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ΟΞΥ ΑΟΡΤΙΚΟ ΣΥΝΔΡΟΜΟ

Φωτεινή Λαζαρίδου
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ΕΒ΄ Νοσοκομείο 'Άγιος Παύλος', Θεσσαλονίκη

Acute aortic syndrome (AAS)

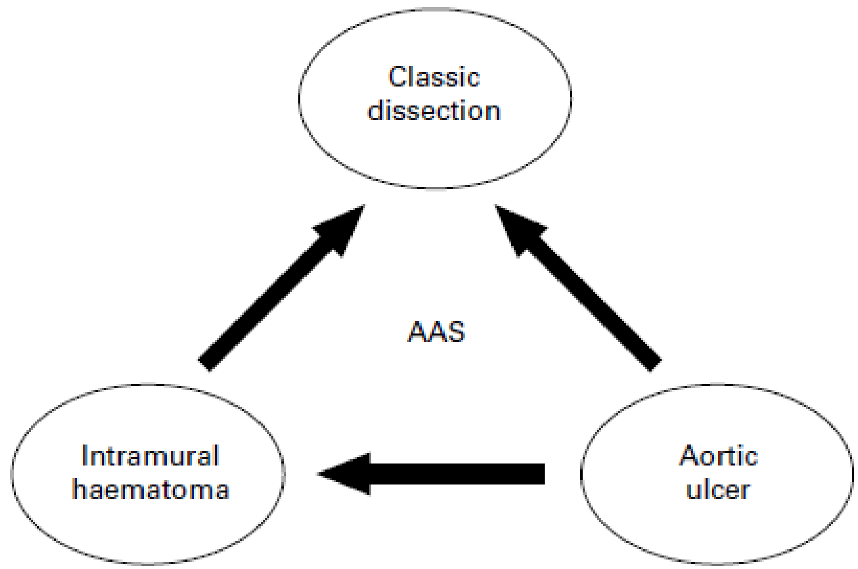


Figure 1 Acute aortic syndrome (AAS). Arrows indicate the possible progression of each of these aortic lesions.

Acute aortic syndrome (AAS)

The common denominator of AAS is **disruption of the media layer of the aorta**

- with bleeding within IMH,
- along the aortic media resulting in separation of the layers of the aorta (dissection), or
- transmurally through the wall in the case of ruptured PAU or trauma.

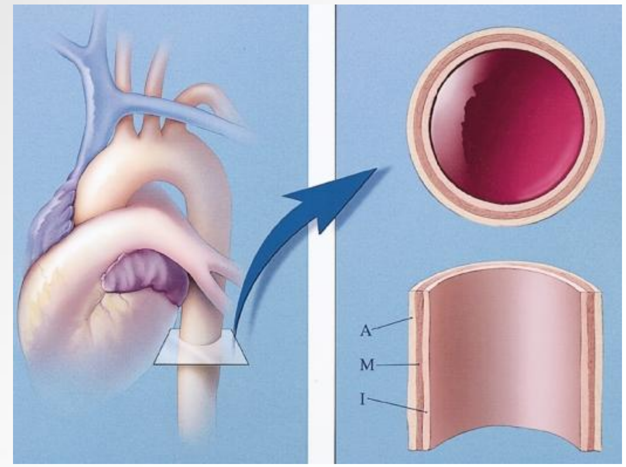
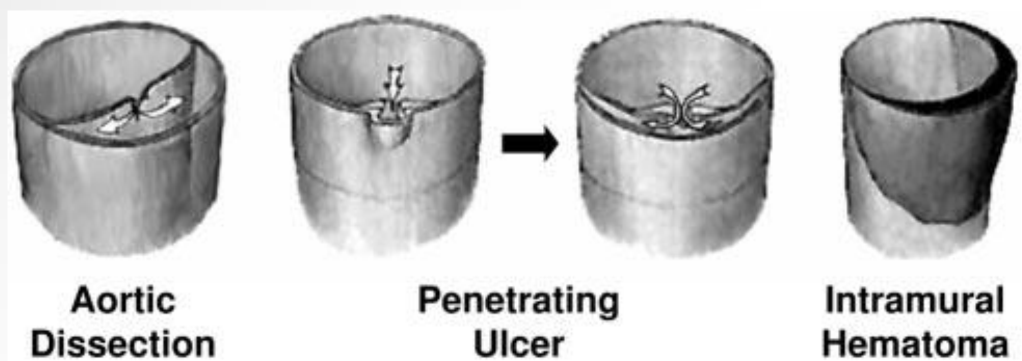


Diagram shows three layers of normal aortic wall, from inner to outer: intima (I), media (M), and adventitia (A).



Age

- Classic dissection or its preceding stage of IMH with no evidence of PAU are considered more prevalent in a middle-aged population.
- Clinical instability of PAU: focal precipitation of a longstanding atherosclerotic process primarily in the descending aorta of elderly patients

Circulation. 2002;106:284-285

Life-threatening effects of acute aortic syndrome

- Mortality from acute ascending aortic (type A) dissection increases rapidly immediately after presentation,
  - reaching 1–2% per hour for the first 48 h, 20% by 24 h after presentation,
  - 30% by 48 h,
  - 40% by Day 7, and
  - 50% by 1 month.

- Ascending aorta IMH and PAU are likewise at increased risk of lethal complications.

- The mortality from IMH is 21%; 16% of patients with IMH will evolve to classic aortic dissection over time

European Heart Journal (2012) 33, 26–35

Acute aortic syndrome - prognosis

- Poor prognosis in acute phase
  - Age,
  - signs and/or symptoms of organ malperfusion
  - clinical instability,
  - fluid extravasation into the pericardium, and
  - periaortic haematoma in the acute phase.

- The maximum aortic diameter in the subacute phase was a significant predictor of progressive dilatation.

- Other variables:
  - compression of the true lumen or
  - partial false lumen thrombosis.

European Journal of Echocardiography (2010) 11, 645–658

Clinical symptoms associated with acute aortic syndromes

Table 3 Clinical symptoms associated with acute aortic syndromes

Acute syndrome arising from	Presenting features	Other characteristics
Type A dissection	Syncope, tamponade, severe chest pain	Aortic insufficiency; collapse; pulse differential; myocardial ischaemia; neurological signs
Type B dissection	Severe chest or back pain, migrating pain, distal pulse differential	High blood pressure; renal insufficiency; claudication; distal malperfusion
Leaking thoracic aneurysm	Diffuse pain in back or chest, rapid deterioration of haemodynamics, paleness, exsanguination	Rapidly increasing diameter of TAA, sudden death within 1 h
Intramural haematoma	Chest or back pain, tamponade[a]	High blood pressure, rarely any malperfusion
Penetrating ulcer	Painless or low intensity pain, pain located in back or abdomen	High blood pressure, collapse with perforation
Traumatic dissection or rupture	Deceleration trauma, severe pain, pulse differential, syncope, exsanguination, tamponade[a]	Stable at low blood pressure, rapid pulse prior to exsanguination

[a]Rare in proximal intramural haematoma.

- A severely intense, acute, searing or tearing, throbbing, and migratory chest/back pain
- Syncope
- Tamponade
- Hypertension
- AR
- Pulse deficits
- End organ ischemia – myocardial ischemia, neurological signs

European Heart Journal (2012) **33**, 26–35

risk factors

Table 1 Contributing conditions for aortic dissection

Long-standing arterial hypertension		
	Smoking, dyslipidaemia, cocaine/crack, amphetamine use	
Connective tissue disorders		
	Hereditary disorders	
		Marfan syndrome
		Loeys–Dietz syndrome
		Ehlers–Danlos syndrome
		Turner syndrome
	Hereditary vascular disease	
		Bicuspid aortic valve
		Coarctation
Vascular inflammation		
	Auto immune disorders	
		Giant cell arteritis
		Takayasu arteritis
		Behcet's disease
		Ormond's disease
	Infection	
		Syphilis
		Tuberculosis
Deceleration trauma		
	Car accident	
	Fall from height	
Iatrogenic factors		
	Catheter/instrument intervention	
	Valvular/aortic surgery	
		Side- or cross-clamping/aortotomy
		Graft anastomosis
		Patch aortoplasty

Table 1 Risk factors for the development of acute aortic syndrome

Hypertension		
Atherosclerosis		
Collagen disorders		
	Marfans	
	Turners	
	Noonans	
	Ehlers danlos	
	Osteogenesis imperfecta	
Bicuspid aortic valve		
Coarctation of the aorta		
Pregnancy		
Trauma		
	Deceleration injuries, blunt trauma, penetrating injuries	
Iatrogenic		
	Post-cardiac surgery	
		Cross-clamping
		Coronary cannulation
		Aortic valve replacement
	Post-coronary angiography/angioplasty	
	Post-renal angioplasty	
Inflammatory		
Giant cell arteritis, Bechets, syphilis, aortitis		

European Heart Journal (2012) **33**, 26–35

AAS Differential Diagnosis Considerations

- In the emergency setting:

- The chest X-ray may or may not reveal a widened mediastinal contour.
- ECG changes (non-specific, pericarditic, ischaemic, or infarction) are common.

- Thus, there is an important differential diagnosis, which includes acute coronary syndrome, pericarditis, and pulmonary embolism (PE).

- Not only may consideration of these conditions result in crucial delay in the diagnosis of type A AAS, but also their initial management (in two of the above) includes anti-platelet, anticoagulant, and thrombolytic therapies, with potential disastrous results.

