

# Απεικονιστικές Τεχνικές στη Διερεύνηση Κλινικών Σεναρίων

## Ασθενής με Αποτραπέντα Αιφνίδιο Θάνατο

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# Sudden death registries

## Oregon Sudden Unexpected Death Study

- 48% had normal LVEF
- 22% had mild to moderately reduced LVEF
- 30% had severely reduced LVEF

## Maastricht Circulatory Arrest Registry

Table 3 SCA rate related to LVEF

	n=9258	n=200 <sup>a</sup>	%*	p	n=81 <sup>b</sup>	%*	p
LVEF							
0–30	508	38	7.5	.000	26	5.1	.000
31–40	628	32	5.1		14	2.2	
41–50	1050	29	2.8		12	1.2	
>50	7072	101	1.4		29	0.41	

\*% of SCA cases per LVEF class is presented.

<sup>a</sup>n=200 all SCA cases with echo data on LVEF.

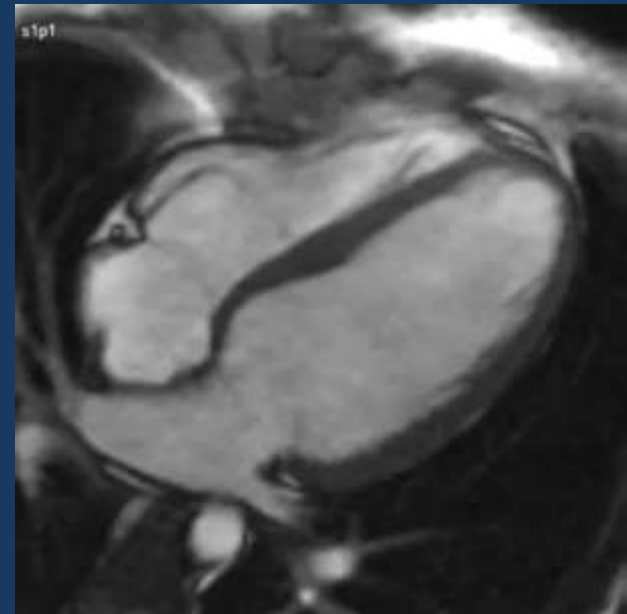
<sup>b</sup>n=81 SCA cases, with echo taken between 1997–2000.

J Am Coll Cardiol 2006;47:1161–6

Eur Heart J. 2003;24:1204-09

# Ejection Fraction and Sudden Death

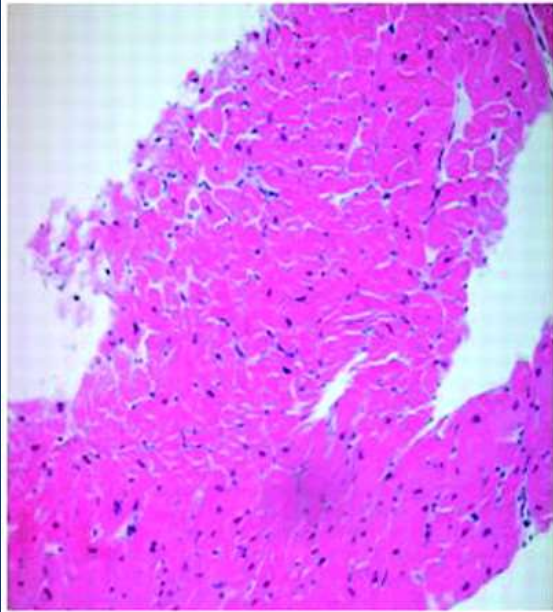
**Not** the **ideal** parameter  
**Not** the **only** parameter



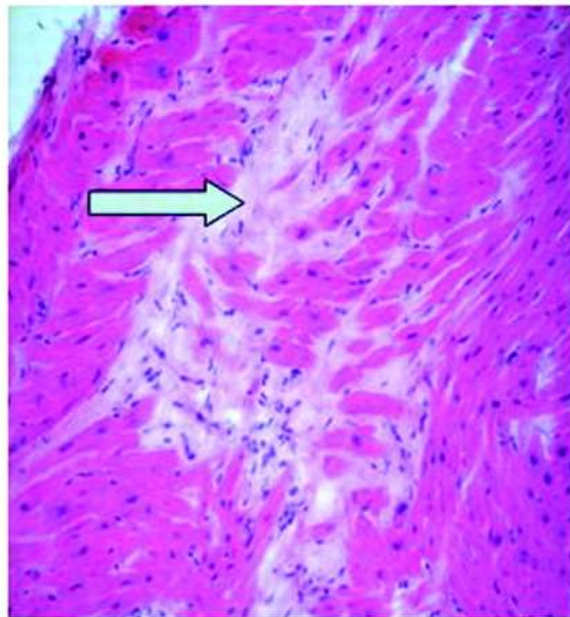
# Myocardial Fibrosis

Hematoxylin and eosin staining from endomyocardial biopsies  
in Aortic Stenosis patients

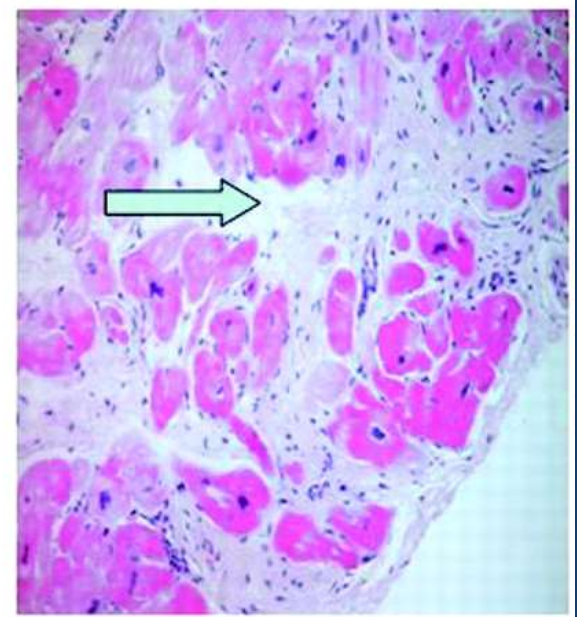
**No Fibrosis**



**Mild Fibrosis**



**Severe Fibrosis**



# Fibrosis – Ejection Fraction

- Fibrosis - Ejection Fraction, not a good correlation!

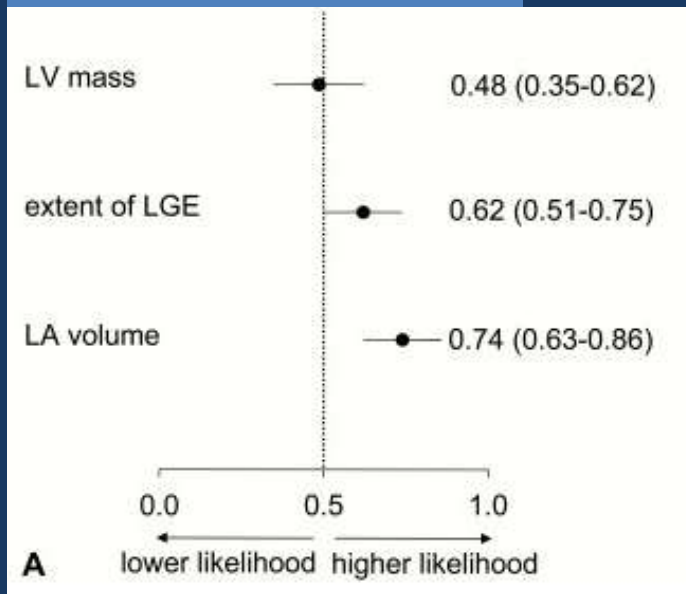
## **Active myocarditis with fibrosis. Poor correlation of ejection fraction with histology of follow-up biopsy**

C. C. Marboe ✉; R. A. Schwartz; D. Adelson; E. L. Escala; M. B. Weiss;  
J. J. Fenoglio, JR.

Eur Heart J (1987) 8 (suppl\_J): 43-45.

