Acute Ischemic Heart Disease Myocarditis, TakoTsubo Syndrome

Chiara Bucciarelli-Ducci

30 Sept 2022

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European Society of Cardiology

CMR syllabus on ACUTE ISCHEMIC HEART DISEASE

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1/ Acute coronary syndromes (ACS)

Clinical application of CMR in the emergency department

Indications

Scanning protocol

Differential diagnosis ACS (chest pain, troponin rise & normal coronary arteries)

* Myocarditis
* Takotsubo cardiomyopathy (see also chapter 3.4)
* Myocardial infarction with spontaneous recanalisation/coronary embolus
* Acute aortic syndromes (Aortic dissection/intramural haematoma/ penetrating atherosclerotic ulcer)
* Pulmonary embolism

T2 weighted CMR (sequences, scanning technique)

Novel techniques for oedema (T2-mapping)

Area at risk & salvaged area

Peri-procedural injury

Clinical & prognostic significance

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Cardiac Magnetic Resonance With T2-Weighted Imaging Improves Detection of Patients With Acute Coronary Syndrome in the Emergency Department

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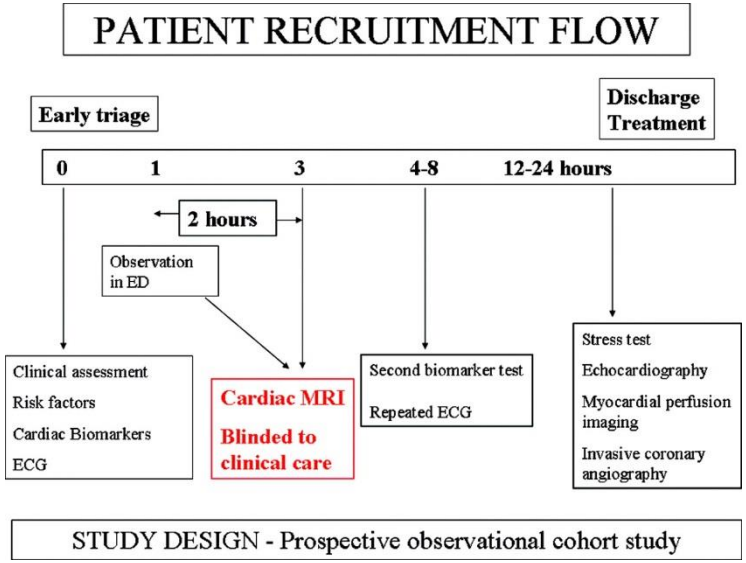
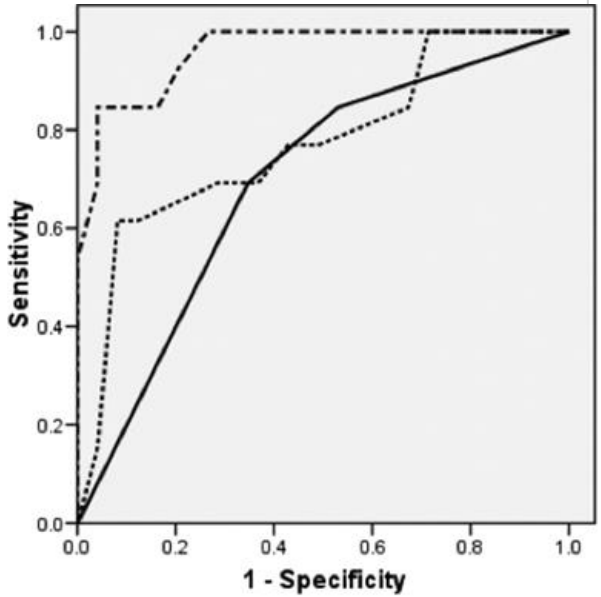
Patients with acute chest pain, negative cardiac biomarkers, and no ECG changes indicative of acute ischemia





Ricardo C. Cury et al. Circulation. 2008;118:837-844

Prognostic Value of Adenosine CMR Perfusion in Patients with Chest pain, inconclusive ECG, negative troponin

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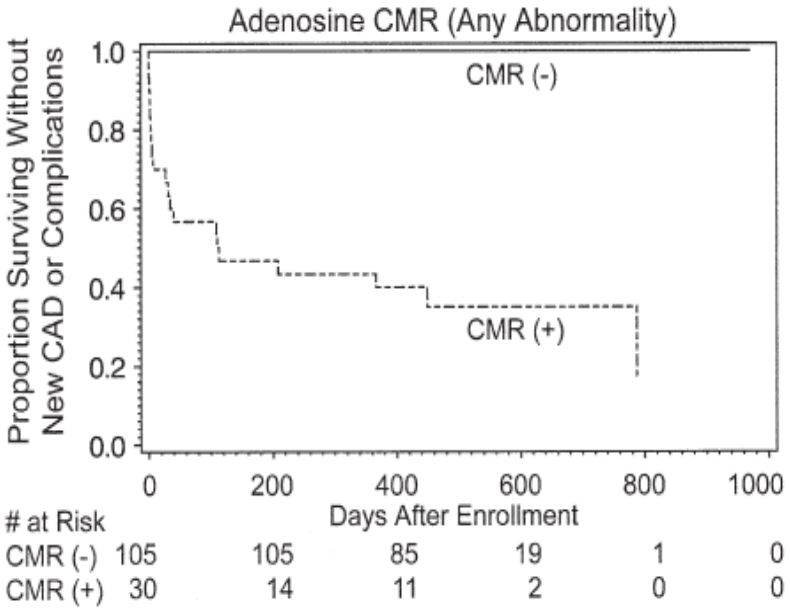

Ingkanisorn, JACC 2006

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Tissue Characterisation

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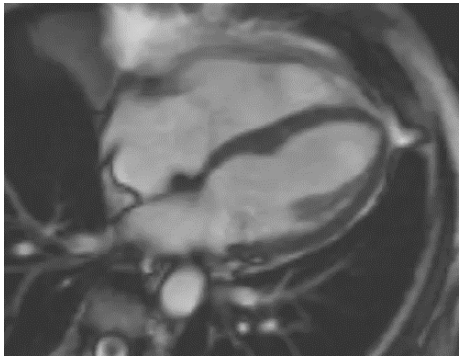
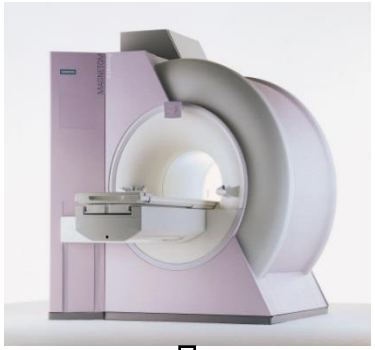
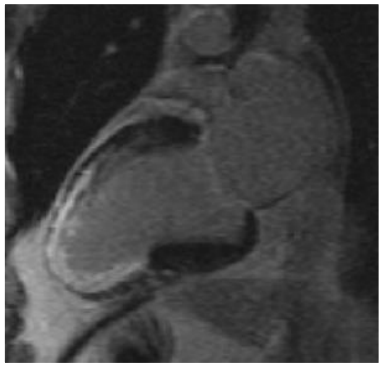
Function





LGE



CMR PROTOCOL:

- Cines
- T2-STIR / T2 mapping
- (Stress perfusion, if trop neg!!)
- LGE

Myocardial oedema

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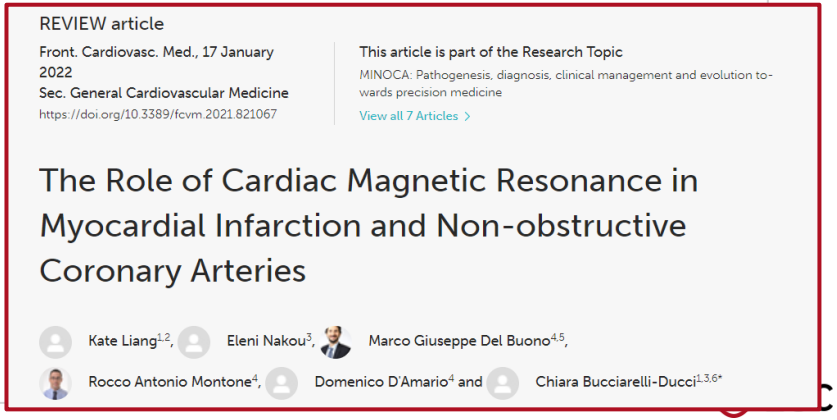
REVIEW article

Front. Cardiovasc. Med., 17 January 2022
Sec. General Cardiovascular Medicine
https://doi.org/10.3389/fcvm.2021.821067

This article is part of the Research Topic
MINOCA: Pathogenesis, diagnosis, clinical management and evolution towards precision medicine
View all 7 Articles >

The Role of Cardiac Magnetic Resonance in Myocardial Infarction and Non-obstructive Coronary Arteries

Kate Liang[1,2], Eleni Nakou[3], Marco Giuseppe Del Buono[4,5], Rocco Antonio Montone[4], Domenico D'Amario[4] and Chiara Bucciarelli-Ducci[1,3,6*]

Case 1

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40 yo Caucasian male

Acute chest pain

ECG: T-wave inversion V2-V6

TnI: 9.0 ug/L

Echo: normal

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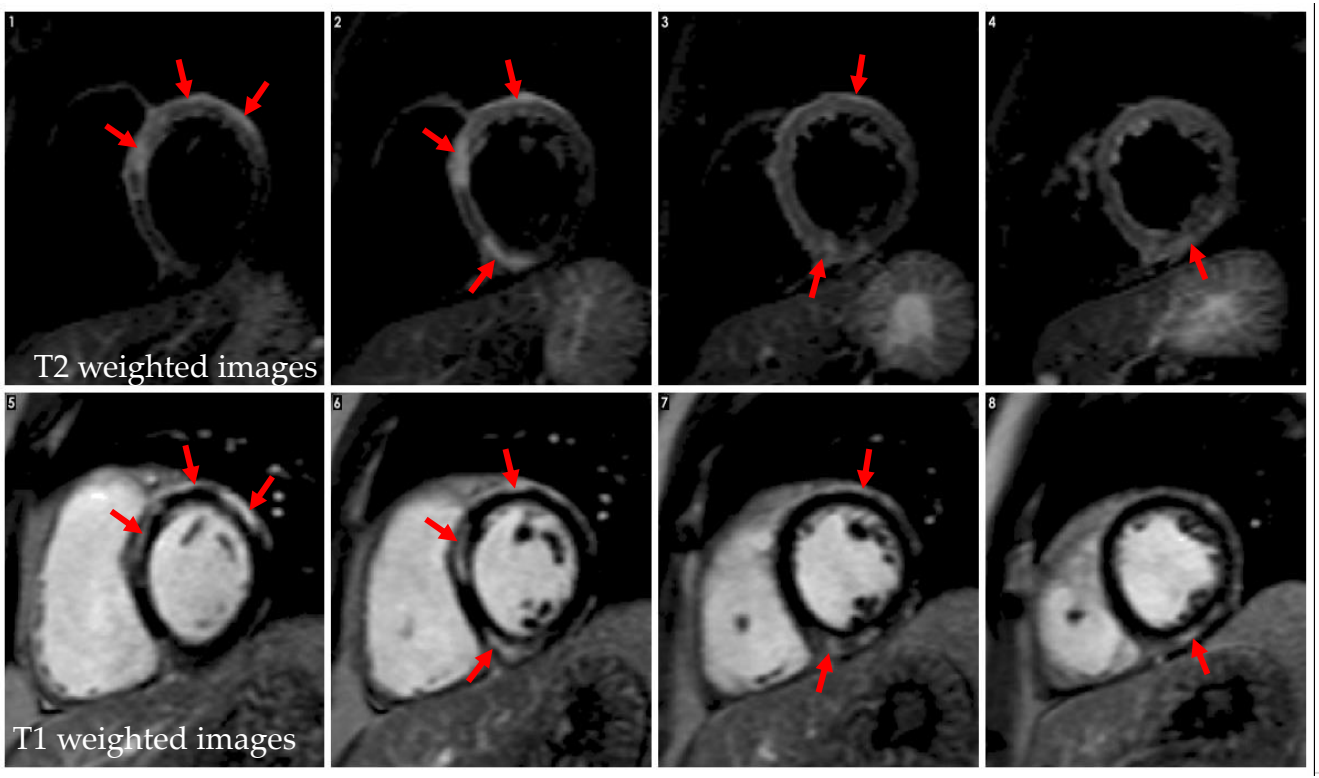
Case 1: T2-STIR and LGE



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What is the likely diagnosis?