Thoracic Aorta segments
how to measure / reference values

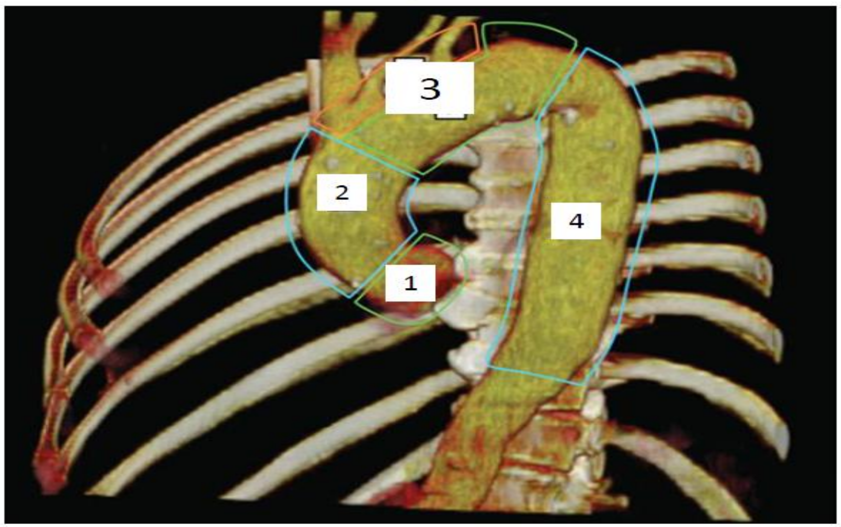


Table I Echocardiographic views of the aorta

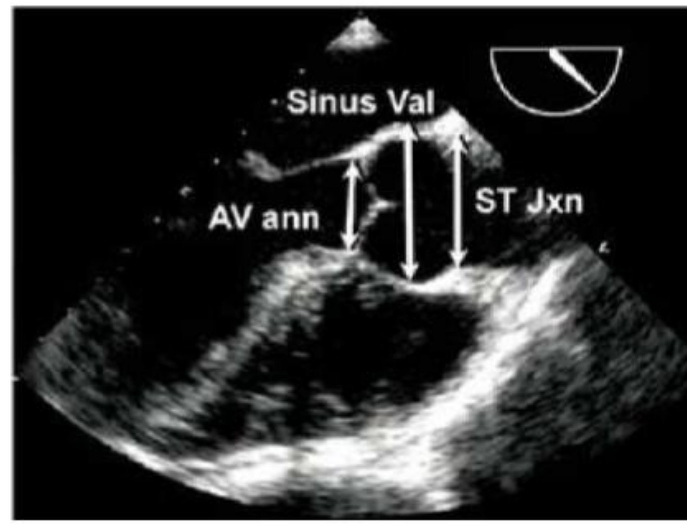
View	Part of aorta
Transthoracic echo	
Parasternal long + short axis	Ascending + descending thoracic
Apical four-chamber	Descending thoracic
Apical two-chamber and/or long axis	Descending thoracic
Suprasternal	Arch, descending + ascending thoracic
Subcostal	Abdominal (+ascending thoracic)
Transoesophageal echo	
Upper oesophageal long + short axis	Ascending thoracic
Aortic (long + short axis)	Descending thoracic + arch

Recommendations for Aortic **Imaging Techniques**

I IIa IIb III

C

For measurements taken by ***Echocardiography***, the internal diameter (inner edge-to-inner edge) should be measured perpendicular to the axis of blood flow.



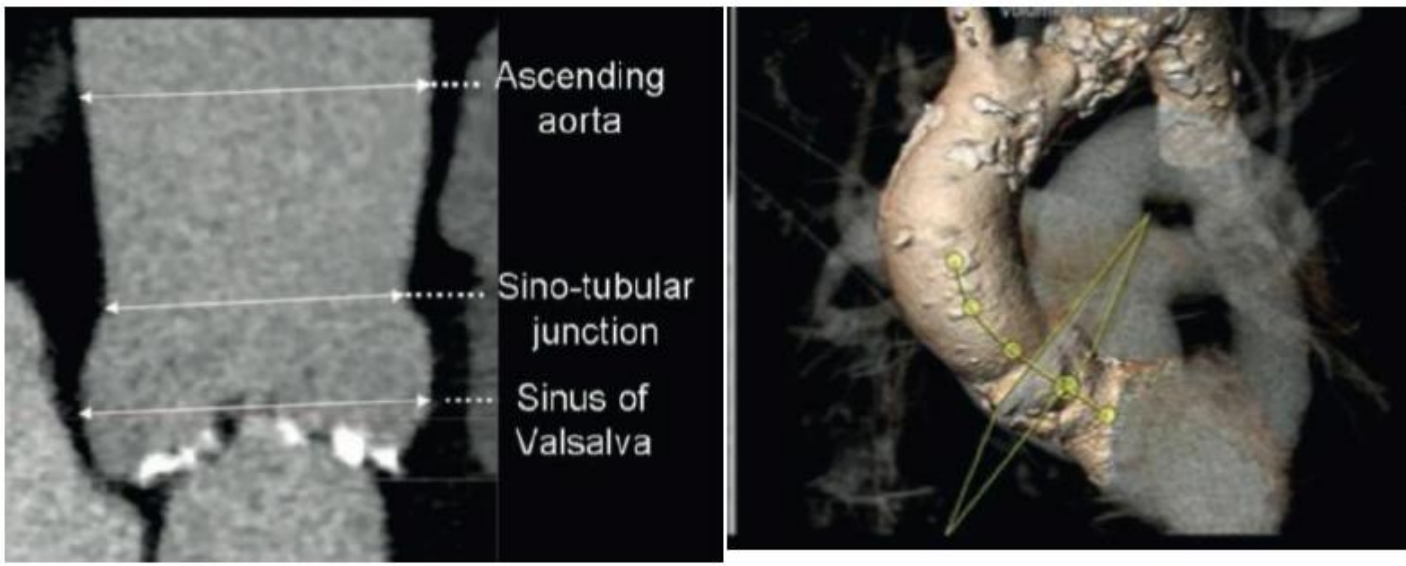
Recommendations for Aortic **Imaging Techniques**

I IIa IIb III

C

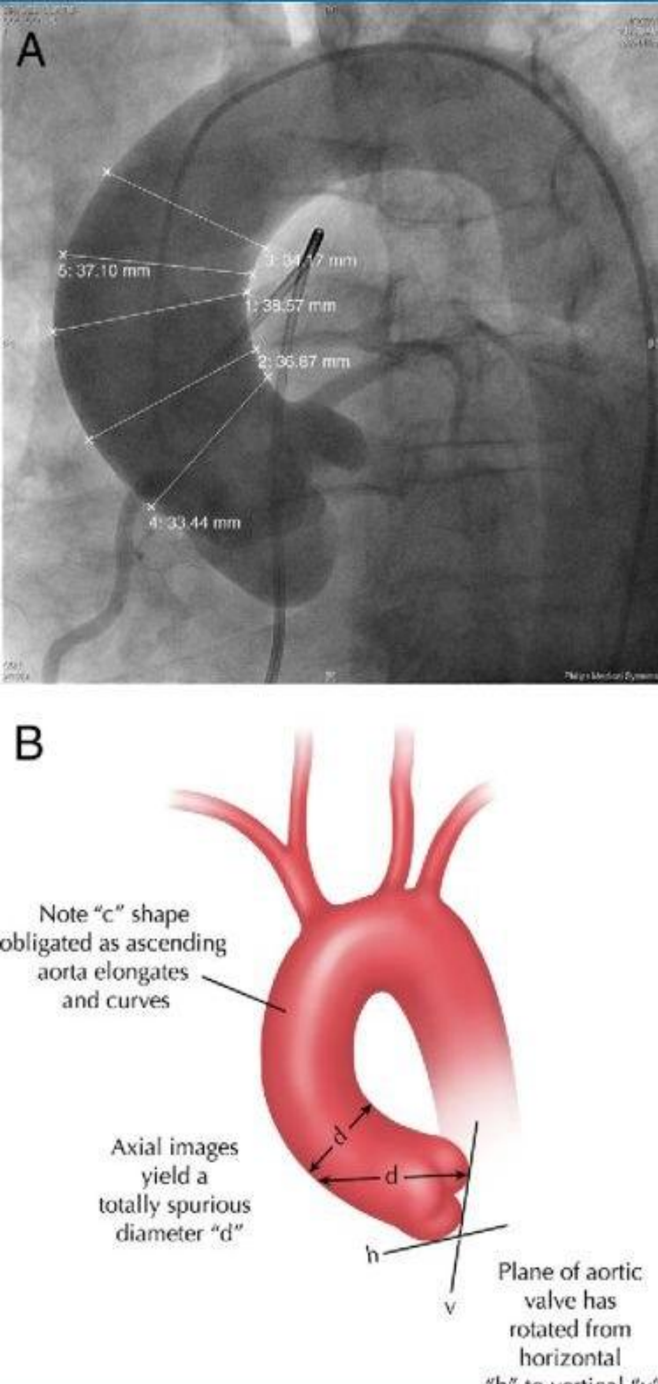
For measurements taken by *Computed Tomographic imaging or Magnetic Resonance Imaging*, the external diameter should be measured perpendicular to the axis of blood flow.

For aortic root measurements, the widest diameter, typically at the mid-sinus level, should be used.



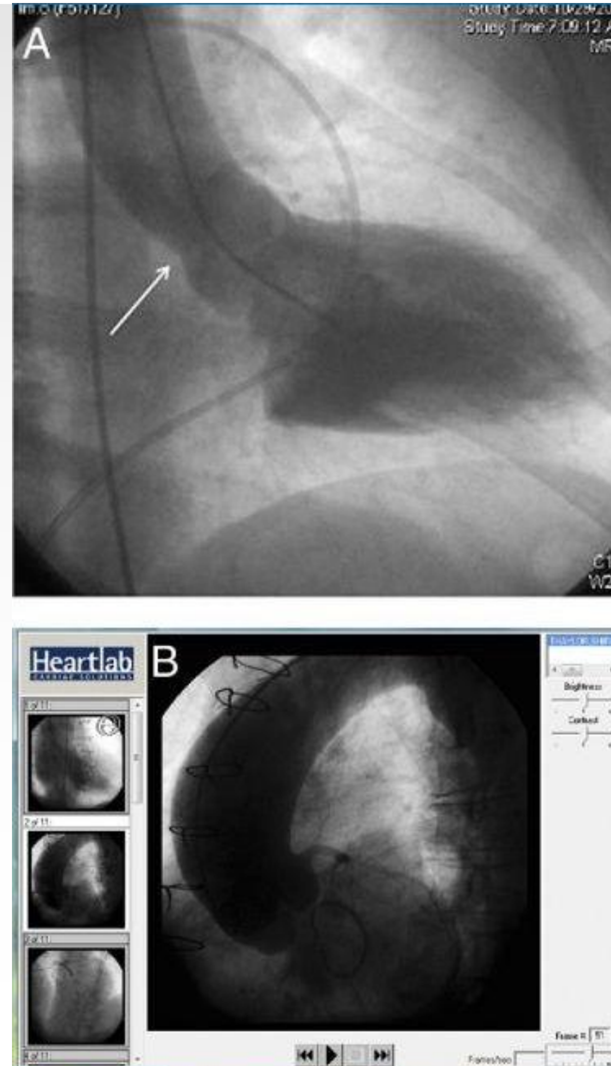
Delgado V. et al EuroIntervention 2010 (6) 643

