

Imaging in Seven Cardiomyopathies: Diagnostic and Prognostic Approaches

Robert O. Bonow, MD, MS, MACC

Northwestern University Feinberg School of Medicine
Bluhm Cardiovascular Institute
Northwestern Memorial Hospital

No Relationships to Disclose

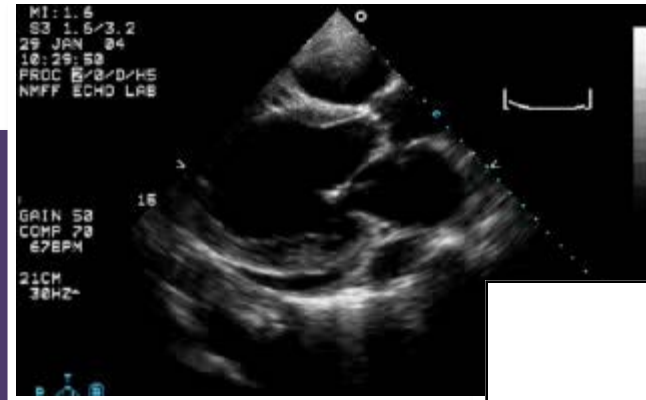


AMERICAN
COLLEGE *of*
CARDIOLOGY

Cardiovascular Imaging 2017

Cardiomyopathies:

- Echocardiography
- Cardiac magnetic resonance
- Cardiac computed tomography



Cardiovascular Imaging 2017

Echocardiography:

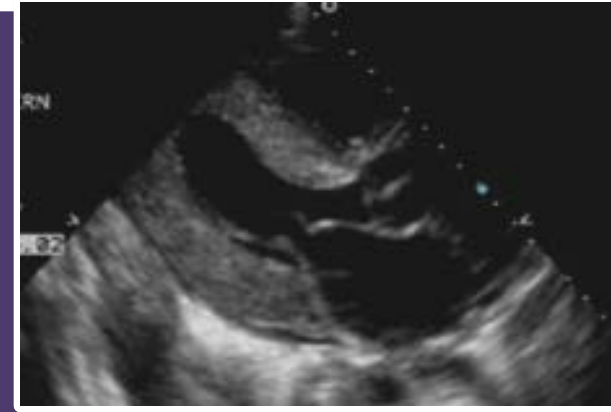
- Versatile
- Portable and available
- Relatively inexpensive
- Quantitative Doppler established and straightforward
- Transesophageal assessment
- Advances in 3D imaging
- Advances in TDI, contrast, speckle tracking, strain imaging



Cardiovascular Imaging 2017

Echocardiography:

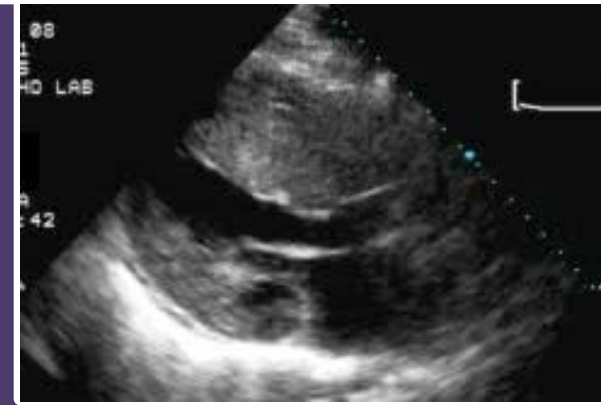
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Cardiovascular Imaging 2017

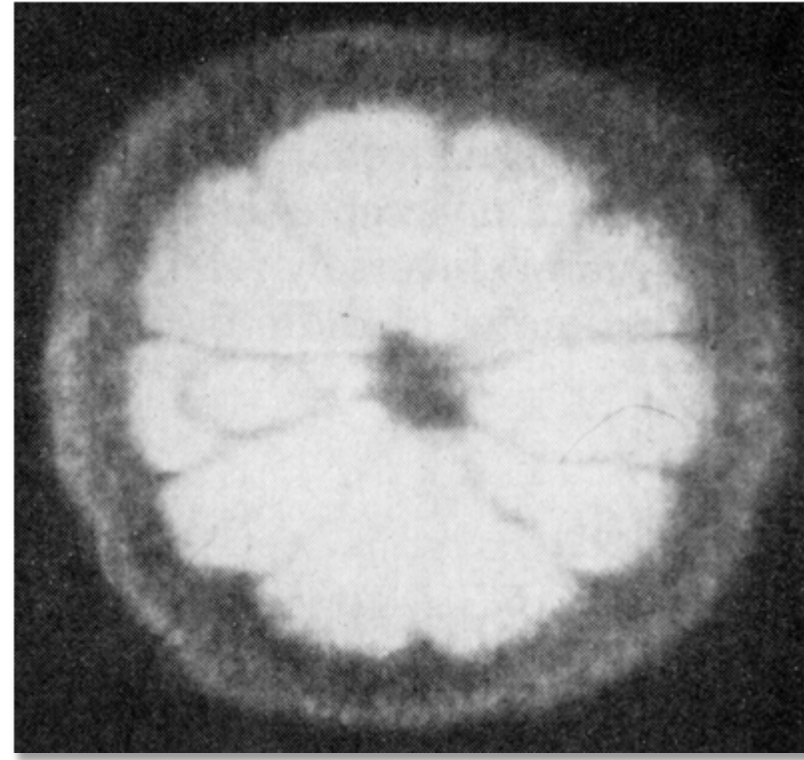
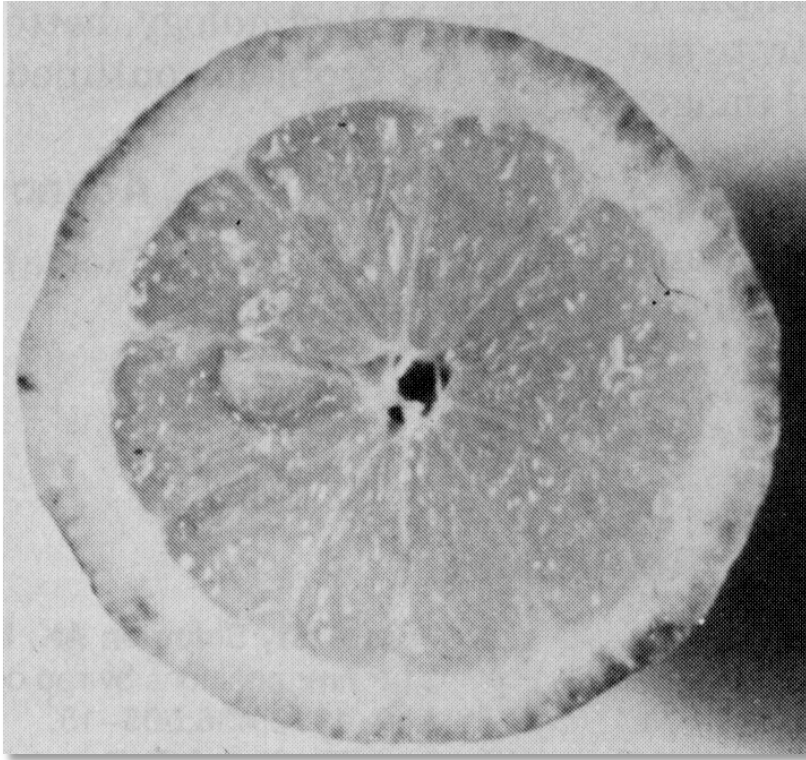
Echocardiography:

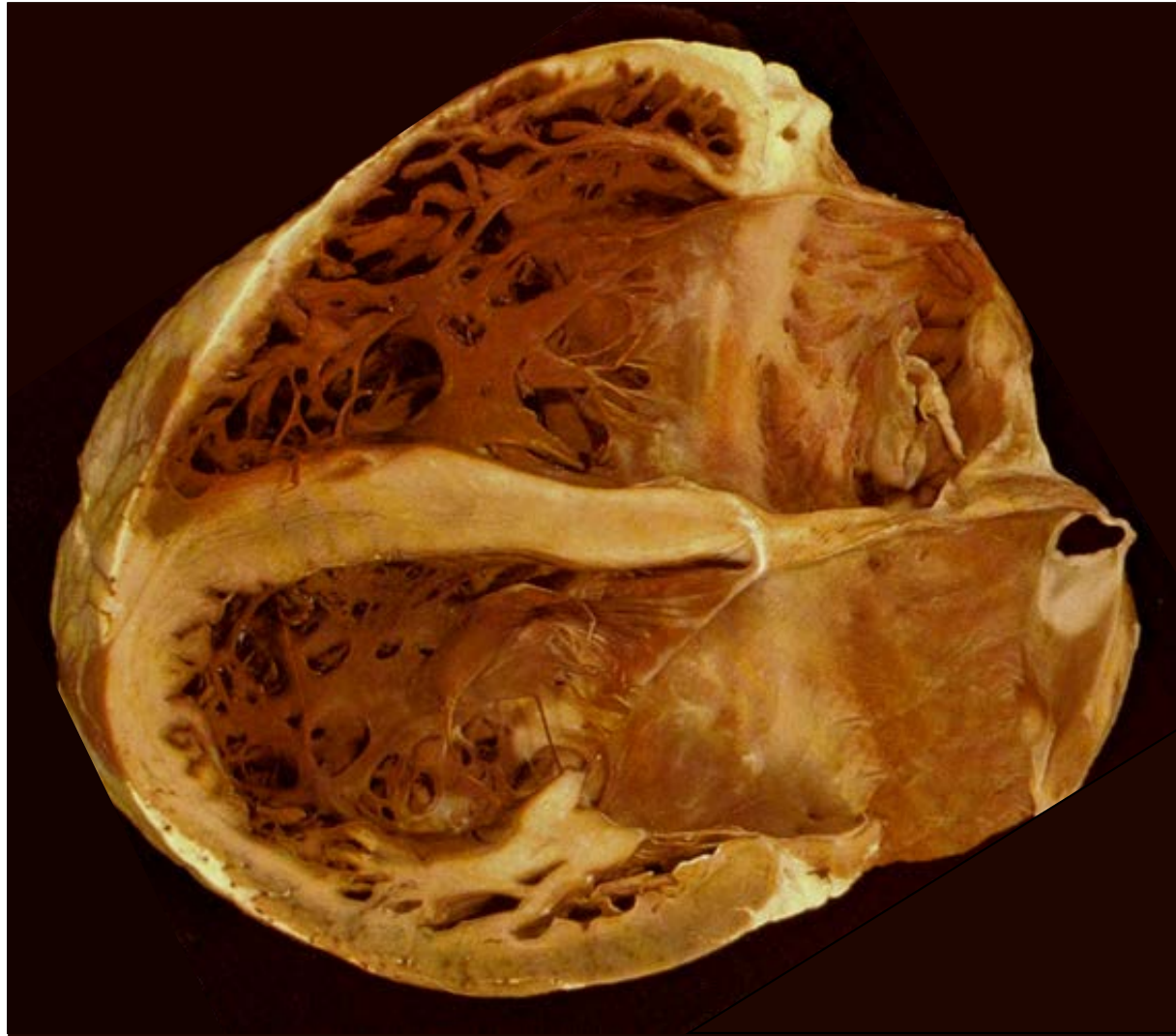
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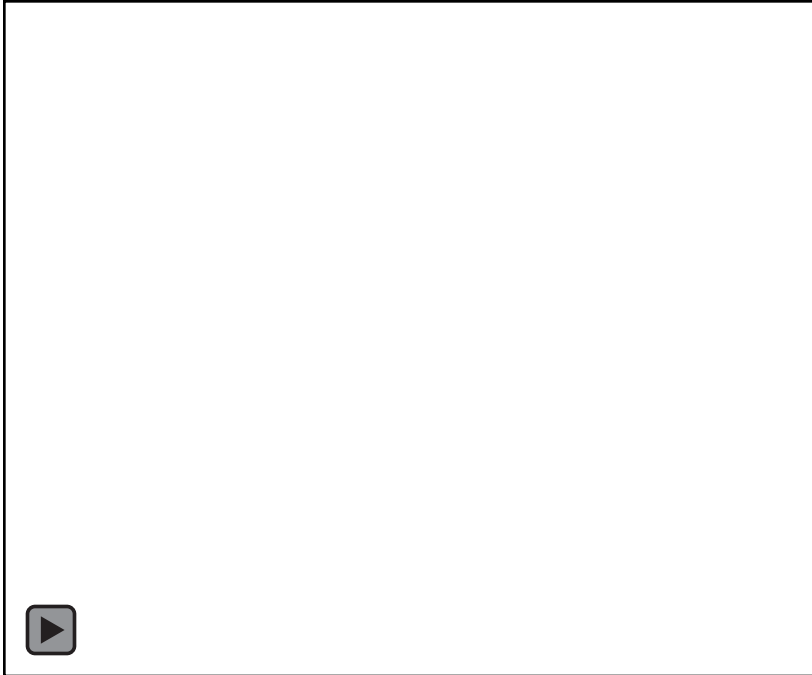




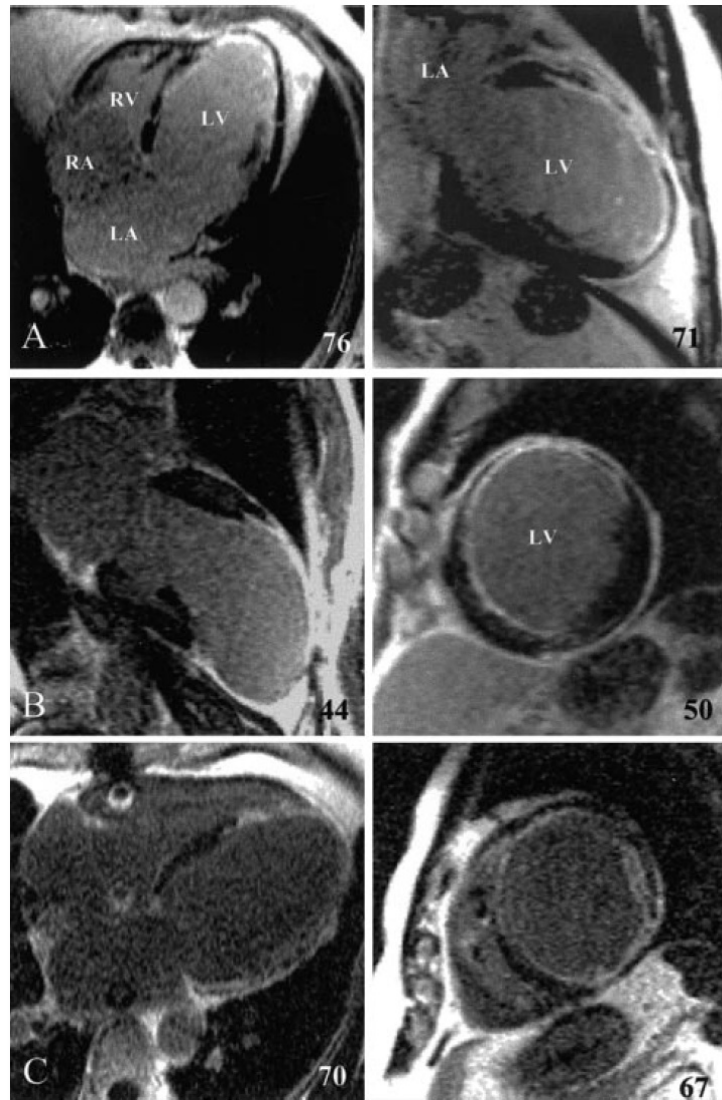
**With advances in echocardiography,
is there role for multimodality imaging
in evaluating myocardial disease?**



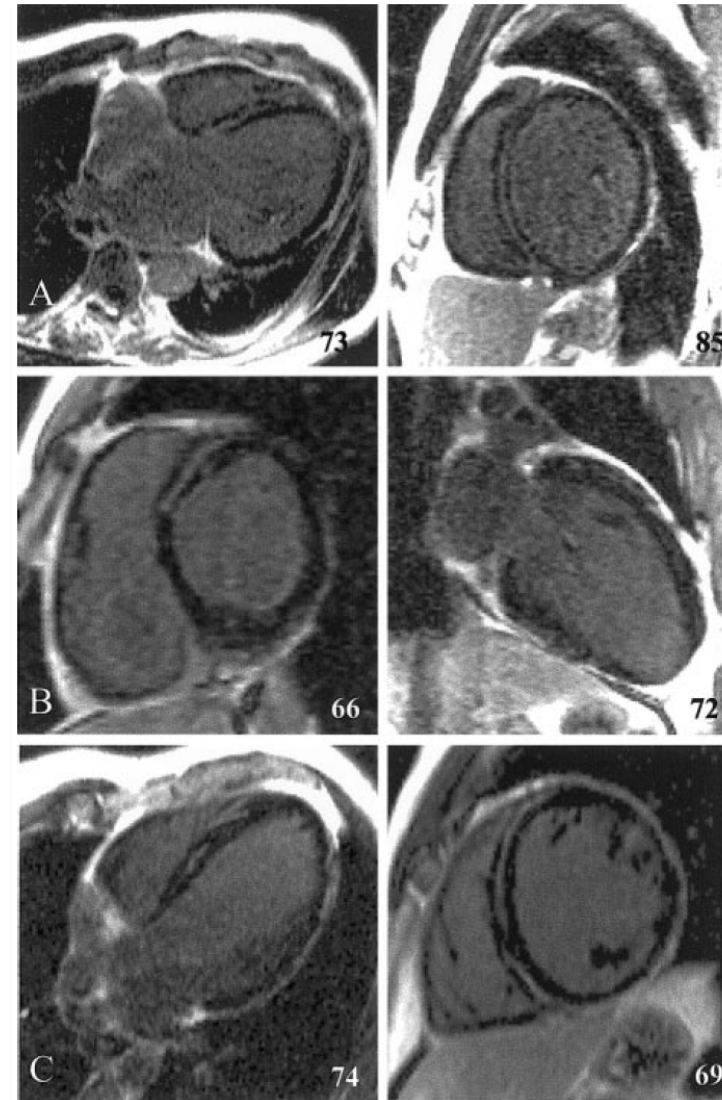




Differentiation of Ischemic and Dilated Cardiomyopathy



CAD



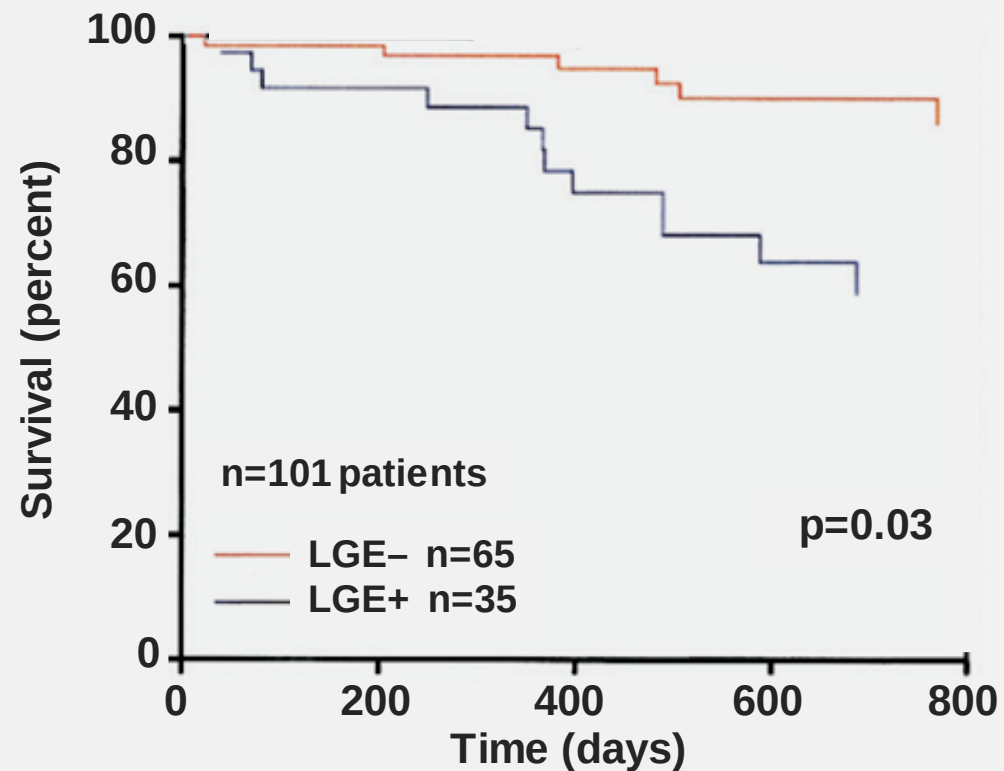
DCM

FOCUS ISSUE: CARDIAC IMAGING

Cardiovascular Magnetic Resonance, Fibrosis, and Prognosis in Dilated Cardiomyopathy