1. Myocarditis
2. Tako Tsubo
3. Embolic MI
4. Normal
5. I don’t know

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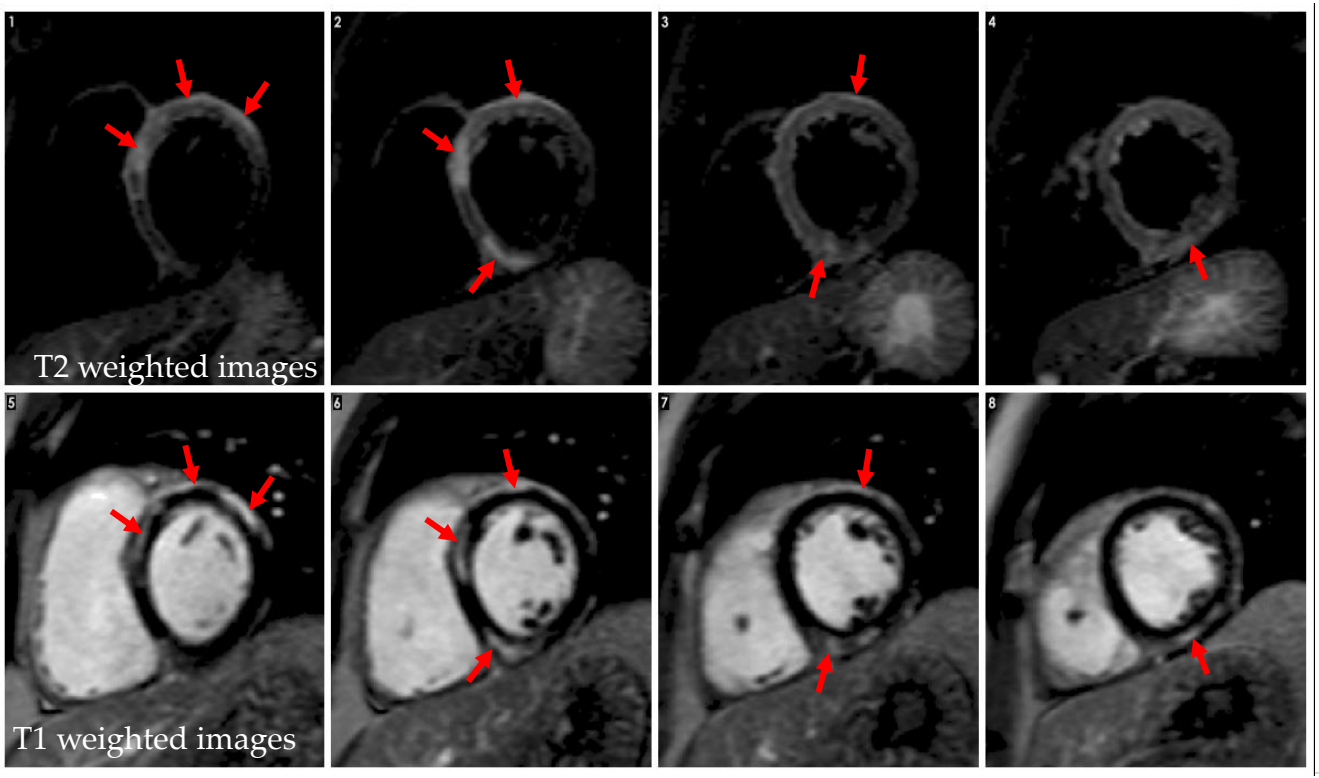

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LGE and Edema: Patterns of Recognition

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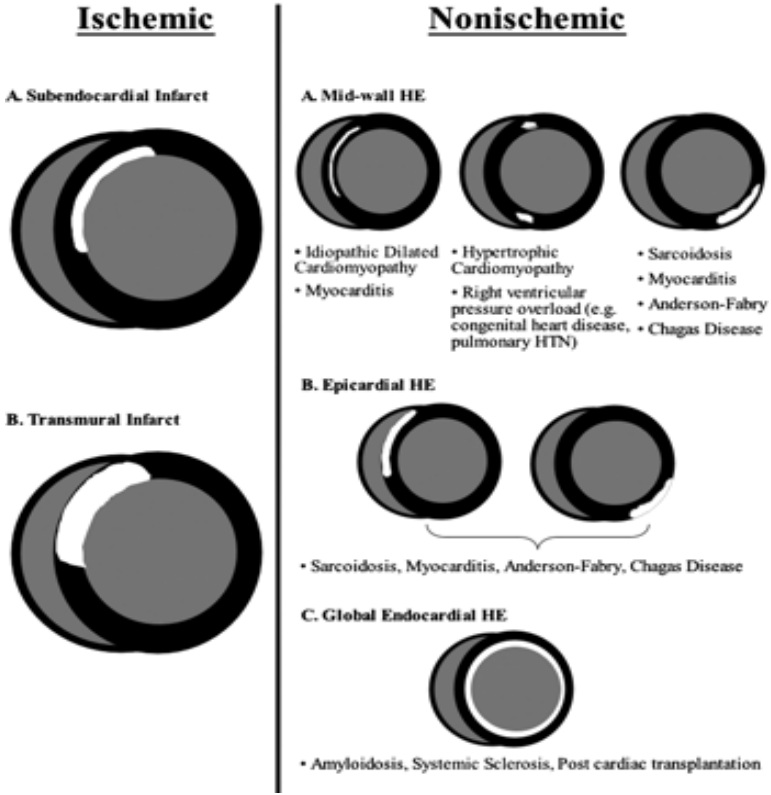

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Mahrholdt H et al , EHJ 2005; 26: 1461-74

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Case 1: T2-STIR and LGE

ACUTE MYOCARDITIS

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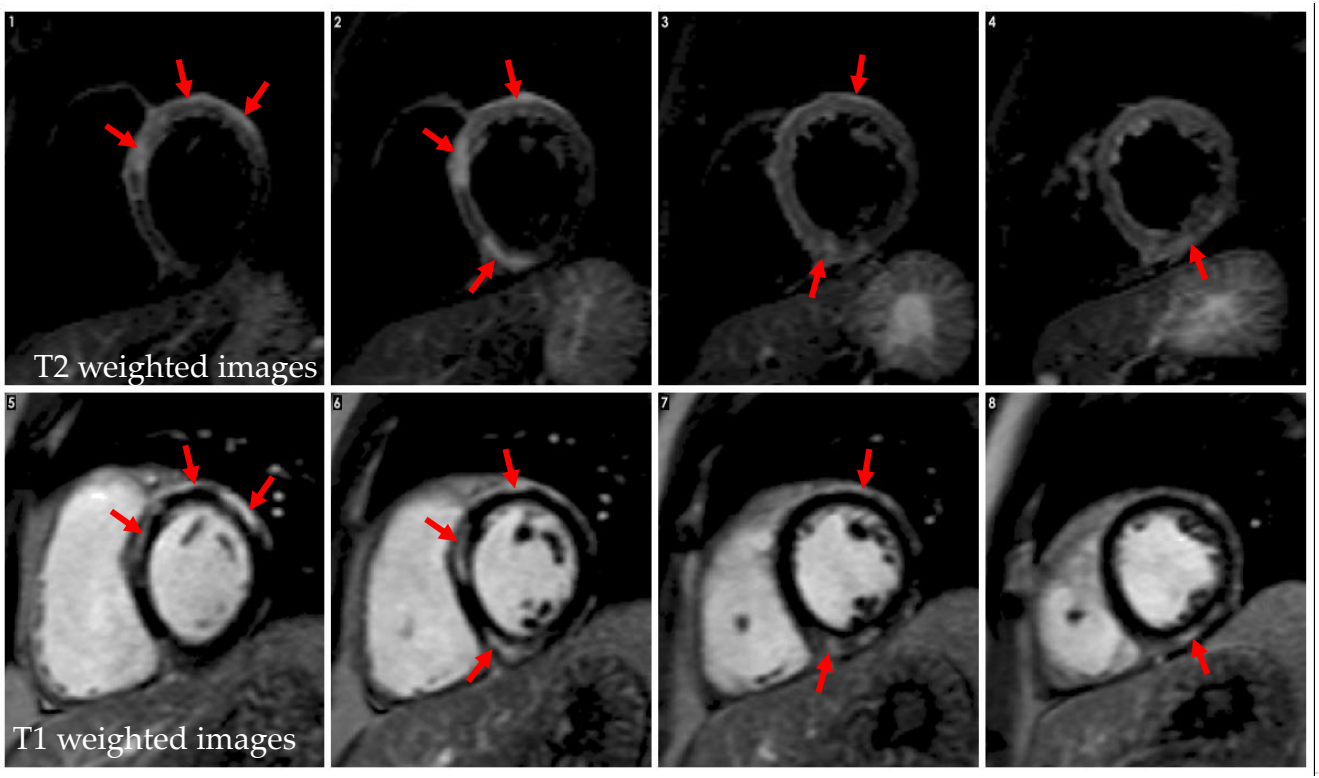

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Case 2

48 year old lady

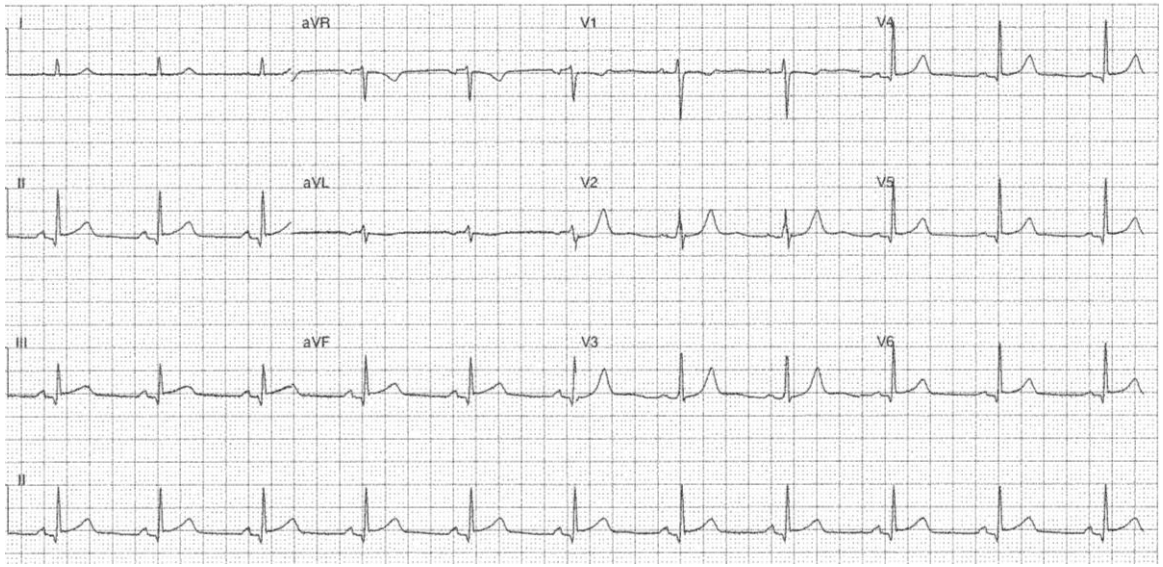
Chest pain

No cardiac risk factors

Troponin T 536 ng/L (normal <14 ng/L)

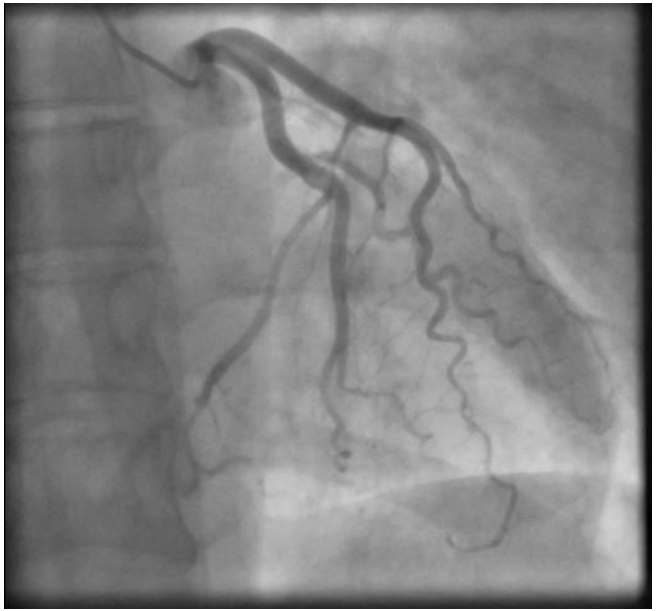
CRP 10 mg/L (normal <10 mg/L)

