



Multimodality Cardiac Imaging: Which Test for Which Indication?

Eric Williamson, MD

Acknowledgements:

Shuai Leng, PhD
Kiaran McGee, PhD
Jerome Breen, MD

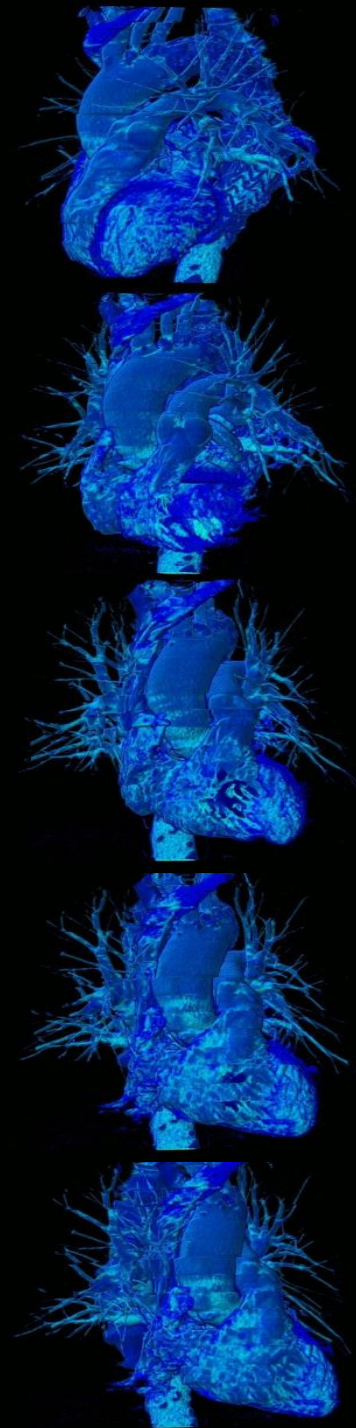
Bhavik Patel, MD
Philip Young, MD
Tom Foley, MD

Disclosures

No relevant financial relationship(s) with industry:

I do intend to discuss off-label / investigative uses(s) of the following commercial product(s)/device(s):

Gadolinium for Cardiovascular MRI

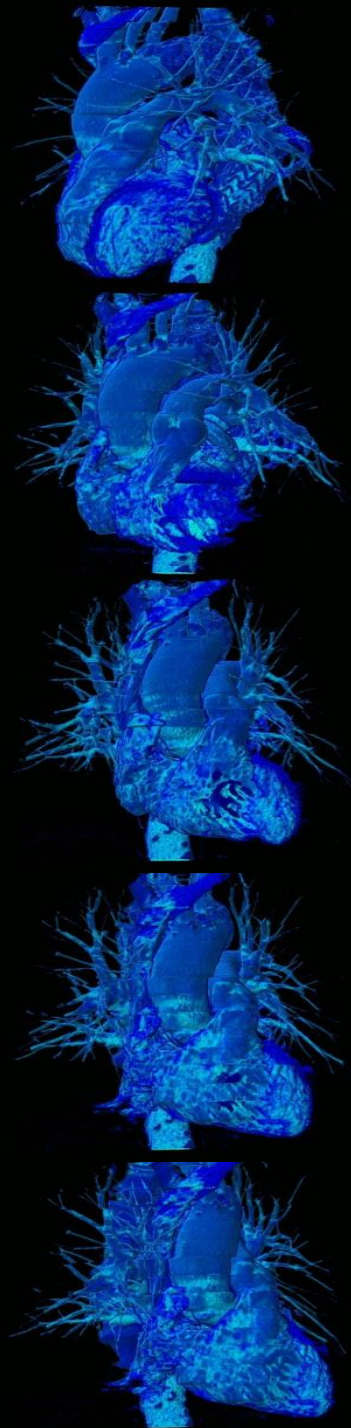


Multimodality Cardiac Imaging: Objectives

Learning Goals:

- Discuss the relative **strengths** and **weaknesses** of various imaging modalities for cardiac imaging
- Use those strengths & weaknesses to guide **management decisions** regarding the use of appropriate cardiac imaging modality

✓ Head-to-head comparison of CT & MRI



Nucs

vs

CT

vs

MRI

Pros:

- Highest contrast sensitivity
- Most published data
- *Widely available*

Pros:

- Better spatial resolution
- Visualize calcification

Pros:

- Tissue characterization
- High contrast sensitivity
- Flow information

All are highly dependent on **available technology** and **local expertise**

Cons:

- Radiation
- Less spatial resolution
- Less tissue discrimination

- Radiation
- Less contrast sensitivity
- No flow information

- Most operator dependent
- More expensive
- *Cardiac devices*

Cardiac Nuclear Medicine: Exam Basics

Radionuclide testing

- ^{99m}Tc -sestamibi & ^{201}Tl (SPECT)
- ^{18}F -FDG (PET)

Traditional role

- Acute coronary syndromes
- Chronic coronary disease

Emerging role

- Novel radiotracers – targeted at specific diseases

ACC/AHA Guideline

ACC/AHA/ASNC Guidelines for the Clinical Use of Cardiac Radionuclide Imaging—Executive Summary
A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASNC Committee to Revise the 1995 Guidelines for the Clinical Use of Cardiac Radionuclide Imaging)

Committee Members

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Raymond J. Gibbons, MD, FACC, FAHA†‡; Richard O. Russell, MD, FACC†

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A. Myocardial Perfusion Imaging in the Assessment of Patients Presenting With Chest Pain to the Emergency Department.....	1406	D. Radionuclide Testing in Risk Assessment: Prognosis and Assessment of Therapy After NSTEMI or UA.....	1406
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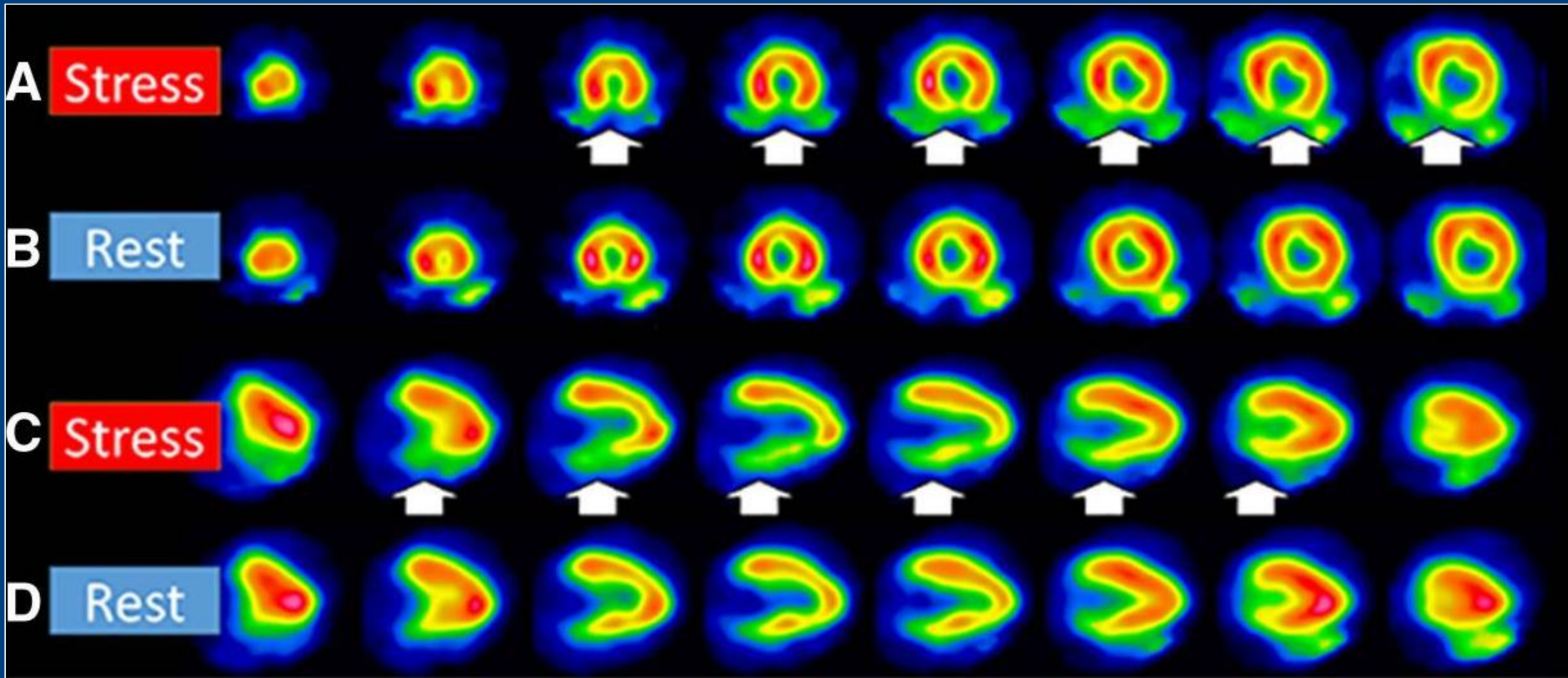
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This document was approved by the American College of Cardiology Foundation Board of Trustees in July, 2003, the American Heart Association Science Advisory and Coordinating Committee in July, 2003, and the American Society of Nuclear Cardiology Board of Directors in July, 2003.

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*Deceased.
†Former Task Force Member.
‡Former Task Force Chair.
(*Circulation* 2003;108:1404–1418).
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Cardiac Nuclear Medicine: Exam Basics

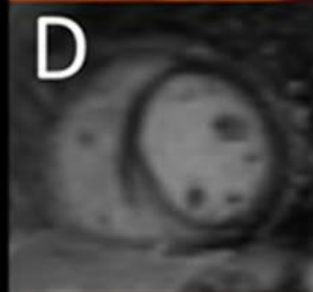
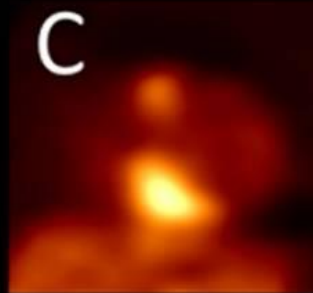
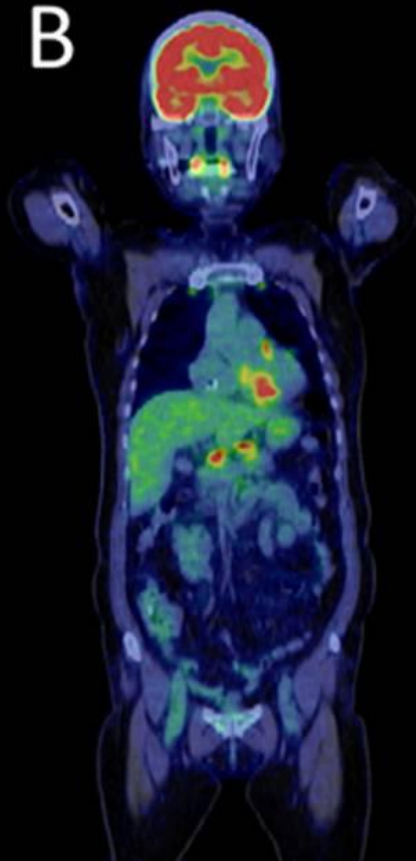
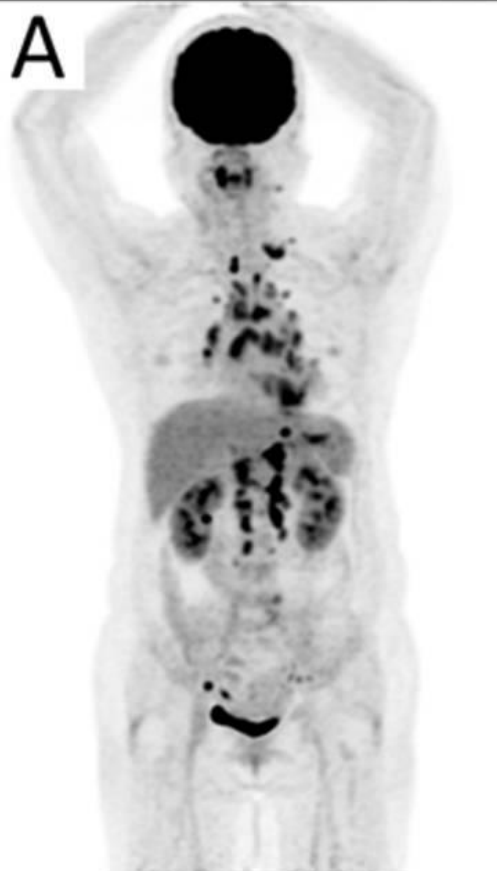


✓ Perfusion imaging of CAD

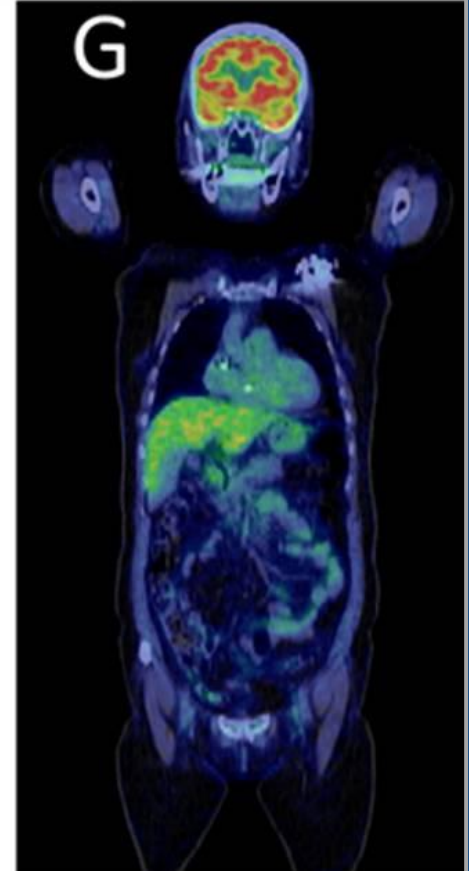
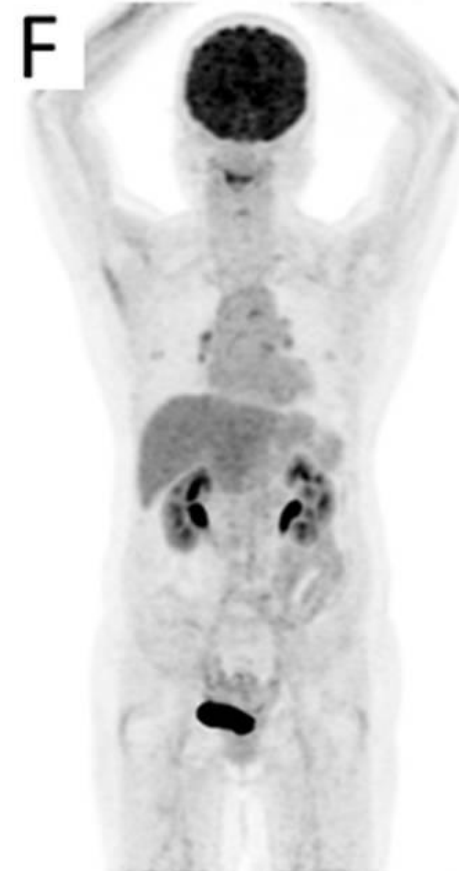
Manabe, J Nucl Cardiol 2018

