

*IV Congresso Nazionale Ecocardiografia  
Milano 10/12 Marzo 2010*

## **MIOCARDITE**

## **IL RUOLO DELL'ECOCARDIOGRAFIA E DELLA RADIO-RMN**

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## Comparison of values of laboratory and imaging techniques in myo

Technique	n	Sensitivity (%)	Specificity (%)	Positive Predictive Value	Negative Predictive Value	Reference(s)
Troponin T	80	53	96	93	56	74
Troponin I	88	34	89	—	—	75
EMB-H	71	10–36	98	—	—	10,11,38
EMB-IH	20	80	85	—	—	76
Gallium-67 scintigraphy	71	87	86	36	98	38
Ultrasonic tissue characterization	106	100	91	—	—	29
AMA vs. EMB-H	50	91–100	31–44	28–33	93–100	63
AMA vs. EMB-IH	65	65	71	86	41	77
CMR-T1	37	84	100	—	—	13
CMR GE-T1	27	100	100	—	—	54
CMR-IR-GRE	44	88	91	—	—	57
CMR						
T2/LGE/gRE	48	84/44/80	74/100/68	—	—	58
Any 2		76	95.5	—	—	

AMA = indium-antimyosin antibody scintigraphy; CMR = cardiac magnetic resonance imaging; EMB-H = endomyocardial biopsy-histological study; EMB-IH = immunohistochemical study; GE T1 = gadolinium-enhanced T1-weighted; gRE = global (early) relative enhancement; IRGRE = inversion recovery gradient echo pulse sequence; LGE = late gadolinium enhancement.

Quadro nosologico	Agente eziologico	Immuno-istochimica	Quadro clinico	ECO	RMC
Acuta fulminante	Virale	+++	shock	Edema+ FEVS↓↓	Edema+ DE diffuso
Acuta a cellule giganti	Autoimmune	+++	shock	Edema+ FEVS↓↓	Edema+ DE diffuso
Acuta non fulminante	virale/ autoimmune	+	SCA	Pericardite FEVS =	Flogosi++ DE ++
Acuta eosinofila	autoimmune/ virale	+++	SCA	Edema+ FEVS↓↓	Edema + DE diffuso
Acuta Ipersensibilita'	Autoimmune	+	Febbre,rush cutaneo	Pericardite FEVS =	Flogosi + DE diffuso
Endocardite di Loeffler	Autoimmune	+++	Febbre,rush cutaneo	Cmio restrittivaV D	Flogosi + DE VD

# **ECHOCARDIOGRAPHY AND MYOCARDITIS**

- **LV SEGMENTAL WALL MOTION – VOLUMES- THICKNESS**
- **PERICARDIAL EFFUSION**
- **RV SYSTOLIC FUNCTION**
- **ASSOCIATE CARDIAC DISEASES**

- **BACKSCATTER**
- **TISSUE DOPPLER VELOCITIES**
- **LONGITUDINAL STRAIN DOPPLER**

## Echocardiographic Findings in Fulminant and Acute Myocarditis

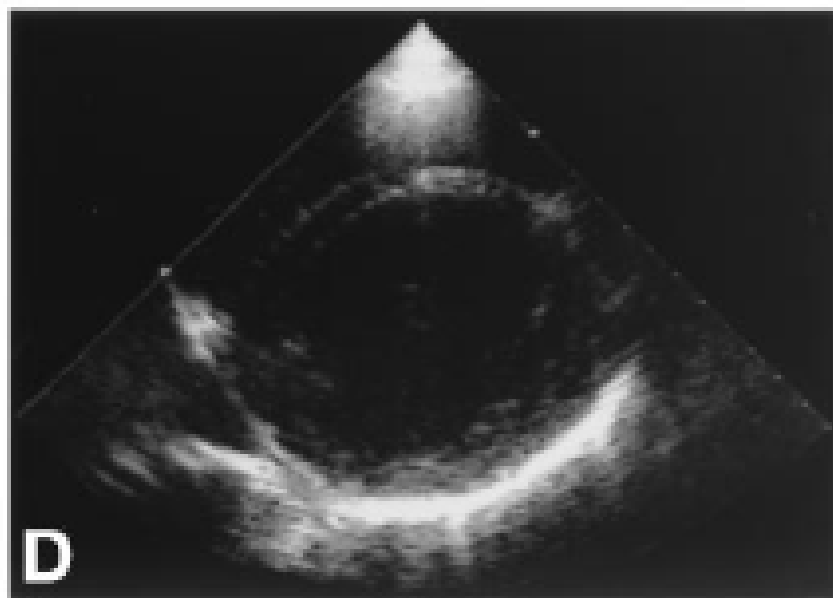
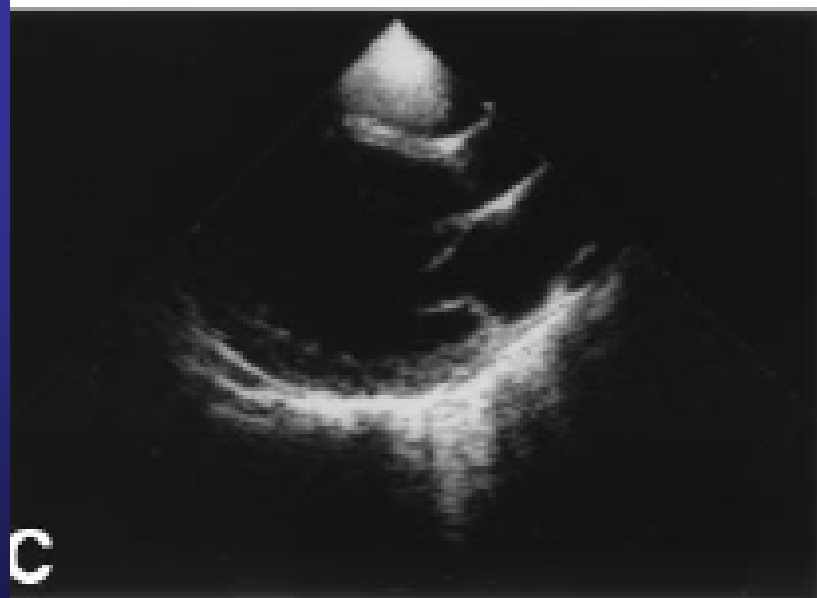
G. Michael Felker, MD,\* John P. Boehmer, MD, FACC,\*‡ Ralph H. Hruban, MD,† Grover M. Hutchins, MD,† Edward K. Kasper, MD, FACC,\* Kenneth L. Baughman, MD, FACC,\* Joshua M. Hare, MD, FACC\*

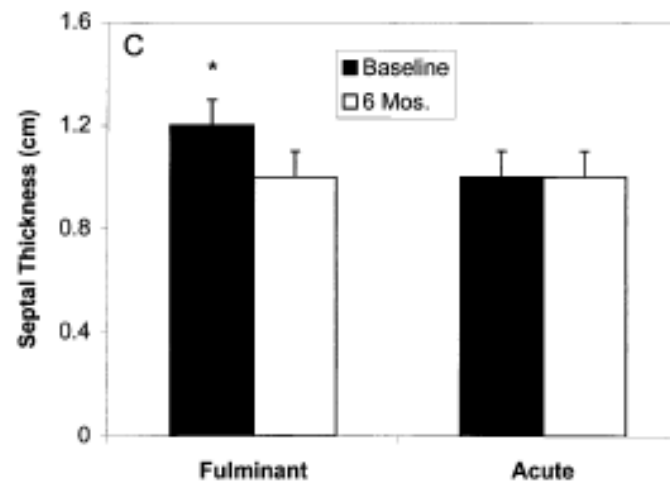
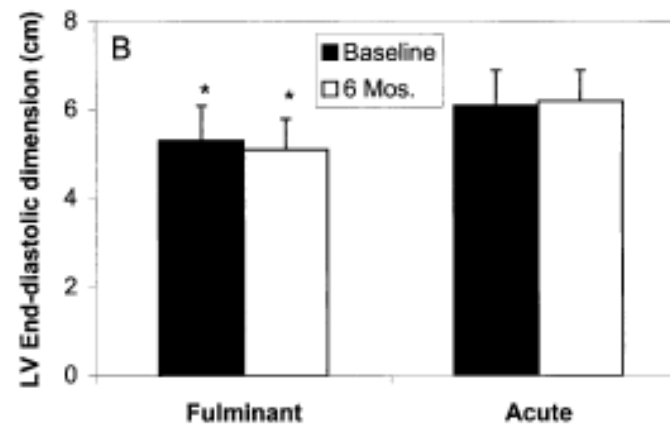
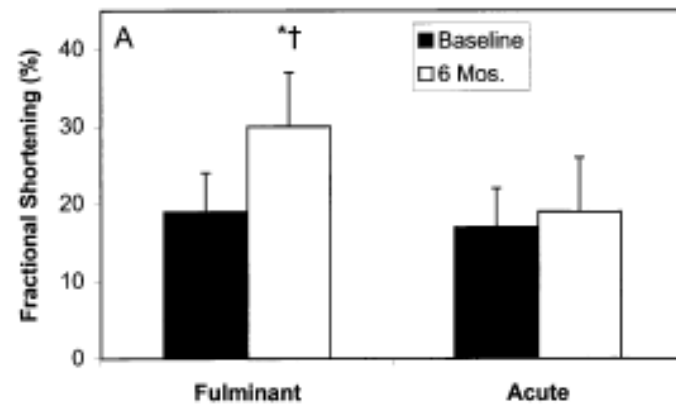
*Baltimore, Maryland*

**Table 1.** Baseline Clinical Characteristics of Patients With Fulminant and Acute Myocarditis

	Fulminant (n = 11)	Acute (n = 43)
Flu-like illness within 4 weeks	100% (11)	21% (9)
Fever within 12 weeks	91% (10)	23% (10)
Acute onset of symptoms	100% (11)	56% (24)
NYHA Functional Class		
4	73% (8)	58% (25)
3	27% (3)	26% (11)
2	0% (0)	16% (7)
1	0% (0)	0% (0)

NYHA = New York Heart Association.





