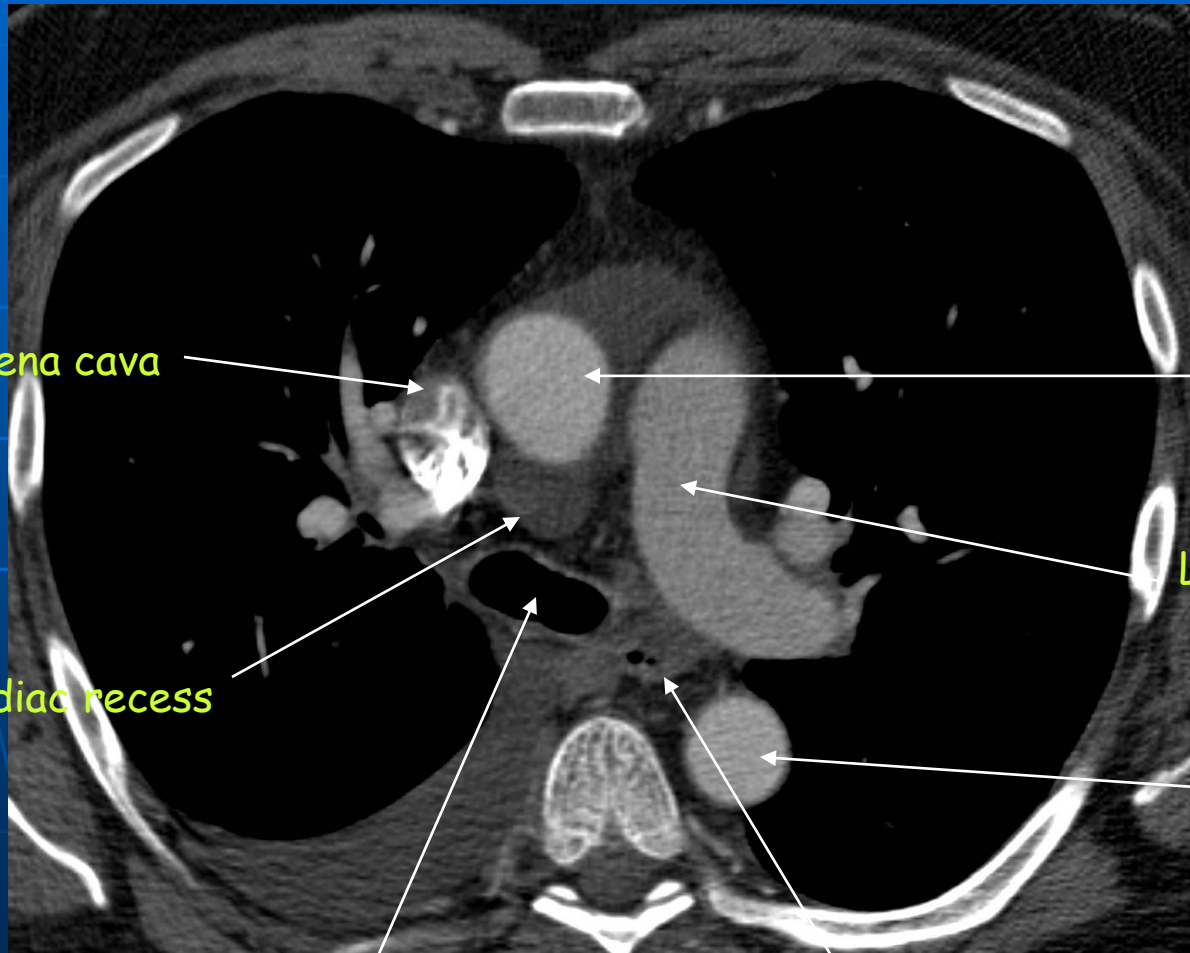
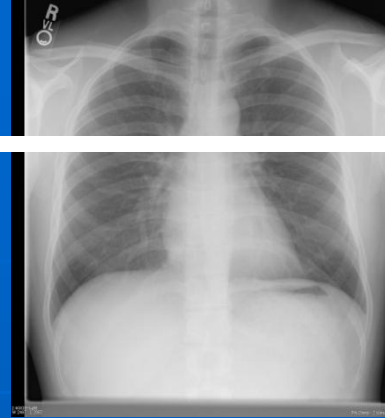
2D strain (speckle tracking)



Radiografia del torace



TC



Superior vena cava

Ascending aorta

Left pulmonary artery

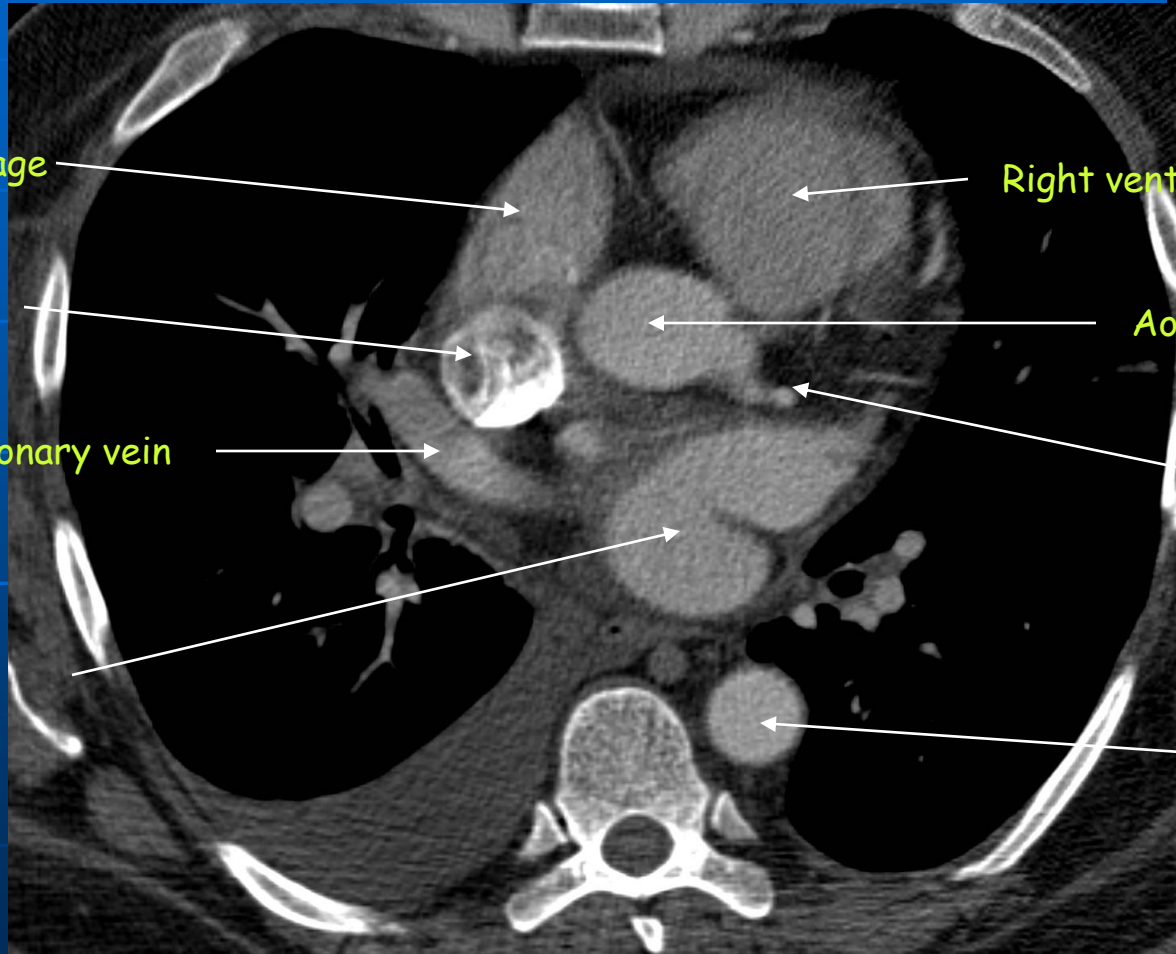
Descending aorta

Superior cardiac recess

Carina

Esophagus

TC



Right atrial appendage



Right ventricular outflow tract



Superior vena cava



Aorta



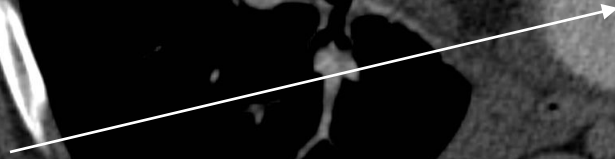
Right superior pulmonary vein



Left coronary artery



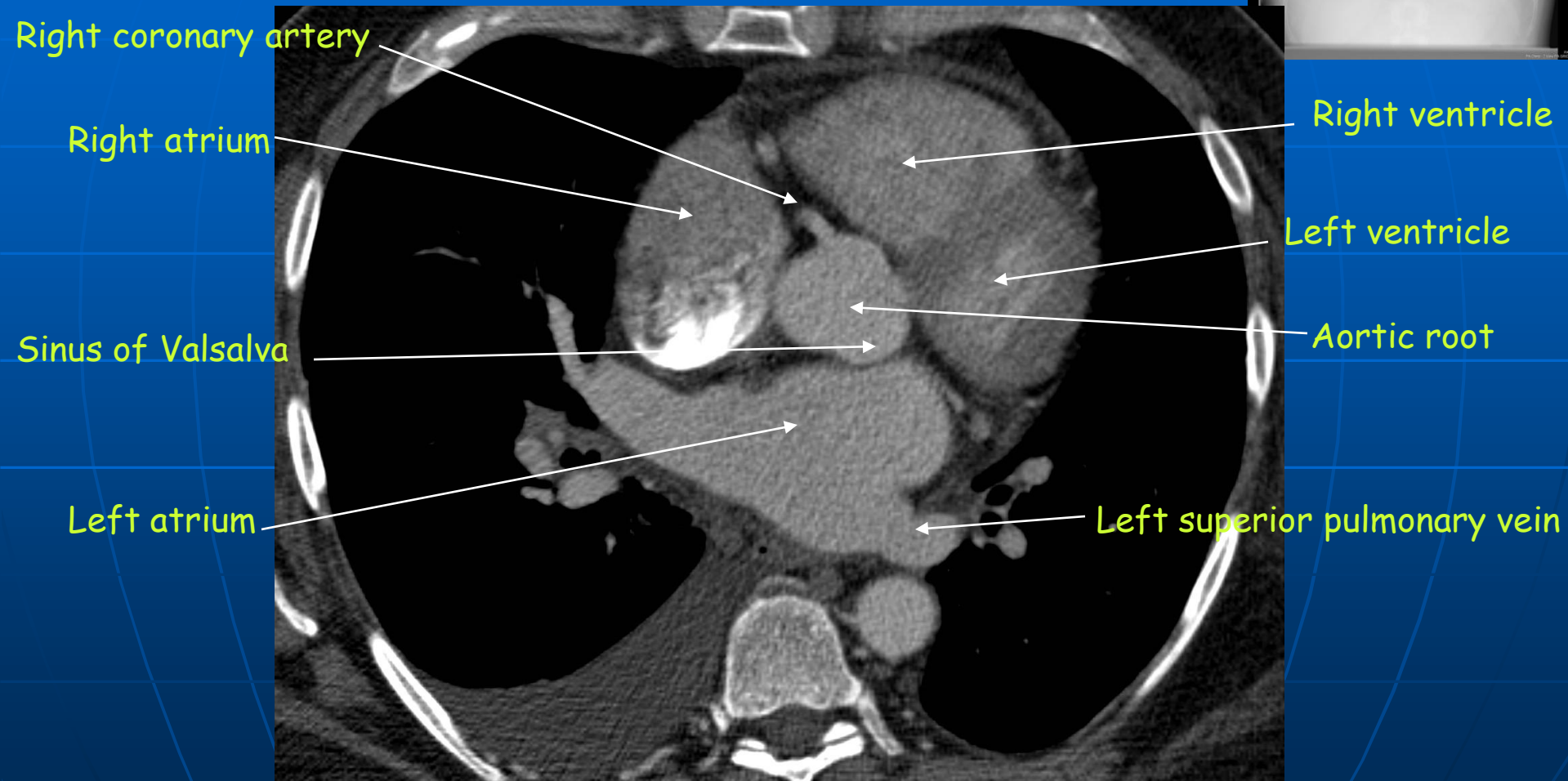
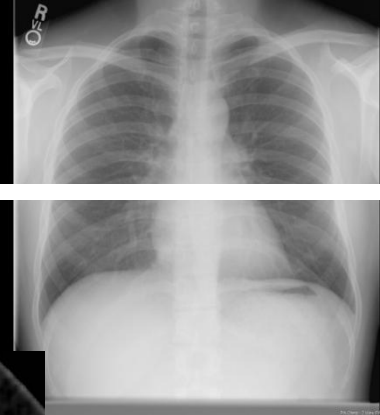
Left atrium



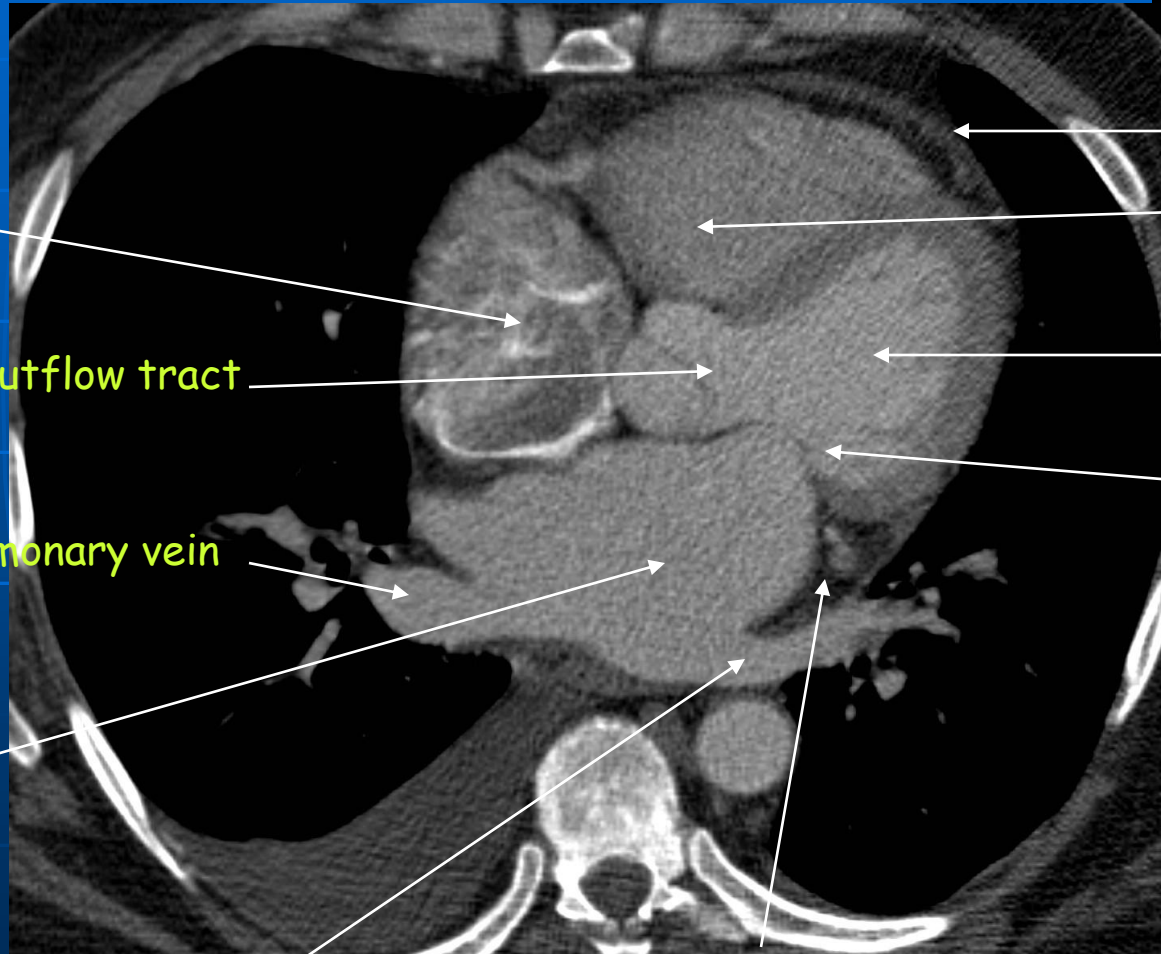
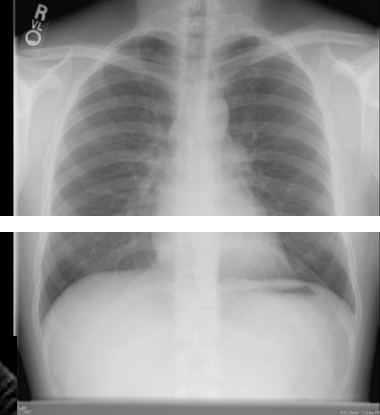
Descending aorta