Estimating True Aortic Size

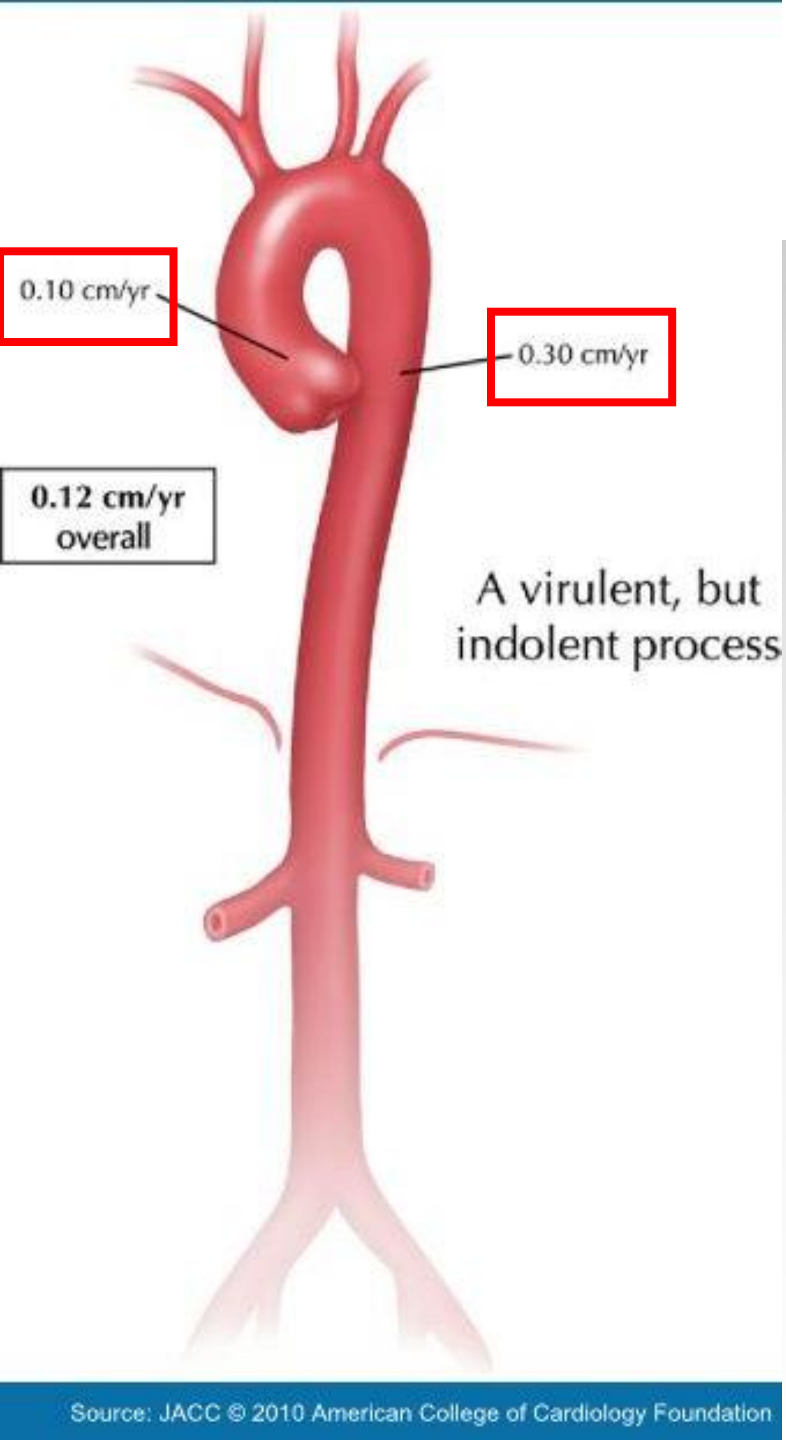


Source: JACC © 2010 American College of Cardiology Foundation

- Size is not the only important imaging criterion
- Shape matters as well, especially loss of the normal "waist" of the aorta at the sinotubular junction.
- Loss of this normal indentation is an indication of intrinsic aortic disease



Source: JACC © 2010 American College of Cardiology Foundation

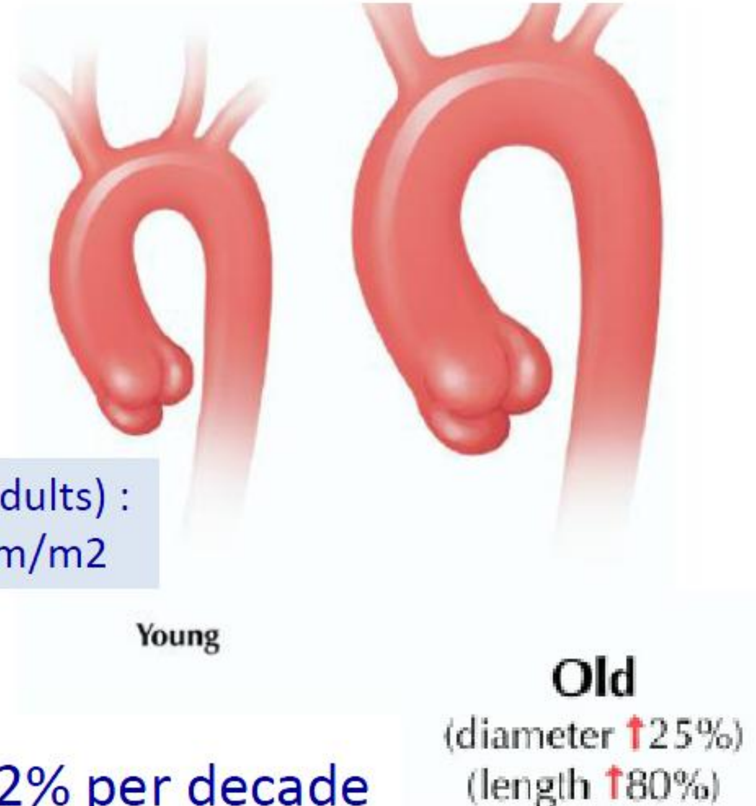


Thoracic aorta growth

- Reports of rapid growth of the thoracic aorta are usually reflective of measurement error

- The only condition in which the thoracic aorta truly grows rapidly in a short time occurs when there has been an intercurrent aortic dissection

Aortic Dimensions and Stiffness in Normal Adults*



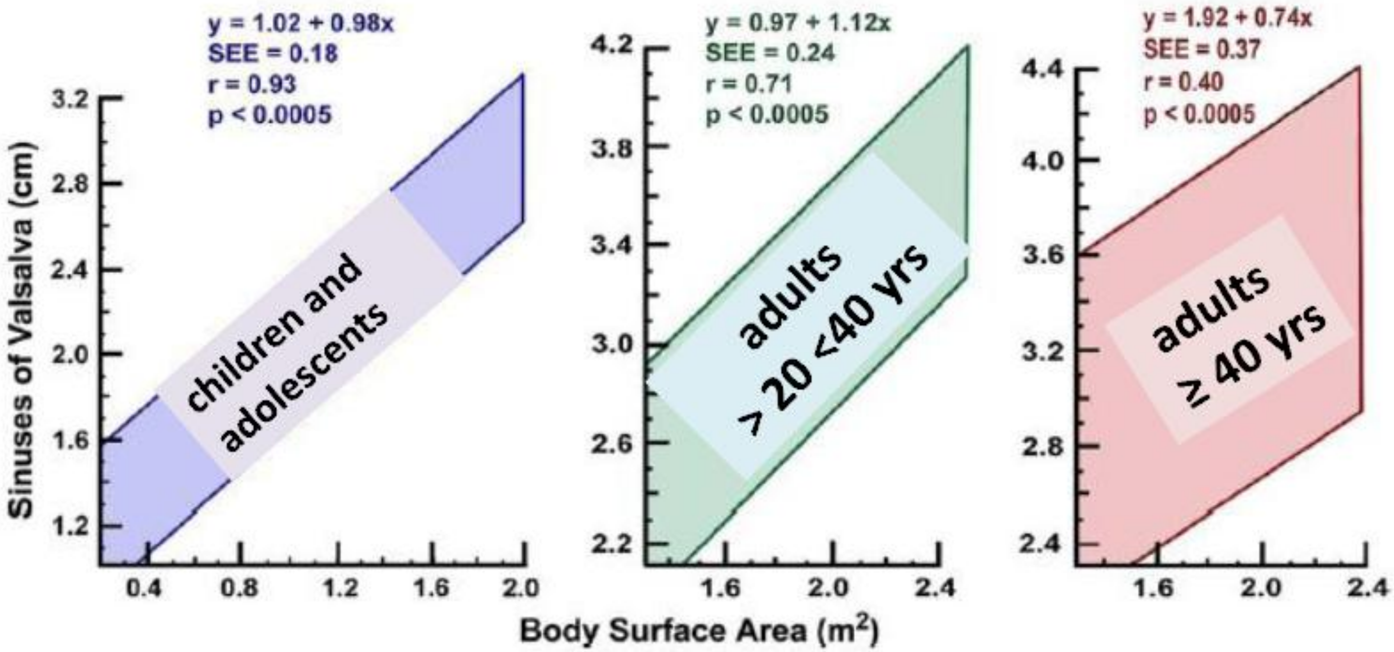
ascending aorta diameter (adults) :
upper normal range - 2.1cm/m2

length increases by 12% per decade
diameter increases by 3% per decade.

