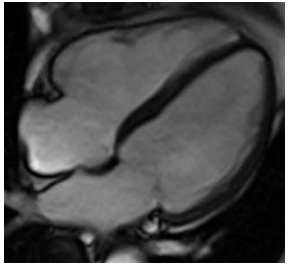
Università degli Studi di Padova

UNIVERSITÀ
DEGLI STUDI
DI PADOVA

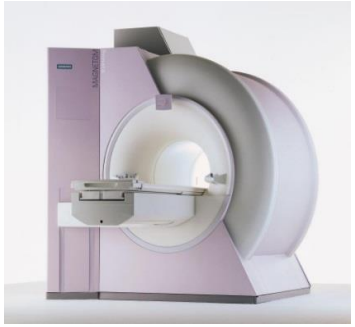
Acquisizione delle sequenze in risonanza magnetica cardiaca
Parte 1

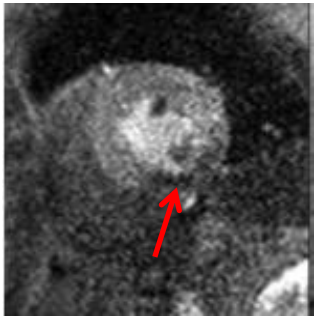
Anna Baritussio, MD, PhD, FEACVI

A “one stop shop” technique

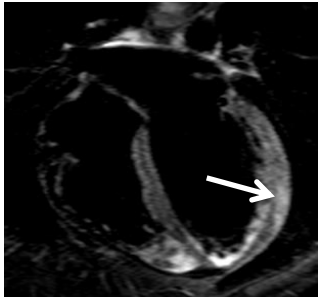


BIVENTRICULAR
VOLUMES AND FUNCTION

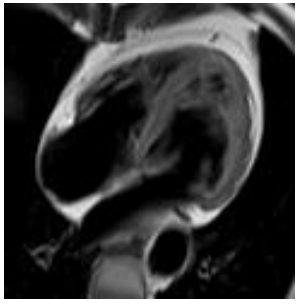




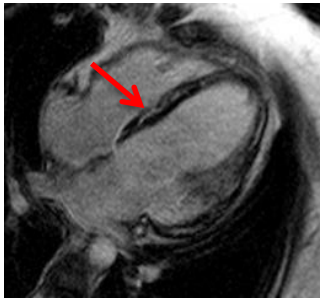
INDUCIBLE ISCHEMIA



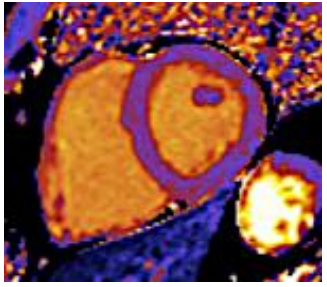
MYOCARDIAL OEDEMA



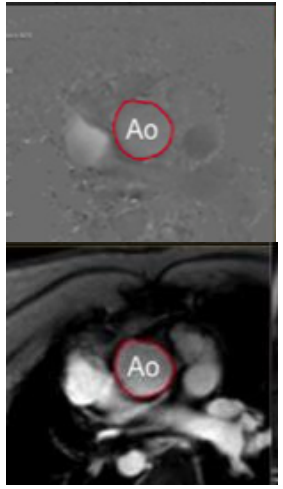
T1-WEIGHTING



LATE ENHANCEMENT



T1/T2 MAPPING



VALVE ASSESSMENT

Università degli Studi di Padova

Kramer *et al. Journal of Cardiovascular Magnetic Resonance* (2020) 22:17
https://doi.org/10.1186/s12968-020-00607-1

Journal of Cardiovascular Magnetic Resonance

RESEARCH Open Access

Standardized cardiovascular magnetic resonance imaging (CMR) protocols: 2020 update

Christopher M. Kramer[1*], Jörg Barkhausen[2], Chiara Bucciarelli-Ducci[3], Scott D. Flamm[4], Raymond J. Kim[5] and Eike Nagel[6]

Schulz-Menger *et al. Journal of Cardiovascular Magnetic Resonance* (2020) 22:19
https://doi.org/10.1186/s12968-020-00610-6

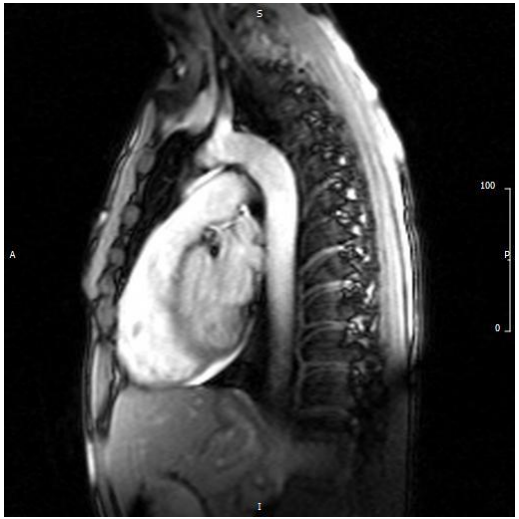
POSITION STATEMENT Open Access

Standardized image interpretation and post-processing in cardiovascular magnetic resonance - 2020 update

Society for Cardiovascular Magnetic Resonance (SCMR): Board of Trustees Task Force on Standardized Post-Processing

Jeanette Schulz-Menger[1*], David A. Bluemke[2], Jens Bremerich[3], Scott D. Flamm[4], Mark A. Fogel[5], Matthias G. Friedrich[6], Raymond J. Kim[7], Florian von Knobelsdorff-Brenkenhoff[8], Christopher M. Kramer[9], Dudley J. Pennell[10], Sven Plein[11] and Eike Nagel[12]

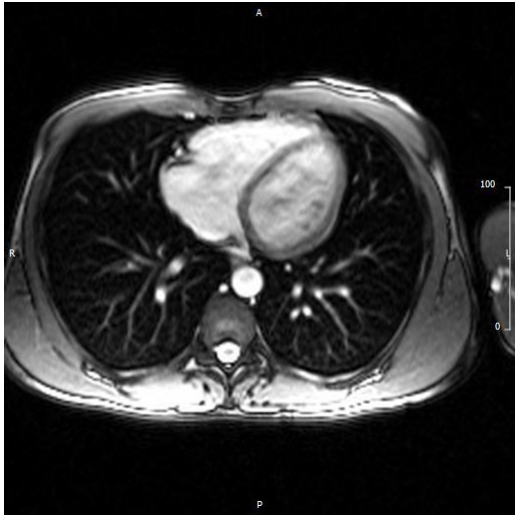
Localisers



SAGITTAL

CORONAL

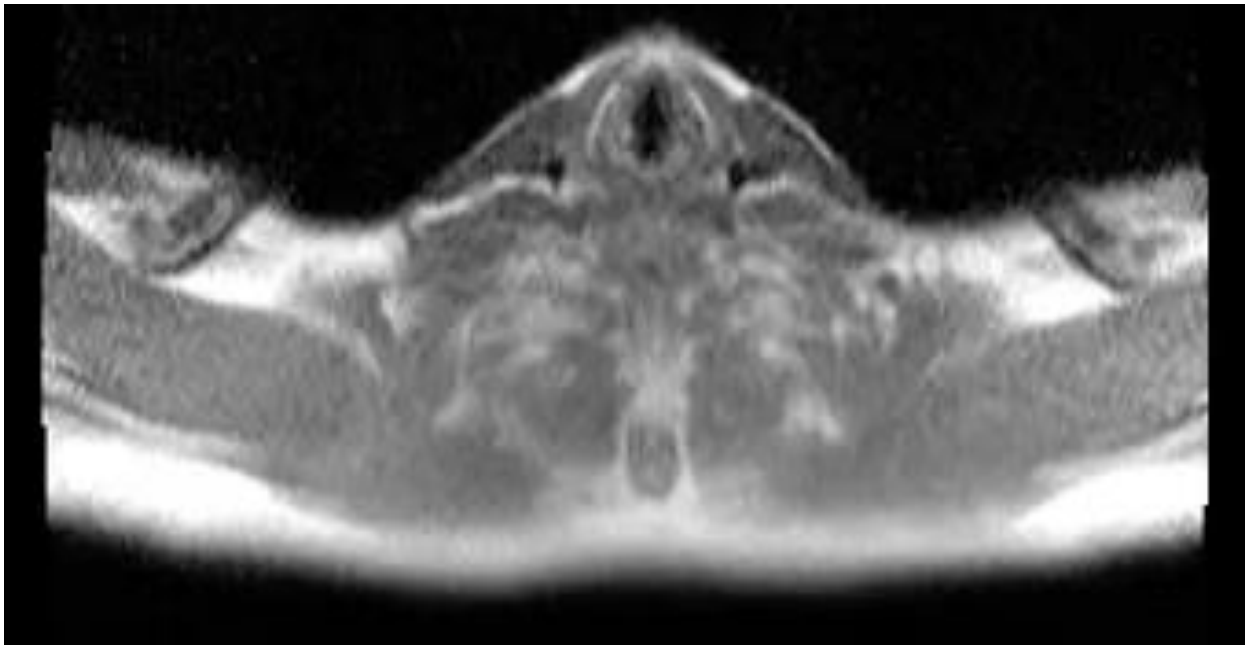
Free breathing



AXIAL

Bright blood

Localisers



Black blood

Localisers

Rodrigues et al. Journal of Cardiovascular Magnetic Resonance (2016) 18:26
DOI 10.1186/s12968-016-0246-1

Journal of Cardiovascular Magnetic Resonance

REVIEW Open Access

Extra-cardiac findings in cardiovascular magnetic resonance: what the imaging cardiologist needs to know

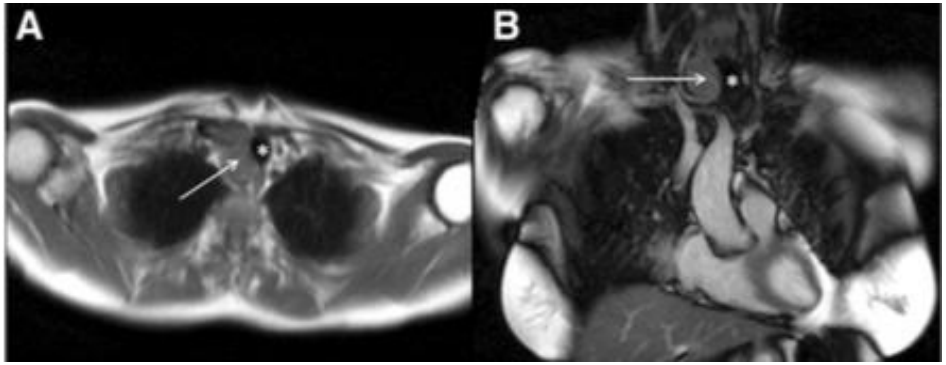
Jonathan C. L. Rodrigues[1,2,3], Stephen M. Lyen[2], William Loughborough[2], Antonio Matteo Amadu[1,4], Anna Baritussio[1,5], Amardeep Ghosh Dastidar[1,5], Nathan E. Manghat[2] and Chiara Bucciarelli-Ducci[1,5*]