TC



TC



Right atrium

Left ventricular outflow tract

Right inferior pulmonary vein

Left atrium

Left inferior pulmonary vein

Pericardium

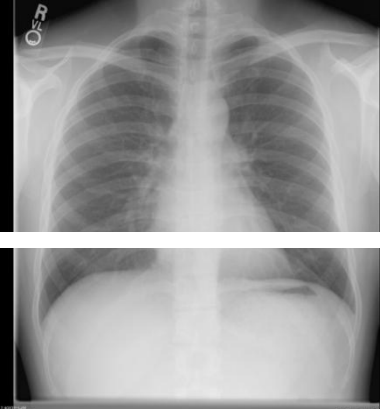
Right ventricle

Left ventricle

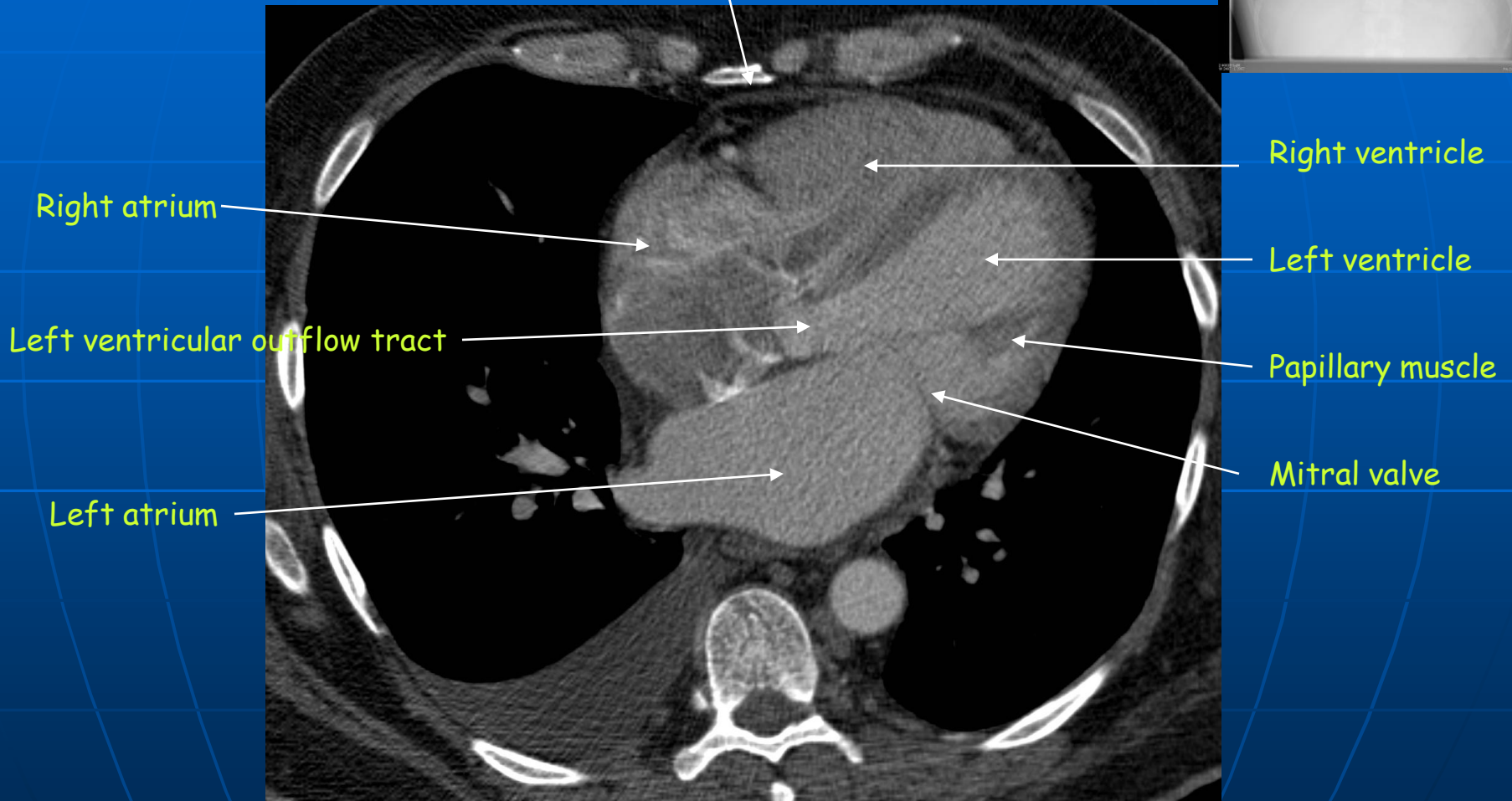
Mitral valve

Left atrioventricular groove with left coronary artery

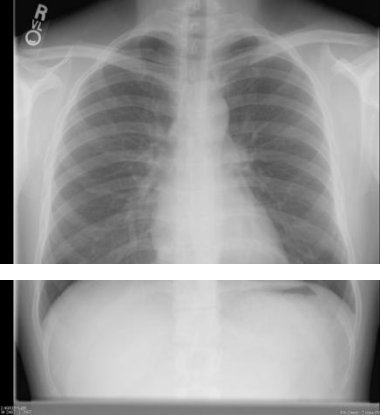
TC



Right atrioventricular groove with right coronary artery



TC



Right ventricle

Apex

Right atrium

Left ventricle

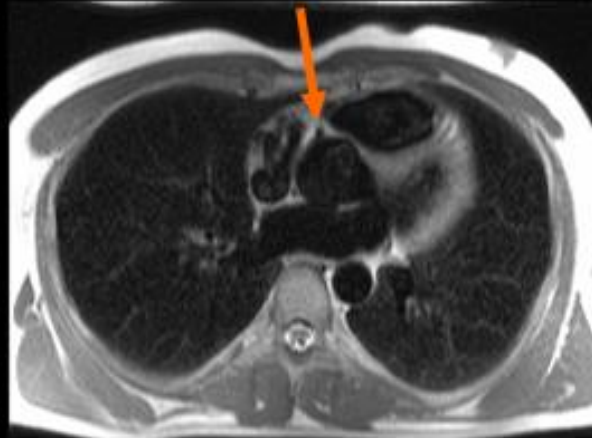
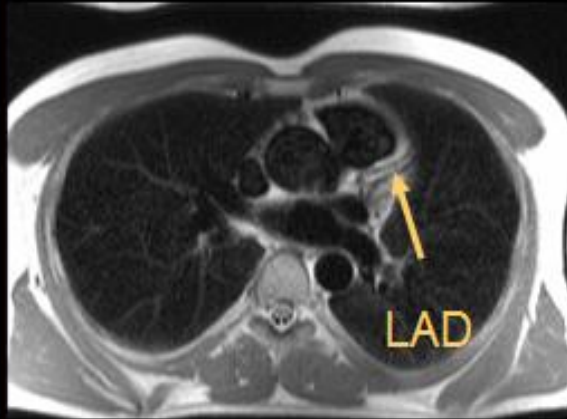
Interventricular septum

Coronary sinus



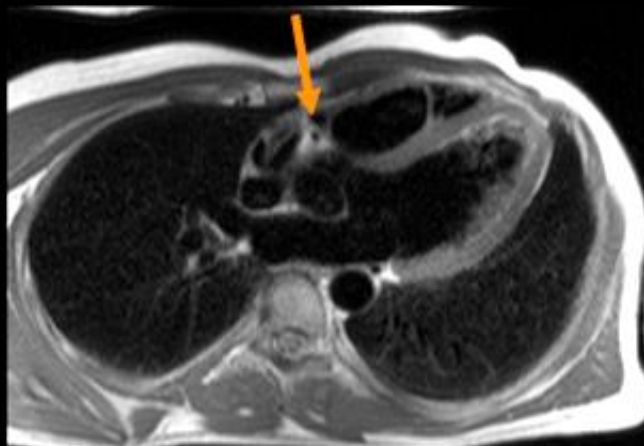
ANATOMIA ASSIALE

RCA

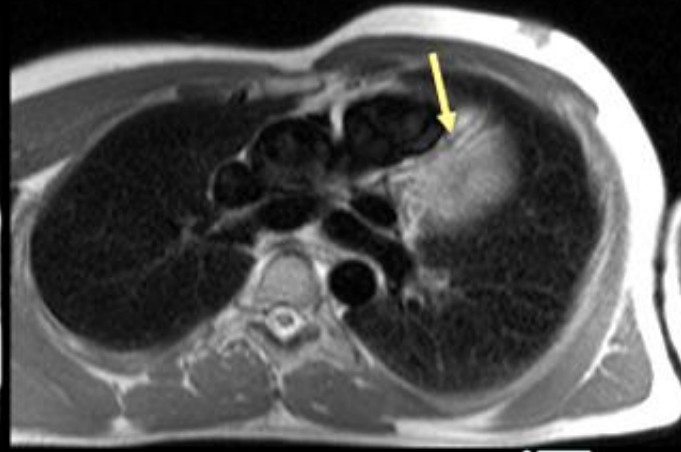


ANATOMIA ASSIALE

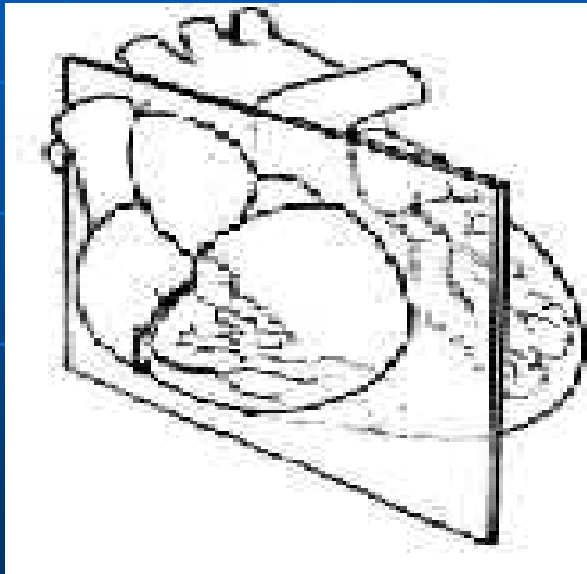
RCA



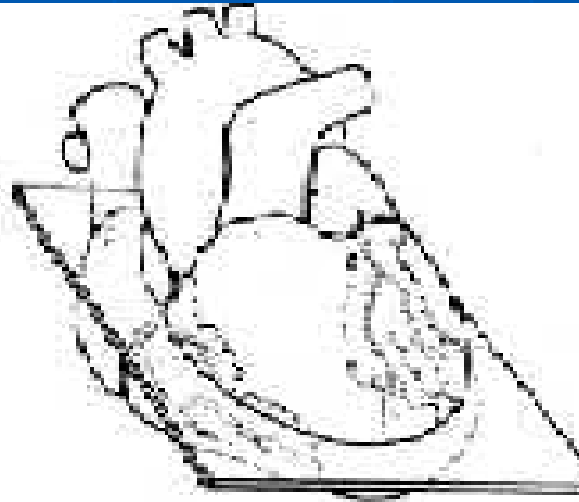
LAD



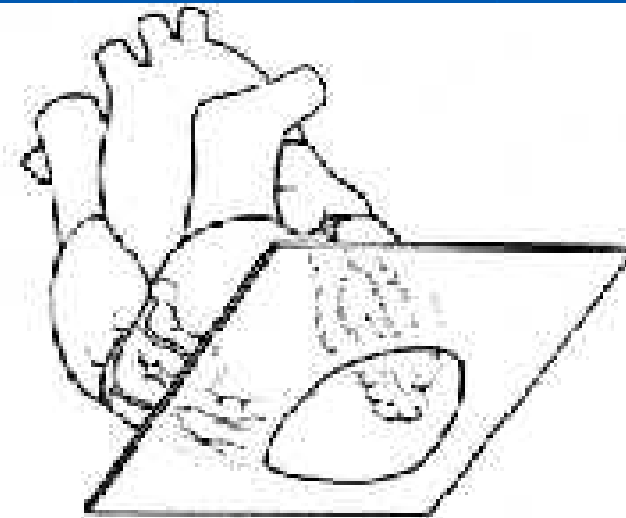
Imaging planes for cardiac CT and MR/Echo