O'Rourke M et al JACC Imag. 2008 (6)

Recommendations for chamber quantification☆

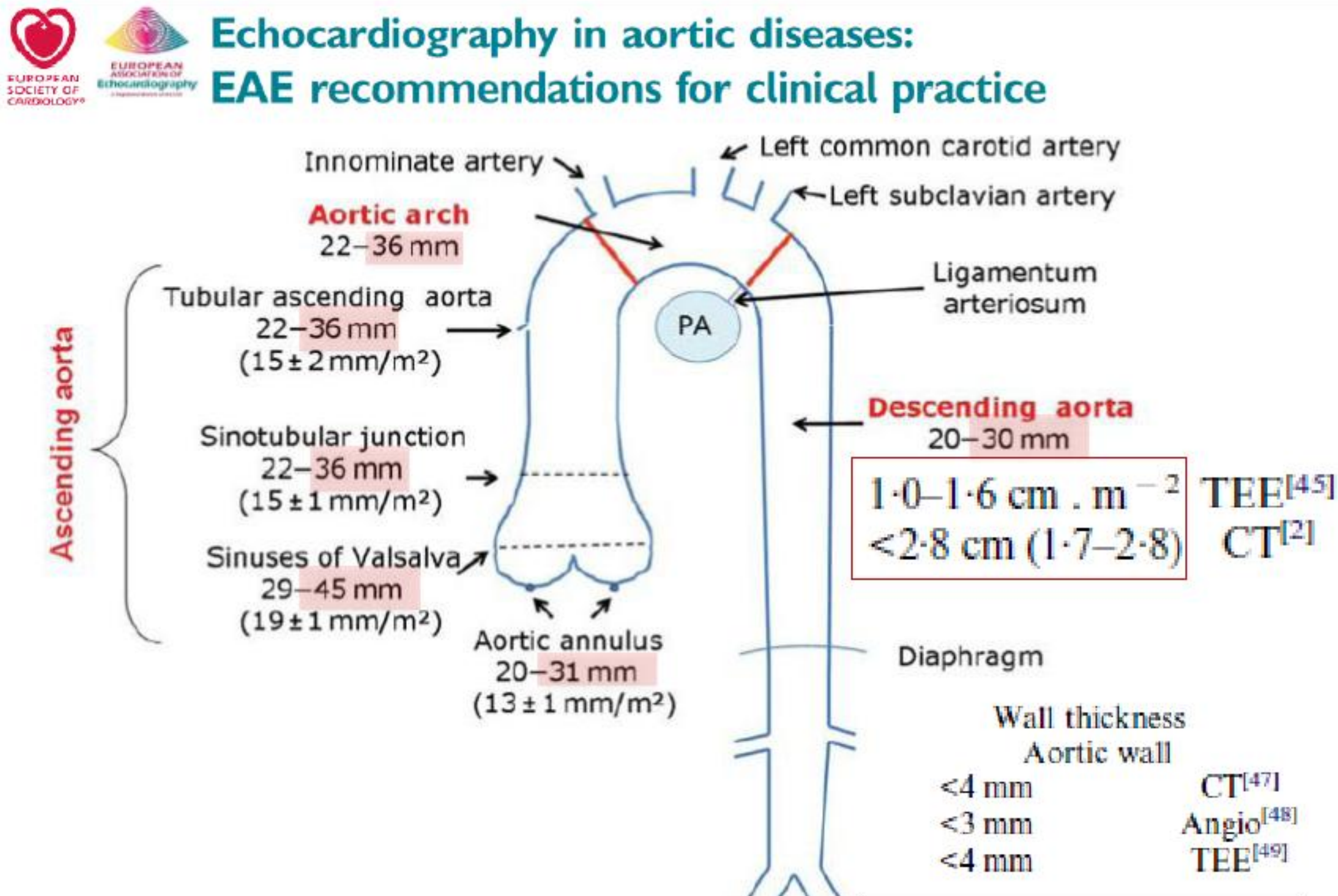
Roberto M. Lang, Michelle Bierig, Richard B. Devereux, Frank A. Flachskampf*, Elyse Foster, Patricia A. Pellikka, Michael H. Picard, Mary J. Roman, James Seward, Jack Shanewise, Scott Solomon, Kirk T. Spencer, Martin St. John Sutton, William Stewart



Roman MJ, Devereux RB, et al. J. Am J Cardiol 1989;64: 507

Normal size of thoracic aorta segments

Echocardiography in aortic diseases: EAE recommendations for clinical practice



ascending aorta diameter (adults) : upper normal range - 2.1cm/m2

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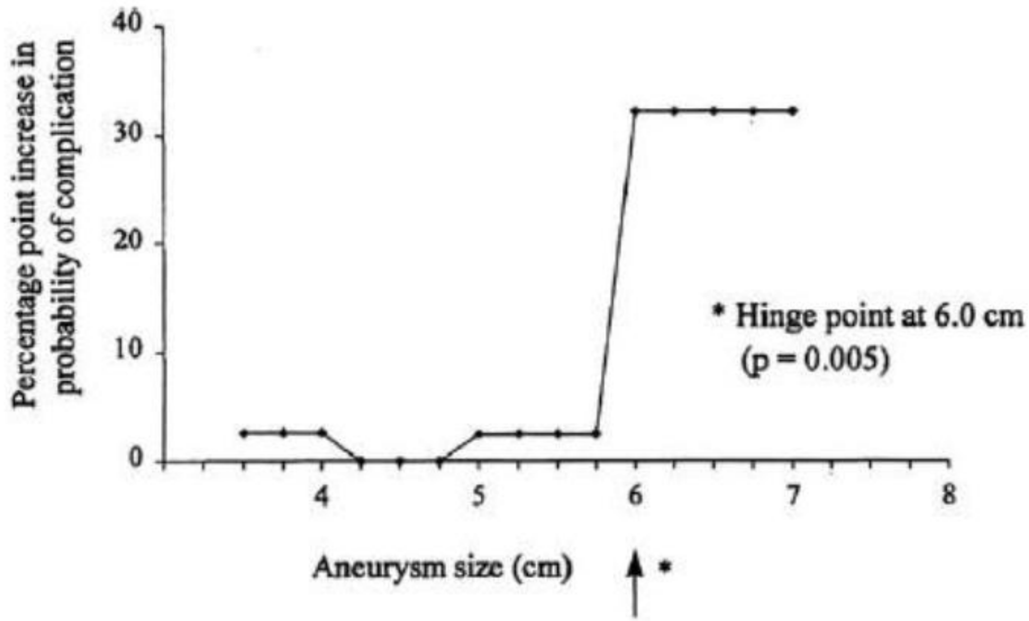
Effect of aortic aneurysms diameter on risk of complication



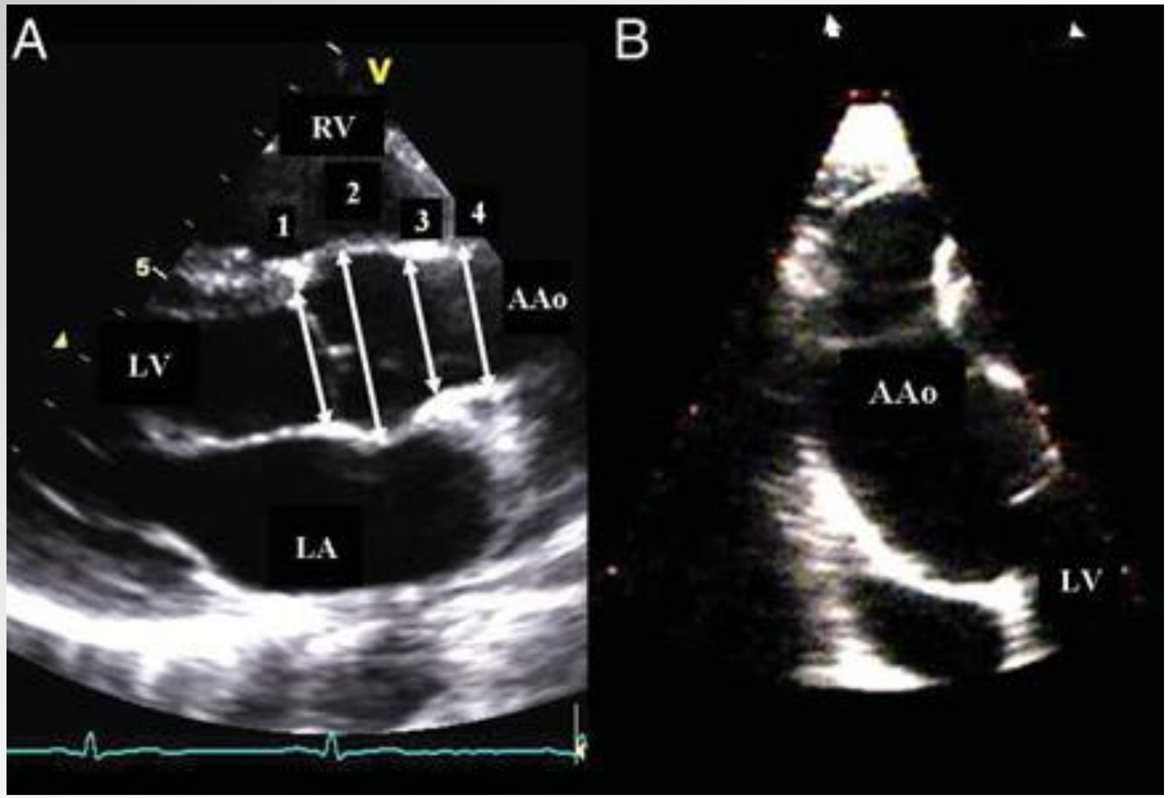
Estimated effect of ascending aortic aneurysm size on risk of complication.

Elefteriades et al. Ann Thorac Surg. 2002;74:S1877– 80.

