



**Dipartimento Cardiologico A. De Gasperis  
Azienda Ospedaliera Niguarda Ca' Granda - Milano**

## **LE CARDIOPATIE CONGENITE IN SOGGETTI ADULTI**

Il ruolo della RM nella caratterizzazione anatomica e funzionale dei difetti cardiovascolari congeniti identificati in età adulta. Il contributo della RM cardiovascolare nella gestione di adulti operati in età pediatrica per cardiopatie congenite complesse

**Patrizia Pedrotti**

**Unità di RMN cardiaca – Ospedale Niguarda Ca' Granda - Milano**

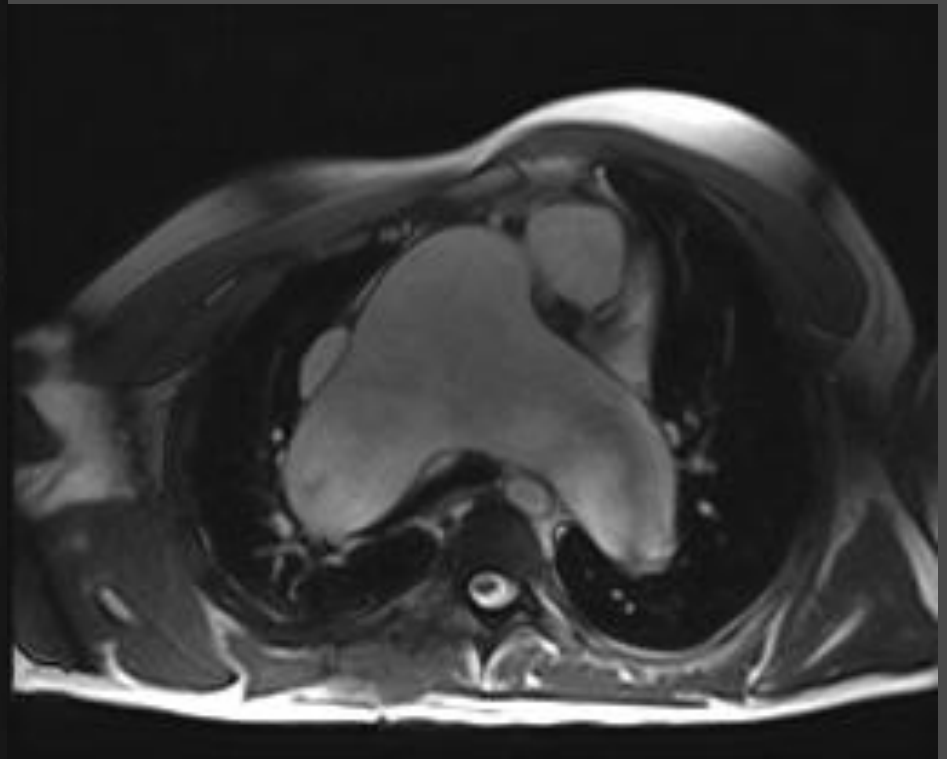
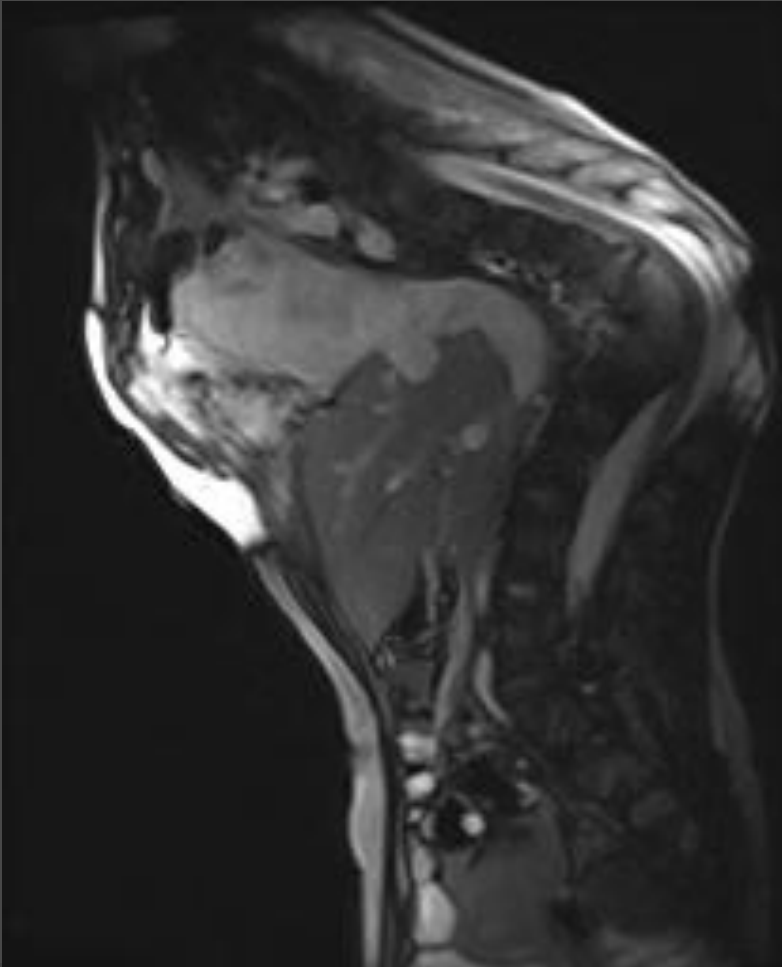
**ECOCARDIOCHIRURGIA – VII CONGRESSO NAZIONALE**

**Milano, 5-7 Maggio 2014**



## INTRODUCTION – WHY CMR?

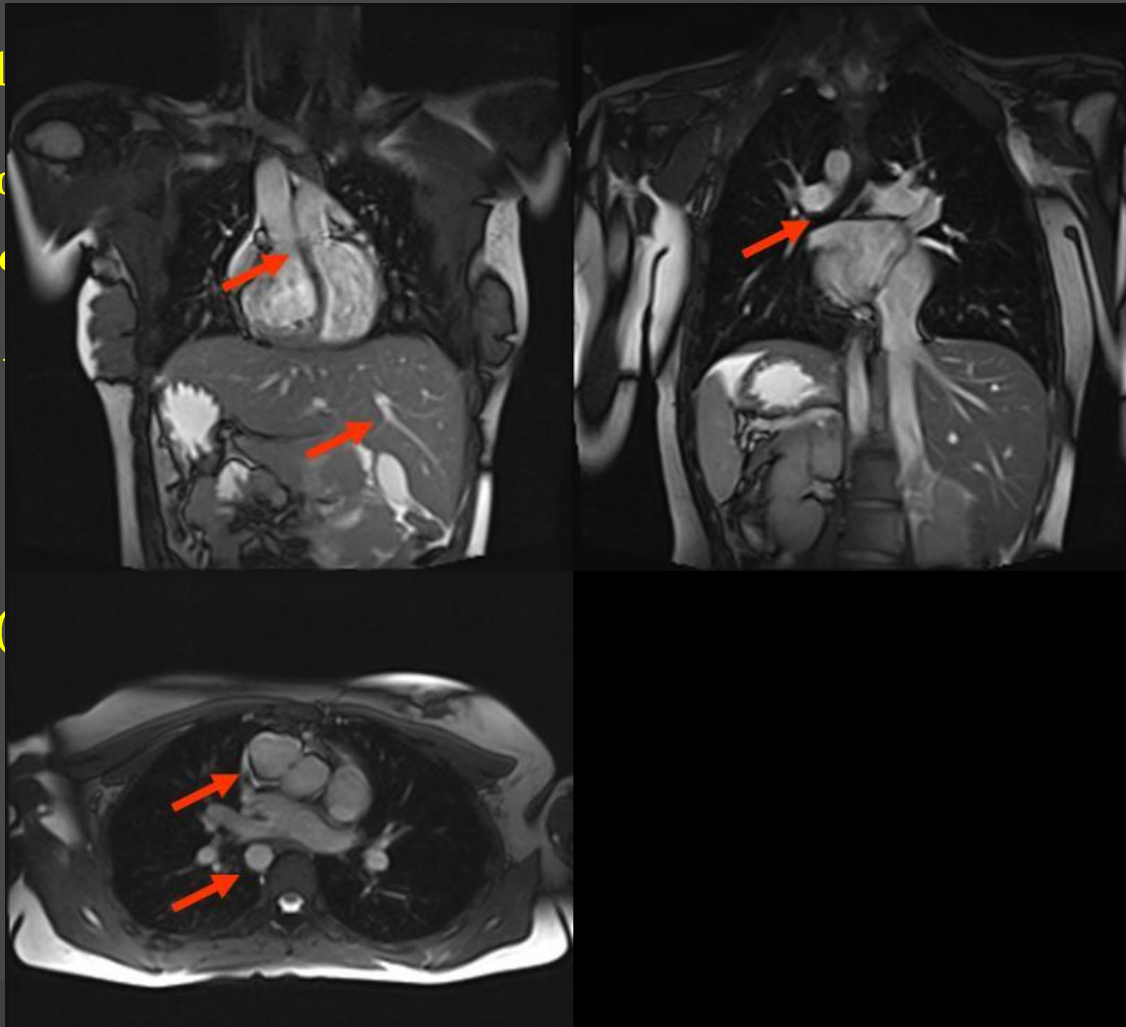
al cardiovascular malformations





## INTRODUCTION – WHY CMR?

- ↑ survival
- Young population (low radiation dose, nephrotoxicity)
- Poor accuracy of other imaging modalities (e.g., echocardiography, CT, PET-CT)
- Complex anatomy (e.g., congenital coronary artery anomalies, bicuspid aortic valve)



