Ecocardiochirurgia 2016,
Milano 22-23 marzo 2016

Il ruolo clinico della Risonanza Magnetica Cardiaca
Perchè la cardiologia moderna non può più farne a meno

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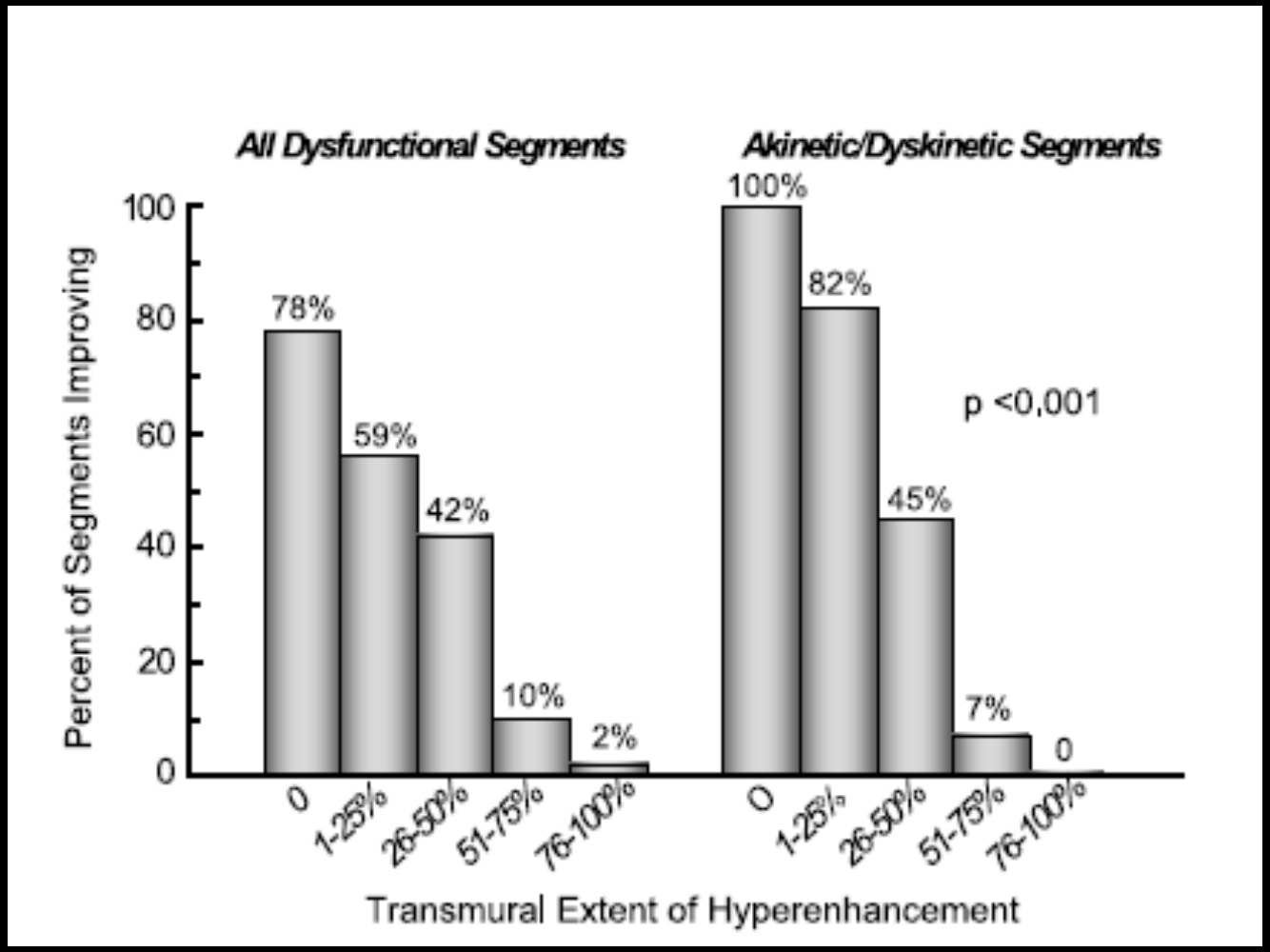
Cardiac Magnetic Resonance

Diagnostic, prognostic, physiopathology insight for:

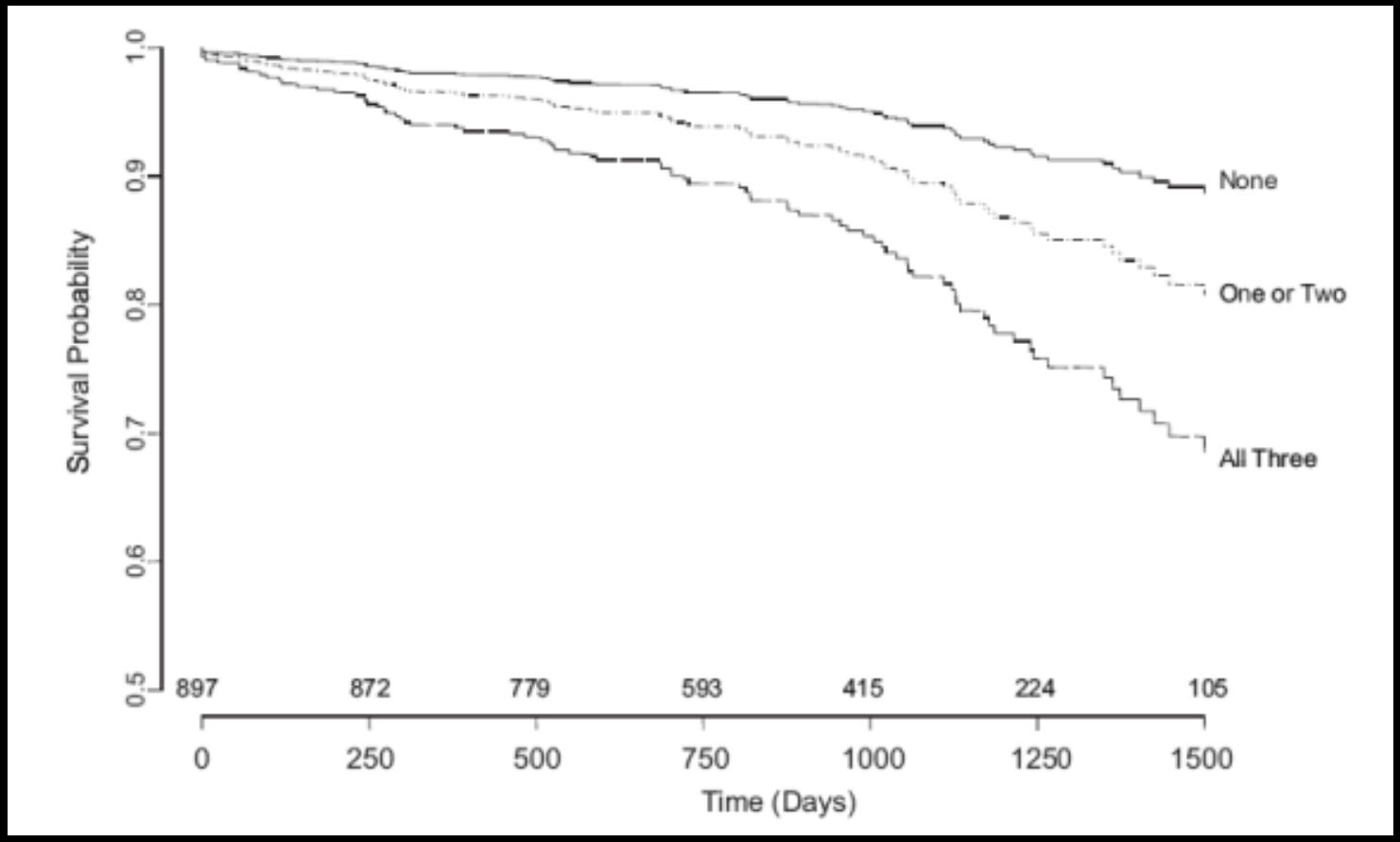
- CAD
- HCMO
- Restrictve CMO
- Dilatative CMO
- Infiltrative CMO
- Myocarditis
- AR (RV and LV) CMO
- Complex Congenital CD
- Pericardial disease
- Cardiac Mass and Tumors
- Aortic diseases

Coronary artery disease

- LGE = myocardial fibrosis, transmural extension
- STRESS = adenosine/dobutamine diagnostic and prognostic accuracy
- MVO = adverse remodeling
- HEMO/NTBI = hemorrhagic core, iron cardiotoxicity



