MRI for assessment of valvular heart disease: promises and pitfalls

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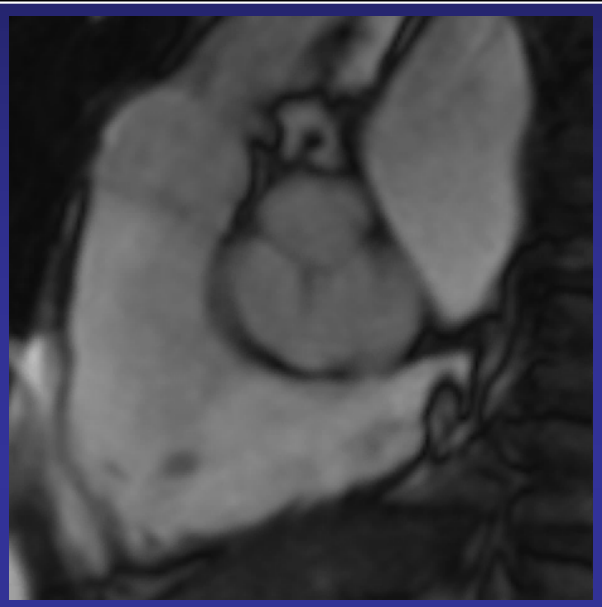
MR comprehensive evaluation

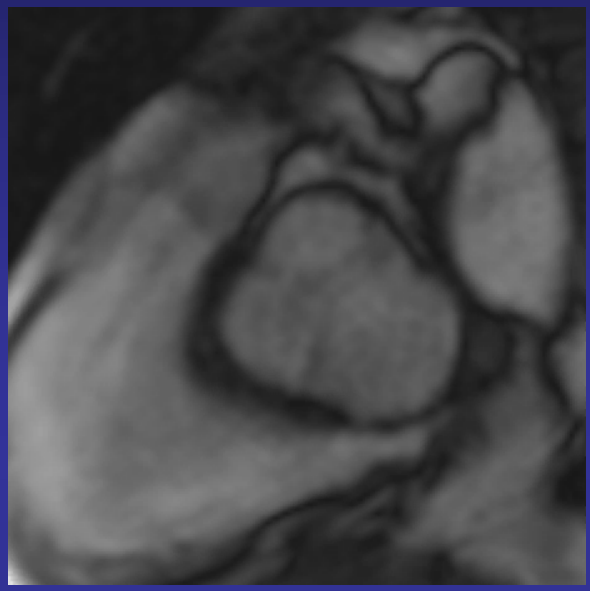
- **Morphology**
- **Function**
- **Flow velocity**
- **3D Angiography**
- **Collateral pathologies** → CAD, DCM, HCM, Myocarditis, Aortic diseases, Congenital HD

