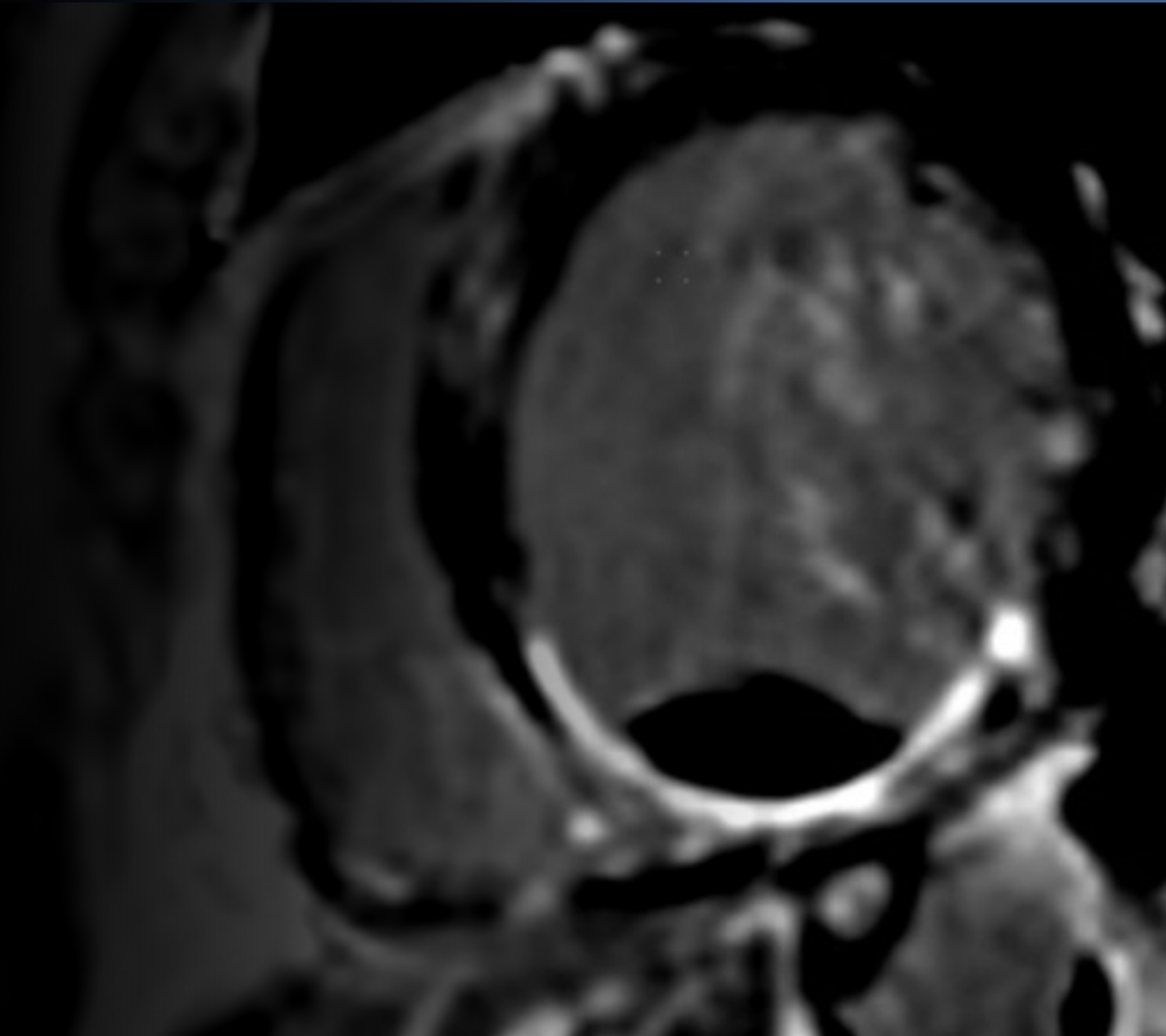
Cardiac MRI & Coronary CTA in 2022



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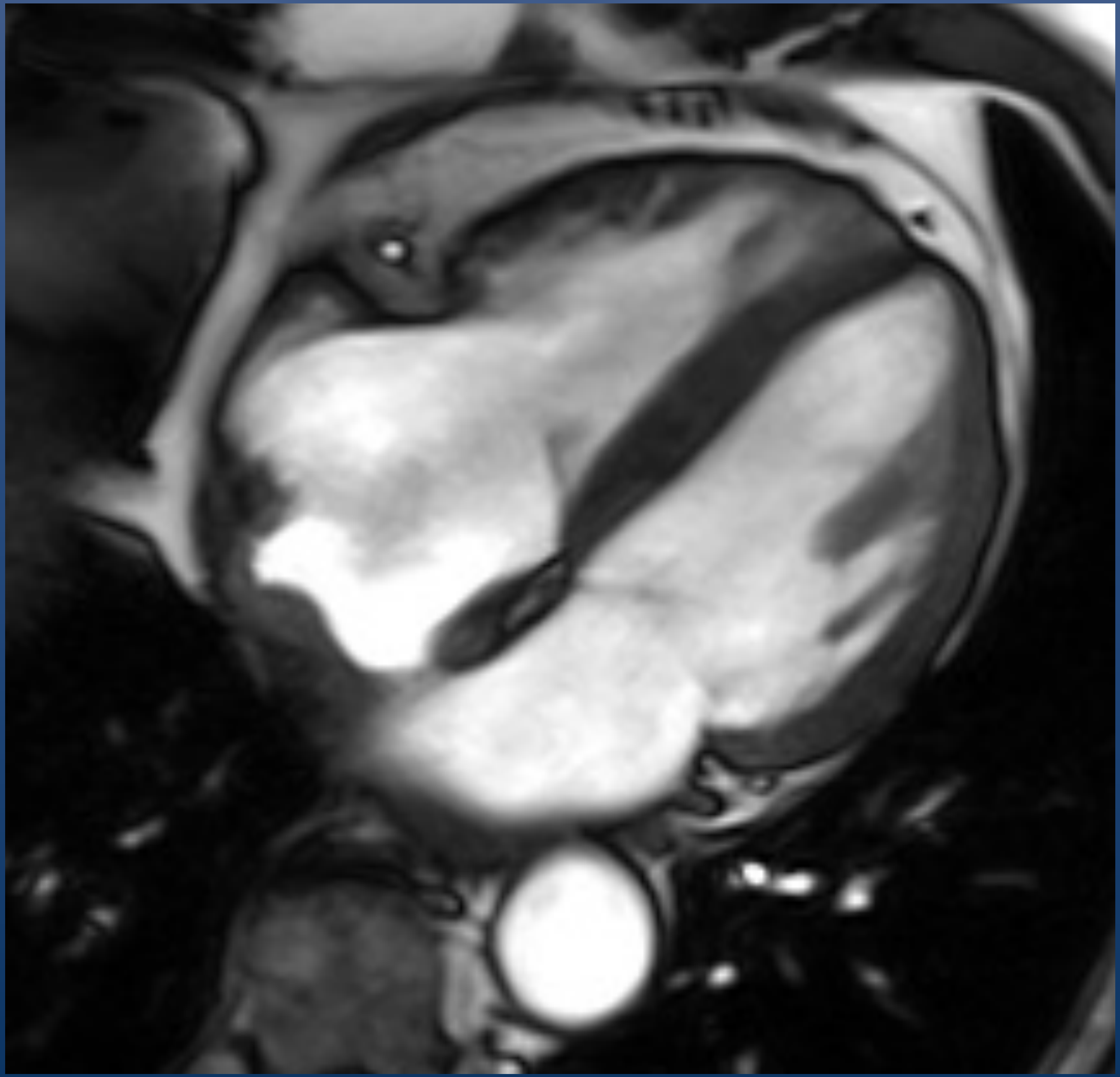
Disclosures

I have no personal or professional financial relationship or interest with any proprietary entity producing healthcare goods/or services.

Objectives

- Part I - Cardiac MRI
  - Overview of common indications and techniques
- Part II - Coronary CTA
  - Common indications
  - 2021 Chest Pain Guidelines



Part I – Cardiac MRI in 2022

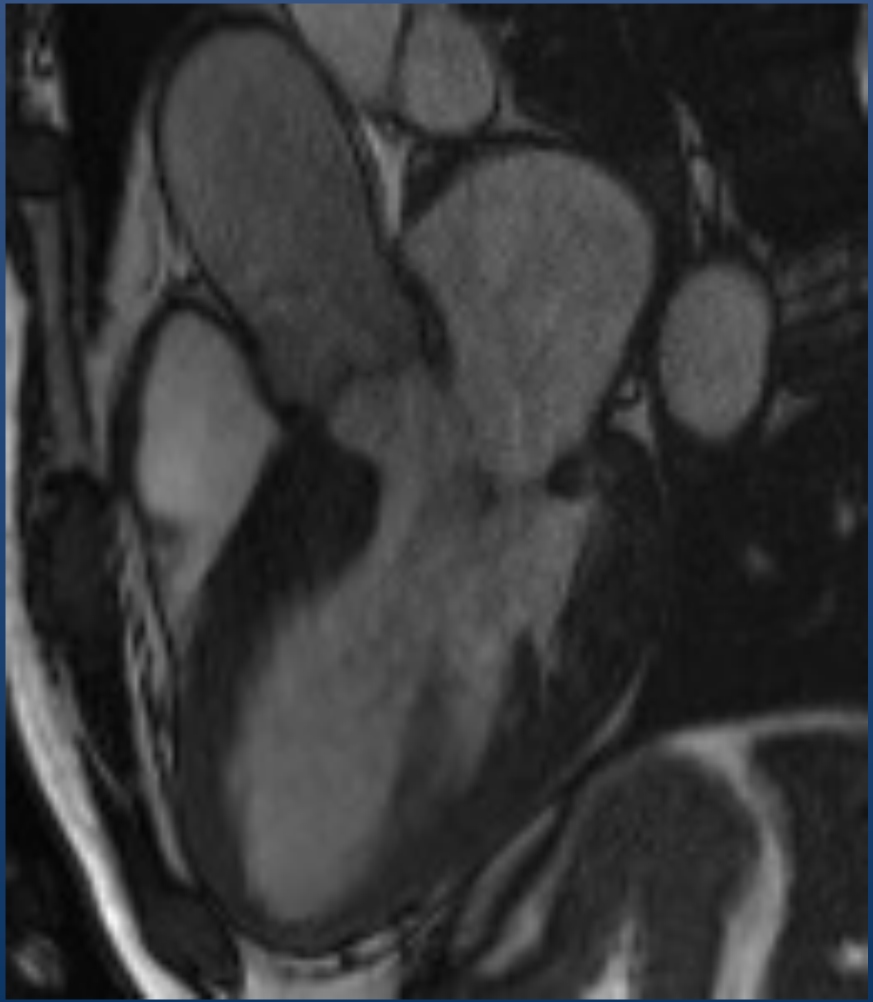
- What does Cardiac MRI (CMR) really offer in 2022?
- Why should I order this study?

What does CMR really offer?

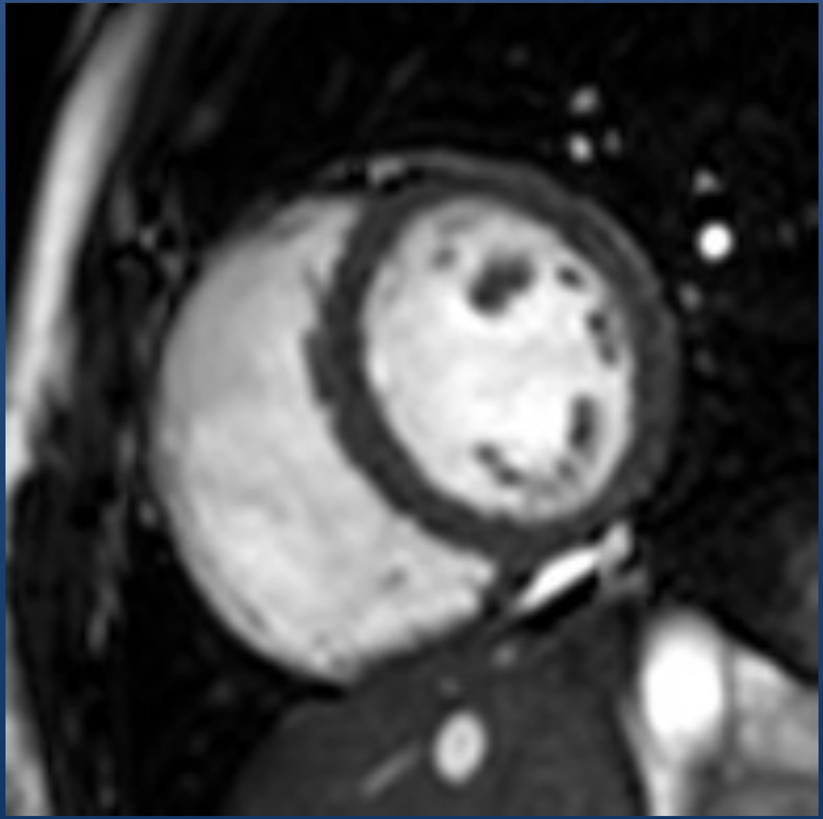
1) Gold standard for the quantitative assessment of cardiac morphology, volume and function
2) Tissue characterization
   - Edema (acute, potentially reversible injury)
   - Necrosis or scar (irreversible injury and viability)
   - Infiltration/storage (abnormal tissue components)
   - Pericardial assessment (physiology and tissue assessment)
   - Cardiac mass assessment
3) Velocity encoding data (assessing flow through regurgitant lesions, stenosis, etc.)
4) Perfusion (rest and stress); we won’t touch on this today.

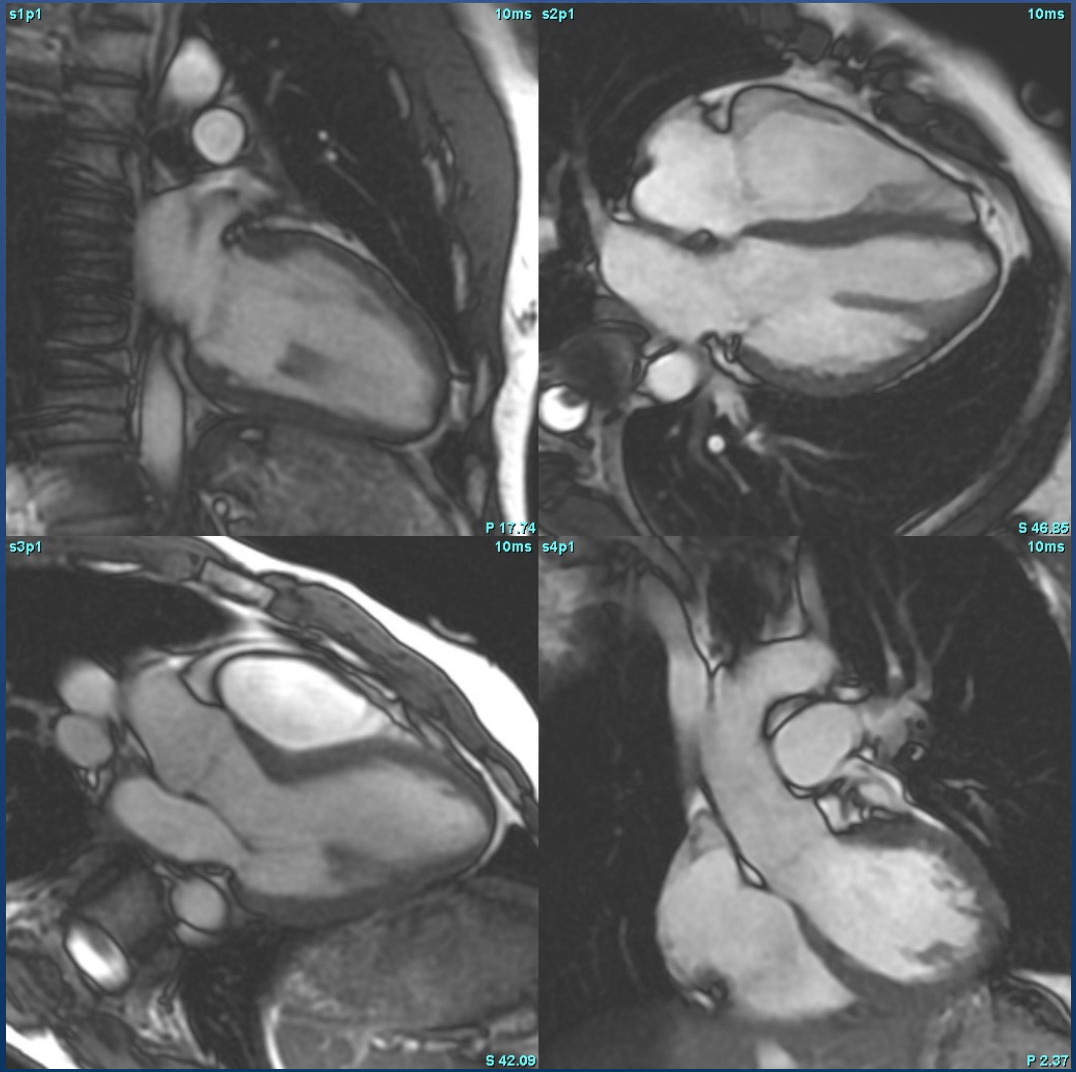
Cardiac morphology, volume and function - SSFP Imaging

High temporal resolution and excellent contrast of SSFP make it ideal for evaluation of wall motion and volumetric measurement, which require clear delineation between myocardium and blood pool

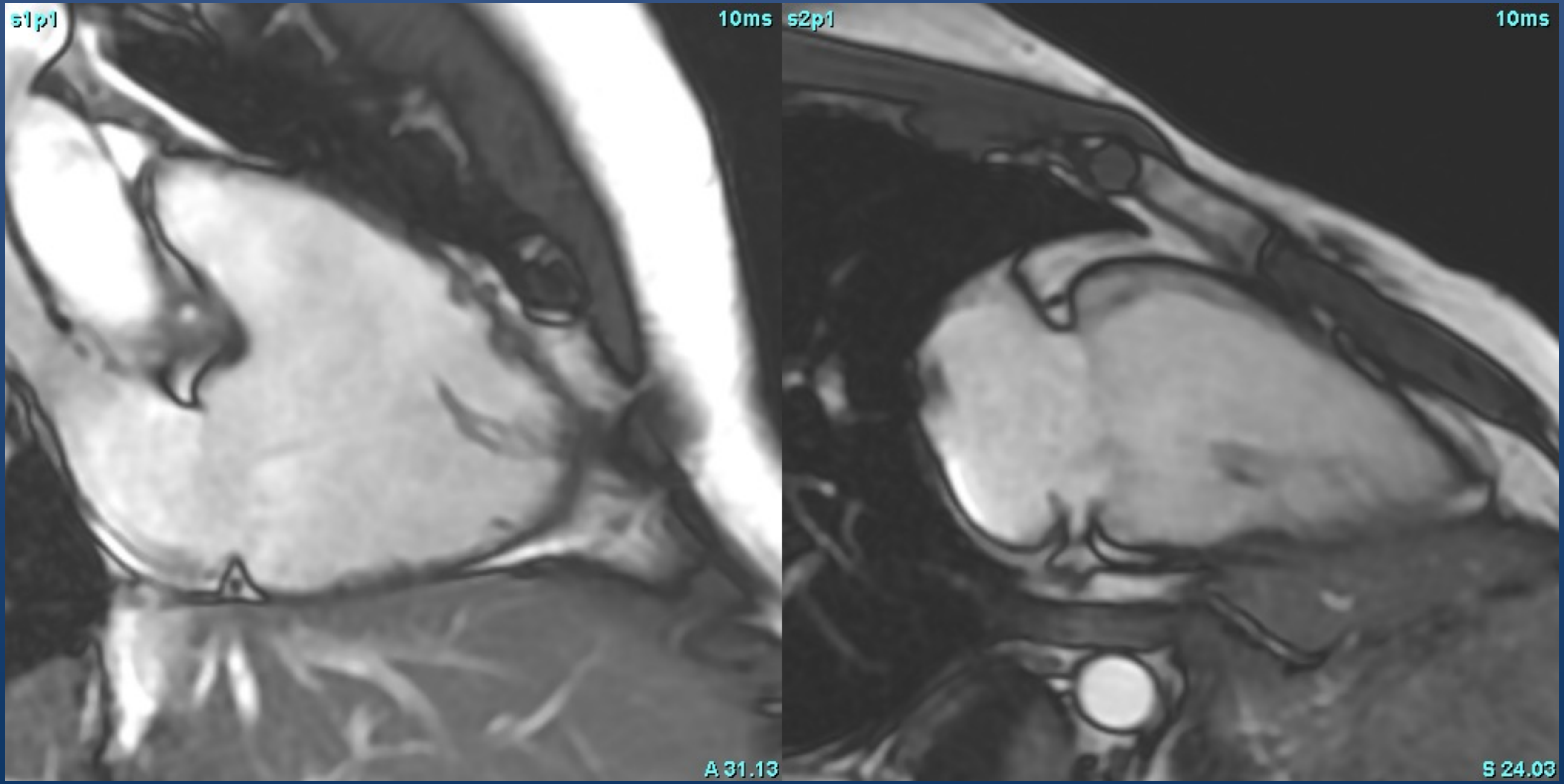


Cardiac morphology, volume and function - SSFP Imaging

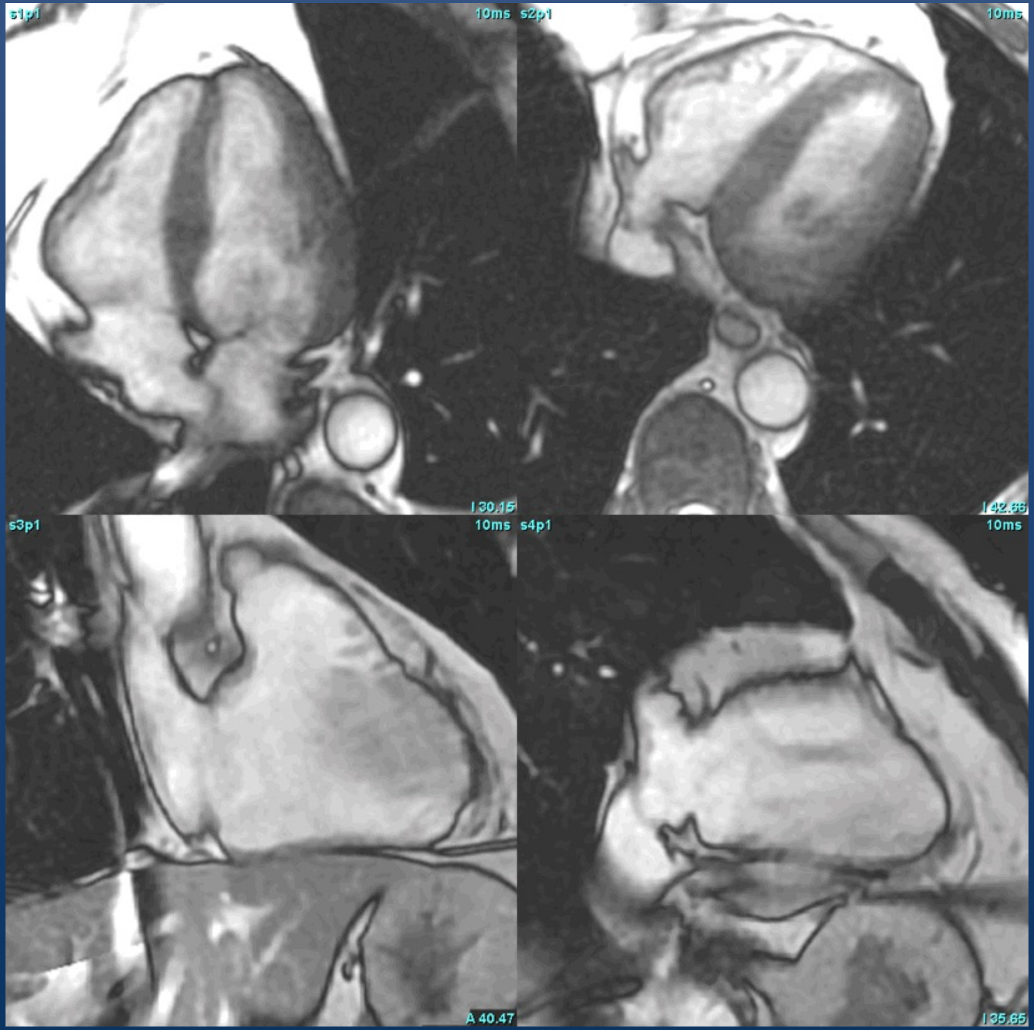


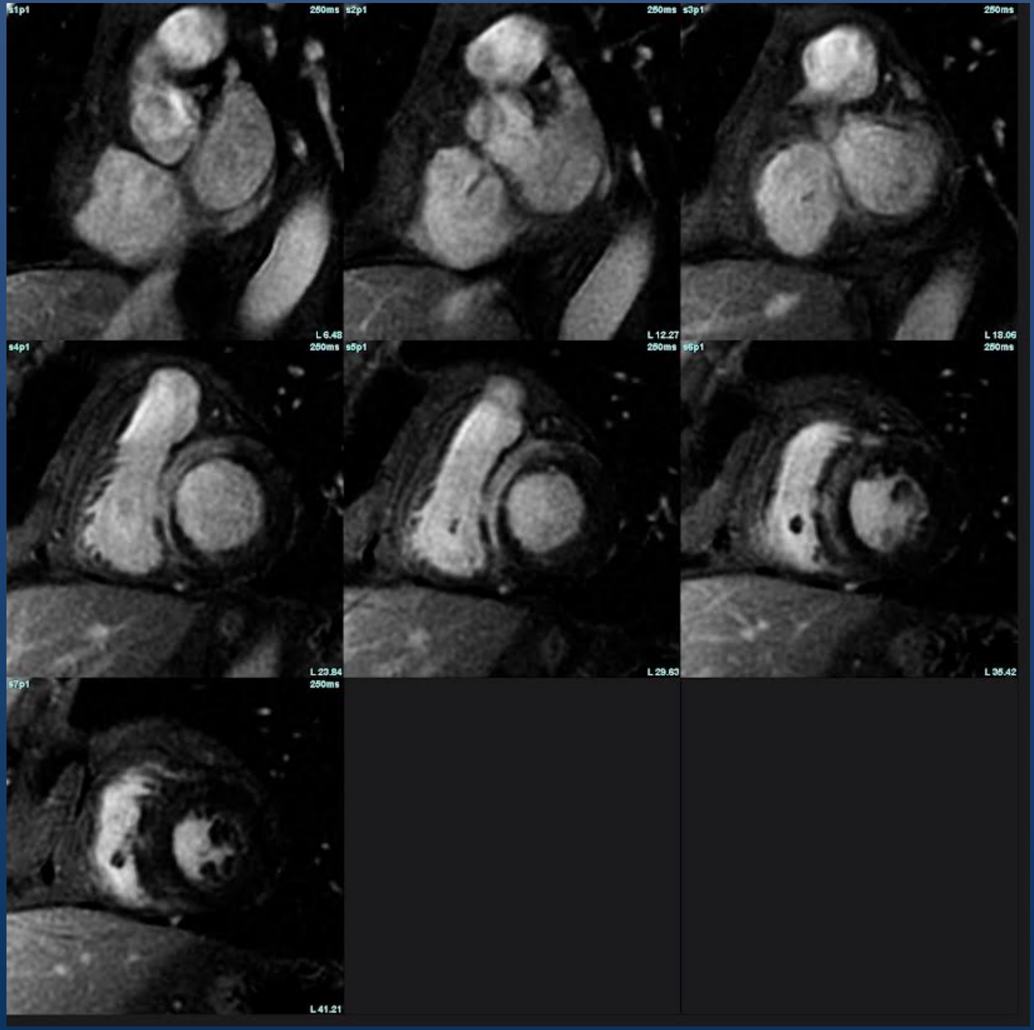


Imaging the Right Ventricle

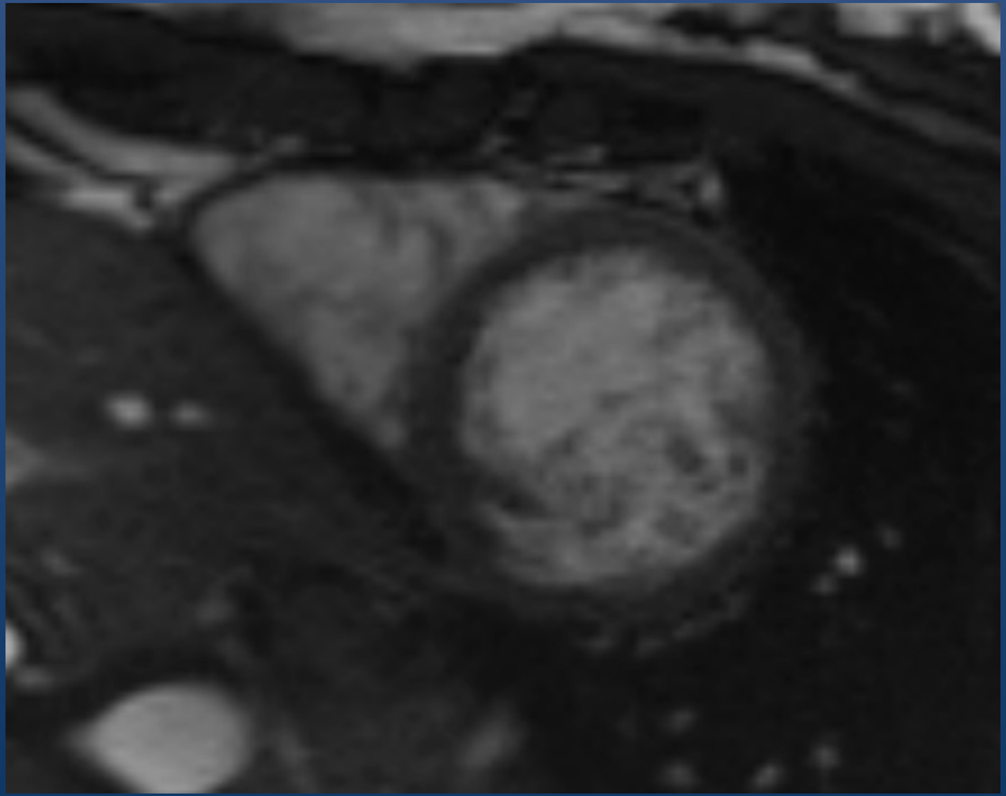


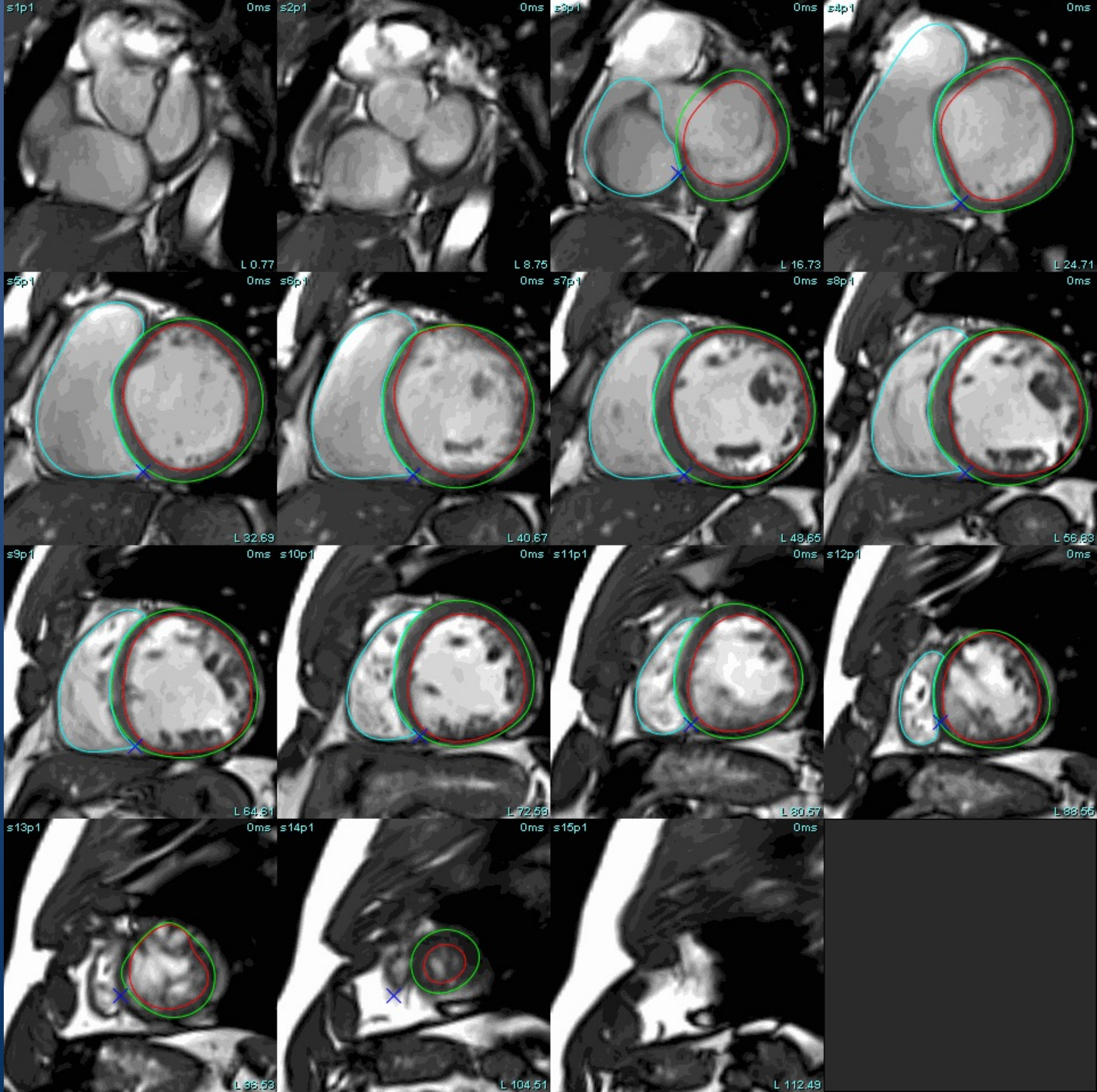
Arrhythmogenic Right Ventricular Cardiomyopathy