Meta-analysis - 12 studies, 7062 patients

- Prevalence extra-cardiac findings 35% (major findings in 12%)
- Change in management in 1%

May contribute to diagnosis of cardiac pathology

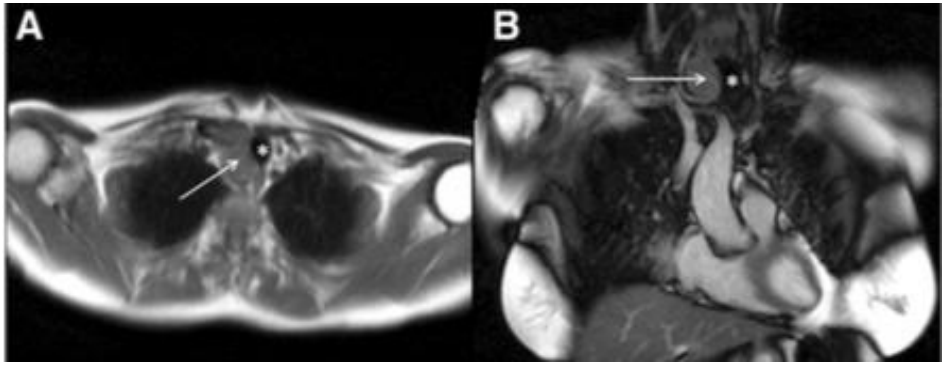
Localisers



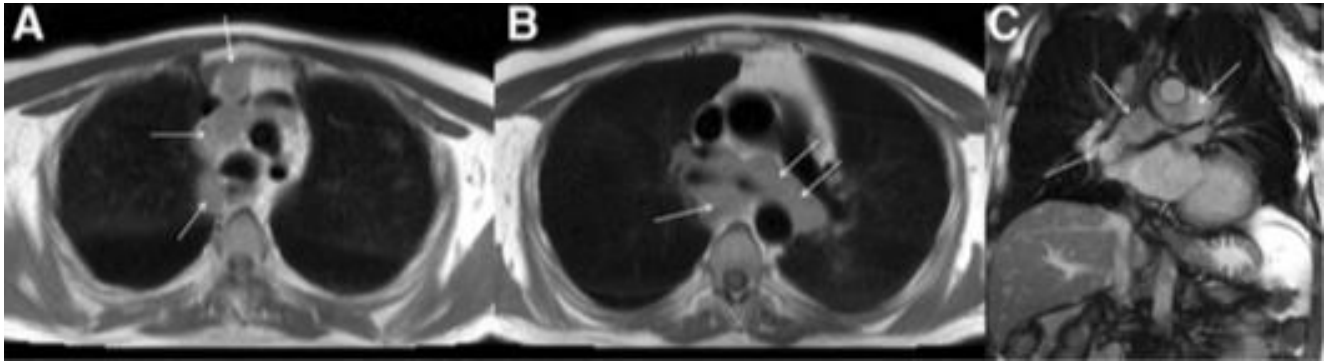
Right thyroid lobe enlargement with local mass effect on the trachea

Rodrigues JCL et al, JCMR 2016; 18: 26

Localisers



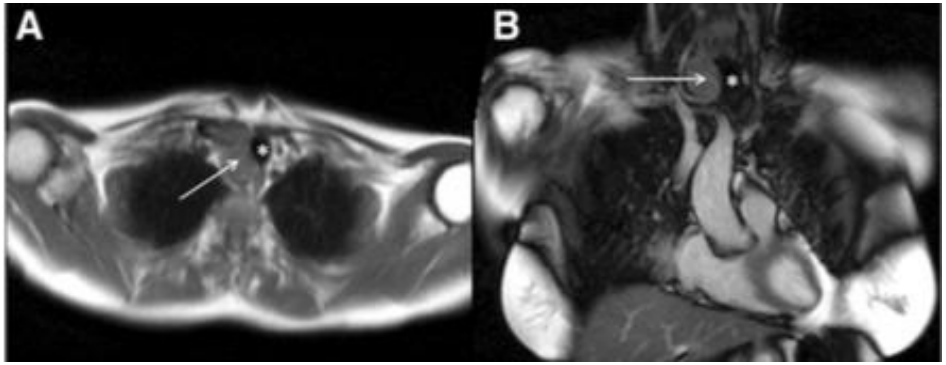
Right thyroid lobe enlargement with local mass effect on the trachea



Incidental florid mediastinal adenopathy

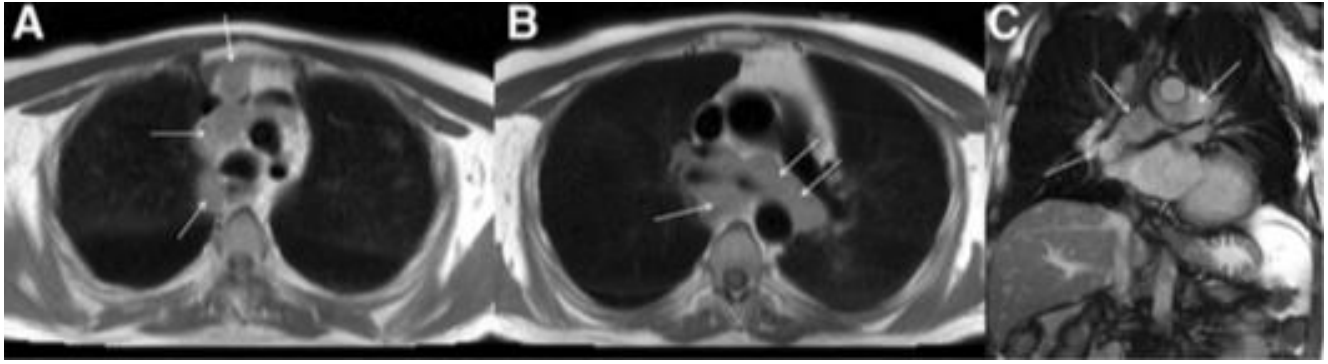
Rodrigues JCL et al, JCMR 2016; 18: 26

Localisers



Right thyroid lobe enlargement with local mass effect on the trachea

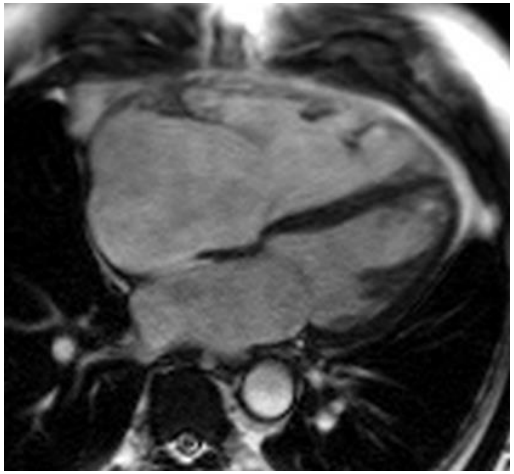
Extra-medullary haematopoiesis



Incidental florid mediastinal adenopathy

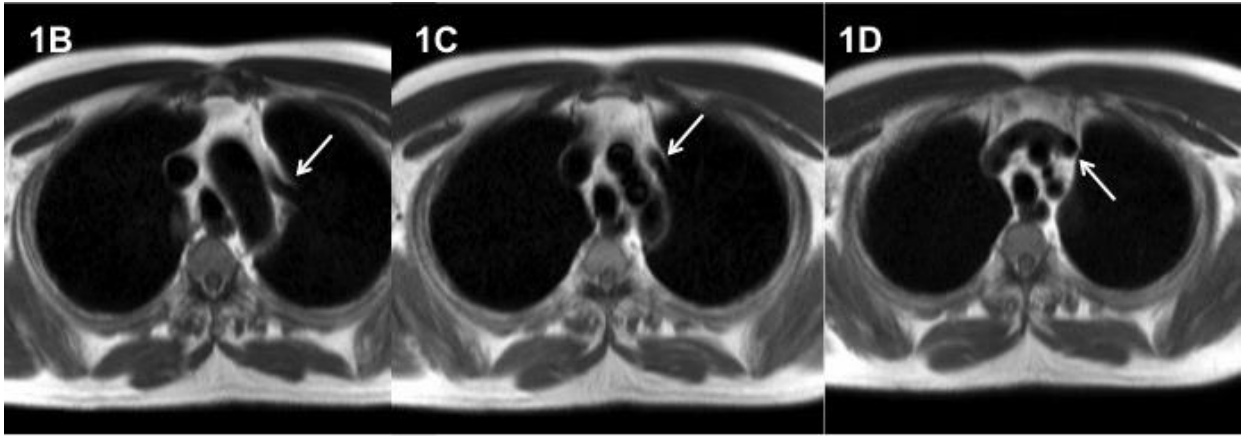
Rodrigues JCL et al, JCMR 2016; 18: 26

Localisers



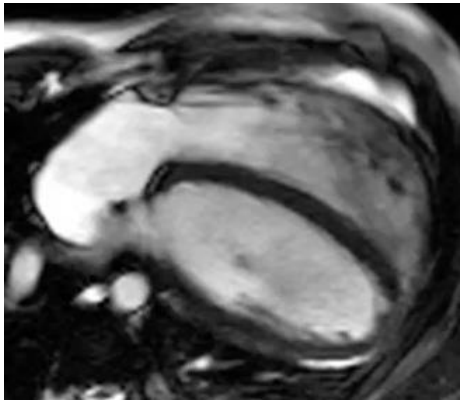
LV SV (ml/mq)	RV SV (ml/mq)
67	149

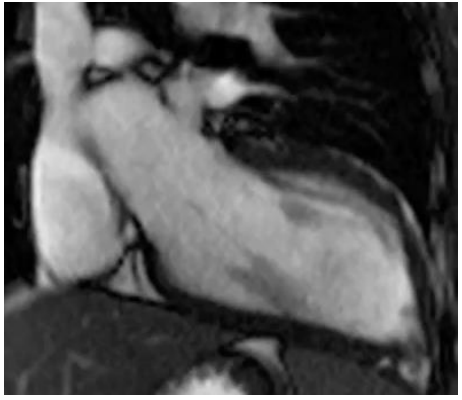
LUPV draining into left brachiocephalic vein