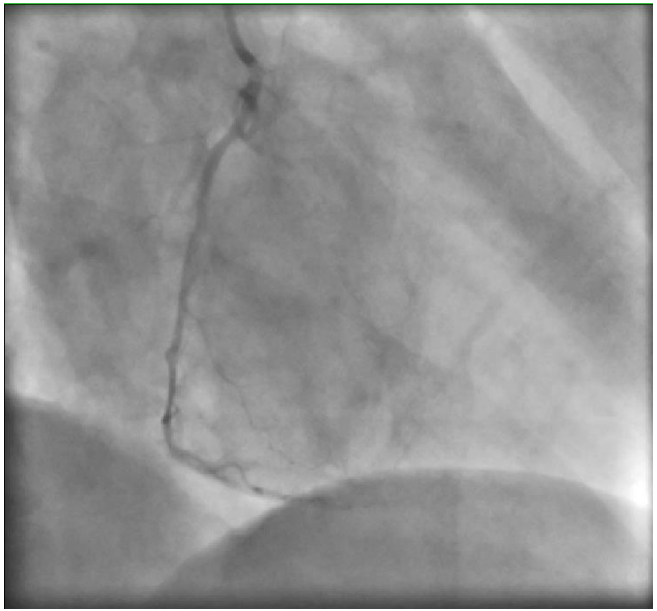
Case 2 - ECG



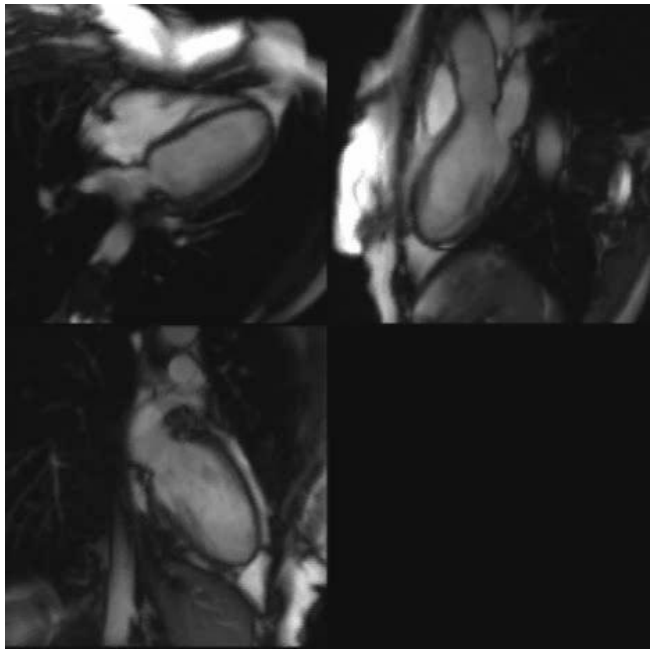
Transthoracic echocardiogram: normal

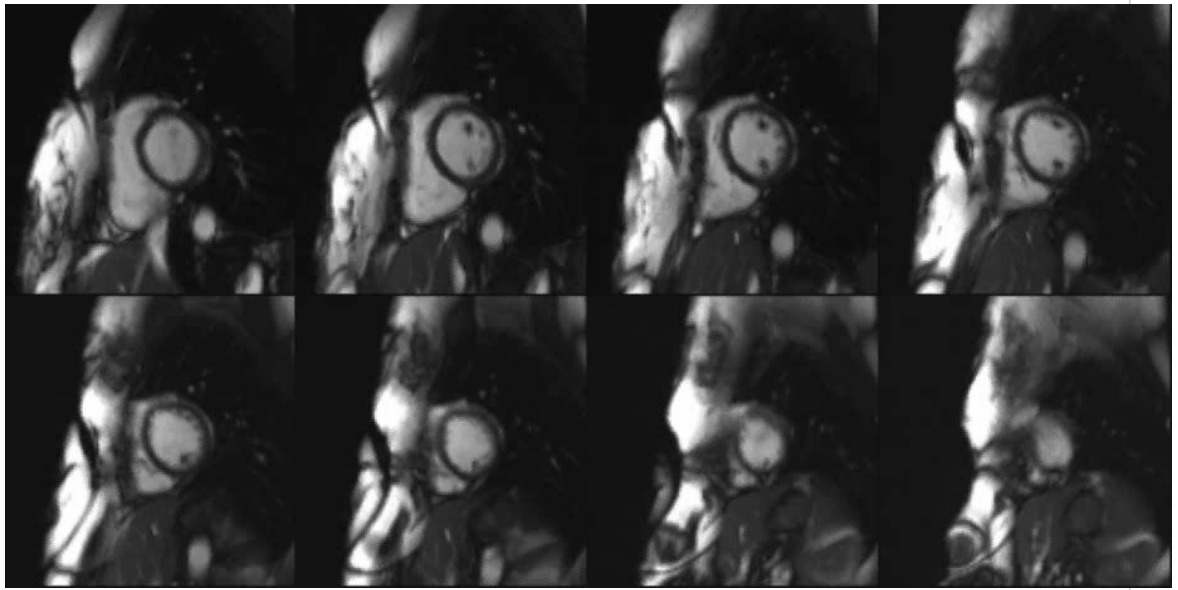
Case 2- Angiogram





Case 2- Long- and Short-Axis Cines





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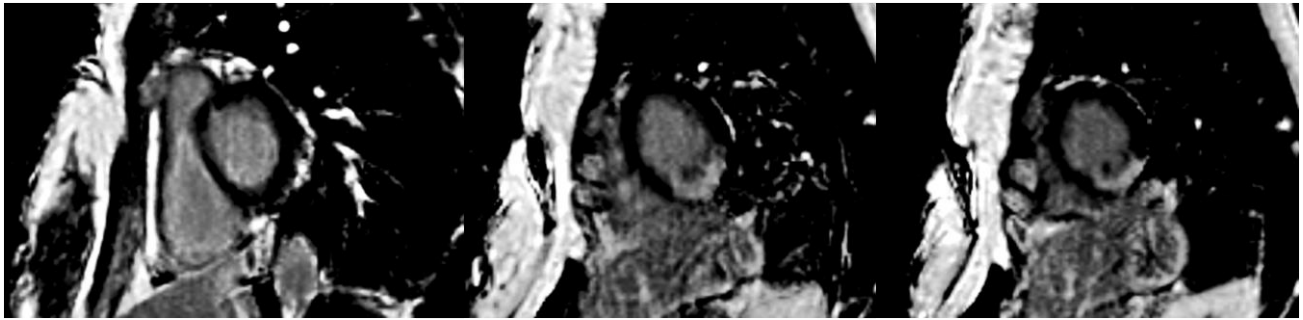
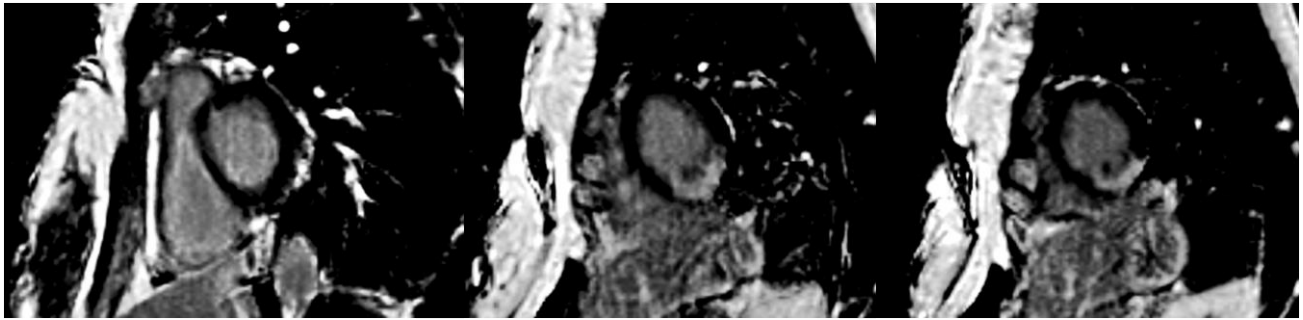
Case 2- LGE Images



1. Myocarditis
2. Tako Tsubo
3. Embolic MI
4. Normal
5. I don't know

Case 2- LGE Images



1. Myocarditis
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4. Normal
5. I don't know

Case 3

52 year-old male

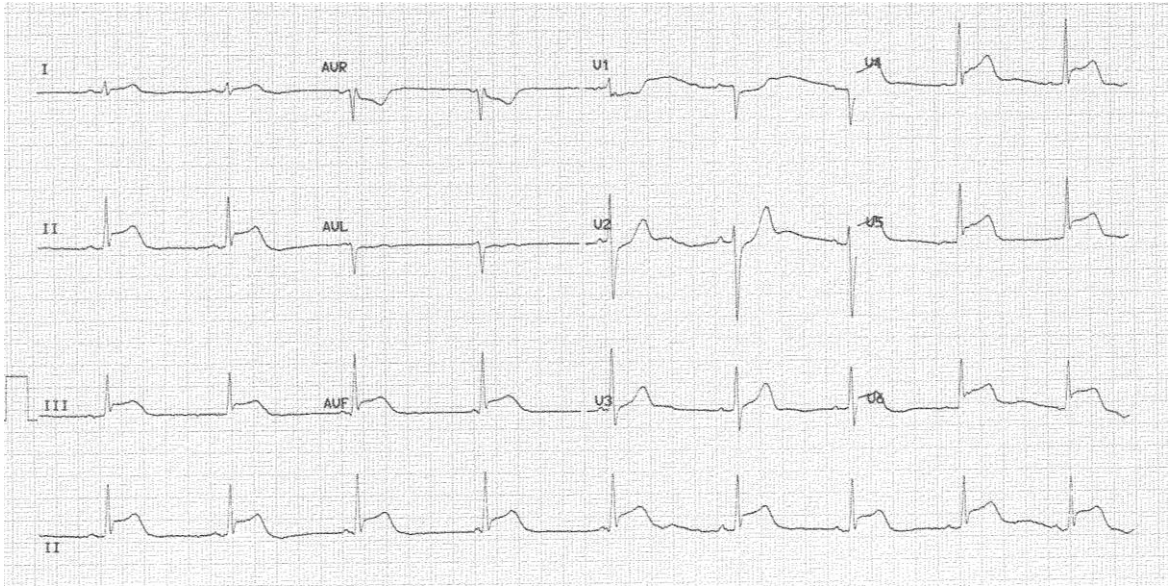
2 hours of chest pain

No cardiac risk factors

Troponin T 1,438 ng/L (normal <14 ng/L)

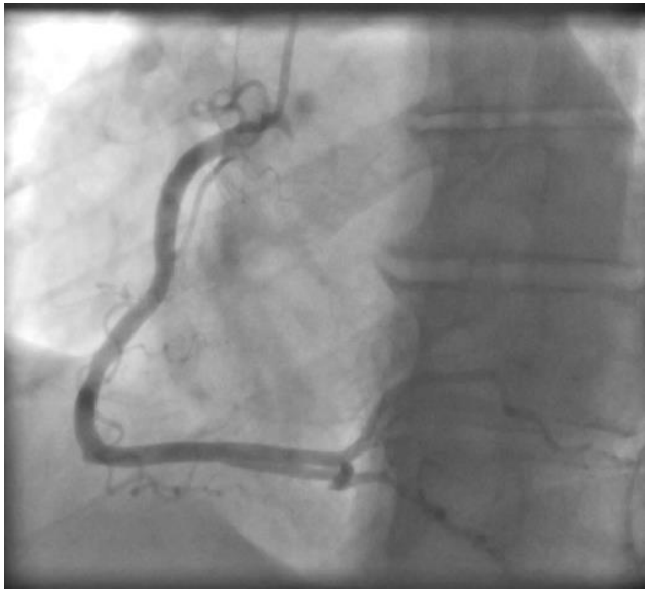
CRP 36 mg/L (normal <10 mg/L)

