What are the Best Techniques to evaluate the Aorta: CT vs. Dynamic MRI

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2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease

Developed in Collaboration with and endorsed by the American Association for Thoracic Surgery, American College of Radiology, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Thoracic Surgeons, and Society for Vascular Surgery.

Endorsed by Society for Interventional Radiology and Society for Vascular Medicine

Isselbacher, E. M., et al. Am Coll Cardiol. 2022 Dec, 80 (24) e223–e393

Advanced Cardiac Imagin
CTA / MRA

- **Wide coverage**
  - Evaluate the entire aorta, including its smaller branches
- **Superior image quality**
  - Isotropic voxels (CT > CMR)
  - 2D & 3D reconstructions in any orientation

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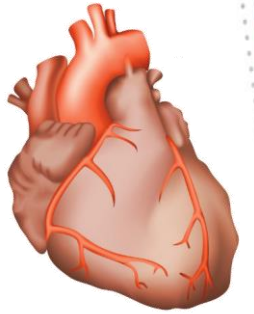
Diagnostic Performance of Aortic Imaging Modalities



	CT	MRI	TTE	TEE	US
Availability	+++	++	+++	++	+++
Portability	-	-	+++	+++	+++
Speed of acquisition	+++	+	++	++	++
Spatial resolution	+++	++	++	+++	++
Temporal resolution	+	++	+++	+++	+++
Three-dimensional data set	+++	++	+	+	+
Arch branch vessel evaluation	+++	+++	++	+	N/A
Evaluation of valve and ventricular function	+	++	+++	+++	N/A

Legend
+++ = excellent results
++ = good results
+ = fair results
- = not available
n/a = not applicable

Abbreviations: CT indicates computed tomography; MRI, magnetic resonance imaging; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography; and US, abdominal aortic ultrasound.

American Heart Association.

Choice of Imaging Modalities

Advantages of CT

- Universal availability but need for EKG-gating
- Short scan times
- Higher spatial resolution
- *Compatibility with ferromagnetic metals*
- *Coronary evaluation*
- 2D/3D reconstructions
- *Better for calcification*

Advantages of CMR

- *Tissue characterization, aortic wall imaging*
- *Dynamic imaging (dissection), 4D flow*
- *Venous imaging*
- *AV pathology*
- Pts with iodine allergy
- Radiation free/young/pregnant/ACHD serial imaging

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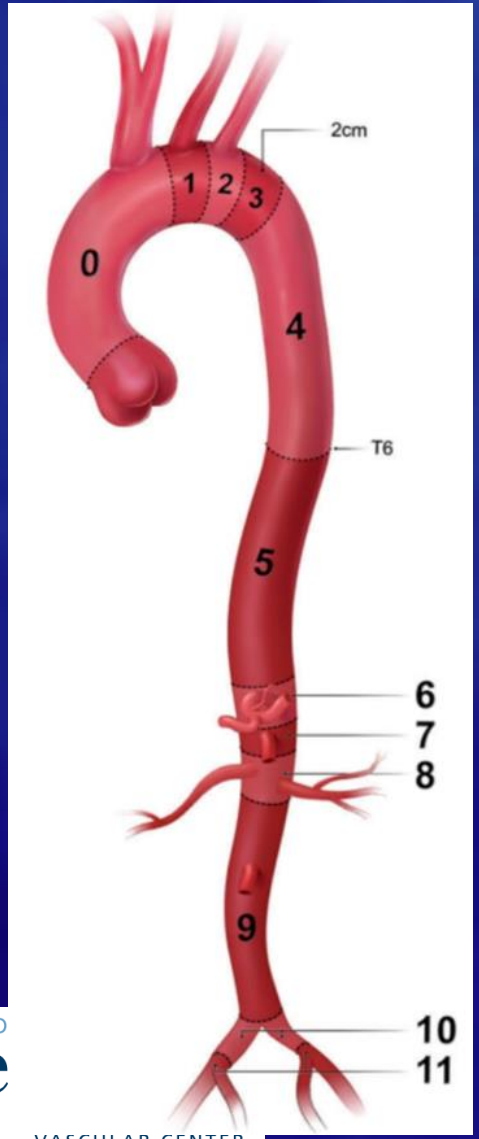
3D-Time resolved MRA



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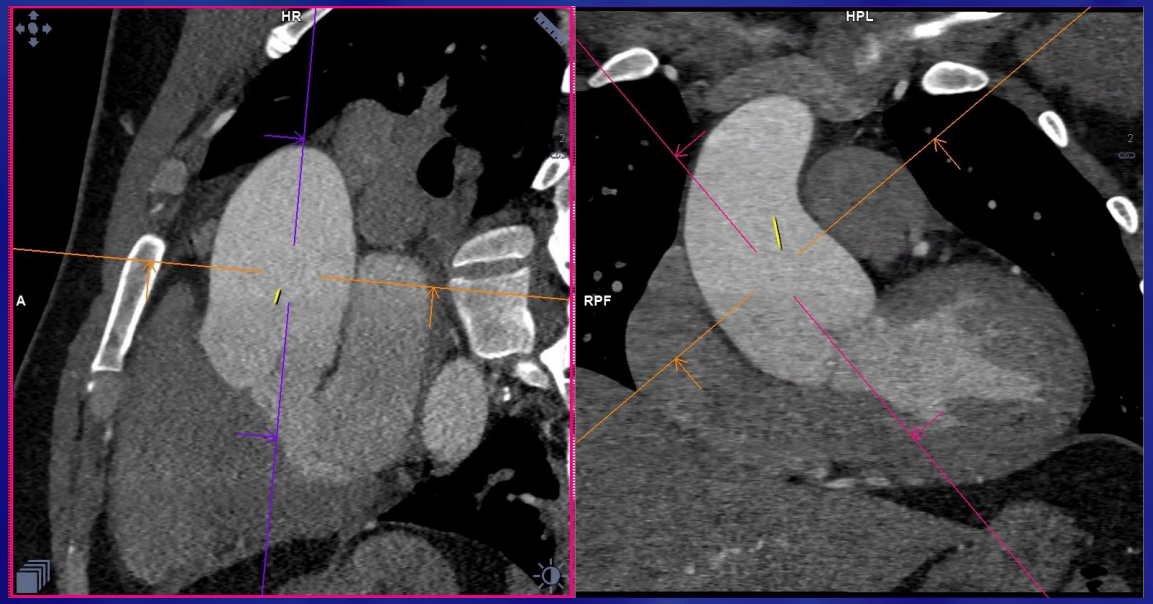
Diameter Is Measured Perpendicular to Axis of Blood Flow



Double Oblique Method

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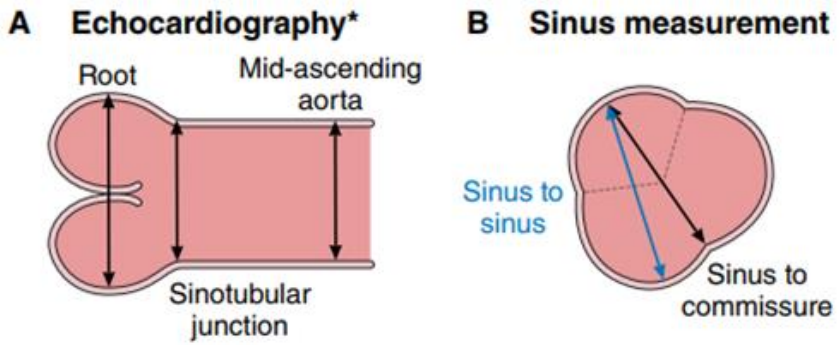
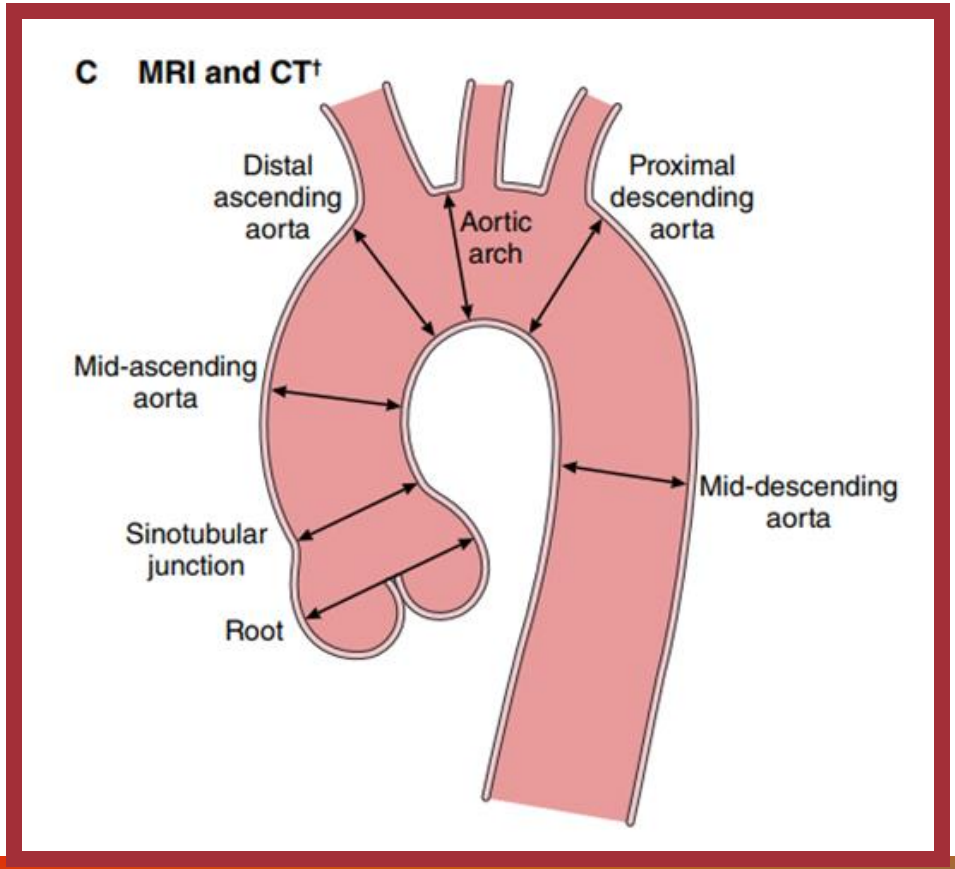


Figure 12. Aortic Imaging Techniques to Determine the Presence and Progression of Aortic Disease.