Kim RJ N Engl J Med 2000



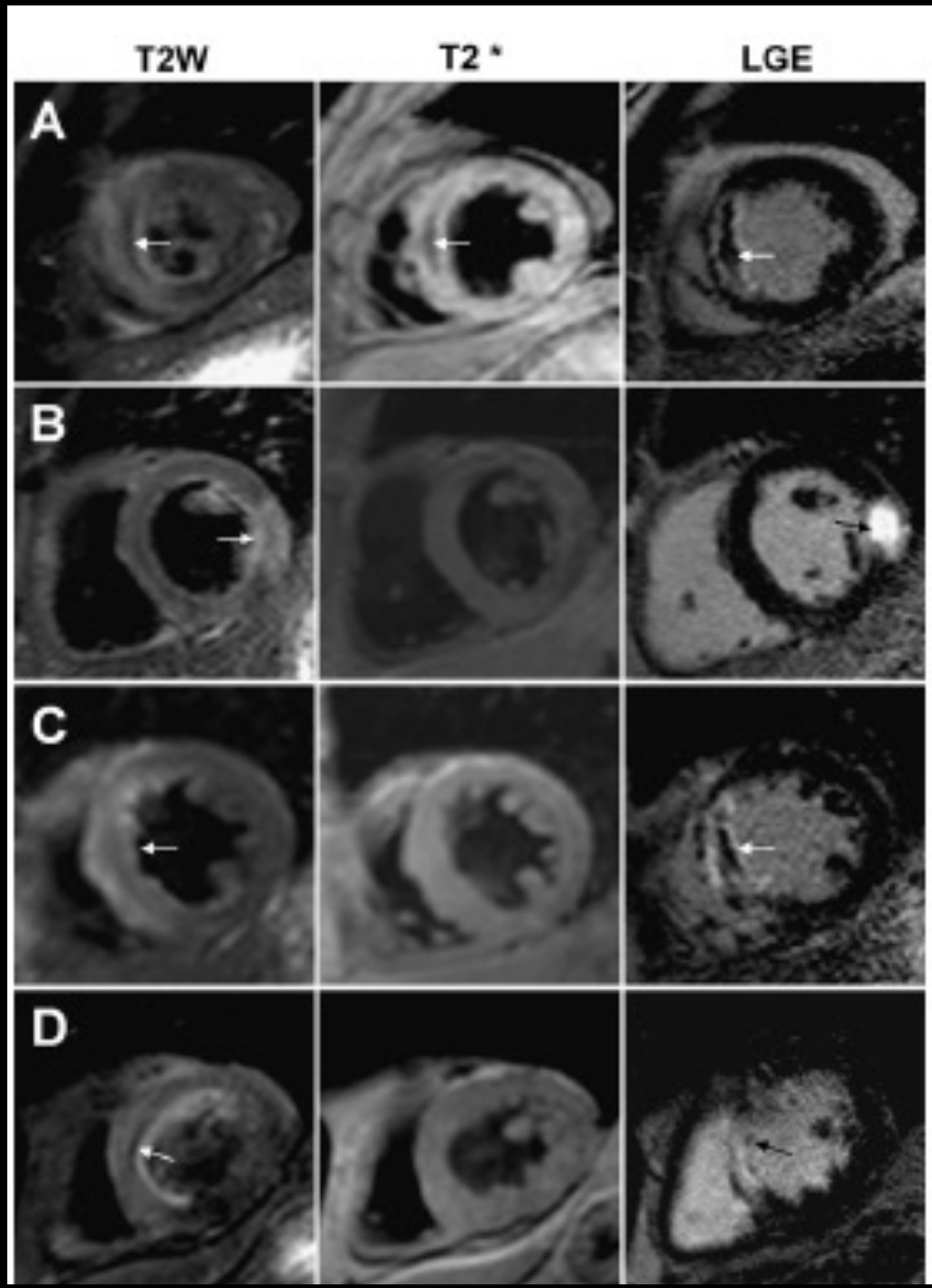
Bingham, Circulation 2011

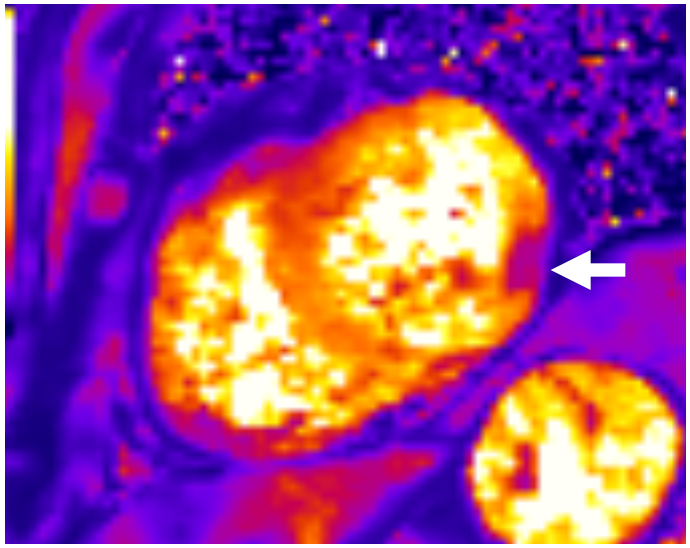
Septal MI, MVO+hemorrage

Lateral MI, no MVO, no hemorrage

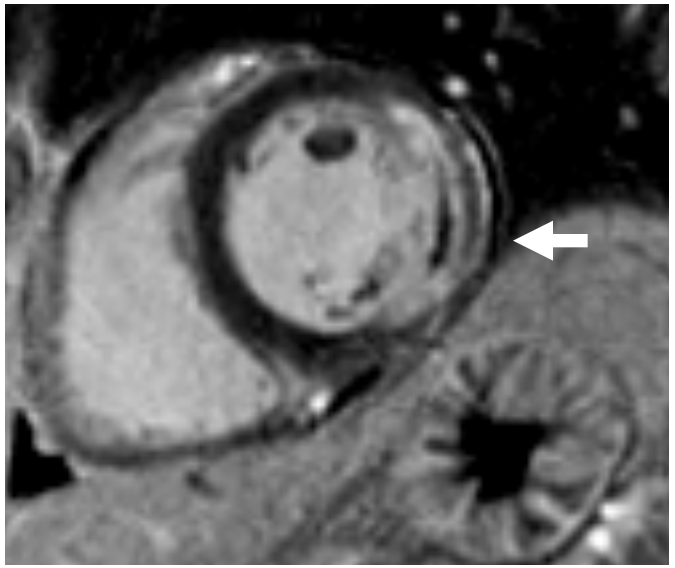
Septal MI, MVO, no hemorrage

Septal MI, little MVO, no hemorrage





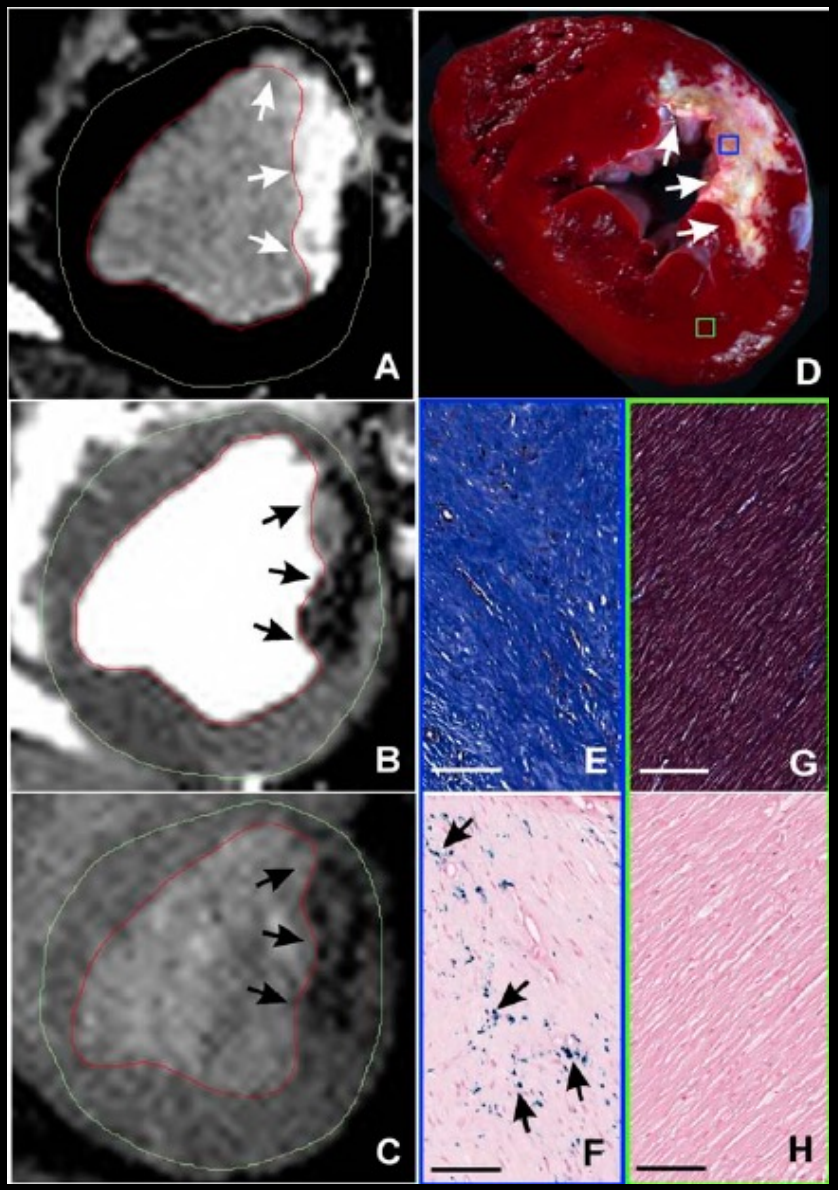
T2* mapping



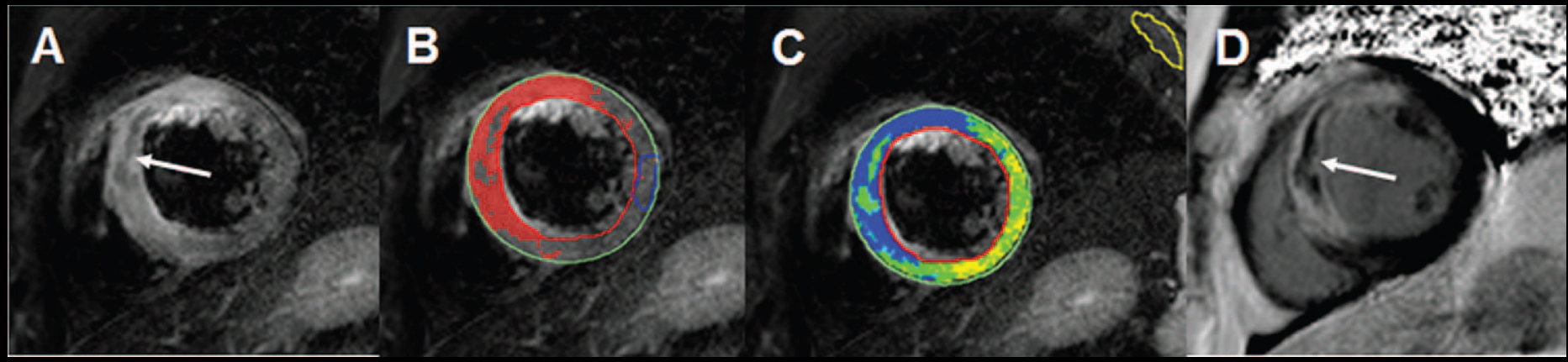
LGE

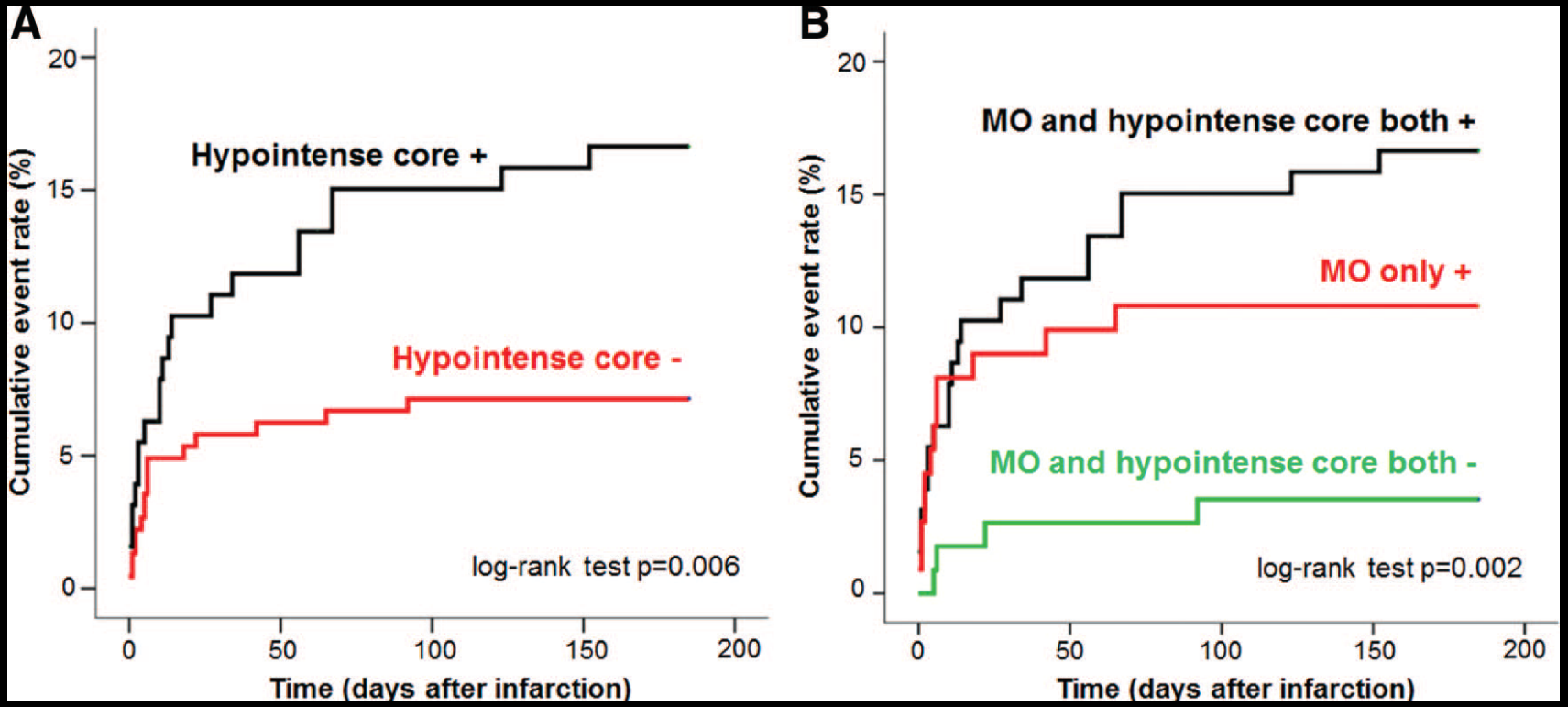
	HEMO+		HEMO -	
	5d	6m	5d	6m
NTBI μM	2.4	0	0.4	0
T2* ms	17	18	31	31

Hypotense core with evidence of focal iron deposition



Cocik, Circ Cardiovasc Imaging 2016





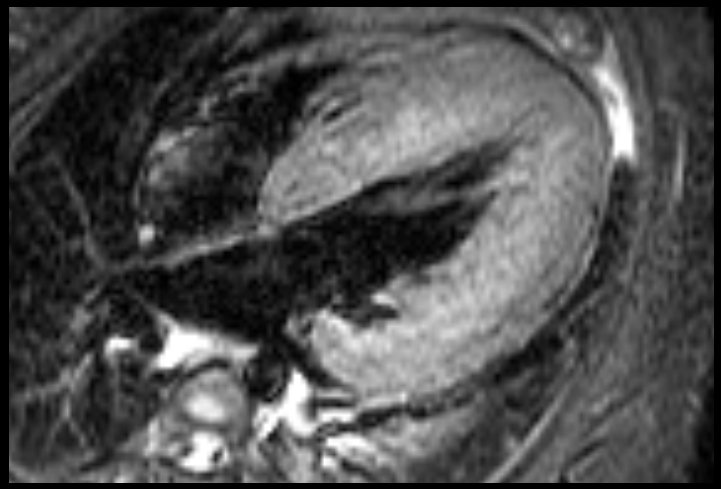
Eitel, Circ Cardiov Imaging 2011

NEXT

- myocardial characterization for arrhytmia risk stratification
- iron chelation therapy for cardiogenic shock in acute setting
- iron chelation therapy for hemorrhagic STEMI in chronic setting
- high resolution coronary angiography
- high resolution plaque characterization

HCMO: myocardial oedema + intramyocardial enhancement

MYOCARDIAL ISCHEMIA



Cardiac Magnetic Resonance Detection of Myocardial Scarring in Hypertrophic Cardiomyopathy

Correlation With Histopathology and Prevalence of Ventricular Tachycardia

Deborah H. Kwon, MD,* Nicholas G. Smedira, MD,* E. Rene Rodriguez, MD,† Carmela Tan, MD,† Randolph Setser, PHD,‡ Maran Thamilarasan, MD,* Bruce W. Lytle, MD,* Harry M. Lever, MD,* Milind Y. Desai, MD*‡

Cleveland, Ohio

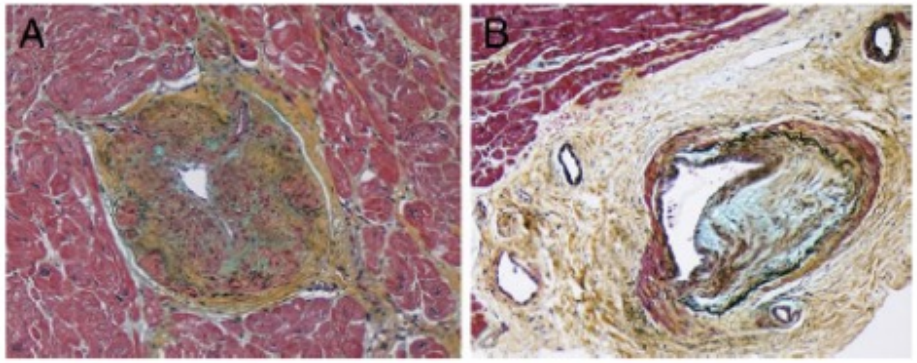
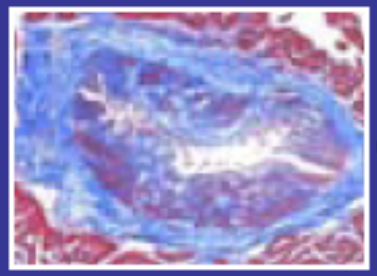
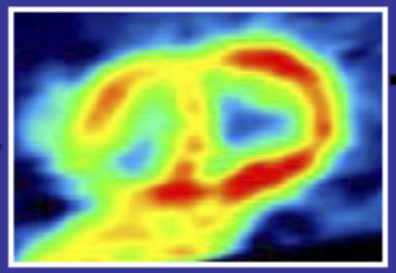


Figure 3 Small Intramural Dysplastic Coronary Arteriole in a Patient With Hypertrophic Cardiomyopathy

