UNIVERSITÀ DEGLI STUDI DI TORINO
Facoltà di Medicina e Chirurgia
Dipartimento di Scienze Chirurgiche
Istituto di Radiologia

Azienda Ospedaliera Universitaria
Città della Salute e della scienza di Torino
Dipartimento di Diagnostica per Immagini
S.C.D.U.- Radiodiagnostica Universitaria

AZIENDA OSPEDALIERO - UNIVERSITARIA
Città della Salute e della Scienza di Torino

Direttore: Prof. Paolo Fonio

Multimodality imaging for PAH: Is CT better than MRI?

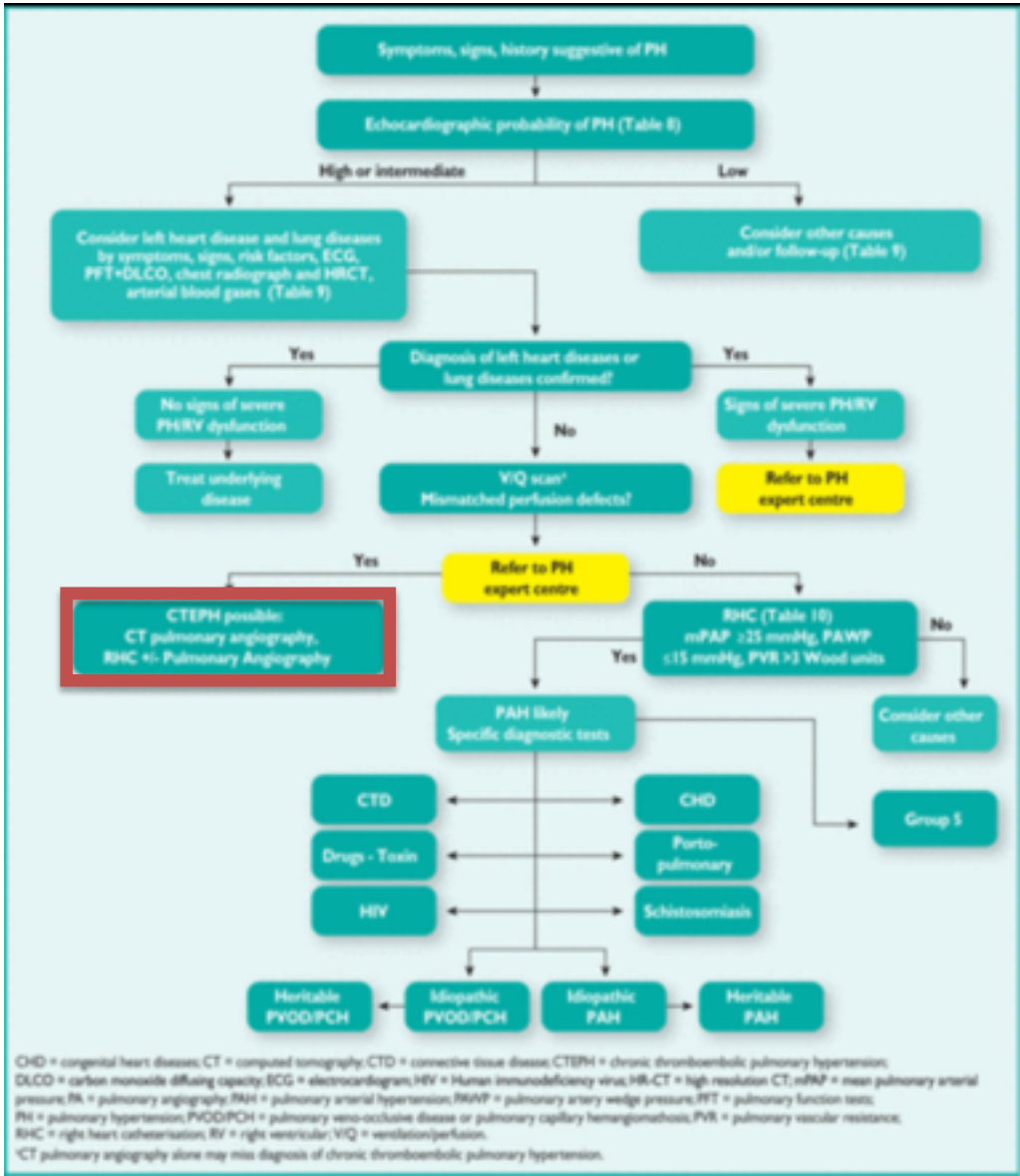
Riccardo Faletti

EDITOR'S CHOICE GUIDELINES

2015 ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension: The Joint Task Force for the Diagnosis and Treatment of Pulmonary Hypertension of the European Society of Cardiology (ESC) and the European Respiratory Society (ERS): Endorsed by: Association for European Paediatric and Congenital Cardiology (AEPC), International Society for Heart and Lung Transplantation (ISHLT)

Nazzareno Galiè ✉, Marc Humbert ✉, Jean-Luc Vachiery, Simon Gibbs, Irene Lang, Adam Torbicki, Gérald Simonneau, Andrew Peacock, Anton Vonk Noordegraaf, Maurice Beghetti, ... Show more

European Heart Journal, Volume 37, Issue 1, 1 January 2016, Pages 67–119,
https://doi.org/10.1093/eurheartj/ehv317
Published: 29 August 2015



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5.1.7 High-resolution computed tomography, contrast-enhanced computed tomography, and pulmonary angiography

CT imaging is a widely available tool that can provide important information on vascular, cardiac, parenchymal and mediastinal abnormalities. It may suggest the diagnosis of PH (PA or RV enlargement), identify a cause of PH such as CTEPH or lung disease, provide clues as to the form of PAH (e.g. oesophageal dilation in SSc or congenital cardiac defects such as anomalous pulmonary venous drainage) and also provide prognostic information.[50]

5.1.8 Cardiac magnetic resonance imaging

CMR imaging is accurate and reproducible in the assessment of RV size, morphology and function and allows non-invasive assessment of blood flow, including stroke volume, CO, pulmonary arterial distensibility and RV mass.

In patients with suspected PH, the presence of late gadolinium enhancement, reduced pulmonary arterial distensibility and retrograde flow have high predictive value for the identification of PH; however, no single CMR measurement can exclude PH.[60–62] In patients with PH, CMR may also be useful in cases of suspected CHD if echocardiography is not conclusive.

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12.1 Facilities and skills required for a expert referral centre

1. Expert referral centres are recommended to provide care by an interprofessional team that should, as a minimum, comprise:[451–456]

   (a) two consultant physicians (normally from either or both cardiology and respiratory medicine) experienced in and with a special interest in PH with dedicated PH clinical sessions for outpatients, inpatients and a multidisciplinary team meeting

   (b) clinical nurse specialist

   (c) radiologist with expertise in pulmonary hypertension imaging

   (d) cardiologist or PH physician with expertise in echocardiography

   (e) cardiologist or PH physician with expertise in RHC and vasoreactivity testing

   (f) access to psychological and social work support

   (g) appropriate on-call cover and expertise

2. For expert referral centres, access to the following facilities is recommended:

   (a) a ward where staff has special expertise in PH

   (b) an intensive therapy unit with relevant expertise

   (c) a specialist outpatient service

   (d) emergency care

   (e) diagnostic investigations including echocardiography, CT scanning, nuclear scanning, MR imaging, ultrasound, exercise testing, lung function testing and a cardiac catheterization laboratory

   (f) access to the full range of specific PAH and CTEPH drug therapy available in their country

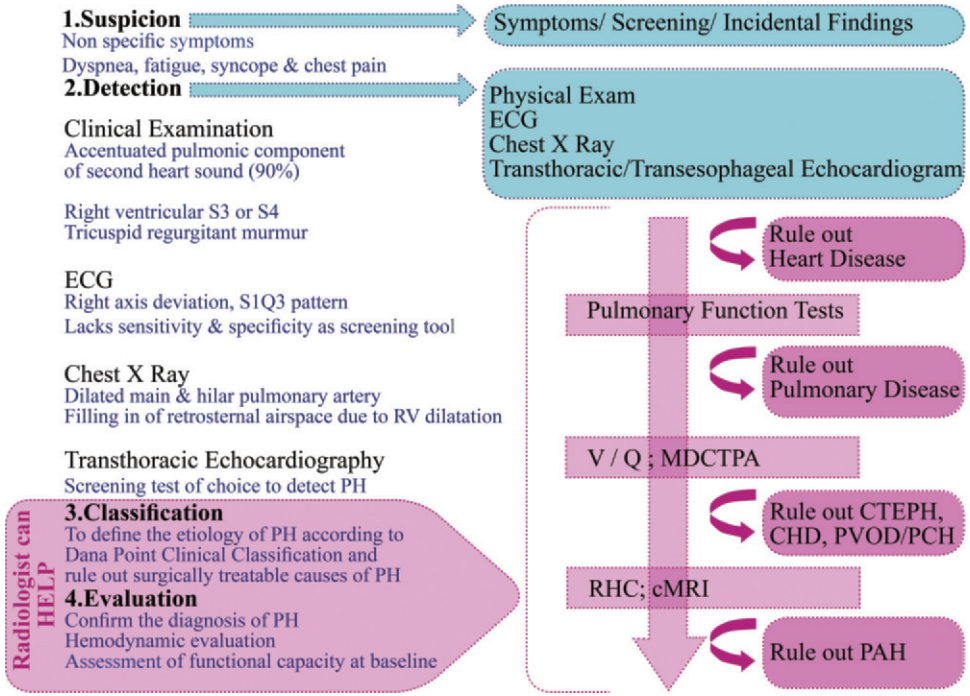
RadioGraphics

Pulmonary Hypertension: How the Radiologist Can Help[1]