## **Right ventricular dysfunction: an independent predictor of adverse outcome in patients with myocarditis.**

**Mendes LA, Dec GW, Picard MH, Palacios IF, Newell J, Davidoff R**

Evans Memorial Department of Clinical Research, Boston University Medical Center Hospital, MA 02118.

*To assess the predictive value of right ventricular systolic function in patients with active myocarditis, the echocardiograms of 23 patients with biopsy-confirmed myocarditis were reviewed. Right ventricular systolic function was evaluated qualitatively and quantitatively by descent of the right ventricular base. Patients were divided into those with normal right ventricular function, in whom right ventricular descent was  $1.9 \pm 0.1$  cm, and those with abnormal right ventricular function, in whom right ventricular descent was  $0.8 \pm 0.1$  cm ( $p < 0.001$ ). There were no differences between the two groups in age, duration of symptoms, baseline hemodynamics, or histologic assessment. Initial left ventricular ejection fraction was significantly lower in patients with depressed right ventricular function ( $27.5 \pm 4.9\%$ ) compared with that in patients with normal right ventricular function ( $47.5 \pm 6.3\%$ ) ( $p = 0.01$ ). **The likelihood of an adverse outcome, defined as death or need for cardiac transplantation, was greater in patients with abnormal right ventricular function (right ventricular descent  $\leq 1.7$  cm) than in patients with normal right ventricular function (right ventricular descent  $> 1.7$  cm) ( $p < 0.03$ ).** Multivariate analysis revealed that right ventricular dysfunction as quantified by right ventricular descent was the most powerful predictor of adverse outcome.*



# Clinical value of echocardiographic tissue characterization in the diagnosis of myocarditis

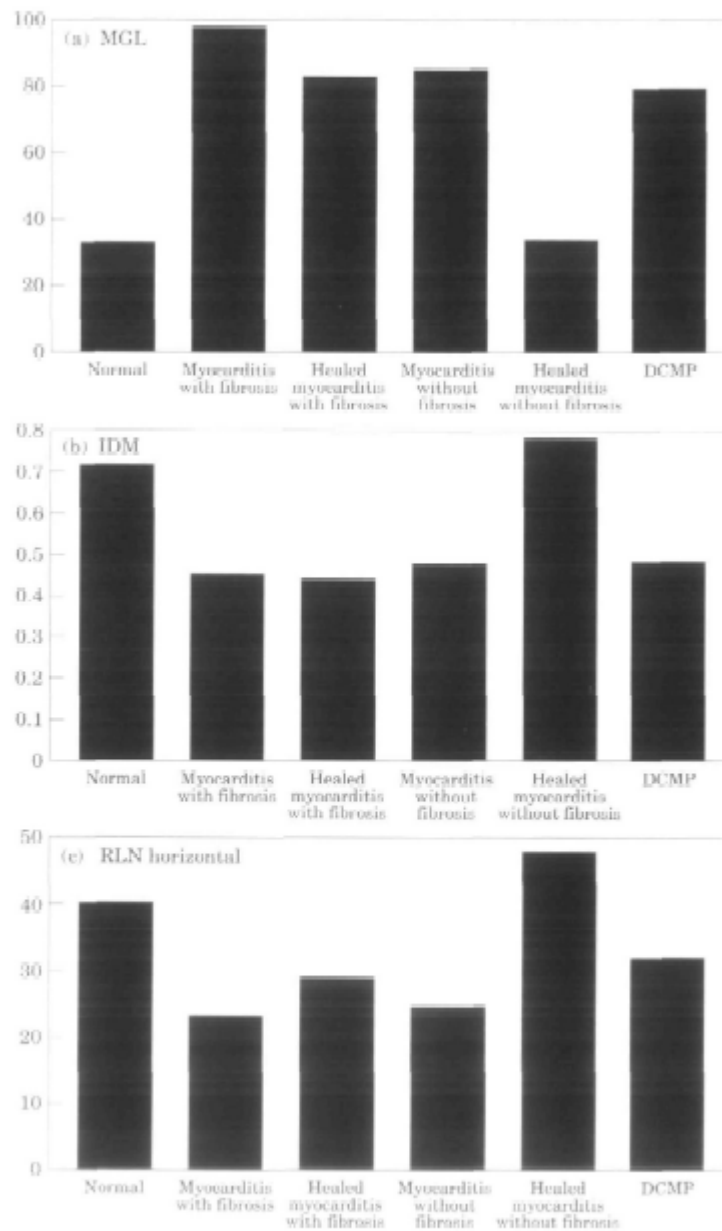
E. Lieback\*, I. Hardouin\*, R. Meyer†, J. Bellach† and R. Hetzer\*

\*German Heart Institute Berlin; †Charité, Humboldt University Berlin, Germany

*Table 1 Histological results of endomyocardial biopsies*

Myocarditis without fibrosis	33
Myocarditis with fibrosis	19
Permanent myocarditis	12
Healed myocarditis without fibrosis	9
Healed myocarditis with fibrosis	17
Dilated cardiomyopathy	35
Hypertrophy	5
Ischaemic heart disease and small vessel disease	4
No pathological changes	8
	142