Hypertrophyc cardiomyopathy

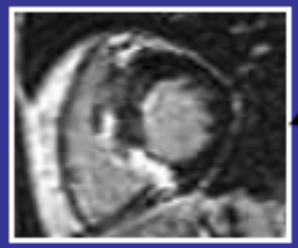


Microvascular Remodeling

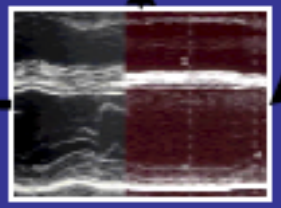


Microvascular Dysfunction

Myocardial Ischemia



Myocardial Fibrosis

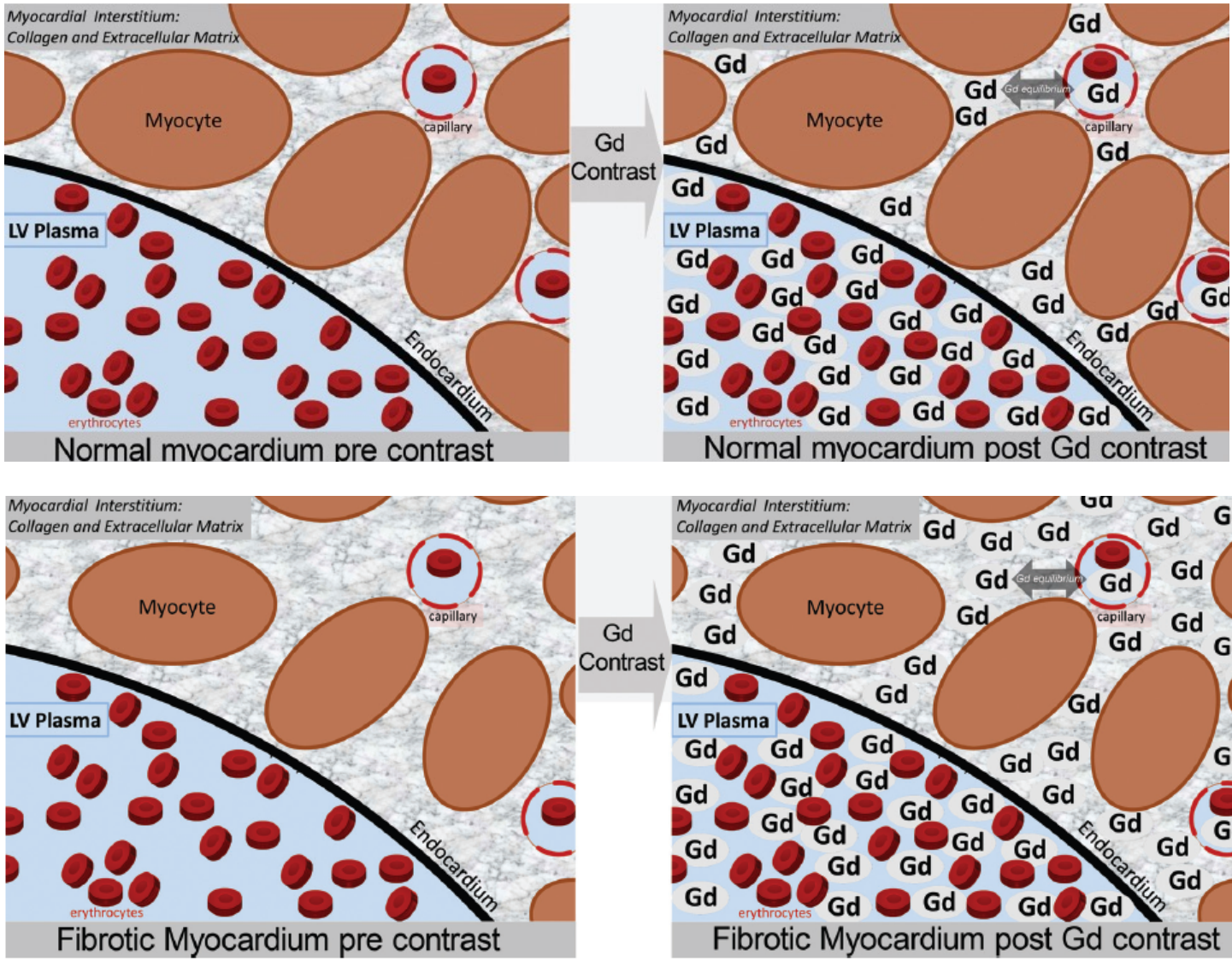


LV Remodeling
Diastolic and Systolic Dysfunction

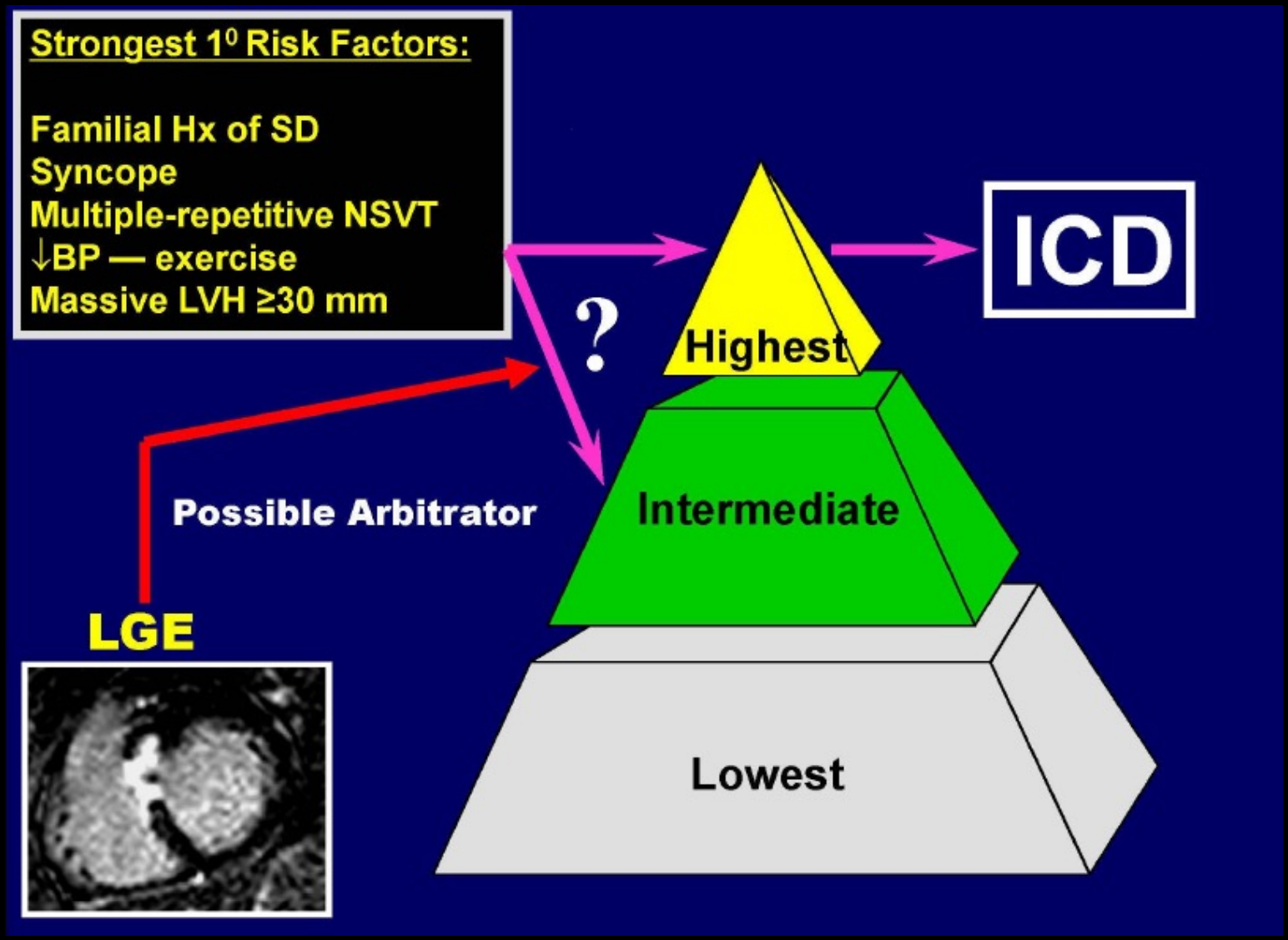
Sudden Death
Heart Failure Symptoms and
Heart Failure Death

Maron JACC 2009

Extracellular Volume Fraction



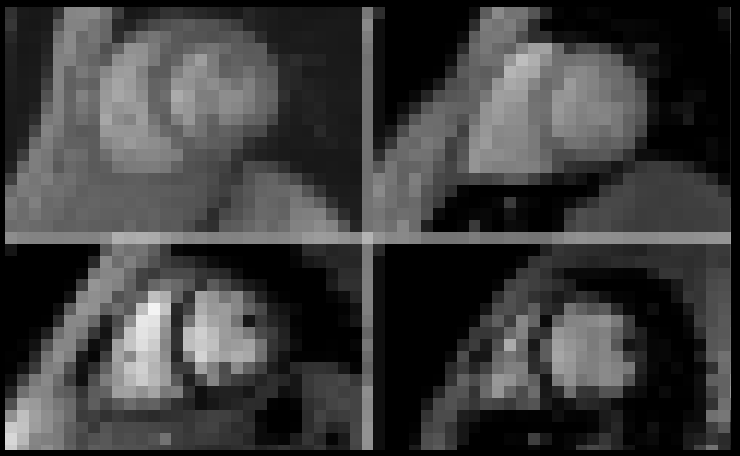
Wong Circulation 2012

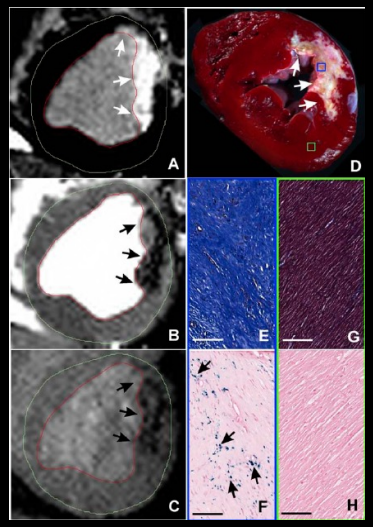


Maron JCMR 2012

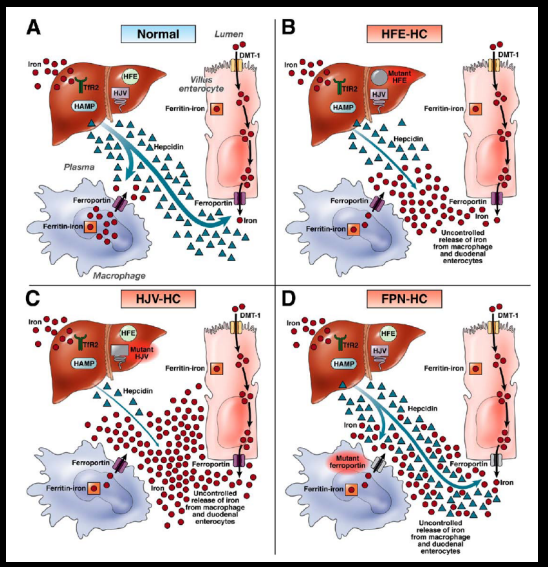
NEXT

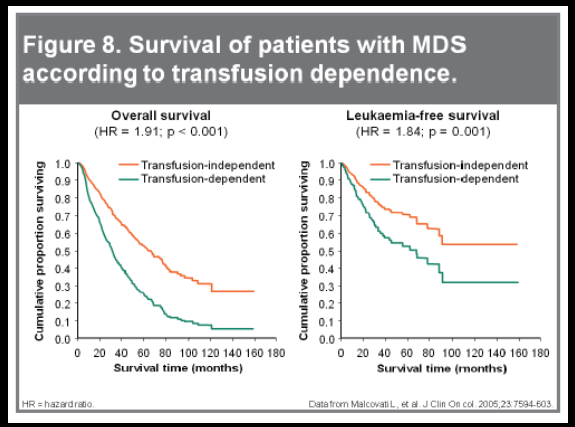
- myocardial characterization for fibrosis (interstitial vs substitutive)
- arrhythmia stratification
- predictors of LV remodeling
- acute vs chronic disease (edema + LGE)
- matching phenotypes, genotypes and pathology : toward cardiomyopathy clinic