Table 1
Dana Point Classification of Pulmonary Hypertension

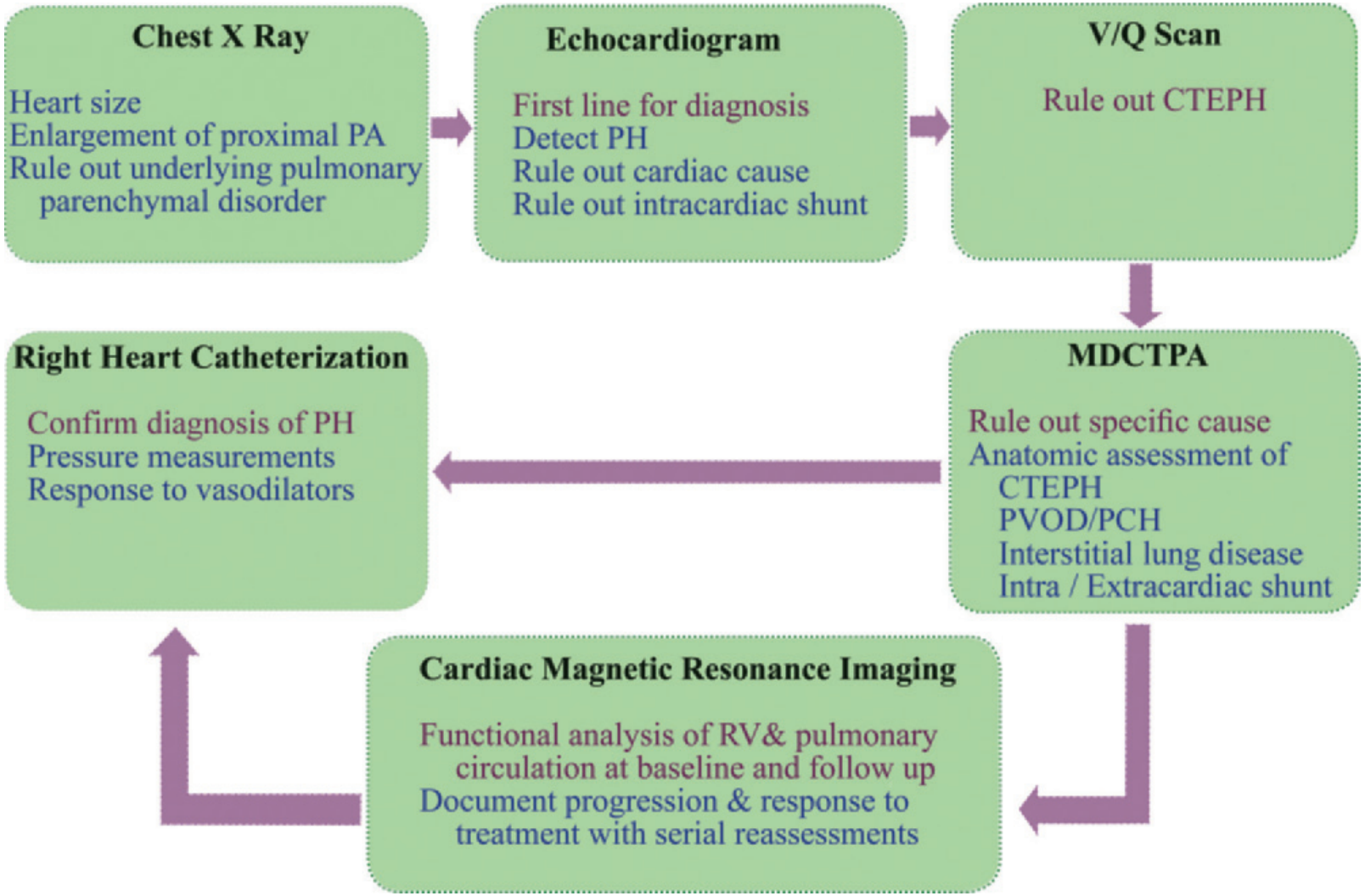
Group	Description
1	Pulmonary arterial hypertension
1.1	Idiopathic pulmonary arterial hypertension
1.2	Heritable
1.3	Drug and toxin induced
1.4	Associated with connective tissue diseases, HIV infection, portal hypertension, congenital heart disease, schistosomiasis, and chronic hemolytic anemia
1.5	Persistent pulmonary hypertension in newborns
1′	PVOD or PCH
2	Pulmonary hypertension due to left-sided heart disease
3	Pulmonary hypertension due to lung diseases or hypoxia
4	Chronic thromboembolic pulmonary hypertension
5	Pulmonary hypertension with unclear multifactorial mechanisms such as hematologic disorders (myeloproliferative disorders, splenectomy), systemic disorders (sarcoidosis, pulmonary Langerhans cell histiocytosis, lymphangioleiomyomatosis, neurofibromatosis, vasculitis), metabolic disorders (glycogen storage disease, Gaucher disease, thyroid disorders), and other disorders (tumoral obstruction, fibrosing mediastinitis, chronic renal failure in patients undergoing dialysis)

Note.—Reprinted, with permission, from reference 4. HIV = human immunodeficiency virus, PCH = pulmonary capillary hemangiomatosis, PVOD = pulmonary veno-occlusive disease.



RadioGraphics

Pulmonary Hypertension: How the Radiologist Can Help[1]



Is CT better than MRI?

CTA

A pulmonary artery with a diameter of 29 mm or more has a positive predictive value of 97%, sensitivity of 87%, and specificity of 89% for the presence of pulmonary hypertension

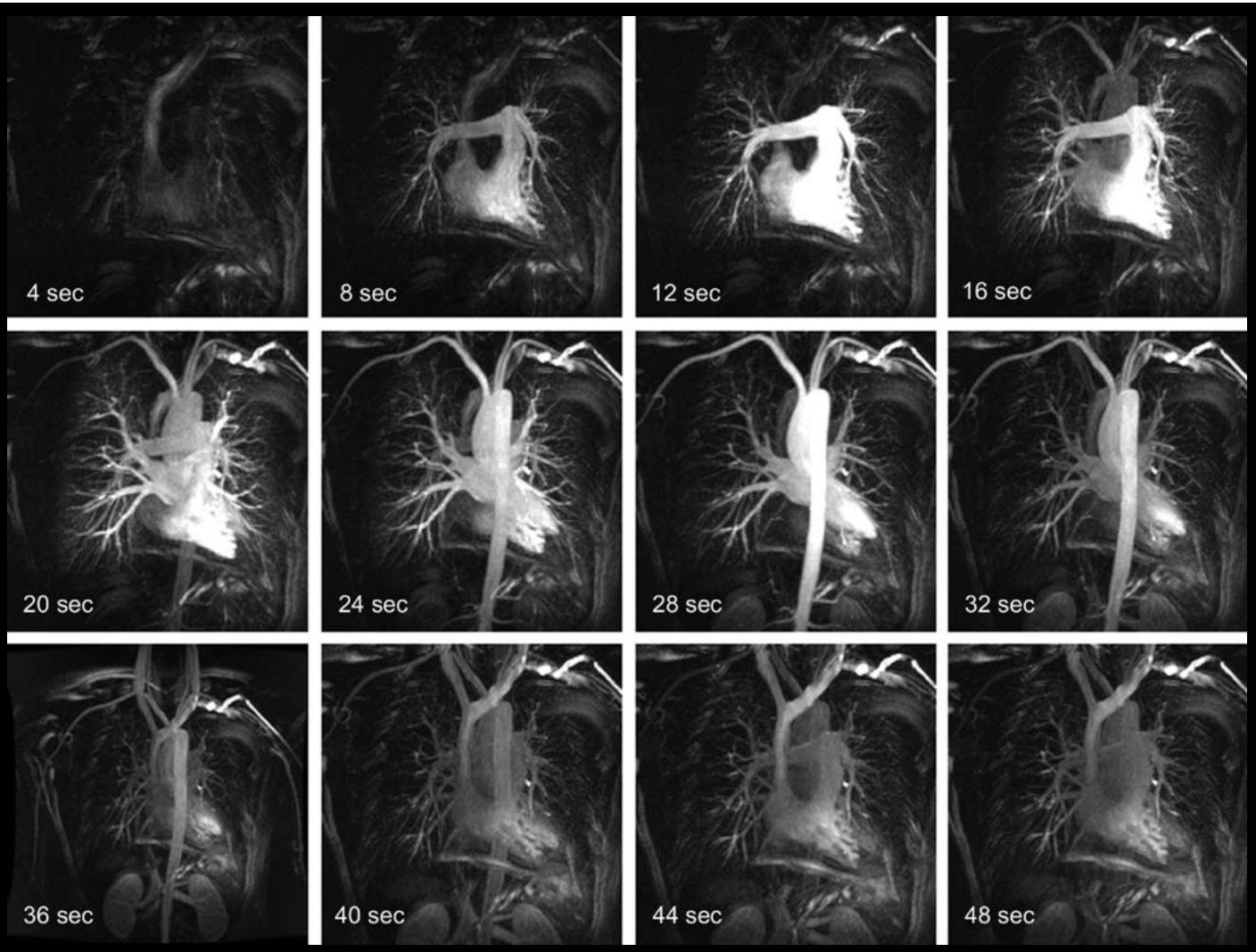
In the presence of a dilated (29 mm or more) main pulmonary artery, a segmental artery-to-bronchus diameter ratio of 1:1 or more in three or four lobes has a specificity of 100% for the presence of pulmonary hypertension

At CTPA, a main pulmonary arterial diameter larger than that of the ascending aorta is also a sign of pulmonary hypertension, with a positive predictive value of 96% and specificity of 92%, especially in patients younger than 50 years old

Devaraj A, Hansell DM. Computed tomography signs of pulmonary hypertension: old and new ob- servations. Clin Radiol 2009;64(8):751–760.