Vertical long axis



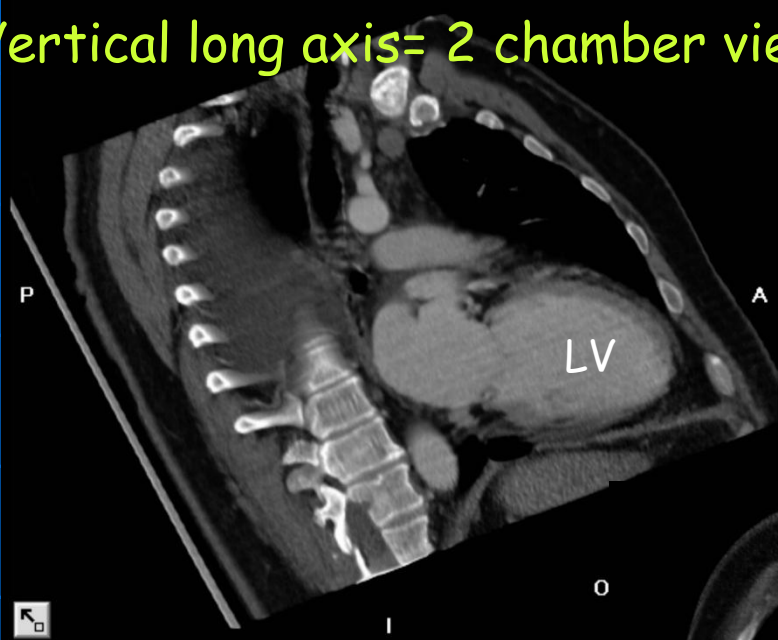
Horizontal long axis



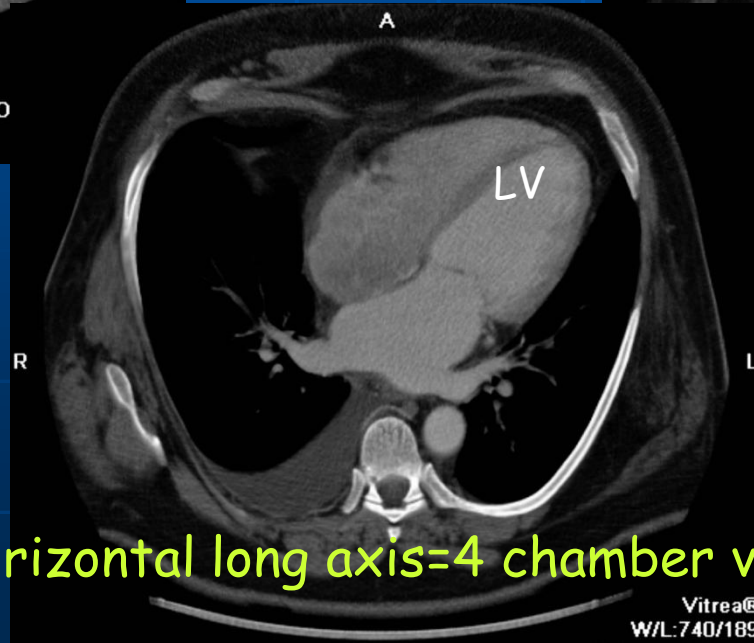
Short axis

CT Reformats in cardiac imaging planes

Vertical long axis= 2 chamber view



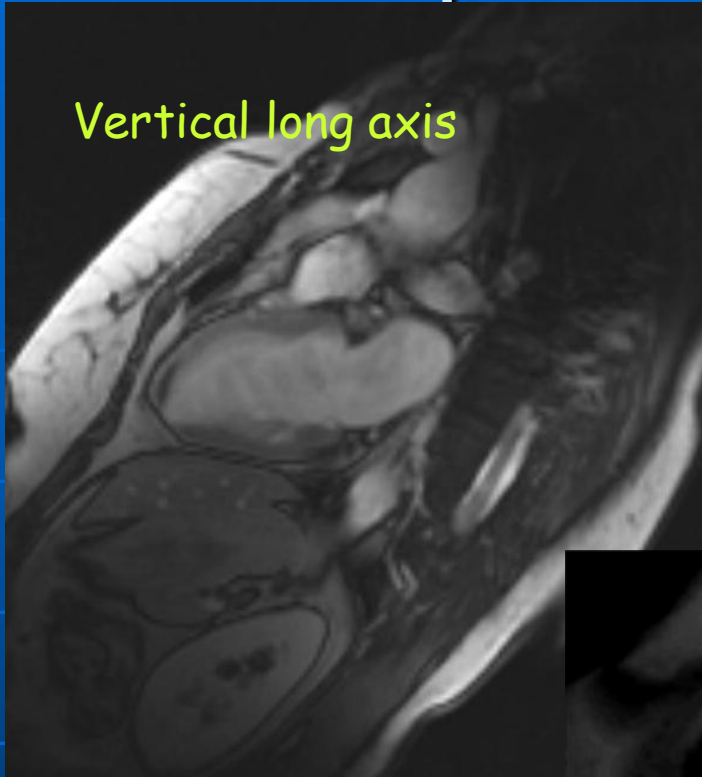
Short axis



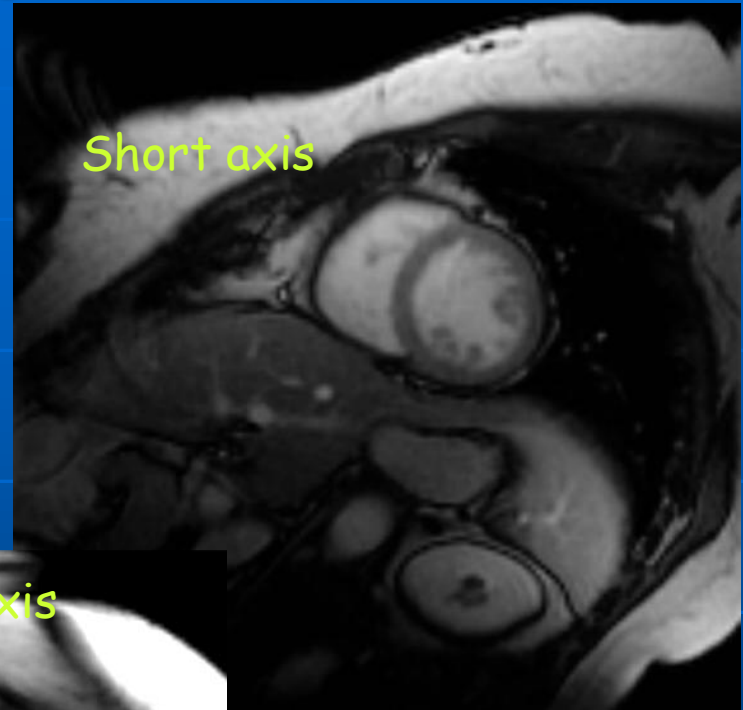
Horizontal long axis=4 chamber view

I piani anatomici in RM

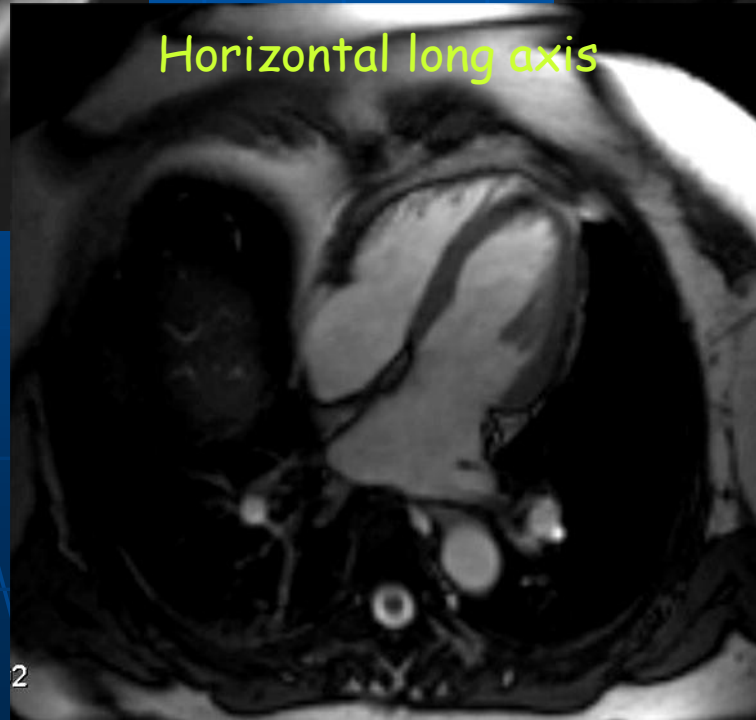
Vertical long axis



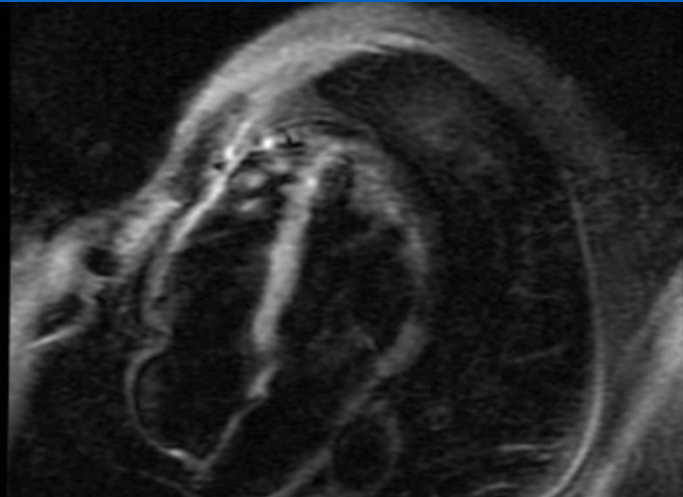
Short axis



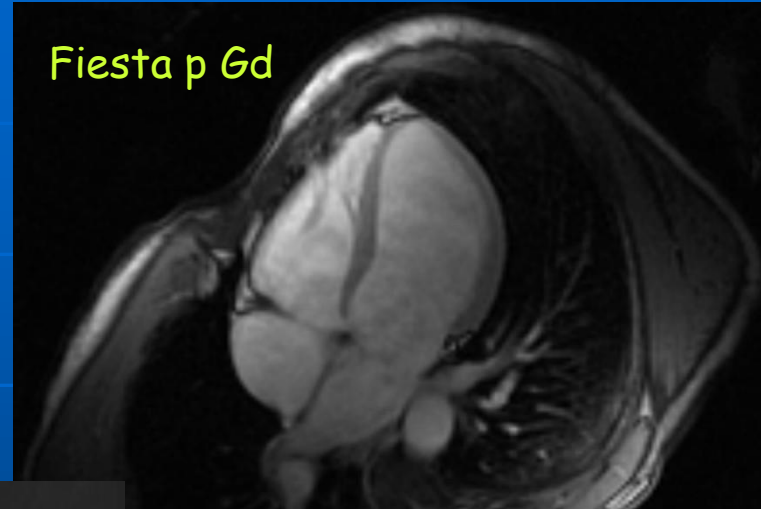
Horizontal long axis



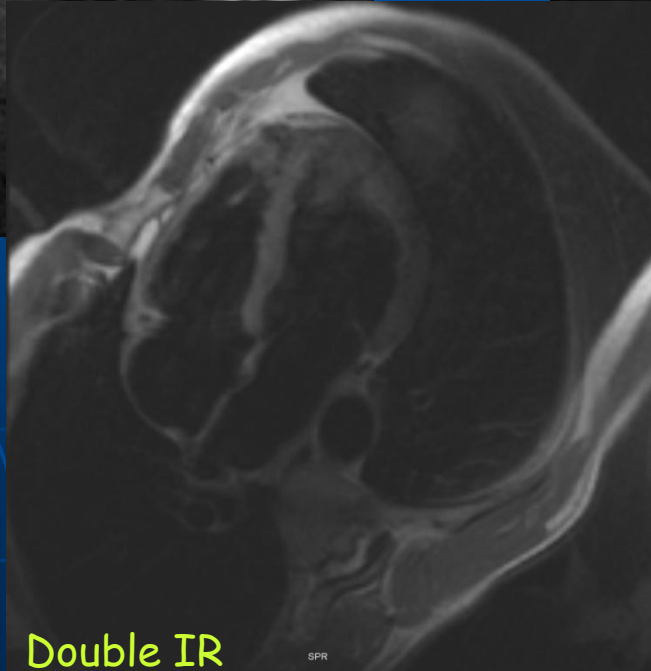
4 camere : acquisizioni con sequenze diverse