- ✓As the aorta enlarges, distensibility of the aortic wall decreases, so that by approximately 6 cm in size, the aorta becomes a rigid tube.
- ✓The result is that because the aneurysmal aortic wall cannot "stretch" in systole, the full force of cardiac contraction is translated into wall stress

J Thorac Cardiovasc Surg 2005;130:677–683

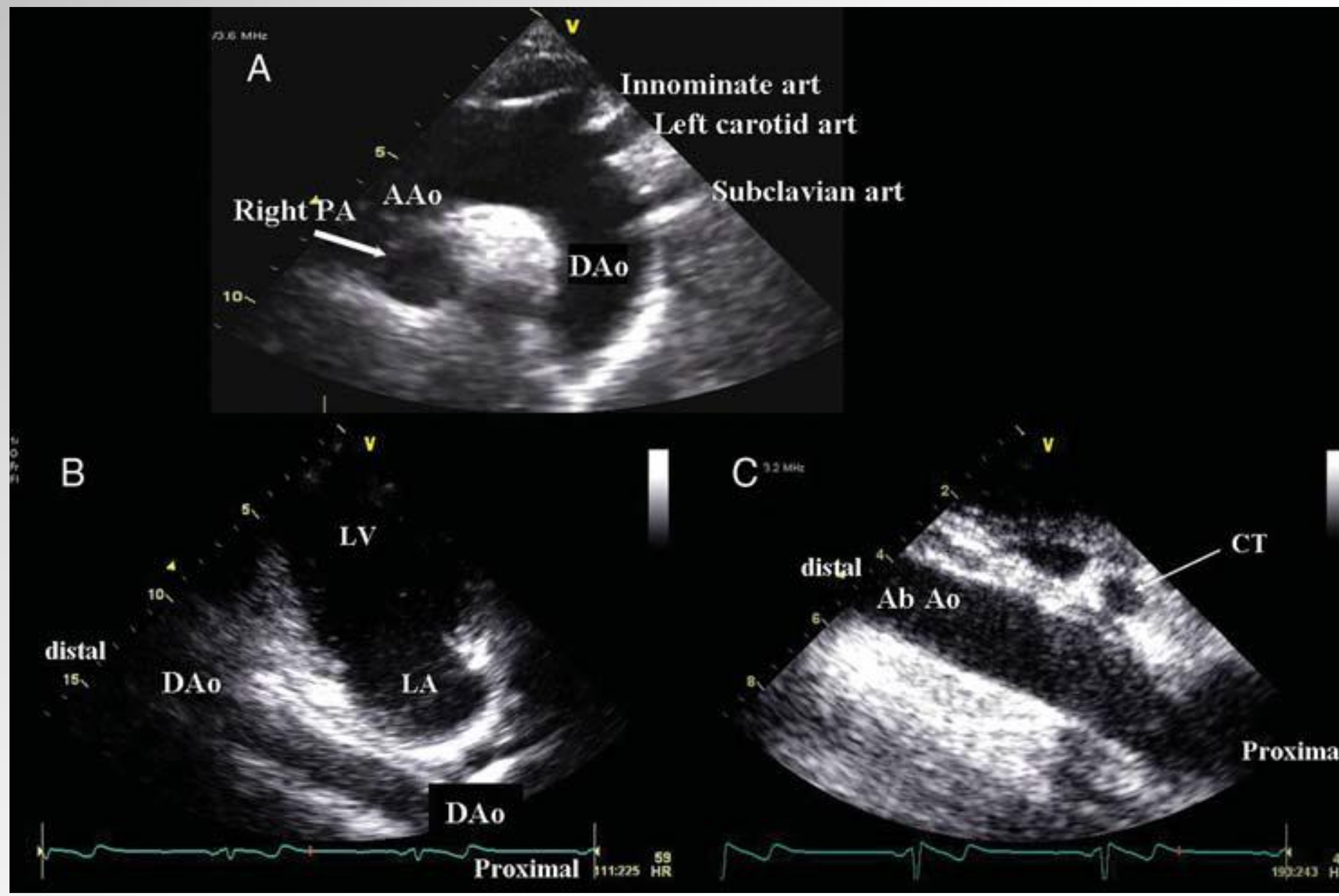
Transthoracic echocardiography



(B) Right parasternal long-axis view,
mid and distal parts of ascending aorta

European Journal of Echocardiography (2010) 11, 645–658

TTE: suprasternal/2C/subcostal view



(A) Suprasternal view of aortic arch and supra-aortic great arteries.
(B) Mid part of the descending thoracic aorta visualized by long axis view from apical window.
(C) Abdominal aorta visualized by subcostal view.

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Performing TTE in suspected AAS

- TTE: assesses presence of pericardial or pleural effusions.
- Bicuspid aortic valve, aortic root dilatation
- Dissection flap
- Assessment of any AR should be made, assessing the severity and mechanism of AR.
- Left and right ventricular function should be assessed. Regional wall abnormalities may represent coronary involvement in the dissection flap or pre-existing coronary disease.
- differential diagnosis in the acutely unwell patient, particularly in the absence of aortic root dilatation:
  - MI (large regional wall motion abnormality),
  - pericardial effusion, and
  - PE (right heart dilatation, etc.).

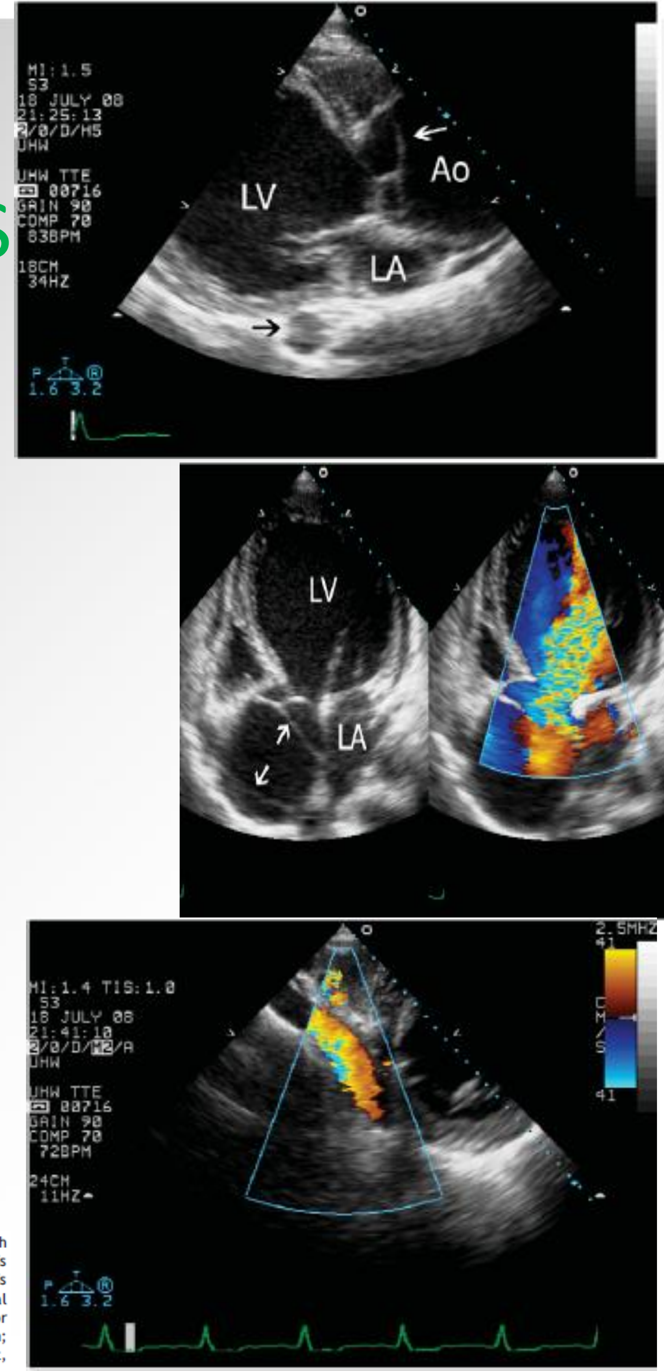
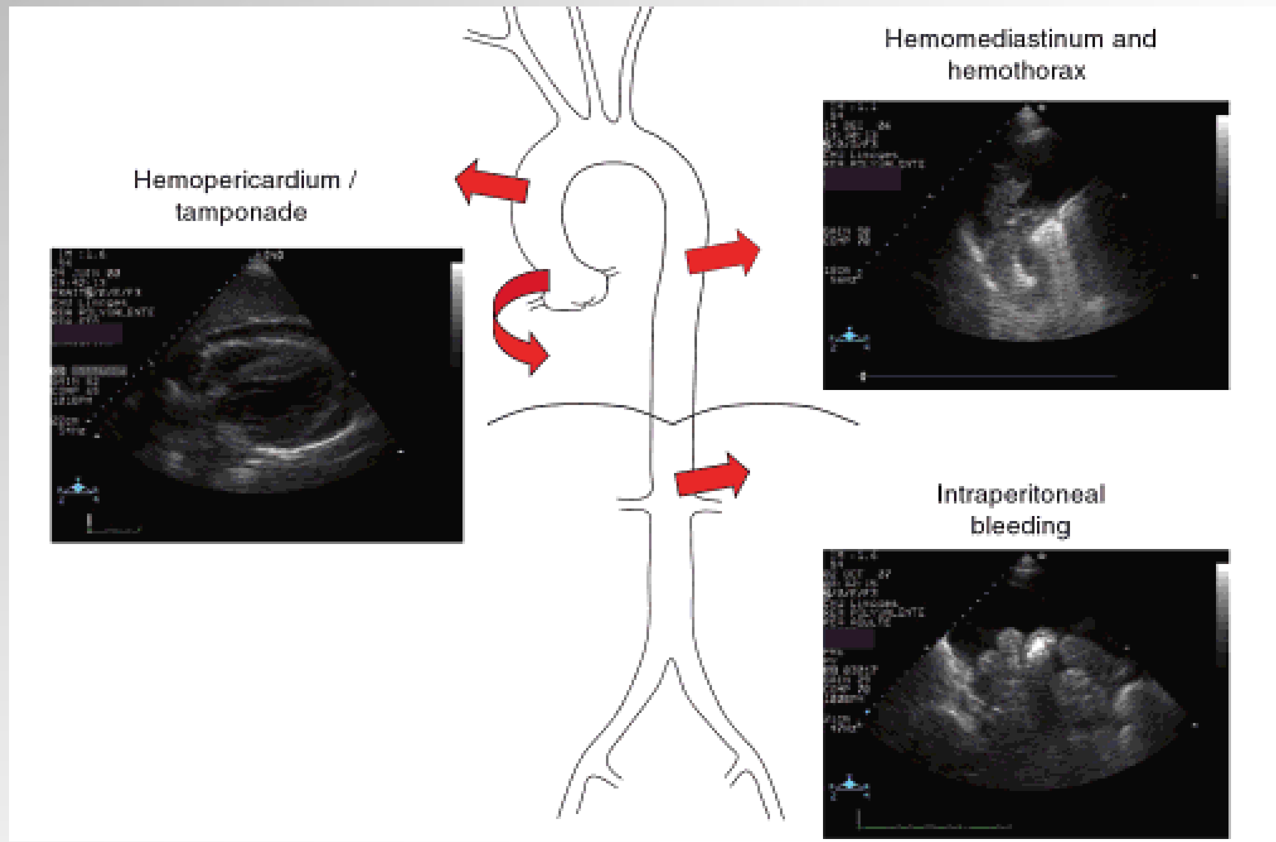


Figure 4 Transthoracic echocardiography in a patient with Marfan's syndrome and type A dissection. (*A*) Parasternal long-axis view. There is severe dilatation of the aorta and a linear echo is seen just above the aortic valve (white arrow). Note the normal caliber and appearance of the descending thoracic aorta, posterior to the left atrium (black arrow). LV, left ventricle; LA, left atrium; Ao, aorta. (*B*) Apical five-chamber view. The dilated aortic root, with two reflections of the intimal flap, (white arrows) is seen. Severe aortic regurgitation (right panel) is seen with colour flow mapping. (*C*) Subcostal view. Normal caliber, no dissection flap and normal flow are seen.