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vascular

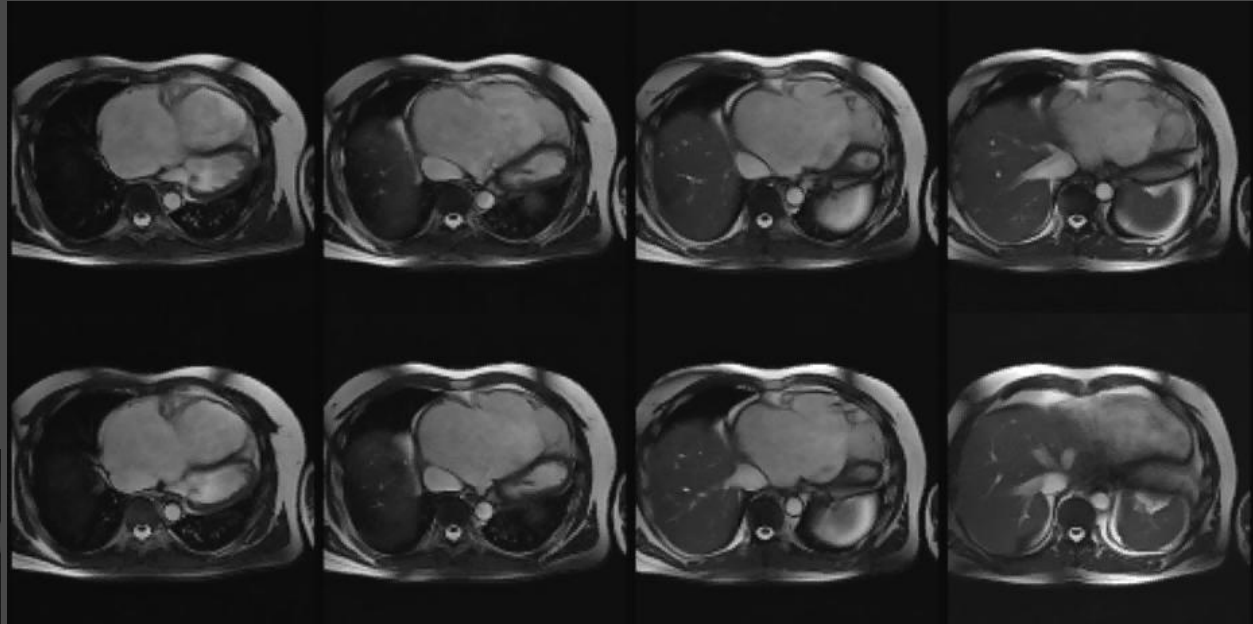
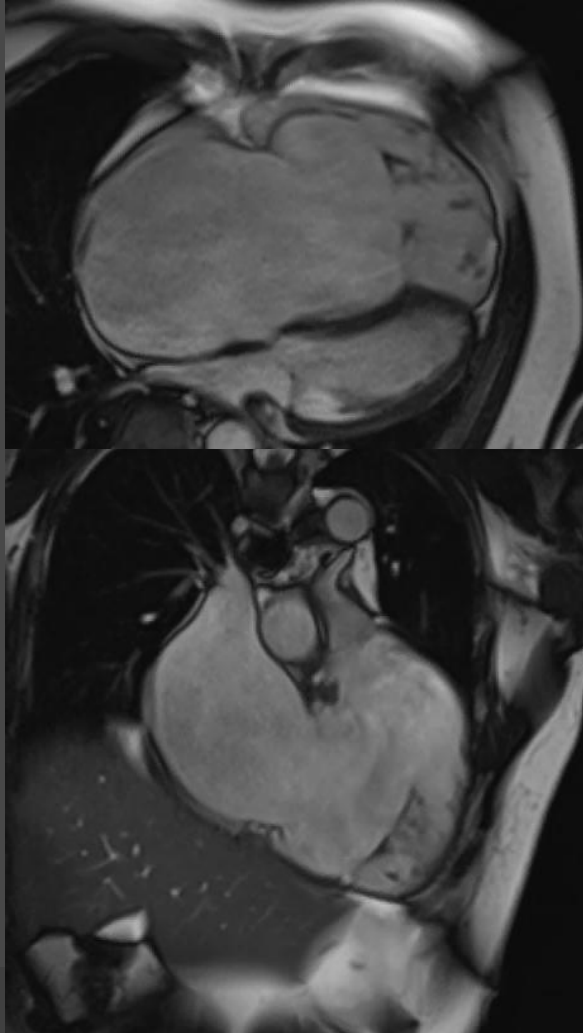


## INTRODUCTION – WHY CMR?

- ↑ survival of pts with congenital cardiovascular malformations
- Young population, pregnancy, lifelong follow-up → radiation dose, nephrotoxic contrast medium
- Poor acoustic window (chest wall deformity, surgery, obesity, lung disease)
- Complex anatomy, involving thoracic and abdominal vascular structures (wide field of view, multiplanar imaging)
- Valve morphology and function; complementary information



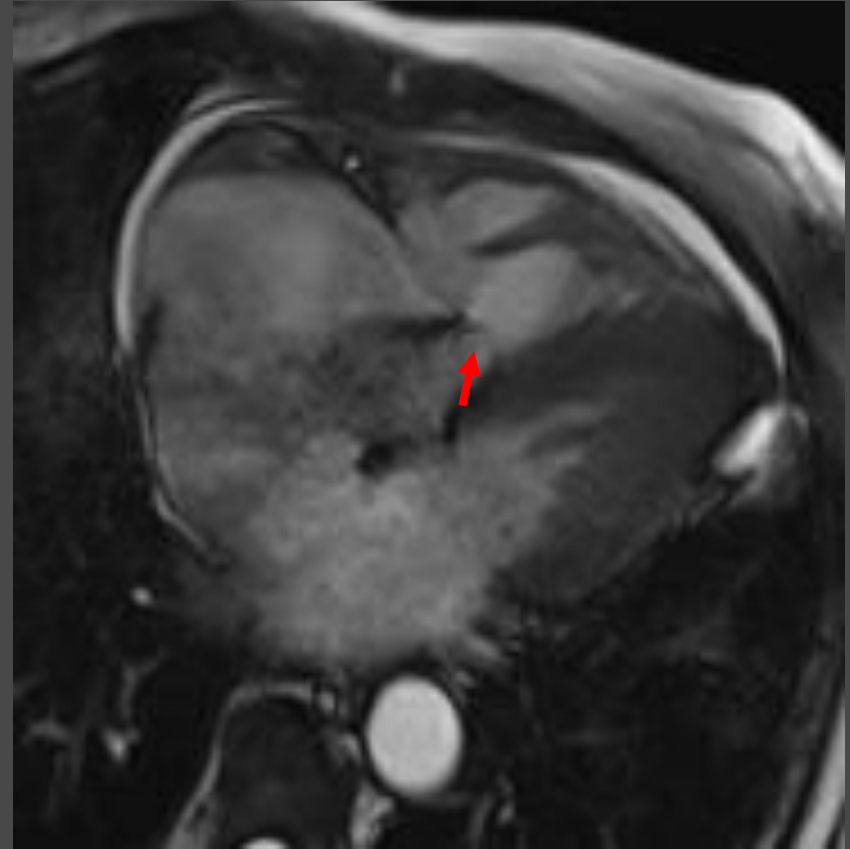
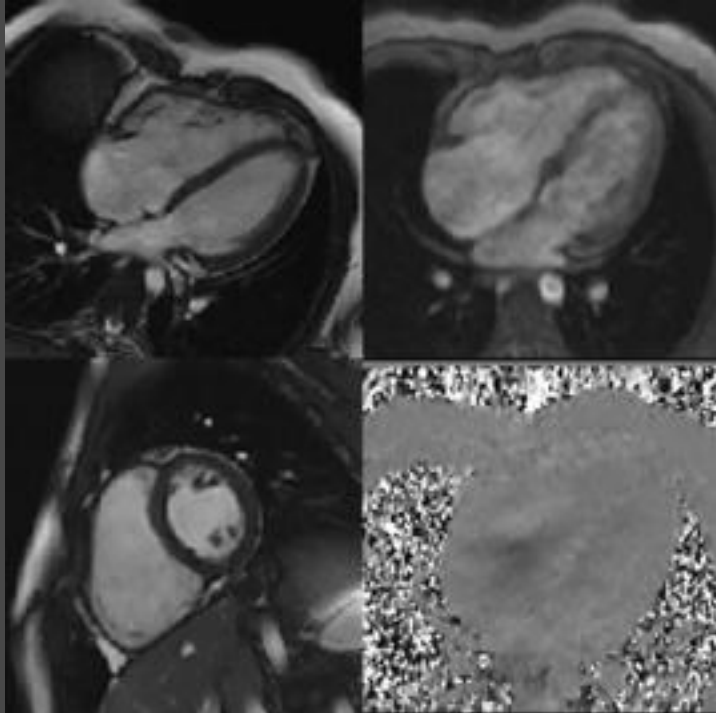
## WHY CMR? – Valve morphology and function



Ebstein's anomaly



## WHY CMR? – Valve morphology and function



### TR QUANTIFICATION

$$RF = RVSV - FWP_0 / RVSV$$

$$FR = RVSV - LVSV / RVSV$$

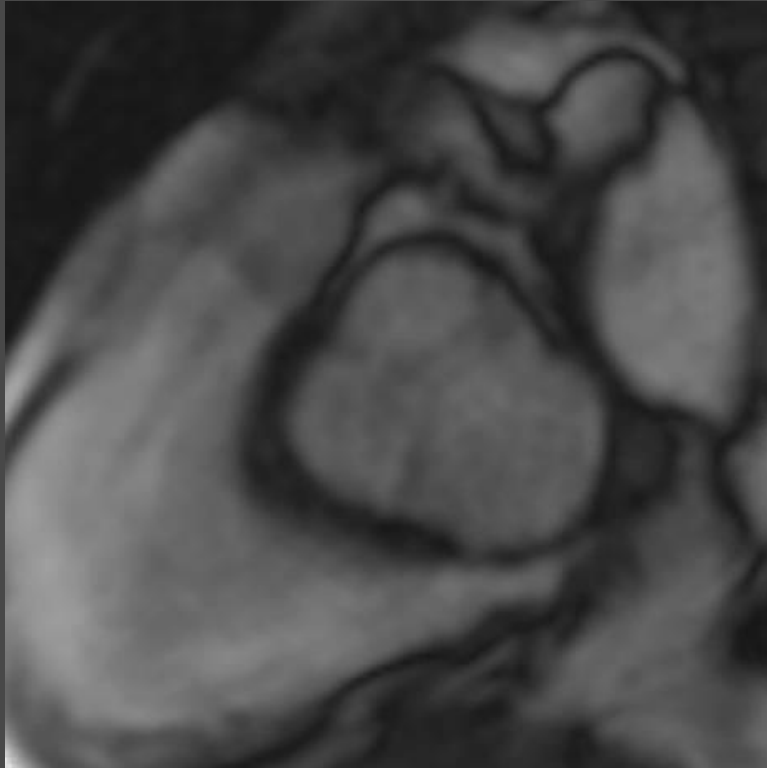
Circulation 2009; 119: 468-478

Ebstein's anomaly

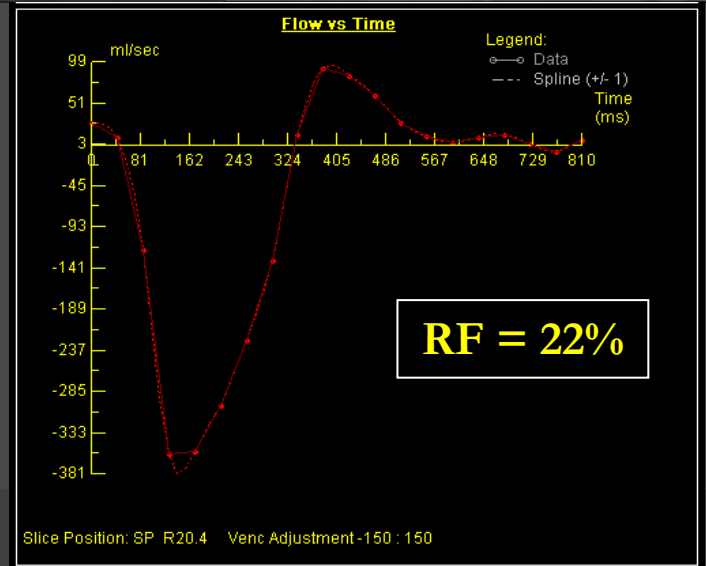
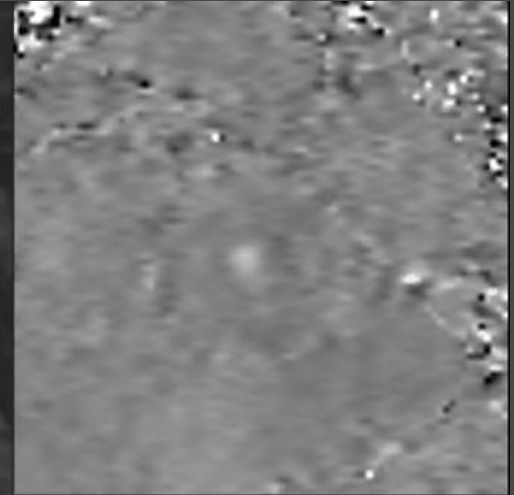