*Leading-edge to leading-edge.

†Inner-wall to inner-wall.

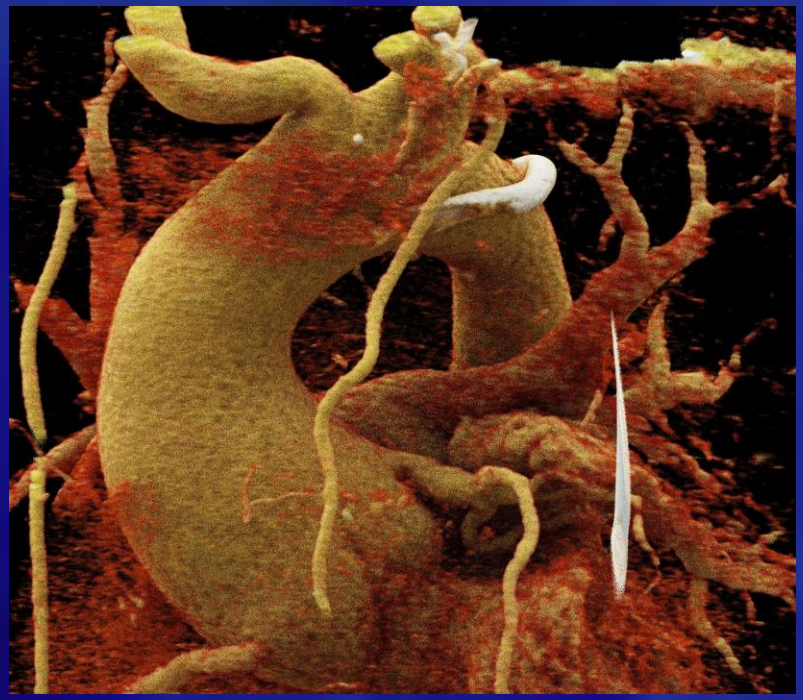
Essential Elements of CT and MRI Aortic Imaging Reports

Essential Elements of CT and MRI Aortic Imaging Reports
Maximum aortic diameter at each level
Abnormalities of aortic wall (e.g. atherosclerosis, diffuse thickening or mural thrombus)
Describe areas of luminal stenosis/occlusion
If acute aortic syndrome → proximal/distal extension, entry tear site, and complications
Branch vessel involvement, evidence of malperfusion or end-organ injury
Disease classification (e.g., acute aortic syndrome, aneurysm/pseudoaneurysm, atherosclerotic disease)
Relevant details regarding method of image acquisition (e.g. ECG-gating, phase of acquisition)

Abbreviations: ECG indicates electrocardiogram.

American Heart Association.

Thoracic Aneurysms



- Localized dilation, reaching 150% expected diameter
- The standard definition is not applicable to the root and ascending aorta, use > 4.5 cm for these segments
- Aortic disease is increasing in incidence
  - Aging population
  - Greater detection with imaging studies)

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Using indexed Values

- **For patients with height or BSA outside of 1-2 SD of the mean, use:**
  - **Aortic size index [aortic diameter (cm) / BSA (m2)]**
  - **Aortic height index [aortic diameter (cm)/ patient height (m)]**
  - **Cross-sectional area to height**
    - Ascending Aorta Cross-sectional area / Height > 10 sq. cm / M predictor for worse outcomes

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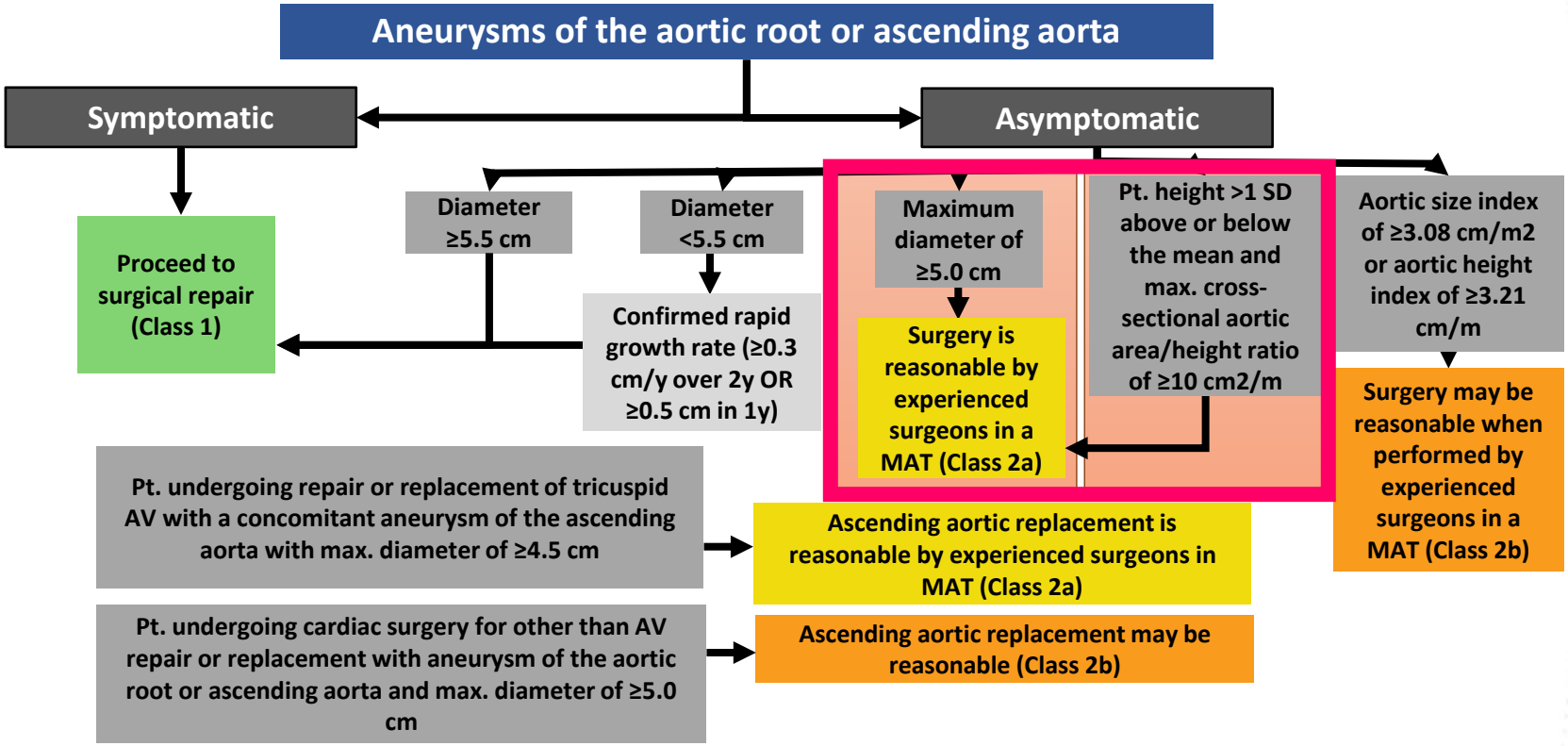
Recommendations for Surgery for Sporadic Aneurysms of the Aortic Root and Ascending Aorta



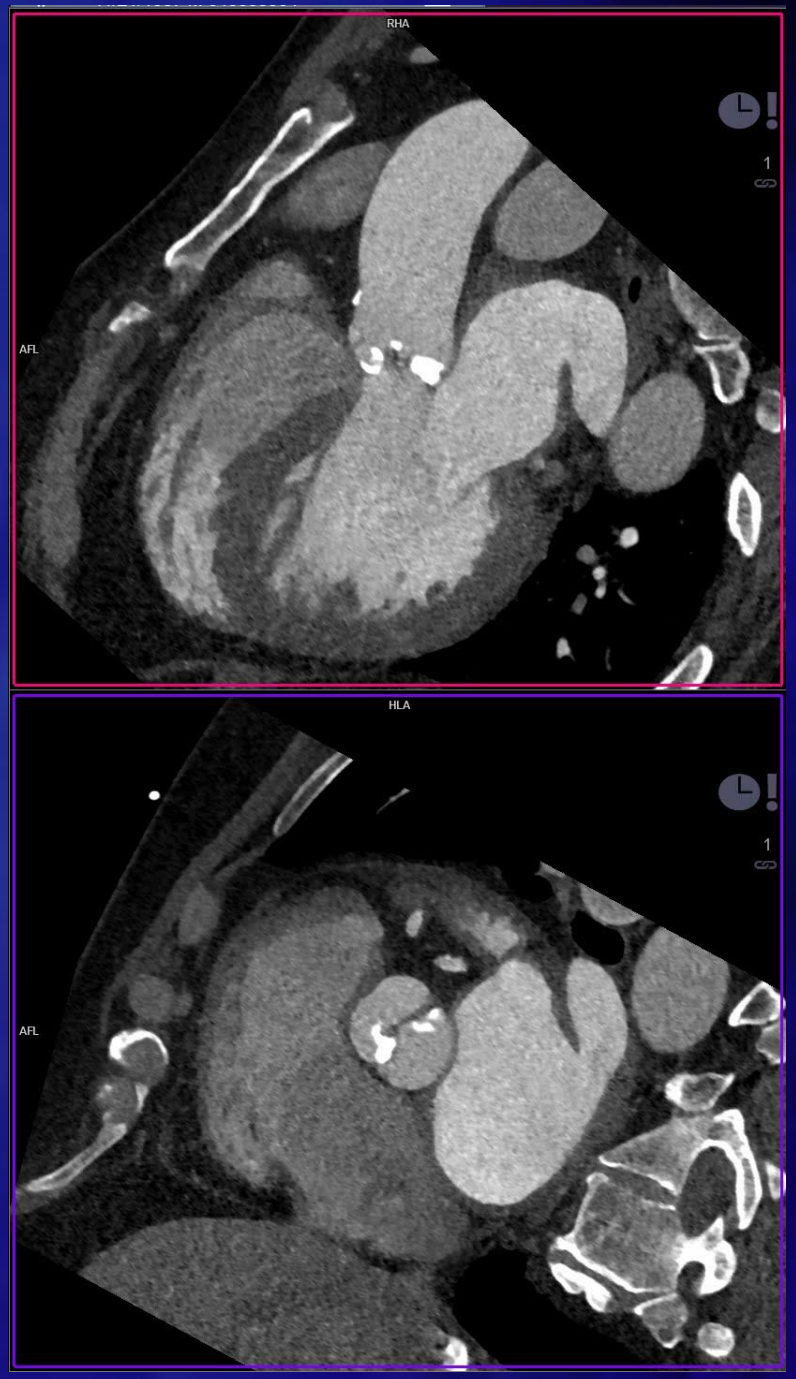
Abbreviations: AV indicates aortic valve; cm, centimeter; CT, computed tomography; y, year; MAT, multidisciplinary aortic team; max, maximal; pt, patient; SD, standard deviation; and y, year.