Cardiac Nuclear Medicine: Exam Basics

pre-therapy



post-therapy



Cardiac Nuclear Medicine: Summary

Evolving role in cardiac imaging

- Traditional noninvasive test of choice for diagnosis and prognosis in **coronary artery disease**
- Increasing role in delineation of causes of heart failure – particularly due to rise of novel radiotracers
- Frequently used in conjunction with cardiac CT and MRI – not a competitor in terms of direct imaging of the heart

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Cardiac CT: Exam Basics

Key Facts

Uses radiation

IV contrast
(variable)



Cardiac CT: Exam Basics

Key Facts

Uses radiation

IV contrast
(variable)

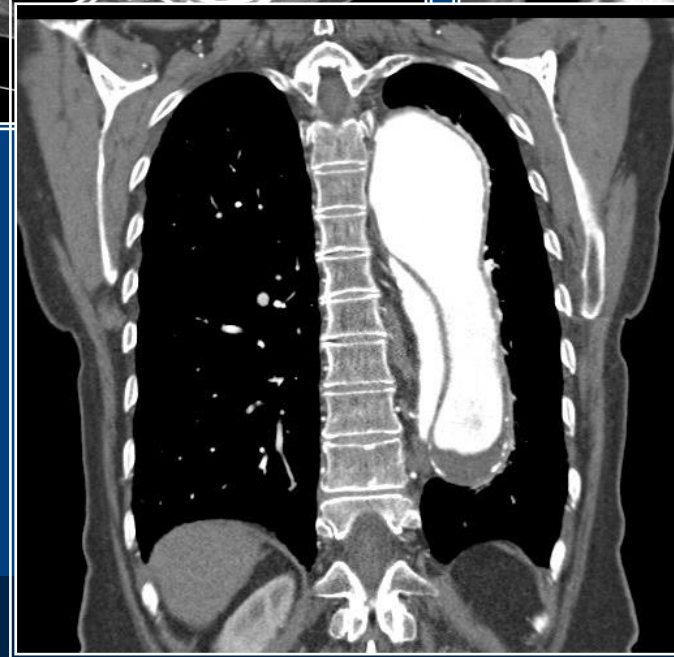
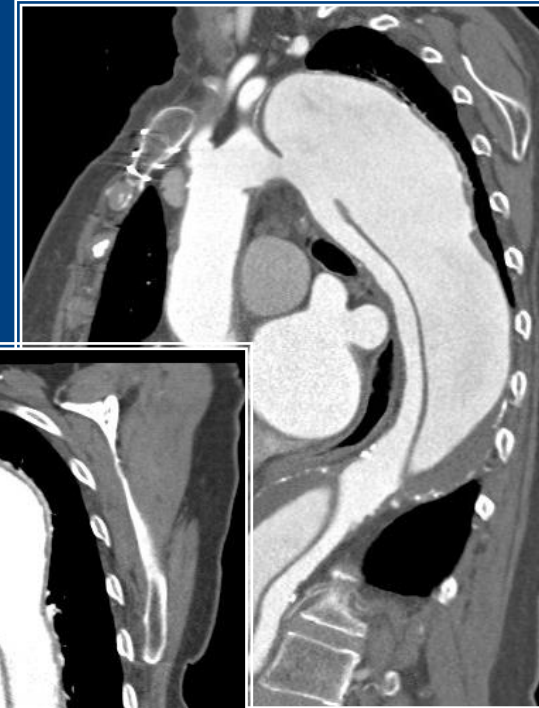


Cardiac CT: Exam Basics

Key Facts

Uses radiation

IV contrast
(variable)



Cardiac CT: Exam Basics

Key Facts

Uses radiation

IV contrast
(variable)

ECG-gating



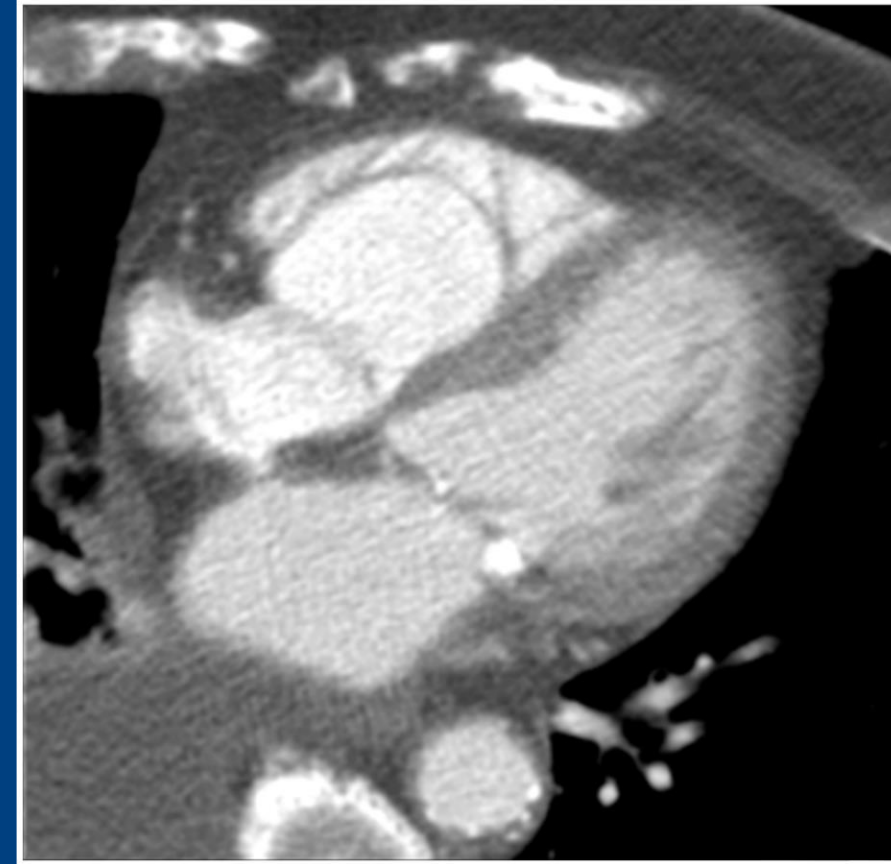
Cardiac CT: Exam Basics

Key Facts

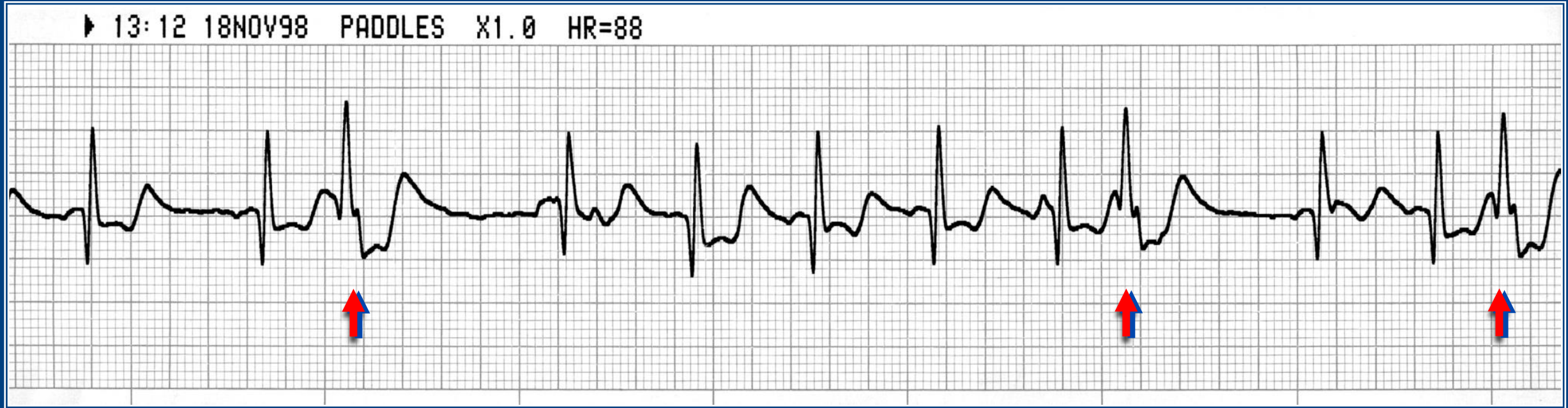
Uses radiation

IV contrast
(variable)

