Frontiers of Advanced Cardiovascular Imaging

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Disclosure

- Gadolinium is not FDA approved for cardiac MRI use.

Objectives

- Discuss the capabilities of modern cardiac CT
- Describe the capabilities of current advanced cardiac MRI techniques

ADVANCES IN CARDIAC CT

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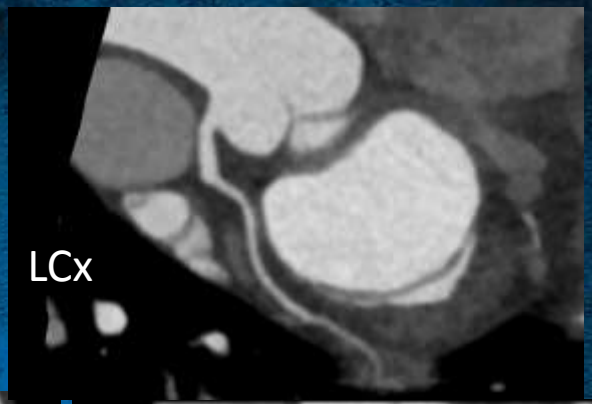
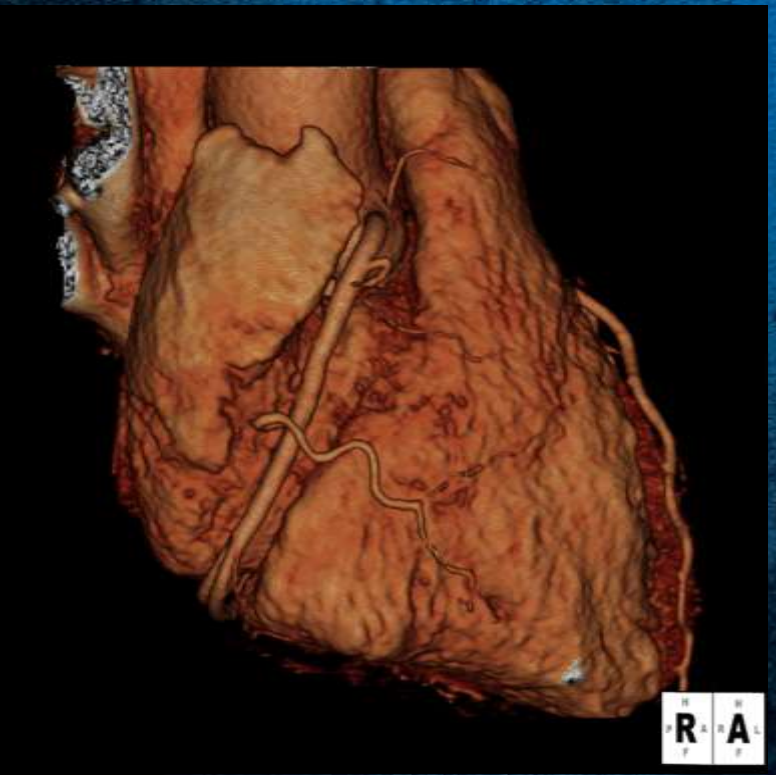
Cardiac CT

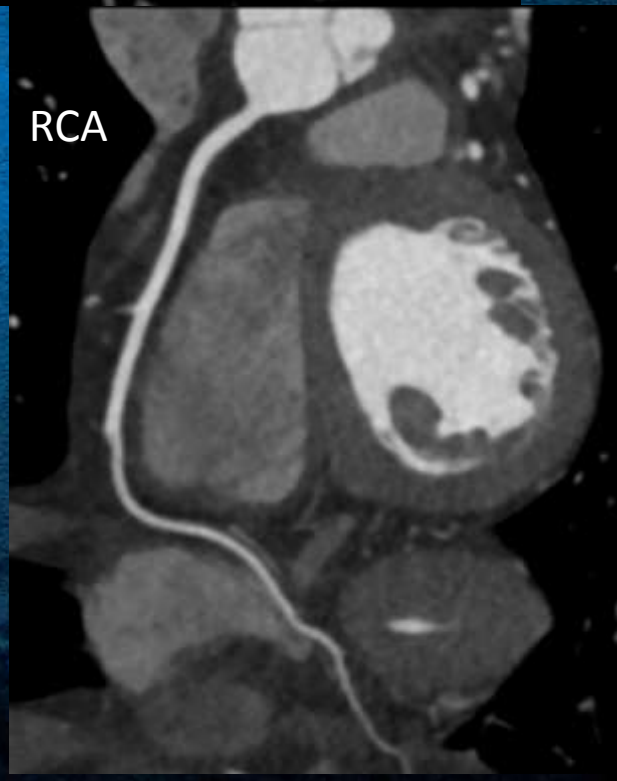
- High spatial resolution for defining anatomy
- High specificity in ruling out coronary artery disease
- Requires radiation, nephrotoxic contrast

Single Heart Beat Cardiac CT

Single Heart Beat Cardiac CT







Single Heart Beat CT

Total mAs 941 Total DLP 49 mGycm =0.686mSv

	Scan	kV	mAs / ref.	CTDIvol* mGy	DLP mGycm	TI s	cSL mm
Patient Position H-SP							
Topogram	1	120	20 mA	0.07 L	[illegible]	2.9	0.6
FI_CaSc	2D	120	58 / 80	0.98 L	18.7	0.25	0.6
Contrast							
TestBolus	3	100	20	2.84 L	2.8	0.25	10.0
Last scan no.	6						
Contrast							
Contrast							
Contrast							
TestBolus	7	100	23	6.46 L	6.5	0.25	10.0
Last scan no.	16						
Contrast							
FI_CorCTA	17D	70	420 / 626	1.18 L	18.7	0.25	0.6

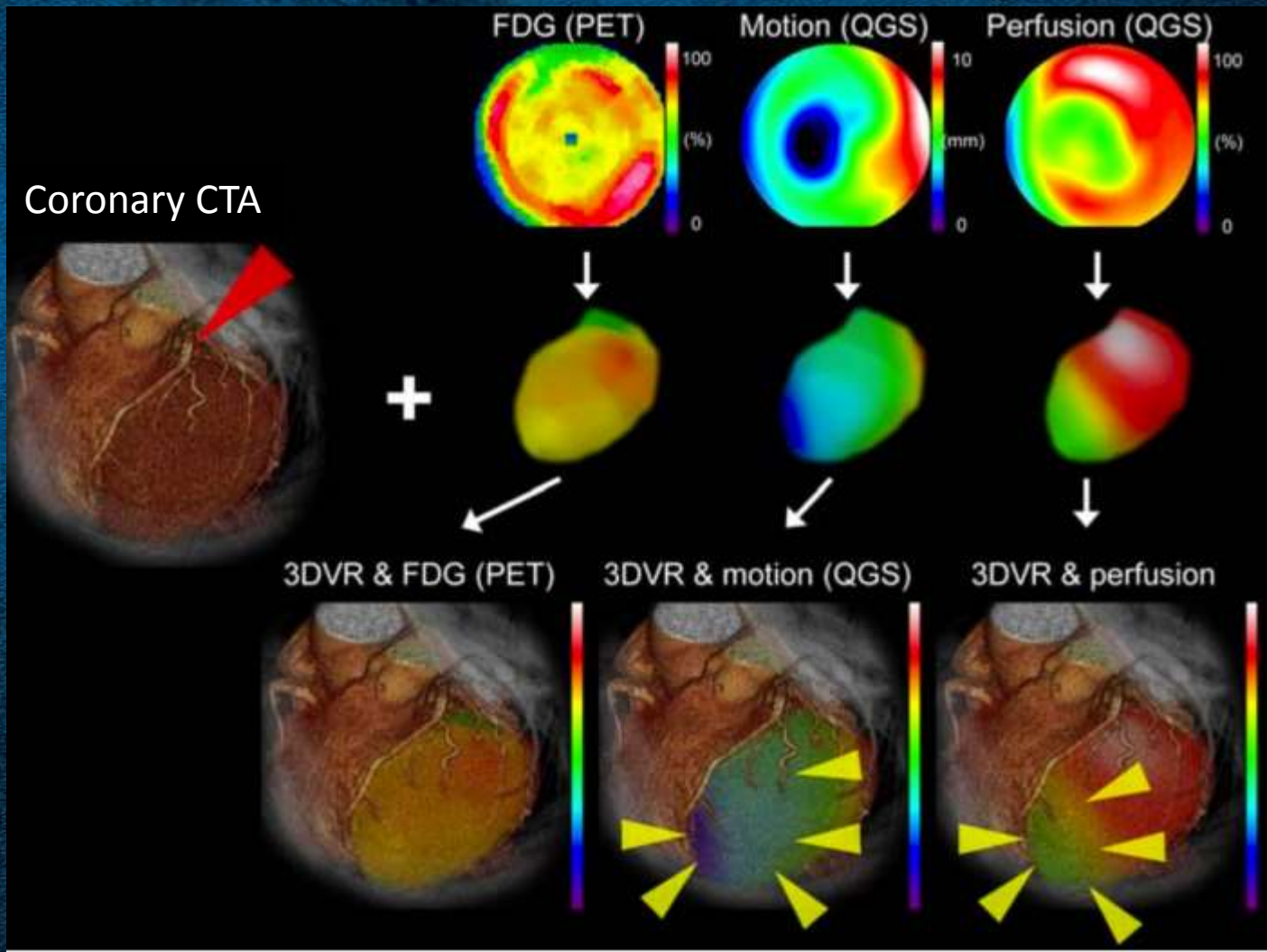
What about physiology?

