



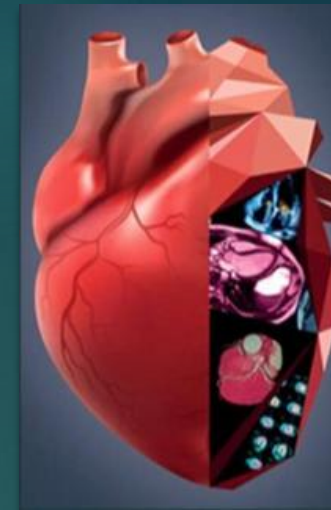
ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ
ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
ΙΑΤΡΙΚΗ ΣΧΟΛΗ



Α' ΚΑΡΔΙΟΛΟΓΙΚΗ ΚΛΙΝΙΚΗ
& ΟΜΟΝΥΜΟ (Α' ΚΑΡΔΙΟΛΟΓΙΚΟ -
ΑΙΜΟΔΥΝΑΜΙΚΟ) ΕΡΓΑΣΤΗΡΙΟ

ΚΑΡΔΙΑΓΓΕΙΑΚΗ ΑΠΕΙΚΟΝΙΣΗ

ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ



CMR σε Αορτοπάθειες και περιφερικά αγγεία

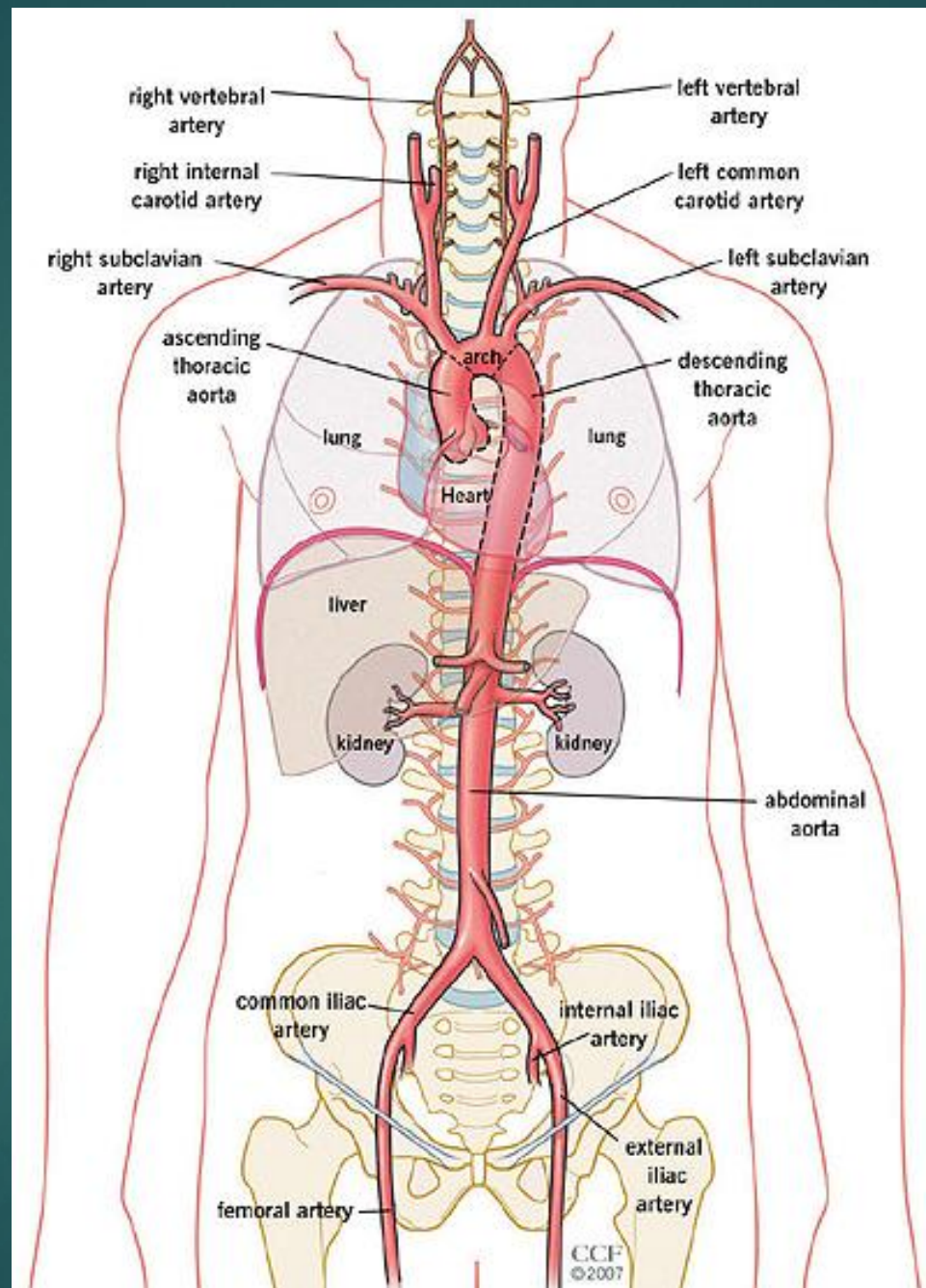
Dr ΖΩΗ ΤΣΟΥΜΑΝΗ MD, MSc

Καρδιολόγος με εξειδίκευση στην καρδιαγγειακή απεικόνιση

EACVI level 3 certified in cardiac CT and CMR

EACVI certification in multimodality imaging

Affidea Greece





	CT	TTE	TOE	CMR
Noninvasive character	+	++	-	++
Field of vision	++	+	+	++
Planes in any orientation	-	+	+	++
Study of the entire vessel	++	-	+	++
Resolution without contrast	+	++	++	++
Dynamic studies	-	++	++	++
Flow quantitation	-	+	+	++
Wall analysis	++	++	++	++
Comprehensible interpretation	++	+	++	++
Availability and reasonable cost	++	++	+	+

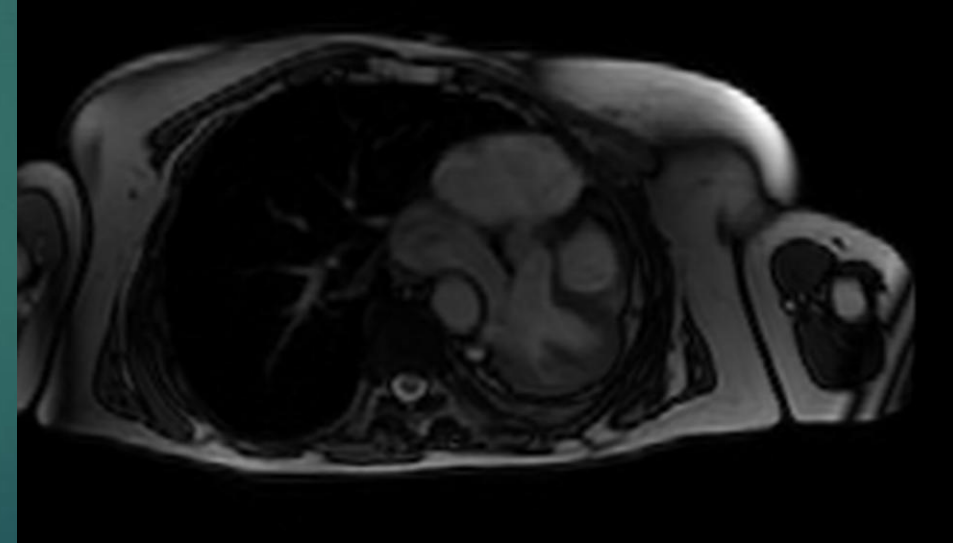
CMR of the Aorta

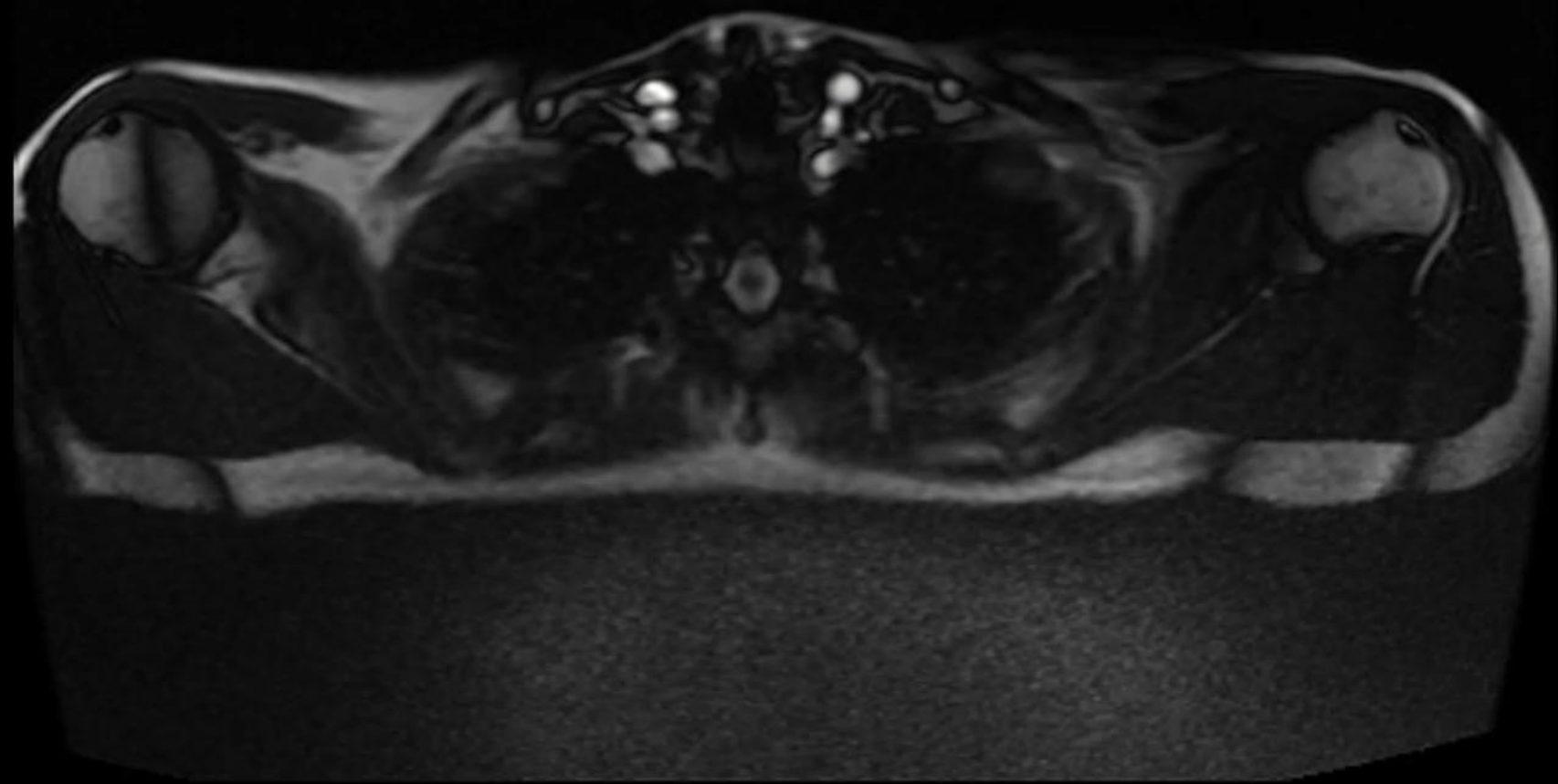
Advantages:

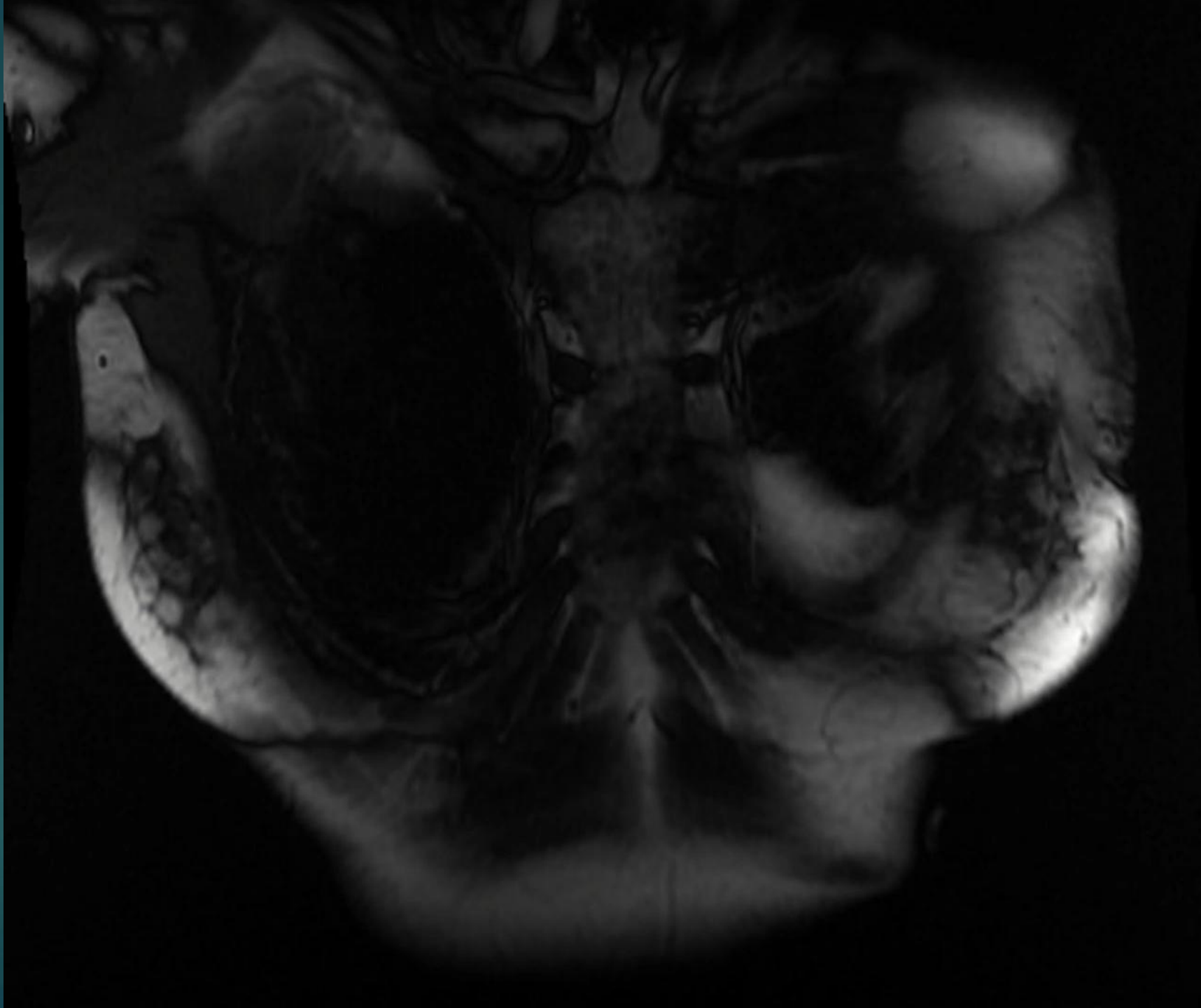
- Non-invasive, no radiation
- Multiple planes (orthogonal and oblique)
- Large field of view
- High spatial resolution
- Excellent Soft tissue contrast
- Non-nephrotoxic contrast agents

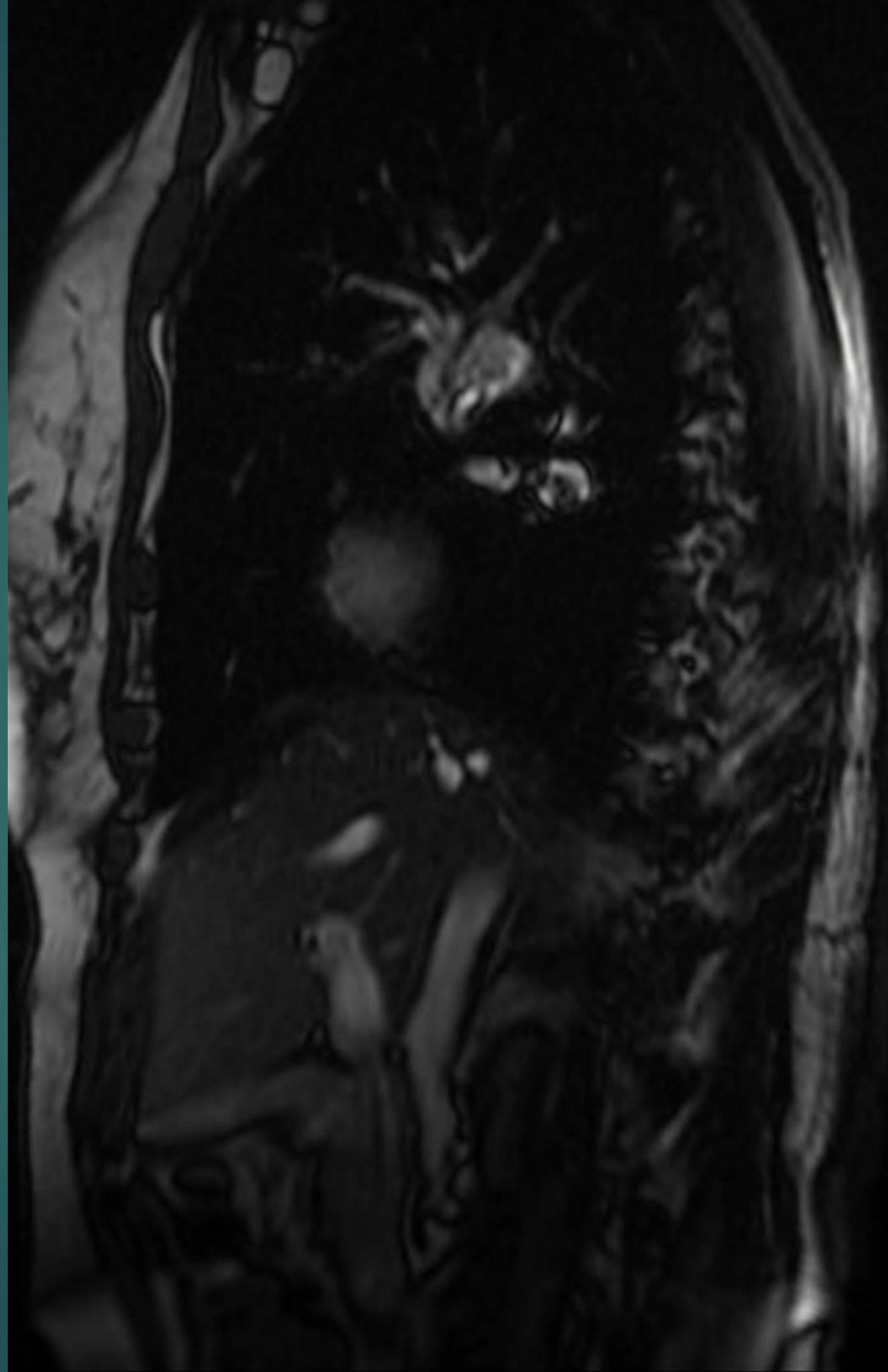
Disadvantages:

- Cost
- Availability
- Time
- Claustrophobia
- Implanted pacemakers & defibrillators
- Sedation or anesthesia is required in paediatric patients