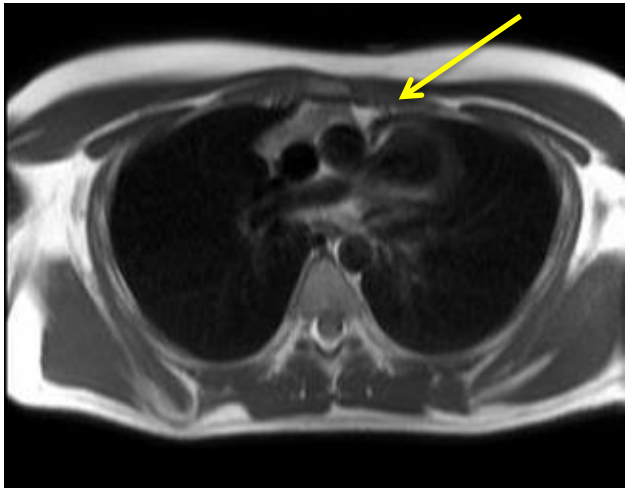
Baritussio A, Bucciarelli-Ducci C, London CMR 2015

Localisers





Absent pericardium



Lung Interposition
between Aorta and Pulmonary Artery

Levoposition
Cardiac Apex Pointing Posteriorly

Baritussio A et al. Heart 2015

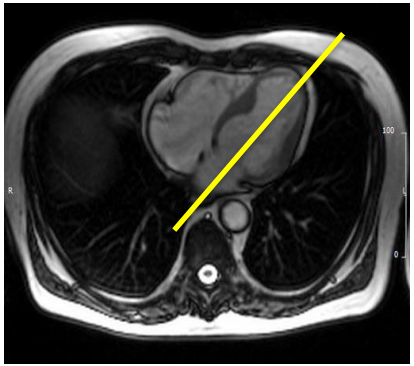
Cine Images

Image property	Spoiled Gradient Echo	bSSFP
Blood to myocardium contrast	Variable – relies on through plane flow	Good – T_2/T_1 ratio
Flow sensitivity	High – can visualise flow jets	Low – uses balanced gradients
Image quality	Low SNR – no shimming required	High SNR – good shimming required

Cine images are acquired during a breath-hold.
Breath-hold on expiration provides more consistent positioning but inspiratory breath-hold may be more comfortable and easier to sustain for some patients.

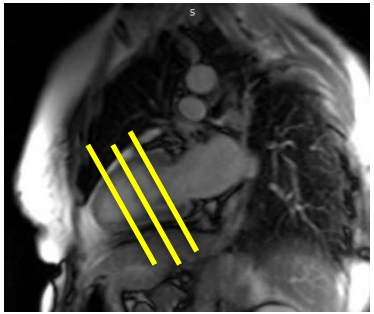
Broadbent D et al. ESC CMR Physics for Clinicians Pocket Guide v1.0.2015

Cine Images

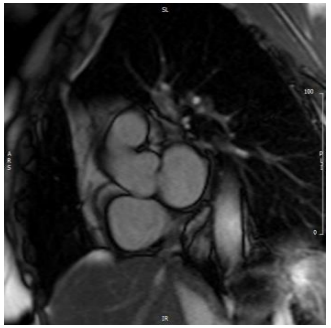


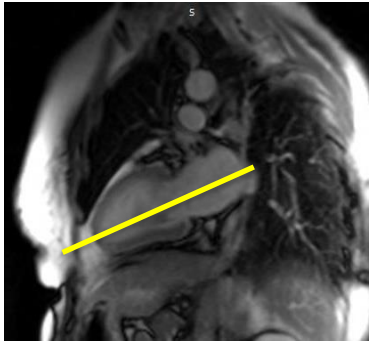
Transaxial

Bisecting Mitral Valve and Apex



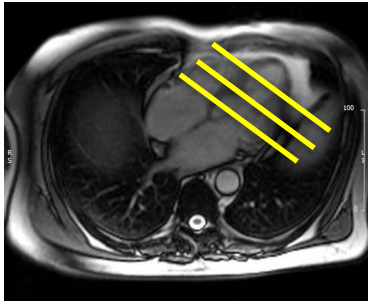
Pseudo 2-chamber



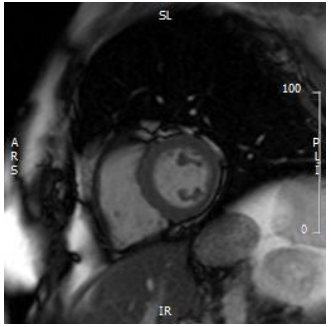


Pseudo 2-chamber

Bisecting Mitral Valve and Apex

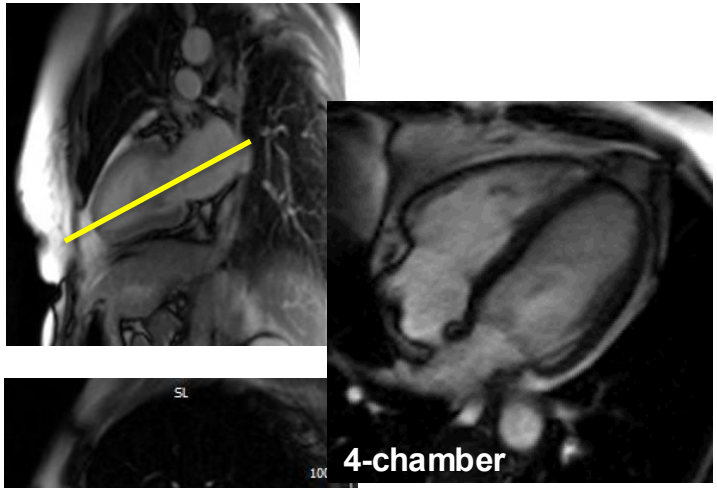


Pseudo 4-chamber

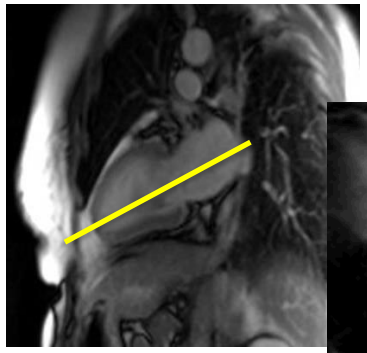


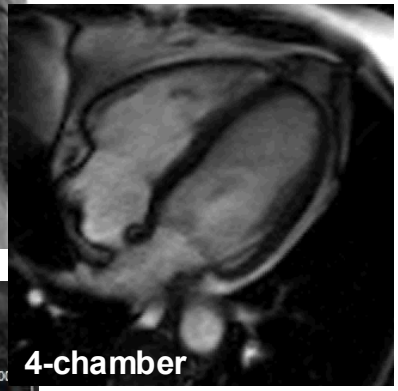
True short axis view

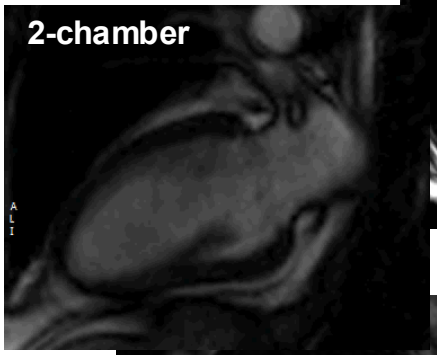
Cine Images

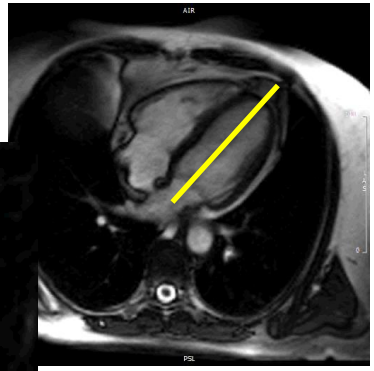


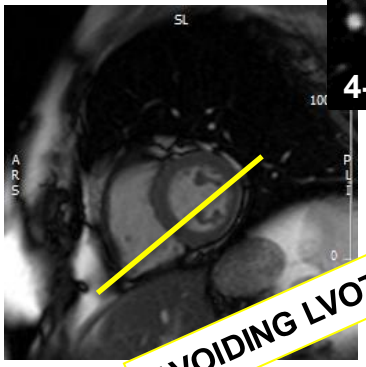
Cine Images



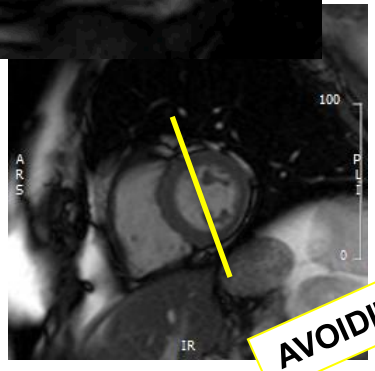






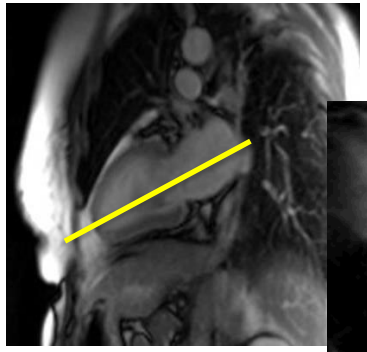


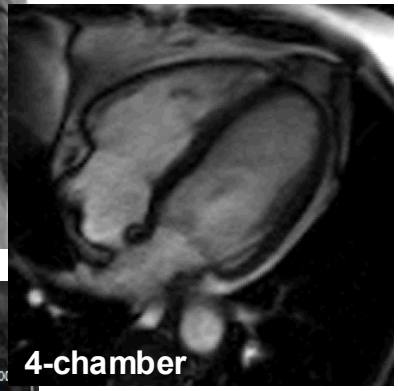
AVOIDING LVOT

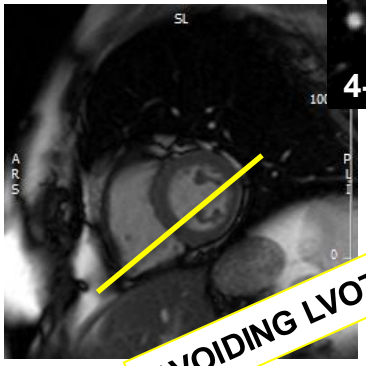


AVOIDING RV

Cine Images







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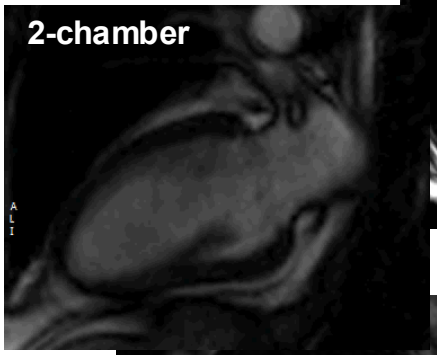