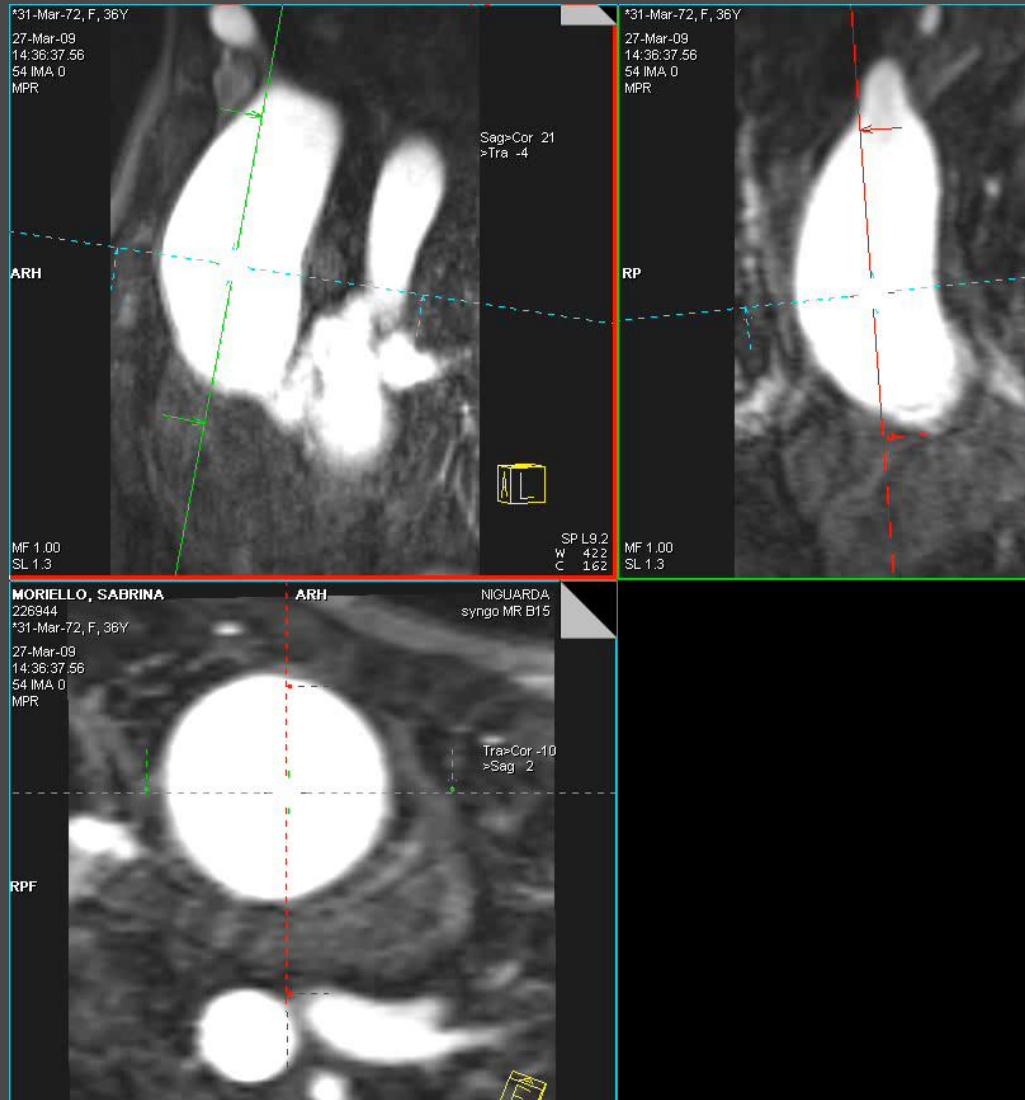


## WHY CMR? – Valve morphology and function



Bicuspid aortic valve





**Complementary information: vascular anatomy; follow up in aortic root dilation**



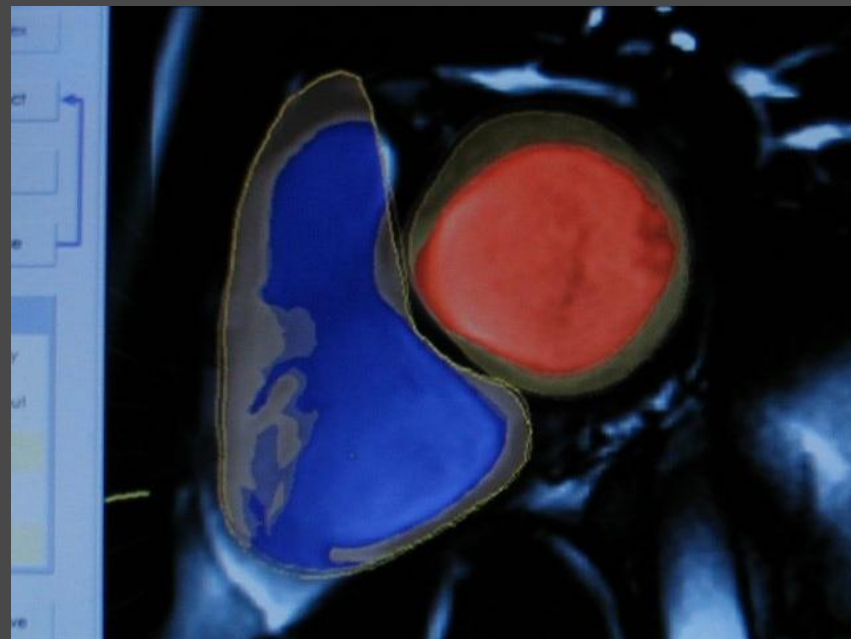


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- **Difficulty in quantification of RV function, pulmonary regurgitation, shunts, vascular anatomy**



## WHY CMR? – Ventricular function

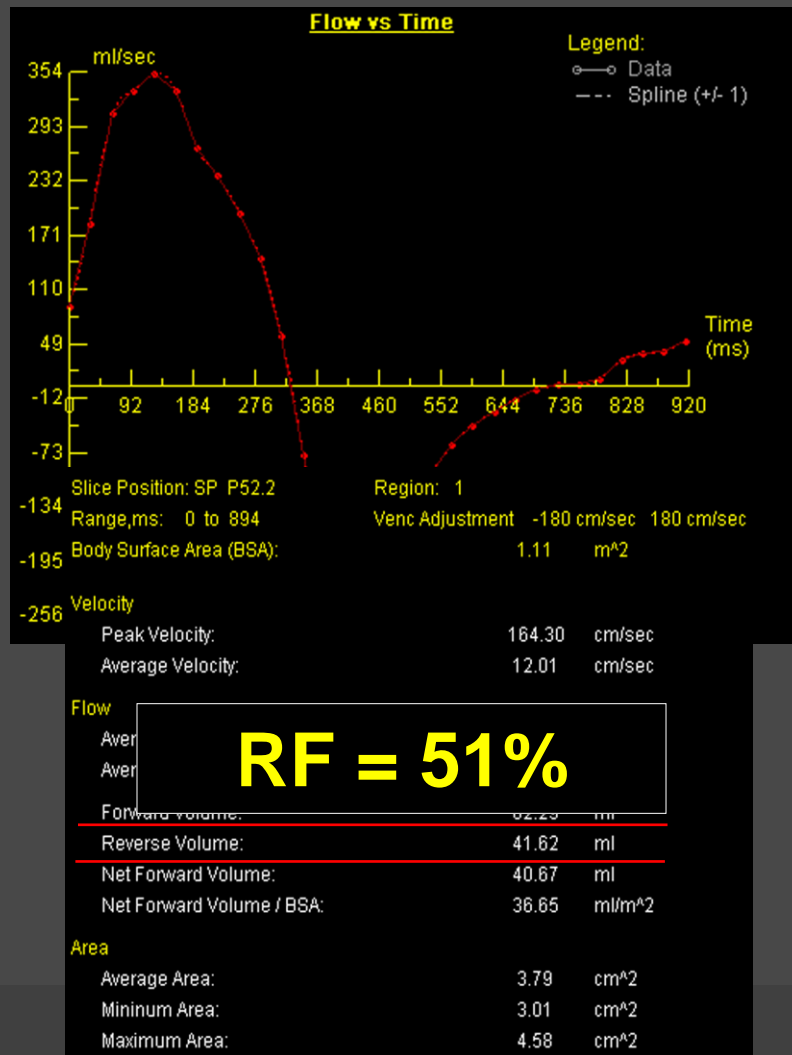
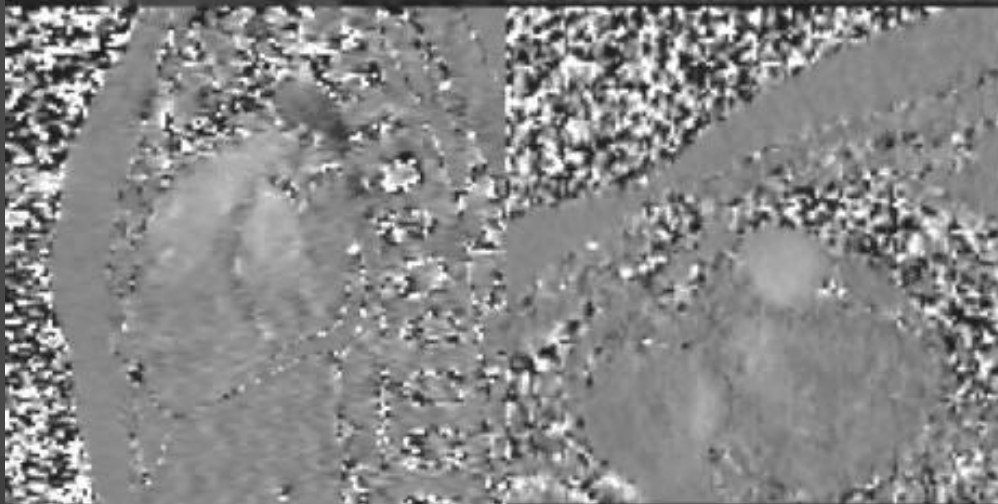
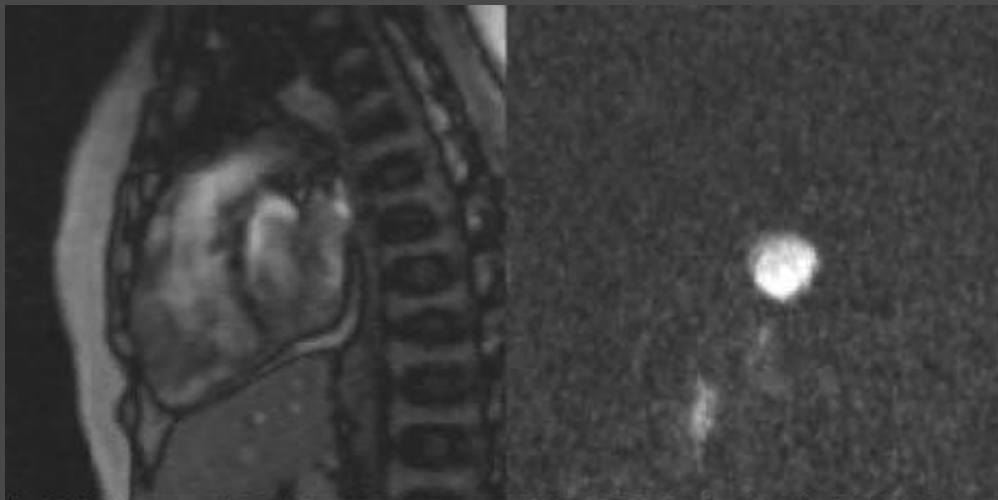