ECG-gating



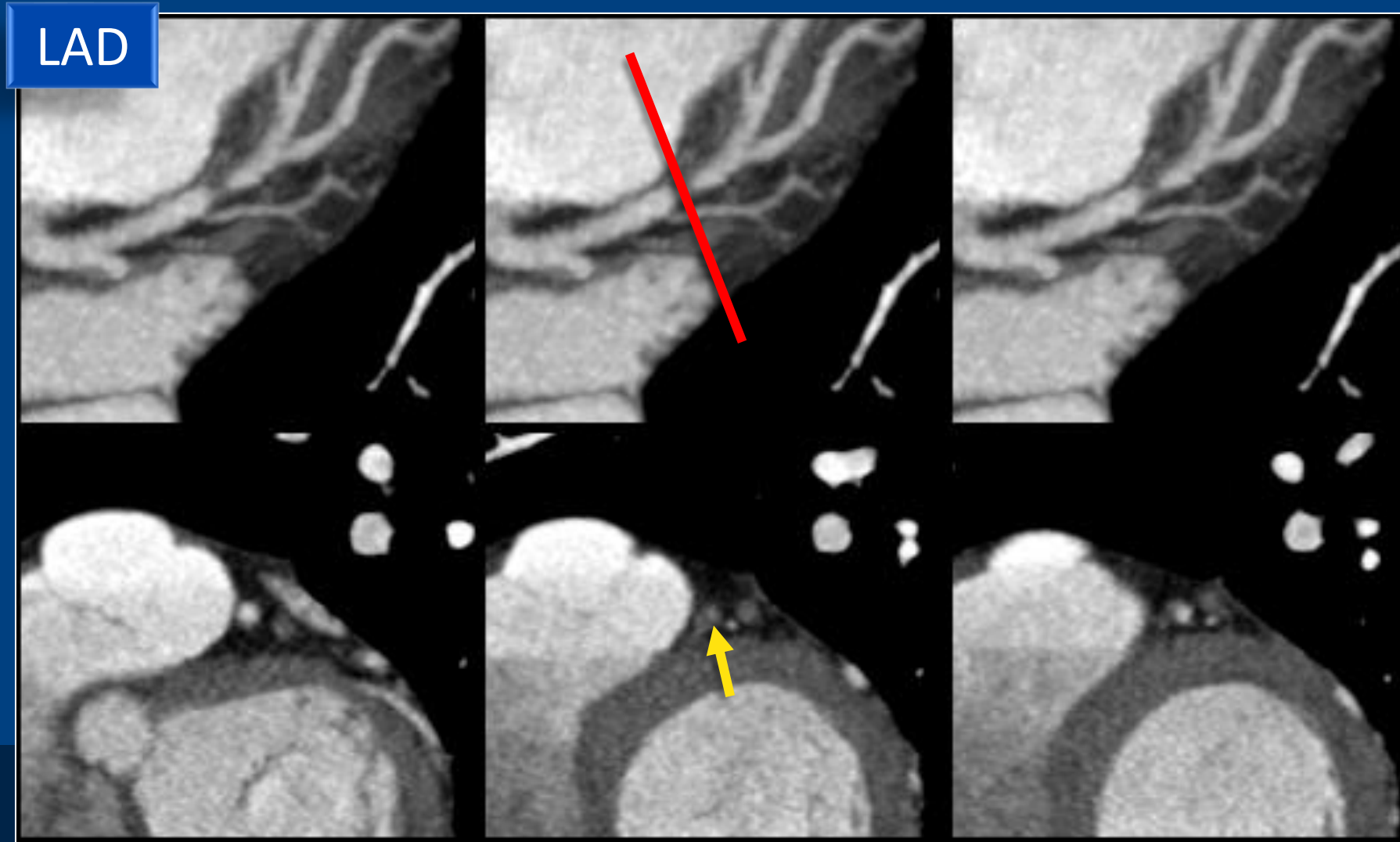
Cardiac CT: Exam Basics



Can't Gate = Not Great

Cardiac CT: Specific Indications

Spatial Resolution – Coronary Arteries

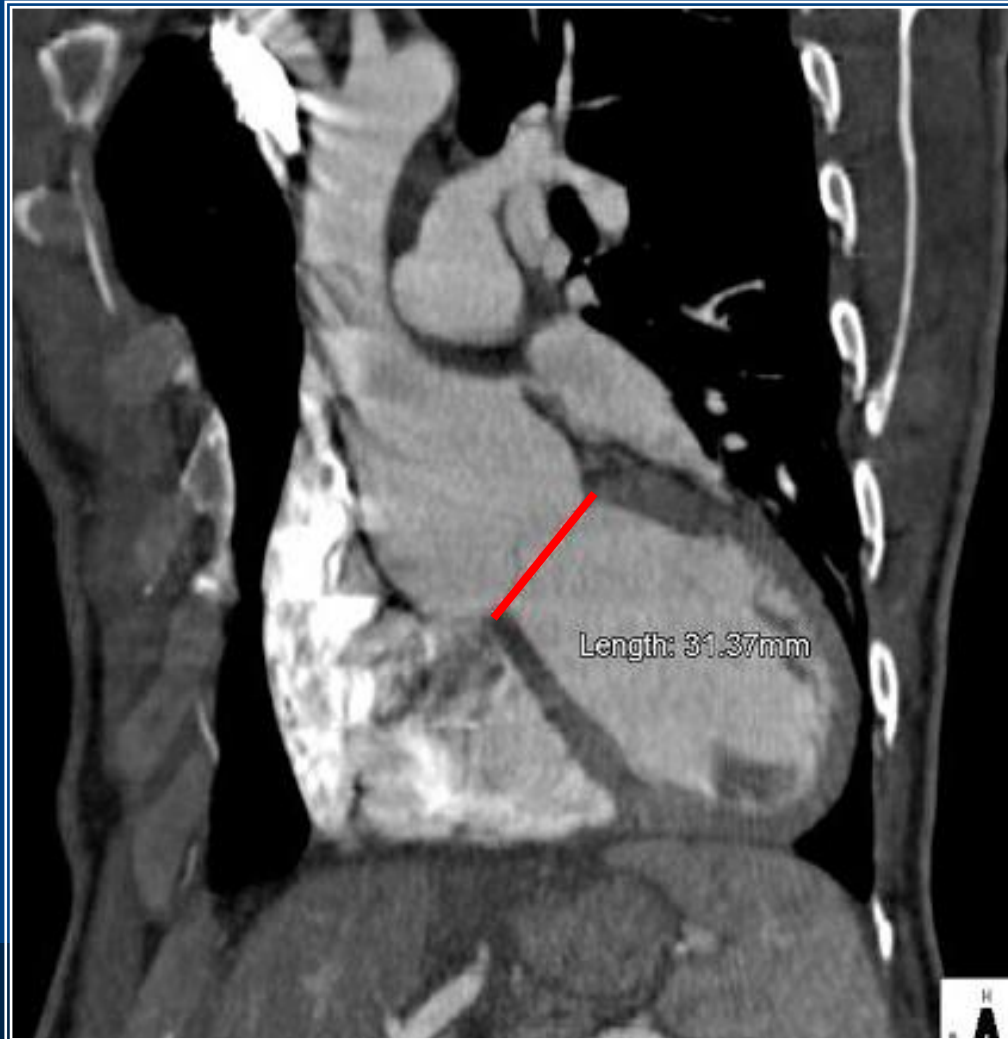


Submillimeter
spatial
resolution

...assuming
ECG-gating is
working

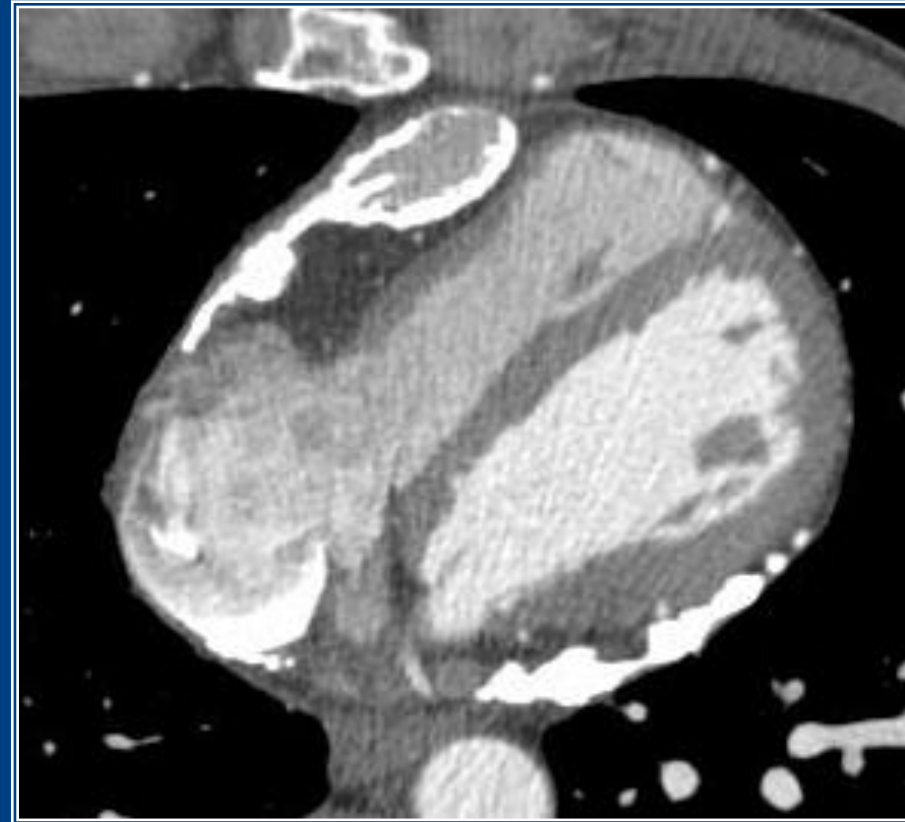
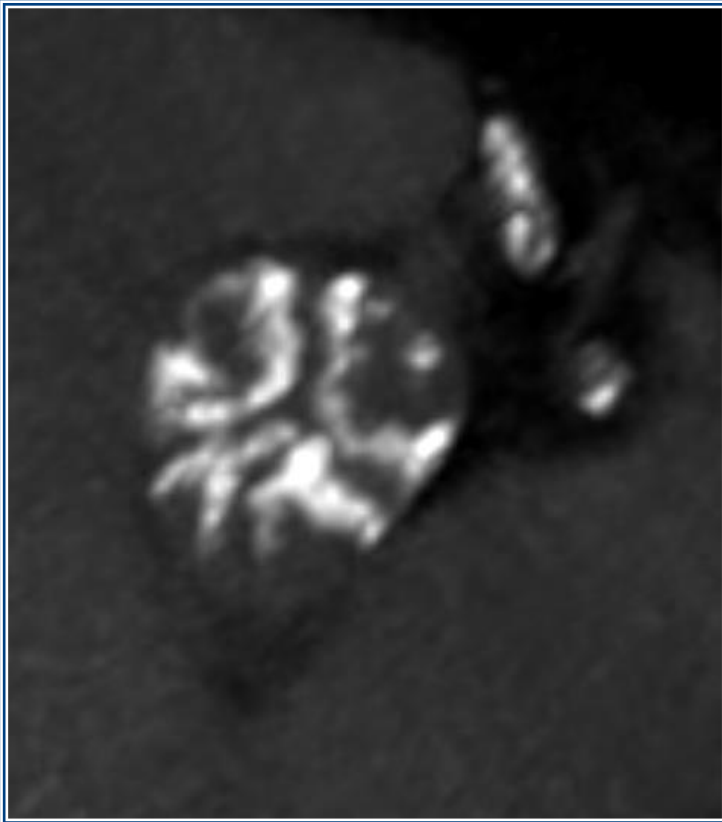
Cardiac CT: Specific Indications

Spatial Resolution – Aortic Root

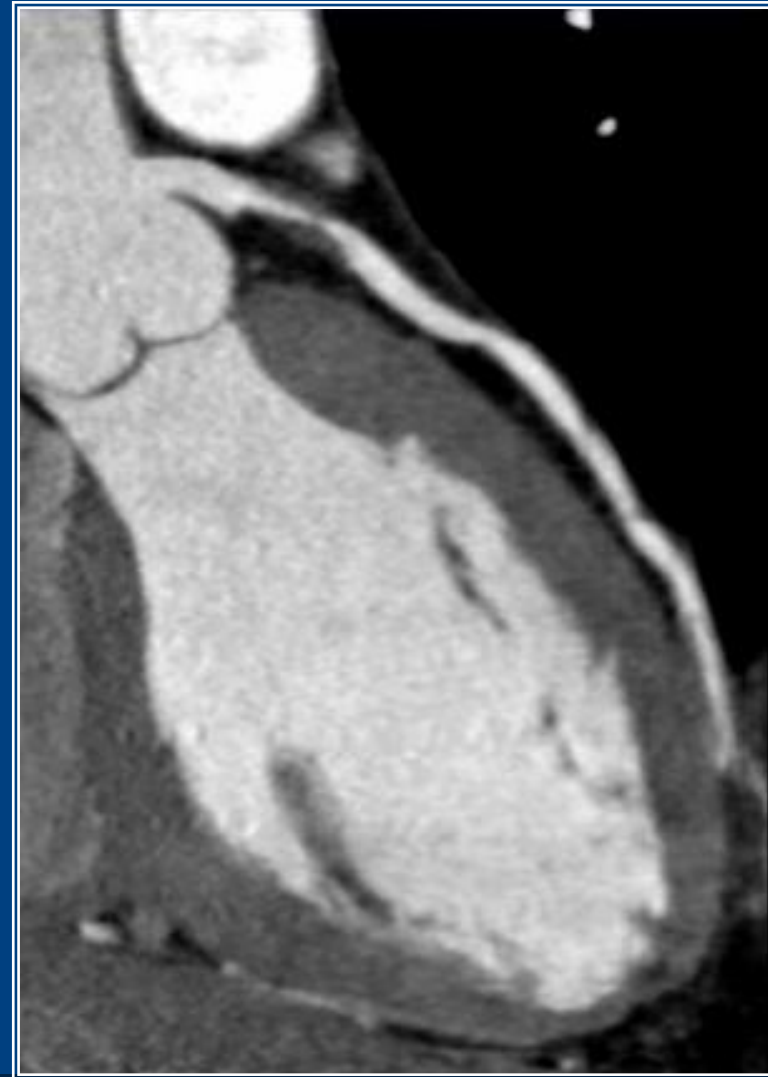
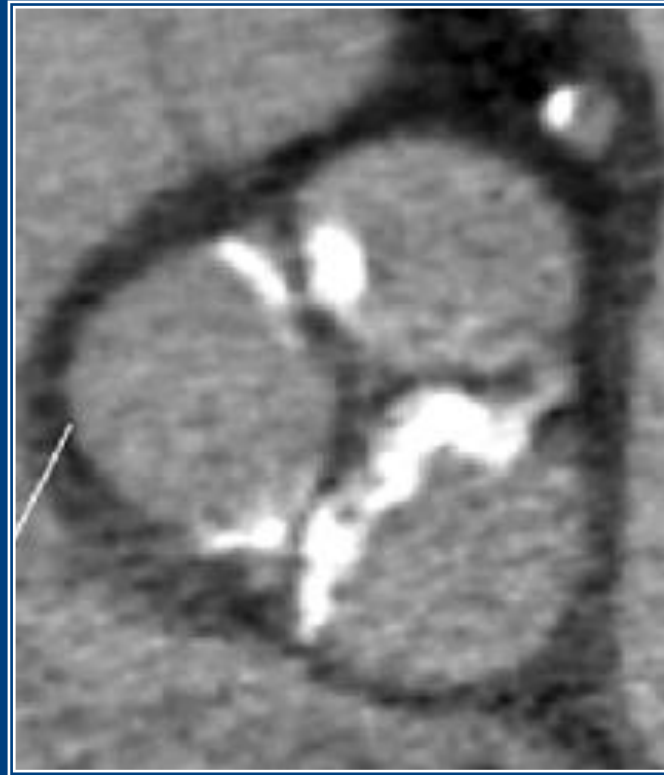
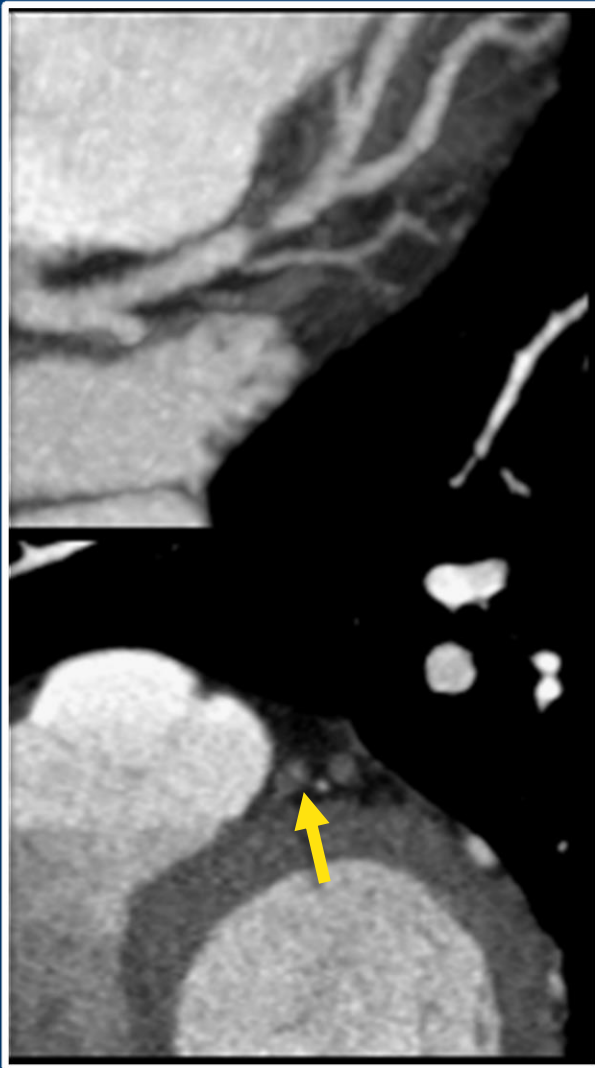


Cardiac CT: Specific Indications

Calcification – Coronary arteries, valves, pericardium, etc...