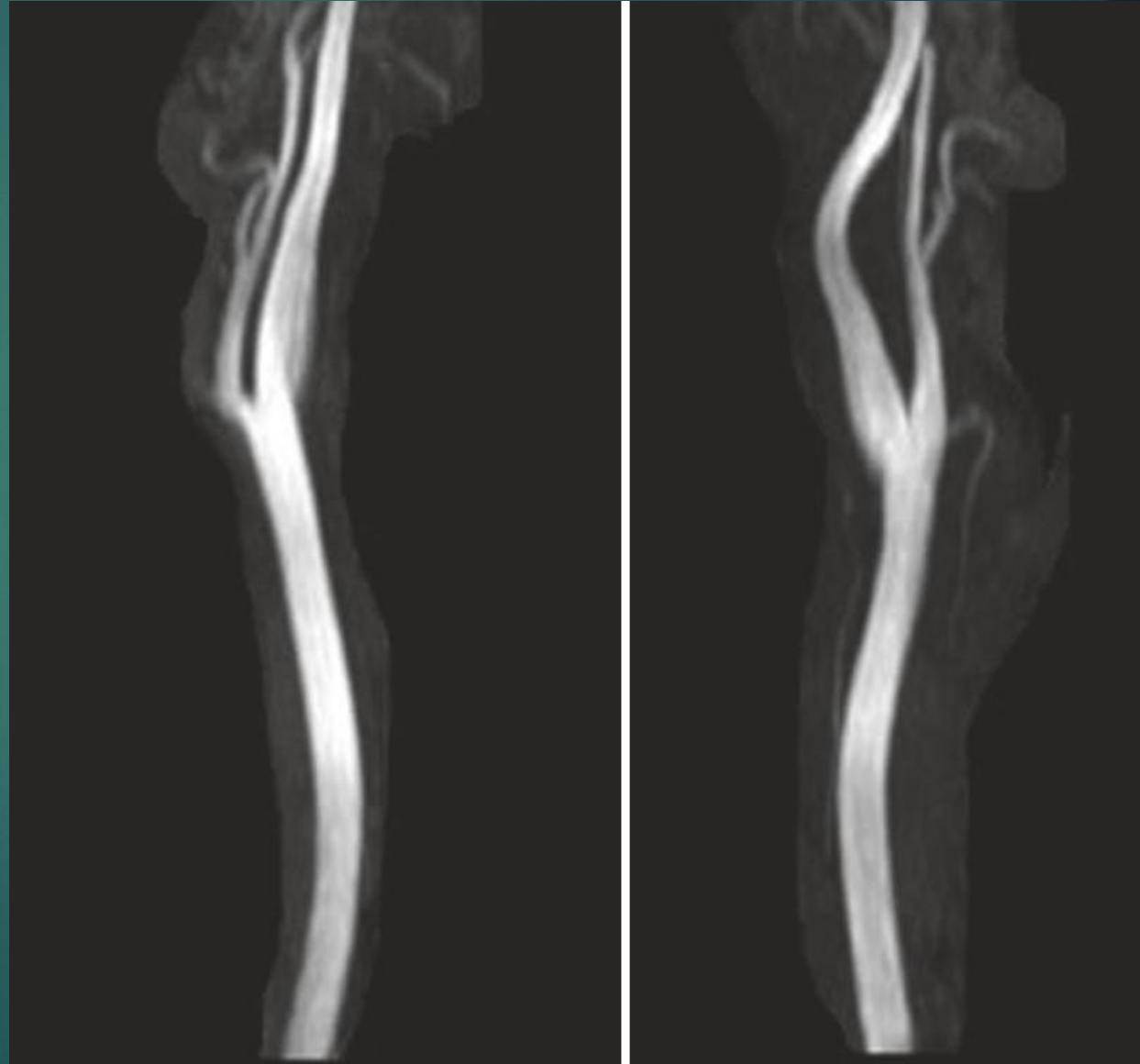




Principle MRA Techniques

Flow-dependent MRA

- ▶ Time-of-Flight MRA
- ▶ Phase-Contrast (PC) MRA



Principle MRA Techniques

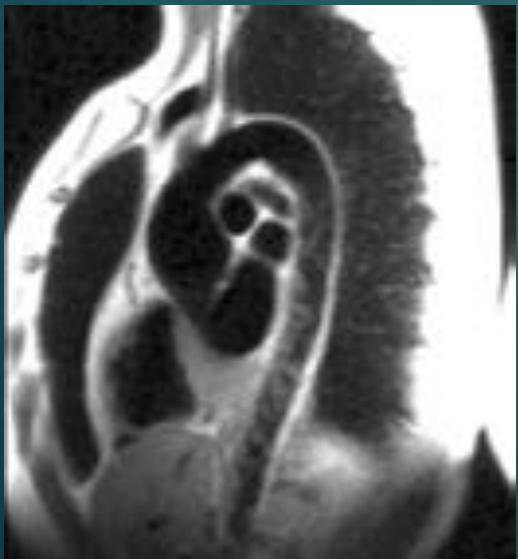
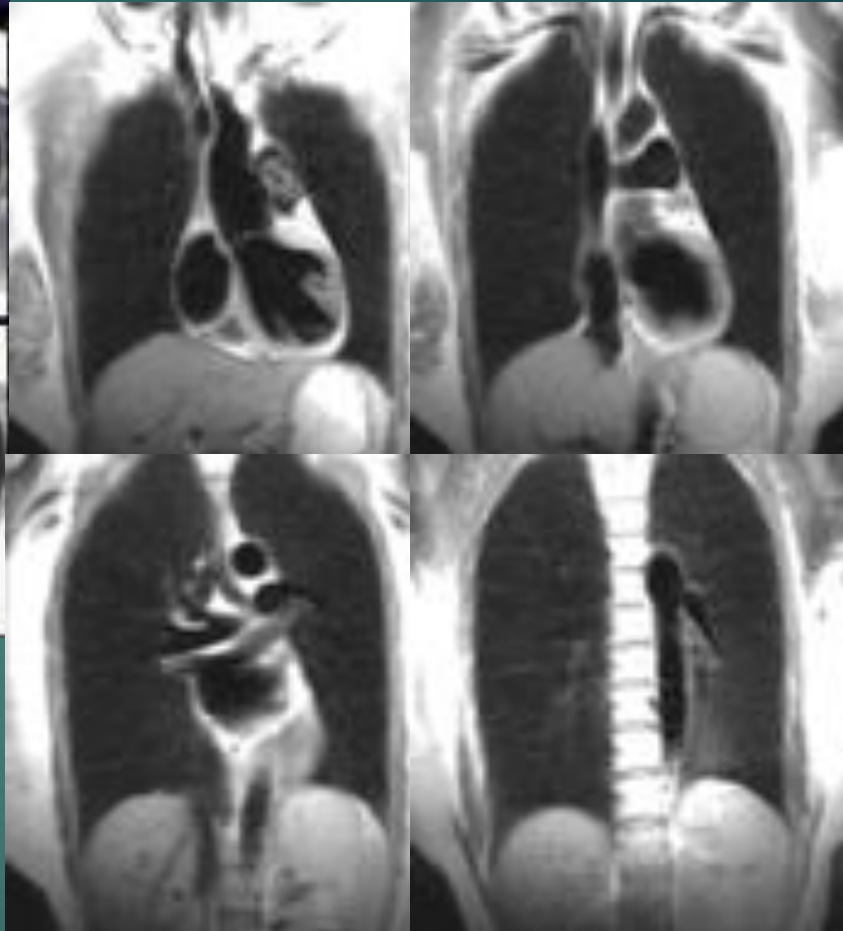
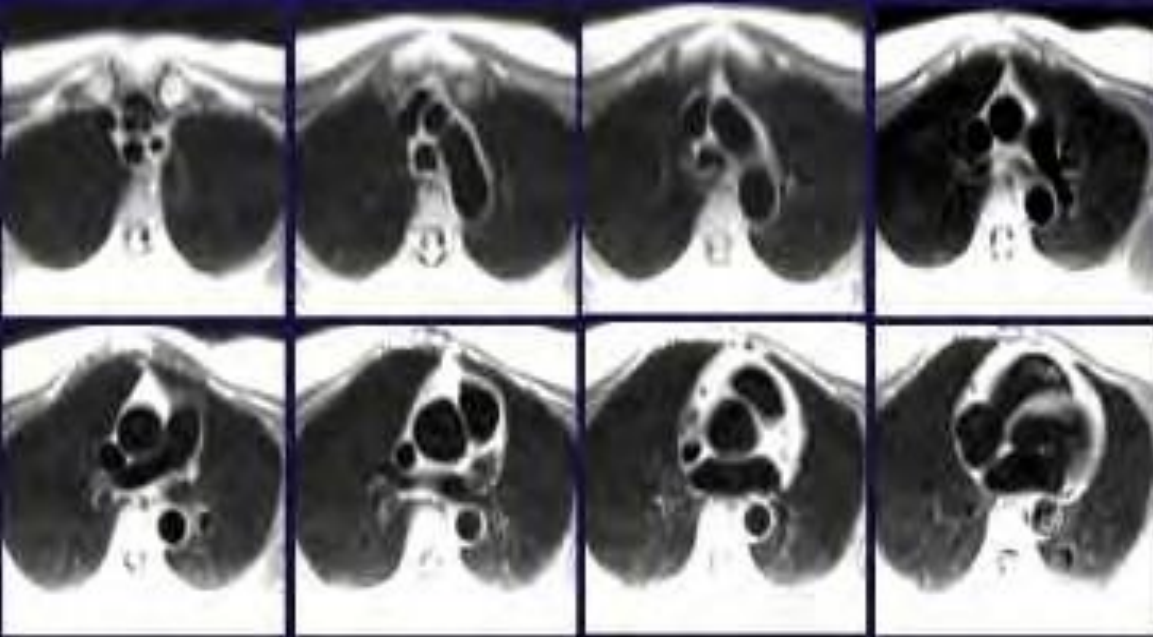
Flow-dependent MRA

- ▶ **Time-of-Flight MRA**
- ▶ **Phase-Contrast (PC) MRA**

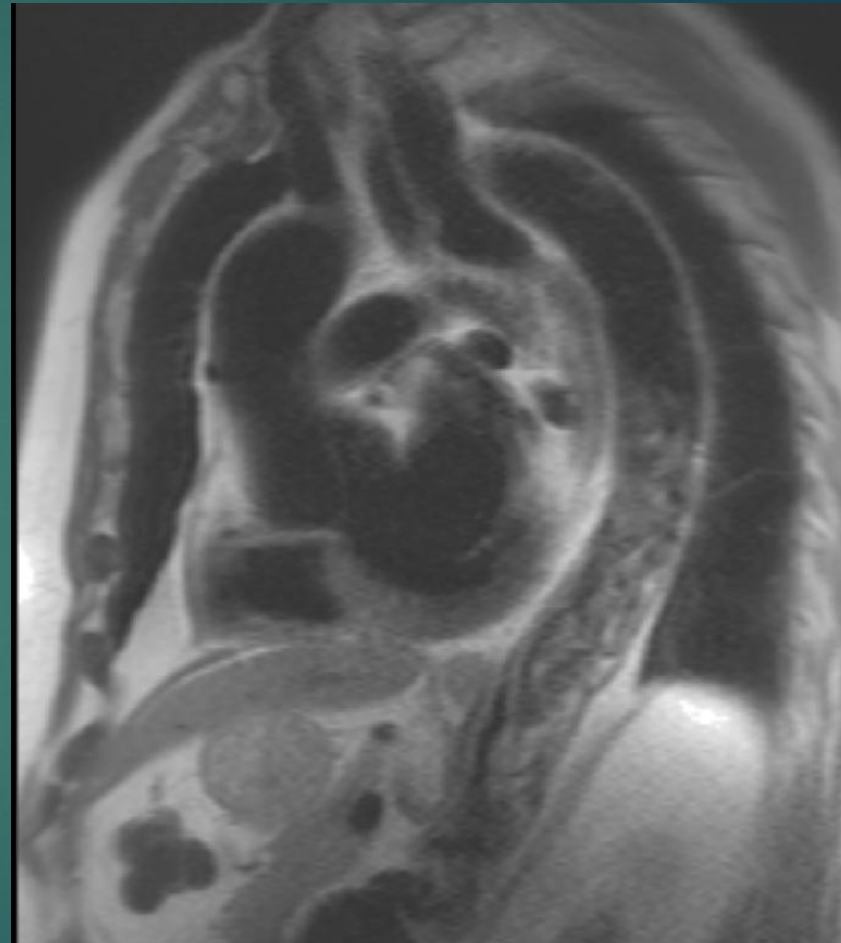
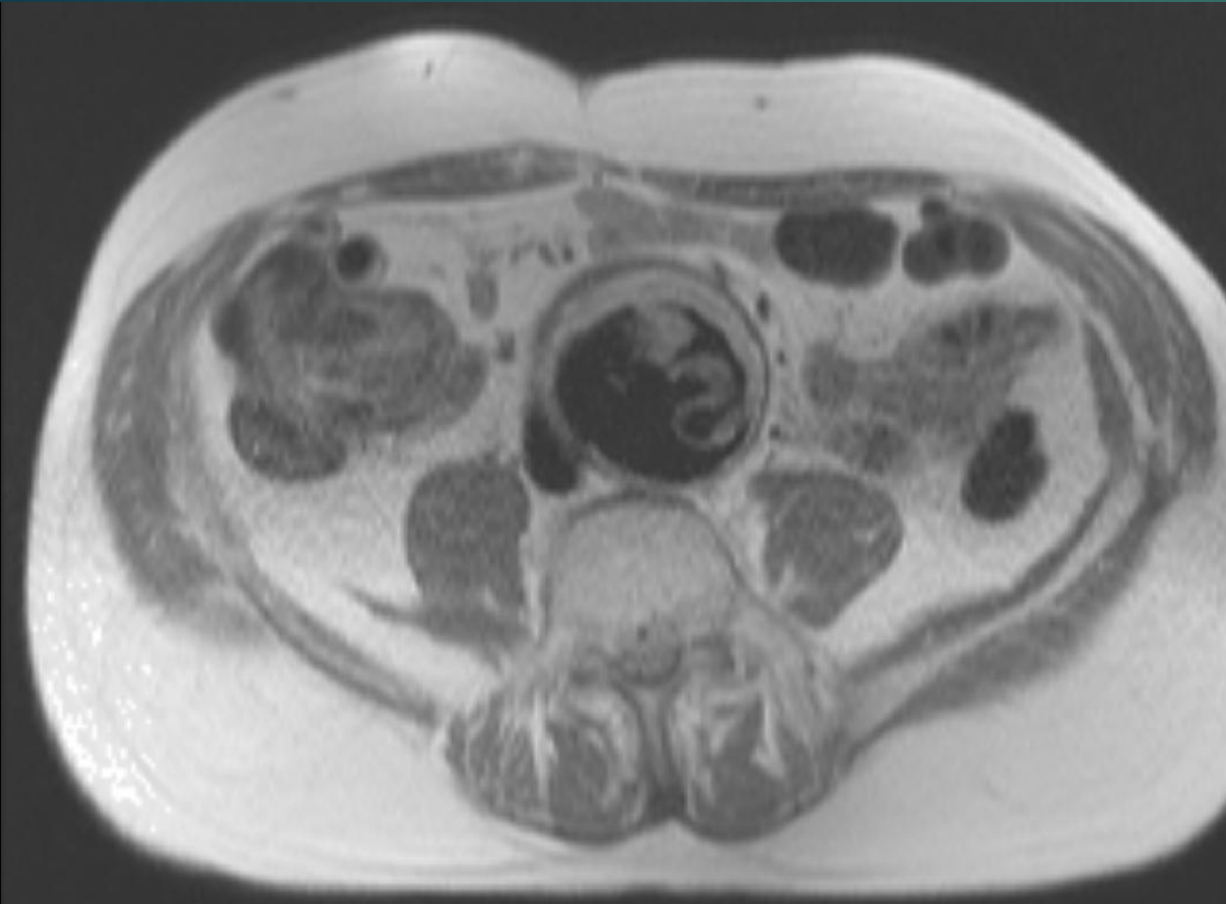
Flow-independent MRA

- ▶ **Black-Blood MRI**
- ▶ **Steady-State Free Precession**
- ▶ **Contrast-Enhanced MRA**
- ▶ **3D SSFP**

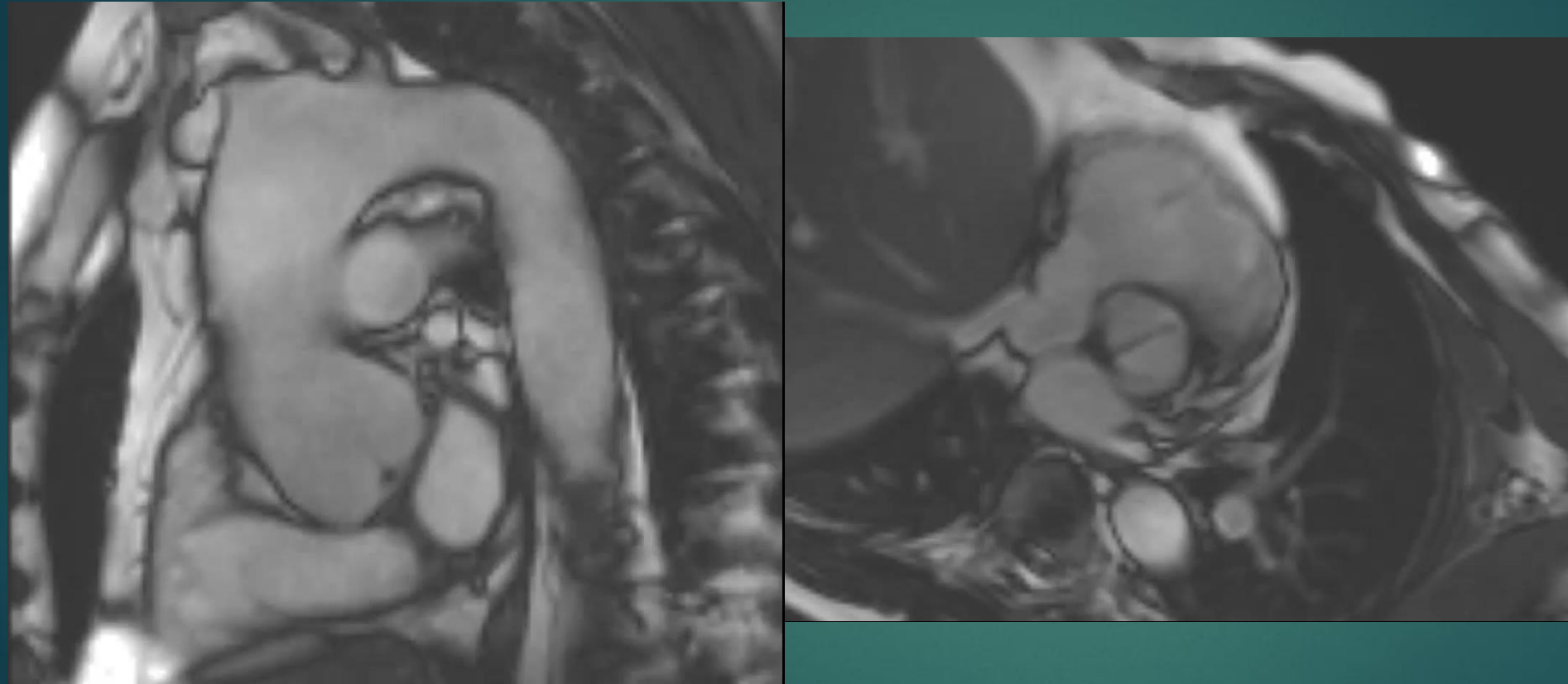
Imaging planes-spin Echo T1 Weighted



- ✓ static images
- ✓ marked, natural contrast between the aorta walls and normal blood flow ("dark blood")
- ✓ excellent resolution for morphology
- ✓ caliber
- ✓ Wall characteristics