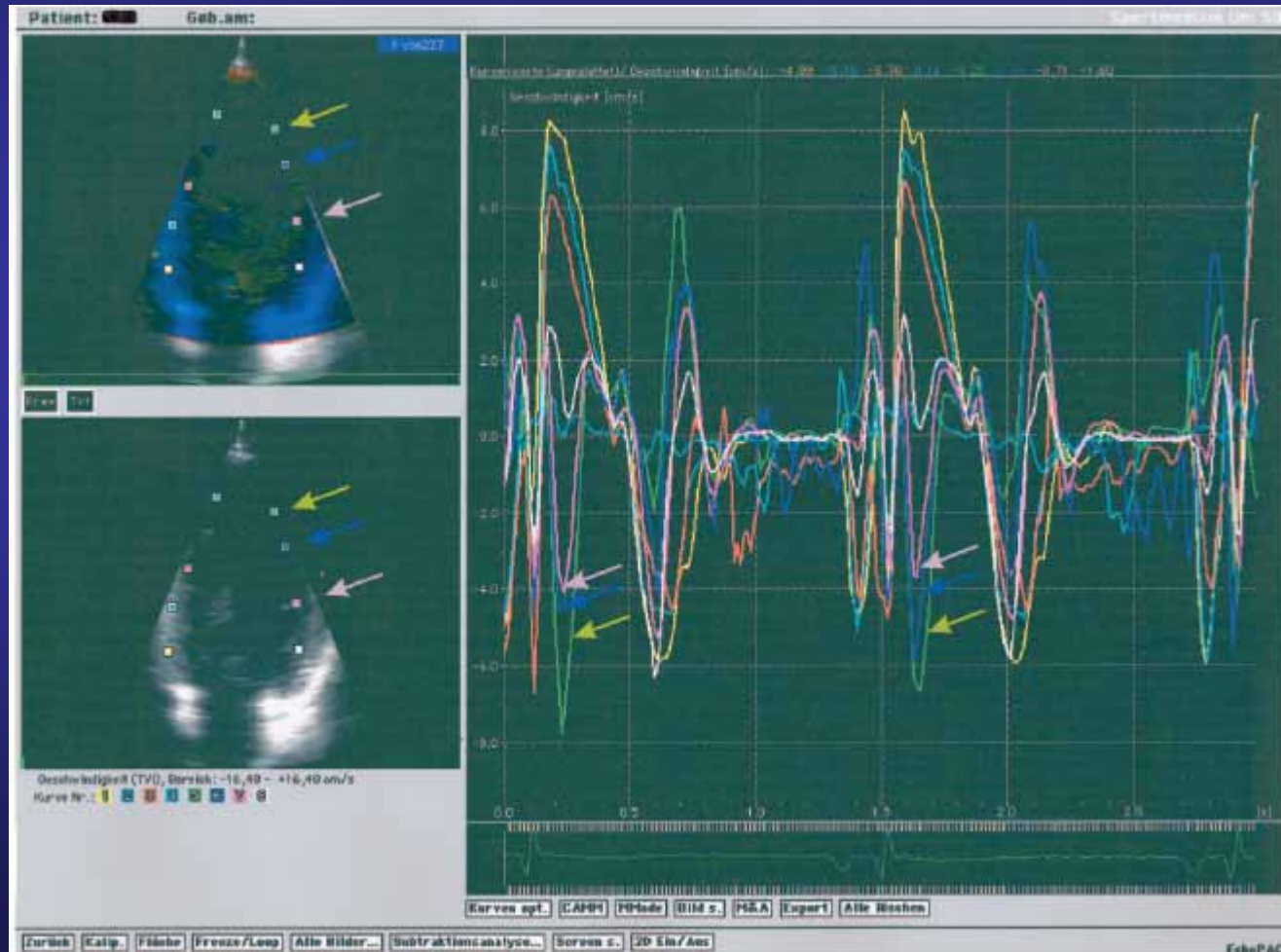




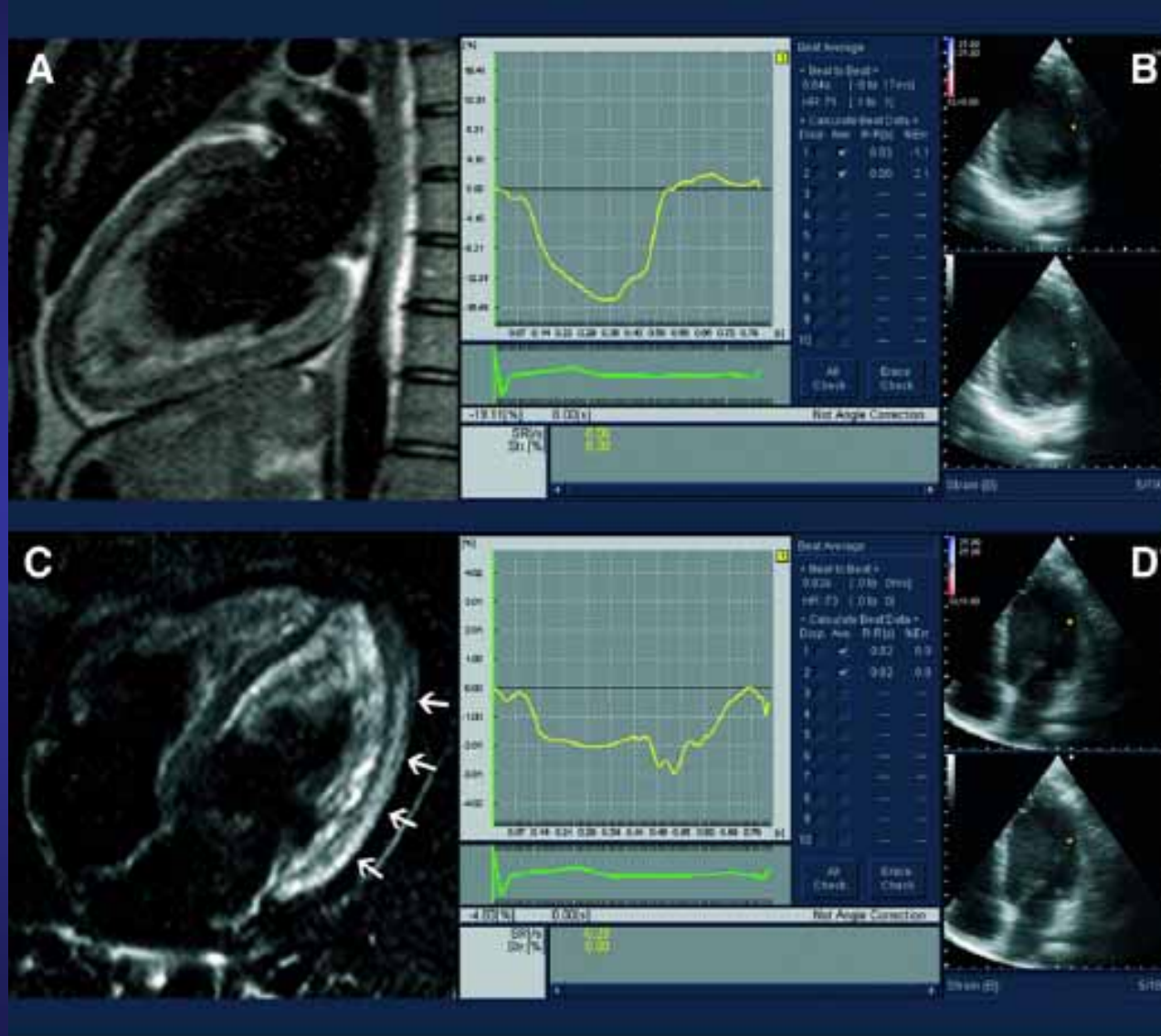
**Figure 4** Average feature values of MGL (a), IDM (b) and RLN (c) for six groups.

# Diagnosis of Myocarditis by Cardiac Tissue Velocity Imaging in an Olympic Athlete

Axel Urhausen, MD; Michael Kindermann, MD; Michael Böhm, MD; Wilfried Kindermann, MD



# Longitudinal Strain Doppler Echocardiography in acute myocarditis



# Cardiovascular Magnetic Resonance in Myocarditis: A JACC White Paper

Matthias G. Friedrich, MD,\* Udo Sechtem, MD,‡ Jeanette Schulz-Menger, MD,§  
Godtfred Holmvang, MD,|| Pauline Abkija, MD,† Leslie T. Cooper, MD,¶ James A. White, MD,#  
Hassan Abdel-Aty, MD,§ Matthias Gutberlet, MD,\*\* Sanjay Prasad, MD,††  
Anthony Aletras, PhD,‡‡ Jean-Pierre Laissy, MD,§§ Ian Paterson, MD,|||  
Neil G. Filipchuk, MD,\* Andreas Kumar, MD,\* Matthias Pauschinger, MD,¶¶  
Peter Liu, MD,## for the *International Consensus Group on Cardiovascular Magnetic Resonance  
in Myocarditis*

**Table 1**

## Published Controlled Studies on Cardiovascular Magnetic Resonance in Myocarditis

	Validation	No. of Patients	No. of Control Patients
Friedrich et al., <i>Circulation</i> 1998 (9)	Clinical	19	18
Laissy et al., <i>Chest</i> 2002 (11)	Clinical	20	7
Rieker et al., <i>Rofo</i> 2002 (36)	Clinical	11	10
Laissy et al., <i>Radiology</i> 2005 (37)*	Clinical	24	31
Abdel-Aty et al., <i>J Am Coll Cardiol</i> 2005 (13)	Clinical	25	22
Mahrholdt et al., <i>Circulation</i> 2006 (40)	Histology	87	26
Gutberlet et al., <i>Radiology</i> 2008 (34)†	Histology	48	35
Yilmaz et al., <i>Heart</i> 2008 (43)†	Histology	55	30
Total		289	179

\*Compared with patients with acute myocardial infarction. †Compared with patients with clinical evidence but lack of immunohistologic evidence for chronic myocarditis.

**Table 7**

## Proposed Diagnostic CMR Criteria (i.e., Lake Louise Consensus Criteria) for Myocarditis

In the setting of clinically suspected myocarditis,\* CMR findings are consistent with myocardial inflammation, if at least 2 of the following criteria are present:

Regional or global myocardial SI increase in T2-weighted images.†

Increased global myocardial early gadolinium enhancement ratio between myocardium and skeletal muscle in gadolinium-enhanced T1-weighted images.‡

There is at least 1 focal lesion with nonischemic regional distribution in inversion recovery-prepared gadolinium-enhanced T1-weighted images ("late gadolinium enhancement").§

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A CMR study is consistent with myocyte injury and/or scar caused by myocardial inflammation if Criterion 3 is present.

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A repeat CMR study between 1 and 2 weeks after the initial CMR study is recommended if

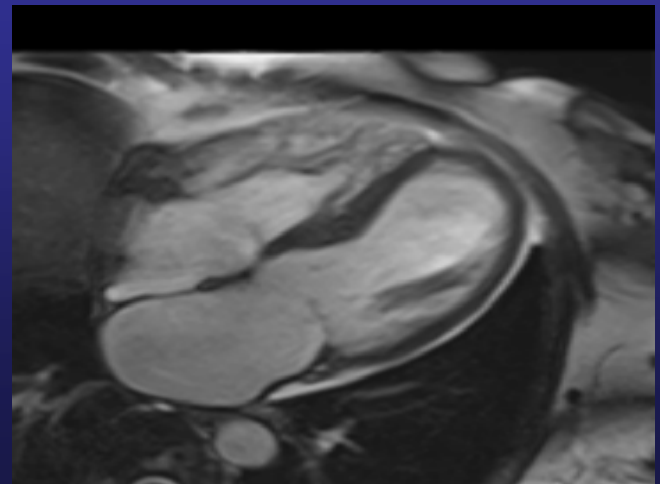
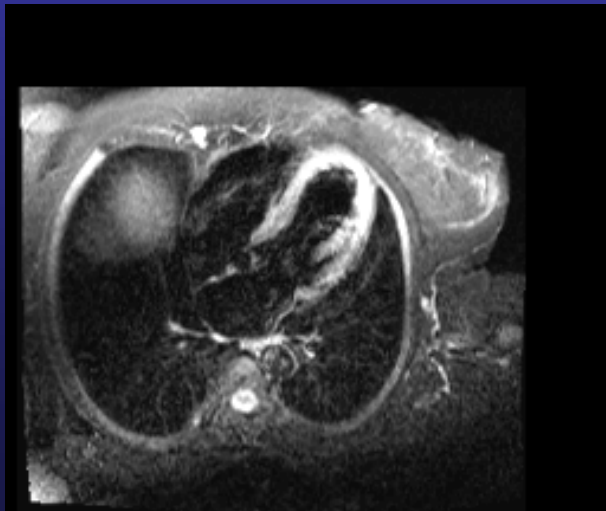
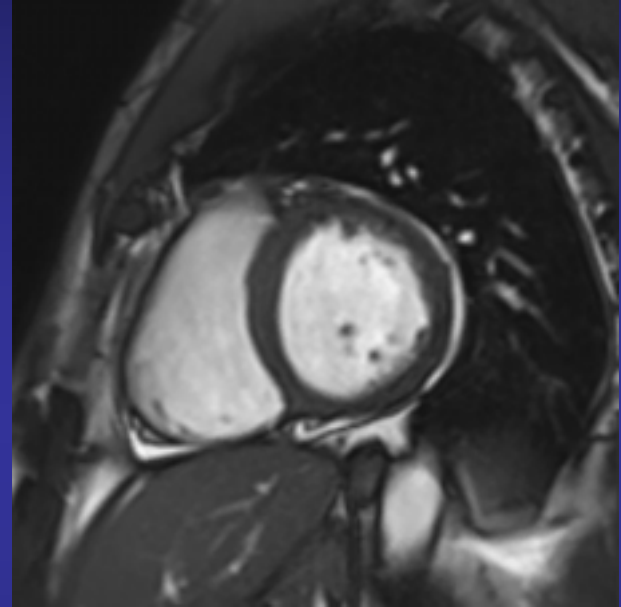
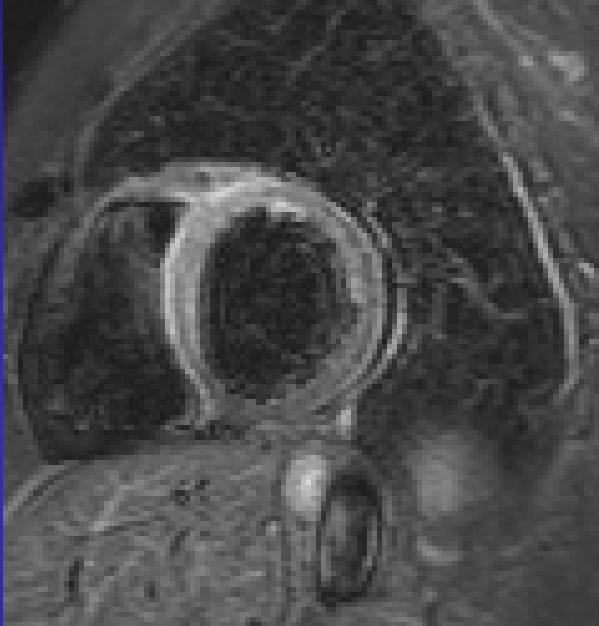
None of the criteria are present, but the onset of symptoms has been very recent and there is strong clinical evidence for myocardial inflammation.