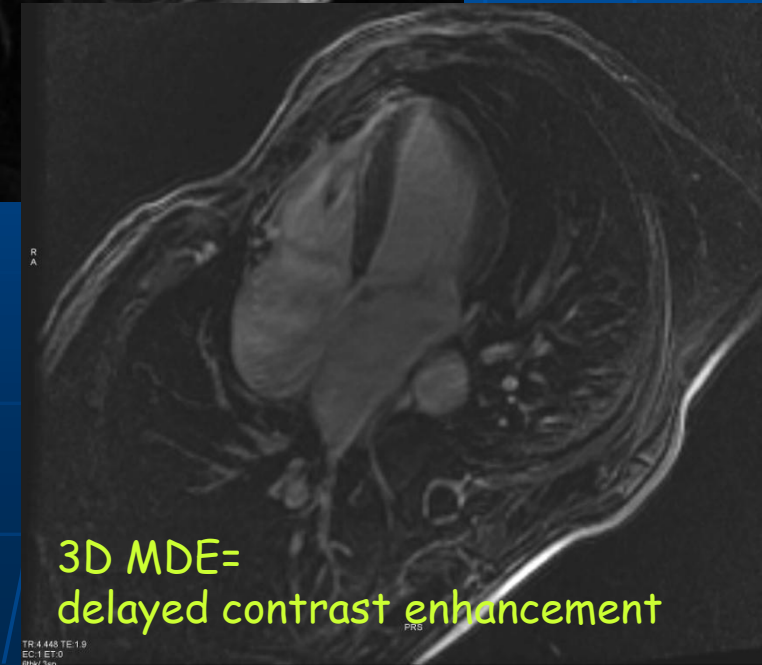
Triple IR



Fiesta p Gd



Double IR

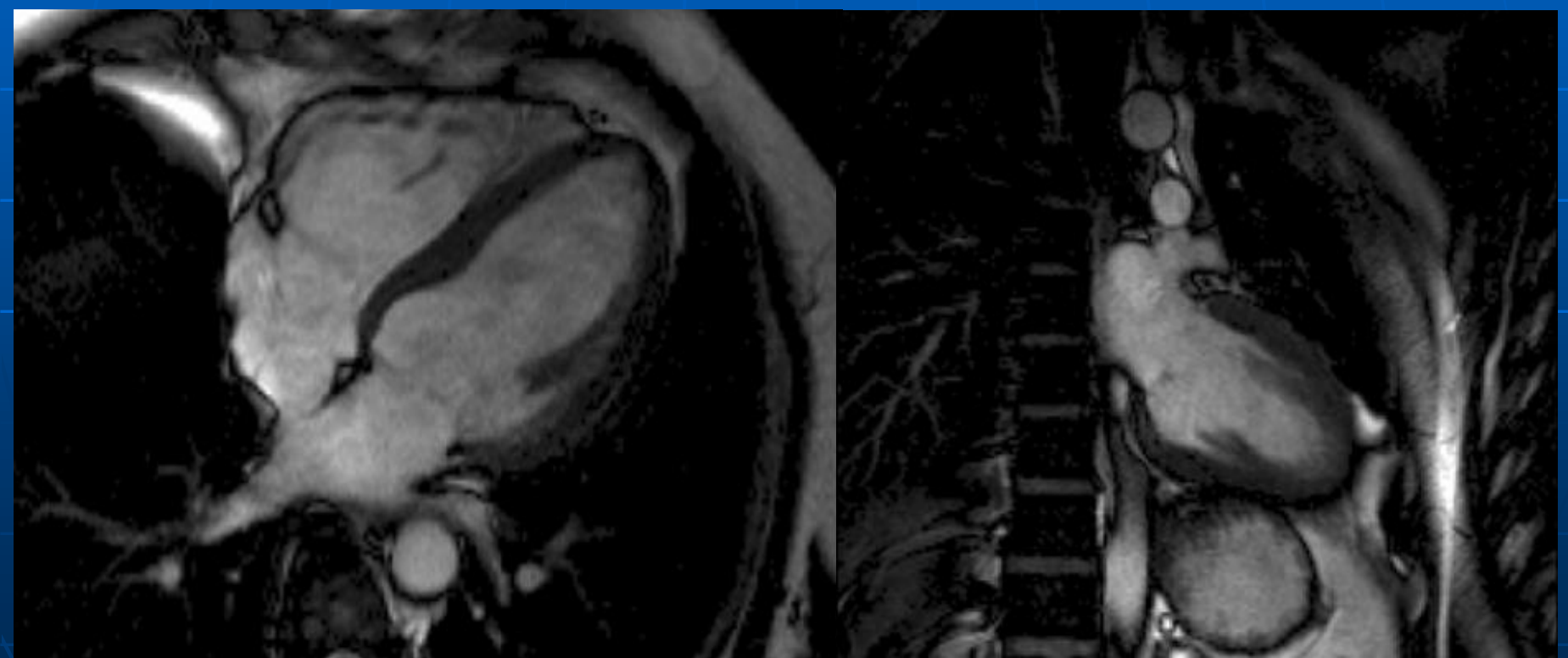


3D MDE=
delayed contrast enhancement

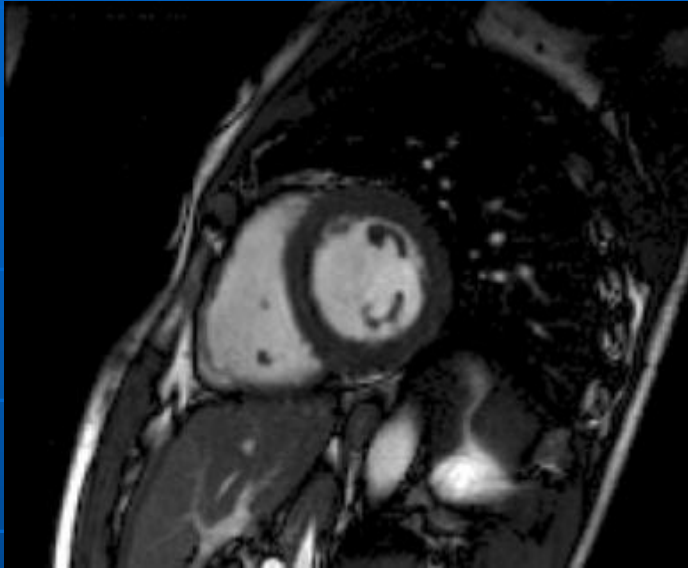
Cardiac Function: True-FISP MRI

Horizontal long axis

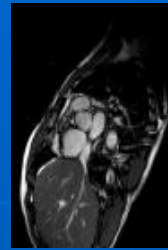
Vertical long axis



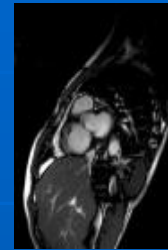
Short axis



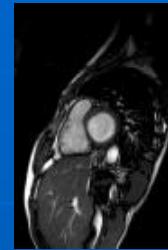
Stack of short axes



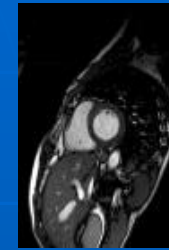
Base



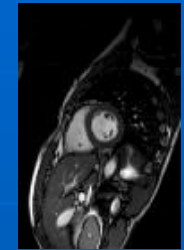
+10mm



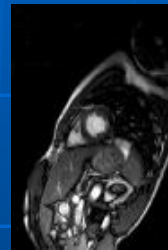
+20mm



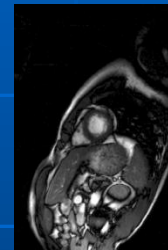
+30mm



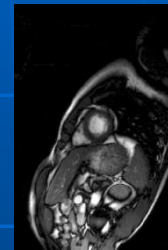
+40mm



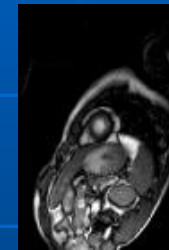
+50mm
+90mm



+60mm



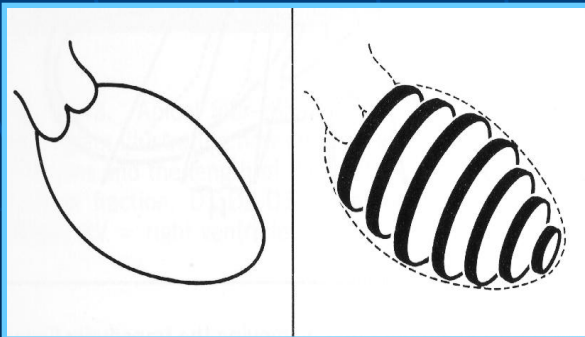
+70mm



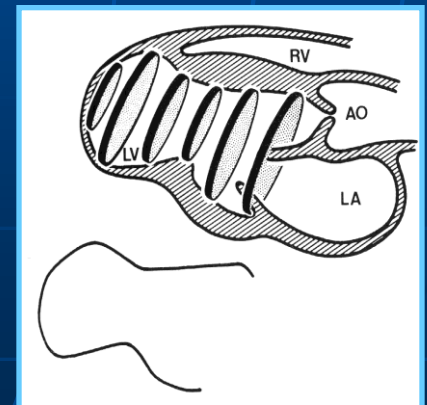
+80mm



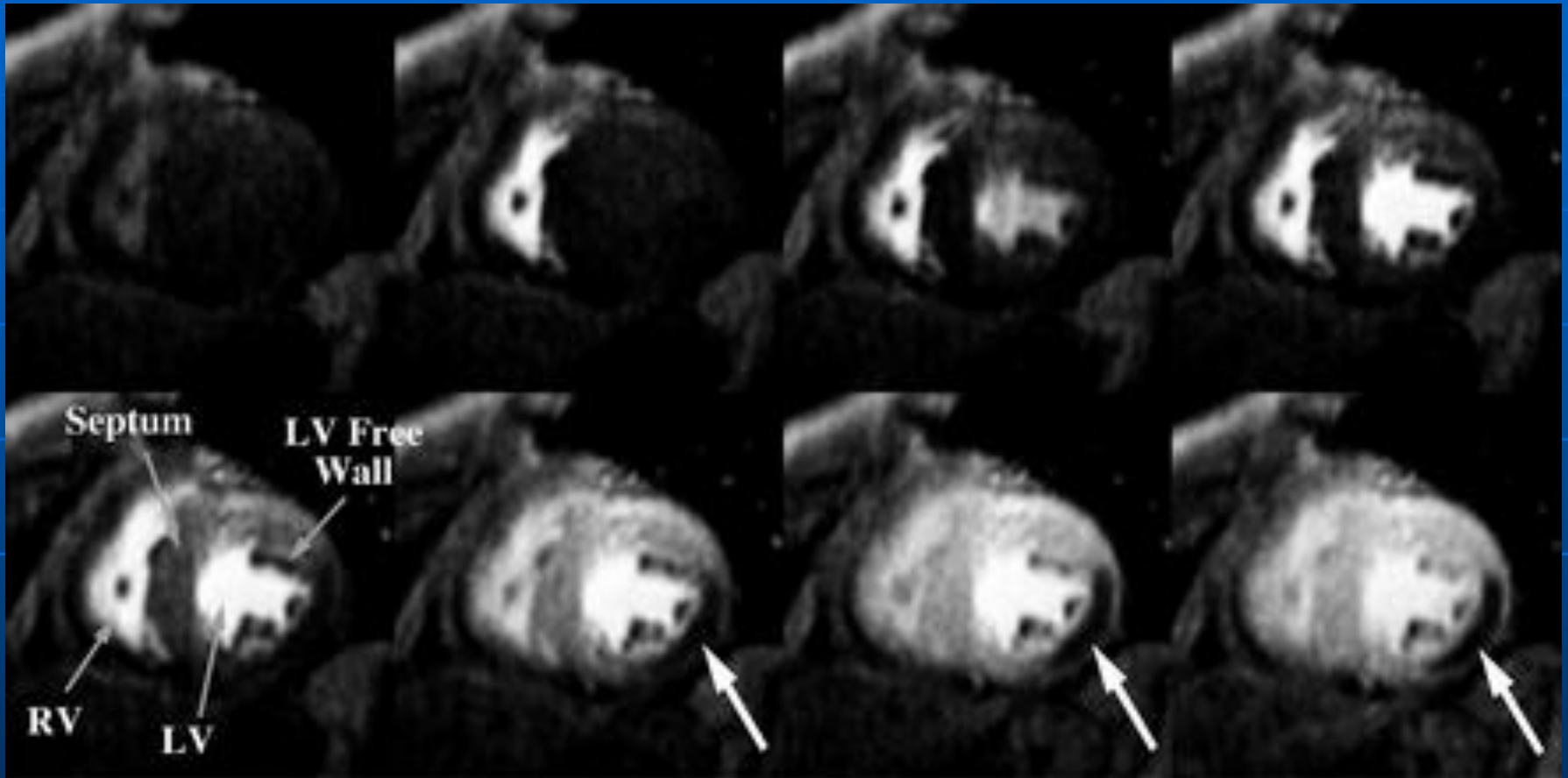
Apex



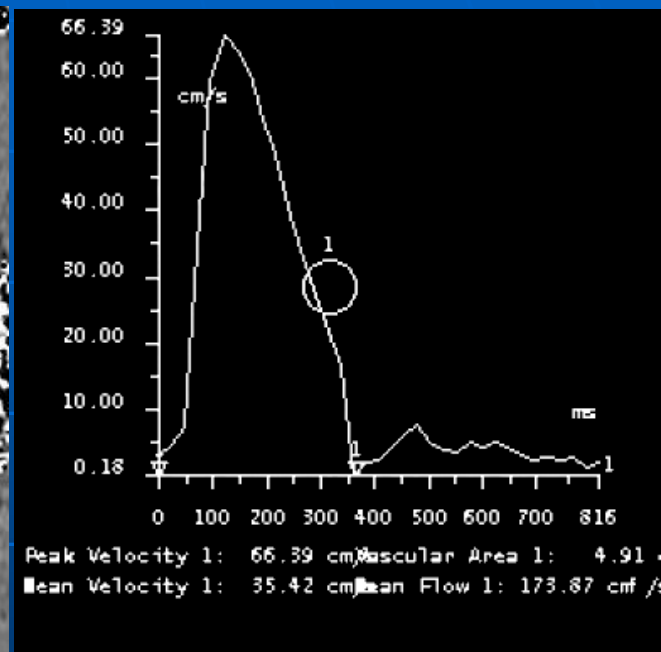
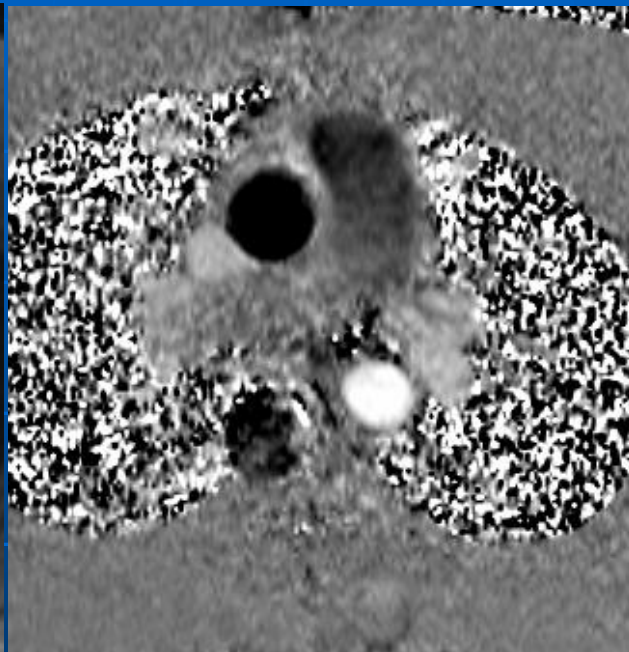
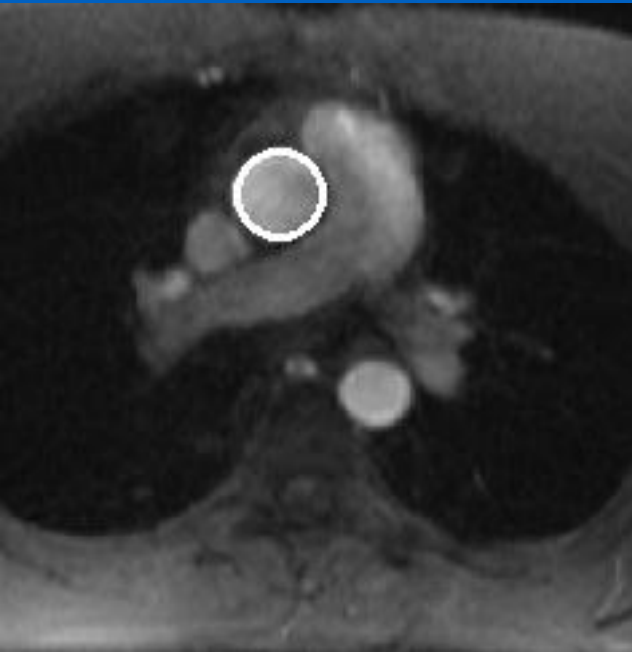
Simpson's Rule



Studio di perfusione con gadolinio



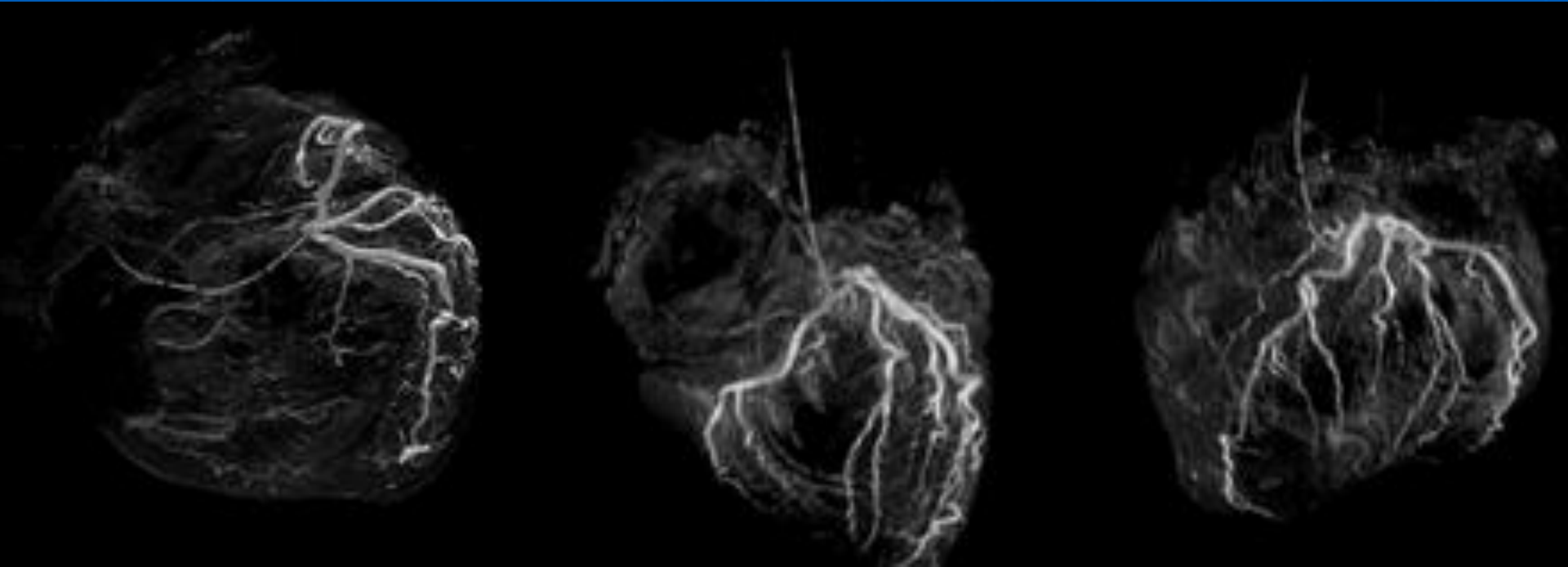
Phase-Contrast



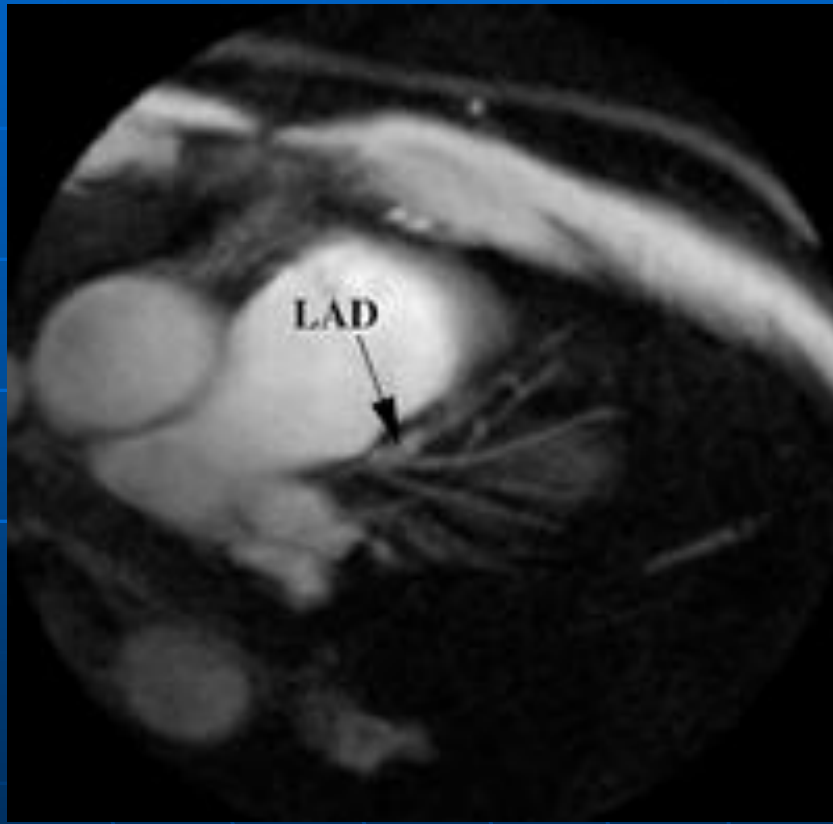
Useful Links

- <http://info.med.yale.edu/intmed/cardio/imaging/>
- <http://www.vh.org/adult/provider/radiology/NormalRadAnatomy/Text/ThorImagtitle.html>
- <http://www.scmr.org/education/atlas/intro/index.html>