Ravi G. Assomull, MRCP,*† Sanjay K. Prasad, MD, MRCP,*† Jonathan Lyne, MRCP,*
Gillian Smith, MSc,* Elizabeth D. Rusman, MSc,* Mohammed Khan, MSc, MPH,*
Mary N. Sheppard, MD, FRCPath
Dudley J. Pennell, MD, FRCP, FES
London, United Kingdom

J Am Coll Cardiol 2006;48:1977–85



Association of Fibrosis With Mortality and Sudden Cardiac Death in Patients With Nonischemic Dilated Cardiomyopathy

Ankur Gulati, MD

Andrew Jabbour, MD, PhD

Tevfik F. Ismail, MD

Kaushik Guha, MD

Jahanzaib Khwaja, BSc

Sadaf Raza, MD

Kishen Morarji, MD

Tristan D. H. Brown, BSc

Nizar A. Ismail, BSc

Marc R. Dweck, MD

Elisa Di Pietro, MD

Michael Roughton, MSc

Ricardo Wage, DCR

Yousef Daryani, MD

Rory O'Hanlon, MD

Mary N. Sheppard, MD

Francisco Alpendurada, MD

Alexander R. Lyon, MD, PhD

Stuart A. Cook, MD

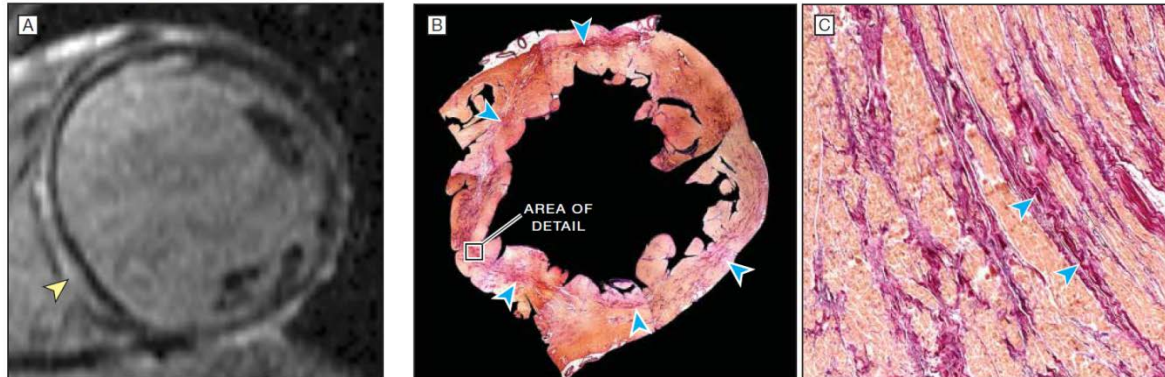
Martin R. Cowie, MD

Ravi G. Assomull, MD

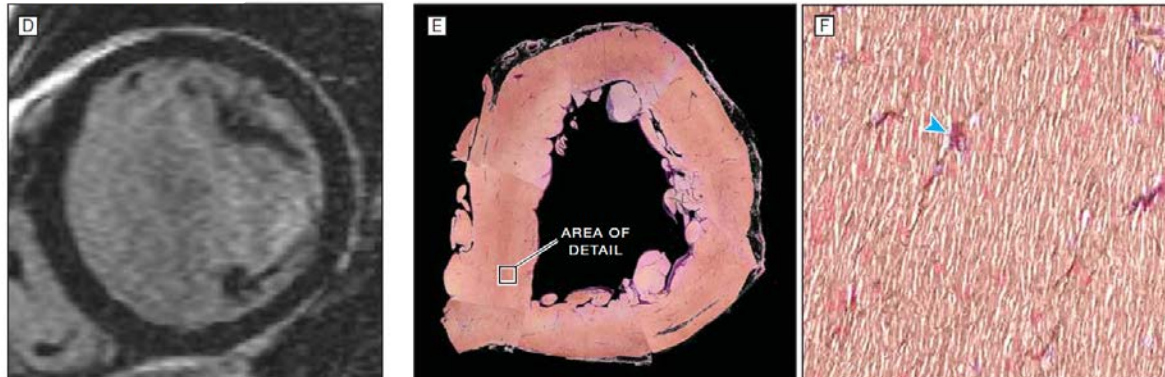
Dudley J. Pennell, MD

Sanjay K. Prasad, MD

Patient with midwall fibrosis



Patient without midwall fibrosis



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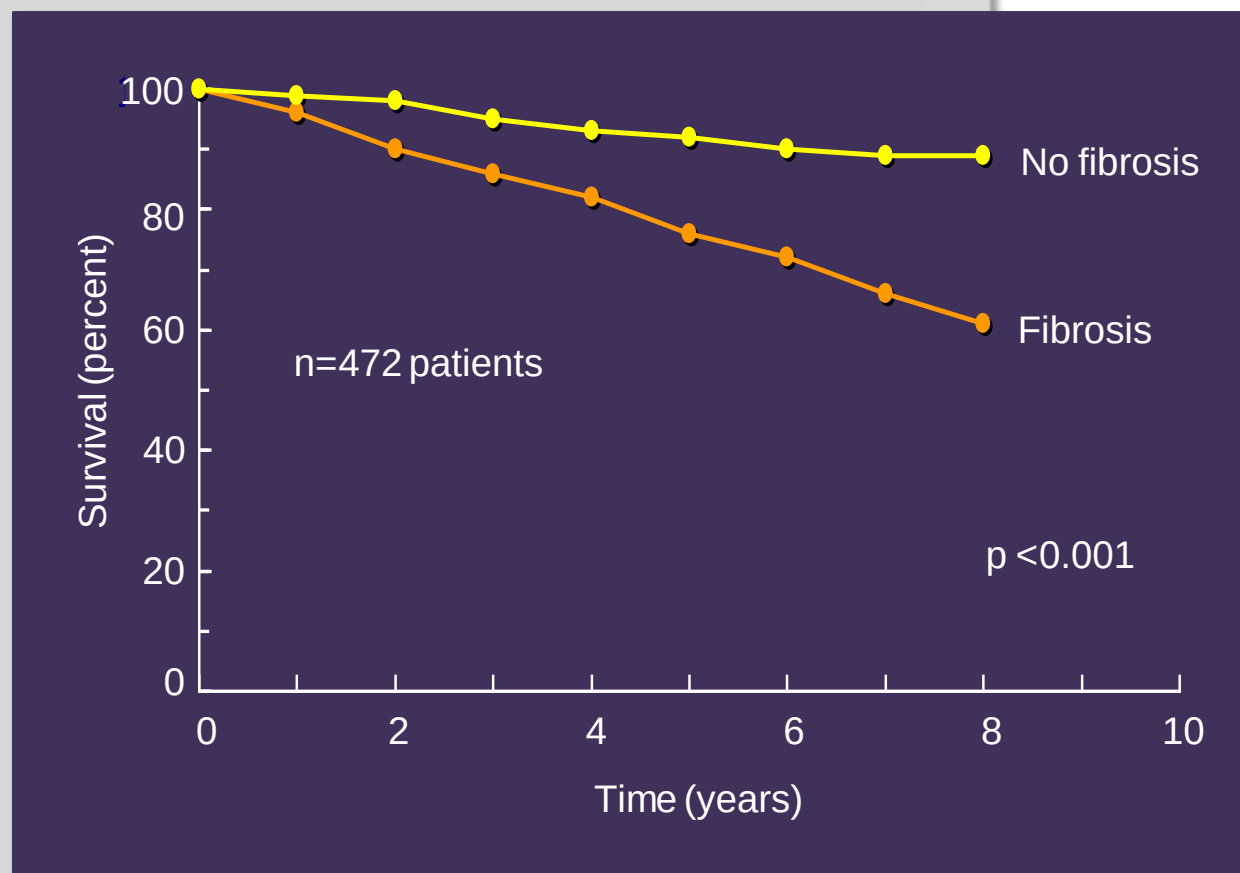
Stuart A. Cook, MD

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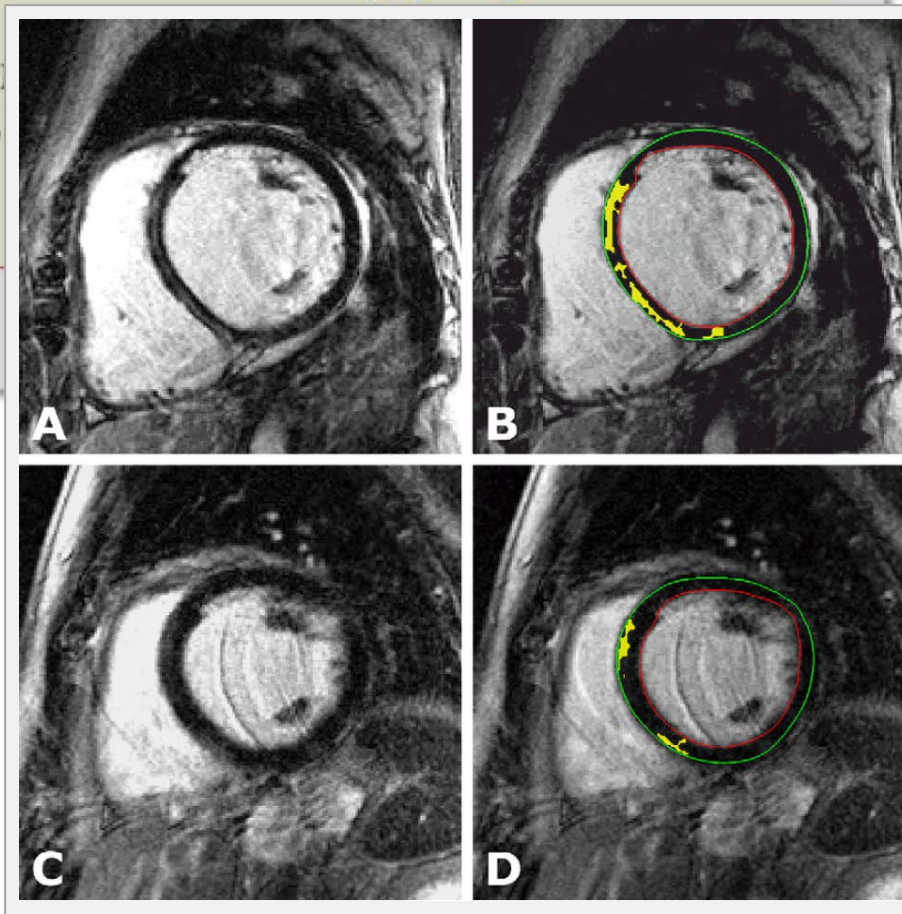


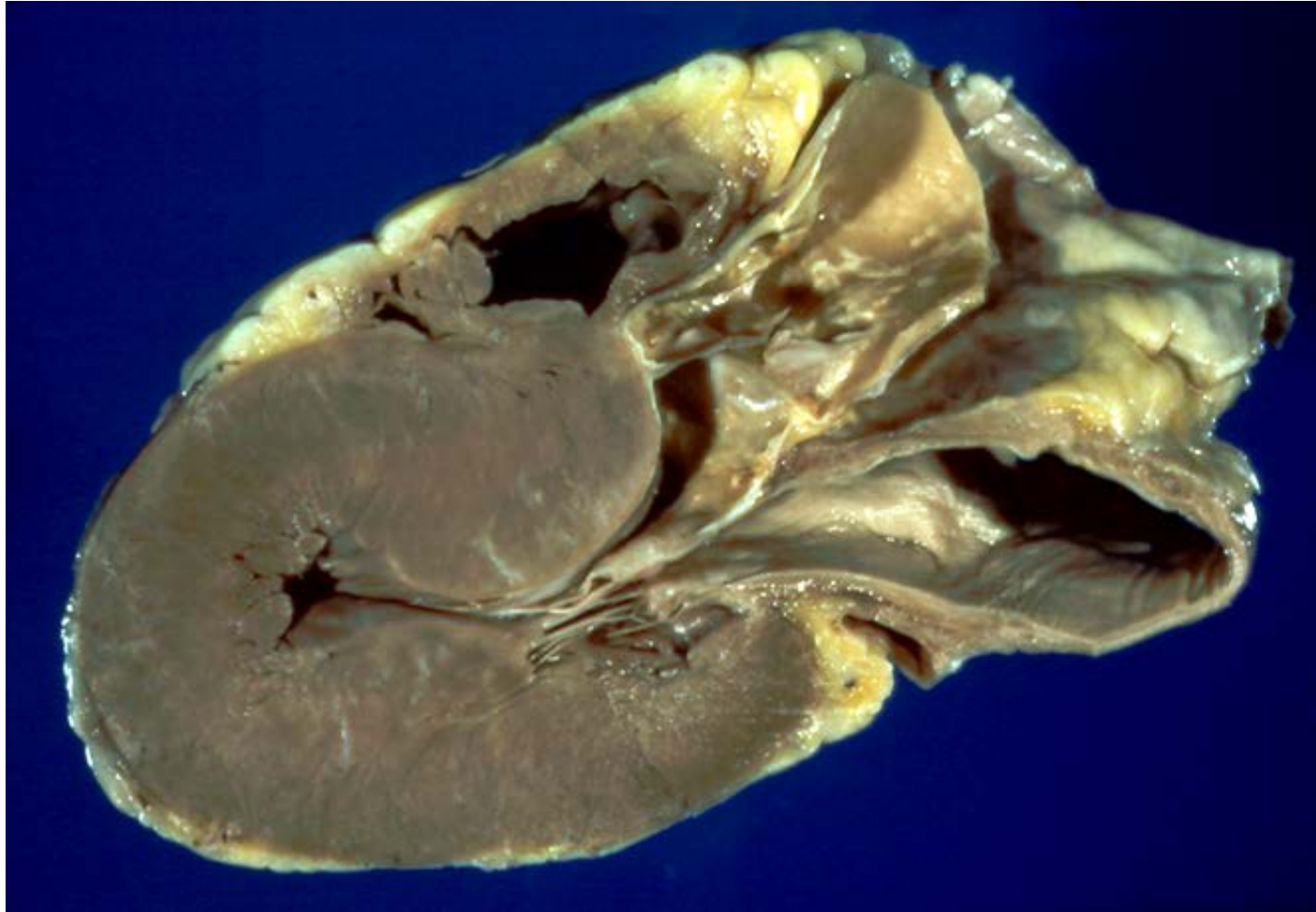
Novel Predictors of Left Ventricular Reverse Remodeling in Individuals With Recent-Onset Dilated Cardiomyopathy

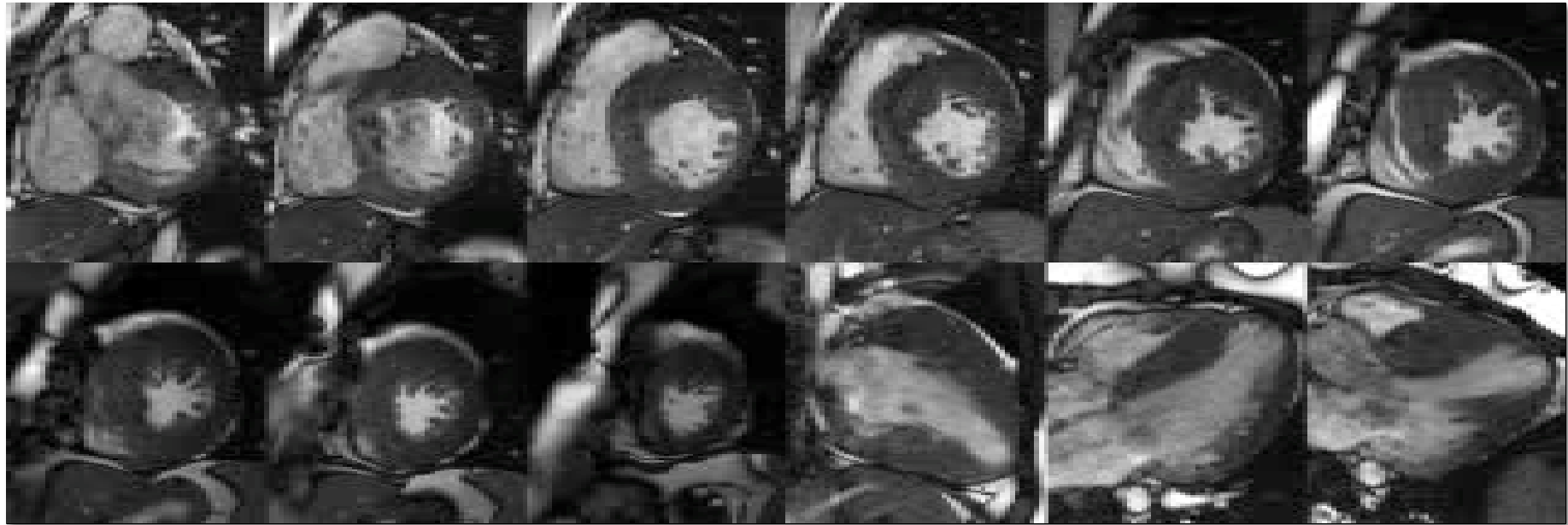
Milos Kubanek, MD, PhD,* Marek Sramko, MD, PhD,*
Jiri Weichet, MD, PhD,* Petr Lupinek, MD, PhD,*
Josef Kautzner, MD, PhD*

