

CORSO AVANZATO DI ECOCARDIOGRAFIA DI "ECOCARDIOCHIRURGIA"

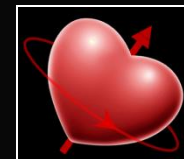
con uno sguardo all'imaging integrato

**Valvulopatie: la Selezione ed il Ruolo del
Centro di III Livello: Come Arrivare alle
Ragionevoli Certezze?**

La RM Può Aiutarci?

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Divisione di Cardiologia
Ospedale Medico-Chirurgico Accreditato Villa dei Fiori
Acerra (Napoli)



Guidelines on the management of valvular heart disease (version 2012)

The Joint Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

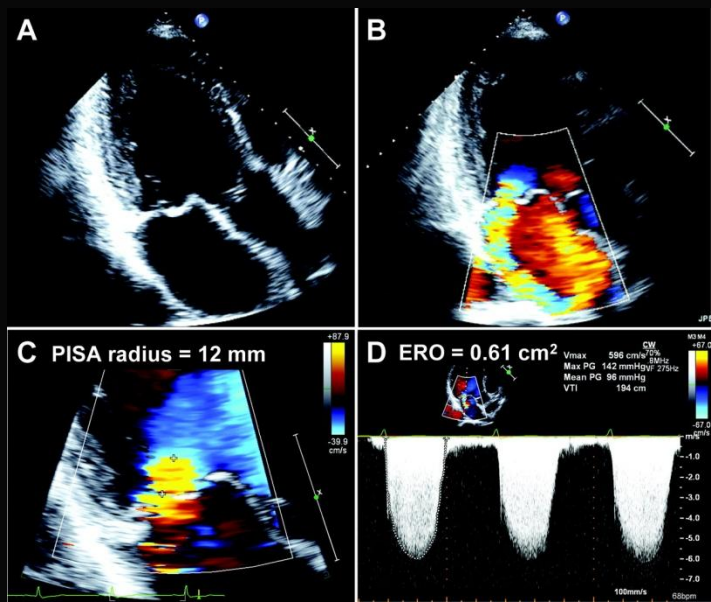
3.1.3.2 Cardiac magnetic resonance

In patients with inadequate echocardiographic quality or discrepant results, cardiac magnetic resonance (CMR) should be used to assess the severity of valvular lesions—particularly regurgitant lesions—and to assess ventricular volumes and systolic function, as CMR assesses these parameters with higher reproducibility than echocardiography.^{2,3}

CMR is the reference method for the evaluation of RV volumes and function and is therefore useful to evaluate the consequences of tricuspid regurgitation (TR). In practice, the routine use of CMR is limited because of its limited availability, compared with echocardiography.



Heart Valve Disease: Investigation by Cardiovascular Magnetic Resonance



Kang D et al. Circulation 2009

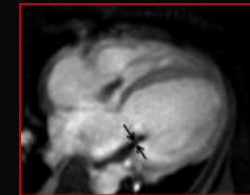
**Echocardiography
remains the major imaging modality
for assessing valve disease**

Cardiovascular MR

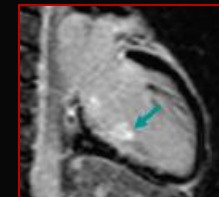
Morphology assessment



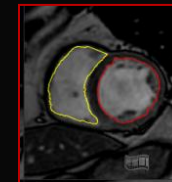
Functional assessment



Aetiology assessment



Impact on ventricular
dimension/function



Associated great vessel
disease



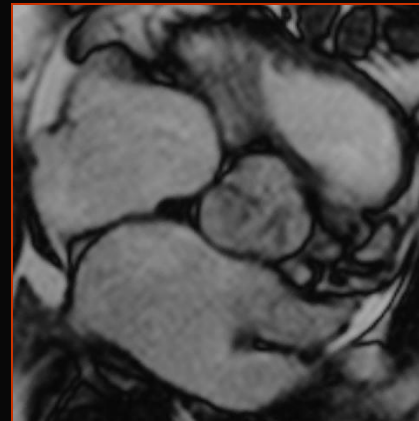
Evaluation of Valvular Function and Morphology

Advantage: unlimited imaging planes

**Tri-Leaflets
Aortic Valve**



**Bi-Leaflets
Aortic Valve**



**Aortic
Stenosis**



**Aortic
Regurgitation**

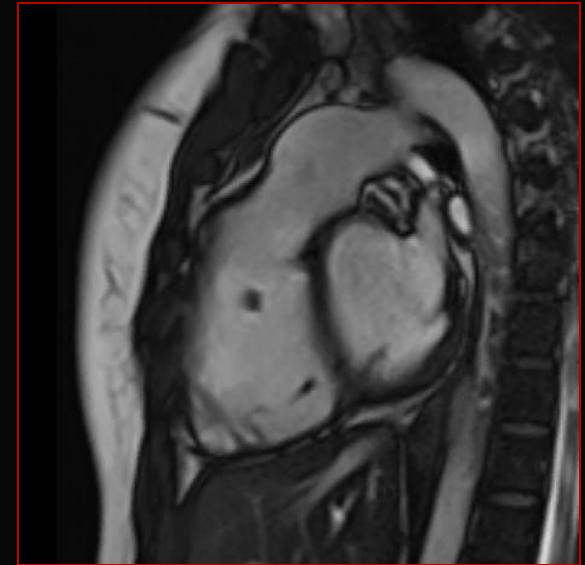
Cardiovascular MR: Right-Heart Valves



**Ebstein
Anomaly**

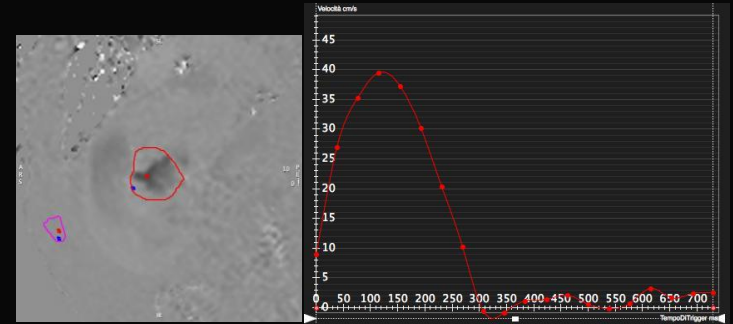


**Tricuspid
Regurgitation**



**Pulmonary
Regurgitation**

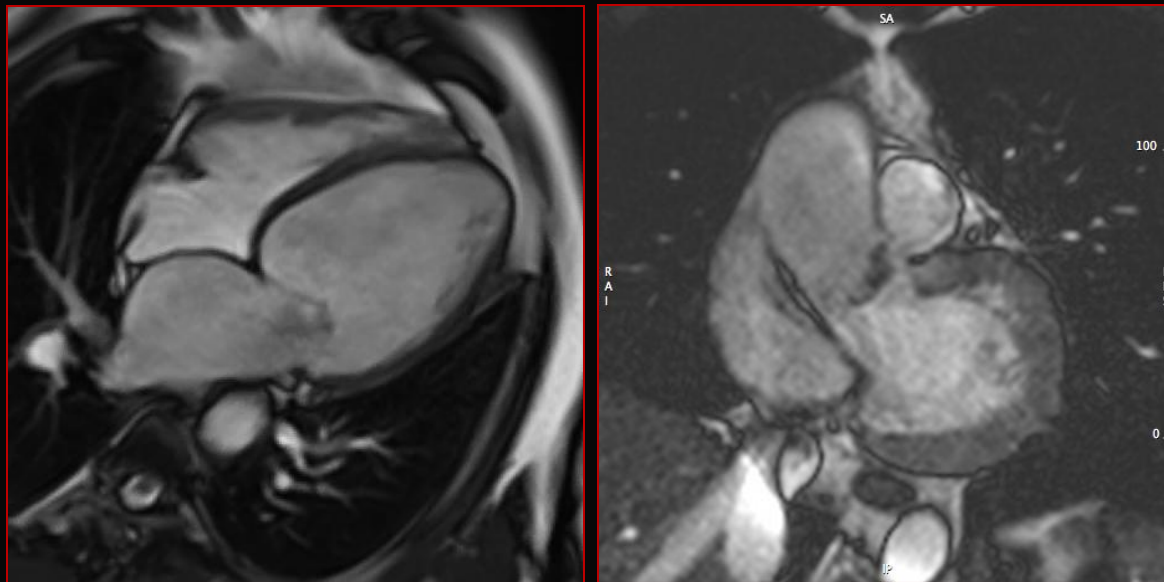
Cardiovascular MR: Poor Acoustic Window



CMR in Heart Valve Disease: Functional Assessment

**Qualitative:
visual assessment of turbulent flow in stenotic
or regurgitant flow jets**

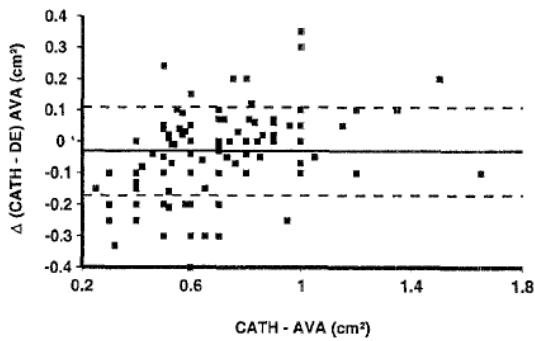
Visualization of signal voids due to spin dephasing in moving protons



Assessing the severity of a valvular defect with visual assessment of cine images requires caution as the technique is subject to slice positioning, partial volume effects, the insensitivity of SSFP sequences and to other sequence parameters.