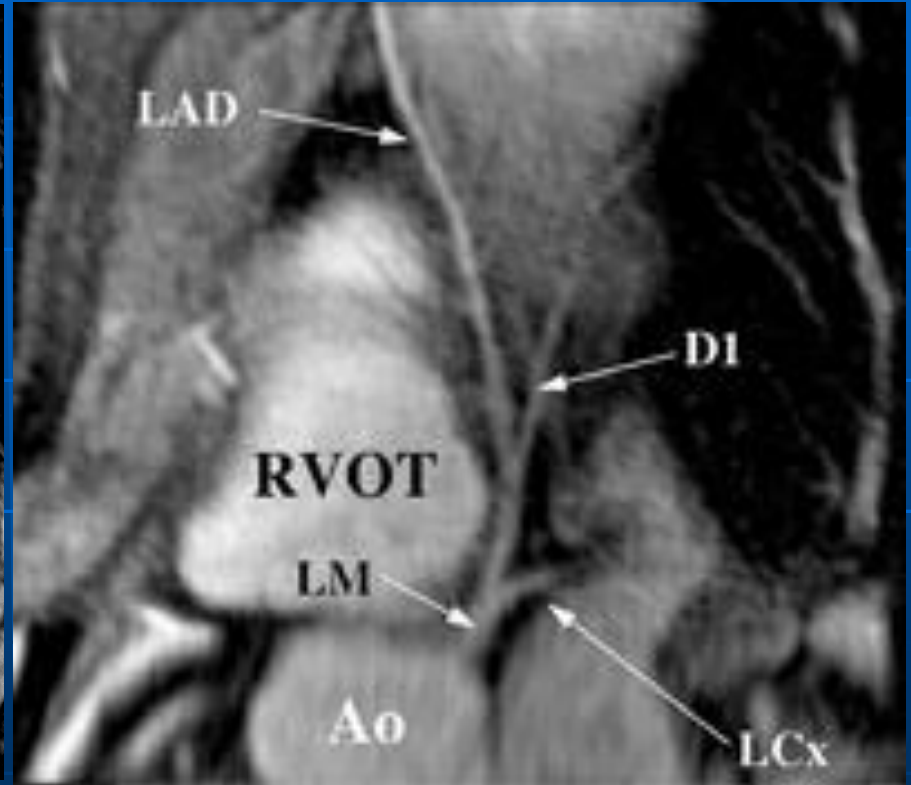
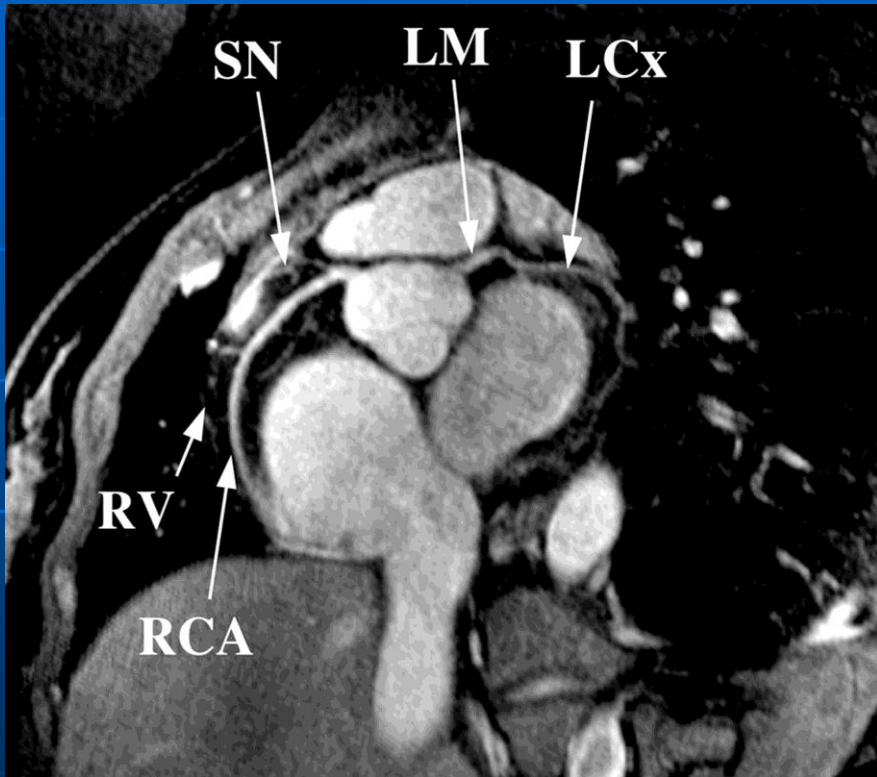
MIP- Coronary Arteries



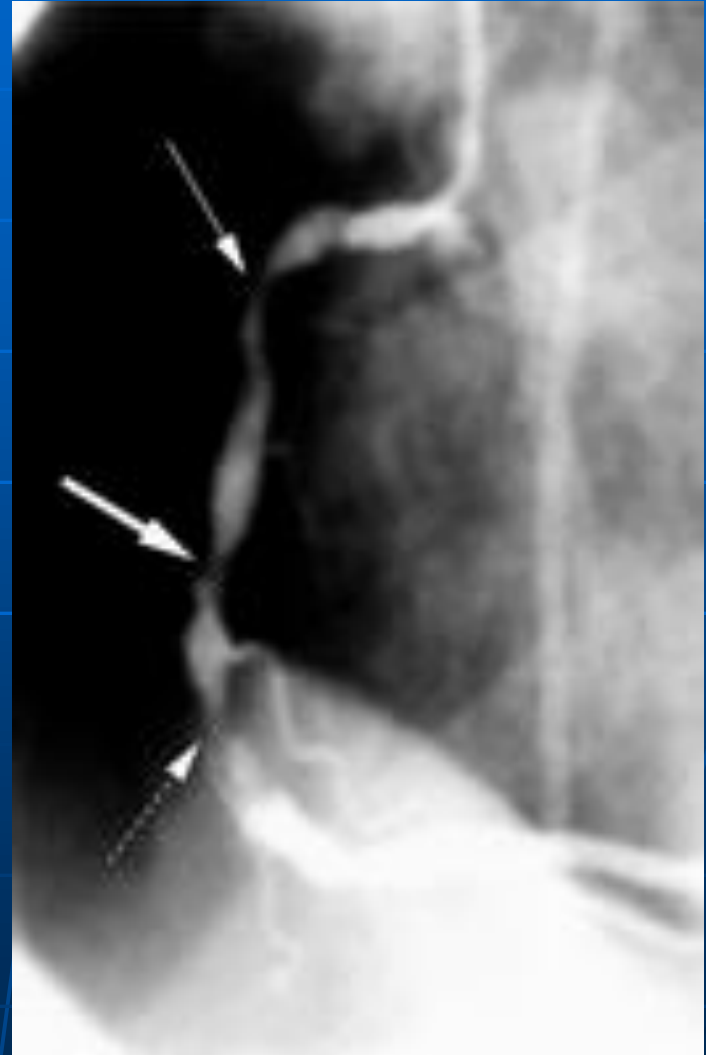
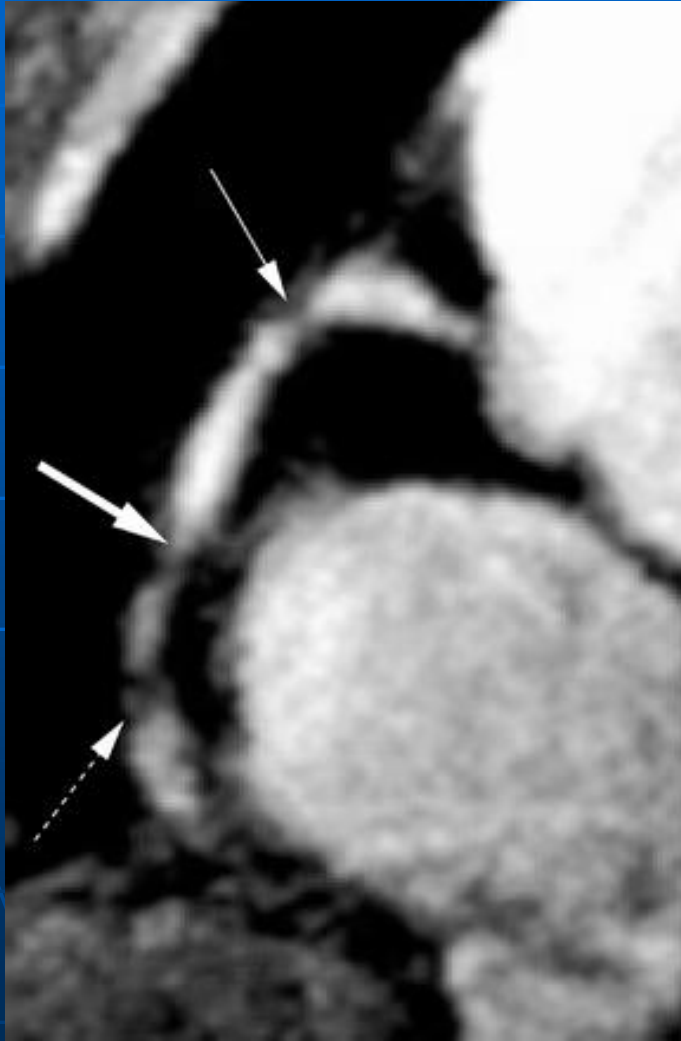
Coronary Artery Imaging



More Angiograms



RCA: MR and Conventional



Utilità clinica della RM cardiaca (superiorità rispetto all'eco 2D)

- La qualità eccellente delle immagini, la riproducibilità rende la RMC il "gold standard" per lo studio di camere cardiache e la valutazione della FE%
- Valutazione delle cardiopatie congenite
- Valutazione delle patologie del pericardio
- Valutazione delle masse cardiache
- Determinazione dell'estensione dell'infarto e della vitalità

Comparative Sample Sizes, Echo vs CMR

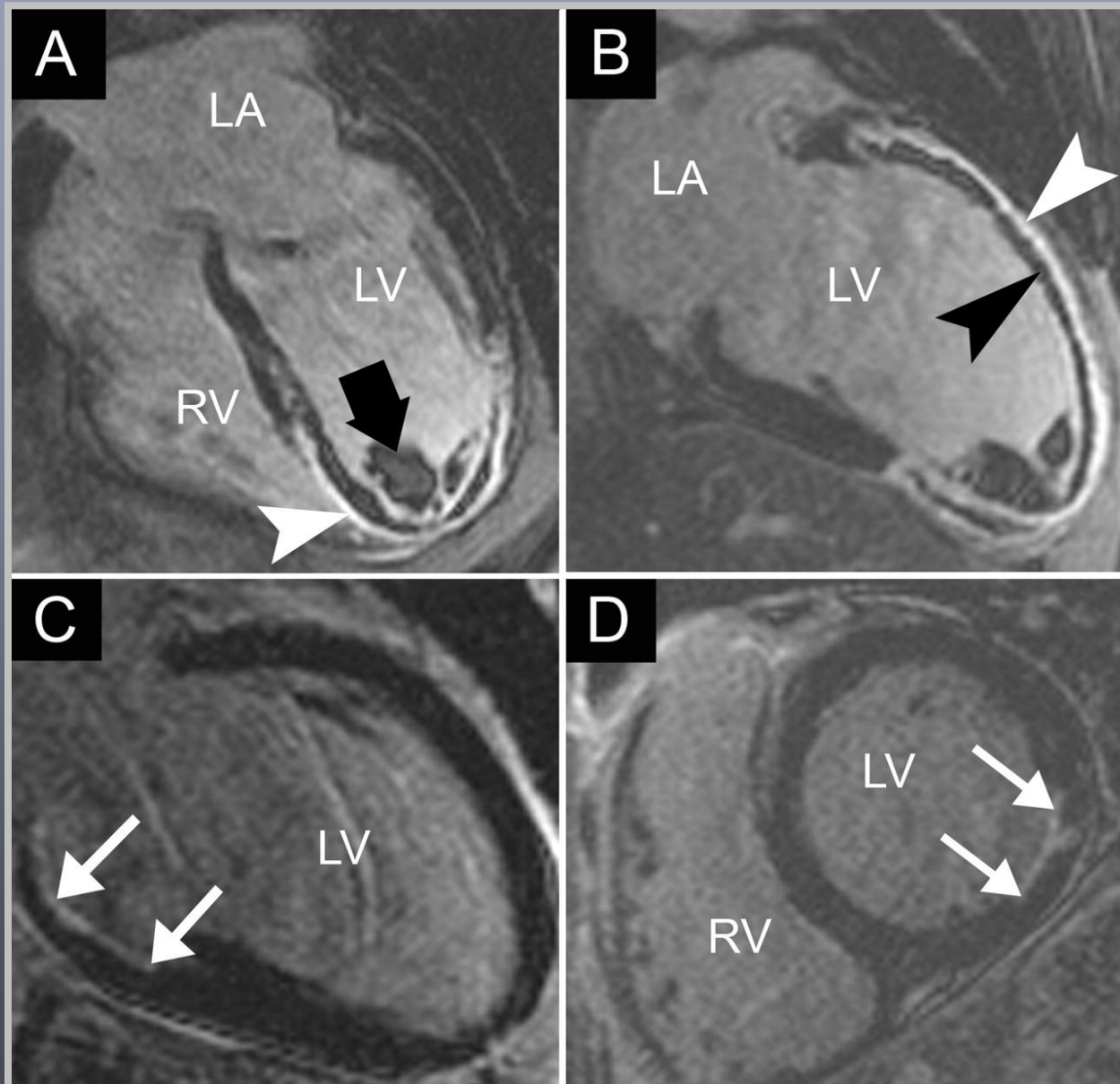
Power 80%,
P<0.05

	Change	Echo	CMR
LV EDV	8.3 mL	250	46 (18%)
LV ESV	5.5 mL	250	34 (14%)
LV EF	2.3%	250	50 (20%)
LV Mass	12.7 g	250	8 (3%)

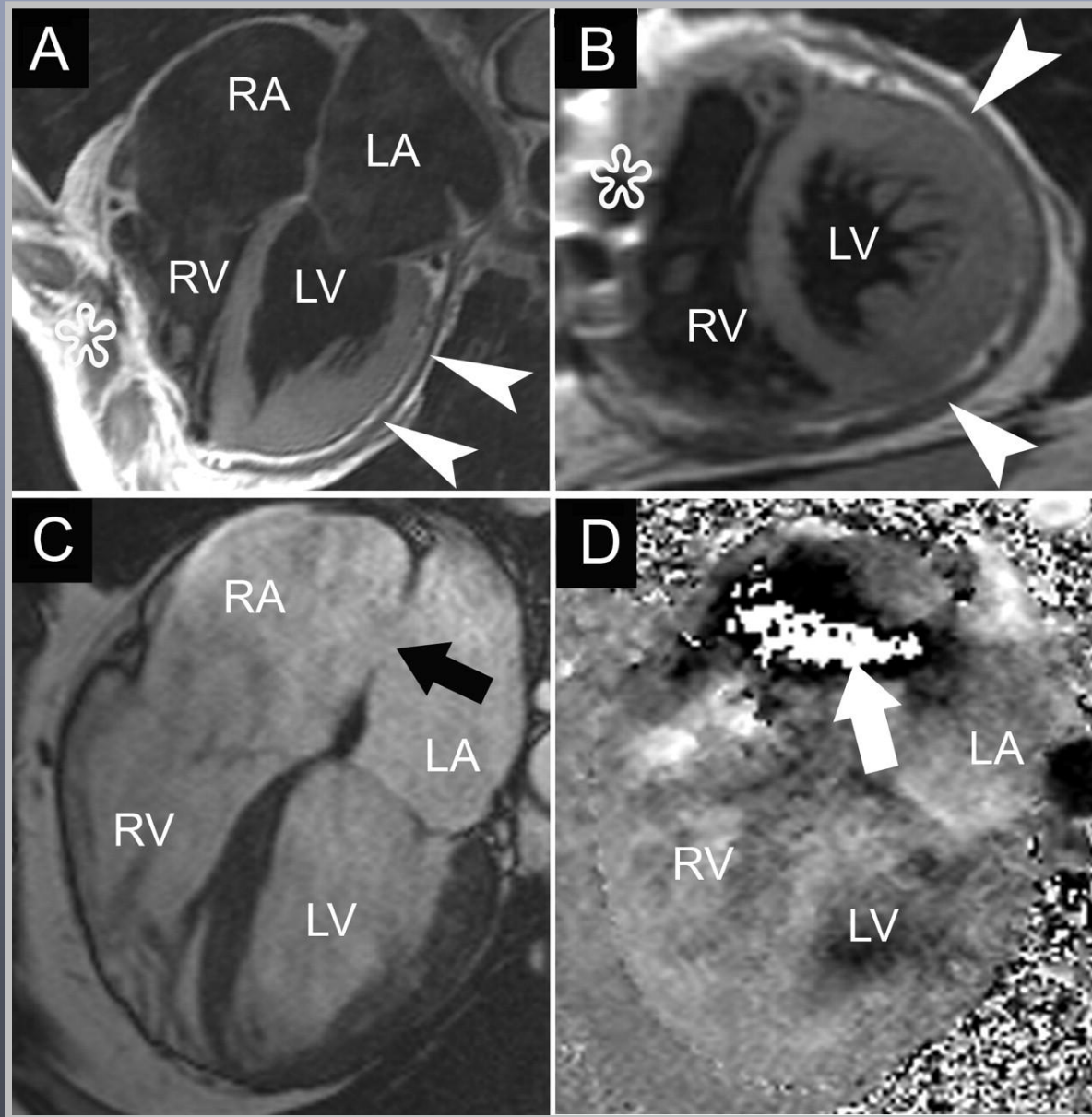
Otterstad, Froeland, St John Sutton, Holme. Eur Heart J 1997