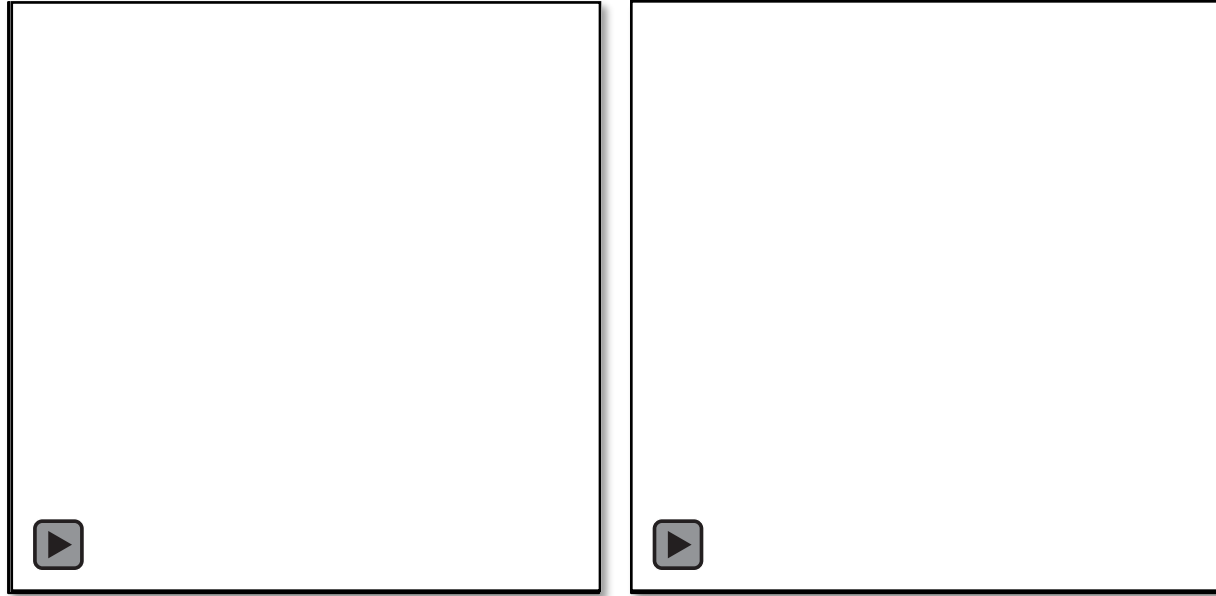
Prague, Czech Republic

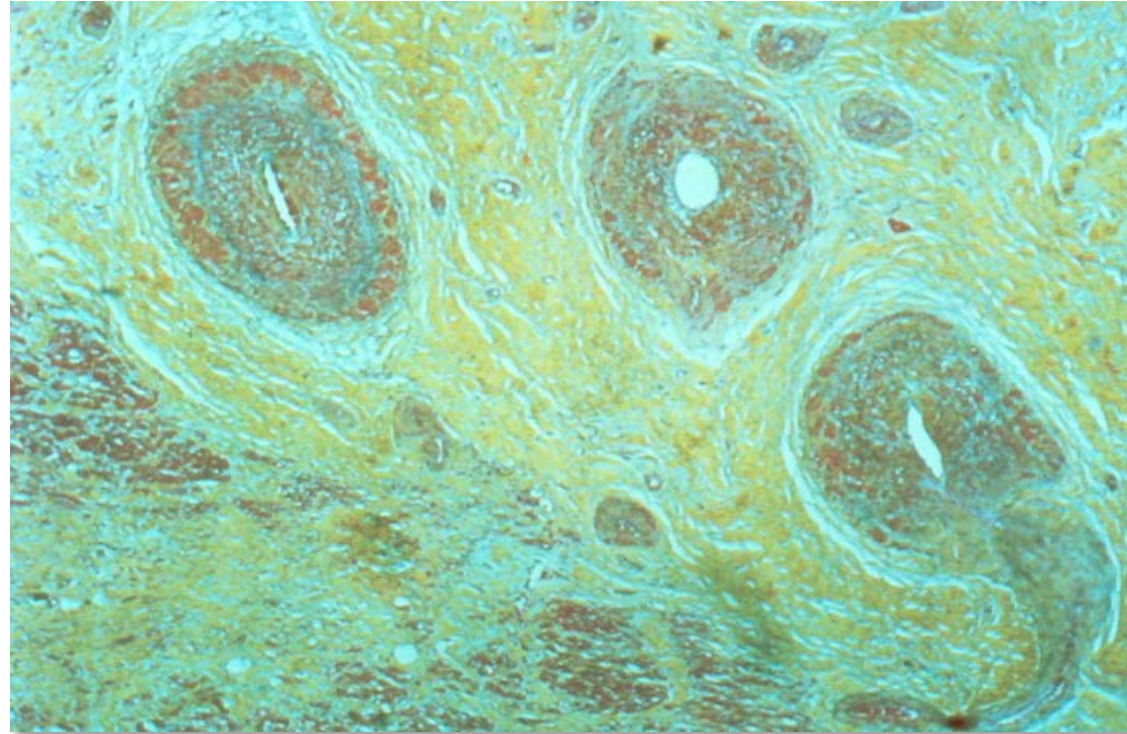
J Am Coll Cardiol 2013;61:54–63











Hypertrophic Cardiomyopathy

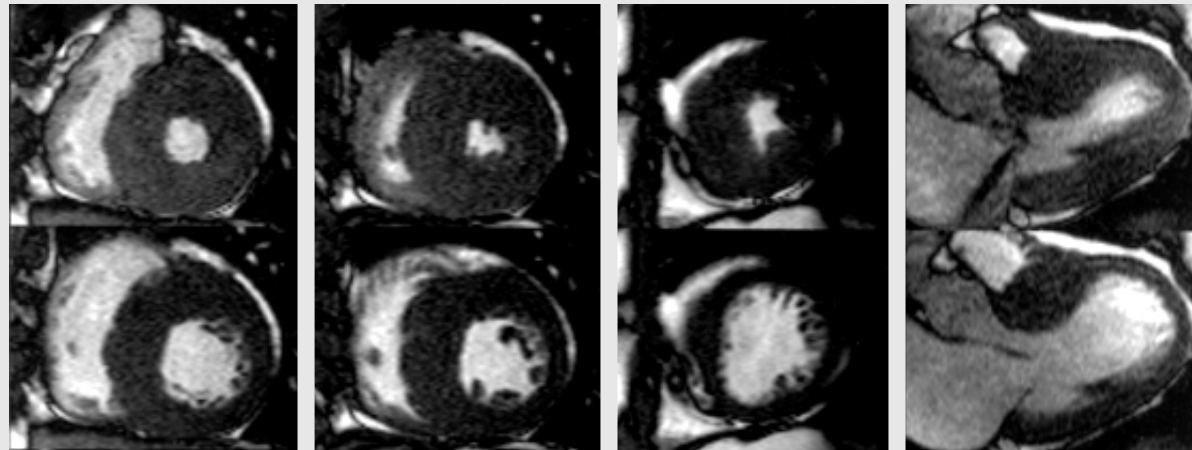
Myocardial Scarring in Asymptomatic or Mildly Symptomatic Patients With Hypertrophic Cardiomyopathy

Lubna Choudhury, MD, MRCP, Heiko Mahrholdt, MD, Anja Wagner, MD, Kelly M. Choi, MD, Michael D. Elliott, MD, Francis J. Klocke, MD, MACC, Robert O. Bonow, MD, FACC, Robert M. Judd, PhD, Raymond J. Kim, MD, FACC

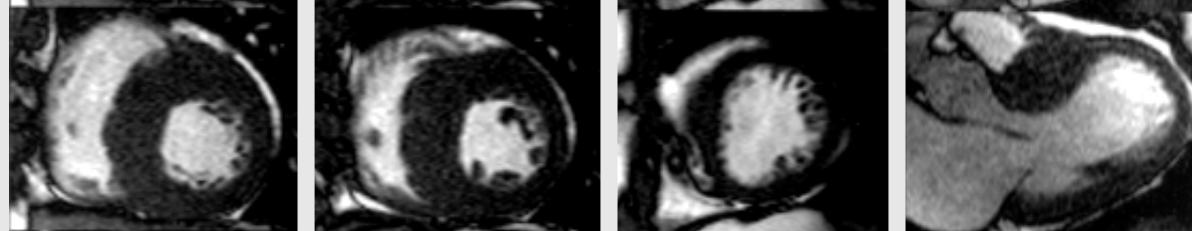
Chicago, Illinois

J Am Coll Cardiol

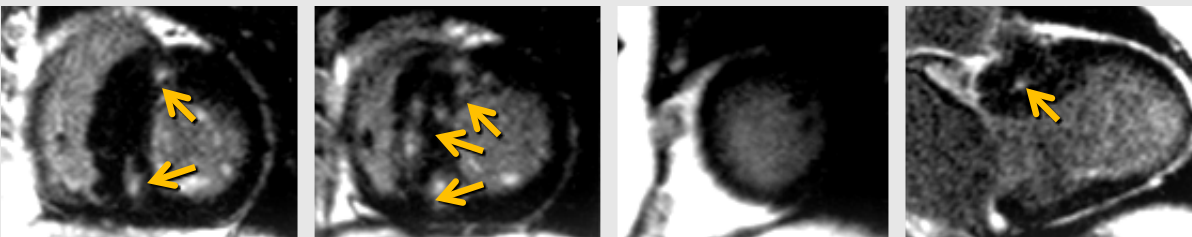
Systole



Diastole



Contrast



Hypertrophic Cardiomyopathy

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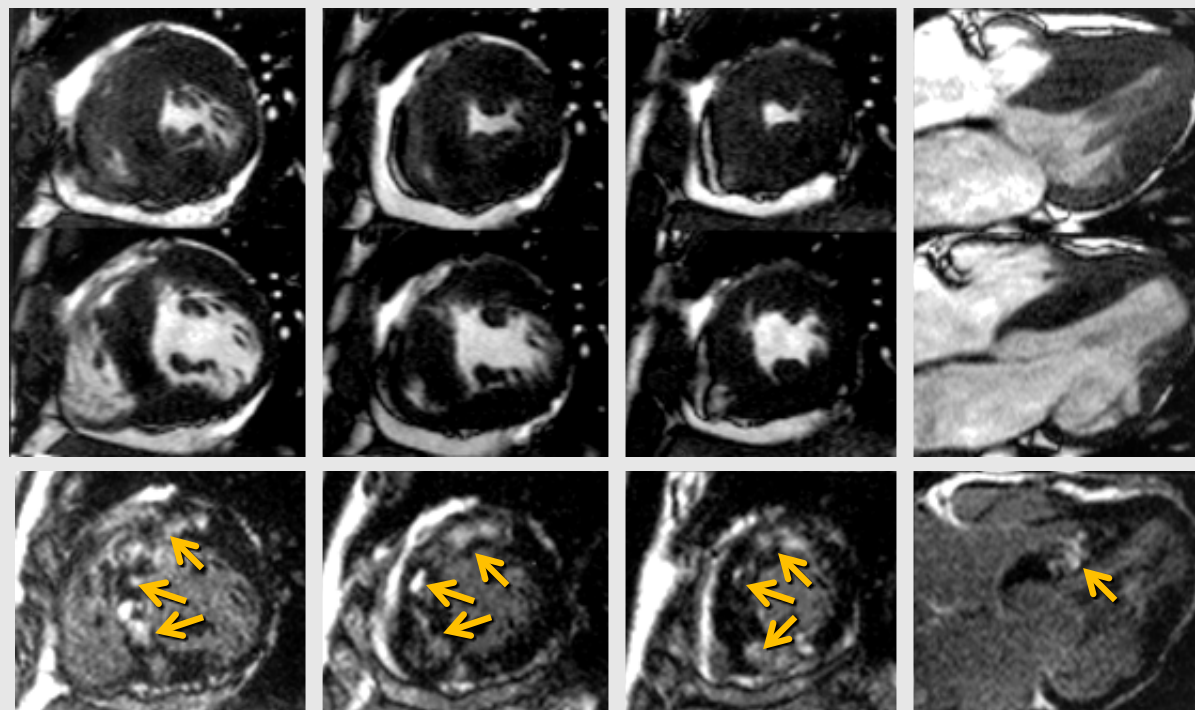
Chicago, Illinois

J Am Coll Cardiol

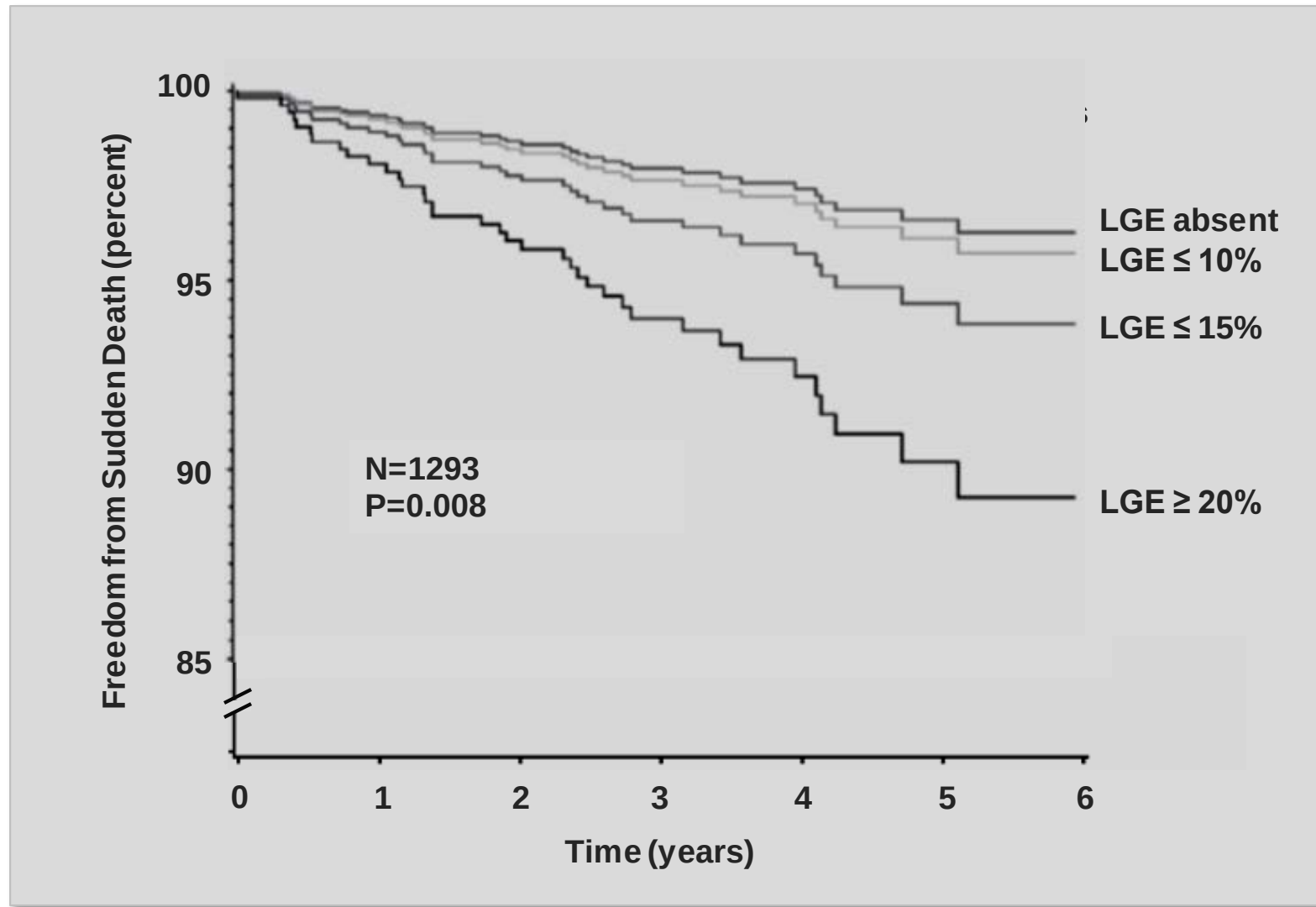
Systole

Diastole

Contrast



Prognostic Significance of Myocardial Fibrosis in HCM



Prognostic Value of LGE-CMR in HCM

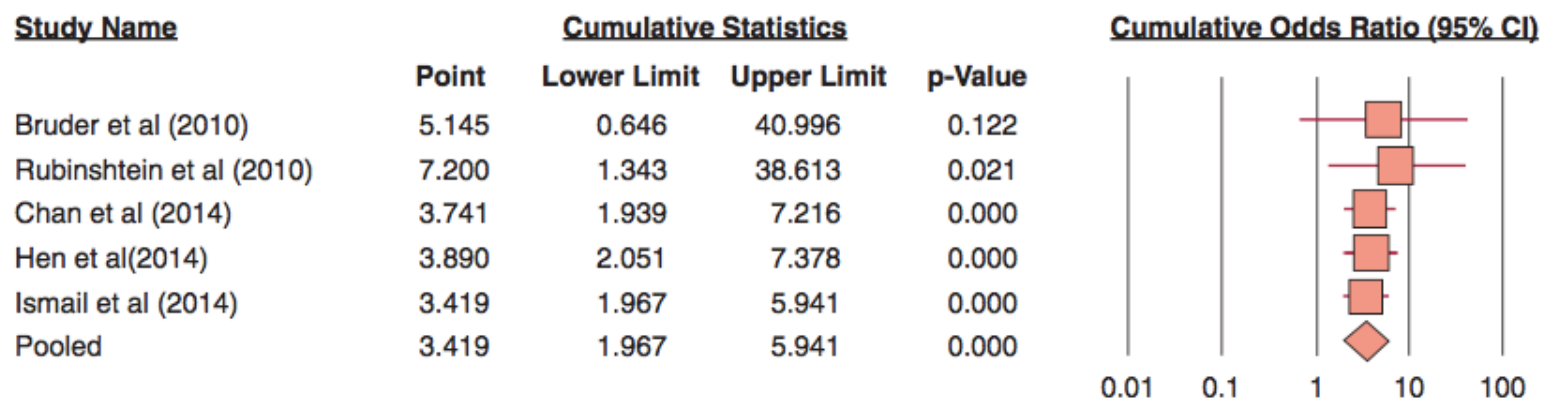


A Meta-Analysis

Zhen Weng, PhD,^a Jialu Yao, MD,^b Raymond H. Chan, MD, MPH,^c Jun He, MD,^a Xiangjun Yang, MD, PhD,^b
Yafeng Zhou, MD, PhD,^b Yang He, MD^a