- (Moderately) Narrow coronary arteries do not equate to ischemia/symptoms

Hybrid Imaging (Nuc + CT)

- SPECT
- PET

Hurlock GS et al. Int J Cardiovasc Imaging 2009 25:31-42



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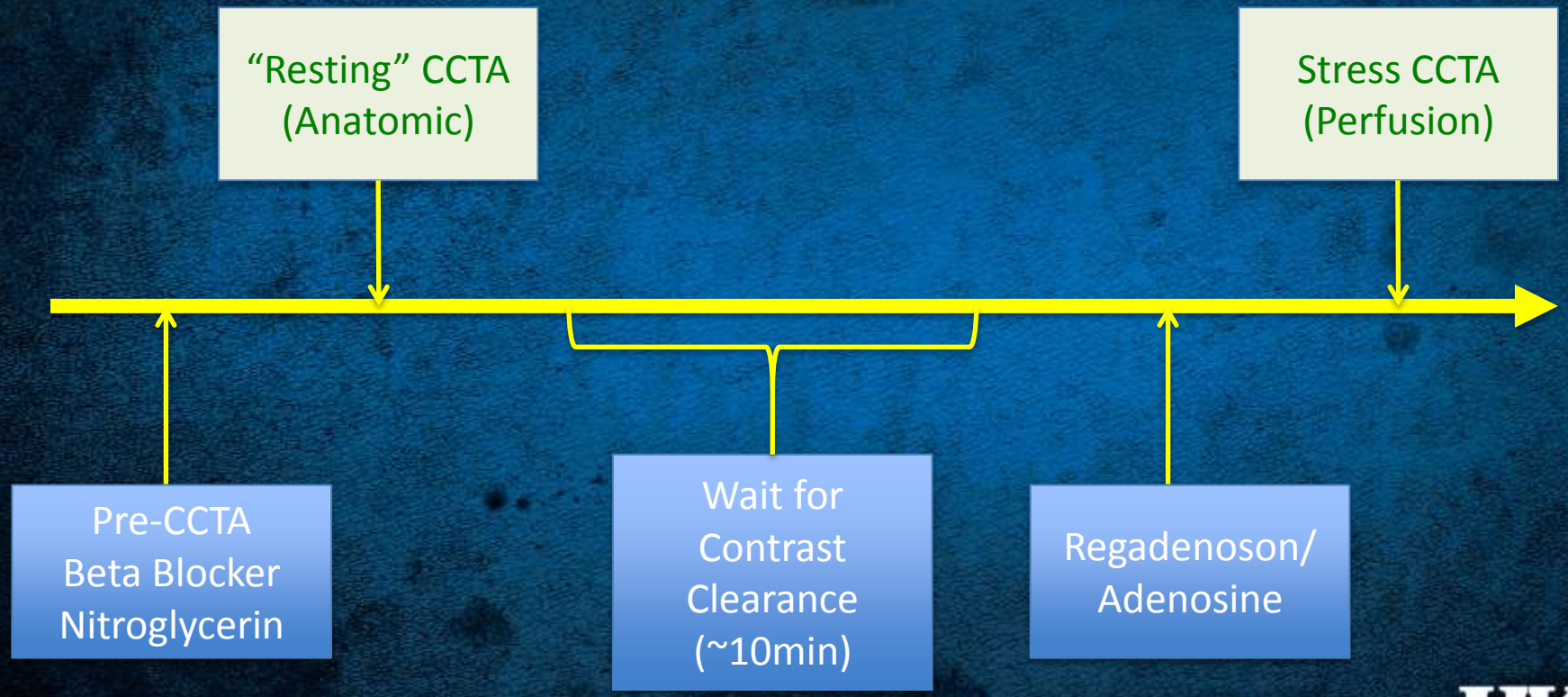
Stress Perfusion CT



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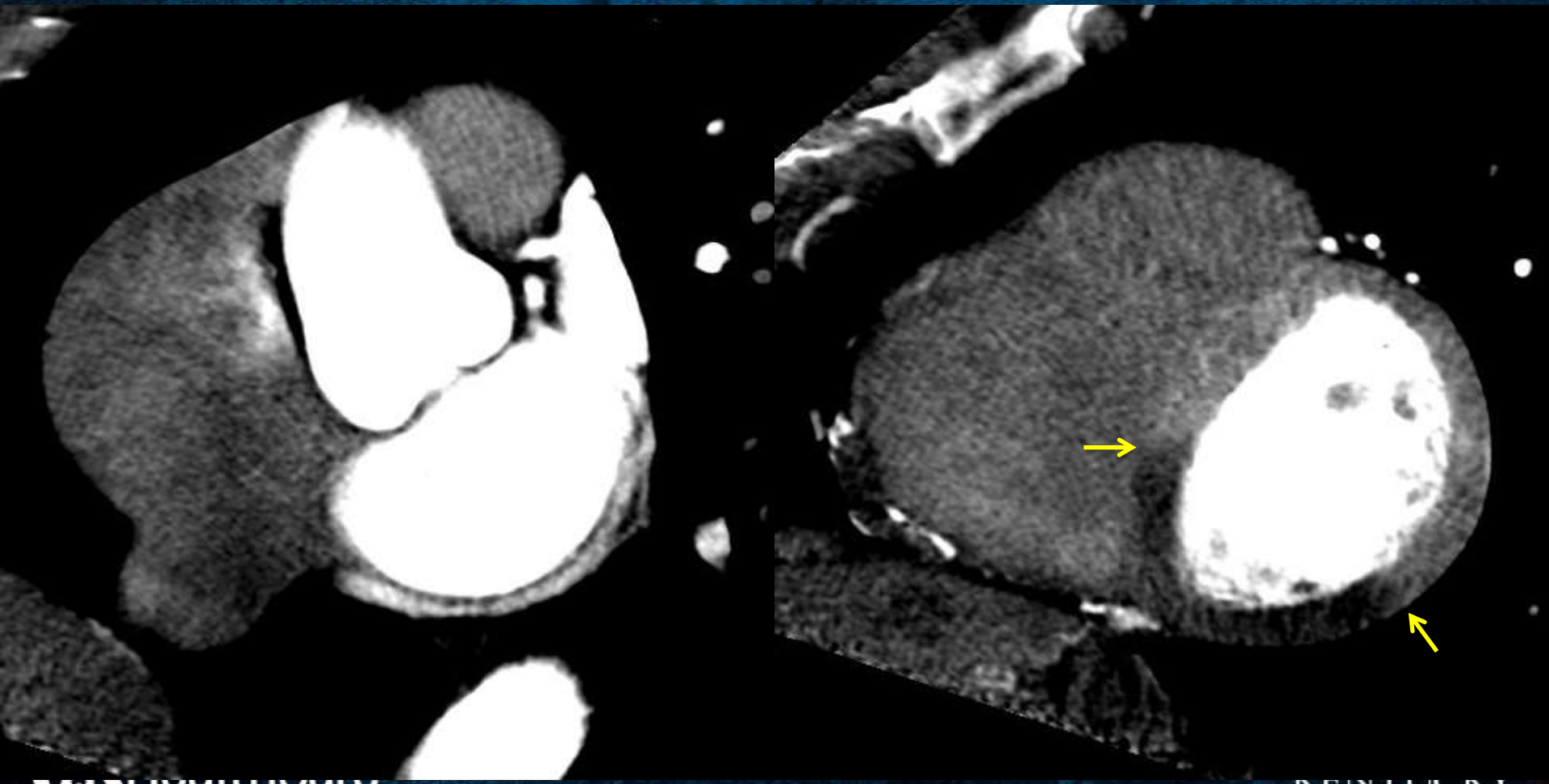
Stress Perfusion CT