MRA

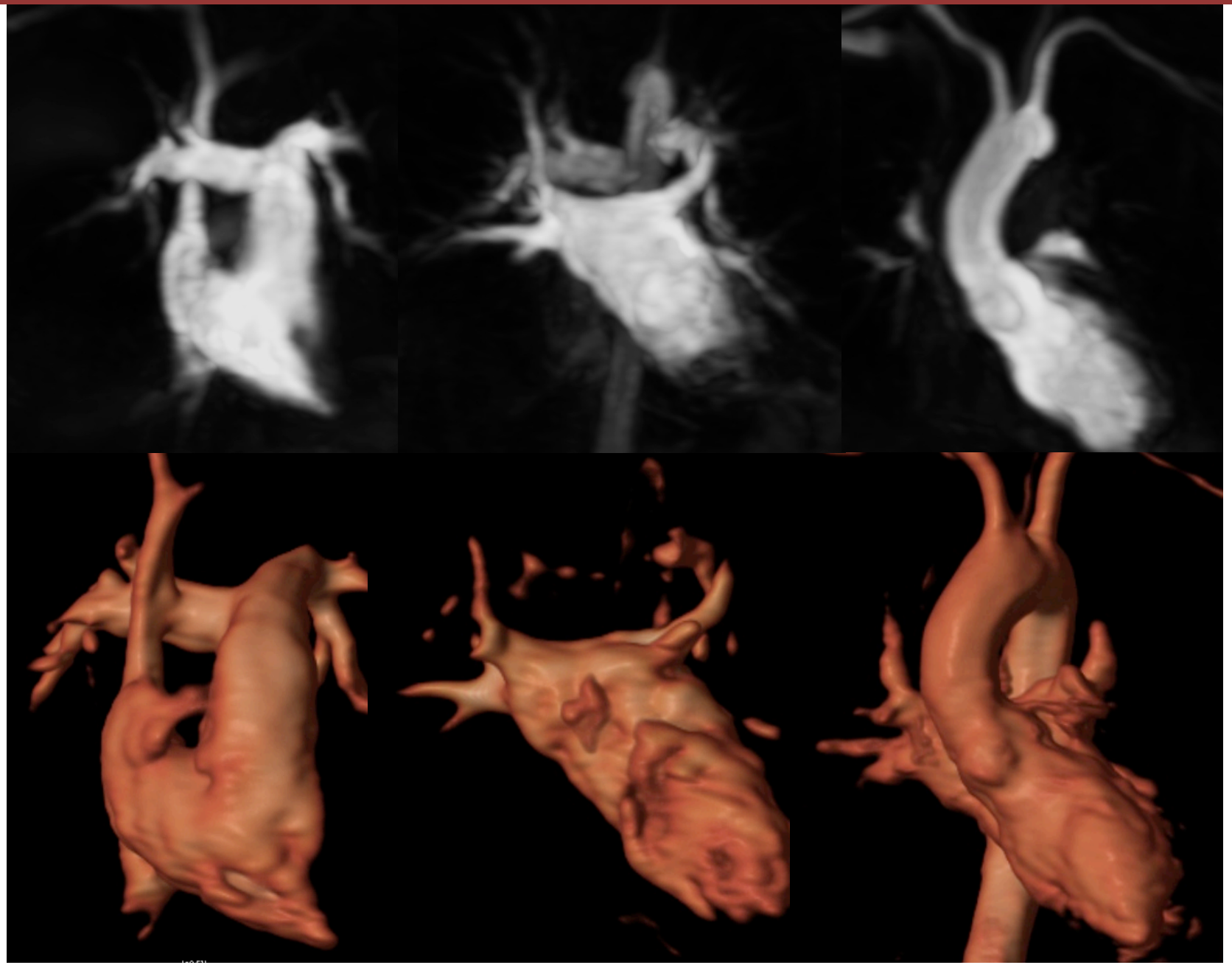
MRA



Time-resolved MR angiography
Three-dimensional volume image sets were obtained every 4 s.

Yoo S, Kellenberger CJ, Roman KS, Al-Habshan F, Branson H, Sun A, Macgowan CK. Magnetic resonance evaluation of pulmonary circulation in children. Progress in Pediatric Cardiology 22 (2006) 211–223.

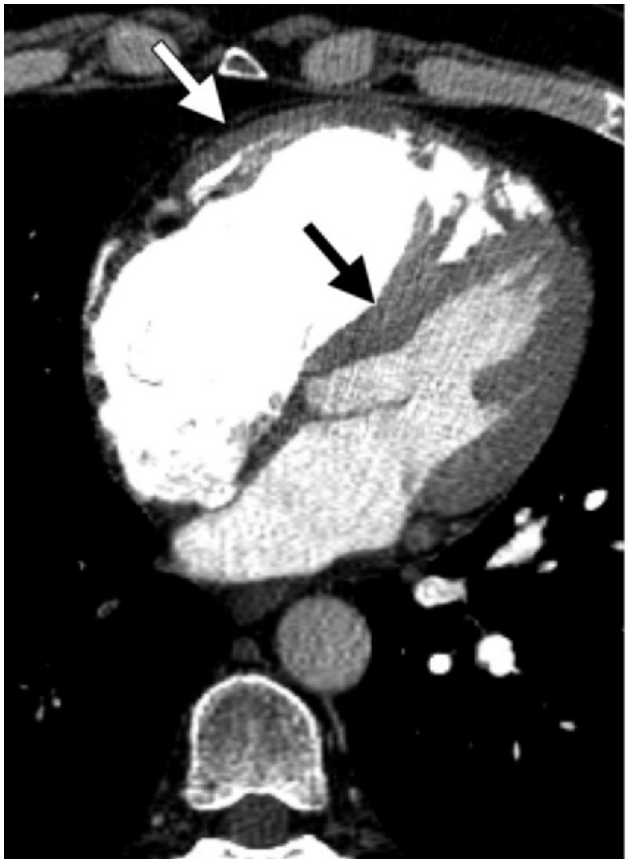
MRA



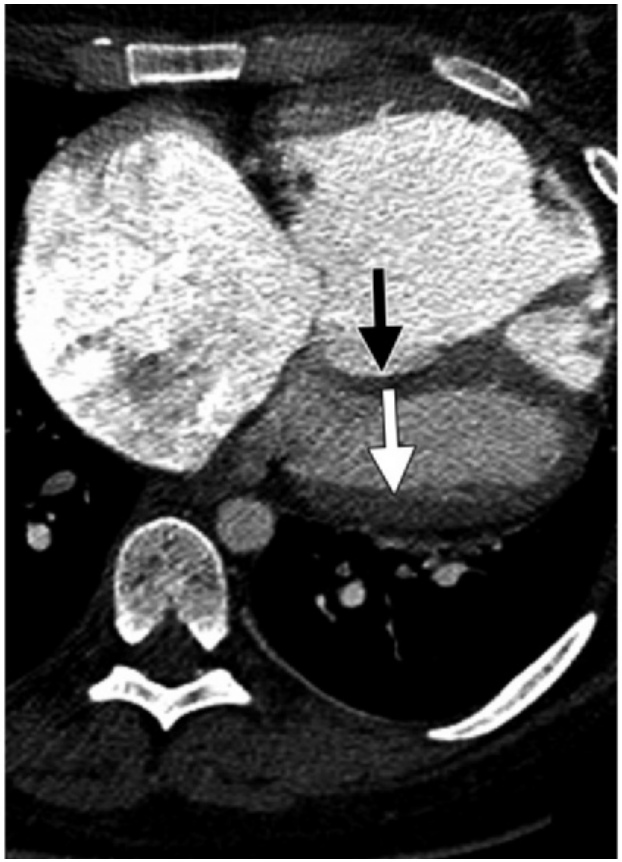
Is CT better than MRI?