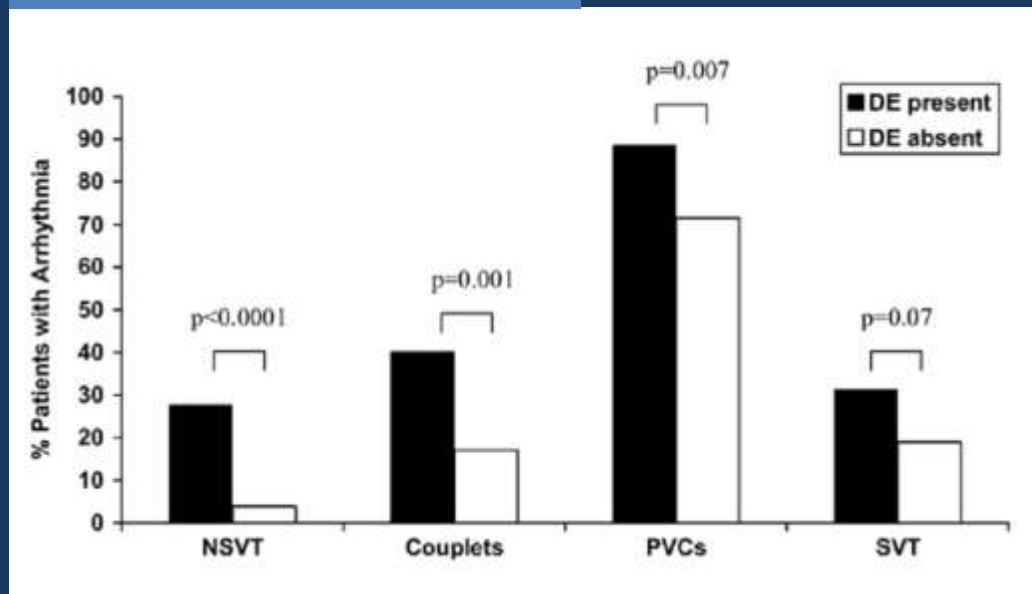
# Fibrosis and Arrhythmias in HCM

87 HCM patients - AF



Papavassiliu T et al.  
JCMR 2009;11:34

177 HCM patients - VEs



Adabag AS et al.  
JACC 2008;51:1369-74

# Detection of Myocardial Fibrosis

## Echocardiographic parameters

- Backscatter
- Subclinical systolic / diastolic dysfunction (TDI, strain)

## Nuclear Methods

- SPECT molecular labeling
- PET-perfusible tissue index

## Endomyocardial Biopsy

Invasive

Sampling error

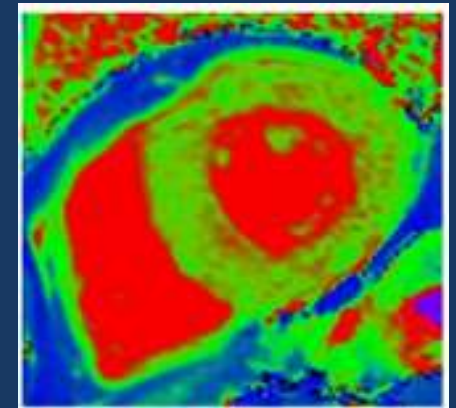
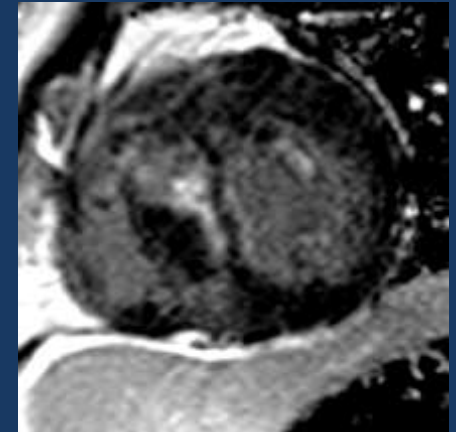
Cannot assess the entire heart



# Detection of Myocardial Fibrosis

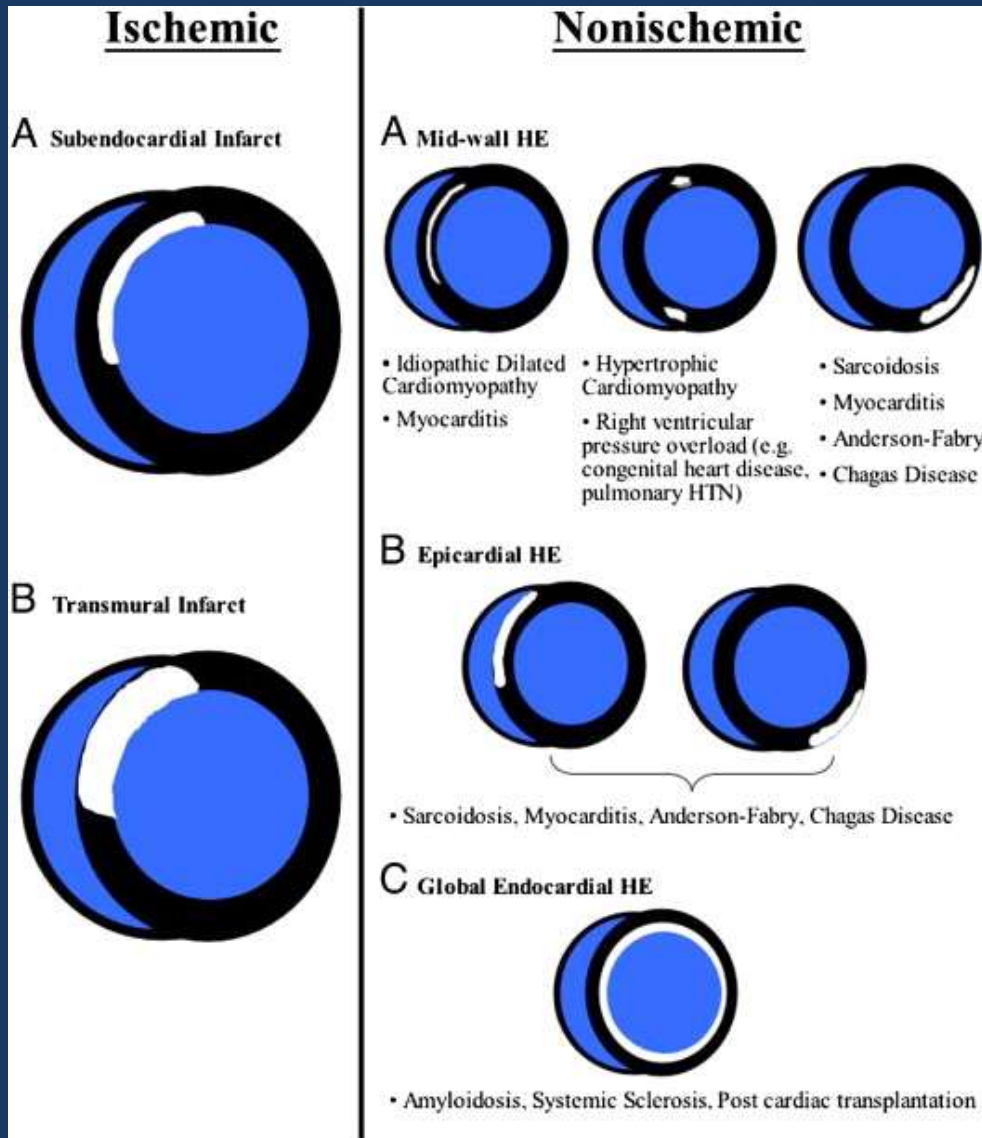
## Cardiac Magnetic Resonance (CMR)

- Late Gadolinium Enhancement (LGE)
- T1 Mapping
- Extracellular volume (ECV) imaging