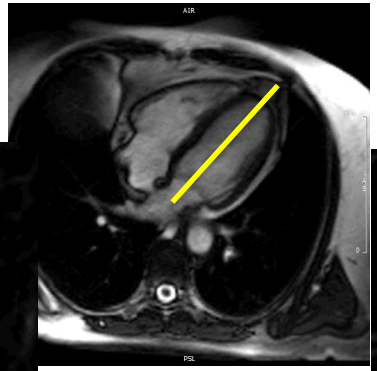

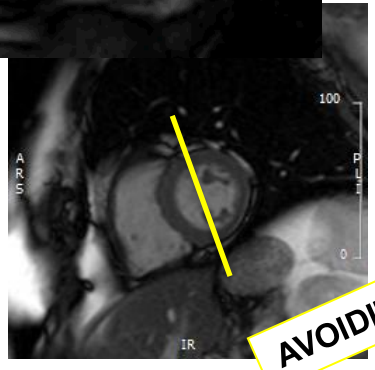

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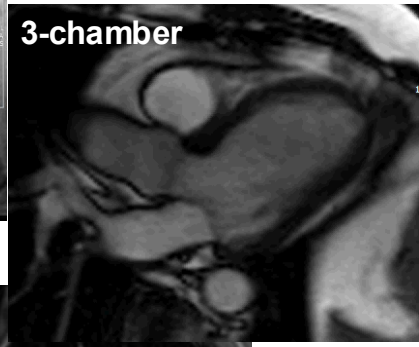
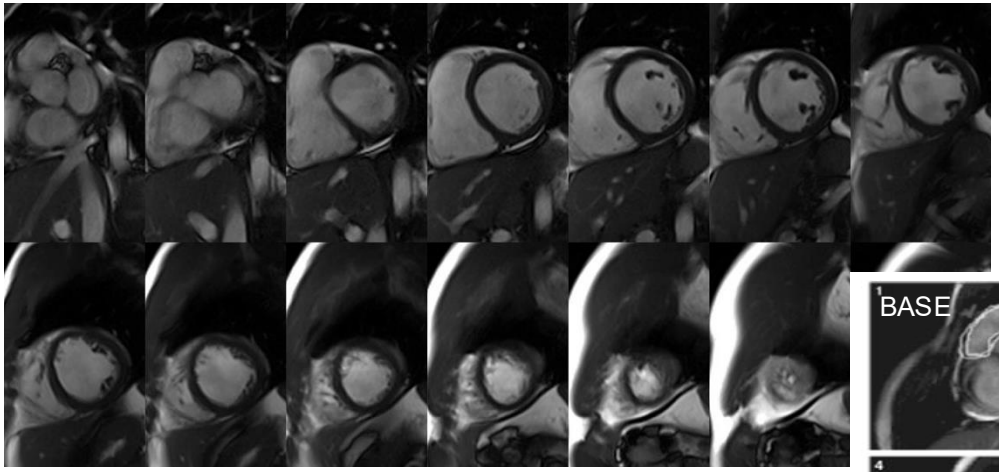
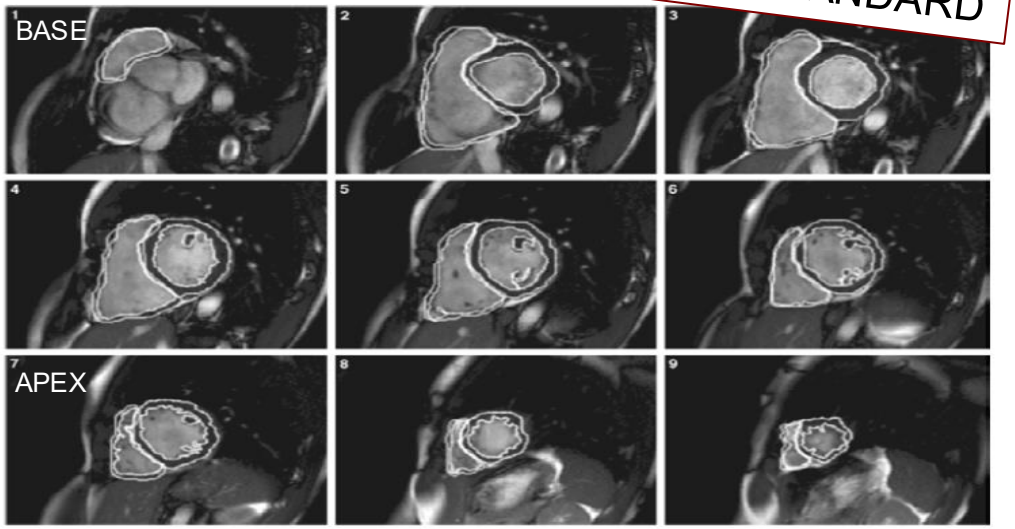


Cine Images



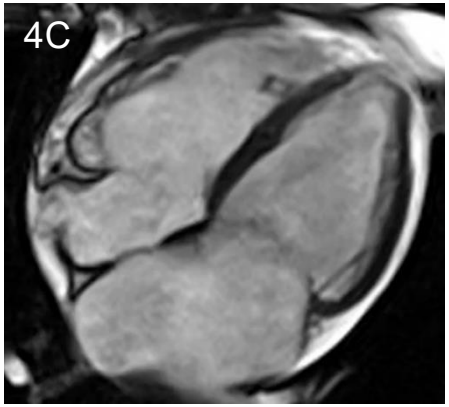
GOLD STANDARD

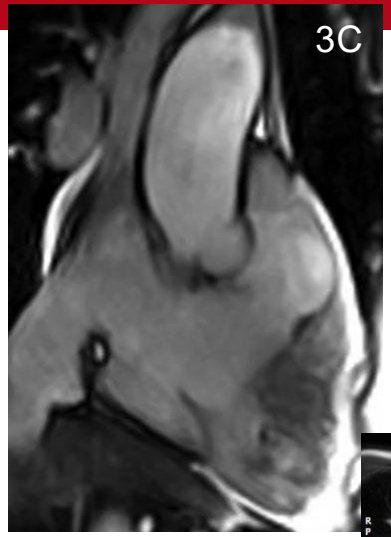


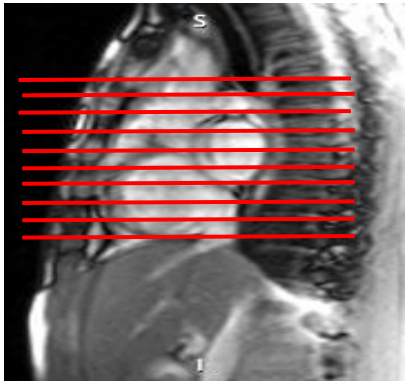
Biventricular volumes and function assessment
free of any geometric assumption

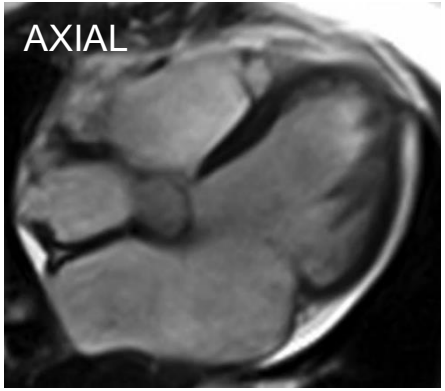
Broadbent D et al. ESC CMR Physics for Clinicians Pocket Guide v1.0.2015