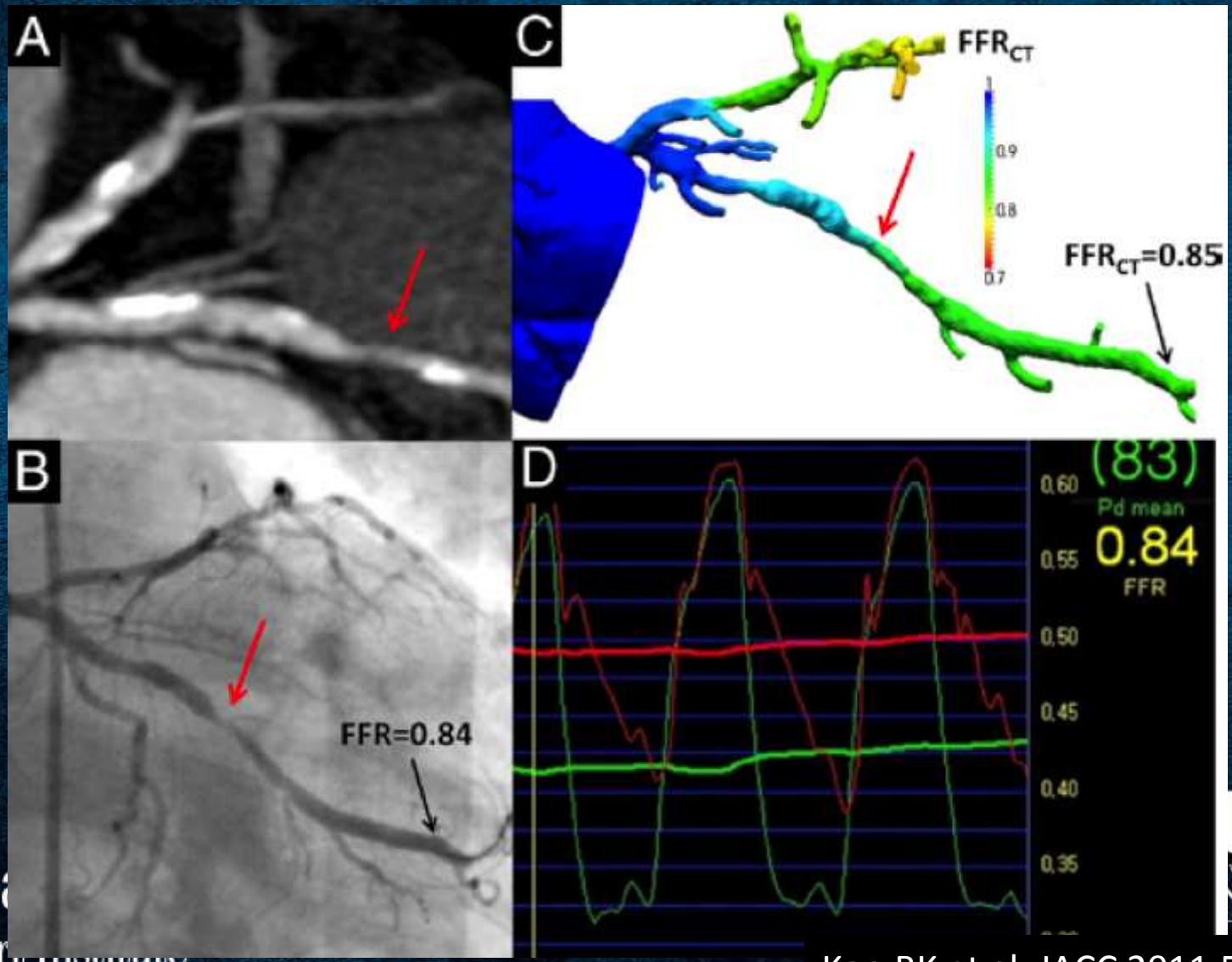


Cardiac CT FFR

- Anatomic prediction of physiologic significance by fluid hemodynamic modeling

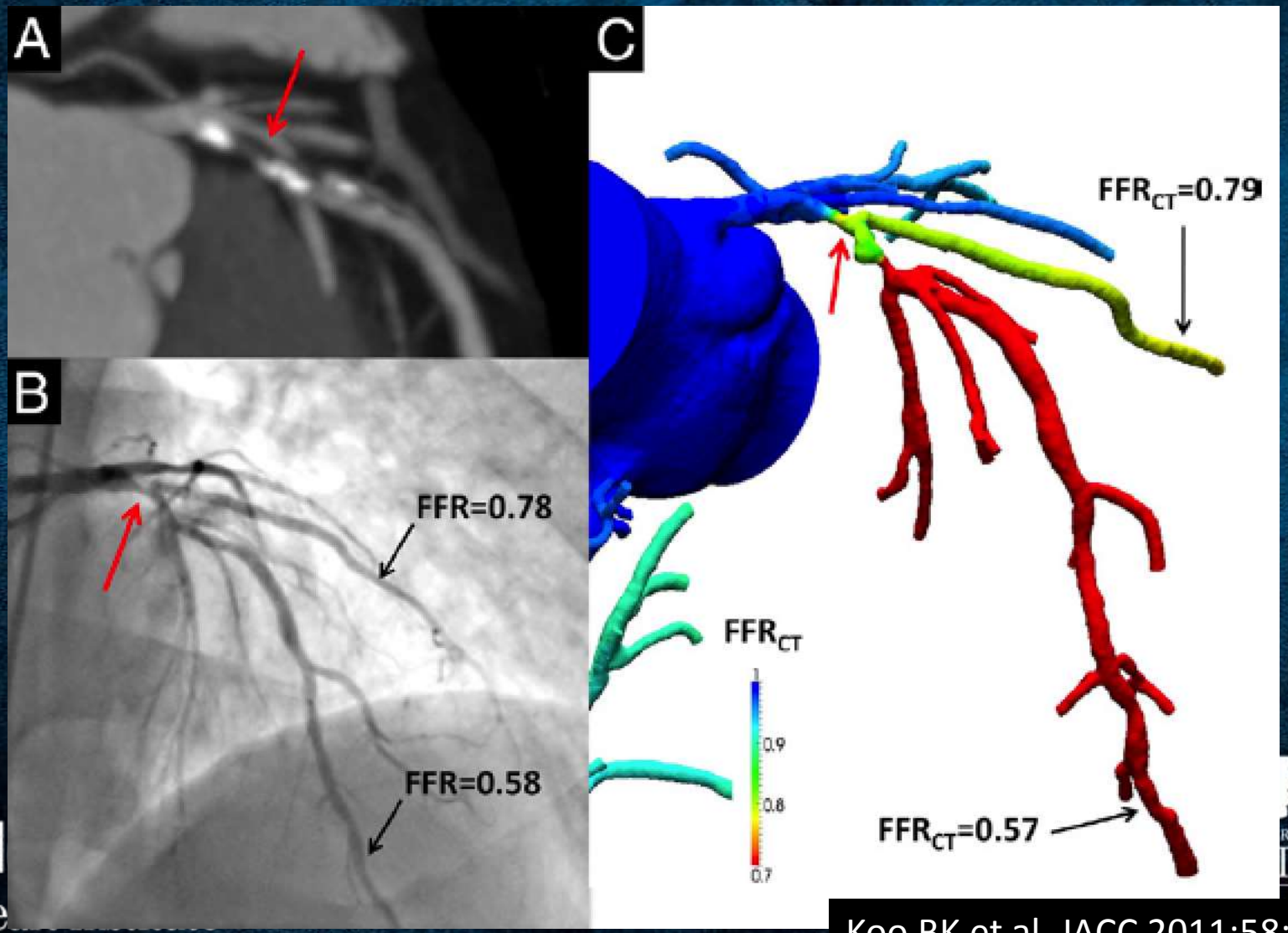
- DISCOVER-FLOW
- DeFACTO
- PLATFORM

Visually Obstructive, Normal FFR



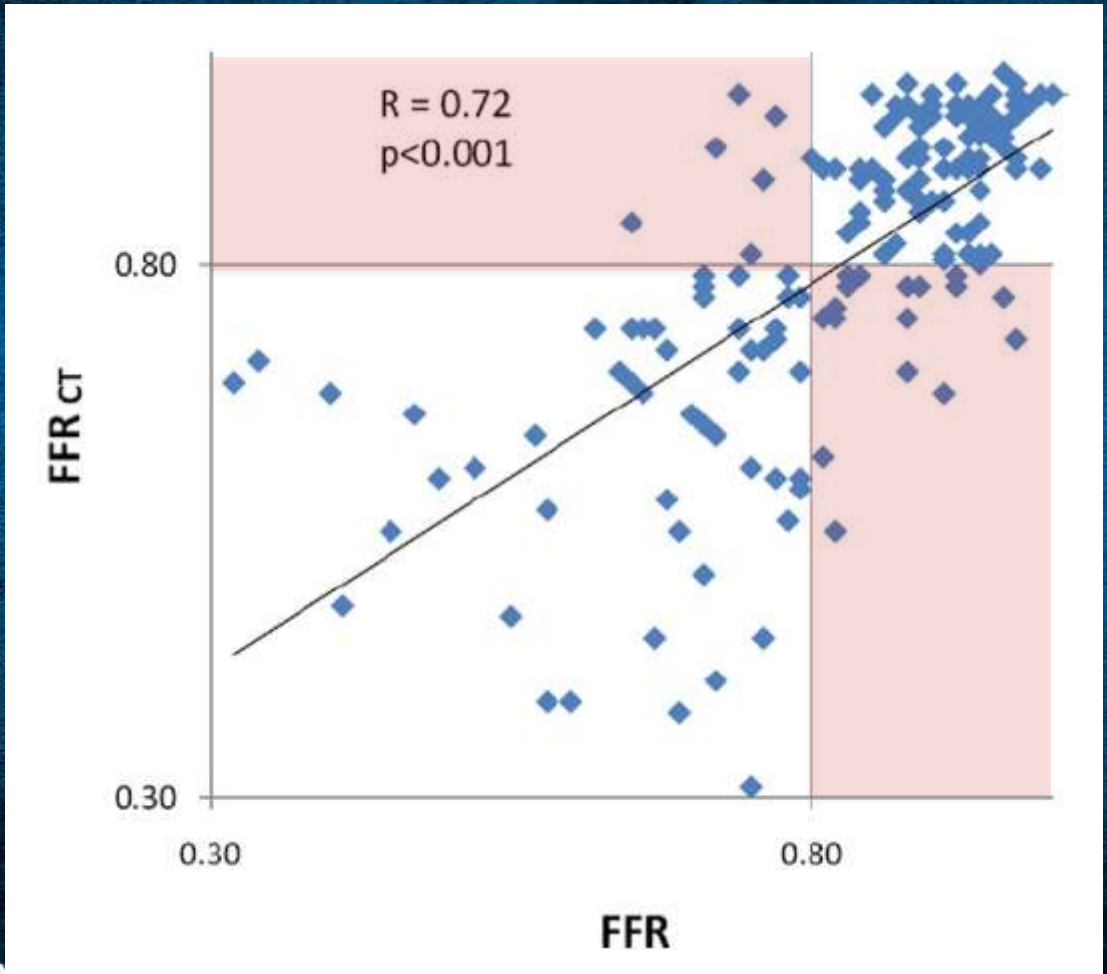
Koo BK et al. JACC 2011;58:1989-97

Abnormal FFR



Koo BK et al. JACC 2011;58:1989-97

FFR_{CT} vs. FFR



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Koo BK et al. JACC 2011;58:1989-97

Current FFR_{CT} Caveats

- One company
- $1500 per study
- Takes a day turn around time

CT Advances

- Better CT Scanners
  - Lower radiation