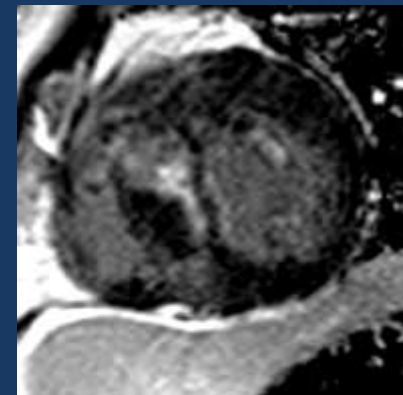
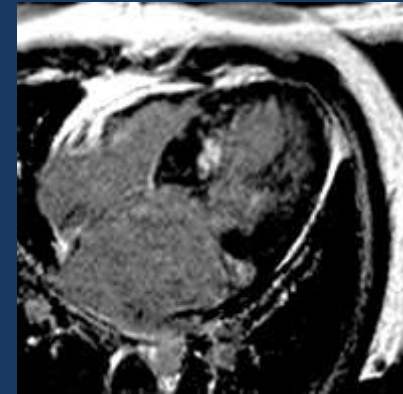
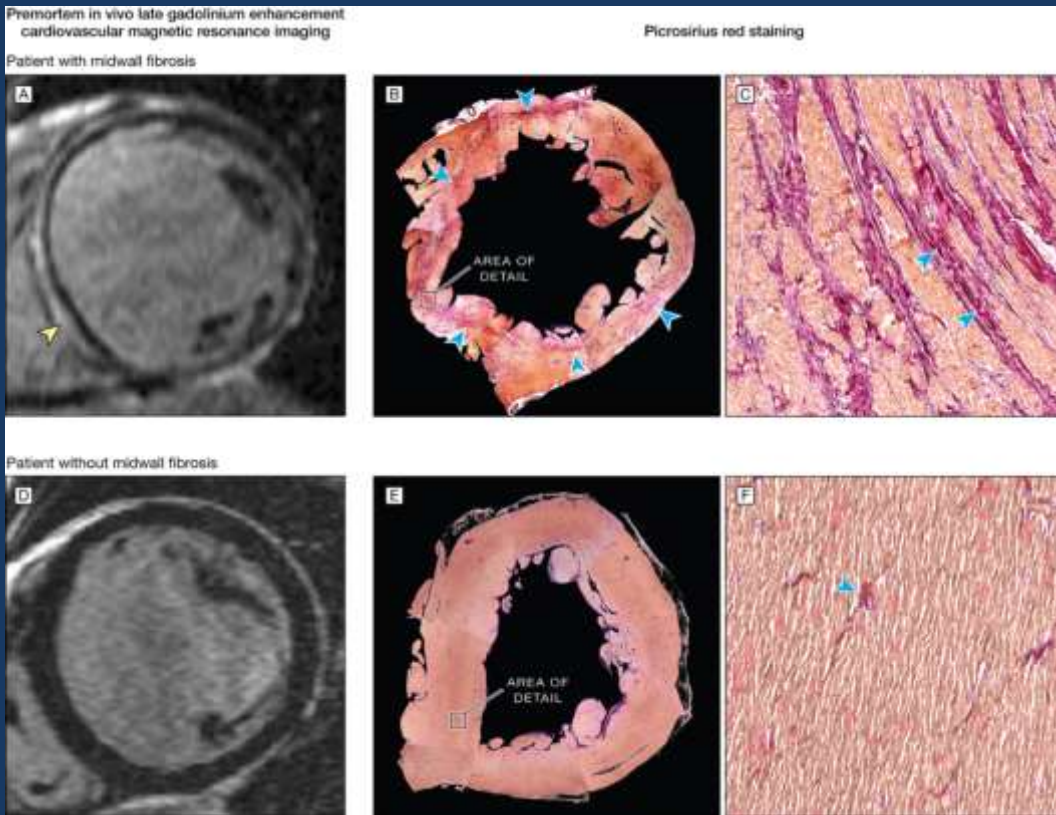




# Patterns of Late Gadolinium Enhancement

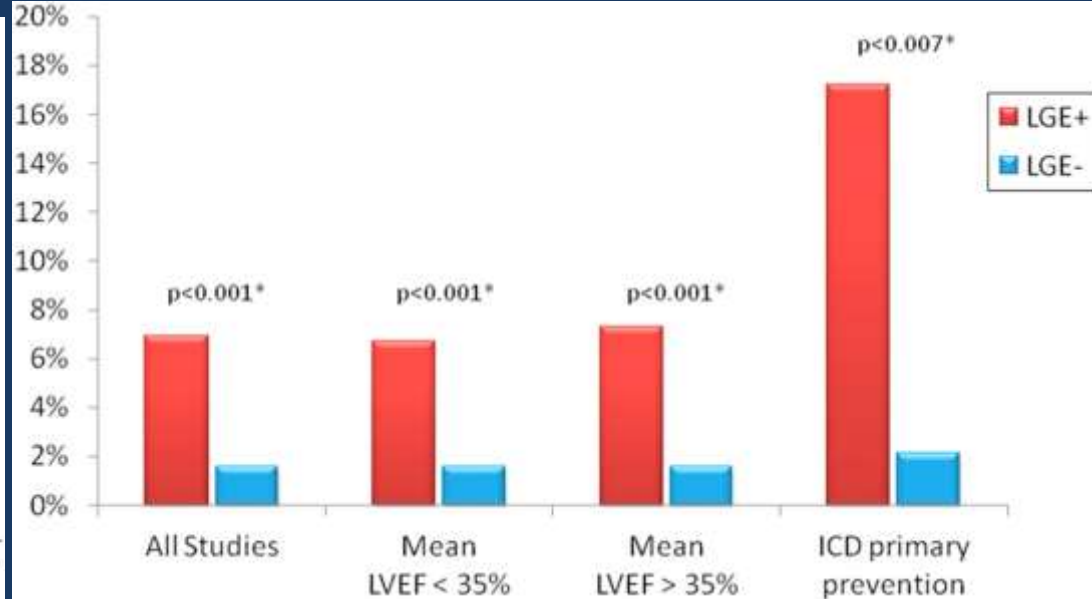
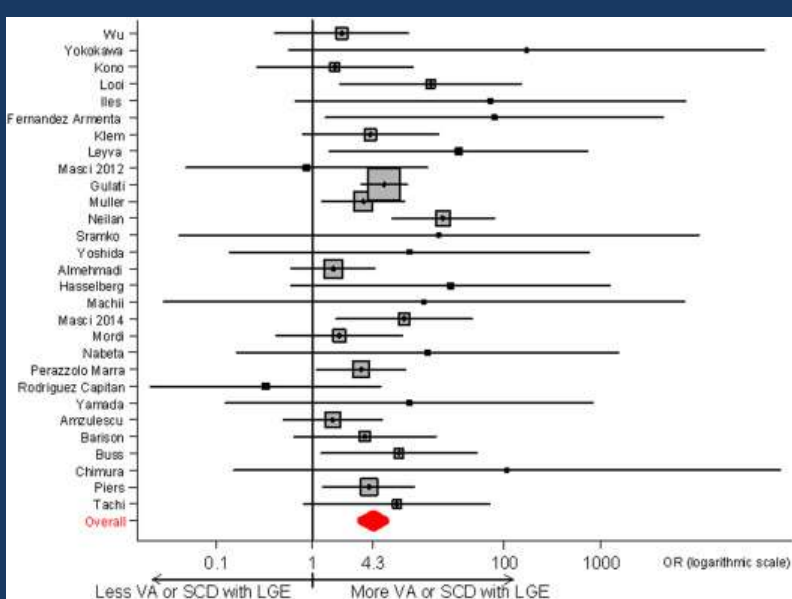


# Dilated Cardiomyopathy – Fibrosis



# LGE in DCM & Prognosis – 2948 patients, 29 studies

Across a wide spectrum of patients with DCM, the presence of LGE is associated with a significant increase in the occurrence of VAs or sudden death