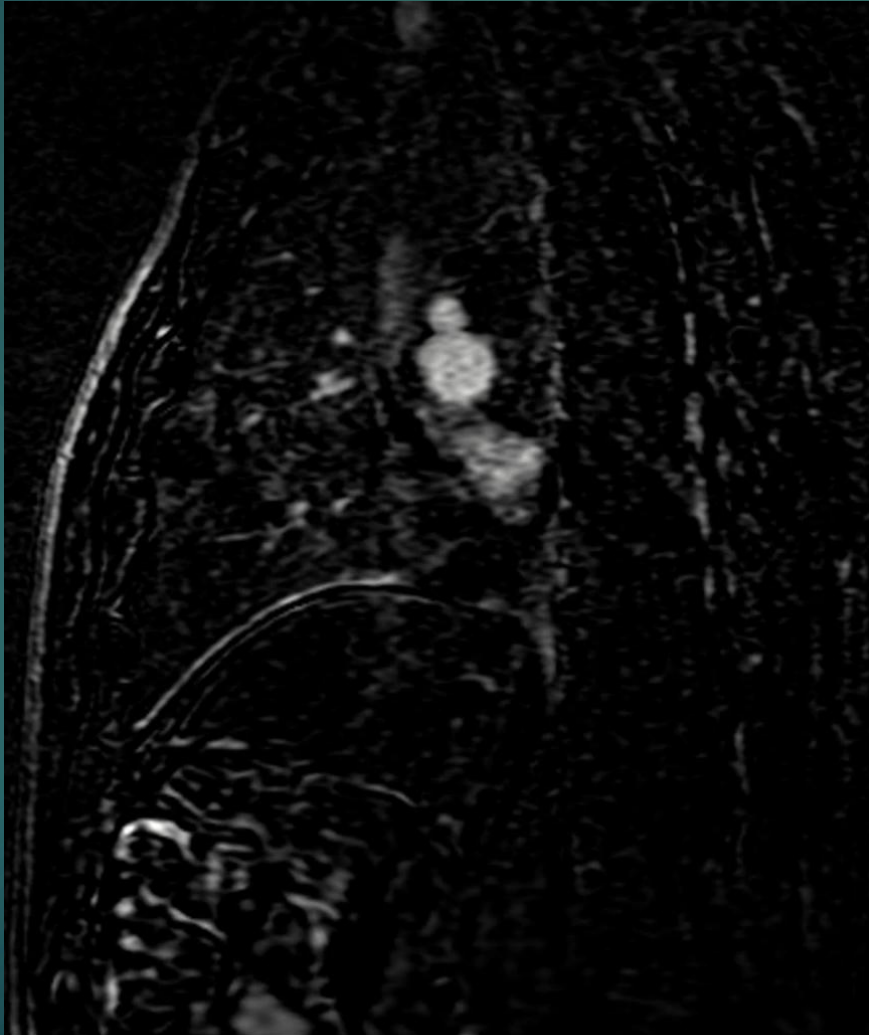
Imaging planes- gradient Echo



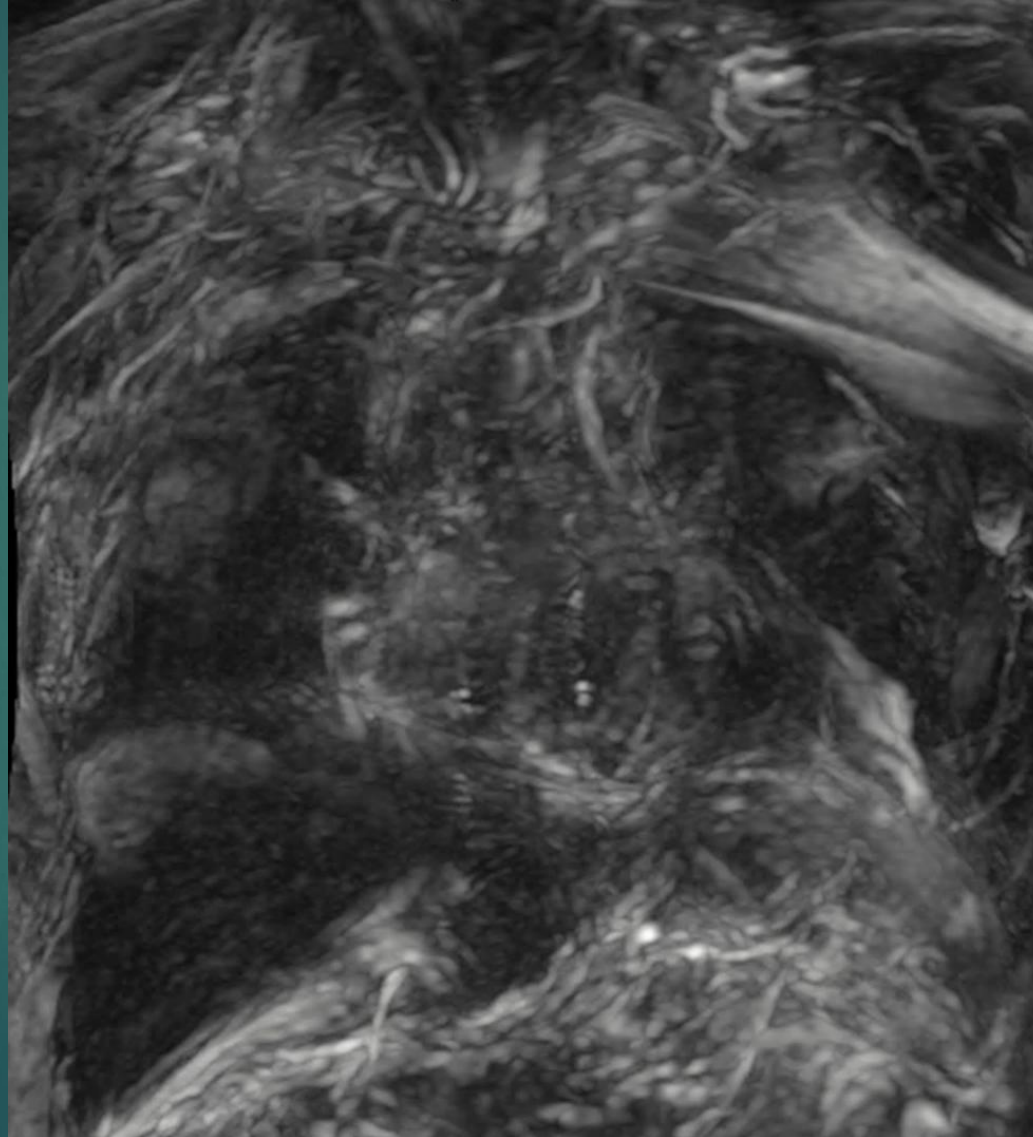
- ✓ 'bright blood'
- ✓ morphology
- ✓ Cine-dynamic study
- ✓ blood flow turbulence
- ✓ thrombosis VS slow blood flow

Contrast-Enhanced (CE) MRA

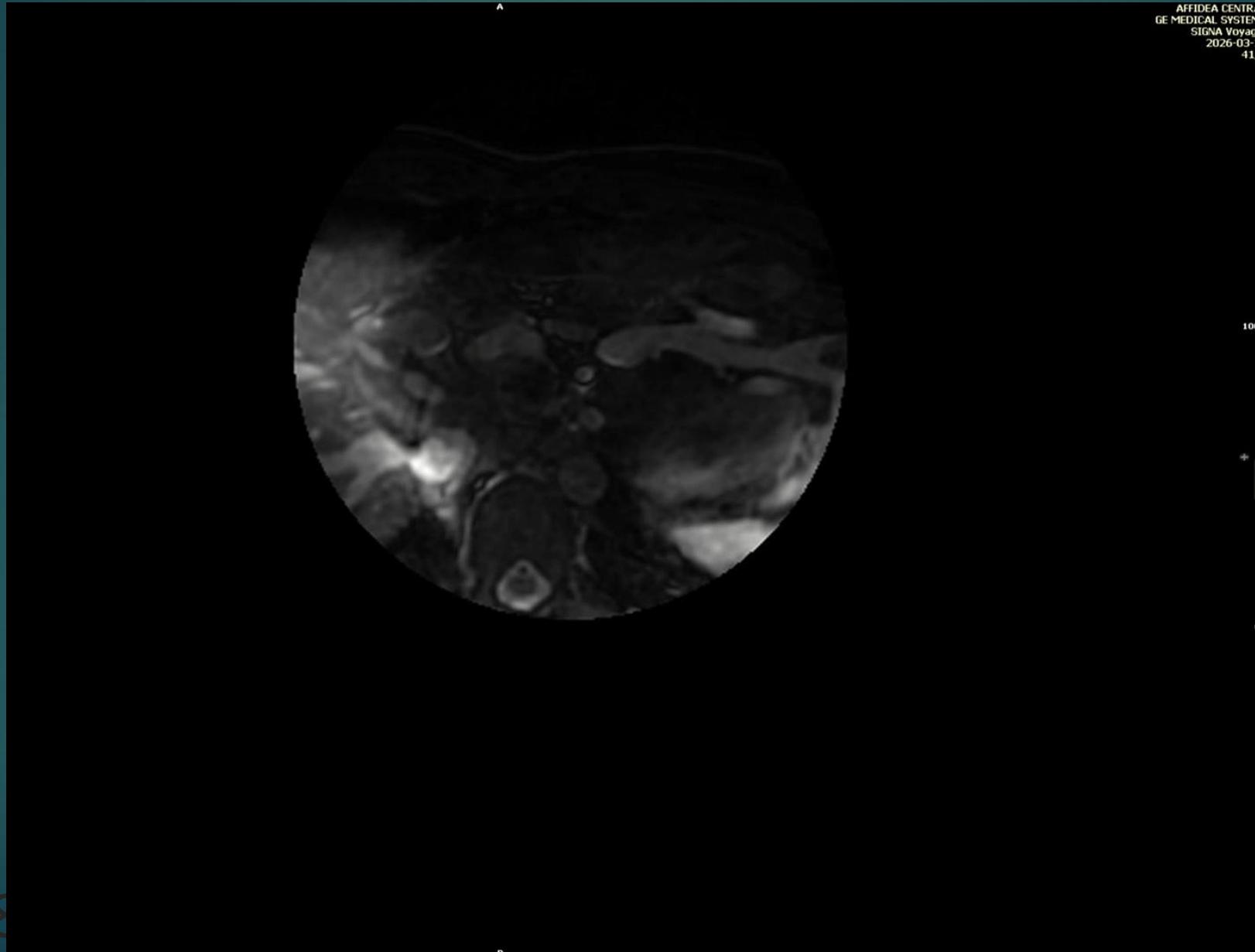
- ▶ Fast with a single breath-hold
- ▶ high-resolution acquisition
- ▶ Robust
- ▶ Aorta/collaterals
- ▶ methods



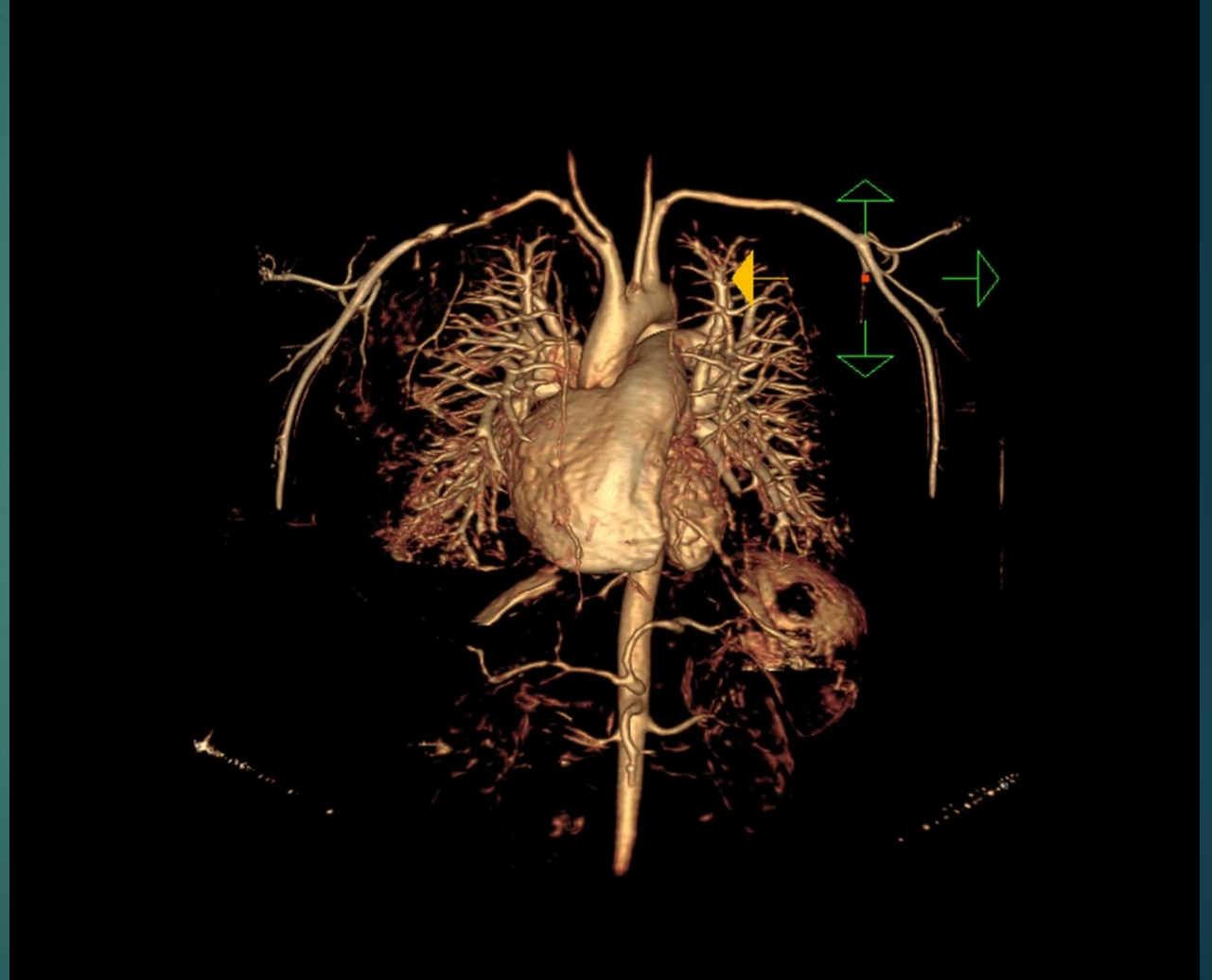
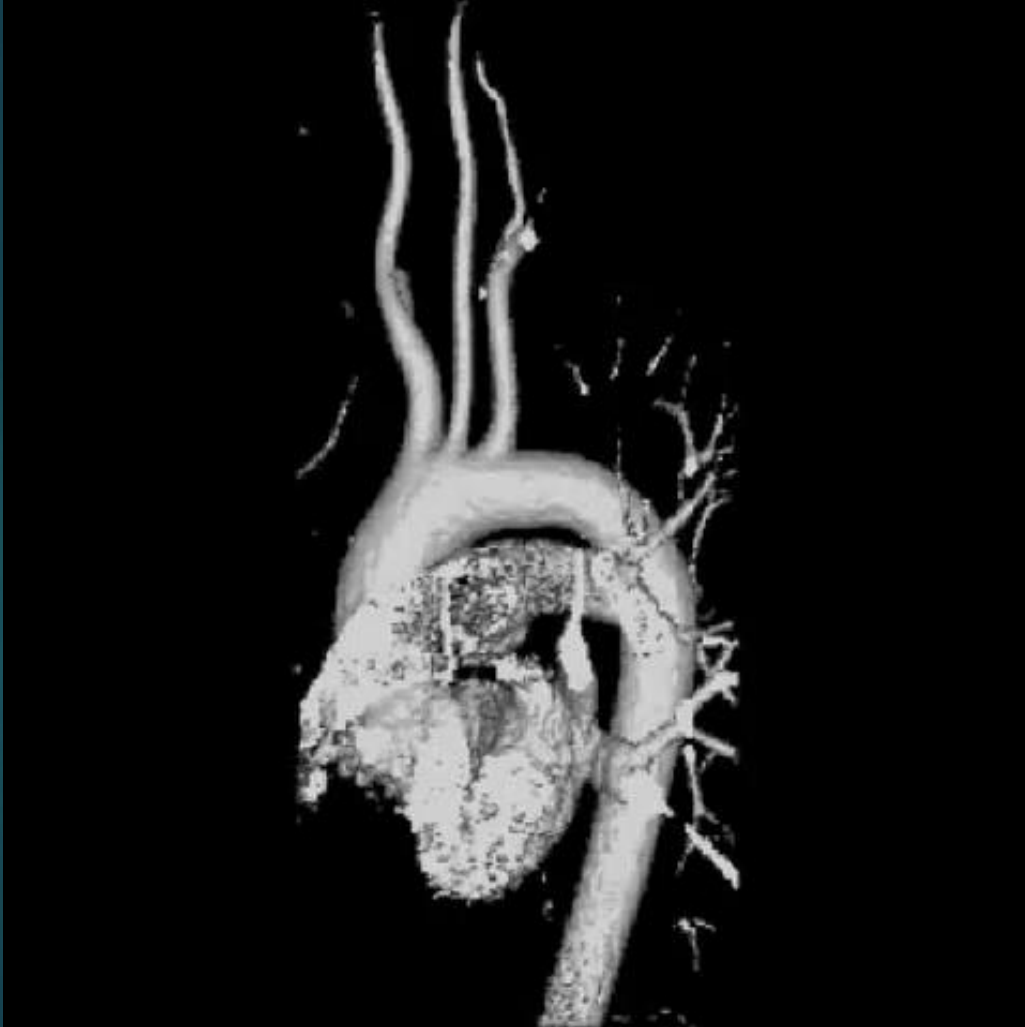
Time-Resolved CE MRA



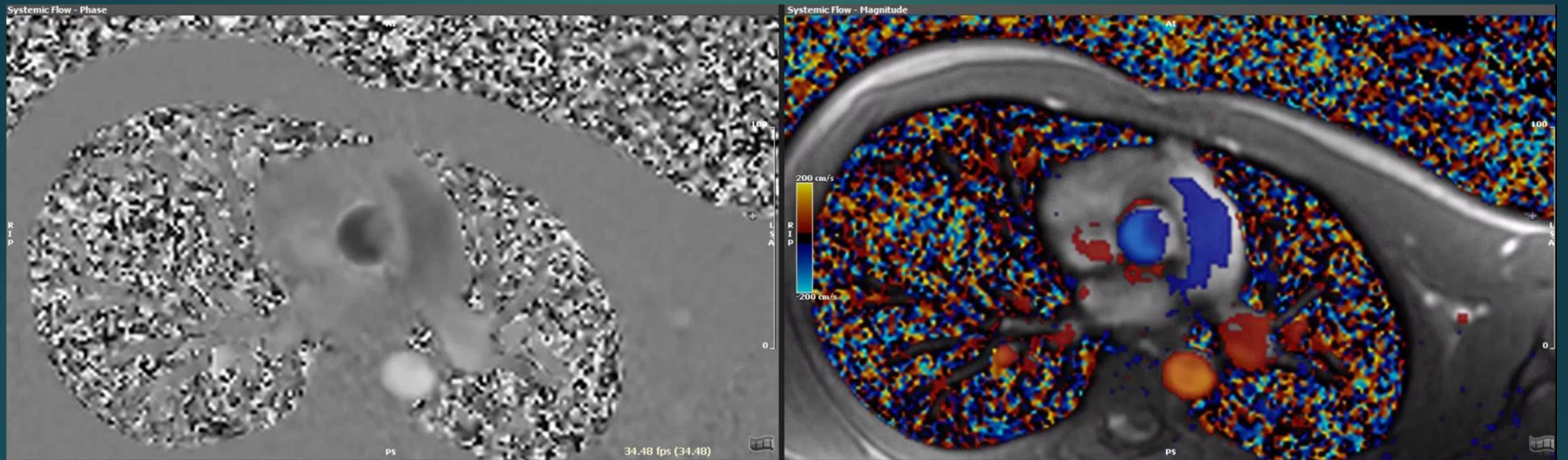
3D Steady State In Free Precession (SSFP)