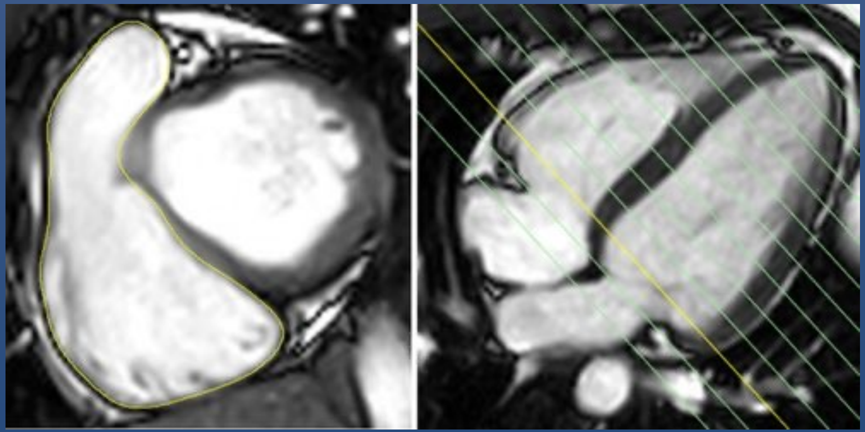


Non-Compaction

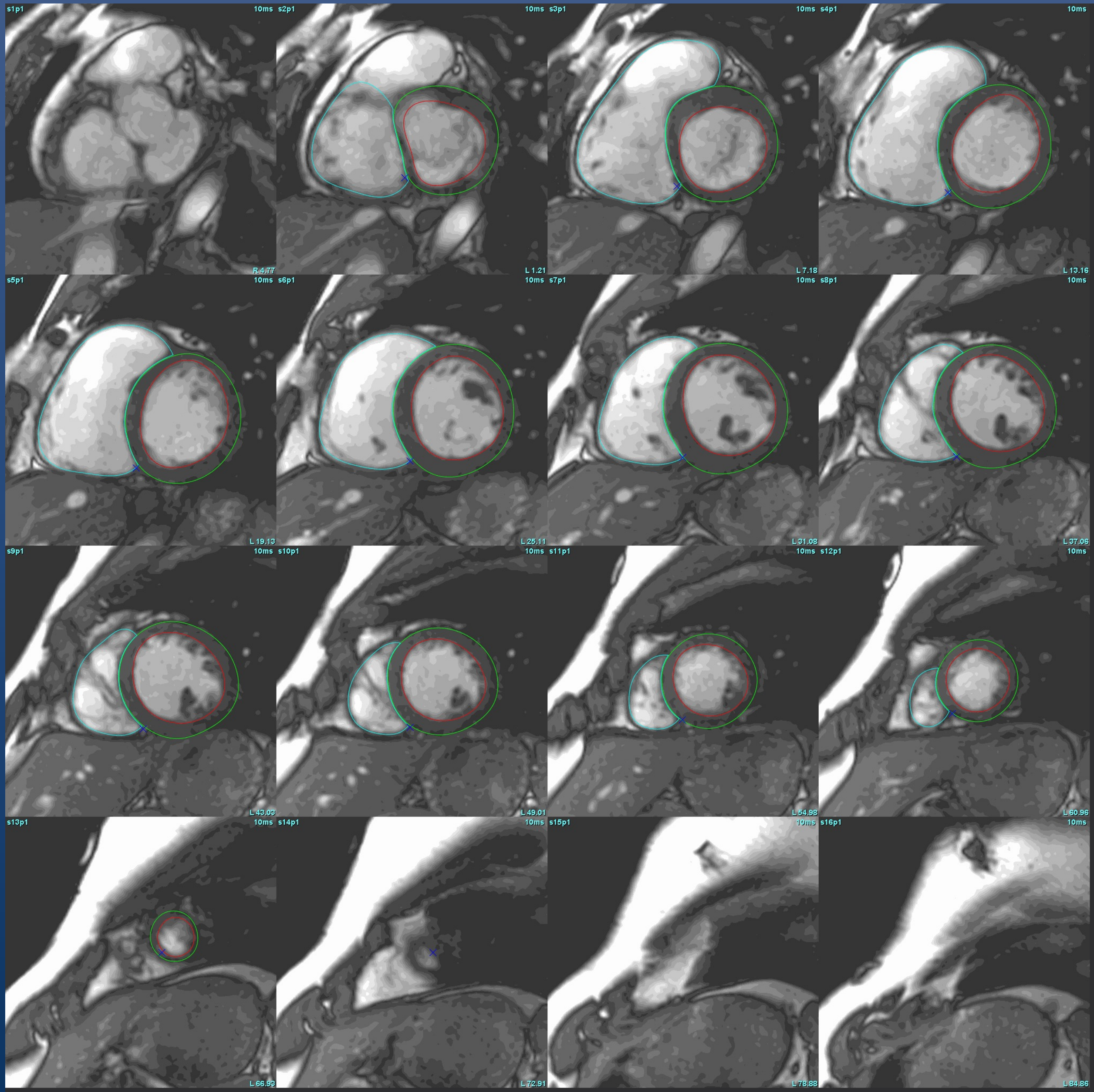




Volume and function



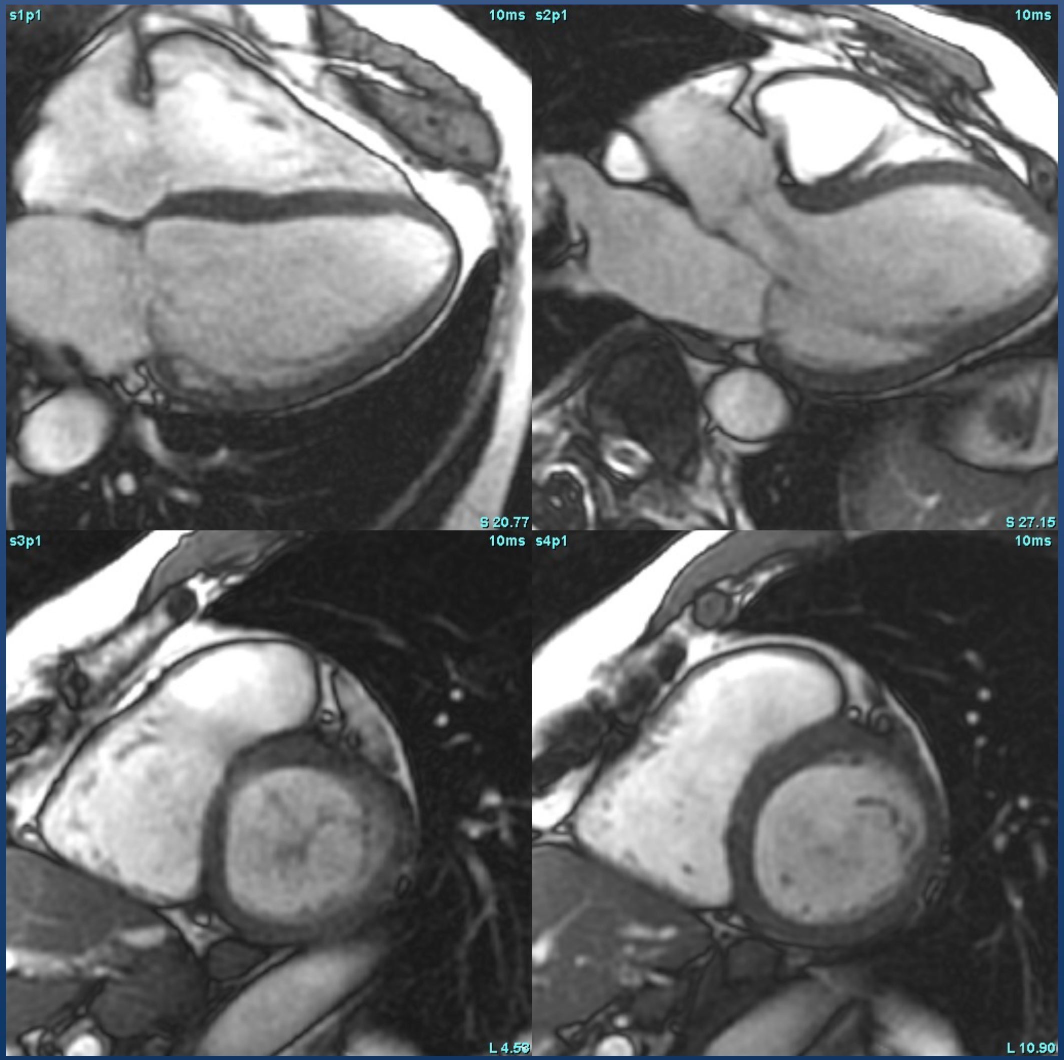
Ventricles	LV	Range	RV	Range
Ejection Fraction (%)	59		52	
Stroke Volume (ml)	90.6		88.9	
End-Diastolic Volume Index (ml/m²)	85.6		95.7	
End-Systolic Volume Index (ml/m²)	34.8		45.8	
End-Diastolic Volume (ml)	153		171	
End-Systolic Volume (ml)	62.0		81.7	
Heart Rate (bpm)	68		68	
Peak Filling Rate (ml/s)	513		806	
Peak Ejection Rate (ml/s)	571		661	
Cardiac Output (l/min)	6.2		6.0	
Cardiac Output Index (l/min/m²)	3.46		3.39	
Stroke Volume Index (ml/m²)	50.8		49.9	
Mass (g)	87(ED)			
Mass Index (g/m²)	49(ED)			
Dyssynchrony Global TUWT	0.75			



Fent G, Plein S. Function. Circulation: Cardiovascular Imaging 2016;9:e004589.

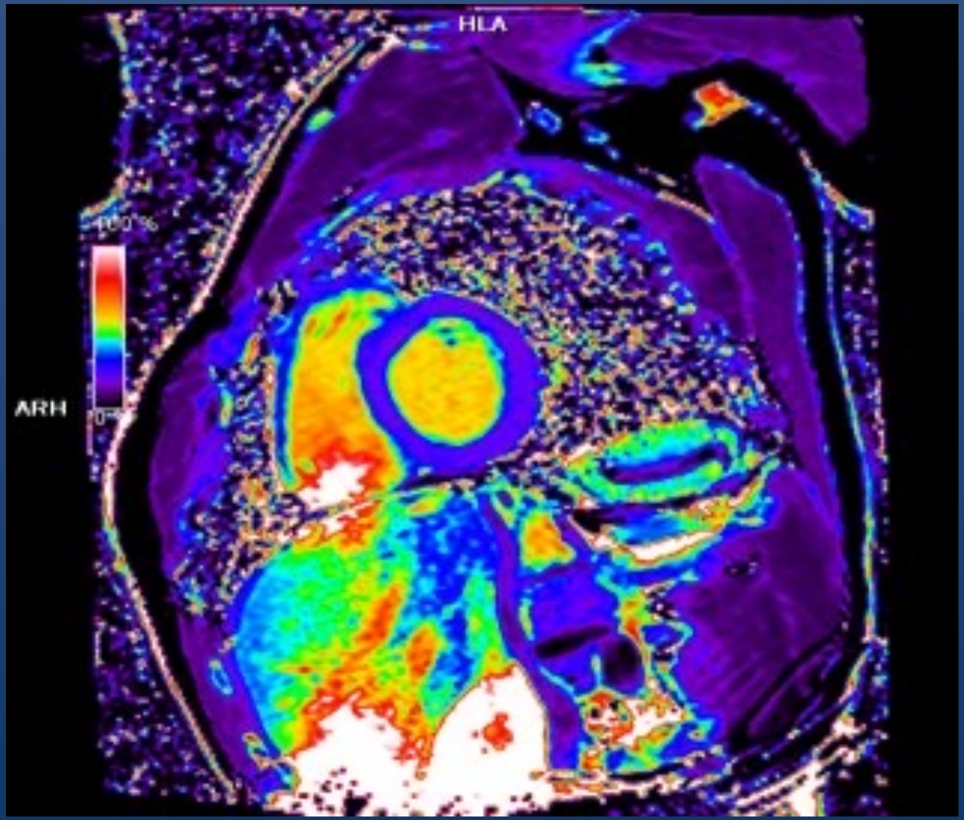
Indications for SSFP imaging

- “Gold standard" for measurements of LV and RV ejection fraction, volumes, and myocardial mass
    - LVEF for chemotherapy monitoring
    - LVEF for ICD
- LVEF and ventricular volumes can help to determine the timing of valvular surgery
    - LV volume for MVR, AVR. etc
- CMR can answer most anatomical questions
- Numerous applications in congenital heart disease
- All of the above can be answered without radiation or contrast!



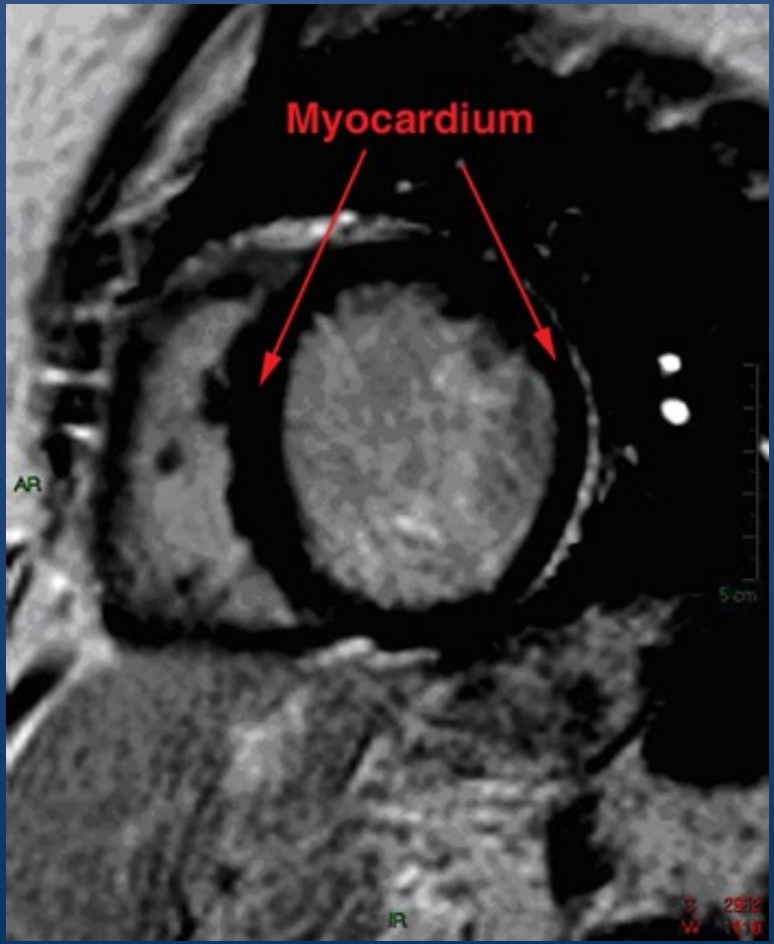
Tissue characterization

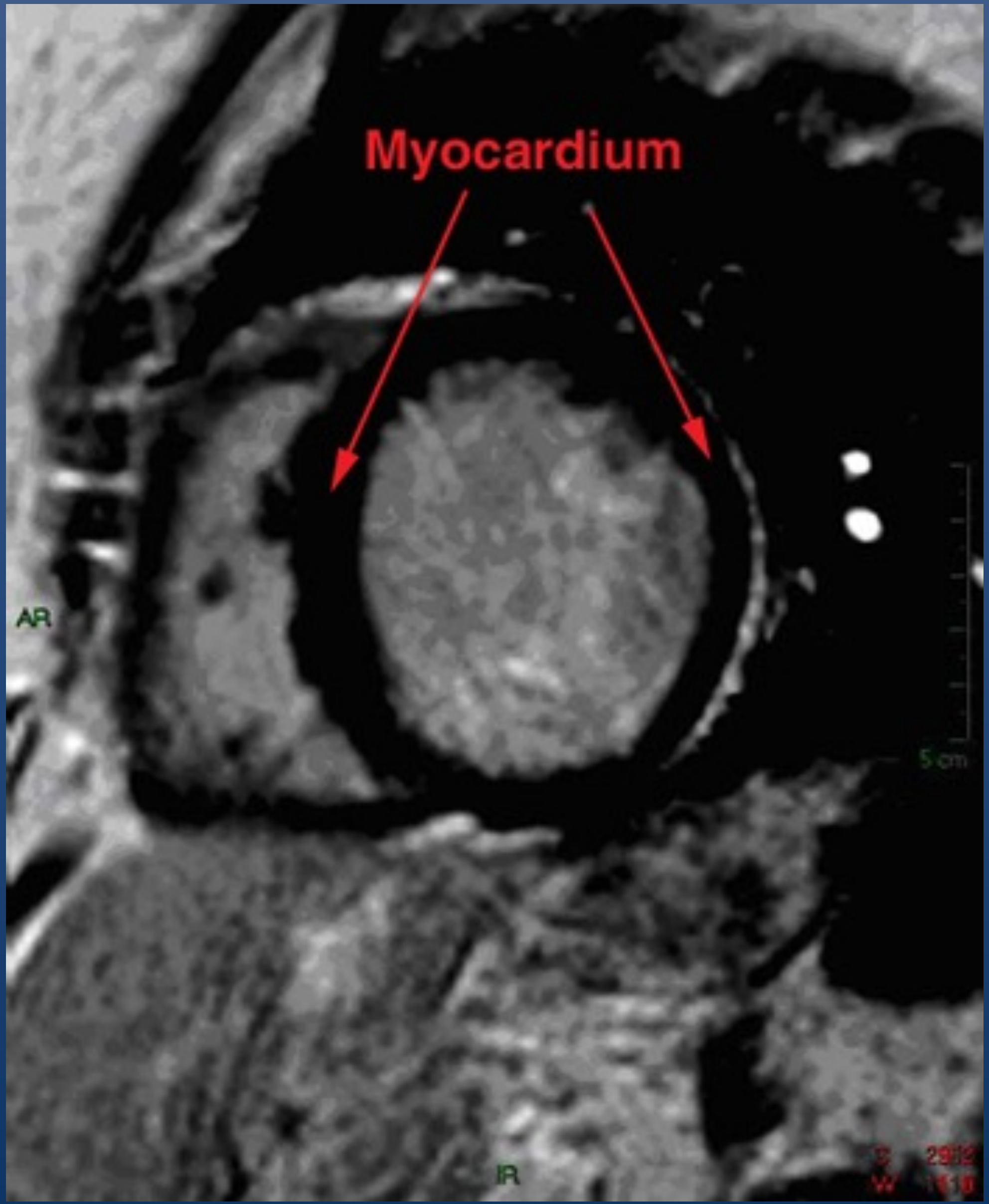
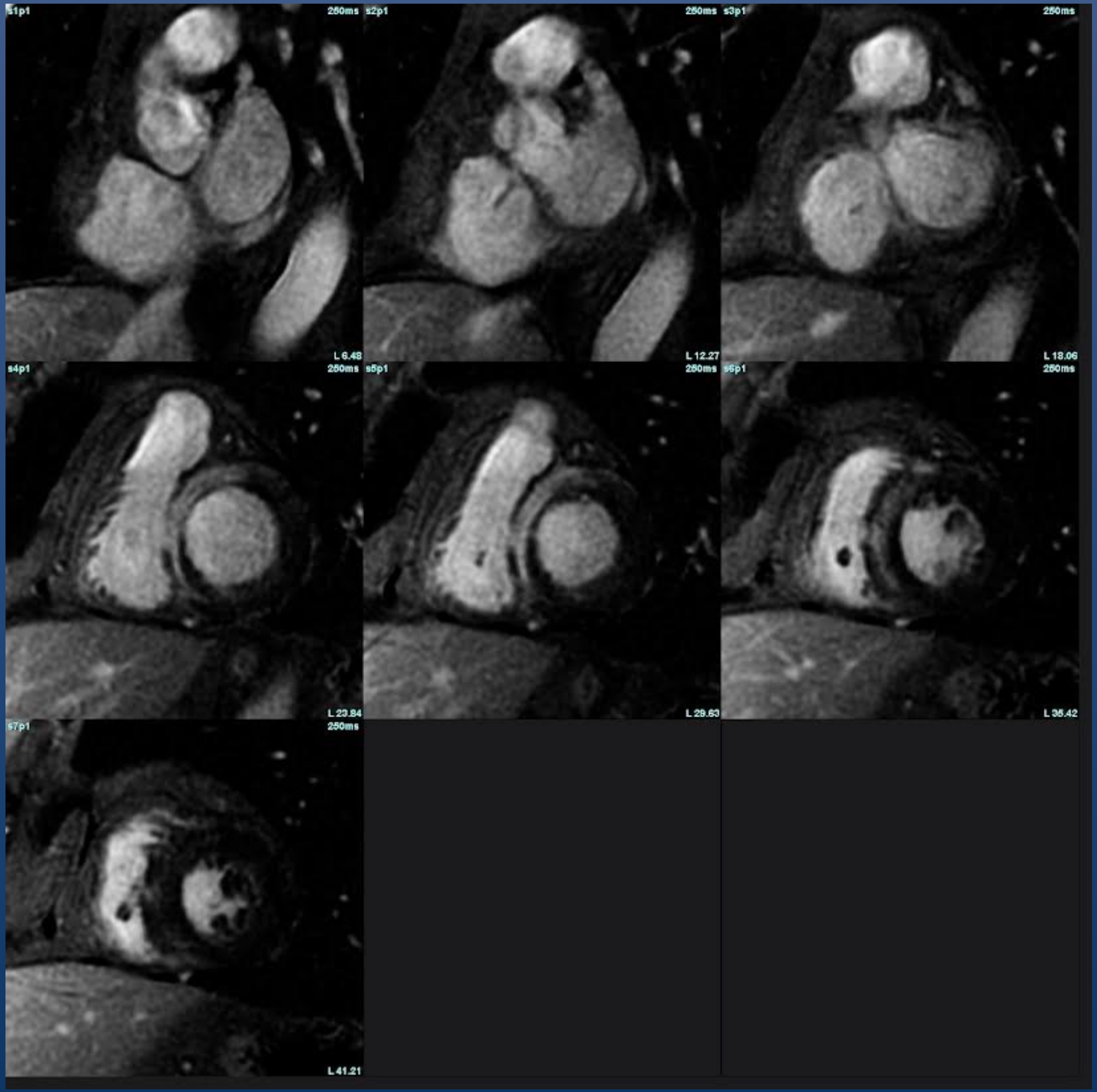
- Necrosis or scar (irreversible injury/fibrosis and viability)
- Edema (acute, potentially reversible injury)
- Abnormal tissue components (infiltration/storage)
- Pericardial assessment (physiology and tissue assessment)
- Cardiac mass assessment



Inversion Recovery – Late Gadolinium Enhancement

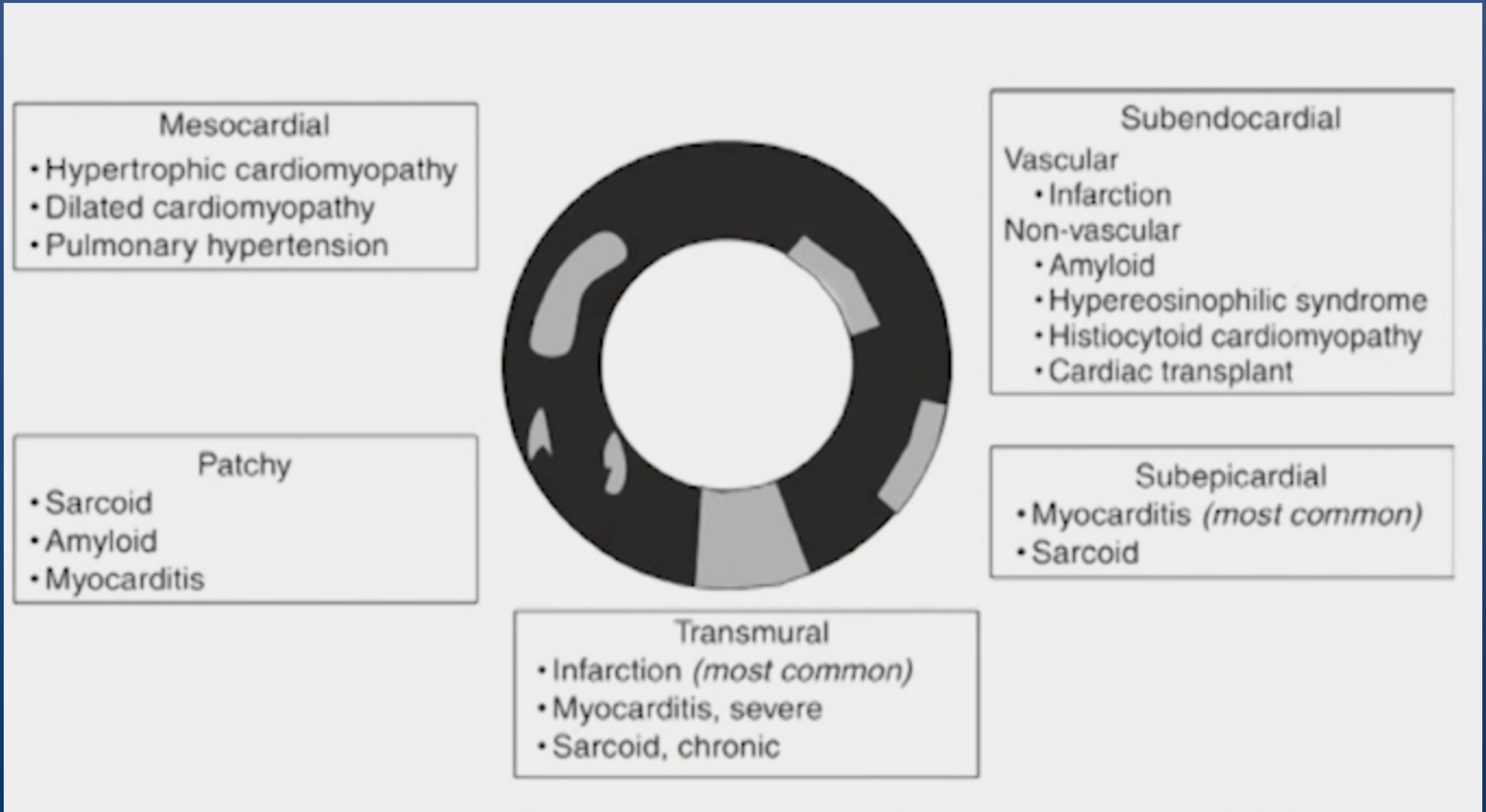
- Inversion Recovery pulses are used to null the signal from a desired tissue to differentiate surrounding pathology
- A common use of this technique is to null the signal from normal myocardium during delayed enhanced imaging
- The nulled normal myocardium will be dark in contrast to the enhanced abnormal myocardium



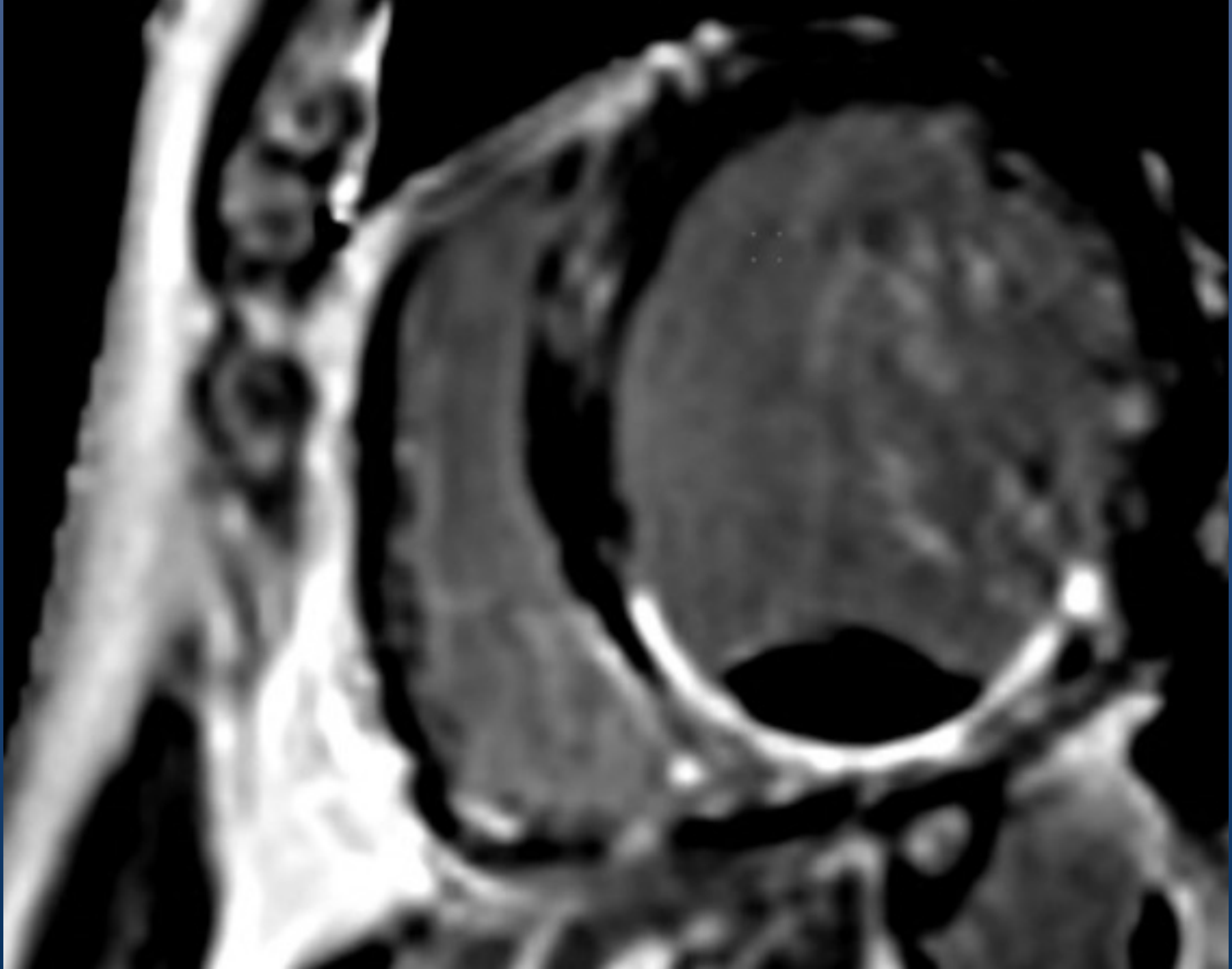

Myocardium
AR
IR


Late Gadolinium Enhancement (LGE) = Scar or Fibrosis

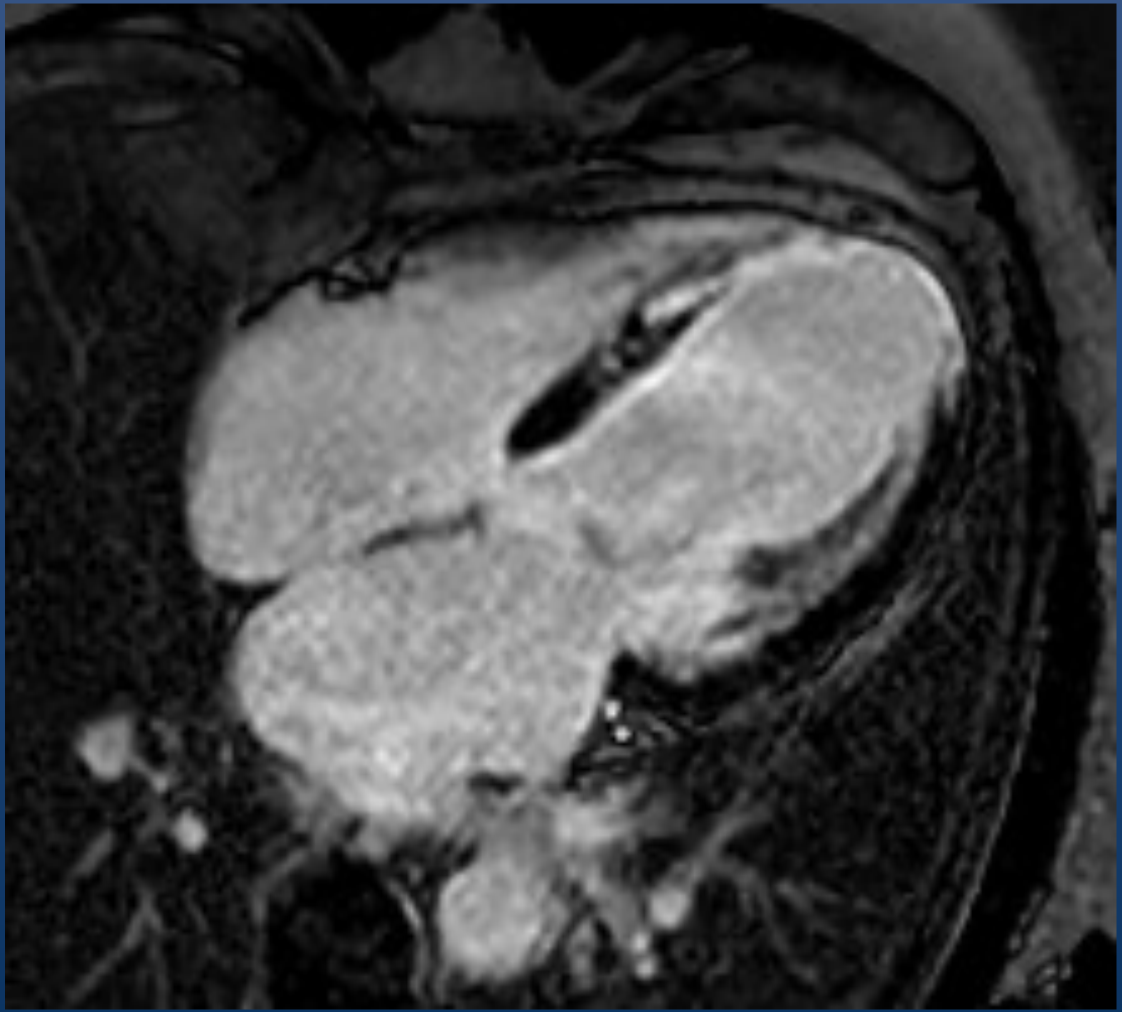
LGE (scar) Assessment

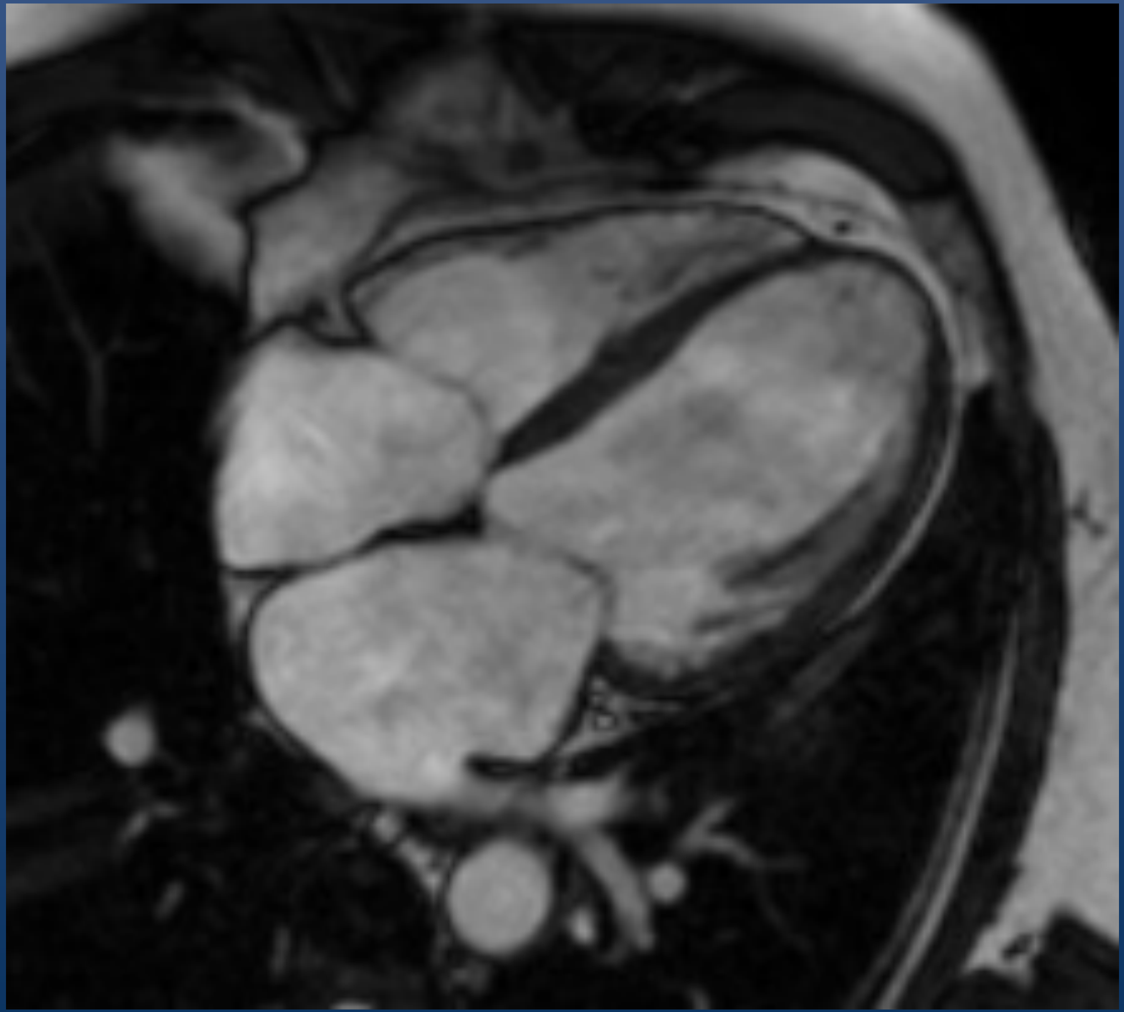


Cummings KW, et al. RadioGraphics 2009;29:89–103.