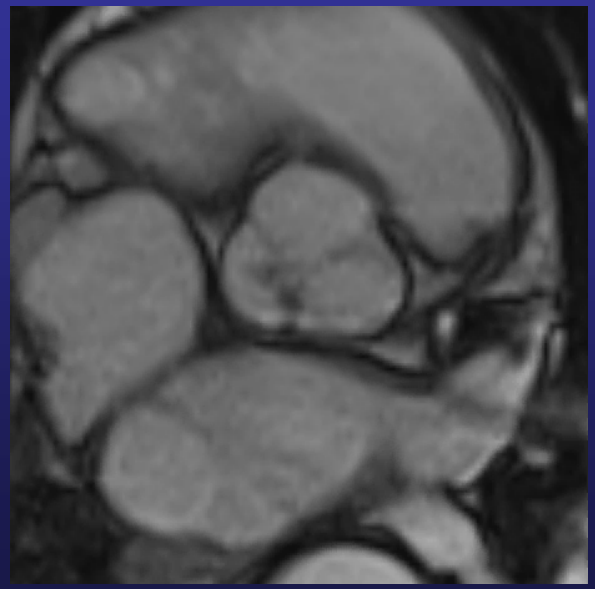
Aortic Regurgitation

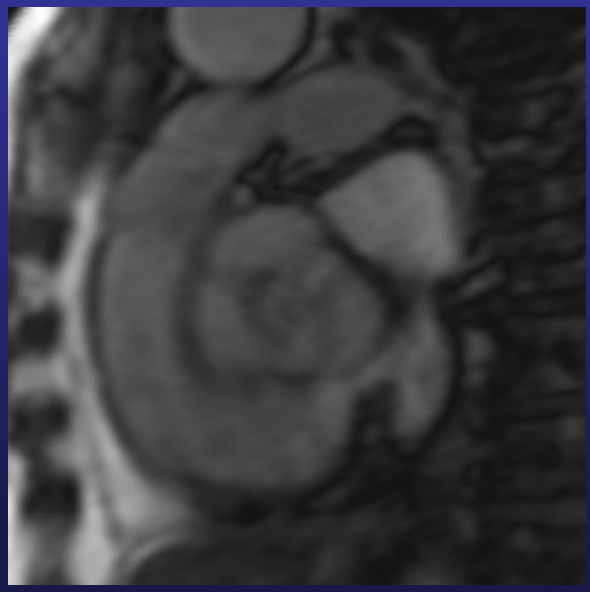
MORPHOLOGY AND FUNCTION

SSFP CINE MRI

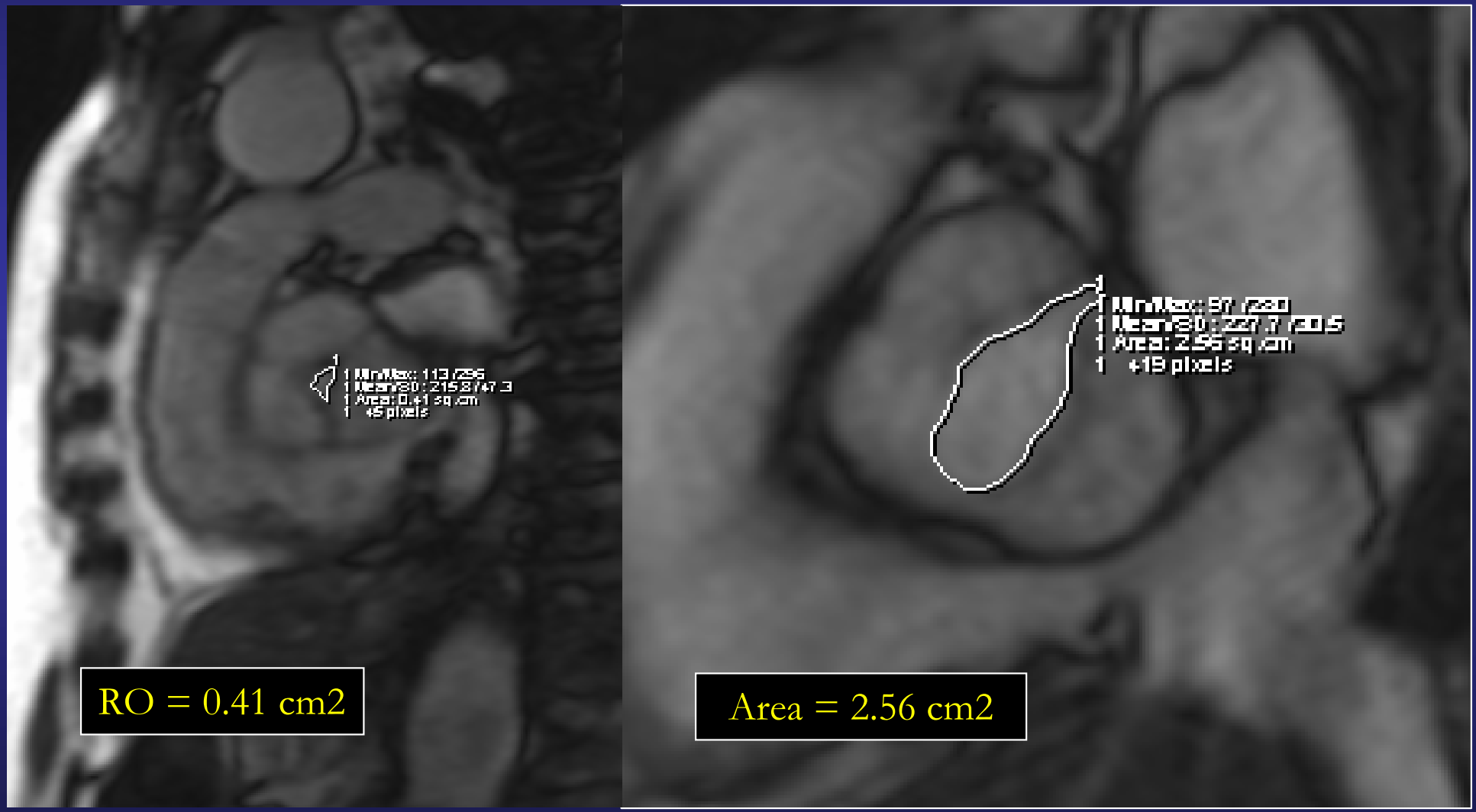






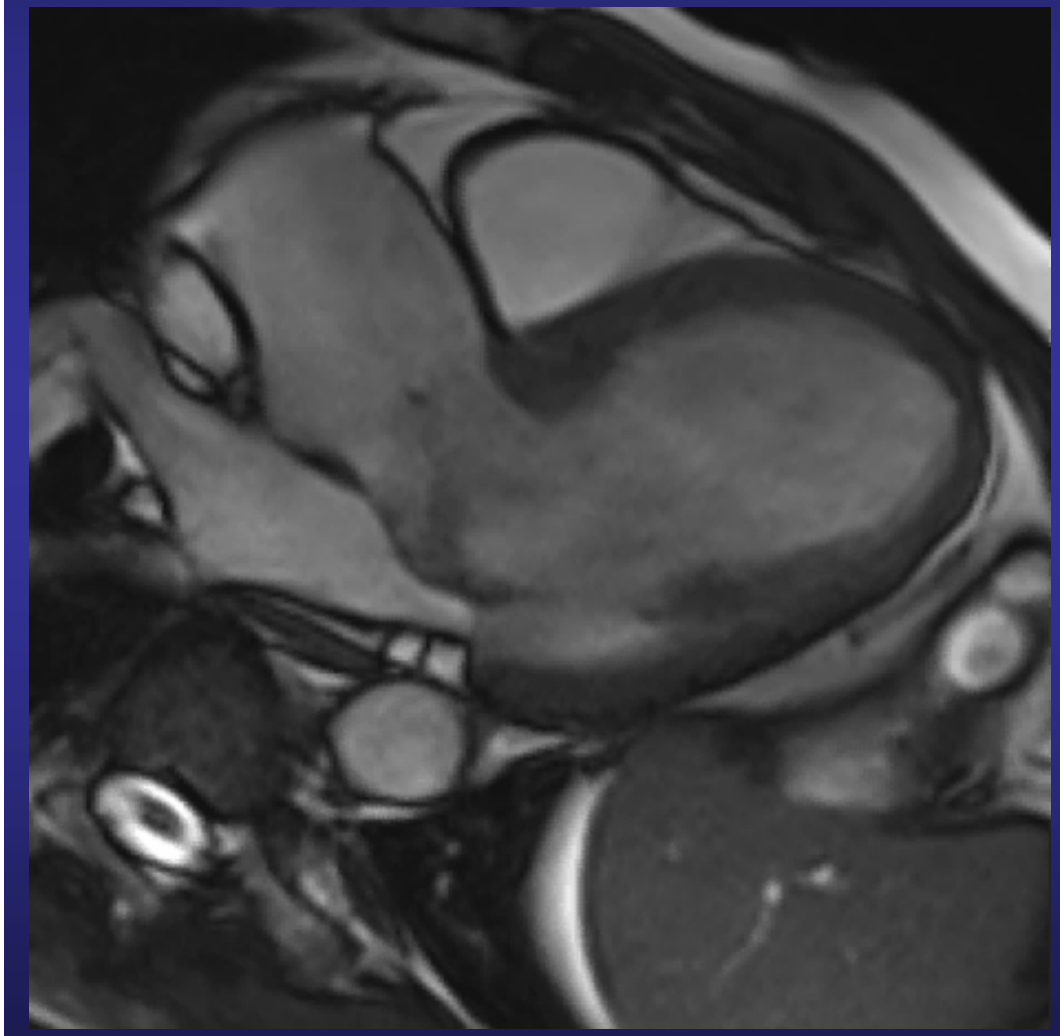


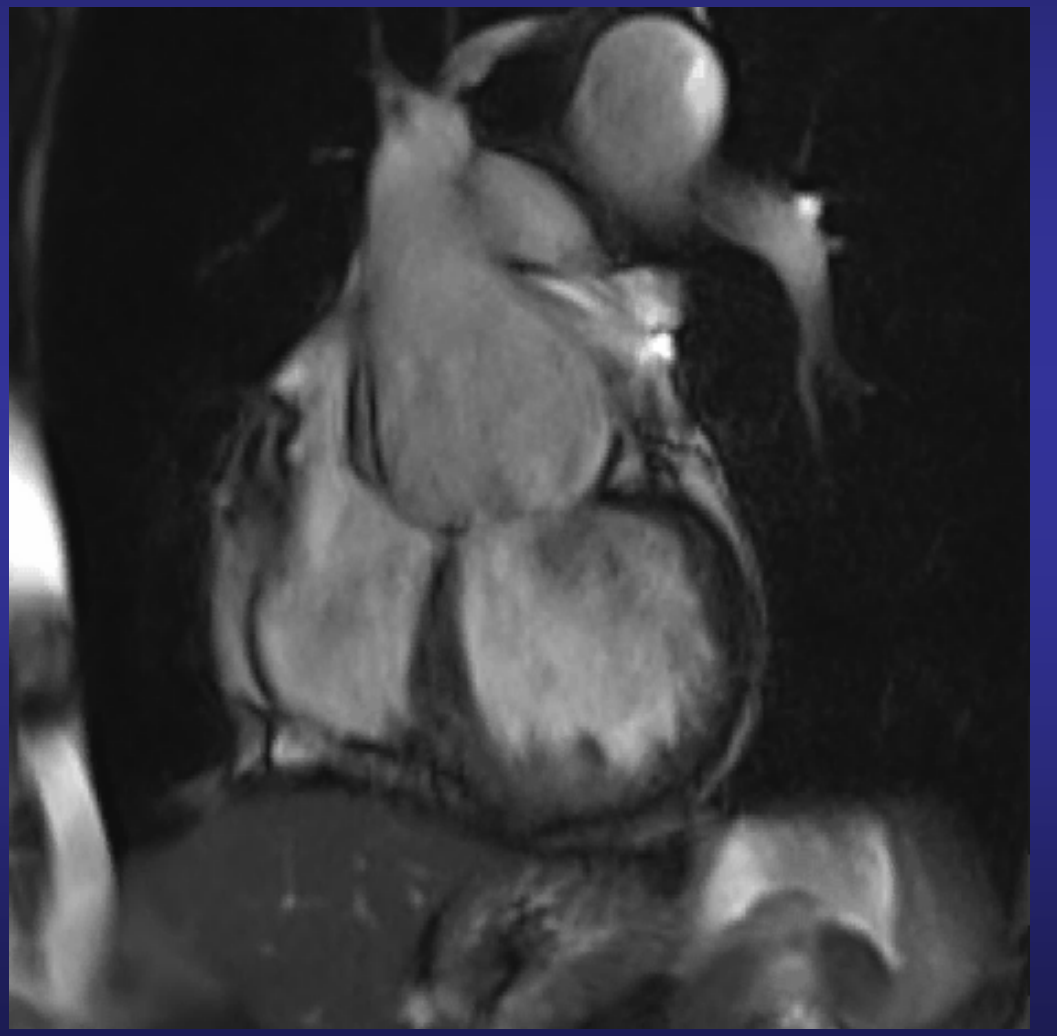
VALVULAR MORPHOLOGY – SSFP CINE MRI



Circulation 2009; 119: 468-478

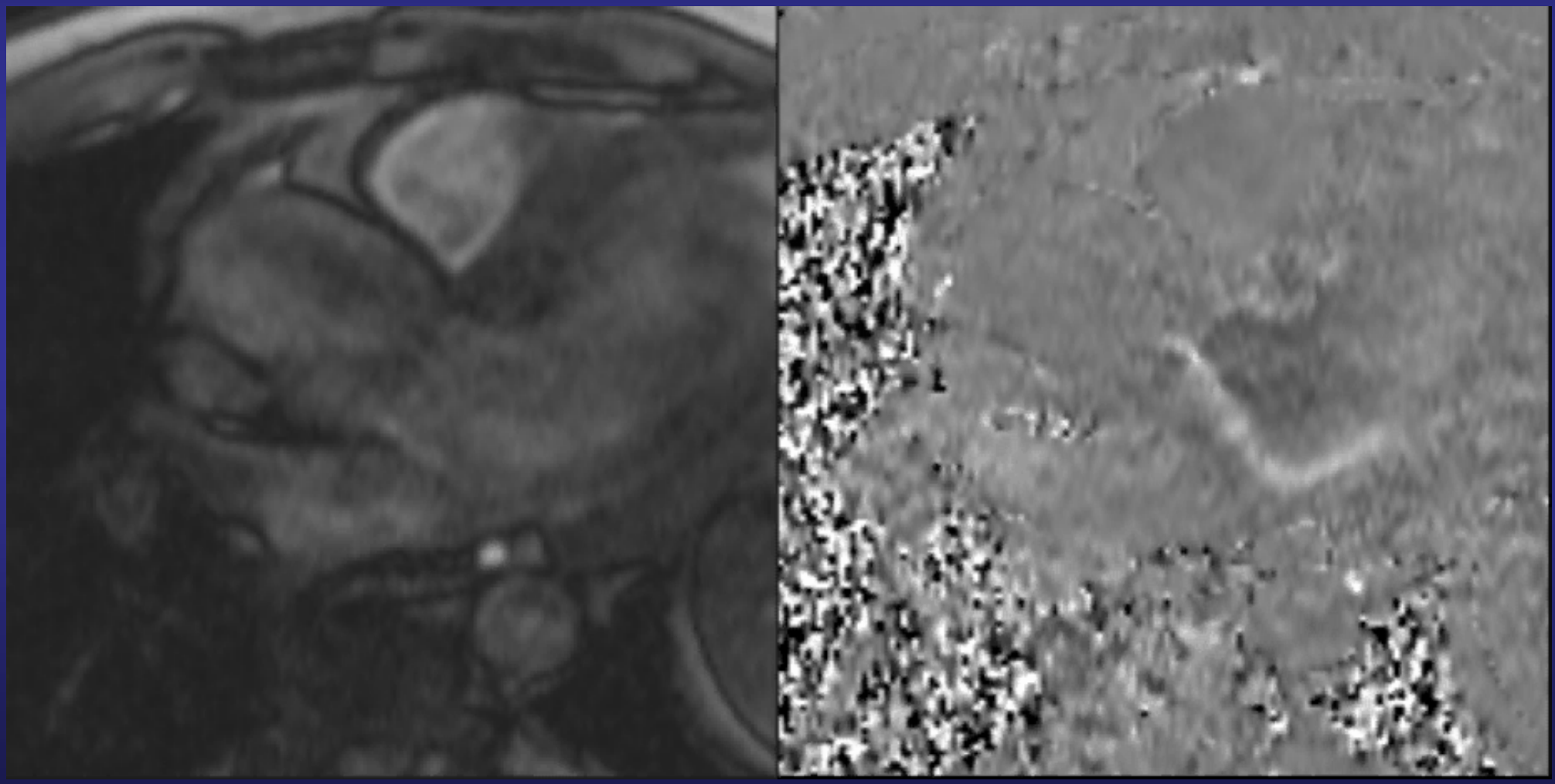
LV FUNCTION – SSFP CINE MRI



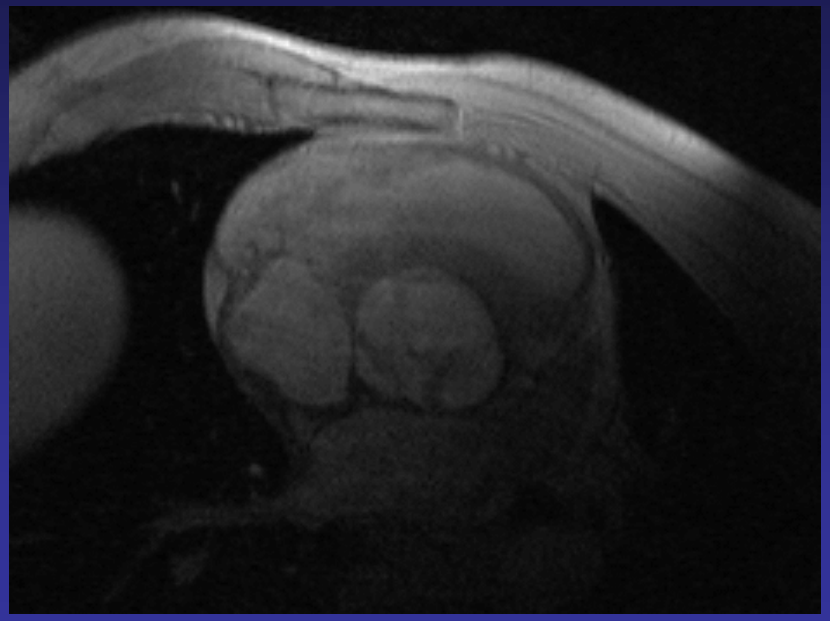


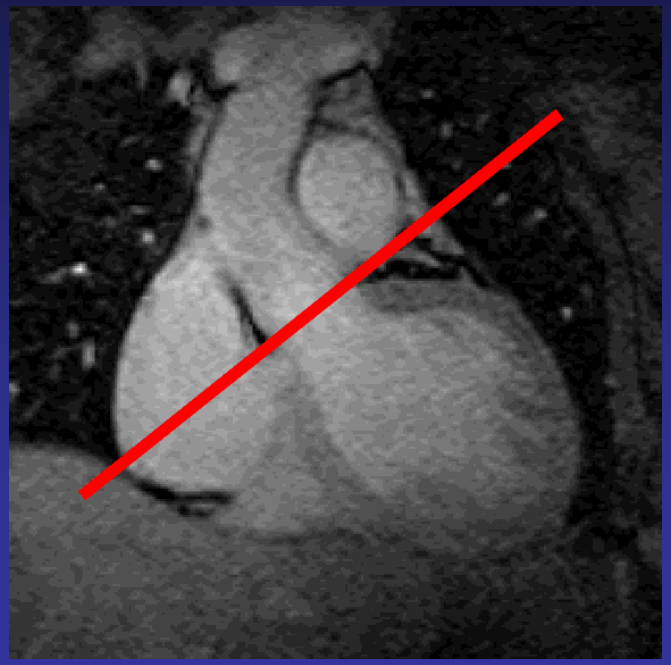
– PHASE-CONTRAST CINE MRI – IN PLANE

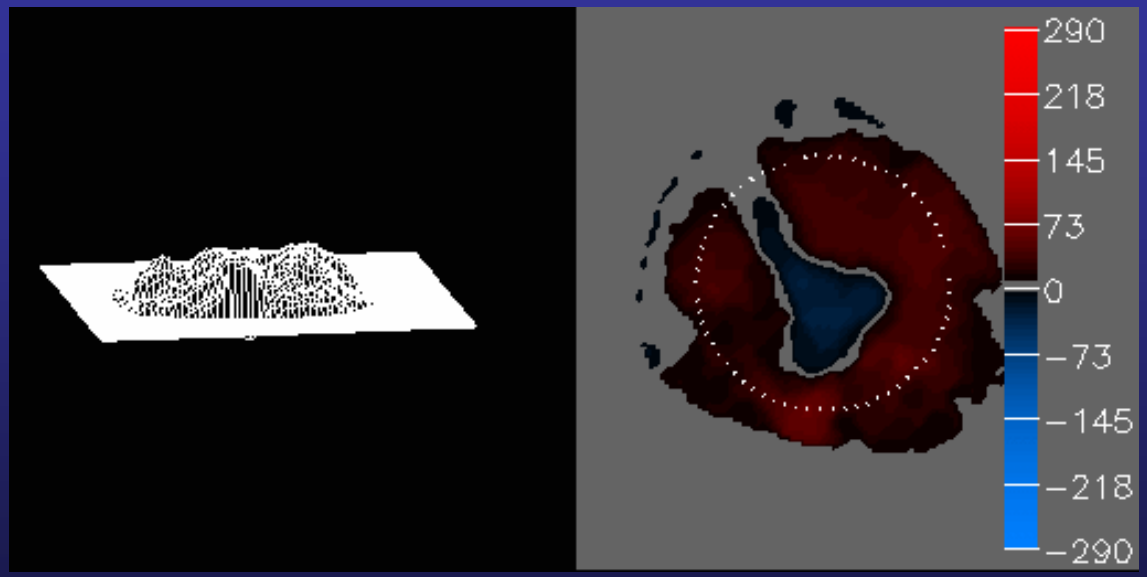
AORTIC REGURGITATION

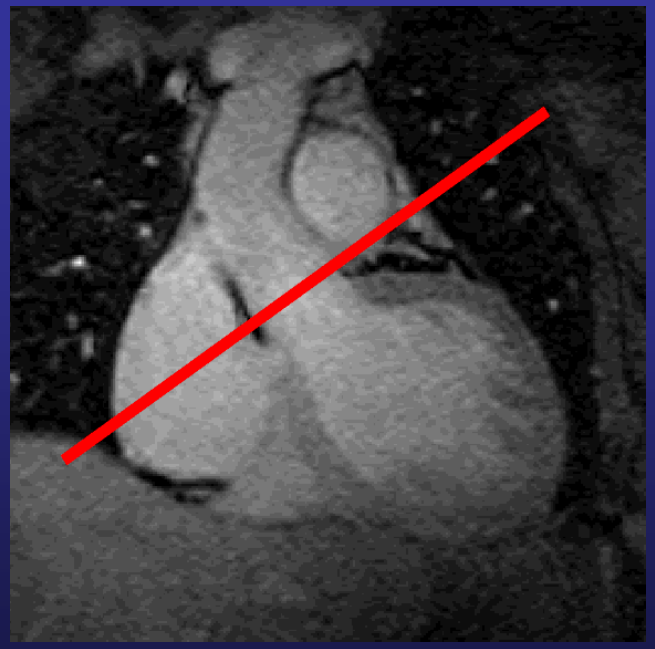


AORTIC REGURGITATION, THROUGH PLANE, MOTION-TRIGGERED 3 D VOLUMETRIC RENDERING





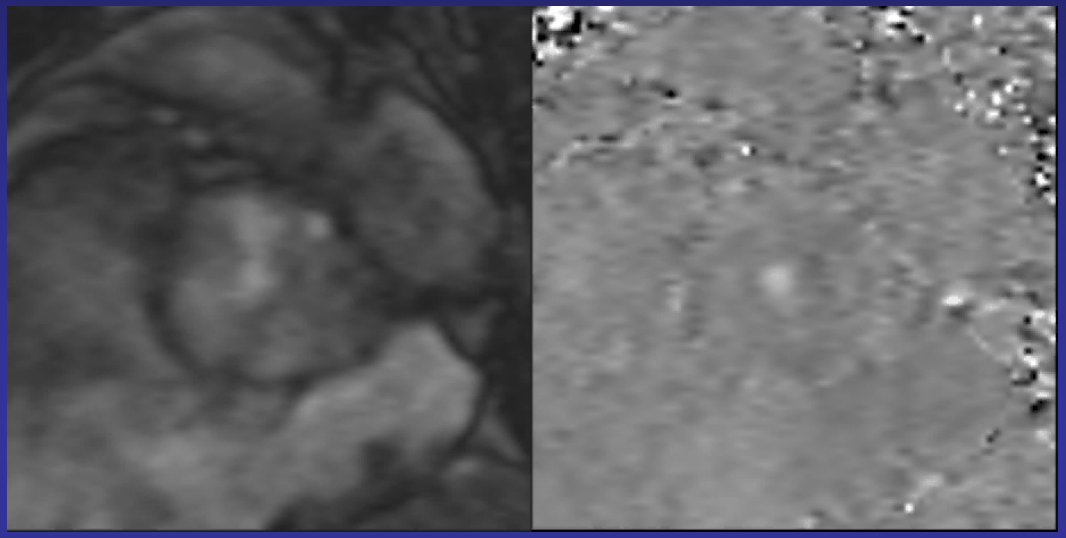


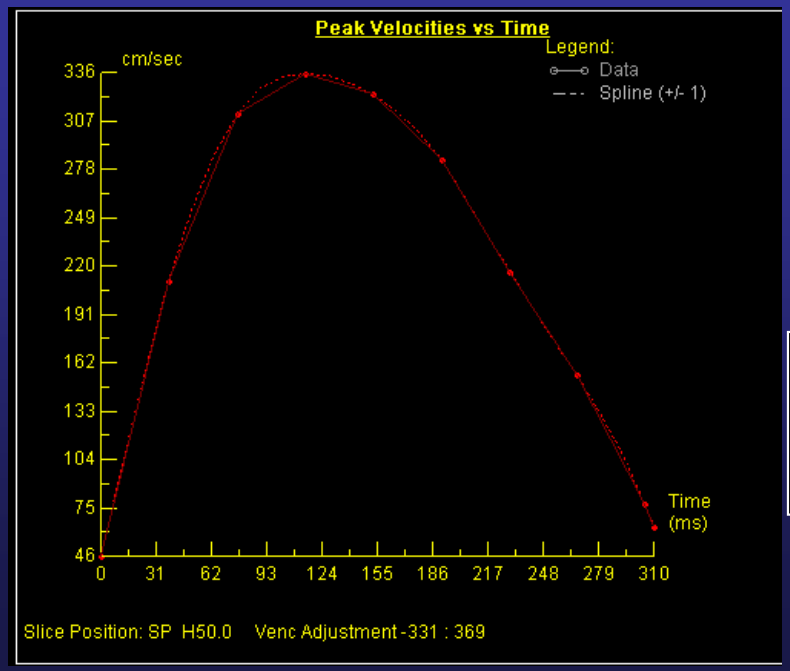


Schwitter

AORTIC REGURGITATION, BICUSPID VALVE

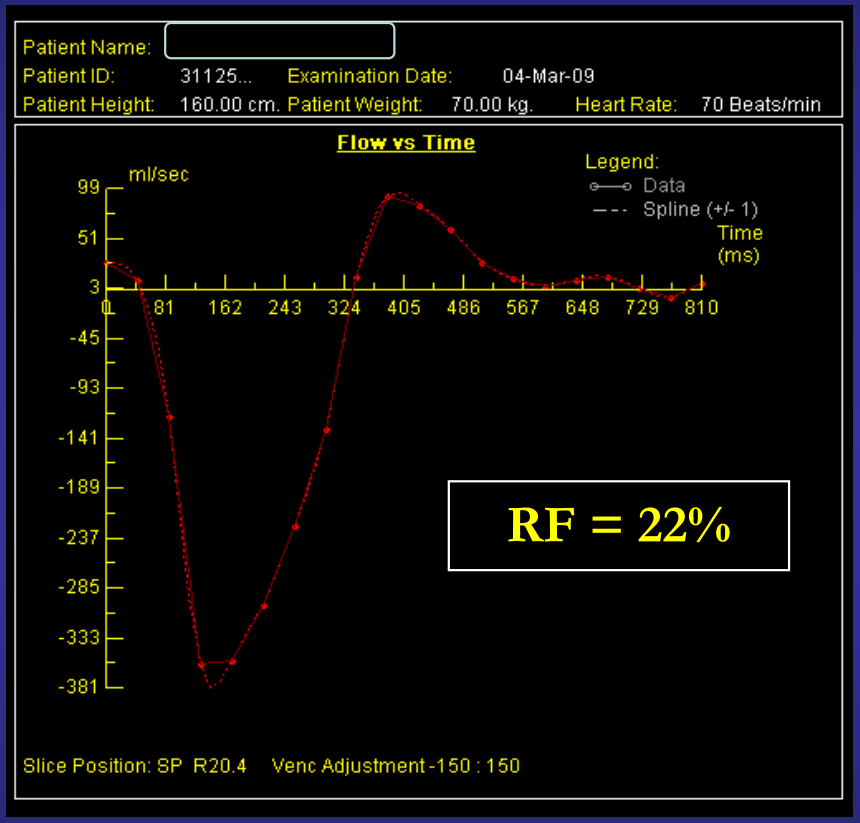
– PHASE-CONTRAST CINE MRI - THROUGH PLANE