American Heart Association.

Isselbacher, E. M., et al. 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease. *Circulation.*

Bicuspid AV Associated Aortopathy

- 20% aneurysm required repair
- 15% of aortic dissection have BAV



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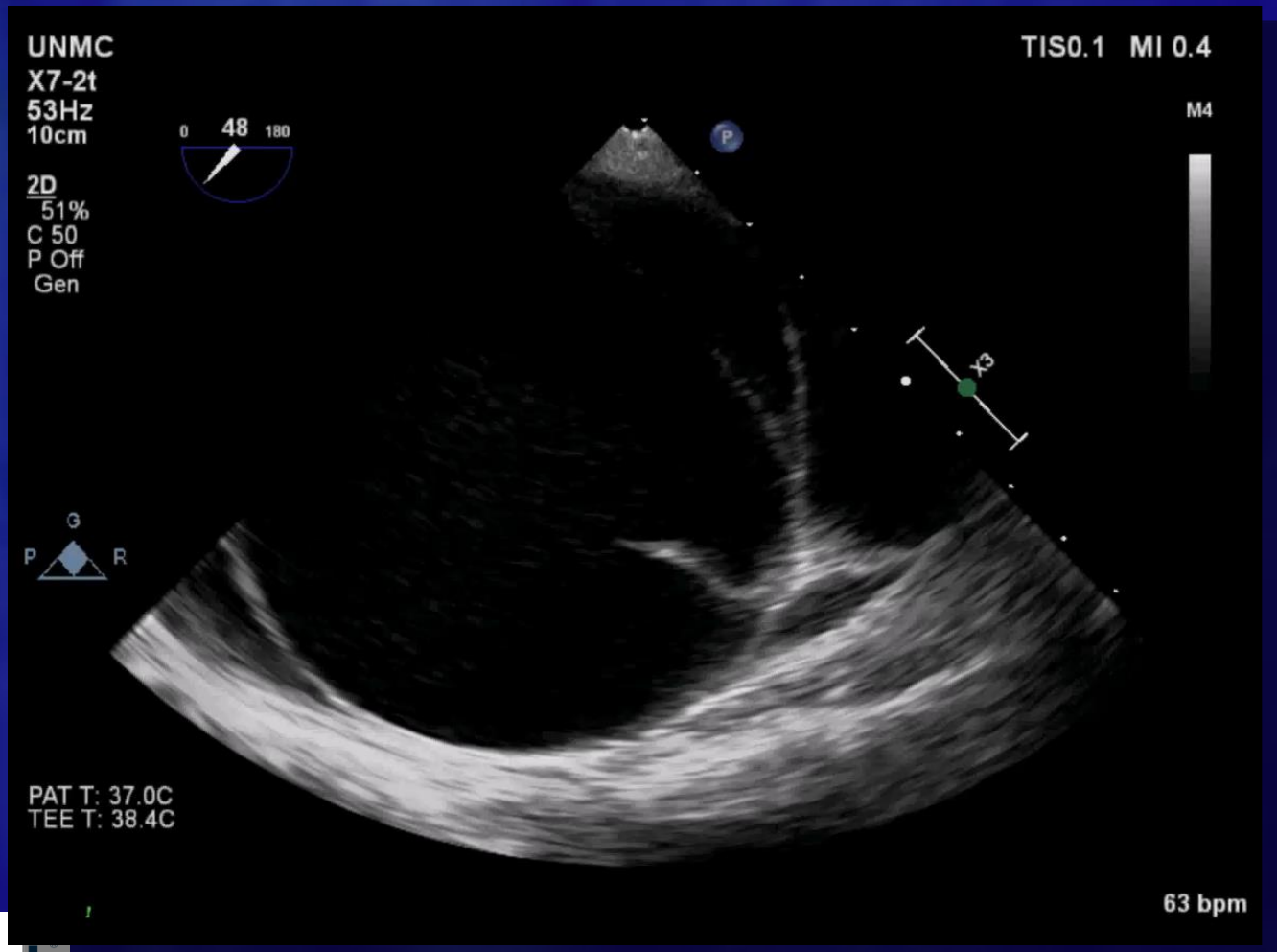
Hiratzka. J Am Coll Cardiol. 2010;55(14):1509-1544

TEE
Dissecting aneurysm



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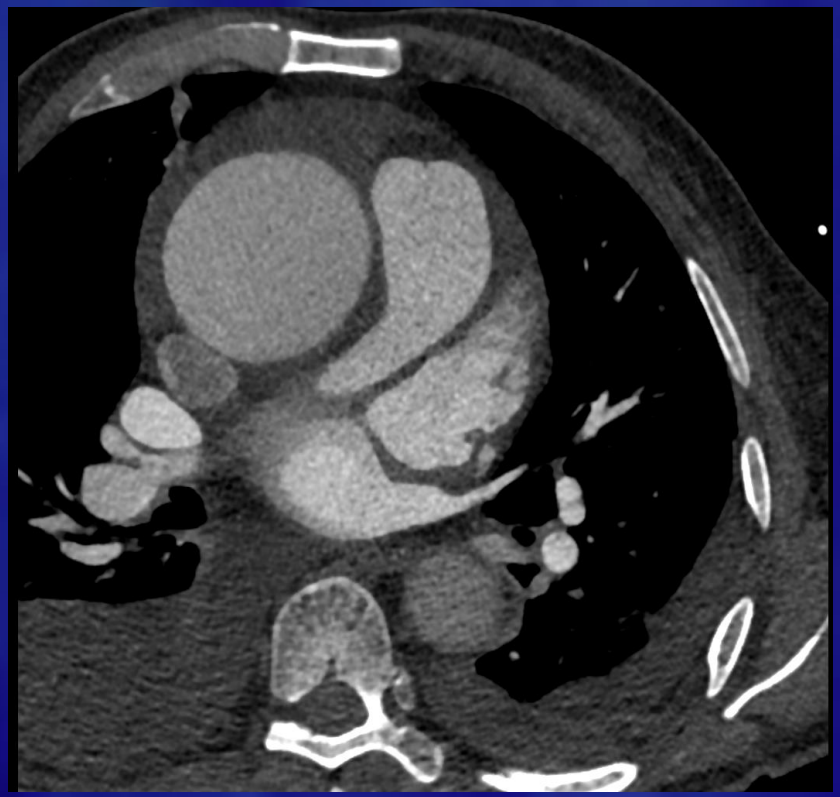
Cardiac CT



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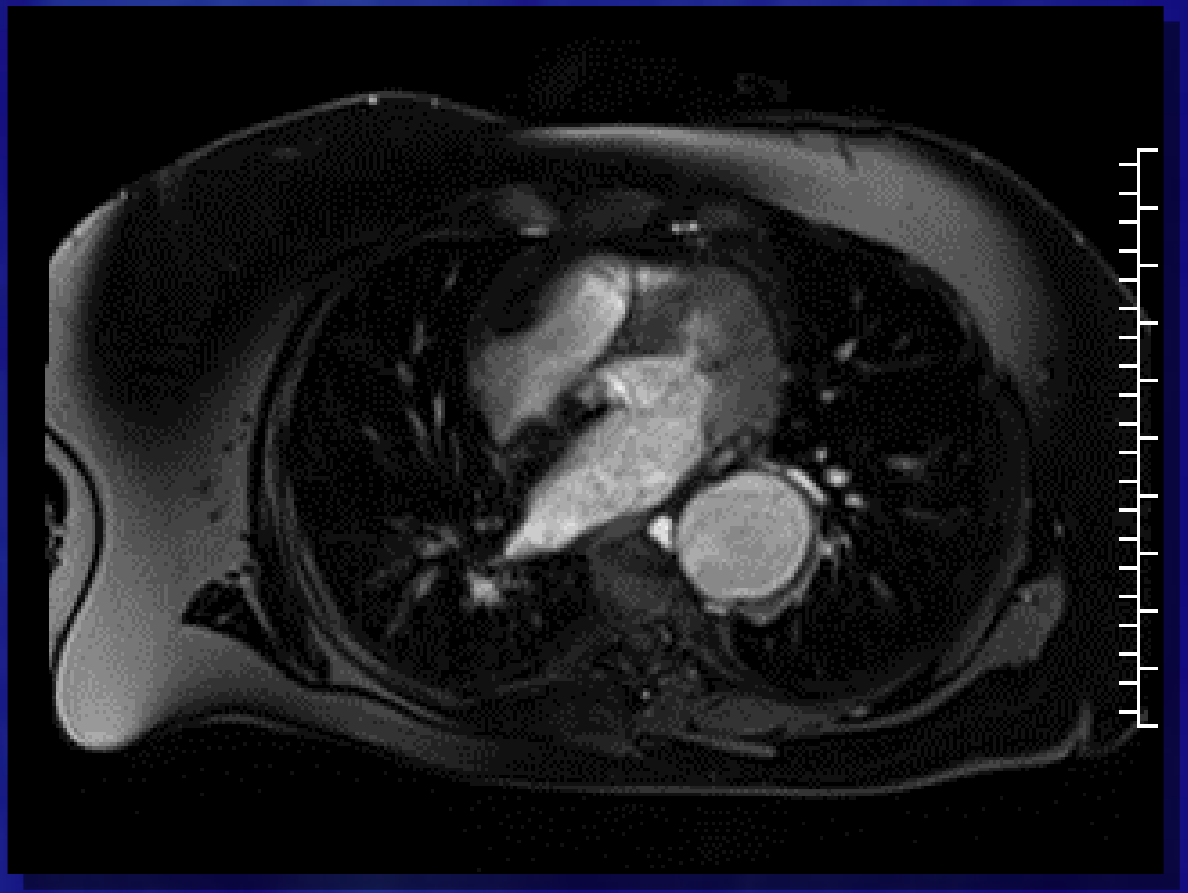
BAV Aortopathy Interventions: Replacement of the Aorta in Patients With BAV