Diagnostic field of echocardiography in pts with circulatory failure associated with acute aortic syndrome

D. De Backer et al. (eds.), *Hemodynamic Monitoring Using Echocardiography in the Critically Ill*,
DOI: 10.1007/978-3-540-87956-5_20, © Springer-Verlag Berlin Heidelberg 2011



Echo can depict blood extravasation in pericardial, pleural or abdominal space secondary to complicated acute aortic disease

TTE with harmonic imaging

TEE in AAS

- TEE is reported to have a sensitivity of 94–100% and specificity of 77–100% for identifying an intimal flap.
- The reduced specificity in early studies relates to the false-positive interpretation of reverberation artefacts in the aortic root particularly with the use of mono- or bi-plane TEE.
- The most recent studies reported 100% sensitivity and 100% specificity for TEE, helical CT, and MRI, whereas conventional CT is less accurate (sensitivity 83–94%, specificity 87–100%).
- The ‘TEE blindspot’ caused by the interposition of the trachea between oesophagus and upper ascending aorta may not be a problem, given the extremely low probability of dissection of IMH confined to this precise location only.
- TEE is rapid and safe. It may be performed at the bedside, or in the operating room when there is a high degree of suspicion for type A dissection or IMH.

TEE execution

- Anecdotal reports relay information regarding patient deterioration with aortic dissection during TEE. However, large studies never reported fatal cases.
- Given a mortality rate of 1−2% per hour, a high risk of fatal deterioration exists when performing an overlong examination.

TEE execution by

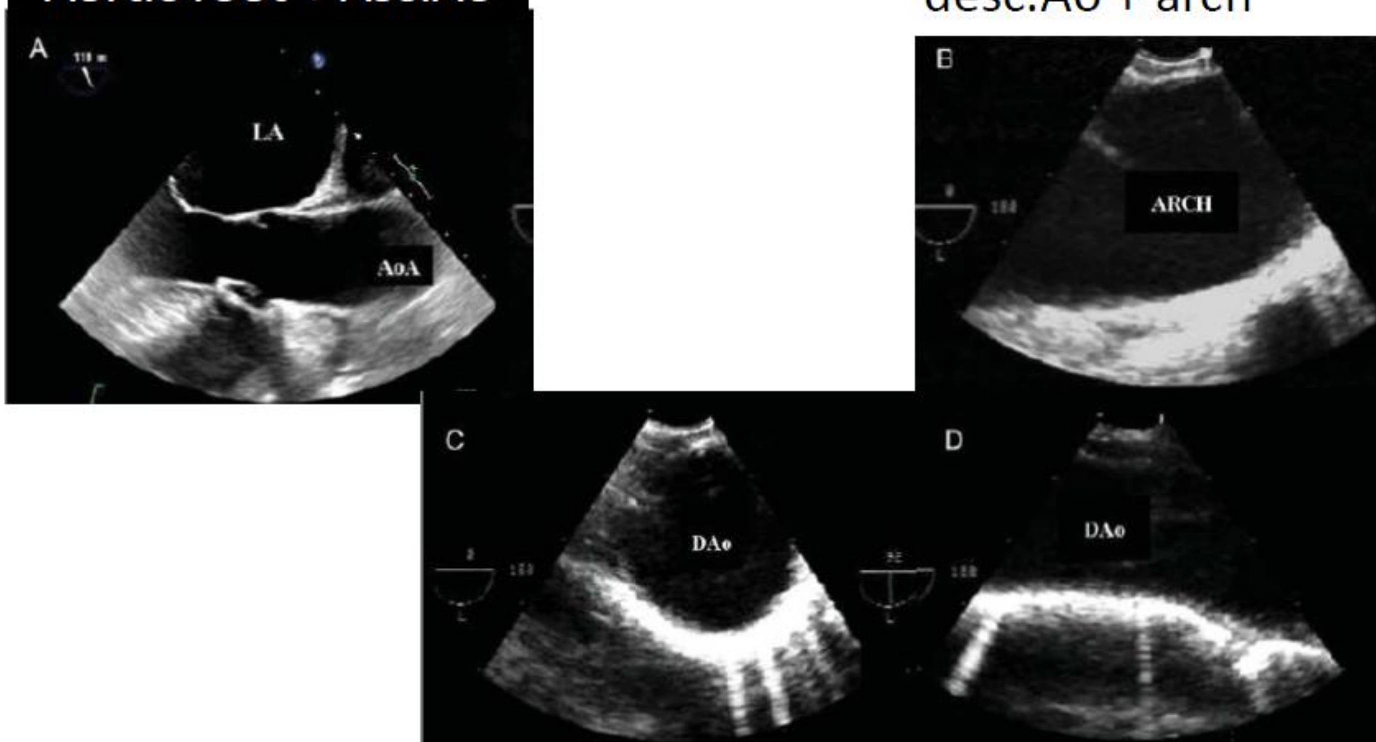
- well trained and experienced operators in this setting is vital
- careful and continuous monitoring of heart rate, blood pressure, and oxygen saturation.
- opioid analgesia
- iv nitroprusside and beta-blockers for maintaining an optimal low blood pressure (e.g., systolic blood pressure < 120 mmHg).
- sedation: iv midazolam.

Transoesophageal echo

Echocardiography in aortic diseases: EAE recommendations for clinical practice

high-oesophageal Lax
Aortic root + Asc.Ao

mid/upper-oesophageal
desc.Ao + arch



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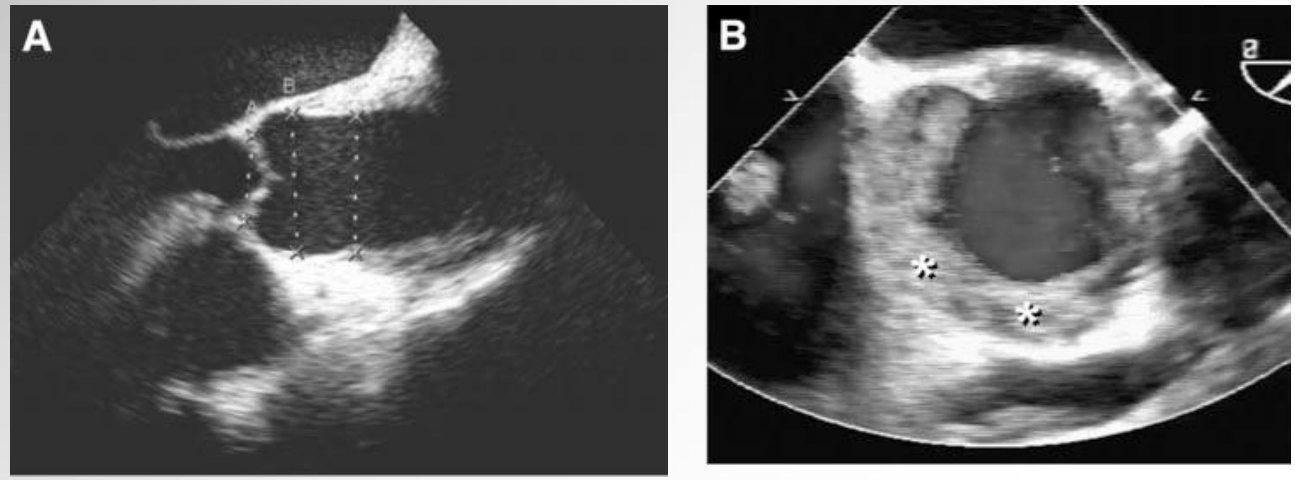
IMH - intraoperative TEE

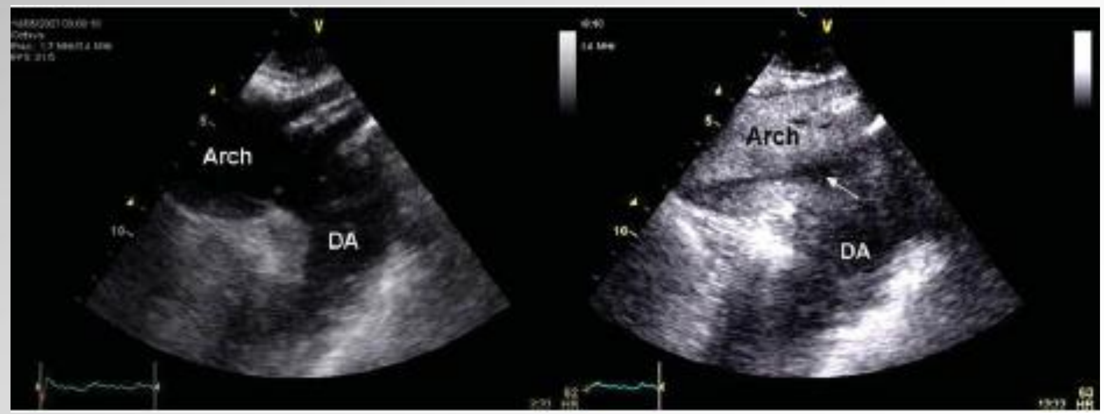


(**A**) Transesophageal echocardiography at presentation showing a normally sized ascending aorta without evidence of overt dissection or significant intramural hematoma formation.
(**B**) Intraoperative TEE revealing large IMH (*) of the ascending aorta.