V max = 3.37 m/s

ΔP max = 45 mmHg



RF = 22%

Circulation 2009; 119: 468-478

AORTIC REGURGITATION

REGURGITATION FRACTION (J Cardiovasc Magn Reson 2006)

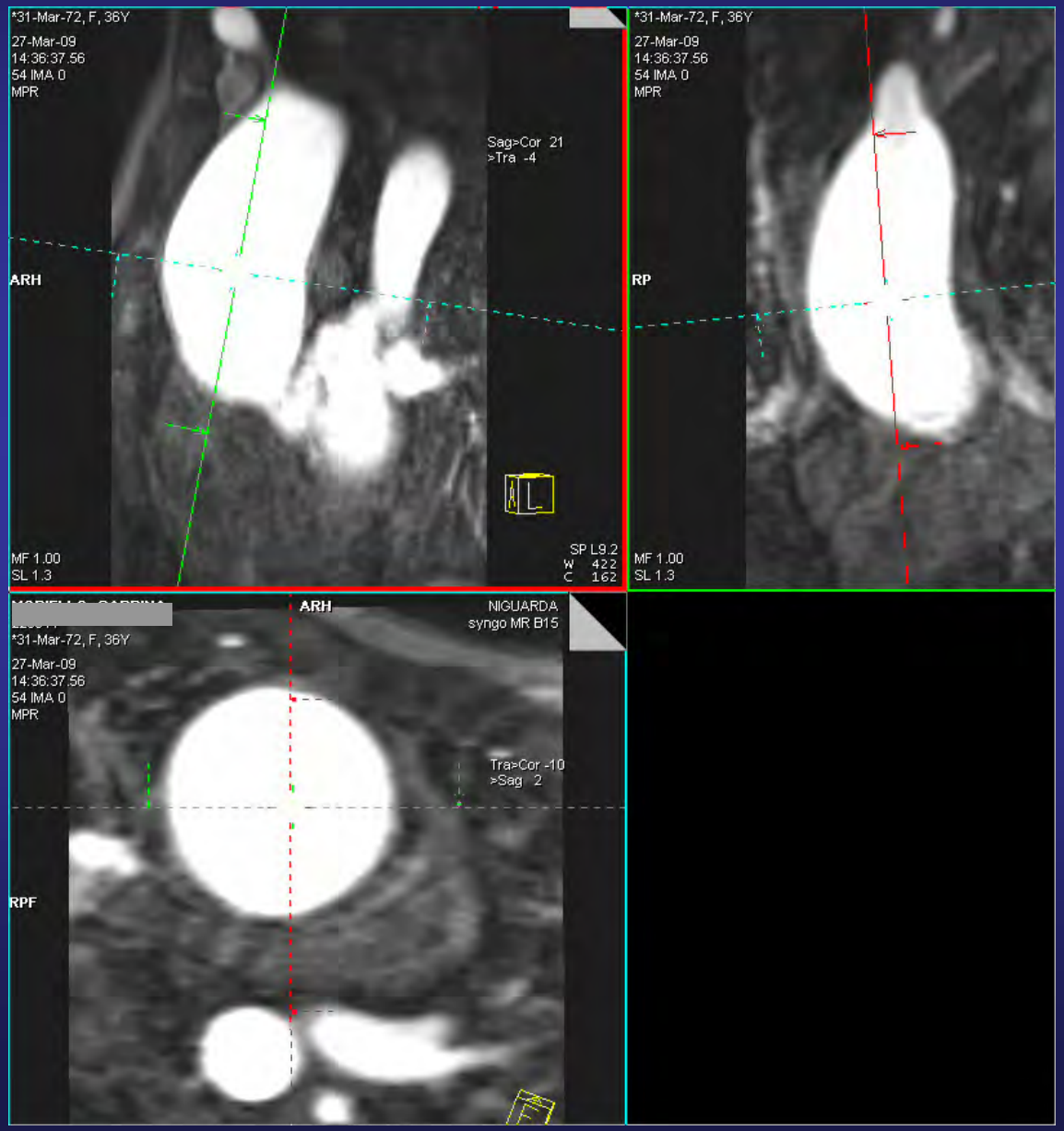
- MILD = RF ≤15%
- MODERATE = RF 16-25%
- MODERATE-SEVERE = RF 26-48%
- SEVERE = RF > 48%

REGURGITATION ORIFICE AREA (ROA) (Heart 2008)

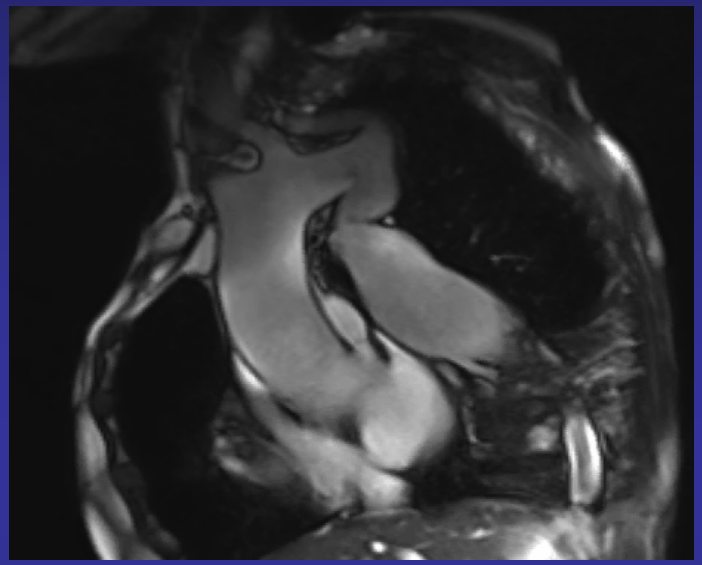
- MODERATE-SEVERE = ROA ≥0.28 cm2
- SEVERE = ROA ≥ 0.48 cm2

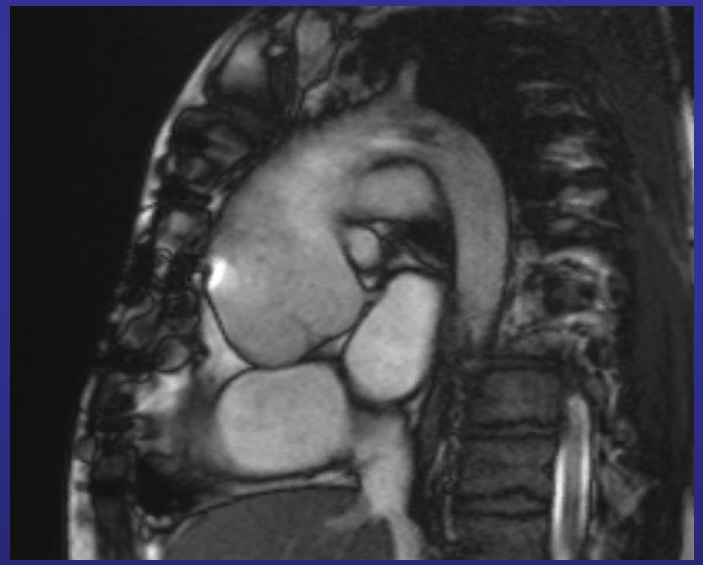
AORTIC ANGIOGRAPHY : ADDITIONAL INFORMATIONS

AORTIC DIAMETERS

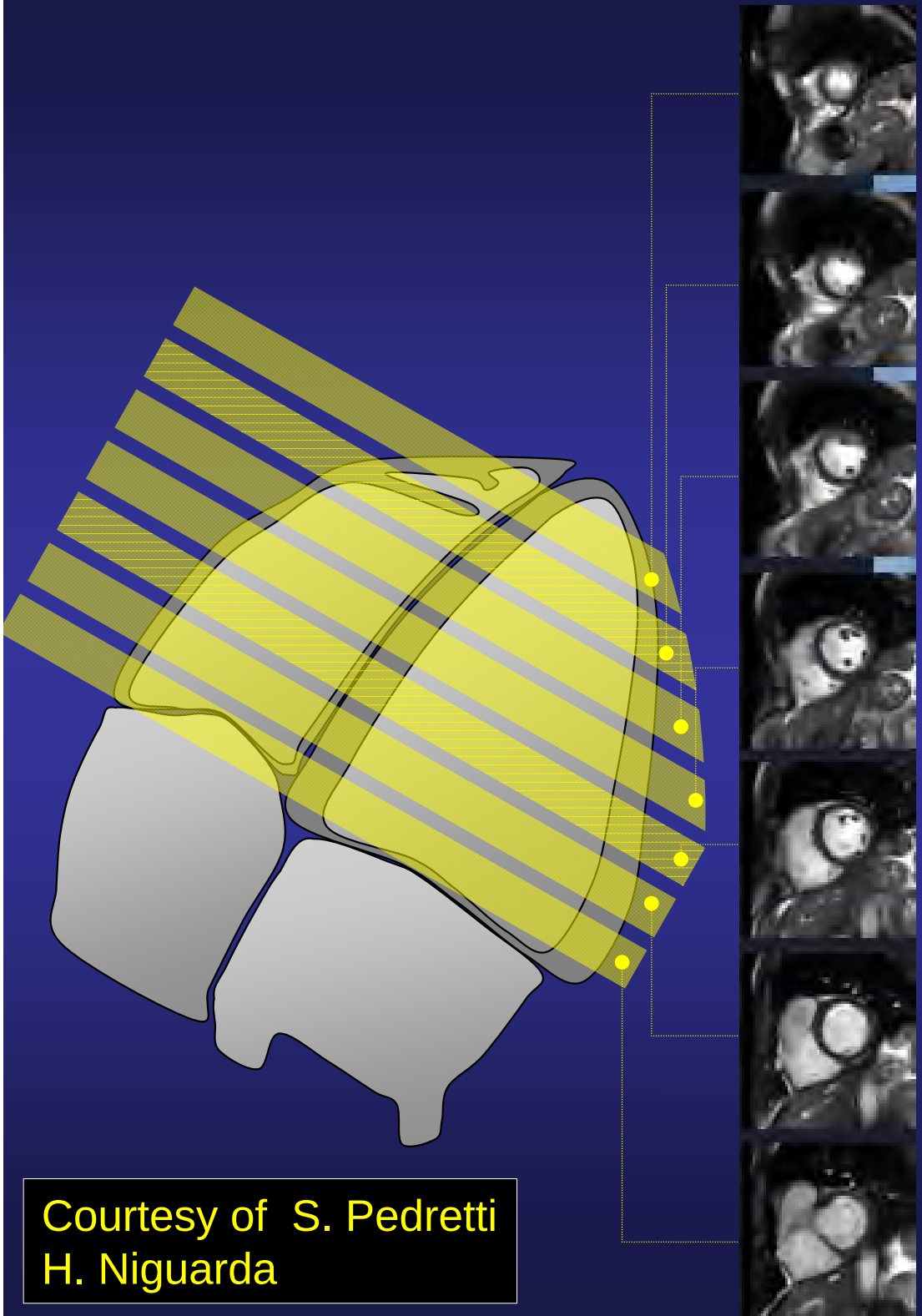


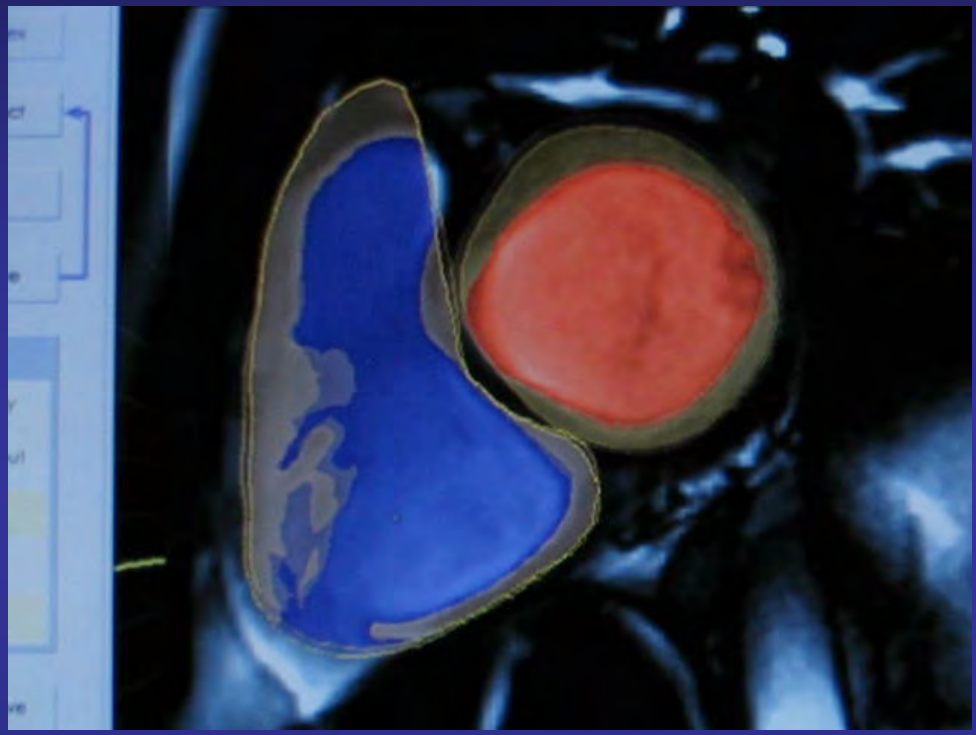
AORTIC ANGIOGRAPHY: ADDITIONAL INFORMATIONS