➤ CMR is the gold standard to measure biventricular volumes, EF and mass (Lancet 1985, Radiology 1990, 2005; J CMR 2003)

Courtesy of Dr. S. Pedretti  
H. Niguarda

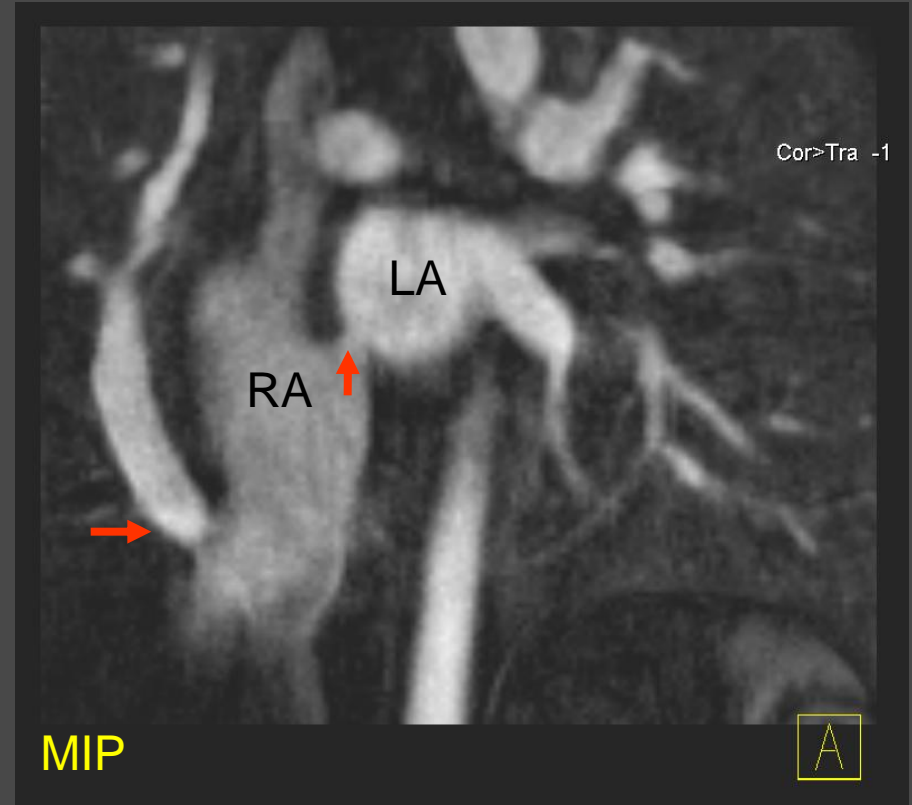
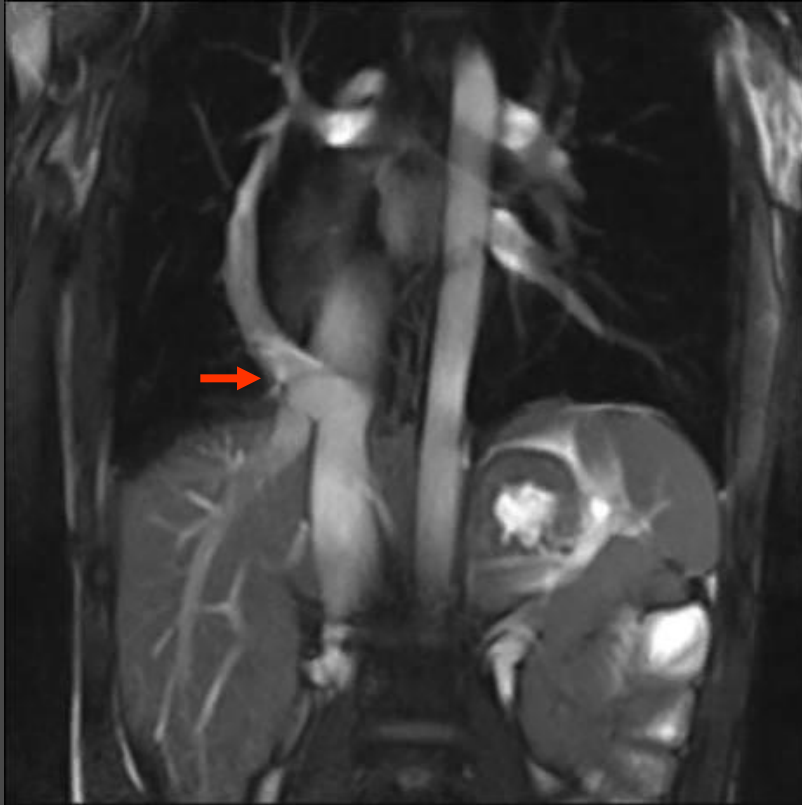


## WHY CMR? – Pulmonary regurgitation





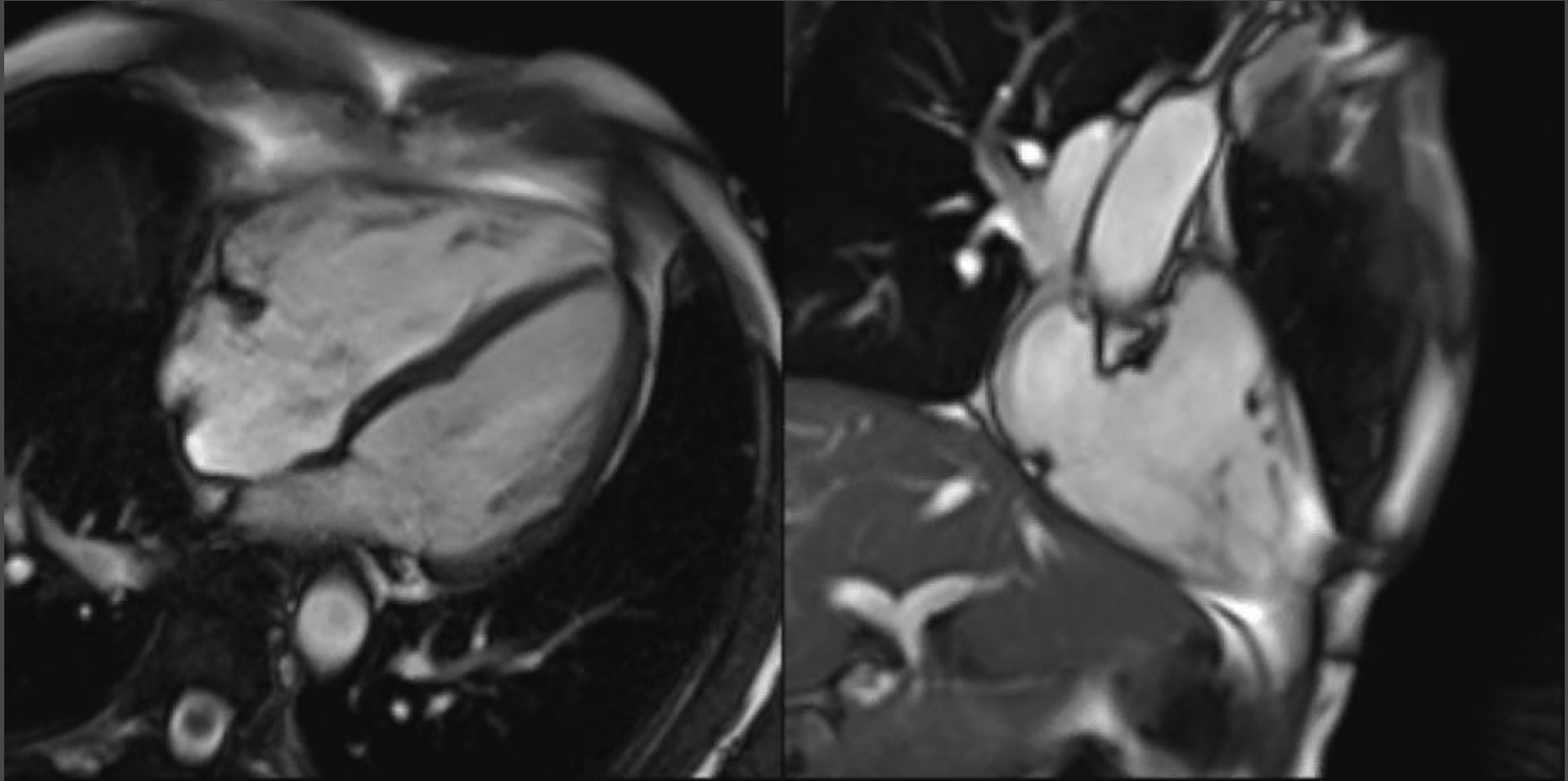
## WHY CMR? – Shunt identification and quantification