Case 3-ECG

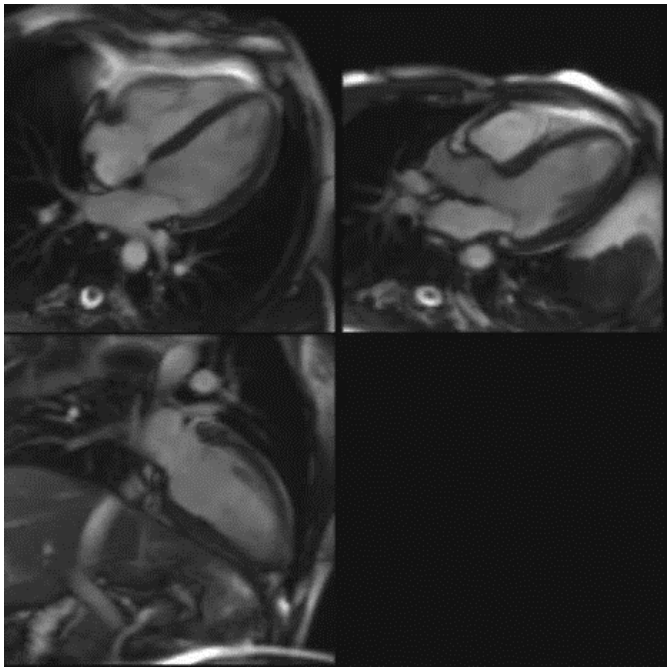


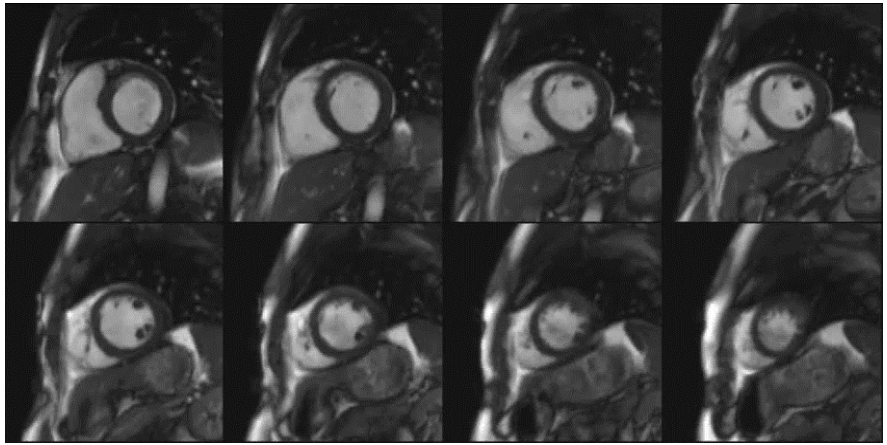
Transthoracic echocardiogram: normal

Case 3- Angiogram



Cardiac MRI- cine images





No regional wall motion abnormalities
No pericardial effusion

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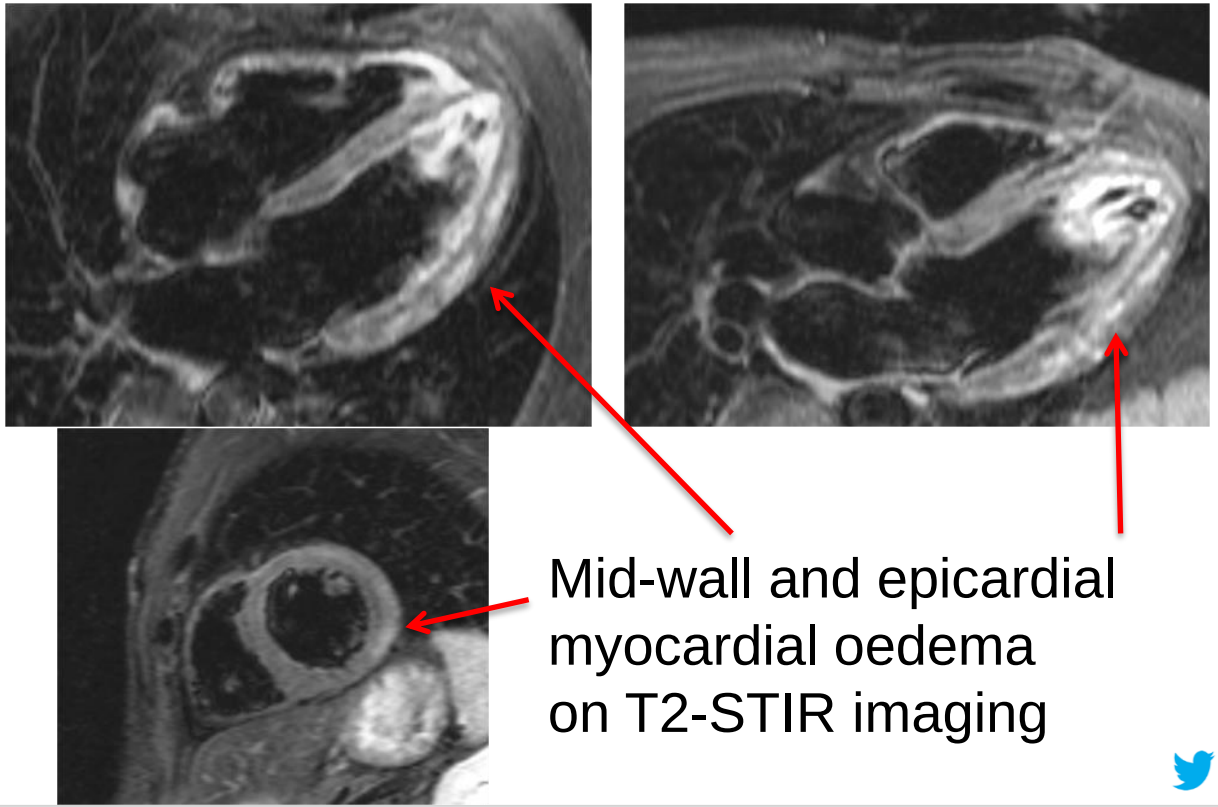
Case 3- T2-STIR images



Mid-wall and epicardial myocardial oedema on T2-STIR imaging

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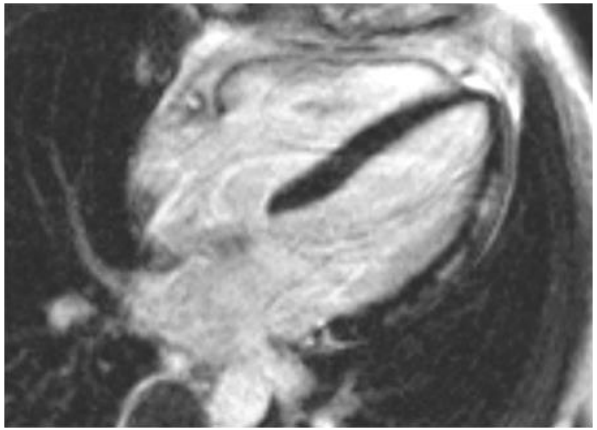
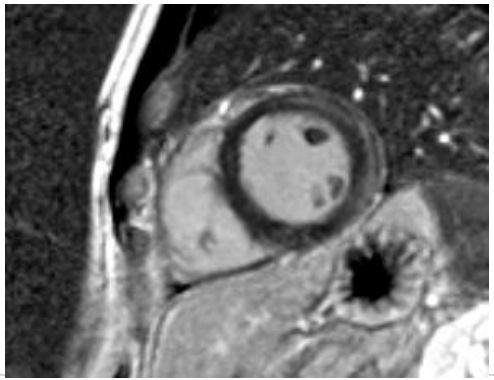
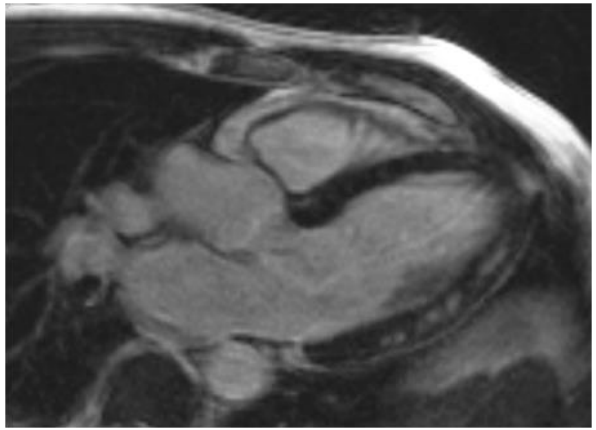
Case 3- LGE images







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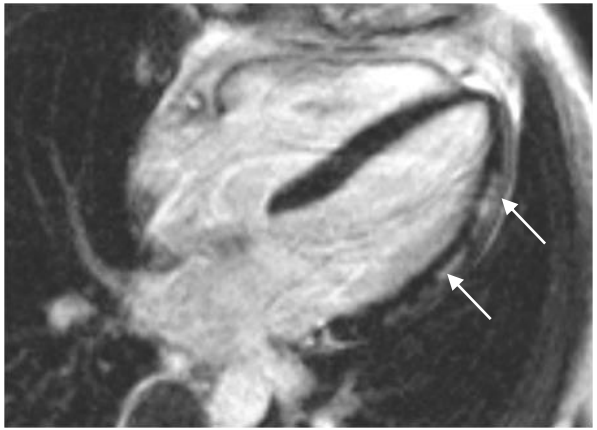

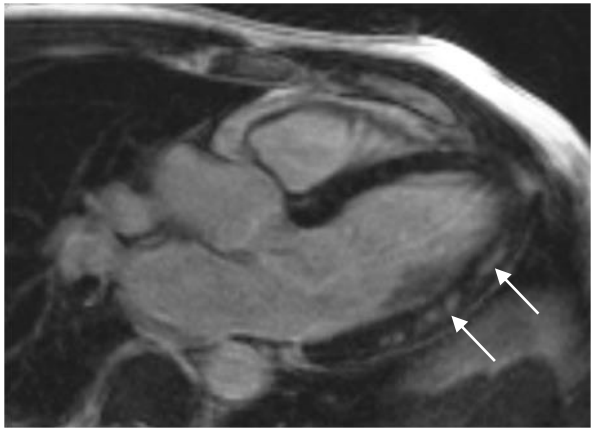

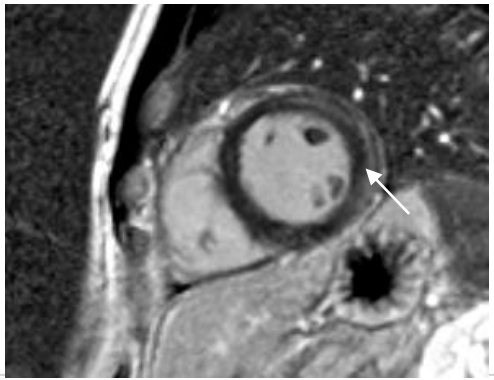

1. **Myocarditis**
2. Tako Tsubo
3. Embolic MI
4. Normal
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Myocarditis- Lake Louise Criteria (2009)

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Cardiovascular Magnetic Resonance in Myocarditis: A JACC White Paper

Friedrich
JACC 2009

In the setting of CLINICALLY suspected myocarditis, at least 2 criteria:

- Regional or **global myocardial SI increase in the T2w images**
- **Increased global EGE* ratio myocardial/skeletal muscle** in T1w images (≥2)
- At least **1 focal non-ischemic LGE** in the IR-GRE T1-weighted images

- Body coil
- Surface coil normalisation
- Early gadolinium enhancement (EGE): at least 5min after contrast

Myocarditis- Lake Louise Criteria (2018)