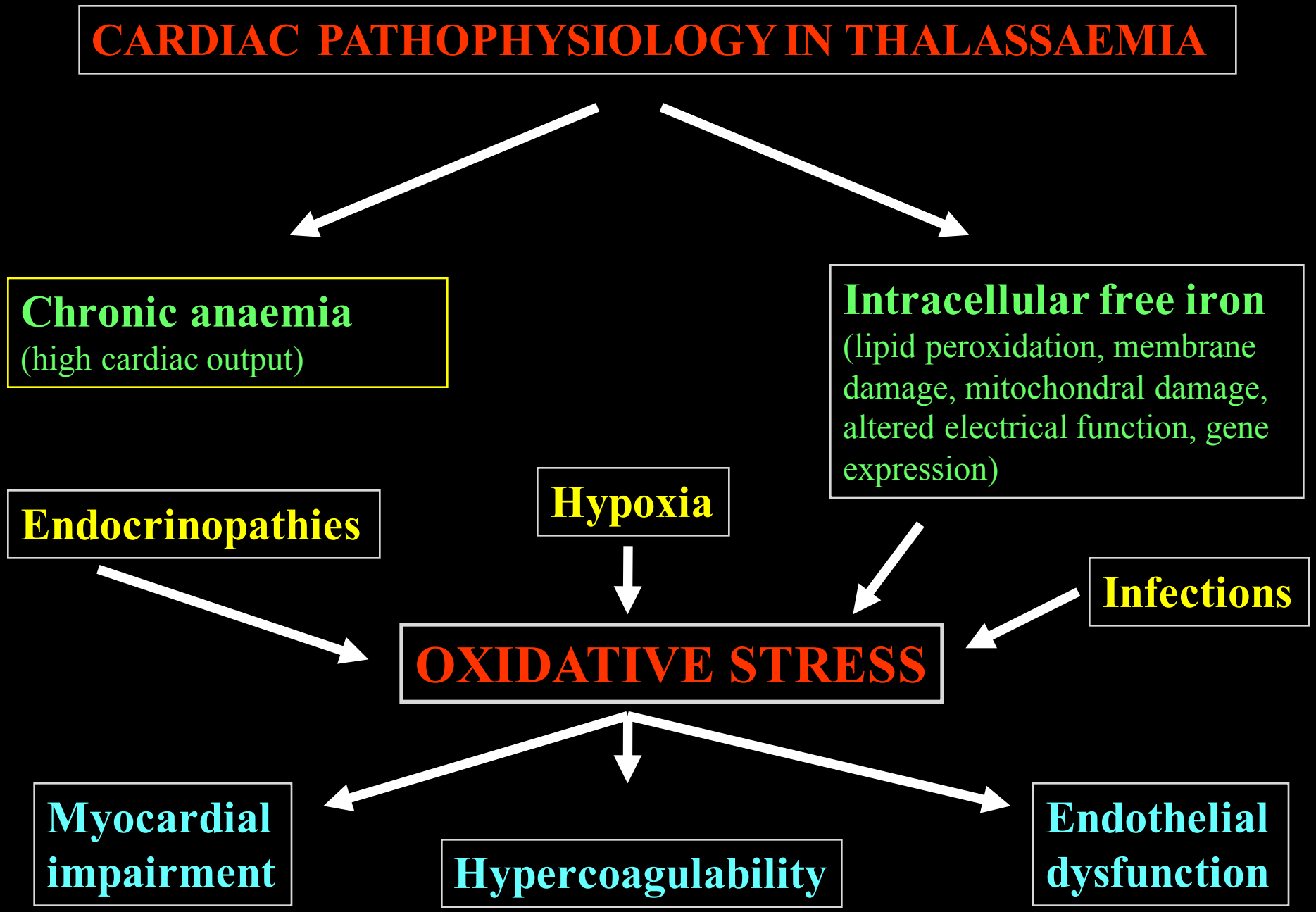




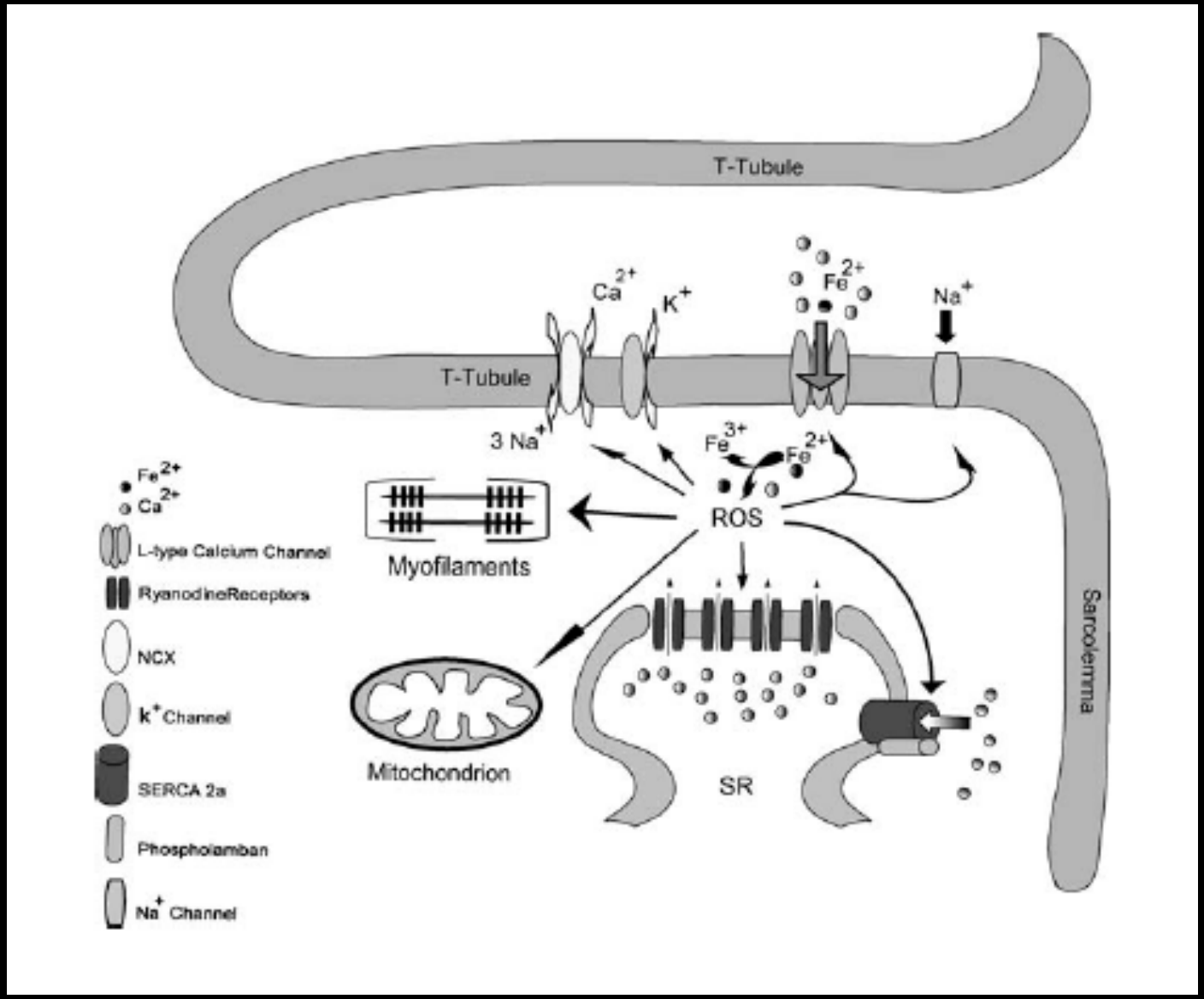
Iron cardiotoxicity





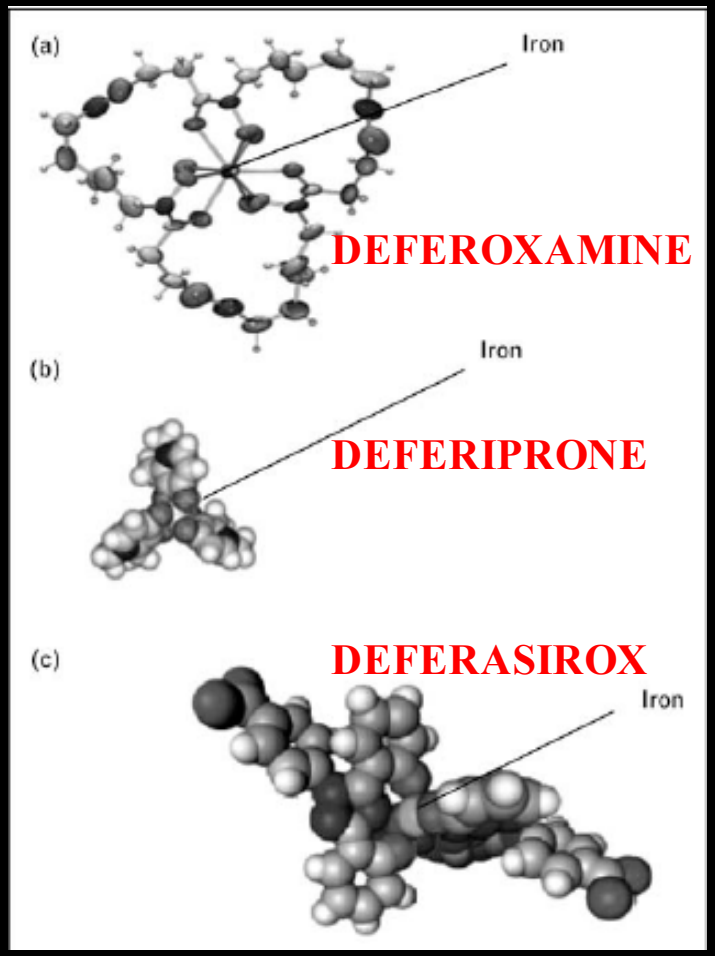

CARDIAC PATHOPHYSIOLOGY IN THALASSAEMIA
Chronic anaemia
(high cardiac output)
Intracellular free iron
(lipid peroxidation, membrane damage, mitochondral damage, altered electrical function, gene expression)
Endocrinopathies
Hypoxia
Infections
OXIDATIVE STRESS
Myocardial impairment
Hypercoagulability
Endothelial dysfunction

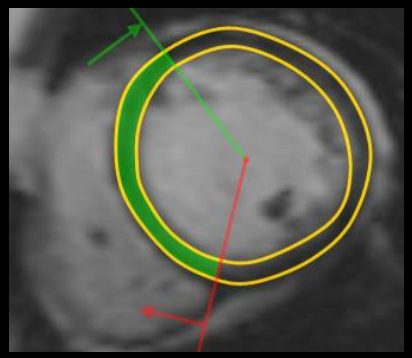
Relationship between iron overload, oxidative stress and calcium channels in myocardial cells



Oudit GY, J Mol Med 2006

IRON CHELATORS





IMPACT OF CMR ON IRON OVERLOAD MORTALITY

UK THALASSEMIA REGISTER

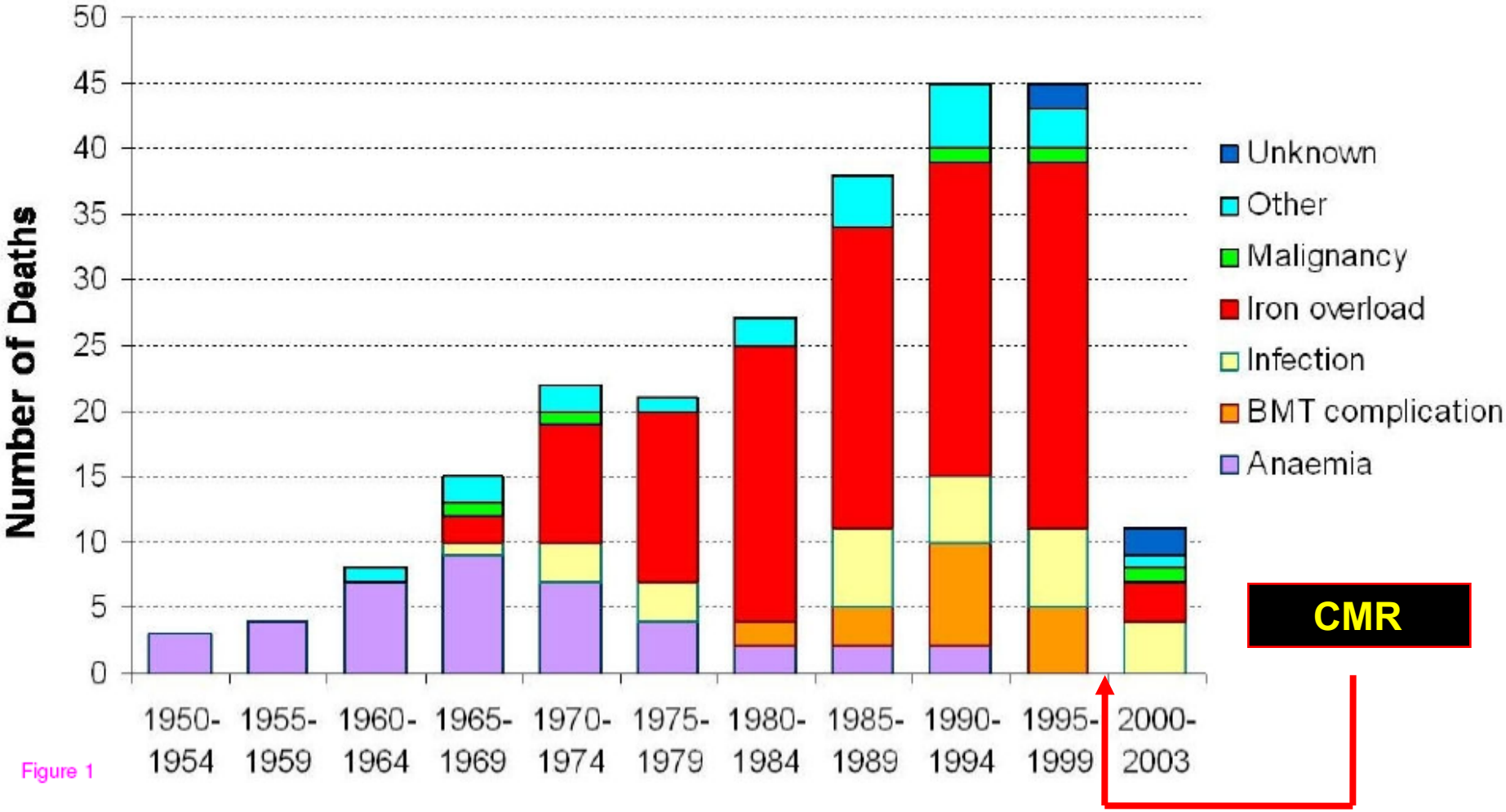


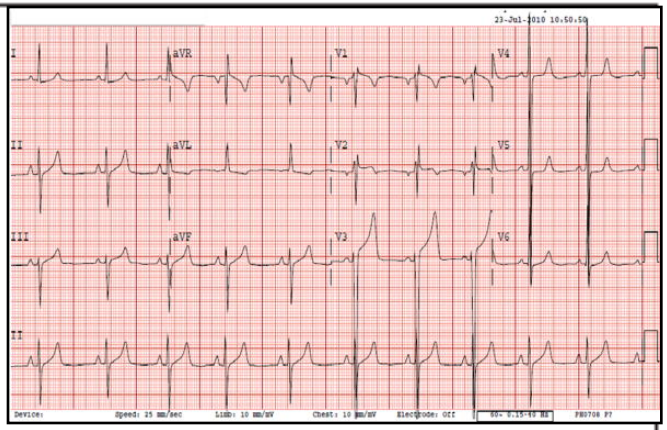
Figure 1

NEXT

- improving myocardial and liver iron-overload assessment: T1 mapping vs T2*
- improving NTBI transport system in different tissues
- iron-overload assessment in new target: pancreas, thyroid, hypophysis
- assess chelation therapy role in STEMI cardiogenic shock
- assess chelation therapy role in post-AMI LV remodeling and arrhythmia