J Am Coll Cardiol Img 2016;9:1392-1402

Cumulative Analysis of Sudden Cardiac Death

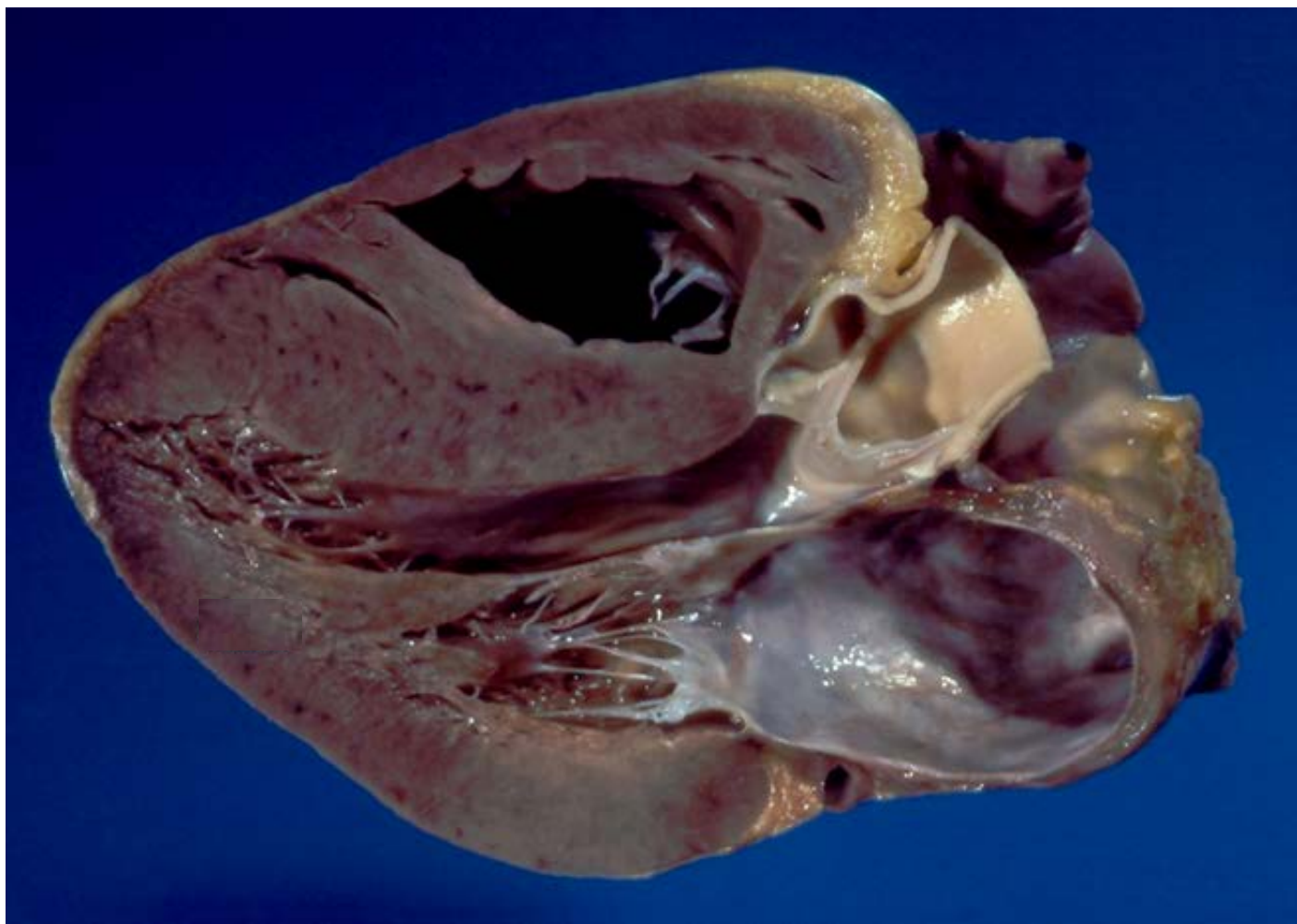


Hypertrophic Cardiomyopathy

Indications for CMR

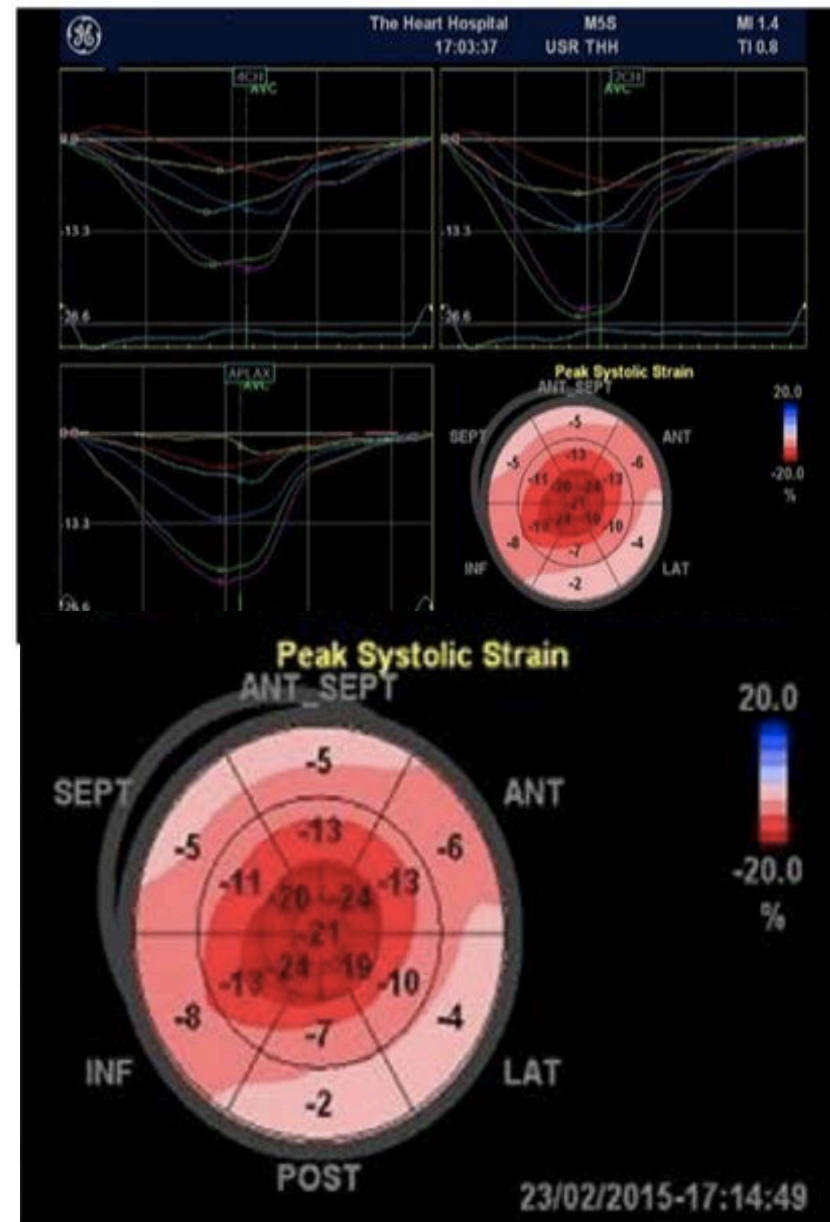
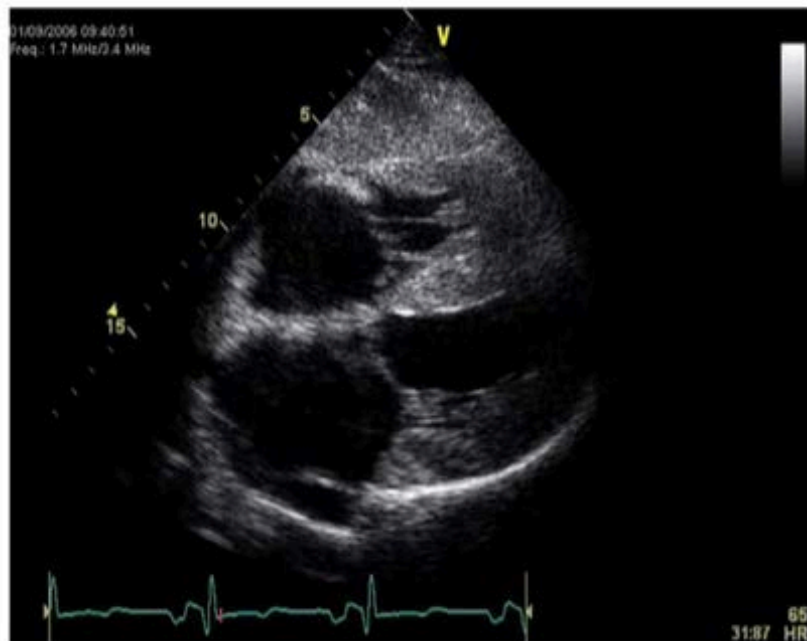


- **Inconclusive echo for diagnosis or assessment of distribution of LVH** **class I**
- **Define apical HCM** **class IIa**
- **Late gadolinium imaging when risk stratification is inconclusive** **class IIb**

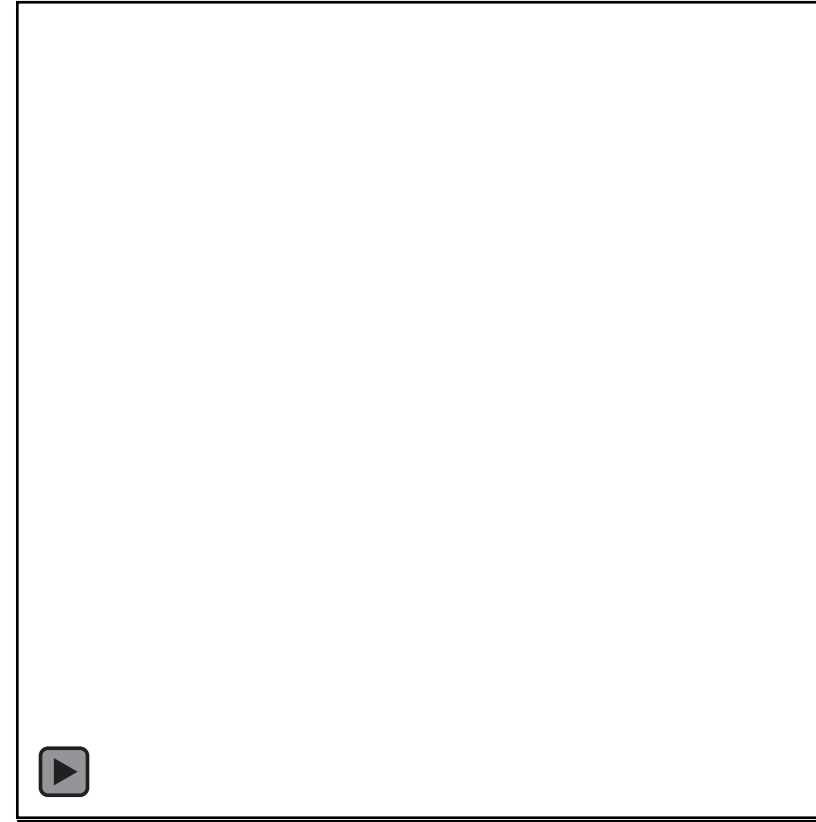
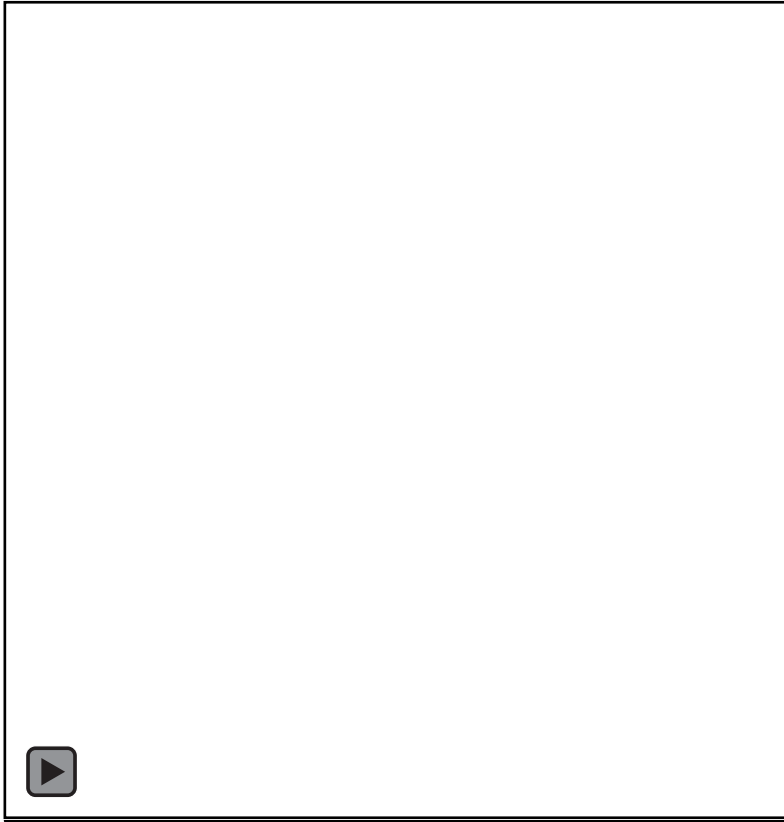


Amyloidosis





Amyloidosis



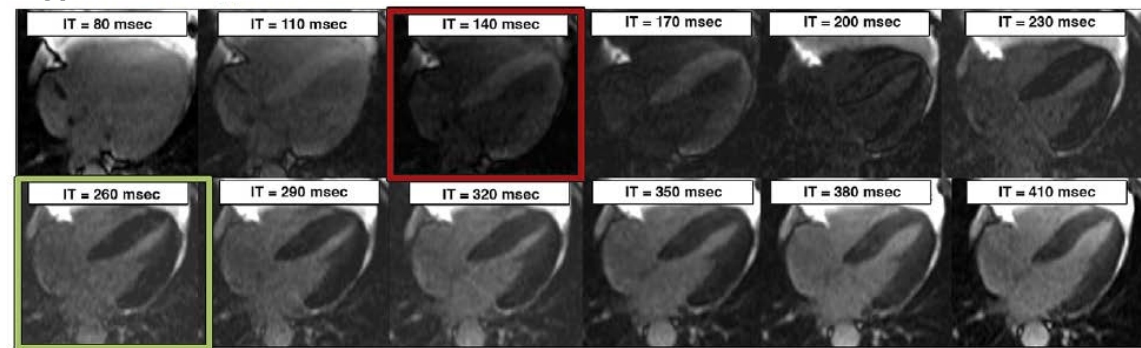


CMR Imaging With Rapid Visual T1 Assessment Predicts Mortality in Patients Suspected of Cardiac Amyloidosis

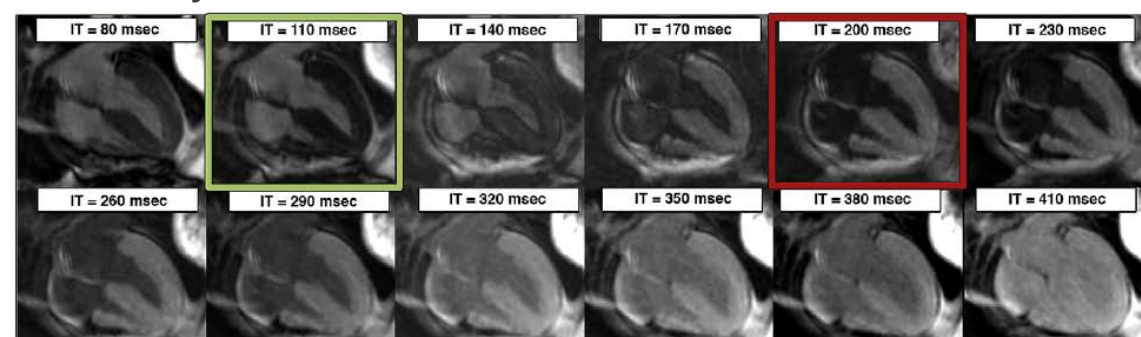
James A. White, MD,*†‡ Han W. Kim, MD,§|| Dipan Shah, MD,# Nowell Fine, MD,*
Ki-Young Kim, MD,§ David C. W. Chan, MD,§|| Michele Parker, MS,§|| Manesh Patel, MD,§||
Robert M. Judd, PhD,§||¶ Raymond C. Starling, MD,§||
London, Ontario, Canada; Durham, NC

J Am Coll Cardiol Img 2014;7:143–56

Hypertensive LVH



Cardiac Amyloidosis

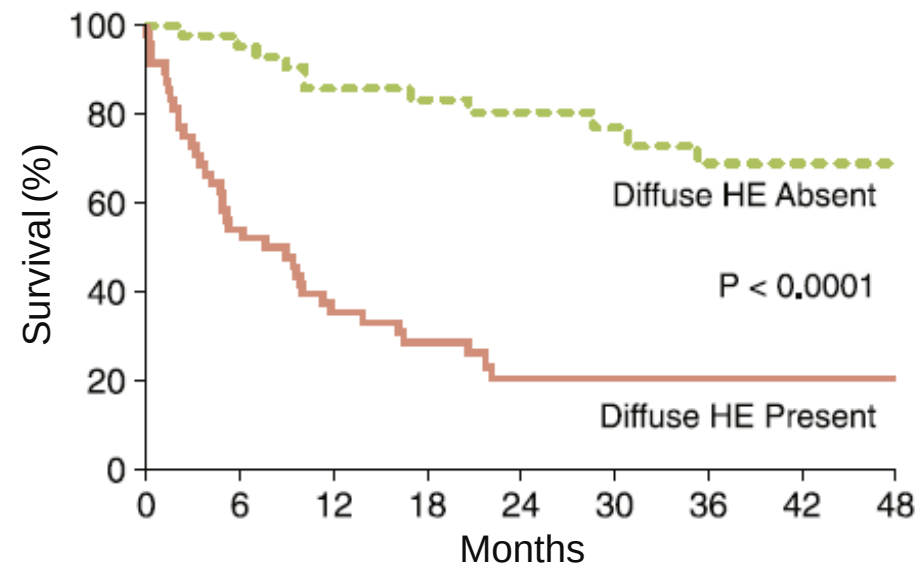


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Michele Parker, MS,§|| Manesh Patel, MD,|| Femida Gwadry-Sridhar, PhD,†
Robert M. Judd, PhD,§|| ¶ Raymond J. Kim, MD§|| ¶

London, Ontario, Canada; Durham, North Carolina

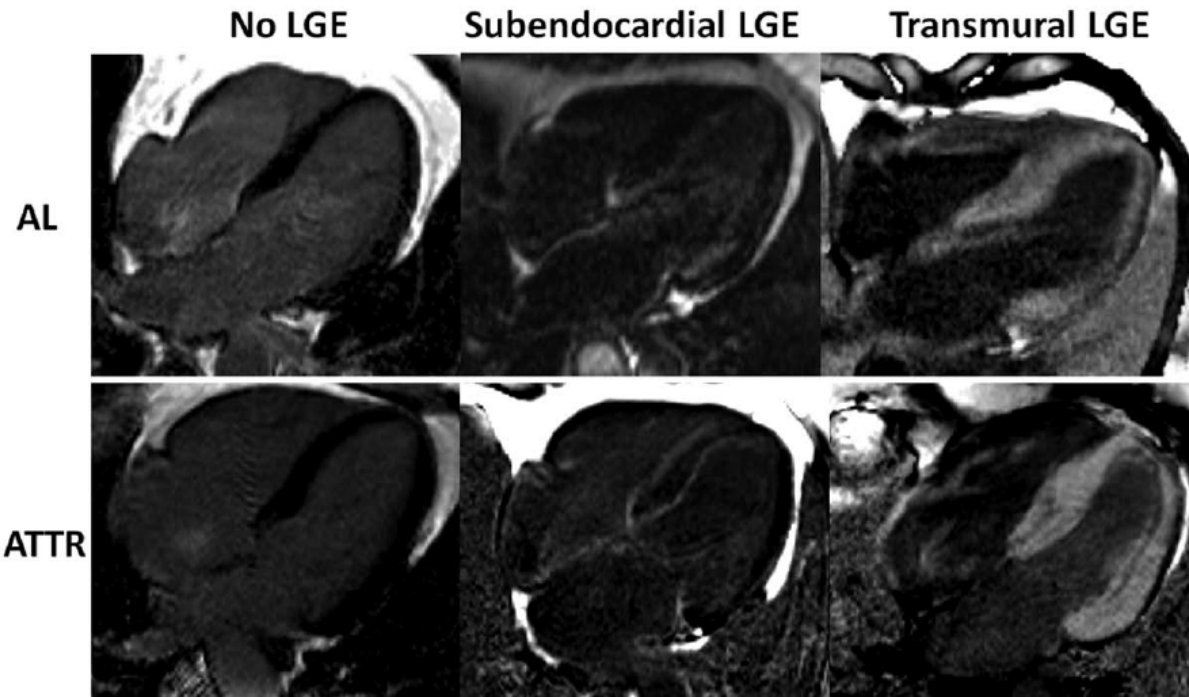
J Am Coll Cardiol Img 2014;7:143–56



Imaging

Prognostic Value of Late Gadolinium Enhancement Cardiovascular Magnetic Resonance in Cardiac Amyloidosis

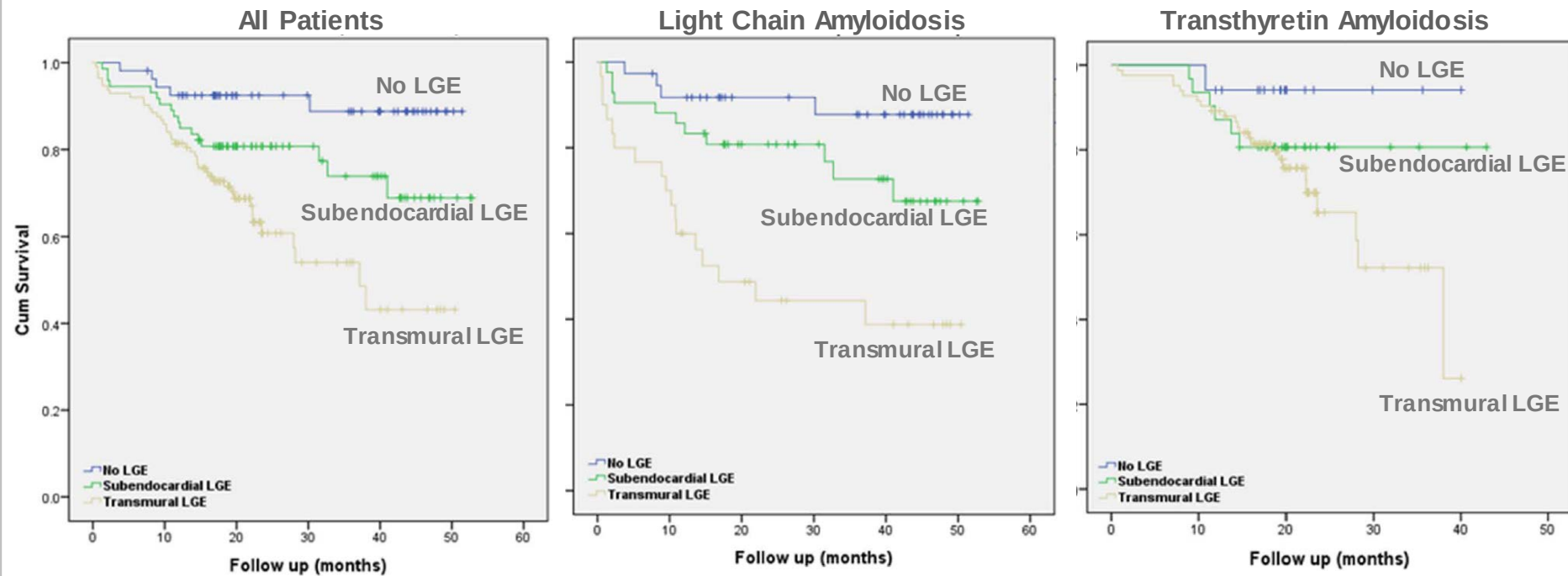
Marianna Fontana, MD; Silvia Pica, MD; Patricia Reant, MD, PhD;
Amna Abdel-Gadir, MBBS; Thomas A. Treibel, MBBS; Sanjay M. Banyersad, MBChB;
Viviana Maestrini, MD; William Barcella, BFIN, MSc; Stefania Rosmini, MD; Heerajnarain Bulluck, MBBS;
Rabya H. Sayed, MBBS; Ketna Patel, MBBS; Shameem Mamhood, MBChBAO;
Chiara Bucciarelli-Ducci, PhD; Carol J. Whelan, MD; Anna S. Herrey, MD;
Helen J. Lachmann, M
Eric B. Schelbe