Cardiac CT: Modality Strengths



CT = best test for calcium
& coronary arteries

MAYO
CLINIC



**Cardiac Magnetic
Resonance Imaging**

Cardiac MRI: Exam Basics

Key Facts

Uses magnet

Always on



Cardiac MRI: Exam Basics

Key Facts

Uses magnet

Always on



Cardiac MRI: Exam Basics

Key Facts

Uses magnet

Tight space

Claustrophobia



Cardiac MRI: Exam Basics

Key Facts

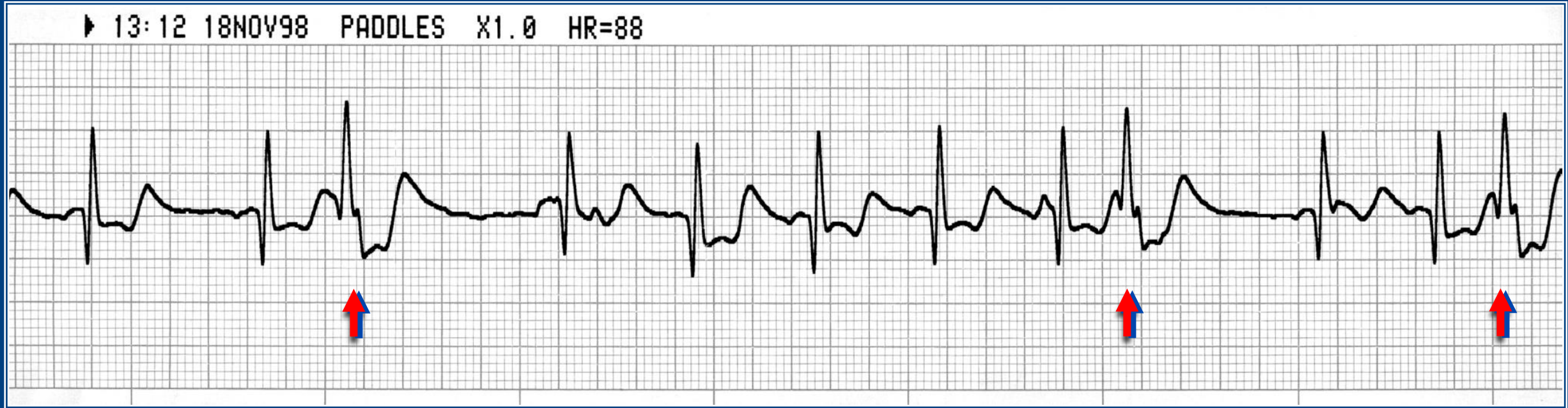
Uses magnet

IV contrast
(variable)

ECG-gating



Cardiac MRI: Exam Basics



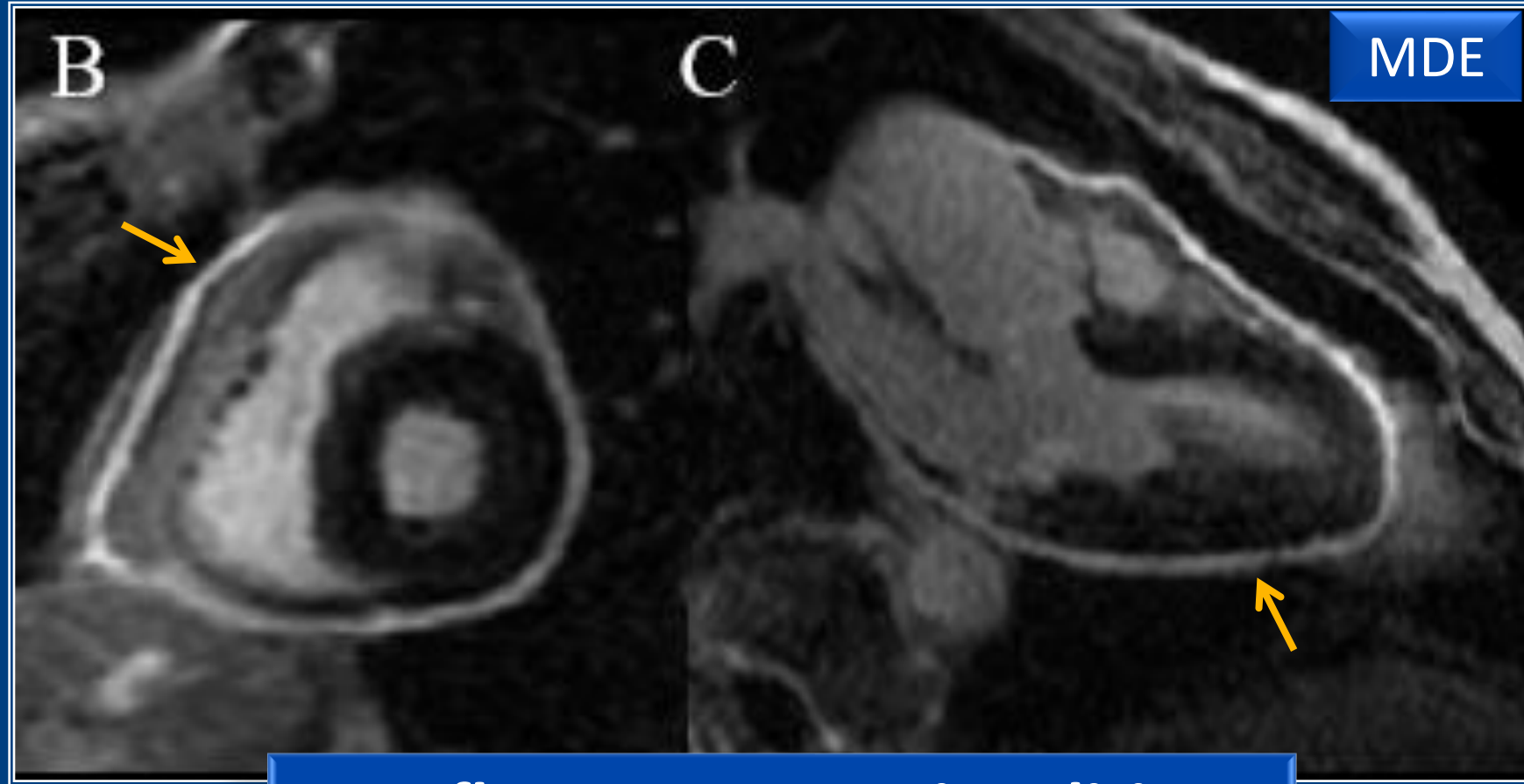
No Gate = No Good

Cardiac MRI: Specific Indications

Contrast Enhancement – Pericardium

44 y/o ♂:

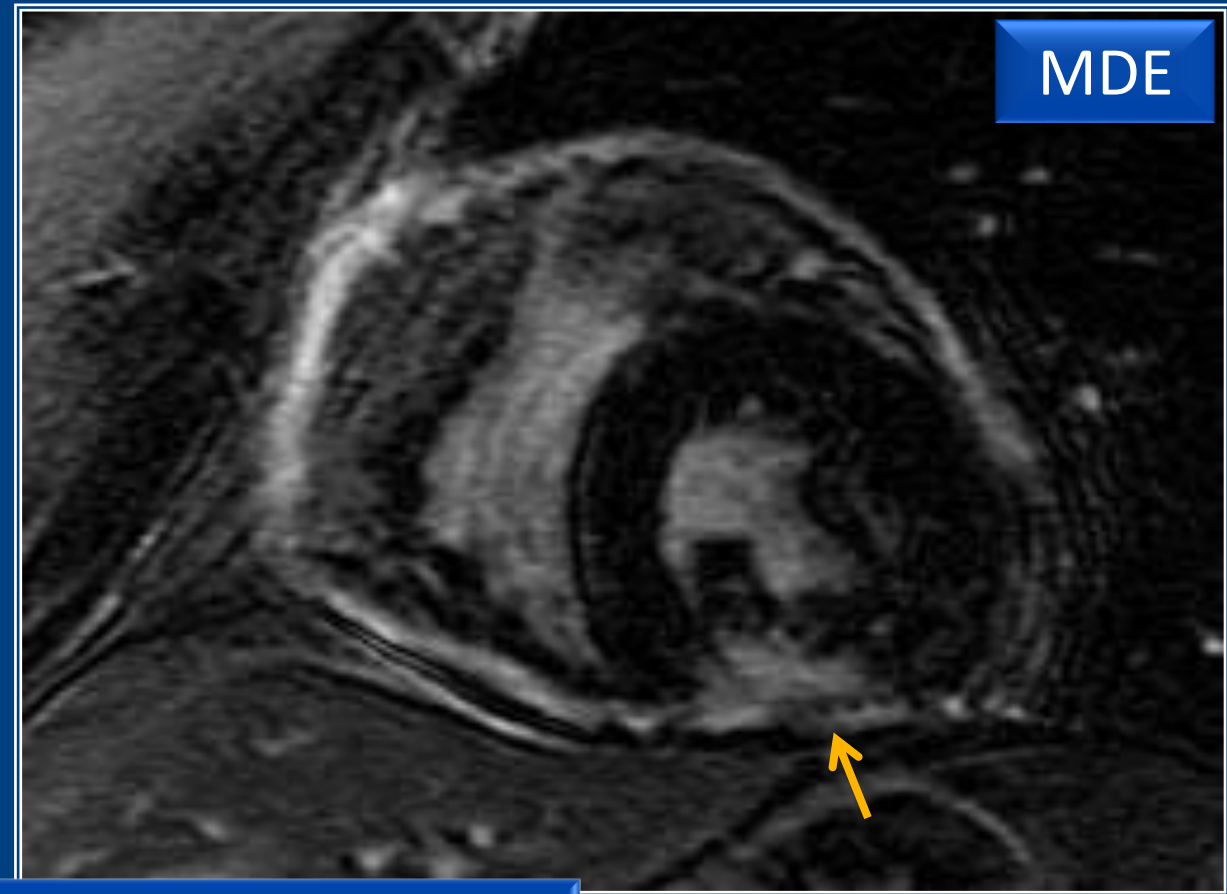
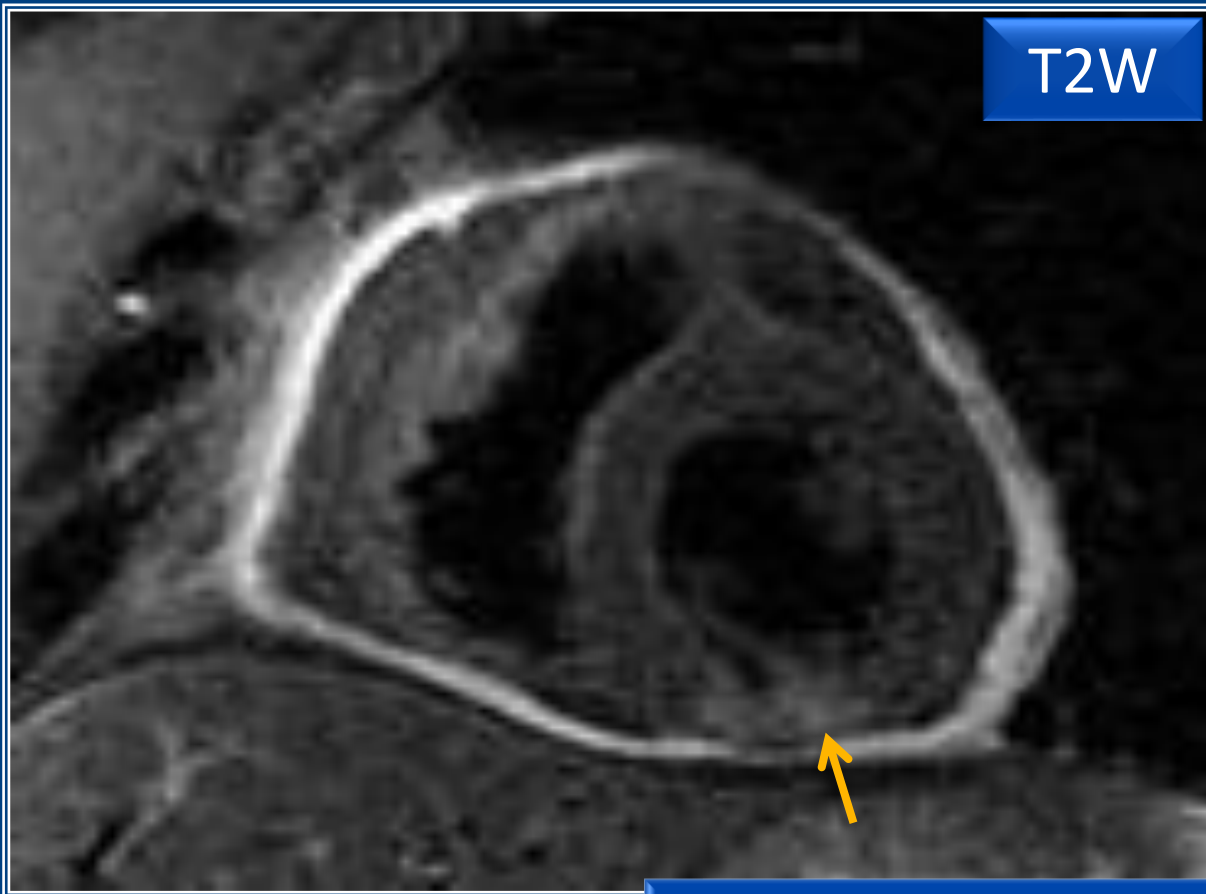
- Echo: indeterminate findings for constrictive physiology