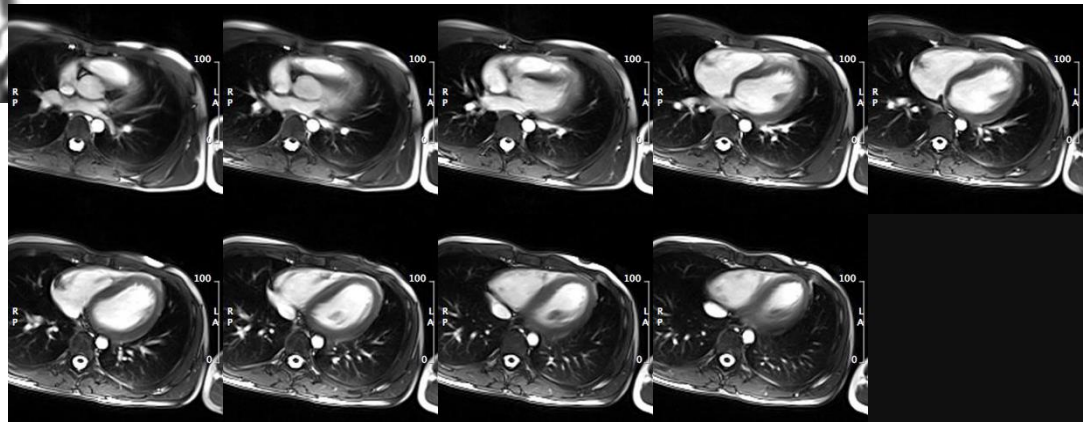
Cine Images





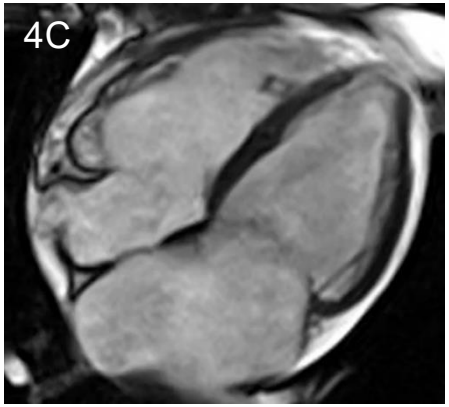


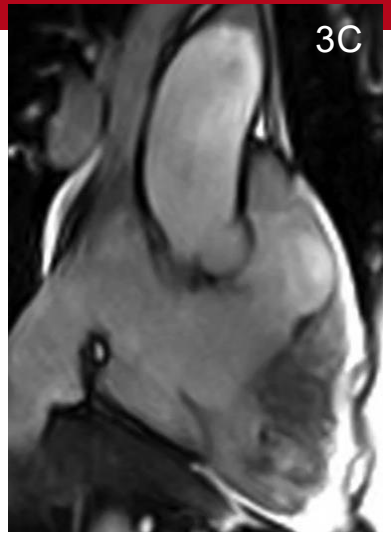


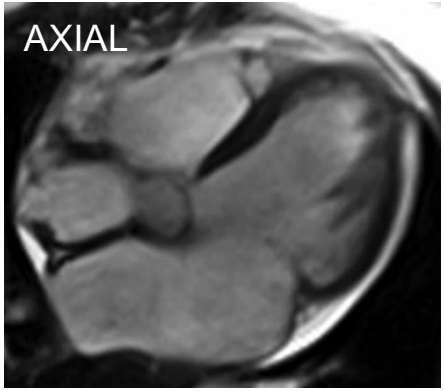


Best identification of tricuspid valve plane

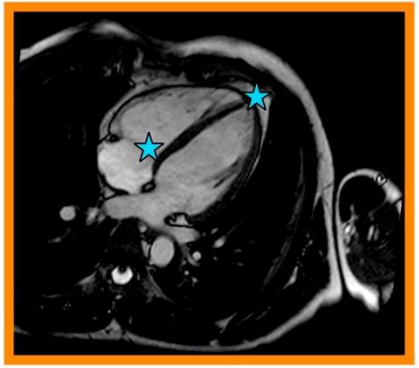
Cine Images



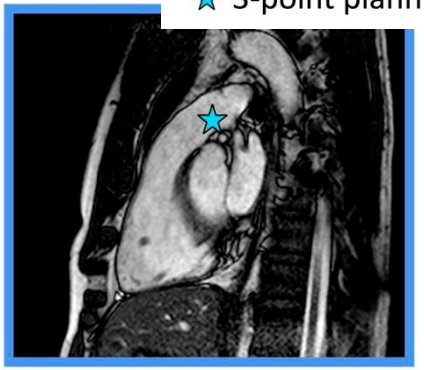




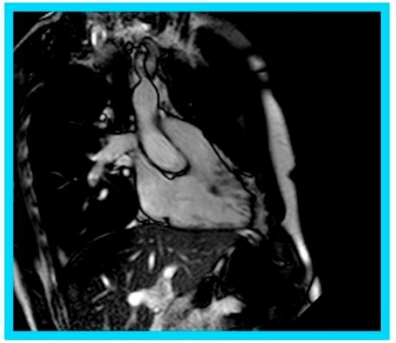
★ 3-point planning



4CH



Sagittal RVOT



RV in-/outflow

Herzog BA et al. EACVI ESC CMR Pocket Guide v2.0.2017

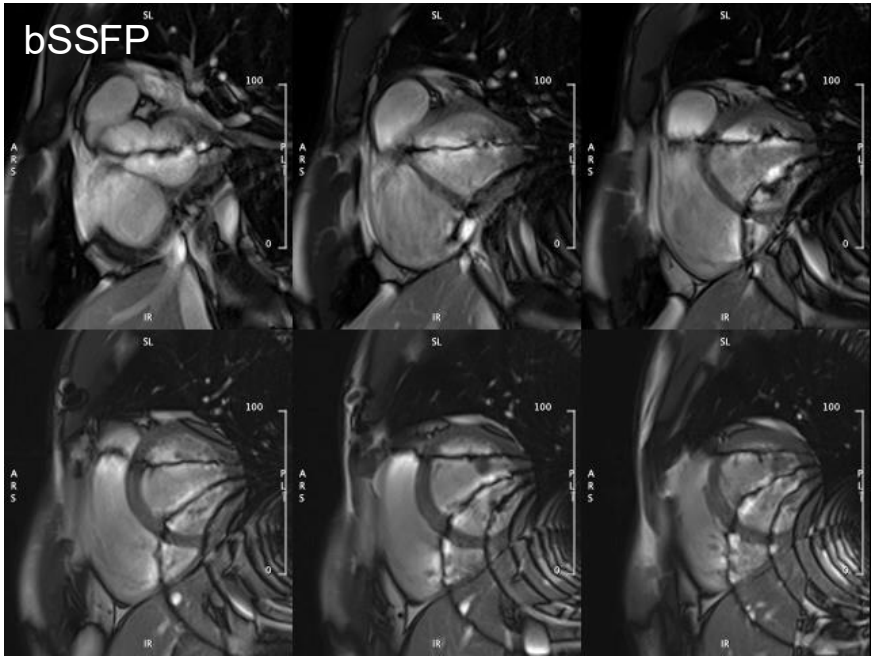
Cine Images

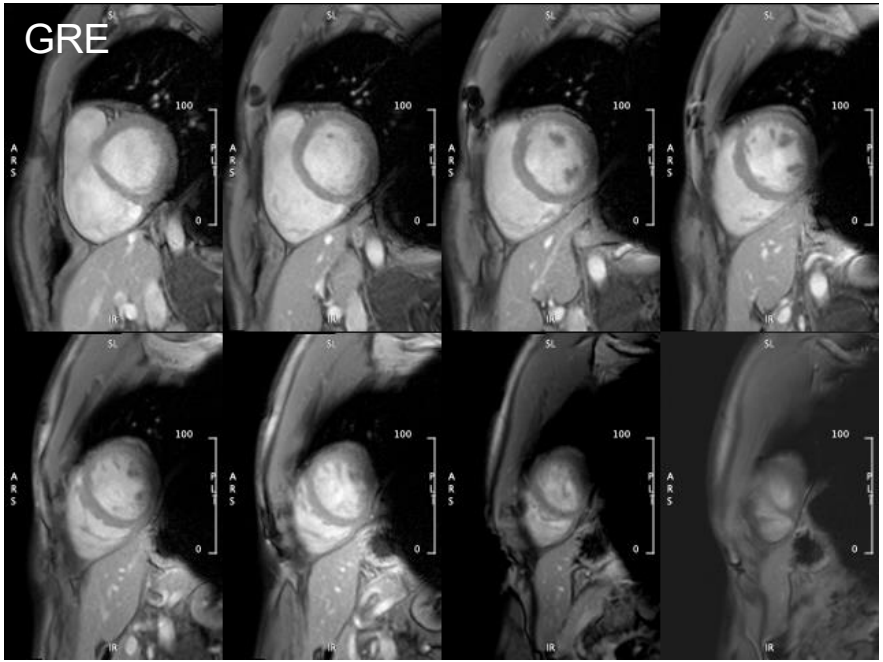
Image property	Spoiled Gradient Echo	bSSFP
Blood to myocardium contrast	Variable – relies on through plane flow	Good – T_2/T_1 ratio
Flow sensitivity	High – can visualise flow jets	Low – uses balanced gradients
Image quality	Low SNR – no shimming required	High SNR – good shimming required

Cine images are acquired during a breath-hold.
Breath-hold on expiration provides more consistent positioning but inspiratory breath-hold may be more comfortable and easier to sustain for some patients.

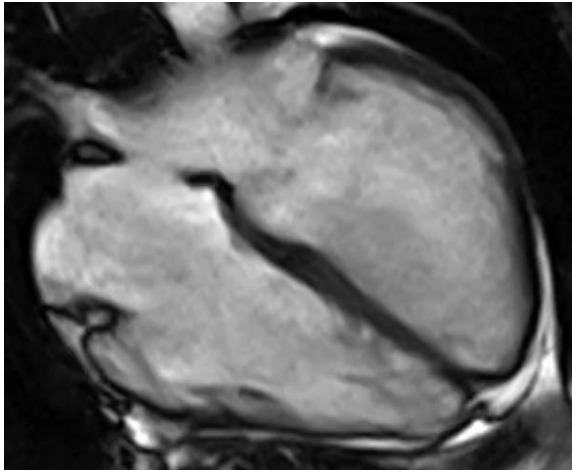
Broadbent D et al. ESC CMR Physics for Clinicians Pocket Guide v1.0.2015