CT team 1-0 MR team

CTA



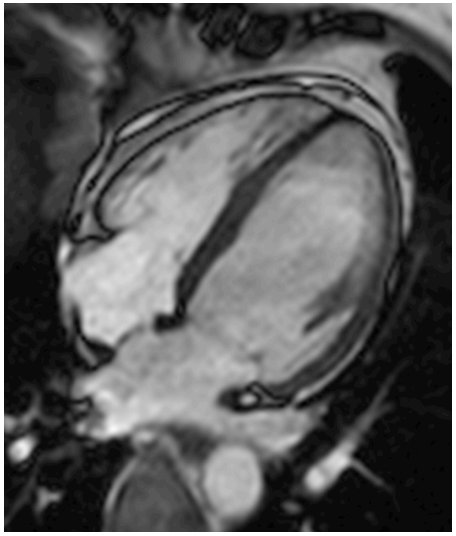
Findings of adaptation and failure of the right side of the heart that may be seen at ECG-gated CTPA include right ventricular hypertrophy, which is defined as wall thickness of more than 4 mm

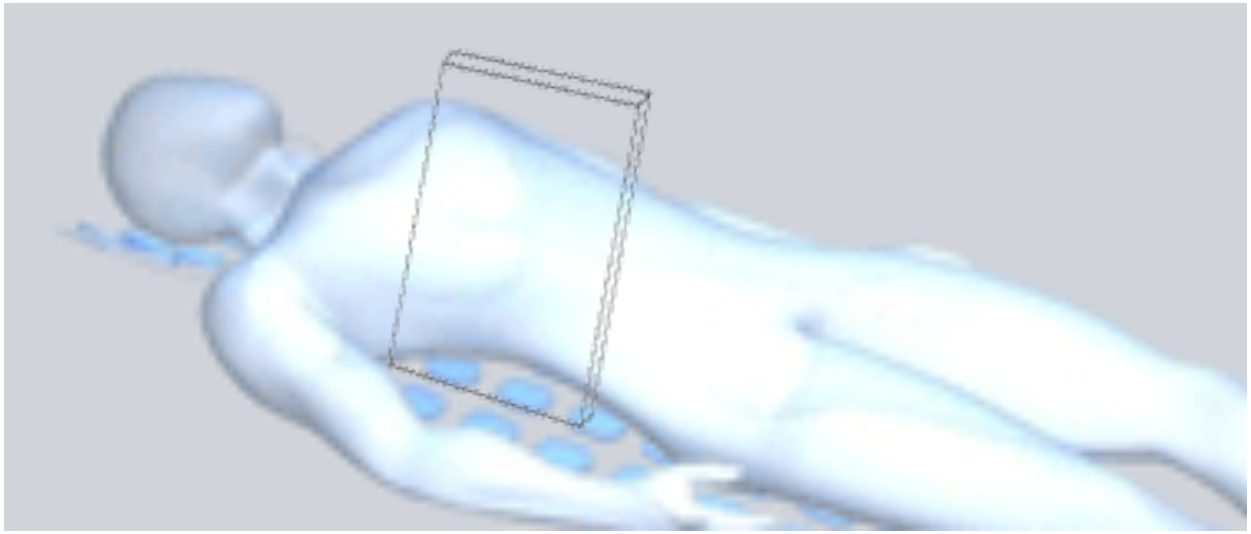


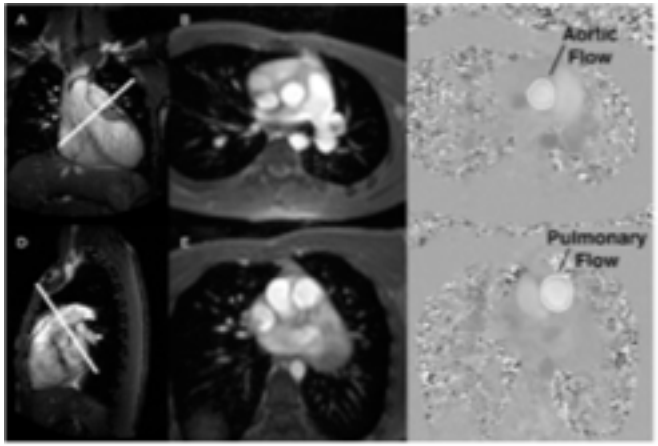
Straightening or leftward bowing of the interventricular septum; right ventricular dilatation

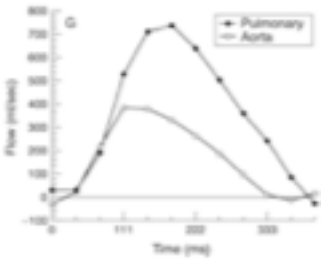
Decreased right ventricular ejection fraction; dilatation of the inferior vena cava and hepatic veins; and pericardial effusion

Cardiac MR





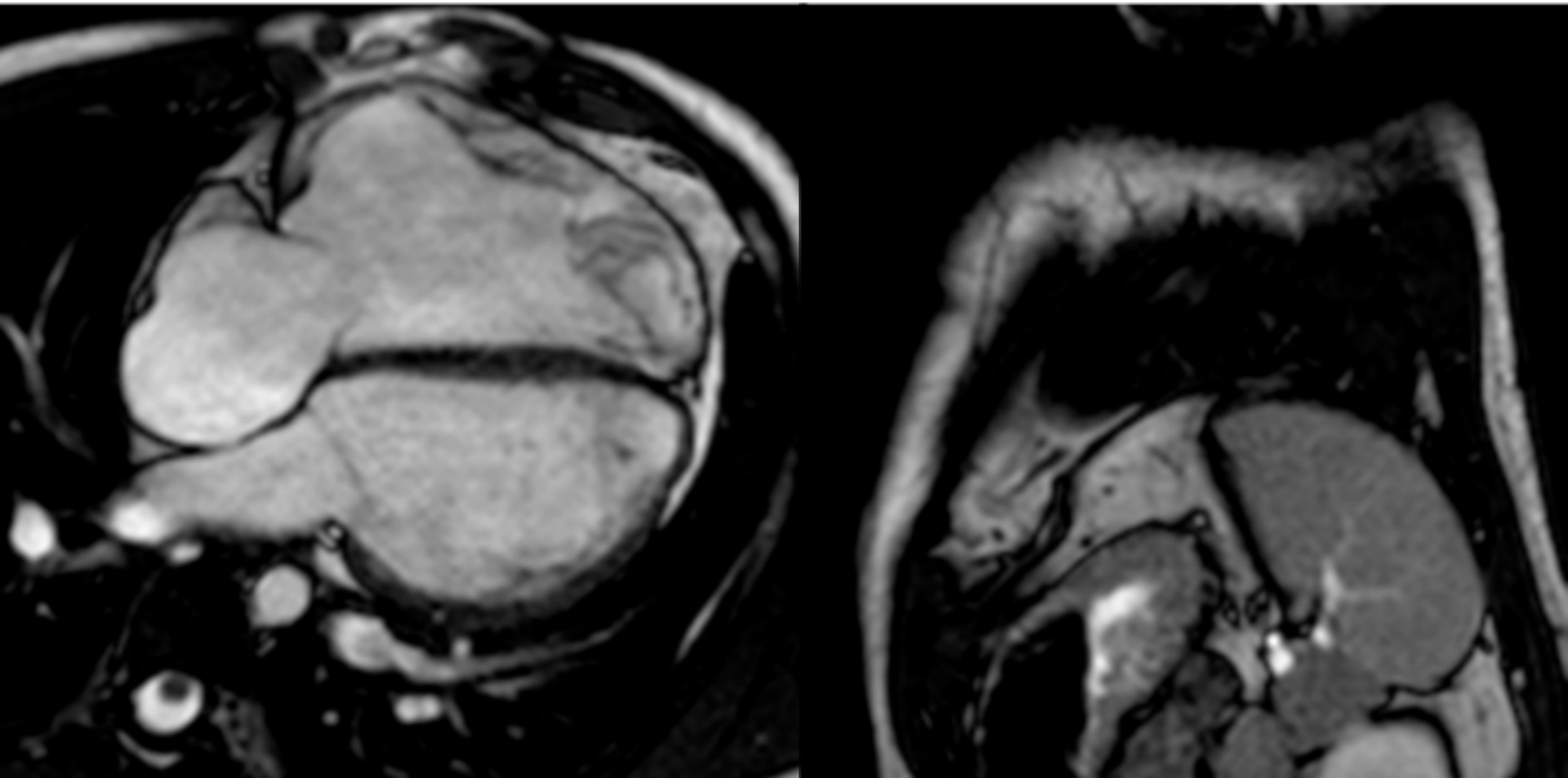




Ventricular Volumes*	Pathologic Characteristics	Clinical Significance
Increased right ventricular end diastolic and end systolic volume, decreased right ventricular stroke volume and right ventricular cardiac output, decreased right ventricular ejection fraction	Right ventricular dilatation	Increased right ventricular volumes and decreased right and left ventricular stroke volumes from baseline indicate mortality and treatment failure
Decreased left ventricular end diastolic volume and end systolic volume, decreased left ventricular peak filling rate (left ventricular end diastolic volume per sec)	Decreased left ventricular volumes due to increased pulmonary vascular resistance, limiting right ventricular stroke volume and available blood volume for left ventricular filling	Increased right ventricular volumes and decreased right and left ventricular stroke volumes from baseline indicate mortality and treatment failure
Increased ventricular mass index†	Right ventricular hypertrophy	Ventricular mass index >0.6 correlates with detection of pulmonary hypertension at catheterization of the right side of the heart

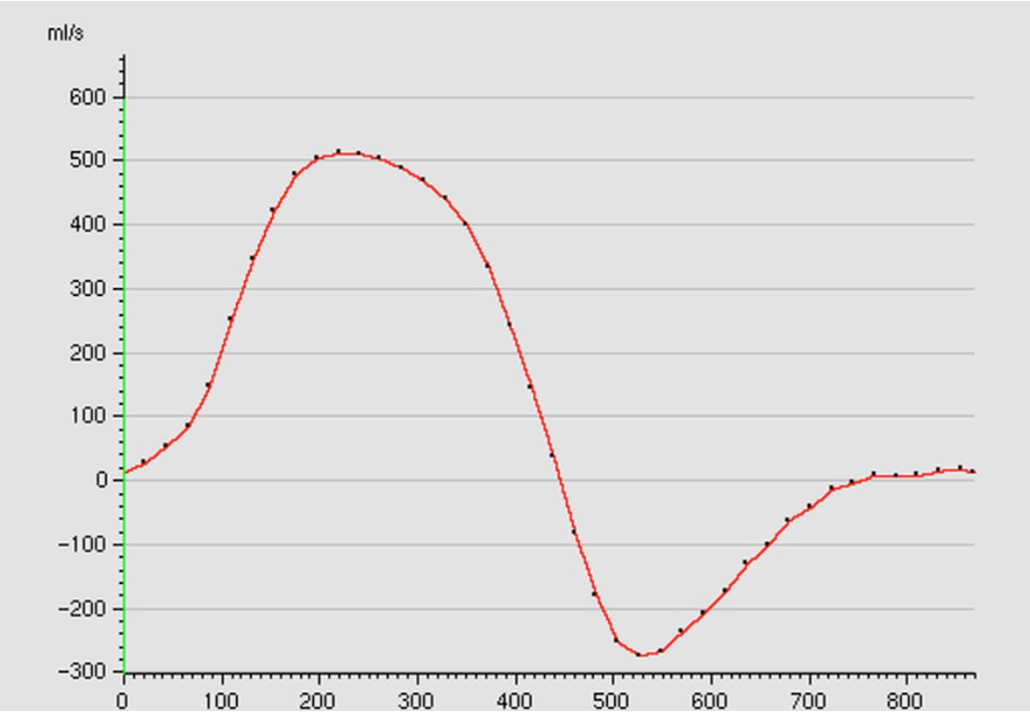
Cardiac MR

19 yo man
Bi-ventricular failure in repaired TOF (surgery in 1996 with closure of ASD and minimal residual shunt)



Cardiac MR

2D PHASE CONTRAST SEQUENCES



Is CT better than MRI?