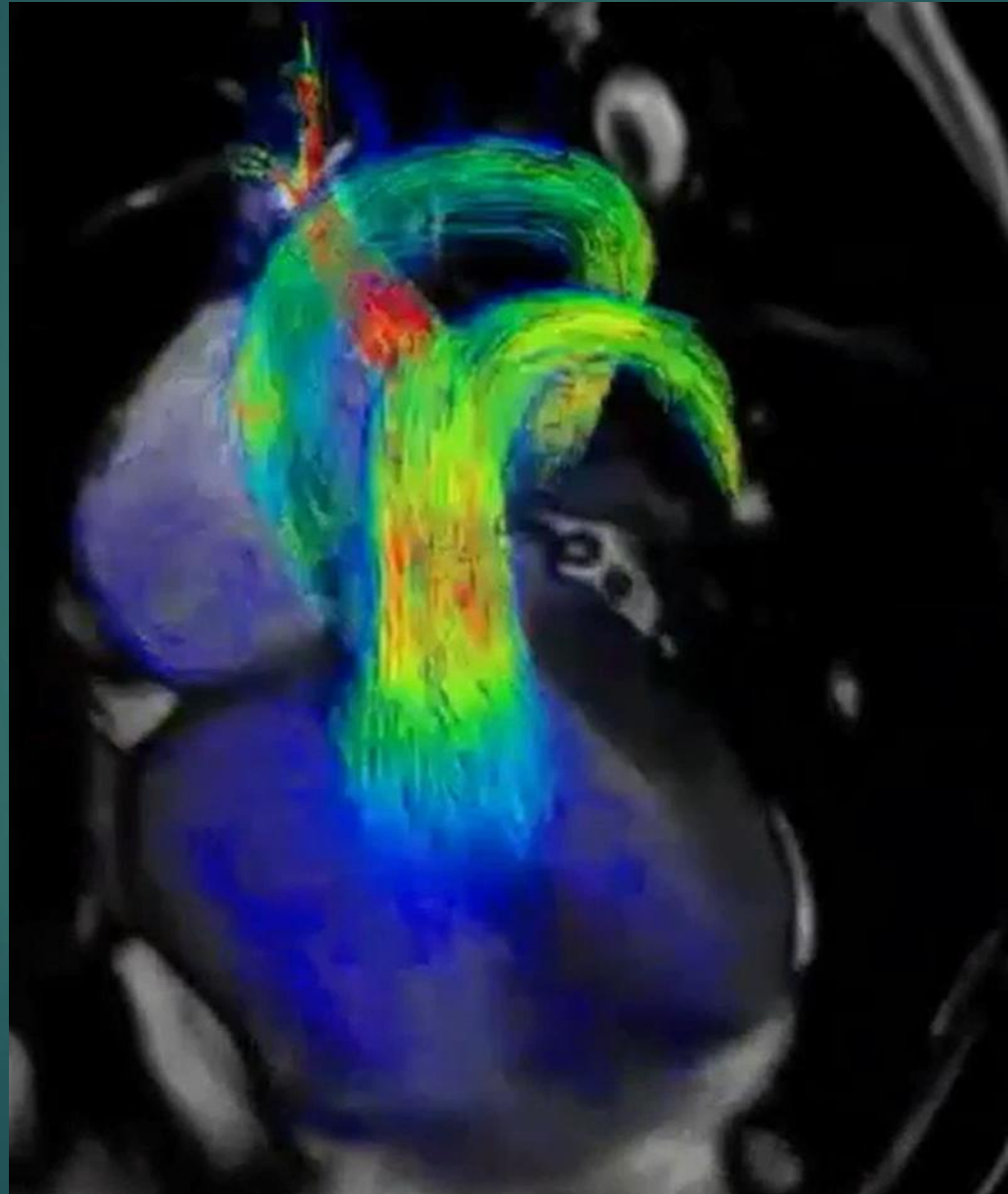
Volume rendering images



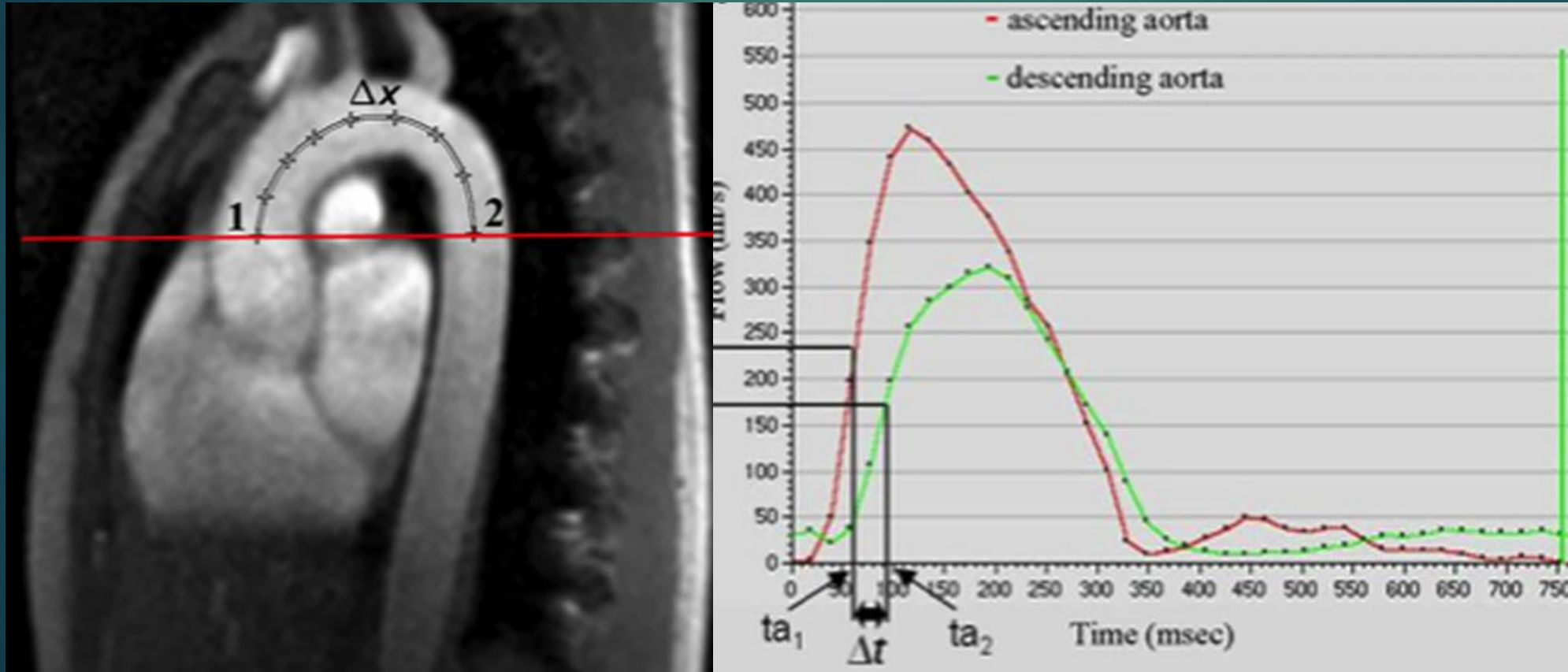
2D FLOW



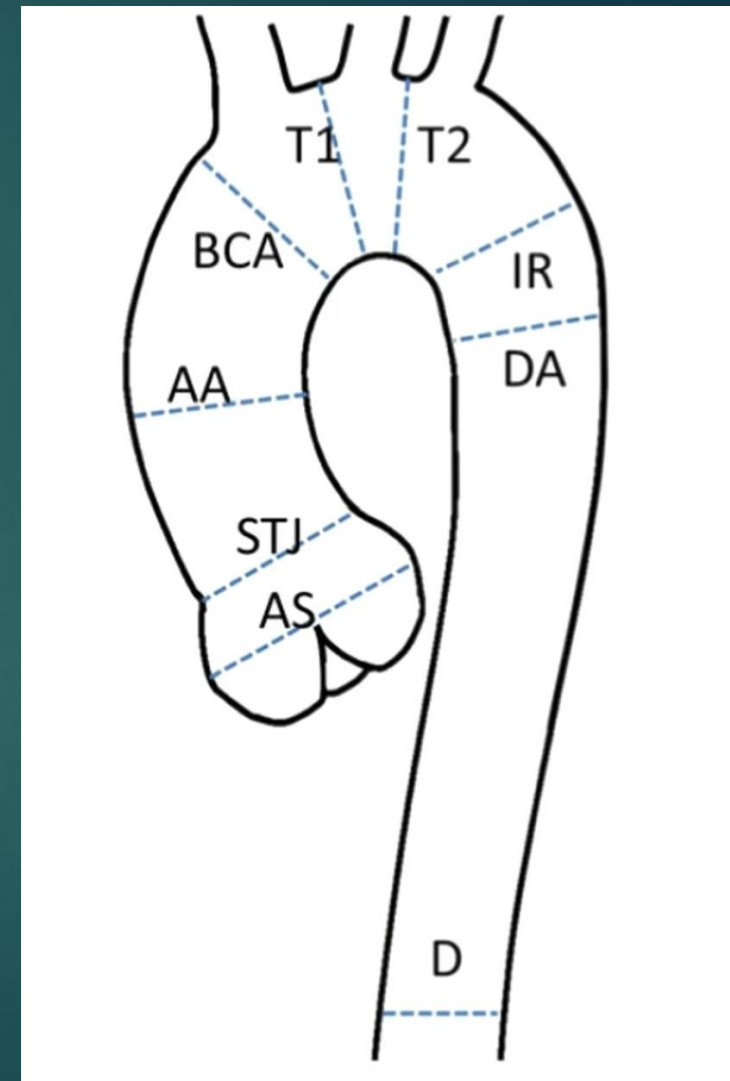
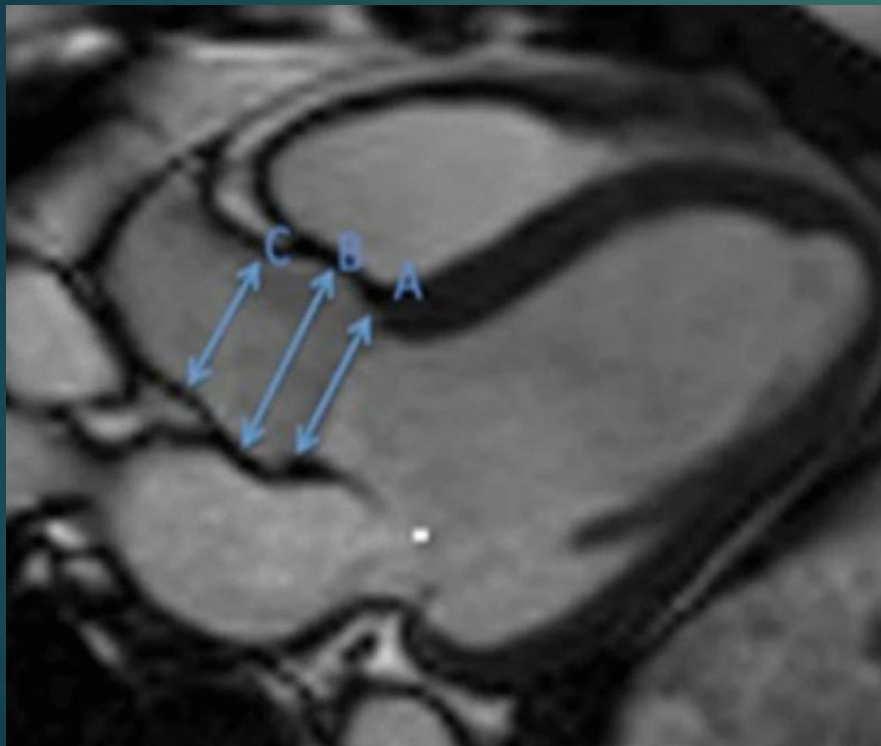
4D FLOW



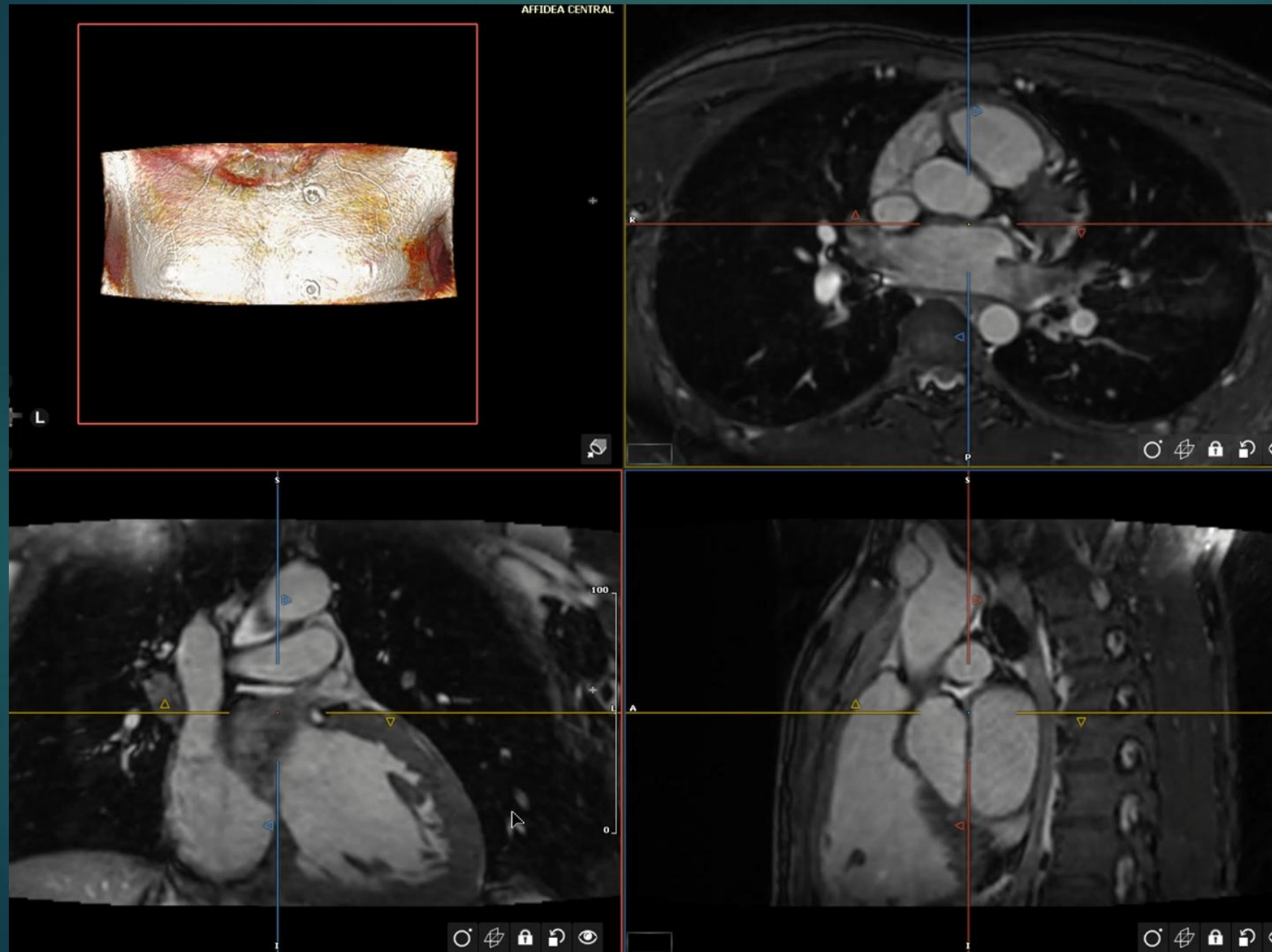
pulse wave velocity/ aortic distensibility