Concentric Left Ventricular Hypertrophy

Obvious Cause of Increased Left Ventricular Afterload



Yes

- Hypertension
- Aortic Valve Stenosis

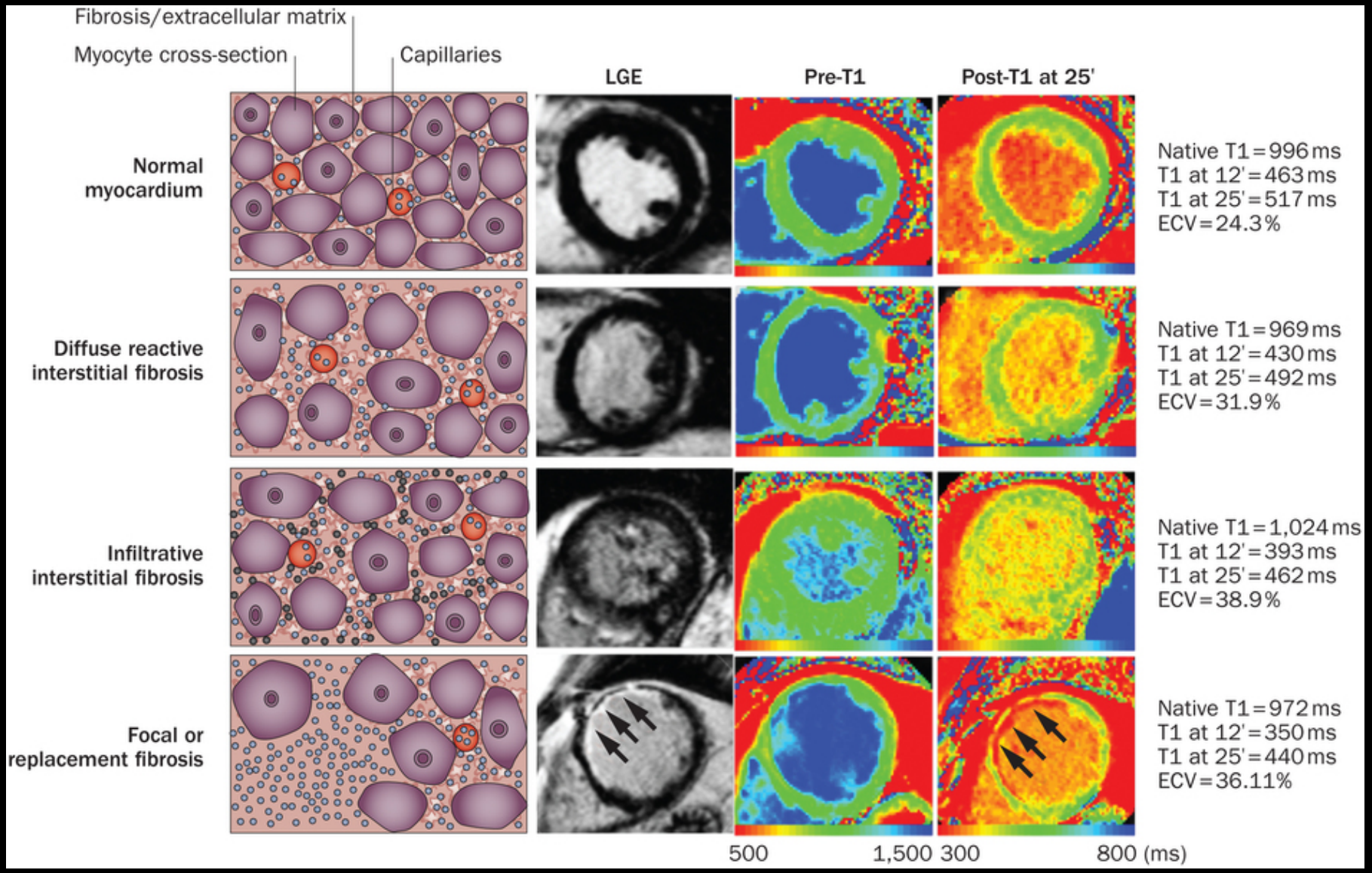
No

Low or Normal Voltage Amplitude on ECG

- Amyloidosis
- Sarcoidosis
- Hemochromatosis

Increased Voltage Amplitude on ECG

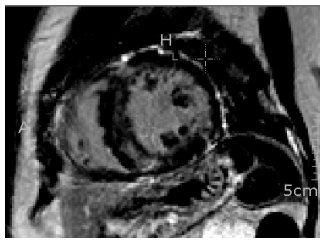
- Fabry Disease
- Pompe Disease
- Hypertrophic Cardiomyopathy
- Athlete's Heart

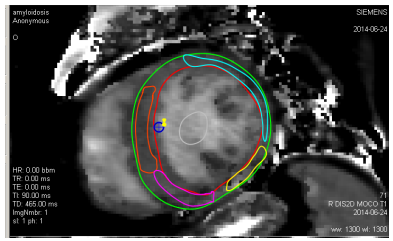

Fibrosis/extracellular matrix
Myocyte cross-section
Capillaries
LGE
Pre-T1
Post-T1 at 25'
Normal myocardium
Native T1 = 996 ms
T1 at 12' = 463 ms
T1 at 25' = 517 ms
ECV = 24.3%
Diffuse reactive interstitial fibrosis
Native T1 = 969 ms
T1 at 12' = 430 ms
T1 at 25' = 492 ms
ECV = 31.9%
Infiltrative interstitial fibrosis
Native T1 = 1,024 ms
T1 at 12' = 393 ms
T1 at 25' = 462 ms
ECV = 38.9%
Focal or replacement fibrosis
Native T1 = 972 ms
T1 at 12' = 350 ms
T1 at 25' = 440 ms
ECV = 36.11%
500
1,500
300
800 (ms)

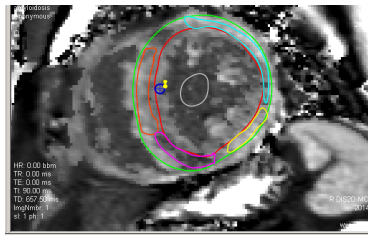
Detection of cardiac amyloidosis

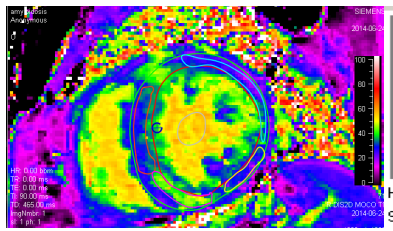
Images provided by Dr. A. Roghi
SS Cardiologia Diagnostica per Immagini
A.O. Niguarda Ca' Granda, Milano

LGE | T1 pre | T1 post | ECV



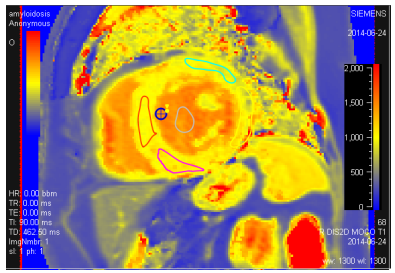


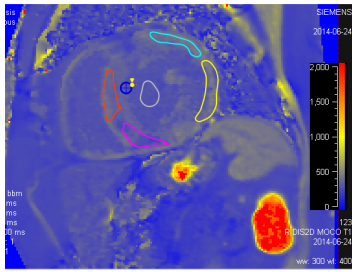


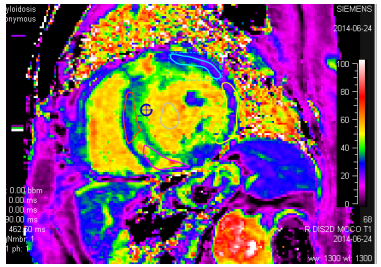


	T1 Native [ms]	T1 Post [ms]	ECV [%]
ROI 1	984.50	413.16	32.67
ROI 2	1012.60	350.26	43.44
ROI 3	1050.62	442.56	30.42
ROI 4	977.11	440.29	29.03
Blood	1428.80	326.34	-

Hematocrit (%): 45.00
Series delay (min): 22.60
Ser. # T1 Native: 71
Ser. # T1 Post: 126

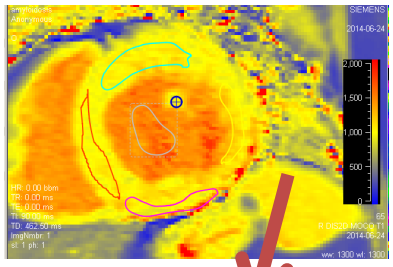


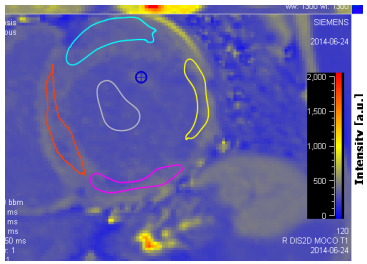


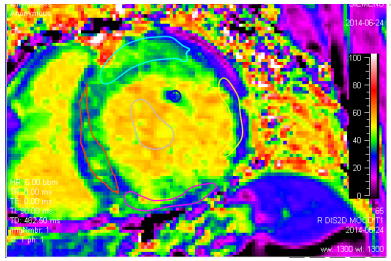


	T1 Native [ms]	T1 Post [ms]	ECV [%]
ROI 1	1006.84	402.62	34.58
ROI 2	1073.46	339.22	46.78
ROI 3	1052.95	411.31	34.37
ROI 4	987.45	441.11	29.10
Blood	1445.70	326.56	-

Hematocrit (%): 45.00
Series delay (min): 22.23
Ser. # T1 Native: 68
Ser. # T1 Post: 123
Acquisition type: Inversion Recovery (T1)

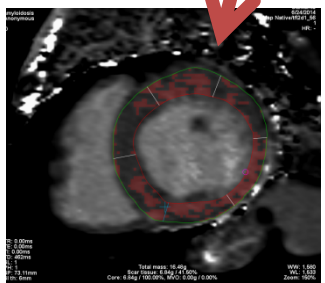






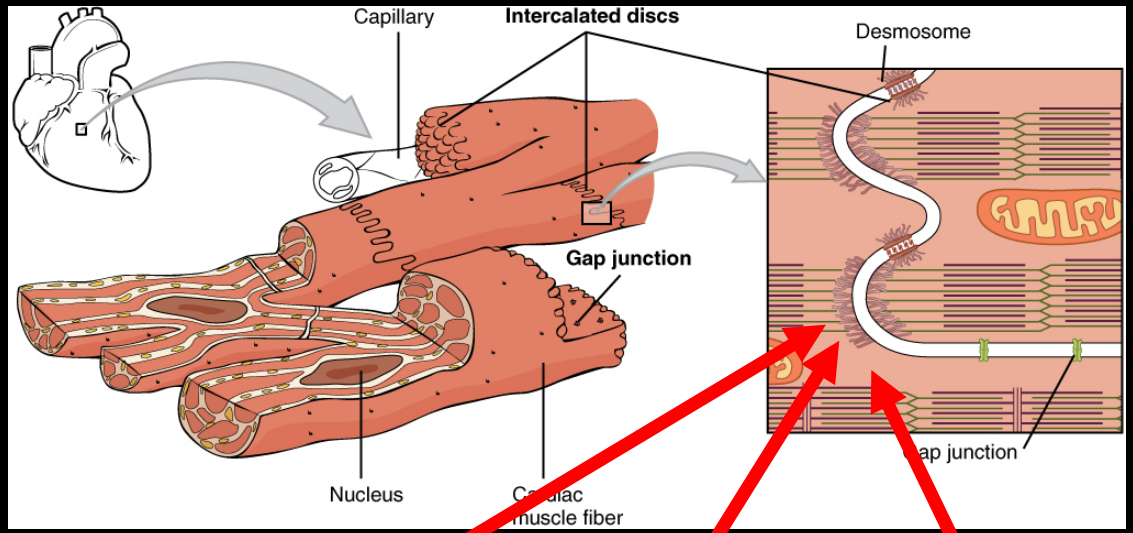
	T1 Native [ms]	T1 Post [ms]	ECV [%]
ROI 1	1024.08	373.10	38.09
ROI 2	1076.46	376.91	38.55
ROI 3	1135.85	388.88	37.81
ROI 4	1066.57	366.57	40.03
Blood	1514.27	320.46	-

Hematocrit (%): 45.00
Series delay (min): 22.23
Ser. # T1 Native: 65
Ser. # T1 Post: 120



T1 pre , Threshold >1150 ms

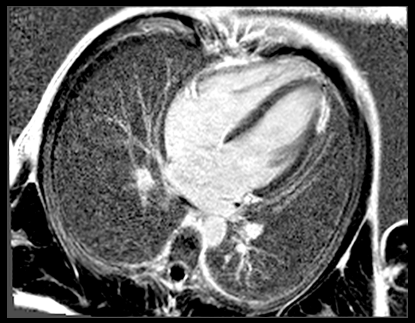
- **LGE** show diffused enhancement
- **T1 pre** High T1 value (984 – 1066 ms)
- **T1 post** Shroten T1 value (350 – 441 ms)
- **ECV** high ECV value (29 43 %)