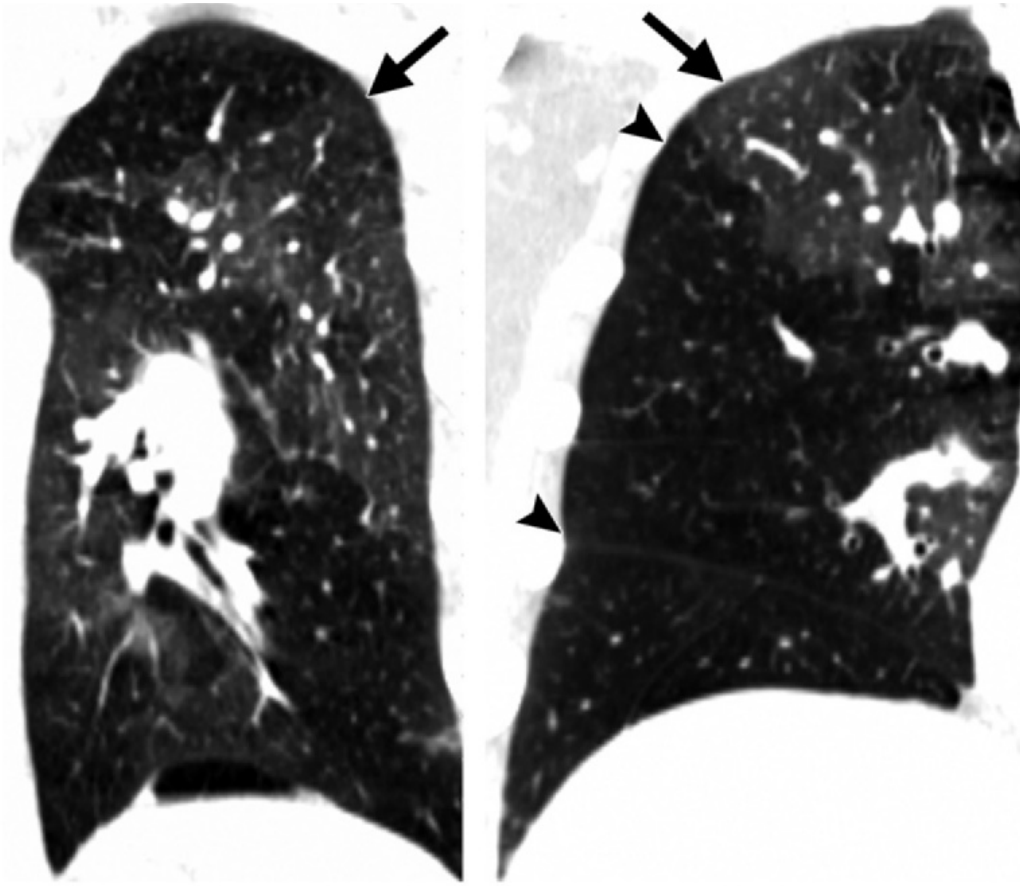
CT team 1-1 MR team

CT

26 yo woman with dyspnea at exertion, shows widespread, ill-defined, centrilobular areas of attenuation: a finding indicative of pulmonary capillary hemangiomatosis.

Centrilobular ground-glass nodules are a feature of pulmonary hypertension and are especially common in patients with idiopathic pulmonary arterial hypertension

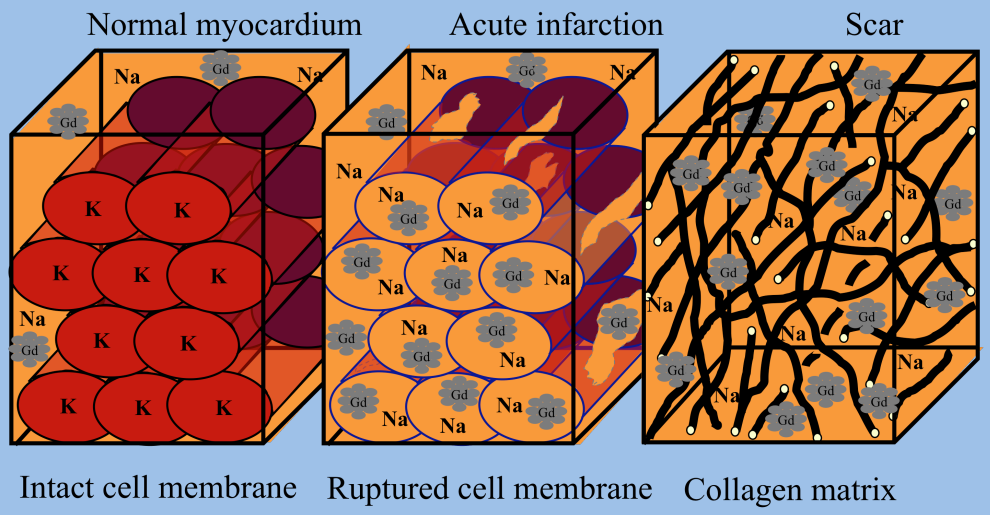
CT

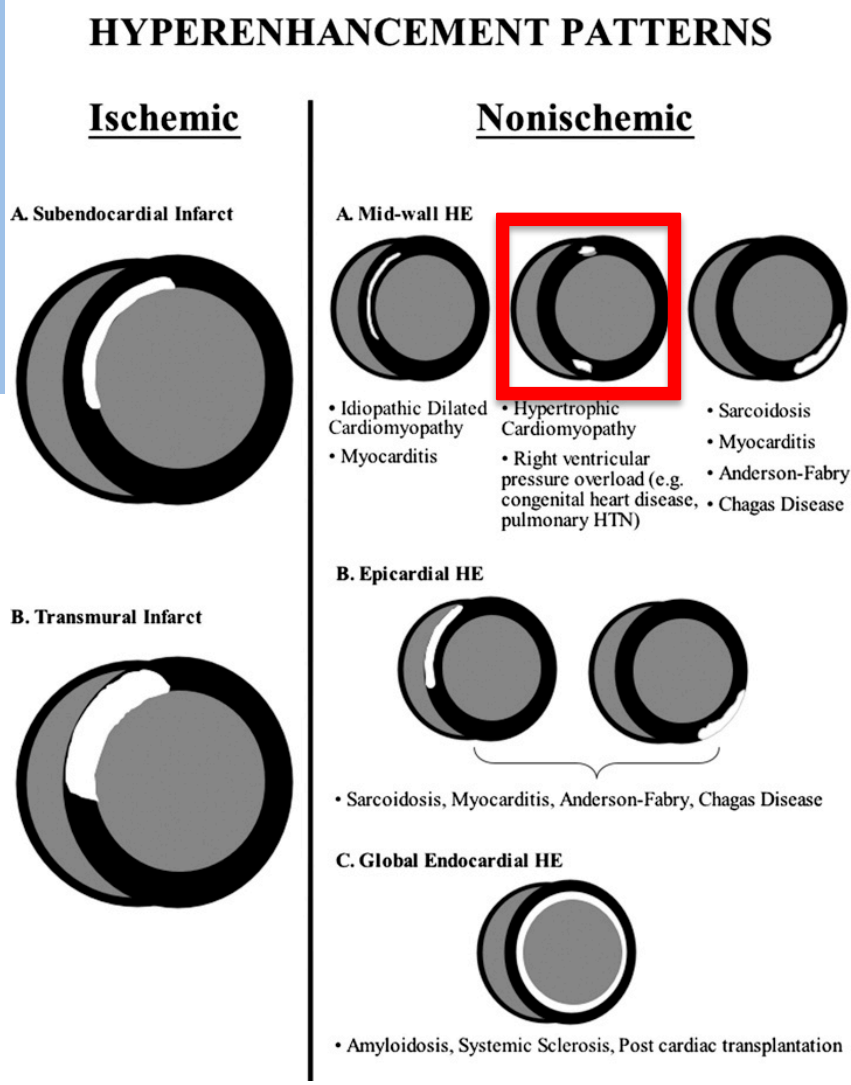


Is CT better than MRI?