USEFULNESS OF INTRAOPERATIVE TEE
Eggebrecht et al.

J ENDOVASC THER
2005;12:252–257

Contrast-enhanced TTE Diagnosis of Type A Dissection



Ascend Ao	Sensitivity	Specificity	PPV	NPV
TTE	82%	89%	80%	90%
Contrast TTE	93%	97%	95%	96%
TEE	96%	96%	94%	98%

Contrast-TTE: similar accuracy to TOE in the diagnosis of type A aortic dissection (sensitivity 93% and specificity 97%)

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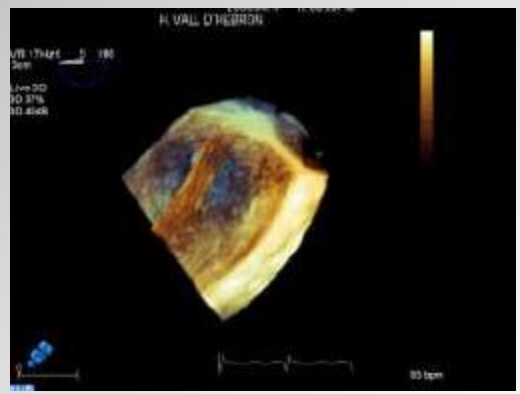
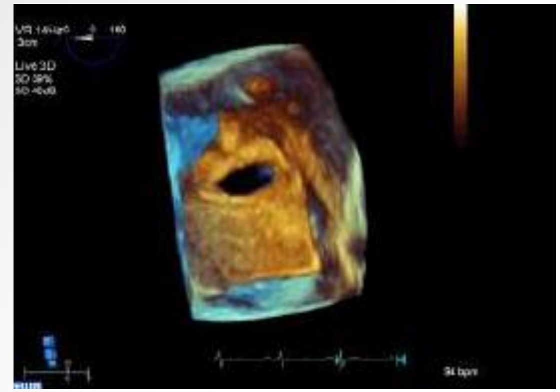
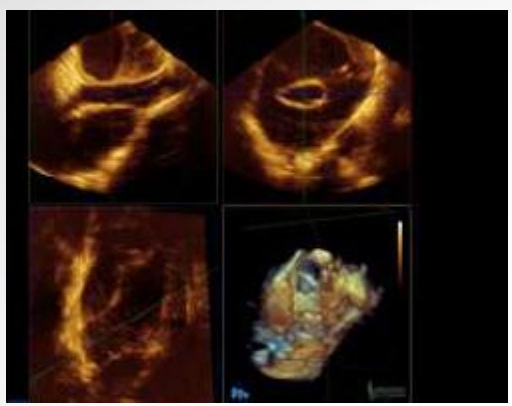
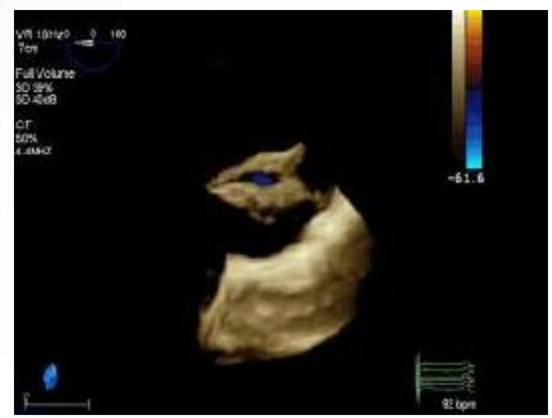
3D-TEE

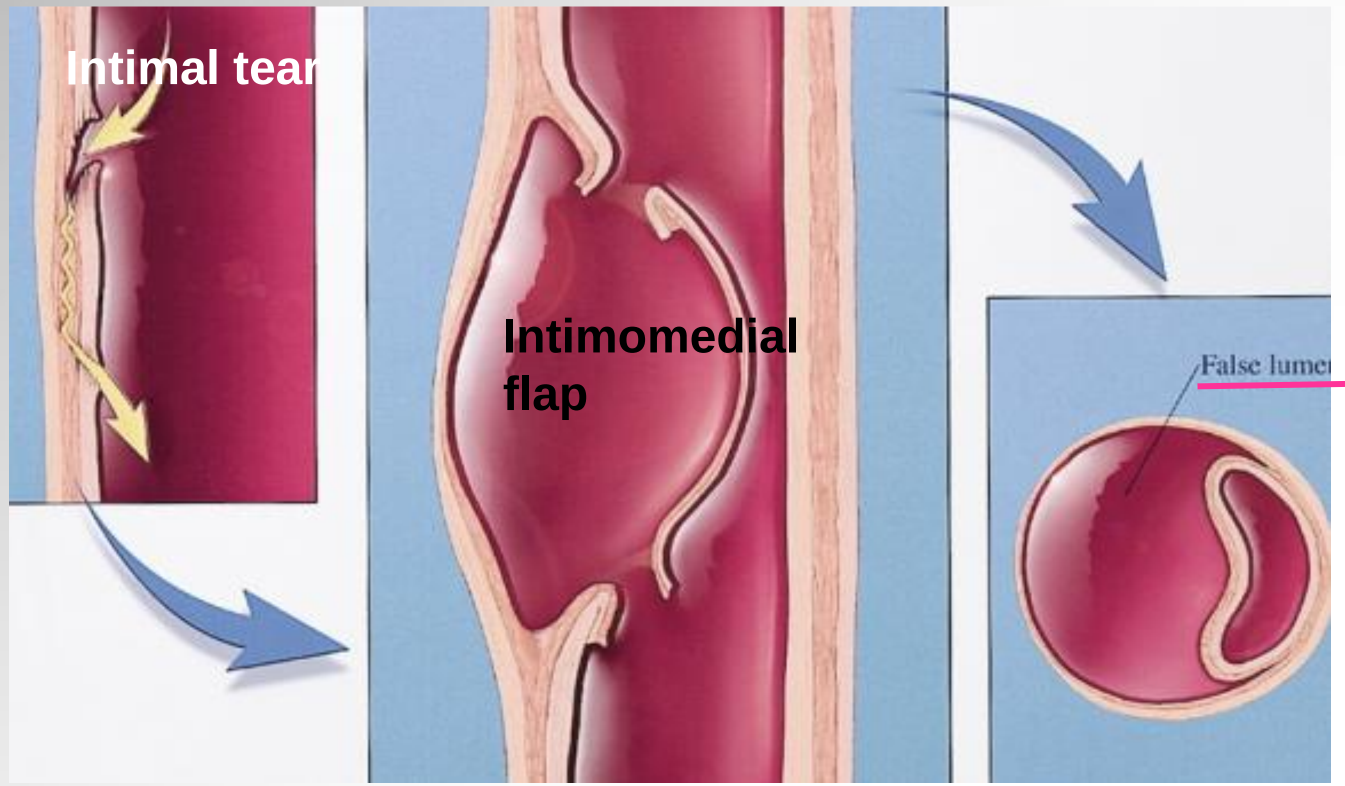






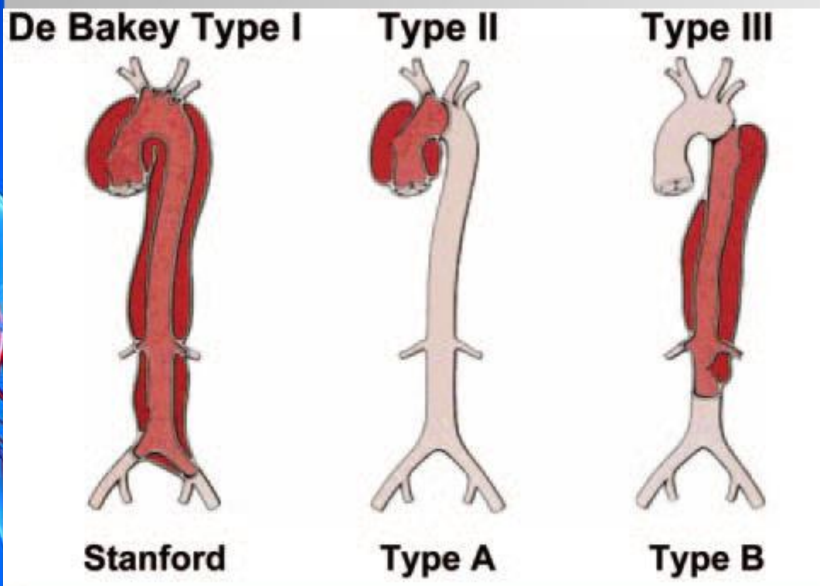


Aortic dissection



Events leading to aortic dissection from formation of entrance tear and exit tear of intima to splitting of aortic media and formation of intimomedial flap. Blood under pressure dissects media longitudinally, and double-channel aorta is formed with blood filling both true and false lumens.

Aortic dissection classification



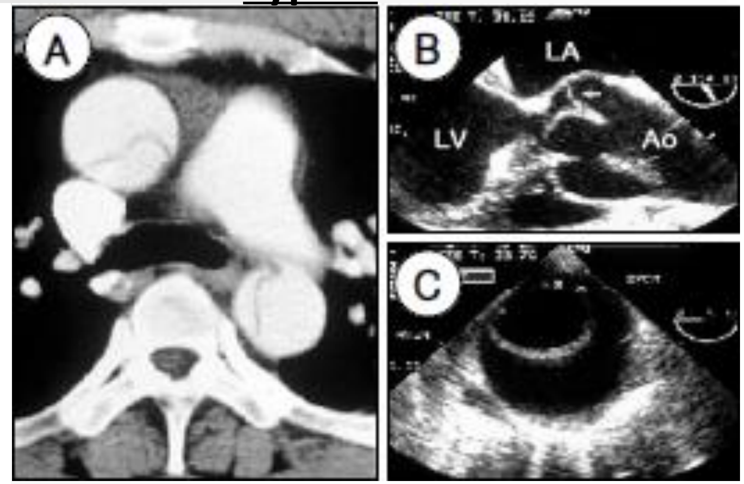
De Bakey

Type I	Originates in the ascending aorta, propagates at least to the aortic arch and often beyond it distally.
Type II	Originates in and as confined to the ascending aorta.
Type III	Originates in the descending aorta and extends distally down the aorta or, rarely retrograde into the aortic arch and ascending aorta.