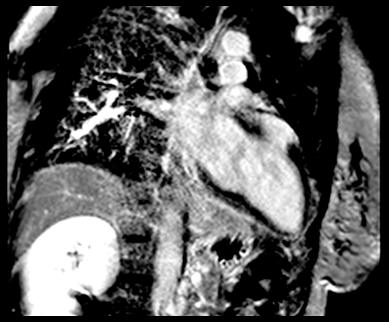


ARVC

SARCOIDOSIS

GIANT CELL MYOCARDITIS

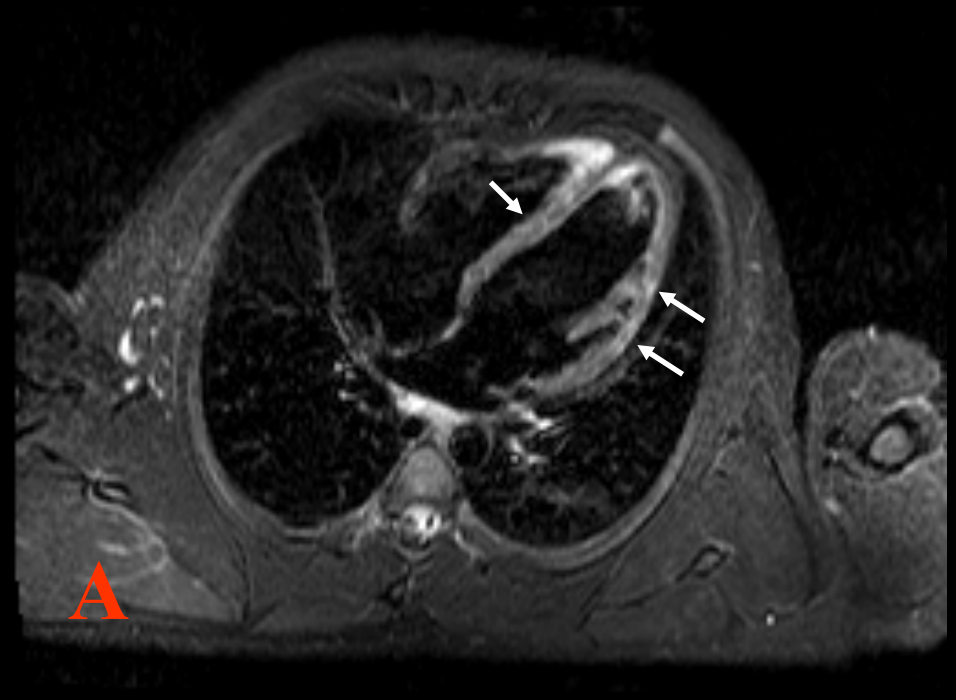


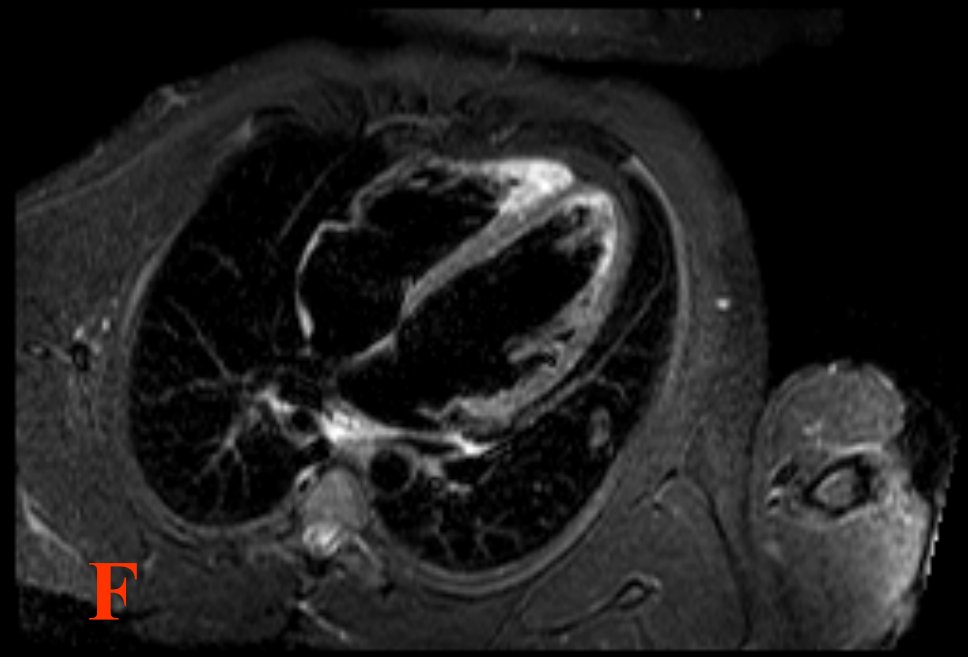


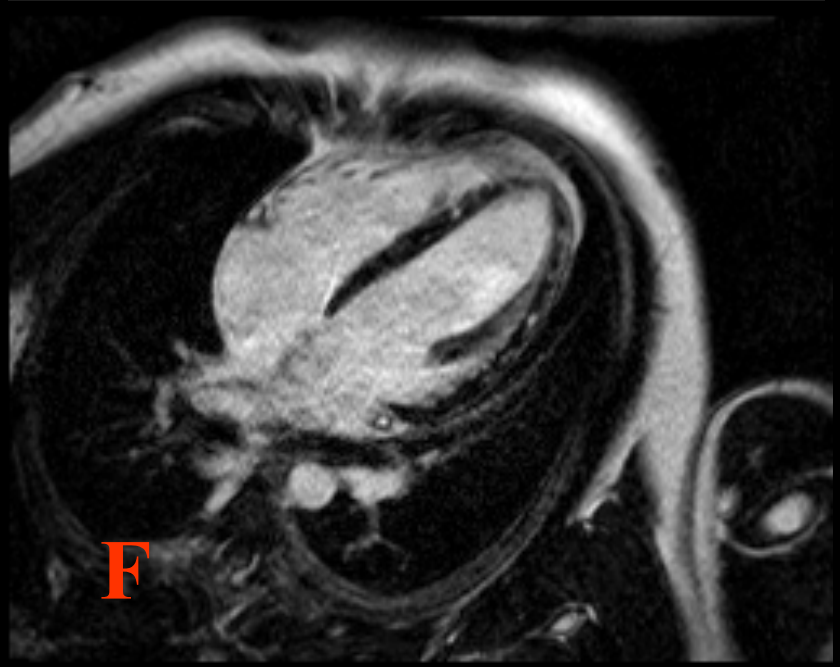
STIR

PATTERN B

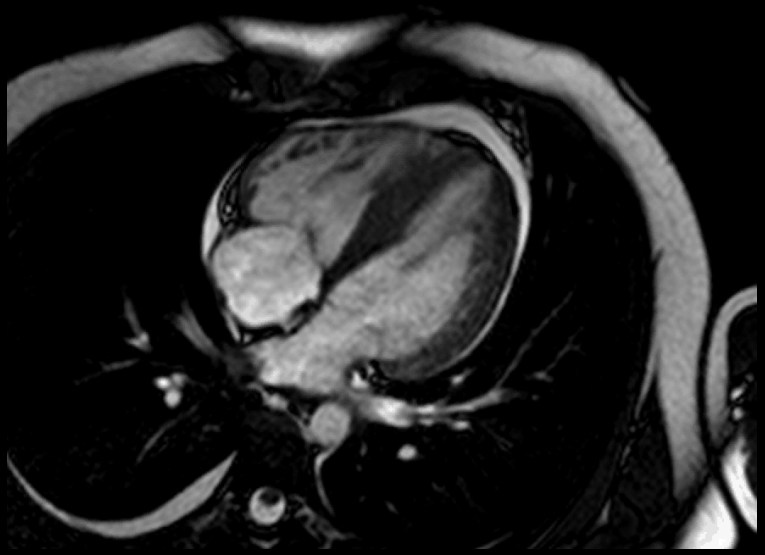
DELAY-ENHANCEMENT

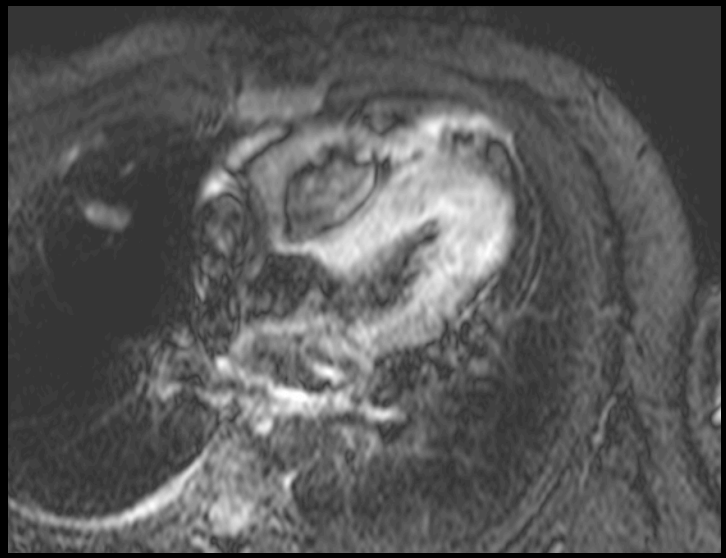




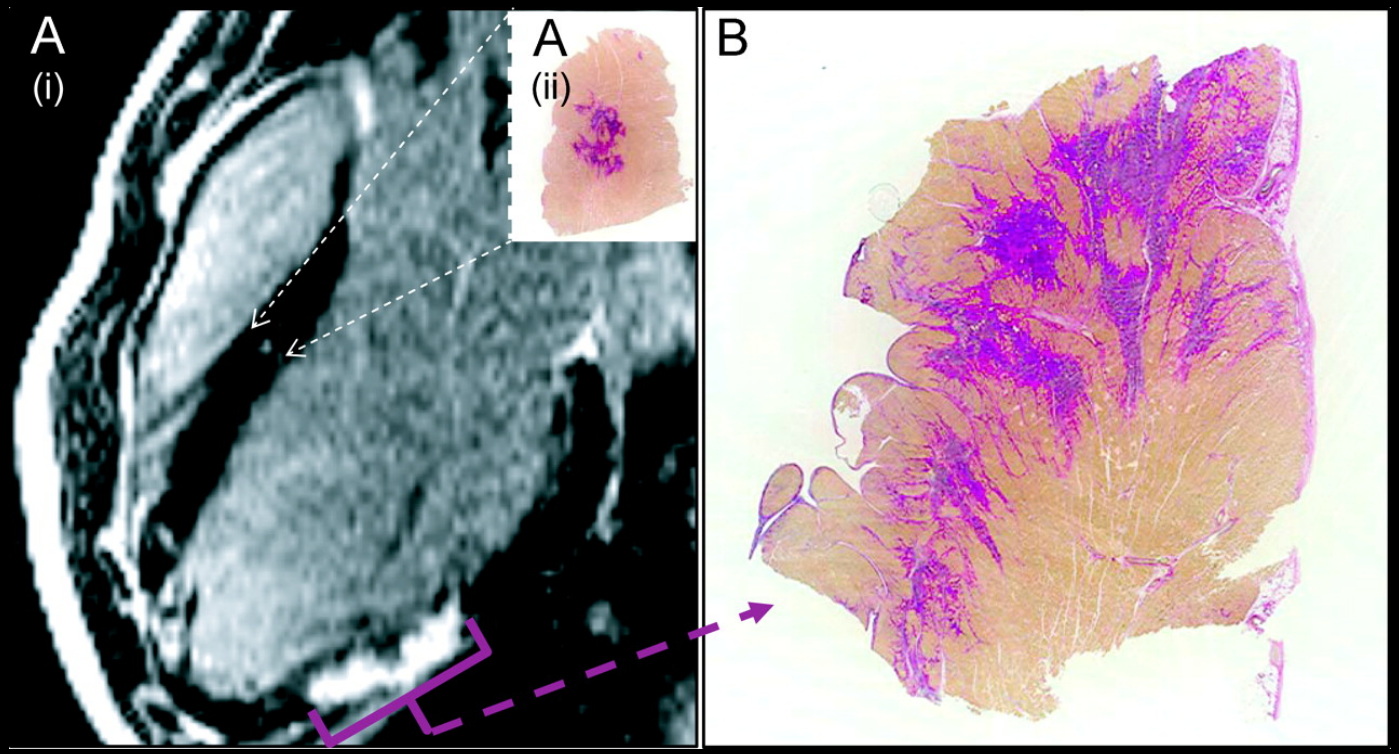


…Caro Roghi, potresti vedere la RM cardiaca fatta qui da noi di questo ragazzo ricoverato ieri sera per dolore toracico, ST sopralivellato e movimento di troponina ? Il Radiologo propende per amiloidosi cardiaca…





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



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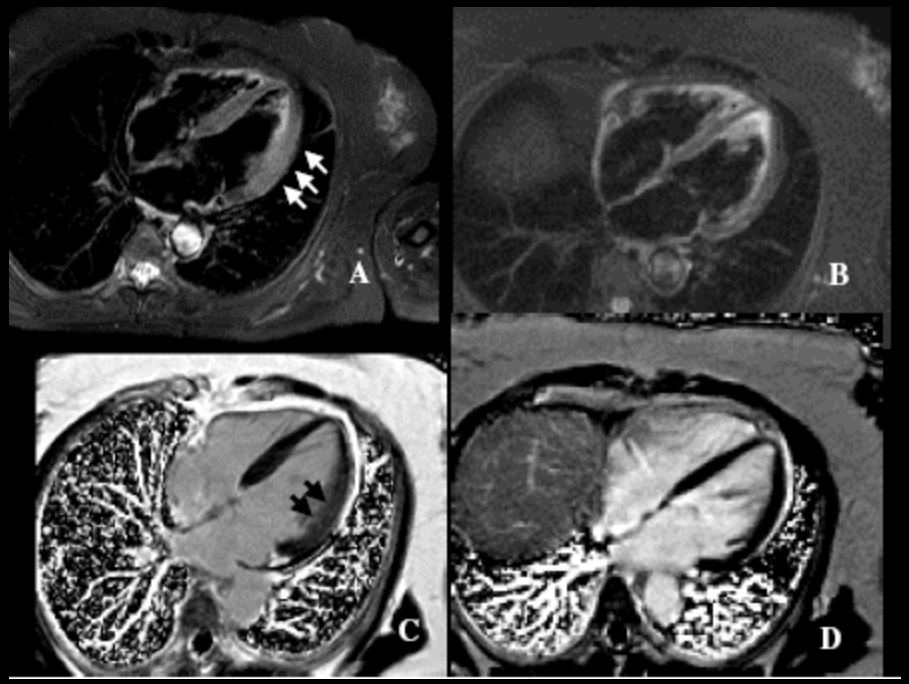
http://www.jcmr-online.com/content/13/1/4

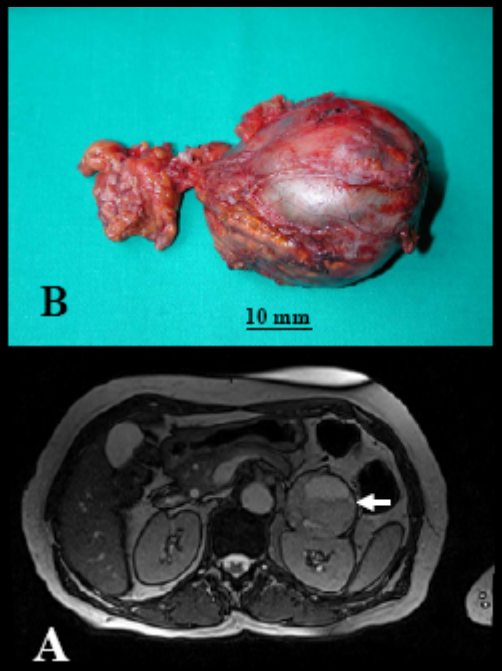
Journal of Cardiovascular Magnetic Resonance