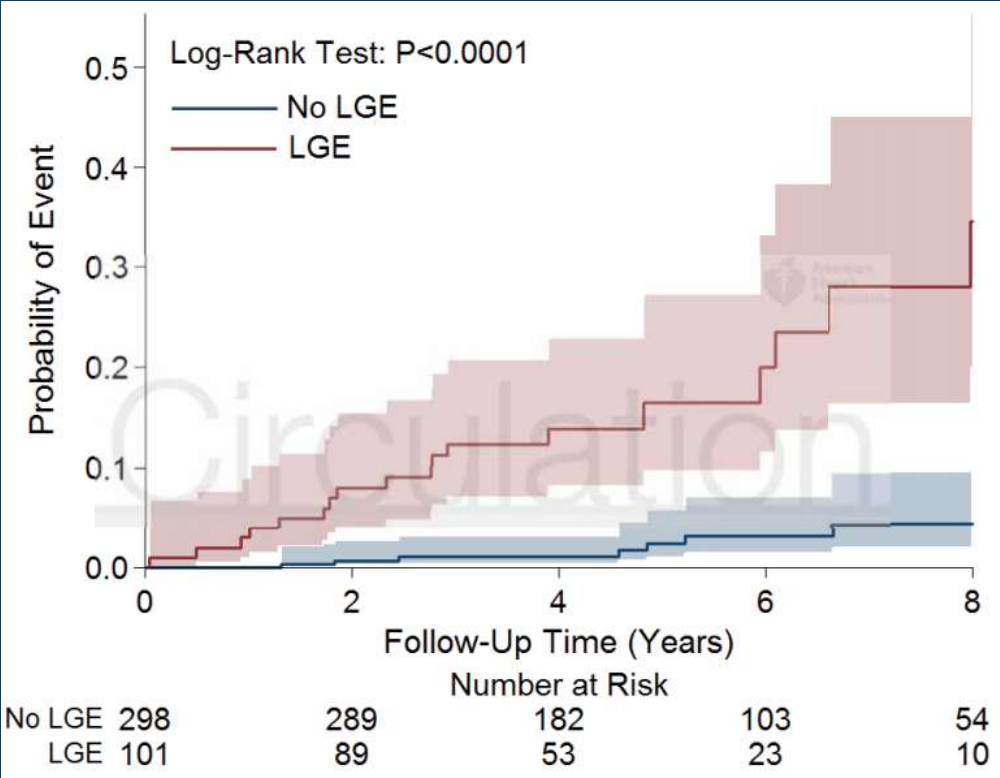


The association between LGE and the arrhythmic outcome was independent of other covariates, including LVEF

# Association Between Mid-Wall Fibrosis and Sudden Death in DCM with mild/moderate LV Systolic Dysfunction

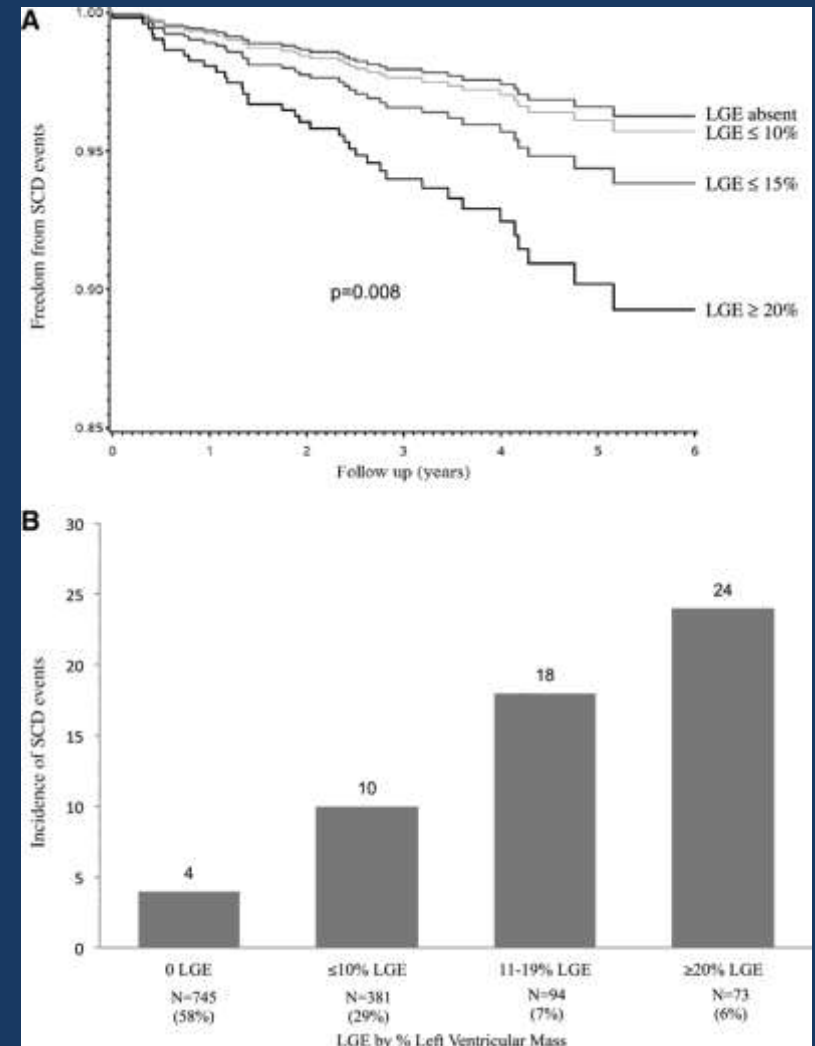
Prospectively investigated the association between mid-wall LGE and the pre-specified **primary composite outcome of SCD or aborted SCD** amongst consecutive referrals with DCM and LVEF $\geq$ 40% who did not have a pre-existing indication for ICD implantation

- 399 patients
  - 145 women
- Median LVEF 50% (IQR:46-54%)
- Mid-wall LGE was present in 25%

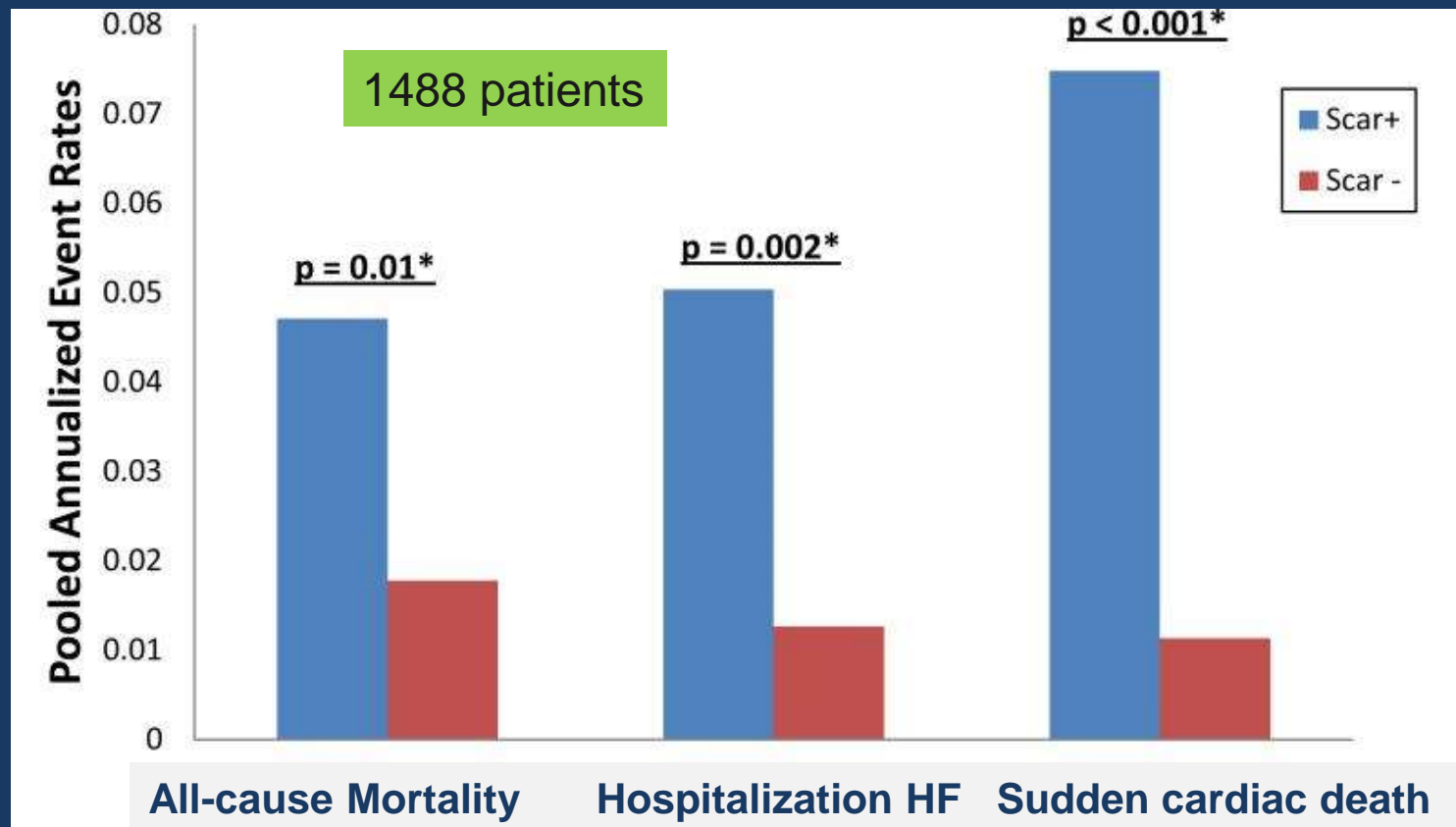


# Prognostic Significance of LGE-CMR in HCM

- Relation between extent of late gadolinium enhancement (LGE) and sudden cardiac death (SCD) events in **1293 patients with HCM**
- Extensive LGE provides additional information for assessing SCD event risk among HCM patients, **particularly patients otherwise judged to be at low risk**