Imaging

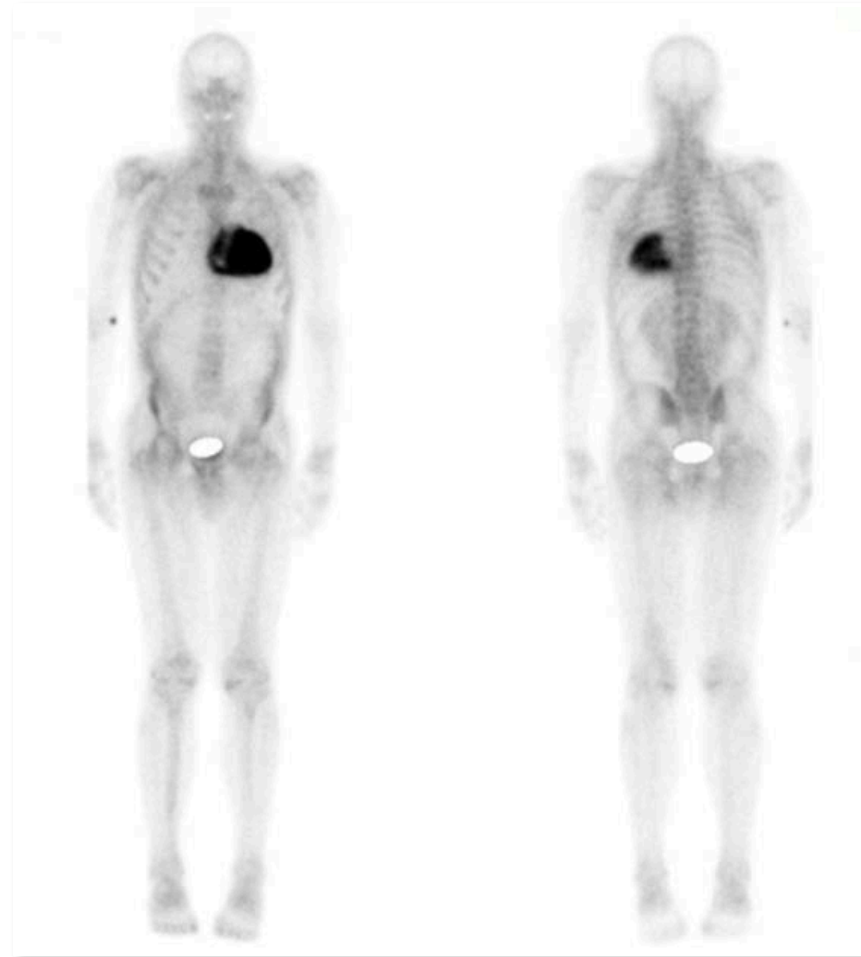
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Helen J. Lachmann, MD; Ashutosh D. Wechalekar, MD, PhD; Charlotte H. Manisty, PhD;



Amyloidosis

Radionuclide Imaging

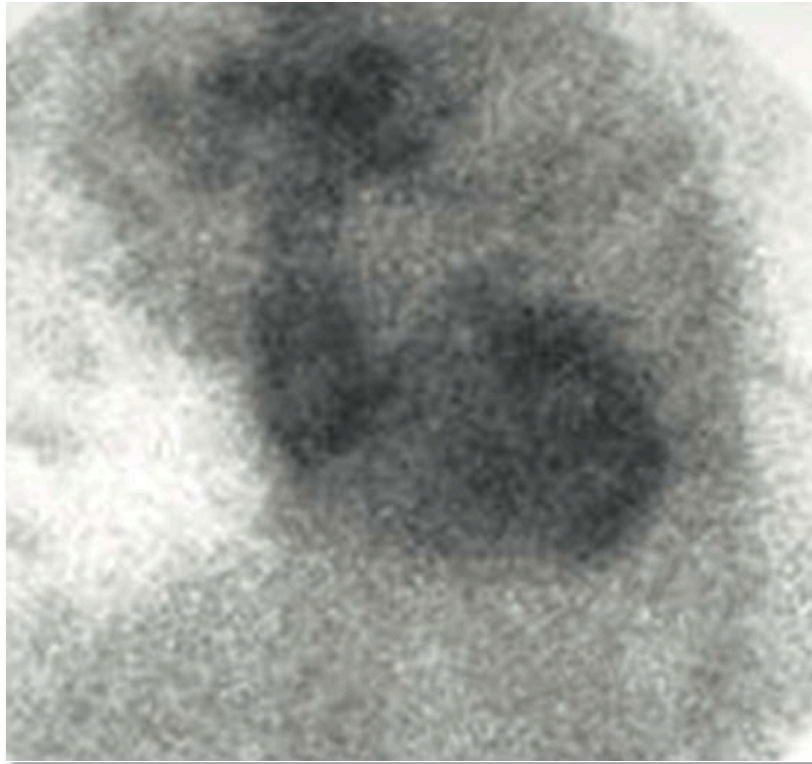


^{99m}Tc - DPD

^{99m}Tc diphosphono-propanodicarboxylic acid

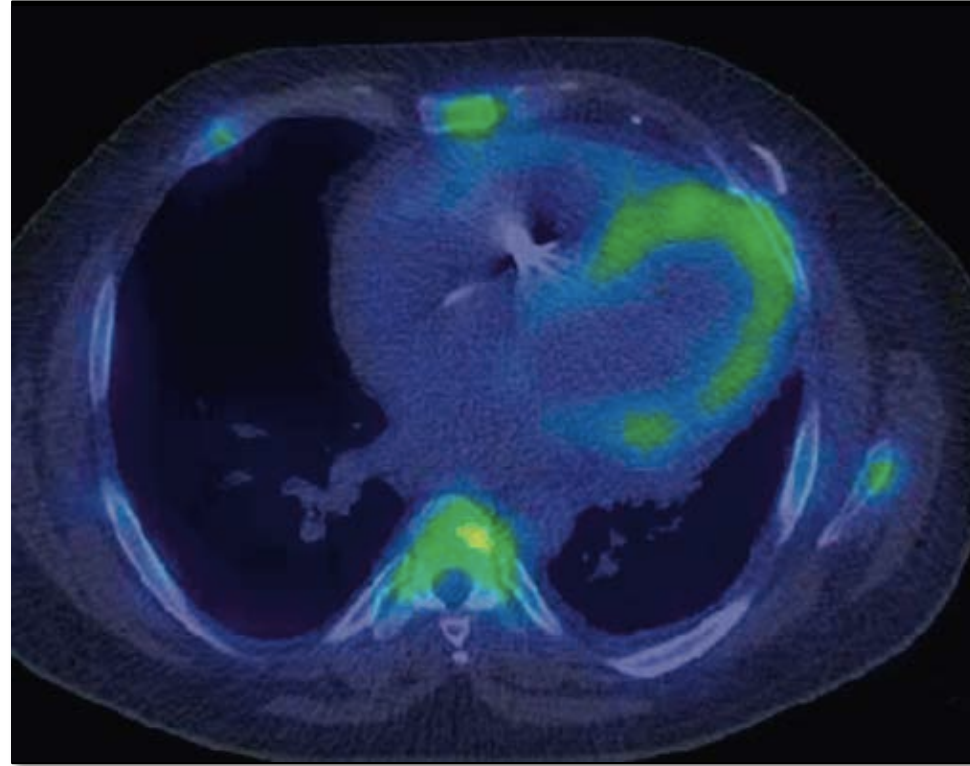
Amyloidosis

Radionuclide Imaging



^{99m}Tc - DPD

^{99m}Tc diphosphono-propanodicarboxylic acid

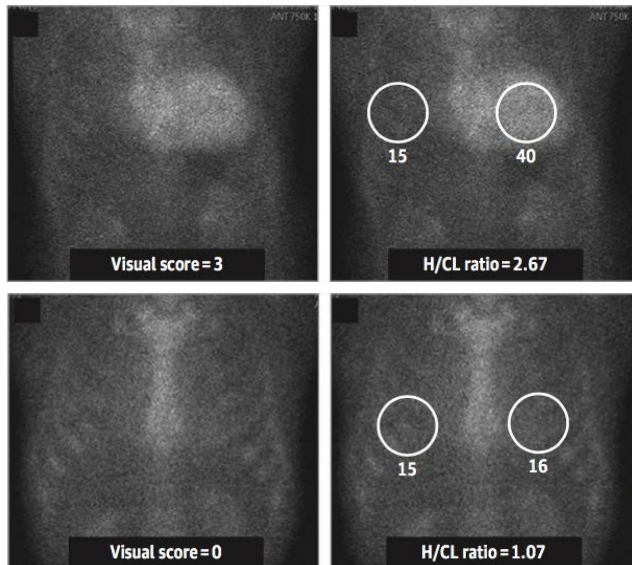


^{99m}Tc - Pyrophosphate

Multicenter Study of Planar Technetium 99m Pyrophosphate Cardiac Imaging Predicting Survival for Patients With ATTR Cardiac Amyloidosis

Adam Castano, MD, MS; Muhammad Haq, MD; David L. Narotsky, MD; Jeff Goldsmith, PhD; Richard L. Weinberg, MD, PhD; Rachelle Morgenstern, MPH; Ted Pozniakoff, ARRT; Frederick L. Ruberg, MD; Edward J. Miller, MD, PhD; John L. Berk, MD; Angela Dispenzieri, MD; Martha Grogan, MD; Geoffrey Johnson, MD, PhD; Sabahat Bokhari, MD; Mathew S. Maurer, MD

JAMA Cardiol. 2016;1:880-889



**ATTR
Amyloidosis**

**Non-ATTR
Amyloidosis**

Multicenter Analysis

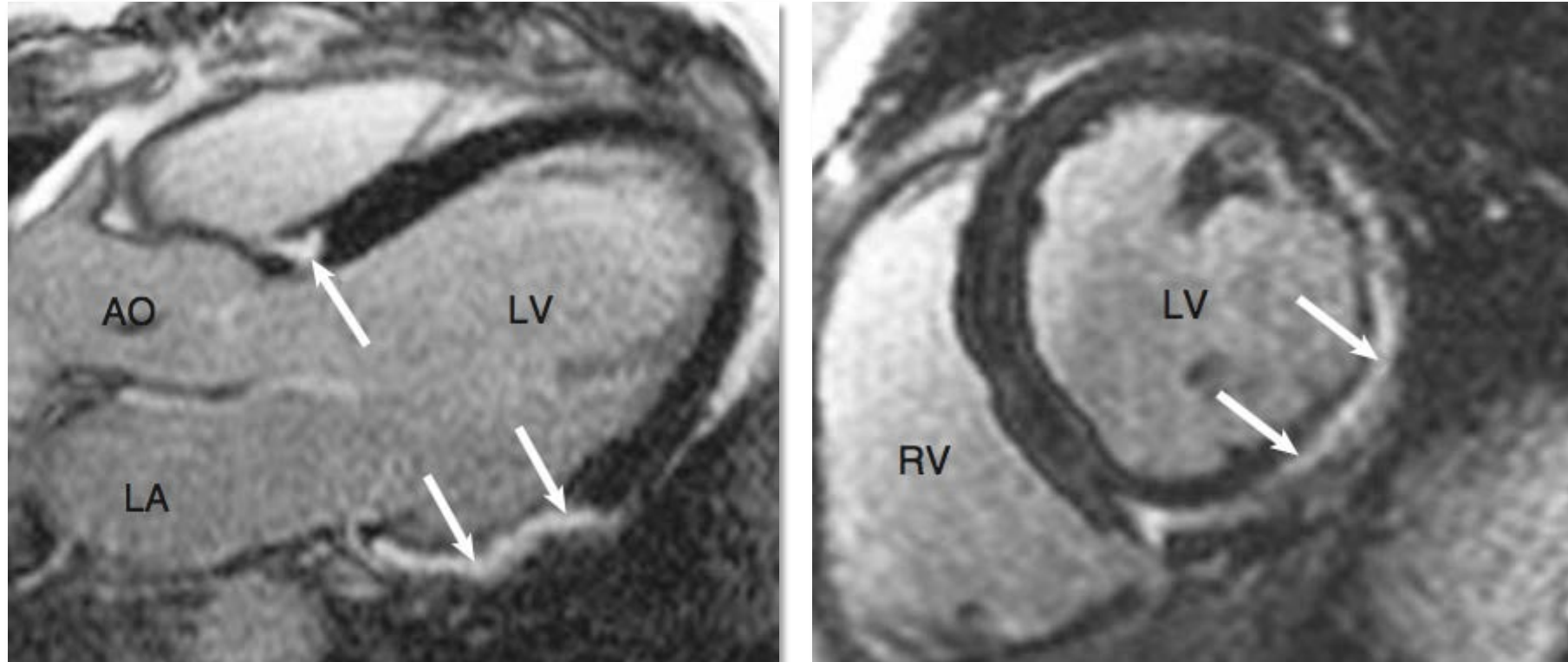
	No. of Patients		
	ATTR ⁺	ATTR ⁻	Total
Positive scan	110	4	114
Negative scan	11	46	57
Total	121	50	171

Sensitivity = 91%

Specificity = 92%

AUC, 0.960 (95% CI, 0.930-0.981)

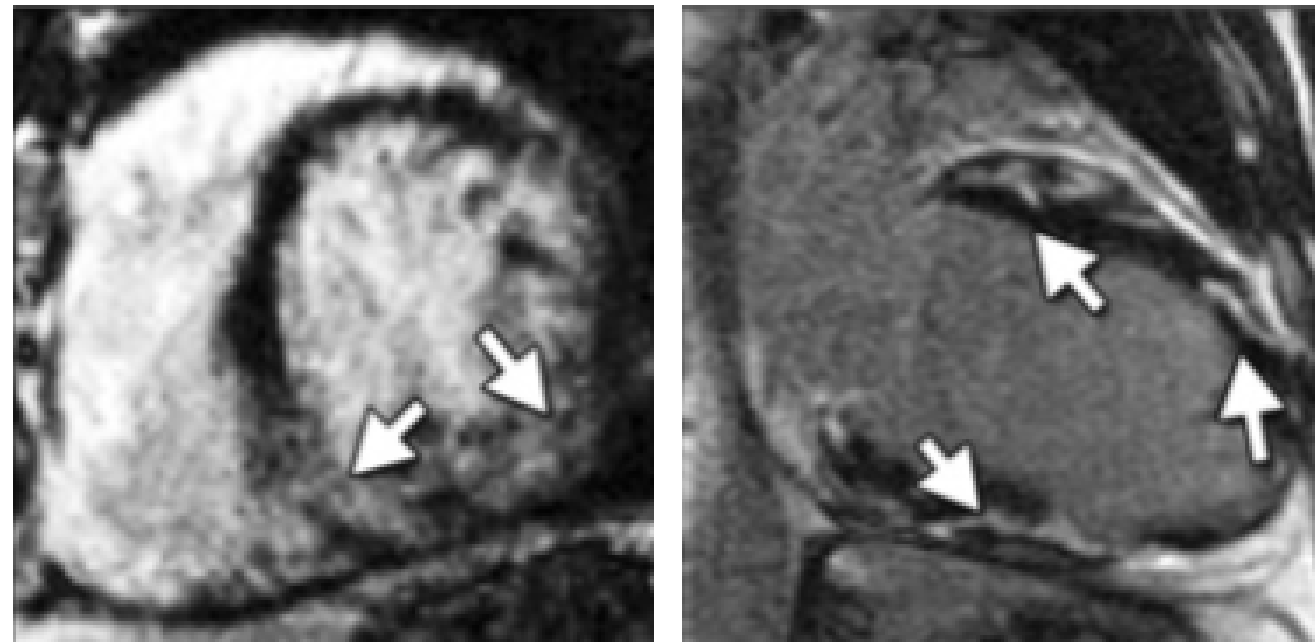
Sarcoidosis



CMR Imaging Predicts Death and Other Adverse Events in Suspected Cardiac Sarcoidosis

Simon Greulich, MD,* Claudia Christina Deluigi, MD,† Steffen Gloekler, MD,‡
Andreas Wahl, MD,‡ Christine Zürn, MD,§ Ulrich Kramer, MD,|| Detlev Nothnagel, MD,¶
Helmut Bültel, MD,‡ Julia Schumacher, MD,* Stefan Geis, MD,* Peter Ochs, MD,*
Anja Wagner, MD,**
Meinrad Gawaz, MD

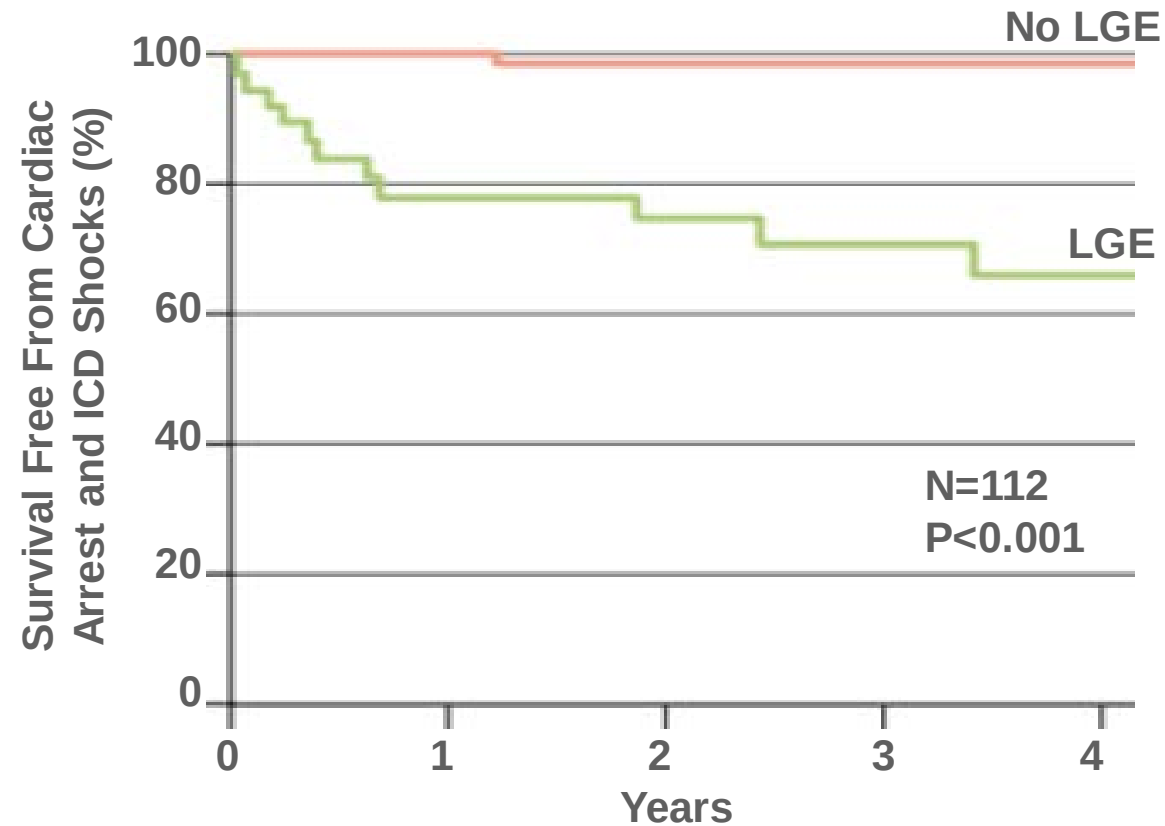
J Am Coll Cardiol Im



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J Am Coll Cardiol Img 2013;6:501-511

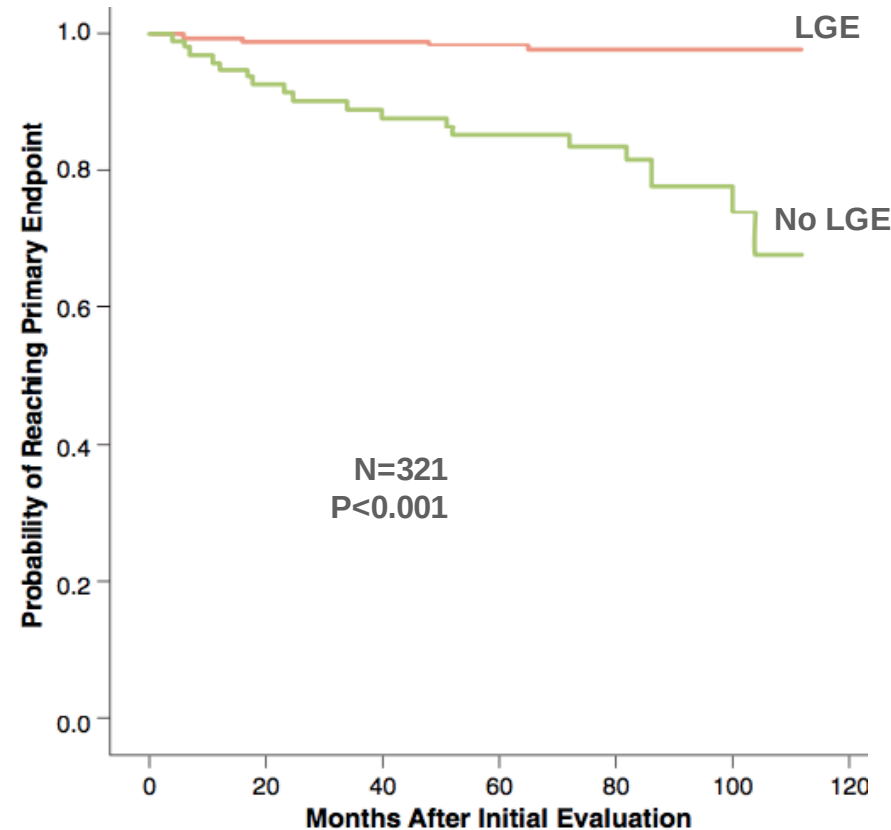


Greulich et al, J Am Coll Cardiol Img 2013;6:501-511

Complementary Role of CMR to Conventional Screening in the Diagnosis and Prognosis of Cardiac Sarcoidosis