Recommendations for BAV Aortopathy Interventions: Replacement of the Aorta in Patients With BAV Referenced studies that support the recommendations are summarized in the Online Data Supplement.		
COR	**LOE**	**Recommendations**
1	**B-NR**	**1. In patients with a BAV and a diameter of *the aortic root, ascending aorta*, or *both of ≥5.5 cm*, surgery to replace the aortic root, ascending aorta, or both is recommended.**
2a	**B-NR**	**2. In patients with a BAV and *a cross-sectional aortic root or ascending aortic area (cm^2) to height (m) ratio of ≥10 cm^2/m*, surgery to replace the aortic root, ascending aorta, or both is reasonable, when performed by experienced surgeons in a Multidisciplinary Aortic Team.**

MRA Descending aortic aneurysm
Severe atherothrombosis



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CARDIOVASCULAR FLASHLIGHT

doi:10.1093/eurheartj/ehx452
Online publish-ahead-of-print 31 July 2017

Aneurysmal left sinus of Valsalva in Marfan's syndrome

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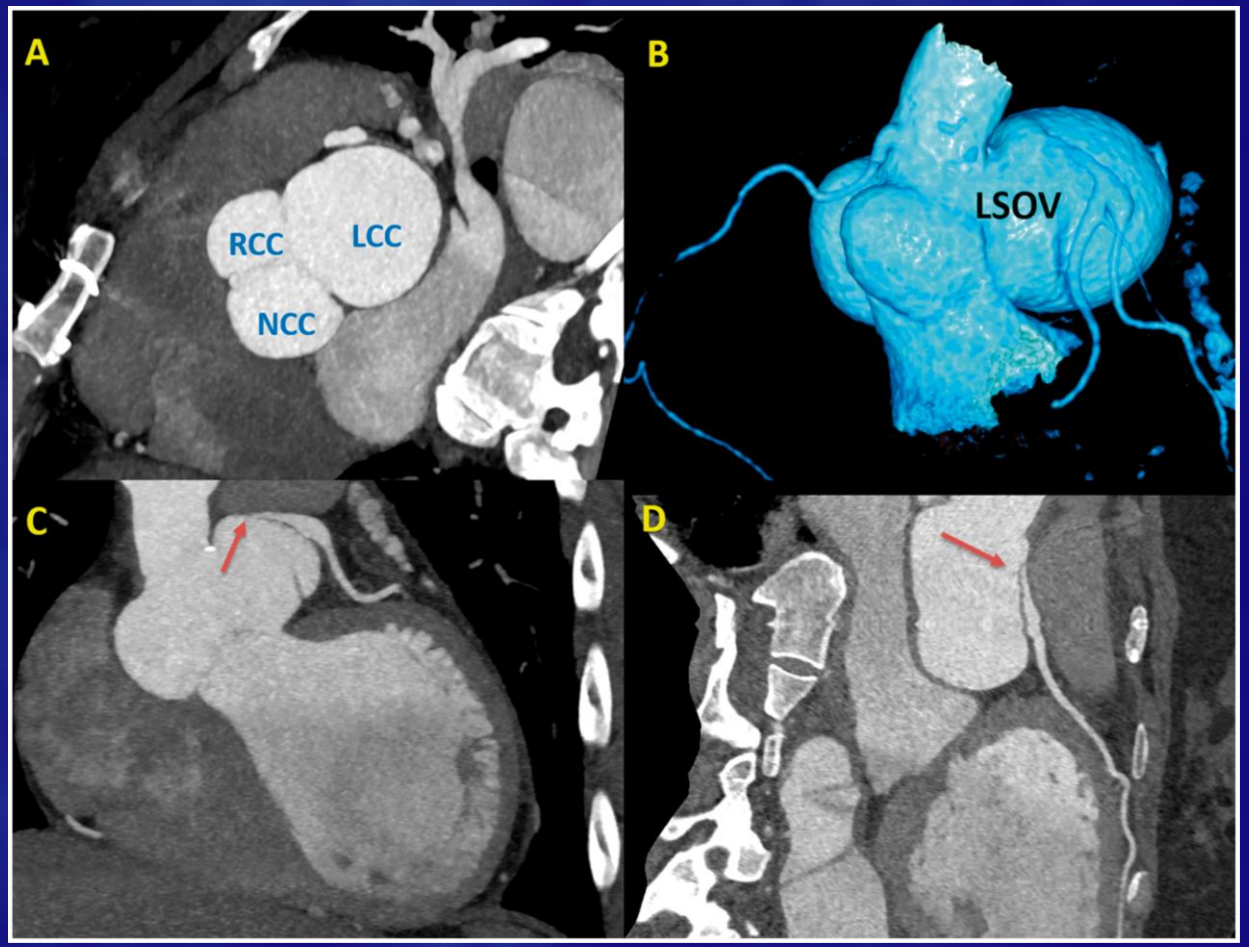
* Corresponding author. Tel: +713–441–2690, Email: drpasha.moh@gmail.com



European Heart Journal, Volume 39, Issue 4, 31 July 2017, 285, https://doi.org/10.1093/eurheartj/ehx452

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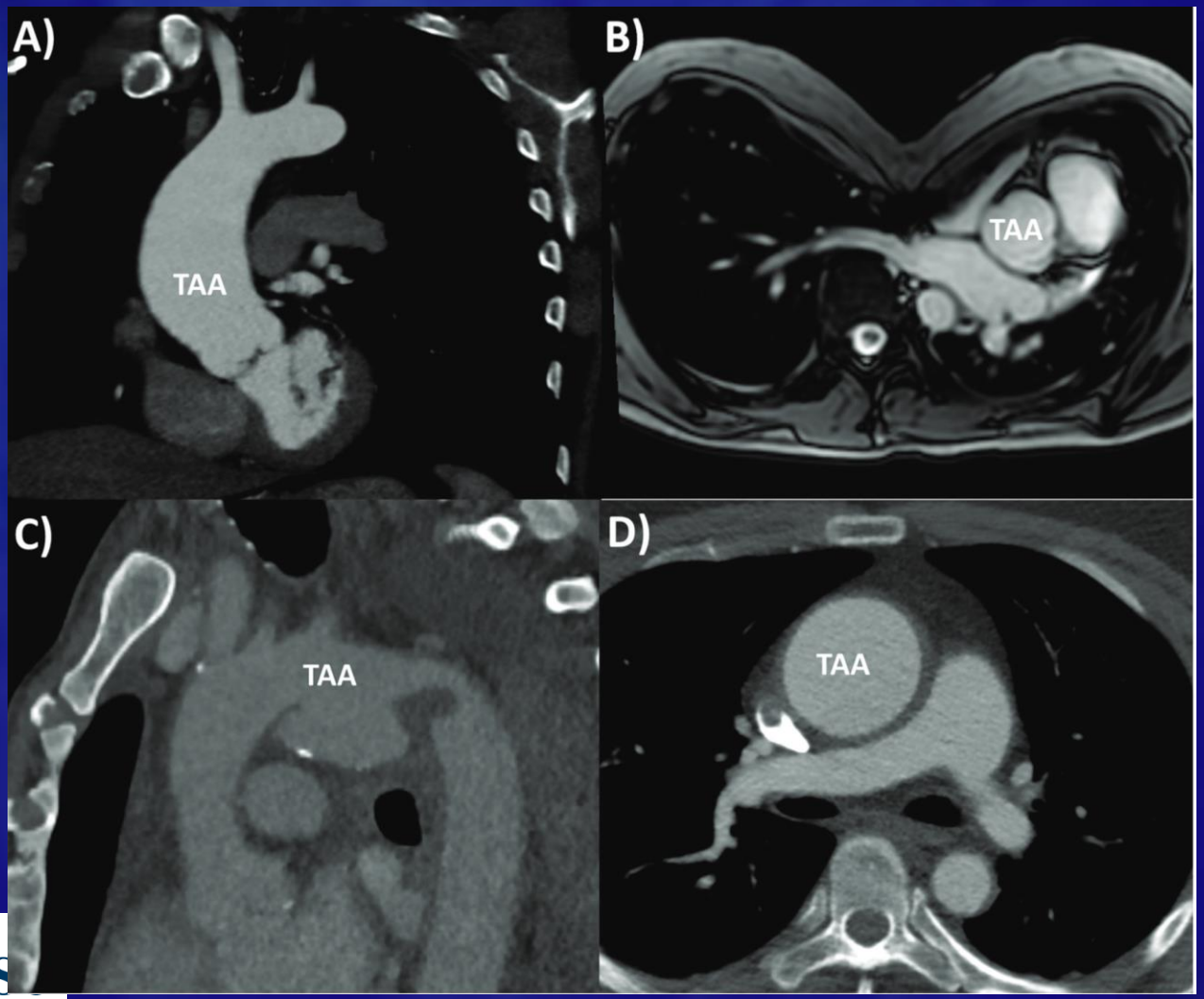
Different spectrum of thoracic aneurysms