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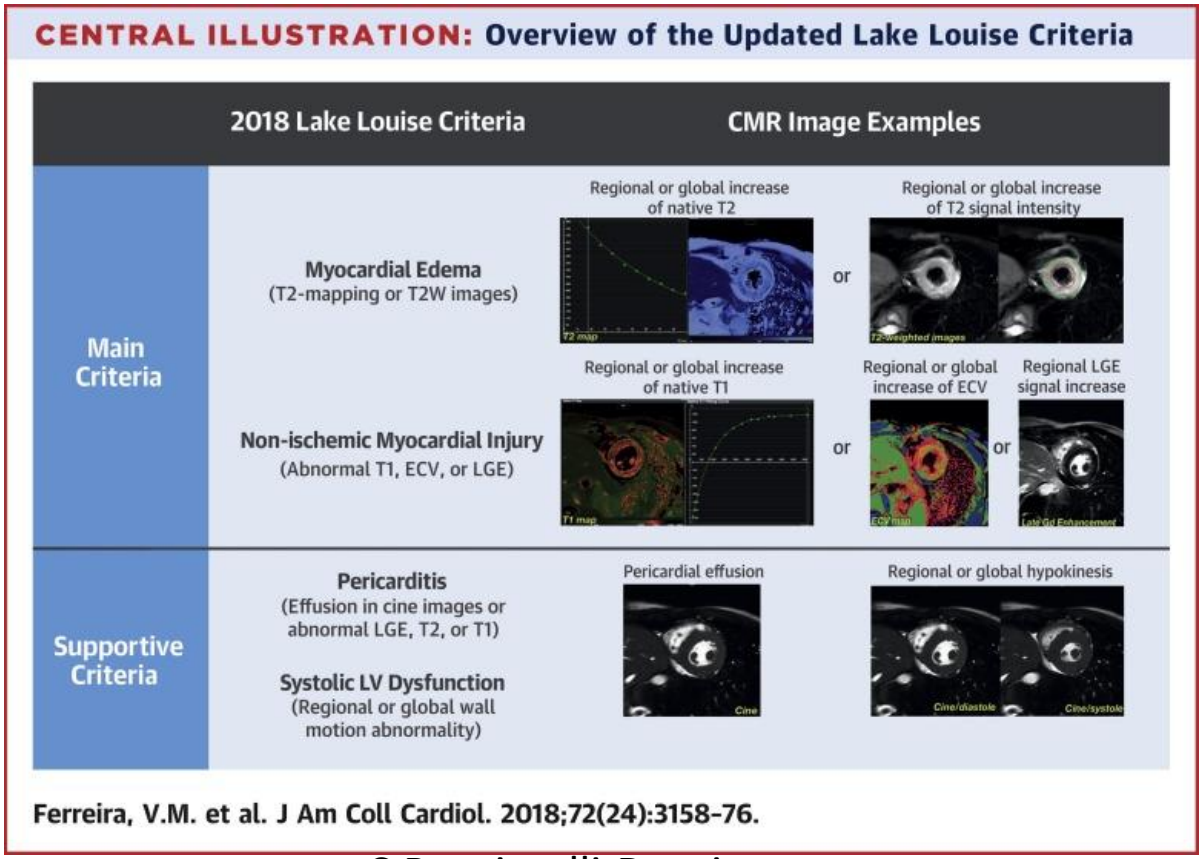

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CMR in MINOCA: timing of CMR

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- 204 consecutive patients (mean age 55yrs & 51% males)
- "Early" (<2wks) CMR in 96 patients "Late" (>2weeks) in 108
- Overall diagnosis in 70% of patients with CMR
- **Diagnostic value improved significantly when carried out early (within 2wks) – 82% vs 54% (p<0.001)**

		Post-CMR diagnosis				
	Total sample n=204	Myocarditis	MI	TakoTsubo	Other CM	Normal CMR
Pre-CMR diagnosis	Myocarditis	34	23	5	4	7
	MI	10	6	8	6	1
	TakoTsubo	1	5	3	0	2
	Other CM	1	0	1	0	0
	Uncertain	8	19	2	8	50

New diagnosis	25%	29%
No change	34%	12%
Clinical impact Overall (n=204)	No change	Change in management

Dastidar D, …… Bucciarelli-Ducci C. JACC Imaging 2017

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Tako-Tsubo Cardiomyopathy

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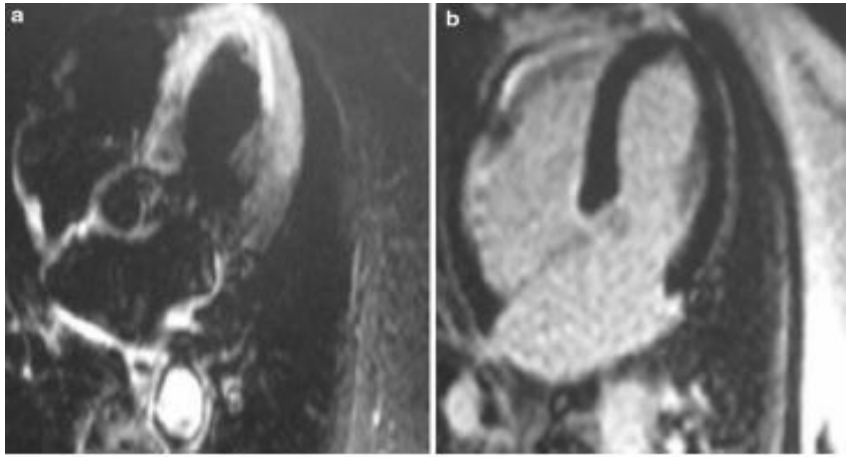

Extensive Myocardial Edema

No myocardial scarring

Dastidar A, ….. Bucciarelli-Ducci C. Heart Fail Rev 2015

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Clinical Characteristics and CMR Findings in Stress (Takotsubo) Cardiomyopathy

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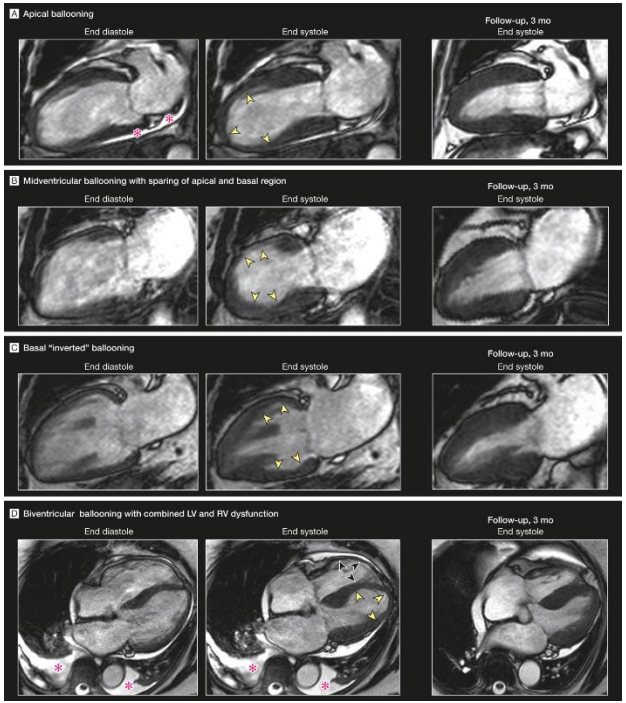

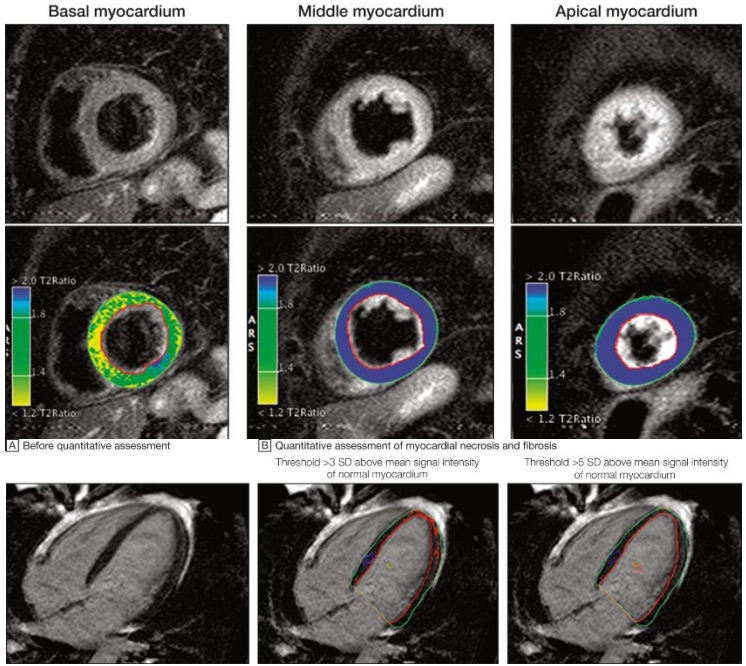

Eitel et al. JAMA. 2011;306(3):277-286.

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Peri-procedural injury

Clinical & prognostic significance

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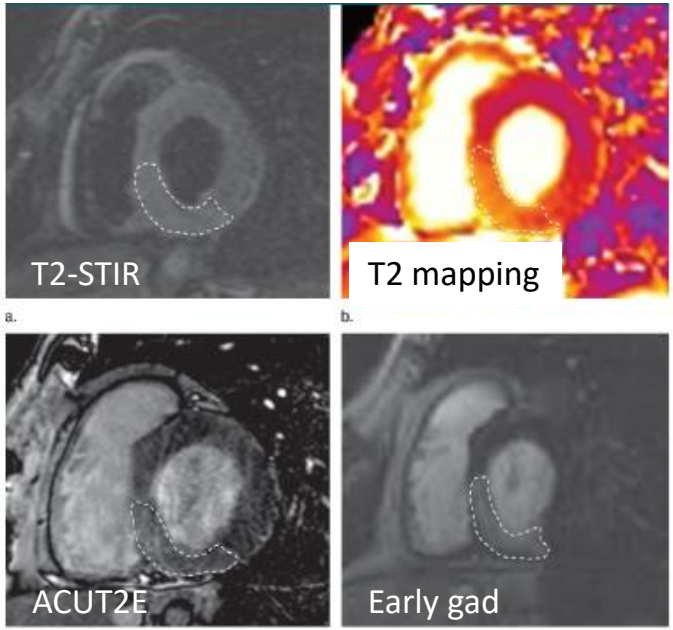
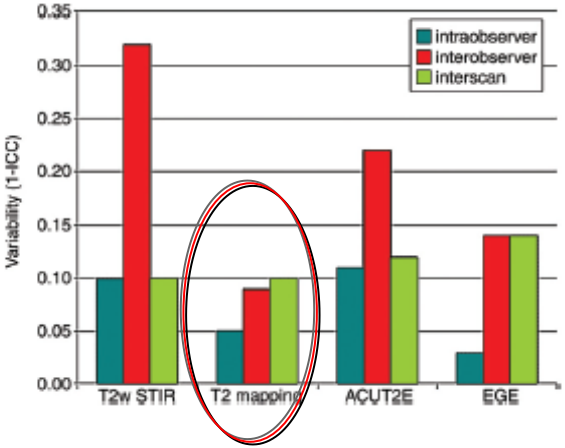
Measurement of Myocardium at Risk with Cardiovascular MR:

Comparison of Techniques for Edema Imaging[1]





McAlindon E,….. Bucciarelli-Ducci C
Radiology 2015

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2/ Complications of acute myocardial infarction

Intracardiac thrombus

Pseudoaneurysm – contained myocardial rupture

True aneurysm

Ventricular septal defect

Acute mitral regurgitation

3/ No reflow phenomenon – microvascular obstruction (MVO)

CMR techniques for MVO assessment

Early vs persistent MVO

Differentiation from thrombus

Clinical validation & application

Infarct/reperfusion haemorrhage

4/ Peri-infarct zone

Definition

Clinical & prognostic significance

Left Ventricular Thrombus

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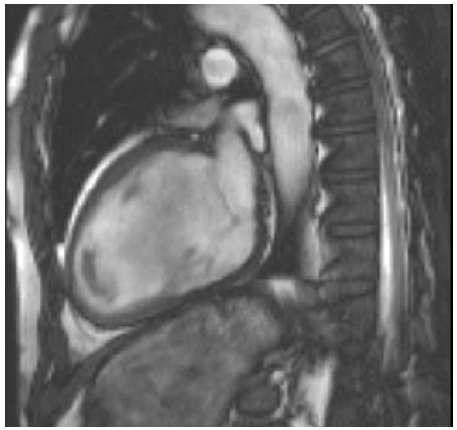