# LGE predicts adverse cardiovascular outcomes in nonischemic cardiomyopathy

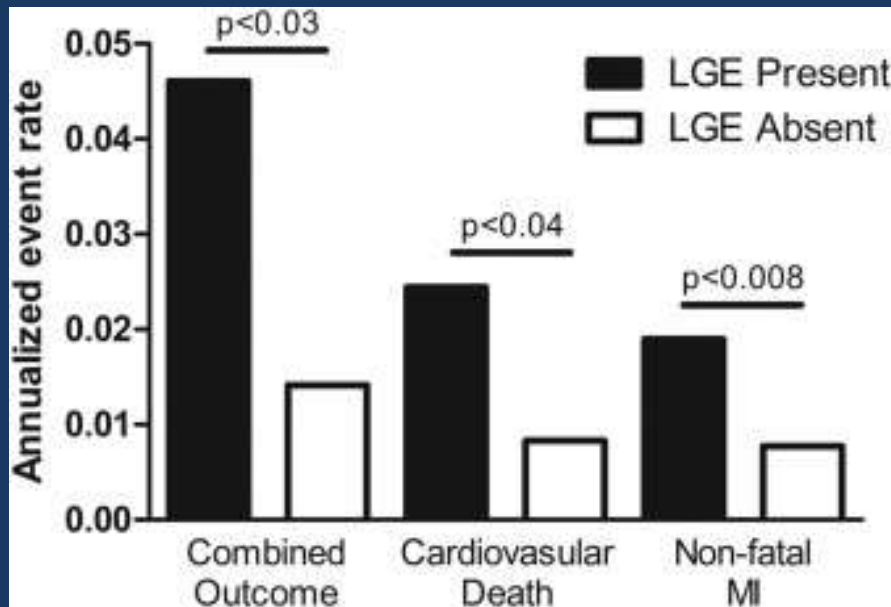


\*p-values are for the significance of the annualized event rate difference between LGE+ and LGE- subjects.



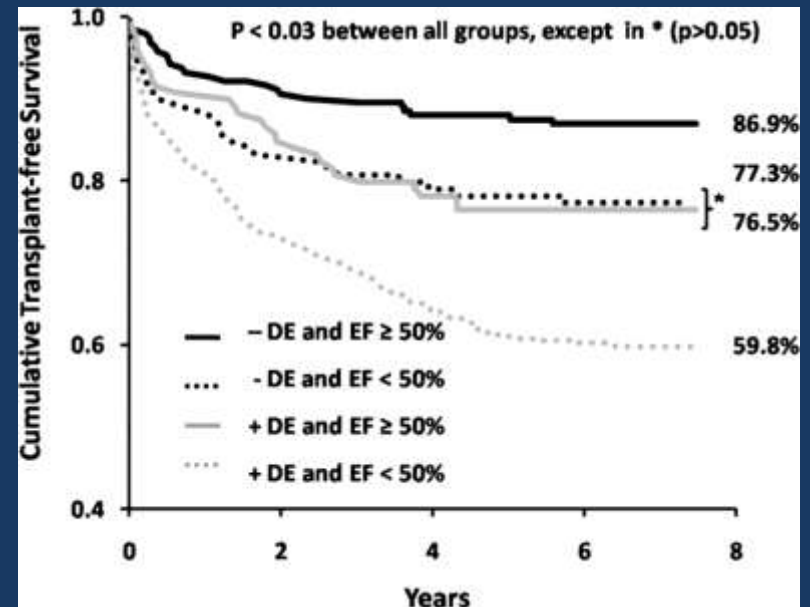
# Scar presence and Outcome in CAD

11,636 patients - follow-up of 32 months



J Am Coll Cardiol. 2013; 62:826-38

857 patients follow-up 4.4 years



Circulation 2009; 120: 2069-2076

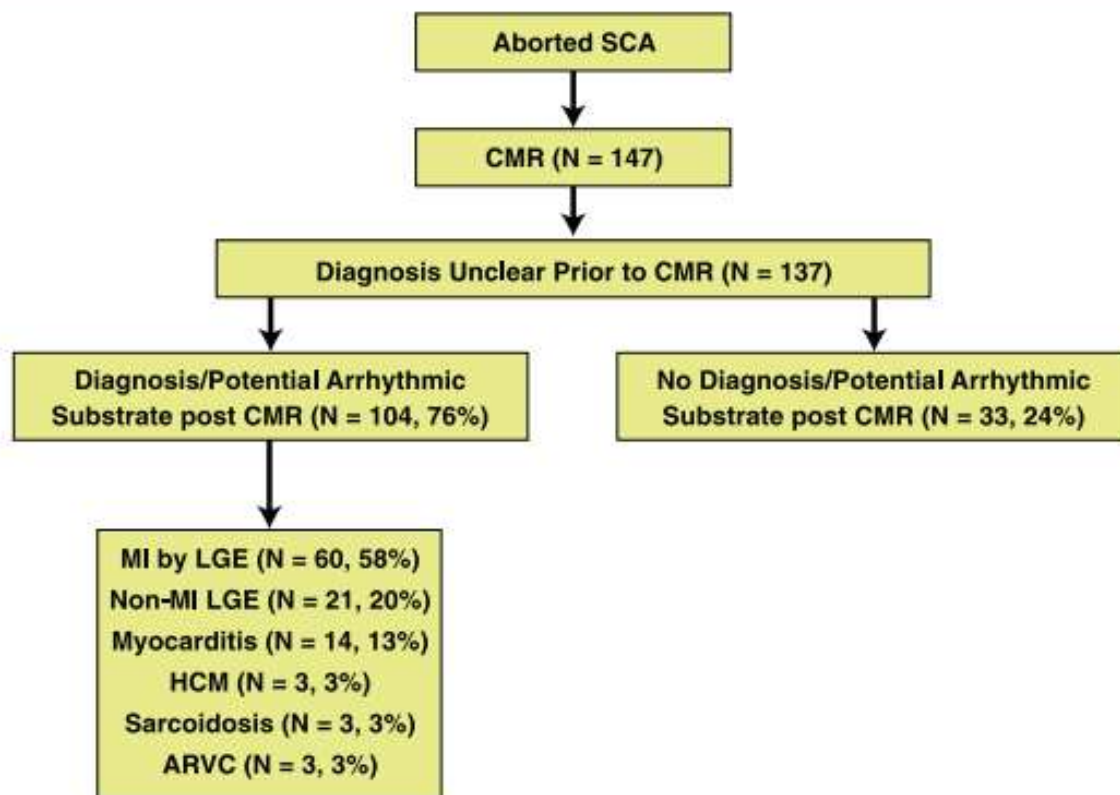


# Late Gadolinium Enhancement Among Survivors of Sudden Cardiac Arrest



Tomas G. Neilan, MD,<sup>††</sup> Hoshang Farhad, MD,<sup>‡</sup> Thomas Mayrhofer, PhD,<sup>‡</sup> Ravi V. Shah, MD,<sup>‡</sup> John A. Dodson, MD,<sup>‡</sup> Siddique A. Abbasi, MD,<sup>‡</sup> Stephan B. Danik, MD,<sup>§</sup> Daniel J. Verdini, MD,<sup>‡</sup> Michifumi Tokuda, MD,<sup>‡</sup> Usha B. Tedrow, MD,<sup>‡</sup> Michael Jerosch-Herold, PhD,<sup>||</sup> Udo Hoffmann, MD, MPH,<sup>‡</sup> Brian B. Ghoshhajra, MD,<sup>‡</sup> William G. Stevenson, MD,<sup>‡</sup> Raymond Y. Kwong, MD, MPH<sup>‡</sup>