Bellenger, Davies, Francis, Marcus, Pennell. JCMR 2000

Results of cardiovascular MRI with delayed contrast enhancement in myocardial infarction (MI)



Results of cardiovascular MRI in constrictive pericarditis and atrial septal defect

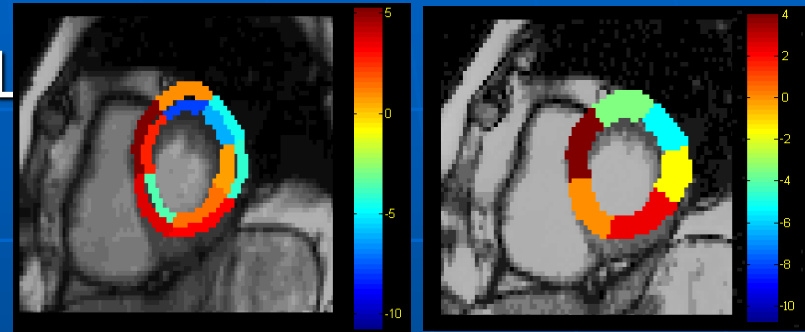


Limiti della RM Cardiaca

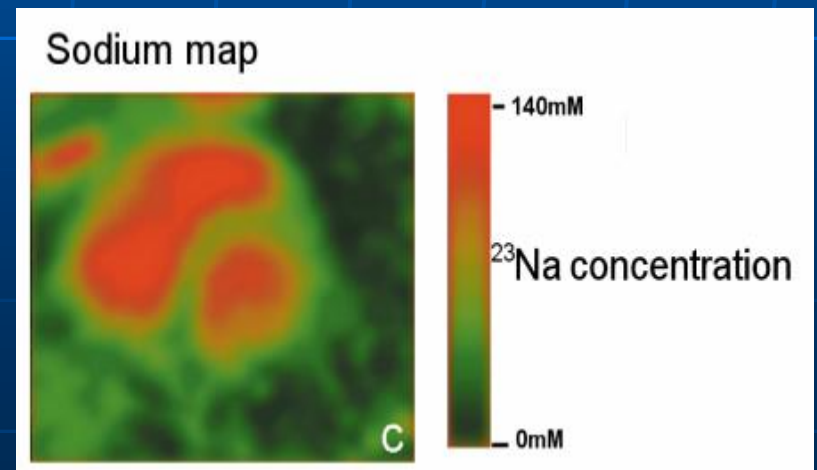
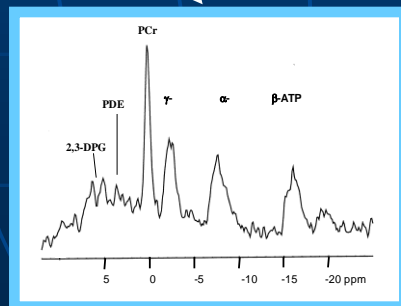
- Valutazione inadeguata delle coronarie
- Valutazione non ottimale degli apparati valvolari
- Time consuming
- Complessa dal punto di vista logistico
- Controindicazioni (pace maker, protesi ferromagnetiche, claustrofobia,...)

Clinical CMR Techniques on the Horizon

- Regional strain (tissue phase mapping)
- Non-contrast perfusion (ASL)
- Oxygenation (BOLD) →
- ^{23}Na -Imaging →
- Metabolism (MRS) →
- 7 Tesla →
- Molecular Imaging →



Selvanayagam J et al, works in progress

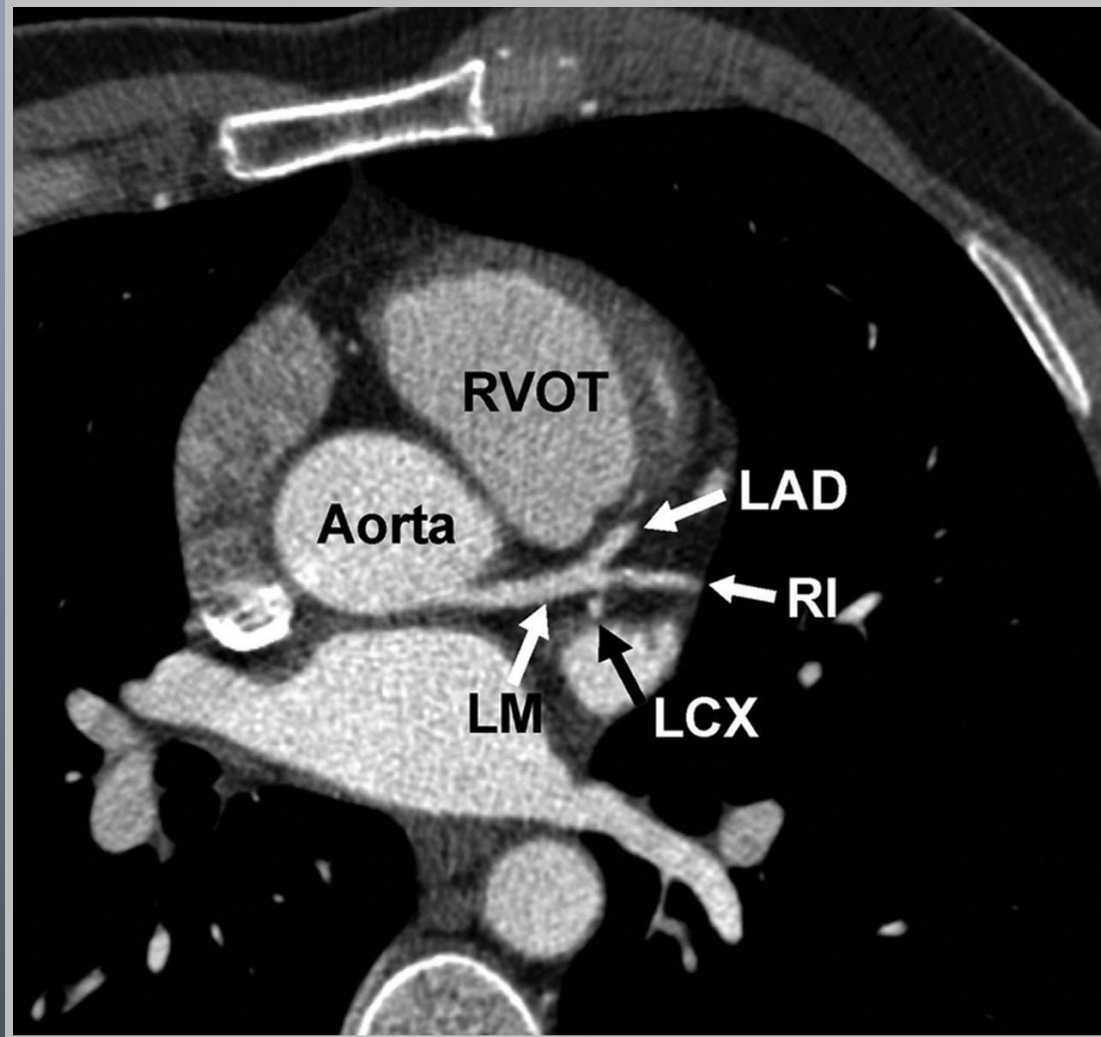


Robson M et al Works in Progress

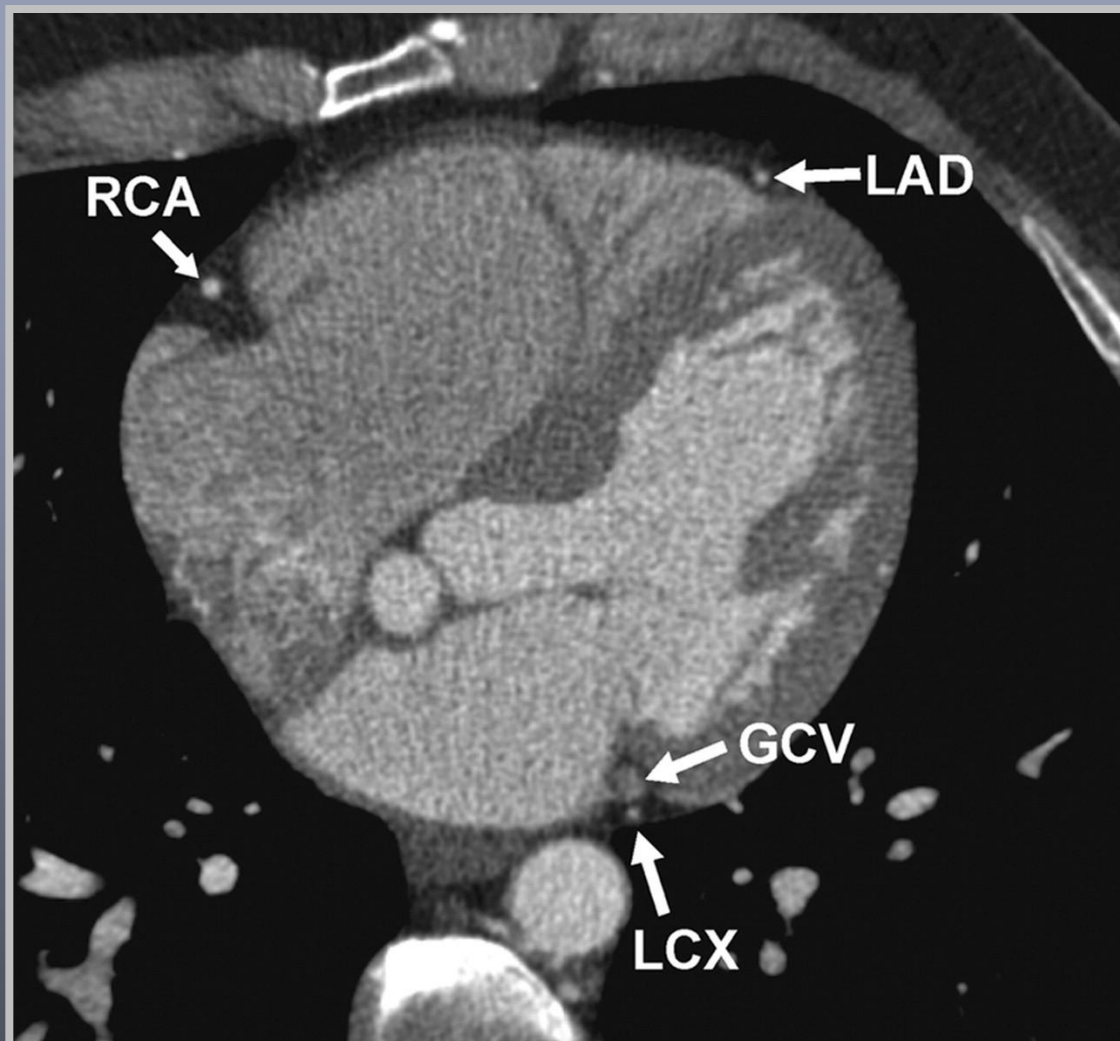
CT of the HEART

- I nuovi sistemi TC (64 slice, multidetector) hanno grande risoluzione spaziale ed ora anche temporale con ricostruzioni 3D e in ogni piano.
- Fornisce informazioni relativamente a pericardio, miocardio, grossi vasi e arterie coronarie.
- Valutazione delle calcificazioni (anche coronariche)

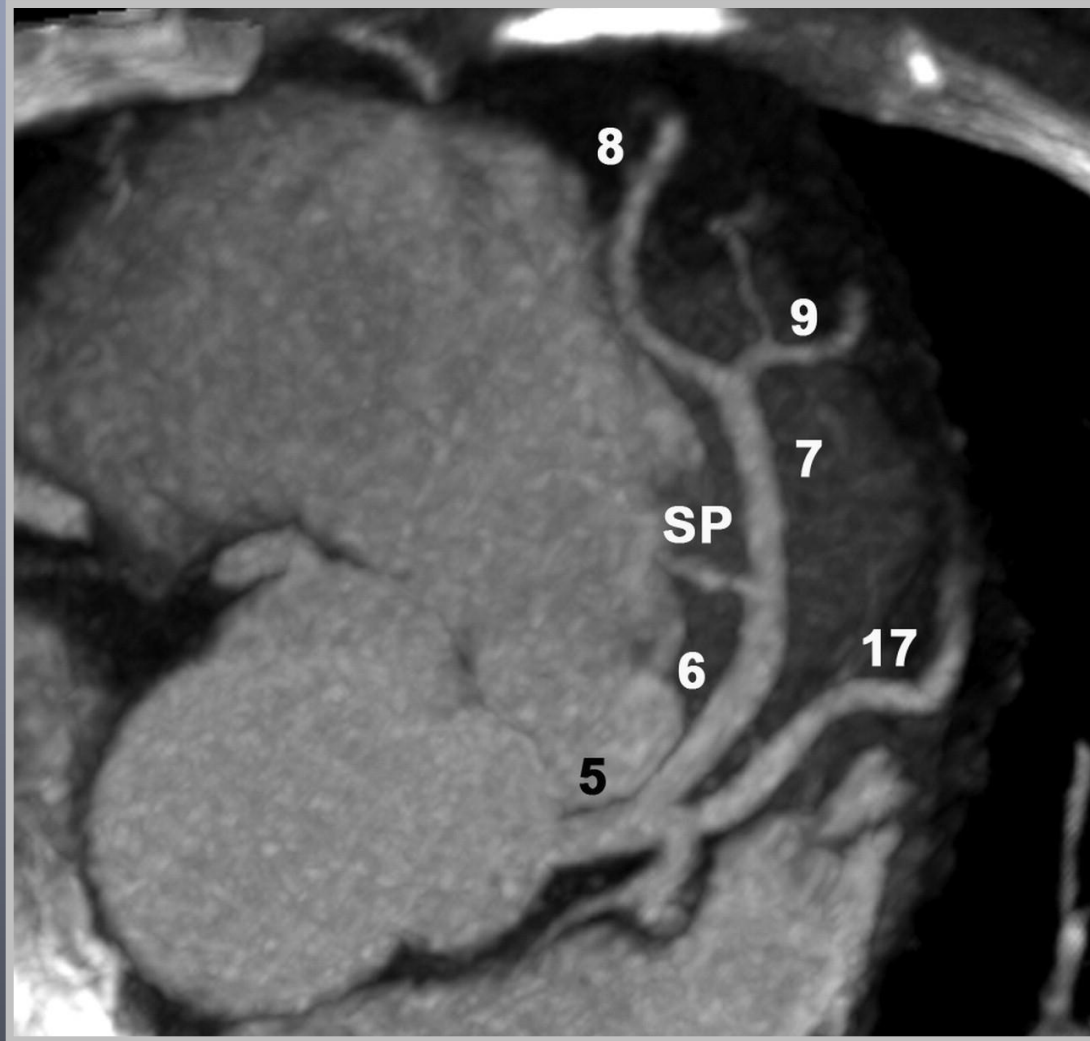
LEFT MAIN CORONARY ARTERY AT THE LEVEL OF THE OSTIUM