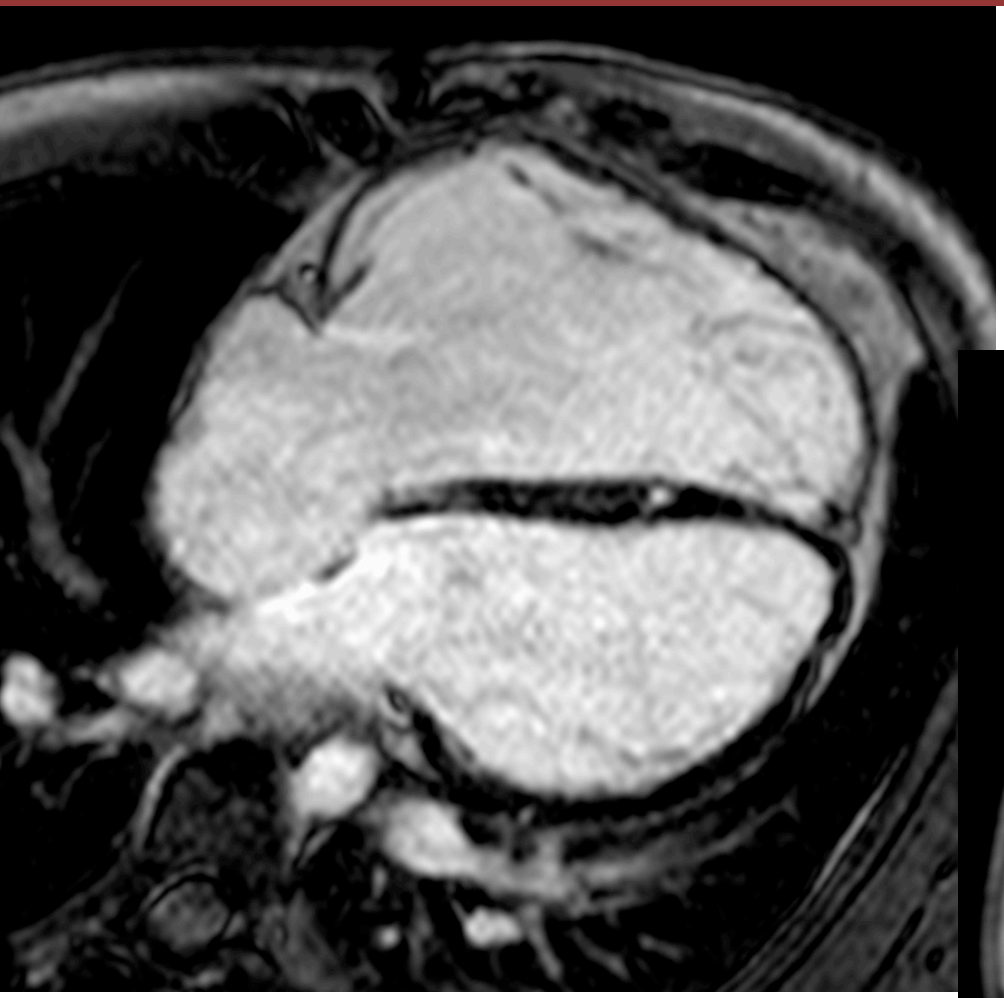
CT team 2-1 MR team

Cardiac MR – Late gadolinium enhancement





Cardiac MR – Late gadolinium enhancement

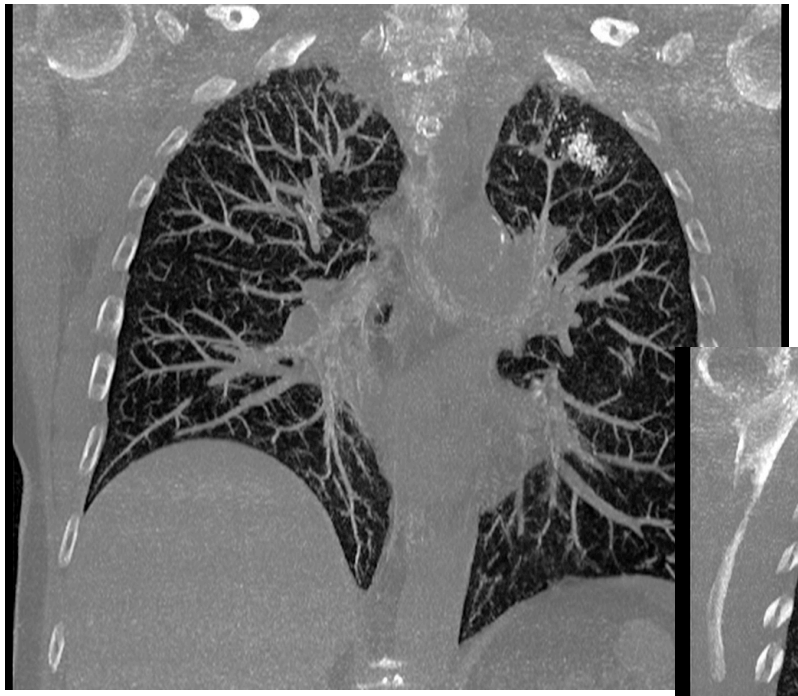


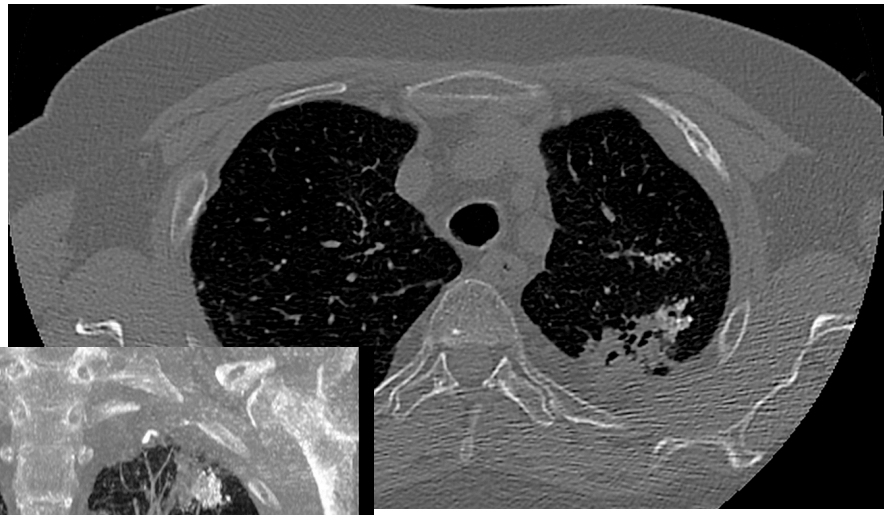
Is CT better than MRI?