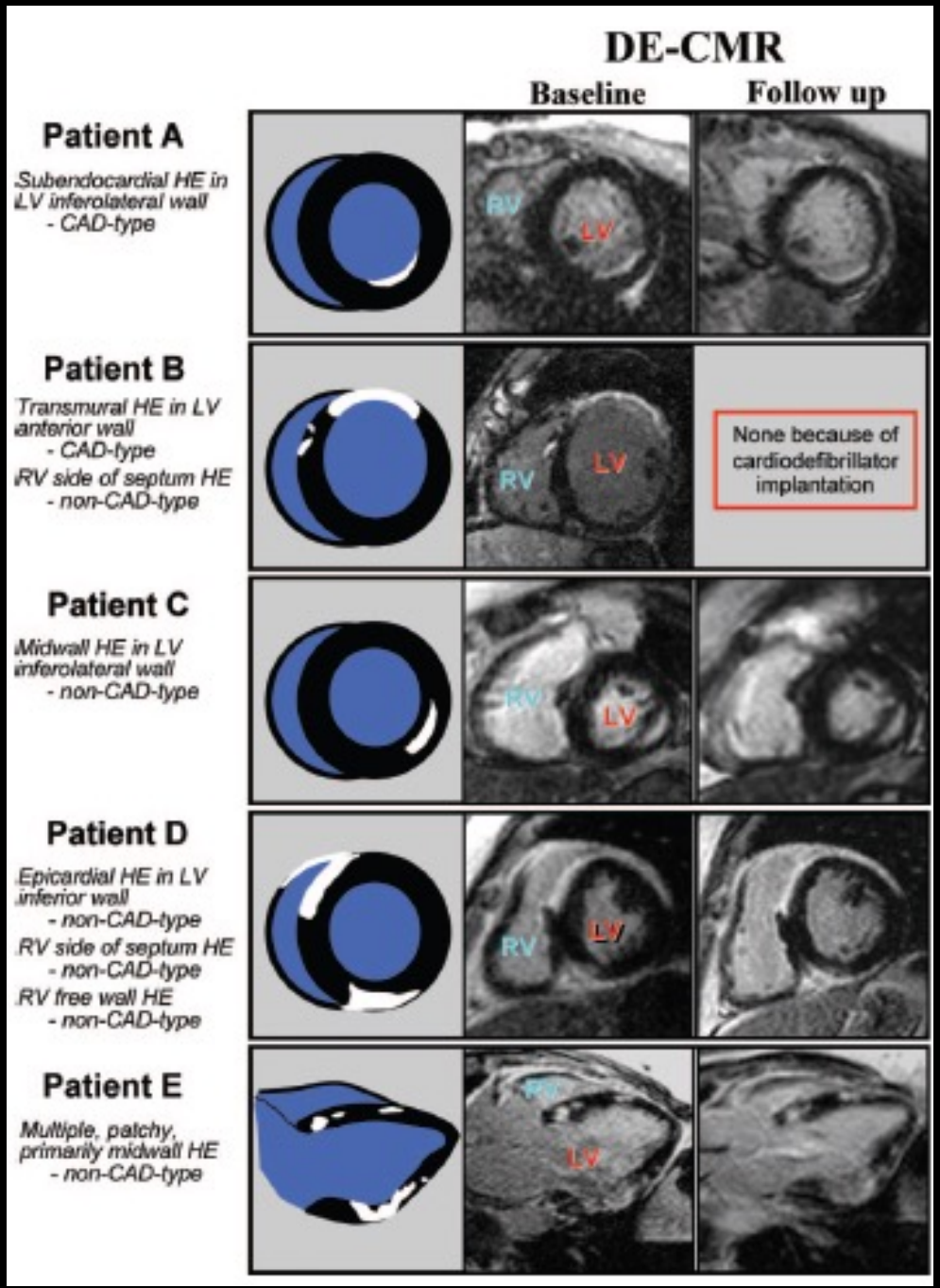
CASE REPORT Open Access

Adrenergic Myocarditis in Pheochromocytoma

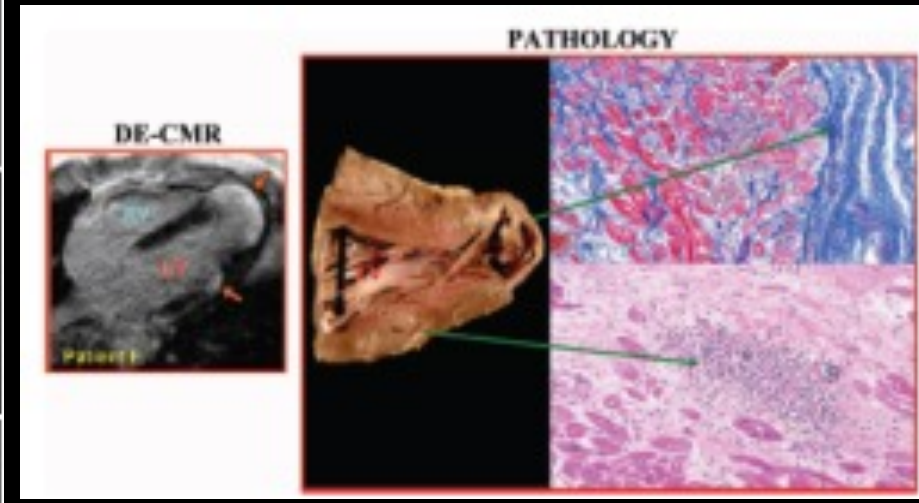
Alberto Roghi[1*], Patrizia Pedrotti[1], Angela Milazzo[1], Edgardo Bonacina[2], Chiara Bucciarelli-Ducci[3,4]



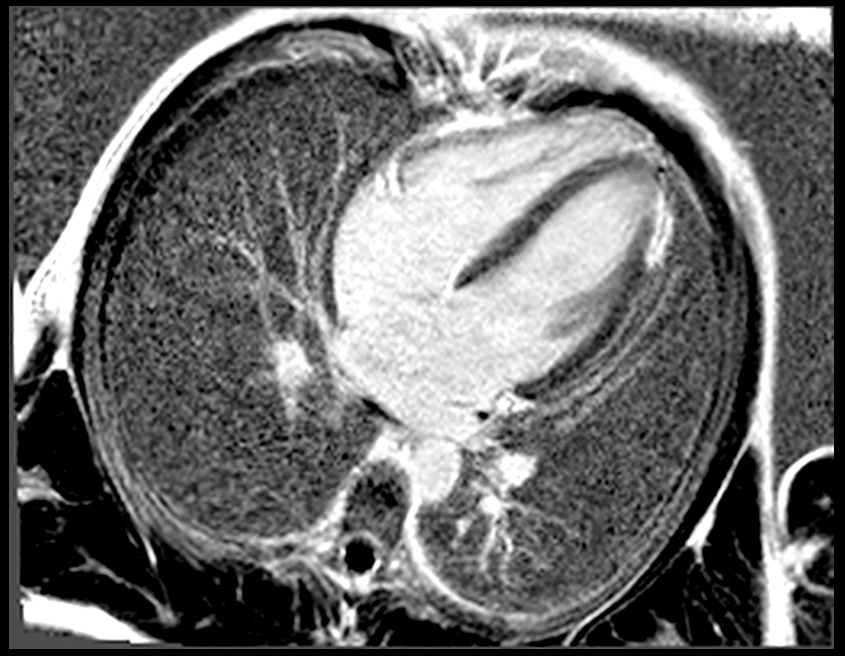


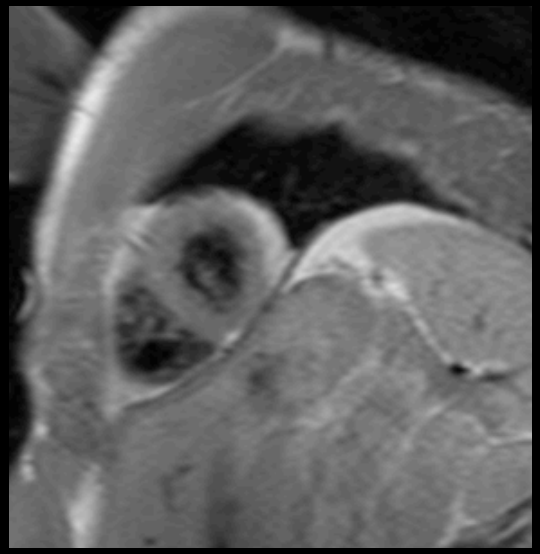


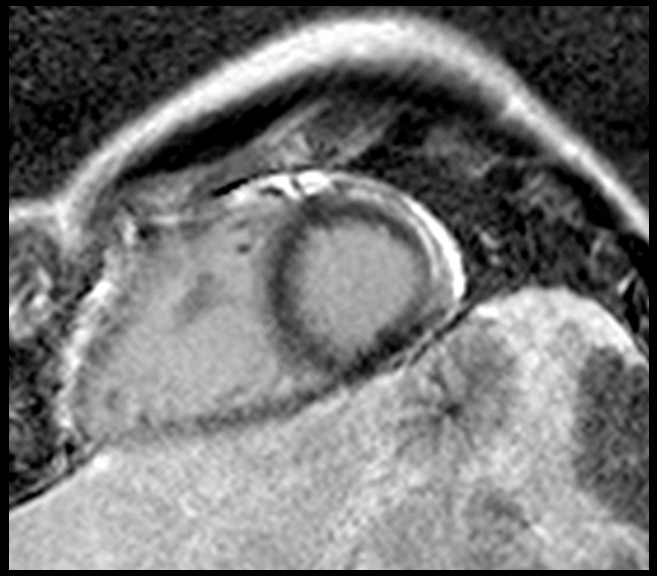
Detection of Myocardial Damage in Patients With Sarcoidosis



Patel Circulation 2009

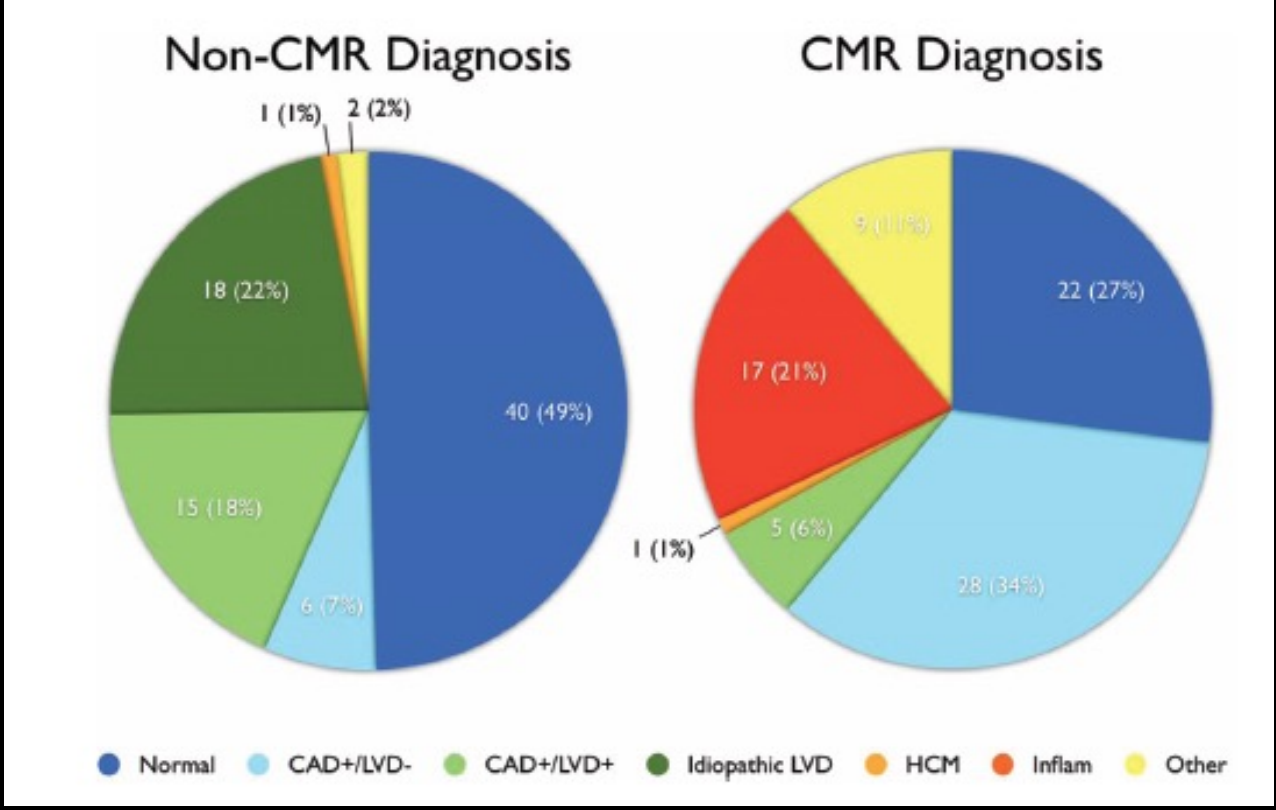




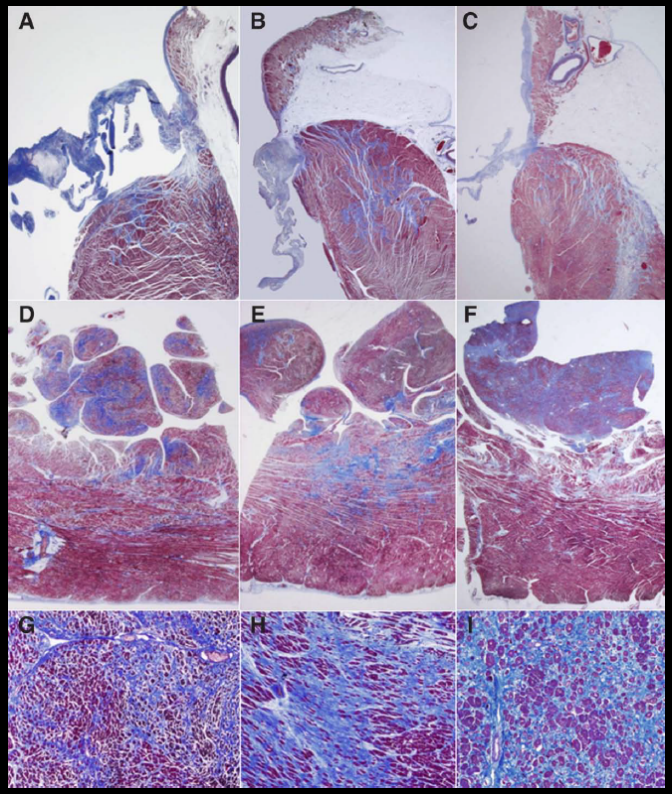


Utility of Cardiovascular Magnetic Resonance in Identifying Substrate for Malignant Ventricular Arrhythmias

James A. White, MD, FRCPC; Nowell M. Fine, MD; Lorne Gula, MD, MSc; Raymond Yee, MD; Allan Skanes, MD; George Klein, MD; Peter Leong-Sit, MD; Heather Warren, MD; Terry Thompson, PhD; Maria Drangova, PhD; Andrew Krahn, MD