One of the criteria is present.

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The presence of LV dysfunction or pericardial effusion provides additional, supportive evidence for myocarditis.

# T2-WEIGHTED SHORT-TAU INVERSION RECOVERY SEQUENCE STIR



# Relationship between myocardial edema and myocardial mass during the convalescent phase of myocarditis Zagrosek et al. J Cardio Magn Res 200

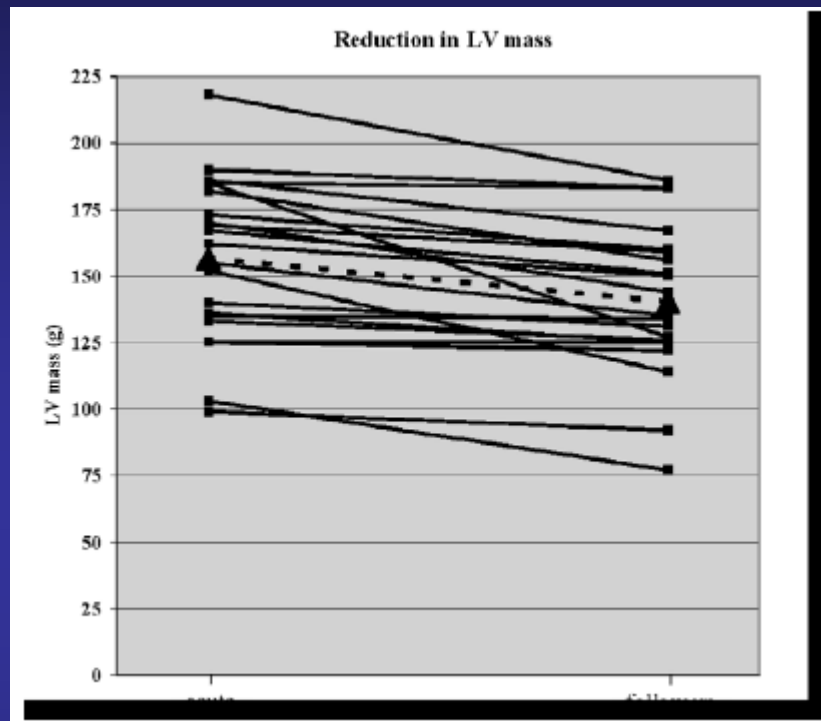
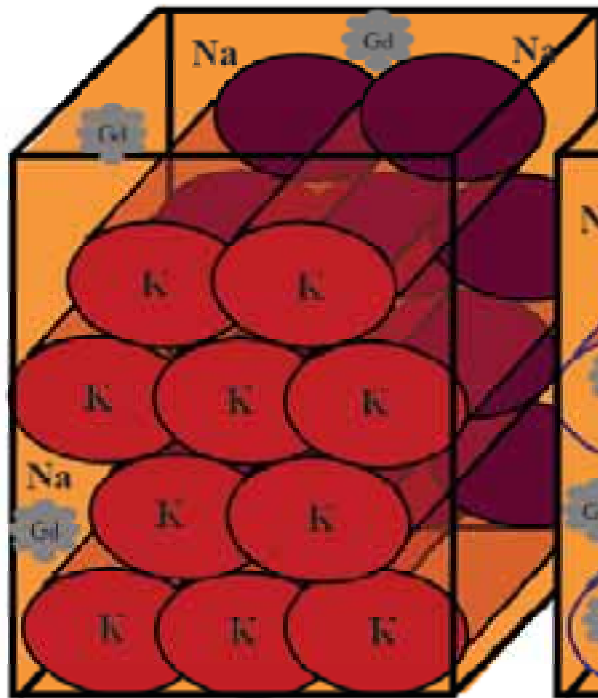


Table 3: CMR results in acute myocarditis and at follow-up

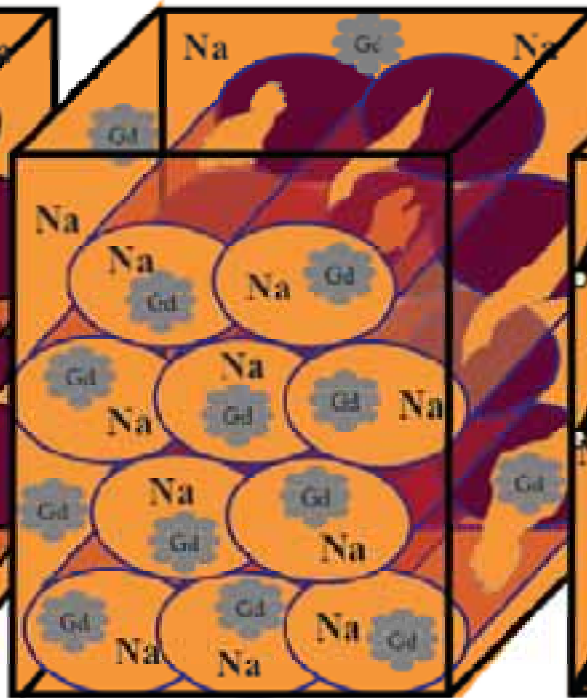
Variable	Acute	Follow-up	Difference between means	P-value acute vs. follow-up
LV mass (g)	156.66 ± 30.56	140.33 ± 28.30	-16.33	<0.0001
LV mass/height (g/cm)	0.90 ± 0.15	0.80 ± 0.12	-0.10	0.0001
LVEDV (ml)	158.10 ± 40.01	153.57 ± 37.50	-4.52	0.395
LVEDV/height (ml/cm)	0.89 ± 0.19	0.85 ± 0.19	-0.04	0.2859
Ejection fraction (%)	59.95 ± 6.39	64.14 ± 5.26	4.19	0.015
T2 ratio	2.41 ± 0.39	1.68 ± 0.29	-0.72	<0.0001



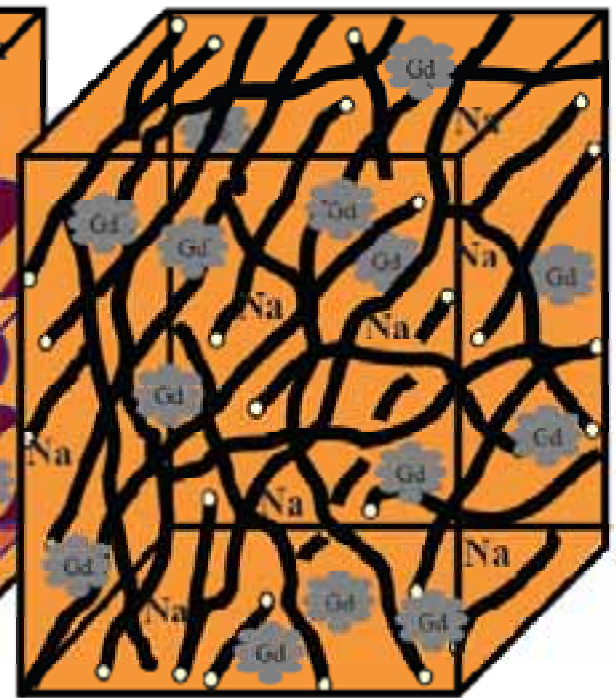
Normal myocardium



Acute infarction



Scar



Intact cell membrane

Ruptured cell membrane

Collagen matrix

# LATE ENHANCEMENT

## Ischemic

### A. Subendocardial Infarct



### B. Transmural Infarct



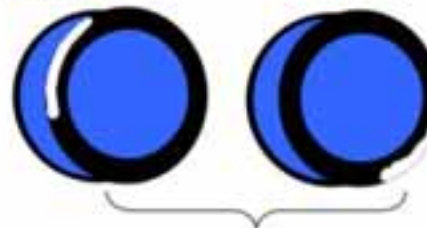
## Nonischemic

### A. Mid-wall HE



- Idiopathic Dilated Cardiomyopathy
- Myocarditis
- Hypertrophic Cardiomyopathy
- Right ventricular pressure overload (e.g. congenital heart disease, pulmonary HTN)
- Sarcoidosis
- Myocarditis
- Anderson-Fabry
- Chagas Disease

### B. Epicardial HE



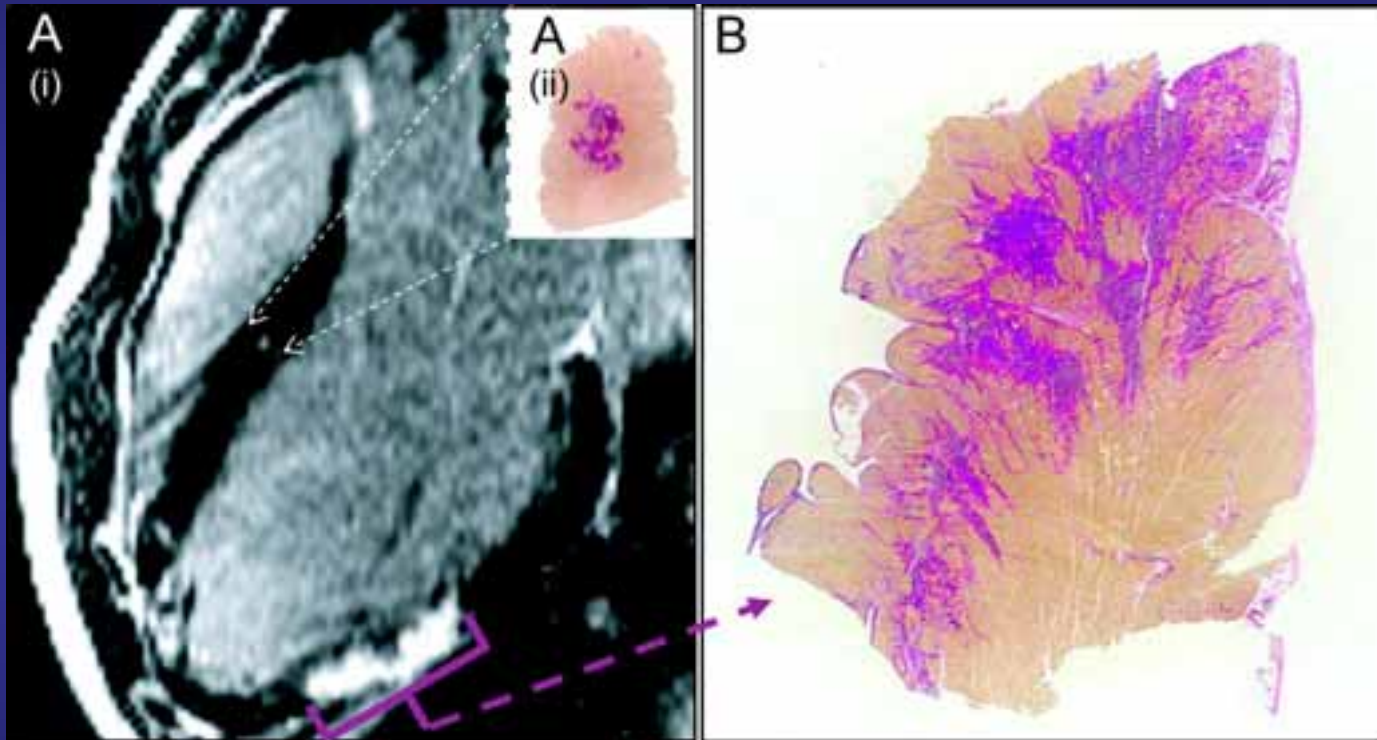
- Sarcoidosis, Myocarditis, Anderson-Fabry, Chagas Disease