Quantification of Aortic Stenosis: Inadequacy of Traditional Methods

Transthoracic Echocardiography

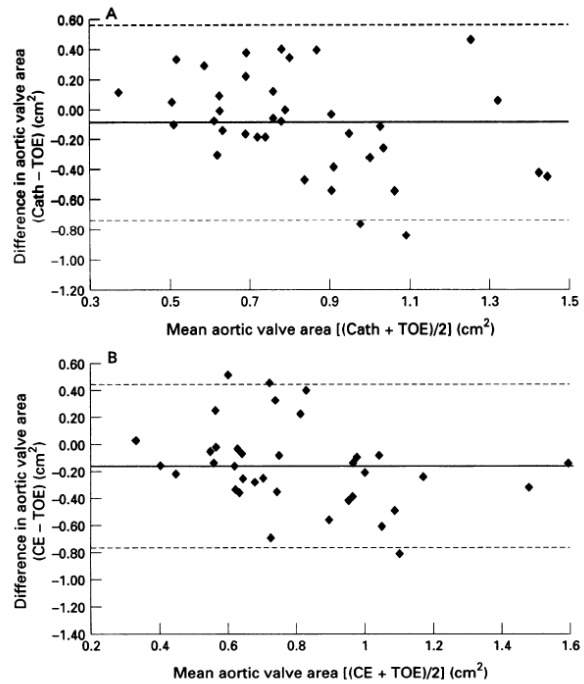


POOR IMAGE QUALITY
(n=49)

		ECHO		
		mild to moderate	severe	
CATH	mild to moderate	10	3	mild to moderate
	severe	11	25	severe ($\kappa = 0.39$)

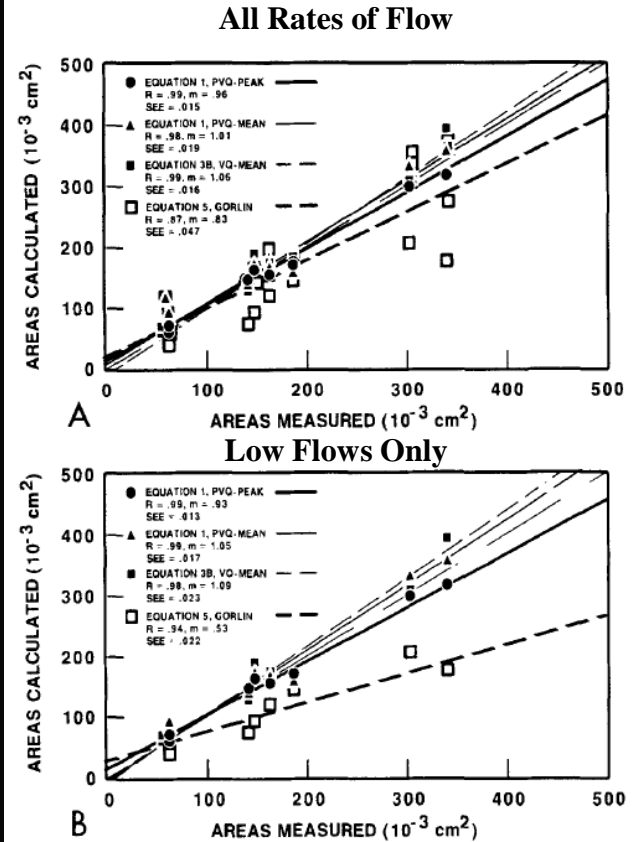
Bartunek J et al. Int J Card Imaging 1995

Transoesophageal Echocardiography



Bernard Y et al. Heart 1997

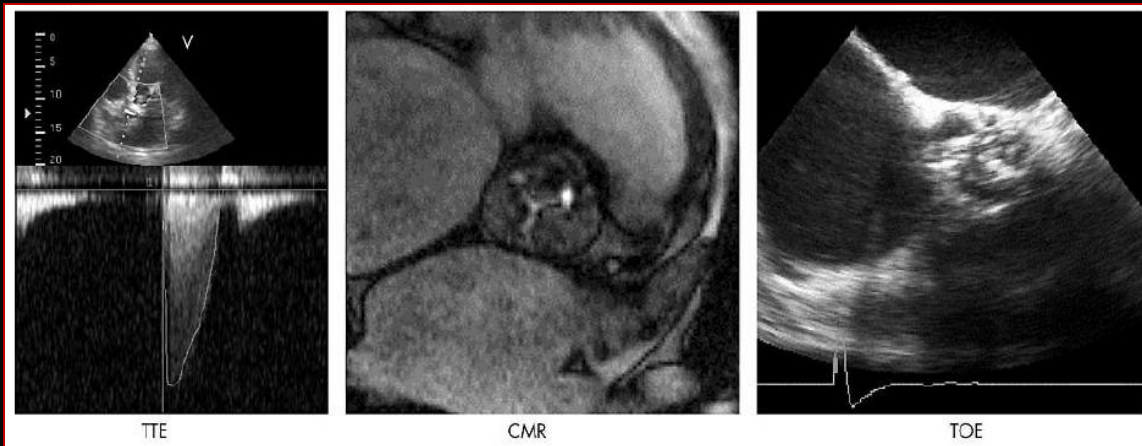
Invasive Catherization



Segal J et al. J Am Coll Cardiol 1987

Evaluation of Aortic Stenosis by CMR Imaging: Comparison with Established Routine Clinical Techniques

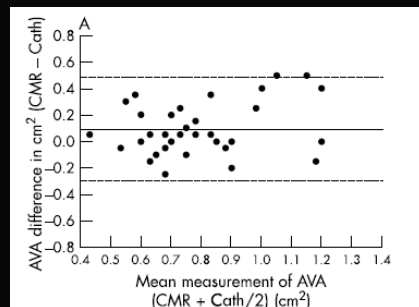
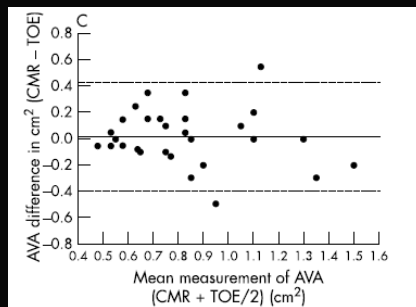
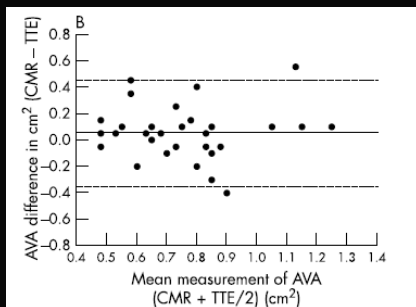
Kupfahl C et al. *Heart* 2004



In this example, the valve could not be assessed by TTE due to poor acoustic window and LVOT calcification as well as by TOE due to commissural calcification

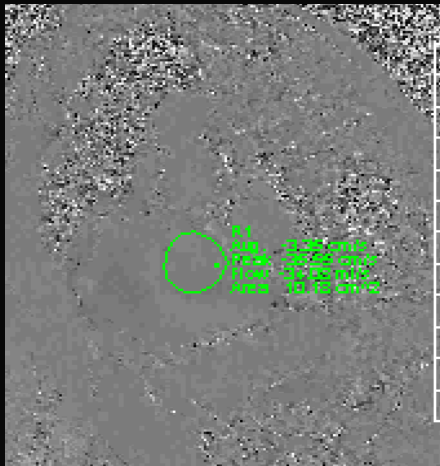
- 44 symptomatic pts. with severe AoSt
- AVA by continuity equation from TTE
- AVA by planimetry from TOE
- AVA by planimetry from cine-CMR
- AVA by Gorlin equation from catheterization

CMR planimetry had the best accuracy of all non-invasive methods for detecting severe AoSt in comparison with cardiac cath