**Retrospective review** of all survivors of sudden cardiac death who were referred for CMR



## Out of hospital cardiac arrest survivors with inconclusive coronary angiogram: Impact of cardiovascular magnetic resonance on clinical management and decision-making<sup>☆</sup>

A. Baritussio<sup>a,b</sup>, A. Zorzi<sup>b</sup>, A. Ghosh Dastidar<sup>a</sup>, A. Susana<sup>b</sup>, G. Mattesi<sup>b</sup>, J.C.L. Rodrigues<sup>a</sup>, G. Biglino<sup>a</sup>, A. Scatteia<sup>a</sup>, E. De Garate<sup>a</sup>, J. Strange<sup>a</sup>, L. Cacciavillani<sup>b</sup>, S. Iliceto<sup>b</sup>, A. Nisbet<sup>a</sup>, G.D. Angelini<sup>a</sup>, D. Corrado<sup>b</sup>, M. Perazzolo Marra<sup>b</sup>, C. Bucciarelli-Ducci<sup>a,\*</sup>

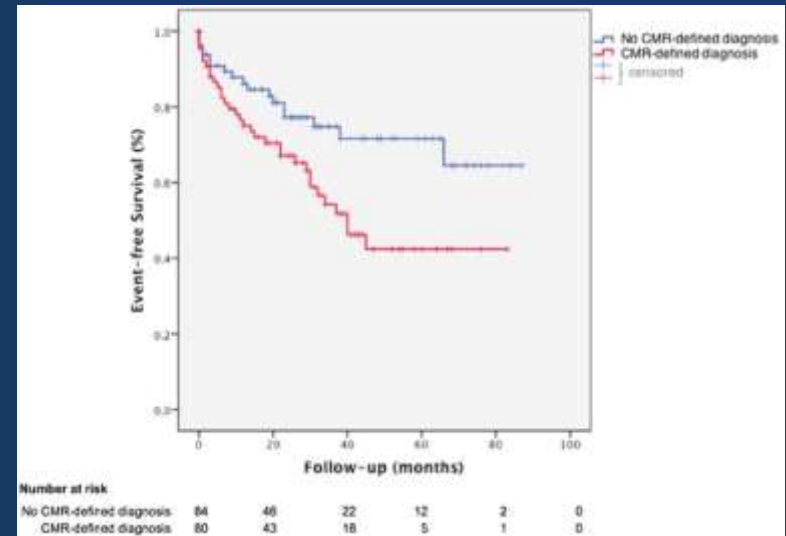
- Retrospective multicentre CMR registry analysis
- Clinical impact of CMR was defined as a change in diagnosis or management
- **CMR identified a pathologic substrate in 76/110 patients (69%)**
  - ischemic heart disease in 45 patients (41%)
  - non-ischemic heart disease in 31 patients (28%)
  - A structurally normal heart in 25 patients (23%)
  - non-specific findings in 9 patients (8%).

# Diagnosis and Prognosis in Sudden Cardiac Arrest Survivors Without Coronary Artery Disease

## Utility of a Clinical Approach Using Cardiac Magnetic Resonance Imaging

Patricia Rodrigues, MD; Abhishek Joshi, MD; Howell Williams, MD; Mark Westwood, MD; Steffen E. Petersen, MD, PhD; Filip Zemrak, MD, PhD; Richard J. Schilling, MD, PhD; Claire Kirkby, RN; Andrew Wragg, MD; Charlotte Manisty, MD; Saidi Mohiddin, MD

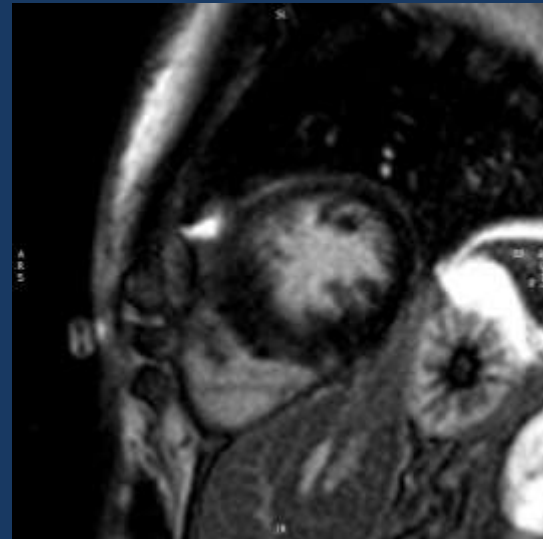
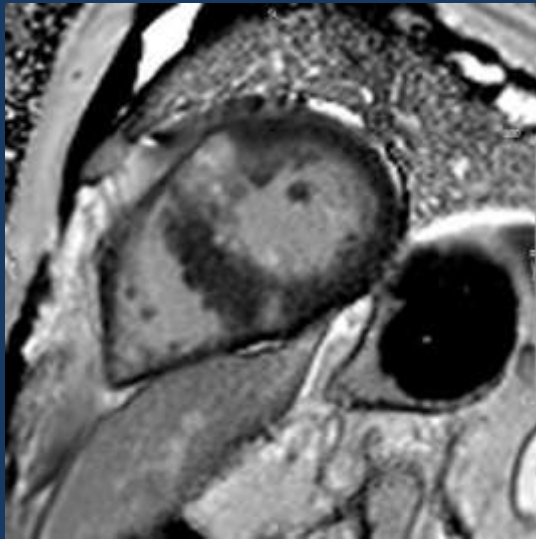
- Retrospective
- Of the **164 patients** (65% men; mean age 48 yrs), **CMR contributed to the diagnosis in 80 (49%)** and was decisive in 50 cases (30%)
- Dilated cardiomyopathy (n=27)
- Myocarditis or sarcoidosis (n=22)
- Occult myocardial infarction (n=13),
- Hypertrophic cardiomyopathy (n=9)



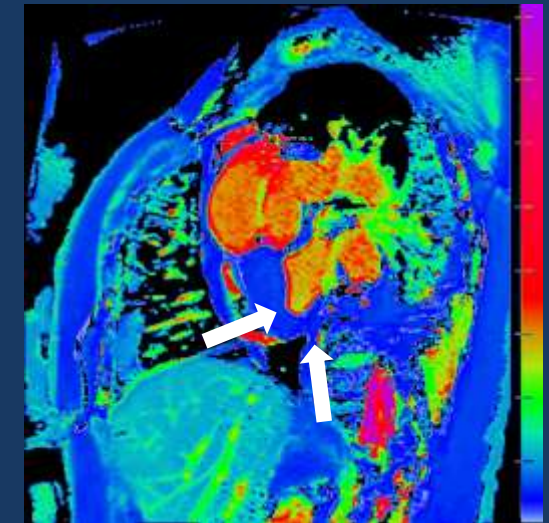
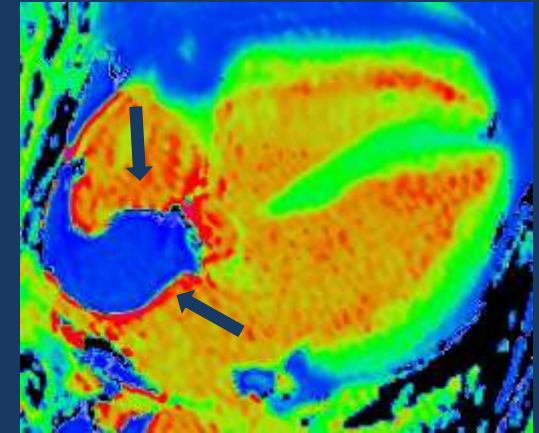
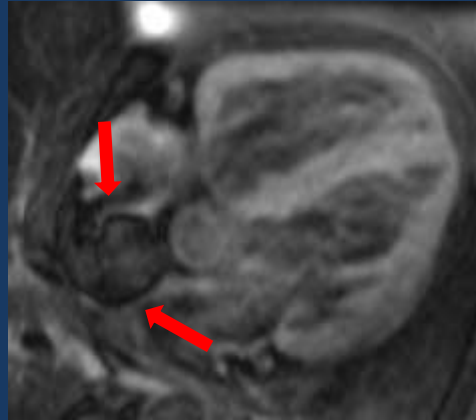
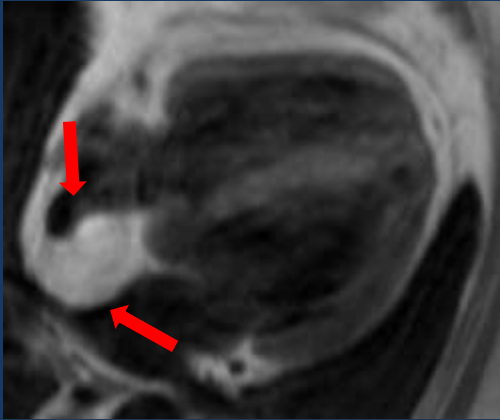
Major adverse cardiac events (MACE): significant nonfatal ventricular arrhythmia or death, was the primary outcome