Inflammatory pericarditis

Cardiac MRI: Specific Indications

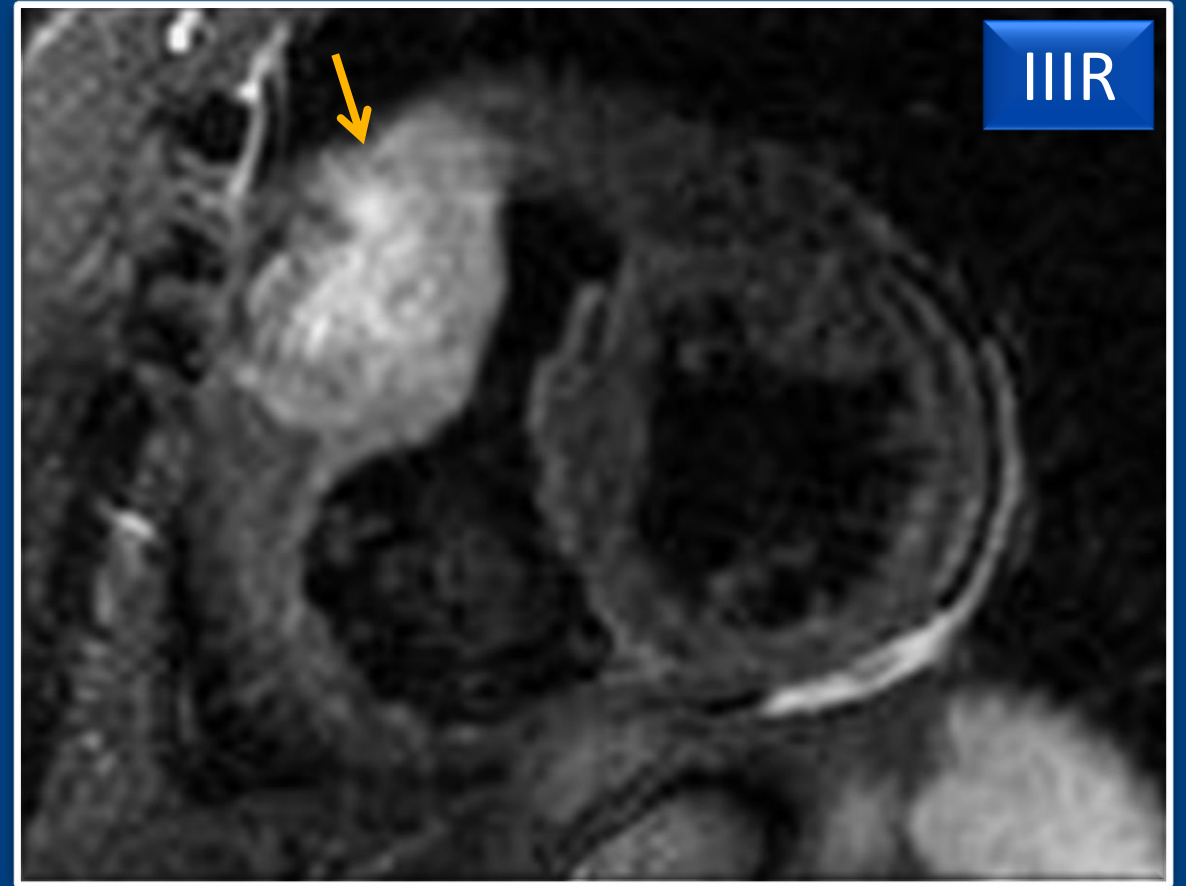
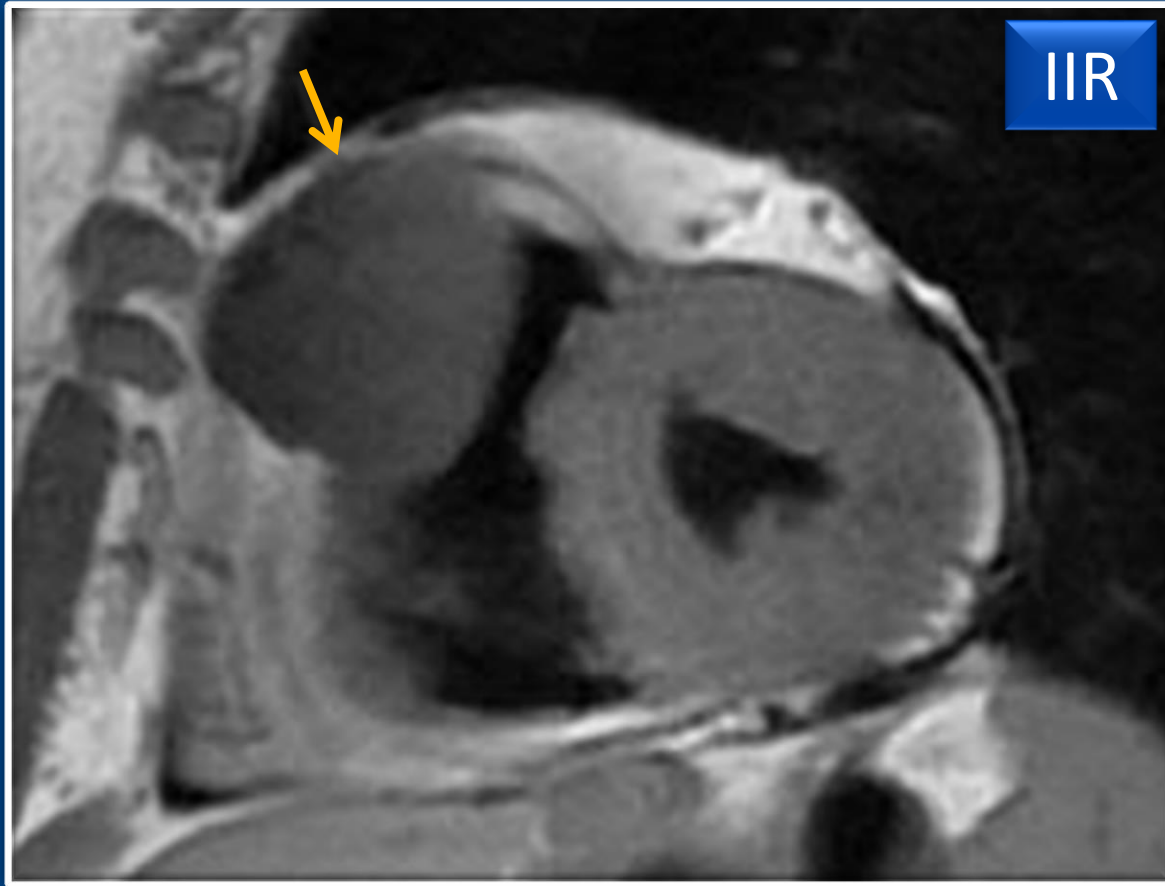
Tissue Characterization – Myocardium



Lupus myopericarditis

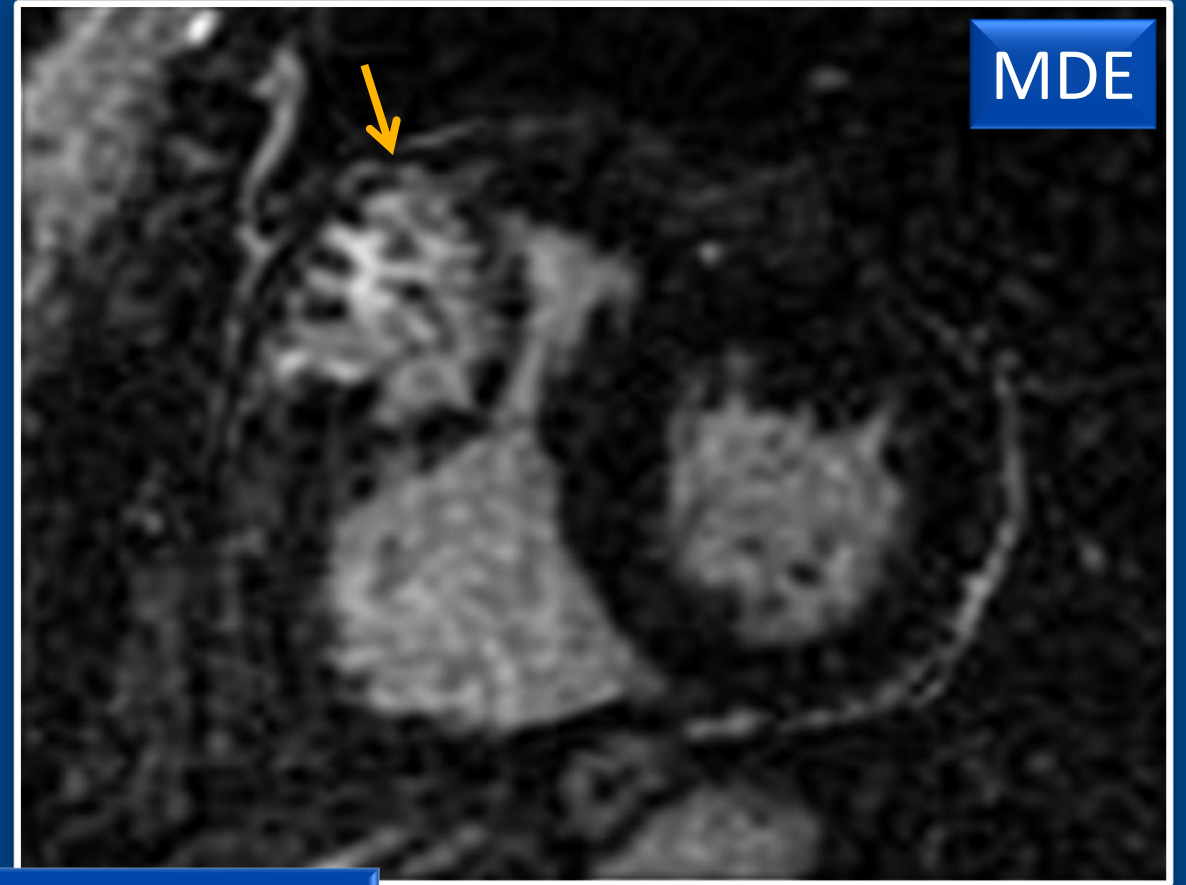
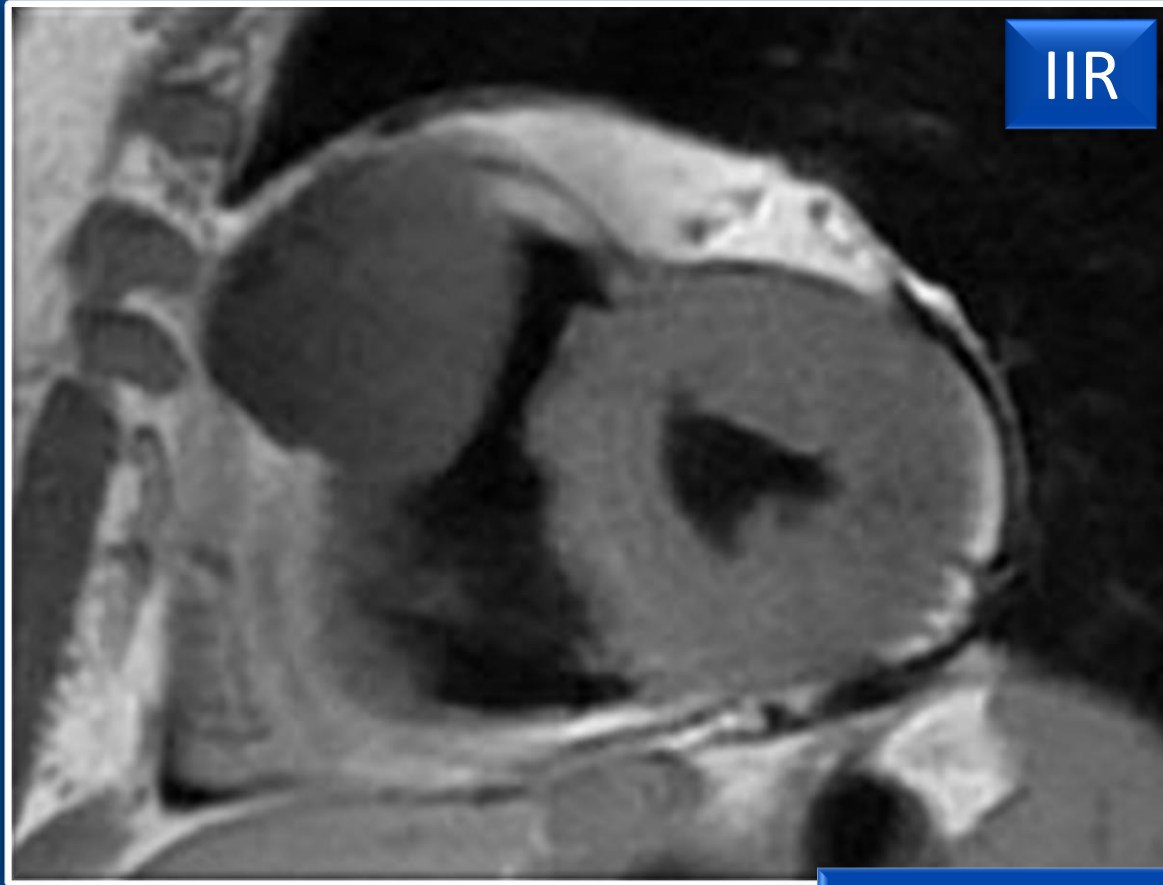
Cardiac MRI: Specific Indications