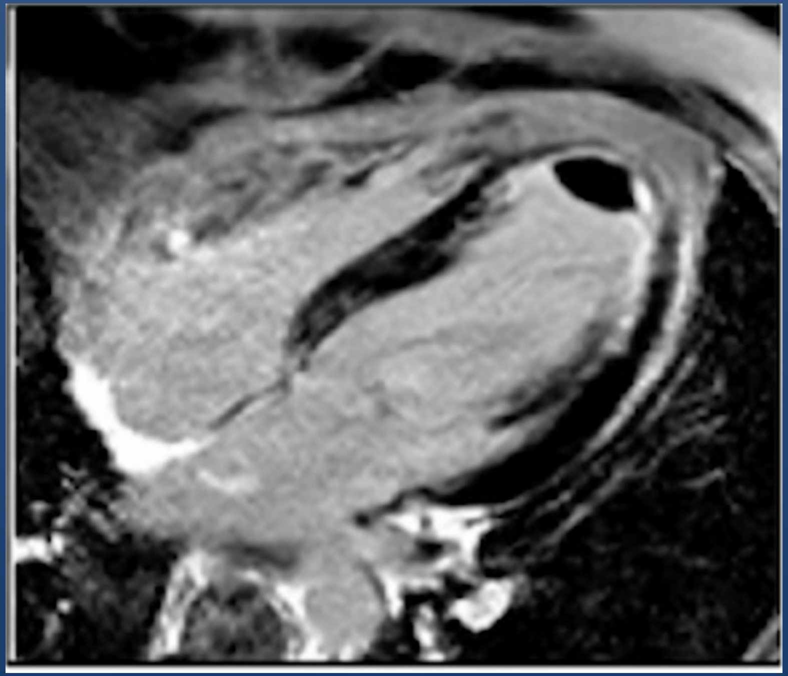
Myocardial Infarction

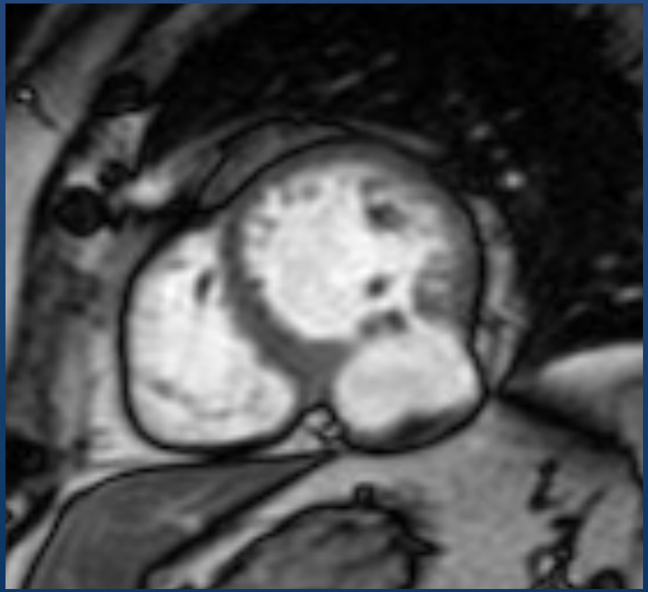


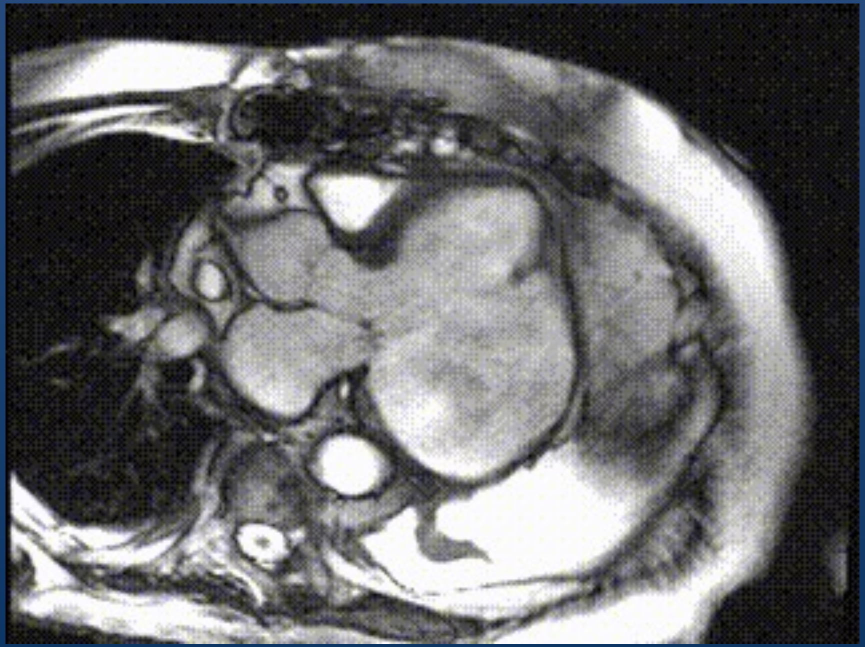


Acute Coronary Syndrome Complications

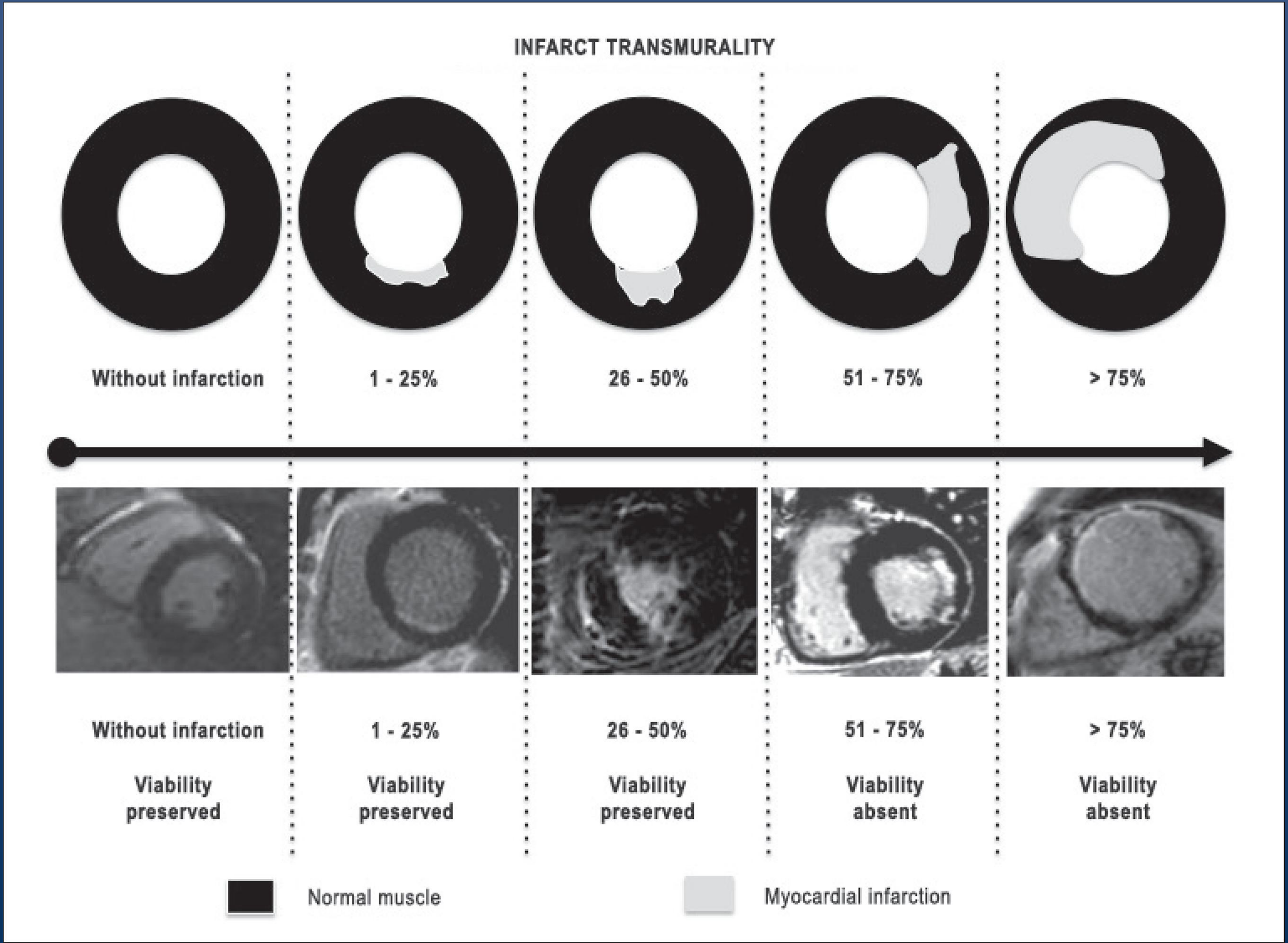
- Thrombus
- LV aneurysm and pseudoaneurysm





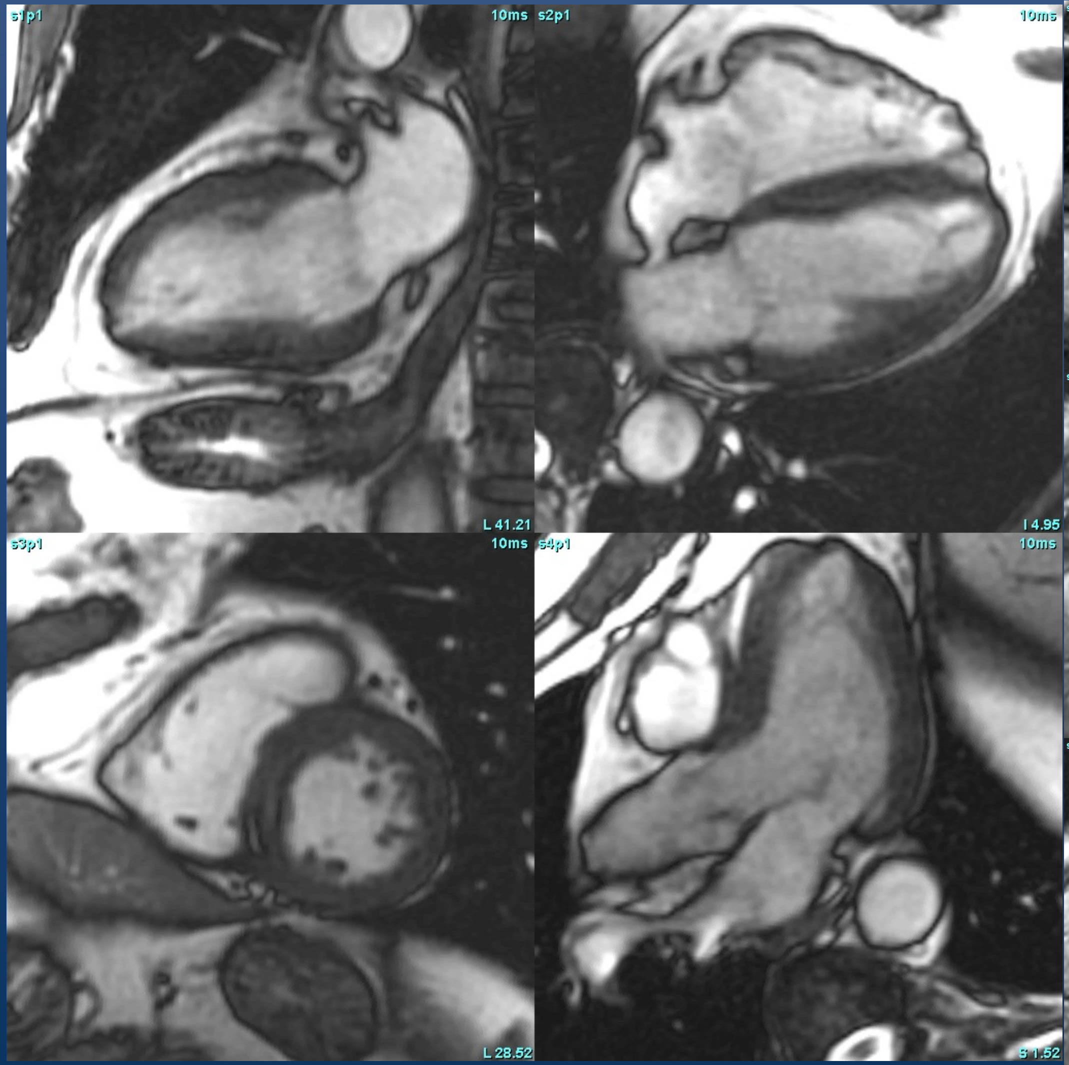


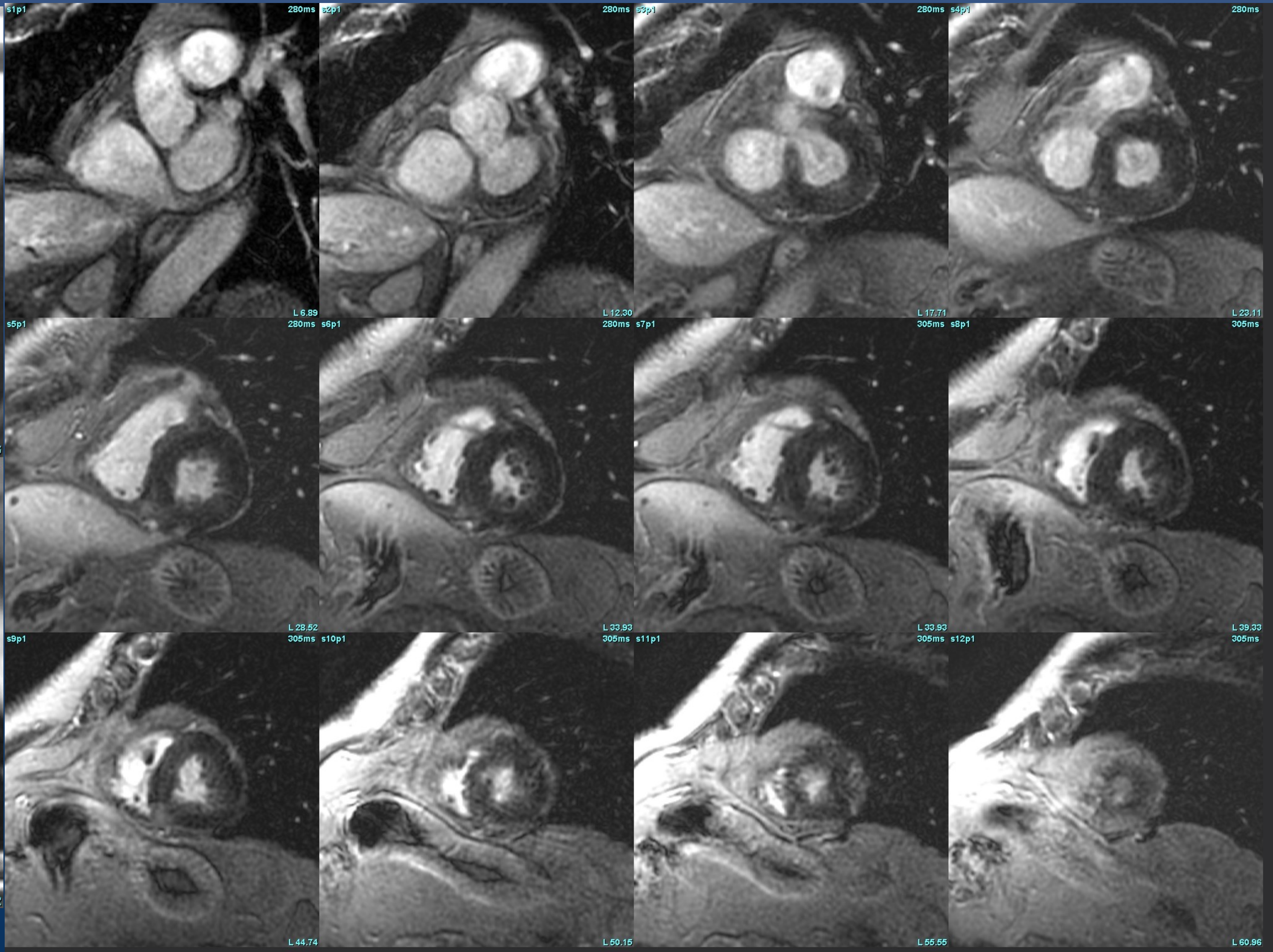
Myocardial Viability



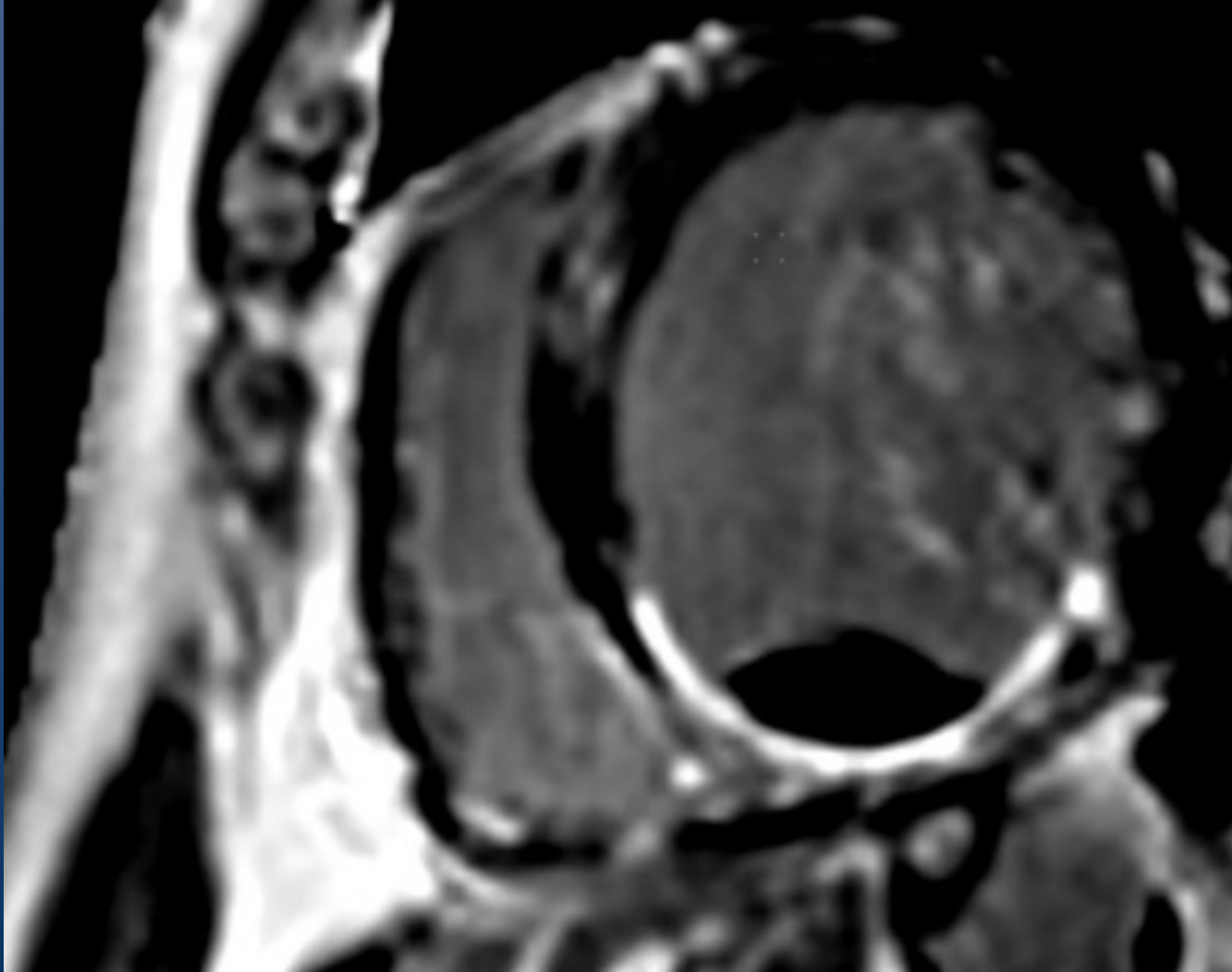
Arai AE. Cardiovascular magnetic resonance imaging. Totowa (NJ): Human Press Inc; 2008. p. 351-75.

CTO MID LAD – worth treating?

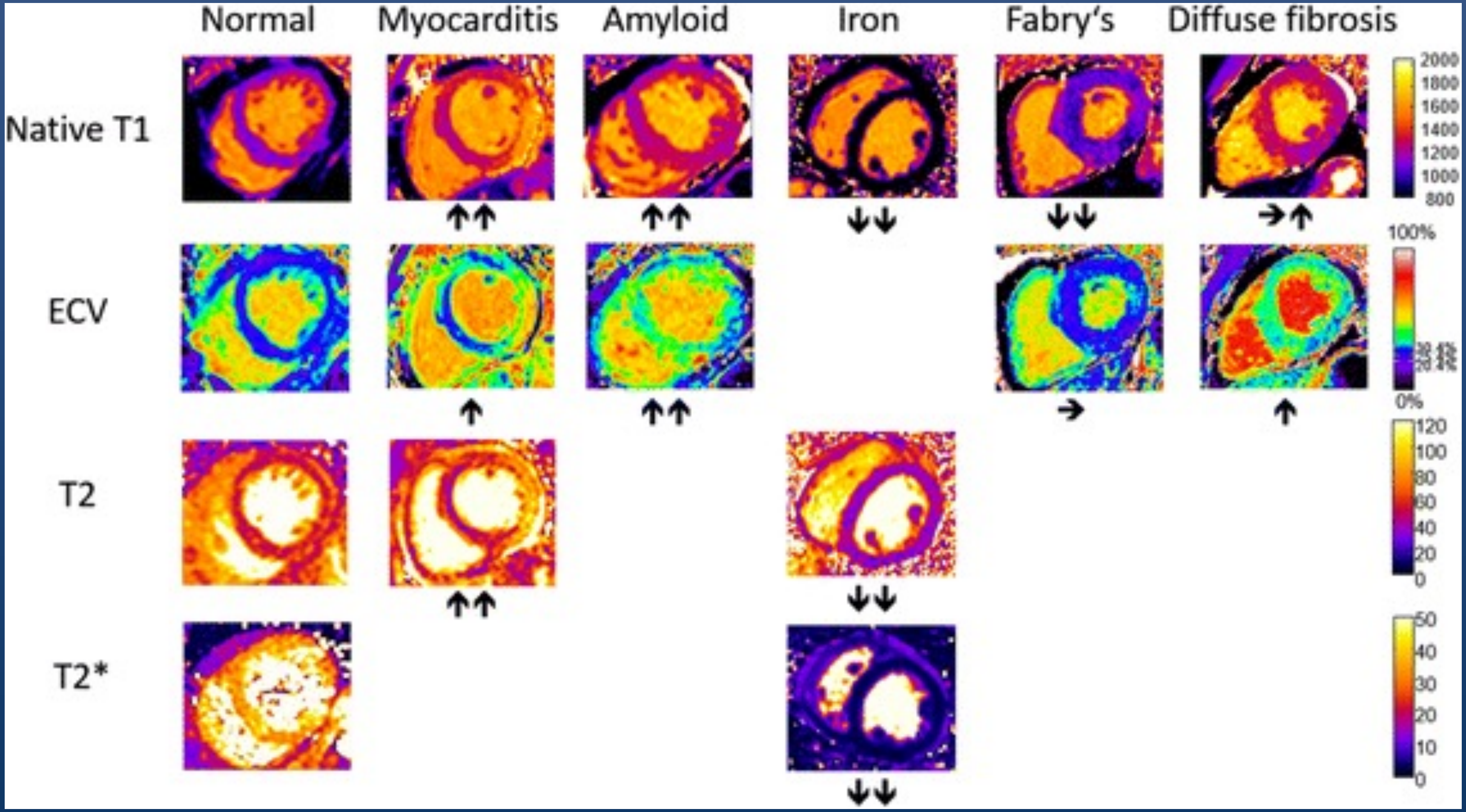




Complex RCA Lesion - worth treating?



Parametric Mapping
Native T1, T2, T2*, and Extracellular Volume Fraction

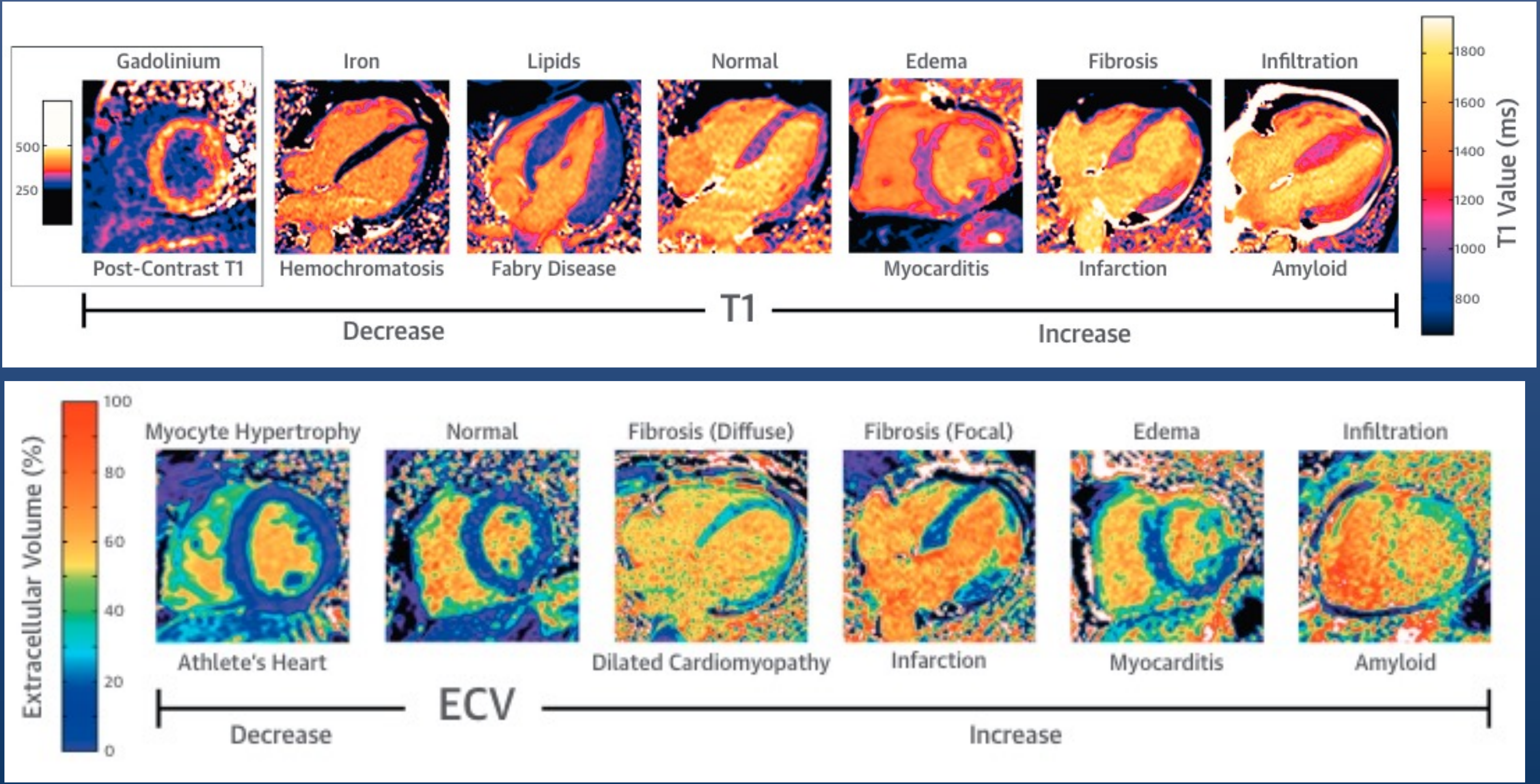


Messroghli DR, et al. J Cardiovasc Magn Reson 2017;19:75.

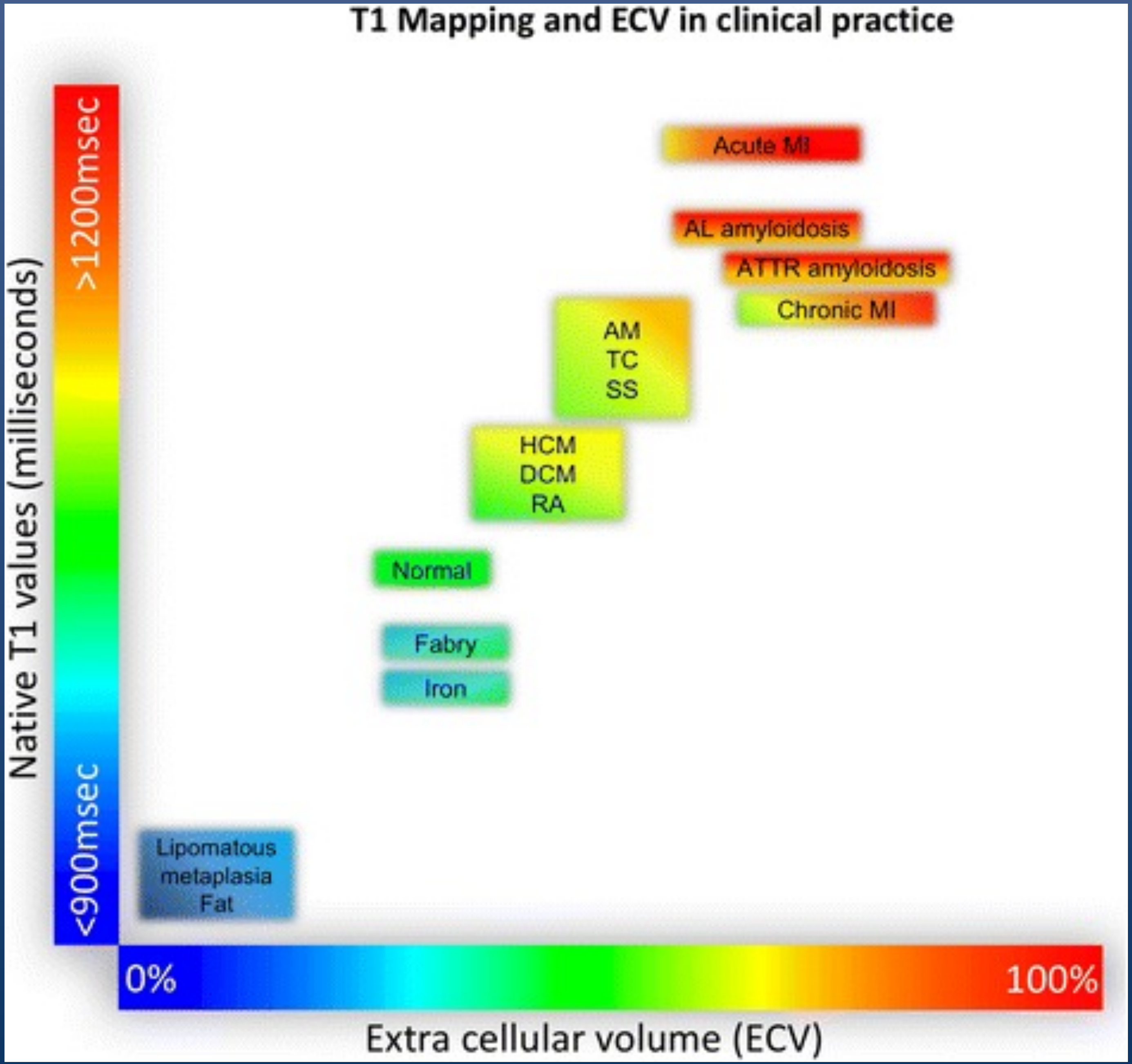
Native T1 and Extracellular Volume (ECV) Mapping

- T1 mapping provides a numerical value for the T1 relaxation of the myocardial tissue
- Native T1 and ECV have traditionally served as a surrogate for myocardial fibrosis; however, T1/ECV have a sensitivity to numerous factors including edema, blood volume, myocyte expansion, ECV expansion secondary to protein infiltration, iron deposition, and intramyocardial lipids.
- T1 mapping has been used to identify abnormalities in various disorders, including myocarditis, cardiac amyloidosis, hypertrophic cardiomyopathy, iron overload states, and Fabry disease

Robinson, A.A. et al. J Am Coll Cardiol Img. 2019;12(11):2332–44.



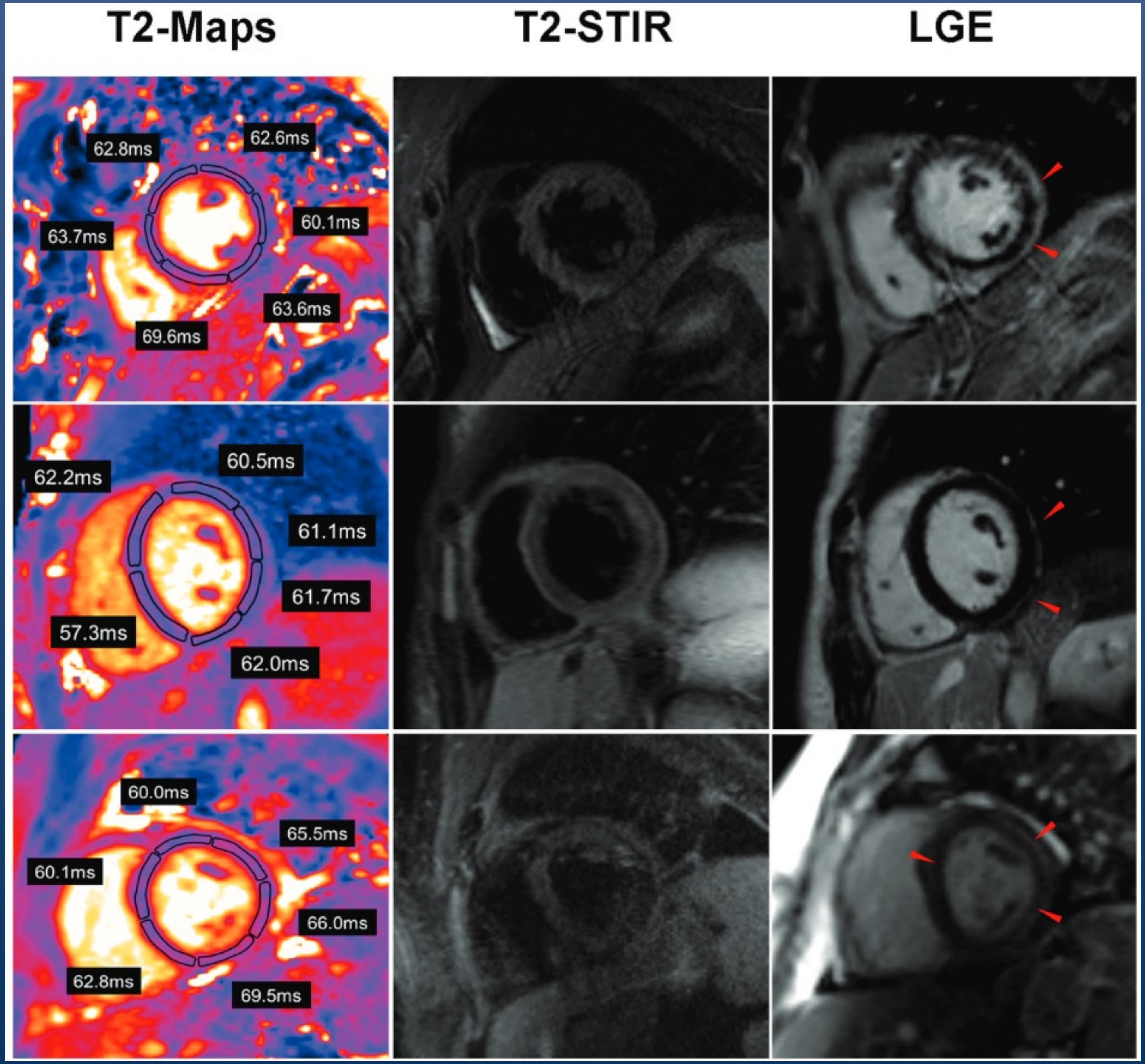
Robinson, A.A. et al. J Am Coll Cardiol Img. 2019;12(11):2332–44.