# Limitations of Late Gadolinium Imaging

- Needs **contrast**
  - Renal dysfunction
  - Allergy
- **Diffuse**, homogenously distributed **fibrosis**?



# Native T1 Mapping



Turbo-spin Echo:  
High signal on TSE

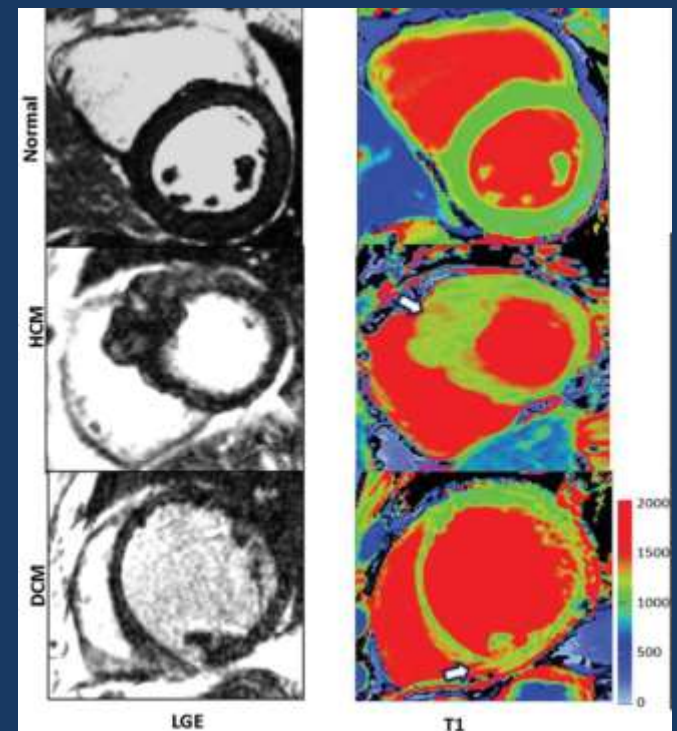
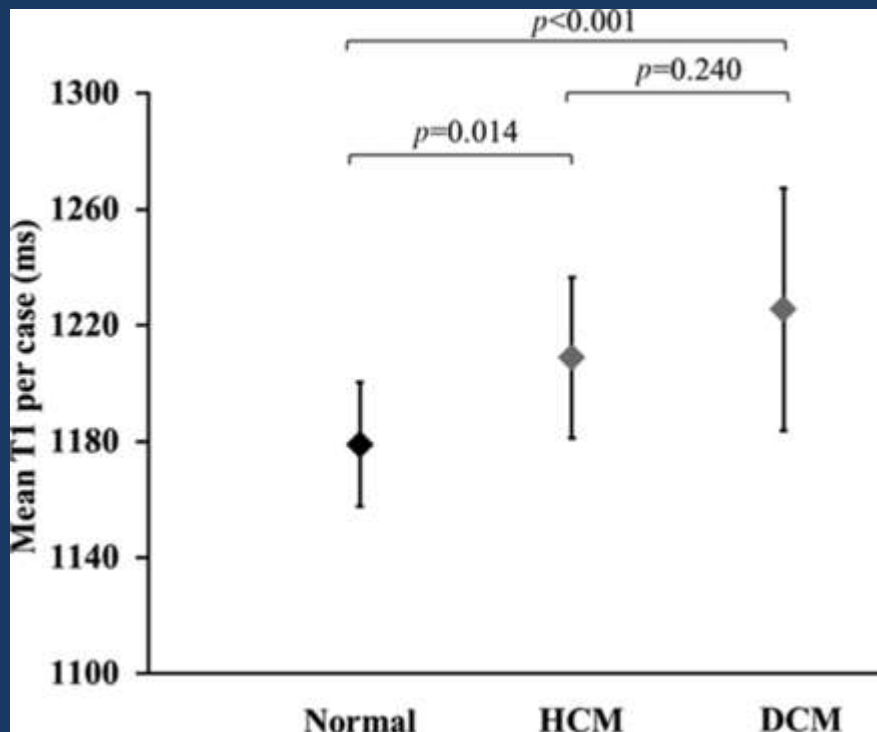
TSE Fat-Sat:  
Fat-suppresses

ShMOLLI T1-map:  
Low T1 ~ 230 – 350 ms



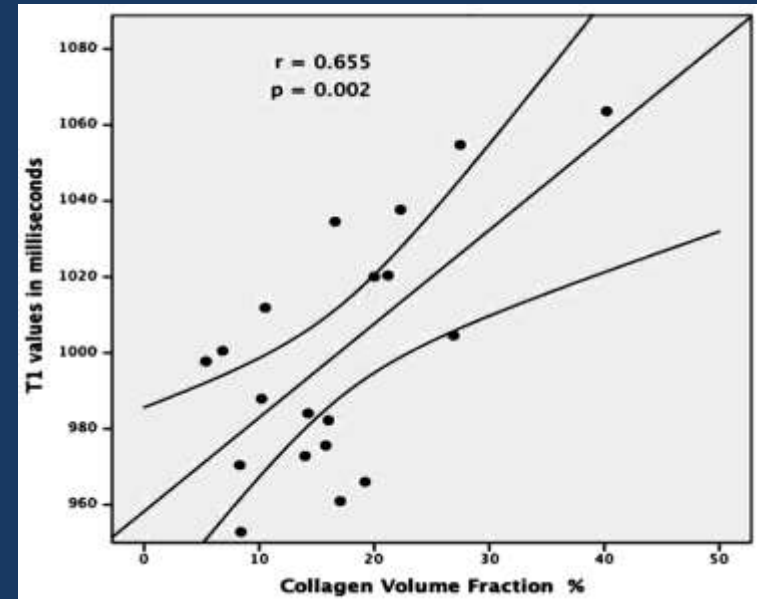
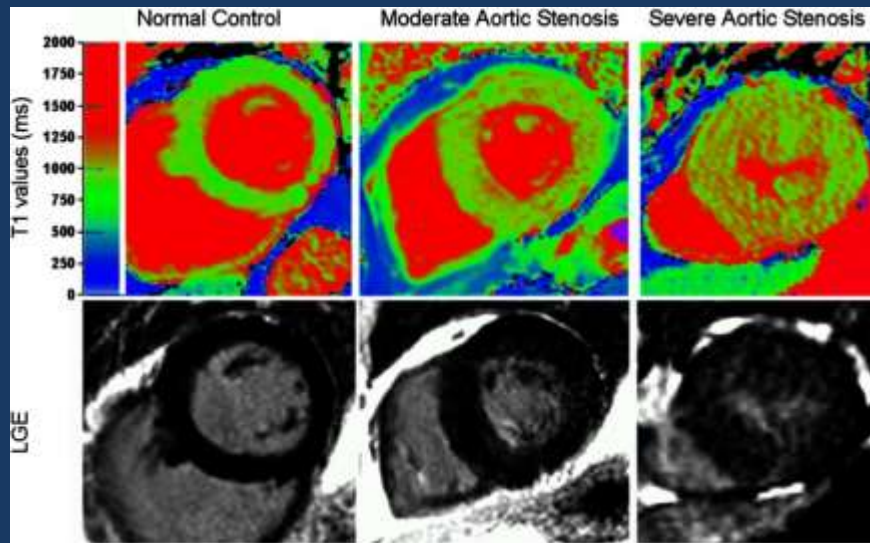
# Native T1 Mapping in HCM and DCM