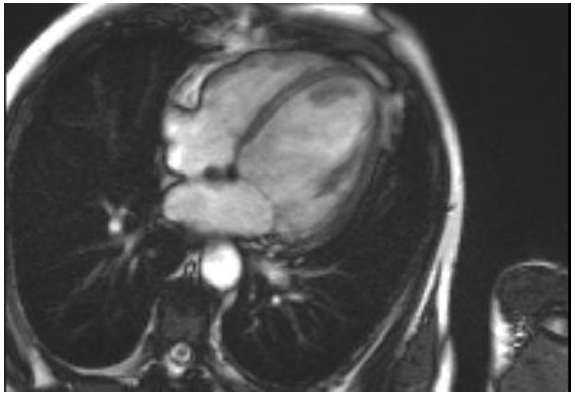

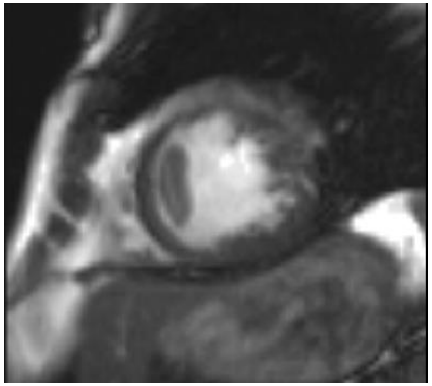

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Left Ventricular Thrombus

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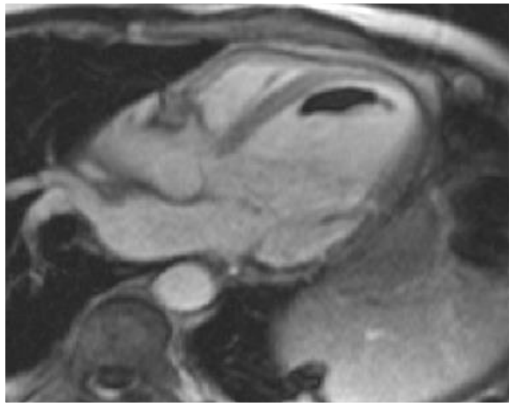
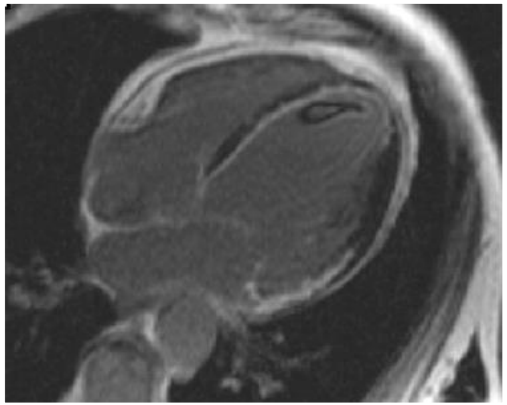
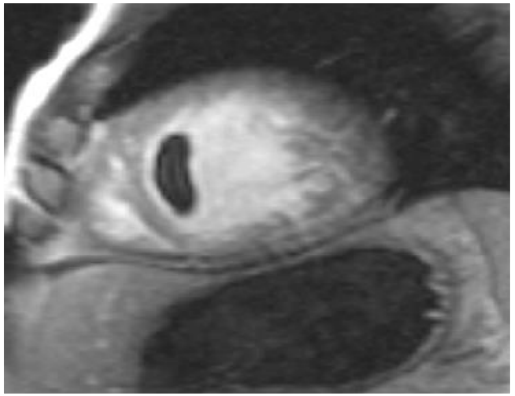
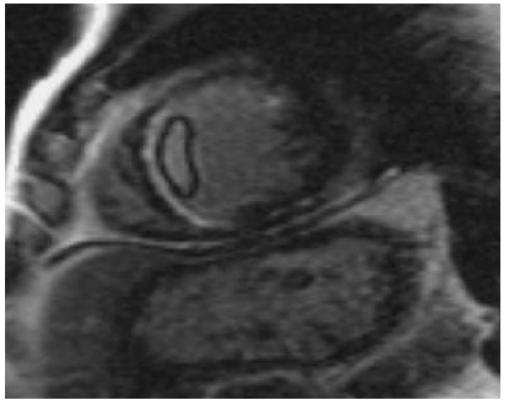
Early gad









LGE

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CMR syllabus on ACUTE ISCHEMIC HEART DISEASE

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2/ Complications of acute myocardial infarction

Intracardiac thrombus

Pseudoaneurysm – contained myocardial rupture

True aneurysm

Ventricular septal defect

Acute mitral regurgitation

3/ No reflow phenomenon – microvascular obstruction (MVO)

CMR techniques for MVO assessment

Early vs persistent MVO

Differentiation from thrombus

Clinical validation & application

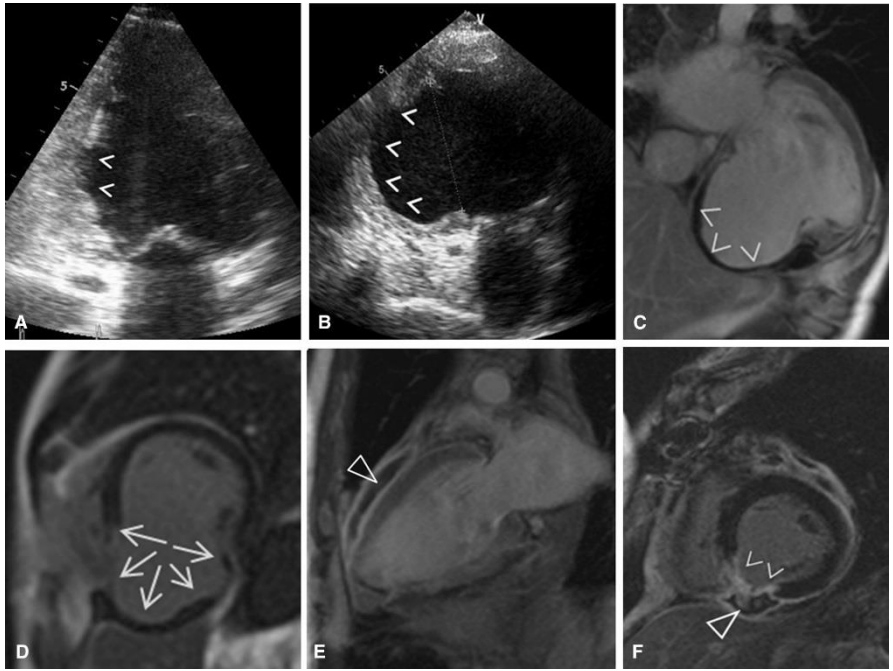
Infarct/reperfusion haemorrhage

4/ Peri-infarct zone

Definition

Clinical & prognostic significance

LV pseudo-aneurysm



Bucciarelli-Ducci C

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Post MI Ventricular Septal Defect

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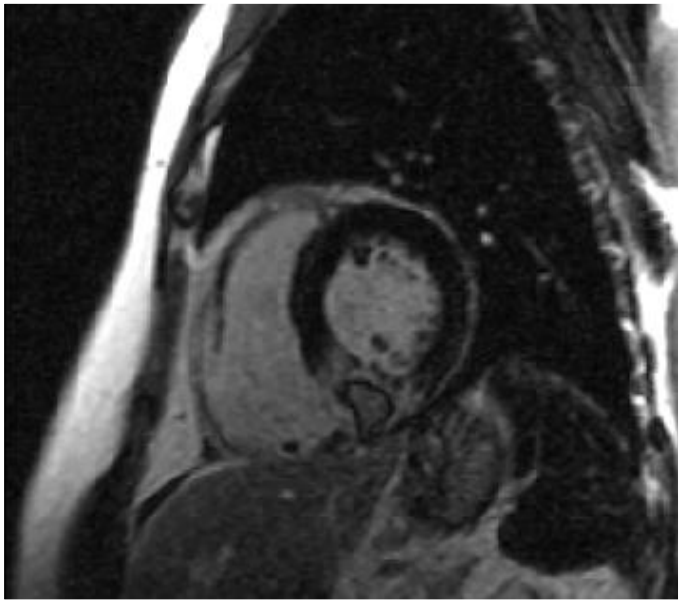
Impending Cardiac Rupture



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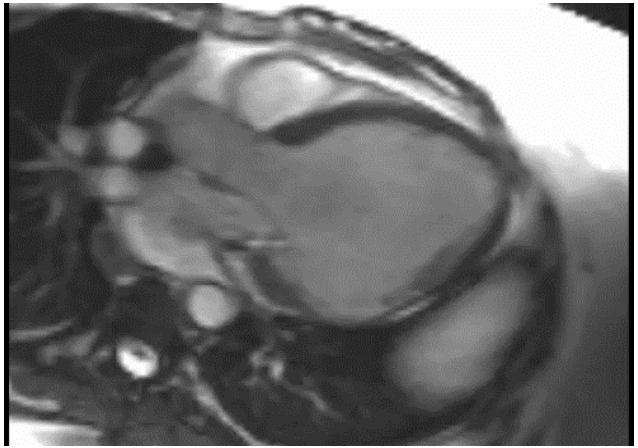
Clinical & prognostic significance

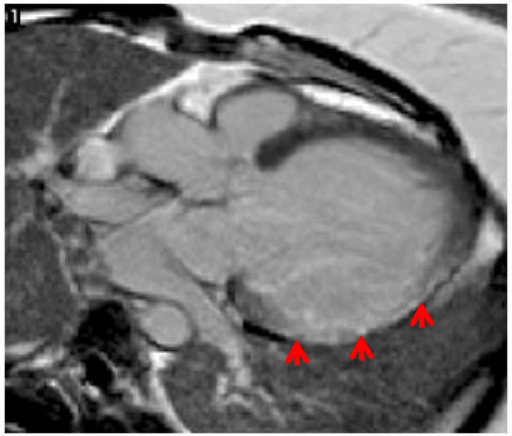
ACUTE MR

Infarcted papillary muscles

Lateral wall infarction



Cine imaging



LGE imaging:
Lateral infarction (LCx territory)

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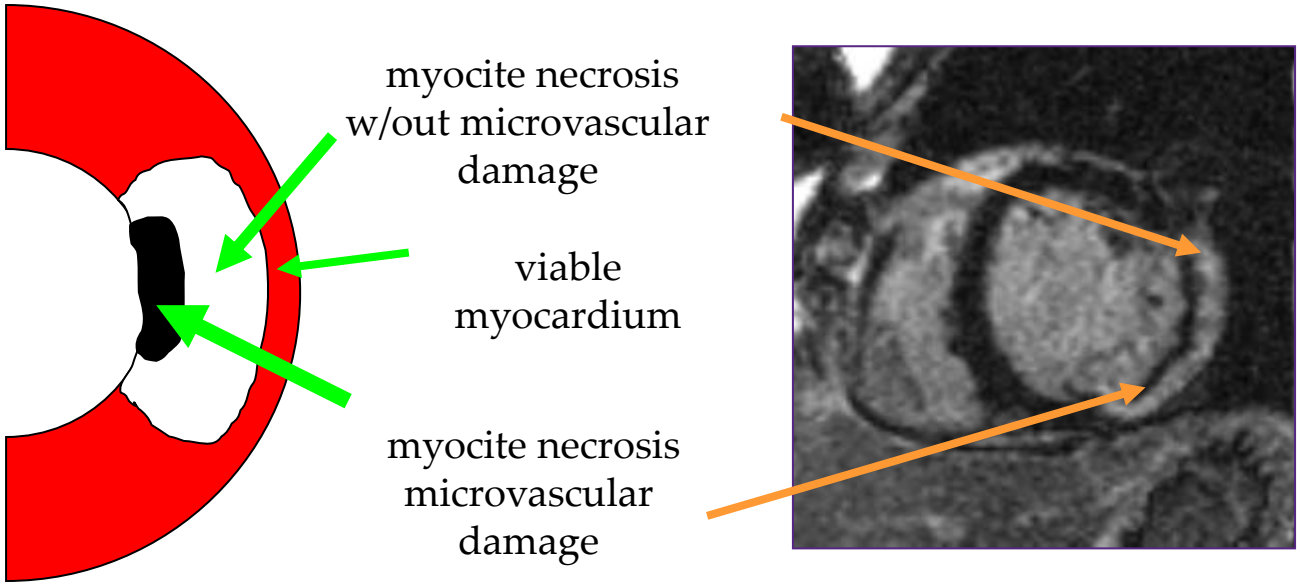
Acute Myocardial Infarction