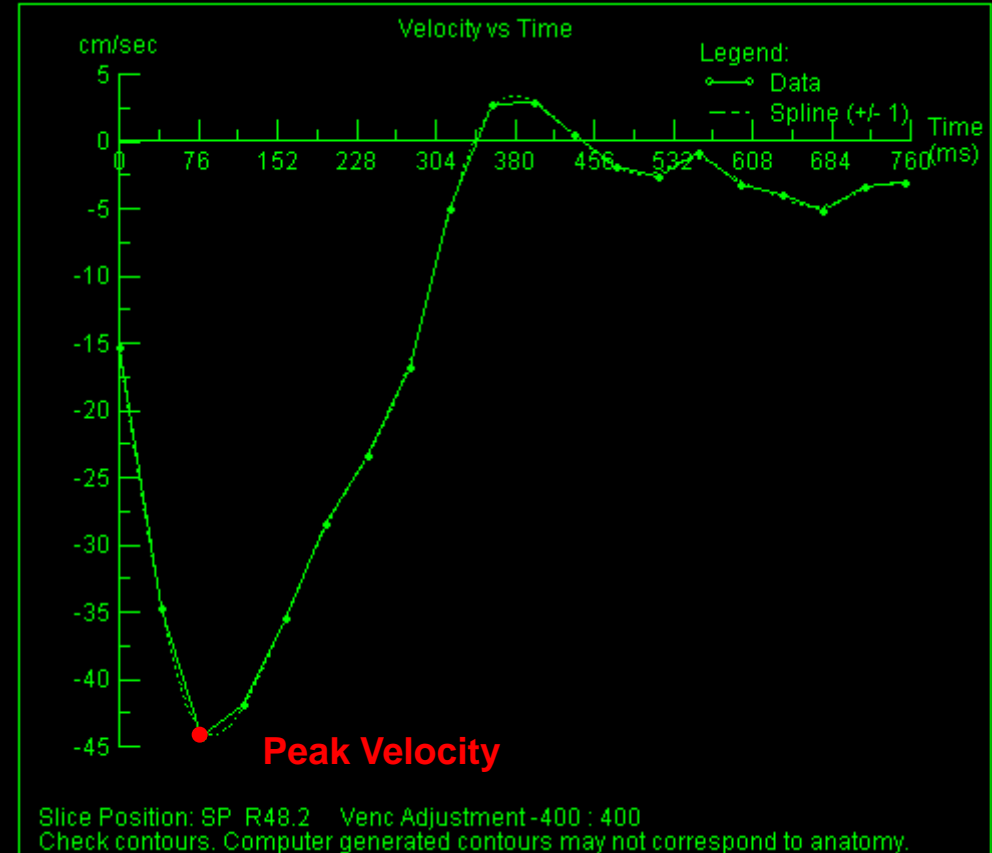


Intra-observer bias = -0.016
 Inter-observer bias = 0.019

Quantification of Aortic Stenosis by Phase-Contrast CMR



Velocity-Time Curve



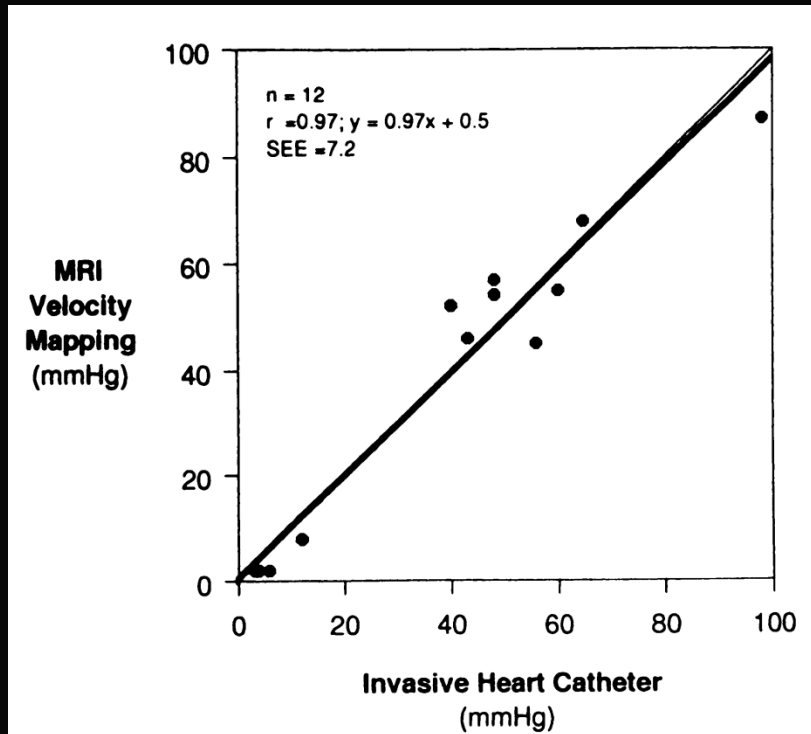
Modified Bernulli Equation

$$\Delta P = 4 V^2$$

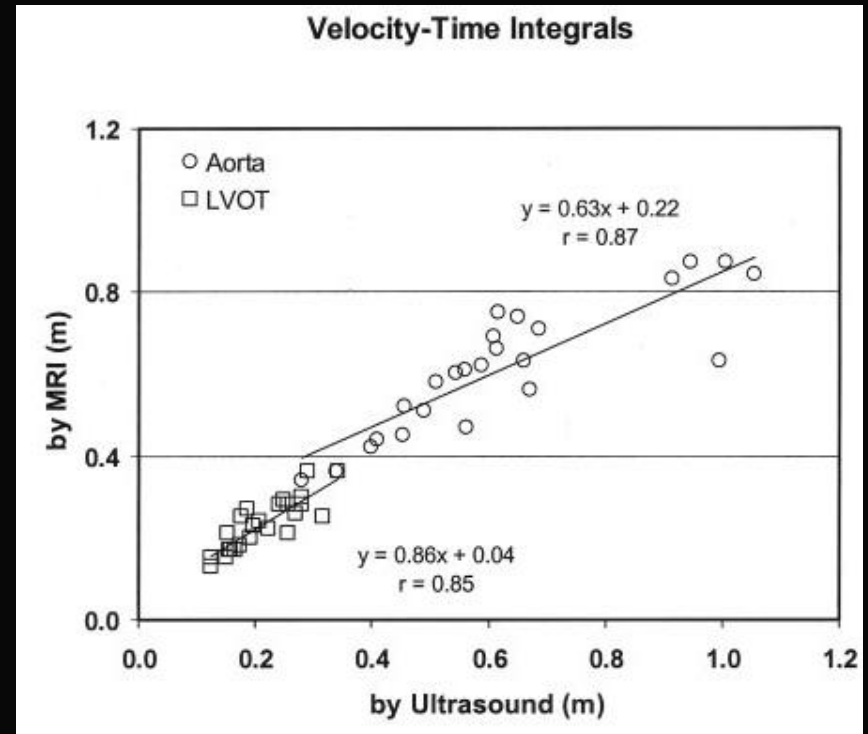
Advantages

- Evaluation of pts. with angulated roots
(correct echo beam alignment is difficult)
- Ability to differentiate sub-valvar and supra-valvar stenosis
- Possibility to assess the ascending aorta which may be dilated

Quantification of Aortic Stenosis by Phase-Contrast CMR



Eichenberger AC et al. Am J Roentgenol 1993

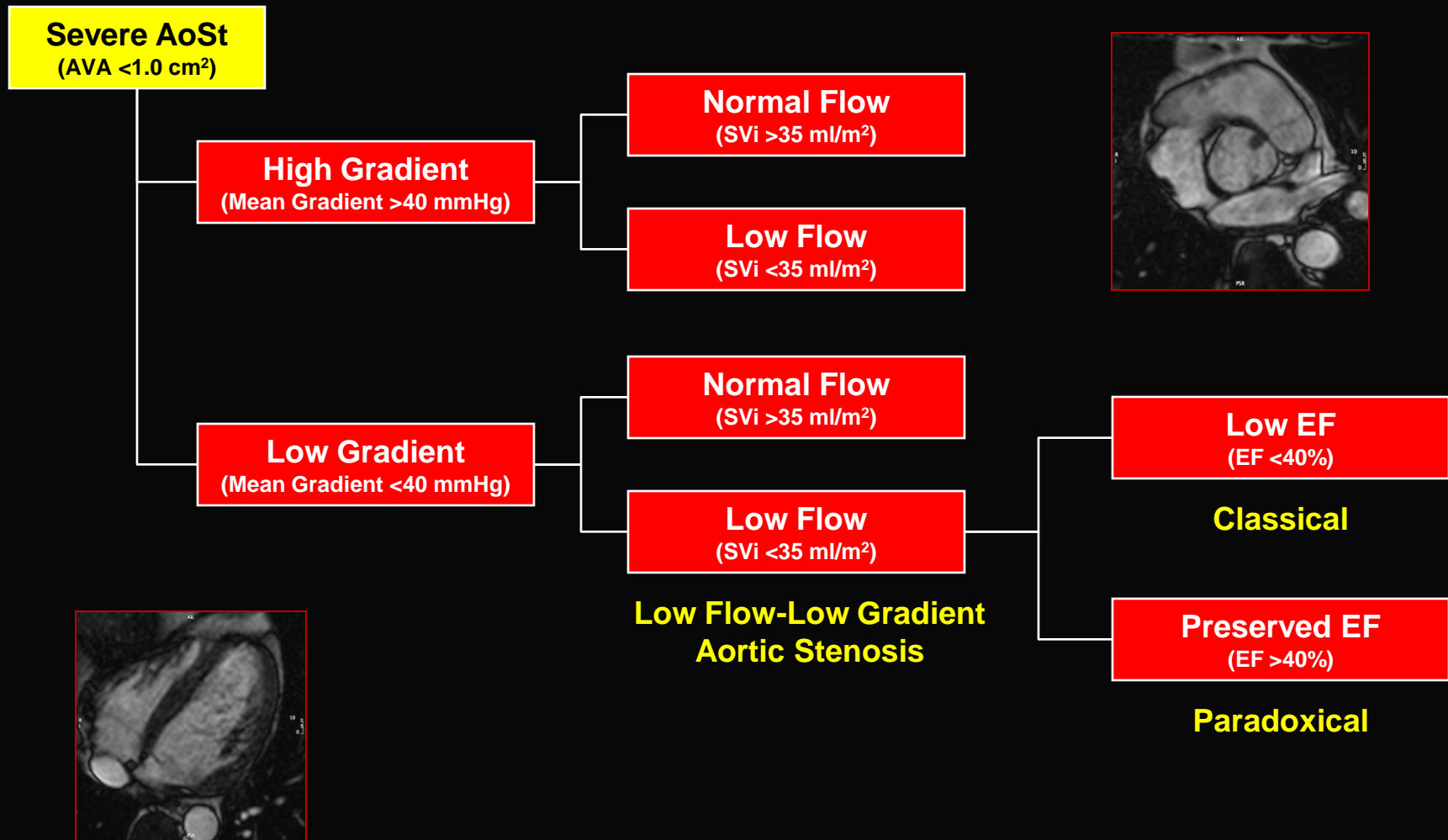


Caruthers SD et al. Circulation 2003

Disadvantages

Less accurate (modest underestimation) compared to continuous-wave Doppler echo for higher velocities (partial volume effects, lower temporal resolution, and artefacts from turbulent jets)

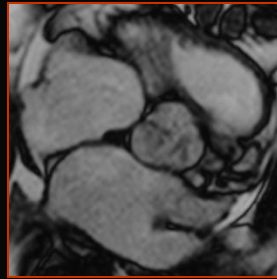
Flow-Gradient Patterns in Severe Aortic Stenosis