**PARTIAL ANOMALOUS PULMONARY VENOUS RETURN + ASD**



**WHY CMR? – Shunt identification and quantification**

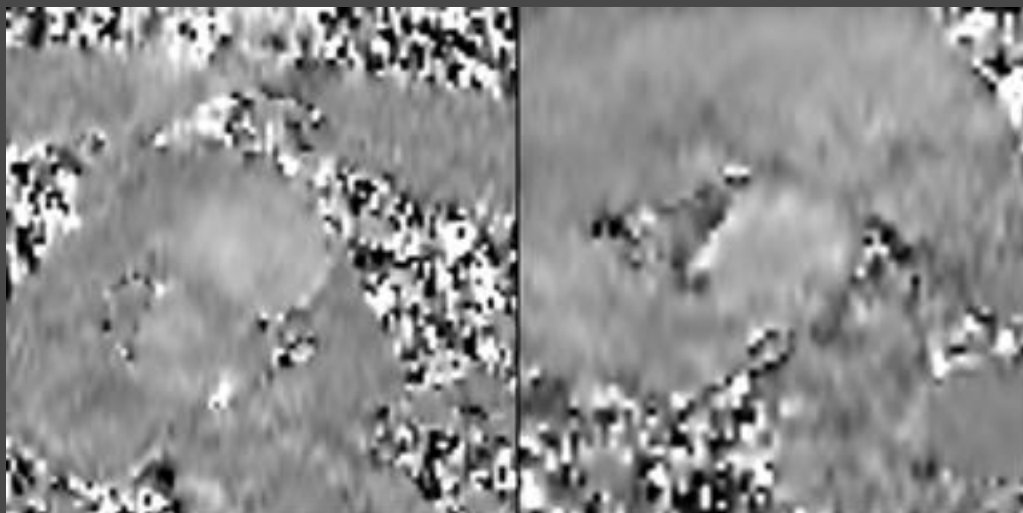


**PARTIAL ANOMALOUS PULMONARY VENOUS RETURN**





## WHY CMR? – Shunt quantification

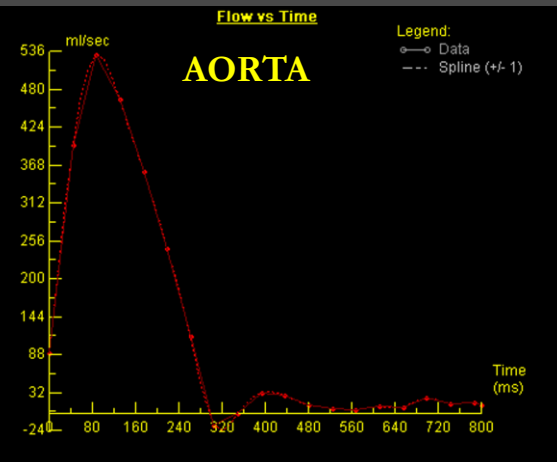
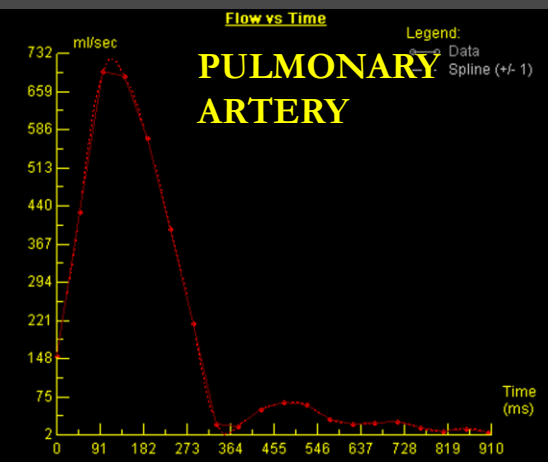


AORTA	
Slice Position: SP H85.8	Region: 1
Range,ms: 0 to 800	Venc Adjustment -150 cm/sec 150 cm/sec
Body Surface Area (BSA):	1.69 m <sup>2</sup>
<b>Velocity</b>	
Peak Velocity:	131.75 cm/sec
Average Velocity:	25.61 cm/sec
<b>Flow</b>	
Average Flow Over Range:	125.39 ml/sec
Average Flow Per Minute:	6.72 l/min
Forward Volume:	100.70 ml
Reverse Volume:	0.392 ml
Net Forward Volume:	100.31 ml
Net Forward Volume / BSA:	59.18 ml/m <sup>2</sup>
<b>Area</b>	
Average Area:	4.90 cm <sup>2</sup>
Minimum Area:	3.63 cm <sup>2</sup>
Maximum Area:	6.30 cm <sup>2</sup>

PULMONARY ARTERY	
Slice Position: SP H61.6	Region: 1
Range,ms: 0 to 904	Venc Adjustment -150 cm/sec 150 cm/sec
Body Surface Area (BSA):	1.69 m <sup>2</sup>
<b>Velocity</b>	
Peak Velocity:	101.57 cm/sec
Average Velocity:	24.35 cm/sec
<b>Flow</b>	
Average Flow Over Range:	180.98 ml/sec
Average Flow Per Minute:	10.30 l/min
Forward Volume:	163.51 ml
Reverse Volume:	0.000 ml
Net Forward Volume:	163.51 ml
<b>Area</b>	
Maximum Area:	10.67 cm <sup>2</sup>

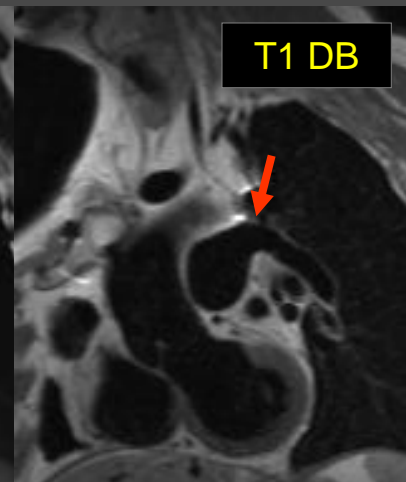
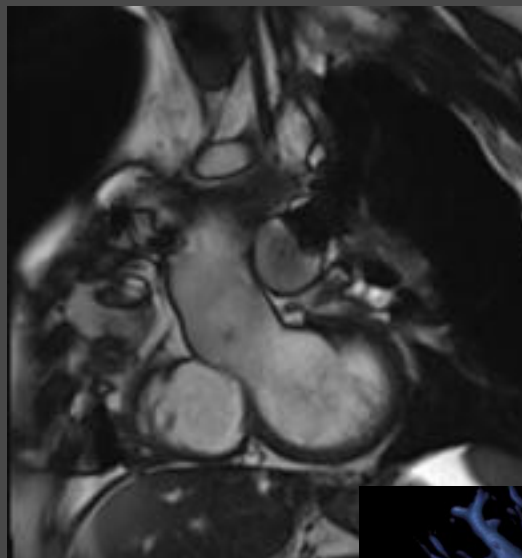
$$QP/QS = 1.6$$



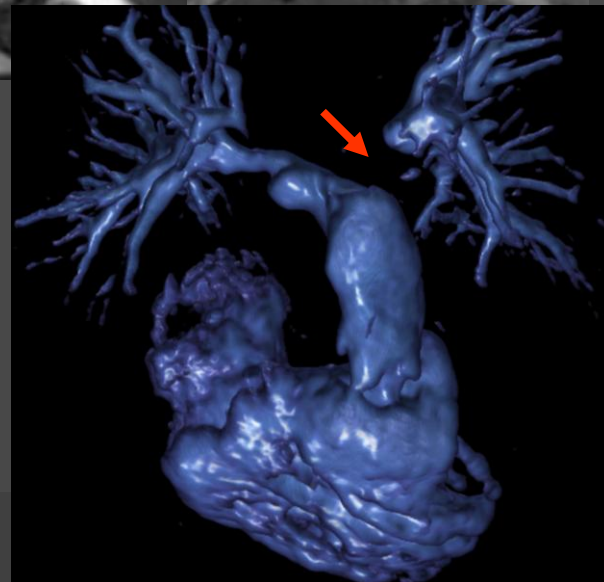




## WHY CMR? – Vascular anatomy



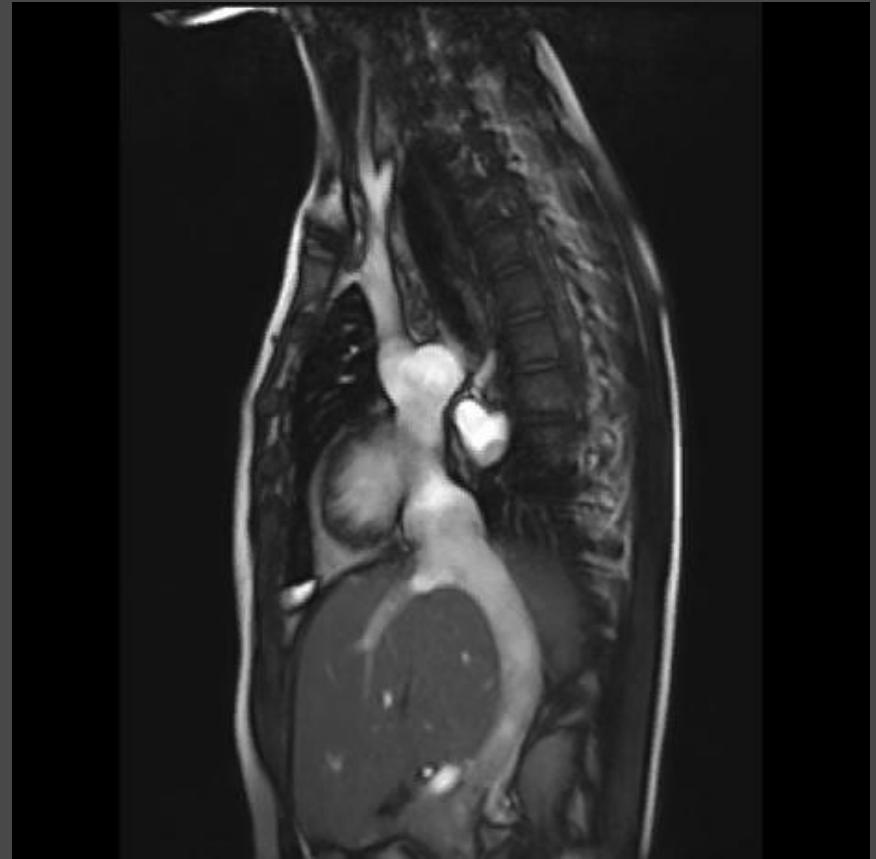
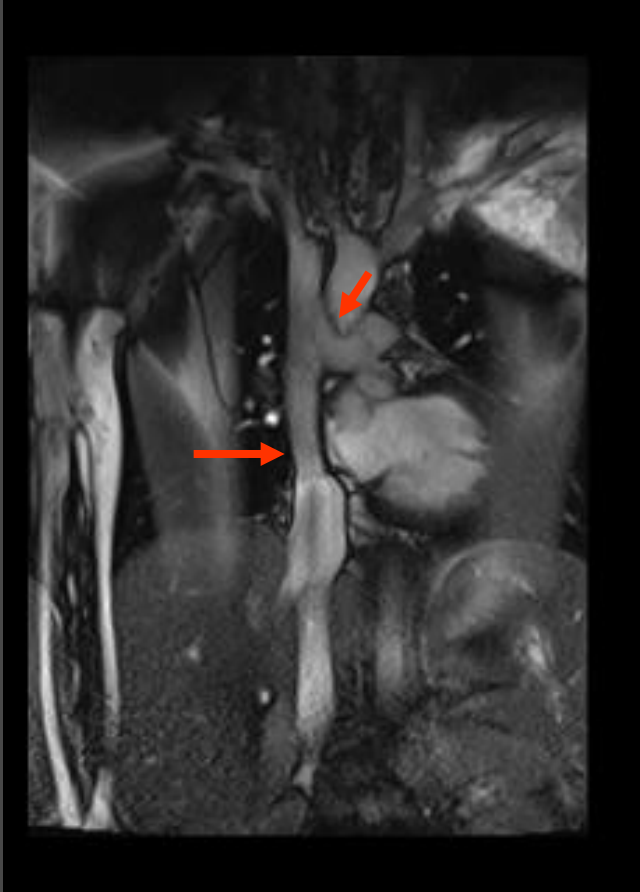
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AORTIC COARCTATION