Messroghli DR, et al. J Cardiovasc Magn Reson 2017;19:75.

T2 Mapping

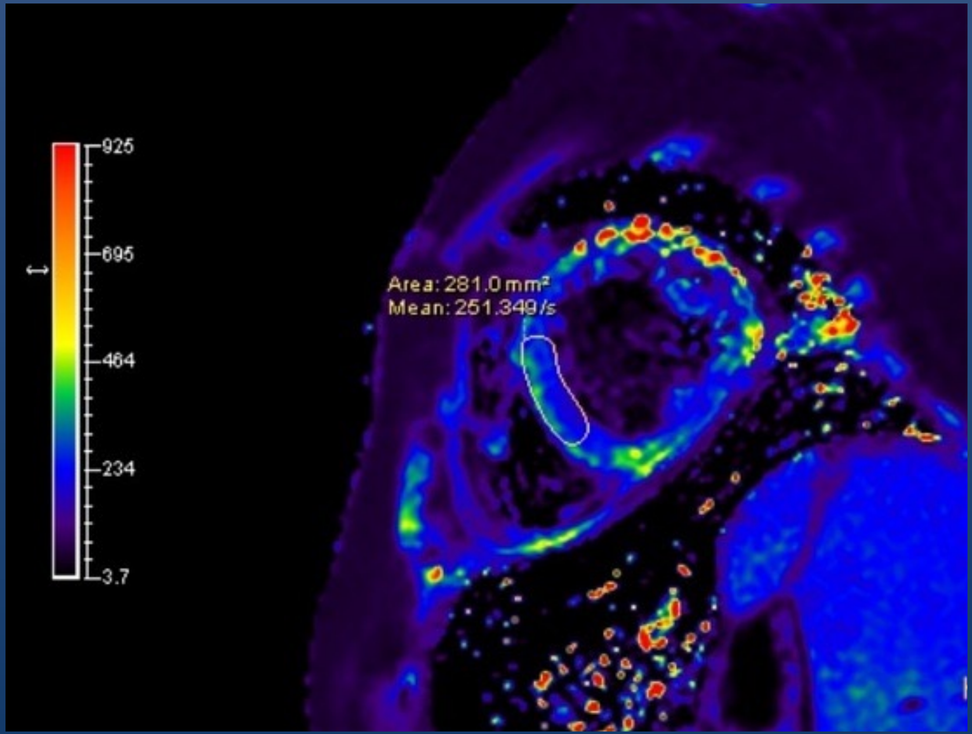
- T2 mapping can be used to identify myocardial edema in patients with acute myocardial infarction, myocarditis, stress cardiomyopathy, cardiac sarcoidosis, and cardiac allograft rejection.
- T2 elevation is now included in CMR criteria for myocarditis



Thavendiranathan P, et al. Circulation: Cardiovascular Imaging 2012;5:102–110.

T2* Mapping

- T2* mapping calculates the T2* time of tissue
- T2* times are useful in the evaluation of myocardial iron content and myocardial hemorrhage
- Myocardial iron overload syndromes
  - Hemochromatosis, Sickle cell disease, & ß-thalassemia
- Assessment of chelation therapy (therapy decision and monitoring)
- Acute myocardial infarction
  - Microvascular injury and hemorrhage

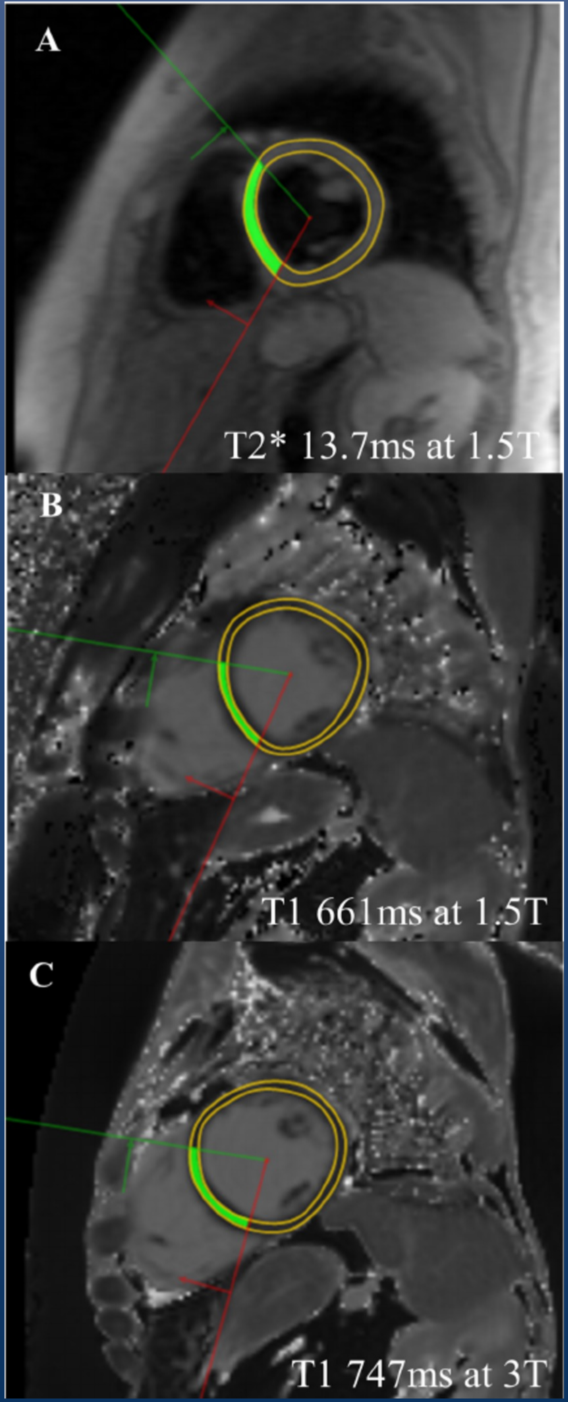


https://radiopaedia.org

Circulation. 2009 Nov 17;120(20):1961-8

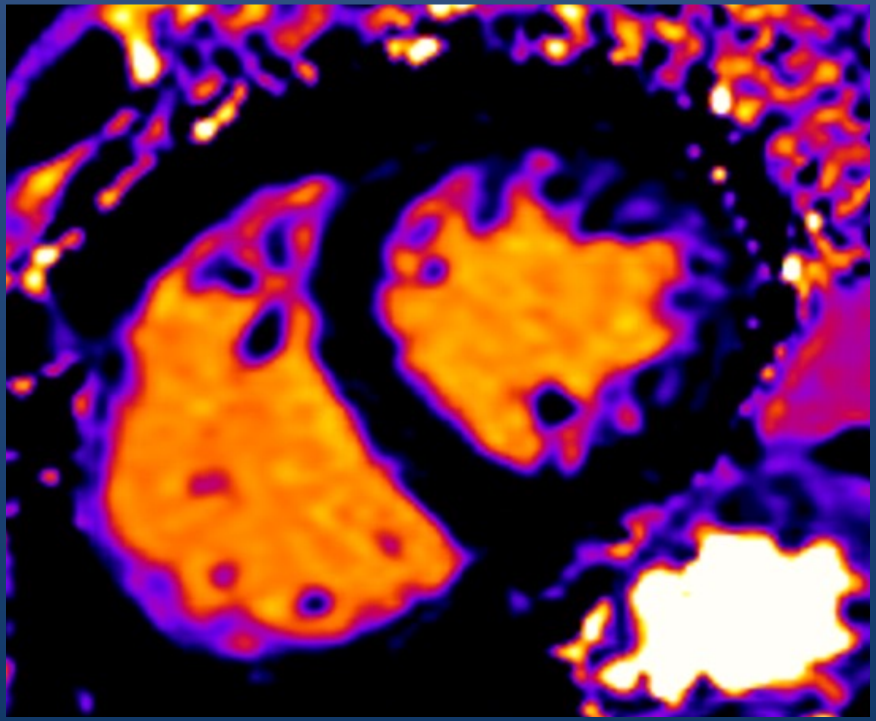
T2* Mapping for Iron Overload

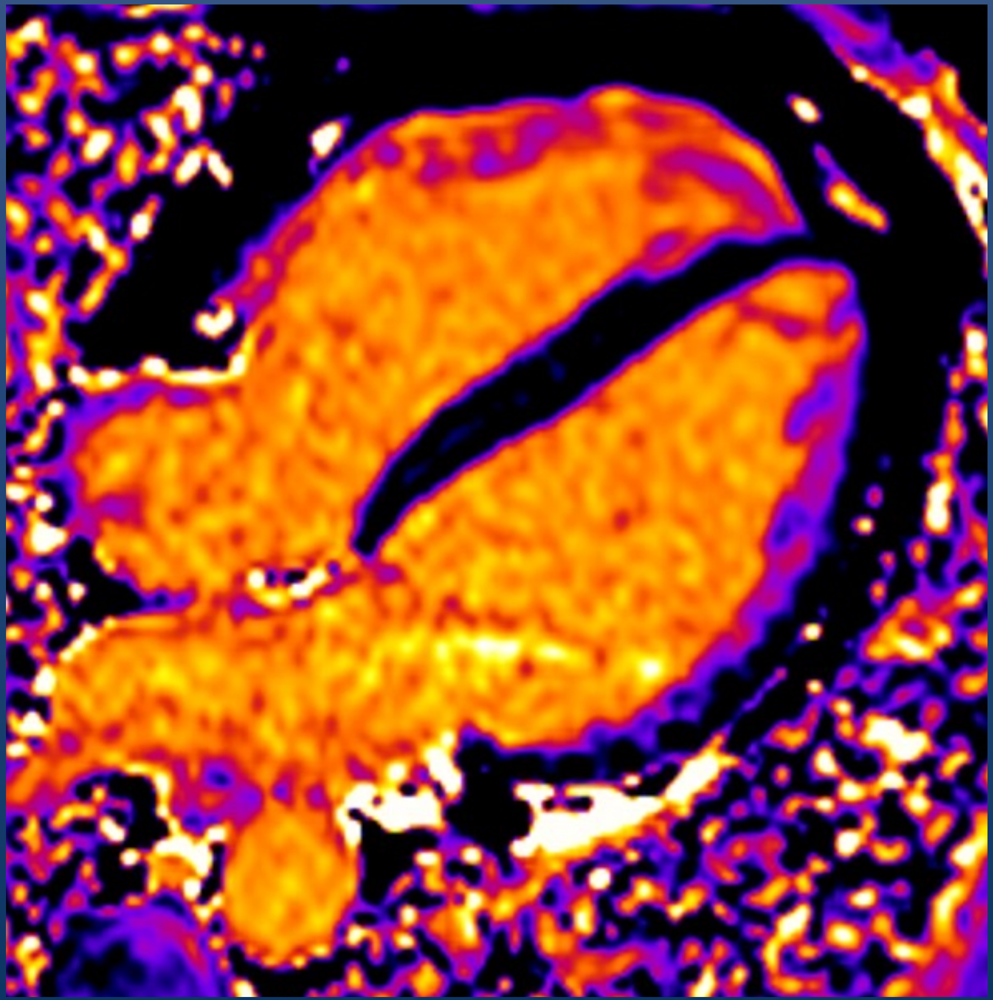
- T2* is measured in the interventricular septum
- T2* >20 ms - no iron overload
- T2* 10-20 ms - mild to moderate iron overload
- T2* <10 ms - severe iron overload



J Cardiovasc Magn Reson. 2015;17:102.

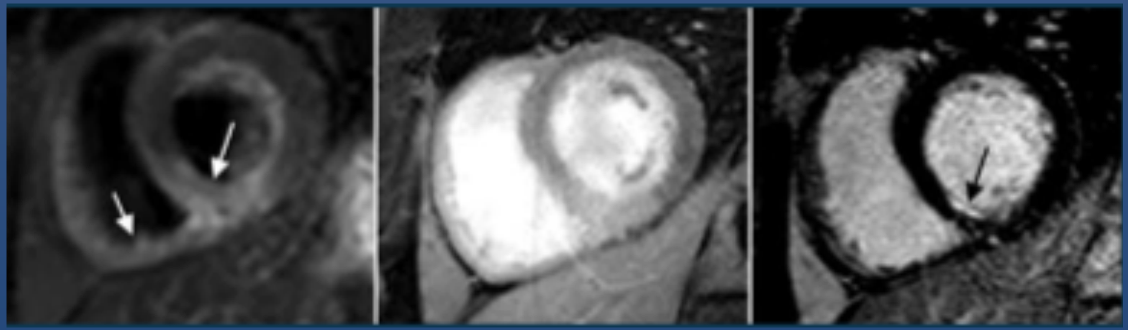
Iron Overload on T1 Mapping



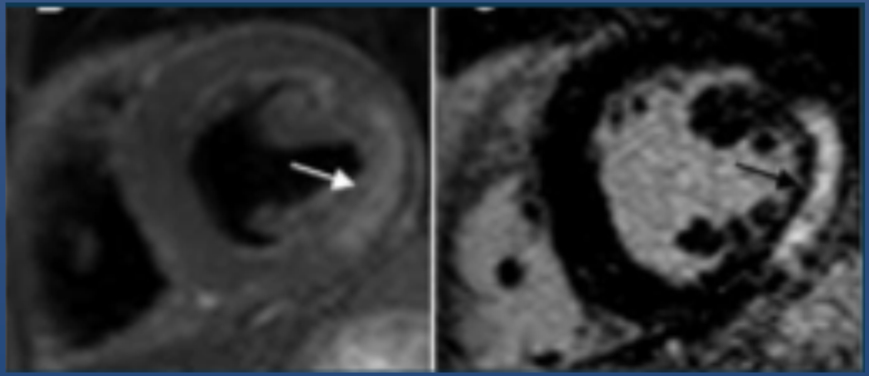


Clinical examples of tissue characterization techniques

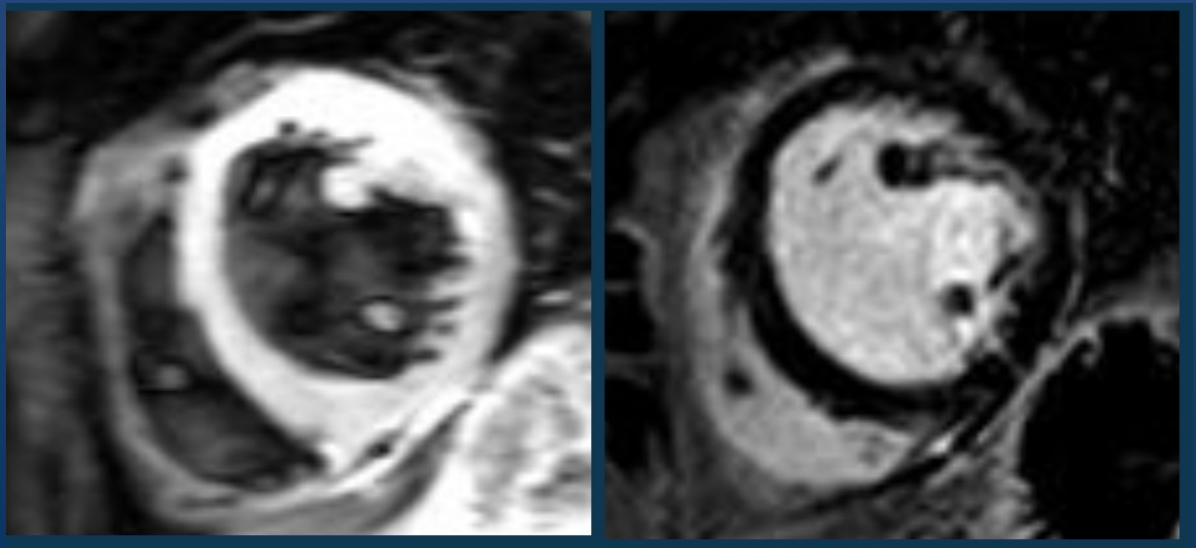
Myocardial Infarction with Nonobstructive Coronary Arteries



Small subendocardial infarction

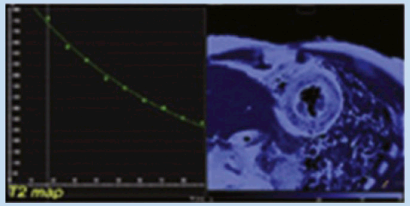
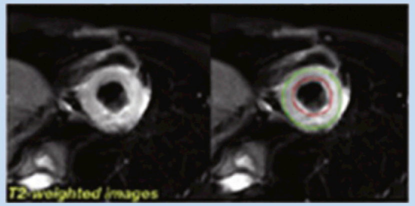
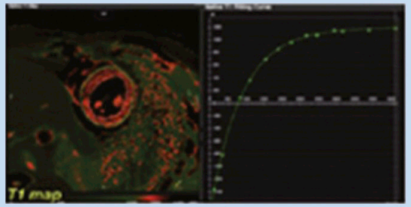
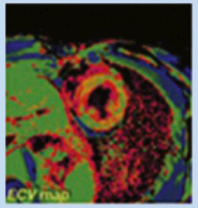
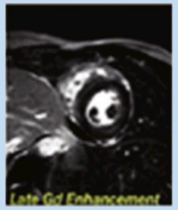
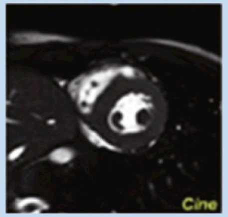
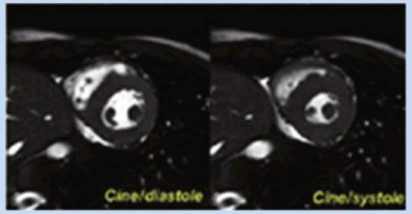


Myocarditis



Stress-induced cardiomyopathy with diffuse edema

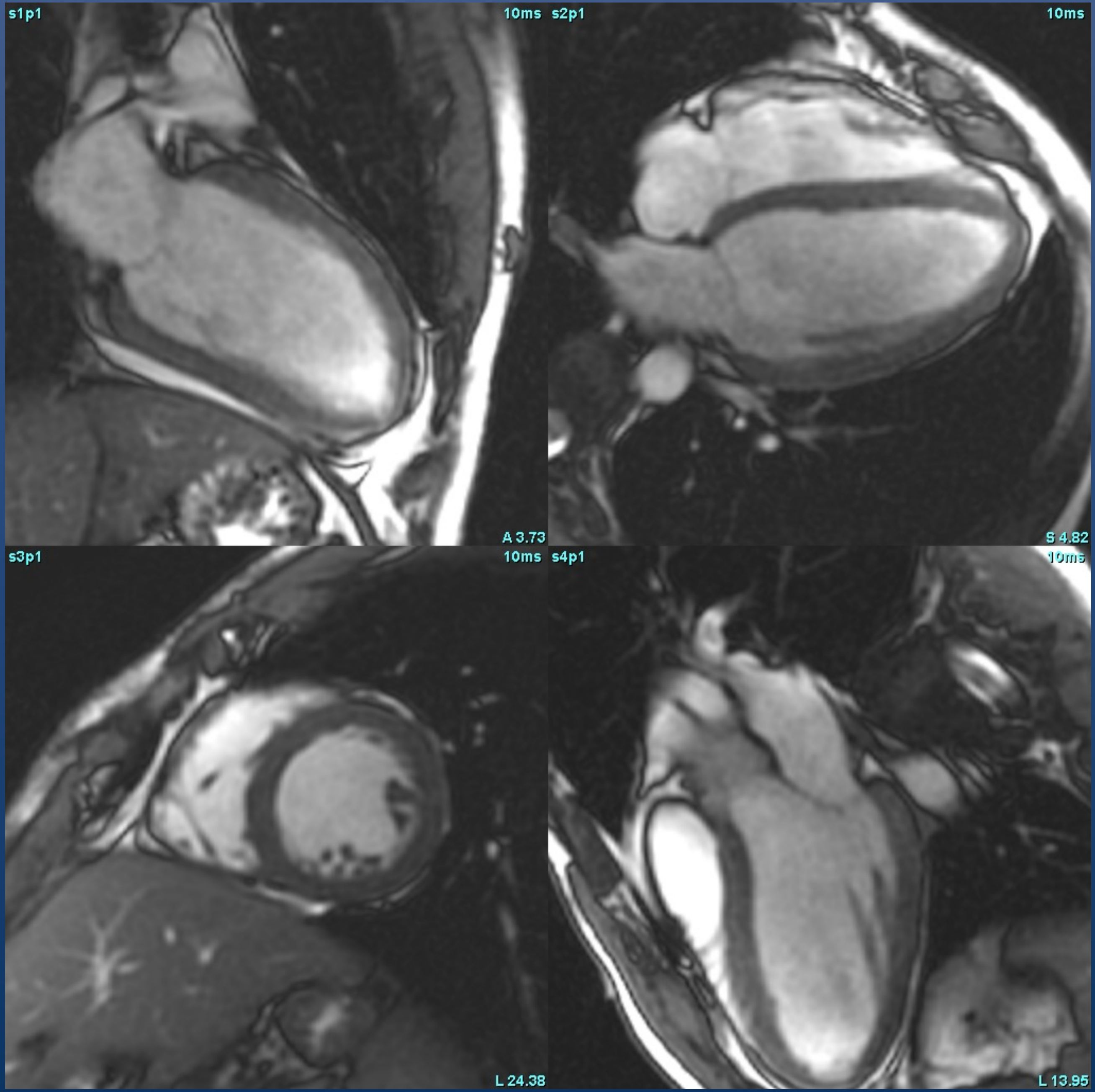
Myocarditis – Lake Louise Criteria

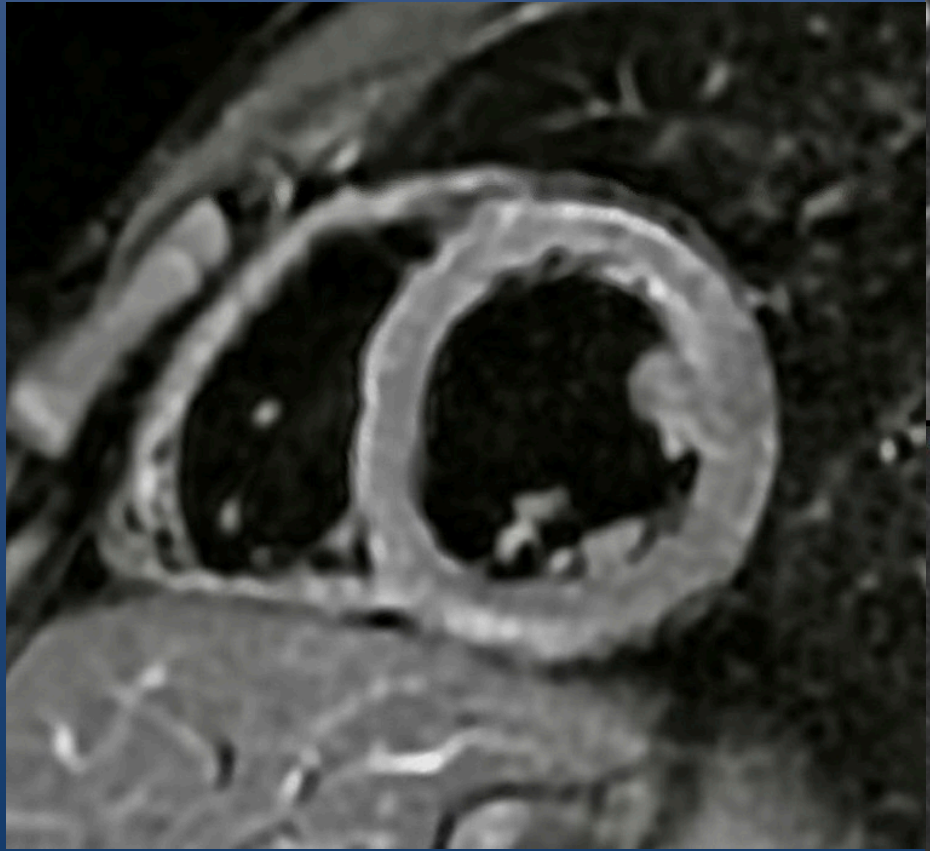
	2018 Lake Louise Criteria	CMR Image Examples
Main Criteria	**Myocardial Edema** (T2-mapping or T2W images)	Regional or global increase of native T2  or Regional or global increase of T2 signal intensity 
	Nonischemic Myocardial Injury (Abnormal T1, ECV, or LGE)	Regional or global increase of native T1  or Regional or global increase of ECV  or Regional LGE signal increase 
Supportive Criteria	**Pericarditis** (Effusion in cine images or abnormal LGE, T2, or T1) **Systolic LV Dysfunction** (Regional or global wall motion abnormality)	Pericardial effusion  Regional or global hypokinesis 

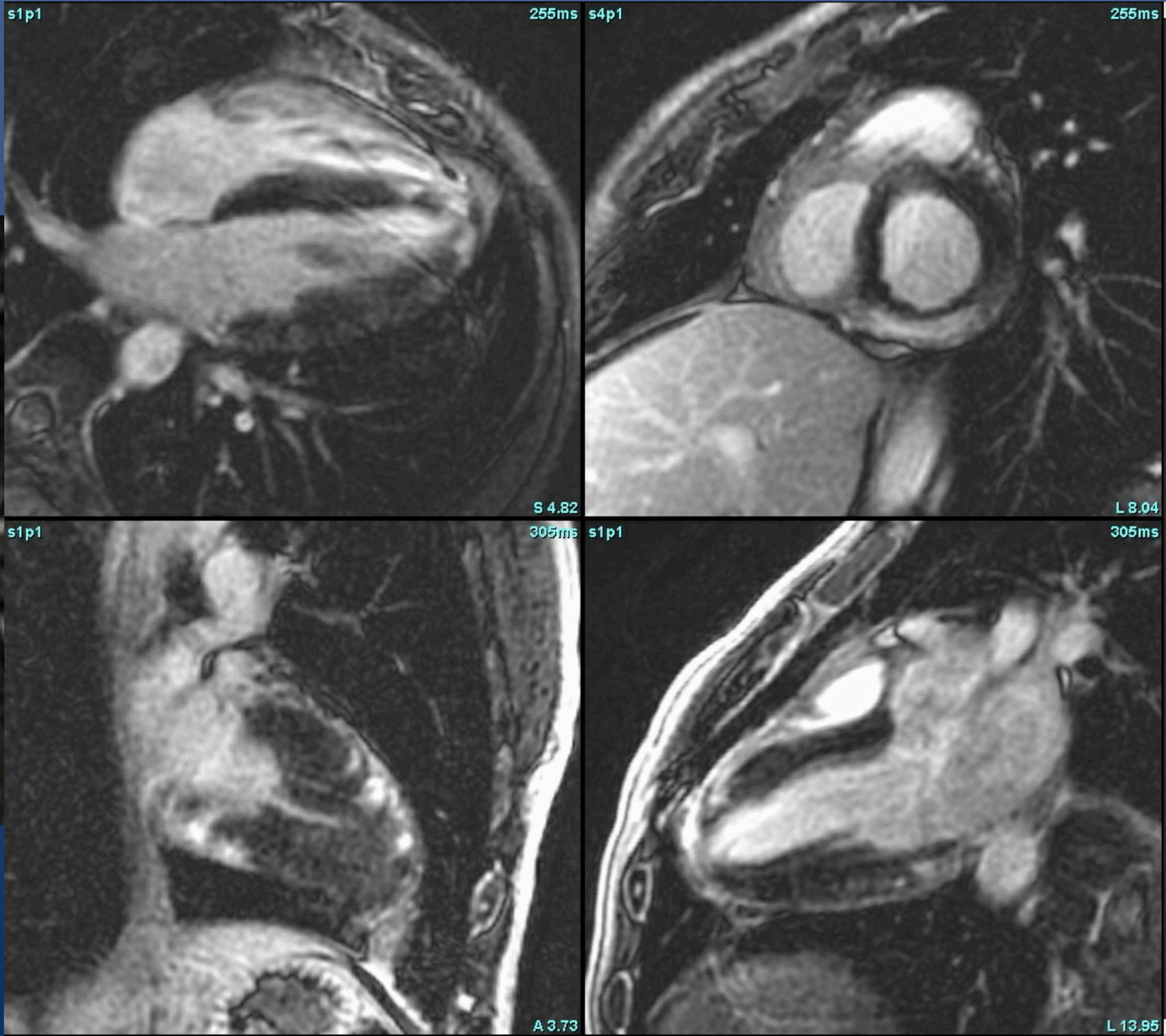
Ferreira V.M., et al. JACC 2018;72:3158-3176.

Myocarditis - Case

- 25-y.o male with dyspnea, chest pain, and palpitations
- Normal ECG
- hs-cTnT 2,000 -> peak 10,000
- Normal TTE
- ICA or Cath? How about Cardiac MRI!

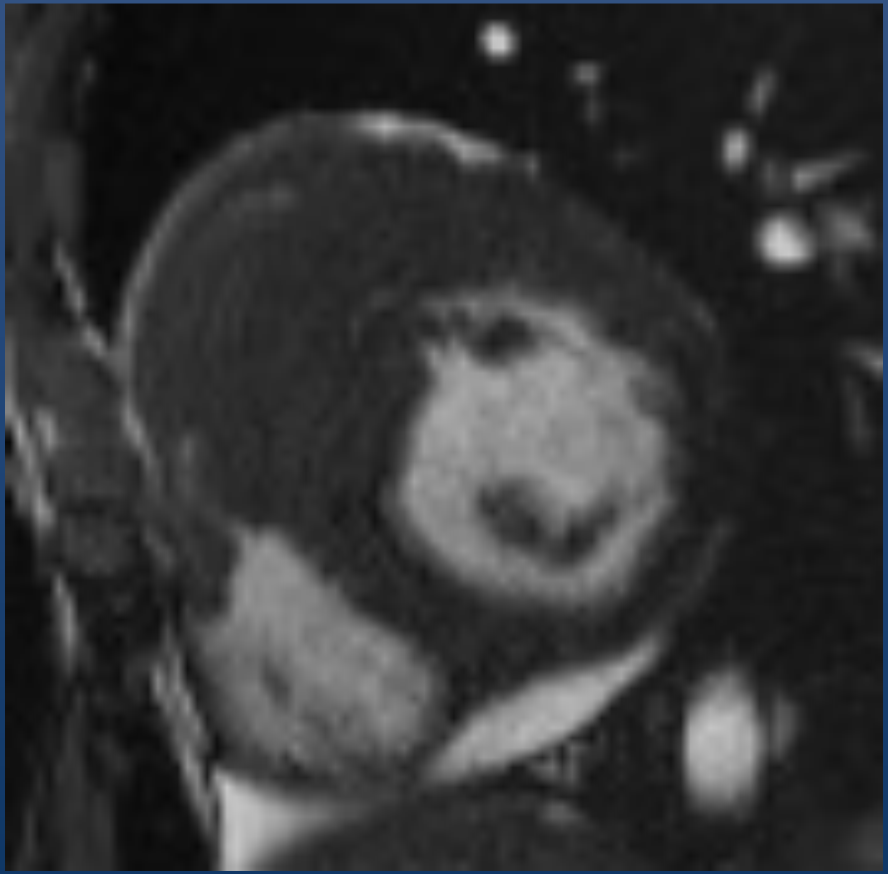




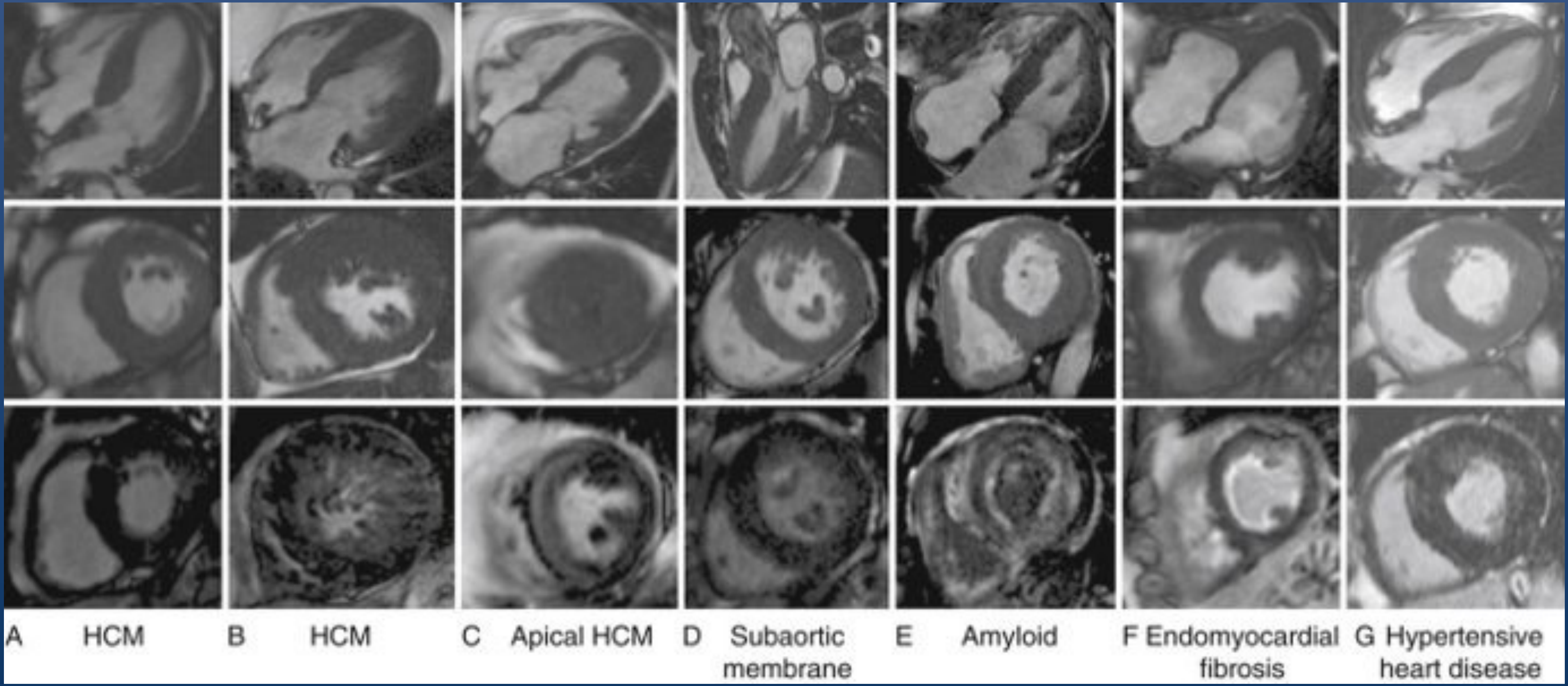

s1p1
255ms
S 4.82
s4p1
255ms
L 8.04
s1p1
305ms
A 3.73
s1p1
305ms
L 13.95

Hypertrophic Cardiomyopathy (HCM)