Tissue Characterization – Cardiac Masses



Cardiac MRI: Specific Indications

Contrast Enhancement – Cardiac Masses



Hemangioma

Cardiac MRI: Modality Strengths


T2W

IIR

MDE

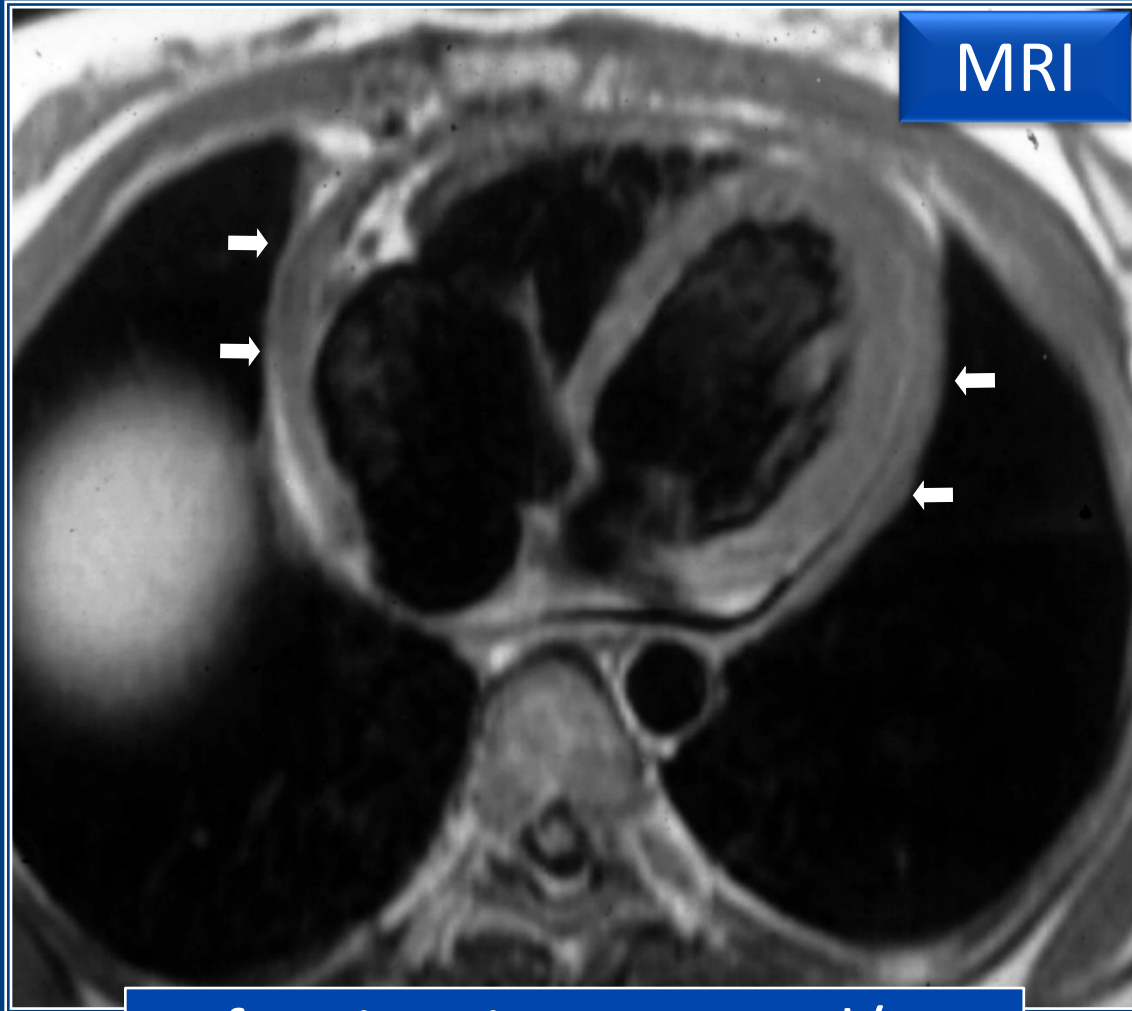
MRI = best test for tissue characterization & enhancement

Multimodality Imaging Comparison

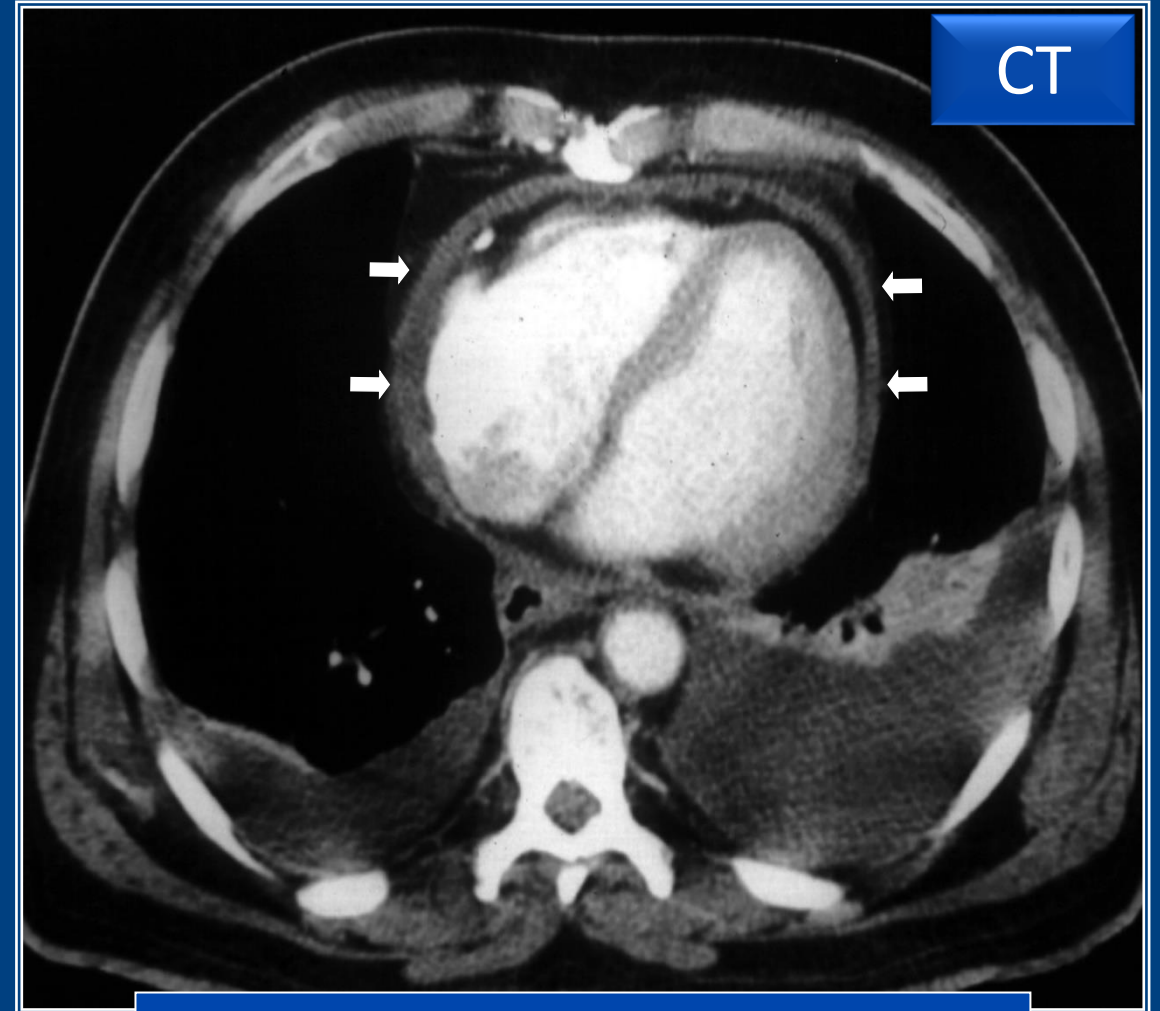
	CT	MRI	NM	Cath	Echo
Anatomy			Competitive		
Function					
Enhancement					
Flow					

The **patient** rather than the **disease** will often dictate the modality

CT vs MRI: Pericardial Disease



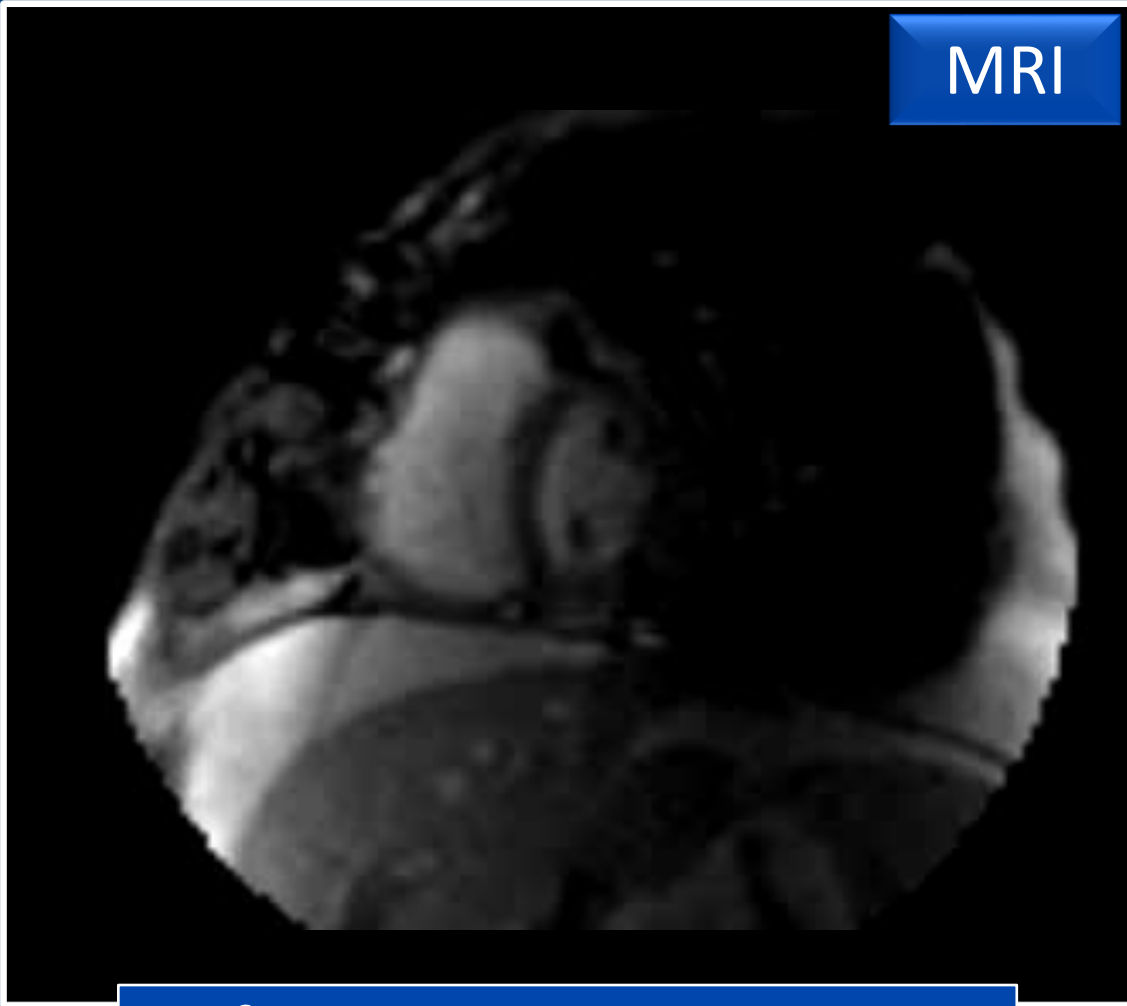
If patient is **young** and/or **female**, consider MRI



If patient is a **poor breath holder**, consider CT

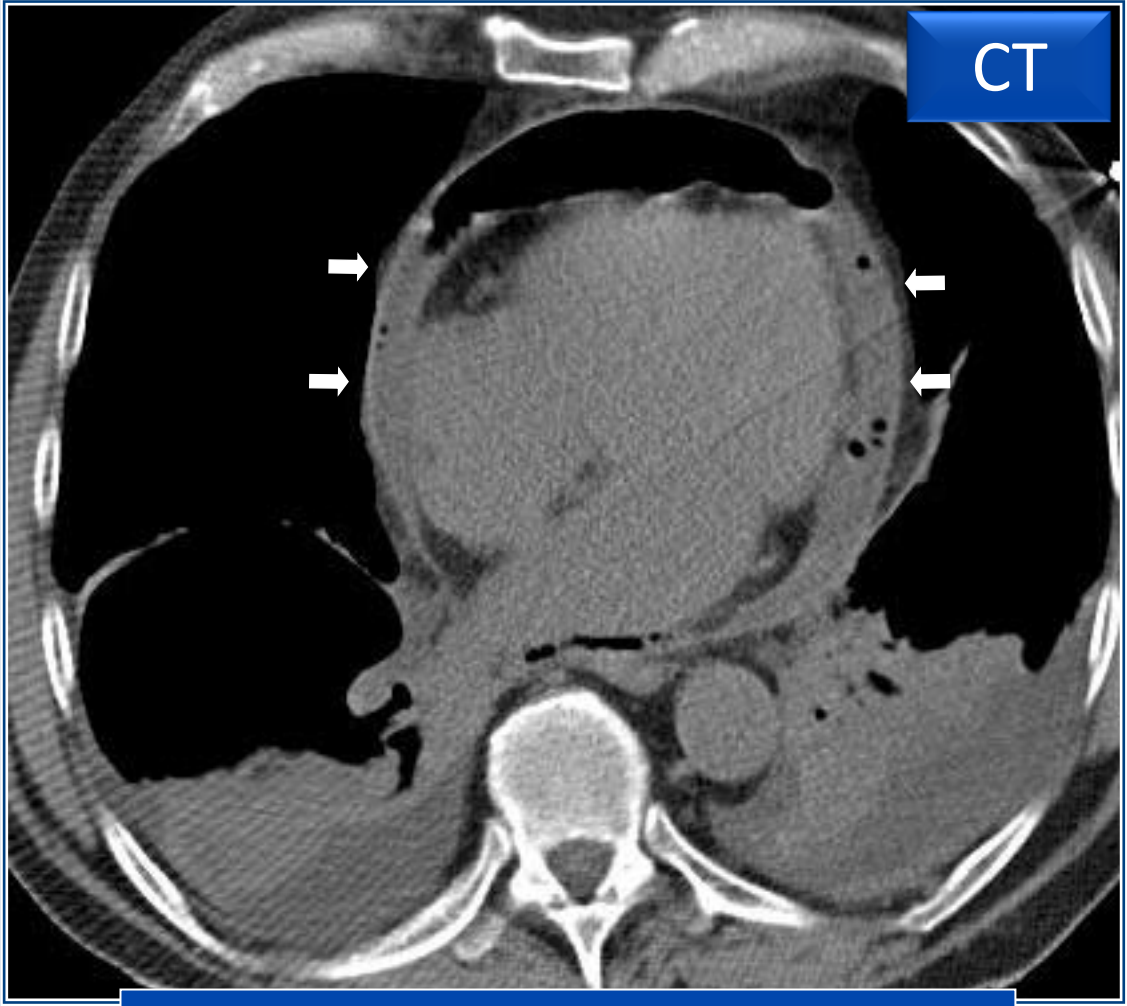
CT vs MRI: Pericardial Disease

MRI



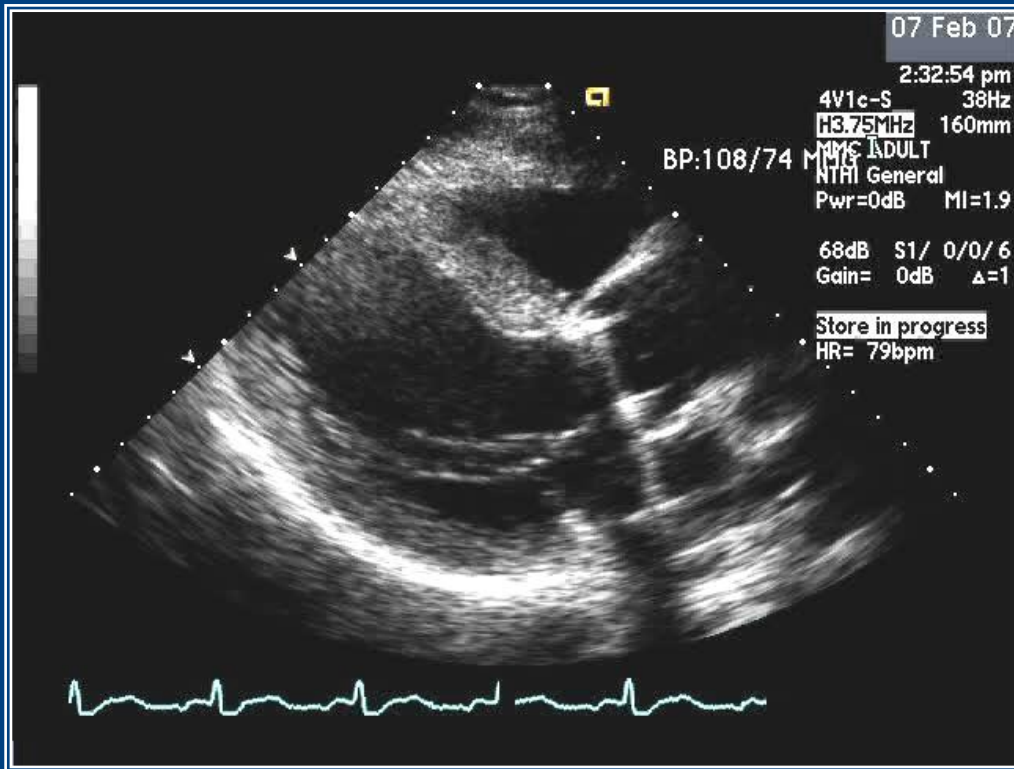
If patient is **cooperative**, consider MRI