  - Less contrast
- Physiologic testing is possible with CT

- FFR_{CT} may be the way of future regarding CCTA

ADVANCES IN CARDIAC MRI

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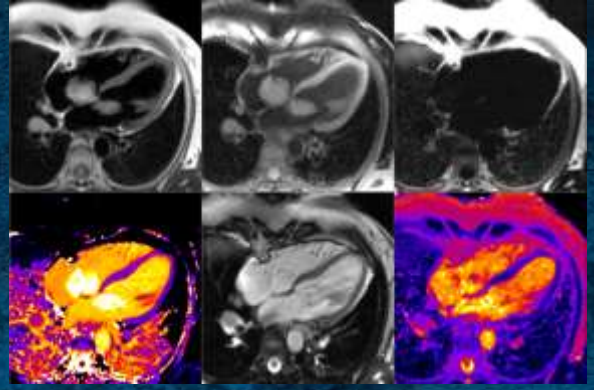
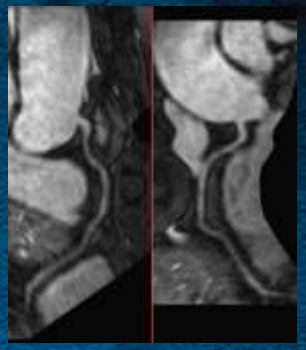
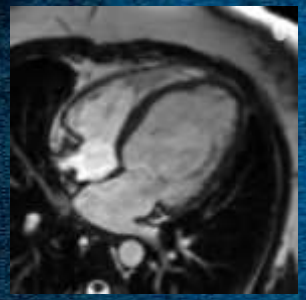


Tissue Characterization

Viability

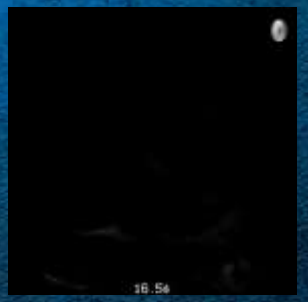


Coronary MRA



Function/Morphology

Cardiac MRI



Angiography

Flow

Rest/Stress Perfusion

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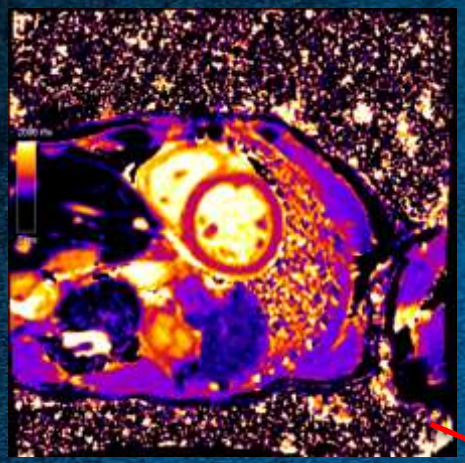
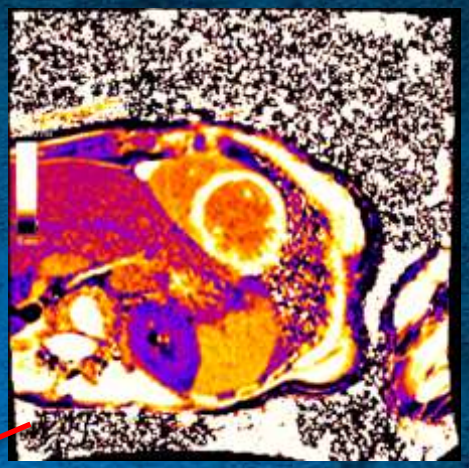
Advances in CMR