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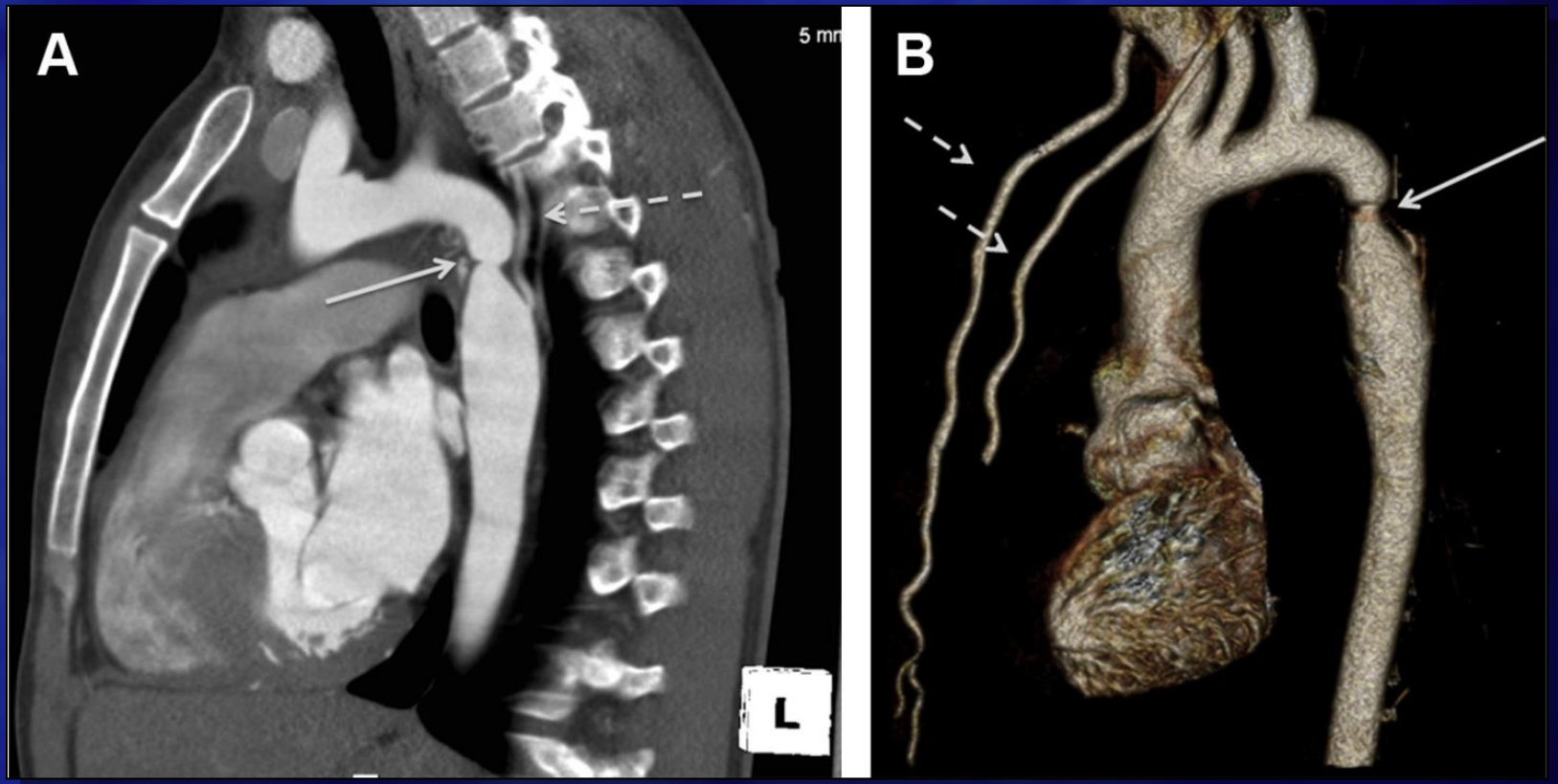
CCJM 2020

Aortic Coarctation



- Focal narrowing of the thoracic aorta, most common at the isthmus
- Caused by a fibrous ridge; abnormal hyperplasia of tunica media
- Left subclavian artery landmark for distinguishing between the more common distal (juxtaductal) and less common proximal subtypes

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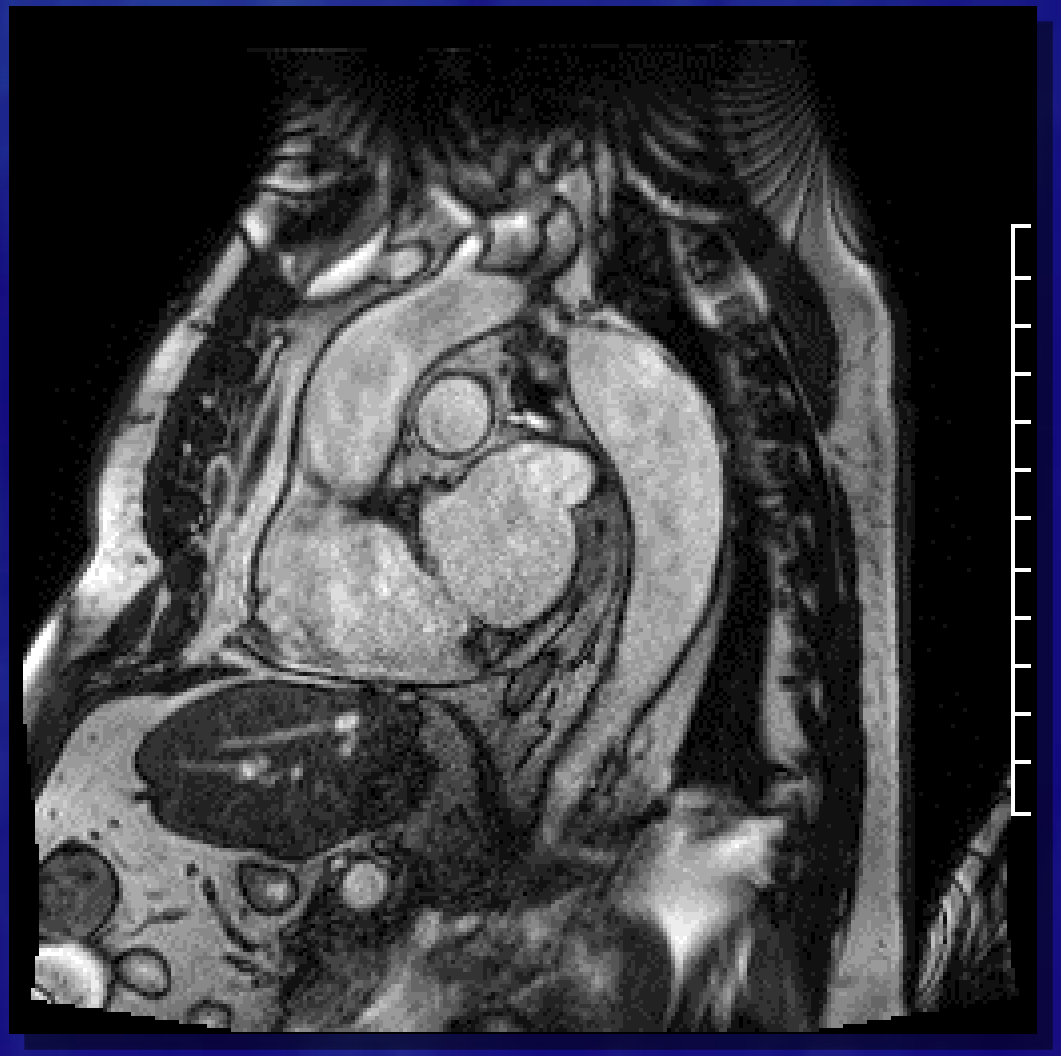
Scheske. Radiol Clin N Am 54 (2016) 13–33

Coarctation
Cine- CMR, non-contrast



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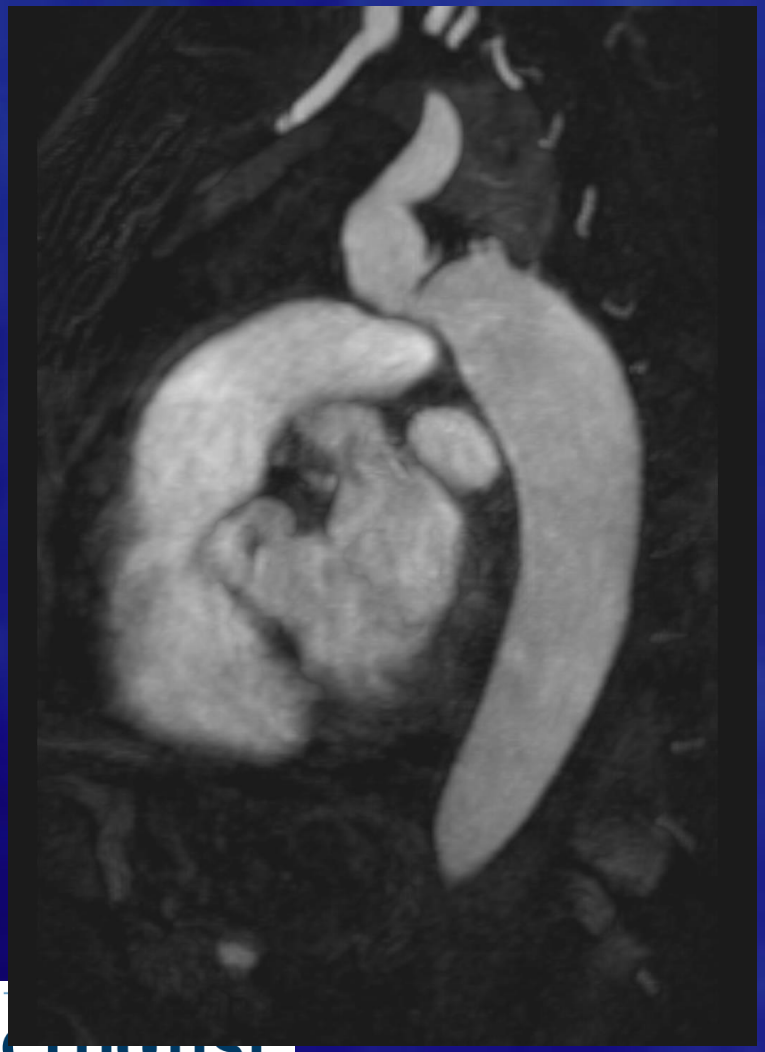
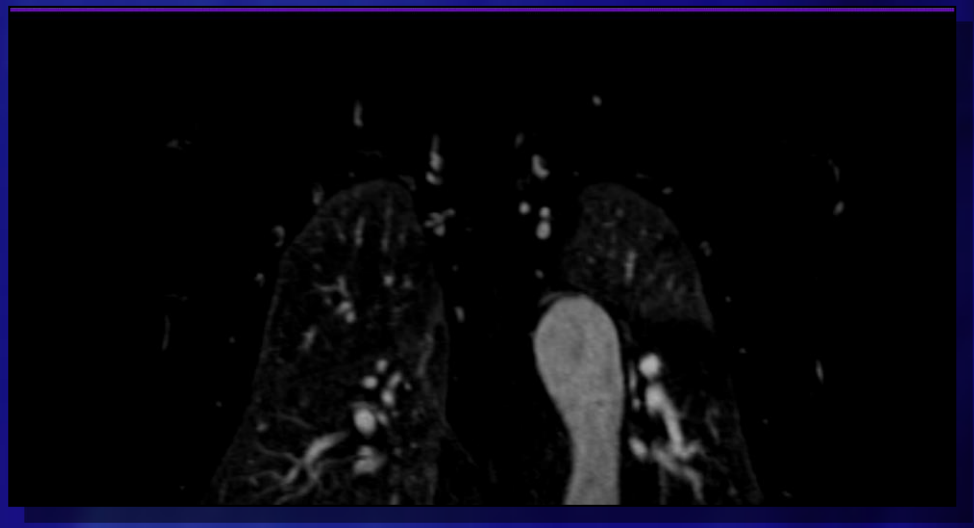
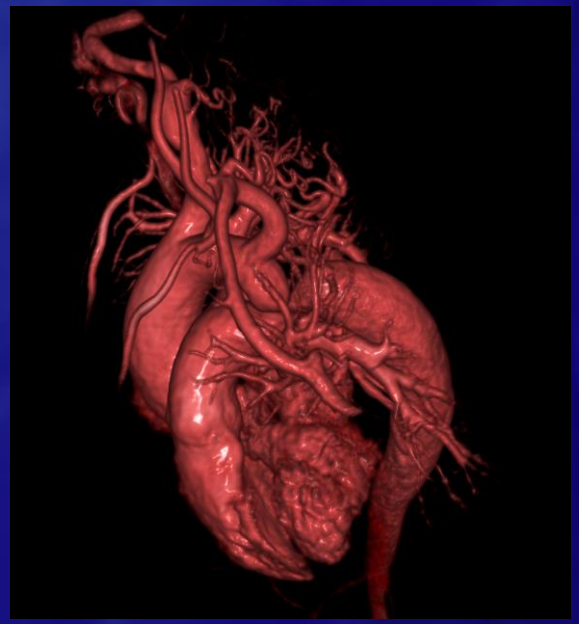
3D-MR angiography