Vasileios Kouranos, MD, MSc,^{a,b} George E. Tzelepis,
Konstantina Aggeli, MD, PhD,^e Marousa Douskou,
Petros Sfikakis, MD, PhD,ⁱ Athol Wells, MD, PhD,^b

J Am Coll Cardiol Img 2017;14:37-1447



Kouranos et al, J Am Coll Cardiol Img 2017;10:1437-1447

Hybrid Magnetic Resonance Imaging and Positron Emission Tomography With Fluorodeoxyglucose to Diagnose Active Cardiac Sarcoidosis

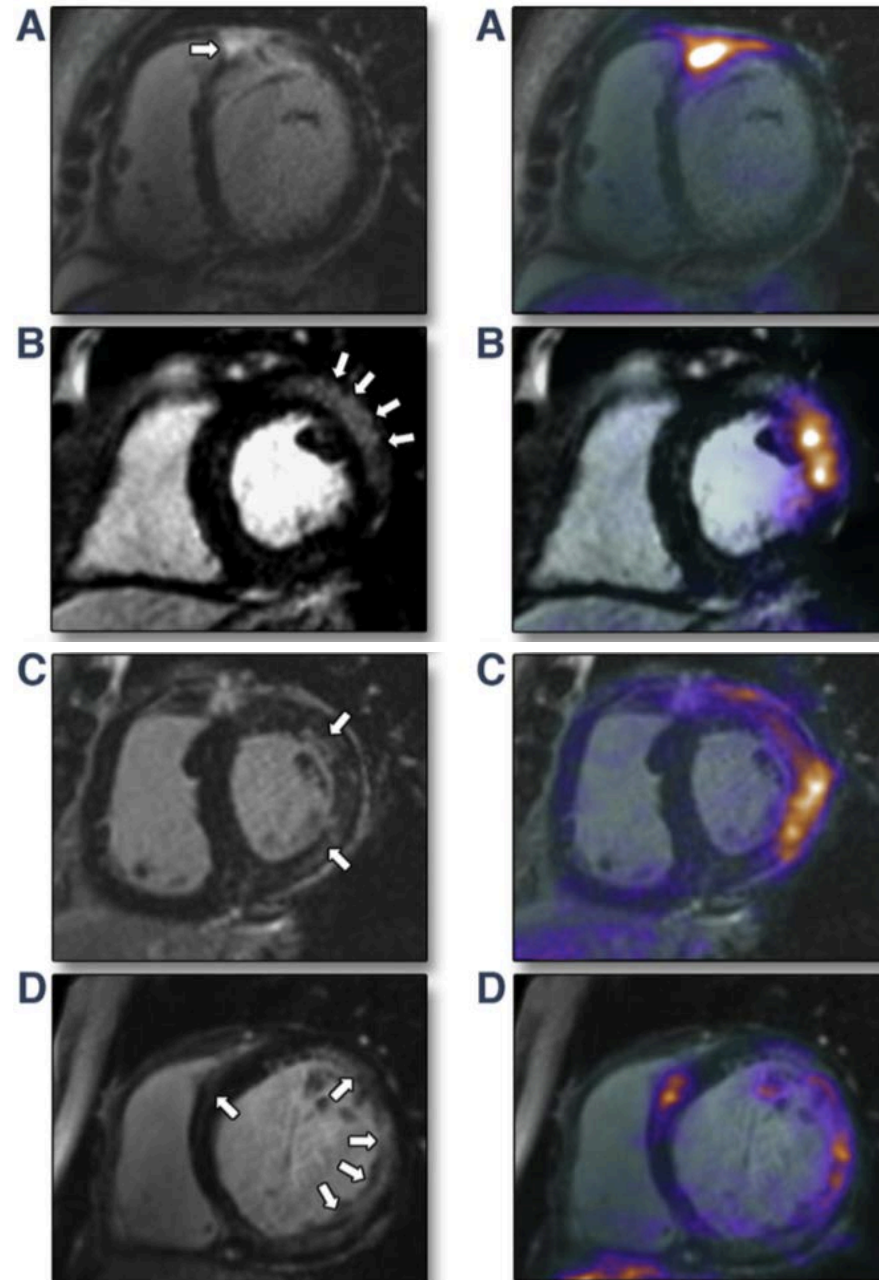
Marc R. Dweck, MD, PhD,^{a,b} Ronan Abgral, MD, PhD,^{a,c} Maria Giovanna Trivieri, MD, PhD,^a Philip M. Robson, PhD,^a Nicolas Karakatsanis, PhD,^a Venkatesh Mani, PhD,^a Anna Palmisano, MD,^a Marc A. Miller, MD,^d Anuradha Lala, MD,^d Helena L. Chang, MS,^e Javier Sanz, MD,^d Johanna Contreras, MD,^d Jagat Narula, MD, PhD,^d Valentin Fuster, MD, PhD,^d Maria Padilla, MD,^f Zahi A. Fayad, PhD,^a Jason C. Kovacic, MD, PhD^d

J Am Coll Cardiol Img <http://dx.doi.org/10.1016/j.jcmg.2017.02.021>

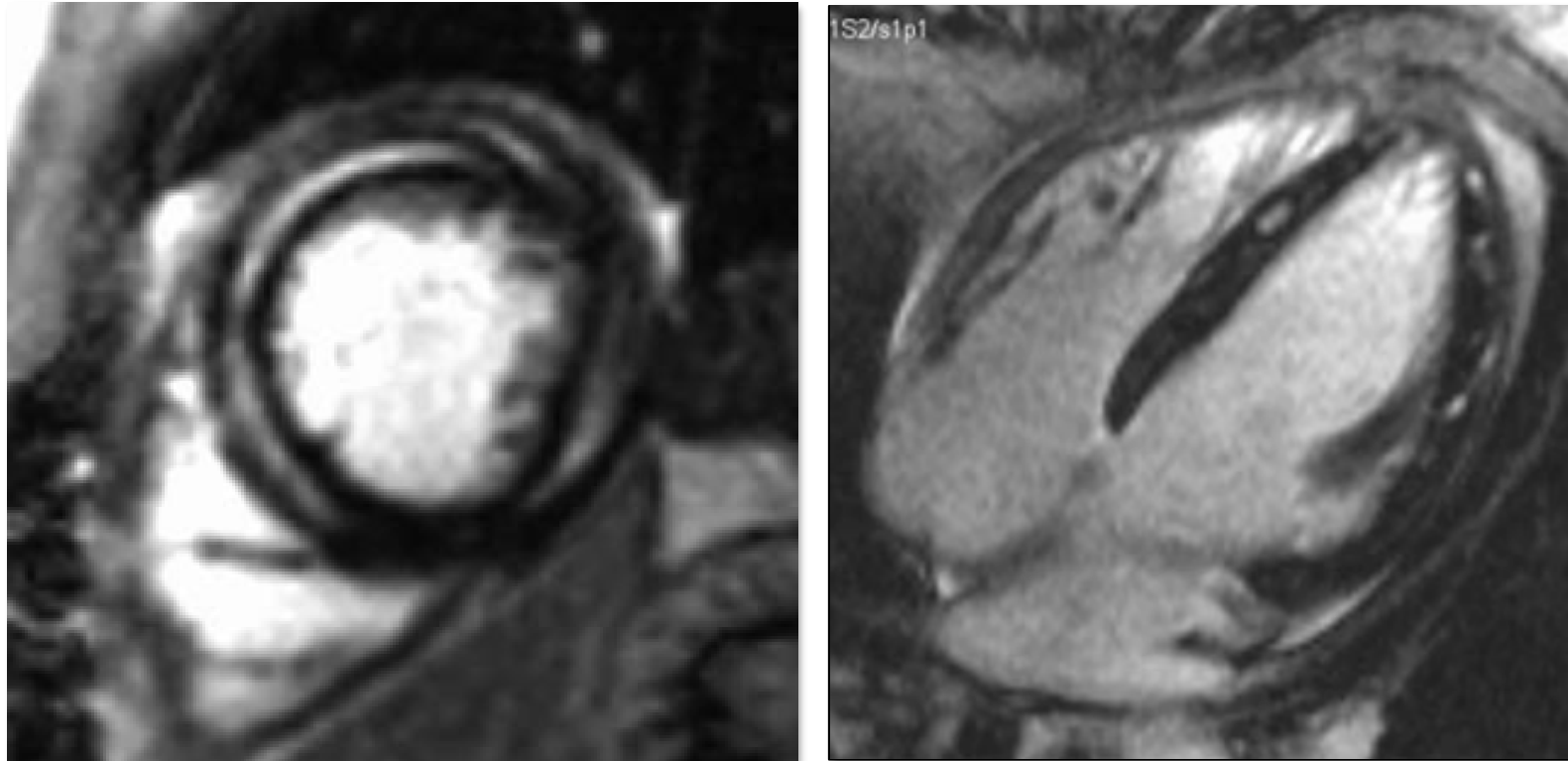
Hybrid Magnetic Resonance Positron Emission Tomography Fluorodeoxyglucose Cardiac Sarcoidosis

Marc R. Dweck, MD, PhD,^{a,b} Ronan Abgral, MD, PhD,^a
Nicolas Karakatsanis, PhD,^a Venkatesh Mani, PhD,^a
Helena L. Chang, MS,^e Javier Sanz, MD,^d Johanna C.
Valentin Fuster, MD, PhD,^d Maria Padilla, MD,^f Zahra

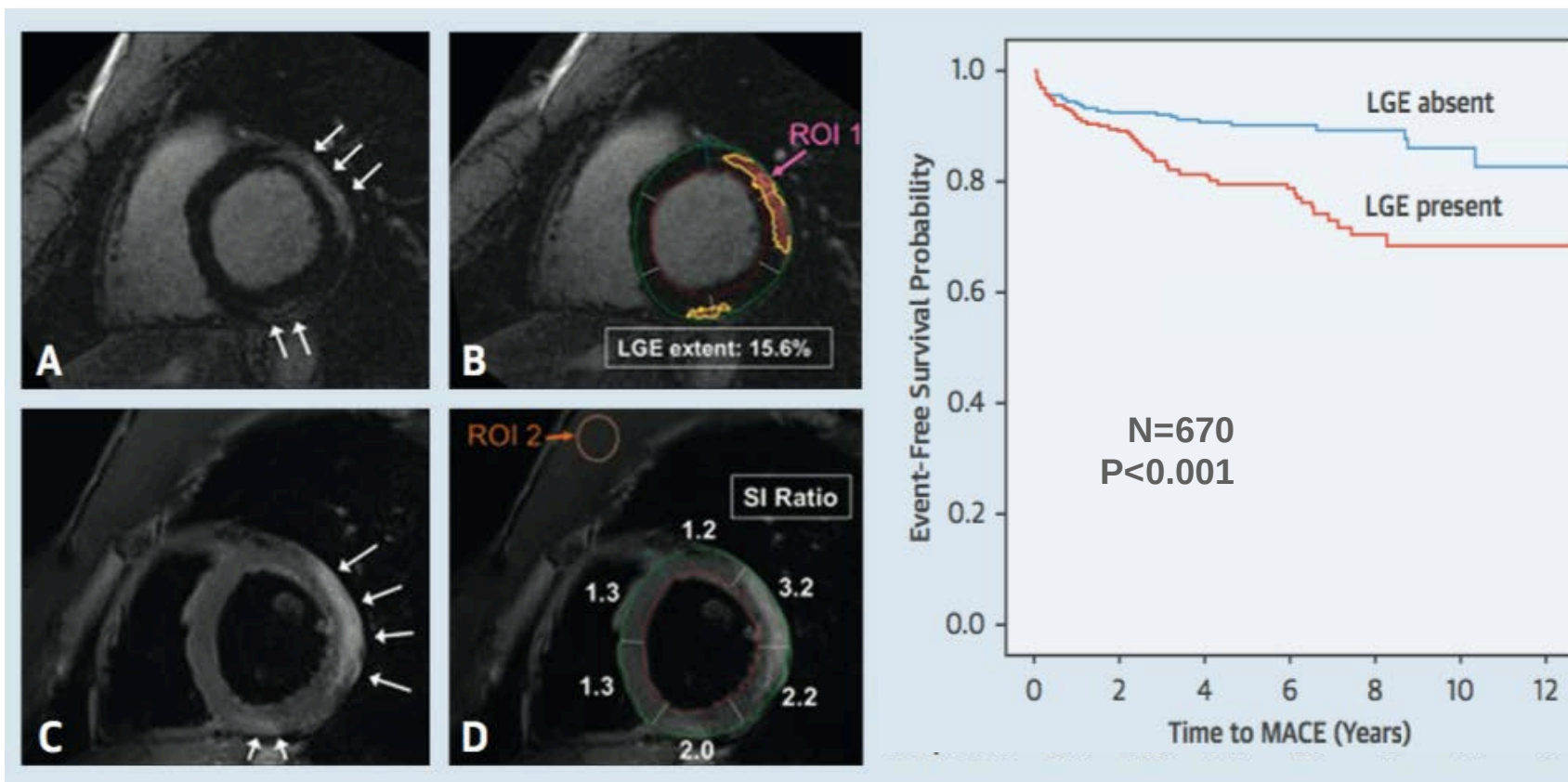
J Am Coll Cardiol Img <http://dx.doi.org/10.1016/j.jaccimg.2017.05.001>

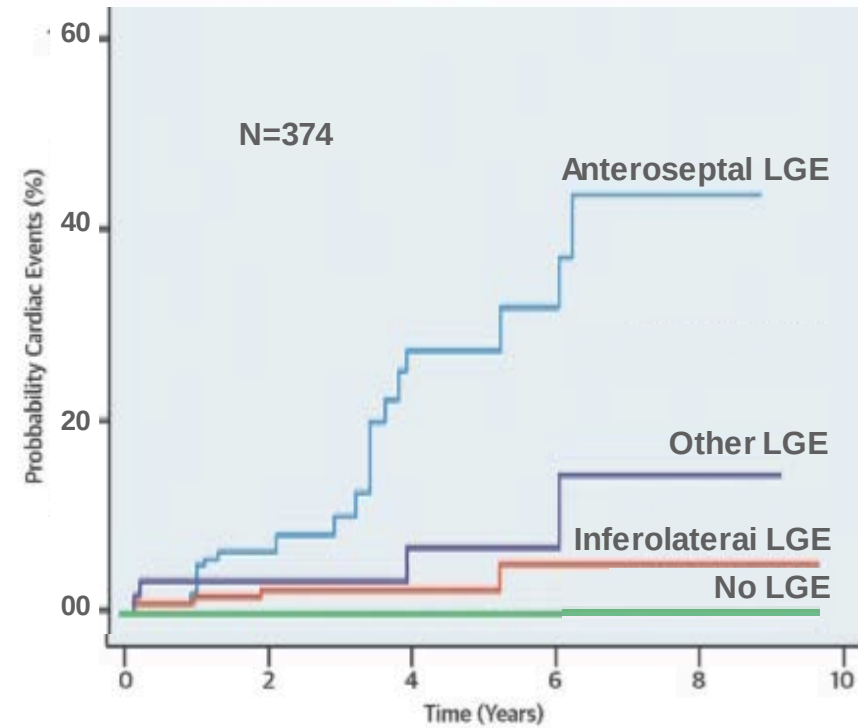
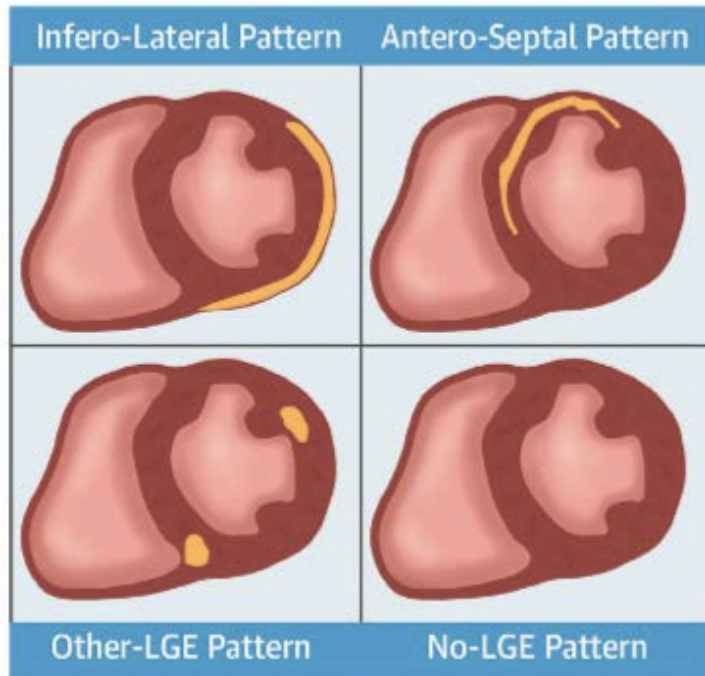