CT



If patient is **sick** or **can't hold still**, consider CT

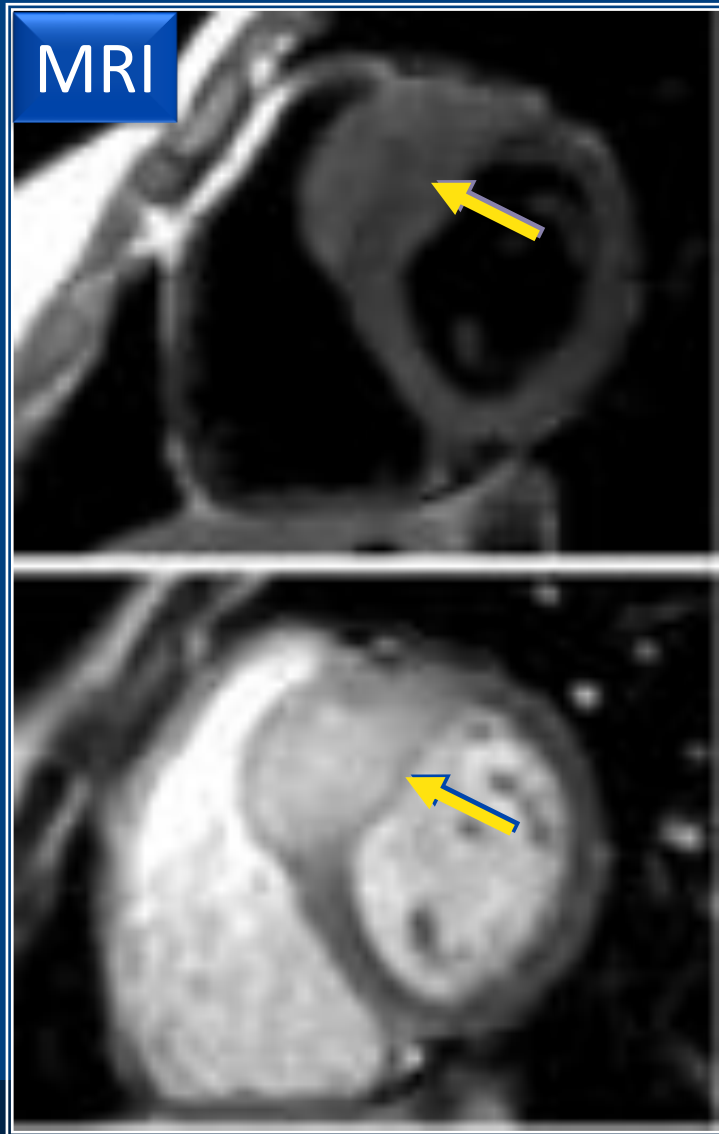
CT vs MRI: Myocardial Infarction



Echo: apical MI ? thrombus









CT vs MRI: Cardiac Masses



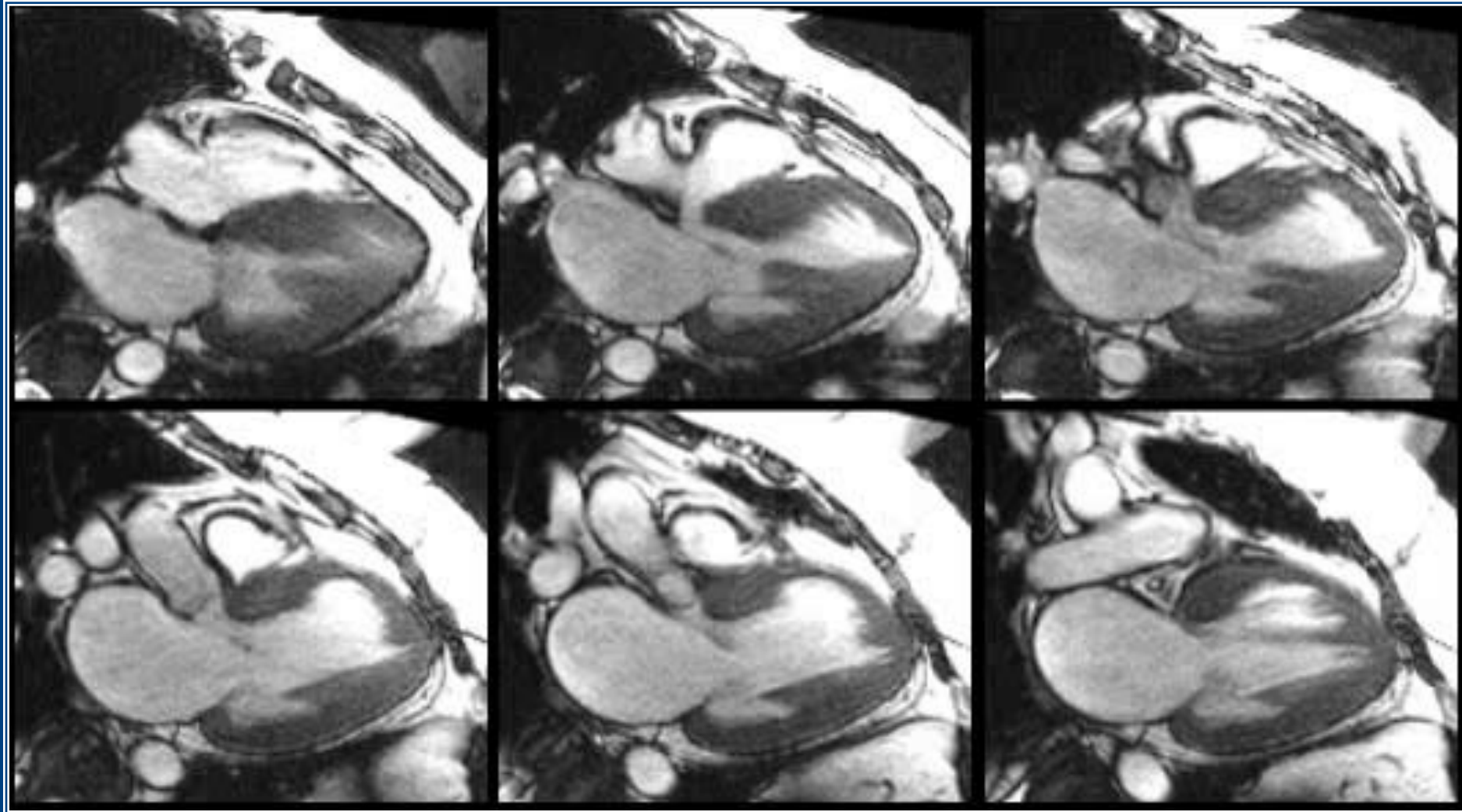
Multimodality Imaging Comparison

	CT	MRI	NM	Cath	Echo
--	----	-----	----	------	------

MRI >> CT for **flow** information
CT >> MRI for **calcium** & PO changes

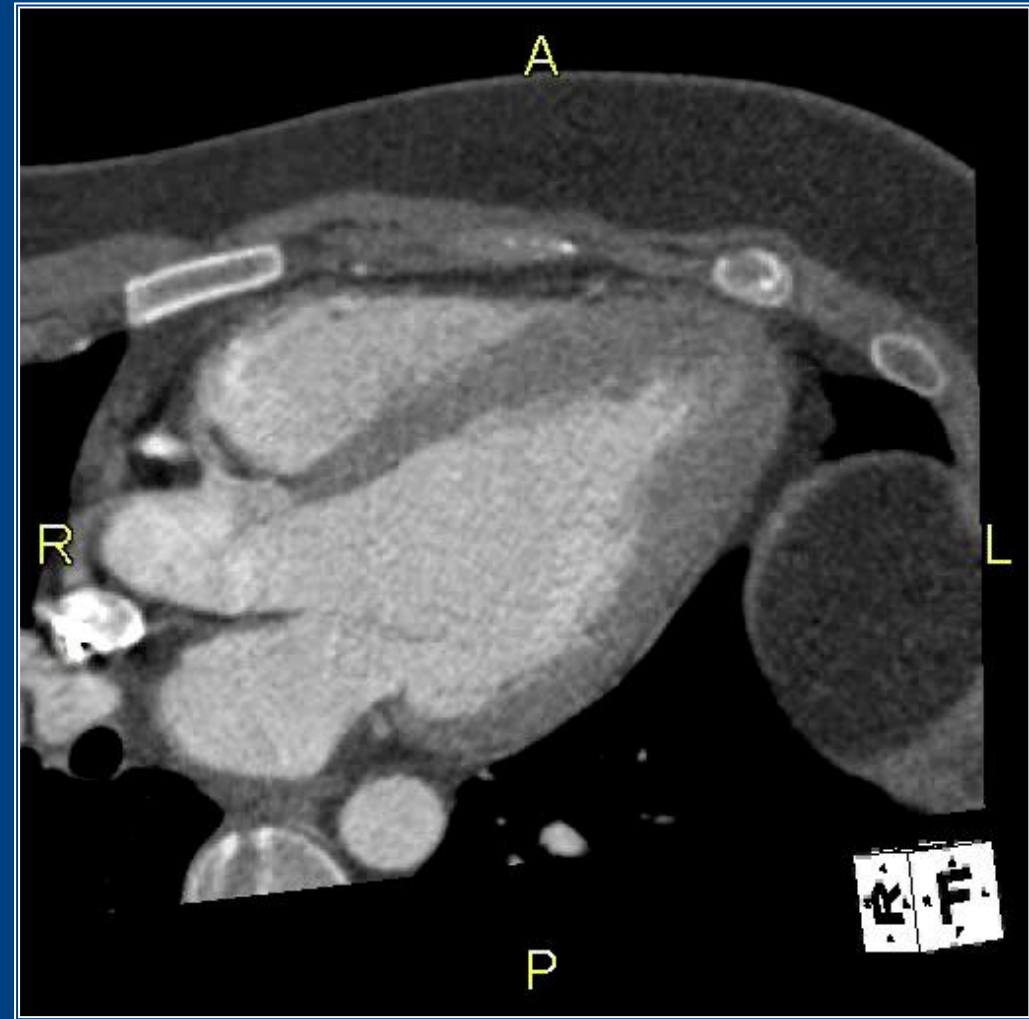
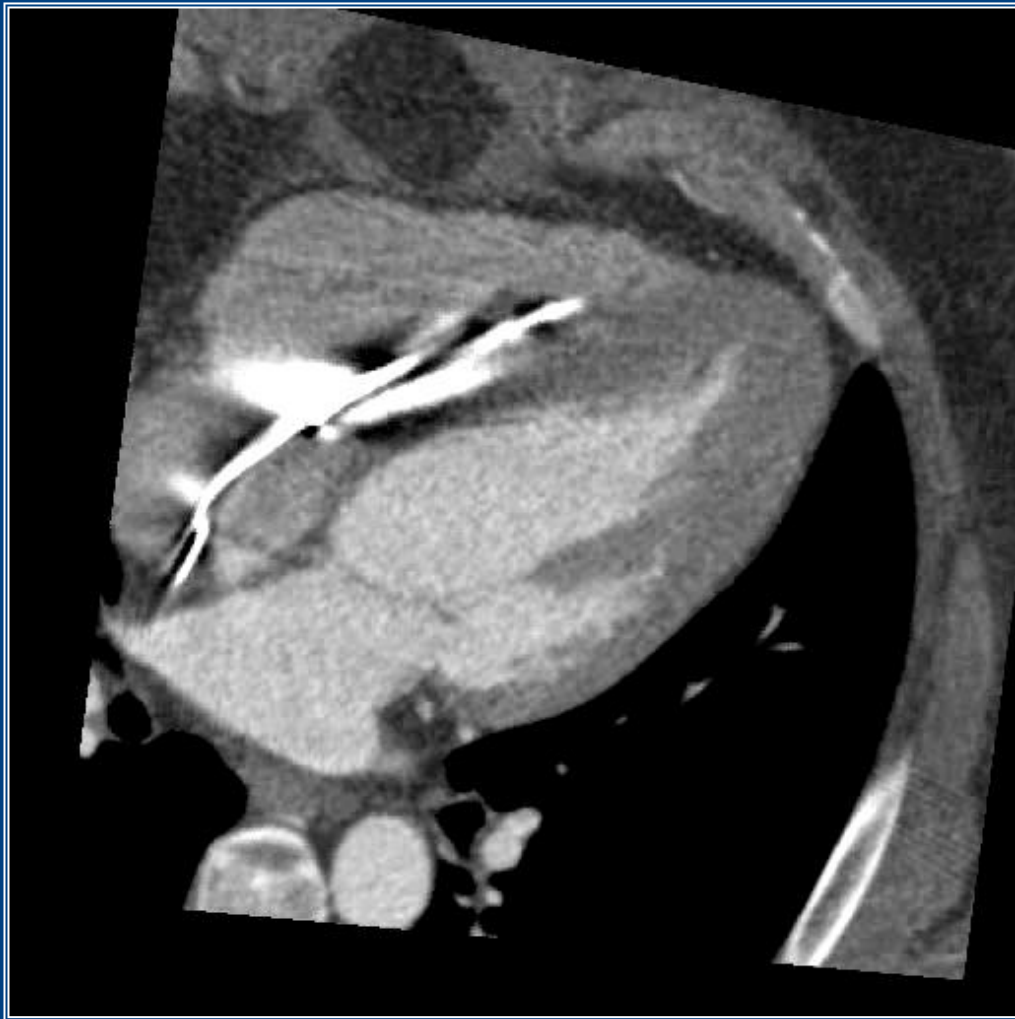
Flow Information			Cooperative		
Calcium					
Surgical changes					