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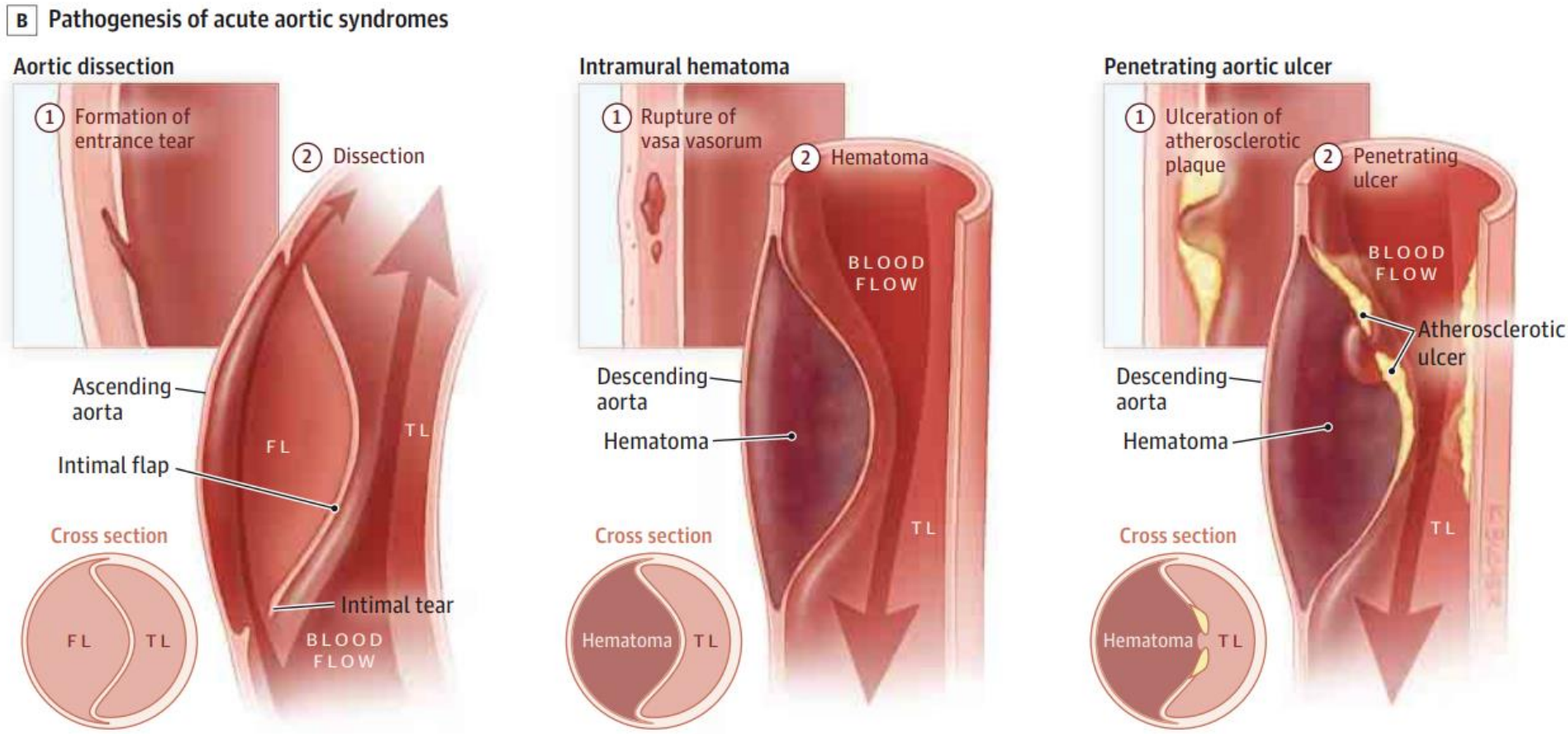
Acute aortic syndrome



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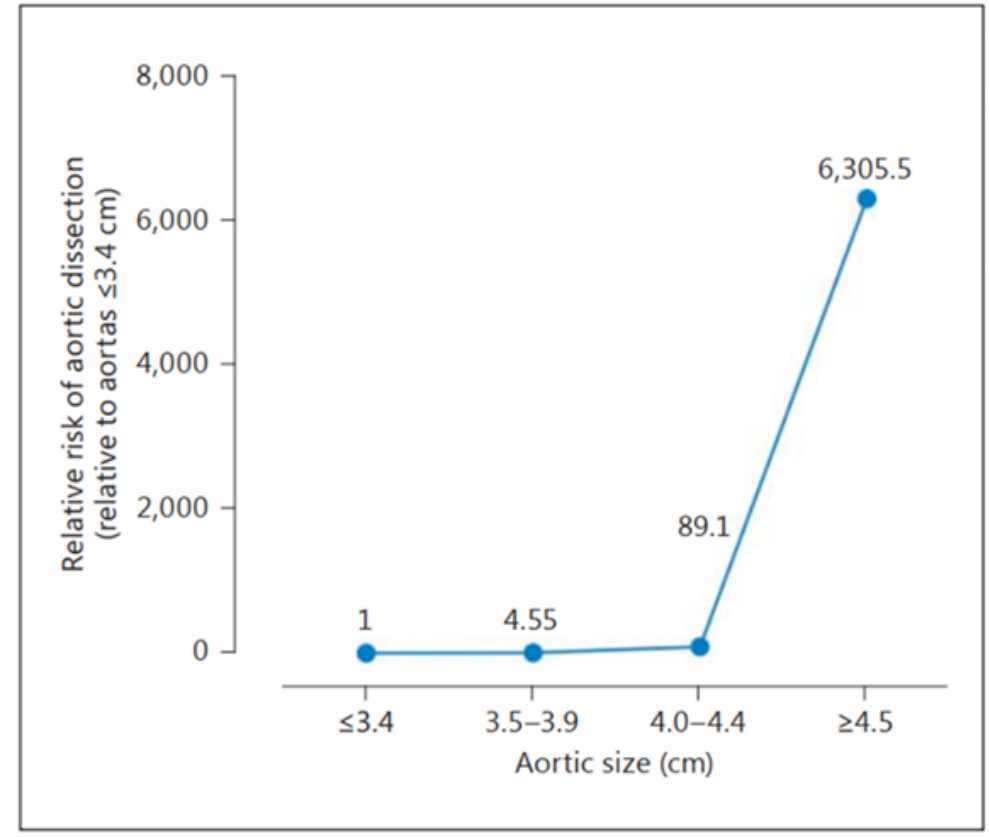
Mussa. JAMA. 2016;316(7):754-763

Type A Dissections Do Occur at Small Sizes



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HPR
RAF

Role of Imaging in Aortic Dissection

- Determine the extent of dissection (proximal and distal)
  - Entry/exit tear site
  - Dimensions of aorta
  - Branch vessels
    - Arising from true or false lumen
    - Dynamic imaging with CMR for compression
- Life-threatening complications of dissection:
  - Pericardial/mediastinal hemorrhage
  - Acute aortic valve insufficiency
  - Coronary artery & carotid artery dissection
  - End-organ malperfusion syndromes

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CT/CMR Gold Standard for Diagnosis

Table 2. Reported Sensitivity and Specificity of Diagnostic Tools for Acute Aortic Syndrome[a]

Diagnostic Tool[b]	Studies, No.[c]	Patients, No.	Threshold	All AASs[d,e]	
				Sensitivity	Specificity
CT[27]	1	49		100 (86.3-100)	100
MRI[29-31]	3	116		95.0-100	94.0-98.0
TEE[17,27,29,30,32,33]	6	520		86.0-100	90.0-100
TTE[34,35]	2	228		73.7-100	71.2-91.0
Intravascular ultrasound[36]	1	28			
D-dimer[37-42]	6	876	>0.5-0.7 µg/mL	51.7-100	32.8-89.2
Elastin degradation products[43]	1	609	>3 SD above mean of healthy patients	99.8 (99.1-100)	
MMP 8/9[44]	1	126	>3.6 ng/mL	100 (93.2-100)	9.5 (3.9-18.5)
Smooth muscle myosin heavy chain[45]	1	27	>10 ng/mL	90.0 (78.7-100)	97.0
Soluble lectin-like oxidized LDLR 1[46]	1	19	>150 pg/mL	89.5	94.3

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electrocardiographic gating is crucial for reducing motion artifact, particularly in the aortic root, ascending aorta, and proximal arch

#ECHO First !

sensitivity for Type A dissection
87% to 92%

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Type 1 Aortic Dissection
Dynamic CTA

(1) double barrel lumen, which represents the true and false lumens separated by an intimal flap
(2) an entry tear
(3) dilatation of the thoracic aorta.