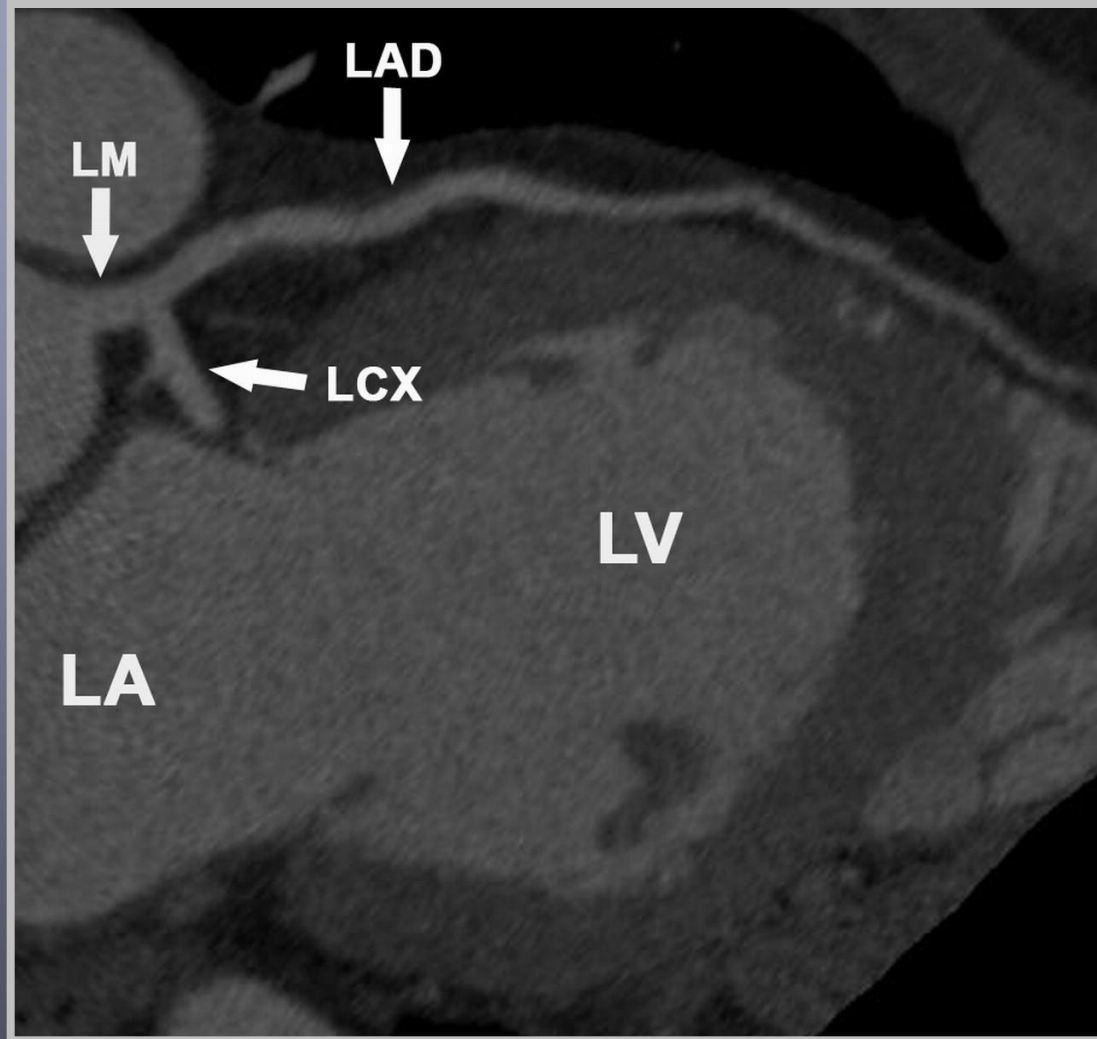
MULTIDETECTOR CT ANGIOGRAM SHOWING CORONARY ARTERIES IN CROSS SECTION



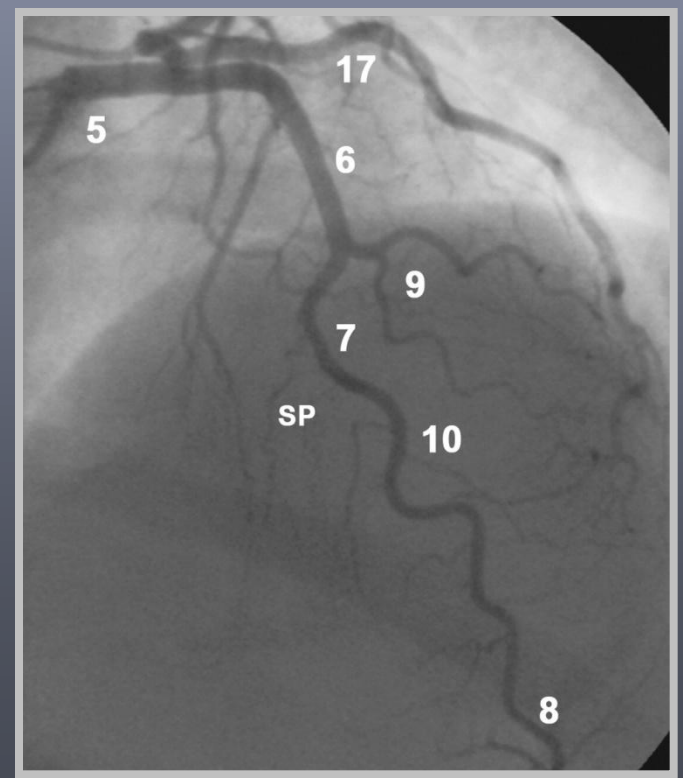
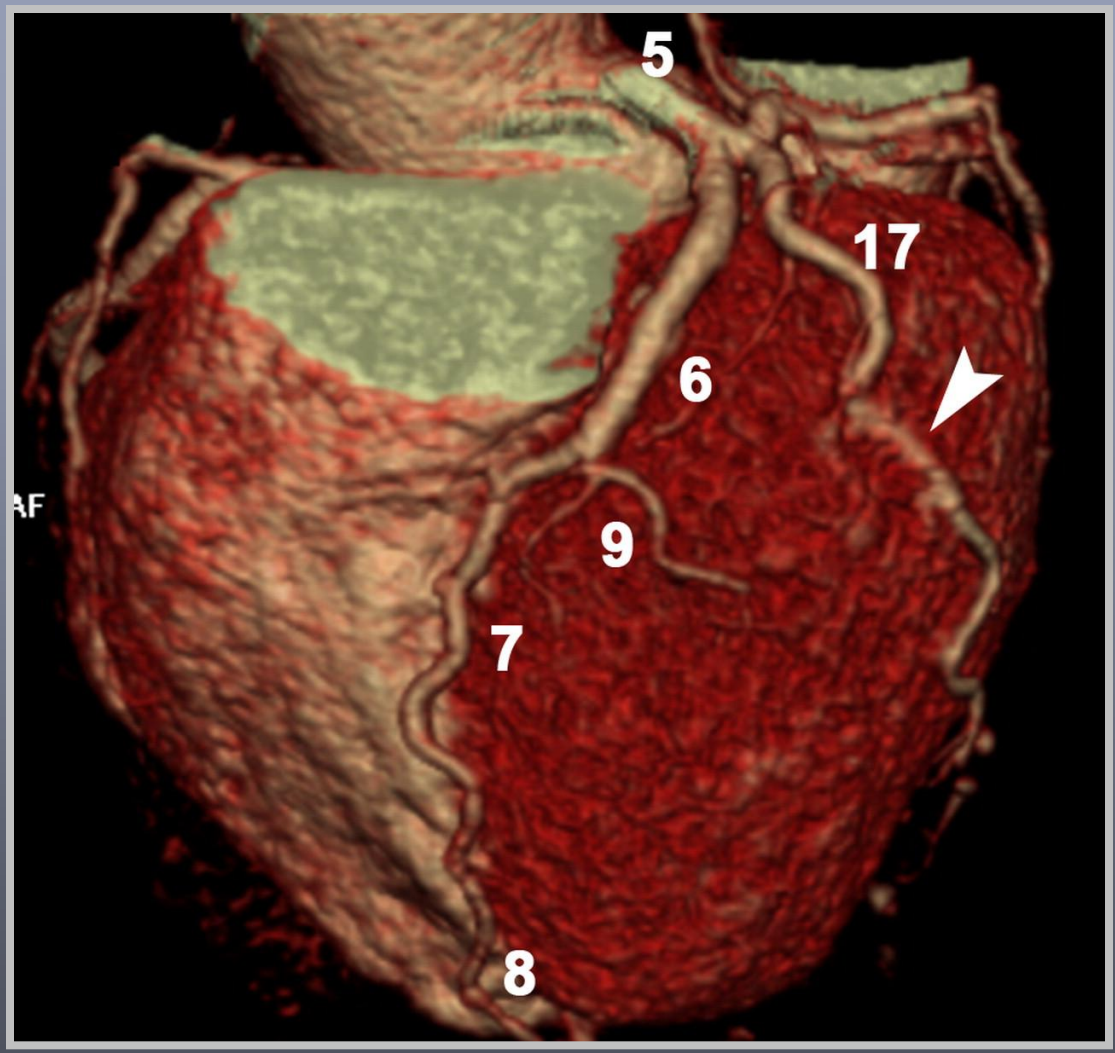
MULTIDECTOR AXIAL CT ANGIOGRAM SHOWING LEFT CORONARY ANATOMY



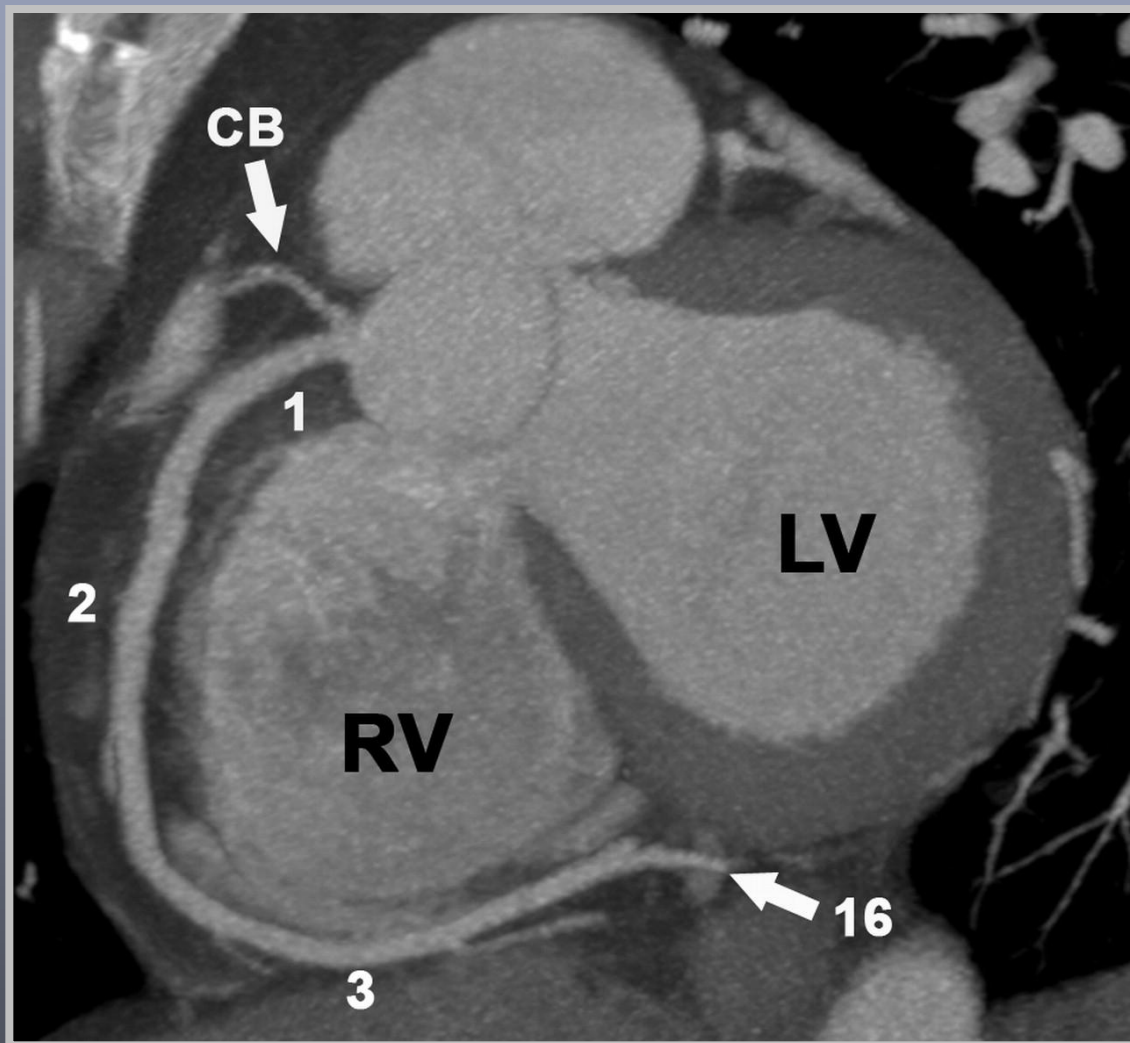
MULTIDETECTOR CT ANGIOGRAM SHOWING LEFT CORONARY ANATOMY



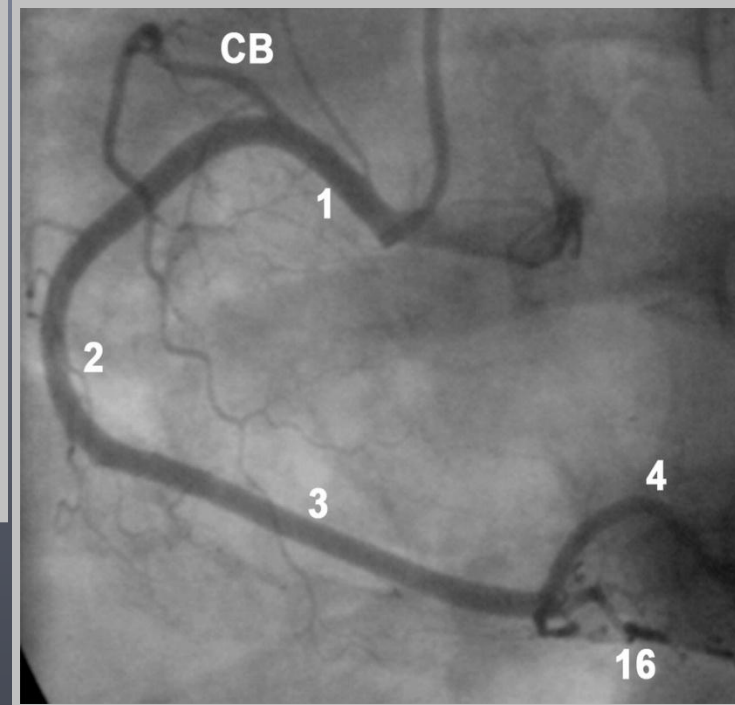
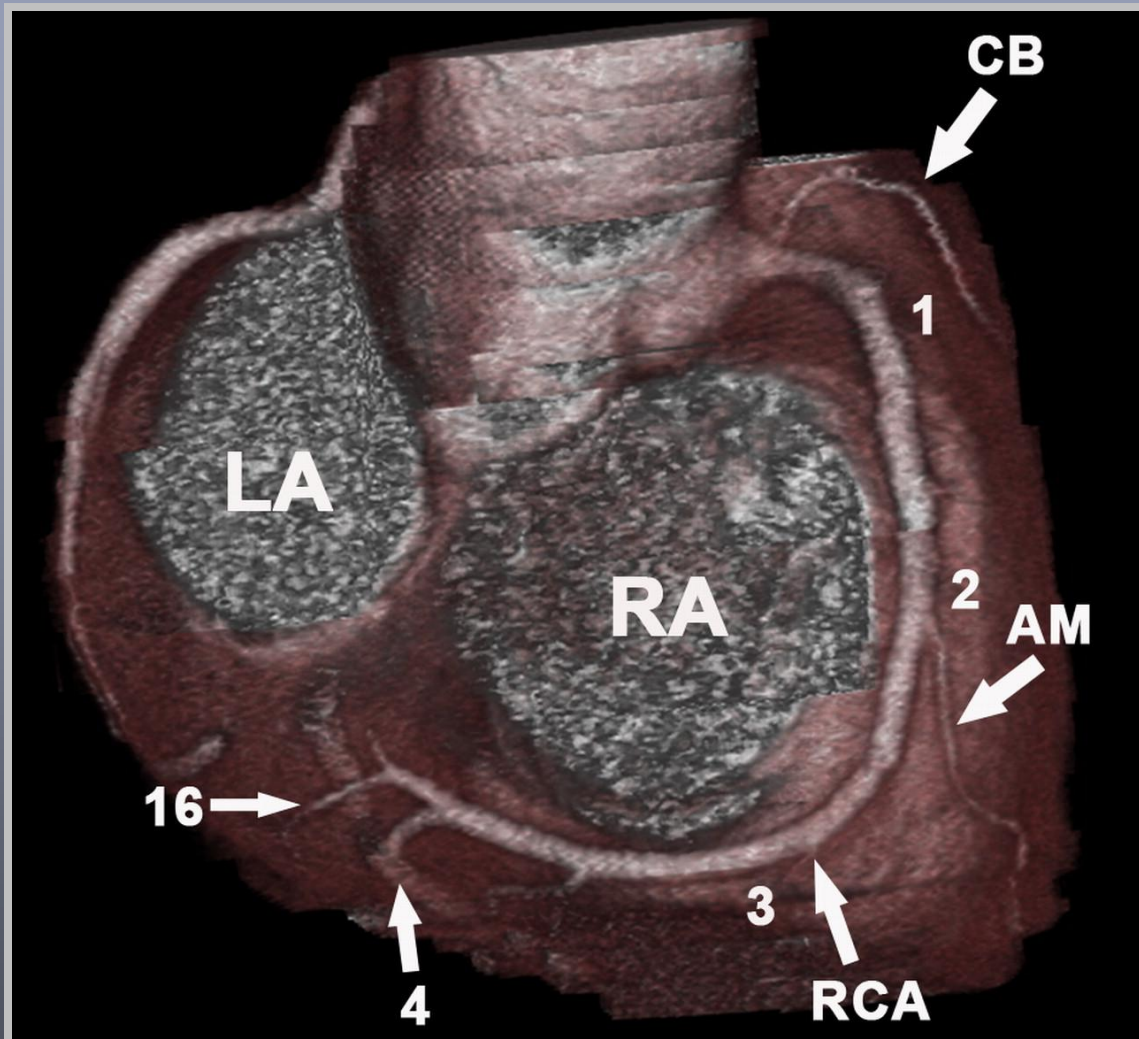
3D VOLUME RENDERED IMAGE SHOWING LEFT CORONARY ANATOMY