### C. Global Endocardial HE



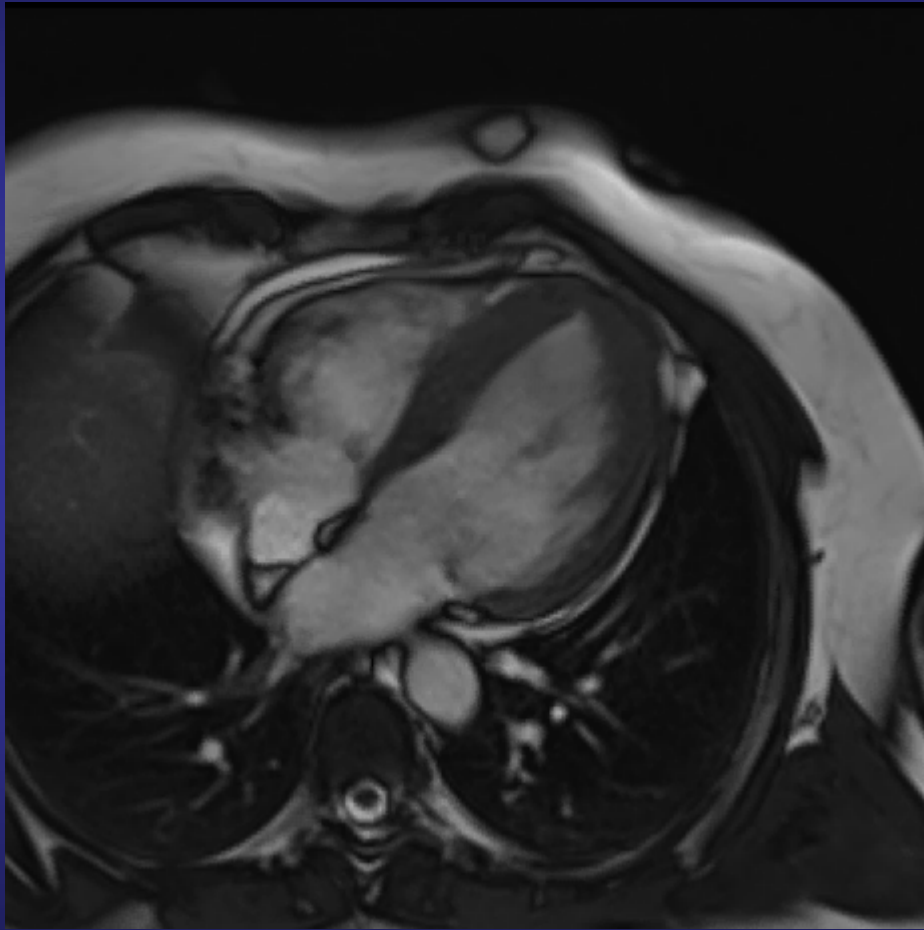
- Amyloidosis, Systemic Sclerosis, Post cardiac transplantation

**LGE CMR image [A(i)] with corresponding histology inset (A(ii)] and further histology corresponding to lateral, patchy, epicardial LGE (B)**