Ventricular Function – SSFP CINE MRI

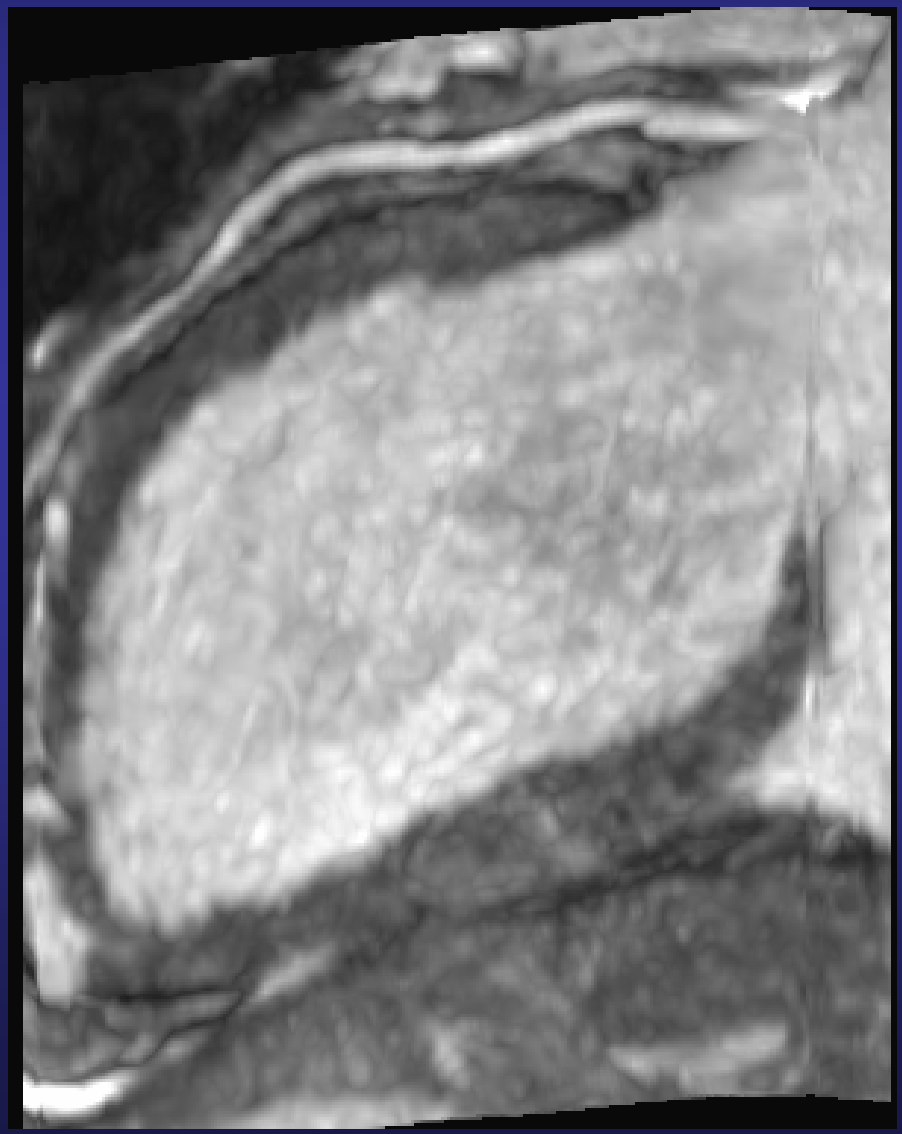




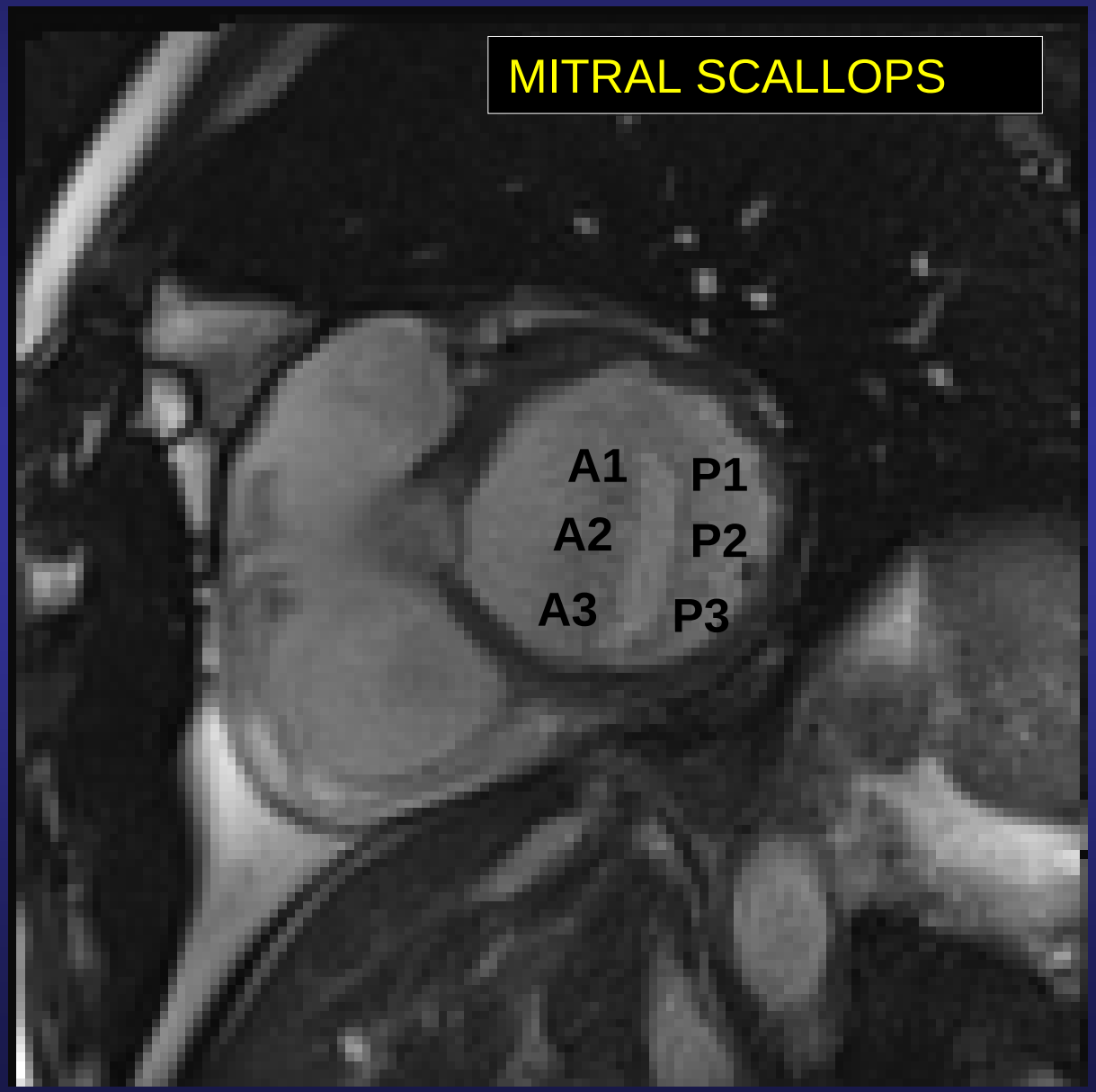
- CMR gold standard for RV and LV volumes and mass (Lancet 1985, Radiology 1990, 2005; J CMR 2003)
- FU pre and post cardiac surgery
- Regional wall motion analysis