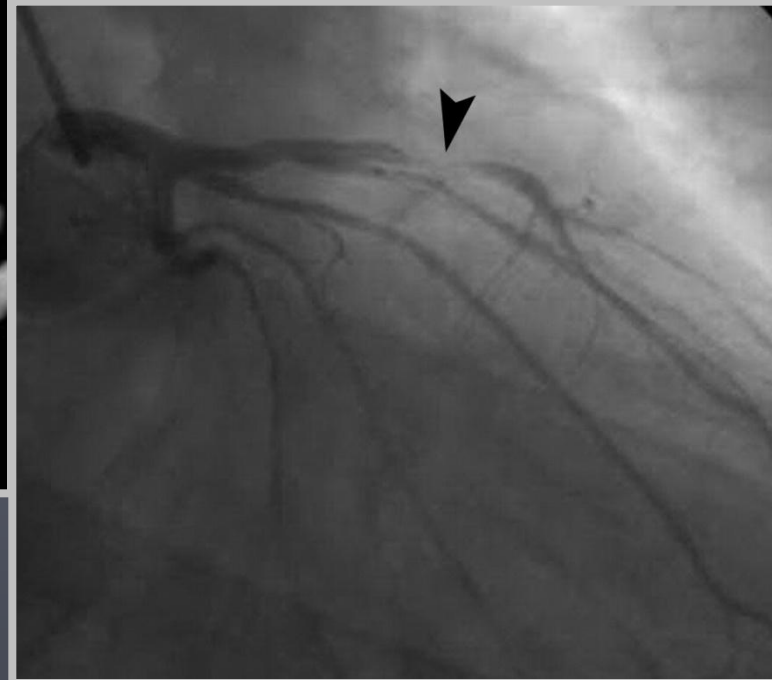
MULTIDECTOR AXIAL CT ANGIOGRAM SHOWING RIGHT CORONARY ARTERY



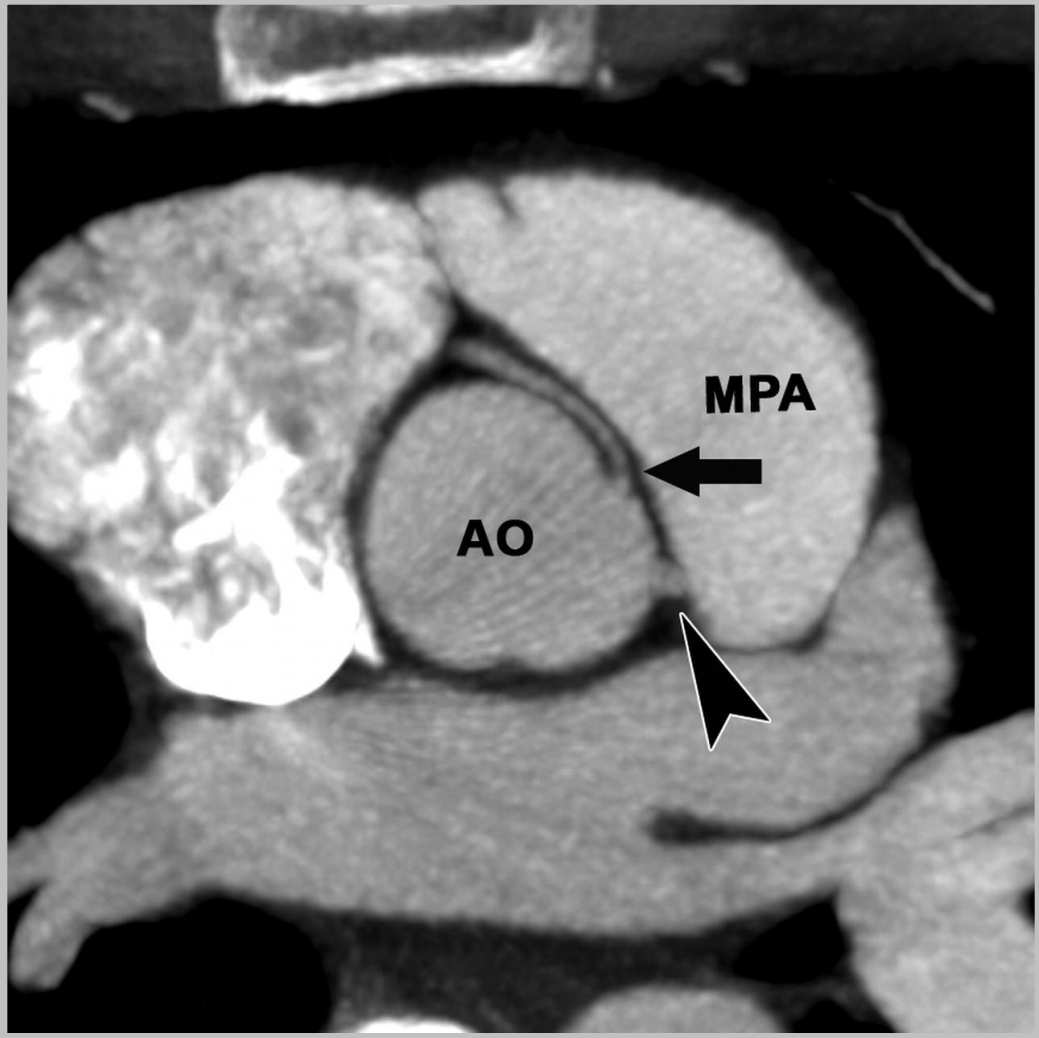
3D VOLUME RENDERED IMAGE SHOWING RIGHT CORONARY ARTERY



MULTIDECTOR CT ANGIOGRAM SHOWING SIGNIFICANT STENOSIS OF LAD



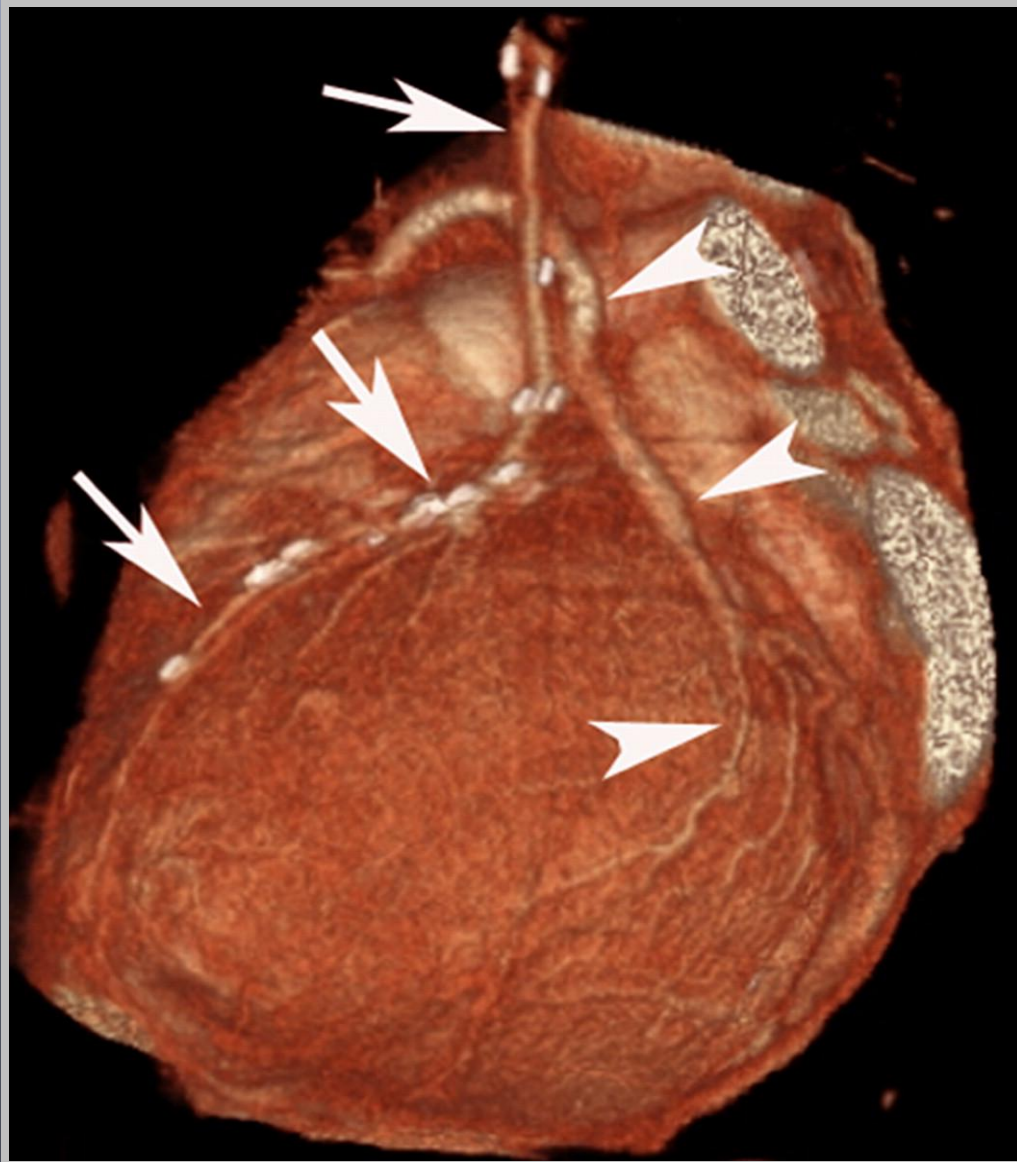
AXIAL CT ANGIOGRAM SHOWING ANOMALOUS ORIGIN OF RCA IN PATIENT WITH SYNCOPE



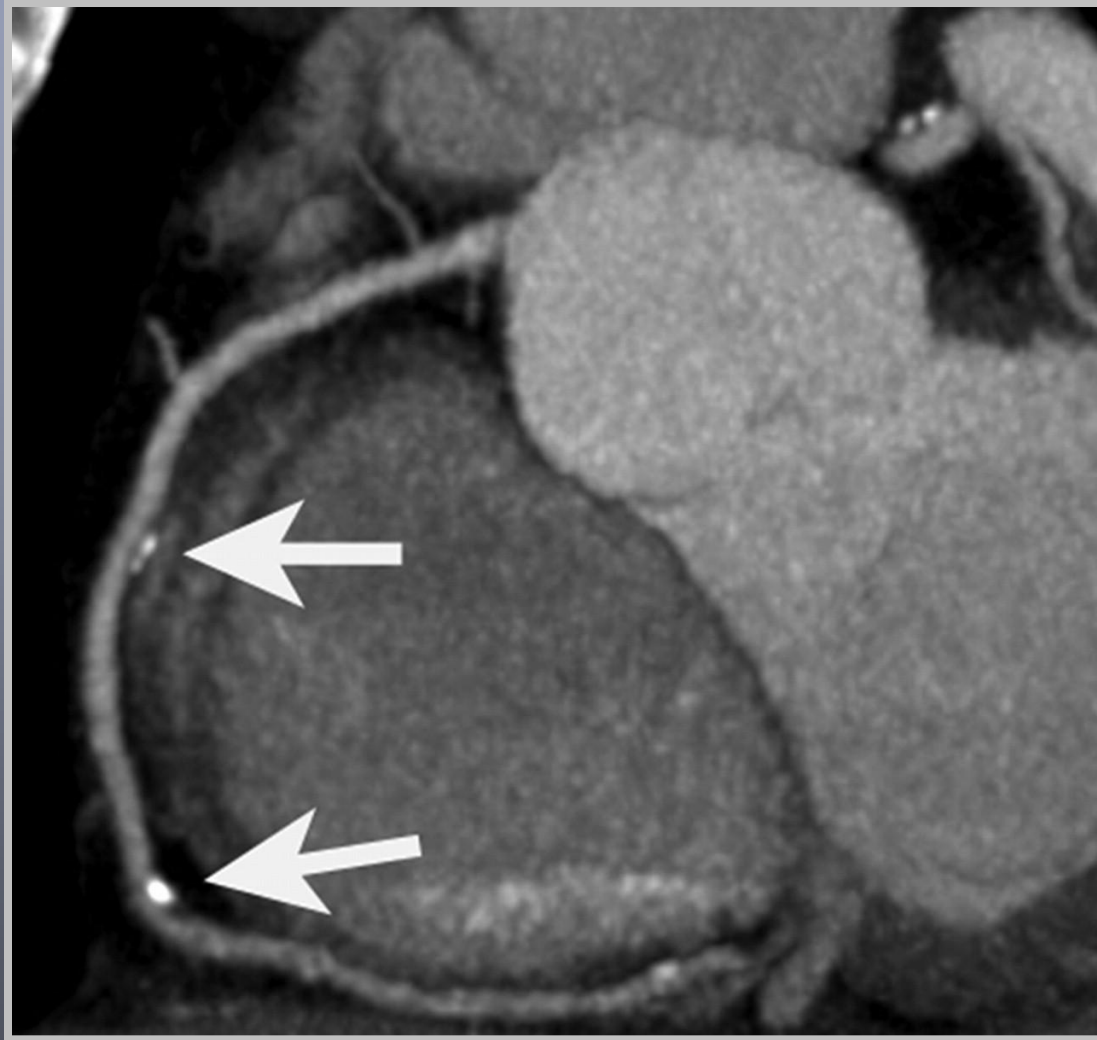
3d VOLUME RENDERED IMAGE CONFIRMING ANOMALOUS ORIGIN OF RCA



3D VOLUME RENDERED IMAGE OF LIMA AND VEIN GRAFT



NON-OBSTRUCTIVE CALCIFIED LESIONS IN RCA



CROSS SECTIONAL IMAGE OF LMCA SHOWING MIXED PLAQUE



Diagnostic Accuracy of 64 Slice CT Angiography for Detection of Coronary Artery Stenosis (> or = 50%) (Pooled data)

	Sensitivity	Specificity
Overall	97%	91%
Proximal Segments	100%	100%
Mid Segments	94%	90%
Distal Segments	79%	96%

*4% of Segments were not evaluable

Limitazioni dell'angiografia TC

- Esposizione alle radiazioni: fino a 10-11 mSv per CTA, 1 mSv per il calcium scoring
- Nefrotossicità del contrasto iodato
- Qualità dell'immagine CTA in relazione al tempo diastolico (frequenza cardiaca e intervallo R-R)
- Visualizzazione dei segmenti distali dell'albero coronarico
- Calcificazioni coronariche e diametro del vaso ("blooming effect")
- Quantizzazione delle stenosi coronariche

APPROPRIATENESS OF CTA

J Am Coll Cardiol 48(7): 1475 – 1497, 2006

- Evaluation of Chest Pain Syndrome
 - Intermediate pre-test probability of CAD
 - Uninterpretable or equivocal stress test
- Acute Chest Pain
 - Intermediate pre-test probability of CAD, no ECG changes and serial enzymes negative
- Assessment of congenital heart disease, including coronary anomalies

Appropriateness of CTA (cont)

- Evaluation of coronary arteries in patients with new onset CHF to assess etiology
- Evaluation of cardiac mass in patient with technically limited TTE, TEE, or MRI
- Evaluation of pericardium
- Evaluation of pulmonary vein anatomy prior to atrial ablation
- Coronary vein mapping prior to biventricular pacemaker placement