- Reliably assess LV morphology, including maximal LV wall thickness
- Determine subtype of HCM
- Further inform risk stratification with assessment of extent of LGE (given the emerging data supporting extensive LGE as a marker of arrhythmic risk and sudden cardiac death

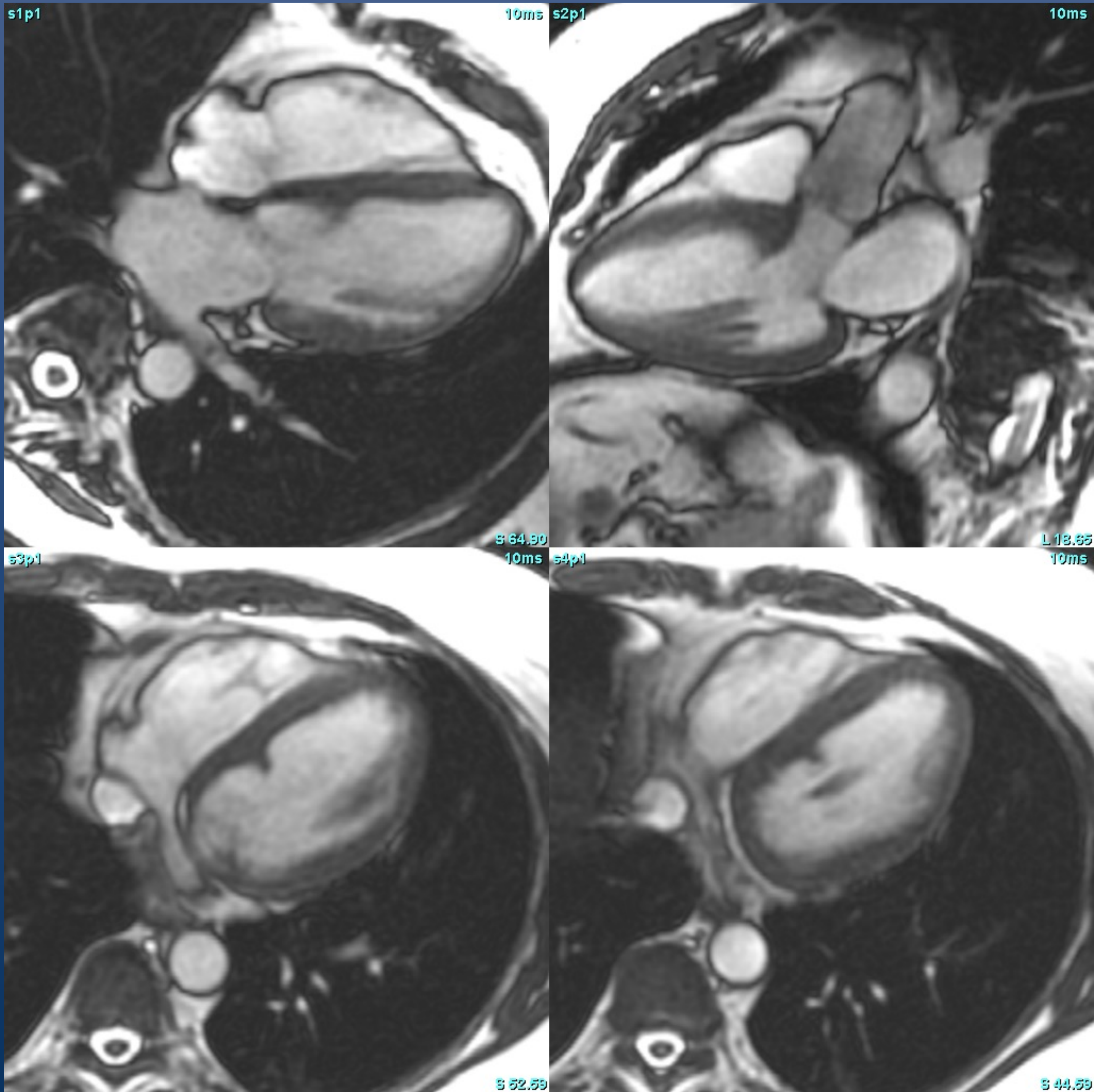


Etiology Assessment in HCM



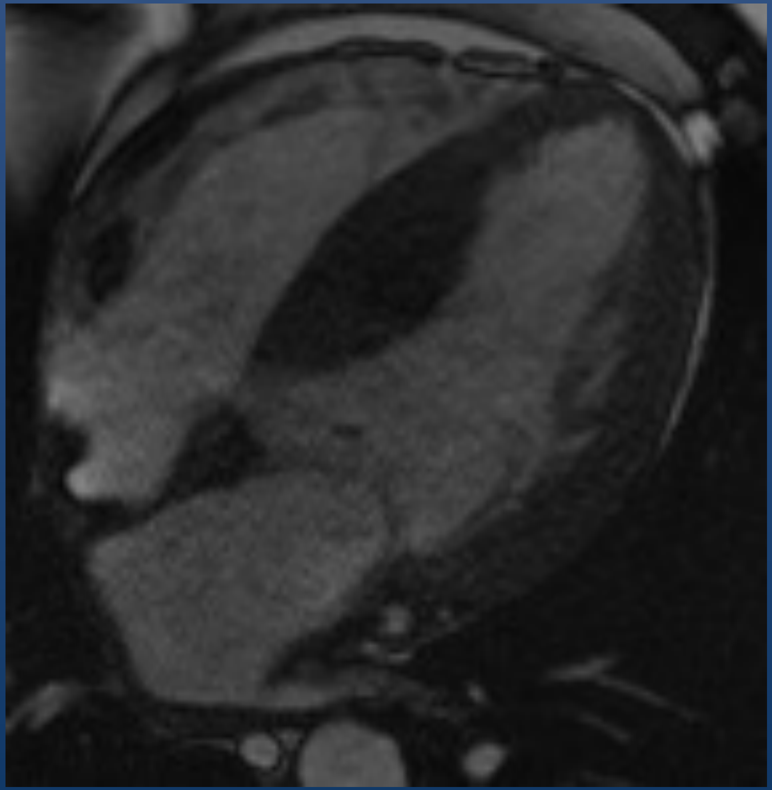
Gati et al. JACC Cardiovasc Imaging. 2018;11(2 Pt 1):247-59

LVOT Obstruction – is this HOCM?

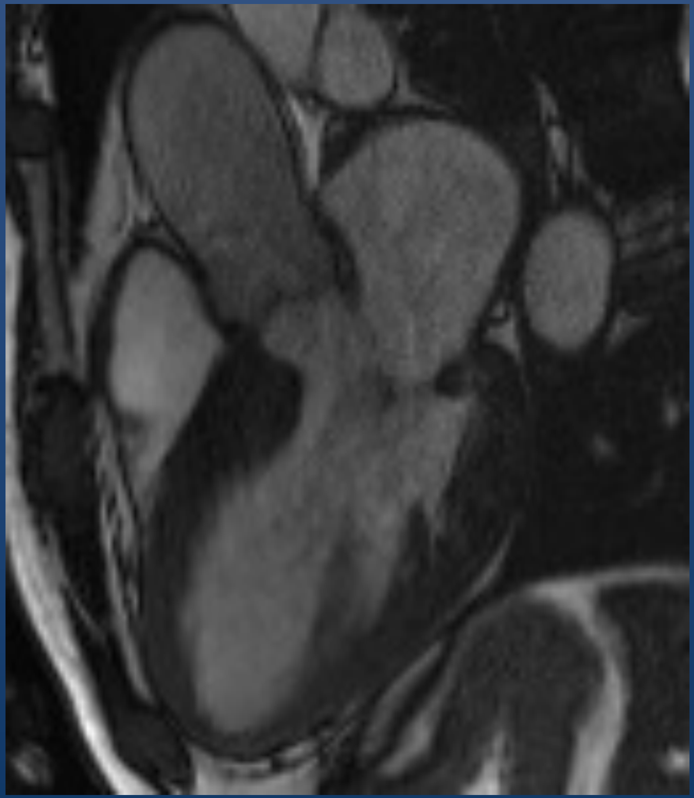


Hypertrophic Cardiomyopathy

- Two broad and distinct subtypes are commonly found: reverse septal curvature and isolated basal septal hypertrophy
- Reverse septal curvature morphology has more LGE, interstitial fibrosis, and genotype positivity



Reverse septal curvature

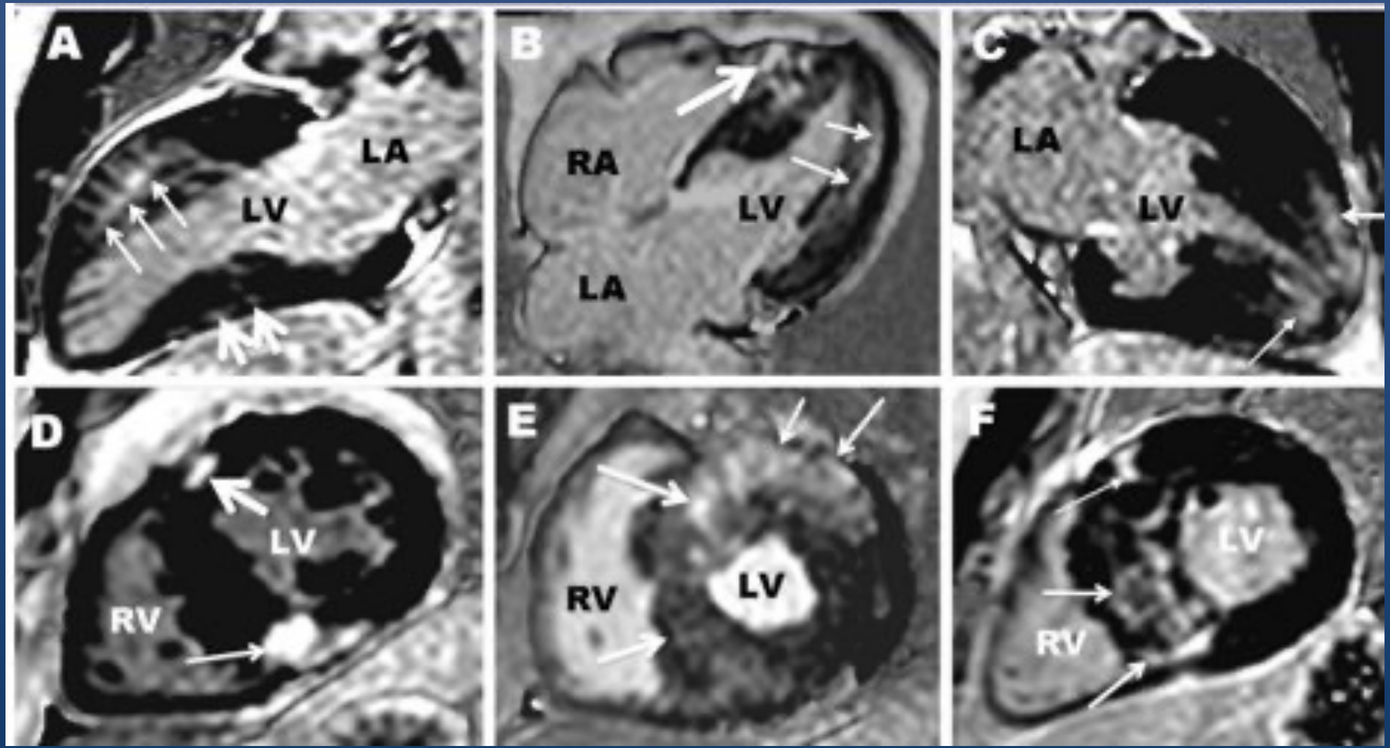


Isolated basal septal hypertrophy

Neubauer & Kramer et al. “Distinct Subgroups in Hypertrophic Cardiomyopathy in the NHLBI HCM Registry.” *JACC* vol. 74,19 (2019): 2333-2345.

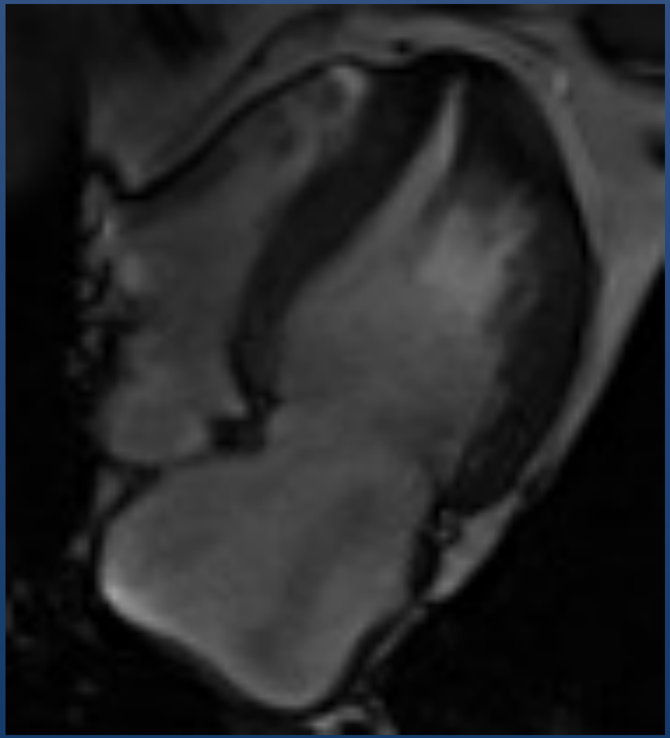
LGE in HCM

- LGE identifies fibrosis/scarring that contributes to risk stratification for HCM
- >15% LGE is significantly related to VT/VF and SCD
- LGE typically occurs in the segments with the greatest hypertrophy

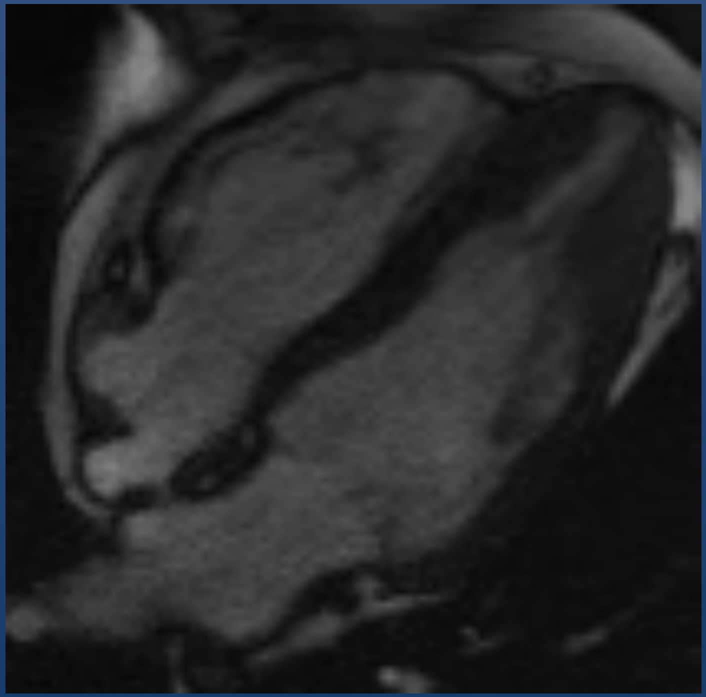


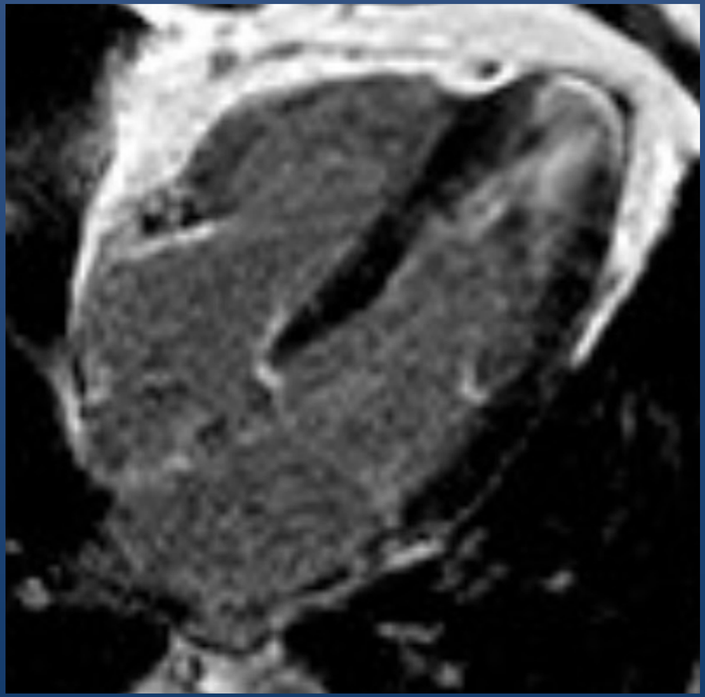
Green JJ, Salerno M, et al. JACC CVI. 2012;5(4):370-7
Chan et al. Circulation. 2014;130:484-495.

More Examples of HCM



Apical HCM

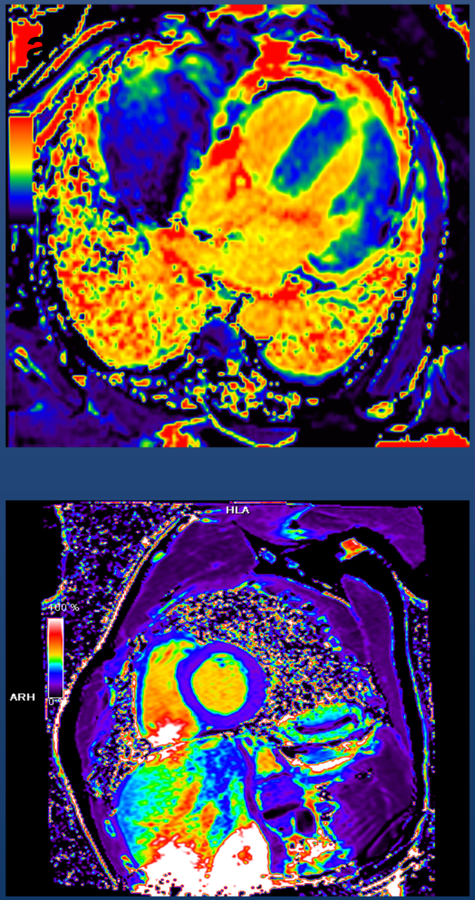




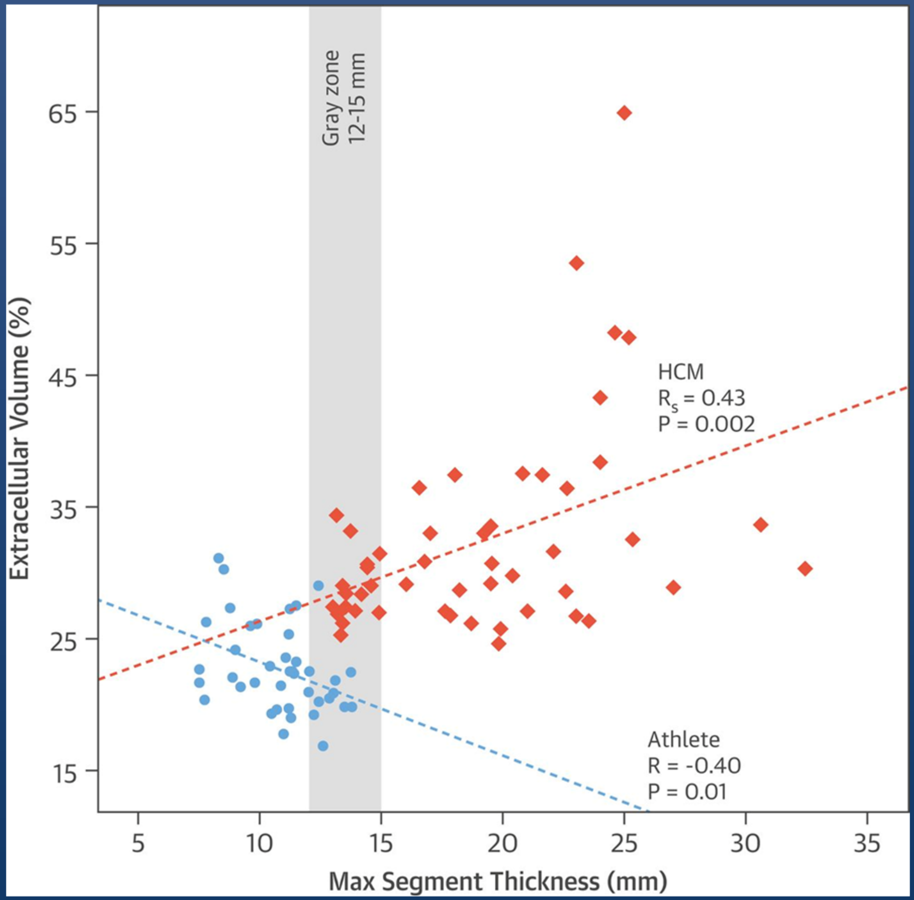
Mid-ventricular hypertrophy is identified with SSFP imaging. Apical aneurysm is a common feature associated with mid-ventricular obstruction.

HCM vs Athletic Remodeling

- HCM has both cellular hypertrophy and interstitial fibrosis resulting in an increase in ECV
- In athletic hypertrophy, there is predominately myocyte hypertrophy without significant fibrosis resulting in a reduction in the ECV
- Normal ECV values of 25 ± 3% have been reported in healthy individuals

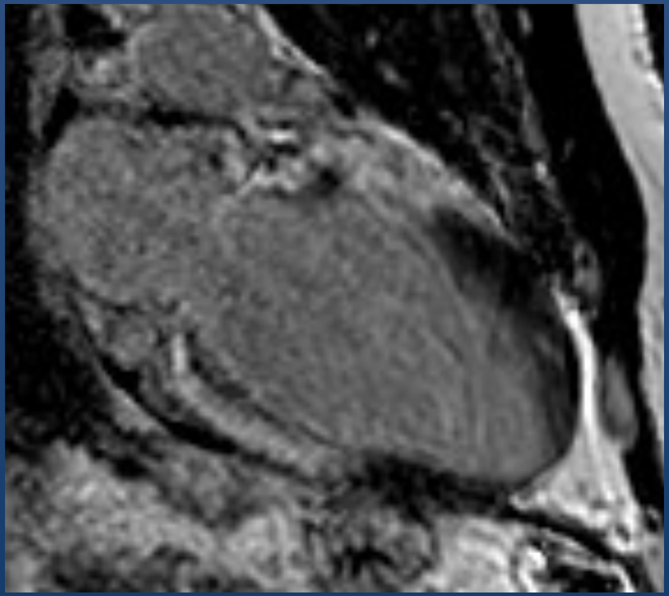


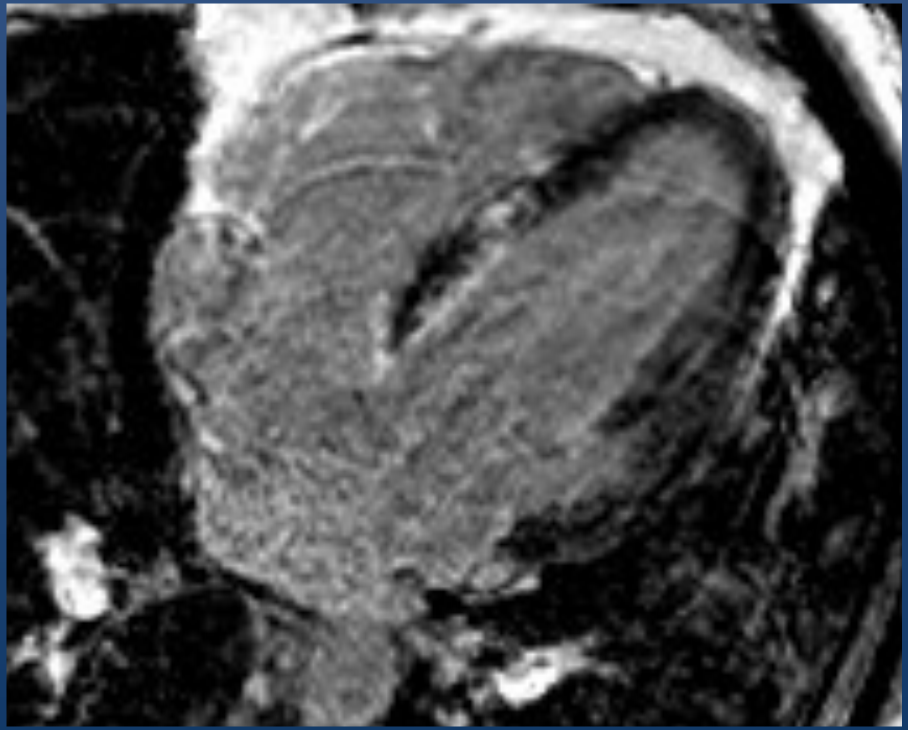
a) ECV map in mid-ventricular obstruction. b) ECV in athletic hypertrophy

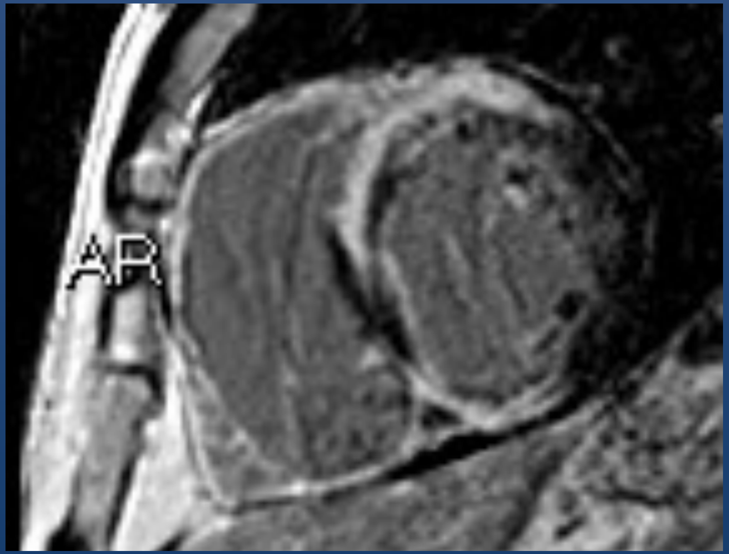


Swoboda PP, et al. J Am Coll Cardiol. 2016;67(18):2189-90.

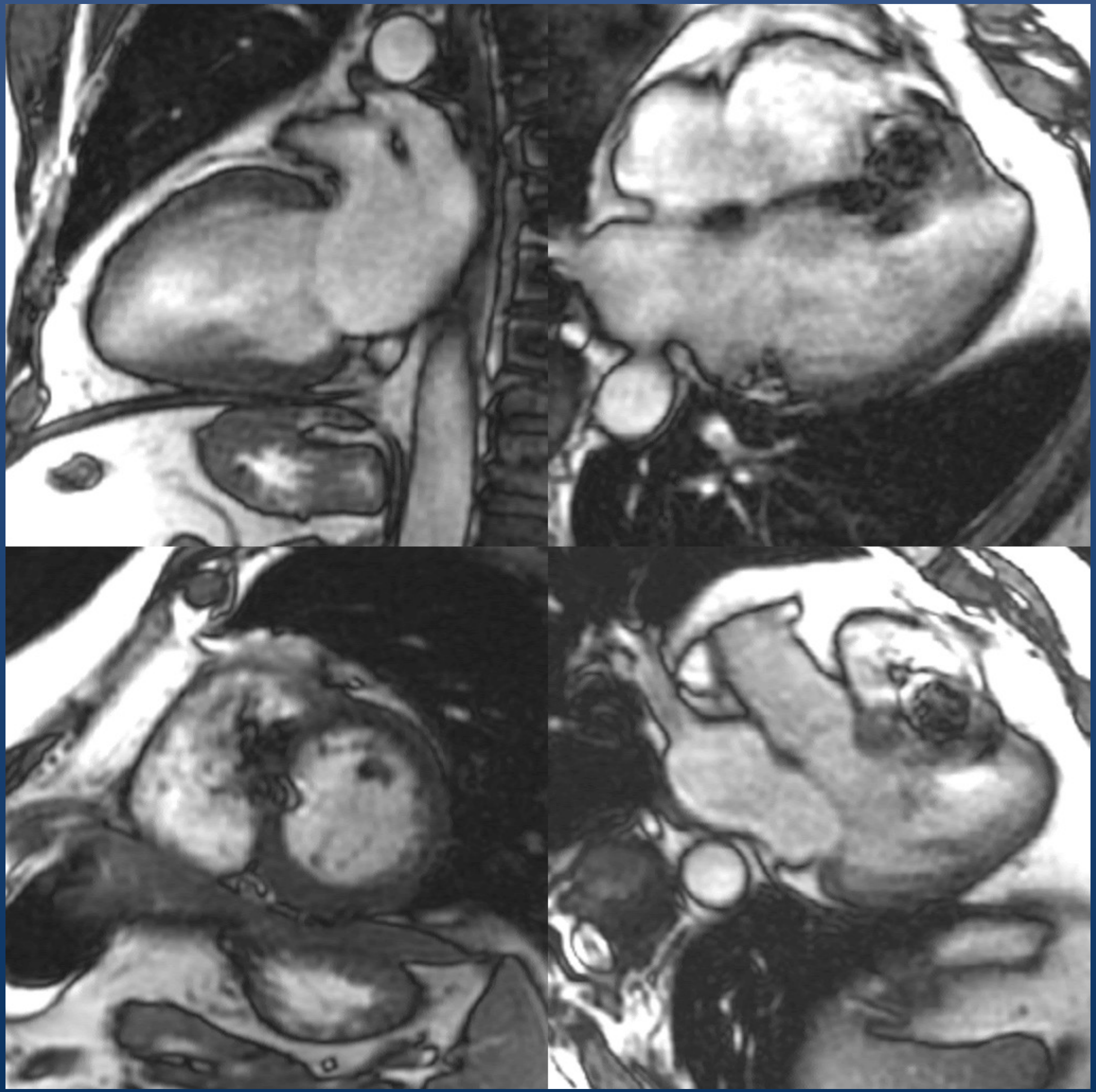
Cardiac Sarcoidosis

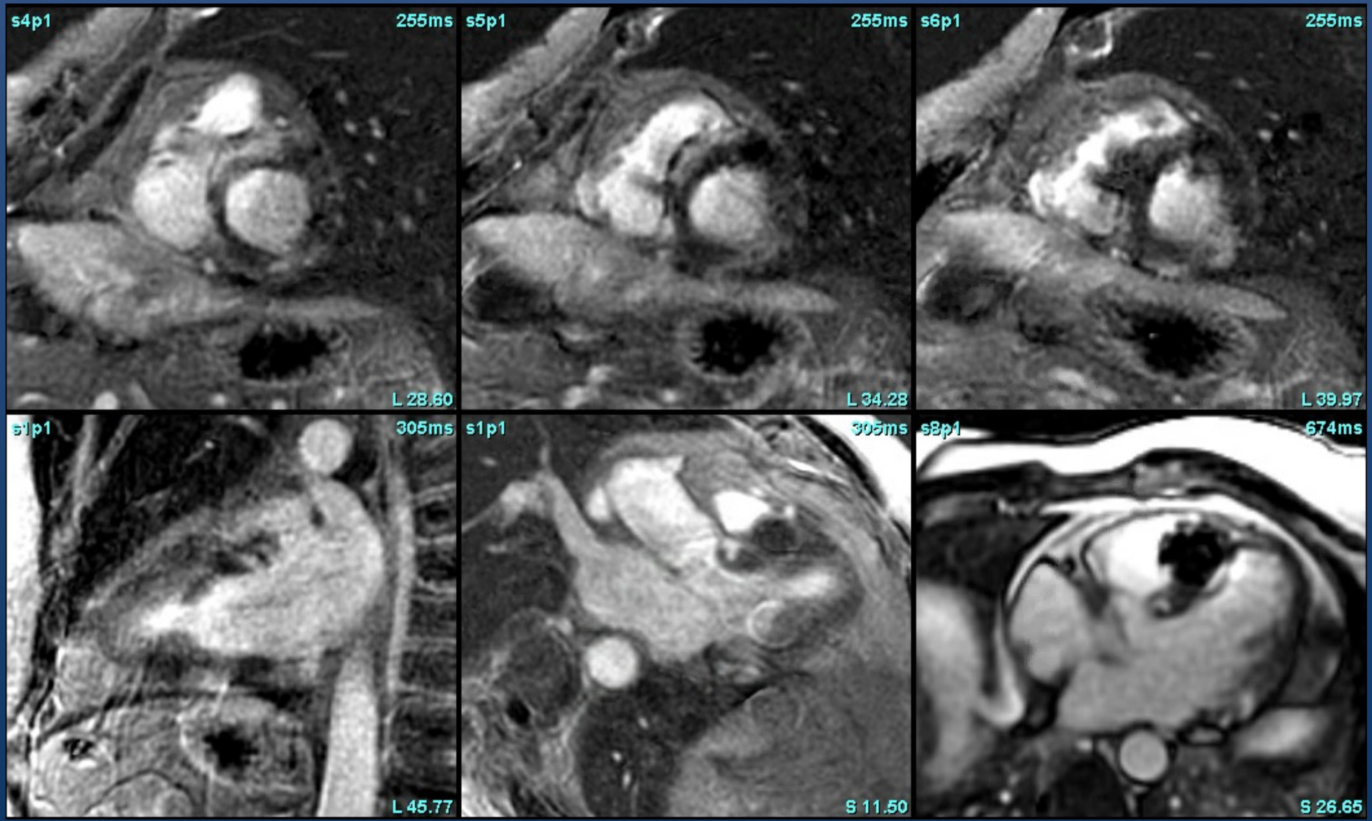






Cardiac Sarcoidosis





Evaluating Cardiac Masses

MR Imaging Tissue Characteristics of Common Cardiac Masses

Cardiac Mass	T1-weighted Imaging*	T2-weighted Imaging*	After Contrast Enhancement (LGE Imaging)
Pseudotumor			
Thrombus	Low (high if recent)	Low (high if recent)	No uptake†
Pericardial cyst	Low	High	No uptake
Benign			
Myxoma	Isointense	High	Heterogeneous
Lipoma	High‡	High‡	No uptake
Fibroma	Isointense	Low	Hyperenhancement§
Rhabdomyoma	Isointense	Isointense/high	No/minimal uptake
Malignant			
Angiosarcoma	Heterogenous	Heterogeneous	Heterogeneous
Rhabdomyosarcoma	Isointense	Hyperintense	Homogeneous
Undifferentiated sarcoma	Isointense	Hyperintense	Heterogeneous/variable
Lymphoma	Isointense	Isointense	No/minimal uptake
Metastasis‖	Low	High	Heterogeneous

Note.—Table presents typical characteristics, but all tumors can have atypical appearances owing to altered tissue composition.