- T1 Mapping / Extracellular Volume Fraction
- Non-contrast Fibrosis Imaging
- Quantitative Perfusion
- Implantable Cardiac Device Imaging

T1 Mapping and Extracellular Volume



(extracellular contrast agent)
Gadolinium
Contrast



Known ECV: Blood → 1 - Hematocrit

$$ECV = (1 - Hct)\frac{(1/T1_{post} - 1/T1_{pre})_{myocardium}}{(1/T1_{post} - 1/T1_{pre})_{blood}}$$

Calculate Myocardial ECV

ECV ≈ Fibrosis

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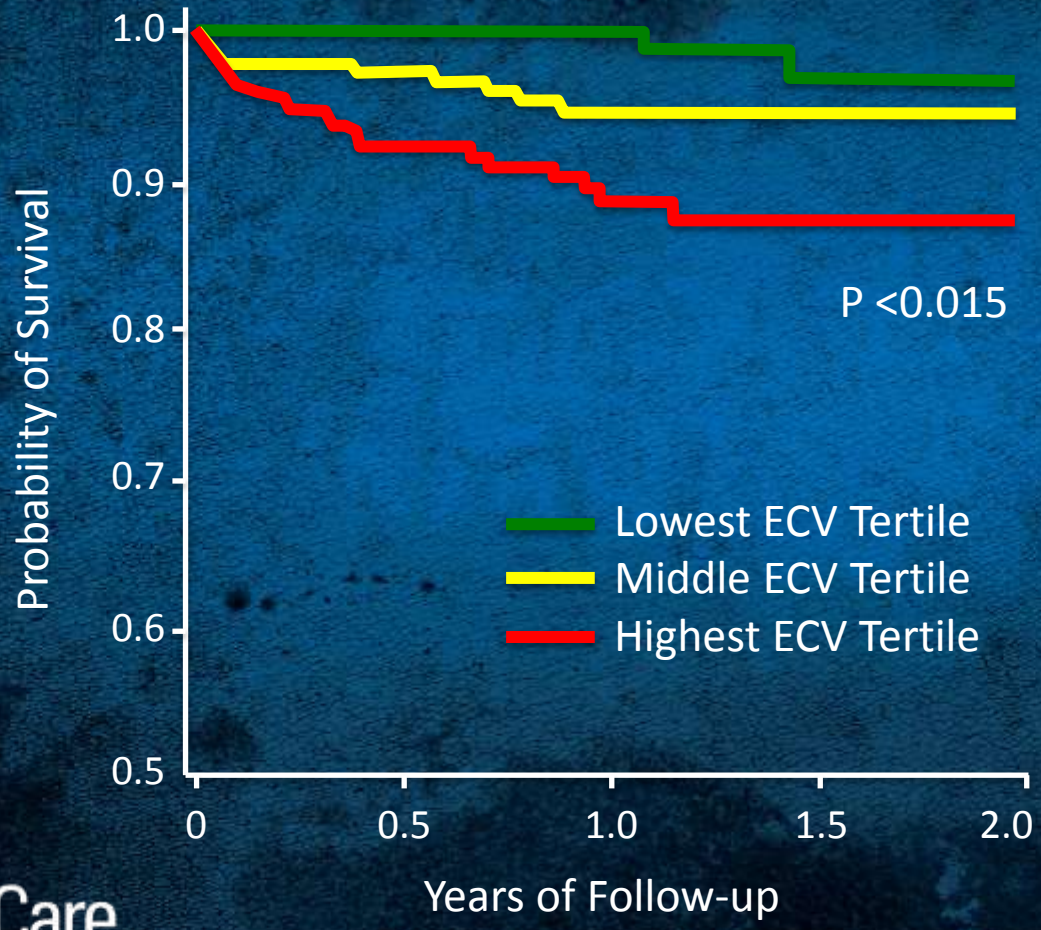
ECV Predicts Mortality



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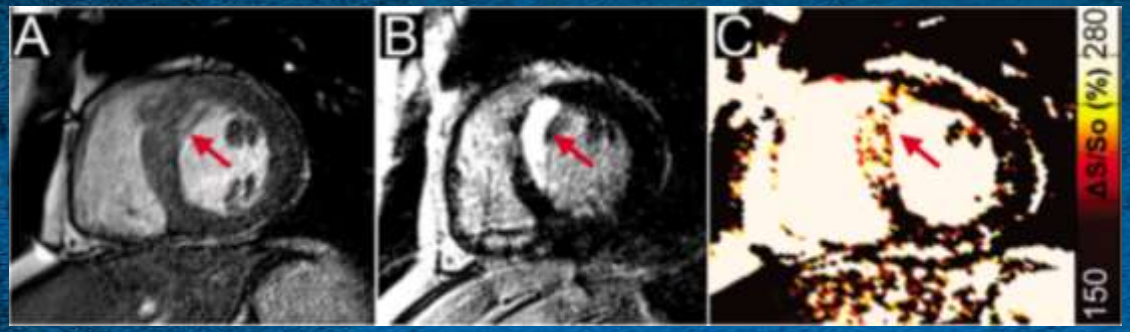
Wong TC et al. Circ 2012;126:1206-1216

Diseases

- Heart Failure
- Chemotherapy
- Aortic Stenosis
- Hypertension
- Diabetes

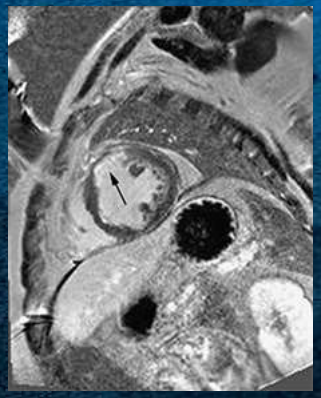
Non-Contrast Fibrosis

- Magnetization Transfer



Cine Stillframe Post-Contrast MT (w/o contrast)

- T1 rho



Post-Contrast

T1rho (w/o contrast)

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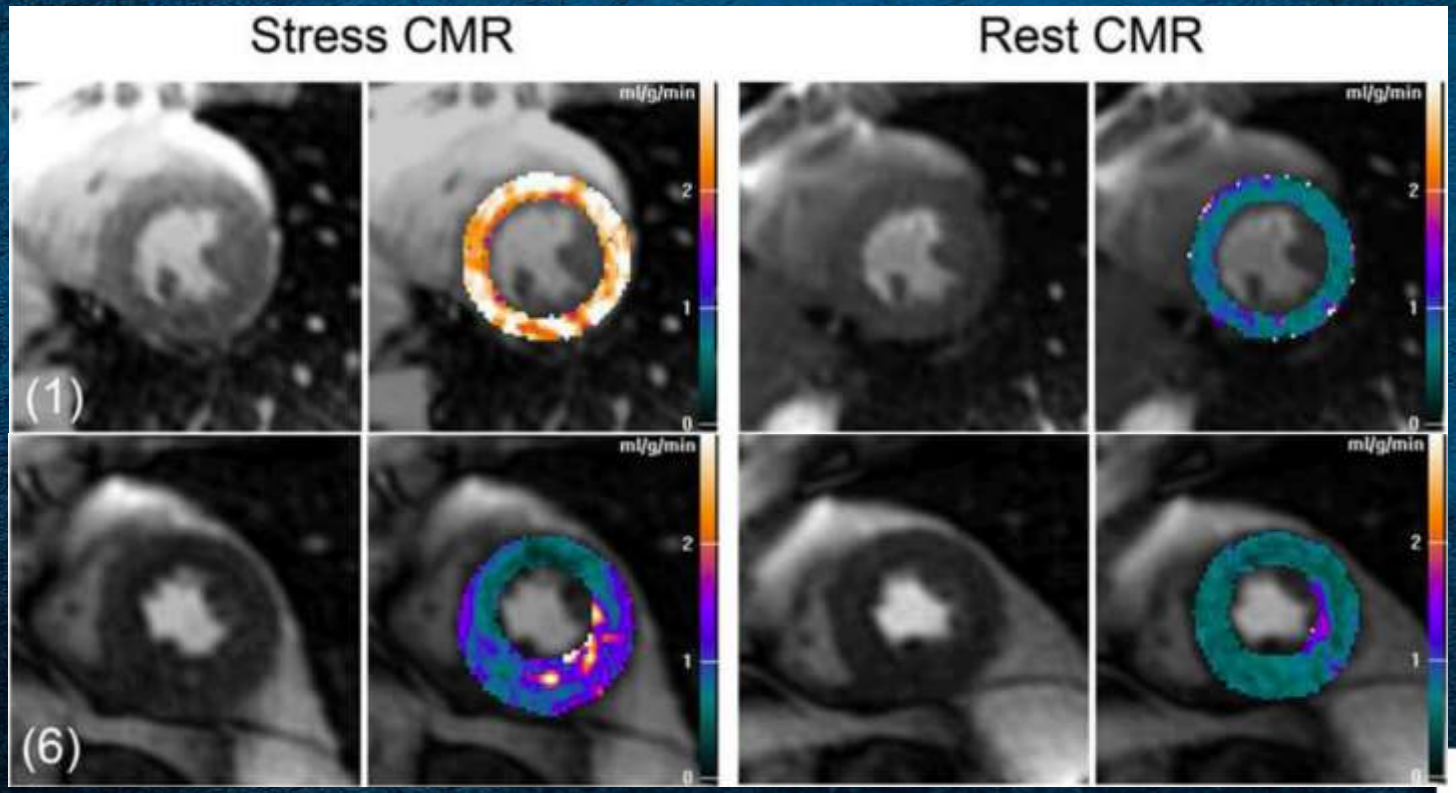
Stromp TA et al JCMR 2015;17:90