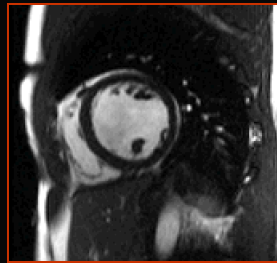
Paradoxical low flow-low-gradient pattern has been reported in up to 35% of patients with severe AS and seems to be consistent with a more advanced stage of the disease (increased global LV afterload, significant LV concentric remodeling, and intrinsic myocardial dysfunction)

Low Flow-Low Gradient Ao St: Potential Role of MRI

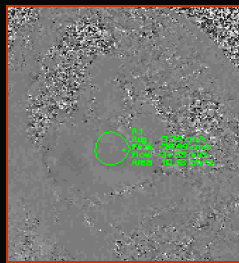
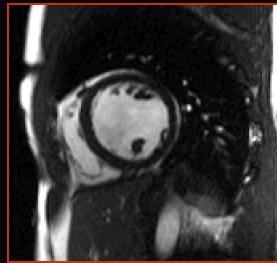
Planimertric AVA



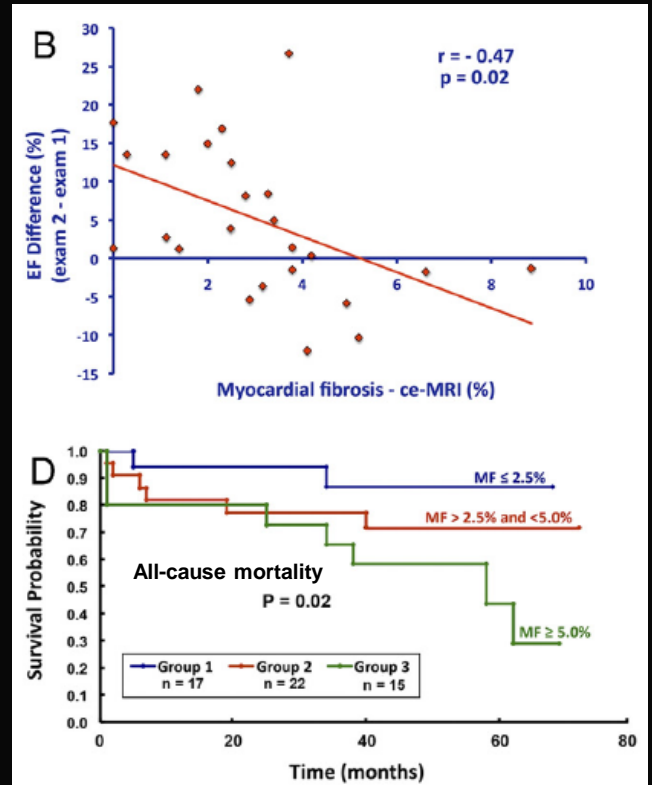
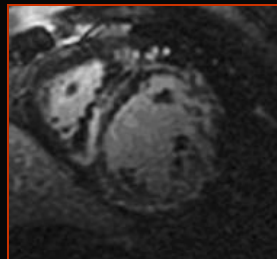
LV Ejection Fraction



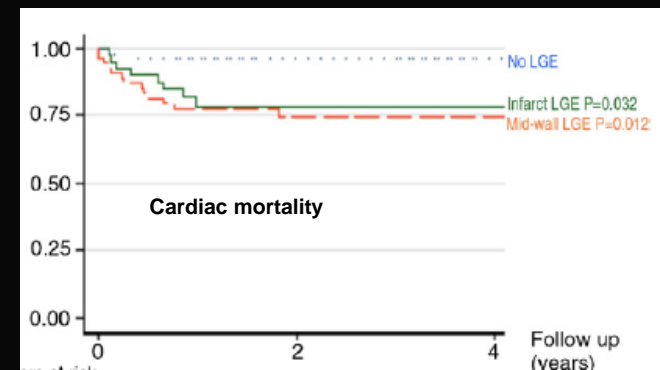
LV Stroke Volume



LV Myocardial Scar/Fibrosis

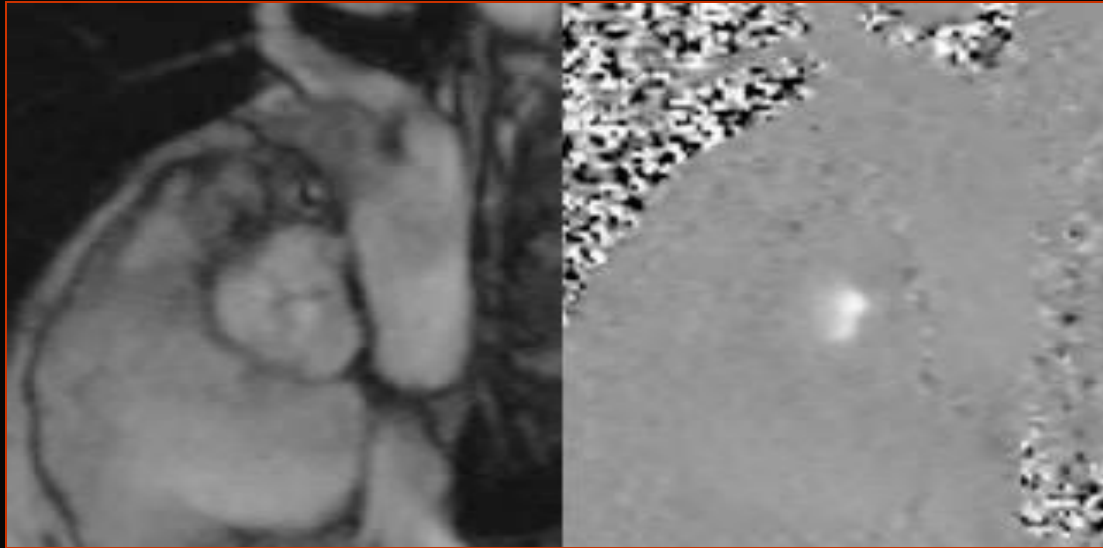


Azevedo CF et al., J Am Coll Cardiol 2010



Dweck MR et al., J Am Coll Cardiol 2011

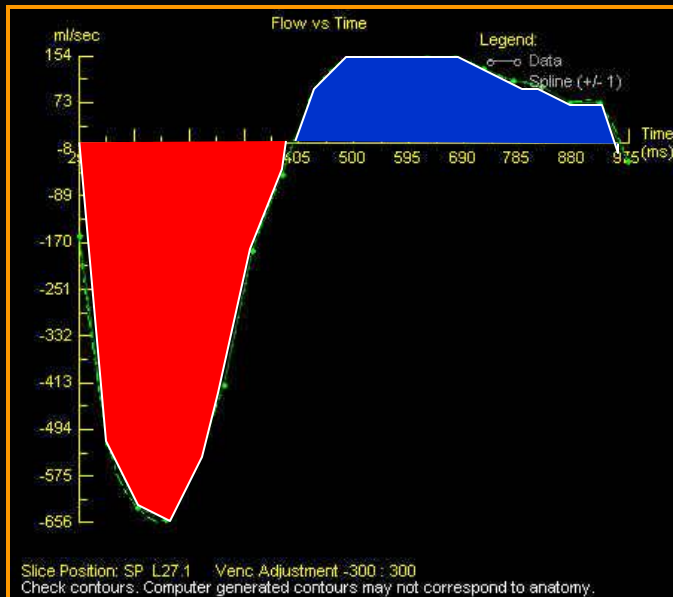
Insufficienza Aortica: Imaging a Contrasto di Fase



Grade	Sinotubular Junction (%)
0-1+	<8
2+	8-19
3+	20-29
4+	≥30

Gabriel RS et al. Am J Cardiol 2011

Curva Flusso-Tempo



Frazione Rigurgitante

$$\frac{\text{Flusso Retrogrado}}{\text{Flusso Anterogrado}} \times 100\%$$

Aortic Regurgitation Quantification Using CMR: Association With Clinical Outcome

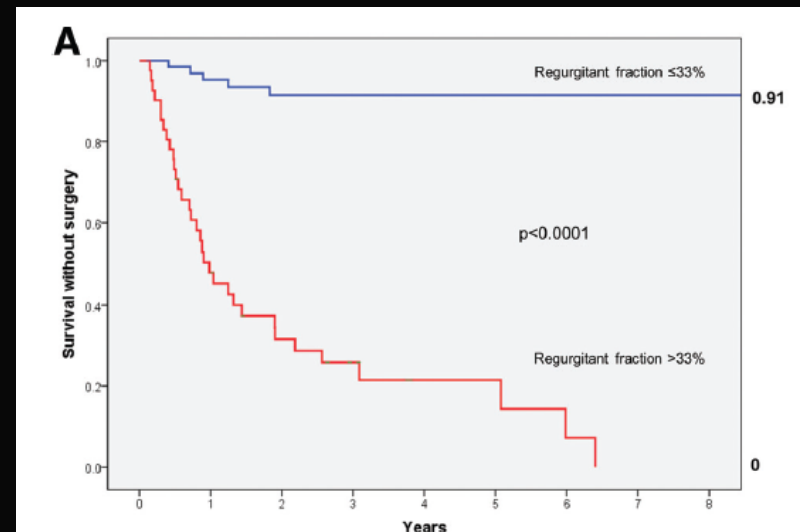
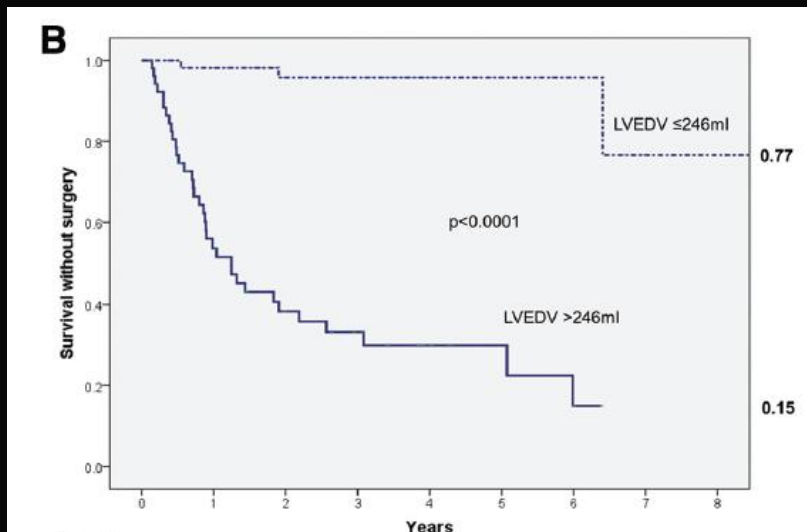
Myerson SG et al. *Circulation* 2012

Aortic valve replacement is usually reserved for when symptoms or significant LV dilation or dysfunction occur, but prognosis is already reduced by this stage. Earlier surgery has been advocated, but it is also important to avoid the increased risks associated with premature surgery.