Gradient echo cine sequences

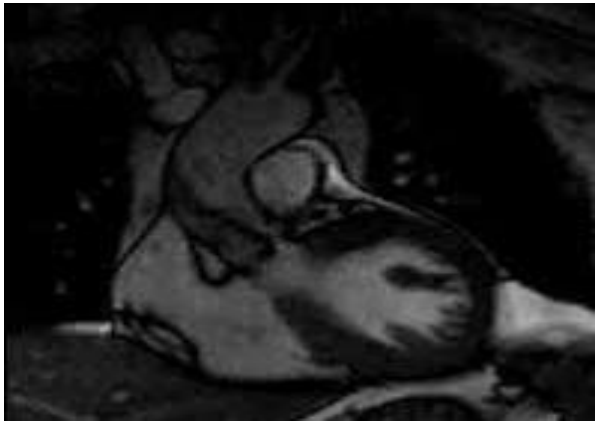




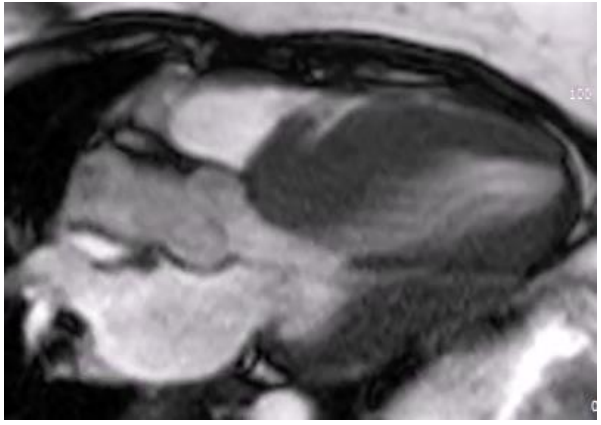
Cine Images



MITRAL REGURGITATION

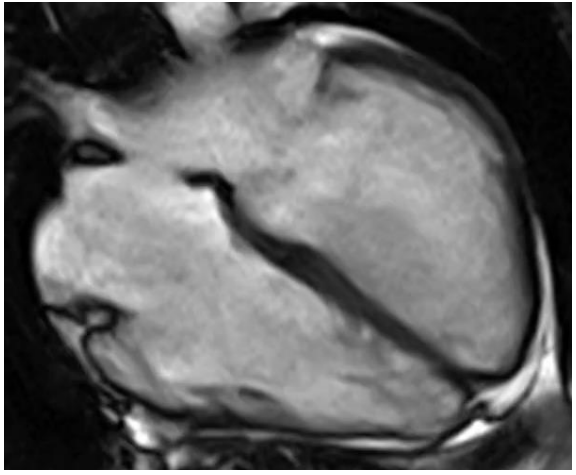


AORTIC STENOSIS

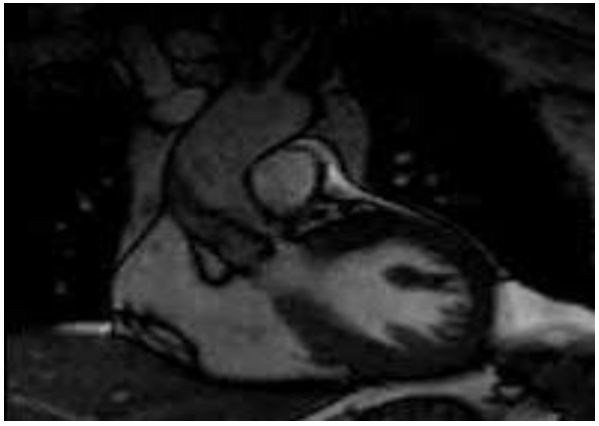


LVOT OBSTRUCTION

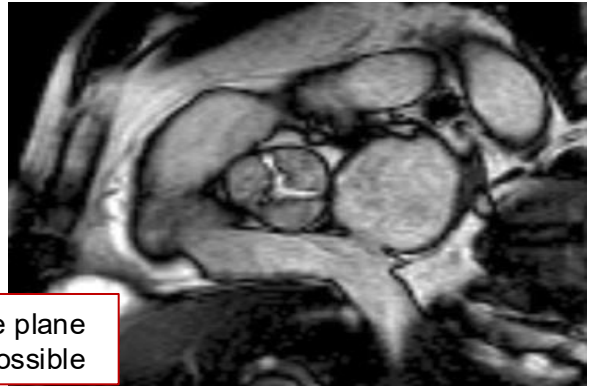
Cine Images



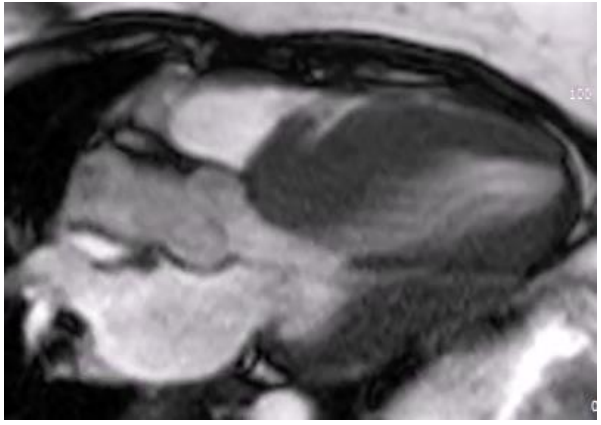
MITRAL REGURGITATION



AORTIC STENOSIS



N.B. a perfect 2D image plane of a 3D structure is impossible



LVOT OBSTRUCTION

- High spatial resolution
- High contrast blood-cusps

Cine Images

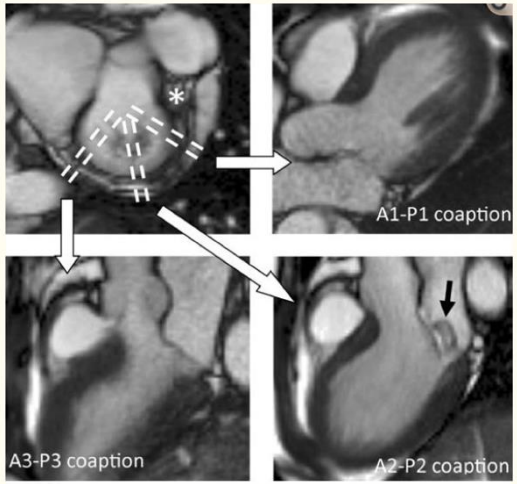
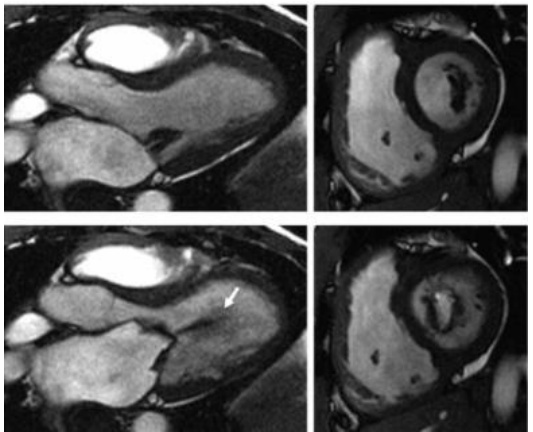
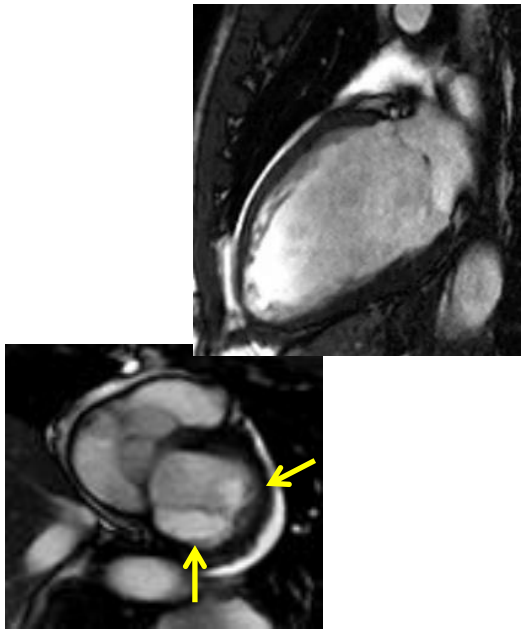


Table 1. CMR Pulse Sequences for Valvular Heart Disease

Pulse Sequence	Indication
SSFP cine	Valve anatomy and motion
	Ventricular volumes and function
Gradient echo cine	Valve anatomy and motion
	Turbulent flow
Phase contrast	Velocity
	Forward and regurgitant volumes
Turbo spin echo (T1, T2, with or without fat saturation)	Valve mass characterization
Segmented inversion recovery gradient echo	Valve mass characterization

Mitral Stenosis





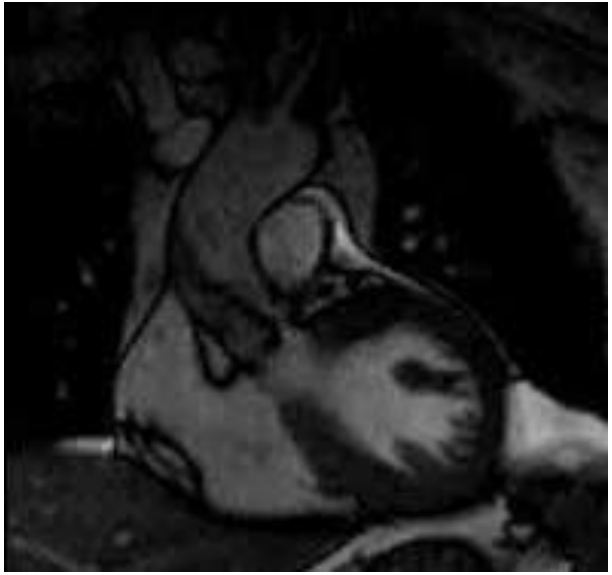
Myerson SG, JCMR 2012; 14 (1): 7

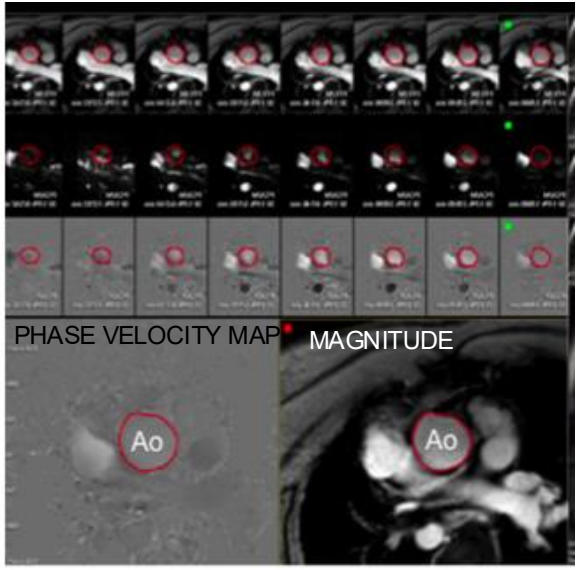
Cawley PJ, Circulation. 2009;119:468-478

Phase-contrast sequences

"Bright blood" GRE
Acquired on a plane perpendicular to flow direction
Level of grey depending on flow velocity and direction
- still protons → grey
- protons moving perpendicular to the plane → black or white

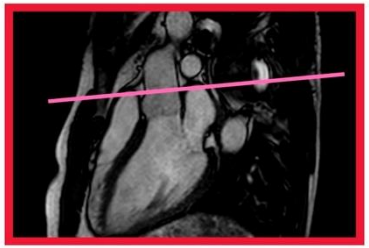
VENC – systemic flow 150 cm/s, pulmonary flow 100 cm/s

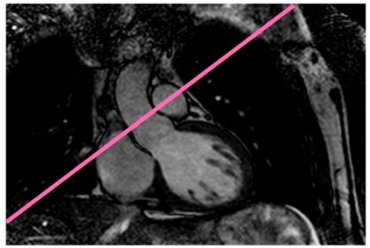


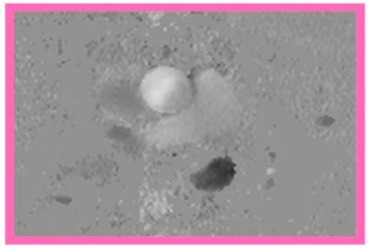


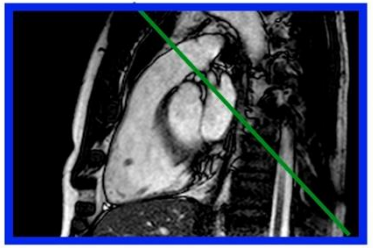
Valve stenosis/regurgitation, Qp:Qs, sistemic-pulmonary shunt