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Thrombosis of False Lumen

- Larger intraluminal diameter
- Slower flow
- Less enhanced
- Intraluminal thrombi

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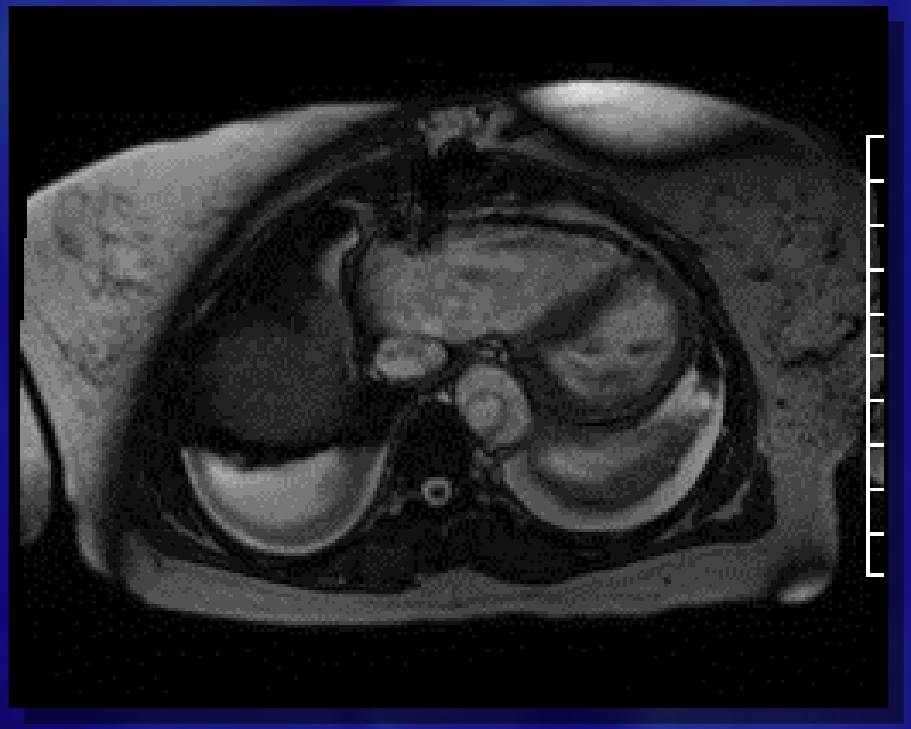
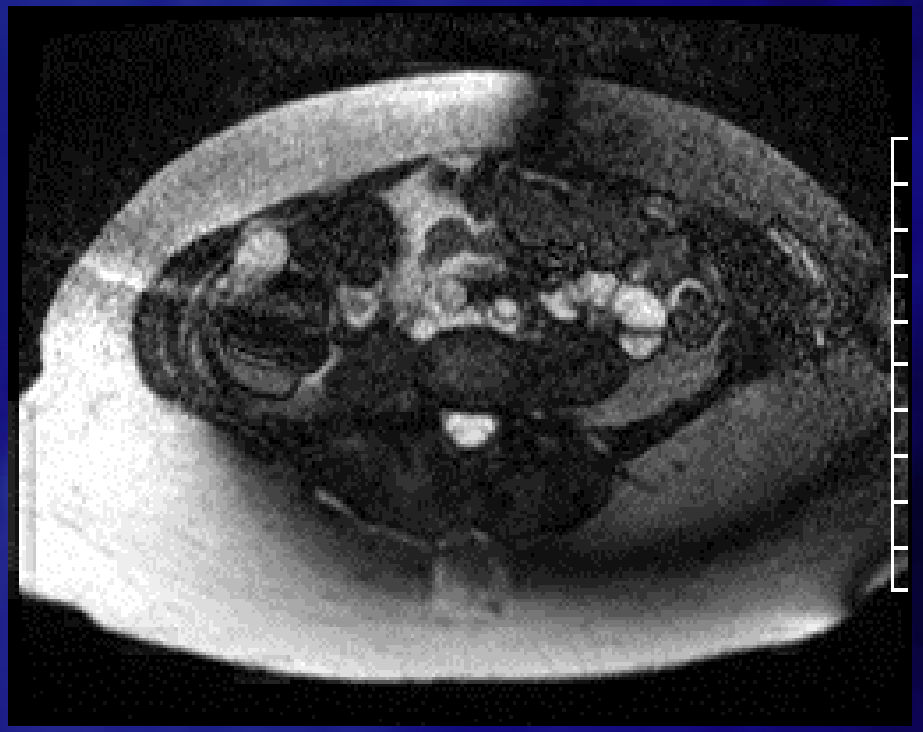
CMR in Aortic Dissection

Chest



Abdomen



CMR Sequences: Bright/dark blood, Cine SSFP, MRA, time resolved, VIBE

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Noncontrast and contrast sequences
are recommended by the SCMR as part of a standard thoracic MRA protocol

Dynamic CMR Imaging
Aortic Dissection

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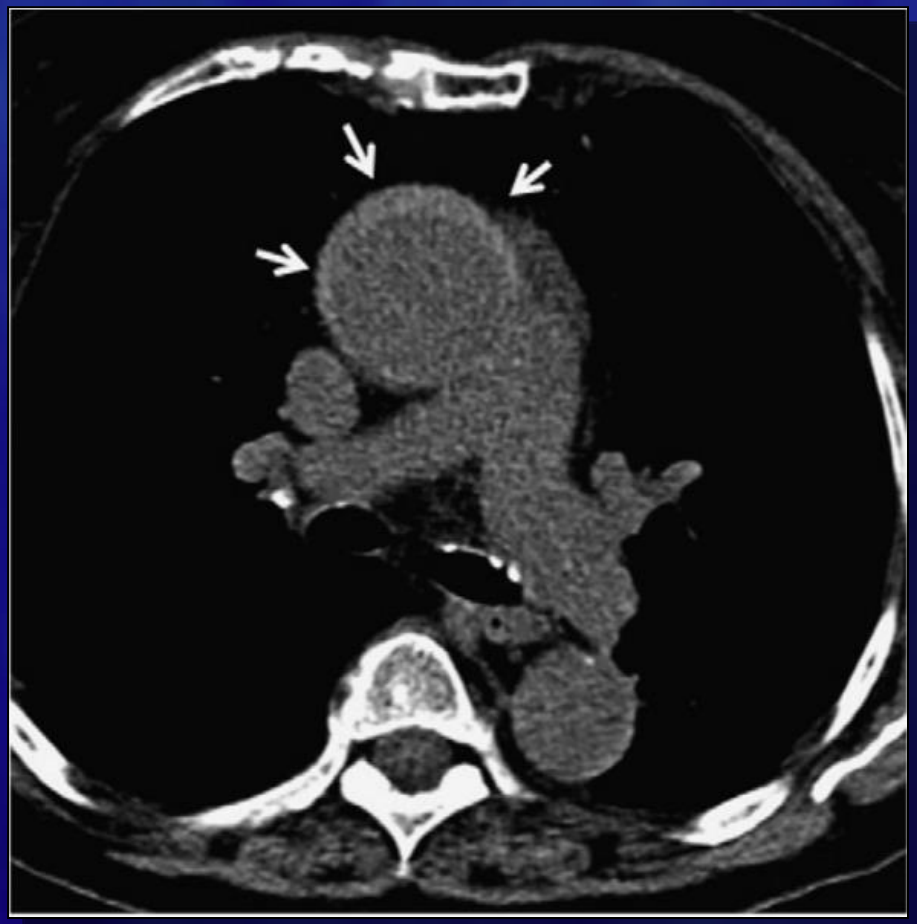
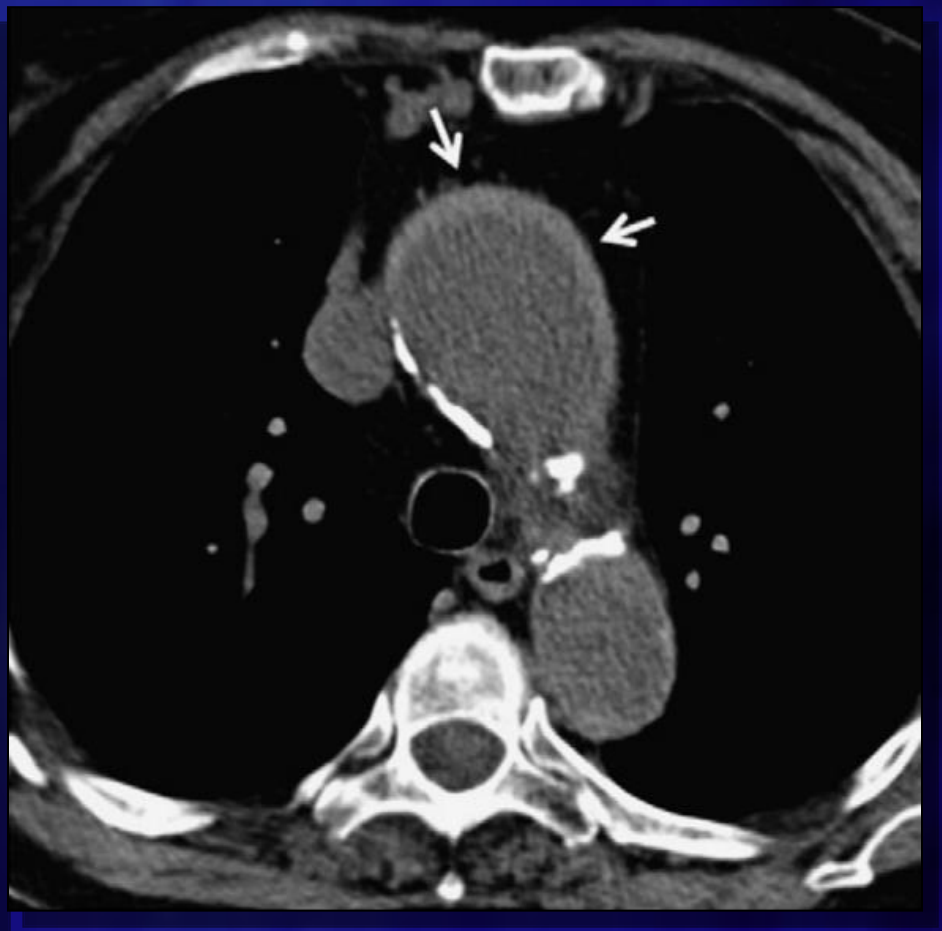
IMH: Non-contrast CT Findings

IMH more evident without intra-arterial contrast !