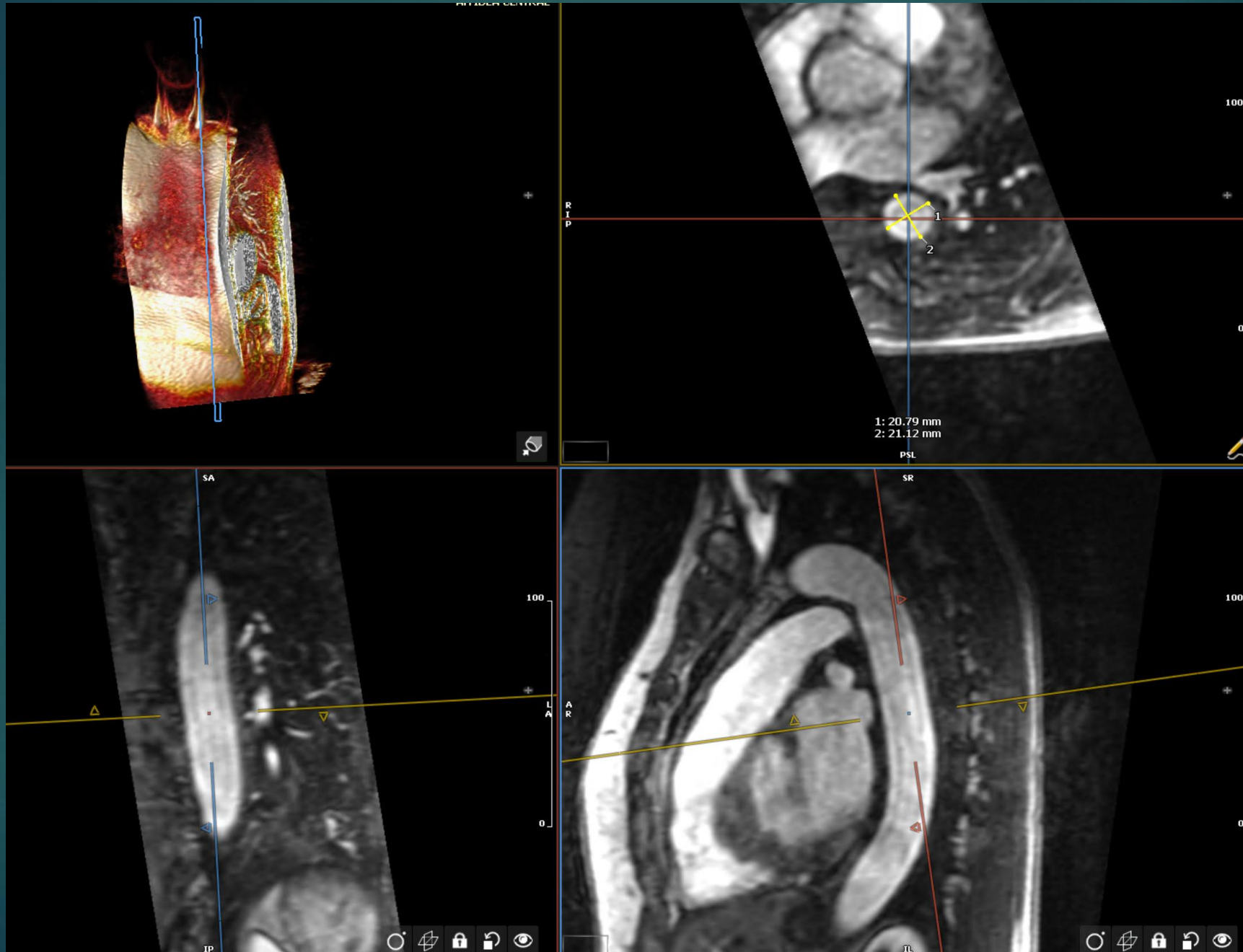
Where to measure



3D bSSFP sequence-the best agreement with CTA

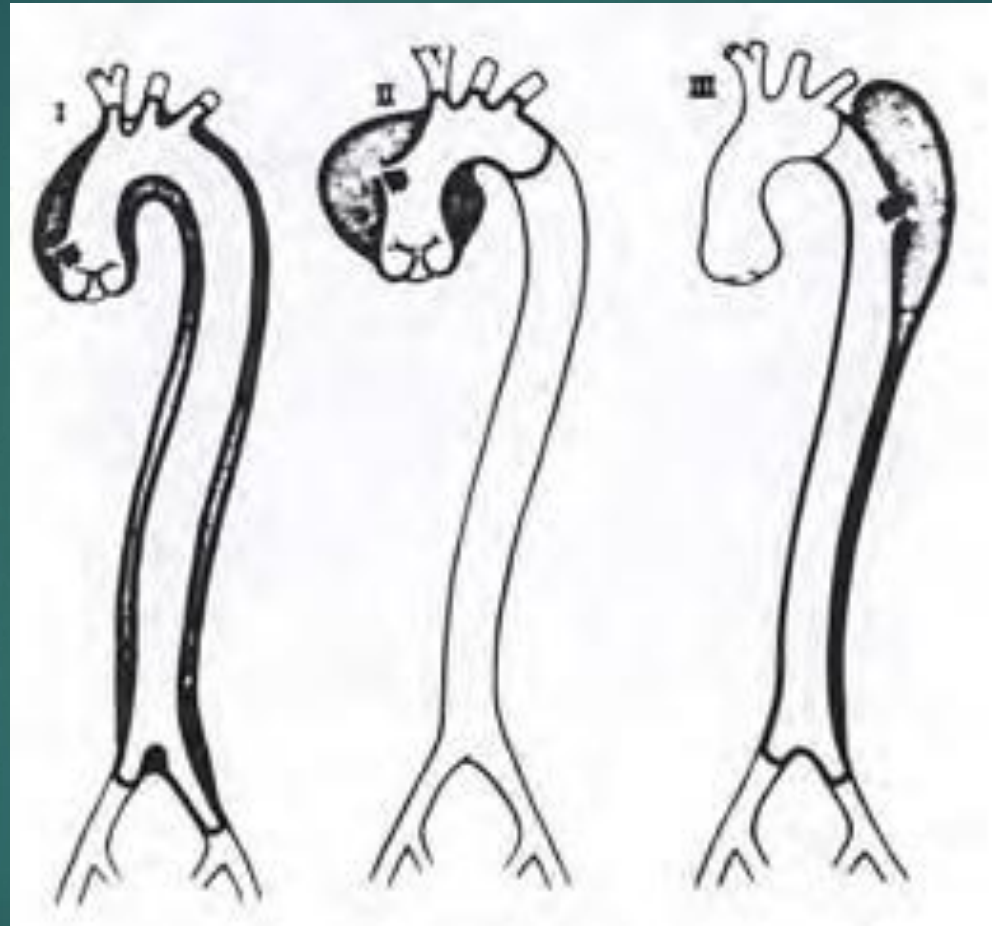


MPR of CE-MRA



Classification of aortic dissection

DeBakey



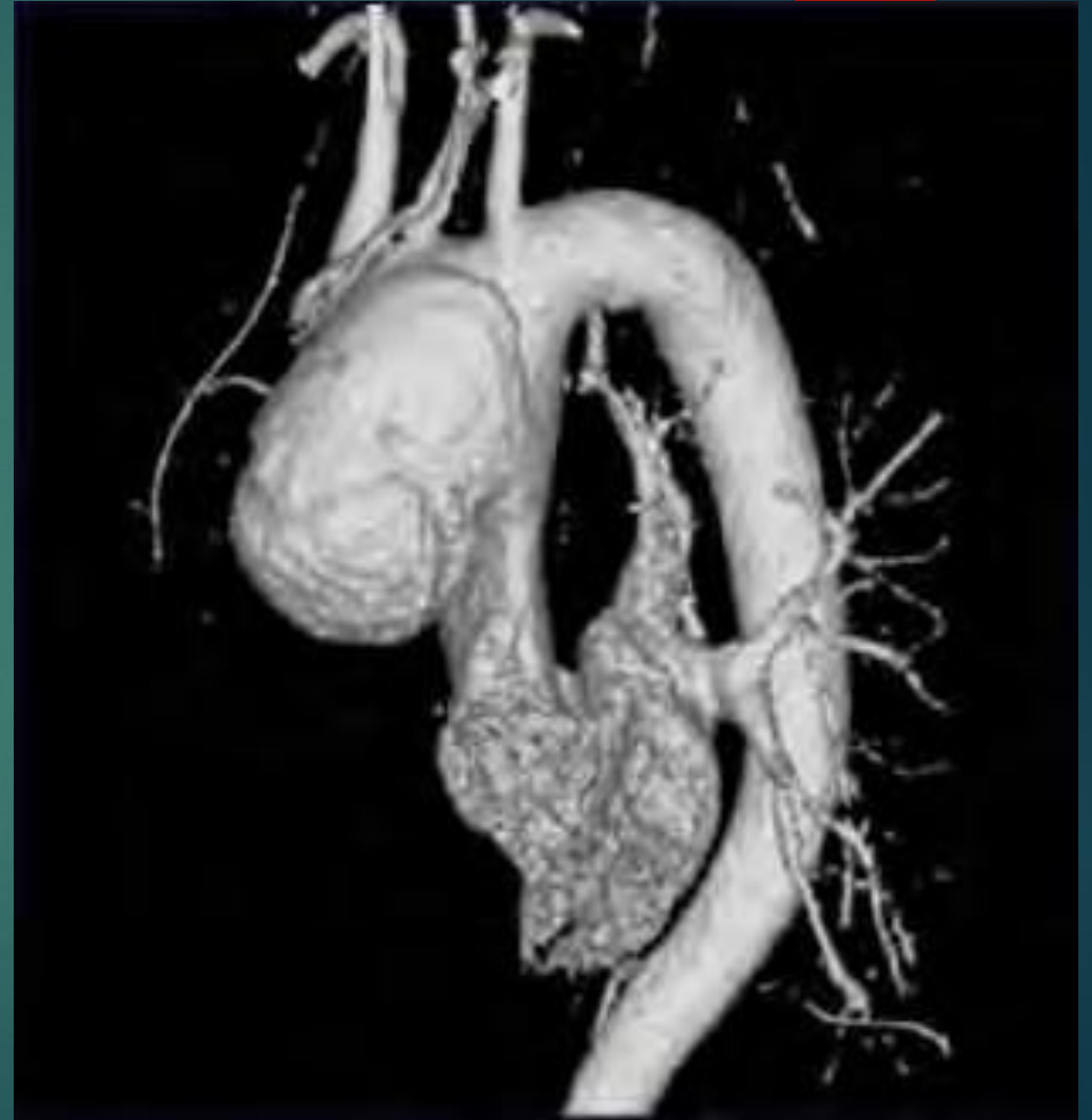
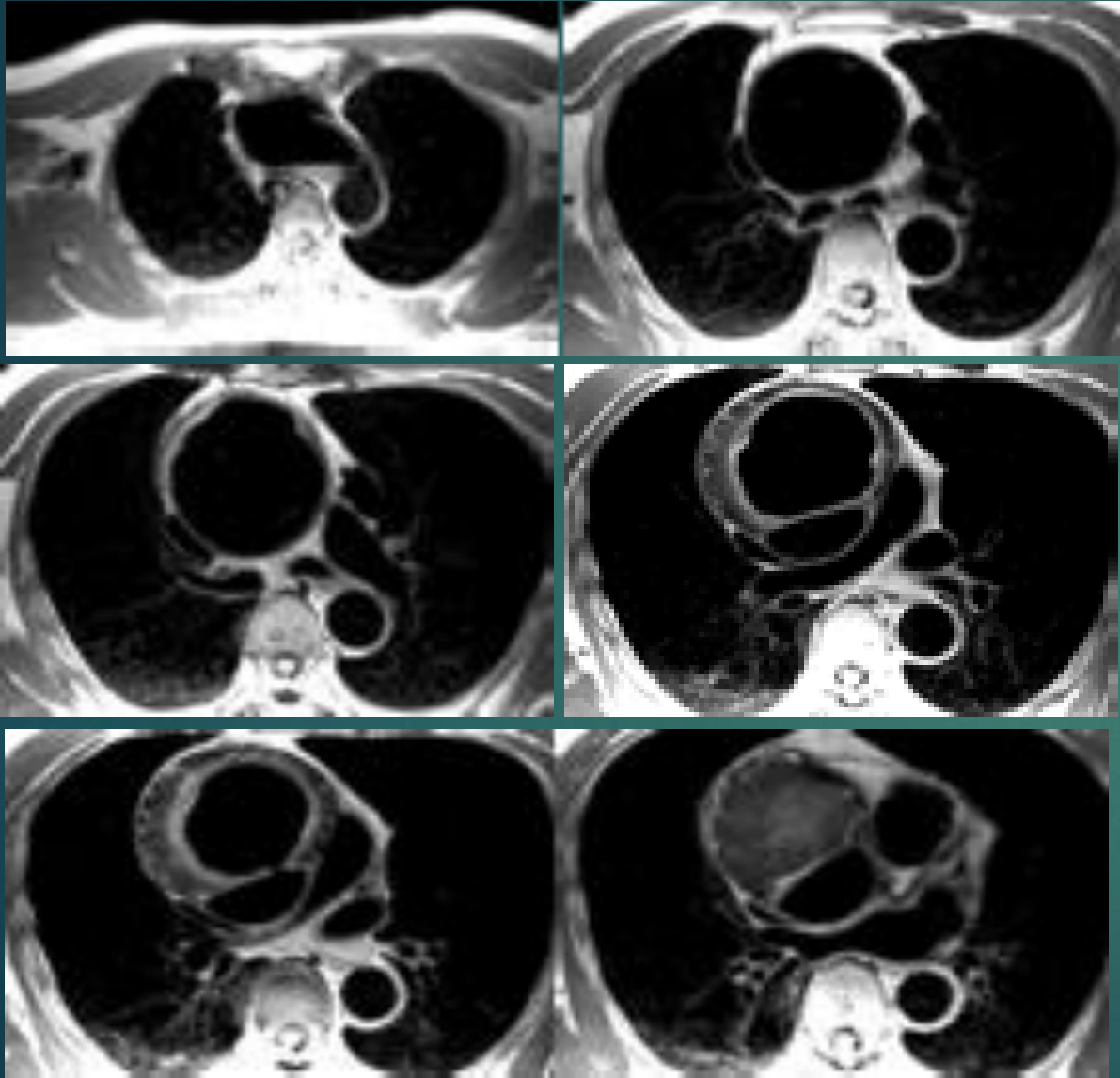
Stanford

Type A

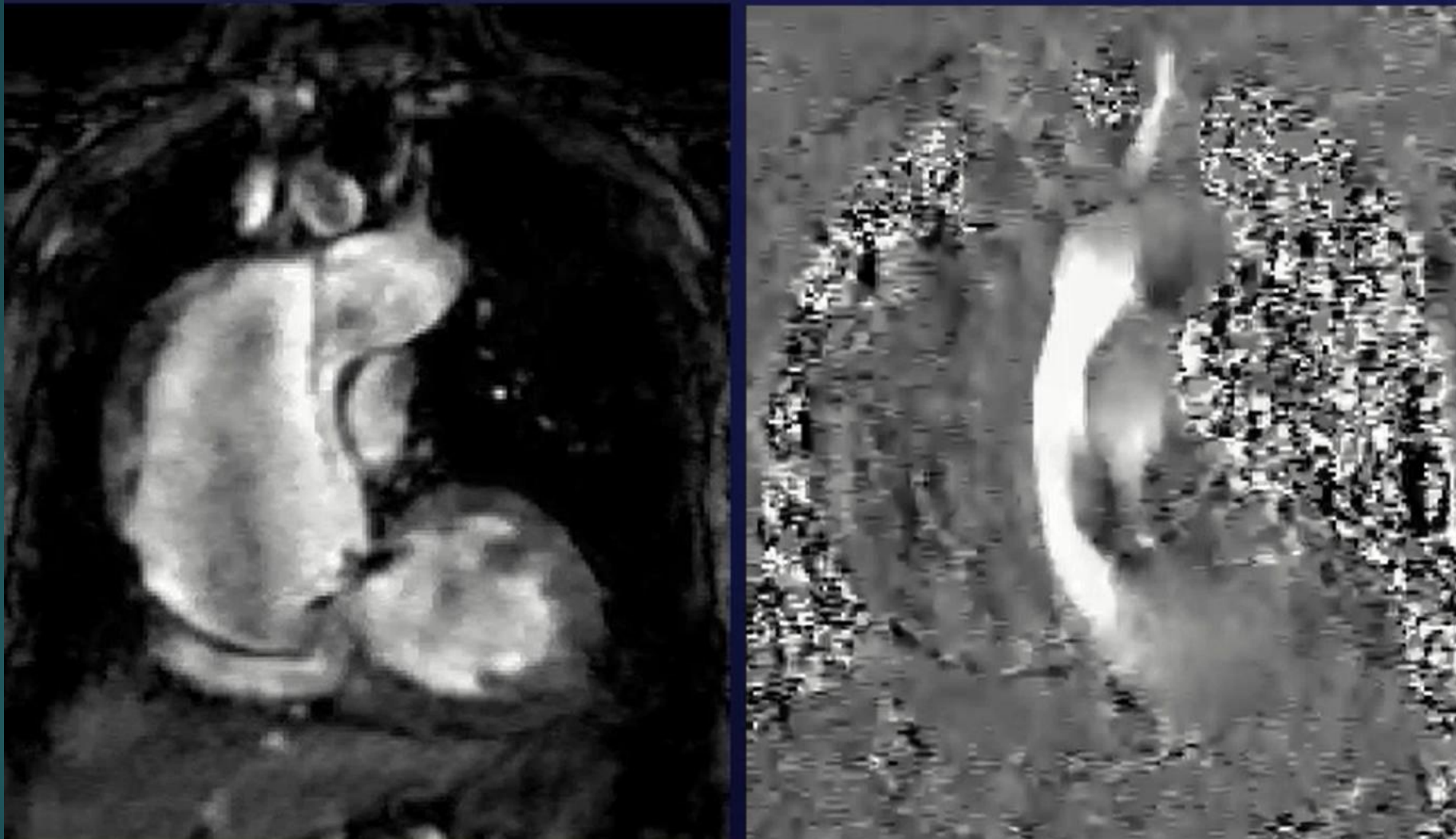
Type B

- 
- Presence of intimal flap
 - Extent of the dissection
 - Sites of entry and re-entry
 - Thrombosed false lumen
 - Involvement of the ascending aorta
 - Aortic valve regurgitation
 - Coronary artery involvement
 - Branch vessels involvement
 - Pericardial effusion

Stanford “Type A” aortic dissection

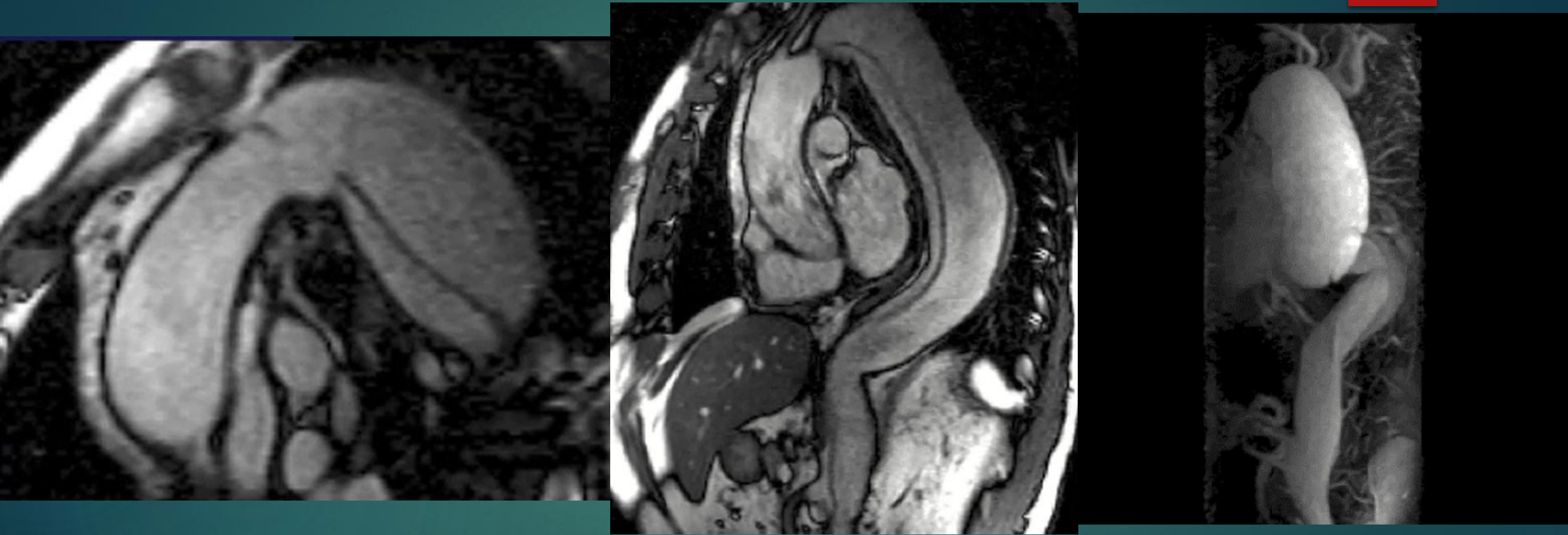


Stanford “Type A” aortic dissection

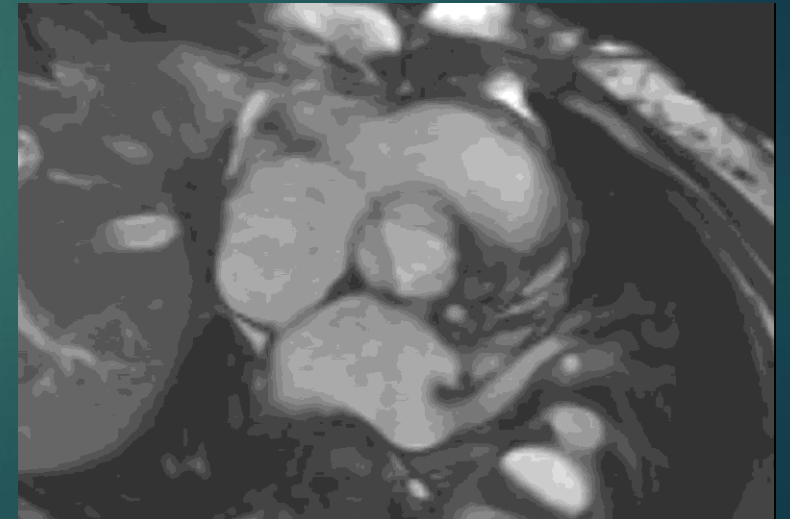
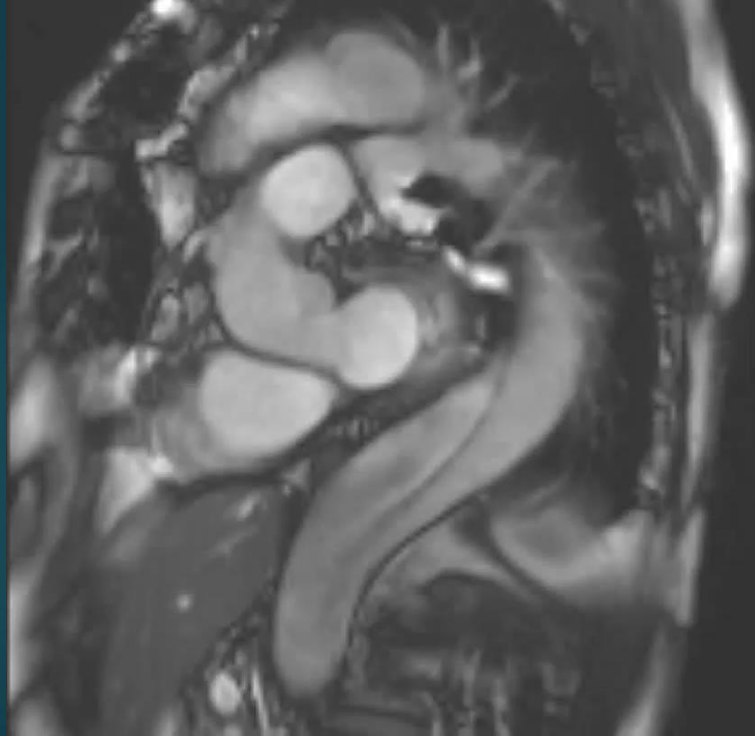




Stanford “Type B” aortic dissection / Entry point

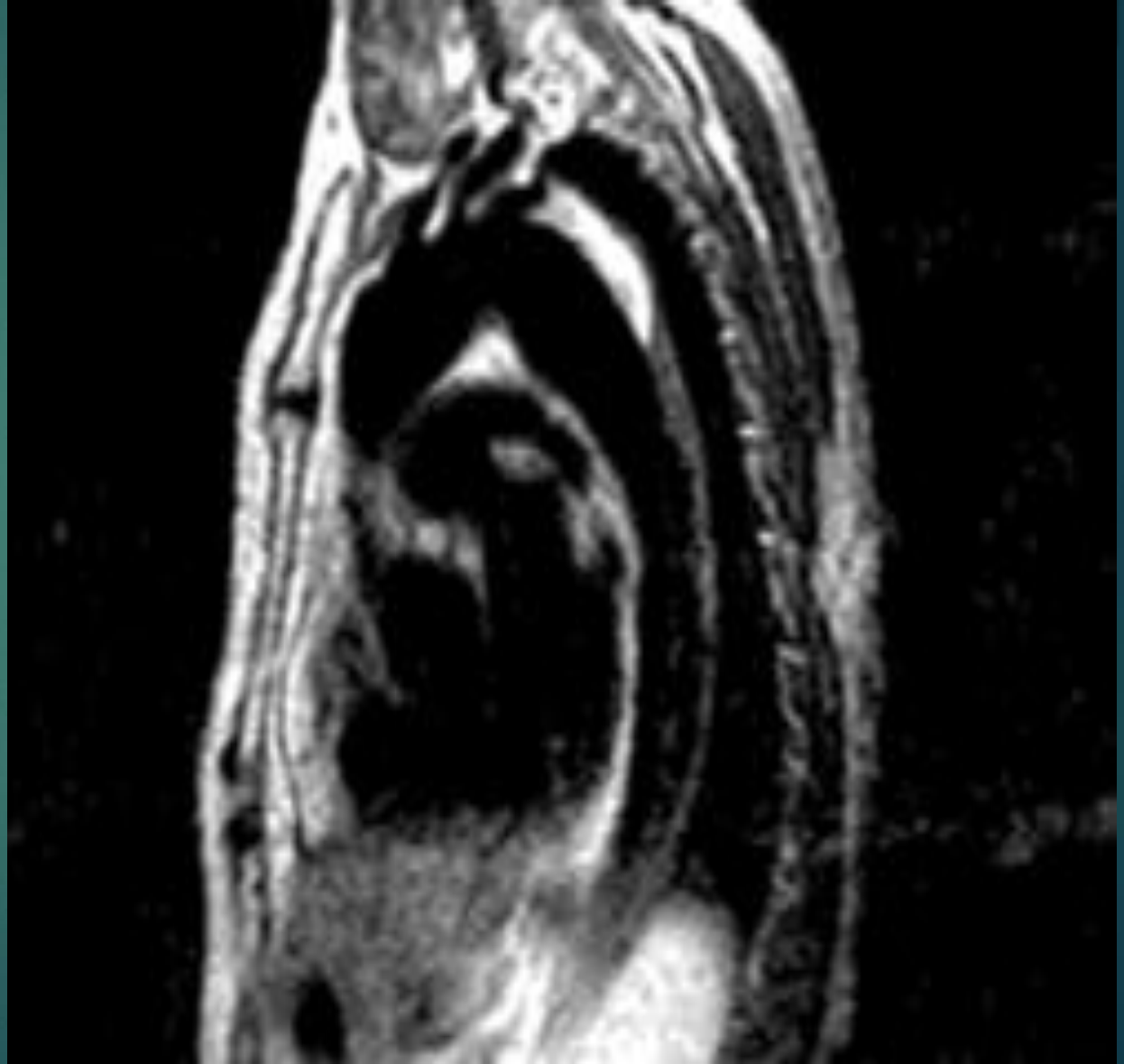


Stanford “Type B” aortic dissection

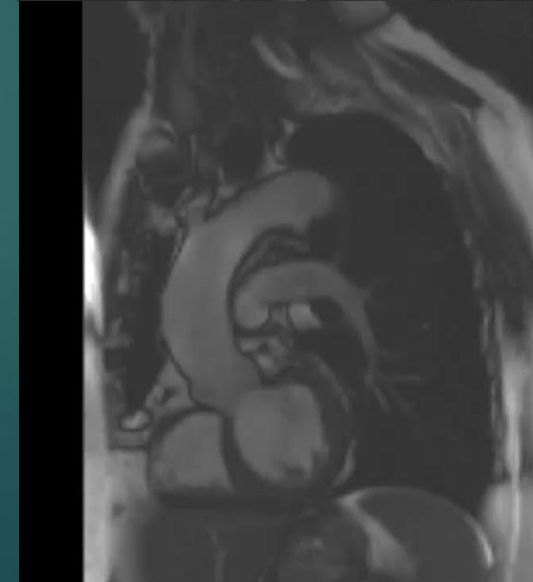
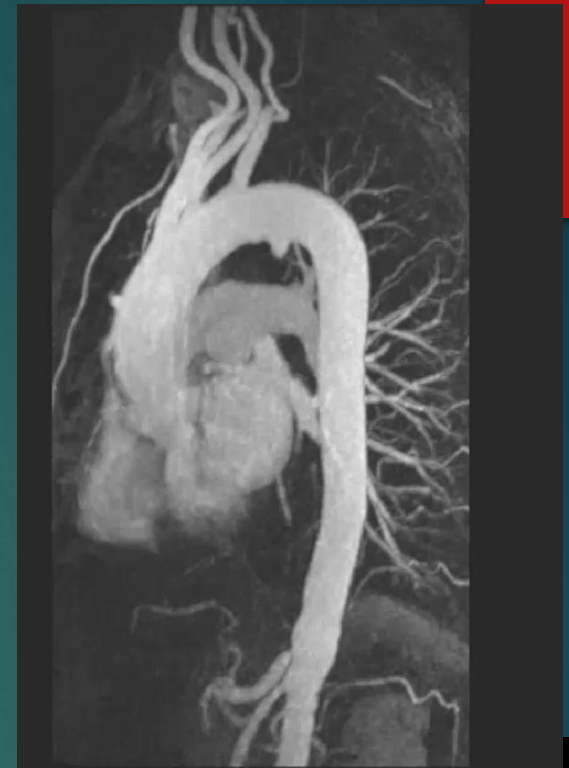