N= 113 pts. with moderate or severe AR by Echo

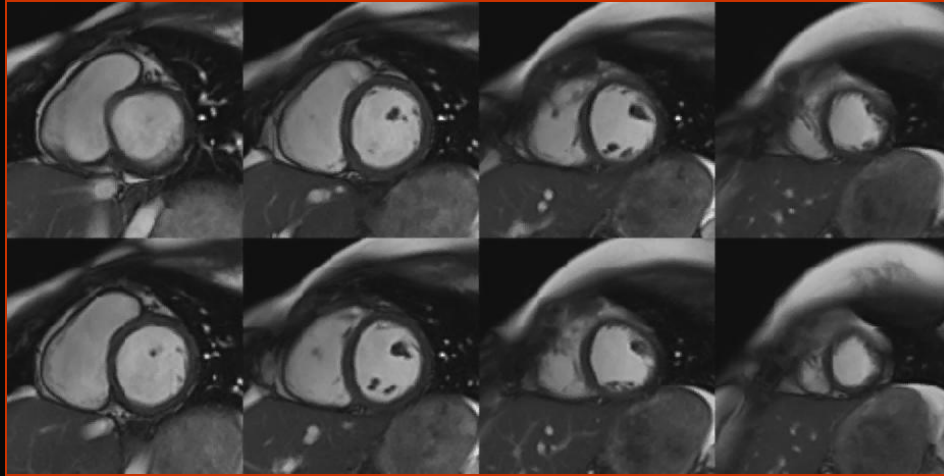
Follow-up = 2.6 ± 2.1 years following a CMR

Outcomes = survival without surgery (progression to symptoms/other indications for surgery)

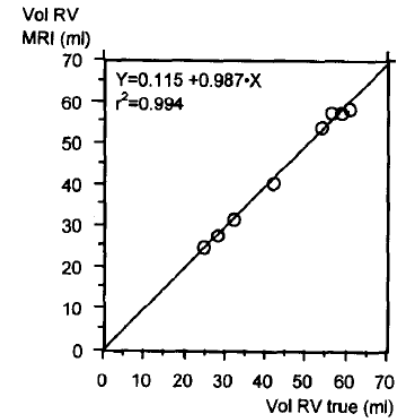
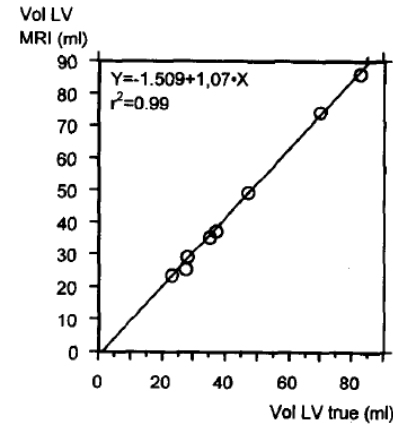


85% of pts. with RF $> 33\%$ progressed to surgery vs. 8% of pts. with RF $\leq 33\%$ ($p < 0.0001$)

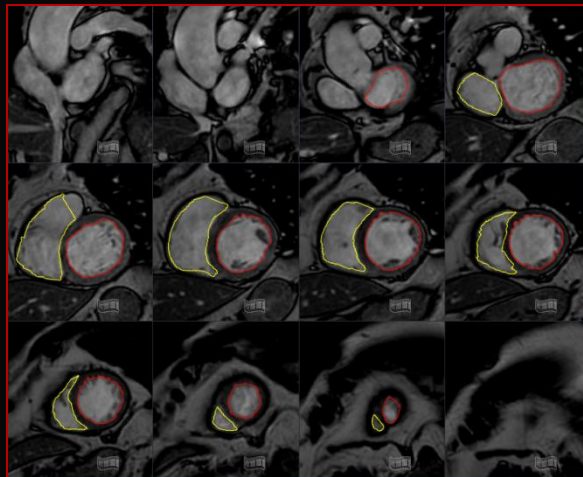
Volumetric Analysis of the Right and Left Ventricle with MRI