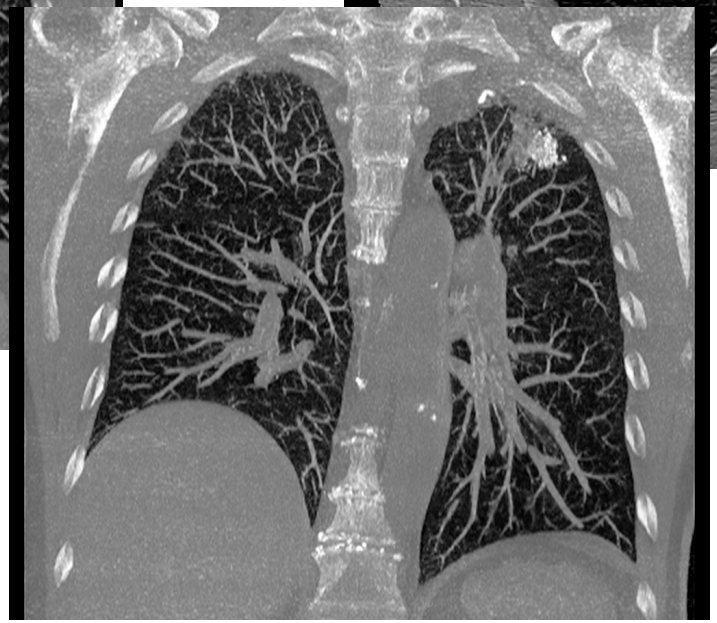
CT team 2-2 MR team

CT

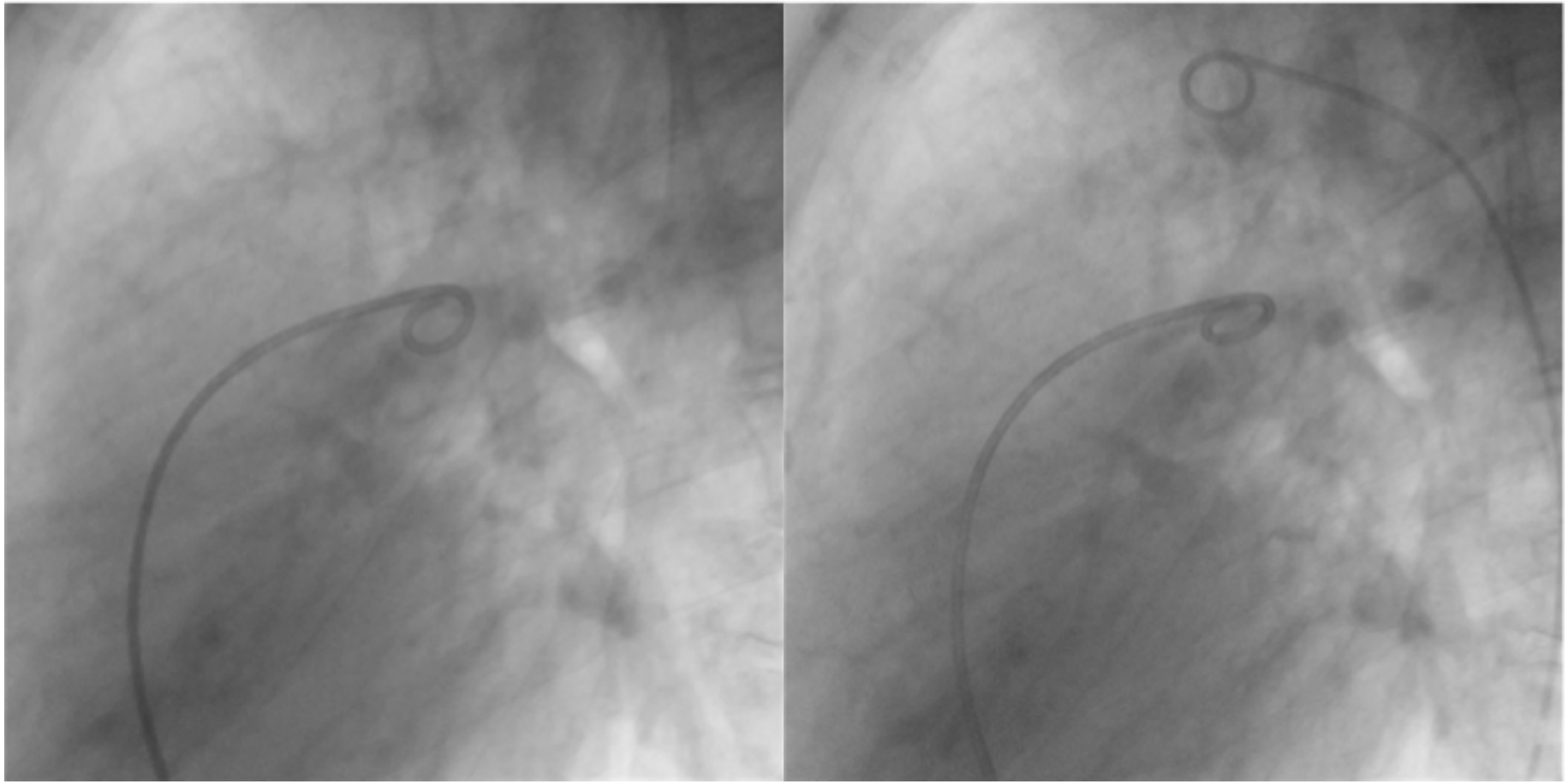
60 yo woman
From 1986 Wegener Granulomatosis
Therapy: corticosteroids and cyclofosfamide
CT: Pulmonary signs of primary disease
From 2006 rise of pulmonary artery inflammatory involvement





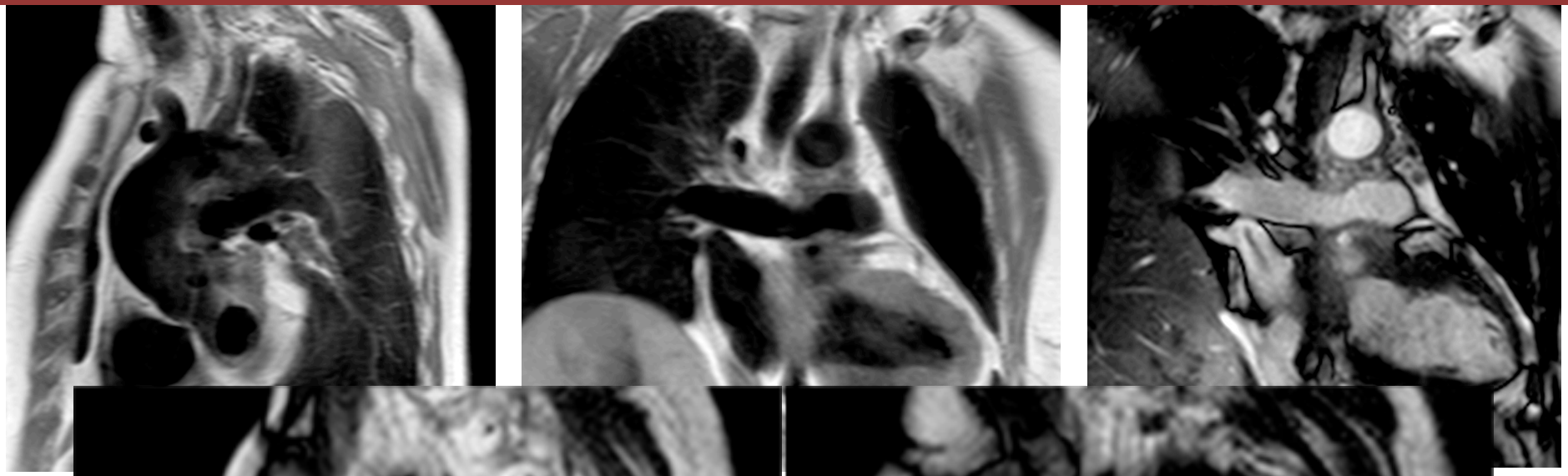


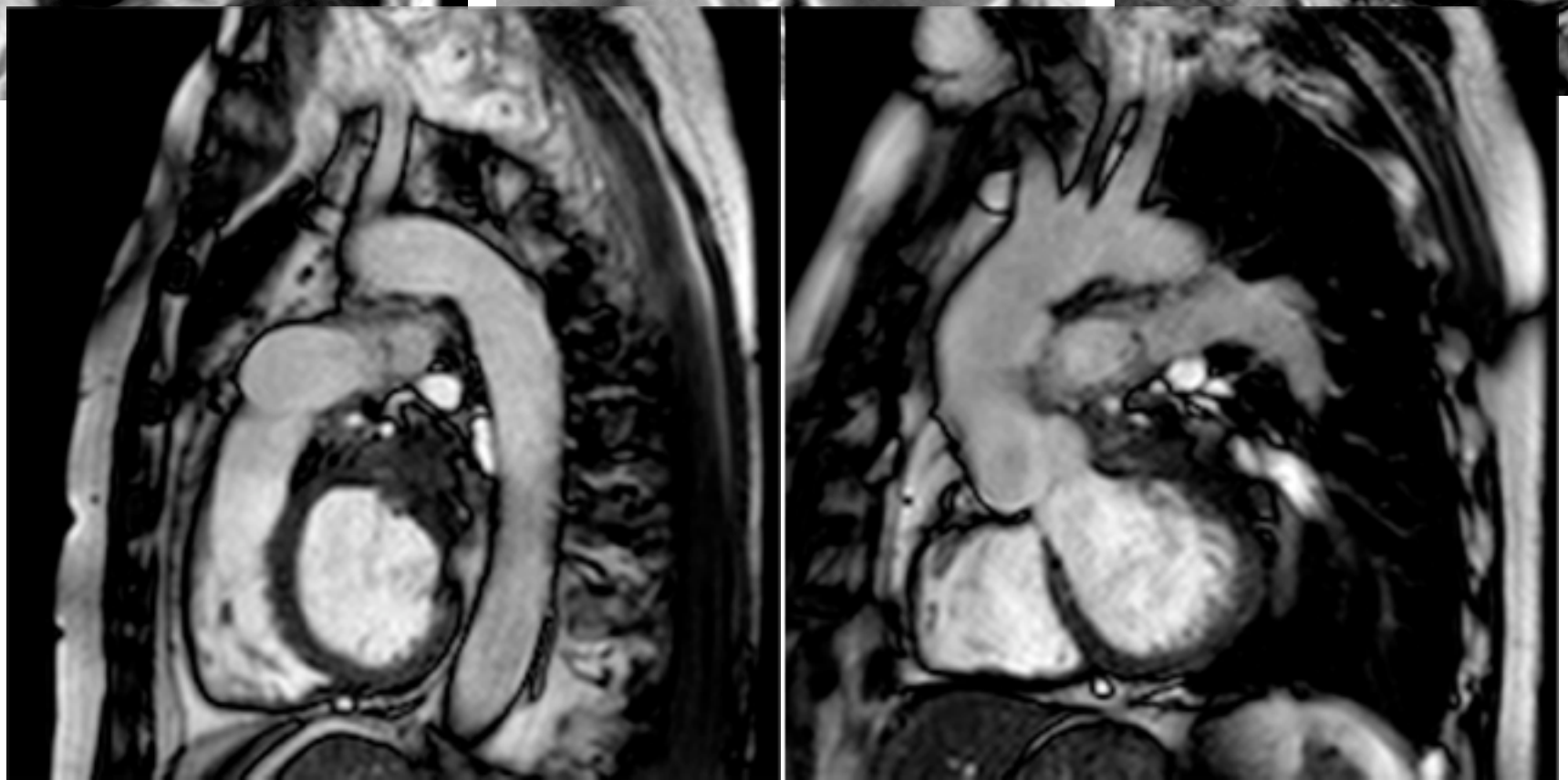
Catheterism: Forward pulmonary garadient and signs of PAH