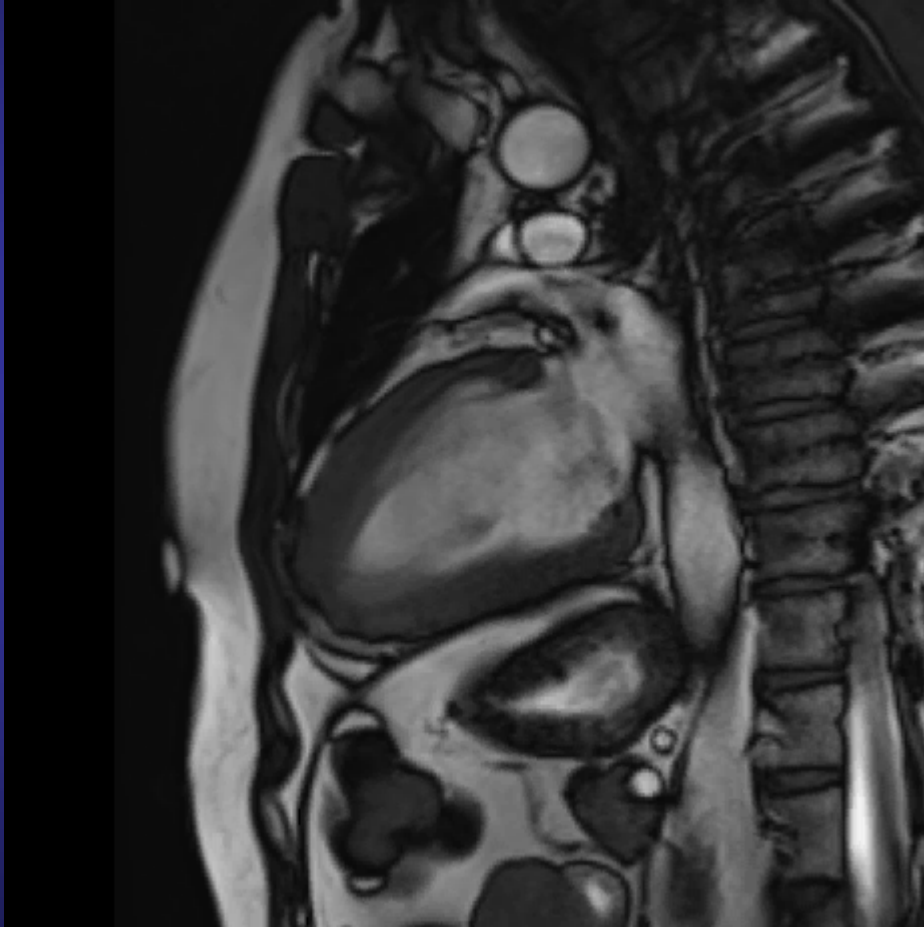


Babu-Narayan, S. V. et al. *Circulation* 2007;116:e122-e125

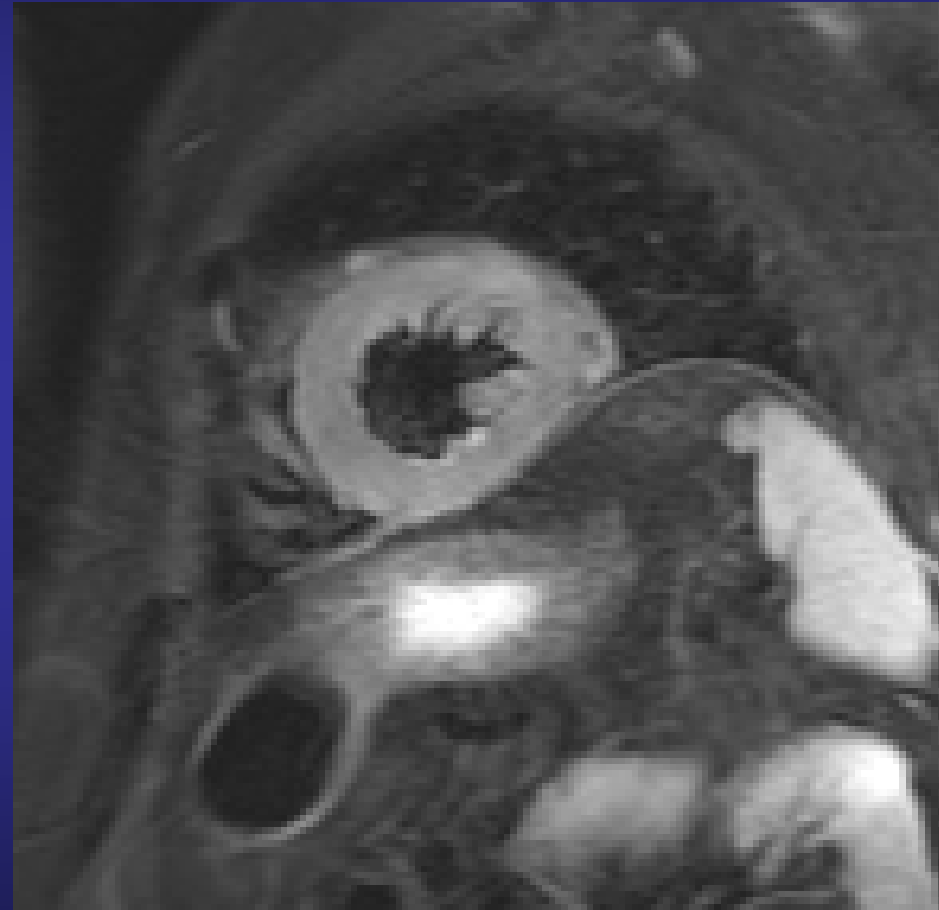
**ACUTE MYOCARDITIS:  
PATTERN A**



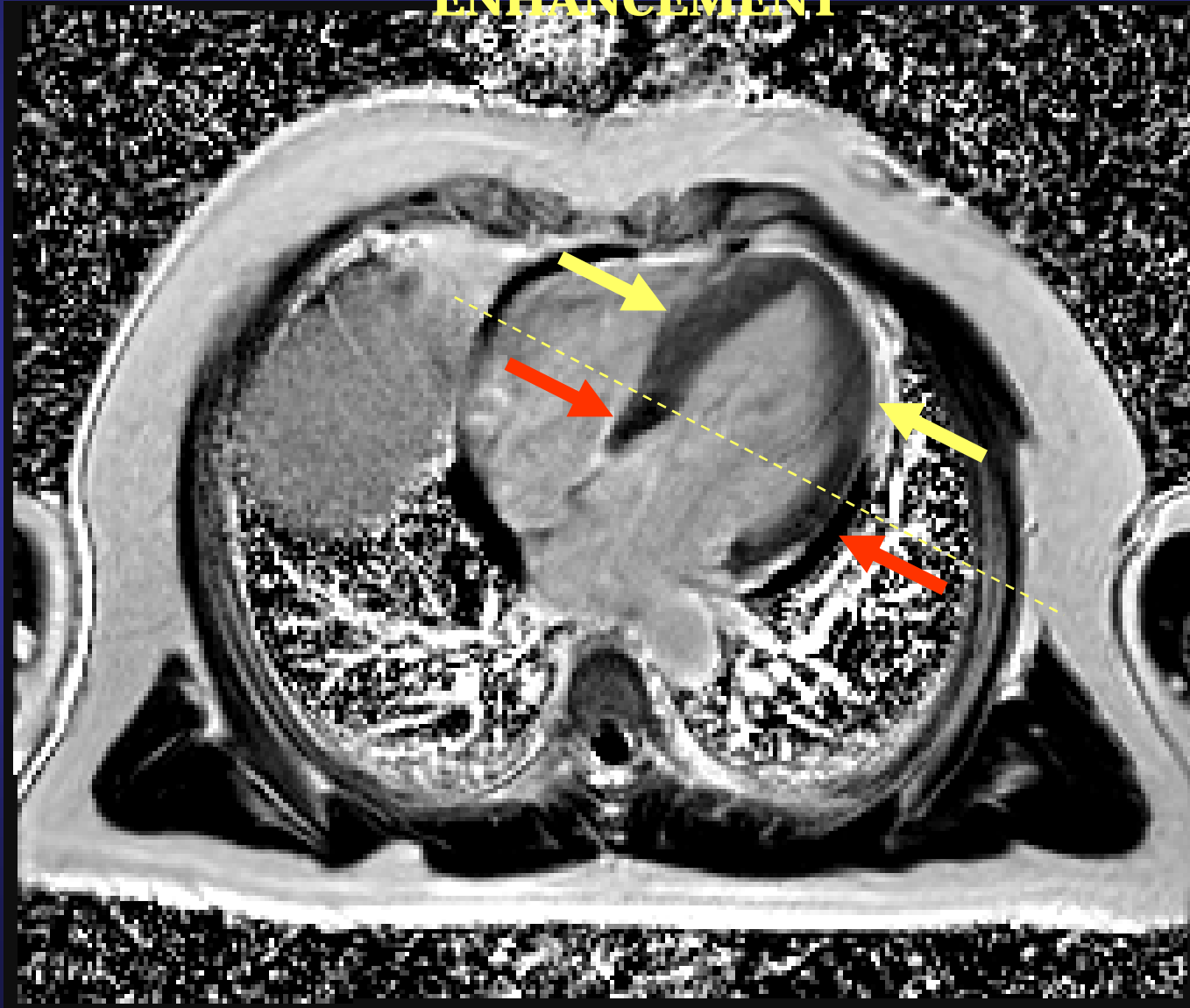
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PATTERN A**



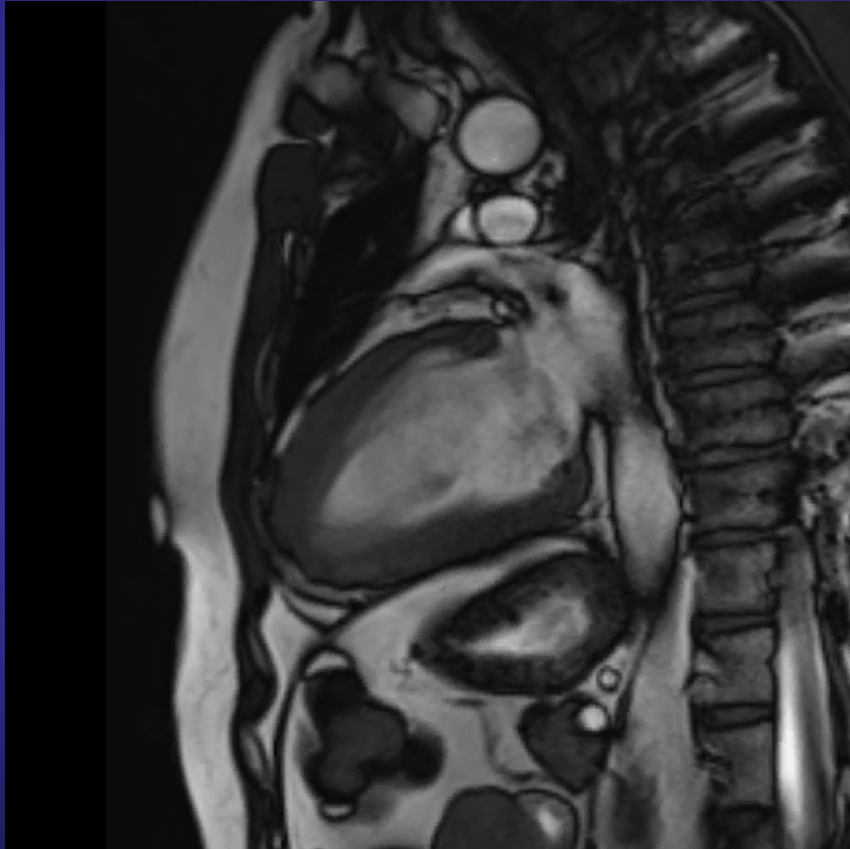
**ACUTE MYOCARDITIS:  
PATTERN A**



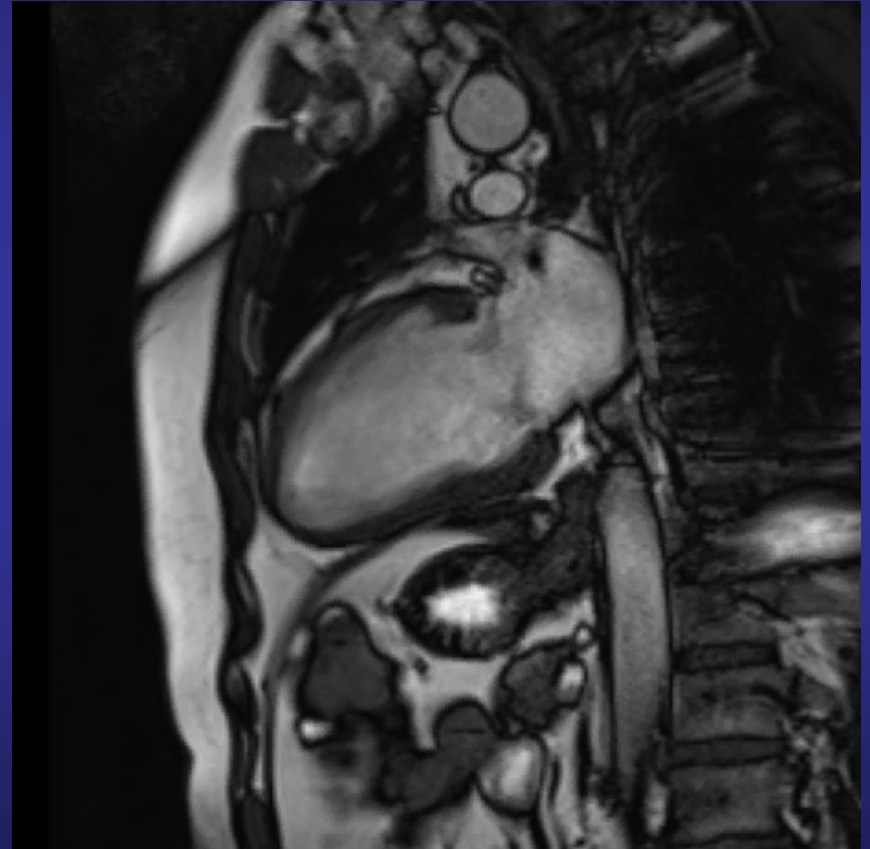
**ACUTE MYOCARDITIS:  
PATTERN A  
DIFFUSE DELAY  
ENHANCEMENT**