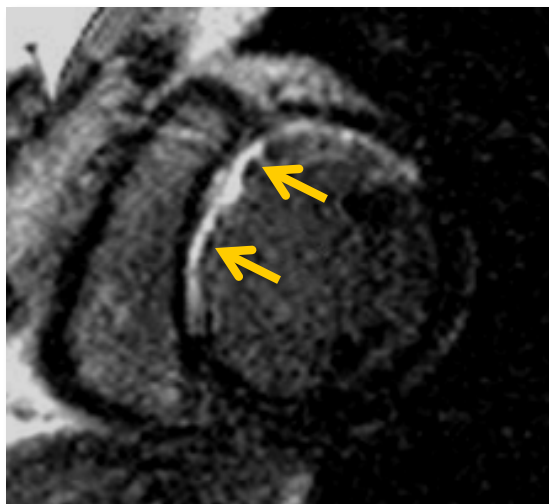
Myocarditis



Myocarditis



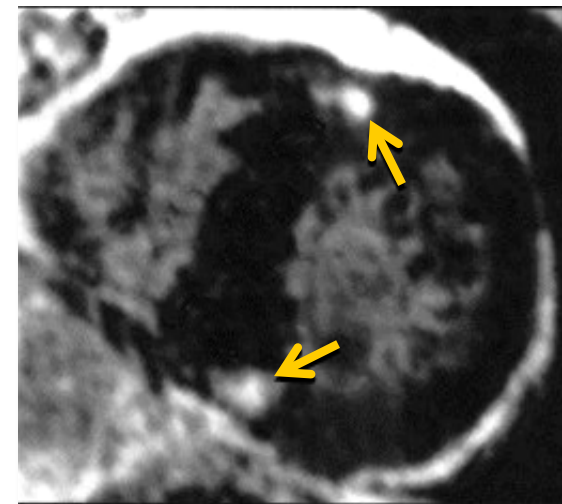




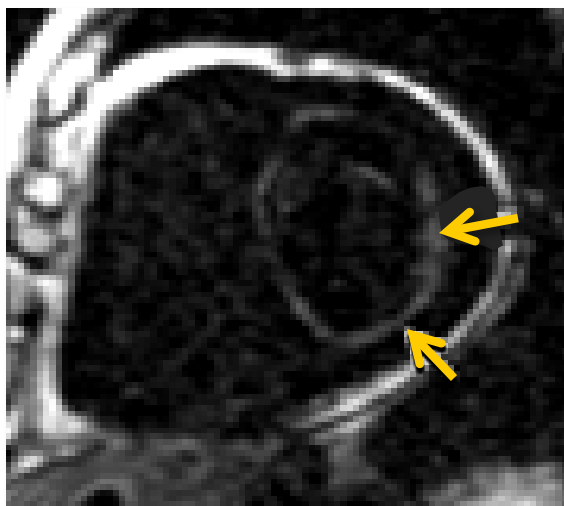
Ischemic cardiomyopathy



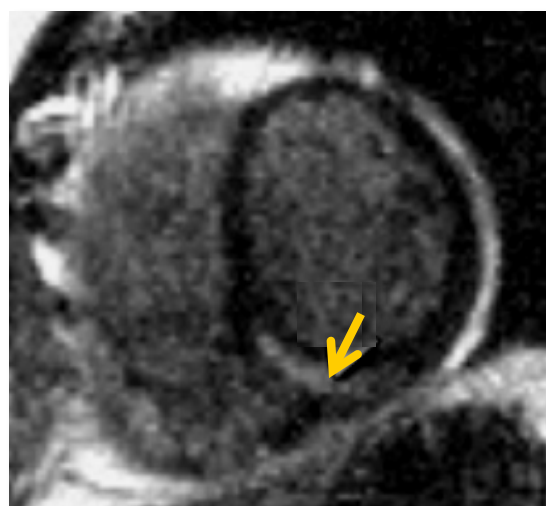
Dilated cardiomyopathy



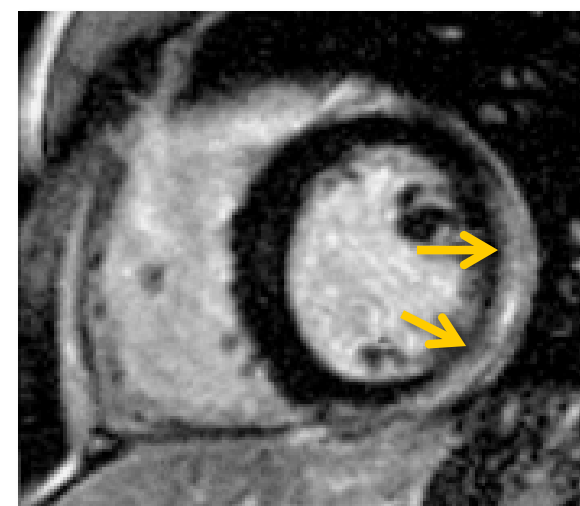
Hypertrophic cardiomyopathy



Amyloidosis



Sarcoidosis



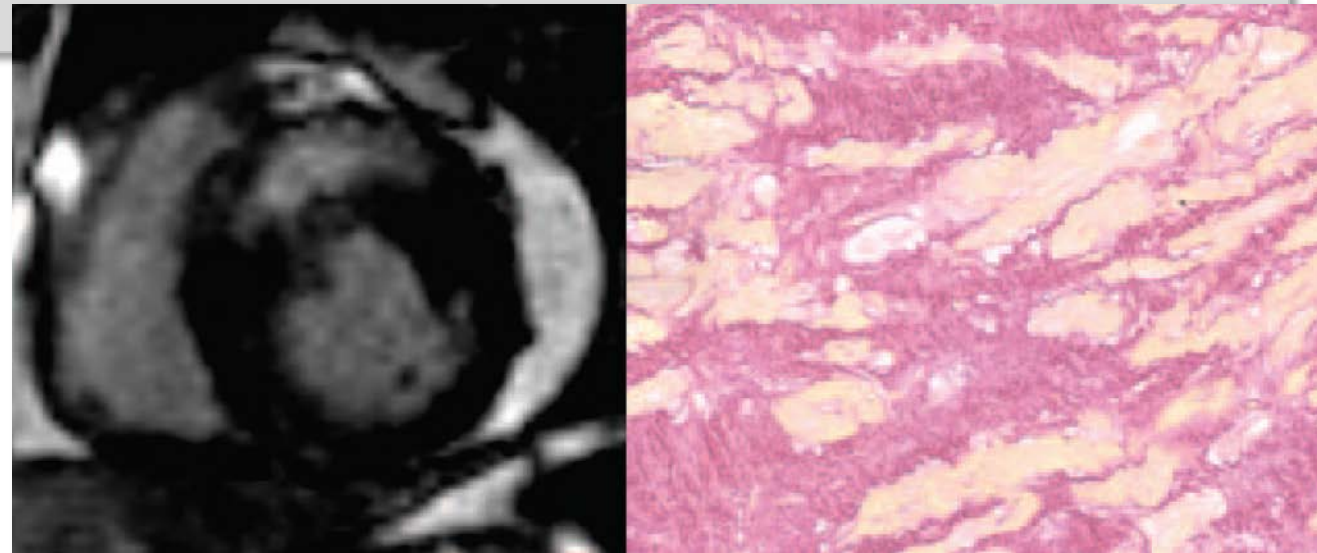
Myocarditis

Imaging

Equilibrium Contrast Cardiovascular Magnetic Resonance for the Measurement of Diffuse Myocardial Fibrosis Preliminary Validation in Humans

Andrew S. Flett, MB, BS, BSc; Martin P. Hayward, MBBS, BSc, MS;
Michael T. Ashworth, MD; Michael S. Hansen, PhD; Andrew M. Taylor, MD;
Perry M. Elliott, MB, BS, MD; Christopher McGregor, MD; James C. Moon, MB, BCh, MD

Circulation. 2010;122:138-144

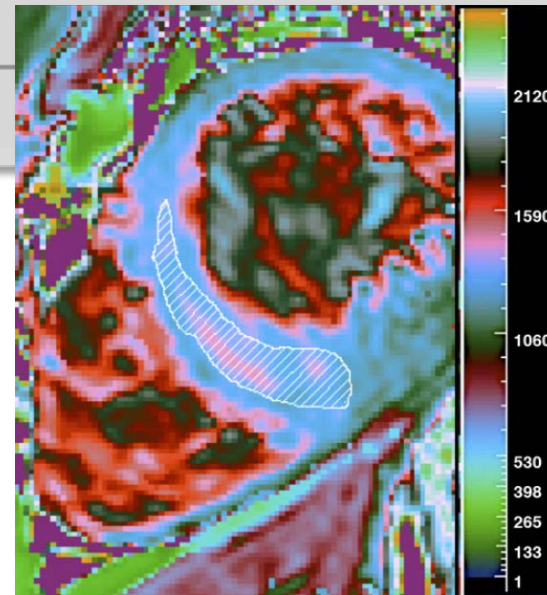


Native T1 Mapping in Differentiation of Normal Myocardium From Diffuse Disease in Hypertrophic and Dilated Cardiomyopathy

Valentina O. Puntmann, MD, PhD,* Tobias Voigt, PhD,† Zhong Chen, MD,*
Manuel Mayr, MD, PhD,‡ Rashed Karim, PhD,* Kawal Rhode, PhD,* Ana Pastor, MD,*
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London, United Kingdom

J Am Coll Cardiol Img 2013;6:273-84

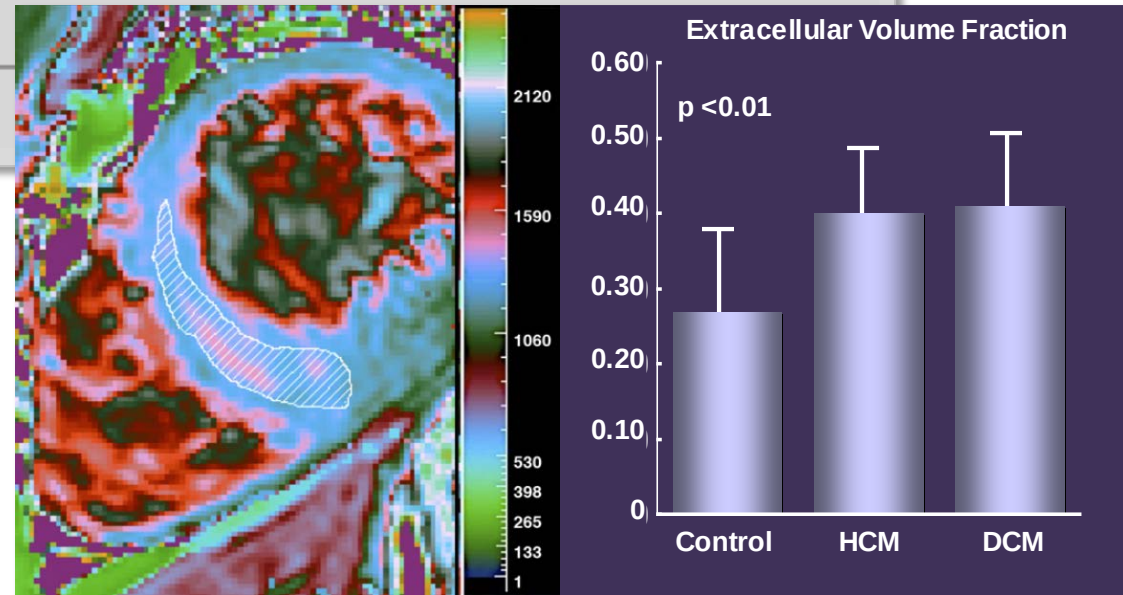


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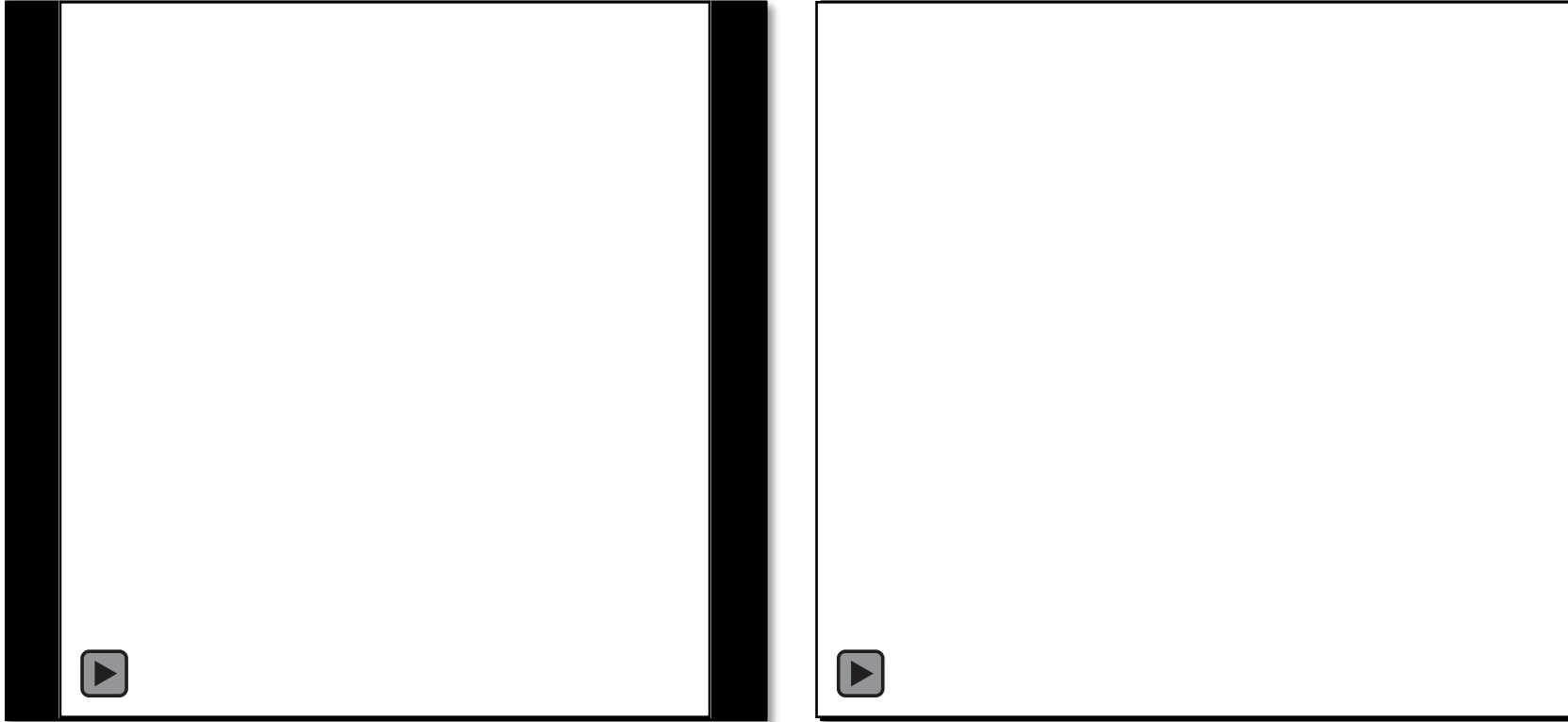
London, United Kingdom

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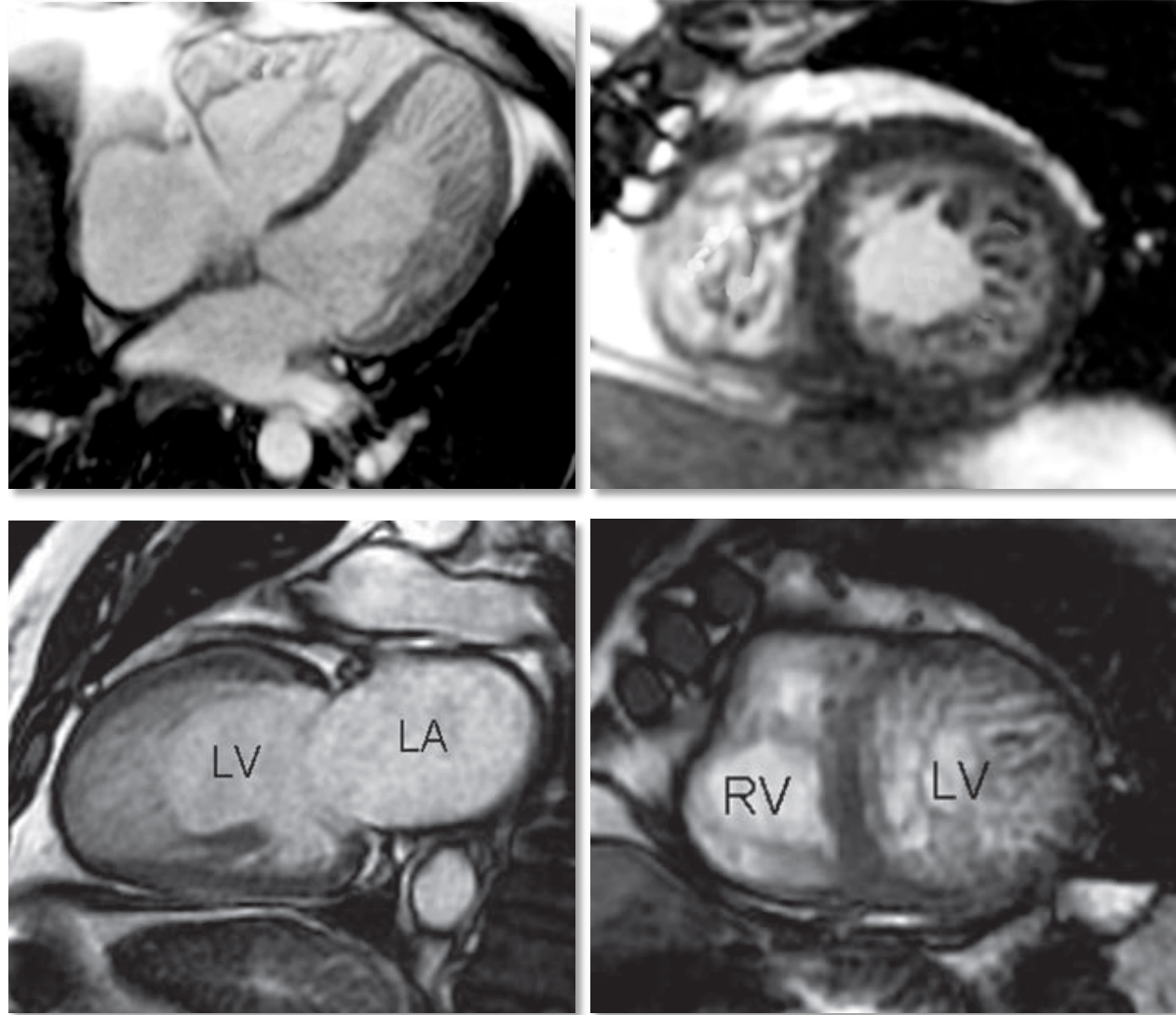




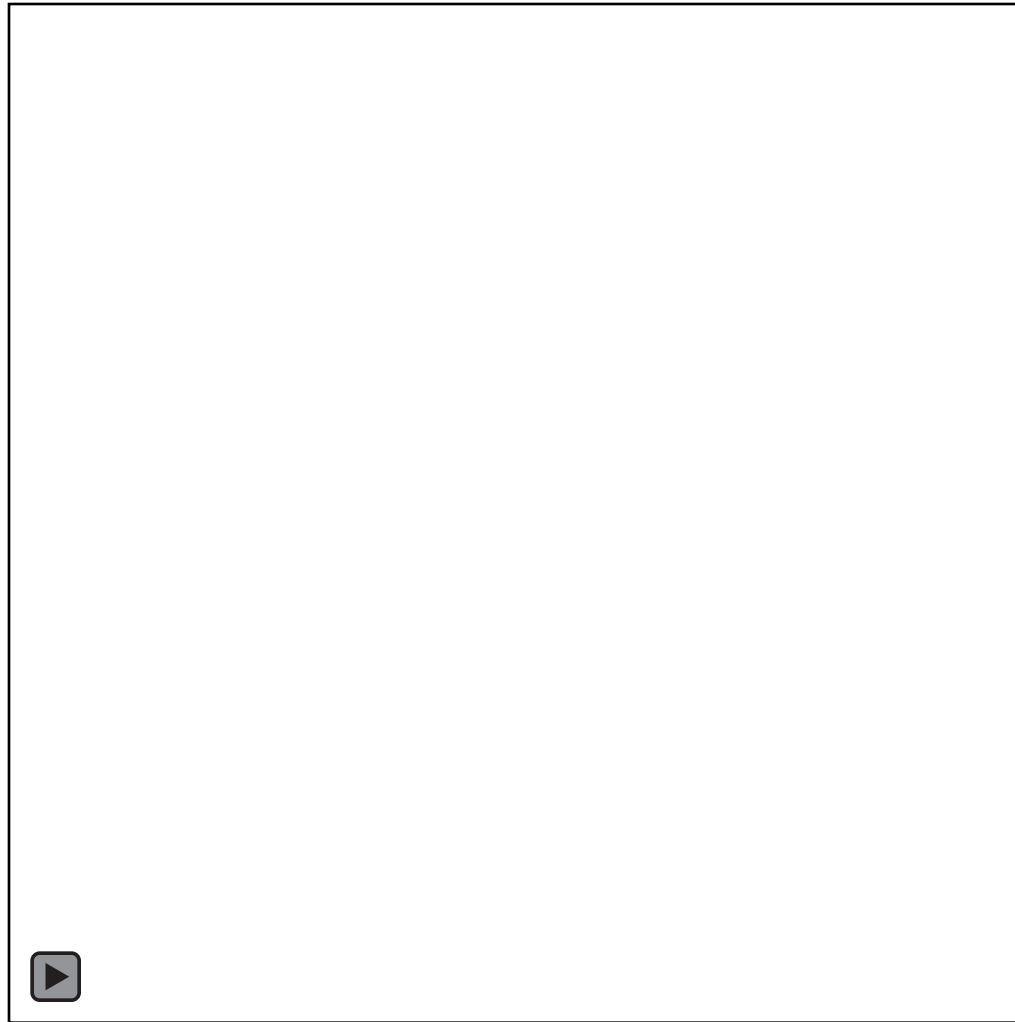
Noncompaction



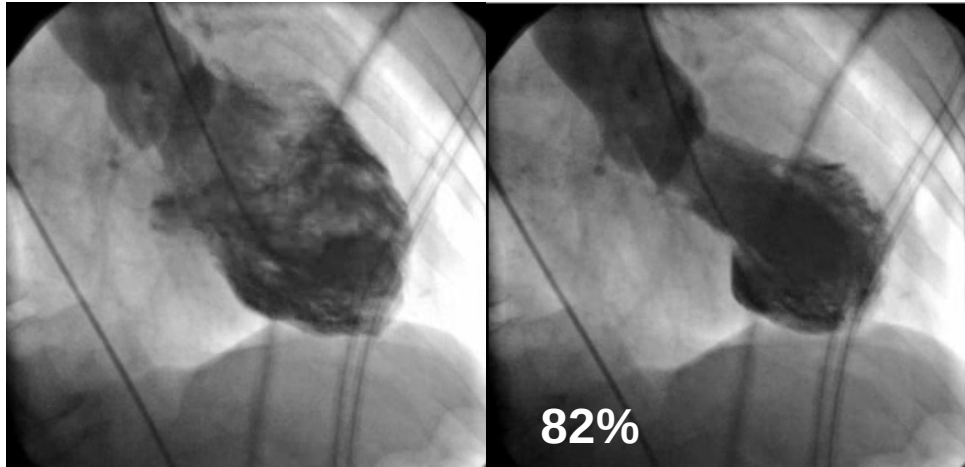
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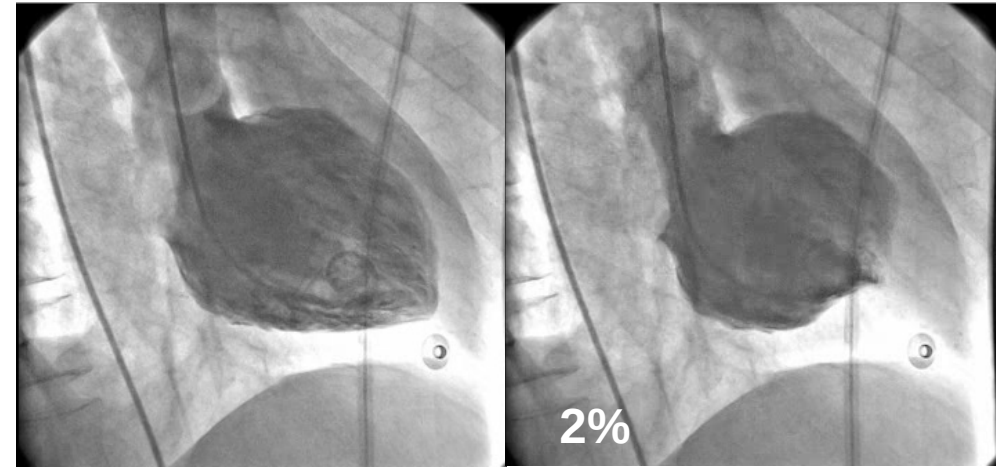
Takotsubo Cardiomyopathy