CT vs MRI: Flow Information



Flow information not available from CT

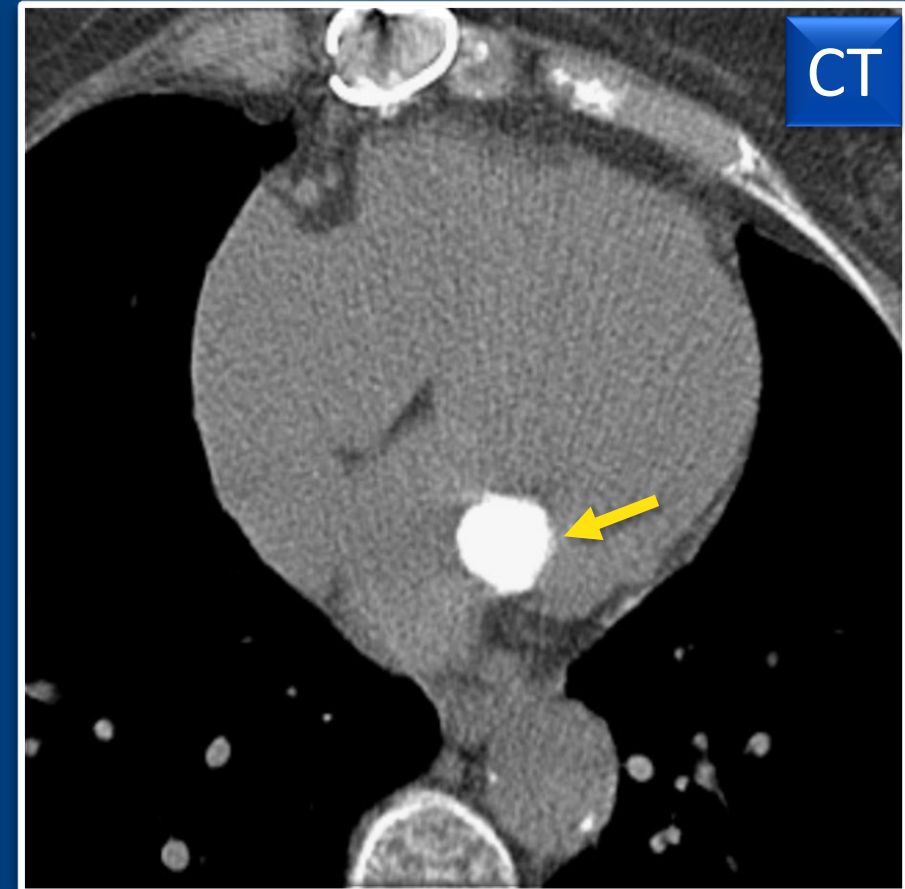
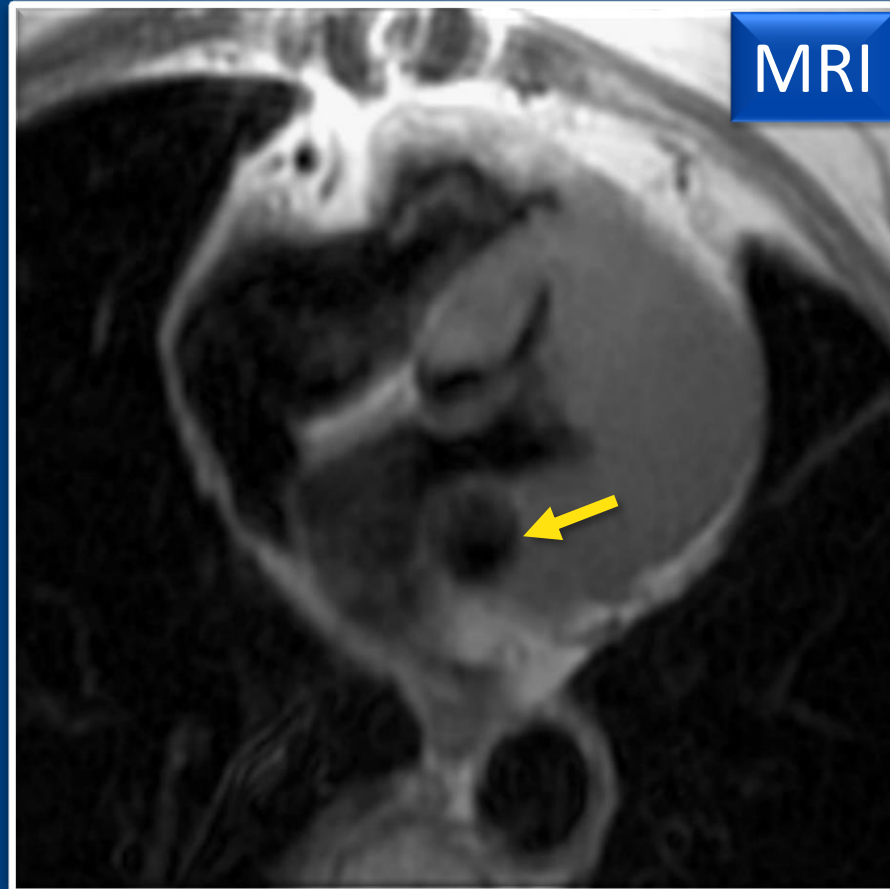
CT vs MRI: Cardiac Devices



...if patient has a device, you may not care

CT vs MRI: Calcification & PO Changes

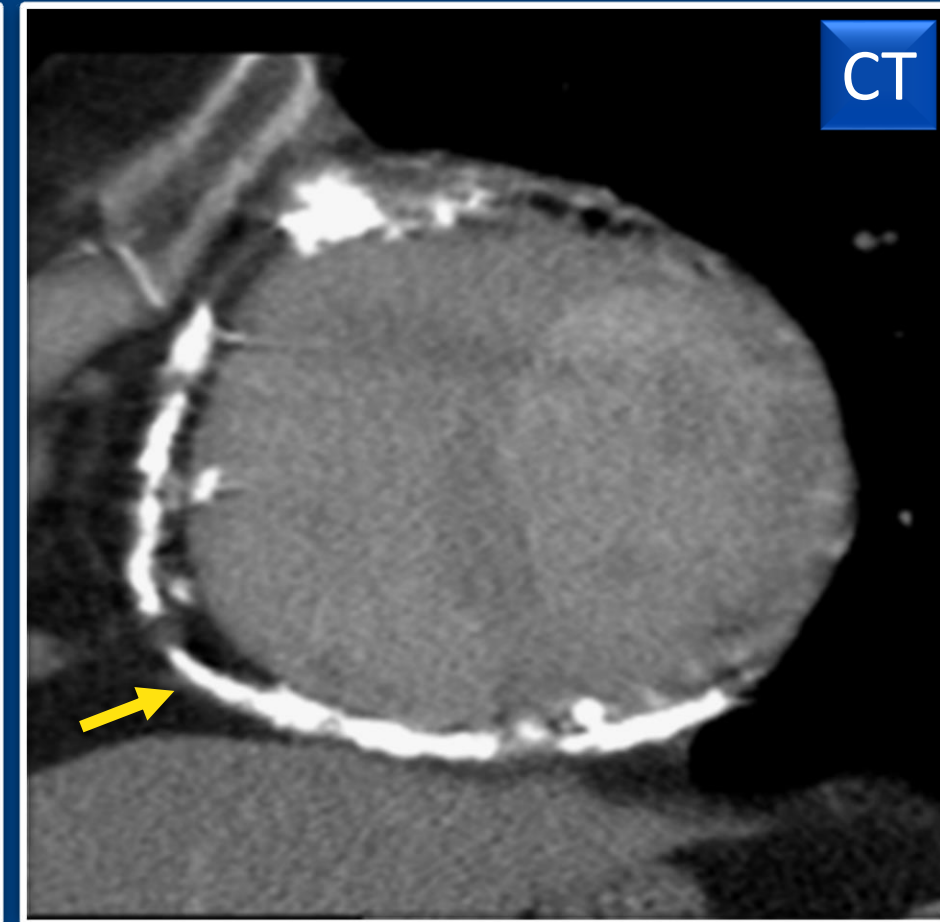
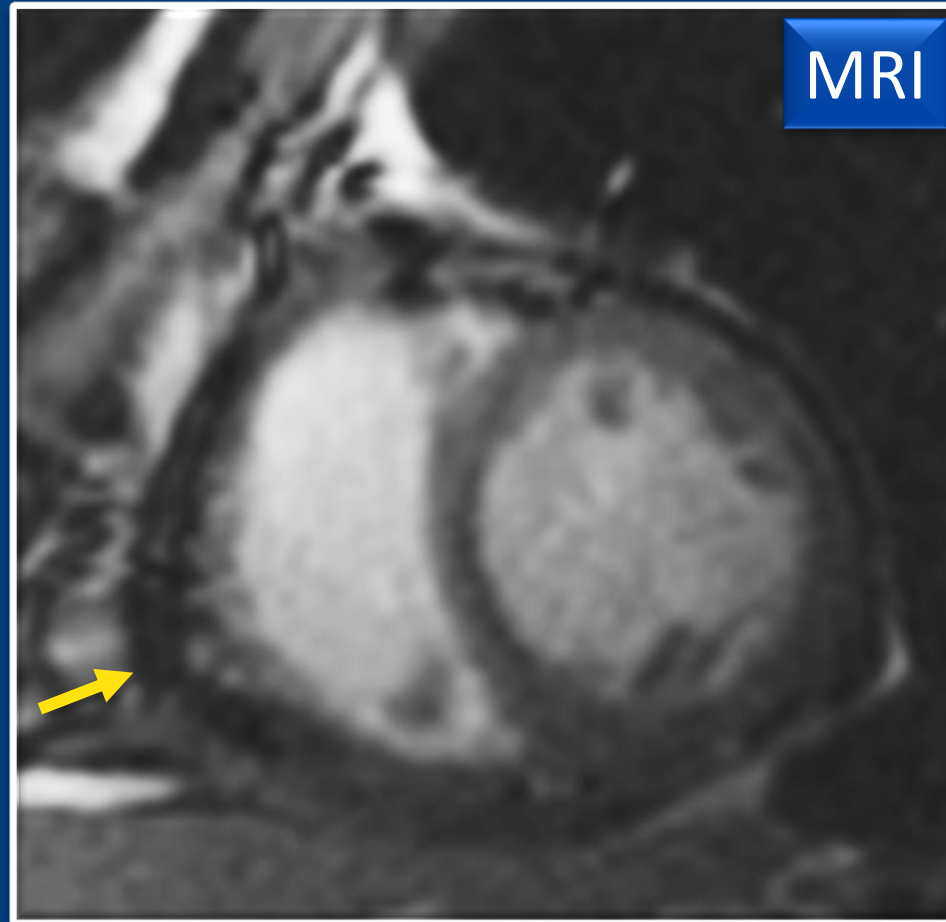
Left AV groove
mass seen at
echocardiography



Calcification not visible on MRI

CT vs MRI: Calcification & PO Changes

Findings on echocardiography suspicious for pericardial constriction



Calcification not visible on MRI

Multimodality Cardiac Imaging: Summary

Cardiac Nuc

- Perfusion imaging for **coronary artery disease**. Novel radiotracers for specific disease entities.

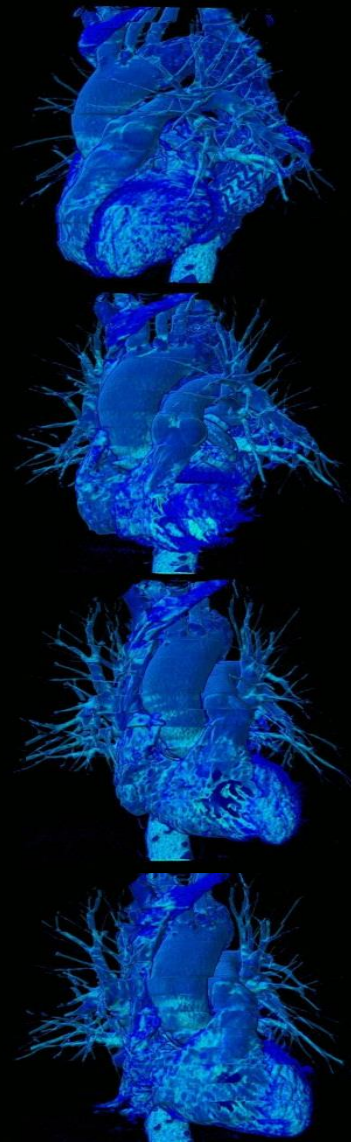
Cardiac CT

- Best test for *visualizing* **coronary arteries** and **calcium**.

Cardiac MRI

- Best test for **tissue characterization** & myocardial / pericardial **enhancement**.

Sometimes the **patient** will dictate the modality rather than the disease





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