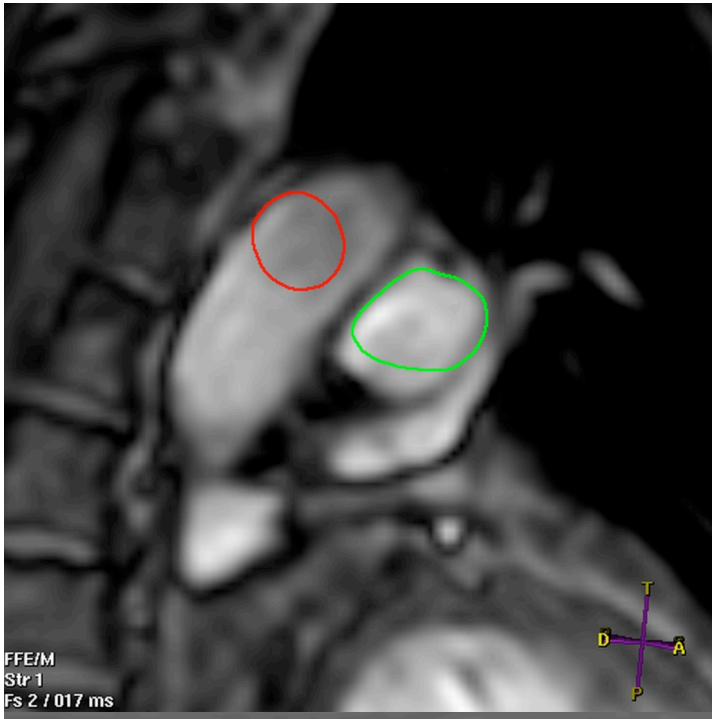


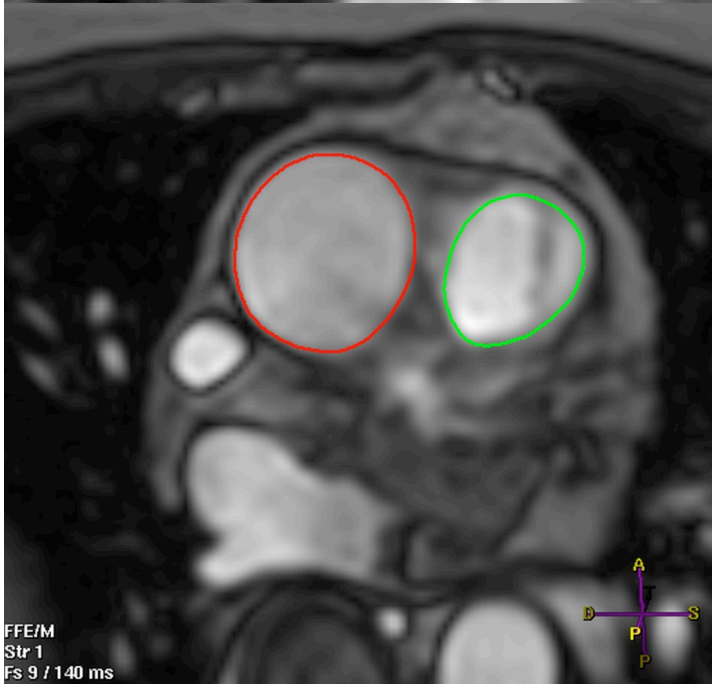
Courtesy of Dott. Fulvio Orzan

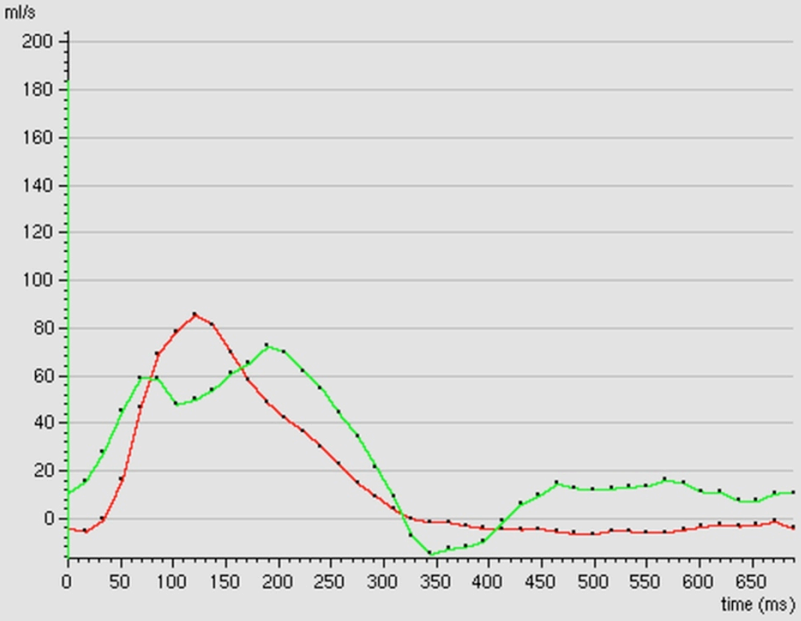
Cardiac MR



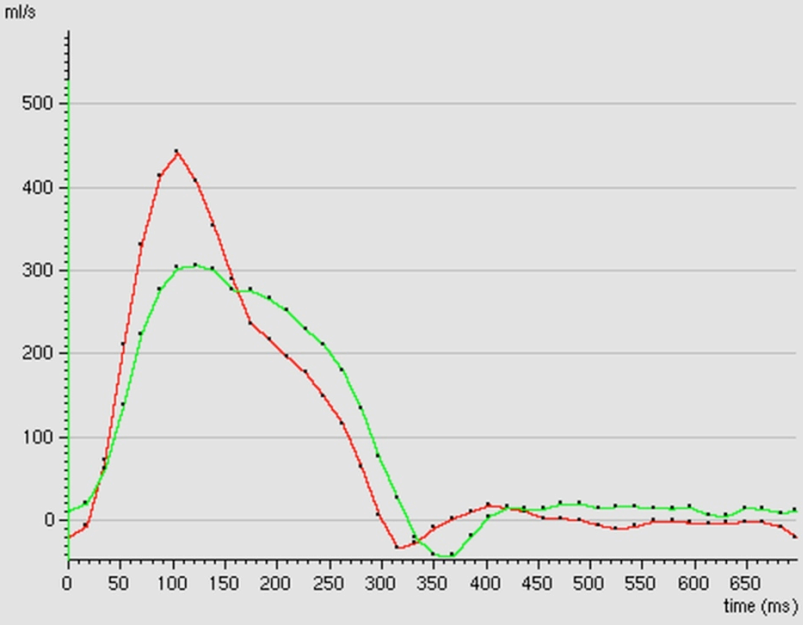




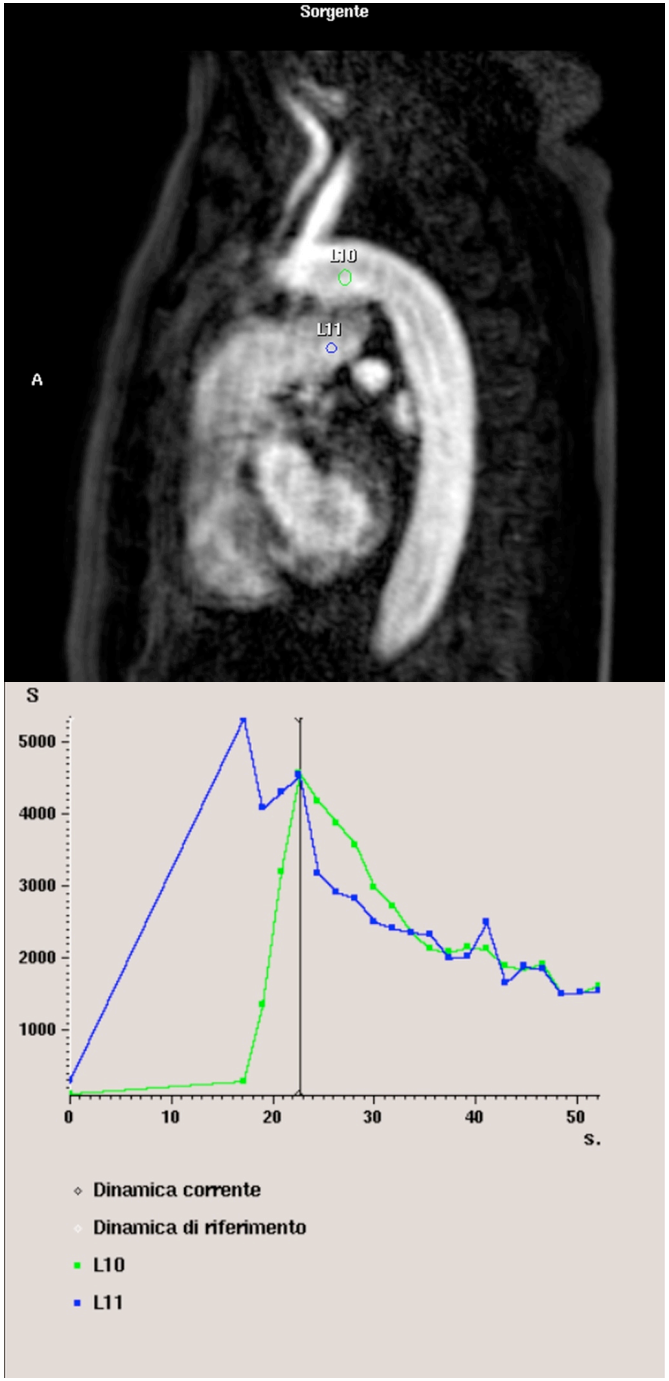




RR-interval: 690 ms (from heart rate)



RR-interval: 698 ms (from heart rate)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Dinamica corrente
Dinamica di riferimento
L10
L11

Take home points

CT

V vessels diameters, lung evaluation, widely available

X cardiac function, flow, radiation exposure

MR

V cardiac function, flow and myocardial fibrosis

X vessels diameters, long time examination, poorly available

COMPLEMENTARY IMAGING TECHNIQUES

IN EVALUATION OF PHA