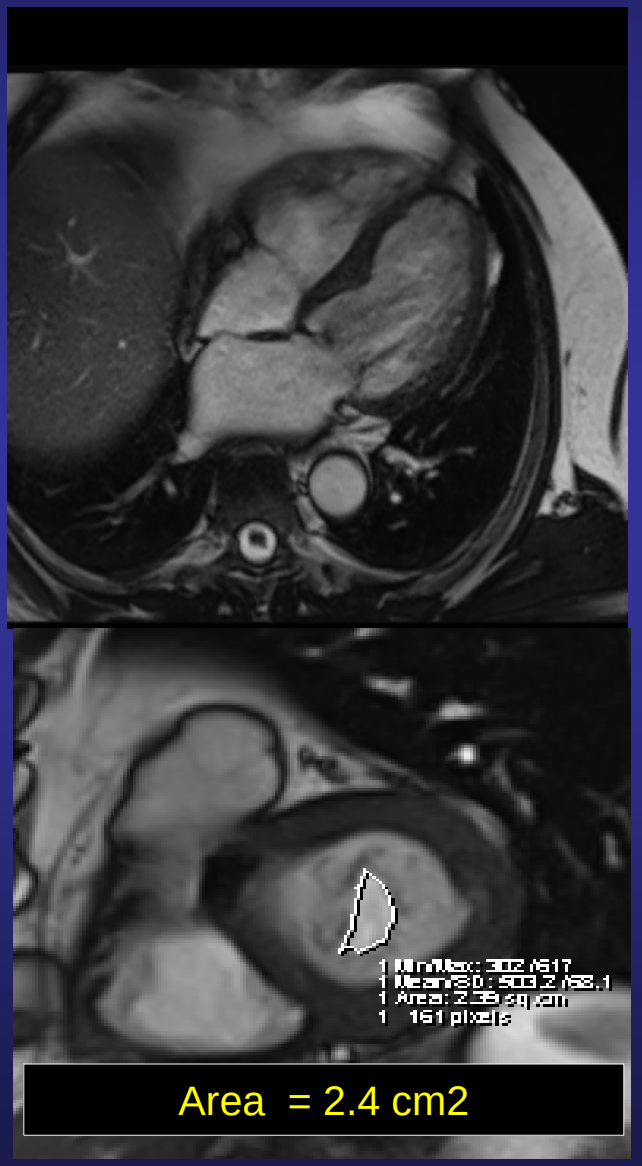
Courtesy of S. Pedretti
H. Niguarda

ADDITIONAL I NFORMATIONS: CORONARY ORIGIN AND COURSE

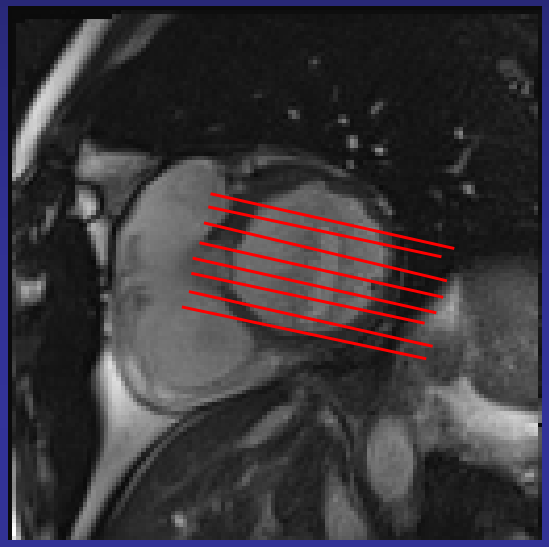


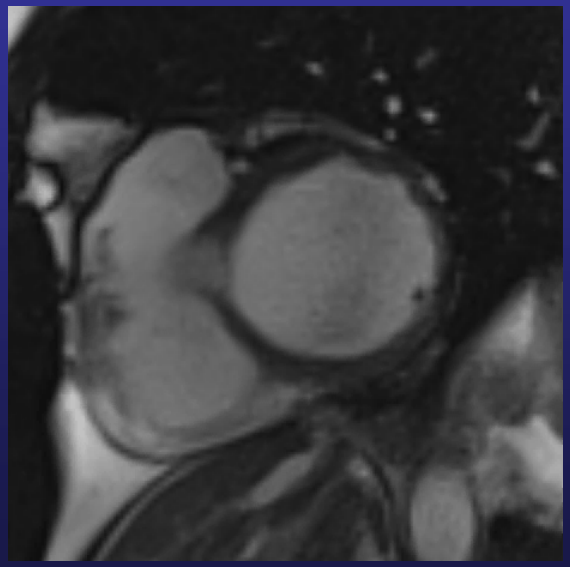
MITRAL VALVE– SSFP CINE MRI

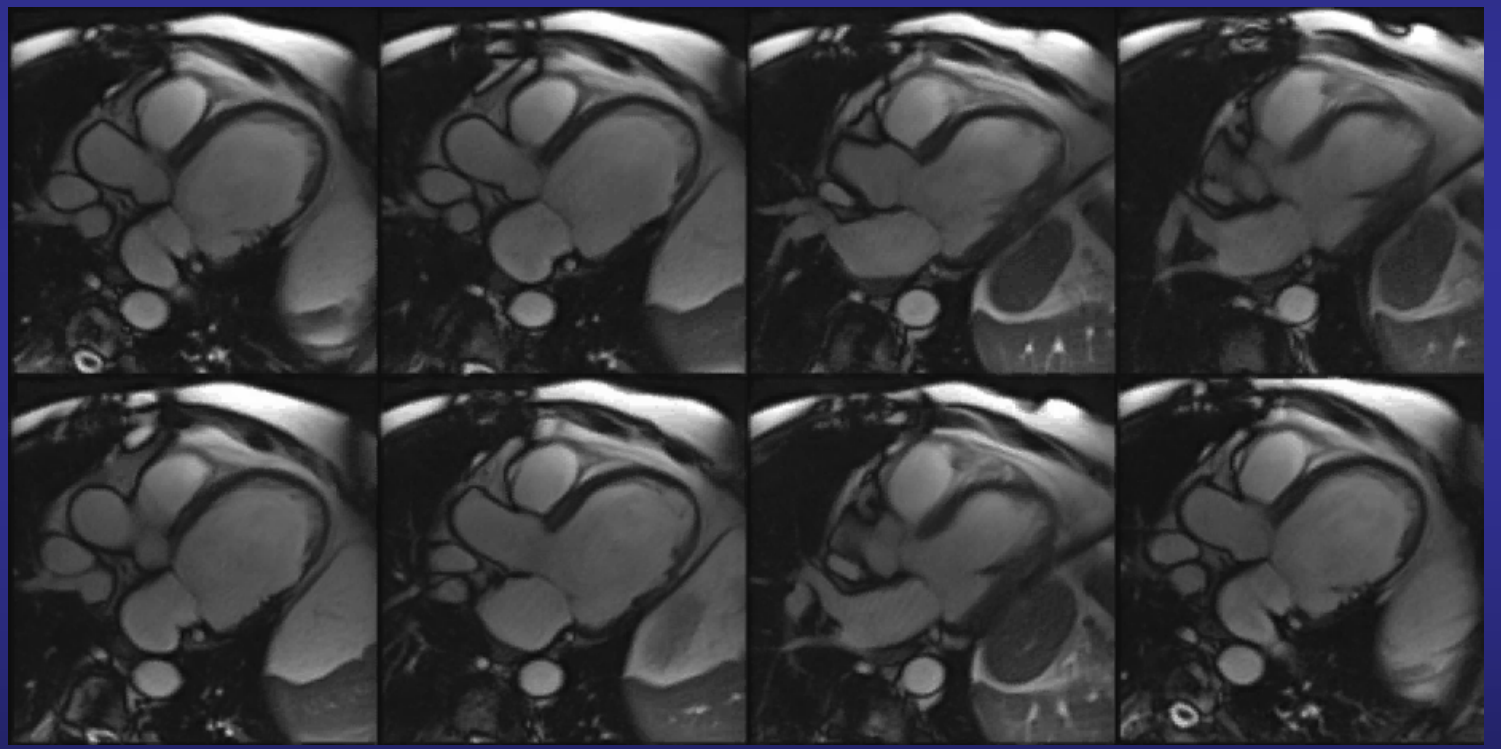




MITRAL VALVE – ANALYTIC EVALUATION WITH SSFP CINE MRI

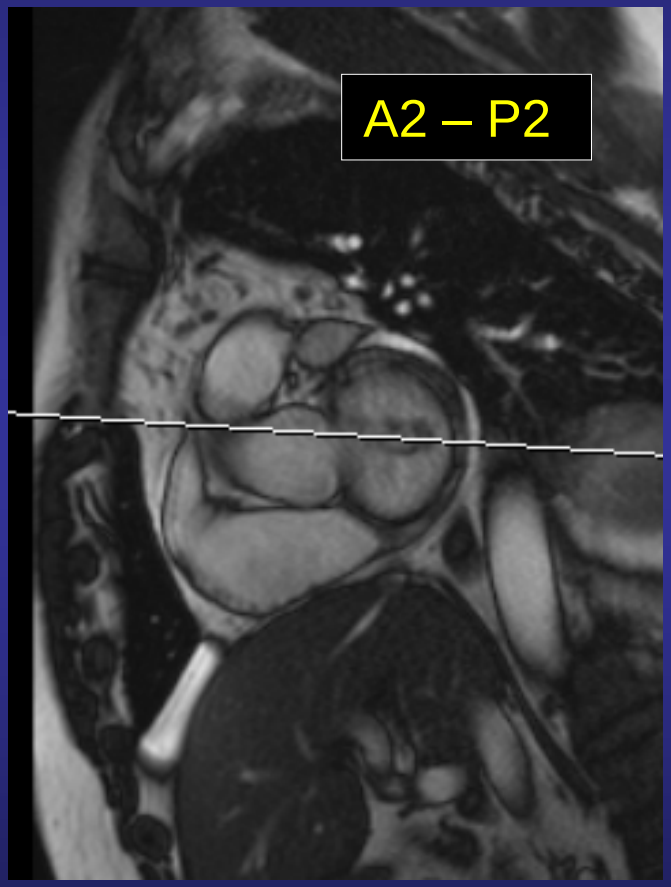


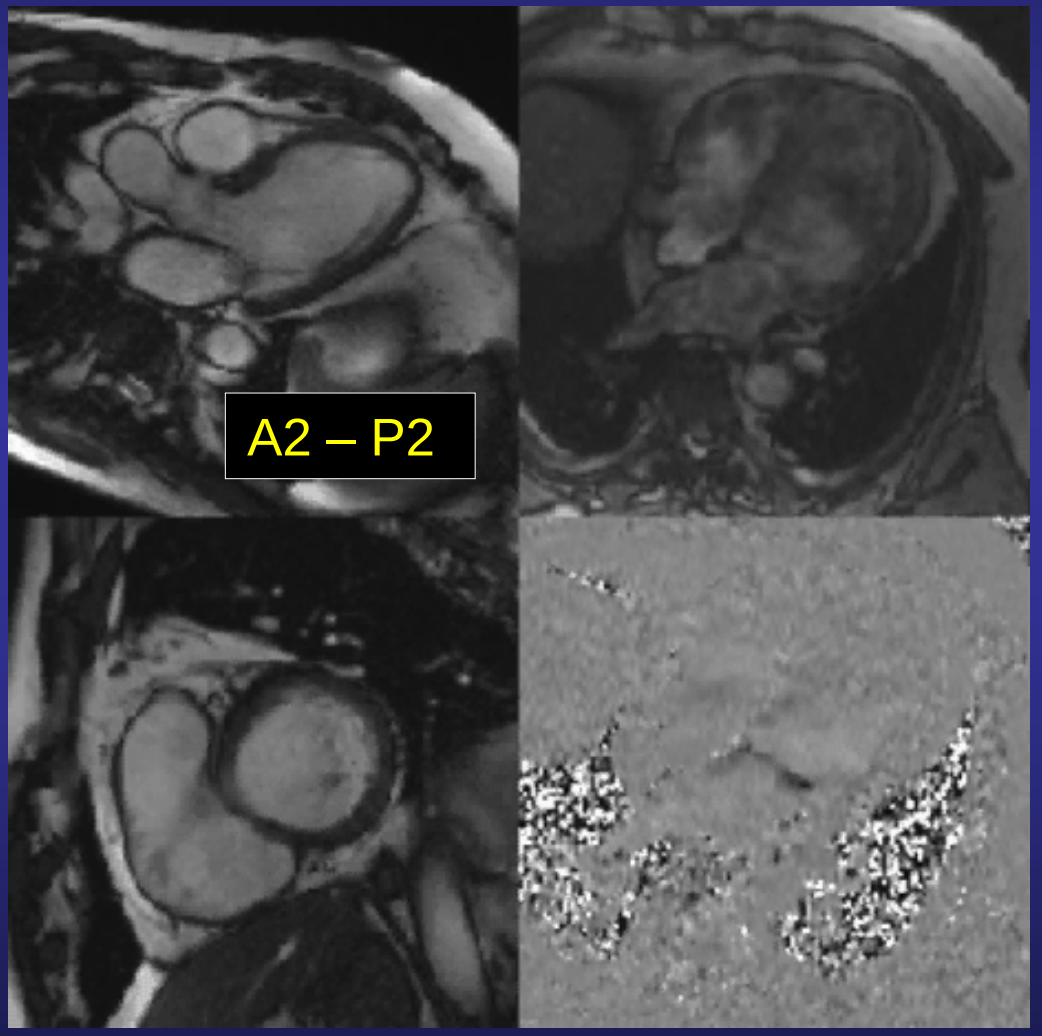




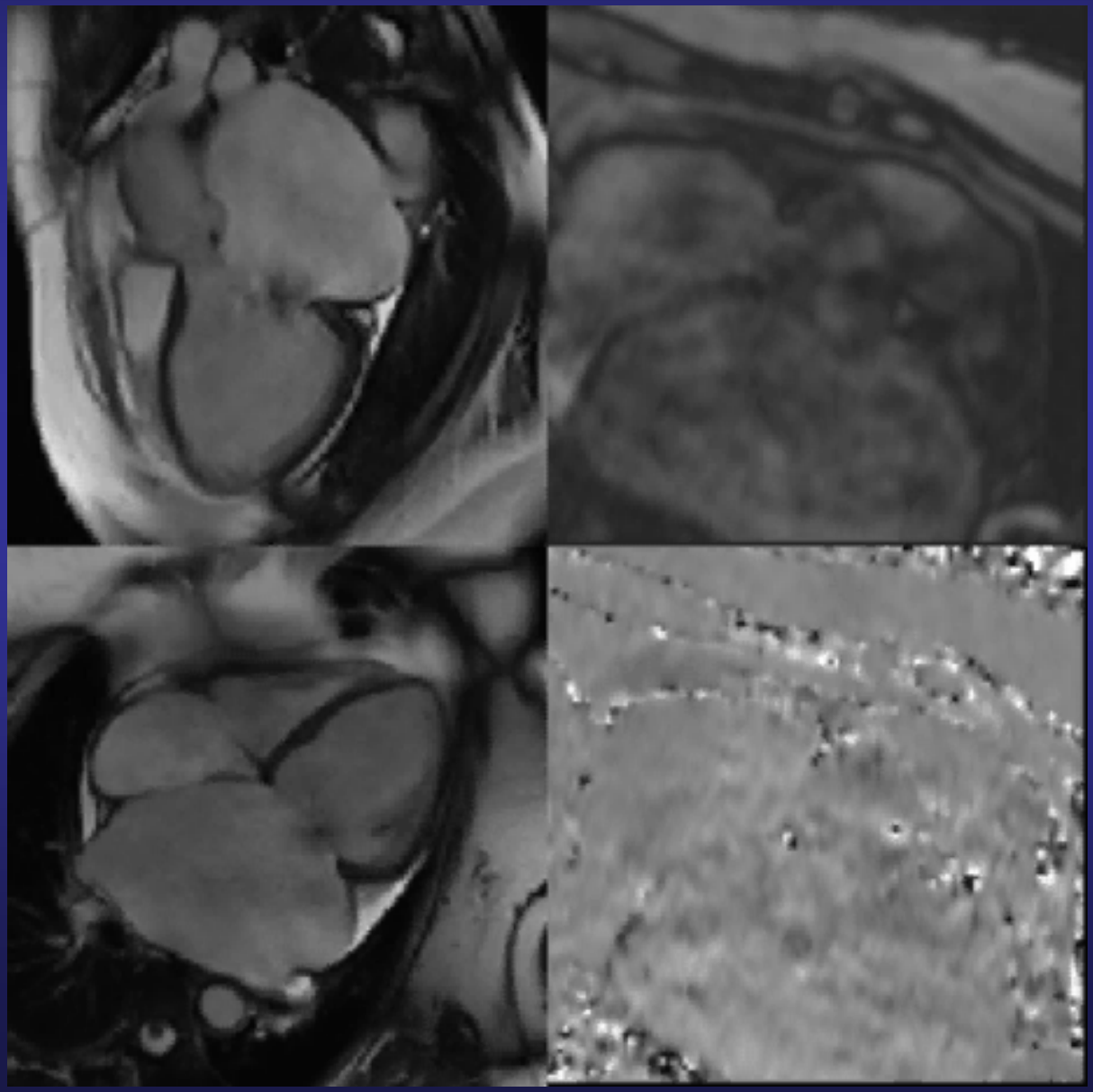
Chan KMJ et at. JCMR 2008;10:61

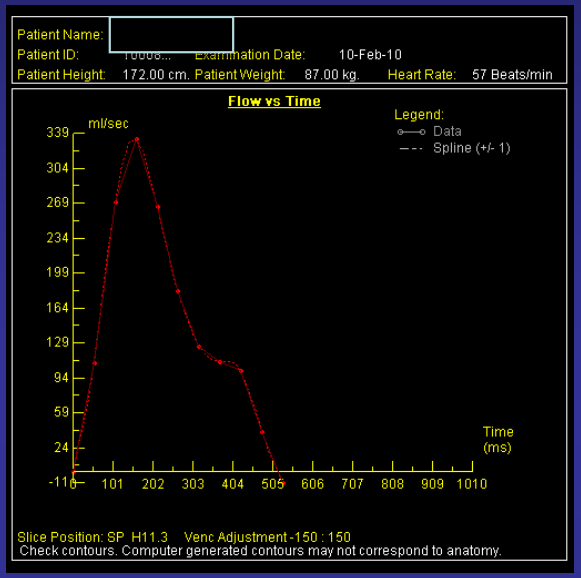
MITRAL VALVE – SSFP CINE MRI – PHASE CONTRAST MRI