**ACUTE MYOCARDITIS, PATTERN A  
VENTRICULAR REMODELING**



**8/2007**



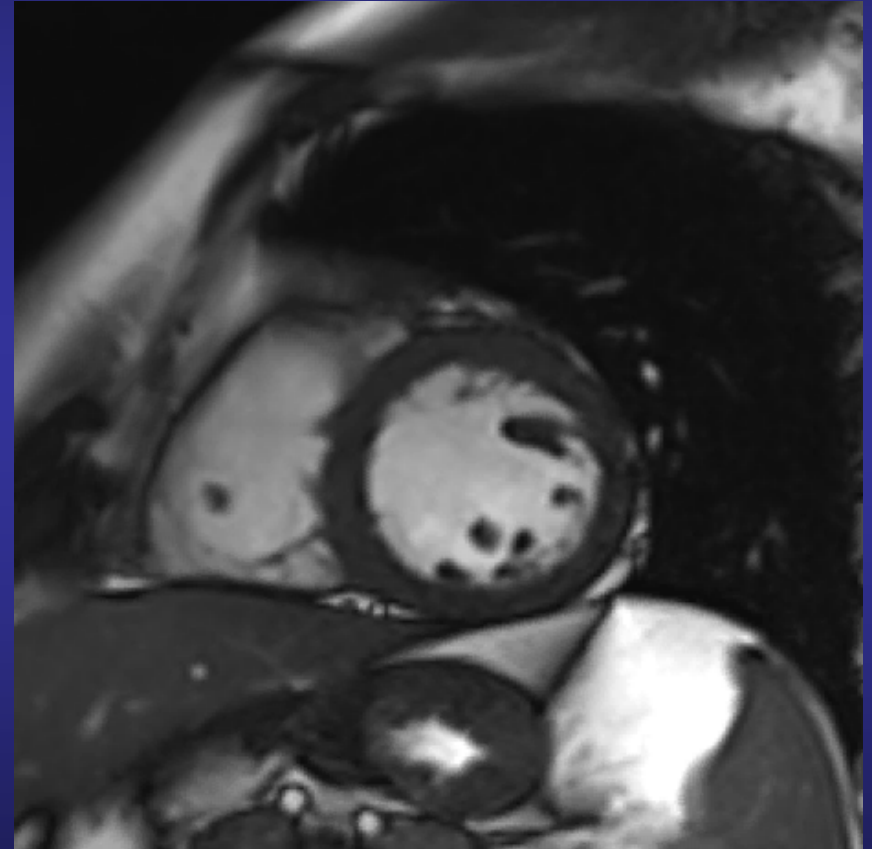
**8/2008**



**ACUTE MYOCARDITIS, PATTERN  
A  
VENTRICULAR REMODELING**

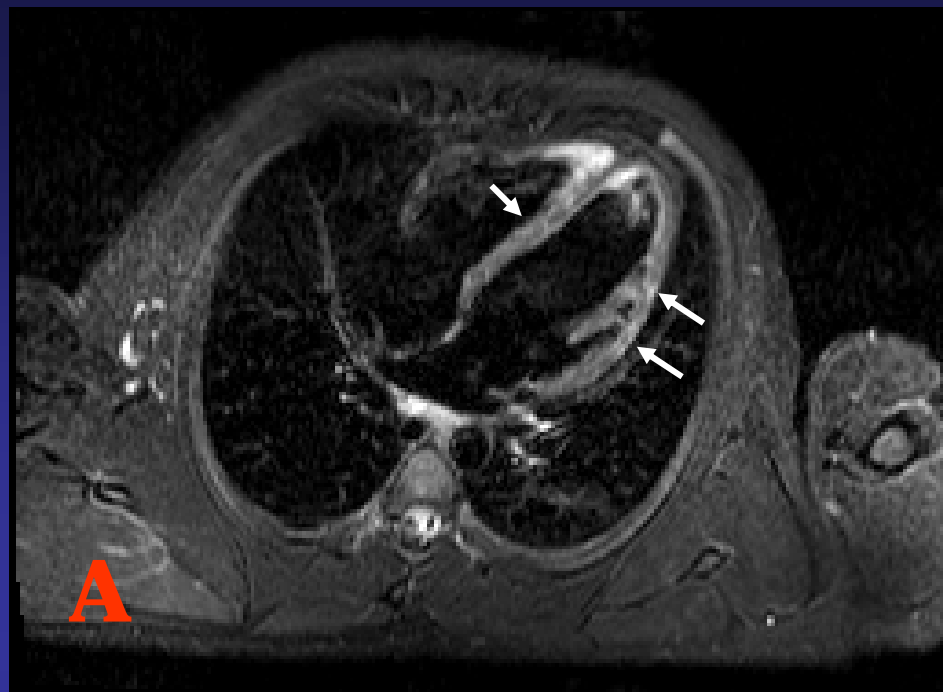


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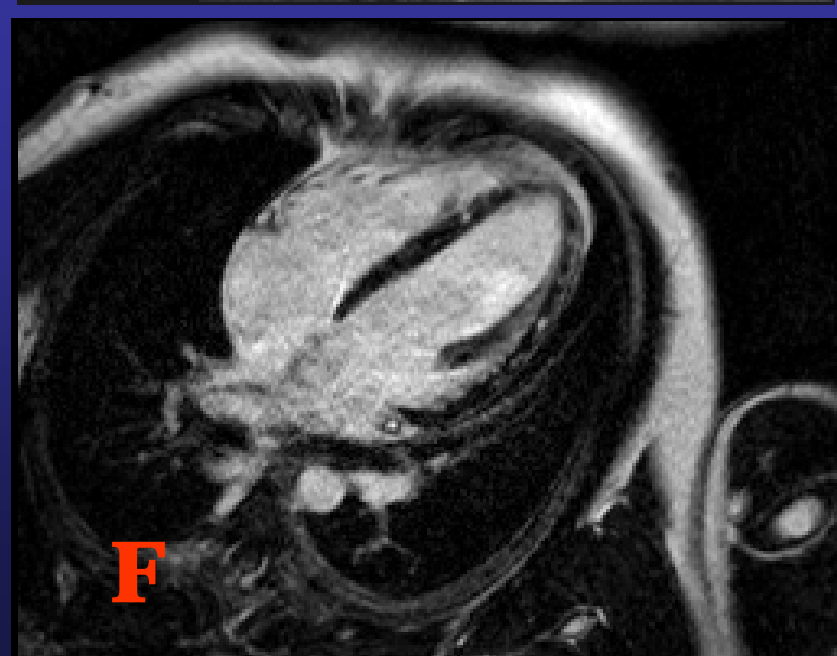
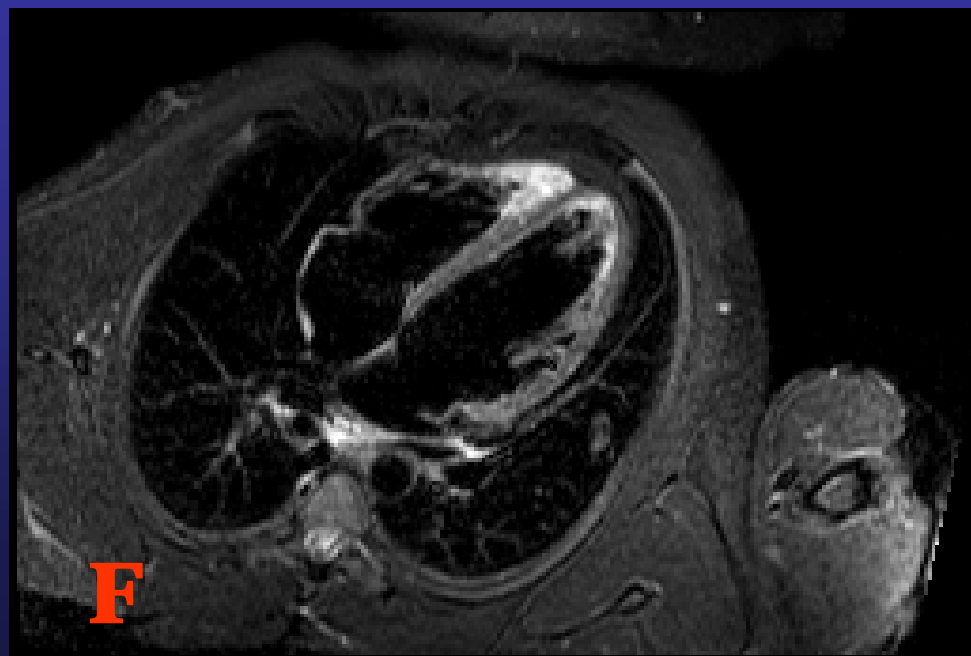
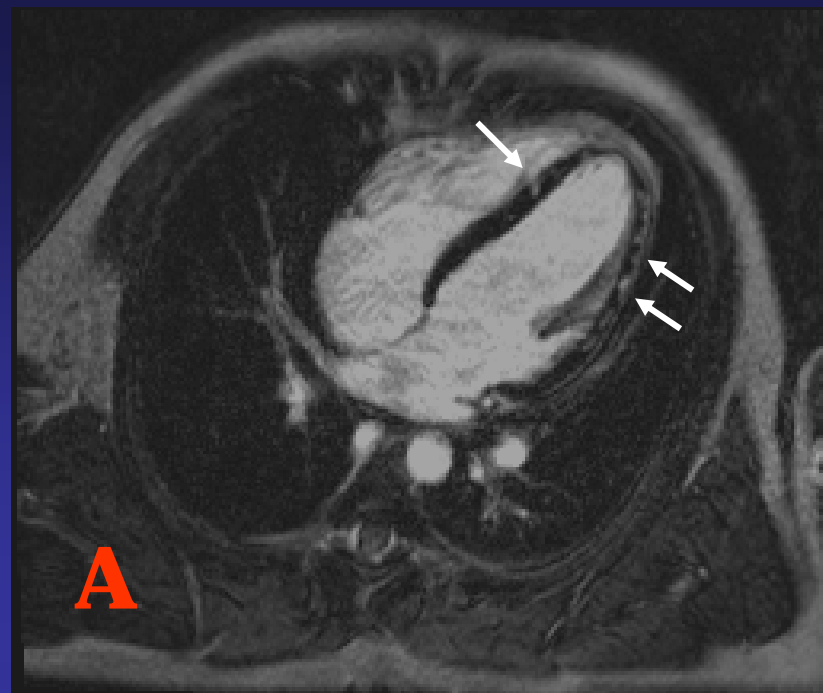