Circulation Imaging 2012



Arrhythmic Mitral Valve Prolapse and Sudden Cardiac Death

Cristina Basso, MD, PhD*; Martina Perazzolo Marra, MD, PhD*; Stefania Rizzo, MD, PhD; Manuel De Lazzari, MD; Benedetta Giorgi, MD; Alberto Cipriani, MD; Anna Chiara Frigo, MSc; Ilaria Rigato, MD, PhD; Federico Migliore, MD, PhD; Kalliopi Pilichou, PhD; Emanuele Bertaglia, MD; Luisa Cacciavillani, MD, PhD; Barbara Bauce, MD, PhD; Domenico Corrado, MD, PhD; Gaetano Thiene, MD; Sabino Iliceto, MD

					P Value			
Variables	MVP With Complex VA (n=30 Patients)	Complex VA >3 VPB Run (n=10 Patients)	Complex VA =3 VPB Run (n=20 Patients)	MVP without Complex VA (n=14 Patients)	With Complex VA vs Without Complex VA	>3VBPs vs Without Complex VA	=3 VPBs vs Without Complex VA	>3VPBs vs =3 VPBs
CMR postcontrast findings								
LV LGE, n (%)	28 (93)	10 (100)	18 (90)	2 (14)	<0.01	<0.01	<0.01	0.54
PMs	25 (83)	10 (100)	15 (75)	2 (14)	<0.01	<0.01	<0.01	0.14
Inferobasal wall	22 (73)	7 (70)	15 (75)	1 (7)	<0.01	<0.01	<0.01	1.00
LV LGE amount, %	1.2 (0.8–2.1)	1.1 (0.9–2.7)	1.4 (0.7–2.1)	0	<0.01	<0.01	<0.01	0.96

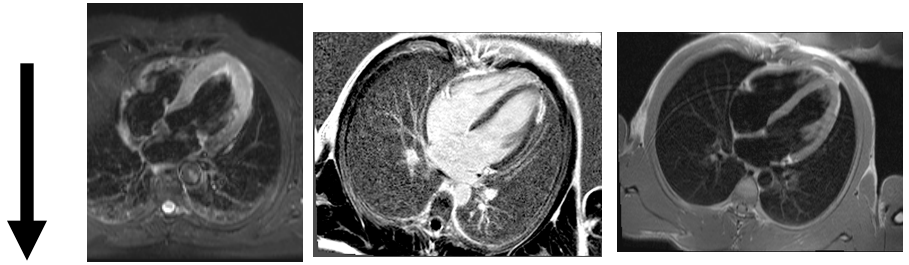

A
B
C
D
E
F

NEXT

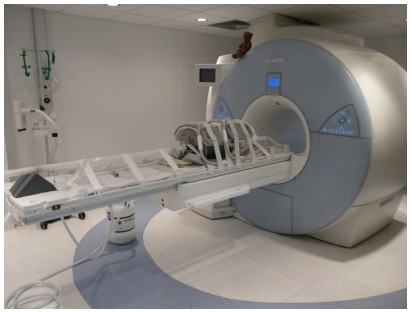
- improving tissue characterization

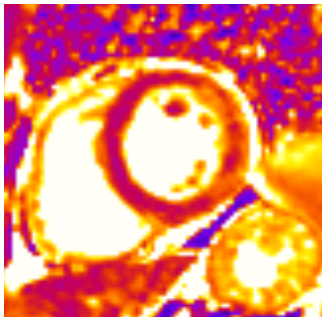
MACRO-PATHOLOGY

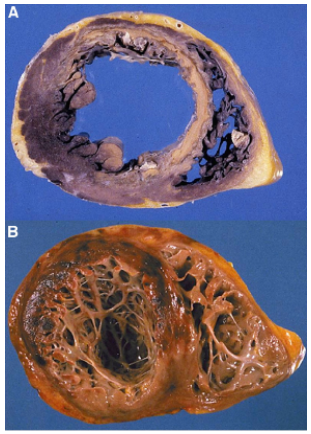
- unrecognized standards: LGE, oedema, fat infiltration



- standardization of quantitative assessment (phantom !!)
- new sequences for oedema and T2* (T2 mapping…)
- comparison with pathology

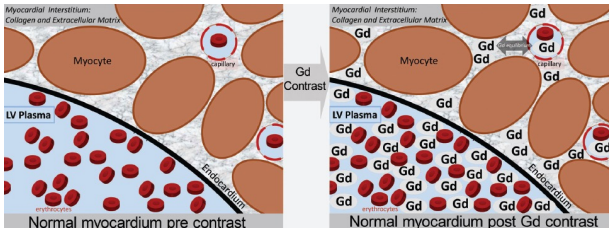




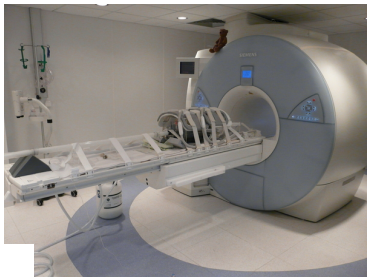


MICRO-PATHOLOGY

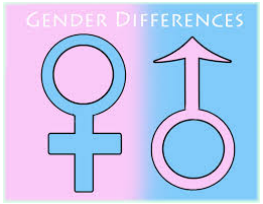
- unrecognized standards: ECV



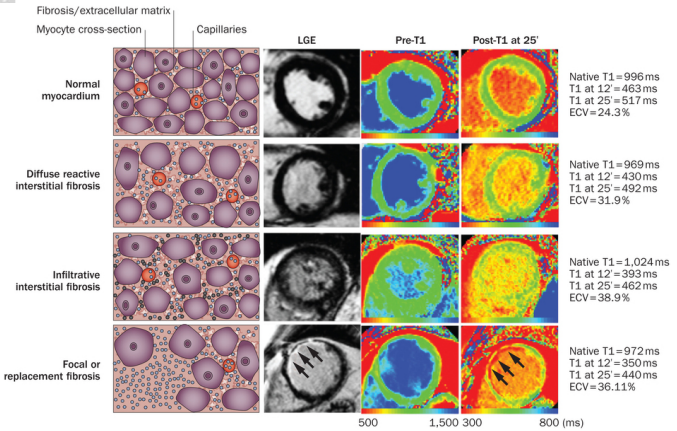
- standardization of quantitative assessment (phantom !!)



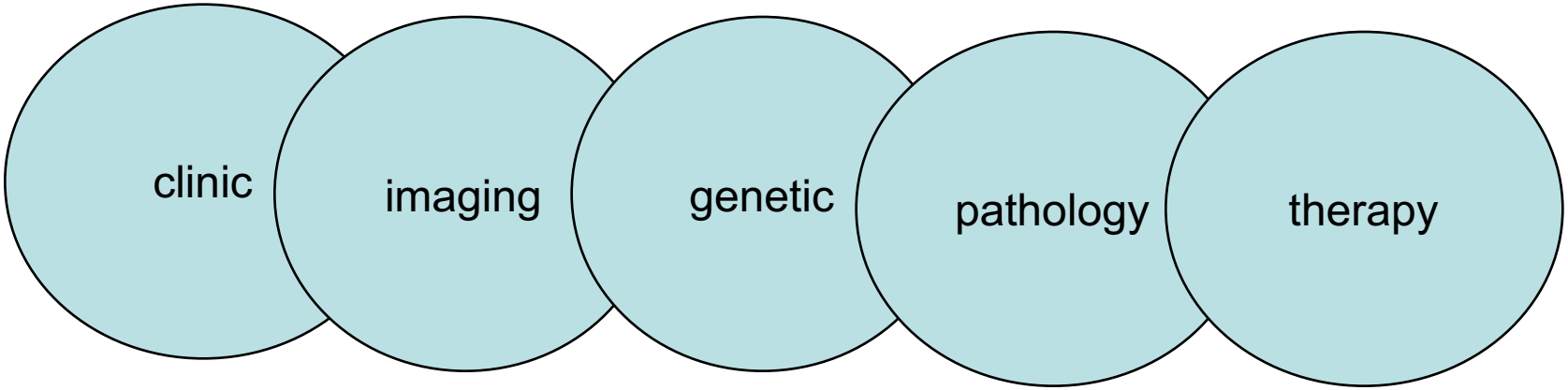
- standardization for age and sex

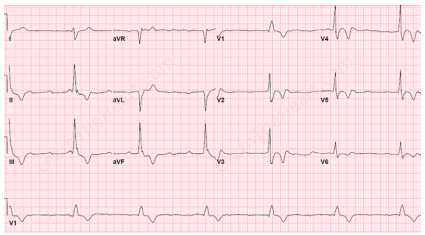


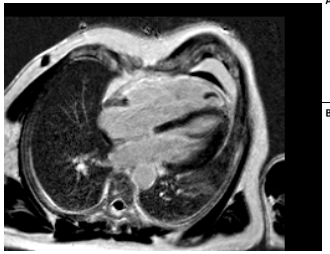
- comparison with pathology

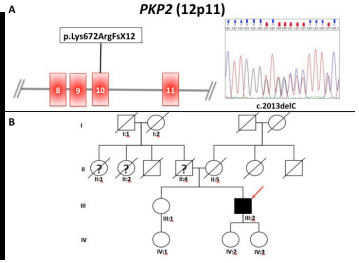


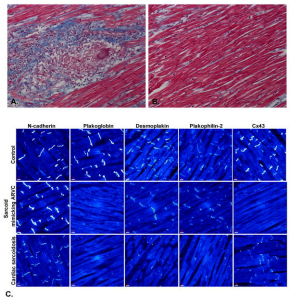
The chain of survival for cardiomyopathies

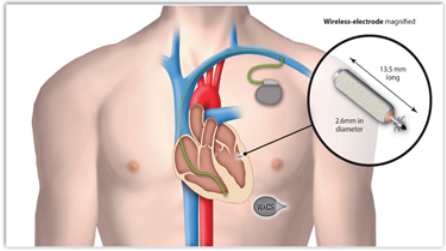












RESEARCH Open Access

Cardiovascular magnetic resonance activity in the United Kingdom: a survey on behalf of the british society of cardiovascular magnetic resonance

Renjith Antony[1], Marwa Daghem[1], Gerry P McCann[2,3], Safa Daghem[1], James Moon[2], Dudley J Pennell[4], Stefan Neubauer[2], Henry J Dargie[2], Colin Berry[6], John Payne[1], Mark C Petrie[1*] and Nathaniel M Hawkins[5]

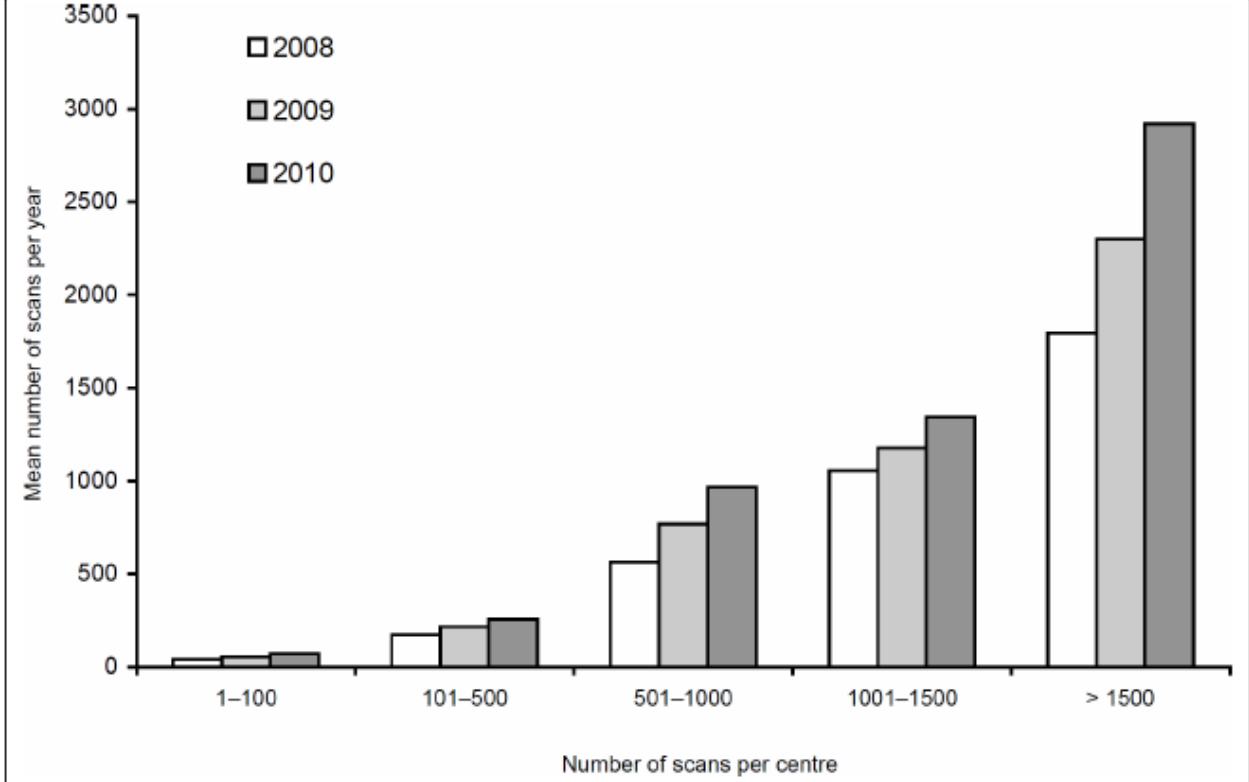


Figure 1 Annual increase in mean number of scans. Annual increase in mean number of scans performed among different volume centres.

JCMR 2011

UK 2010
53 Hospitals with CMR, n scans = 38.485

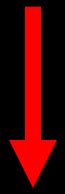
Low Volume = < 300 pts/year	28	13%
High Volume = > 1000 pts/year	12	66%
Very High Volume = > 1500 pts/year	6	

ITALY 2012*
20 Hospitals with CMR, n scans = 15.000

Low Volume = < 300 pts/year	10
High Volume = > 1000 pts/year	2
Very High Volume = > 1500 pts/year	1

* Unpublished data, CMR WG SIC

The BCS working group forecast a need to deliver 400 CMR scans per million adults by 2010 and 2275 scans per million adults by 2015



ITALY, 60 MILLIONS,
EXPECTED NEED FOR 2015:

136.500

Hub-spoke issue

- CMR is recognised as a highly complex imaging modality and both the National Imaging Board and BSCMR/BSCI recommended a minimum number of scans per centre of 300

- Accreditation by ESC imaging WG (EACVI) is mandatory for CMR Centers, with a 3-level training program including european CMR examination and assisted reporting recorded in a log-book with central supervision

- CMR complexity, cardiology and radiology competence, training and logistic costs support a Hub-spoke network to offer the best quality of examinations

NEXT