- High-attenuating crescent of varying thickness in aortic wall
- Intimal calcifications may be displaced
- Extends in a longitudinal, non-spiral fashion

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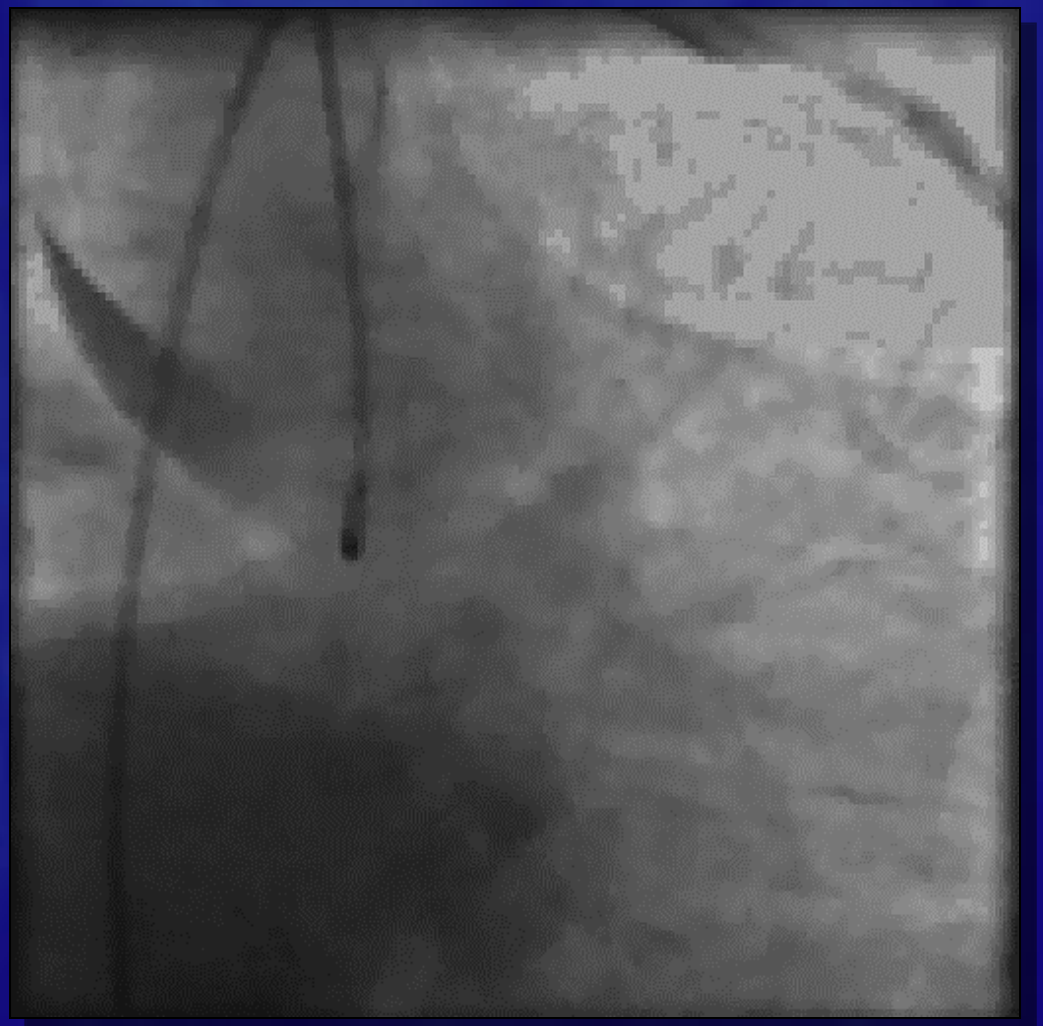
Emergent Transfer post Heart catheterization



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Iatrogenic aortic dissection / IMH

- No enhancement after IV contrast
- No intimal tear
- No spiraling

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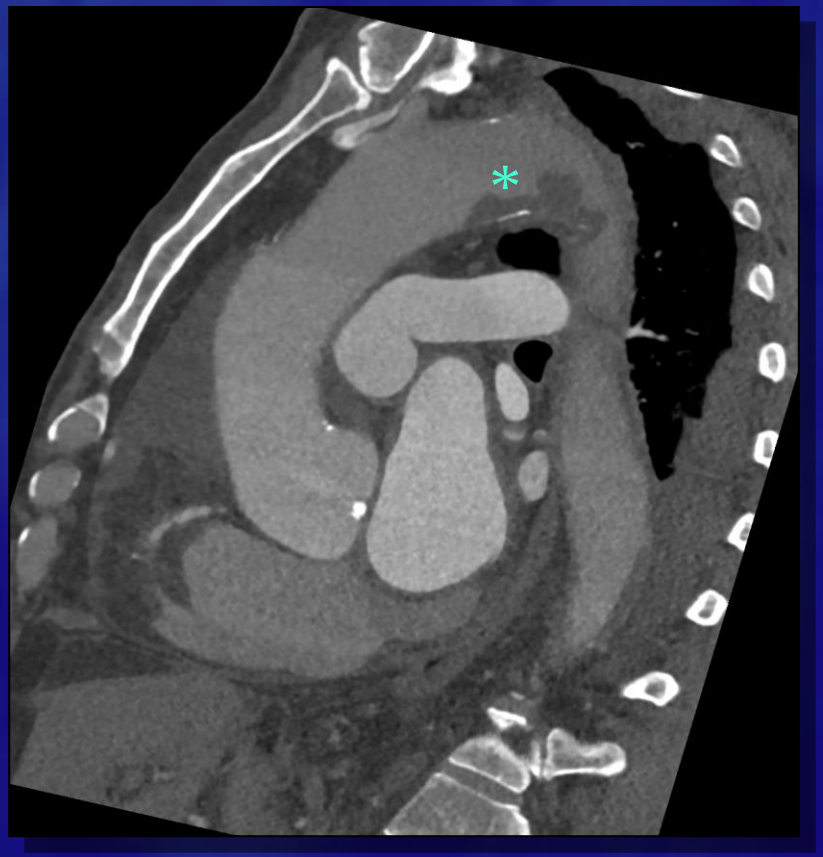
Severe atherosclerotic changes in Aortic arch



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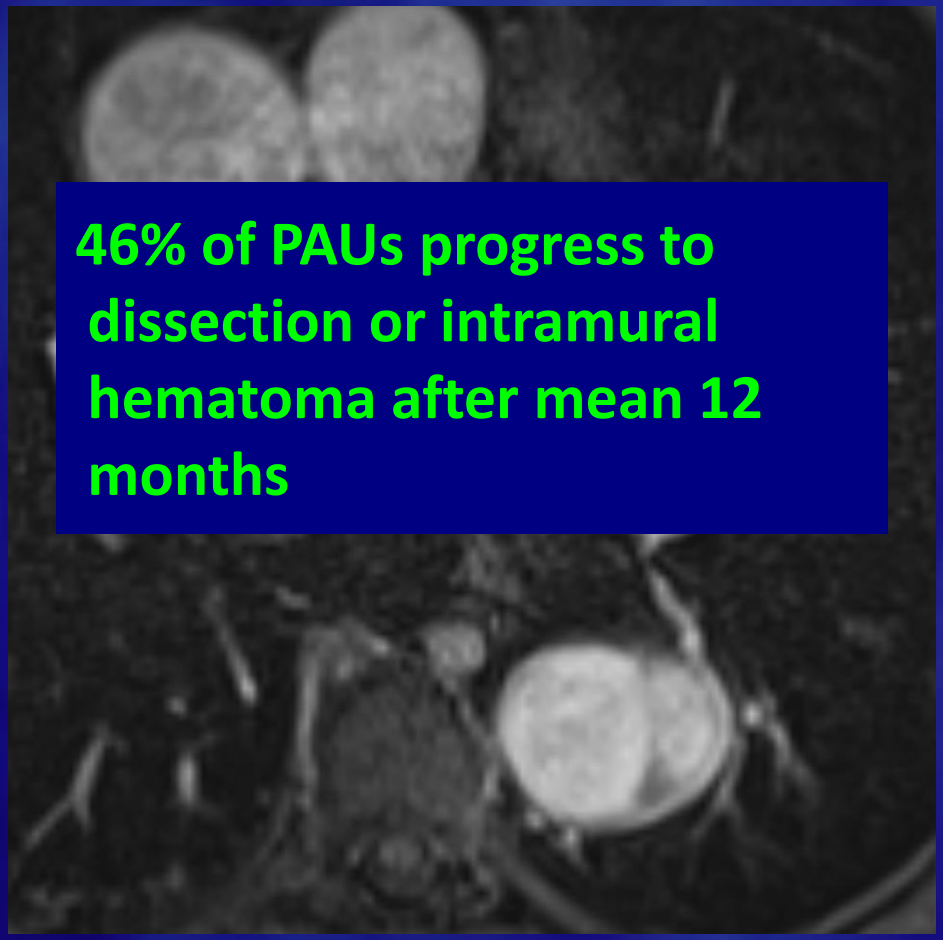
PAU – MRA Imaging



46% of PAUs progress to dissection or intramural hematoma after mean 12 months

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Lehrich's syndrome
Aortoiliac occlusion

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