**8/2008**

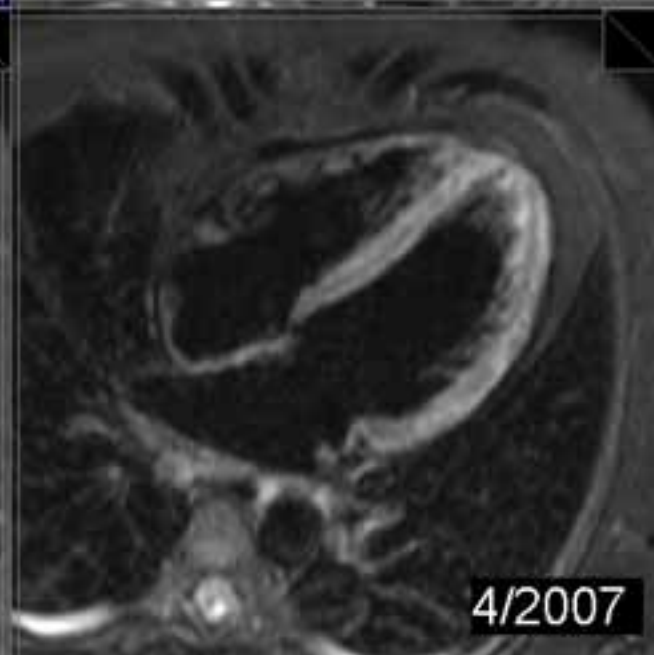
# STIR



# DELAY-ENHANCEMENT



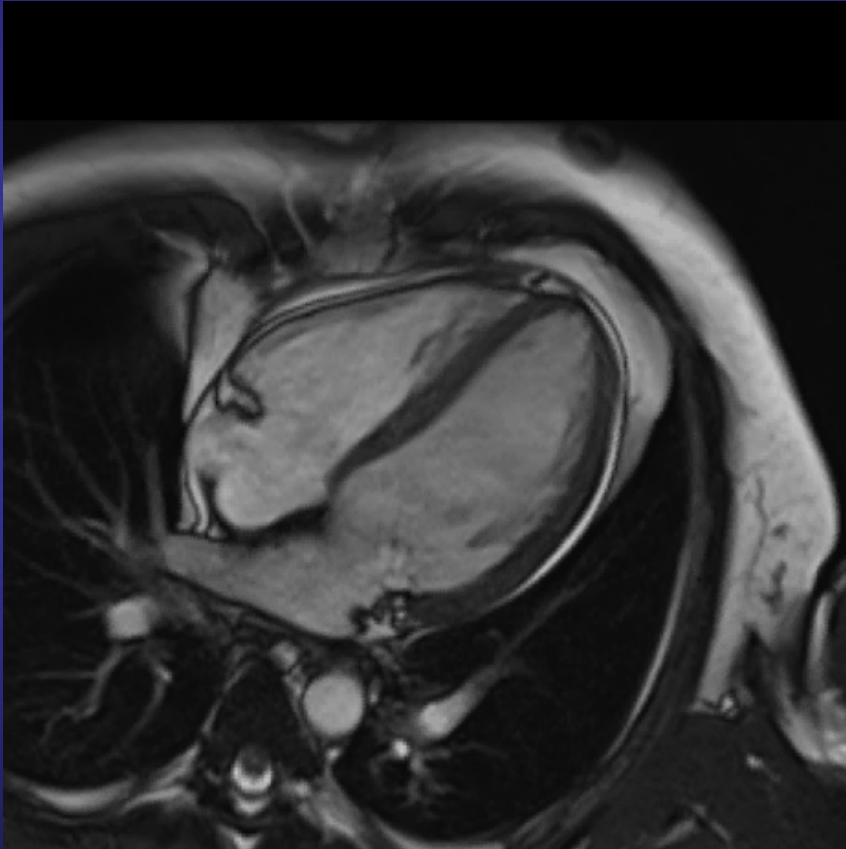
# ACUTE MYOCARDITIS: PATTERN B



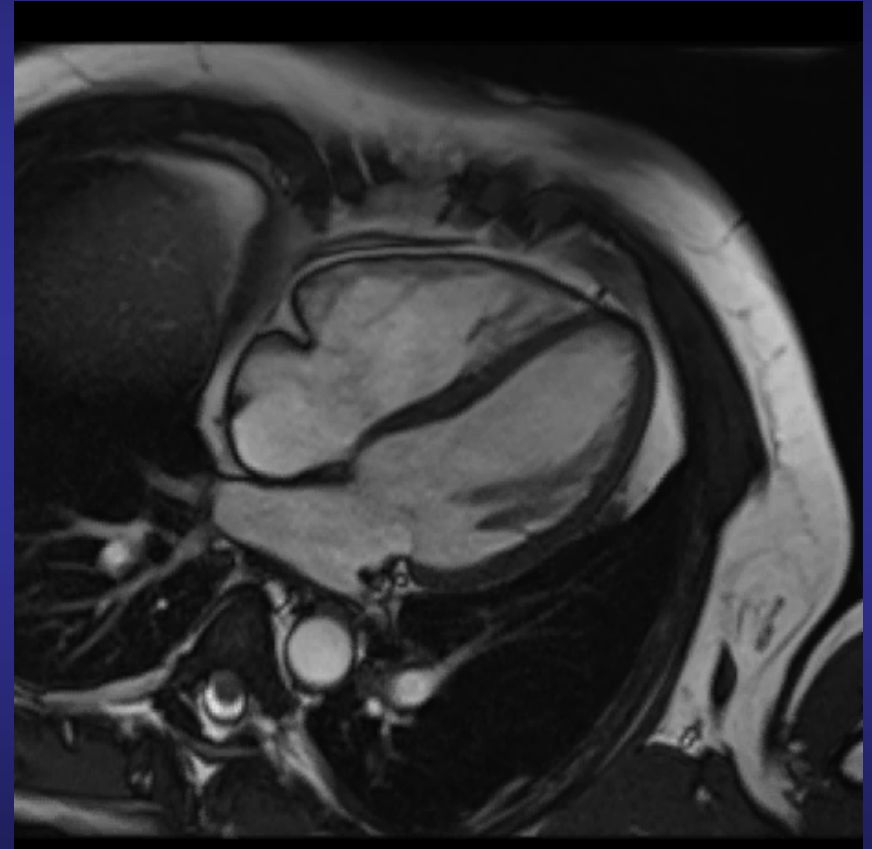
# ACUTE MYOCARDITIS: PATTERN B



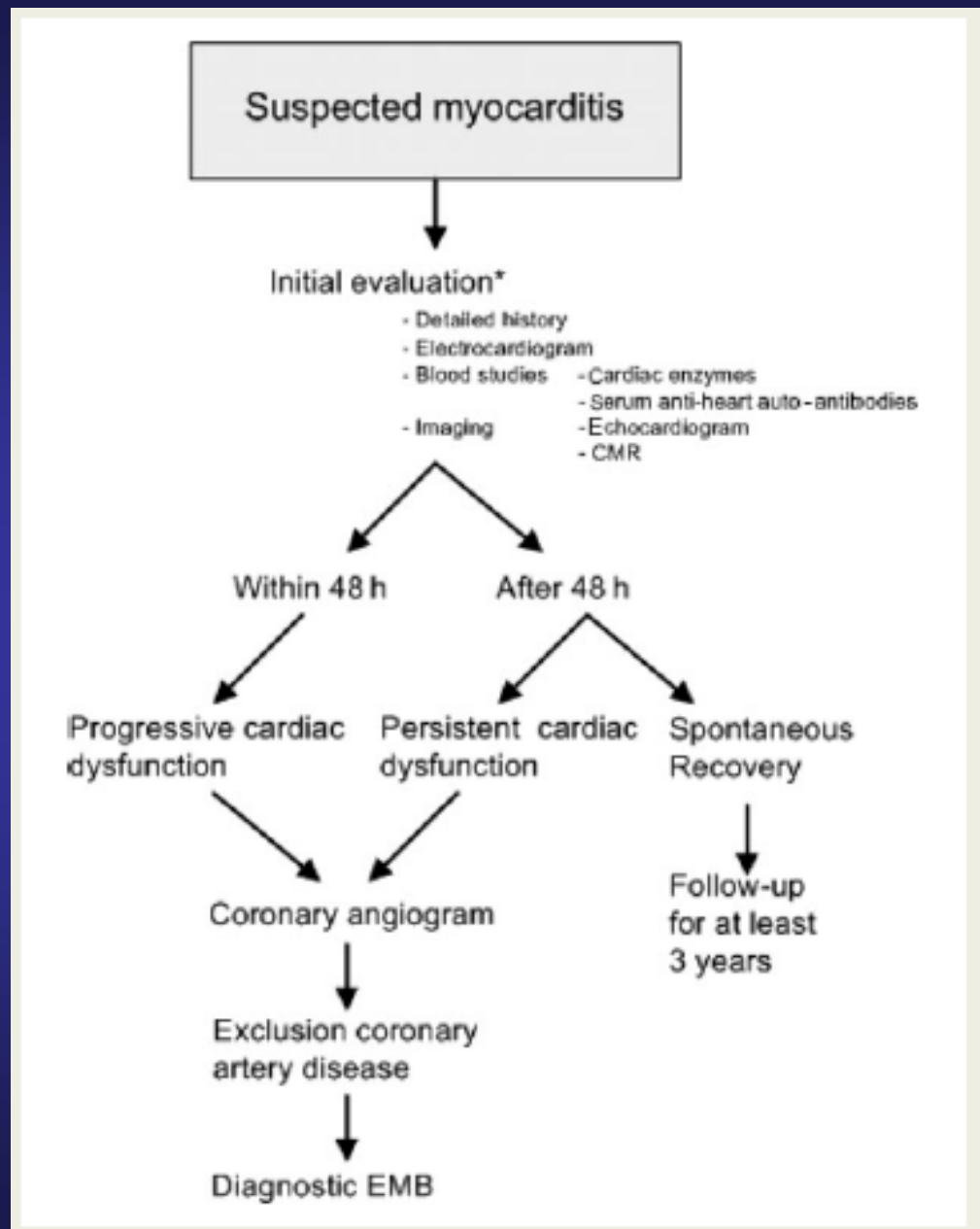
**ACUTE MYOCARDITIS, PATTERN B  
VENTRICULAR REMODELING**



**4/2007**



**6/2008**



# CONCLUSIONI 1.

- **L'eco è la metodica di prima scelta nella miocardite per accessibilità e costo**
- **Nonostante la limitata accuratezza diagnostica, l'ECO è in grado di individuare i pazienti più gravi da avviare a BE e trattamenti aggressivi (miocardite fulminea)**
- **La differenziazione tissutale con tecniche ultrasonore è ancora sperimentale e necessita di una validazione clinica robusta**

## **CONCLUSIONI 2.**

- **la RM cardiaca rappresenta lo standard diagnostico non invasivo in grado di confermare il sospetto diagnostico di miocardite**
- **la possibilita' di evidenziare edema/flogosi e fibrosi miocardica consente una accurata valutazione del quadro clinico e del timing della malattia**
- **il significato prognostico dei due pattern identificabili con RM in fase acuta e' ancora indefinito**
- **Il significato prognostico della fibrosi miocardica residua e' ancora indefinito**
- **L'integrazione dei dati di imaging, di amplificazione virale, di tipizzazione**