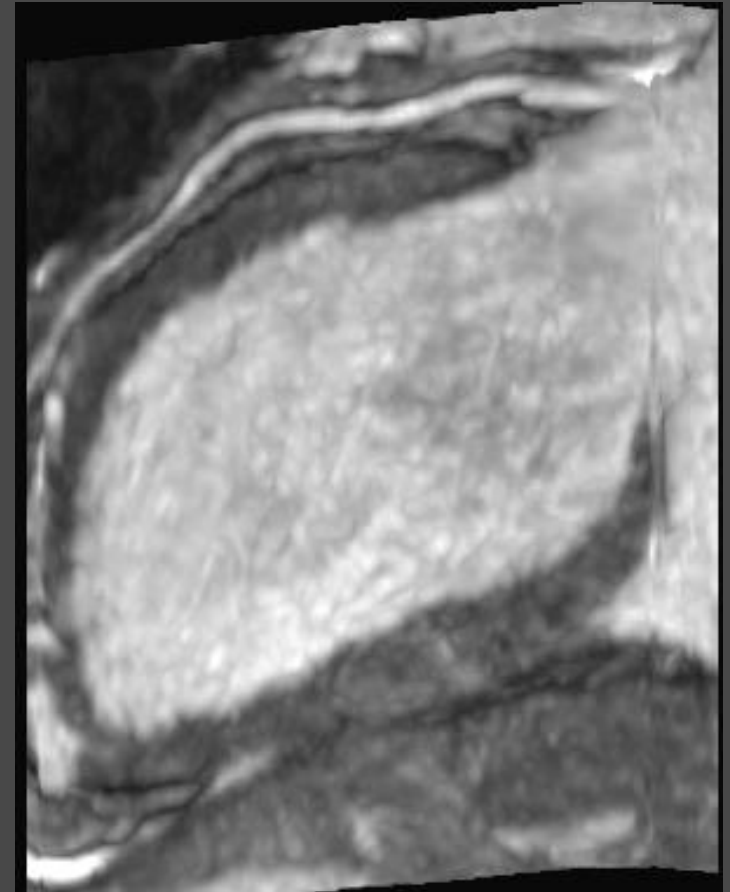
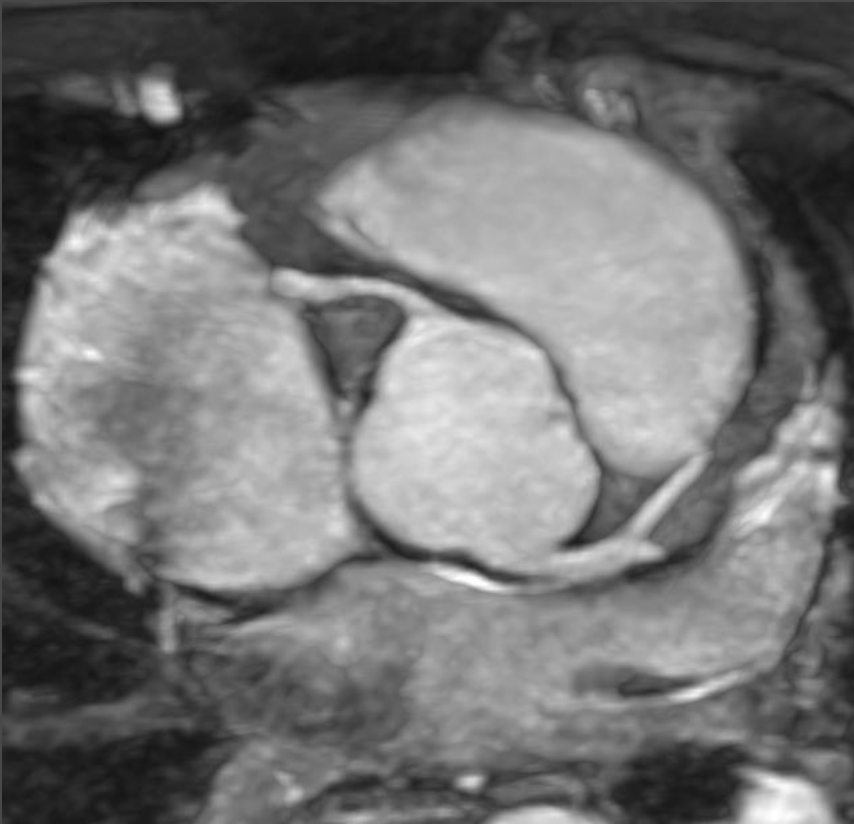
## WHY CMR? – Vascular anatomy



Extracardiac Fontan



## WHY CMR? – Vascular anatomy



Coronary arteries

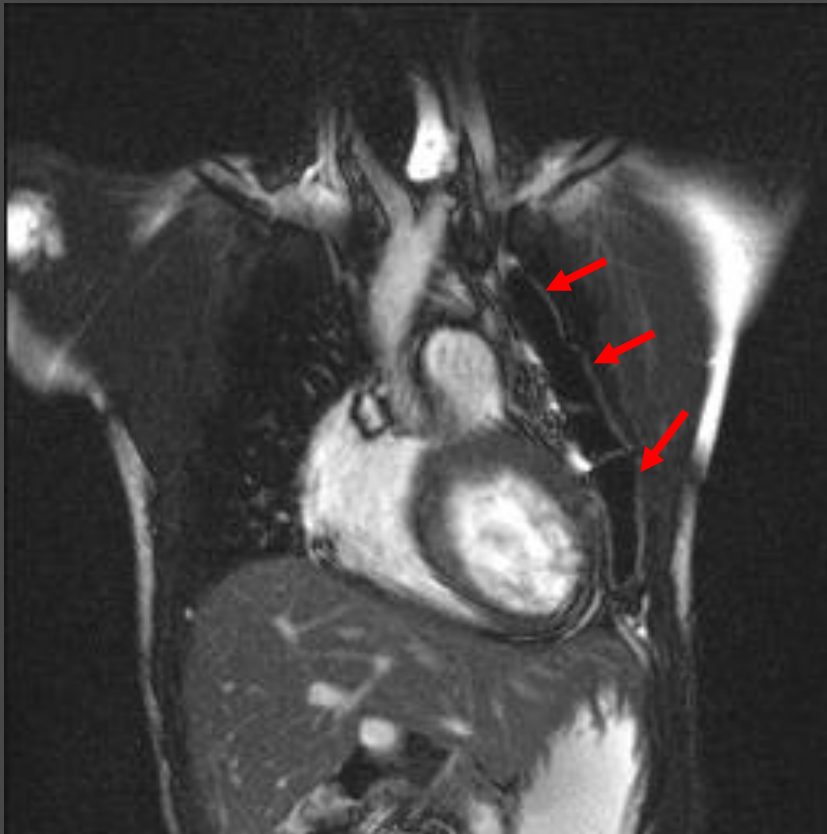


## INTRODUCTION – WHY CMR?

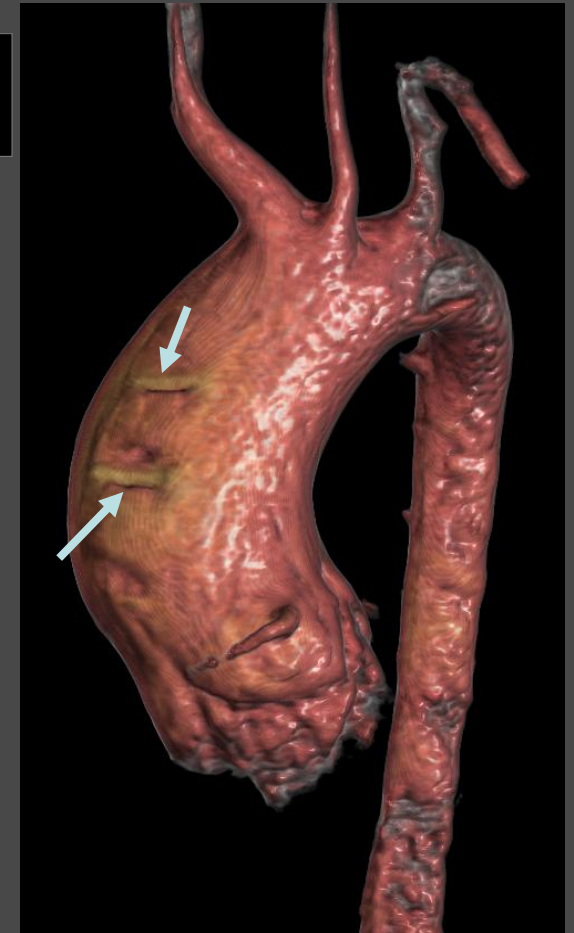
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- **Valve morphology and function**
- **Difficulty in quantification of RV function, pulmonary regurgitation, shunts, vascular anatomy**
- **Further invasive procedures or cardiac surgery → surgical/ interventional planning/interventional MRI**