MITRAL REGURGITATION – SSFP CINE MRI





REGURGITATION FRACTION

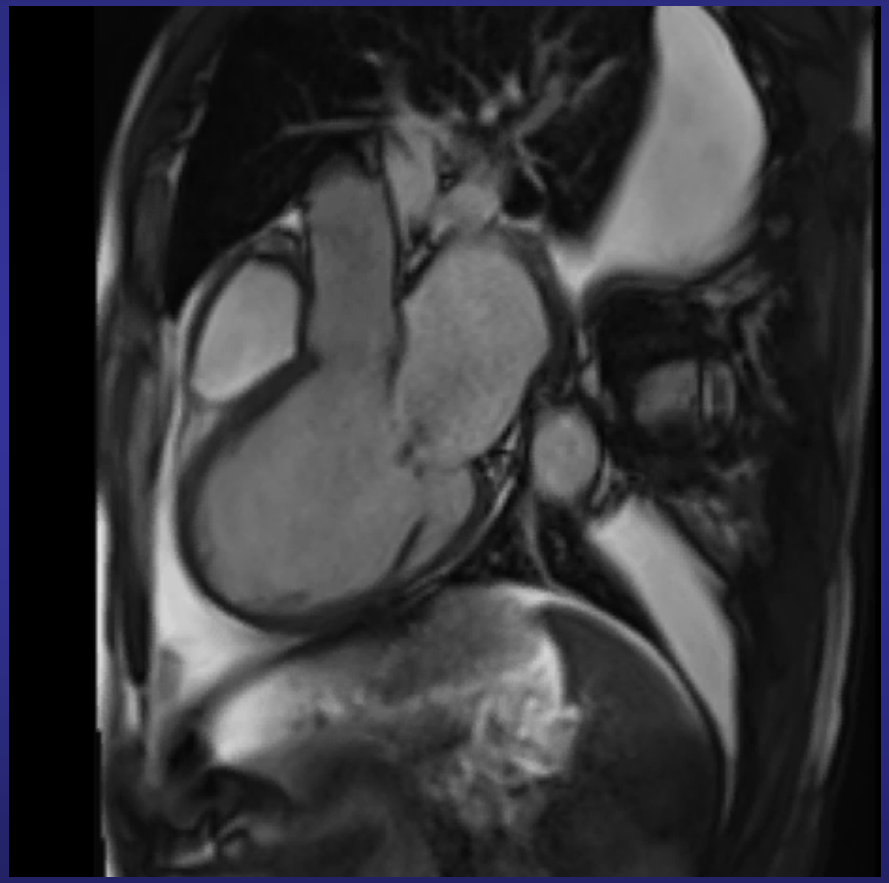
RF = LVSV – FWAo / LVSV

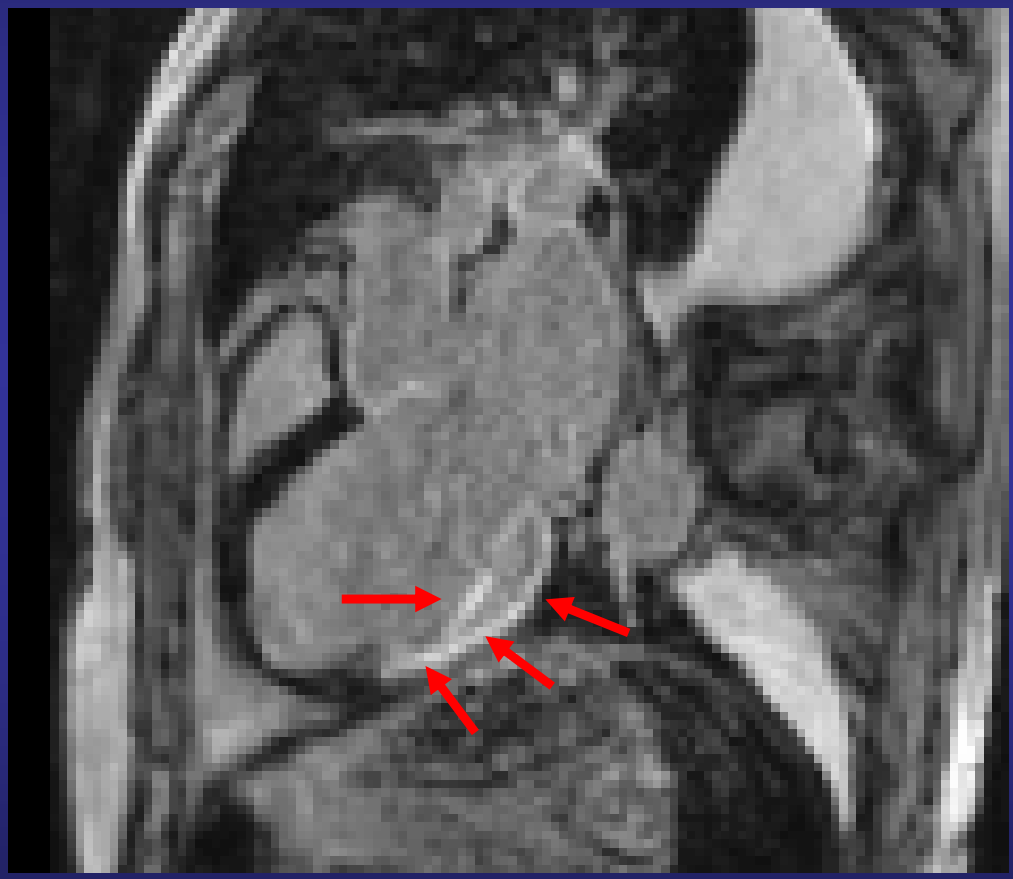
RF = LVSV – RVSV / LVSV

RV = 52ml, RF = 44%

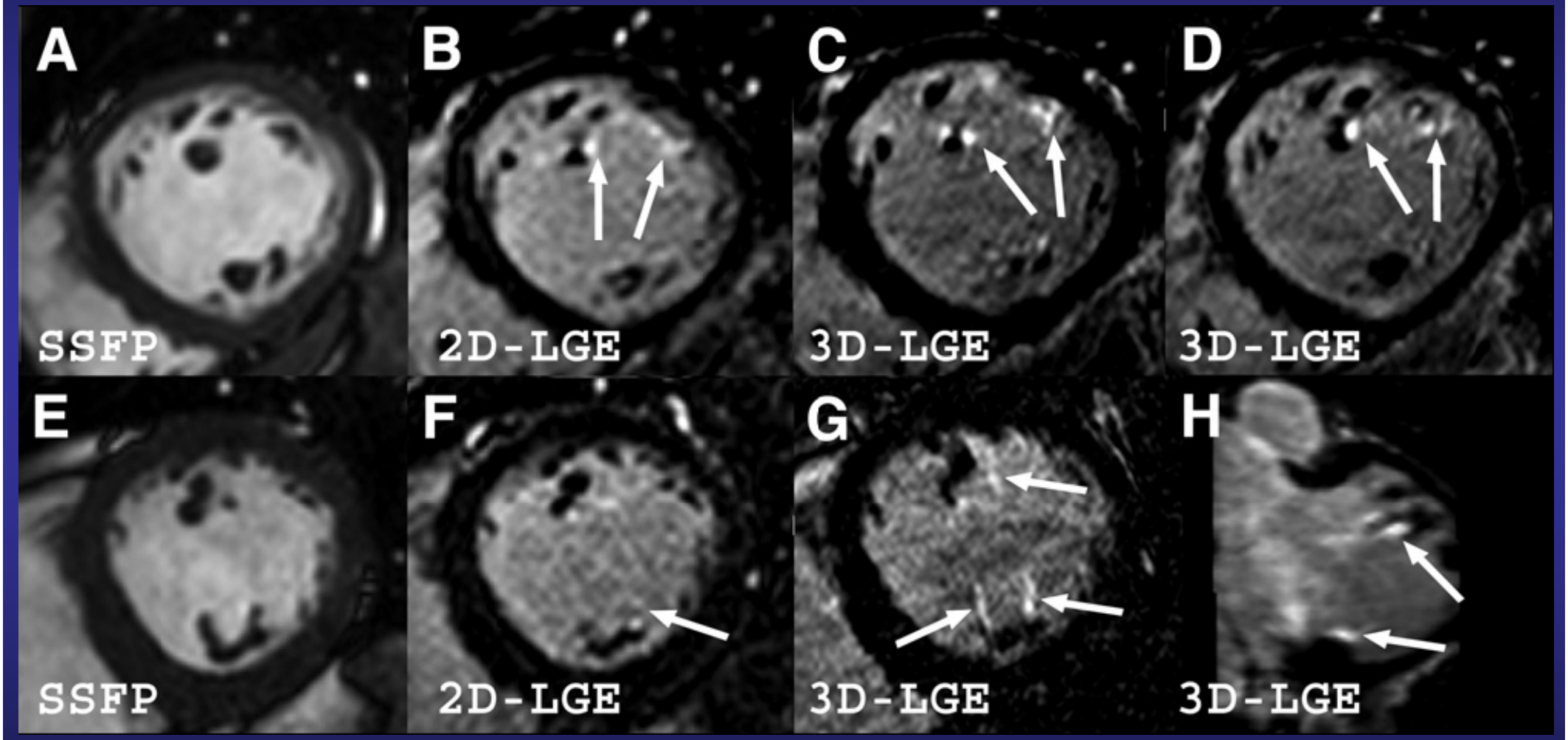
Circulation 2009; 119: 468-478

ADDITIONAL INFORMATIONS – LATE ENHANCEMENT



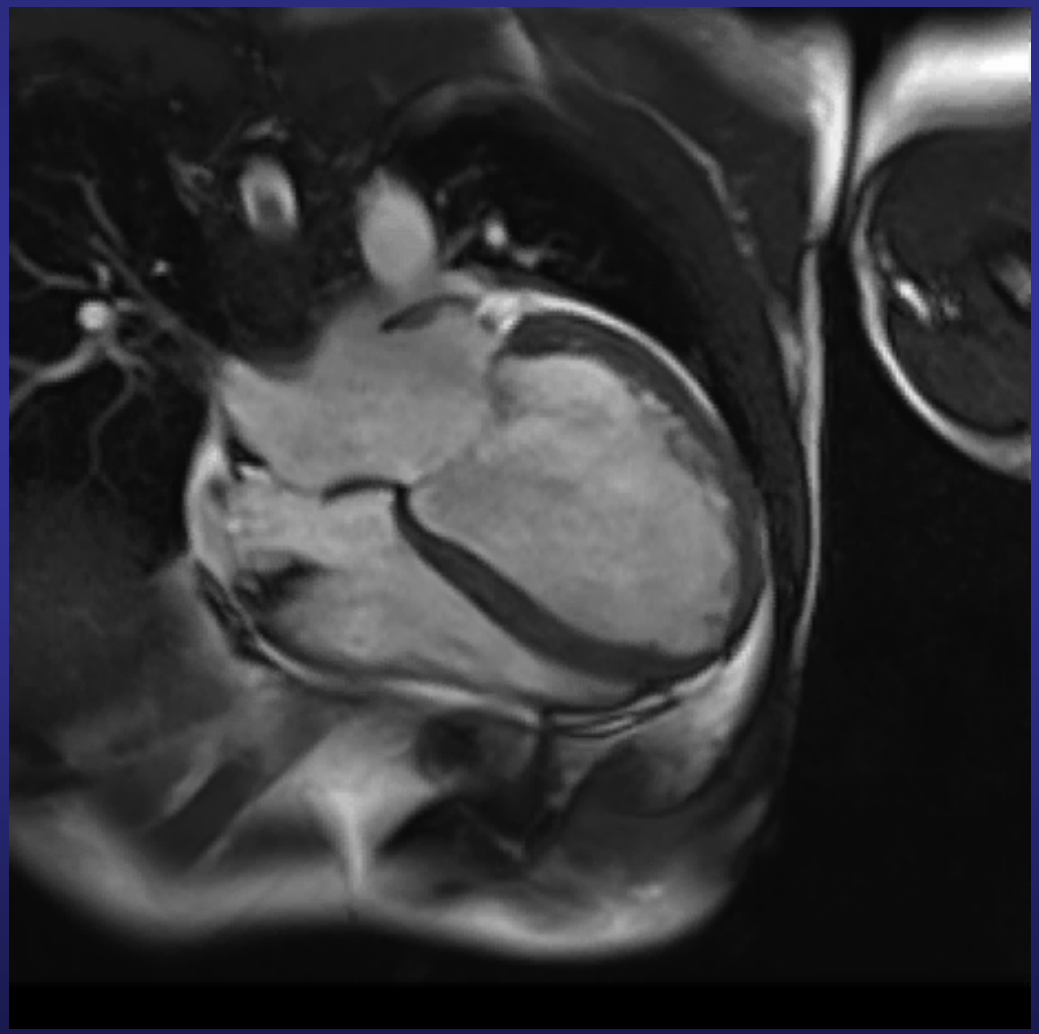


ADDITIONAL INFORMATIONS – LATE ENHANCEMENT

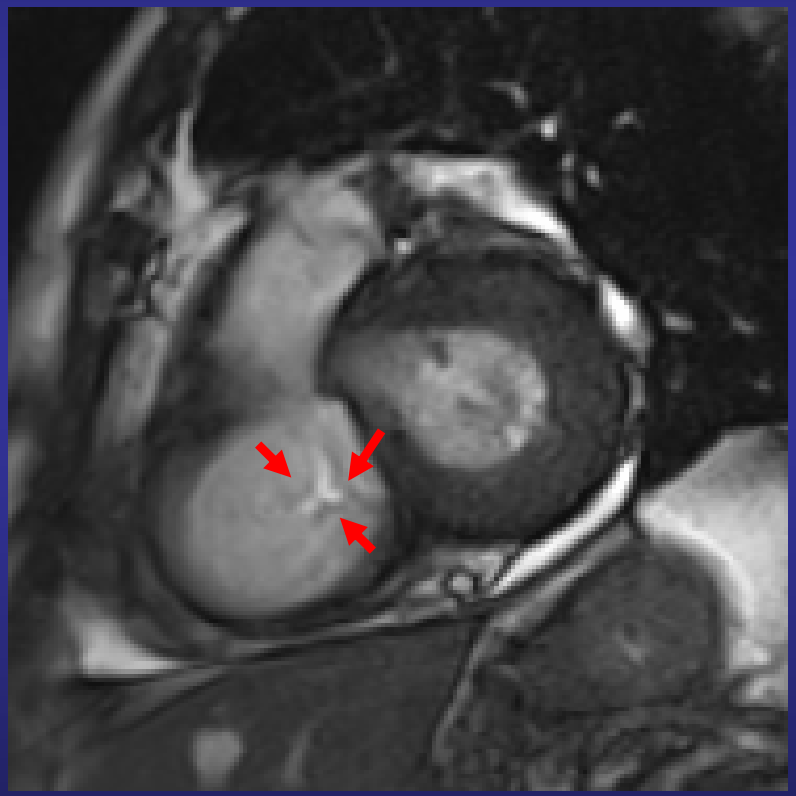


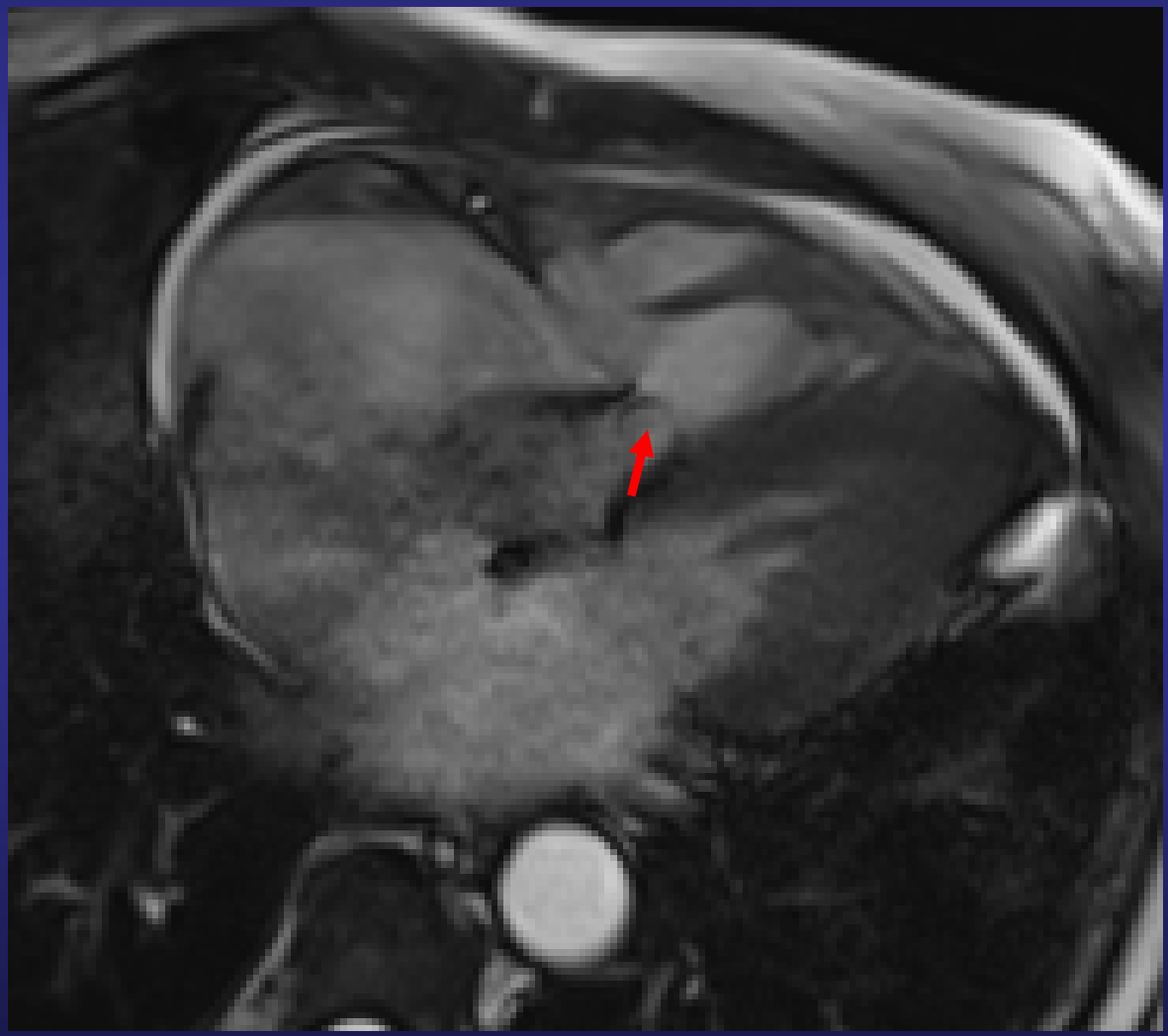
MITRAL PROLAPSE: papillary muscles late enhancement and major ventricular arrhythmias (JACC Cardiovascular Imaging 2008;1:294-303)