Intramural Haematoma



Penetrating Aortic Ulcer



Aortic Aneurysm

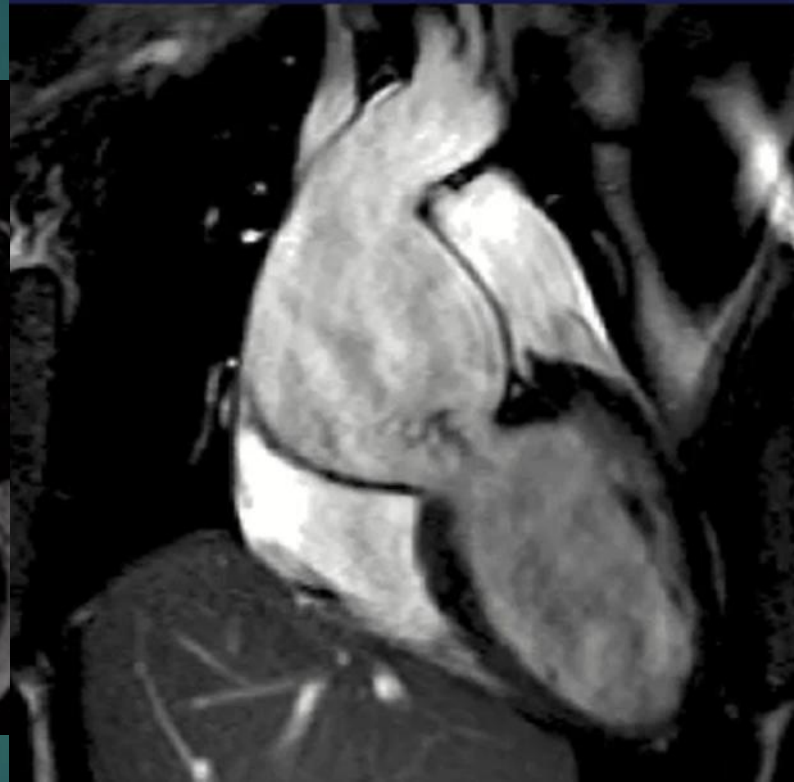
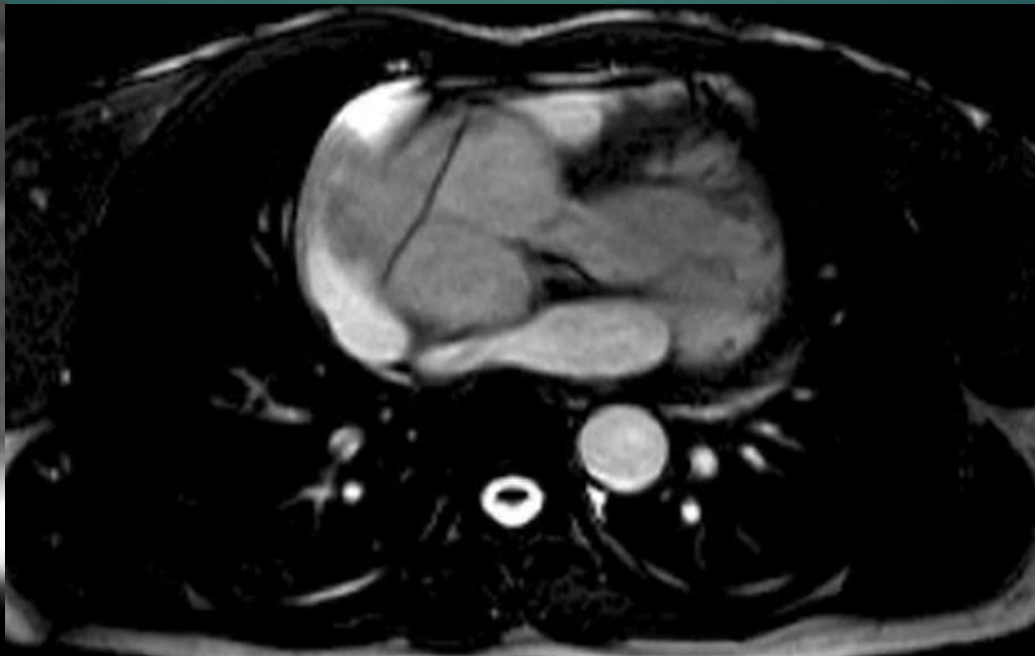


Fusiform

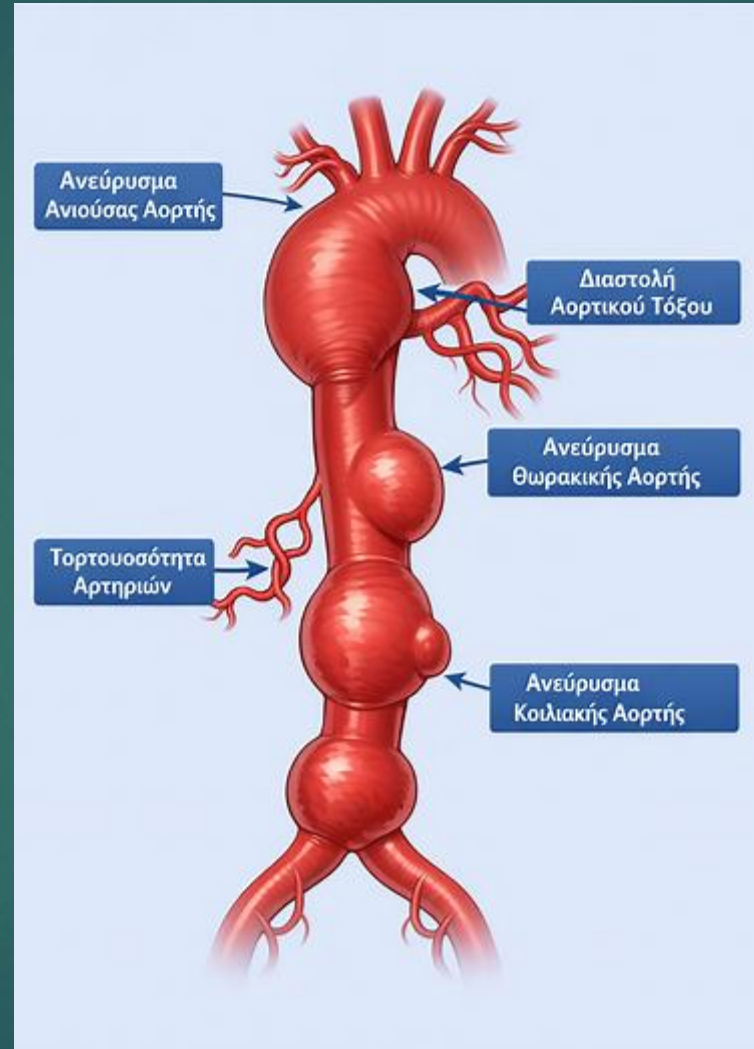
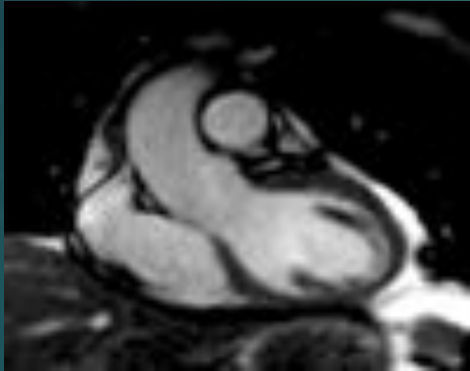
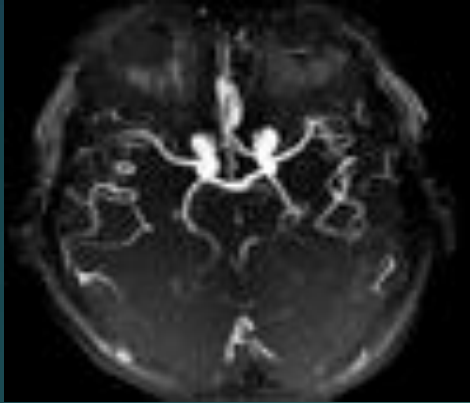


Saccular

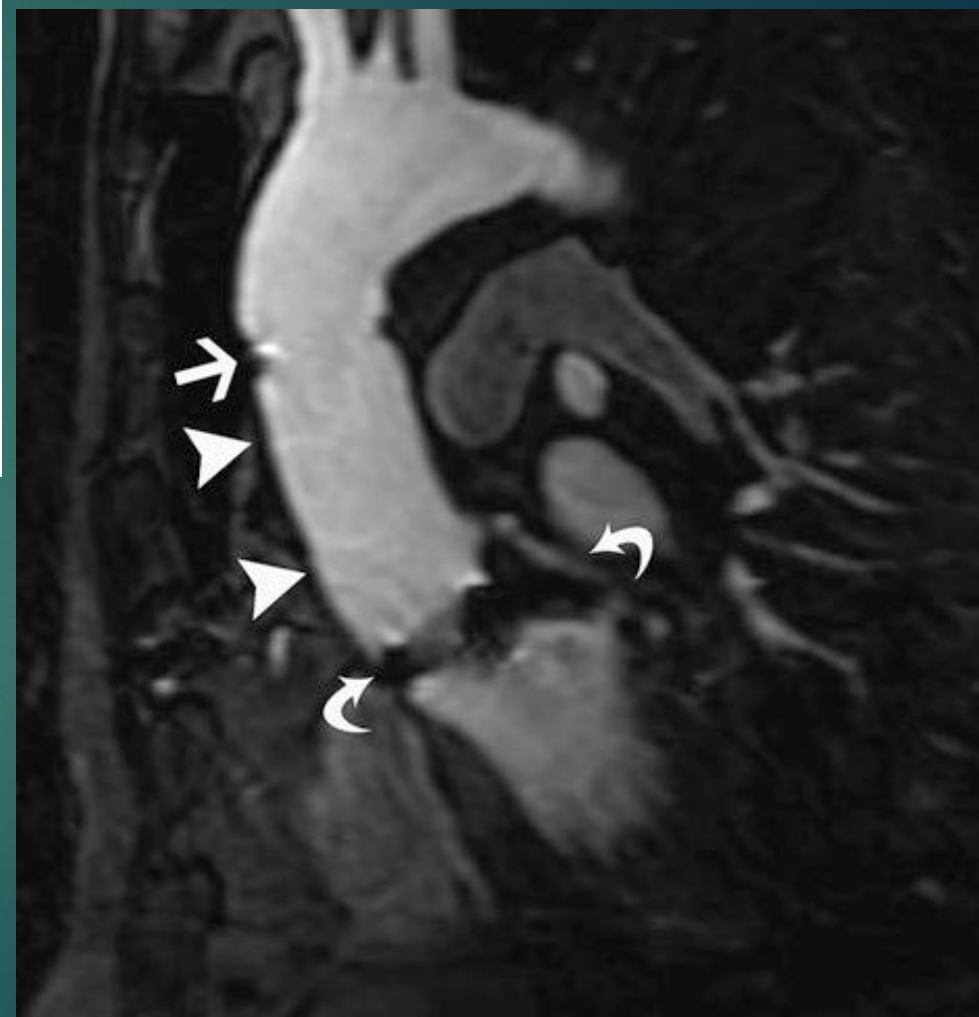
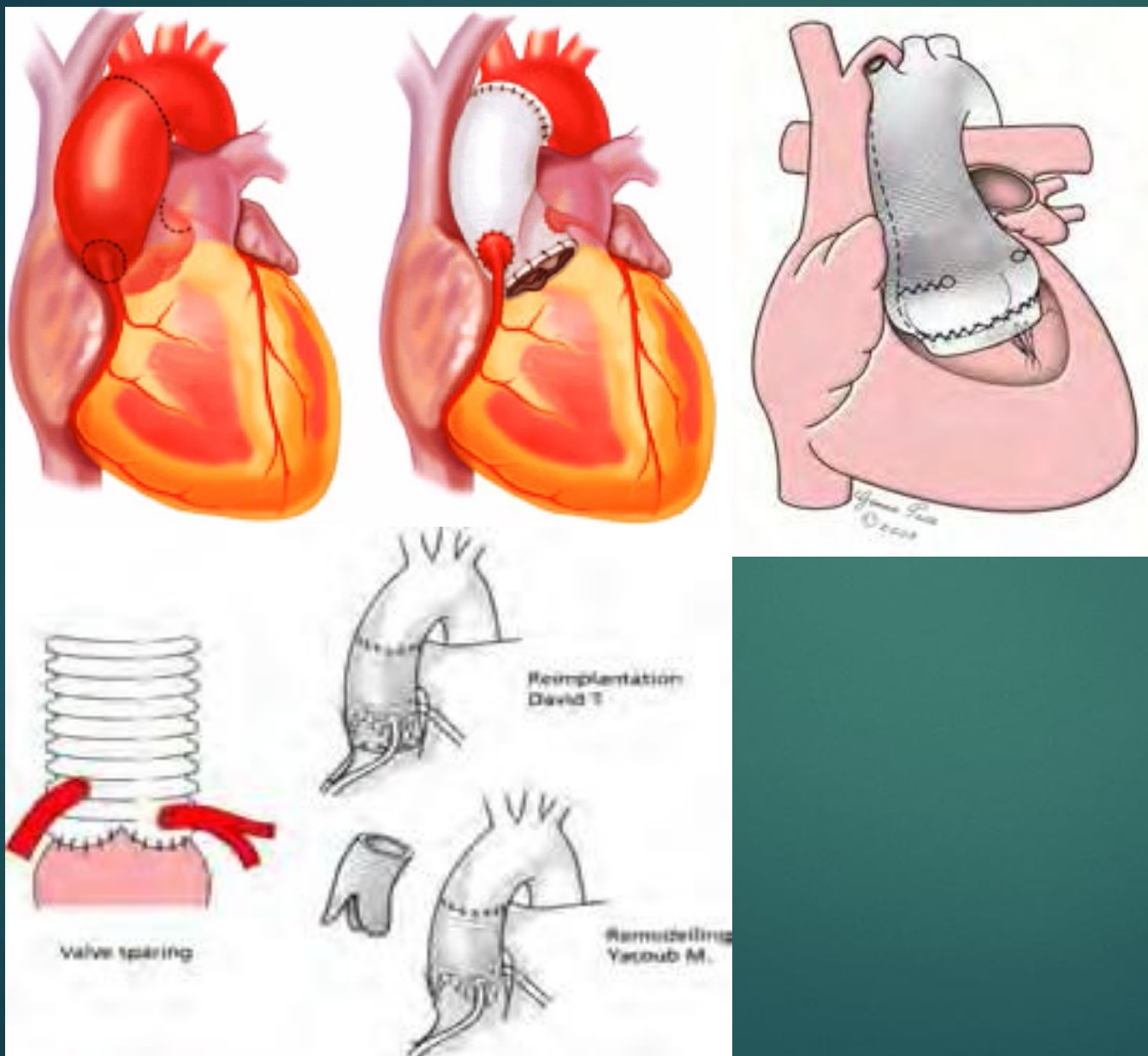
Aortic Aneurysm/ Marfan's syndrome



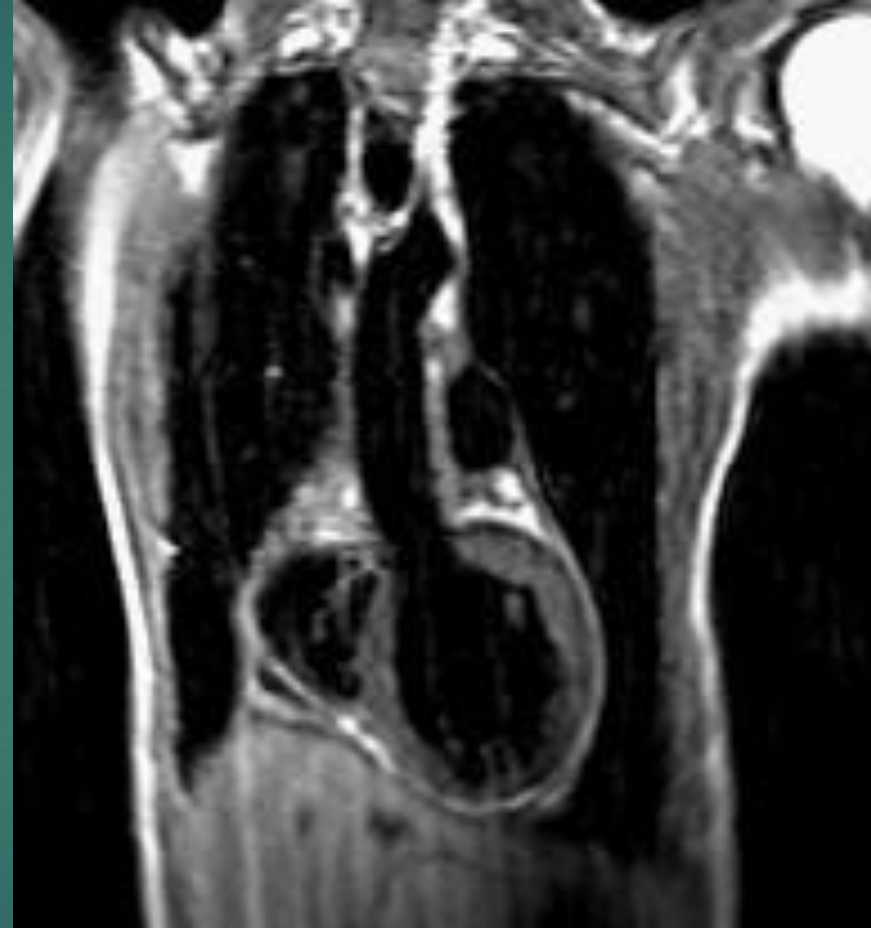
Loeys-Dietz syndrome

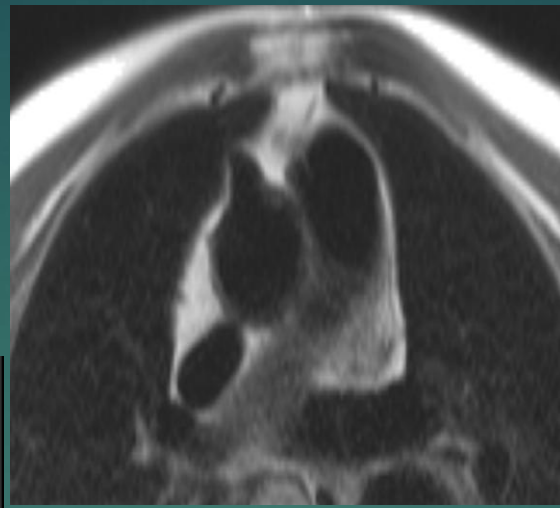
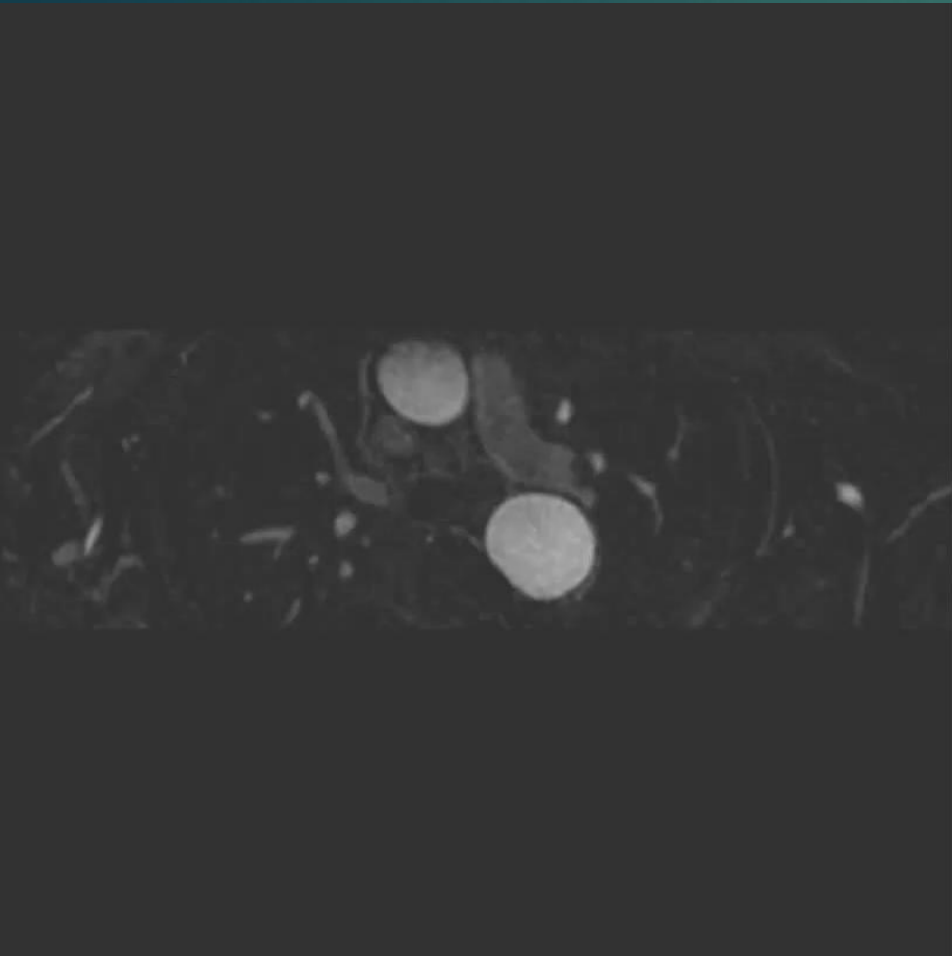