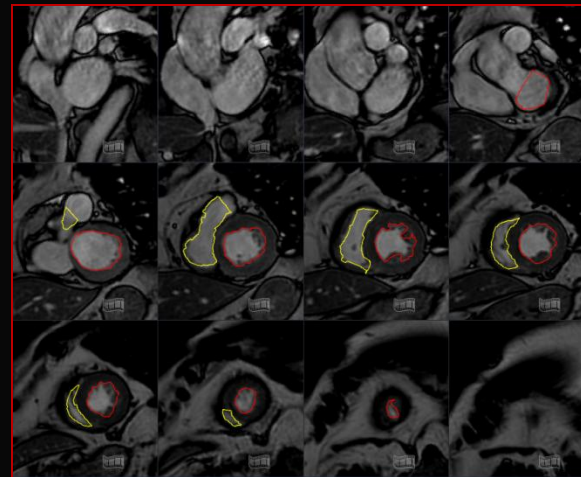
N = 8 explanted porcine hearts



Heusch A et al. *Eur J Ultrasound* 1999

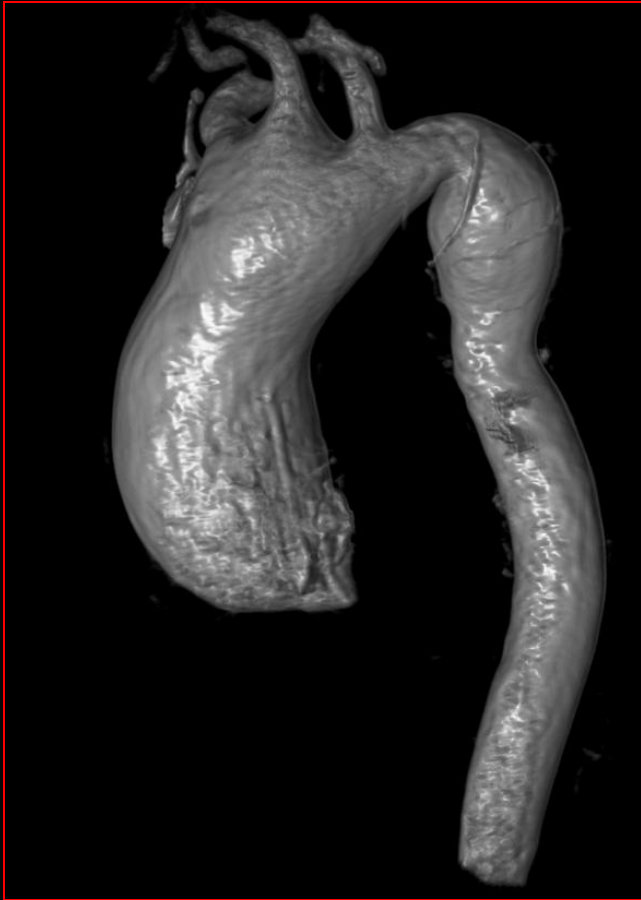


End-diastole



End-systole

MR Angiography of the Thoracic Aorta



Aneurysm



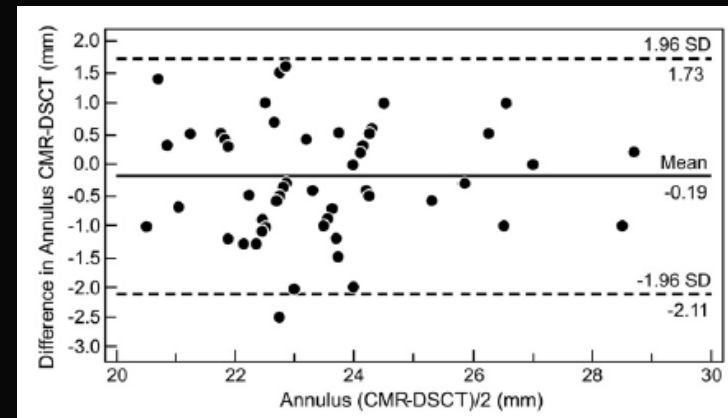
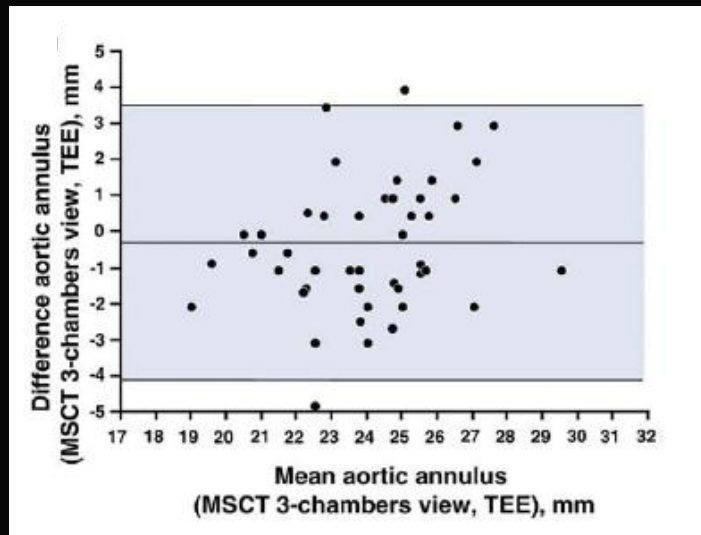
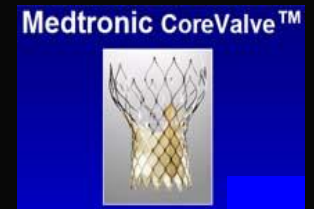
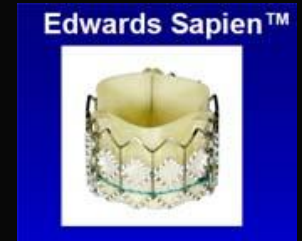
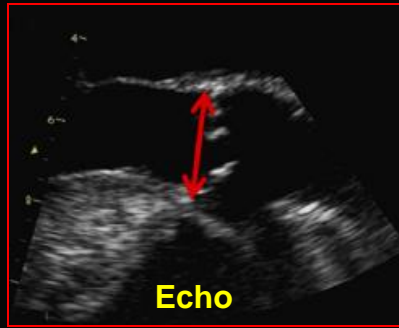
Dissection



Coarctation

Assessment of Aortic Annulus Diameter

Are the Noninvasive Imaging Modalities Interchangeable?



Koos R et al., Int J Cardiol 2011

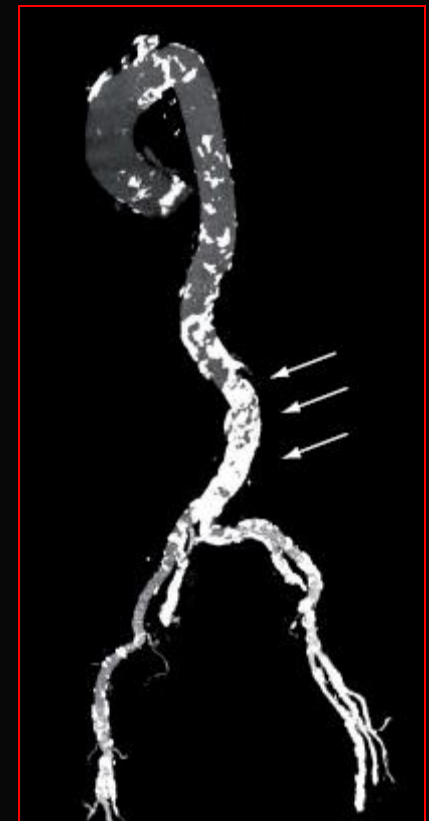
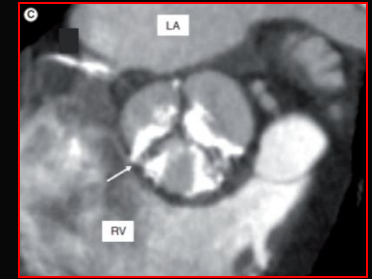
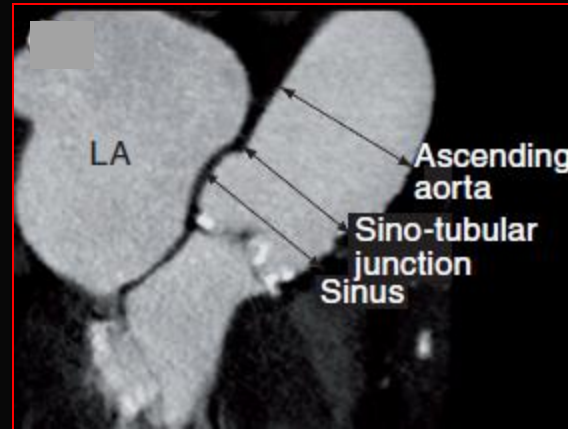
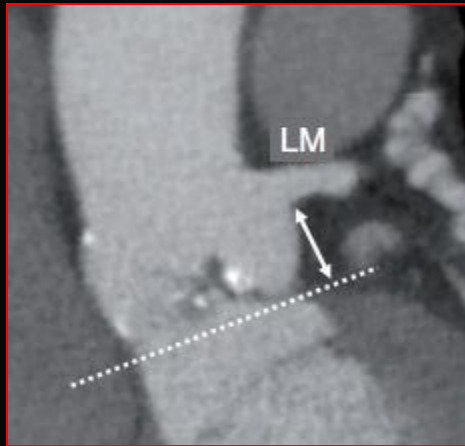
Messika-Zeitoun D et al., J Am Coll Cardiol 2010

Transcatheter Aortic Valve Implantation (TAVI)

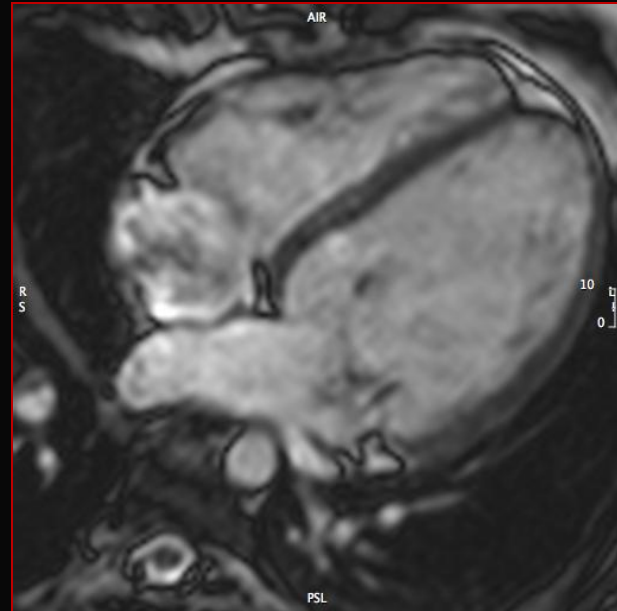
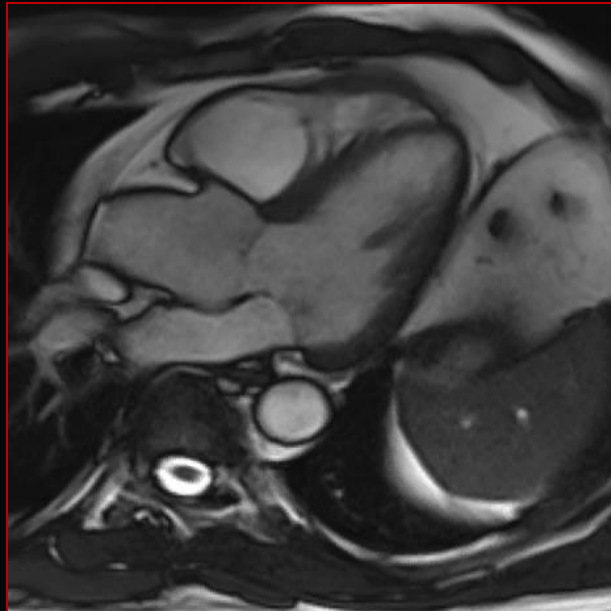
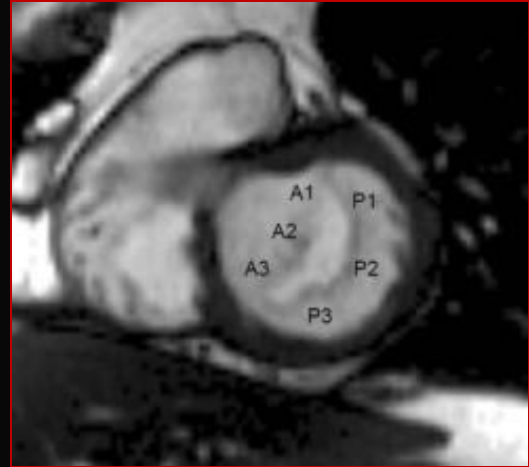
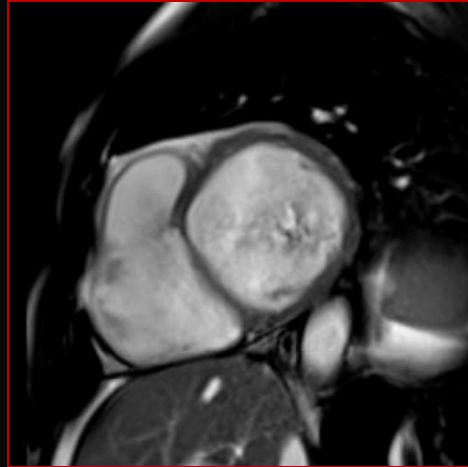
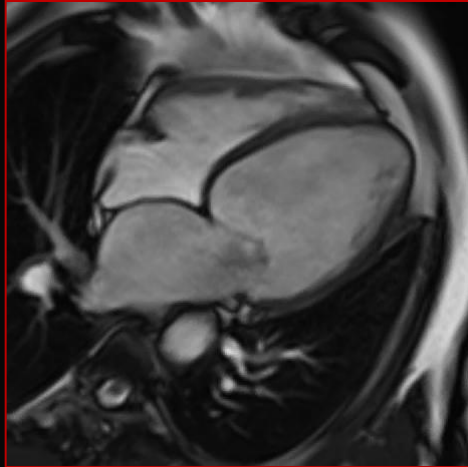
Morphologic Selection Criteria