Han Y et al. Curr Cardiovasc Imaging Rep. 2014;7:9248

Quantitative Perfusion



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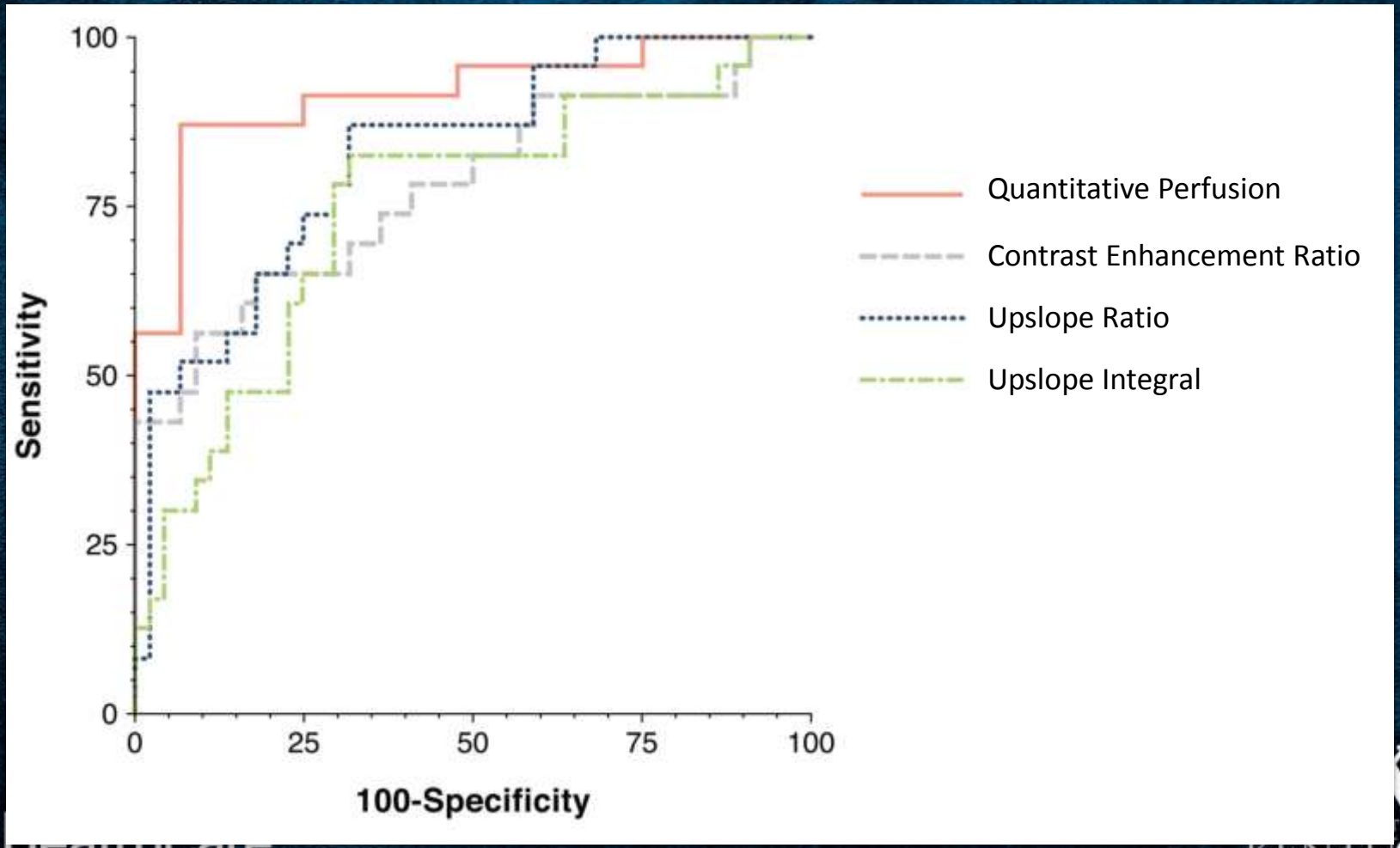
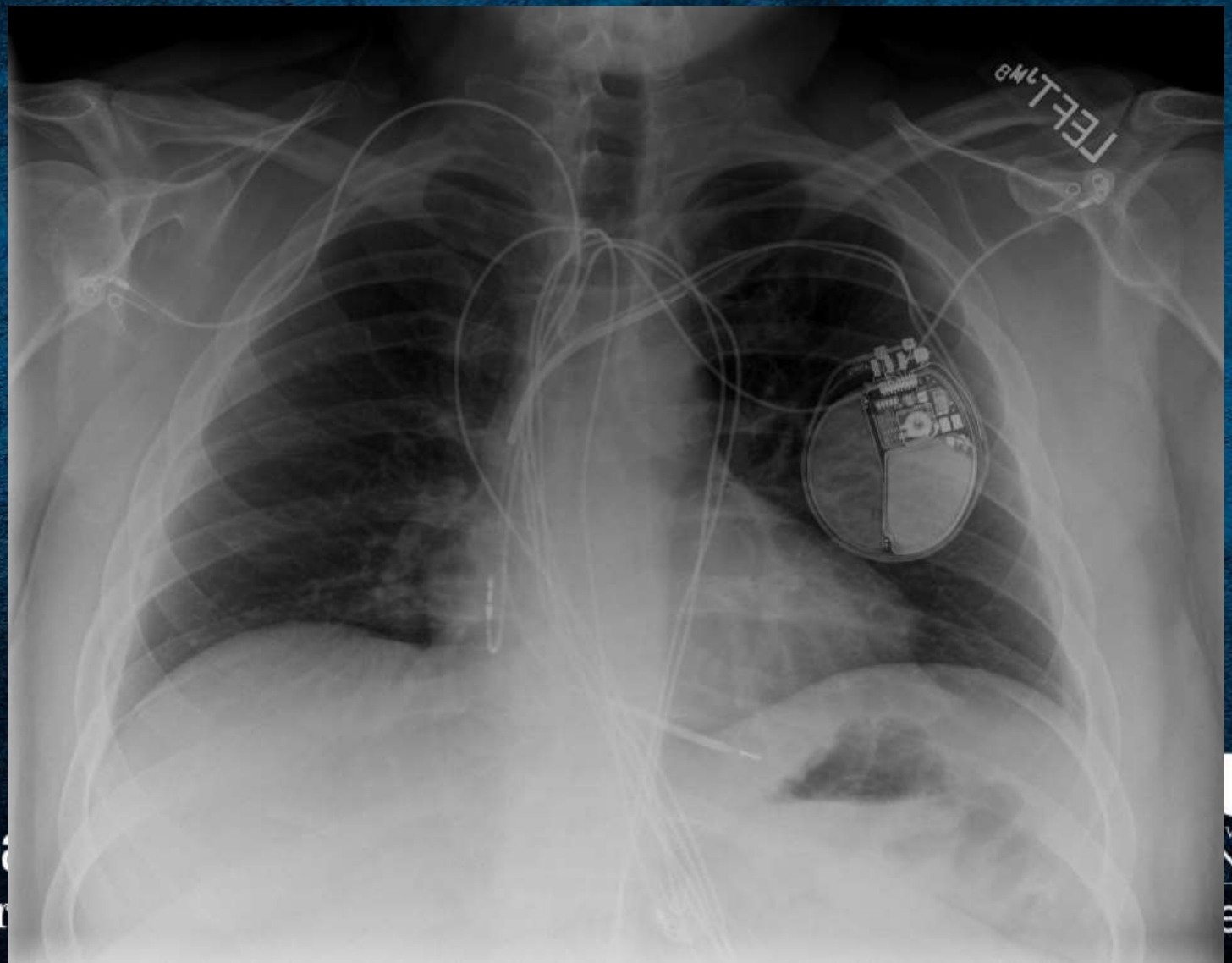
Quantitative Perfusion