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CMR techniques for MVO:

- Early gadolinium enhancement
- Late gadolinium enhancement

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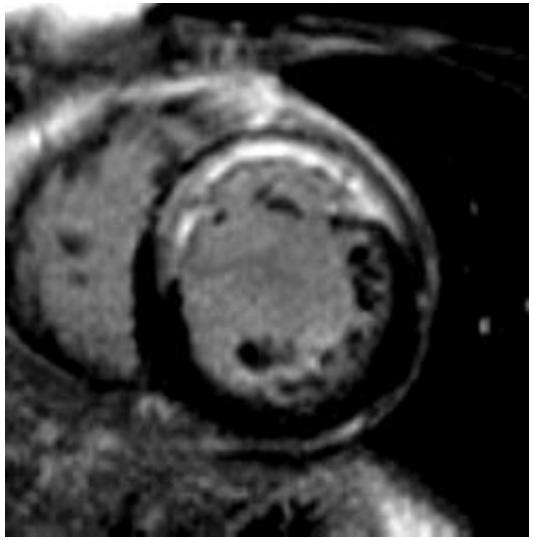
Thrombus:

- Does not change its size early vs late LGE
- Sits over the infarct (compare with cine and LGE)

MVO:

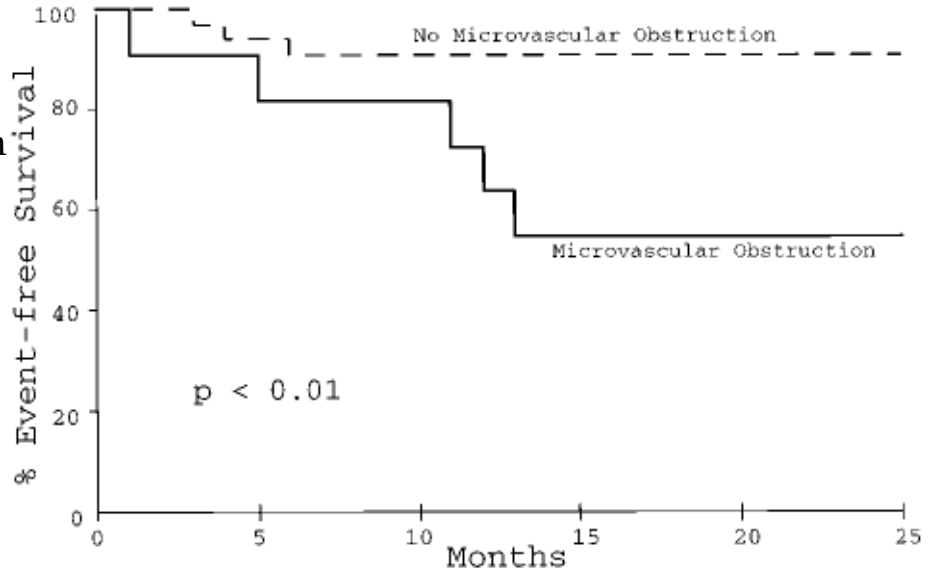
- Gets smaller with time (contrast fills in)
- Sits within the infarct (compare with cine and LGE)

Infarction and MVO



Prognostic Value of MVO

- Cardiovasc death
- Re-infarct
- HF
- stroke



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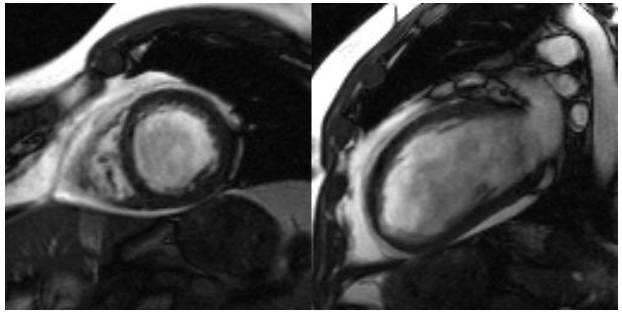
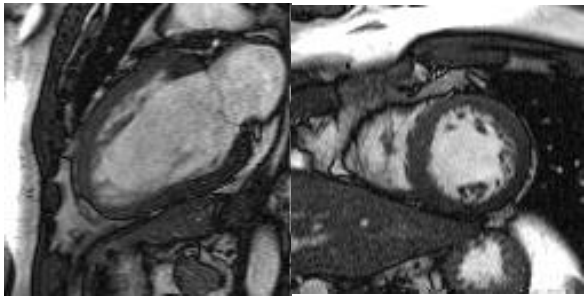
Wu K, Circulation 1998

3 days after STEMI

Patient A

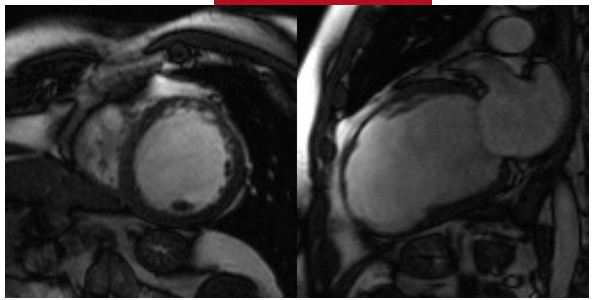


Patient B

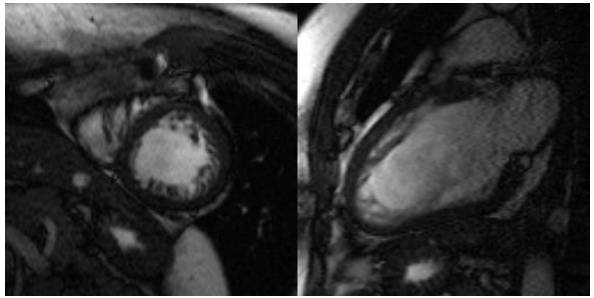


6 months after STEMI

Patient A



Patient B



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LGE Images

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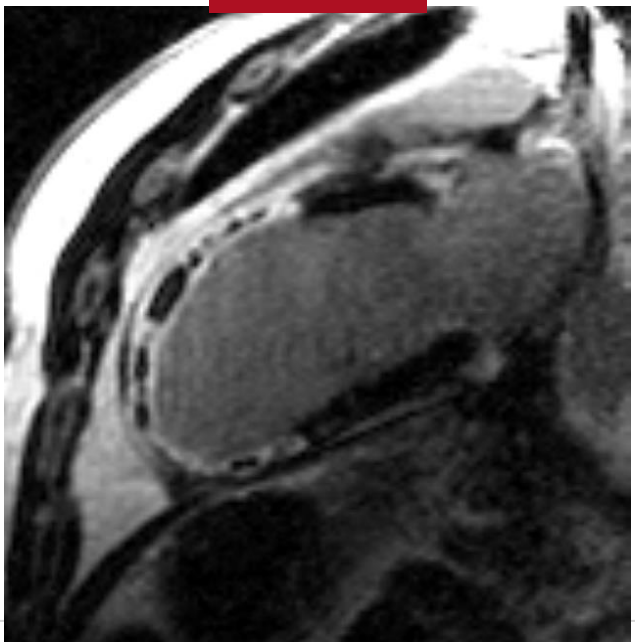
3 days after STEMI

Patient A



Patient B

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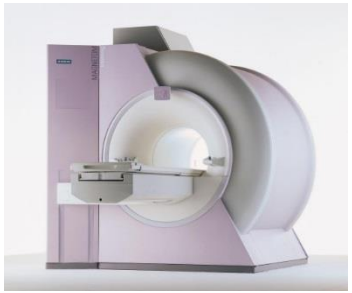
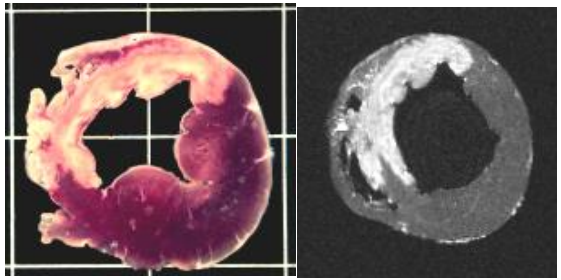
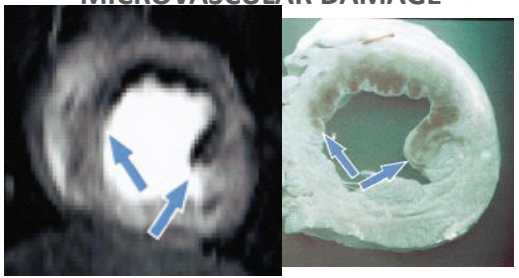


MYOCARDIAL NECROSIS



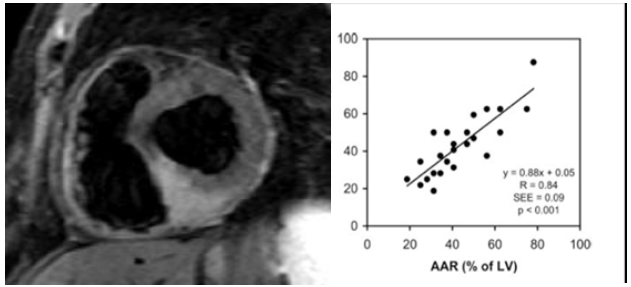
Kim RJ et al, Circulation 1999

MICROVASCULAR DAMAGE



Rochitte C et al, Circulation 1998

MYOCARDIUM AT RISK



Aletras AH et al, Circulation 2006

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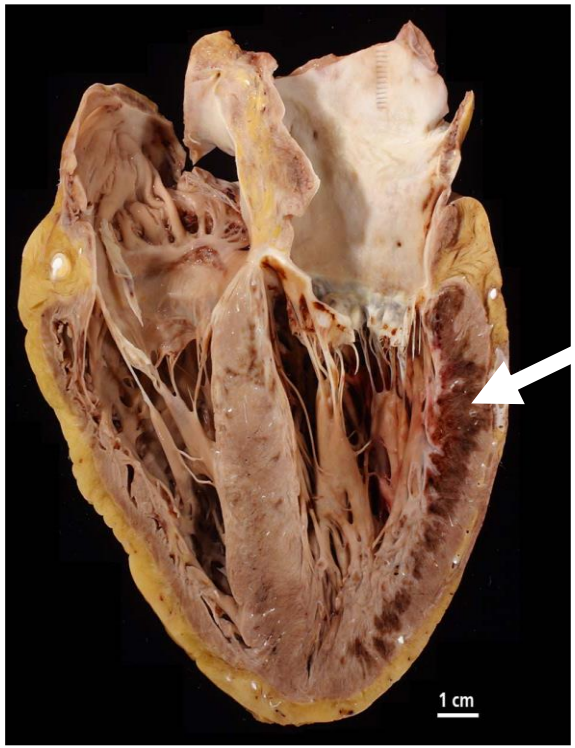
Clinical & prognostic significance

Intramyocardial Hemorrhage



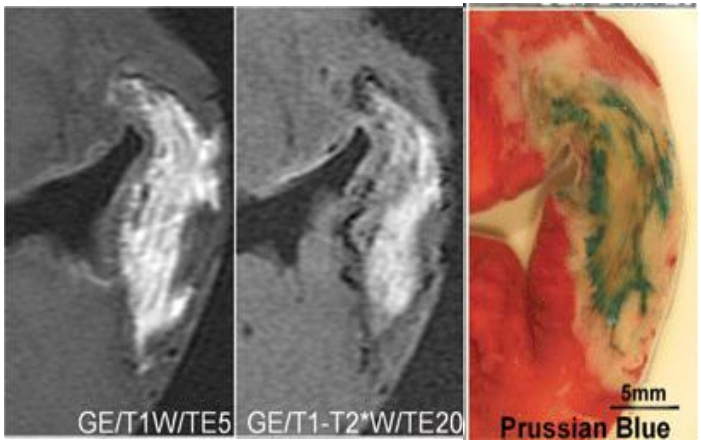
- Disruption of capillary integrity during myocardial necrosis
- Leakage of red blood cells into the interstitium during the reflow period

CMR:

selective shortening of T2 relaxation times in hemorrhagic regions consistent with the paramagnetic effects of deoxyhemoglobin