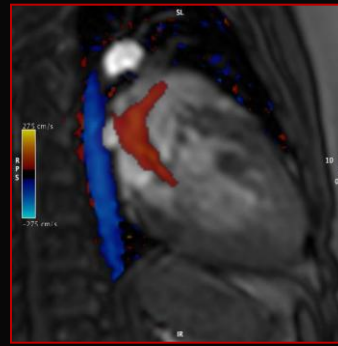
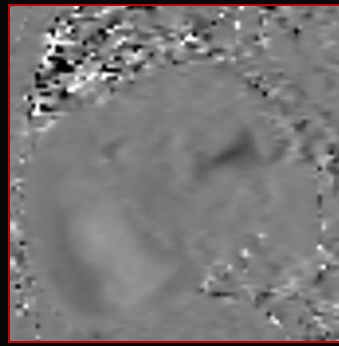
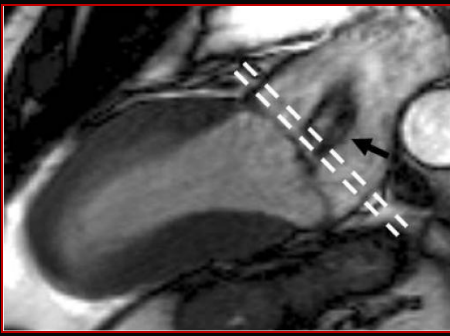
Feasibility assessment:

- Left ventricular function
- Coronary artery anatomy/disease severity
- Coronary ostia position (take-off)
- Aortic valve calcification
- Size of aortic annulus
- Size, calcification, tortuosity of aorta/ilio-femoral arteries



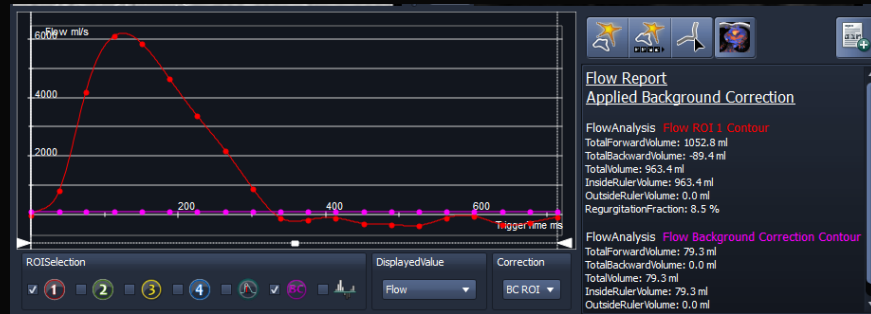
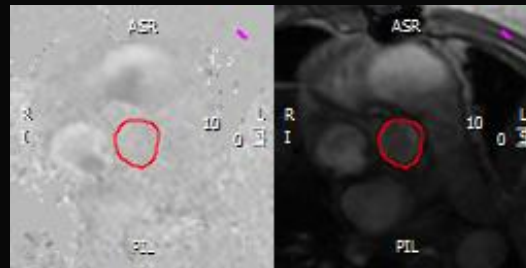
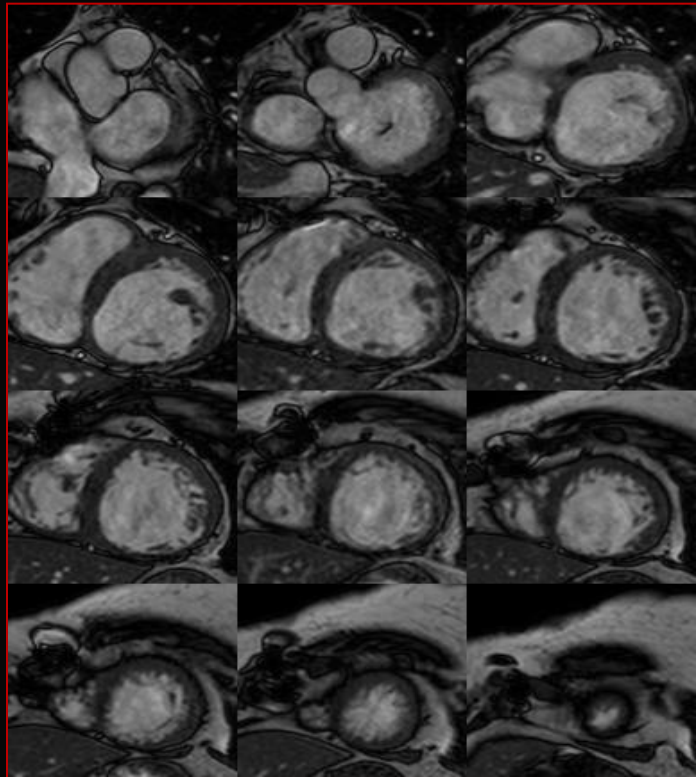
Comprehensive Assessment of Mitral Regurgitation Using Cardiac Magnetic Resonance





Grade	Regurgitant Volume
Mild	≤15%
Moderate	16-24%
Mod-severe	25-42%
Severe	>42%

Gelfand EV et al. J Cardio Magn Res 2006

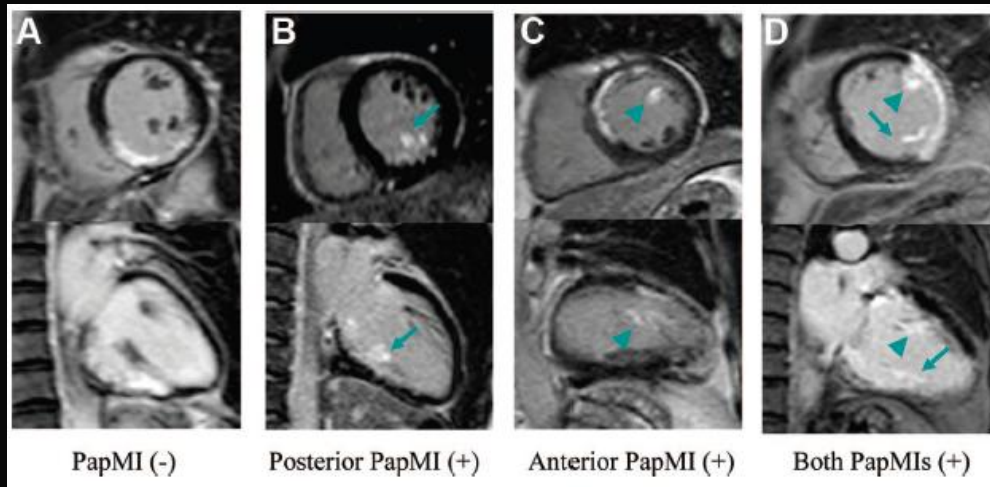


LV Stroke Volume – Aortic Systolic Flow
=
Mitral Regurgitant Volume

Kon MW et al. J Heart Valve Dis 2004

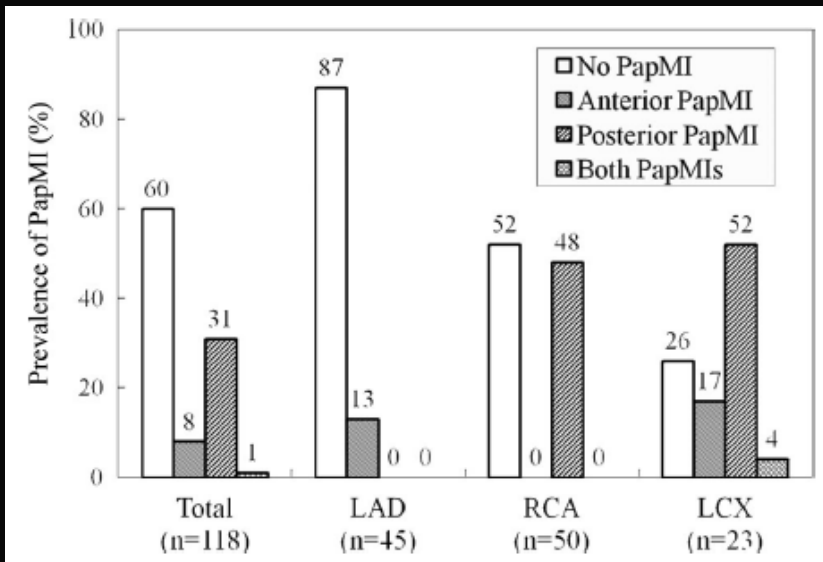
Prevalence and Clinical Significance of Papillary Muscle Infarction Detected by LGE MRI in Patients With STEMI

Tanimoto T et al. *Circulation* 2010



N= 118 STEMI with primary PCI
PapMI in 40%

	MR		P
	Yes (n=34)	No (n=84)	
Maximum total CK, IU/L	3229±2487	2509±1747	0.08
Maximum CK-MB, IU/L	301±123	209±150	<0.01
Infarct-related artery, n			0.44
LAD	11	34	
LCx	9	14	
RCA	14	36	
Time to reperfusion, h	5.3±3.1	5.0±3.3	0.65
LVEDV, mL	130±33	116±29	0.20
LVESV, mL	71±28	60±25	0.04
LVEF, %	47±10	50±10	0.14
Infarct size, %	21±8	16±11	0.02
MVO, n (%)	11 (32)	27 (32)	1.00
Sphericity index	0.61±0.06	0.57±0.07	0.04
Mitral annular diameter, mm	34.9±2.7	34.4±2.8	0.29
Coaptation height, mm	6.7±1.6	3.6±1.5	<0.01
LA diameter, mm	32.7±6.1	31.1±5.7	0.18
PapMI, n (%)			0.32
None	18 (53)	53 (63)	
Anterior	2 (6)	8 (10)	
Posterior	14 (41)	23 (27)	