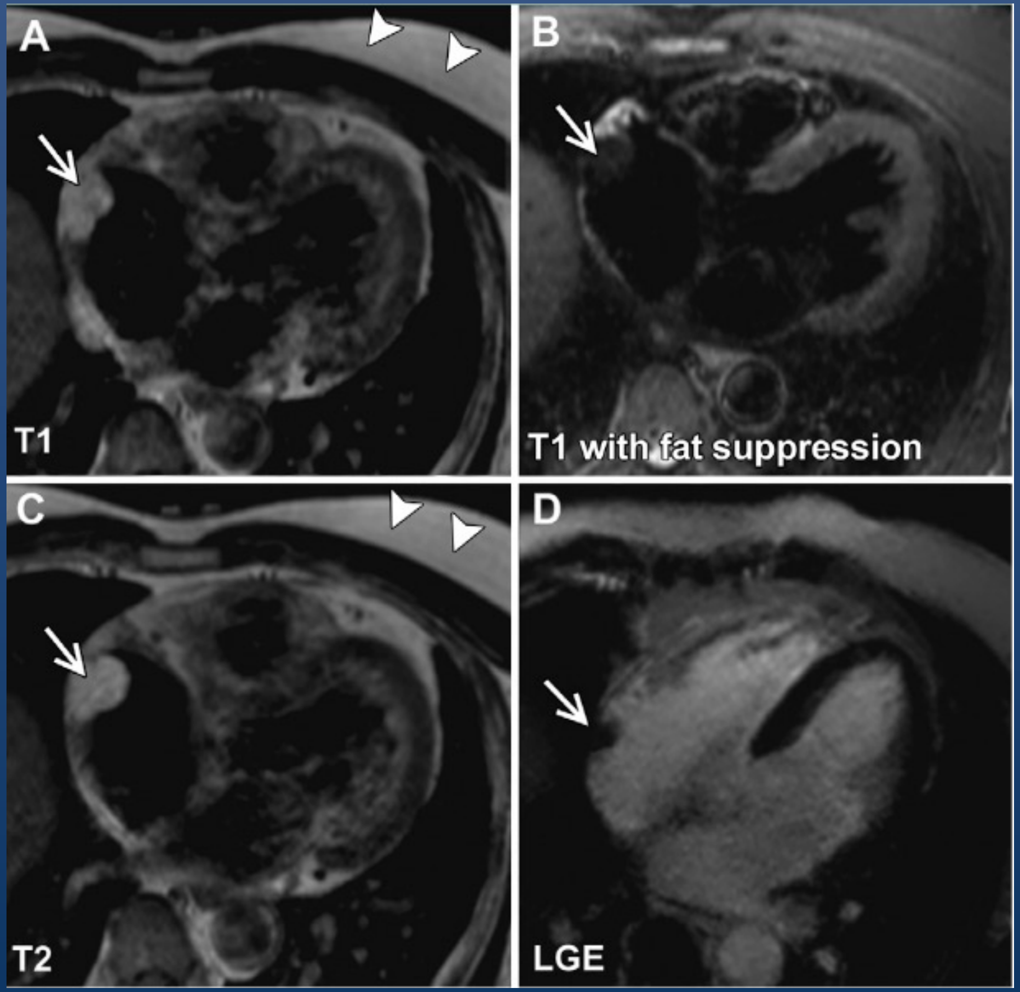
* T1- and T2-weighted imaging signal intensity is given relative to myocardium.

† Best seen on EGE images (no uptake) 2 minutes after contrast agent administration (Fig 1).

‡ Similar to surrounding fat signal intensity and characterized by marked suppression with a fat-saturation prepulse.

§ However, fibromas are nonenhancing at perfusion imaging because of avascularity.

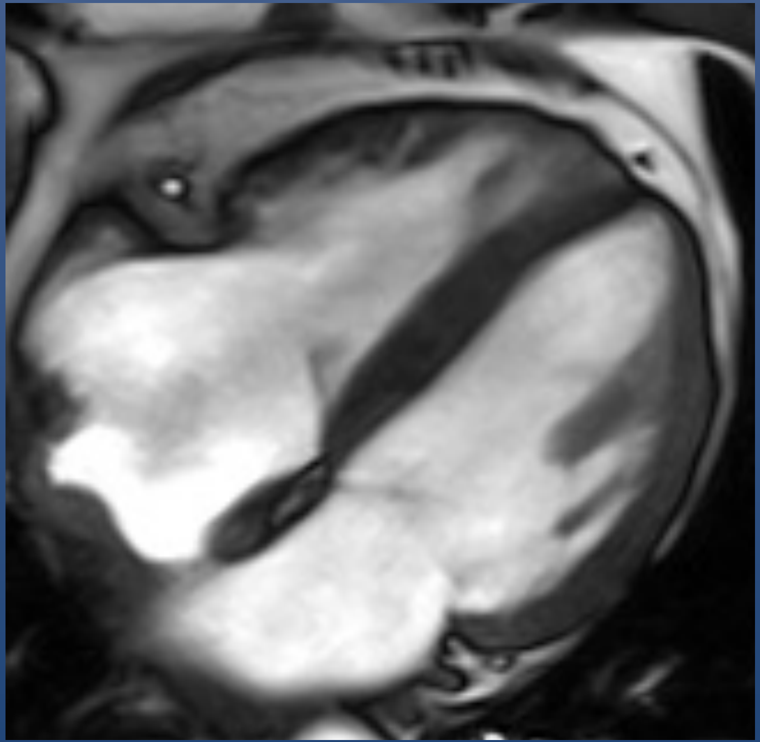
‖ The exception is metastatic melanoma ,which has a high T1-weighted and a low T2-weighted signal intensity.

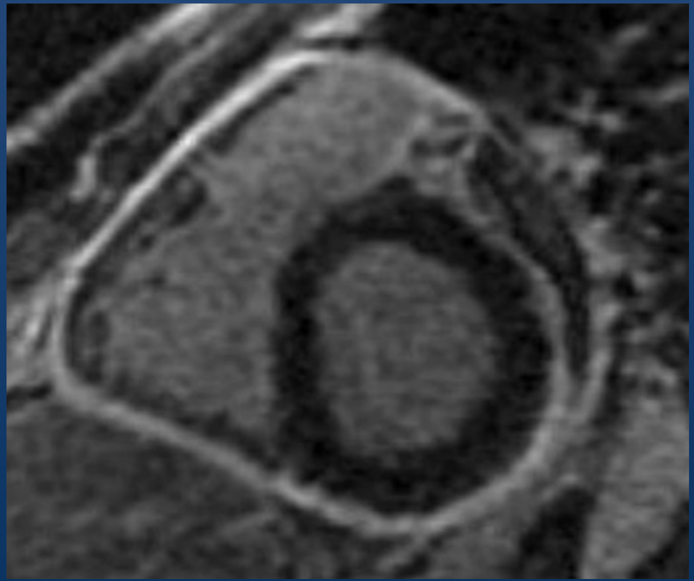


Motwani M, et al. MR Imaging of Cardiac Tumors and Masses. Radiology 2013;268:26–43.

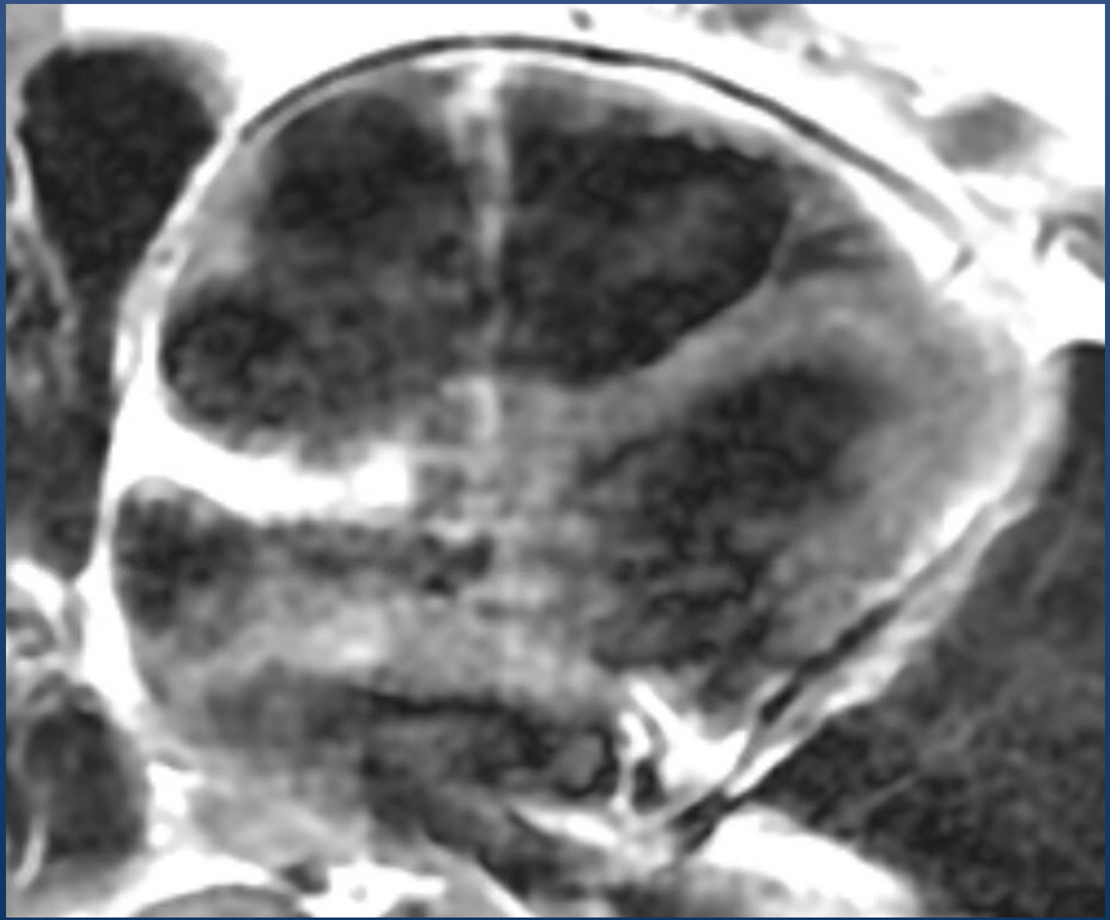
Pericardial Assessment

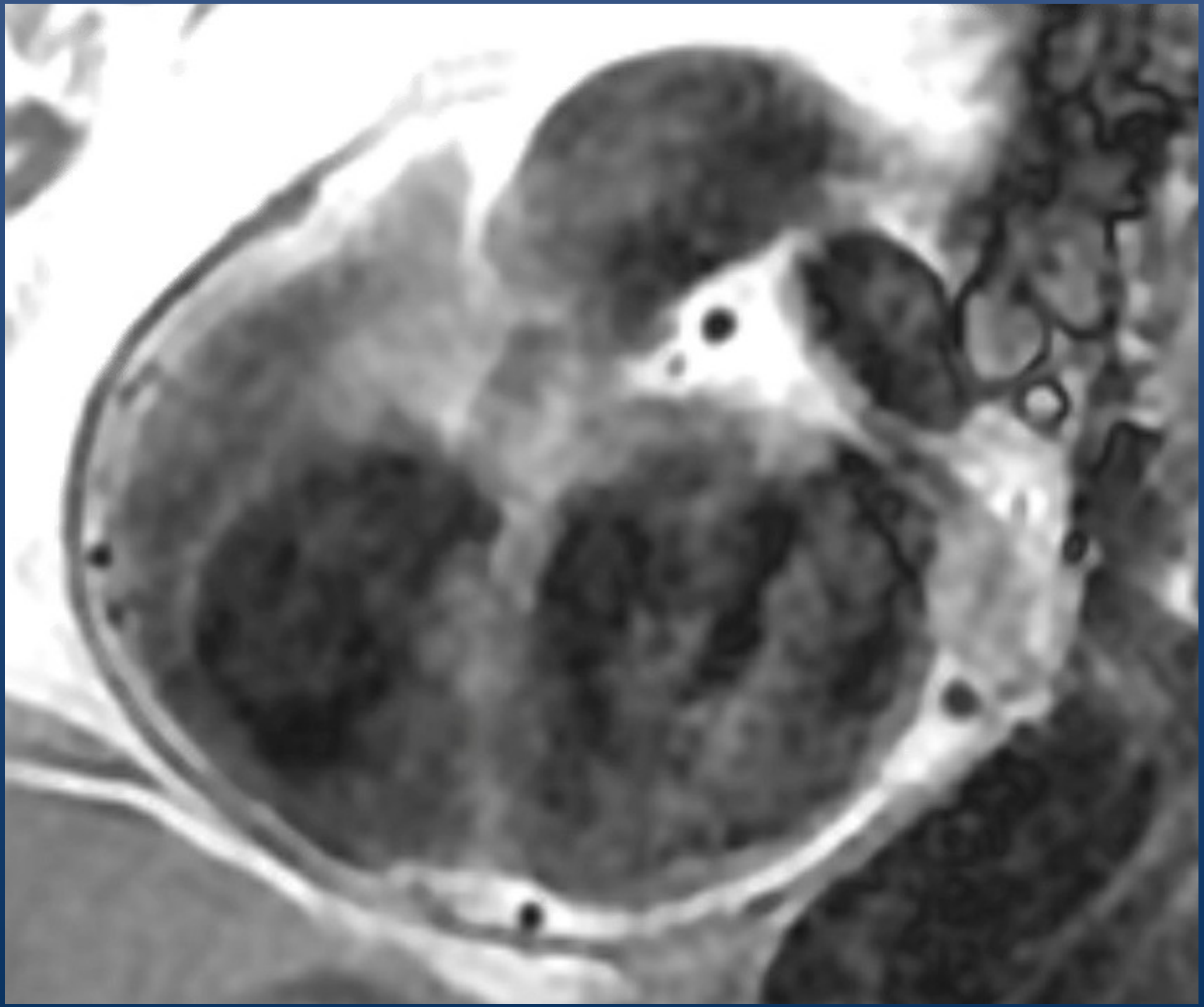
- CMR permits direct visualization of the normal pericardium, which measures <2 mm in thickness
- On SSFP imaging, pericardial fluid has a very bright signal in contrast to the dark line of the pericardium
- CMR is ideal for the detection of constrictive pericarditis, pericardial malignancy and congenital absence of the pericardium
- Pericardial enhancement seen after administration of contrast agent is suggestive of an inflammatory process



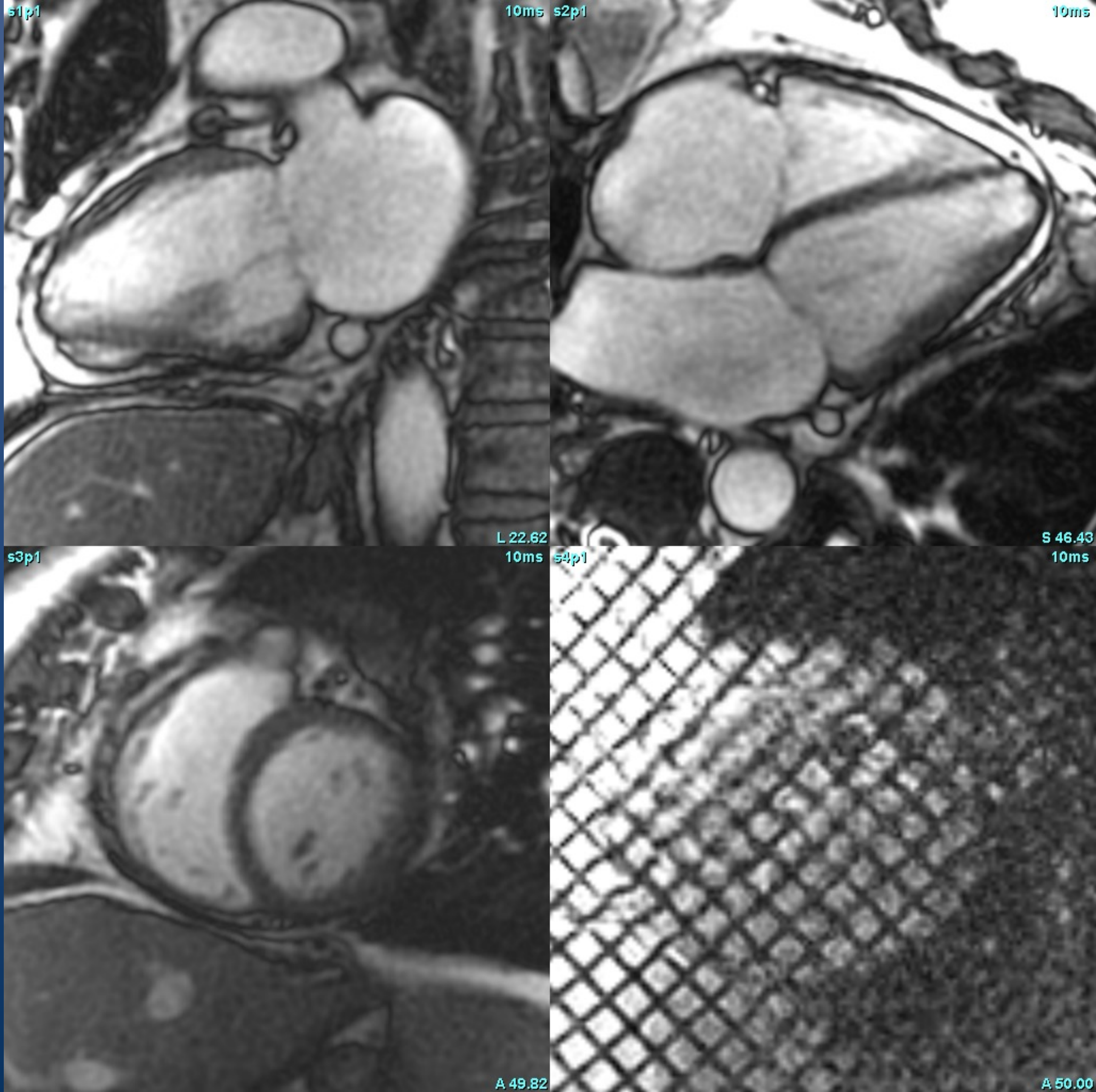


Pericardial Constriction

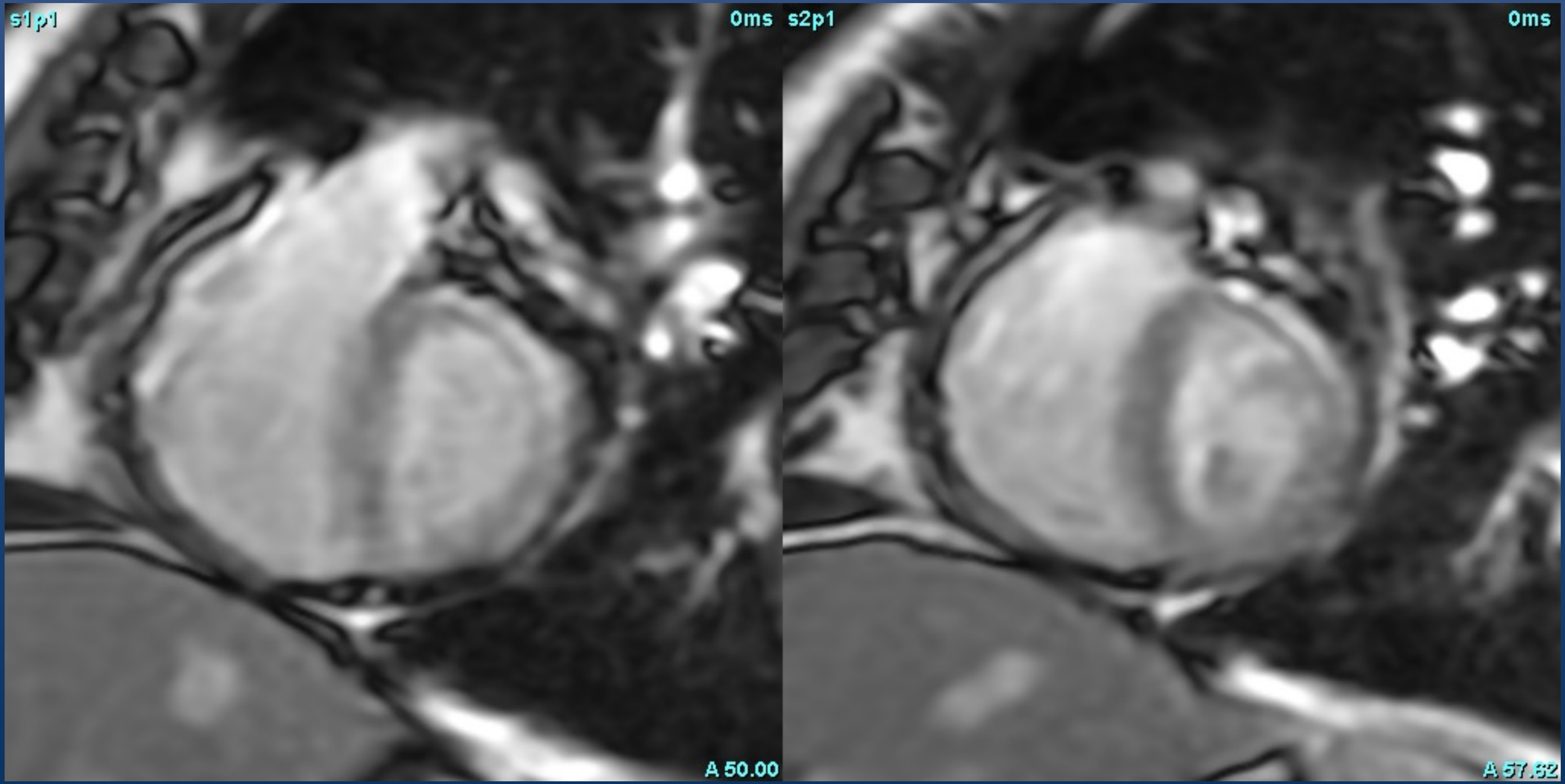




Pericardial Constriction



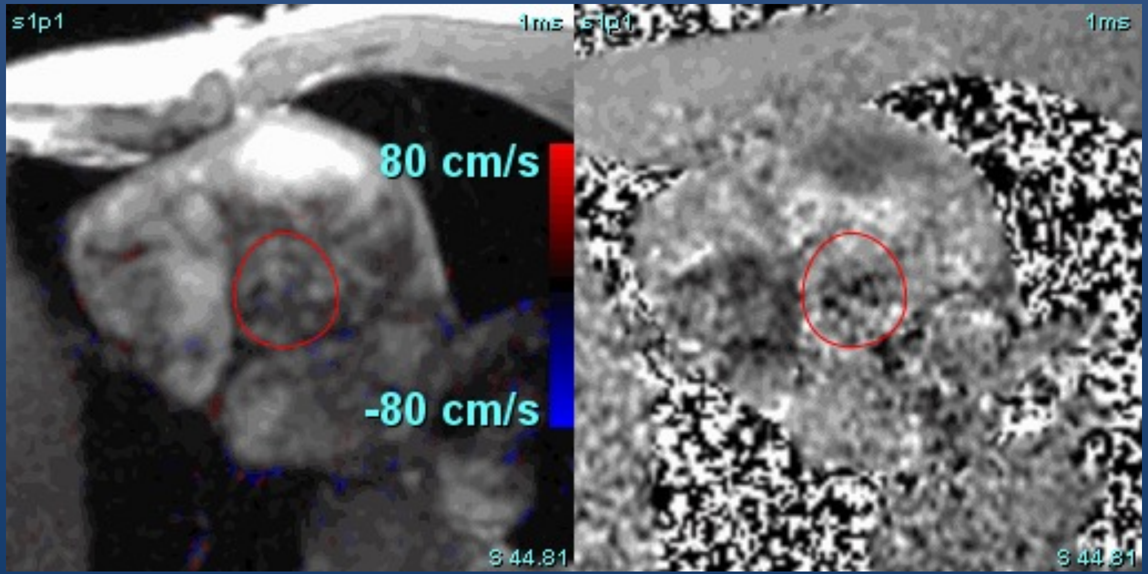
Pericardial Constriction

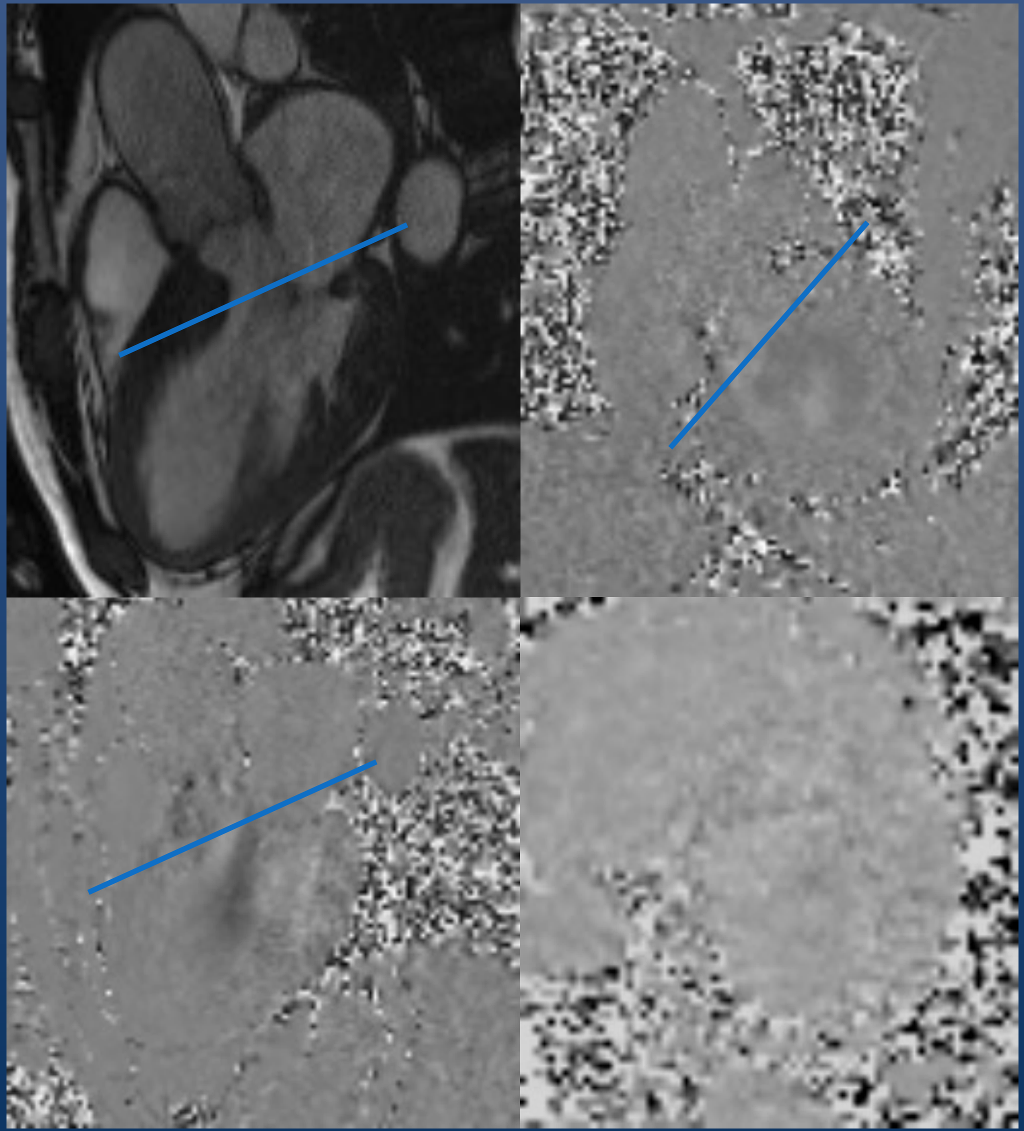


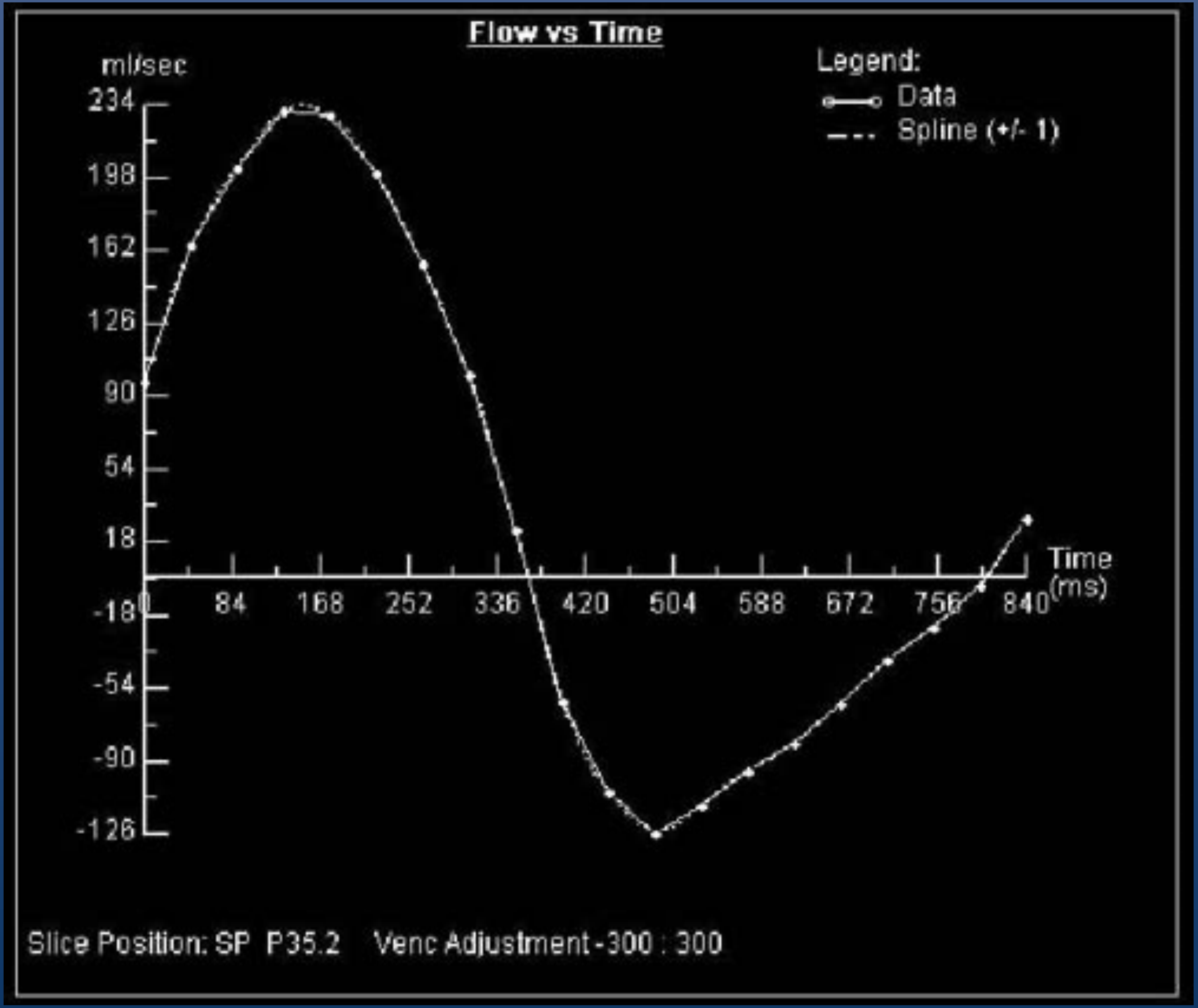
Velocity Encoding Imaging (Imaging Flowing Blood)

- Velocity encoded gradient echo imaging (VENC), also known as phase contrast imaging, is a technique for quantifying flowing blood
- Measuring the phase shift that occurs as protons in the blood move through a magnetic field, the velocity and direction of the blood can be obtained, and flow quantified
- VENC imaging is used to determine the relative flows in the systemic and pulmonary systems when evaluating:
  - Cardiac shunts
  - Regurgitant flow through a valve
  - Pressure gradients across a stenotic valve (echo is better for this)

Velocity Encoding Imaging

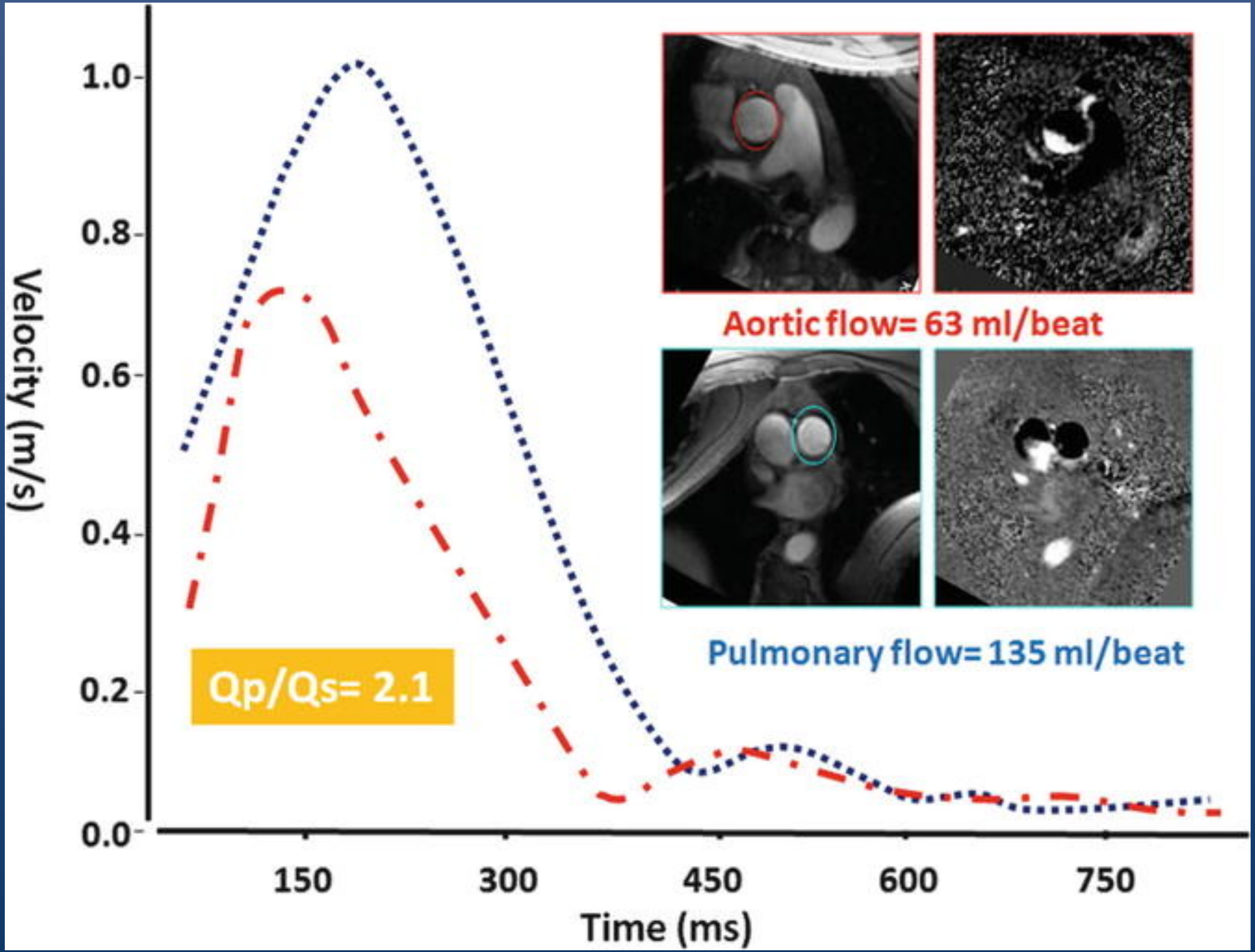






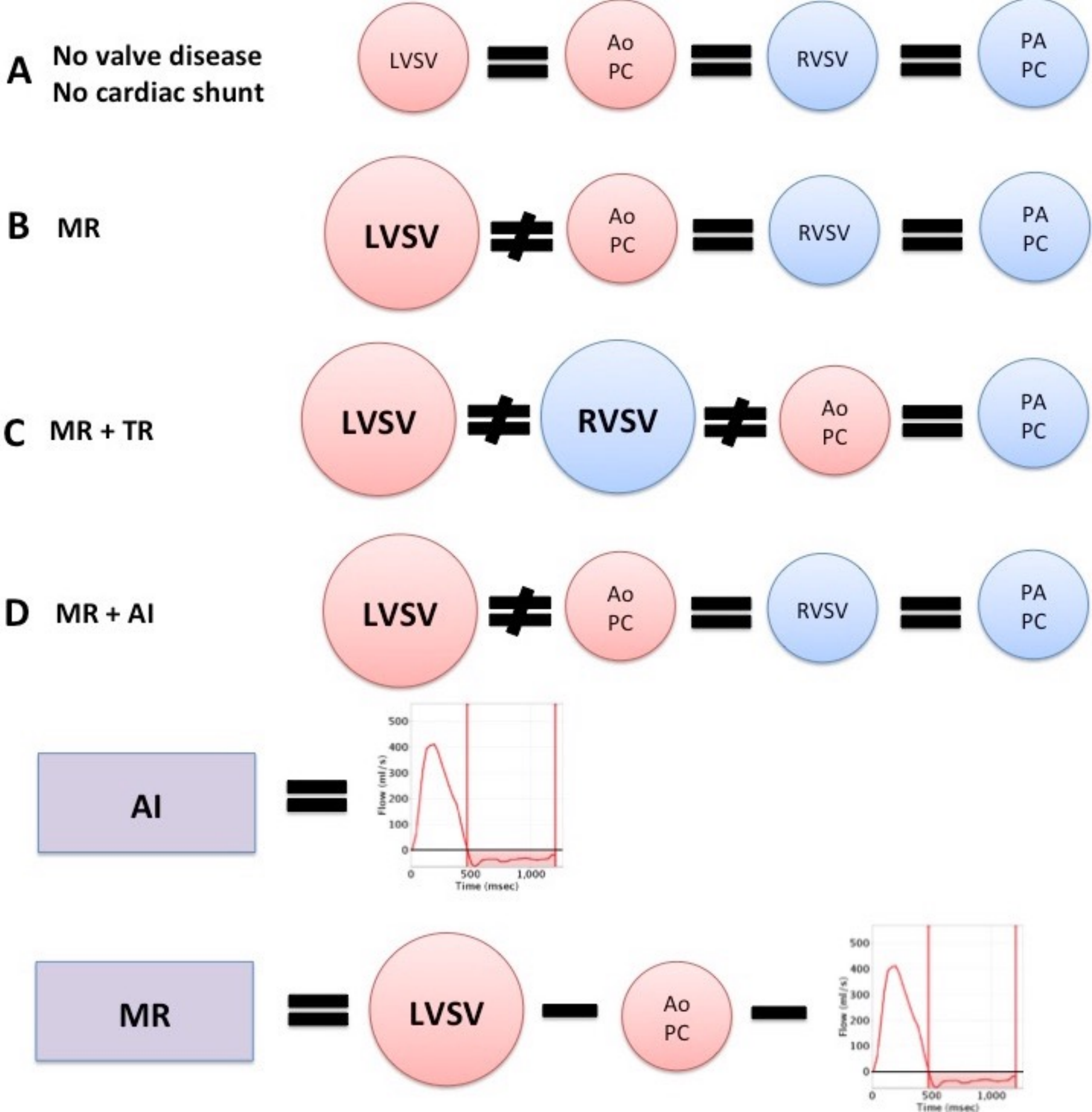
Cardiac MRI. Available at:
https://introductiontoradiology.net/courses/rad/CardiacMR/index.html

Qp/Qs Assessment for ASDs and Other Shunts

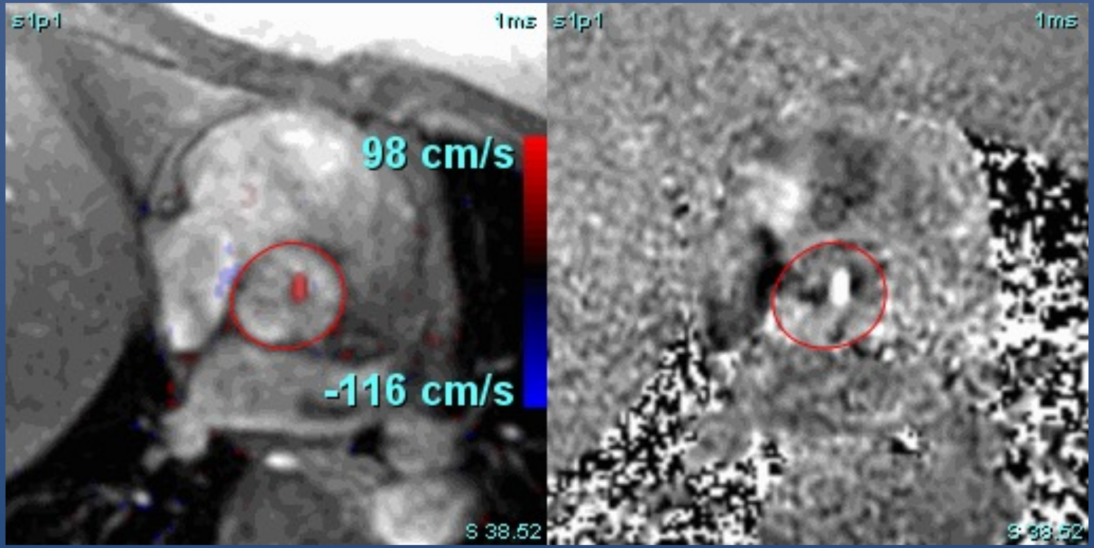


Cardiac Shunts: ASD, VSD, PDA. Radiology Key 2016.