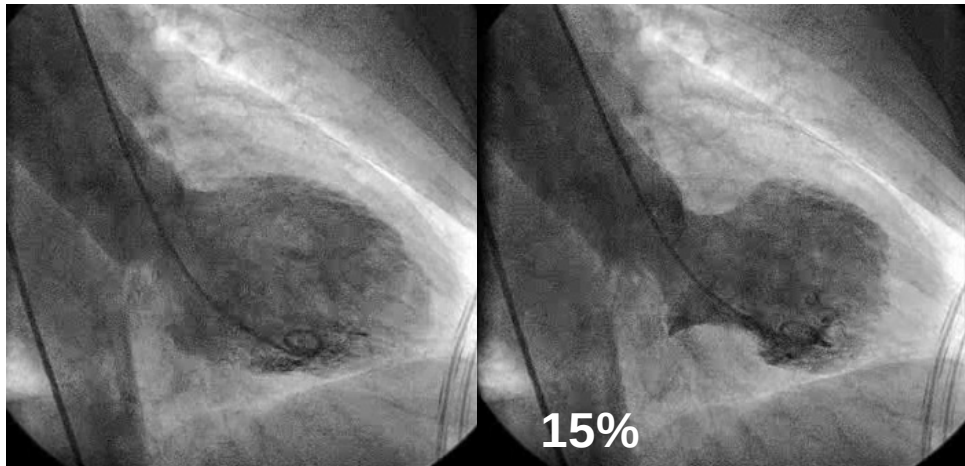
Takotsubo Cardiomyopathy



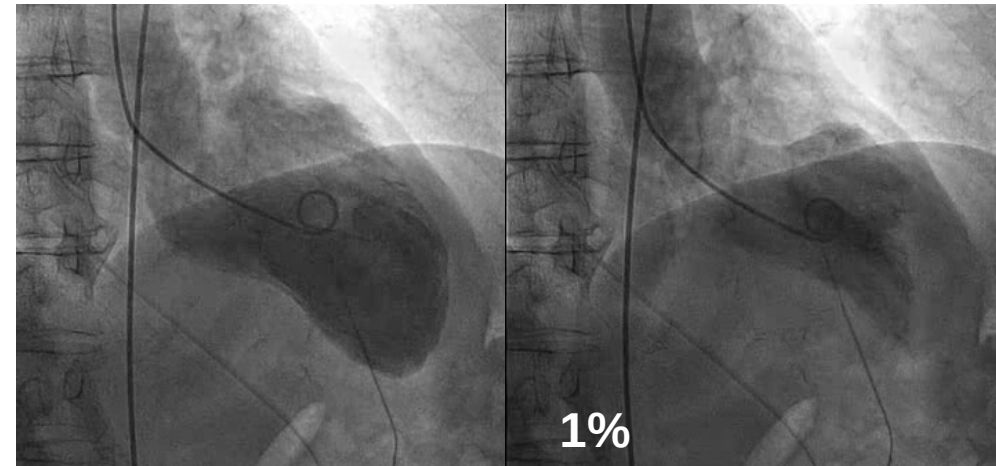
Apical



Basal



Midventricular



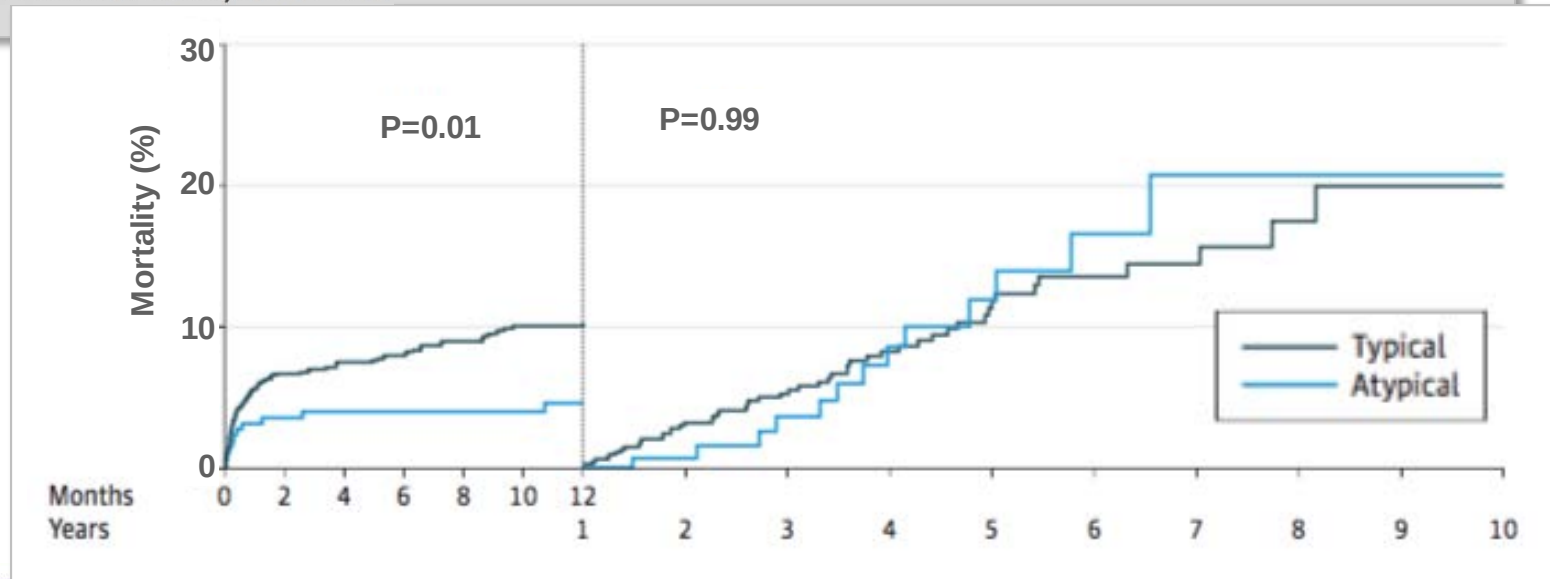
Focal

Brief Report

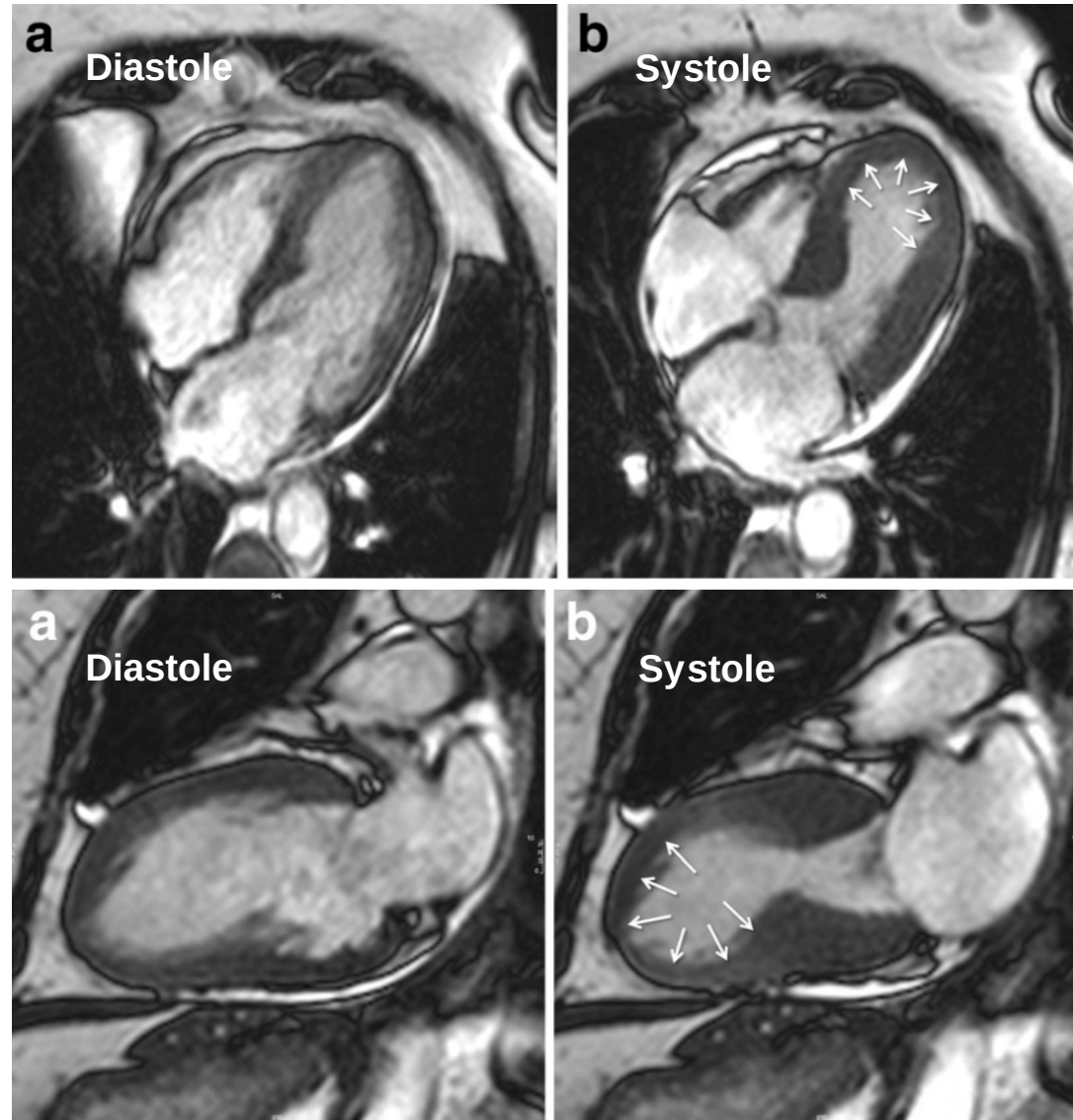
Differences in the Clinical Profile and Outcomes of Typical and Atypical Takotsubo Syndrome Data From the International Takotsubo Registry

Jelena R. Ghadri, MD; Victoria L. Cammann; L. Christian Napp, MD; Stjepan Jurisic; Johanna Diekmann; Dana Roxana Bataiosu, MD; Burkhardt Seifert, PhD; Milosz Jaguszewski, MD; Annahita Sarcon, MD; Catharina A. Neumann; Verena Geyer, MD; Abhiram Prasad, MD; Jeroen J. Bax, MD, PhD; Frank Ruschitzka, MD; Thomas F. Lüscher, MD; Christian Templin, MD, PhD; for the International Takotsubo (InterTAK) Registry

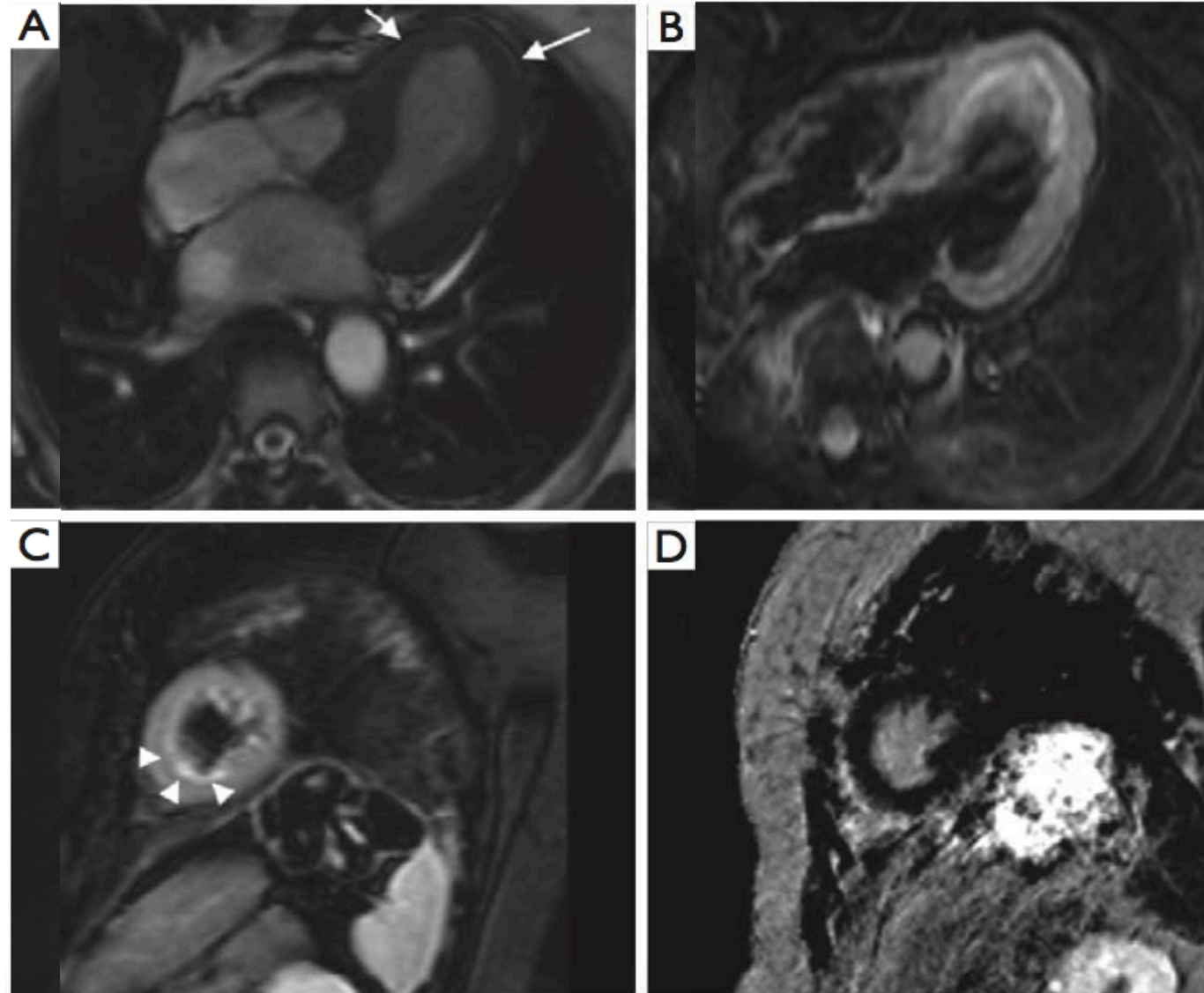
JAMA Cardiol. 2016;1:335-340



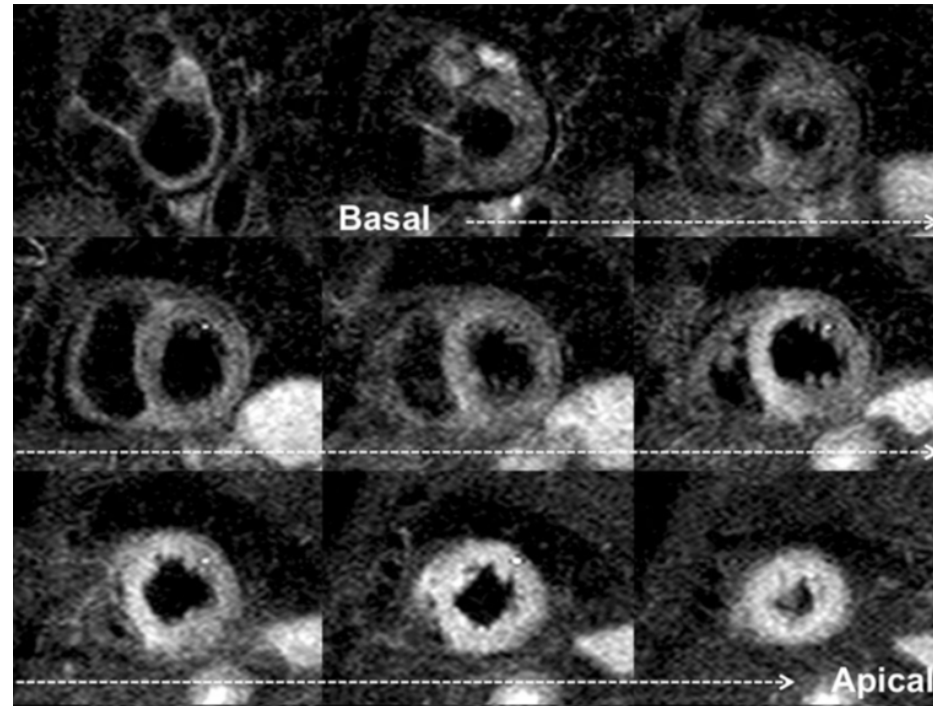
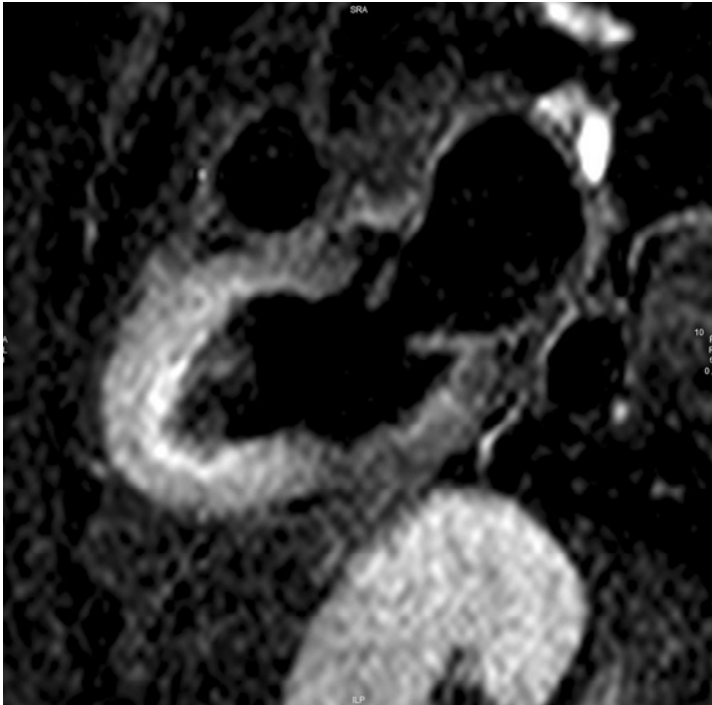
Takotsubo Cardiomyopathy



Takotsubo Cardiomyopathy



Takotsubo Cardiomyopathy





Usefulness of Electron Beam Computed Tomography Scanning for Distinguishing Ischemic From Nonischemic Cardiomyopathy

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J Am Coll Cardiol 1998;32:1173-8

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Cardiac Imaging

Diagnostic Accuracy of Multidetector Computed Tomography Coronary Angiography in Patients With Dilated Cardiomyopathy

Daniele Andreini, MD, Gianluca Pontone, MD, Mauro Pepi, MD, Giovanni Ballerini, MD,
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J Am Coll Cardiol 2007;49:2044-50

Multimodality Imaging: Myocardial Disease

Cardiac magnetic resonance:

- HCM: morphology and fibrosis (prognosis)
- DCM: exclude prior MI
- DCM: function and fibrosis (prognosis)
- Sarcoid: diagnosis
- Amyloid: diagnosis, therapeutic options
- Noncompaction: accurate diagnosis
- Takotsubo: diagnosis (...prognosis?)

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CT angiography:

- DCM: exclude ischemic cardiomyopathy