Mordini FE et al. JACC CV Img 2014;7:14-22

Implantable Cardiac Device

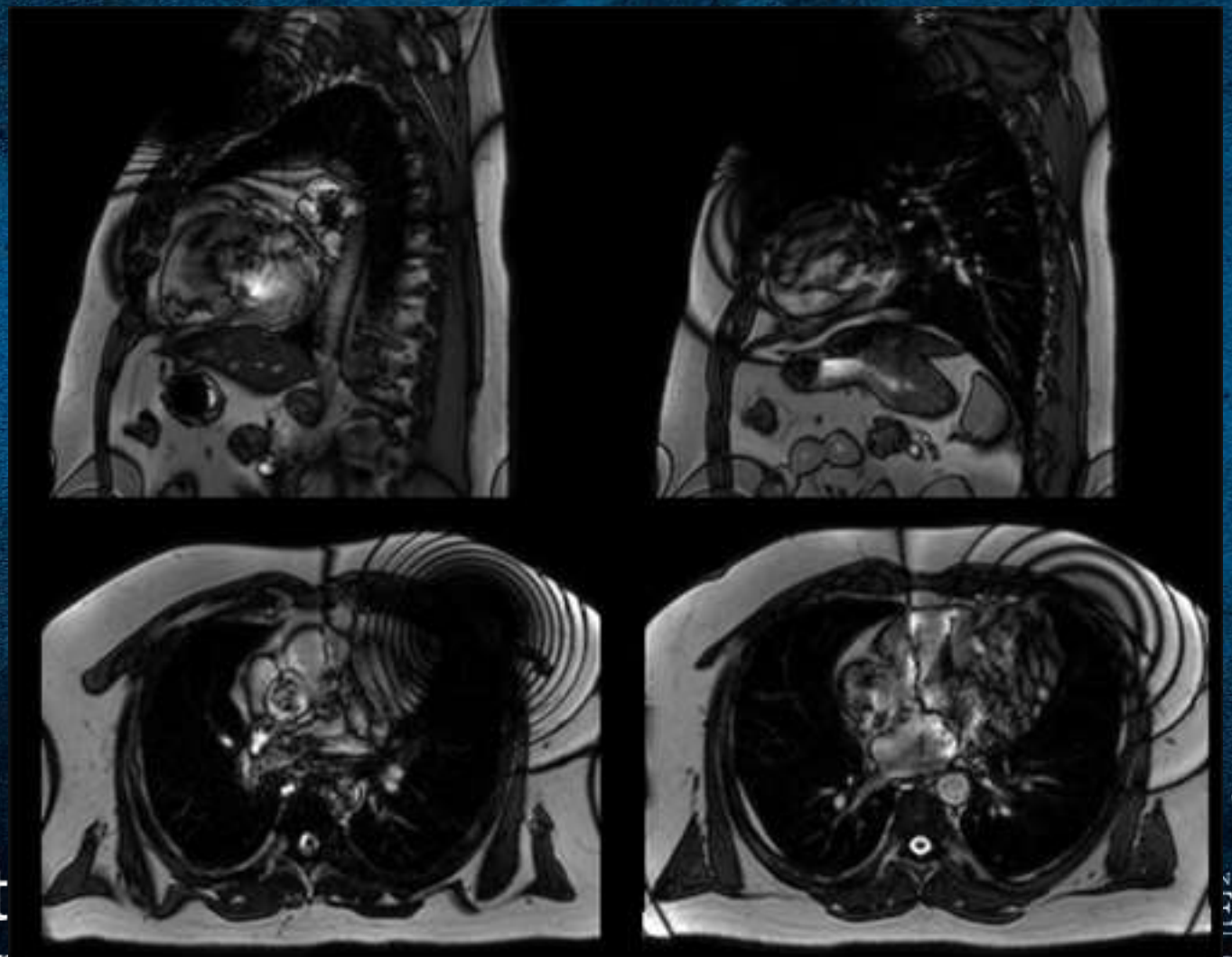


Implantable Cardiac Devices

- Avoid fresh implants (<6 weeks)
- 1.5T MRI Scanners
- No abandoned wires
- Non-MRI conditional devices
  - Not pacemaker dependent

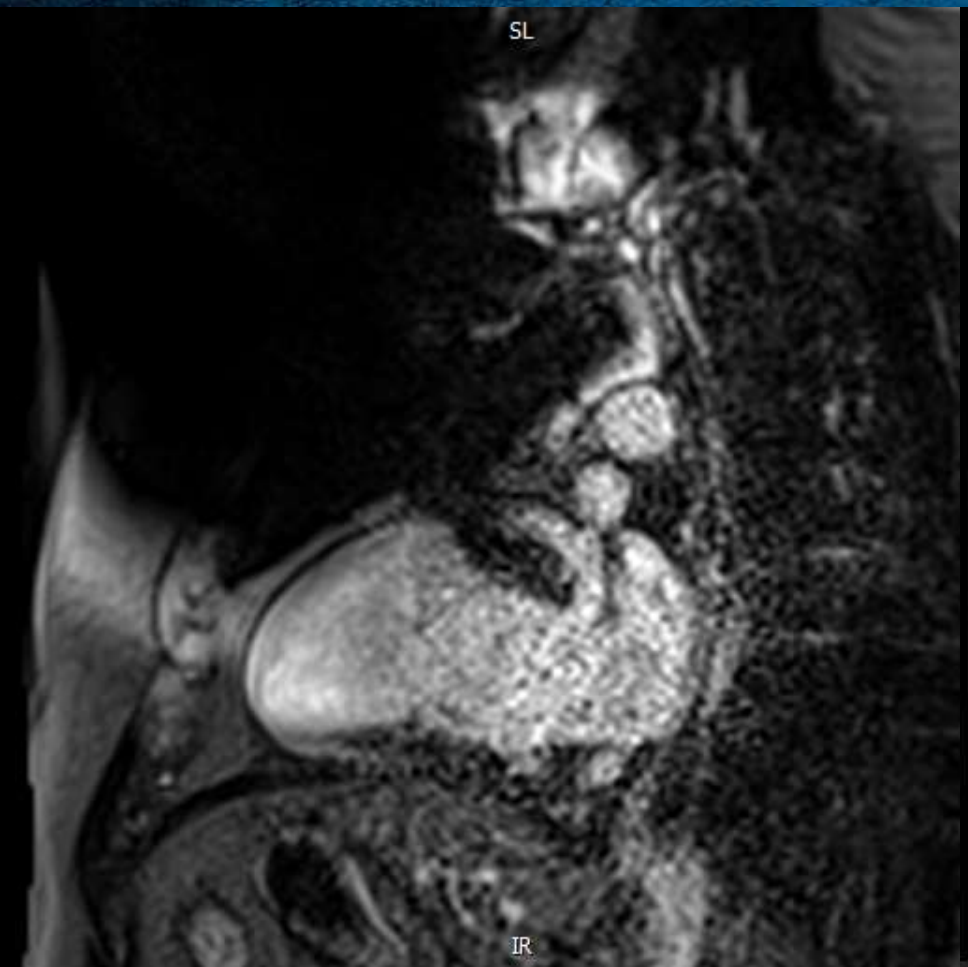
- However, even if you can scan…

ARTIFACTS!