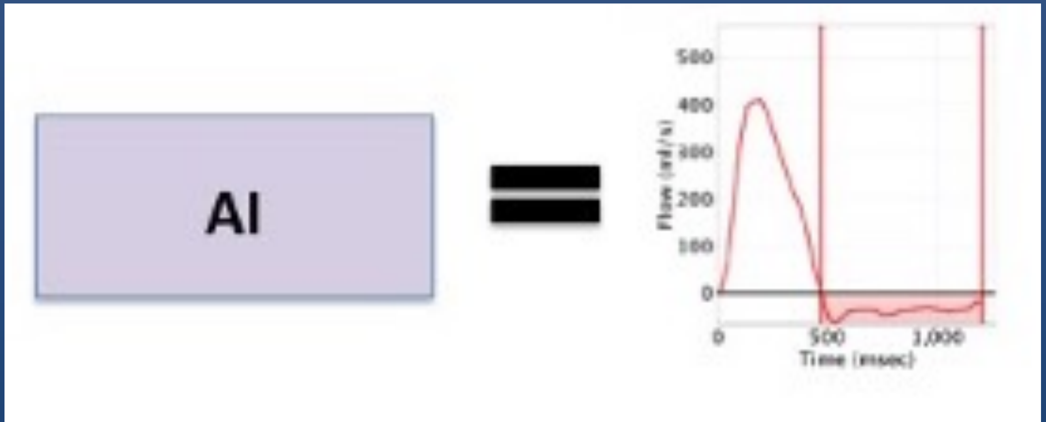
Quantification of Aortic and Mitral Regurgitation by CMR



Seth Uretsky. Quantification of Mitral Regurgitation Using MRI. American College of Cardiology. Available at: acc.org



Aortic Insufficiency Case



LV EF: 58 % (Normal 52-79%)

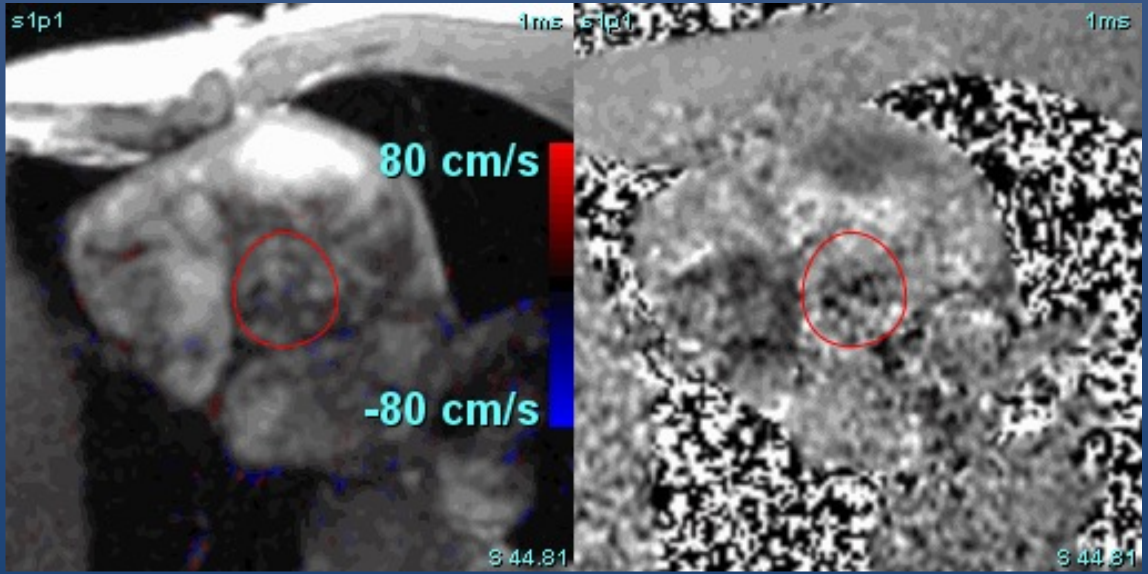
Absolute volumes:
LV EDV: 202 mL (Normal 70-155 mL)
LV ESV: 85 mL (Normal 15-64 mL)
LV SV: 117 mL (Normal 47-99 mL)
CO: 8.0 L/min (Normal 3.0-6.9 L/min)

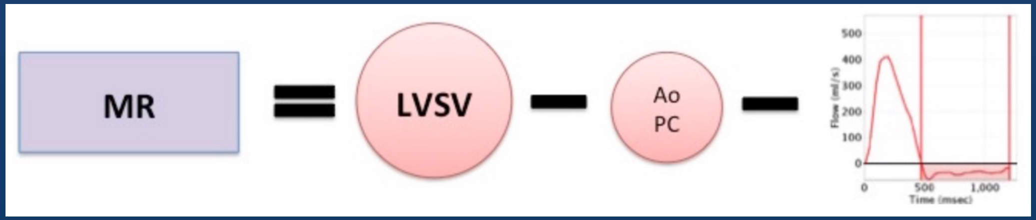
Indexed volumes Height 63" (160 cm) Weight 270 lb (122.5 kg)

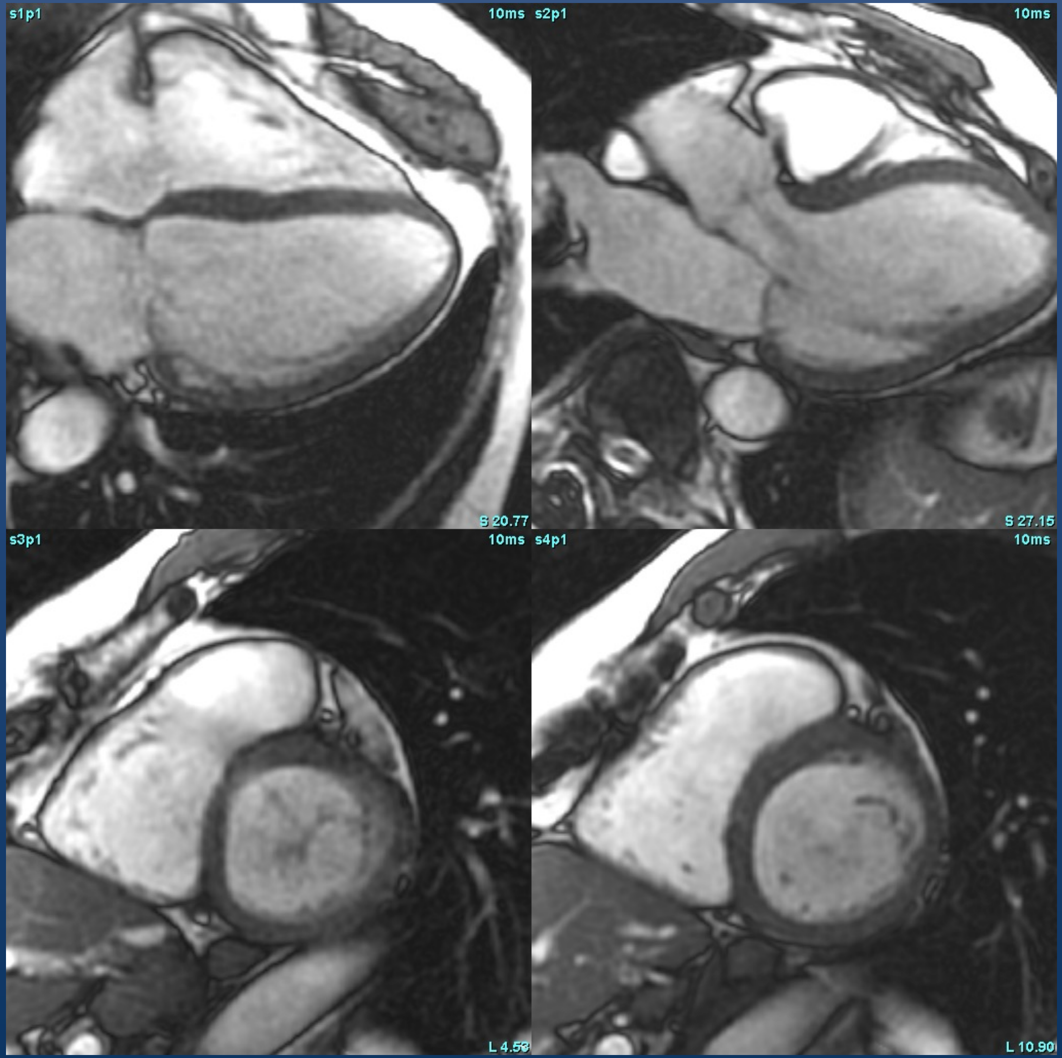
LV EDV: 92 mL/sq-m (Normal 45-93 mL/sq-m)
LV ESV: 38 mL/sq-m (Normal 10-38 mL/sq-m)
LV SV: 53 mL/sq-m (Normal 30-59 mL/sq-m)
CI: 3.6 L/min/sq-m (Normal 1.9-4.0 mL/sq-m)

Regurgitant fraction = -20%

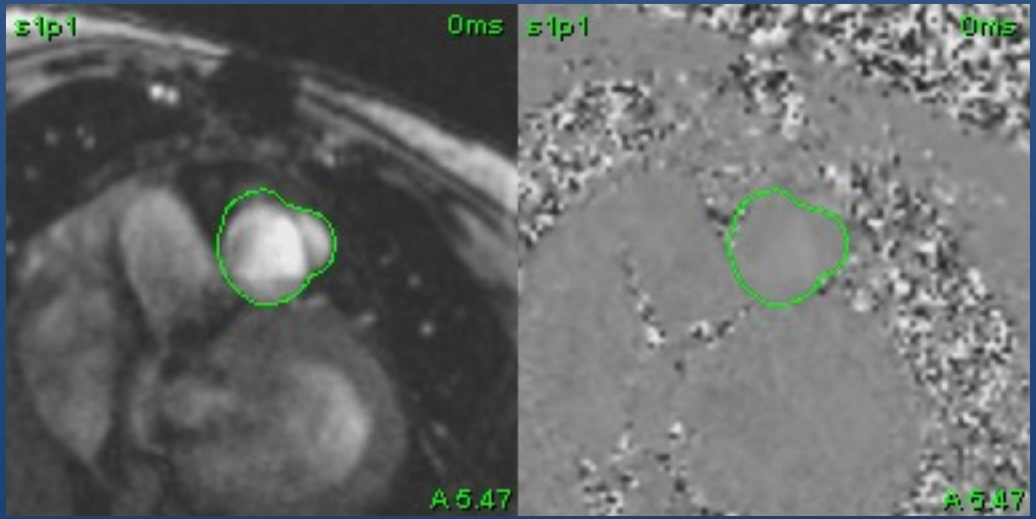
Mitral Regurgitation







Pulmonic Insufficiency



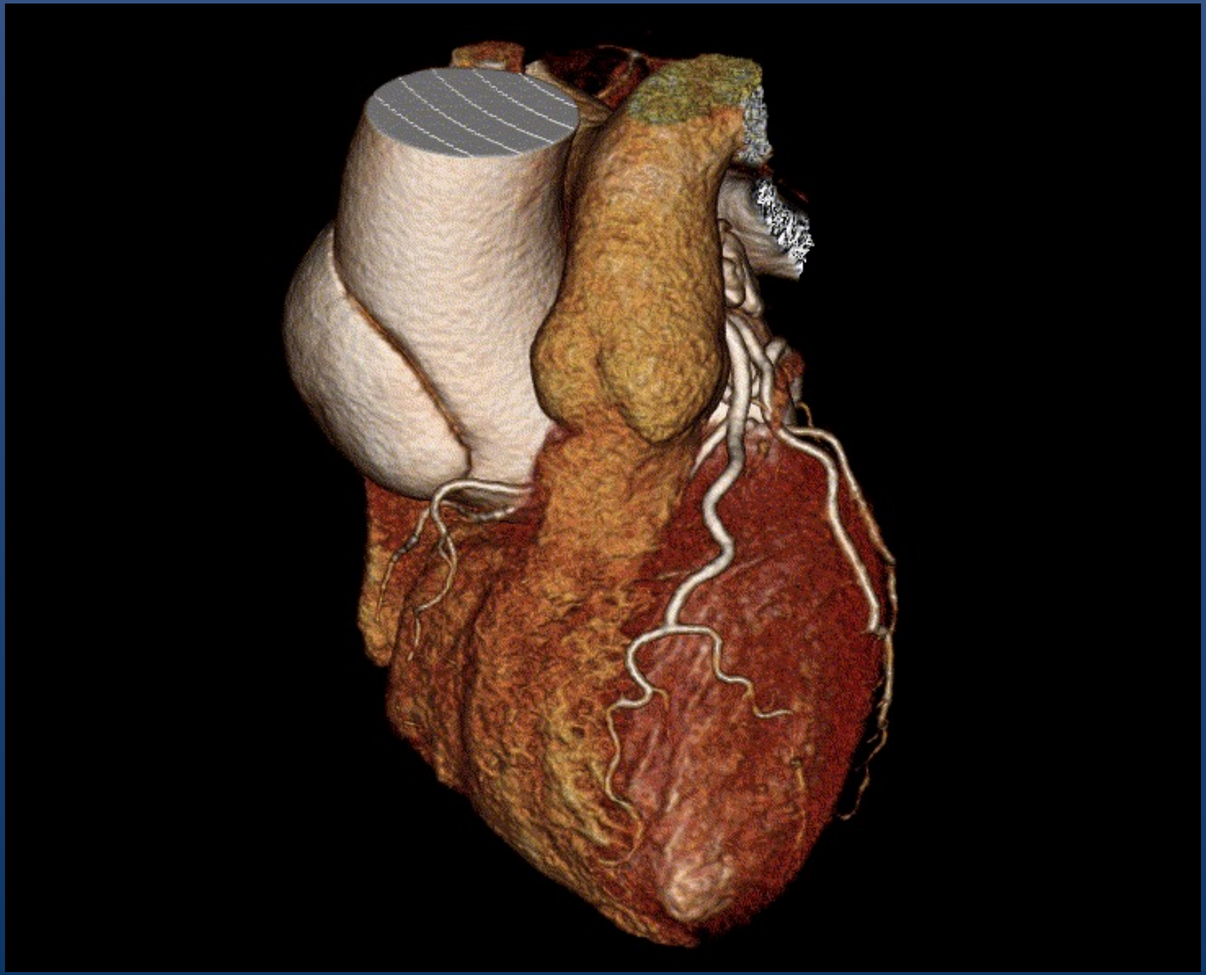
Regurgitant Fraction -53.2 %

What does CMR really offer?
CMR has a lot to offer!

1) Gold standard for the quantitative assessment of cardiac morphology, volume and function
2) Tissue characterization
   - Edema (acute, potentially reversible injury)
   - Necrosis or scar (irreversible injury and viability)
   - Infiltration/storage (abnormal tissue components)
   - Pericardial assessment (physiology and tissue assessment)
   - Cardiac mass assessment
3) Velocity encoding data (assessing flow through the heart, regurgitant lesions, stenosis, etc.)

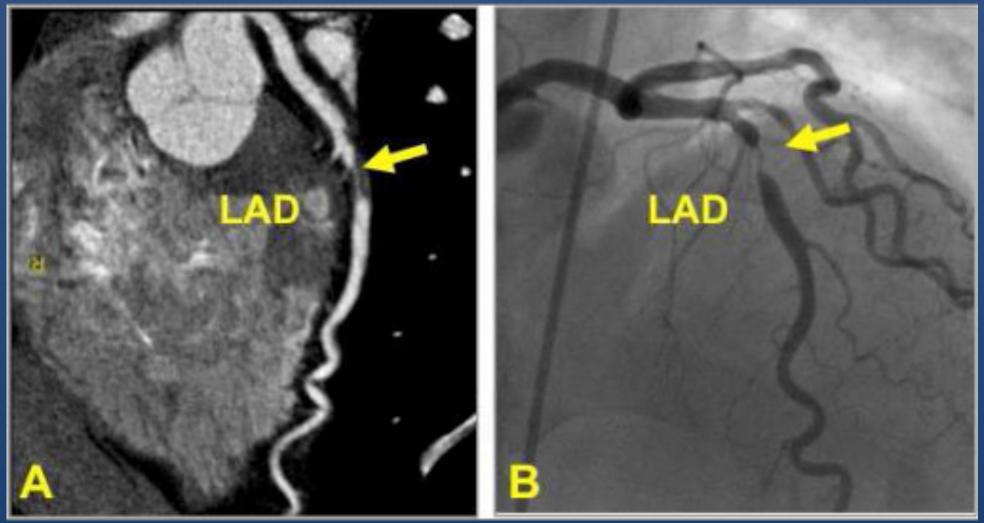
Coronary CTA (CCTA) in 2022

- Common Indications
- 2021 Chest Pain Guidelines

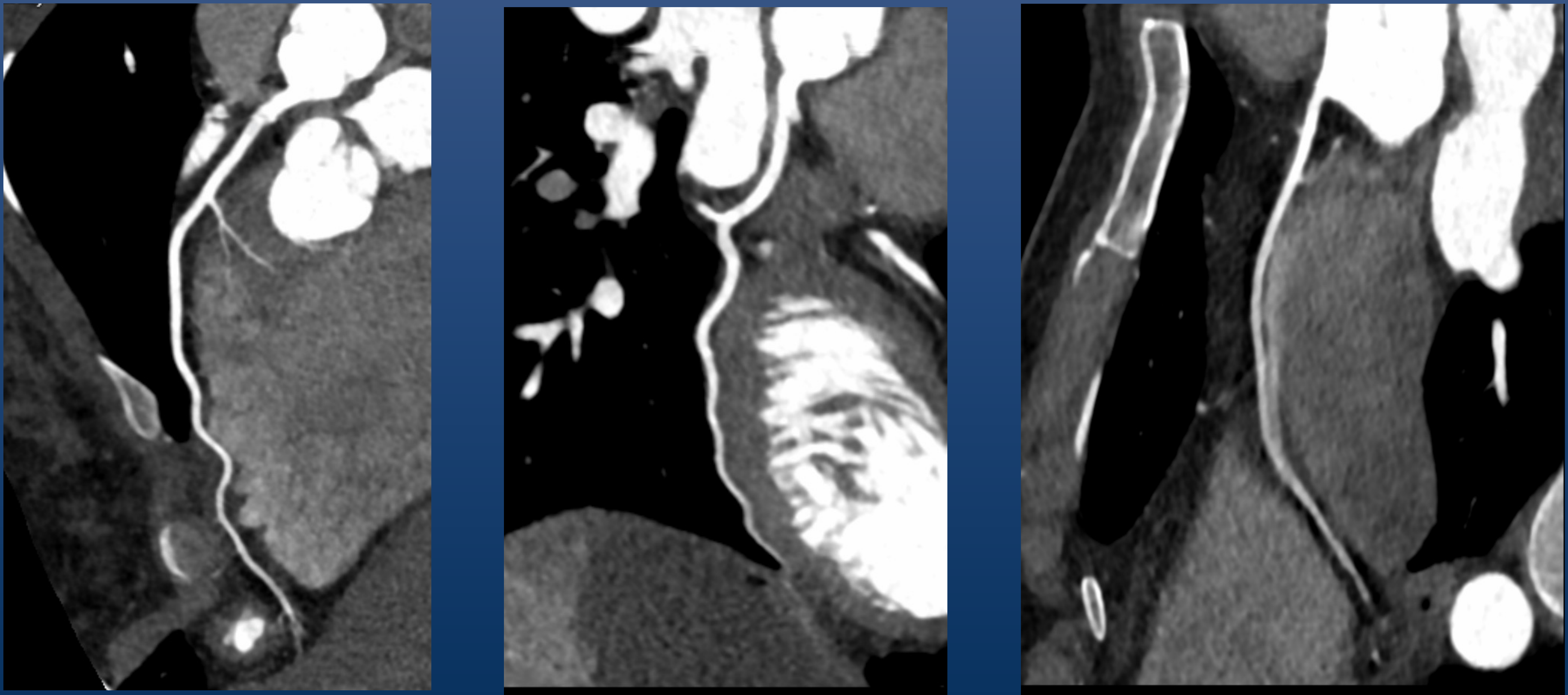


What is a CCTA?

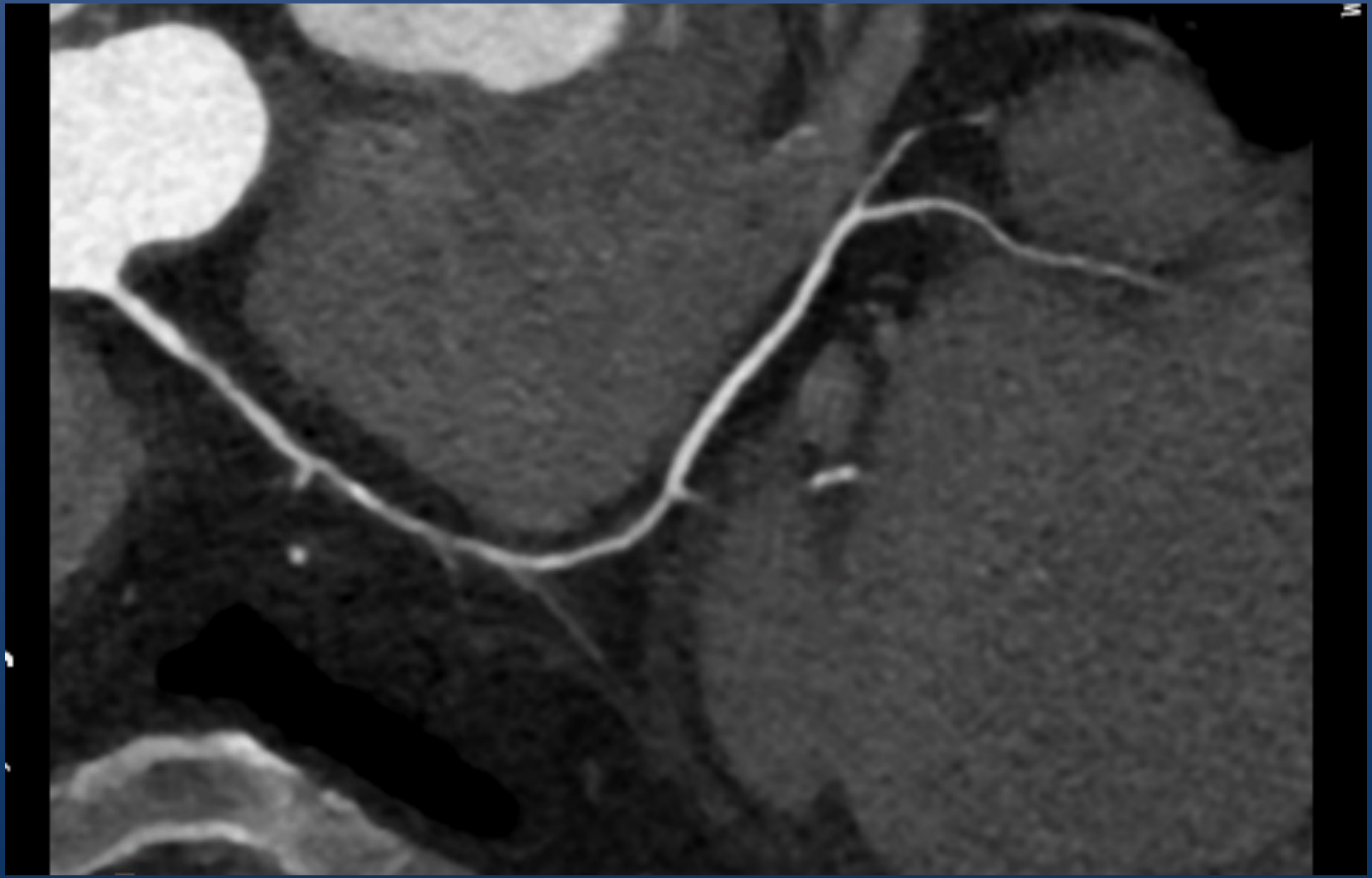
- CCTA is a well-validated and increasingly utilized noninvasive test for the assessment of CAD in appropriately selected patients with suspected acute or chronic coronary syndromes
- In addition to detecting CAD, CCTA is an excellent method to exclude angiographically significant coronary stenoses.



Normal Study



Abnormal RCA



CCTA reporting
CAD-RADS™

- CAD-RADS™ is an expert consensus document produced by a multi-society, multidisciplinary working group
- Goal of improving communication of CCTA results to referring physicians
- Standardizes the reporting of CCTA
- CAD-RADS™ can also be used as a decision-making tool

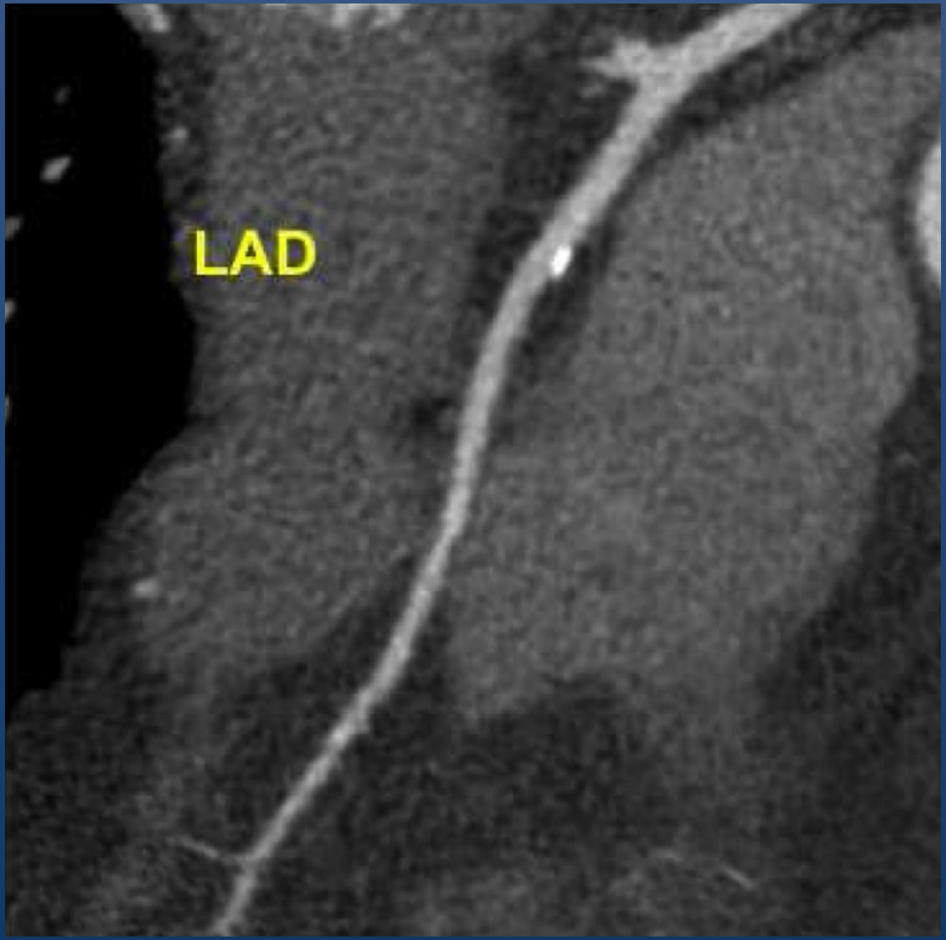
Cad-Rads	Stenosis	CT imaging	Illustration	Additional Tests
Cad-Rads **0**	0% No stenosis	LAD		None
Cad-Rads **1**	1-24% Minimal stenosis	LAD		None
Cad-Rads **2**	25-49% Mild stenosis	RCA		None
Cad-Rads **3**	50-70% Moderate stenosis	LCX		Consider functional assessment
Cad-Rads **4**	A: 70-99% stenosis in 1 or 2 vessels B: >50% stenosis in the left main or >70% stenosis in 3-vessels	LAD		A: Consider functional assessment or ICA B: ICA is recommended
Cad-Rads **5**	100% total occlusion	RCA		ICA and/or viability assessment
Cad-Rads **N**	Non-diagnostic study	RCA		Additional evaluation

Cury S, et al. JCCT 2016;10:269–281 & https://radiologyassistant.nl

	Degree of maximal coronary stenosis	Interpretation	Further Cardiac Investigation	Management
CAD-RADS 0	0% (No plaque or stenosis)	Documented absence of CAD[a]	None	- Reassurance. Consider non- atherosclerotic causes of chest pain
CAD-RADS 1	1–24% - Minimal stenosis or plaque with no stenosis[b]	Minimal non-obstructive CAD	None	- Consider non- atherosclerotic causes of chest pain - Consider preventive therapy and risk factor modification
CAD-RADS 2	25–49% Mild stenosis	Mild non-obstructive CAD	None	- Consider non- atherosclerotic causes of chest pain - Consider preventive therapy and risk factor modification, particularly for patients with non-obstructive plaque in multiple segments.
CAD-RADS 3	50–69% stenosis	Moderate stenosis	Consider functional assessment	- Consider symptom-guided anti-ischemic and preventive pharmacotherapy as well as risk factor modification per guideline-directed care[c] - Other treatments should be considered per guideline-directed care[c]
CAD-RADS 4	**A** - 70–99% stenosis or **B** - Left main >50% or 3- vessel obstructive (≥70%) disease	Severe stenosis	A: Consider ICA[d] or functional assessment B: ICA is recommended	- Consider symptom-guided anti-ischemic and preventive pharmacotherapy as well as risk factor modification per guideline-directed care[c] - Other treatments (including options of revascularization) should be considered per guideline-directed care[c]
CAD-RADS 5	100% (total occlusion)	Total coronary occlusion	Consider ICA and/or viability assessment	- Consider symptom-guided anti-ischemic and preventive pharmacotherapy as well as risk factors modification per guideline-directed care[c] - Other treatments (including options of revascularization) should be considered per guideline-directed care[c]
CAD-RADS N	Non-diagnostic study	Obstructive CAD cannot be excluded	Additional or alternative evaluation may be needed	

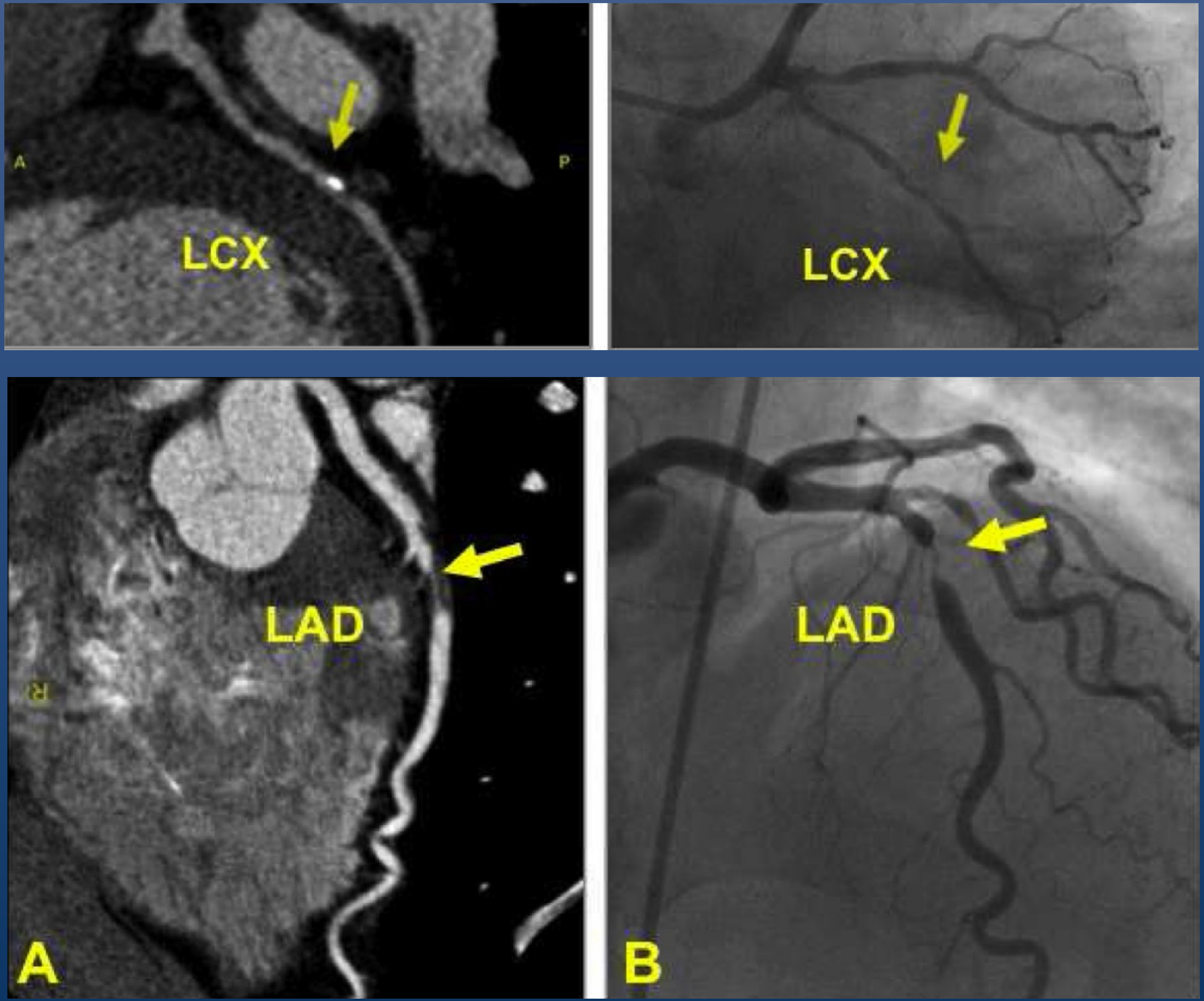
Cury S, et al. Journal of Cardiovascular Computed Tomography 2016;10:269–281.