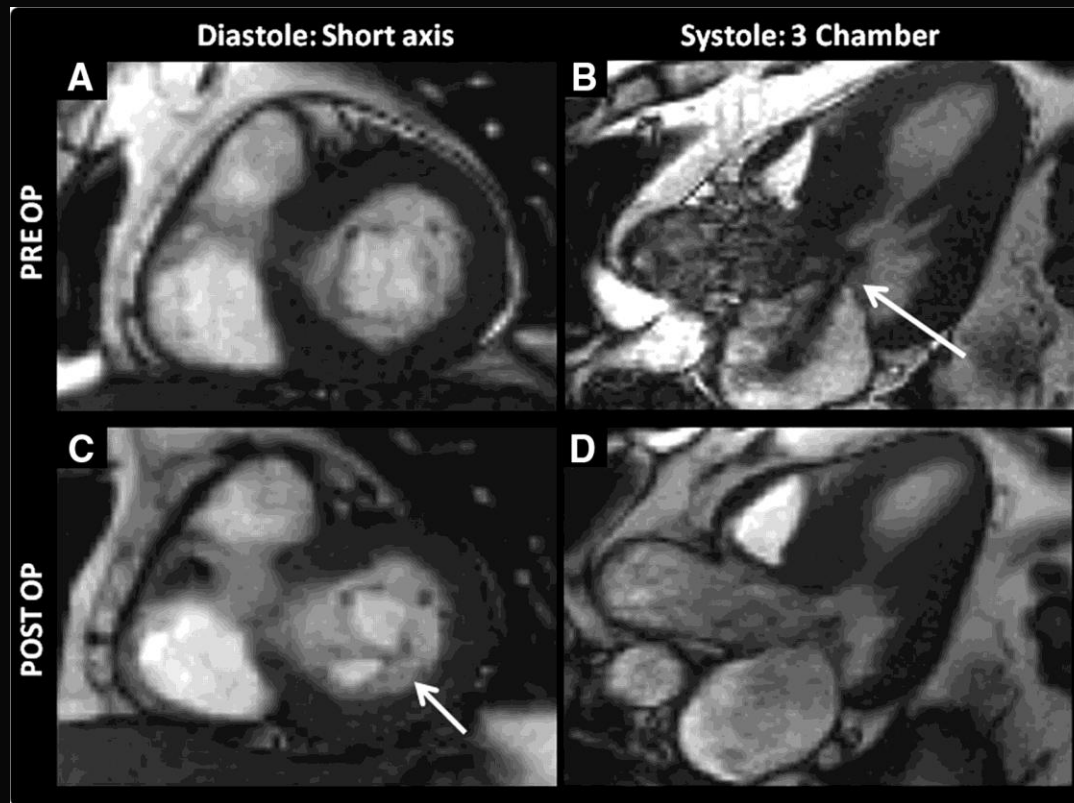


Myectomy Plus Alfieri Technique for Outflow Tract Obstruction in Hypertrophic Cardiomyopathy

Sado DM et al. *Circulation* 2010

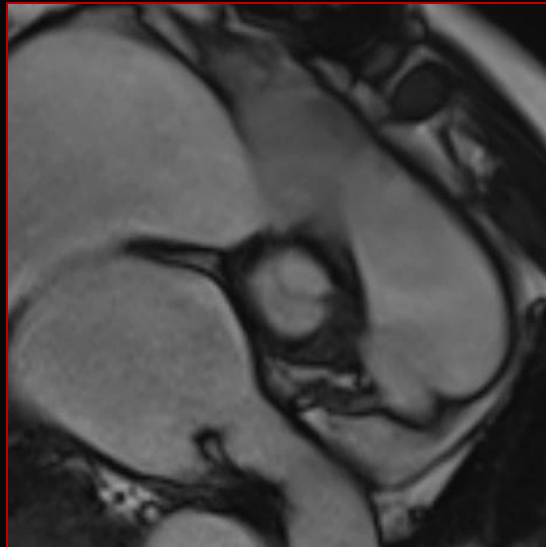
Pre-op:

- Septal hypertrophy
- SAM of the anteriore mitral leaflet
- Severe mitral regurgitation
- LVOT gradient = 40 mmhg (56 mmhg during Valsalva)

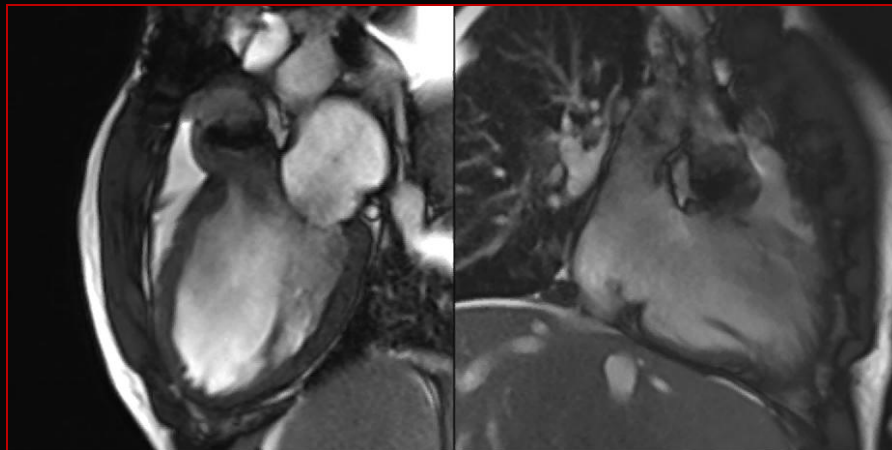
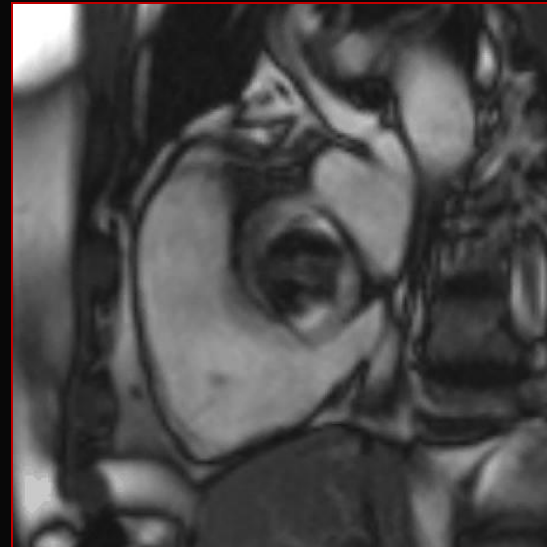


Cardiovascular MR: Prosthetic Valves

Biological



Mechanical



Heart Valve Disease: Investigation by Cardiovascular MRI

- Limitations -

Spatial Resolution

(valve thickness = 1-2 mm; slice thickness = 5-6 mm)



Partial volume effect

Temporal Resolution

(30-50 ms)



Underestimation of functional significance of valve disease

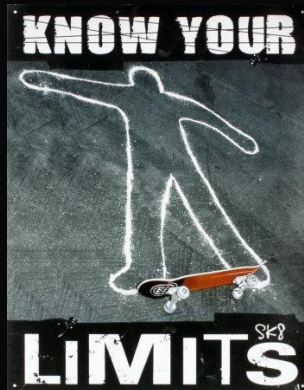
Multisegment acquisition

(signal coverage from multiple cardiac cycles)



Suboptimal visualization of small/chaotically mobile structures (i.e. vegetations)

Very irregular rhythms (e.g. uncontrolled AF, multiple VEs) can present a challenge



Guidelines on the management of valvular heart disease (version 2012)

The Joint Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Table 11 Recommendations for the use of transcatheter aortic valve implantation

Recommendations	Class ^a	Level ^b	Ref ^c
TAVI should only be undertaken with a multidisciplinary 'heart team' including cardiologists and cardiac surgeons and other specialists if necessary.	I	C	
TAVI should only be performed in hospitals with cardiac surgery on-site.	I	C	
TAVI is indicated in patients with severe symptomatic AS who are not suitable for AVR as assessed by a 'heart team' and who are likely to gain improvement in their quality of life and to have a life expectancy of more than 1 year after consideration of their comorbidities.	I	B	99
TAVI should be considered in high-risk patients with severe symptomatic AS who may still be suitable for surgery, but in whom TAVI is favoured by a 'heart team' based on the individual risk profile and anatomic suitability.	Ila	B	97

Decision-making should ideally be made by a 'heart team' with a particular expertise in VHD, including cardiologists, cardiac surgeons, imaging specialists, anaesthetists and, if needed, general practitioners, geriatricians, or intensive care specialists.

Cardiochirurgo

Cardiologo
Interventista

Cardiologo
dell'Imaging

Cardioanestesista

QUAL E' LA VOSTRA
OPINIONE CIRCA LA
SCARSITA' DEGLI
ALIMENTI NEL
MONDO?

COSA SONO
GLI
"ALIMENTI"?

COS'E'
LA
"SCARSITA'?"

COS'E' IL
"RESTO DEL
MONDO?"

COS'E' L'
"OPINIONE"?

AFRICA

EUROPA

AMERICA

ARABIA

Cardiologo
clinico

بيومسنا

Laboratorio RM Cardiaca

Ospedale Medico-Chirurgico Accreditato Villa dei Fiori
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**CORSO AVANZATO DI ECOCARDIOGRAFIA DI
"ECOCARDIOCHIRURGIA"
*con uno sguardo all'imaging integrato***

**Valvulopatie: la Selezione ed il Ruolo del
Centro di III Livello: Come Arrivare alle
Ragionevoli Certezze?**

La RM Può Aiutarci?

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