MITRAL PROLAPSE: PAPILLARY MUSCLES FIBROSIS

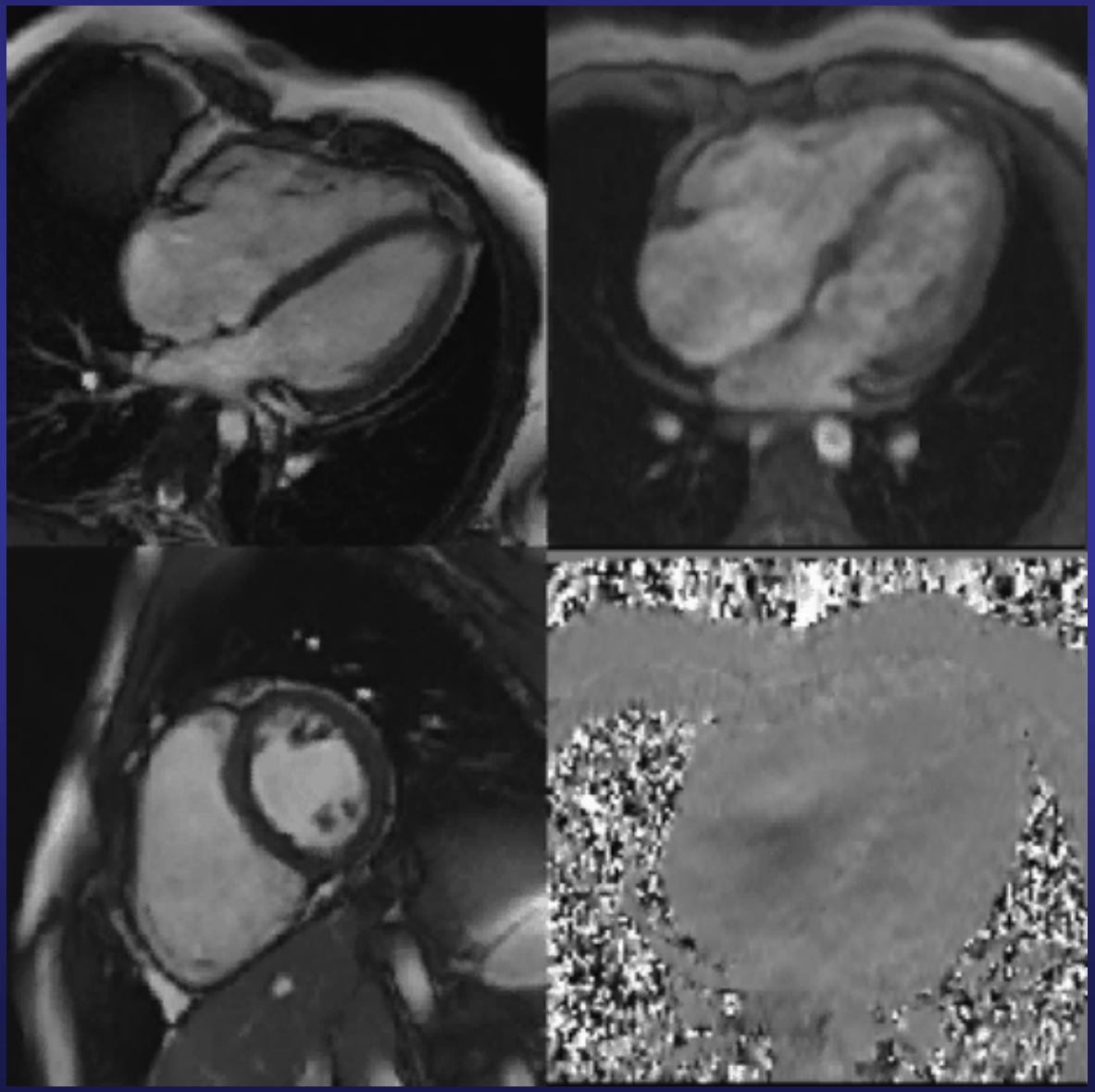


Ebstein's Disease – SSFP CINE MRI





TRICUSPID REGURGITATION – SSFP CINE MRI – PHASE CONTRAST



TRICUSPID REGURGITANT FRACTION

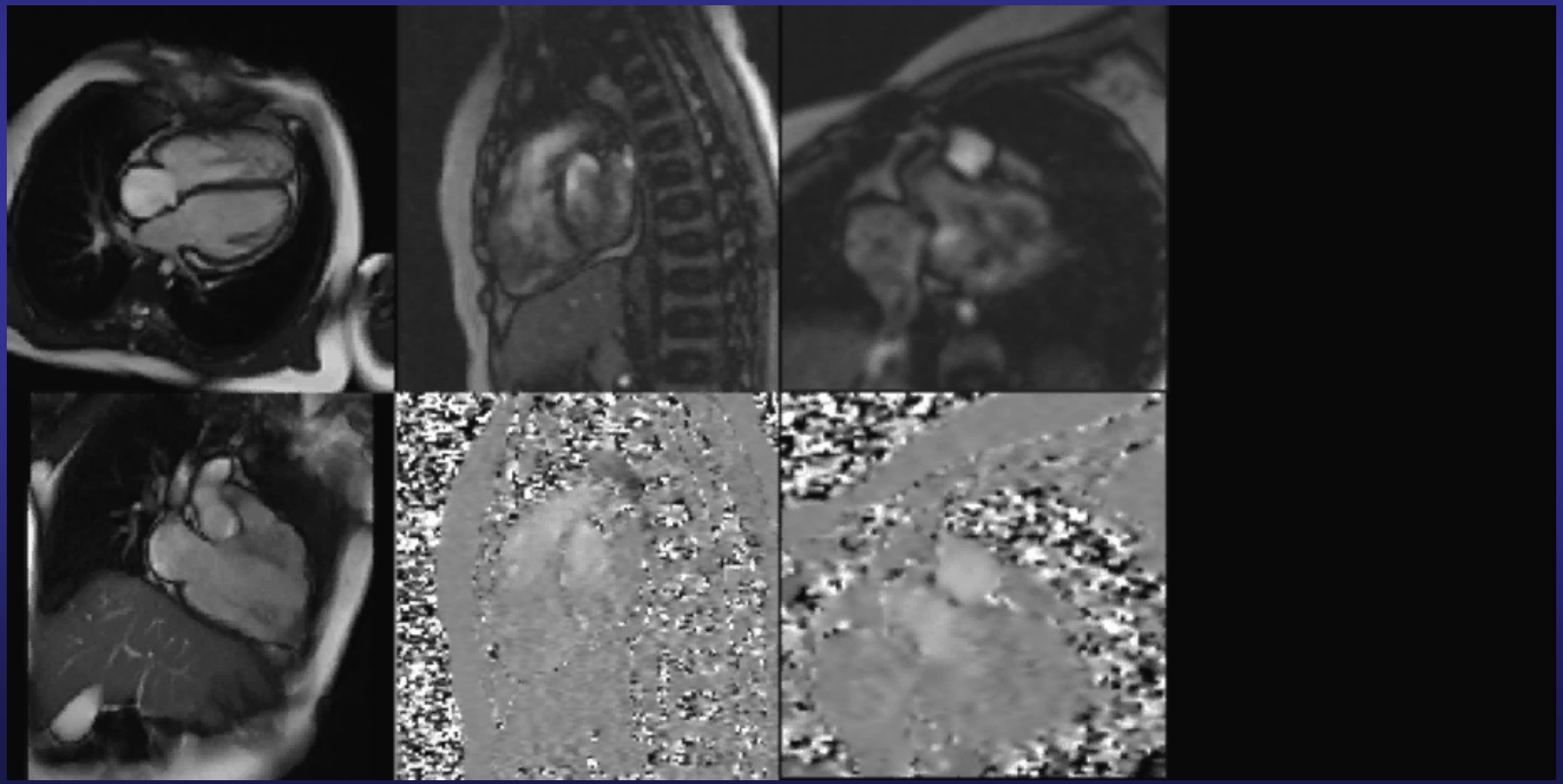
RF = RVSV – FWPo / RVSV

RF = RVSV – LVSV / RVSV

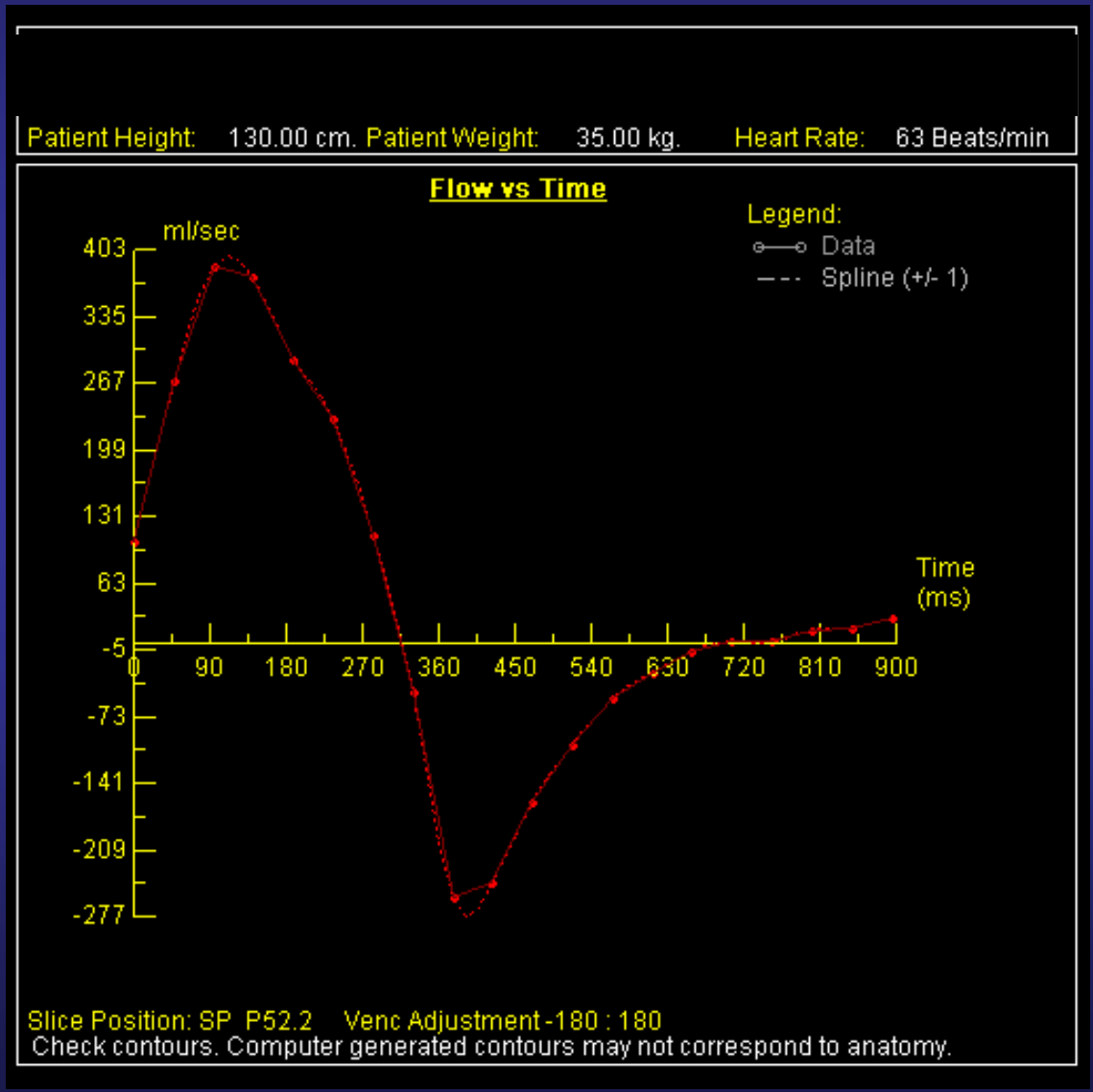
Circulation 2009; 119: 468-478

PULMONARY VALVE – SSFP CINE MRI – PHASE CONTRAST

TETRALOGY OF FALLOT : PULMONARY REGURGITATION



PULMONARY REGURGITATION – PHASE CONTRAST – THROUGH PLANE



LV EDV = 66 ml

LV ESV = 19 ml

LVEF = 71%

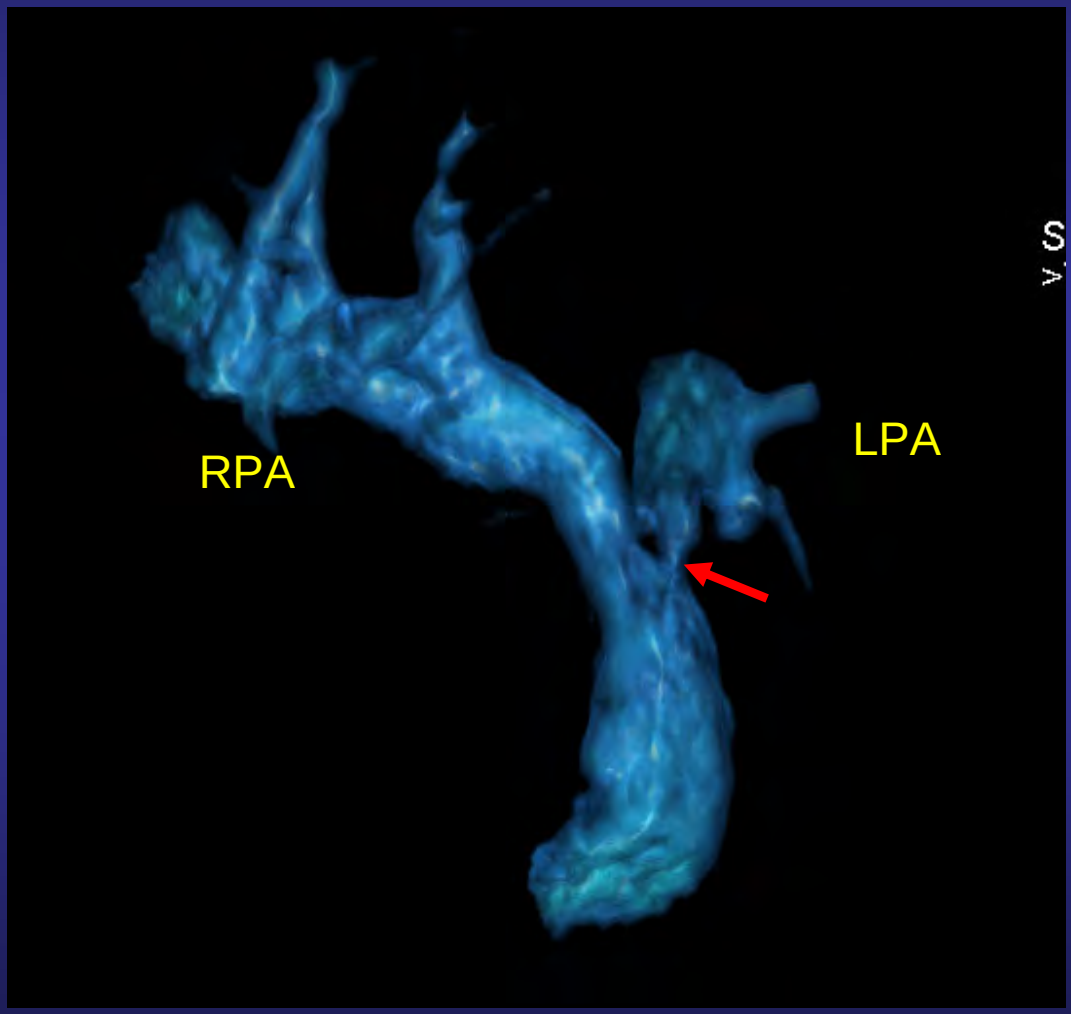
RV EDV = 139 ml

RV ESV = 46 ml

RV EF = 63%

RF = 51%

ADDITIONAL INFORMATIONS - ANGIOGRAPHY



LPA Stenosis – Left Lung hypoperfusion

ADDITIONAL IN FORMATIONS – LATE ENHANCEMENT

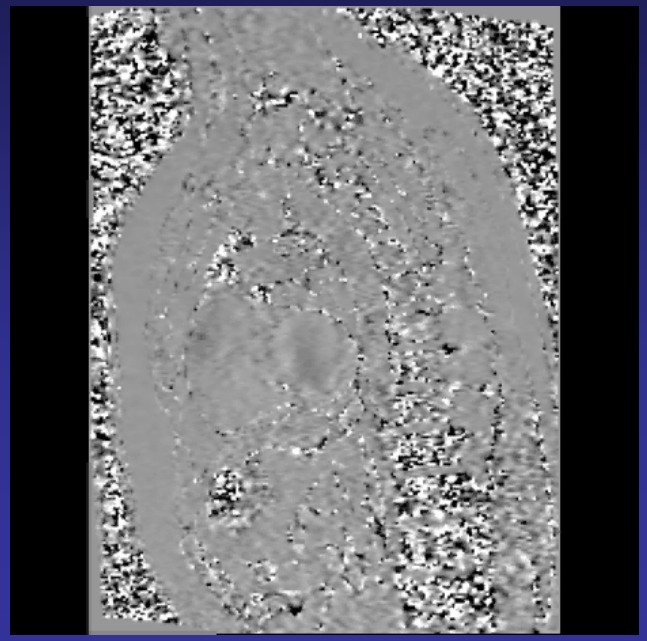
LE as adverse marker of clinical outcome in repaired Tetralogy of Fallot