CAD-RADS™ Examples

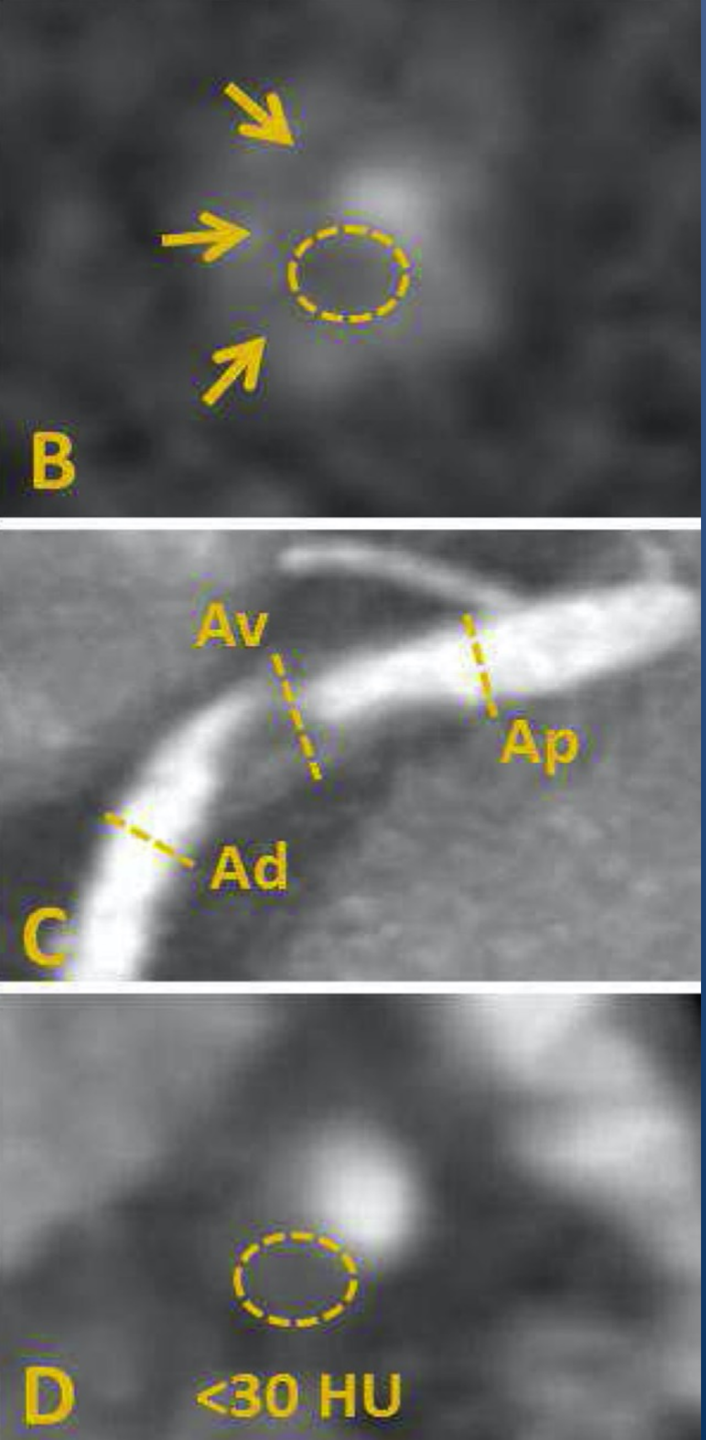


Cury S, et al. Journal of Cardiovascular Computed Tomography 2016;10:269–281.

CAD-RADS™ Examples



Cury S, et al. Journal of Cardiovascular Computed Tomography 2016;10:269–281.



High Risk Features on CCTA

Cury S, et al. Journal of Cardiovascular Computed Tomography 2016;10:269–281.

Observational Trials in the ED

Study	N	Scanner	ACS risk	Inclusion criteria	ACS definition	ACS rate	Outcome (follow-up)	CT criterion	SE (%)	SP (%)	PPV (%)	NPV (%)
Rubinshtein, et al	58	64-CT	Intermediate	Negative troponin; normal ECG	CAG≥50%, positive troponins or positive stress test	34%	MACE (15 months)	Stenosis ≥50%	100	92	87	100
Gallagher, et al	85	64-CT	Low	Negative troponin; normal ECG	AMI, UA + CAG>70%	8%	Cardiac death or ACS (30 days)	Stenosis >50% CS > 400	86	92	50	99
Johnson, et al	109	64-DSCT	All	Negative troponin; non-ischemic ECG	CAG >50%	14%	ICA (6 months)	Stenosis >50% (per segment)	100	99	79	100
Beigel, et al	340	MDCT	Low-intermediate	Negative troponin; non-ischemic ECG	CAG significant stenosis	4.40%	MACE (5 months)	Stenosis >50%	100	97	65	100
ROMICAT	368	64-CT	Low	Negative troponin; non-ischemic ECG	AMI, UA	8.40%	MACE (6 months)	Plaque	100	92	87	100
								Stenosis >50%	77	87	35	98
Dedic, et al	111	64-DSCT	All	TnT ≤0.15 µg/mL	AMI, UA	17%	AMI or revascularization (3 months)	Calcium	89	41	24	95
								Any plaque	100	40	26	100
								Stenosis	89	79	47	97

Rubinshtein R, et al. Am. J. Cardiol 2007;99:925–929. Gallagher MJ, et al. Annals of Emergency Medicine 2007;49:125–136.
Johnson TRC, et a. Eur Radiol 2008;18:773–780. Beigel R, et al. Am. J. Cardiol. 2009;103:1481–1486.
Hoffmann U, et al. JACC 2009;53:1642–1650. Dedic A, et al. International Journal of Cardiology 2013;167:1597–1602.

Indications for CCTA (Most Common)

1. CCTA be used as an initial test in patients with stable symptoms suggestive of ischemic chest pain who do not have known CAD
2. CCTA can be used as an alternative to invasive coronary angiography in patients with nondiagnostic or equivocal stress test results and persistent symptoms in whom a diagnosis of CAD is uncertain
3. Evaluate for coronary anomalies or other anatomic considerations (more common in pediatrics)

Indications for CCTA (Intermittently Used)

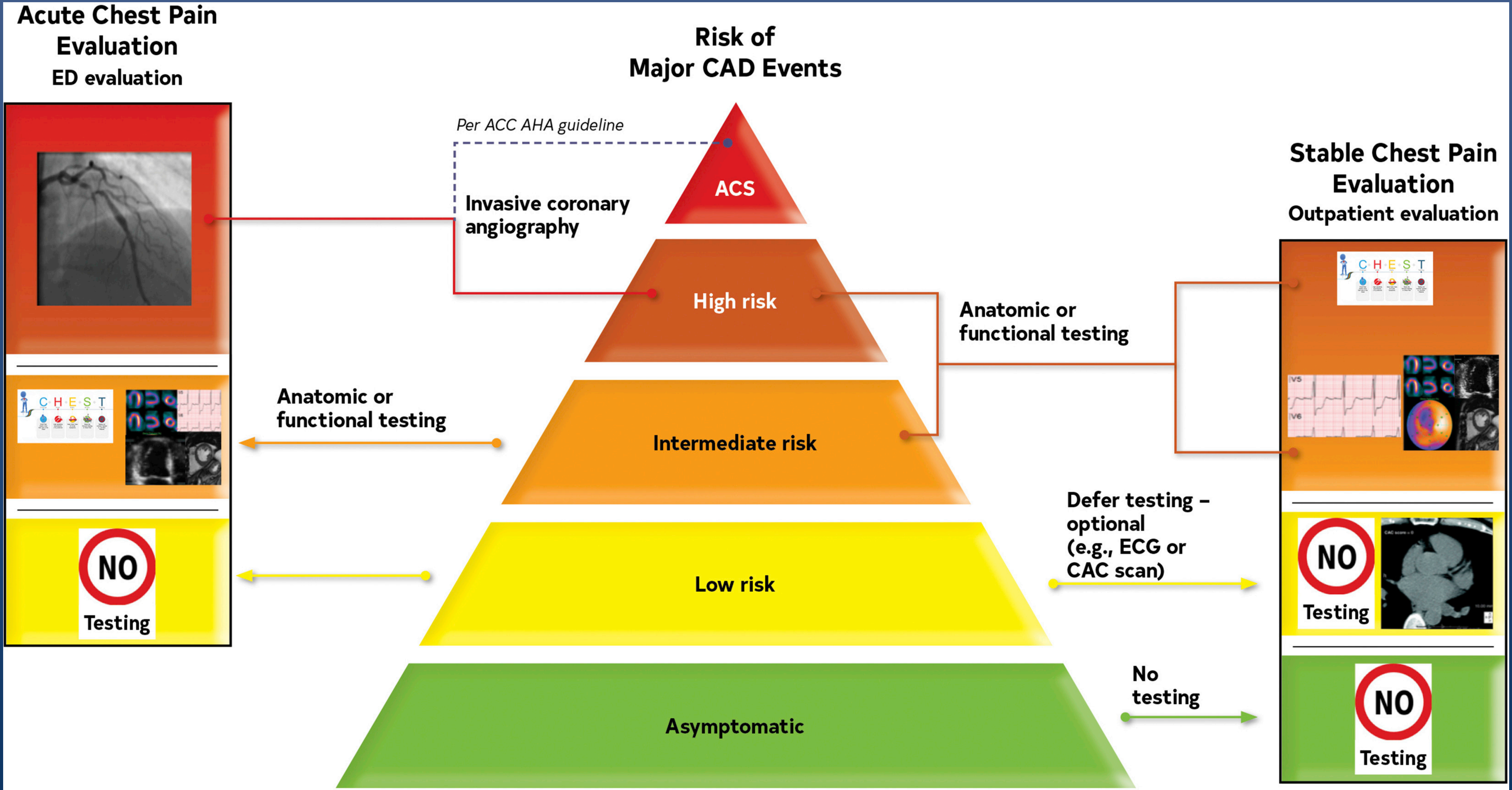
- As the initial test in patients without known CAD who present with possible ACS when troponin testing and the clinical evaluation cannot exclude ACS
- Or when the cause for troponin elevation is uncertain or strongly felt to be non-ACS in origin
- BUT, CCTA should not be performed in patients with ongoing chest pain who may have ACS - CT suites are not generally equipped to manage unstable patients
- Used to simultaneously evaluate the aorta and pulmonary arteries (triple rule out study)
- Evaluation of bypass grafts

Indications for CCTA (Rarely Used)

- Evaluation of coronary stent patency
- Alternative to stress testing or ICA in patients without known CAD with NSTEMI and low-risk presentation (no heart failure or unstable symptoms), and there is a desire to avoid invasive coronary angiography

2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain

A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines



Gulati M, et al. J Am Coll Cardiol. 2021;78:e187–e285.

Choosing the right test – CCTA or stress testing?

	Favors use of CCTA	Favors use of stress imaging
Goal	• Rule out obstructive CAD • Detect nonobstructive CAD	• Ischemia-guided management
Availability and expertise	• High-quality imaging and expert interpretation routinely available	• High-quality imaging and expert interpretation routinely available
Likelihood of obstructive CAD	• Age <65 y	• Age ≥65 y
Prior test results	• Prior functional study inconclusive	• Prior CCTA inconclusive
Other compelling indications	• Anomalous coronary arteries • Require evaluation of aorta or pulmonary arteries	• Suspect scar (especially if PET or stress CMR available) • Suspect coronary microvascular dysfunction (when PET or CMR available)

Gulati M, et al. J Am Coll Cardiol. 2021;78:e187–e285.

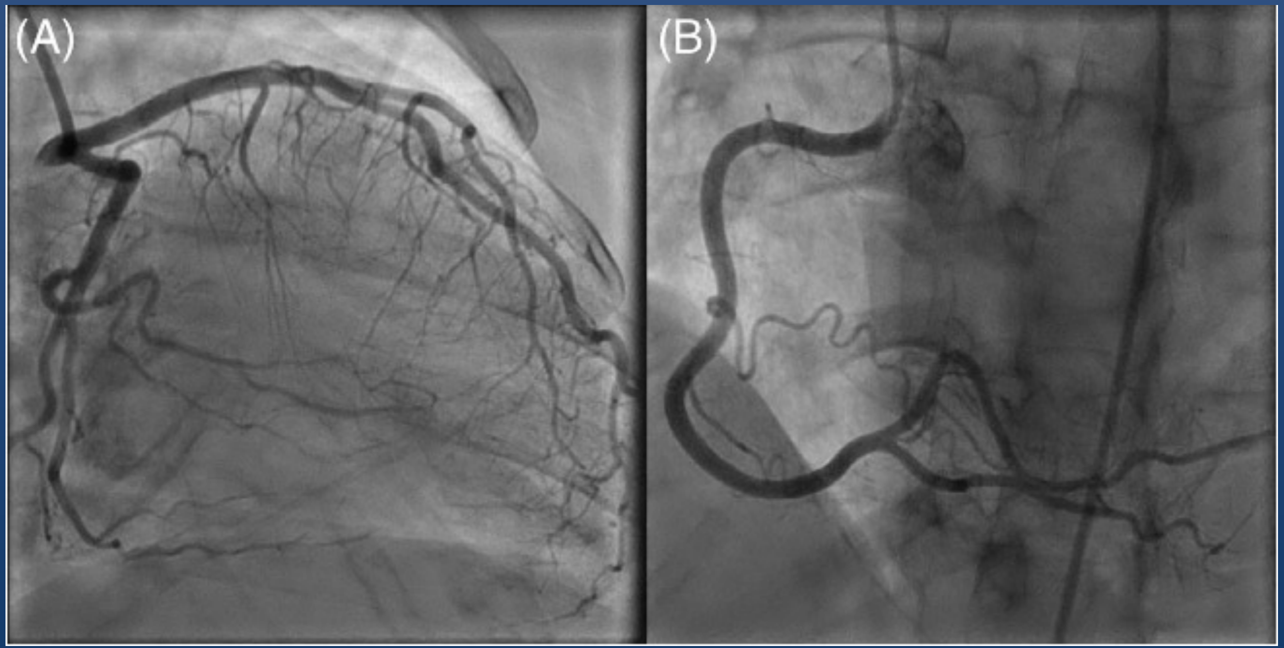
Choosing the right test within stress testing

Stress testing information					
	ETT	Stress echocardiography	SPECT MPI	PET MPI	Stress CMR MPI
Patient capable of exercise	✓	✓	✓		
Pharmacologic stress indicated		✓	✓	✓	✓
Quantitative flow				✓	✓
LV dysfunction/scar		✓	✓	✓	✓

Gulati M, et al. J Am Coll Cardiol. 2021;78:e187–e285.

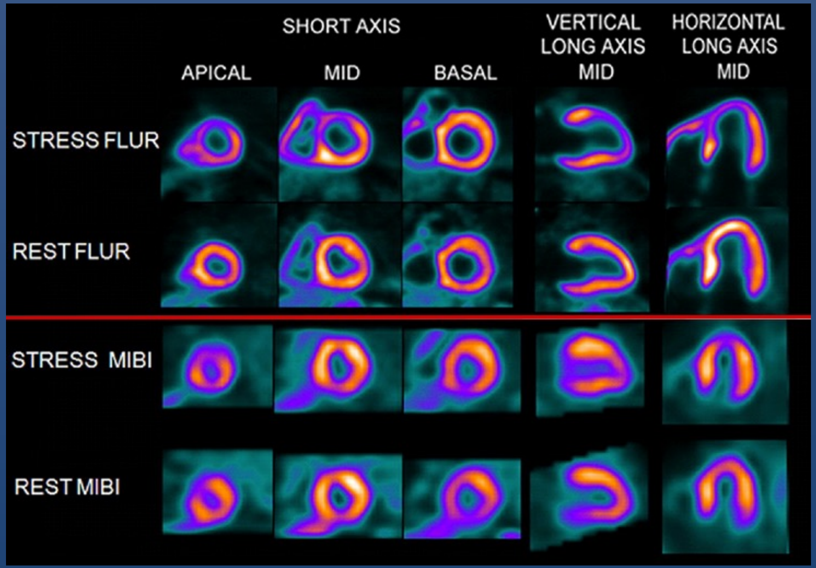
Anatomic vs. Functional Imaging

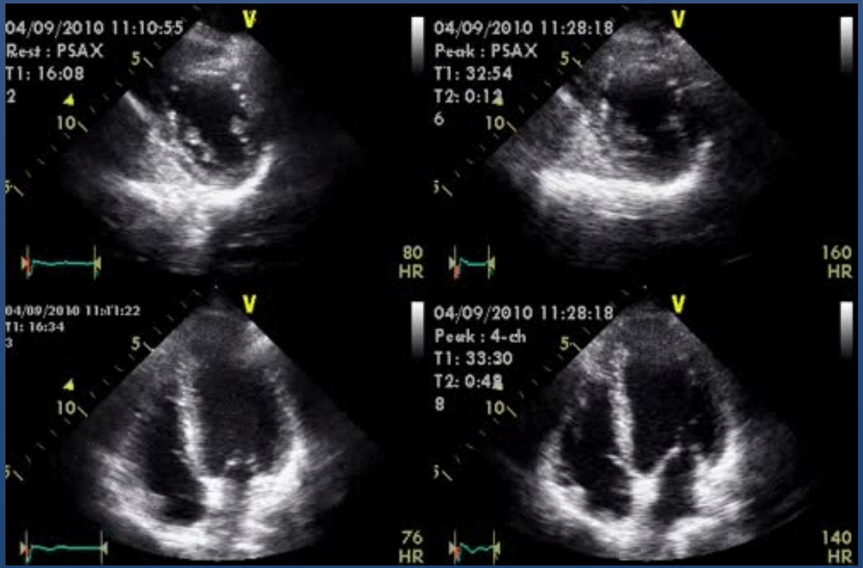
CCTA

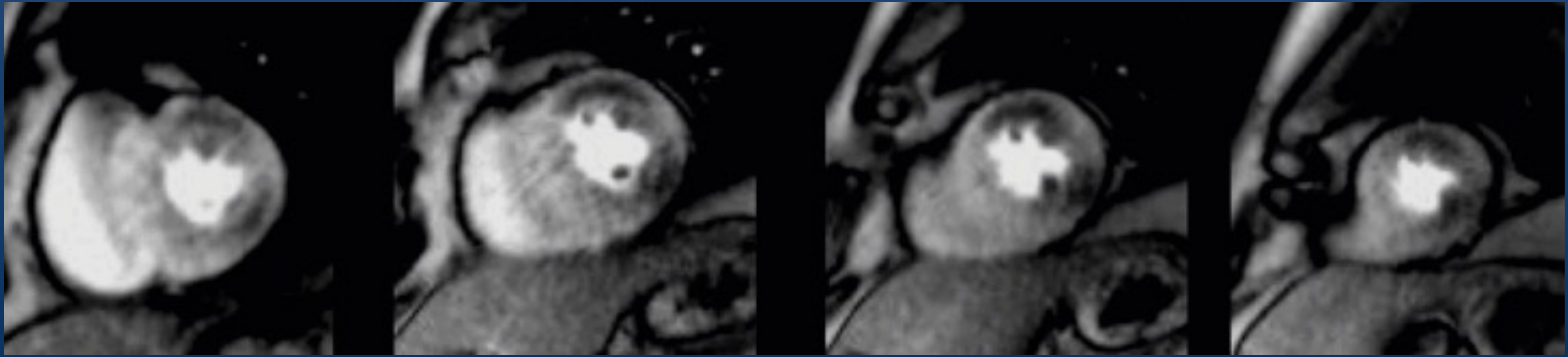


Invasive Coronary Angiography

Anatomic vs. Functional Imaging



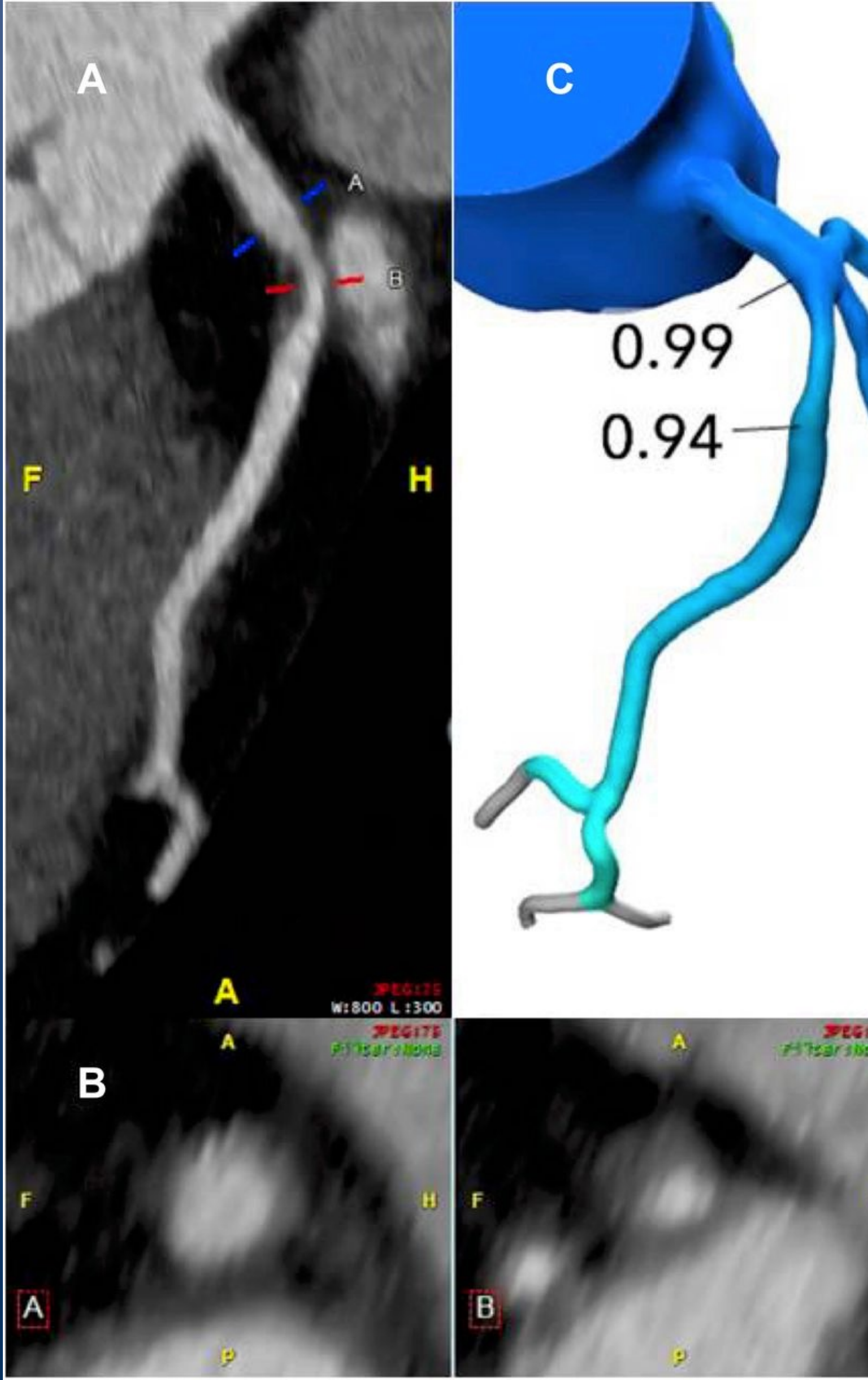


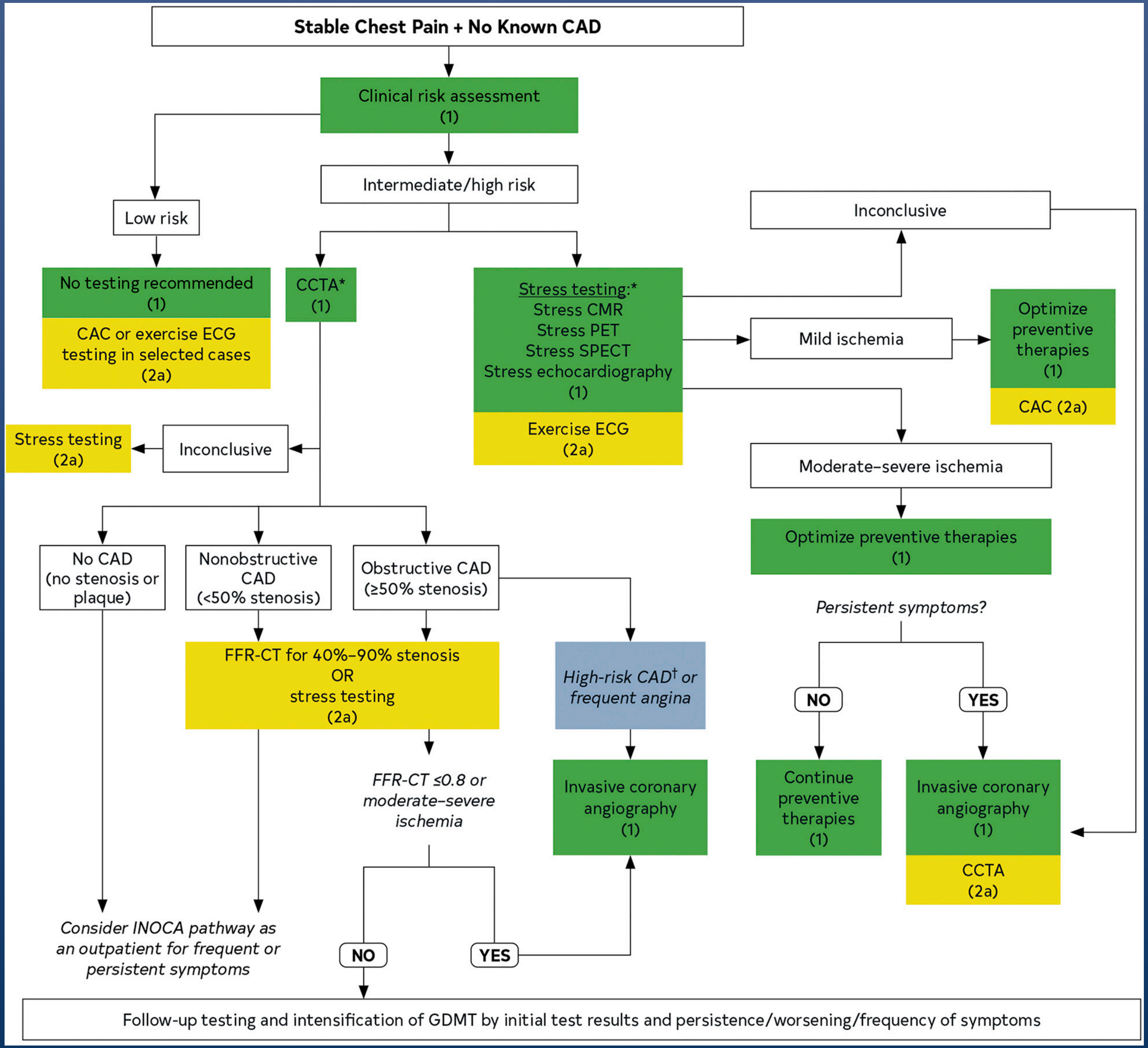


What is CT-FFR?

- Application of computational fluid dynamics to calculate coronary fluid pressure, velocity, and flow
- Noninvasive assessment of the physiologic significance of stenosis – is the lesion hemodynamically significant or not?
- Utilizes routine CCTA images
- Does not require additional medications
- Performed as a separate and incremental analysis of the CCTA

Nørgaard BL, et al. JACC. 2014;63:1145–1155.
Chinnaiyan KM, et al. J Am Coll Cardiol Img 2020;13:452–461.





Gulati M, et al. J Am Coll Cardiol. 2021;78:e187–e285.

Recommendations for Intermediate-High Risk Patients With Stable Chest Pain and No Known CAD

COR	LOE	RECOMMENDATIONS
		Index Diagnostic Testing
		Anatomic Testing
1	A	1. For intermediate-high risk patients with stable chest pain and no known CAD, CCTA is effective for diagnosis of CAD, for risk stratification, and for guiding treatment decisions (1-12).
		Stress Testing
1	B-R	2. For intermediate-high risk patients with stable chest pain and no known CAD, stress imaging (stress echocardiography, PET/SPECT MPI or CMR) is effective for diagnosis of myocardial ischemia and for estimating risk of MACE (8,13-35).
2a	B-R	3. For intermediate-high risk patients with stable chest pain and no known CAD for whom rest/stress nuclear MPI is selected, PET is reasonable in preference to SPECT, if available to improve diagnostic accuracy and decrease the rate of nondiagnostic test results (36-39).
2a	B-R	4. For intermediate-high risk patients with stable chest pain and no known CAD with an interpretable ECG and ability to achieve maximal levels of exercise (≥5 METs), exercise electrocardiography is reasonable (8,13,15,40-45).
2b	B-NR	5. In intermediate-high risk patients with stable chest pain selected for stress MPI using SPECT, the use of attenuation correction or prone imaging may be reasonable to decrease the rate of false-positive findings (46-51).

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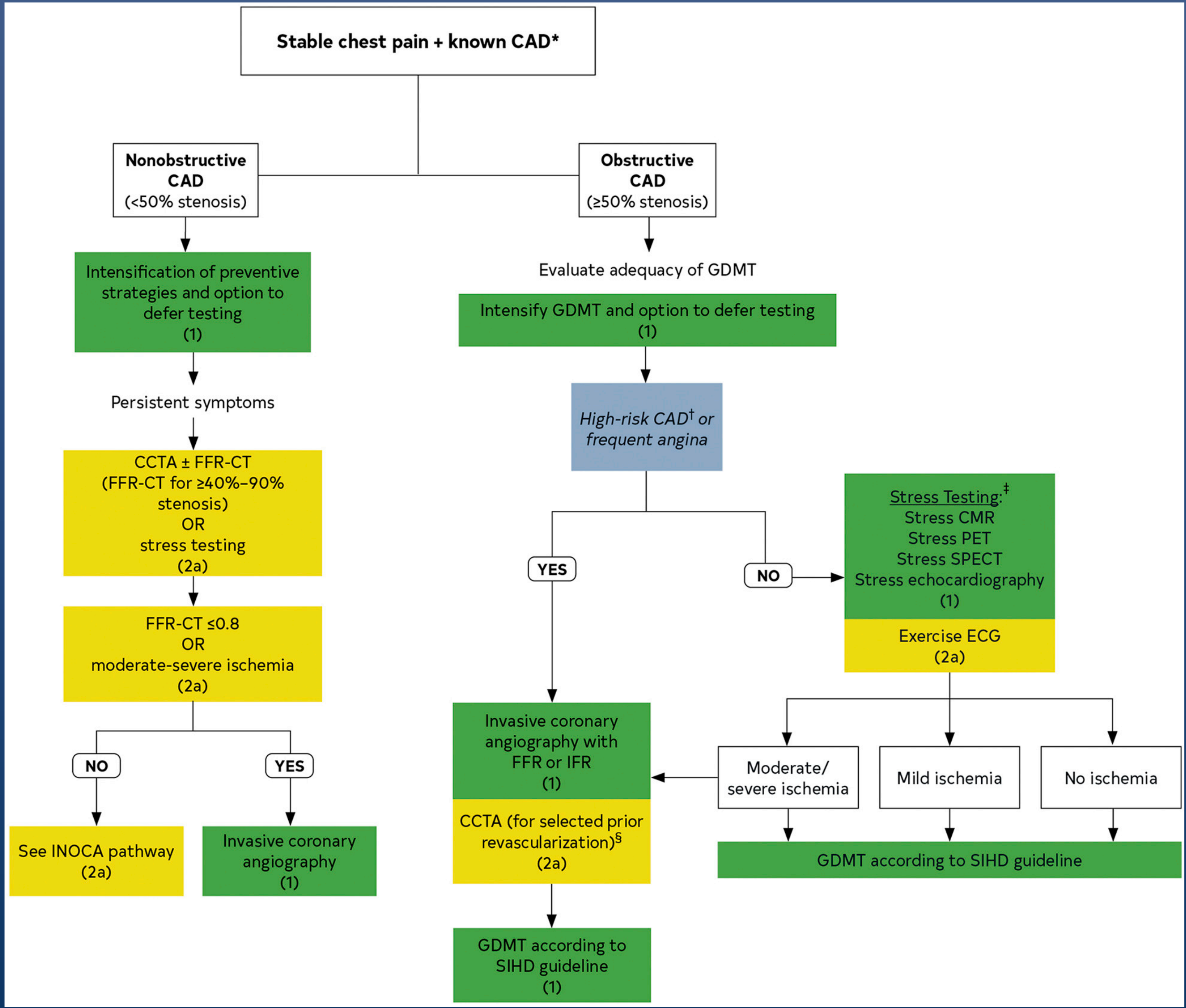

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Thank You!

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