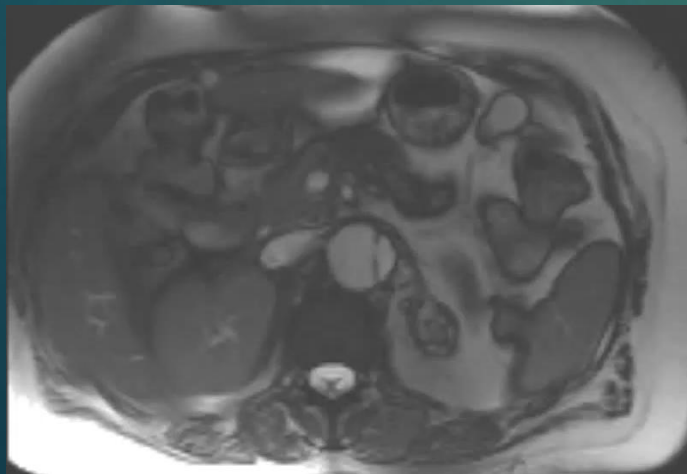
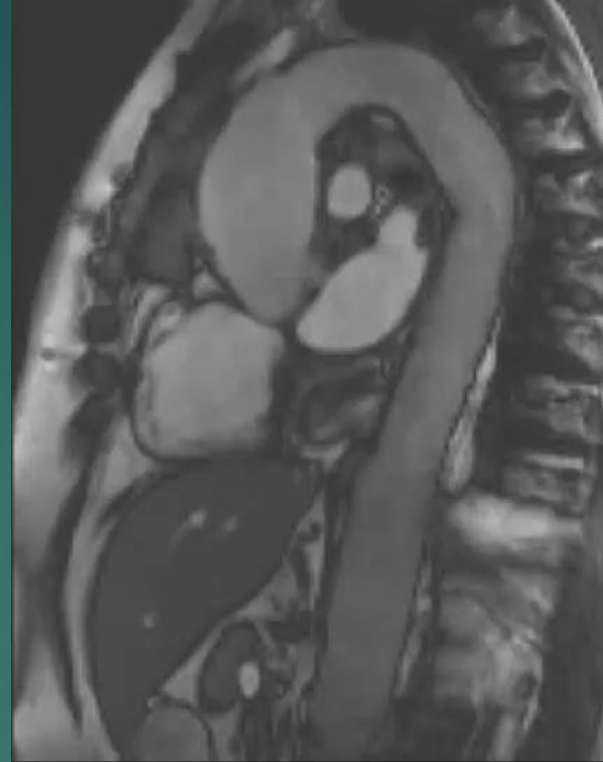
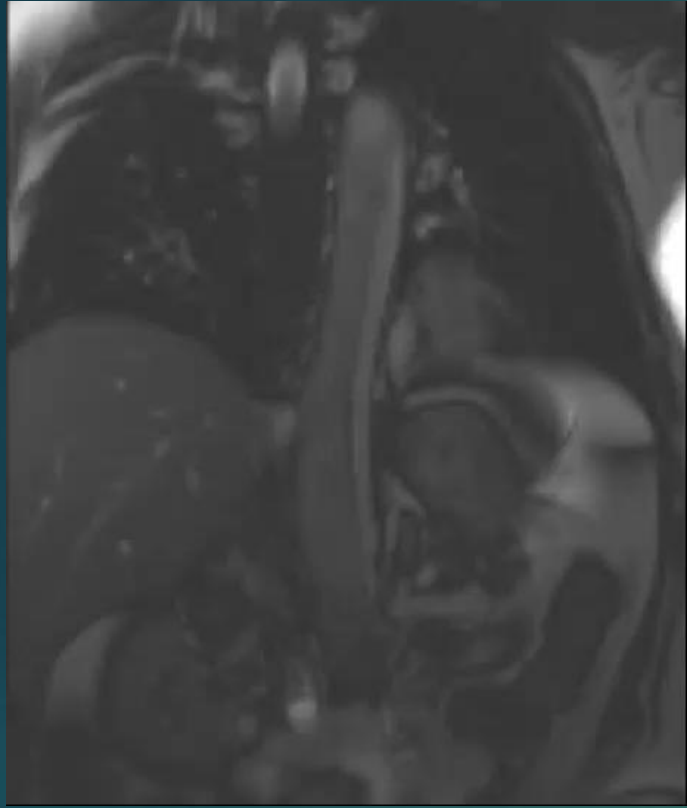
Aorta After Surgical or Endovascular Repair



Bentall Composite valve graft repair

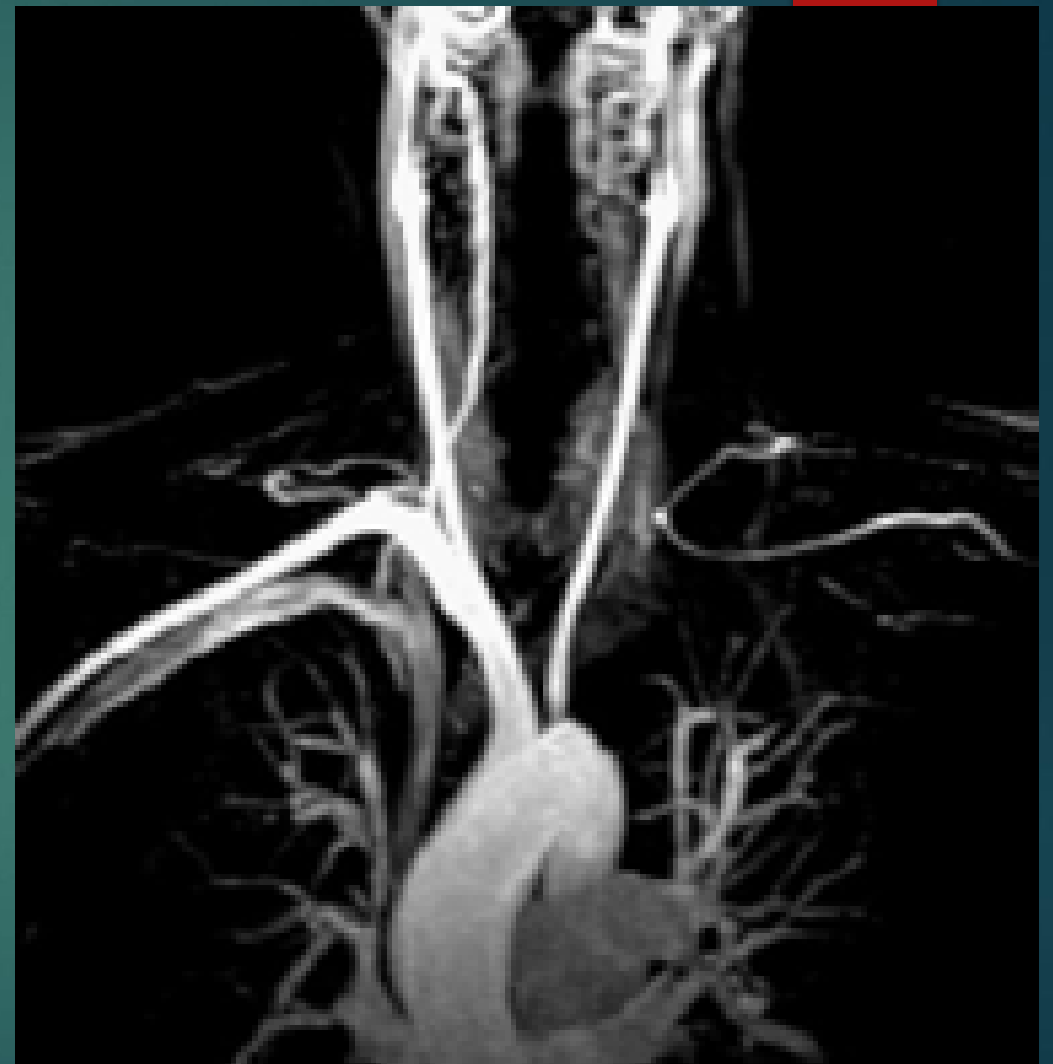
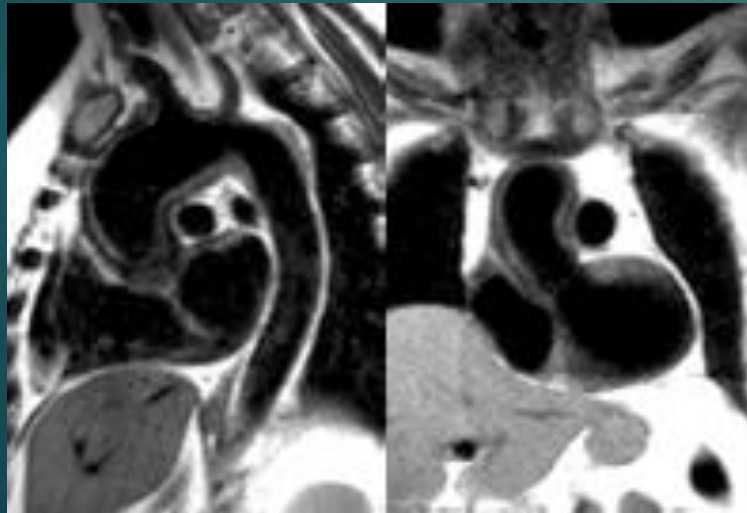
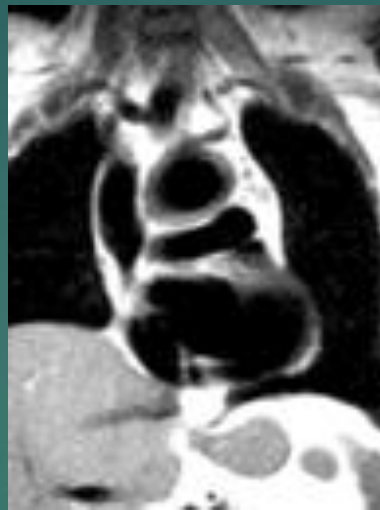






Infectious and Inflammatory Disease of the Aorta

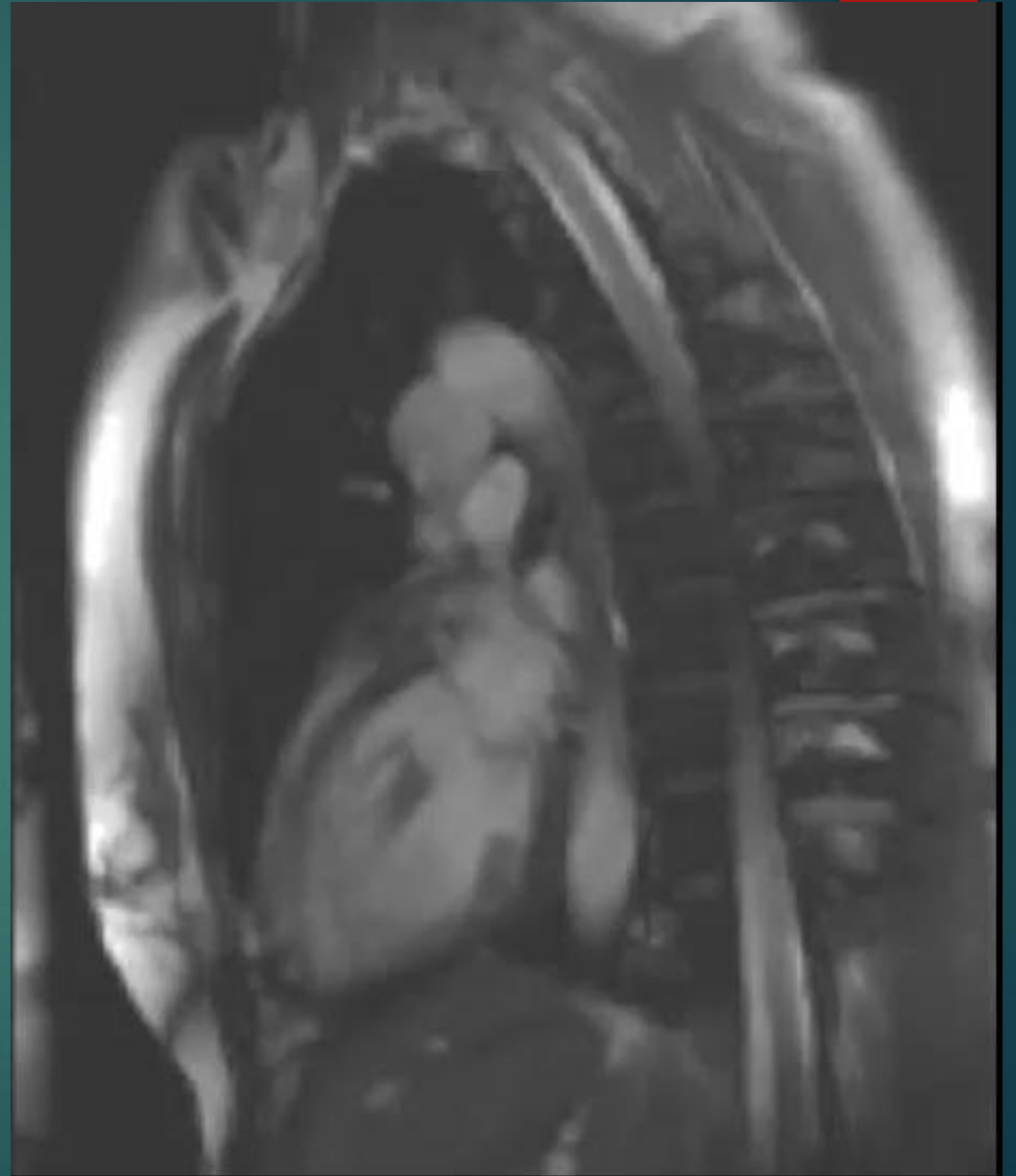
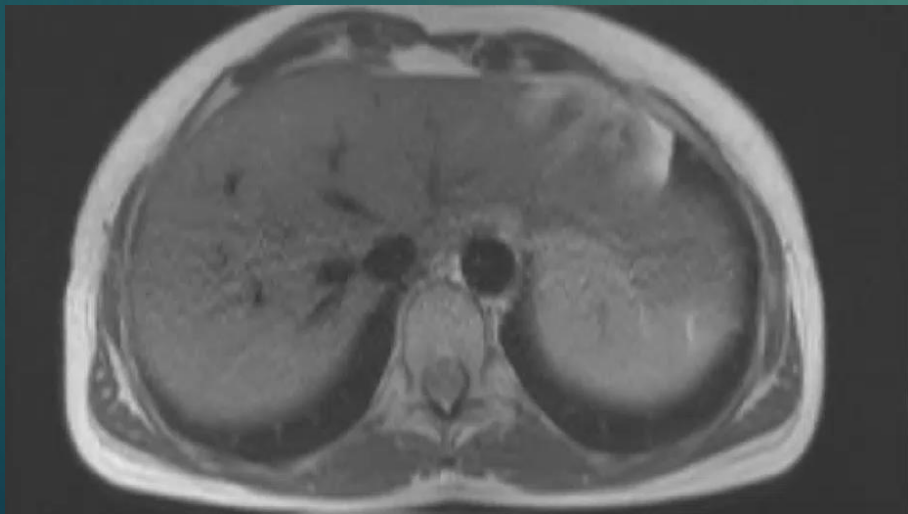
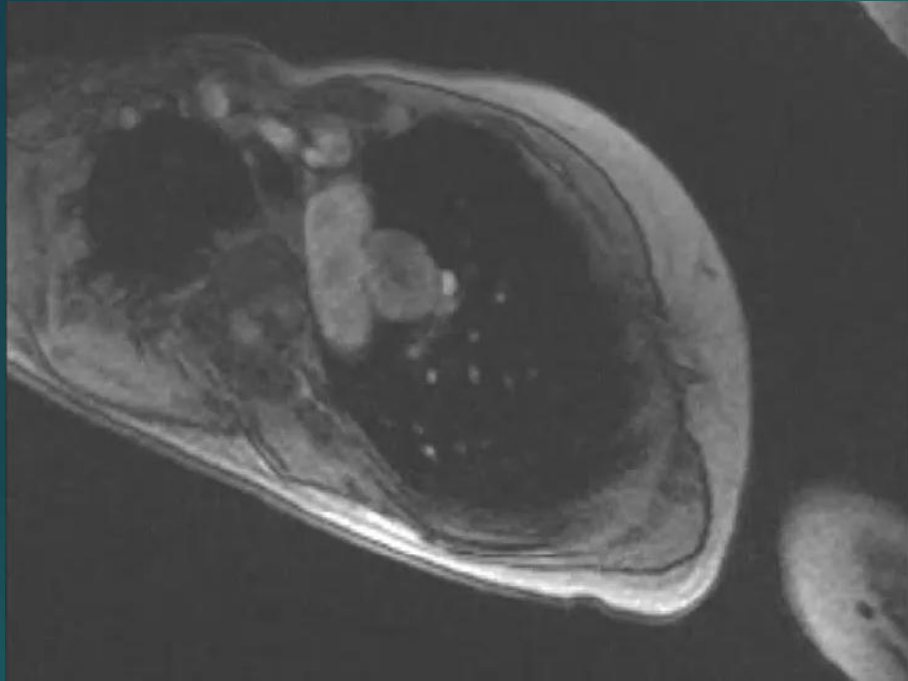
Takayasu's Arteritis/ Giant cell arteritis