## WHY CMR? – Interventional/Surgical planning



TOF; ascending  
aorta aneurysm

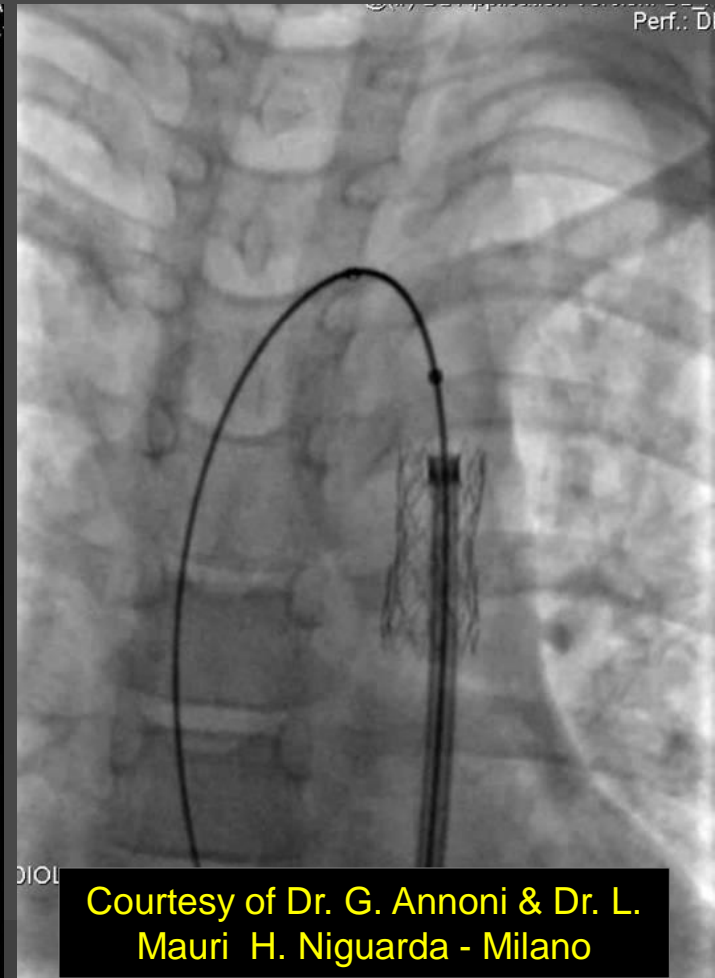


Severe congenital aortic stenosis;  
esophageal atresia corrected with  
intestinal loop





## WHY CMR? – Interventional/Surgical planning





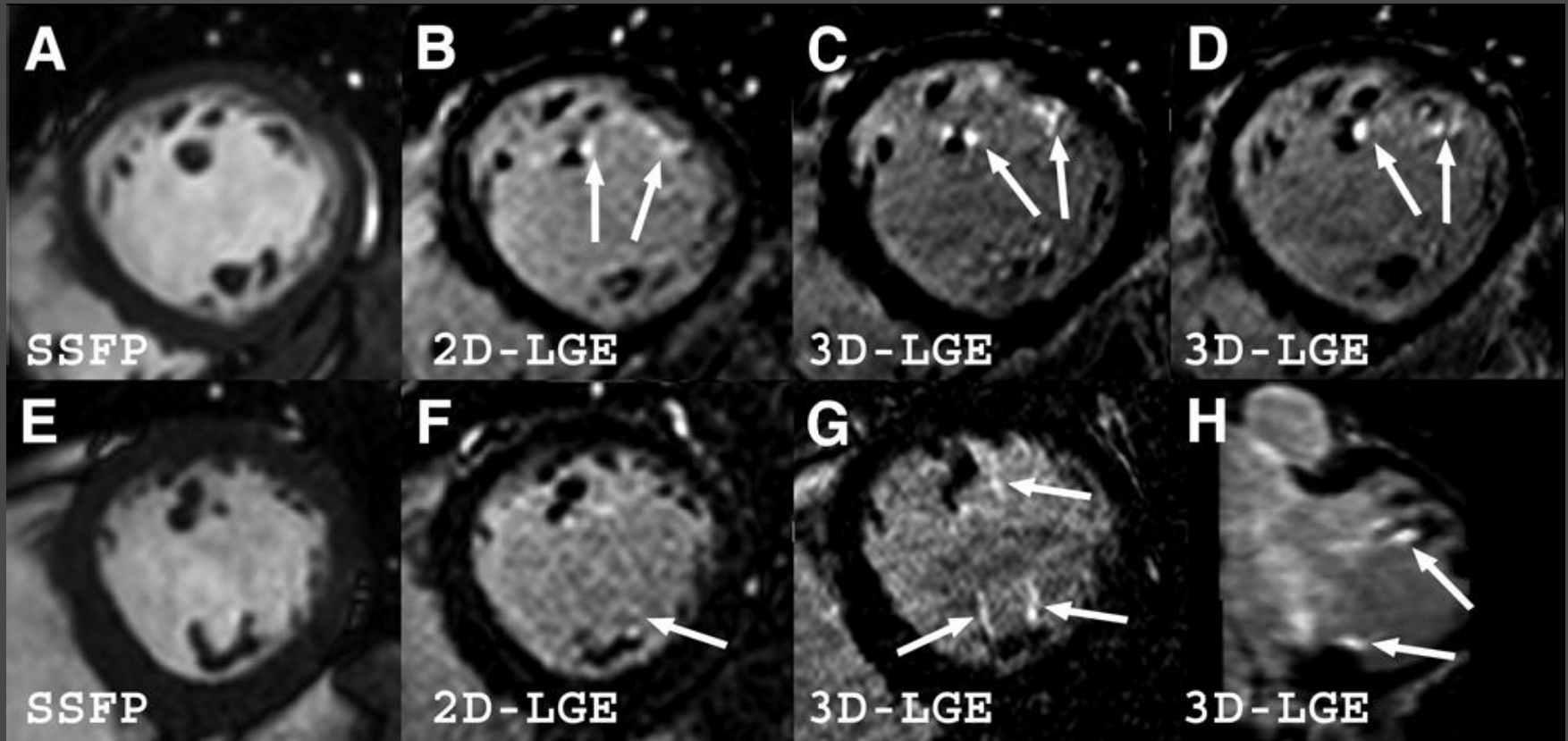


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- Further invasive procedures or cardiac surgery → surgical/ interventional planning/interventional MRI
- Perfusion; viability (scar identification)



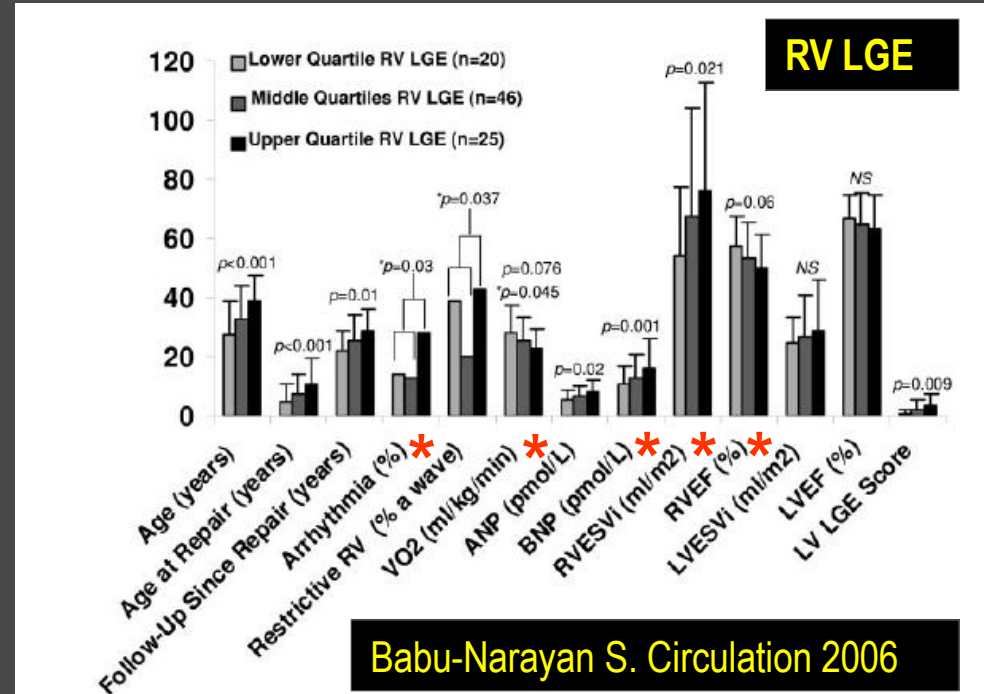
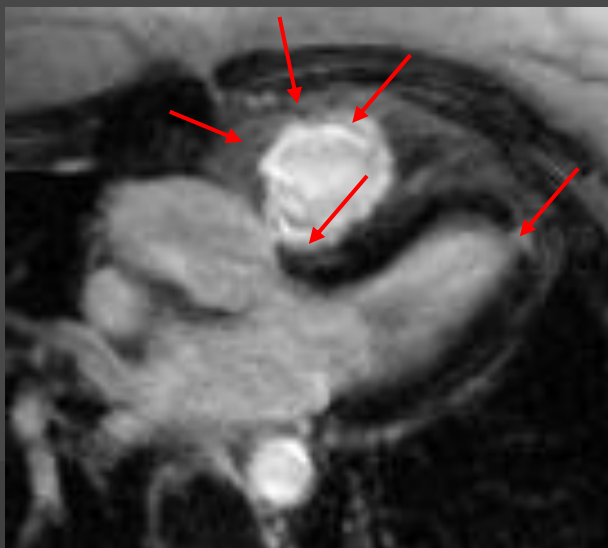
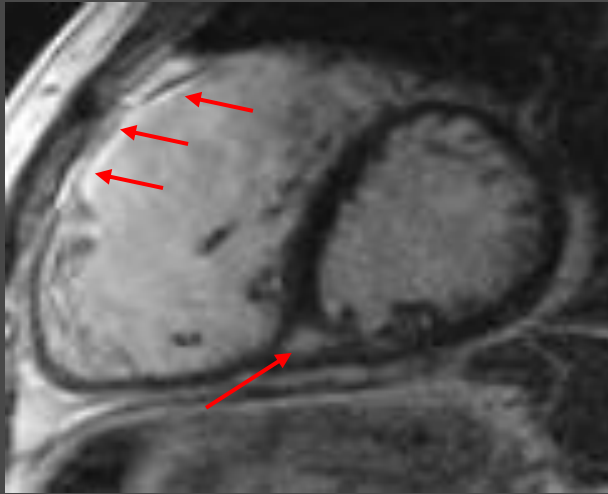
## WHY CMR? – Scar identification



**MITRAL VALVE PROLAPSE: late enhancement of papillary muscles related to complex ventricular arrhythmias (JACC Cardiovas Imaging 2008;1:294-303)**