- 28 HCM, 18 DCM, and 12 normal – CMR 3-Tesla



# Native T1 Mapping – Correlation with Histology

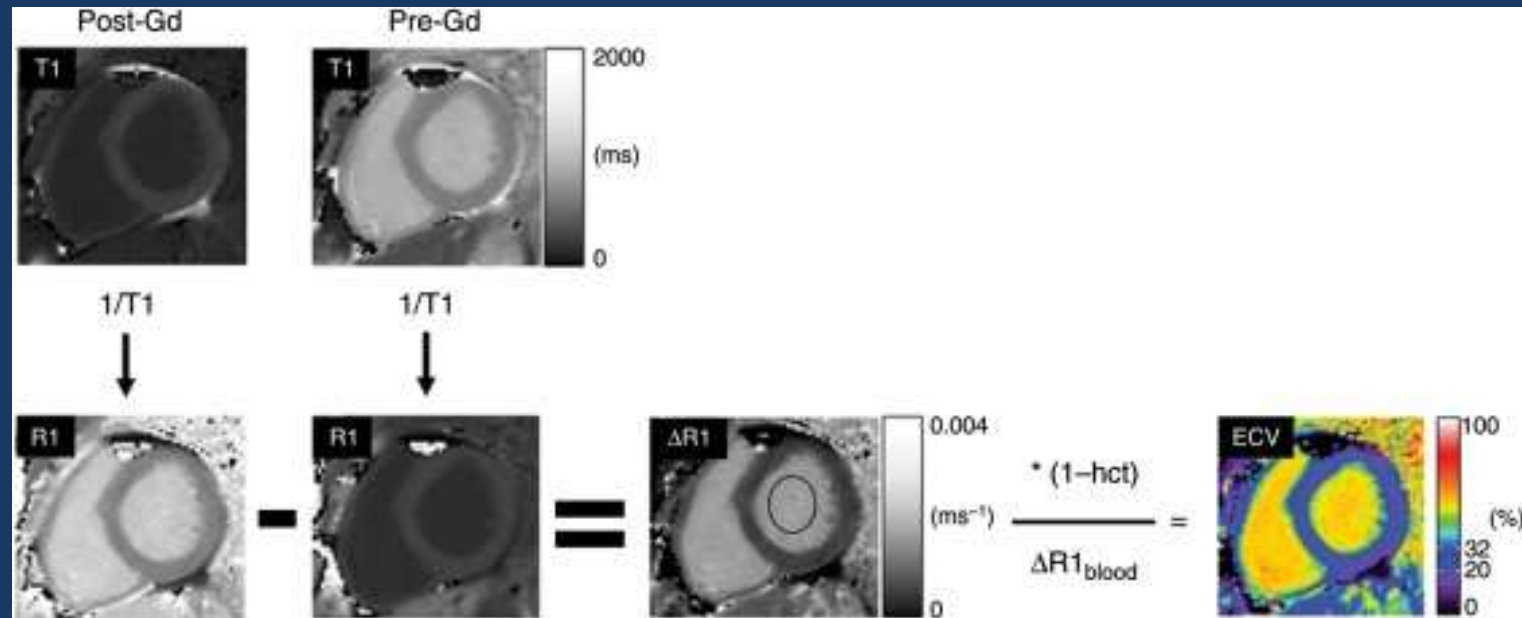
- 109 patients with moderate and severe Aortic stenosis
- 33 controls



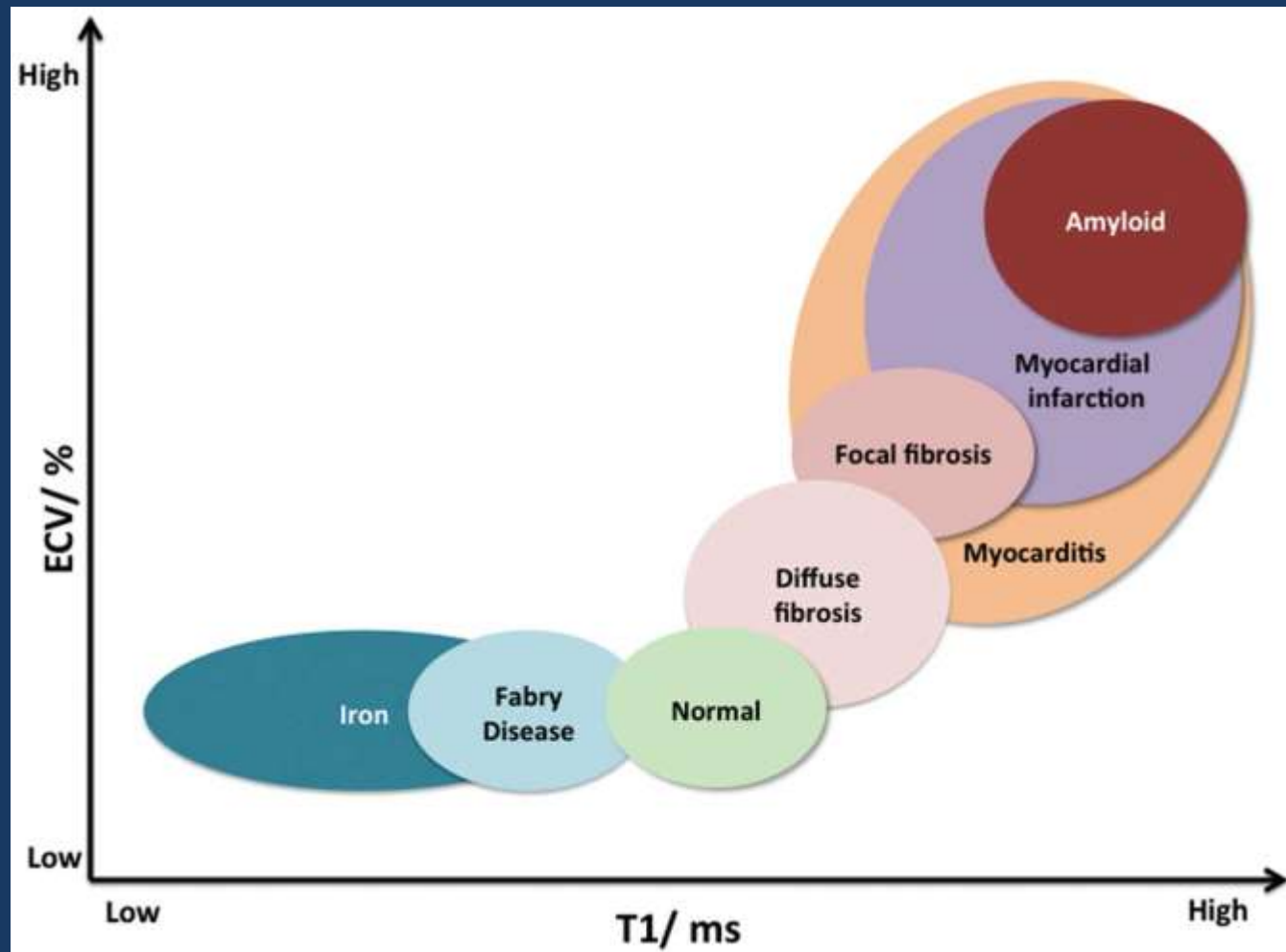


# Extracellular Volume Imaging

- Combining **T1 measurements before and after contrast**, and adding the Ht into the equation...



# T1 Mapping in Clinical Context



# Take Home Messages

- **Fibrosis** in ischemic and non-ischemic cardiomyopathies is probably **a better predictor of sudden death than ejection fraction**
- **Imaging fibrosis – CMR**
  - LGE CMR for regional fibrosis
  - T1 Mapping/ECV techniques for diffuse fibrosis
- CMR studies on post-sudden death revealed a **significant clinical impact of CMR** on diagnosis and management
- Impact of T1 mapping techniques?