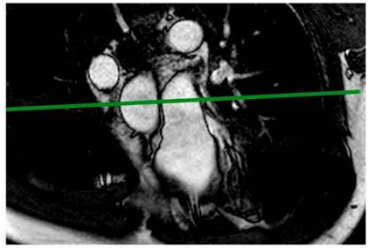
Phase-contrast sequences

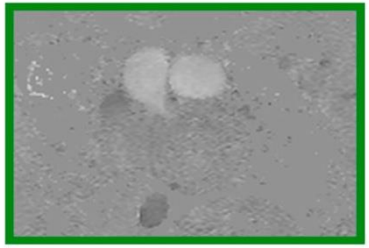

Sagittal LVOT


Coronal LVOT


Ao flow


Sagittal RVOT


Coronal RVOT


MPA flow

VENC settings:

- Optimal within 25% of the true peak velocity
  - Too low: flow aliasing
  - Too high: underestimating velocity
- Correct direction of flow (Right-Left, Foot-Head)
- Image plane distal from valve leaflet tips

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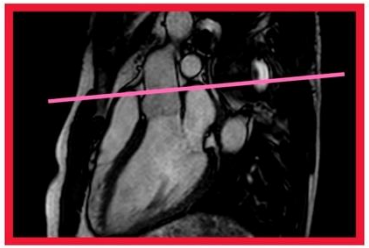
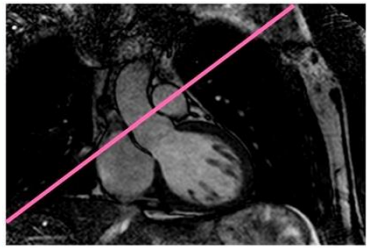
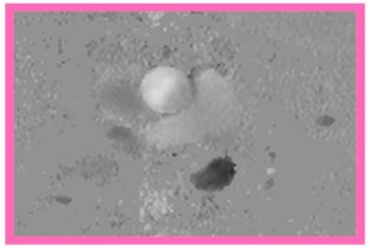
Phase-contrast sequences



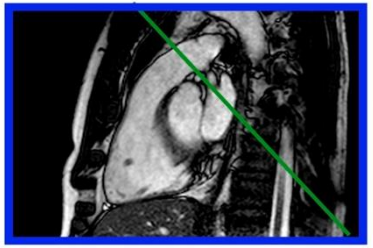
Sagittal LVOT



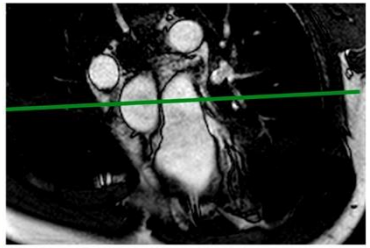
Coronal LVOT



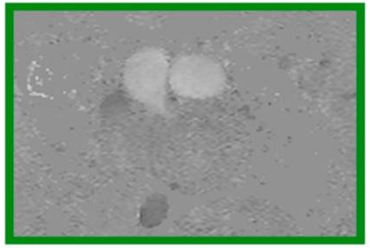
Ao flow



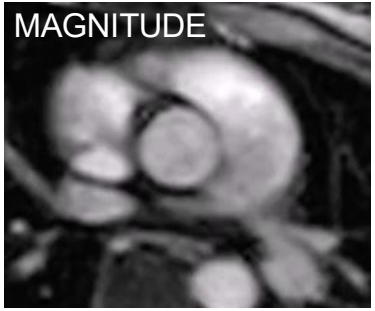
Sagittal RVOT

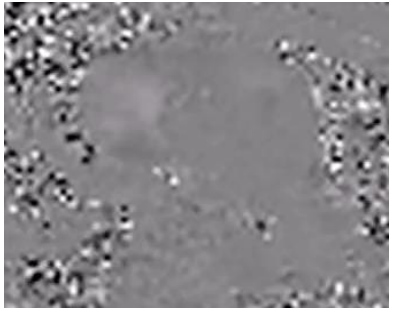


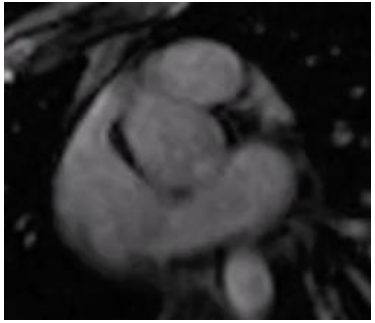
Coronal RVOT



MPA flow







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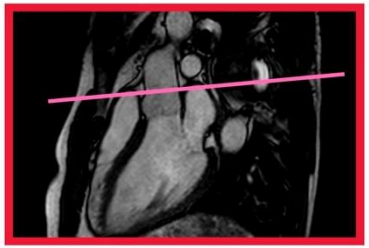
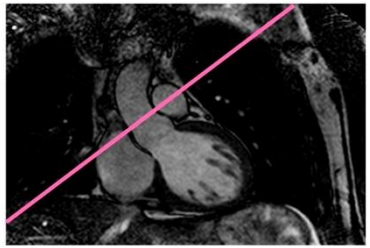
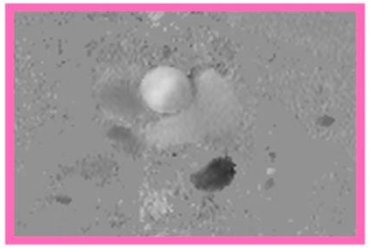
Phase-contrast sequences



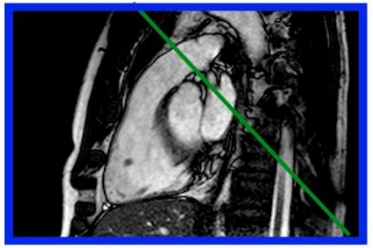
Sagittal LVOT



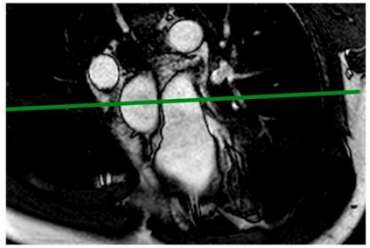
Coronal LVOT



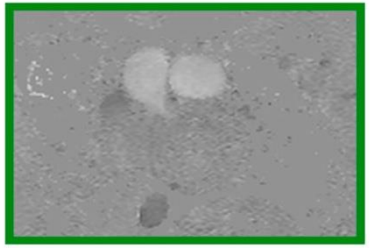
Ao flow



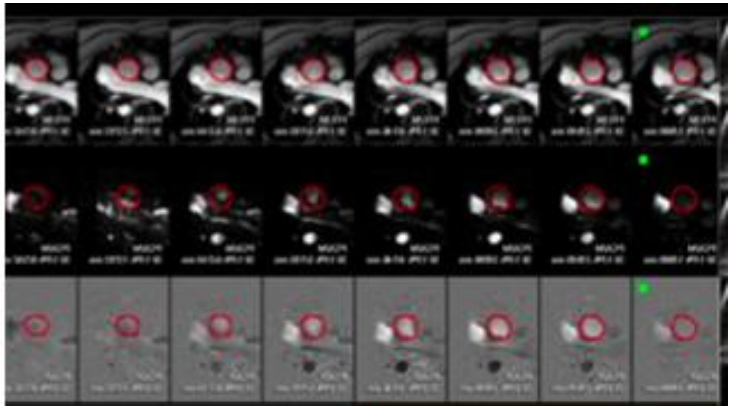
Sagittal RVOT

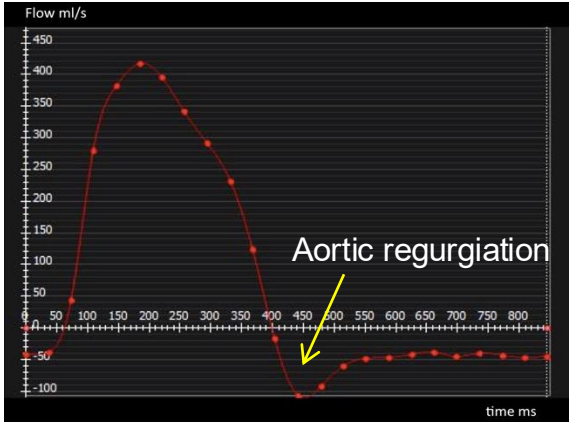


Coronal RVOT



MPA flow





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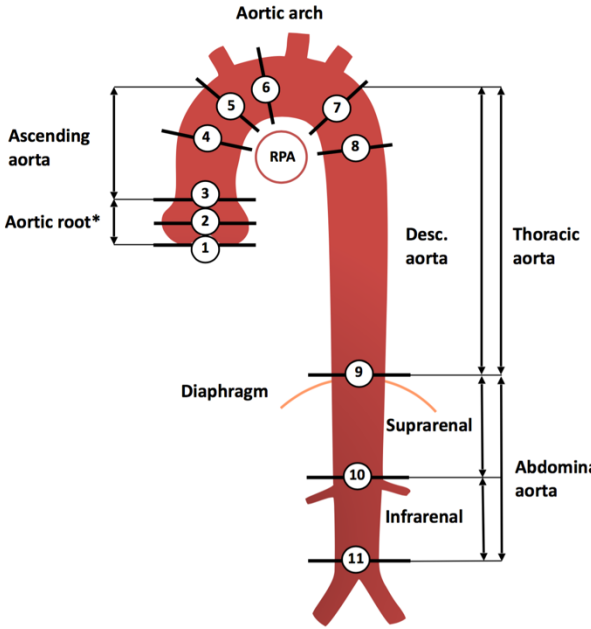
Aortic Assessment



1. Aortic annulus
2. Sinuses of Valsalva
3. Sinotubular junction
4. Mid ascending aorta (level of the pulmonary arteries)
5. Proximal aortic arch (at the origin of the brachiocephalic trunk)
6. Mid aortic arch (btw. left common carotid and subclavian arteries)
7. Proximal descending thoracic aorta
8. Mid descending aorta (level of the pulmonary arteries)
9. At diaphragm
10. At the celiac axis origin
11. Immediately proximal to aortic bifurcation.