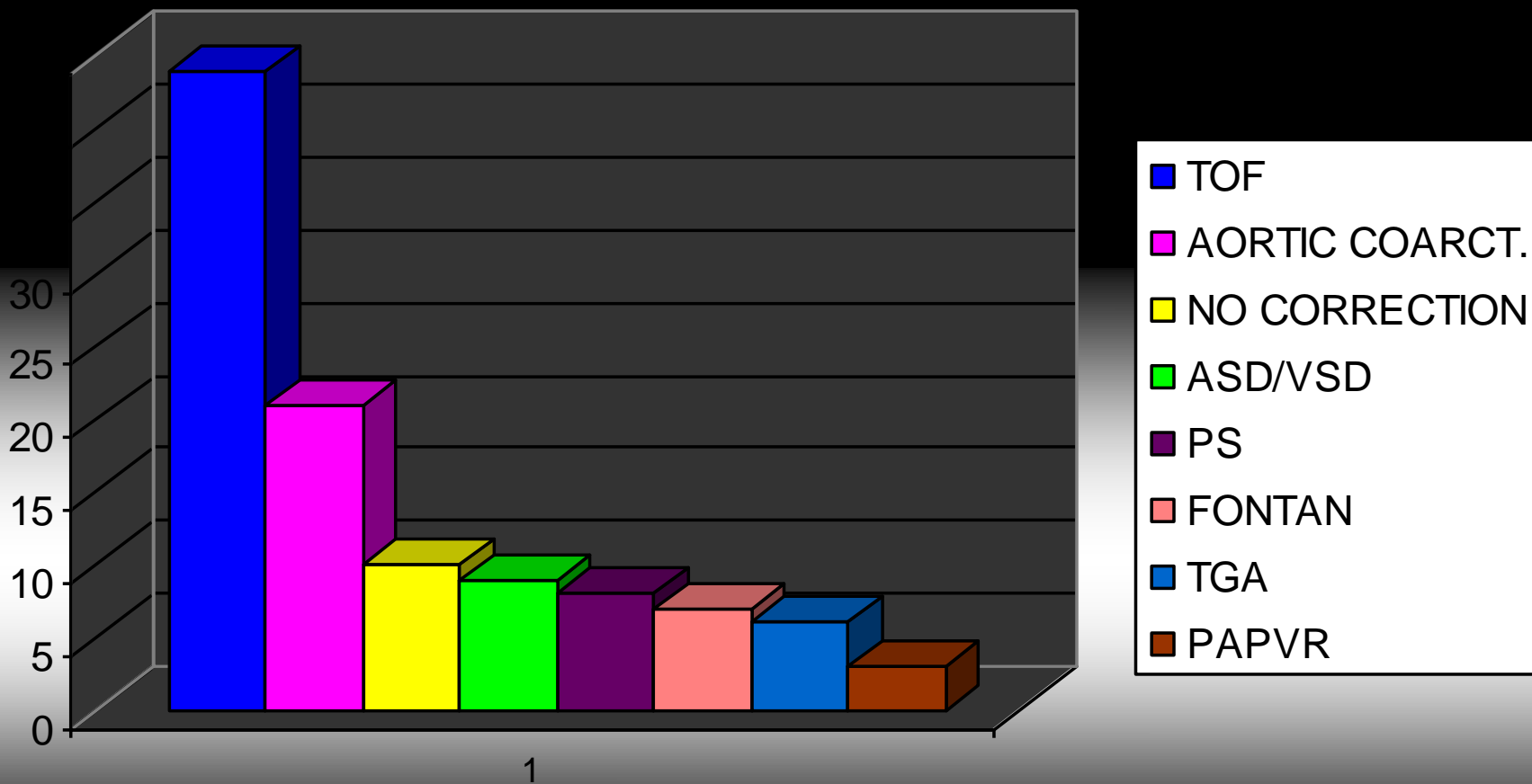
## WHY CMR? – Scar identification



**TOF: Non apical LV LGE related to adverse prognostic markers**

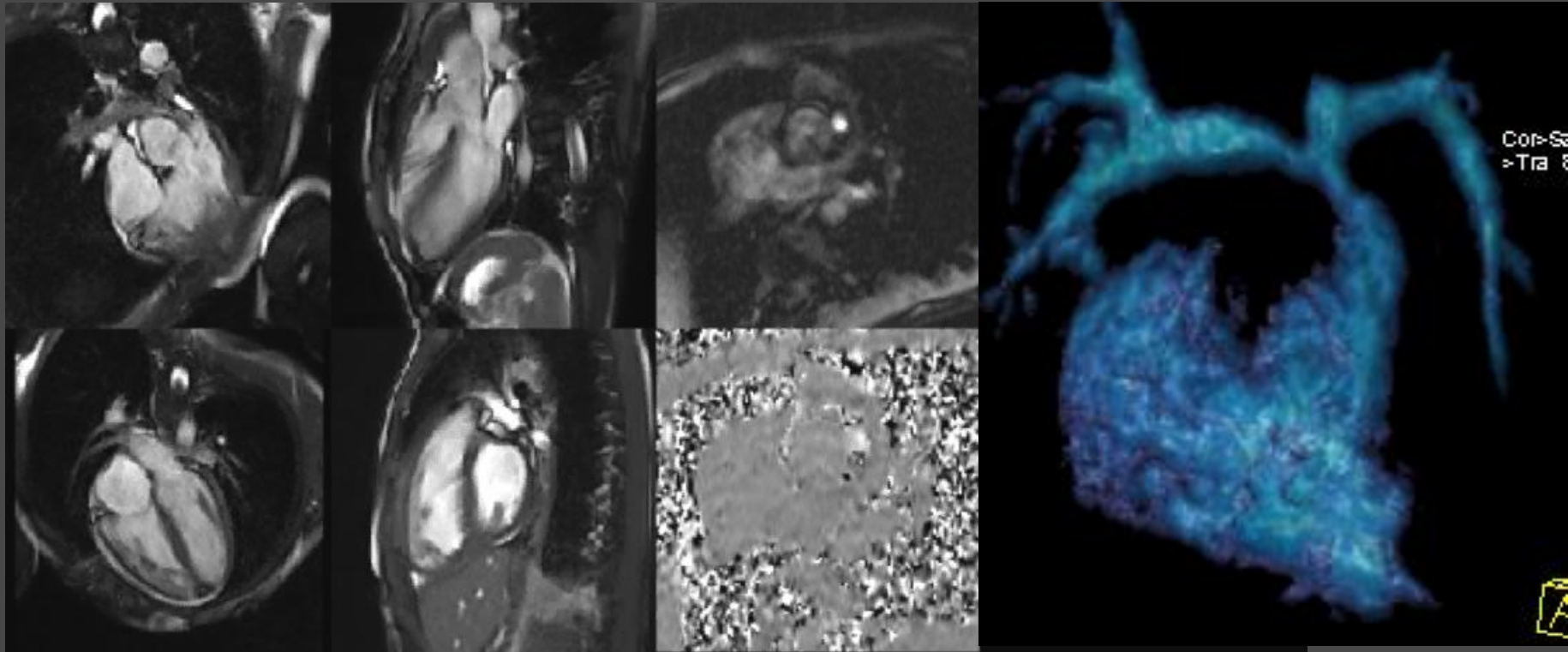


## CONGENITAL CASES – CMR UNIT NIGUARDA HOSPITAL





## CMR IN TETRALOGY OF FALLOT - Anatomy





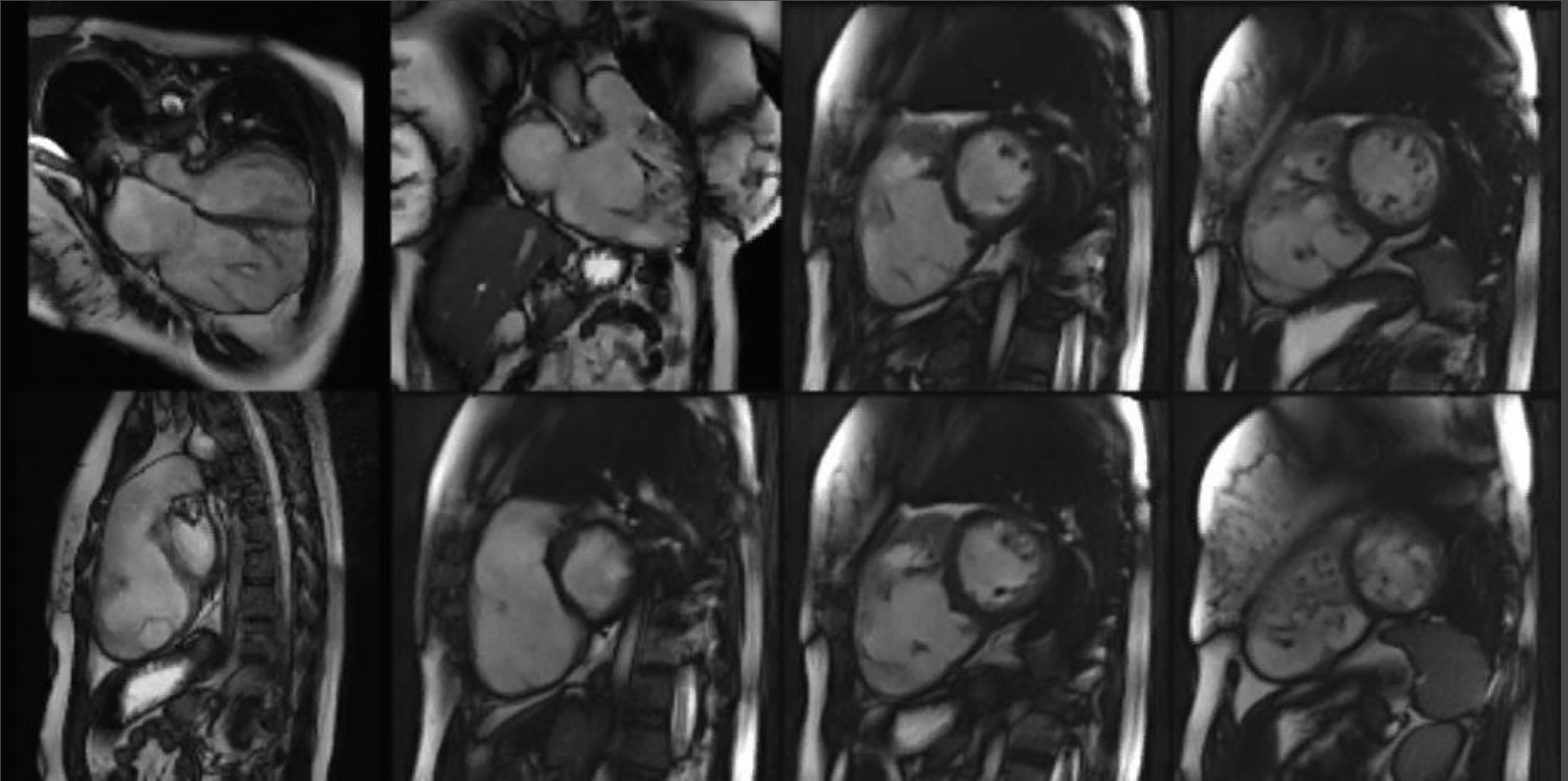
## CMR IN TETRALOGY OF FALLOT – Clinical issues

- **Pulmonary regurgitation**
- **Pulmonary stenosis (including peripheral stenosis)**
- Conduits; prosthetic valves
- VSD
- **RV size and function; patch aneurysm**
- LV function
- **Aortic root dilatation**
- Associated defects
- **SCD and the role of scar**





**CMR IN TETRALOGY OF FALLOT – RV dilation and dysfunction, severe PR**





## ...BECAUSE CMR ALLOWS:

- **Comprehensive non invasive assessment of pts with complex congenital heart disease**
- **Anatomy**
- **Global and regional biventricular function**
- **Quantitative flow analysis**
- **Myocardial perfusion and viability**