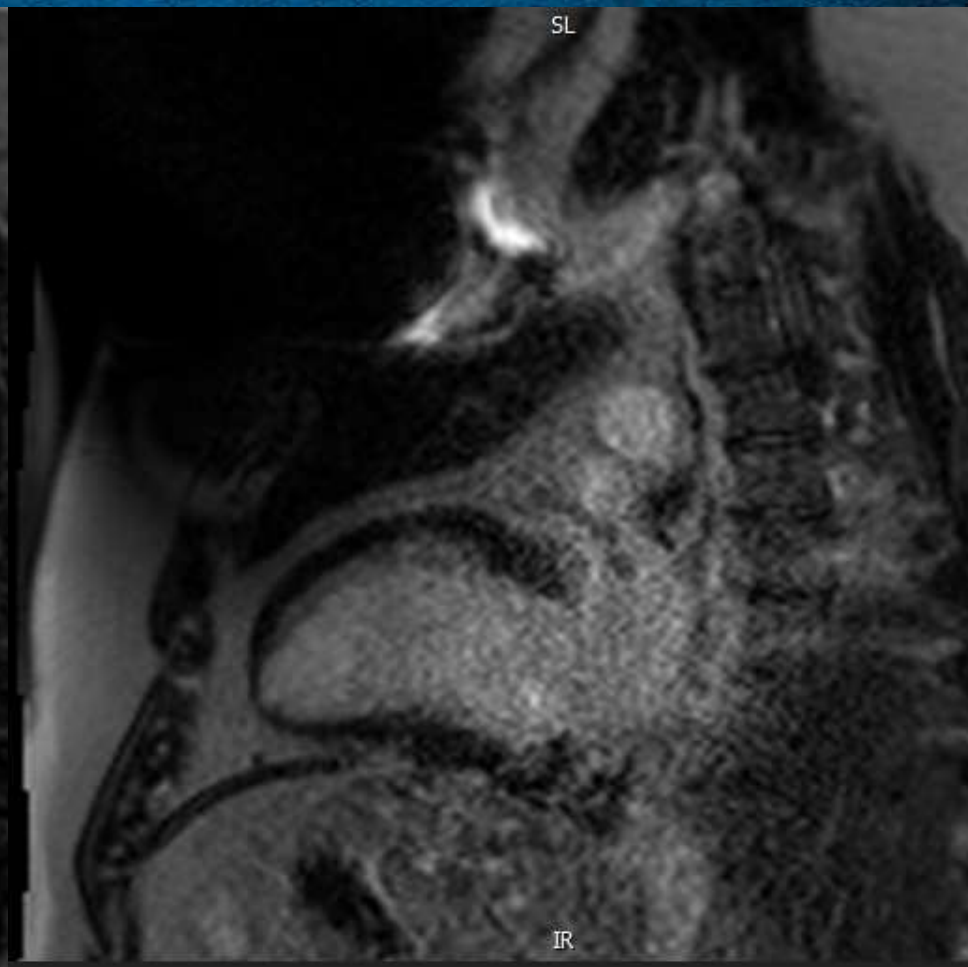


Adjustments

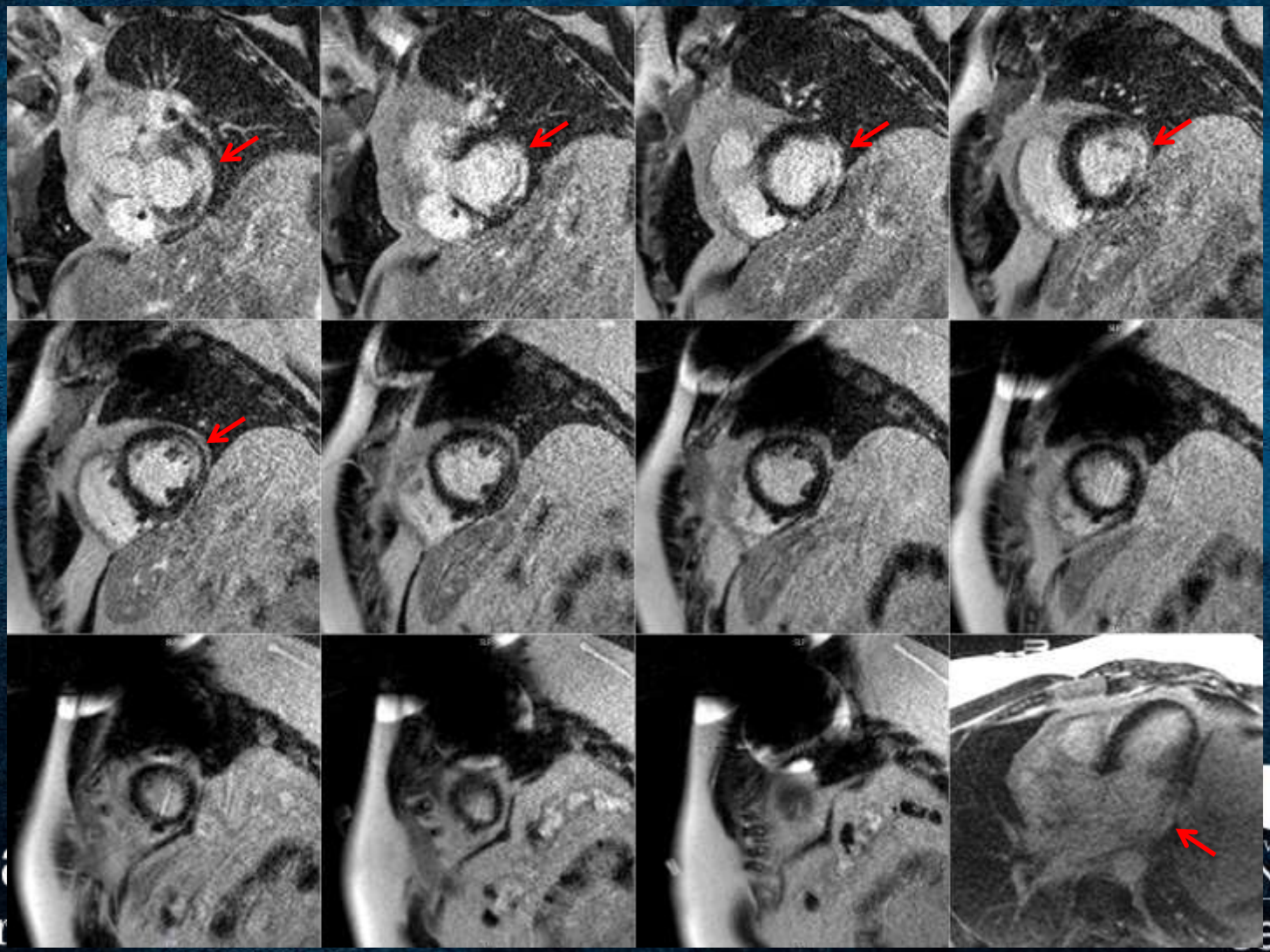
Traditional Late Gadolinium Enhancement Image



Wide Bandwidth Late Gadolinium Enhancement Image



Basal Inferolateral Enhancement



What does the future hold…

- There will be many new methods of imaging the heart
- The best test for each patient for specific indications
- More research is needed to evaluate how we can improve patient care and reduce overall cost

Thank you

- Cardiologists/Radiologists
  - Vincent L Sorrell, MD
  - Michael Brooks, MD
  - Stephen Hobbs, MD
  - Vidya Nadig, MD
  - Michael Winkler, MD
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- Physicists
  - Peter Hardy, PhD
  - David Powell, PhD
  - Moriel Vandsburger, PhD
  - Jie Zhang, PhD
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  - Arash Seratnahaei, MD
  - Vrinda Sardana, MD
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  - Matthew Noll
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UCLA

Penn
University of Pennsylvania

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