Circulation 2006; 113:405-413

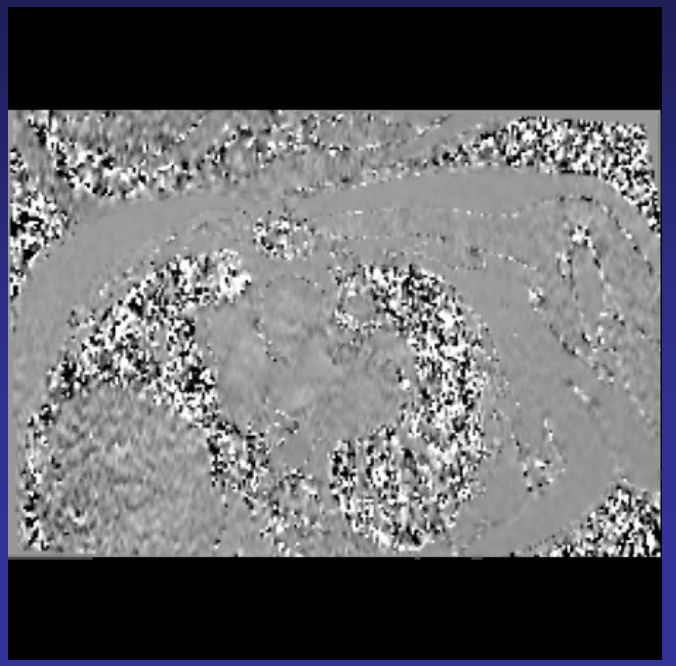
PHASE CONTRAST ALIASING: CHOOSING THE RIGHT VELOCITY

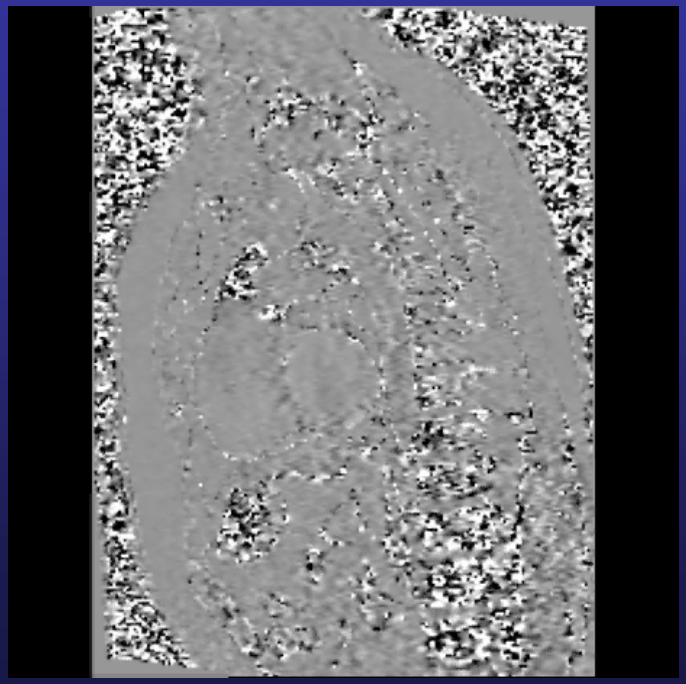
IN-PLANE

THROUGH-PLANE

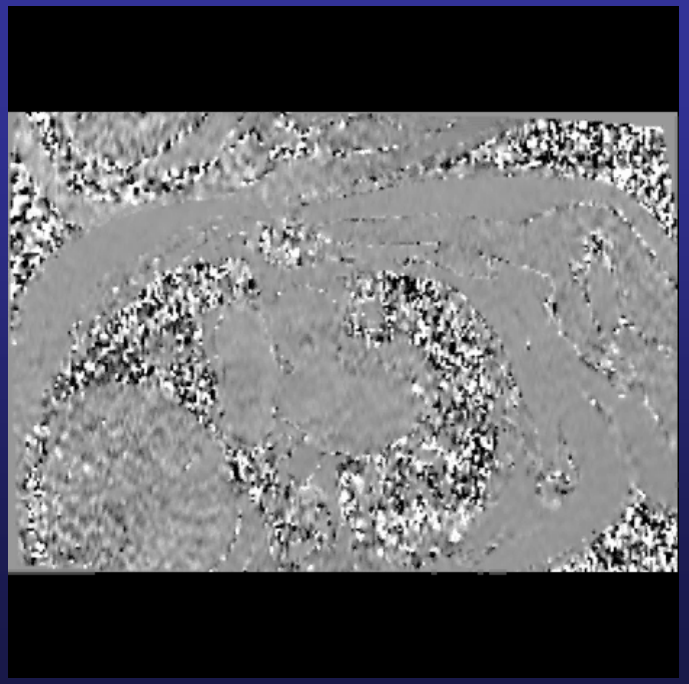


1,5 m/s





3,0 m/s



Flow measurement by cardiovascular magnetic resonance: a multi-centre multi-vendor study of background phase offset errors that can compromise the accuracy of derived regurgitant or shunt flow measurements

Peter D Gatehouse[1], Marijn P Rolf[2], Martin J Graves[3], Mark BM Hofman[2], John Totman[4], Beat Werner[5], Rebecca A Quest[6], Yingmin Liu[7], Jochen von Spiczak[8], Matthias Dieringer[9], David N Firmin[1], Albert van Rossum[10], Massimo Lombardi[11], Juerg Schwitter[12], Jeanette Schulz-Menger[13], Philip J Kilner[1*]

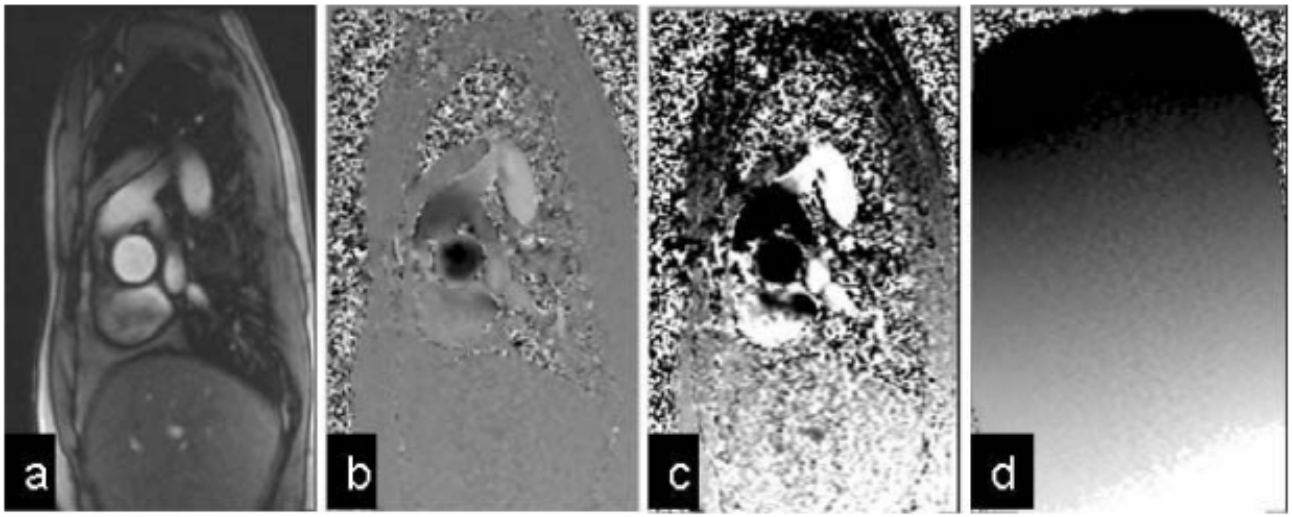
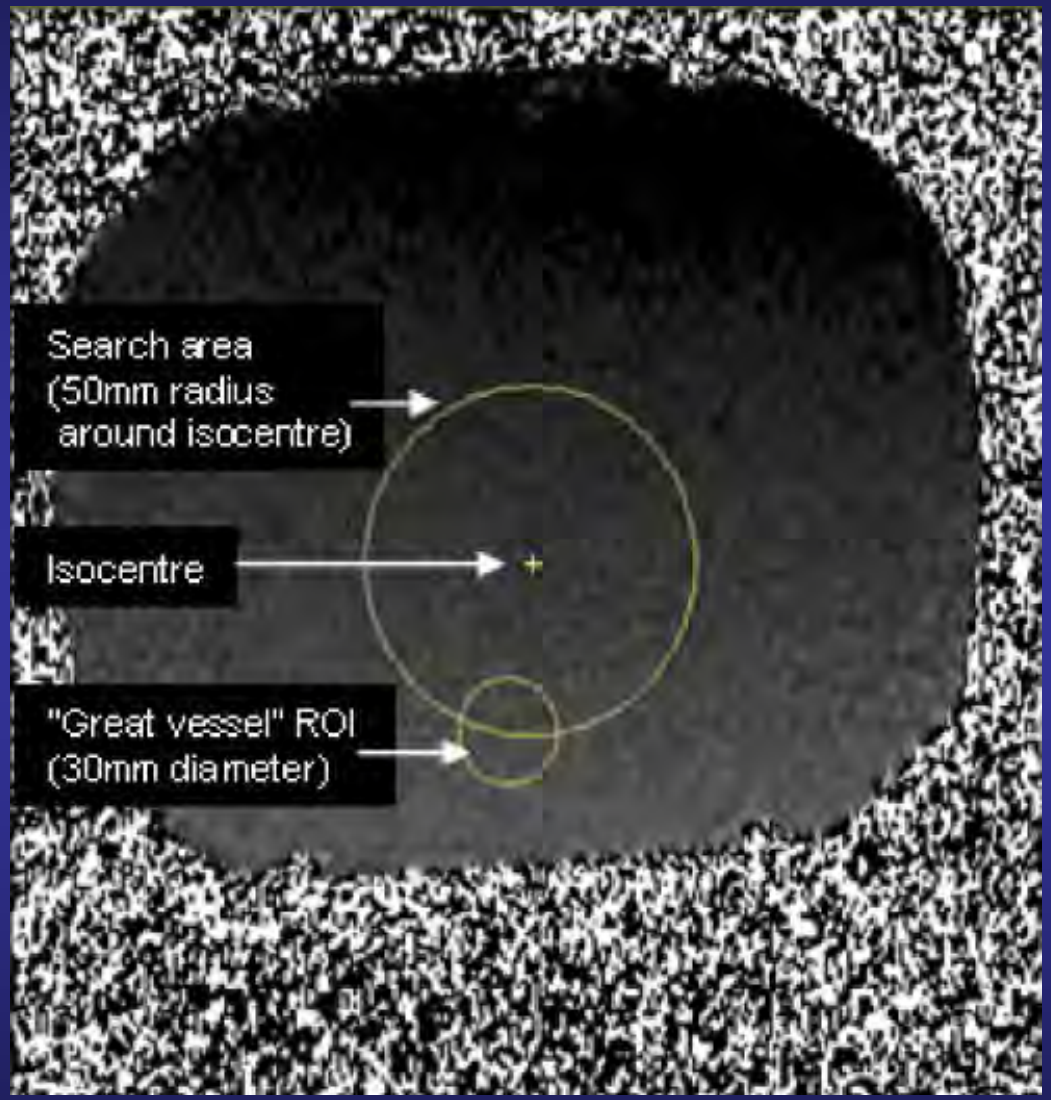
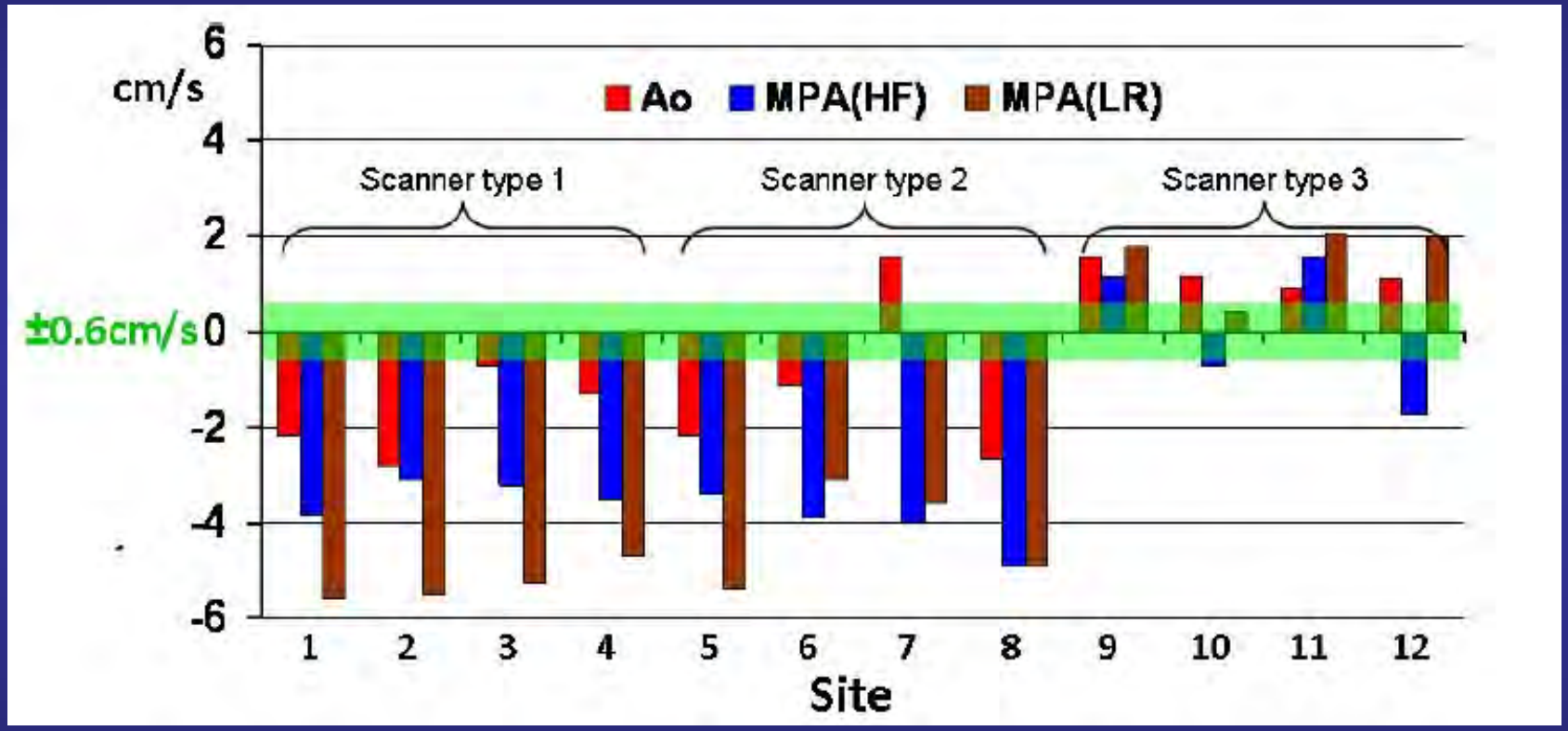


Figure 1 A systolic frame of an aortic flow acquisition. (170 ms after R-wave, at Venc = 150 cm/s). (a) Signal magnitude image, (b) Phase contrast velocity image shown at normal greyscale settings (black = -150 cm/s, white = +150 cm/s) where there apparently uniformly grey chest wall fails to reveal the background offset error. The same image is therefore reprinted in (c) with more extreme greyscale contrast to show up the background offset errors (black ≤ -15 cm/s, white ≥ +15 cm/s) (d) Phase contrast image using identical sequence protocol, but of static gelatin phantom, displayed with same greyscale as (c), demonstrating the phase offset.


Search area
(50mm radius
around isocentre)
Isocentre
"Great vessel" ROI
(30mm diameter)


cm/s
6
4
2
0
-2
-4
-6
±0.6cm/s
Ao
MPA(HF)
MPA(LR)
Scanner type 1
Scanner type 2
Scanner type 3
1
2
3
4
5
6
7
8
9
10
11
12
Site

Technical pitfalls

- Velocity encoding interval sampling
- Background correction
- Non breath-hold acquisition for right-sided valves
- Isocenter acquisition (FOV automatic positioning)
- Correct through-plane positioning

Clinical limitations

- Arrhythmias
- Claustrophobia
- Pace-maker
- Cerebro-vascular clips
- Severe chronic renal disease (GFR < 30 ml/min)