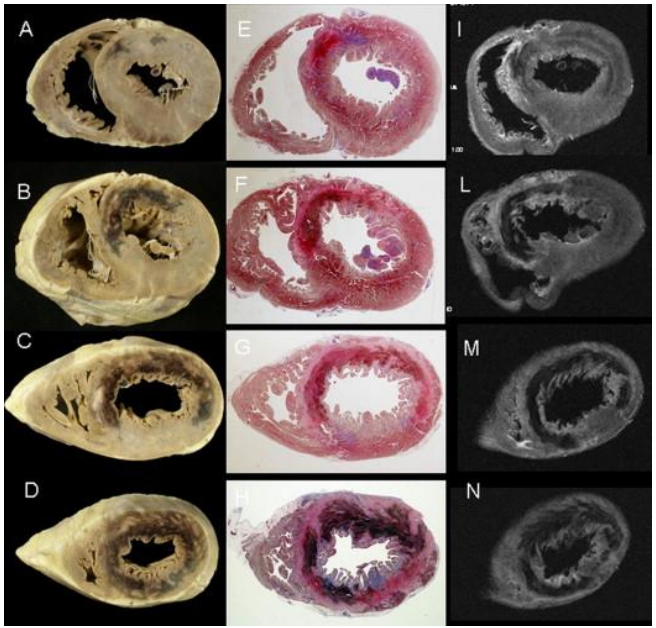
***** Haemorrhage: hypointense in T2w**

Intramyocardial Hemorrhage



Hemosiderin deposits

Van den Bos et al, Eur Heart J 2006



Basso C et al, AJC 07

Impact of myocardial haemorrhage on left ventricular function and remodelling in patients with reperfused acute myocardial infarction

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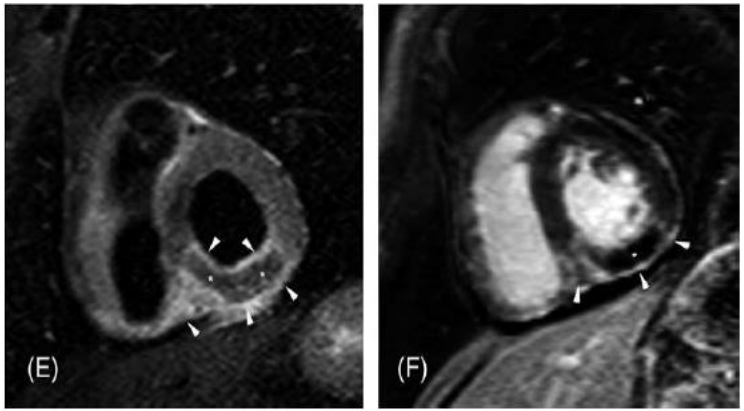

Conclusion Myocardial haemorrhage, the presence of which can easily be detected with T2-weighted MRI, is a frequent complication after successful myocardial reperfusion and an independent predictor of adverse LV remodelling regardless of the initial infarct size.

Ganame, ...Bogaert, Eur Heart J 2009

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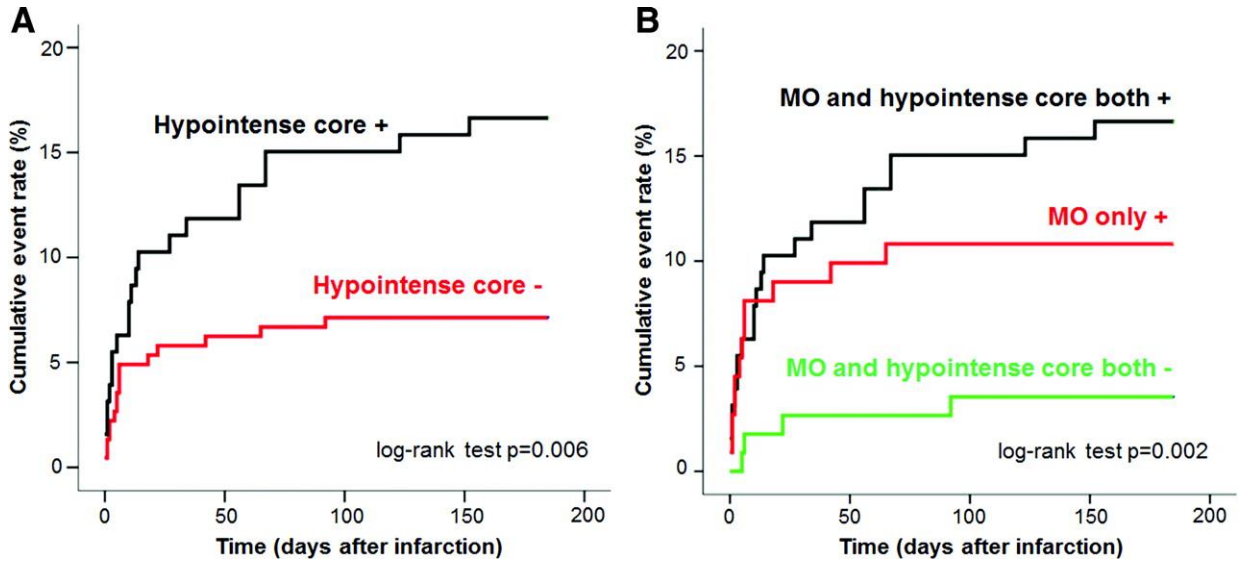
Unadjusted survival curves of the cumulative incidence of death, reinfarction, and new congestive heart failure during the first 6 months after infarction in patients with and without the presence of a hypointense core in T2-weighted imaging (A) and in pati...



Eitel I et al. Circ Cardiovasc Imaging 2011;4:354-362

Inferior LV infarction in a 56-year-old man with proximal RCA occlusion

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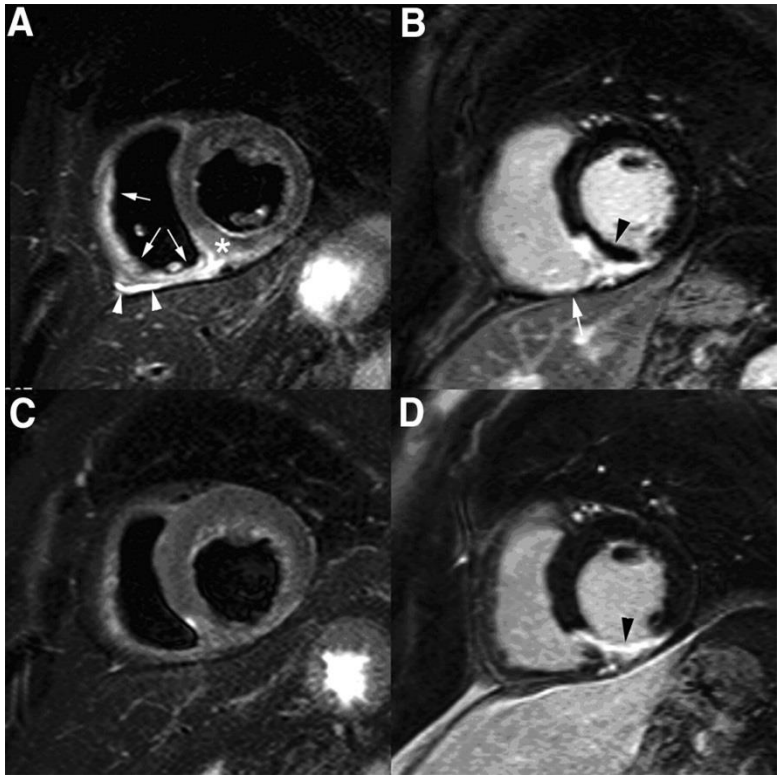
ACUTE
RV infarction



Masci PG., …… Bogaert et al. Circulation 2010;122:1405-1412

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Clinical & prognostic significance

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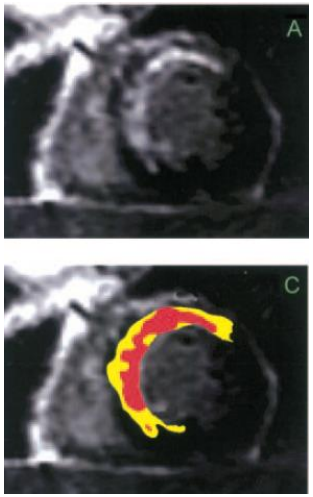
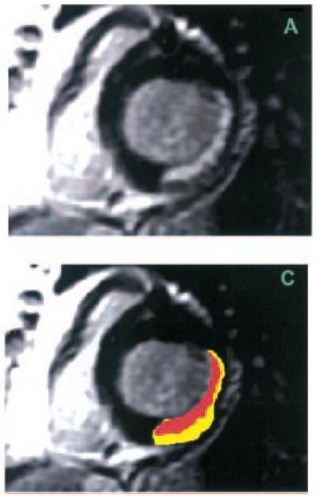
Infarct Tissue Heterogeneity by Magnetic Resonance Imaging Identifies Enhanced Cardiac Arrhythmia Susceptibility in Patients With Left Ventricular Dysfunction



Variable	Noninducible for MVT (n=27)	Inducible for MVT (n=20)	P
MRI LVEF	0.30±0.10	0.29±0.07	0.79
LV end-diastolic volume, mL	220±70	228±57	0.68
LV end-systolic volume, mL	156±61	162±44	0.71
LV end-diastolic mass, g	146±46	132±30	0.23
Infarct location, n (%)			0.23
Anterior±other territory	15 (56)	15 (75)	
Inferior and/or lateral only	12 (44)	5 (25)	
No. of coronary territories with hyperenhancement (%)			0.1*
Single vessel	21 (78)	19 (95)	
Two vessel	6 (22)	1 (5)	
Transmural infarct extent: % of sectors grouped by quartiles of transmurality			
No infarct	51±15	45±9	0.11
1% to 25% infarct transmurality	8±4	7±2	0.61
26% to 50% infarct transmurality	8±3	8±5	0.88
51% to 75% infarct transmurality	11±5	12±5	0.39
76% to 100% infarct transmurality	23±14	28±11	0.17
Extent of hyperenhancement, g			
Total (core+gray)	34±17	40±11	0.17
Infarct core	21±10	21±5	0.95
Gray zone	13±9	19±8	0.015



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Schmidt Circulation 2007; 115: 2006

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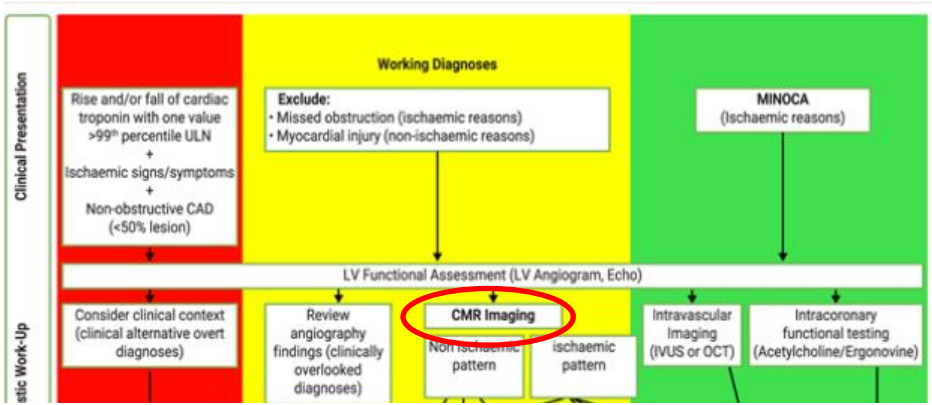
2020 ESC NSTEACS



Recommendations for myocardial infarction with non-obstructive coronary arteries

Recommendations	Class[a]	Level[b]
In all patients with an initial working diagnosis of MINOCA, it is recommended to follow a diagnostic algorithm to differentiate true MINOCA from alternative diagnoses.	I	C
It is recommended to perform CMR in all MINOCA patients without an obvious underlying cause.[370]	I	B
It is recommended to manage patients with an initial diagnosis of MINOCA and a final established underlying cause according to the disease-specific guidelines.	I	C
Patients with a final diagnosis of MINOCA of unknown cause may be treated according to secondary prevention guidelines for atherosclerotic disease.	IIb	C

CMR = cardiac magnetic resonance; MINOCA = myocardial infarction with non-obstructive coronary arteries.
[a]Class of recommendation.
[b]Level of evidence.