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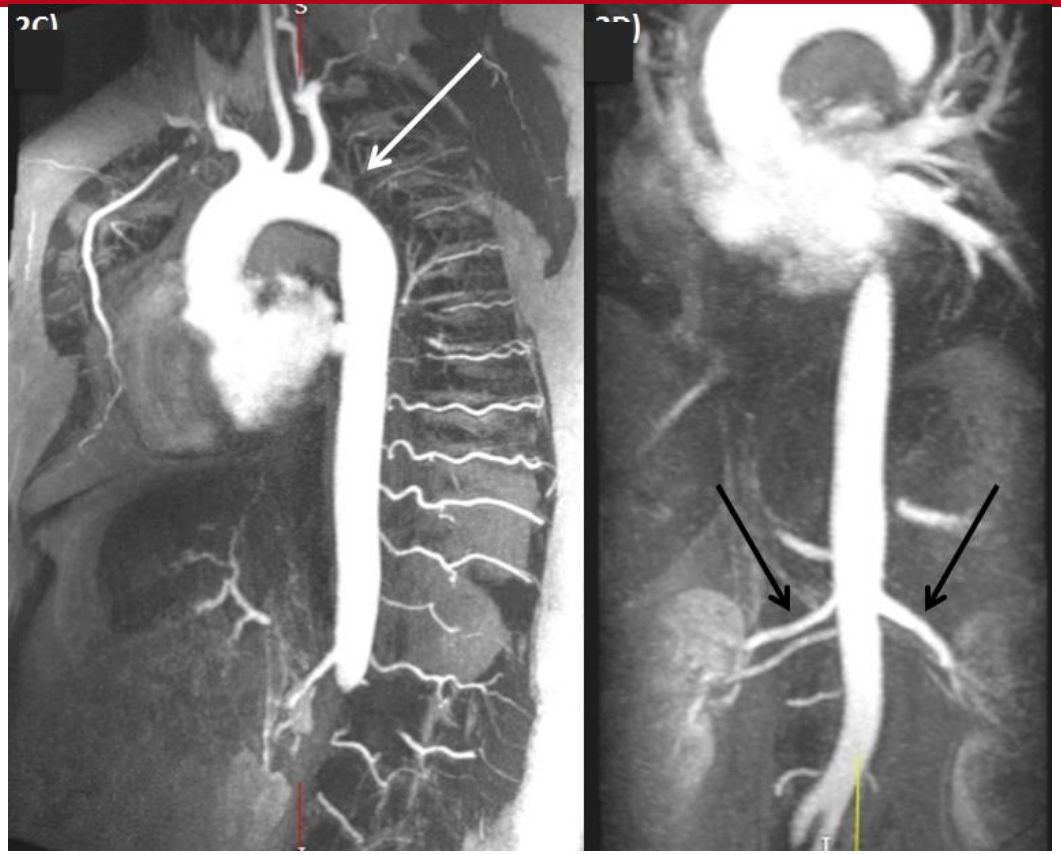
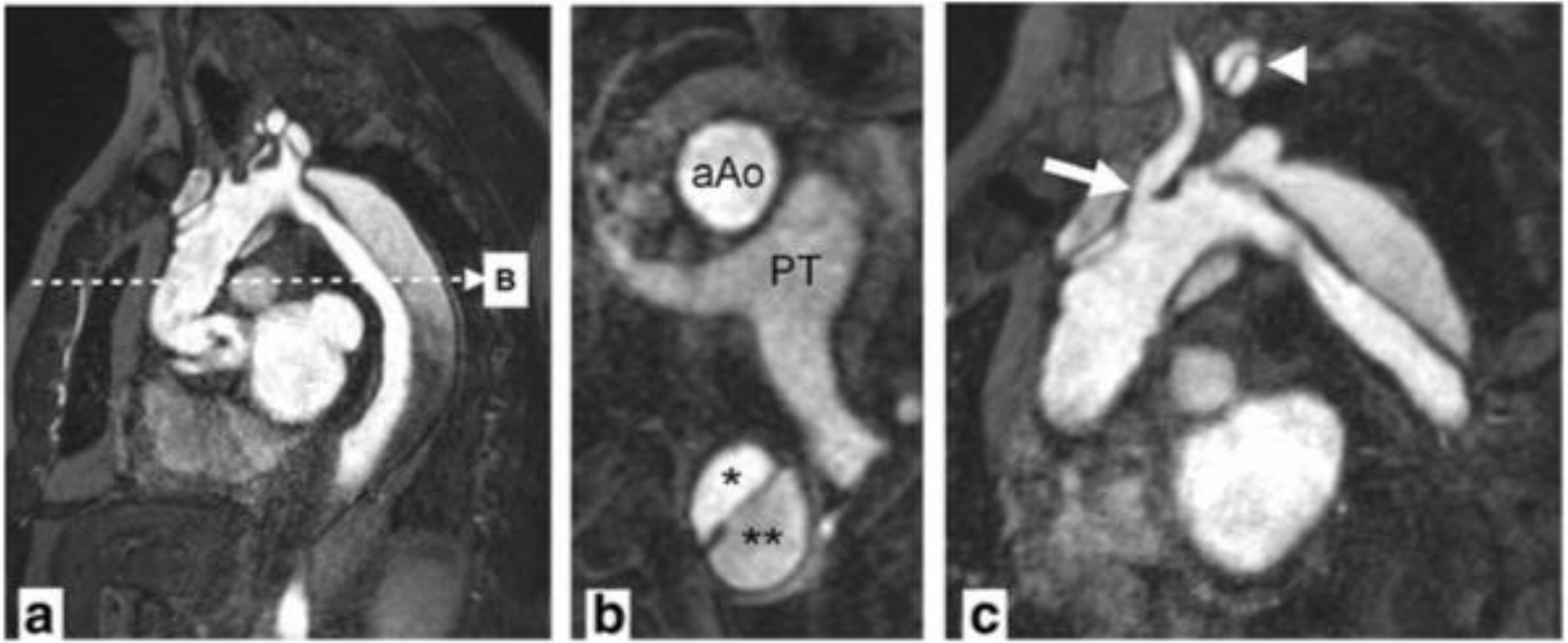
MR Angiography



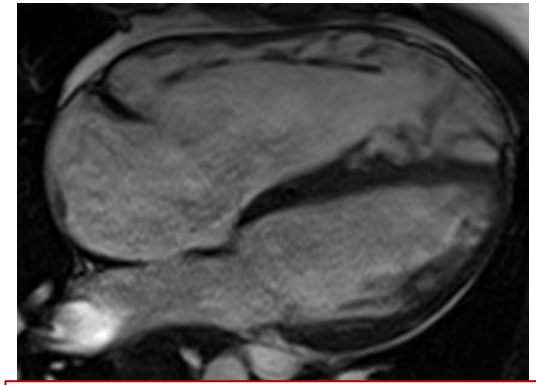
Rodrigues JCL et al. EHJ 2017 doi:10.1093/ehjci/jew319

MR Angiography

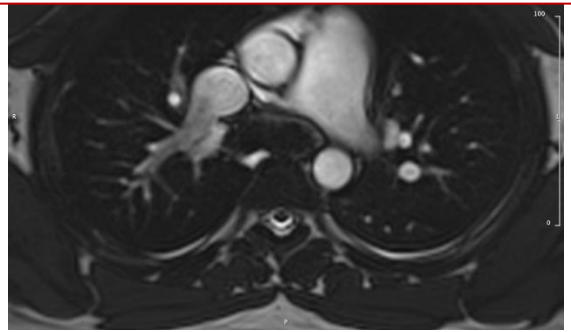


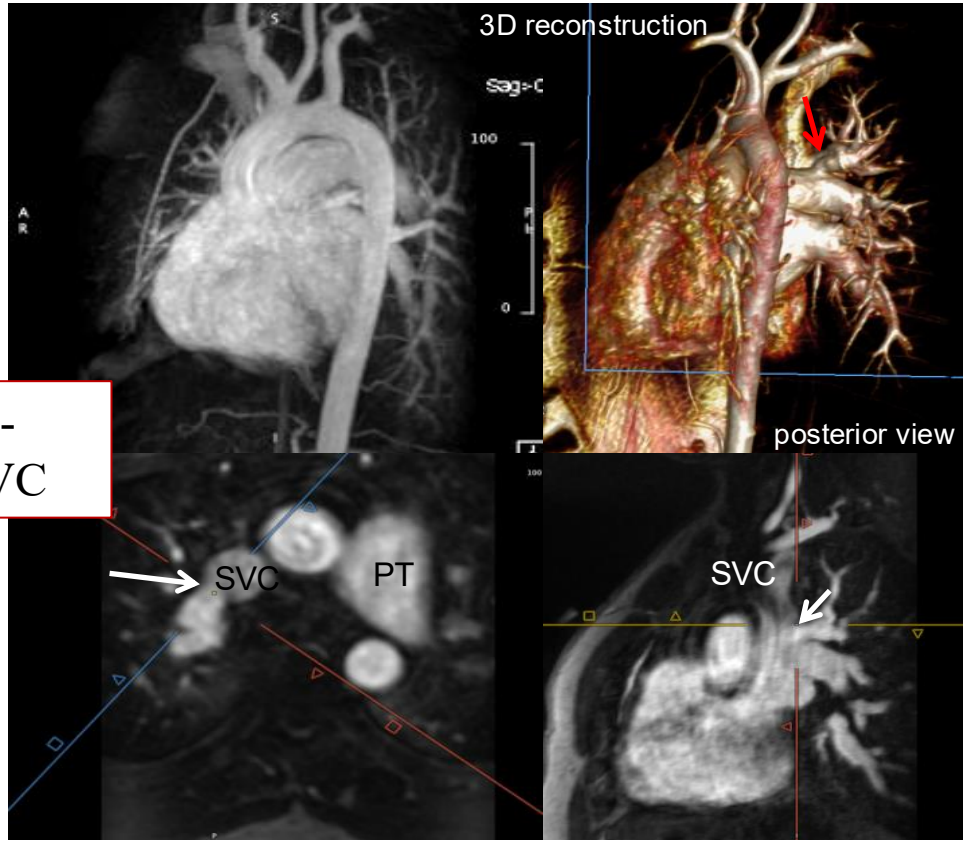
Schulz-Menger J et al. JCMR 2020; 22: 19

MR Angiography



Partial anomalous pulmonary venous return - right superior lobar vein draining into the SVC





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