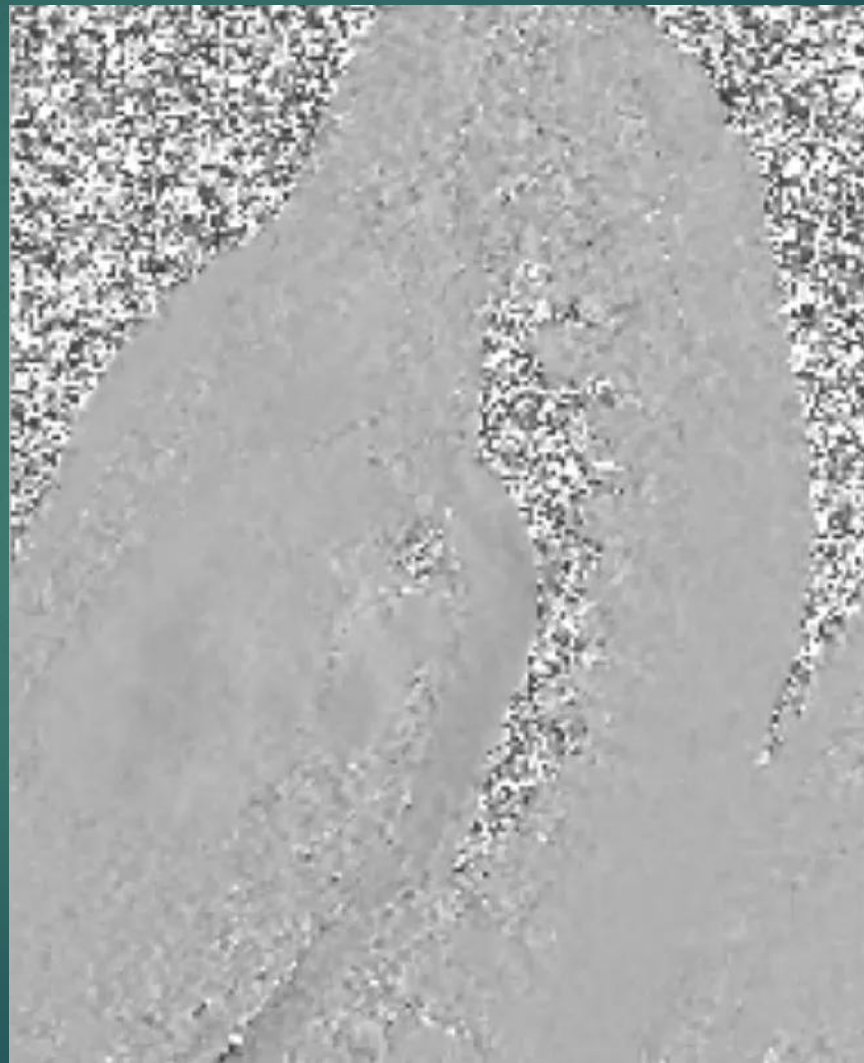
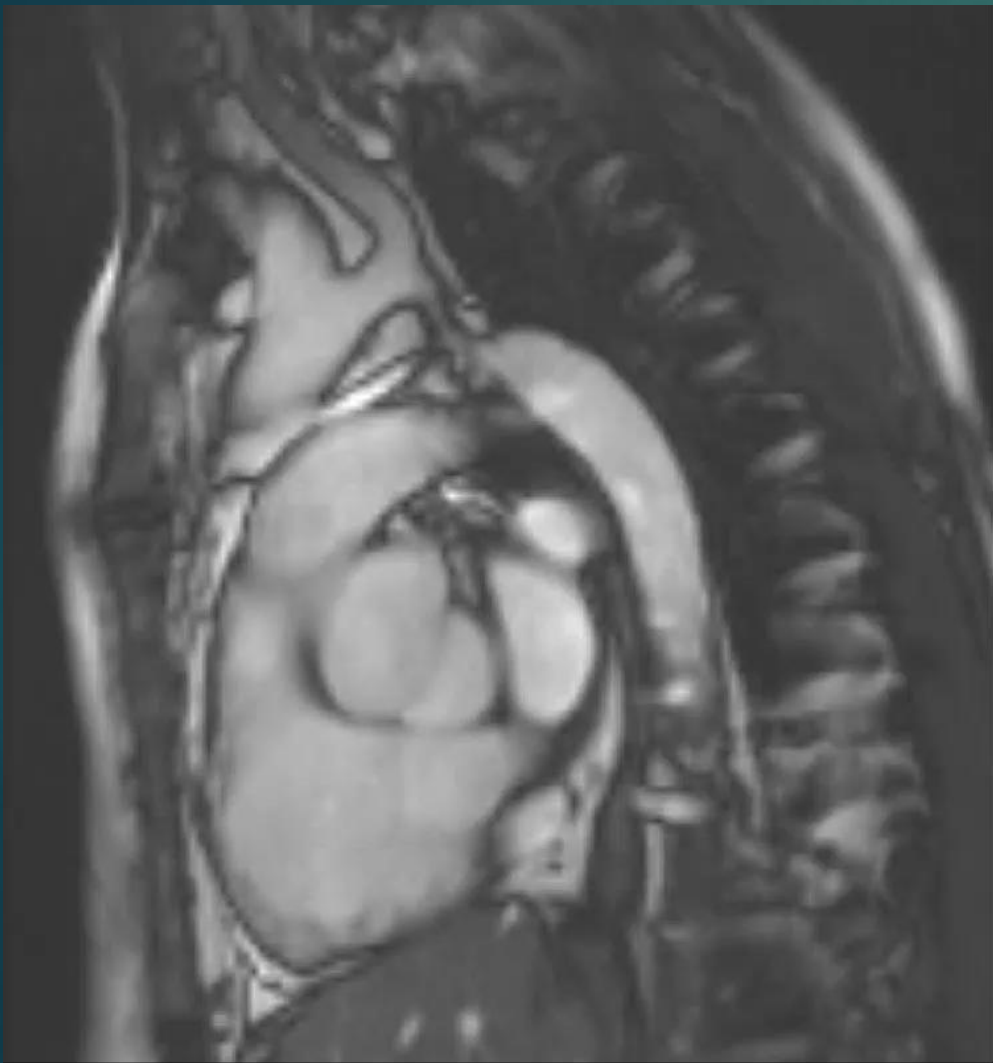
Acute phase

Late phase

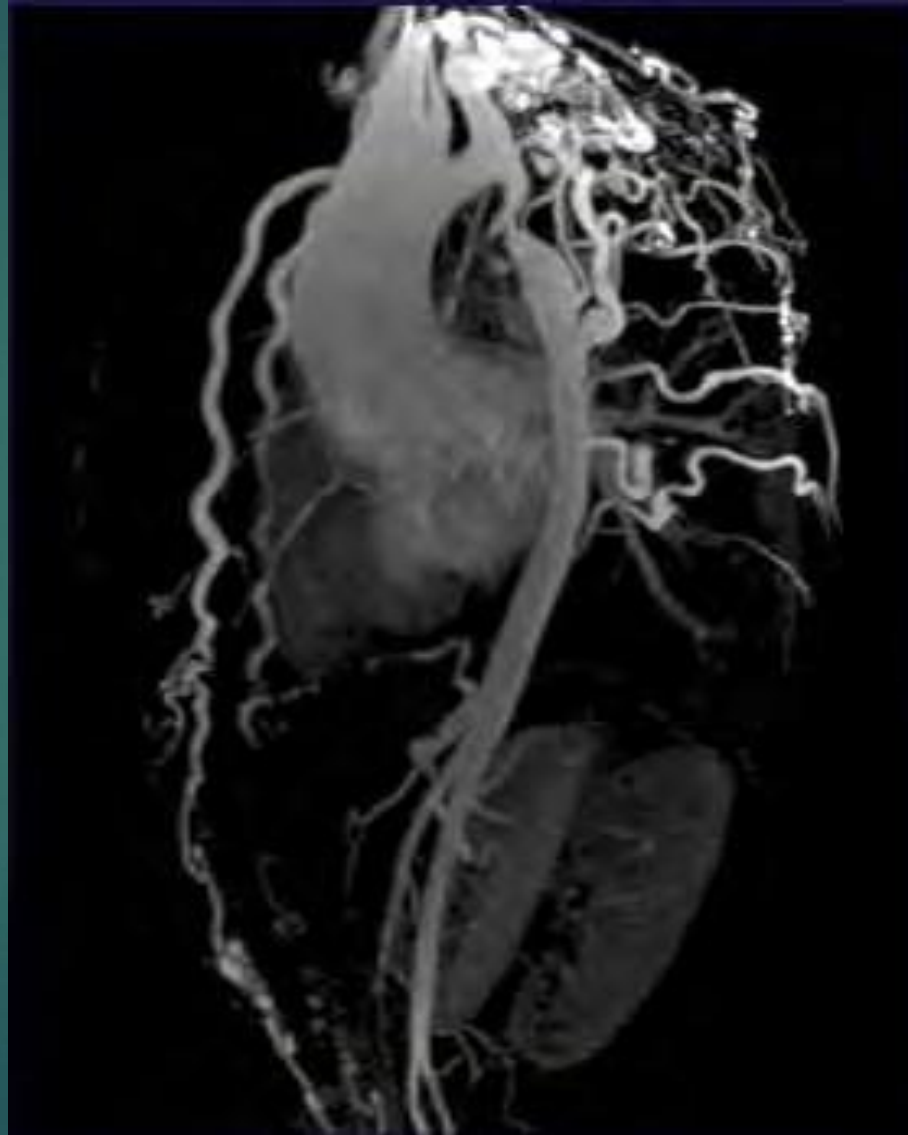
Post-traumatic Aneurysm



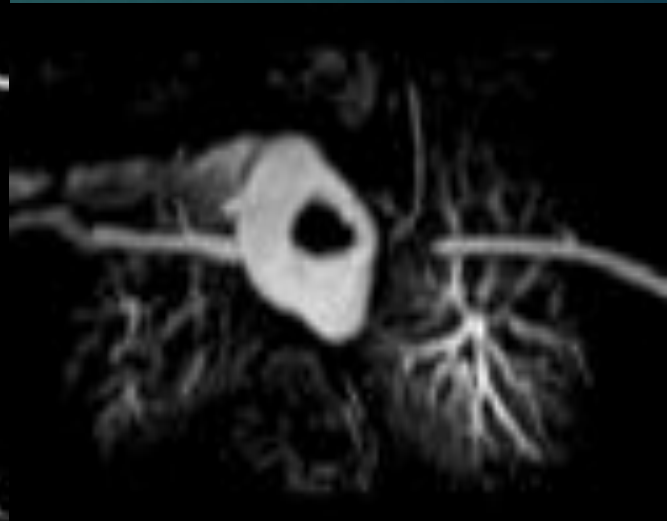
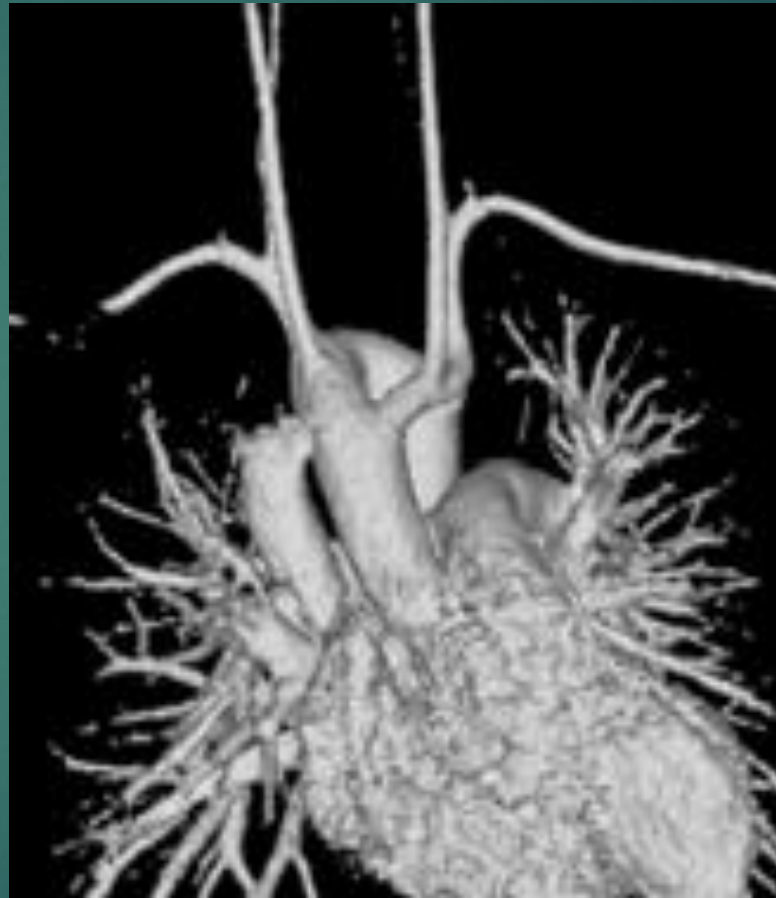
Aortic Coarctation



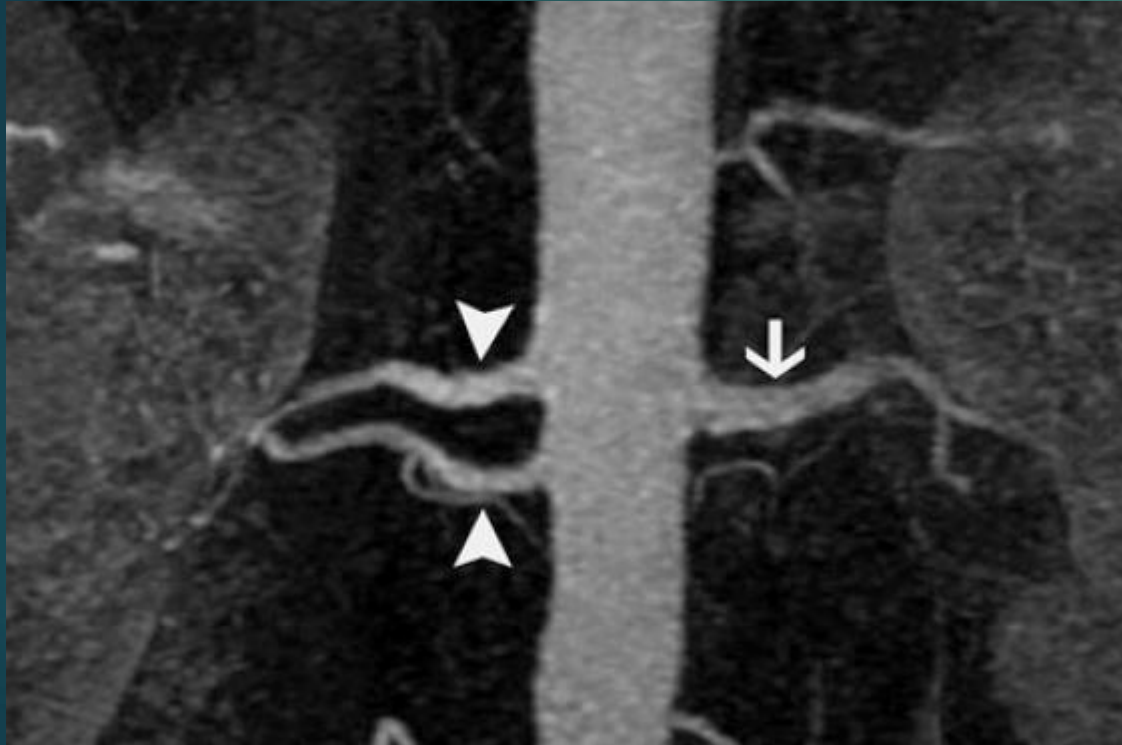
Severe Aortic Coarctation: 3D CE-MRA



Double aortic arch



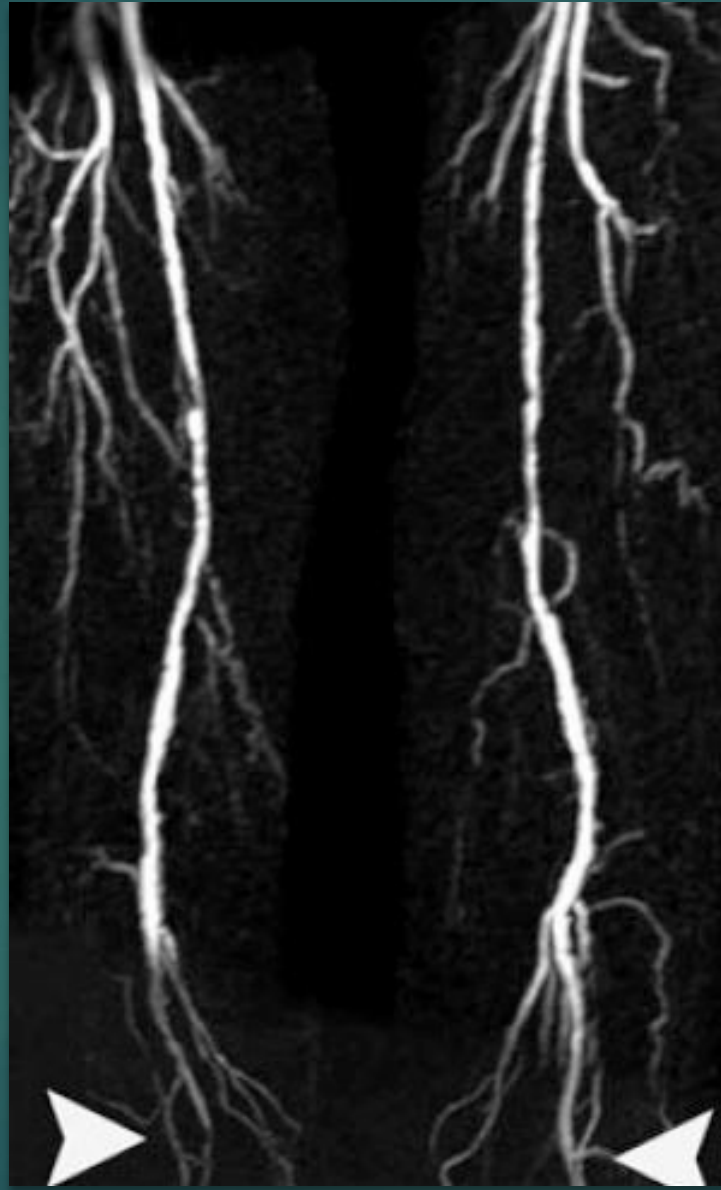
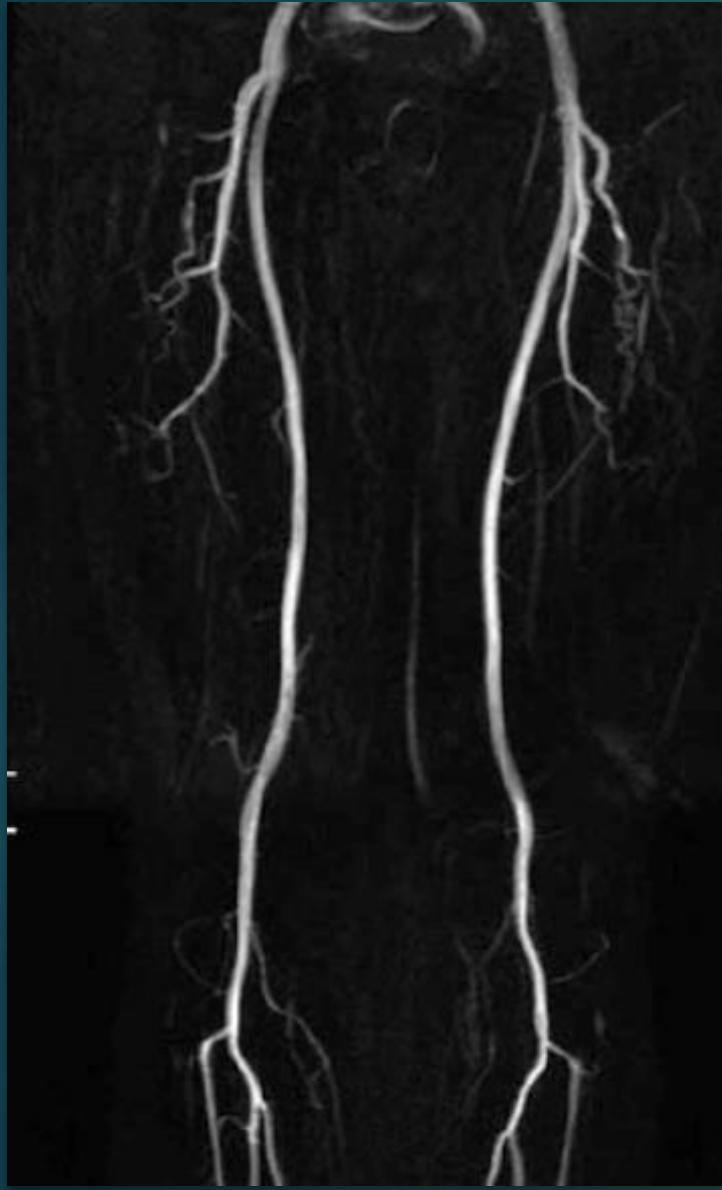
RENAL ARTERIES



MESENTERIC ARTERIES



Arteries of the Lower Extremity



Conclusions

- ✓ **Radiation-Free Imaging**
- ✓ **Highly Reproducible Measurements**
- ✓ **Superior Flow Assessment (Accurate quantification of regurgitant flow, 4D flow MRI for complex hemodynamics and wall shear stress)**
- ✓ **Unique Tissue Characterization (Detects inflammation, fibrosis, edema, intramural hematoma)**
- ✓ **Excellent for Long-Term Monitoring**