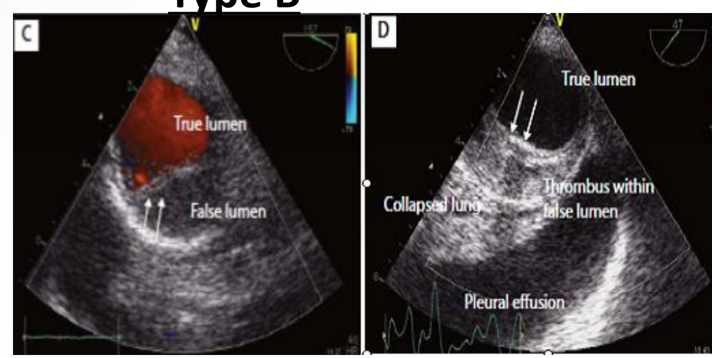
Stanford

Type A	All dissections involving the ascending aorta, regardless of the site of origin.
Type B	All dissections not involving the ascending aorta.

Type A



Type B



Aortic dissection: ESC classification

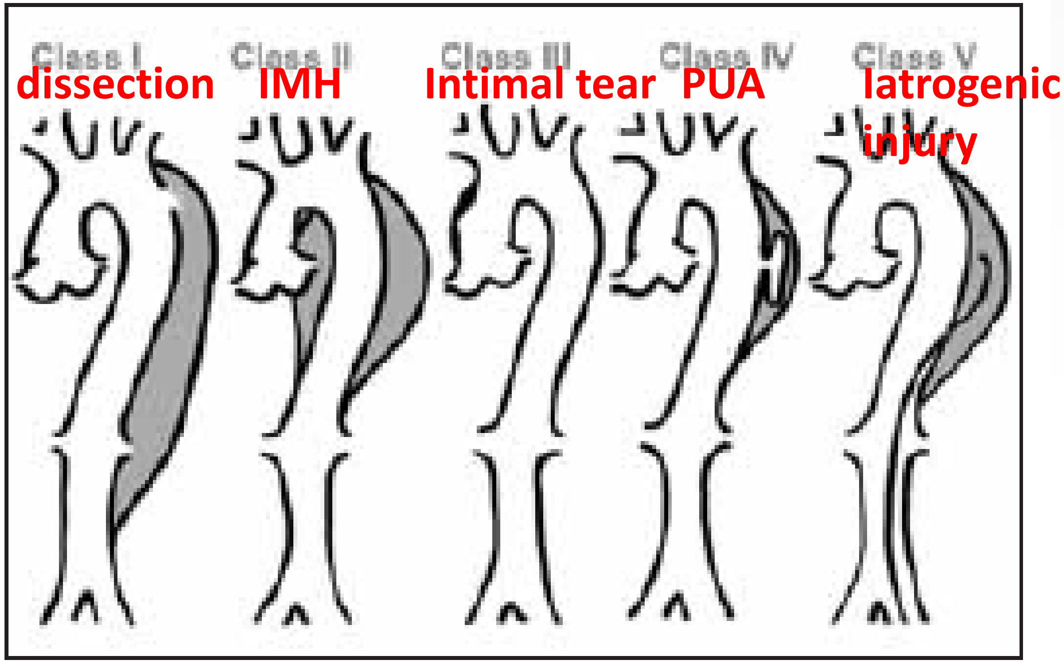


Figure 1. Classification proposed by Svensson et al[2] and later adopted by the European Society of Cardiology. Class I, classic double-barrel dissection; class II, intramural hematoma without intimal disruption; class III, intimal tear; class IV, penetrating aortic ulcer; class V, iatrogenic injury.

Intimal flap: The classic sign of aortic dissection

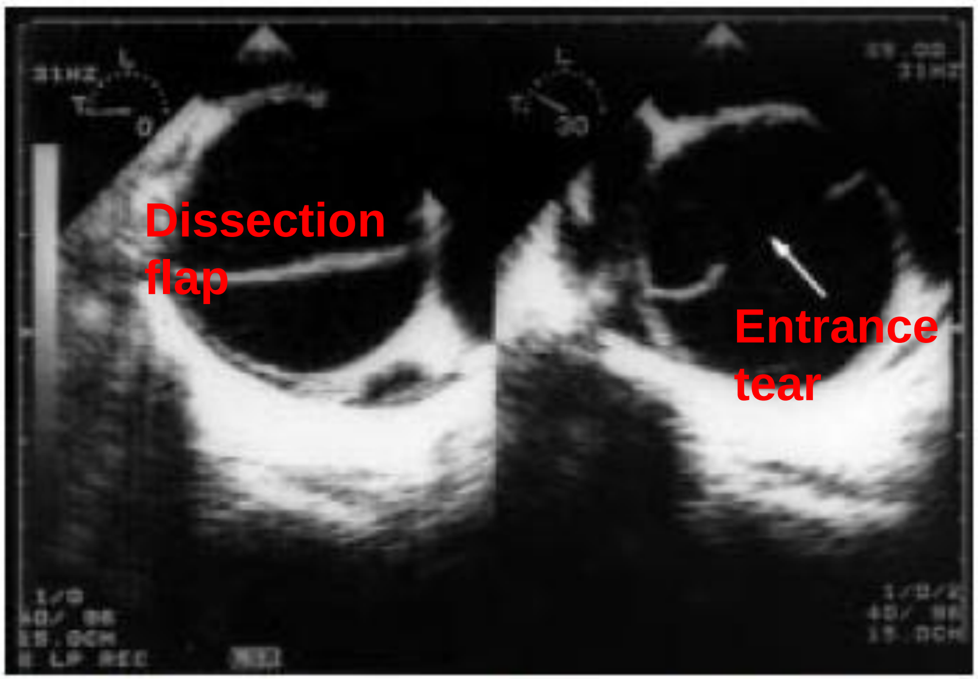
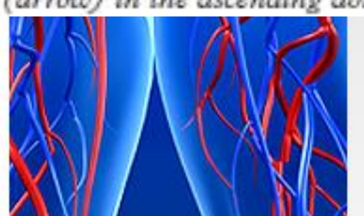
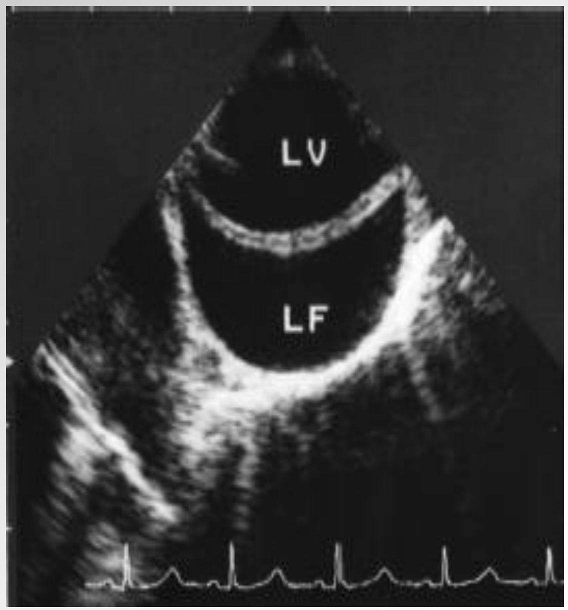


Figure 4 Transoesophageal echocardiographic study illustrating the double channel aorta and dissection flap (left panel), and the entrance tear (arrow) in the ascending aorta (right panel). Transversal planes.



- mobile linear echo separating the true from the false lumen with flow on either side.
- false lumen >> true lumen.
- moves throughout the cardiac cycle (antegrade flow during systole)
- chronic dissections: ↓ mobility of intimal flap
- identification of the proximal extension of the dissection ➡ urgent surgical approach
- aortic wall thickness > 15 mm suggests dissection with thrombosis in the false lumen.

Aortic dissection – intimal flap



Aortic dissection
Entry tear site

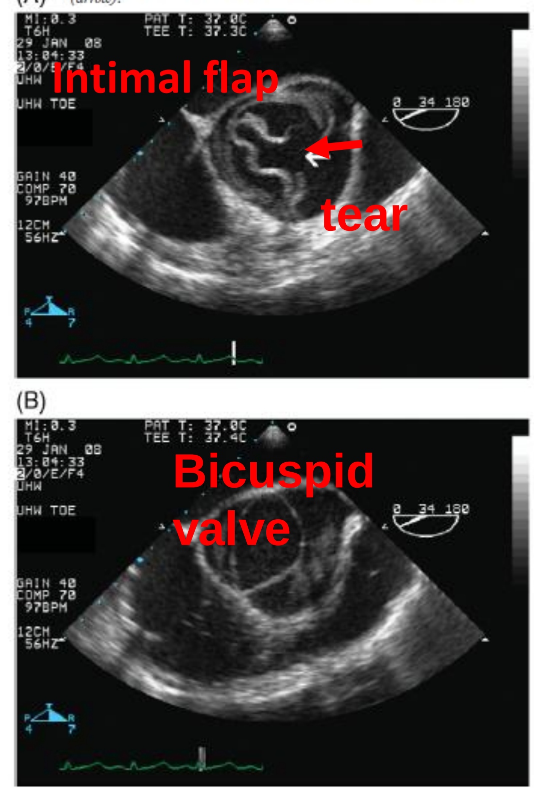
- Entry tear occurs at sites of greatest wall stress.
  - most commonly within a few cm of the AV on the right lateral wall of the Asc Ao or close to the ligamentum arteriosum in the Desc Ao.

- 65% of the cases occur within 3 cm of the coronary ostia,
- 10% occur within the arch, and
- 10% in the descending thoracic aorta.

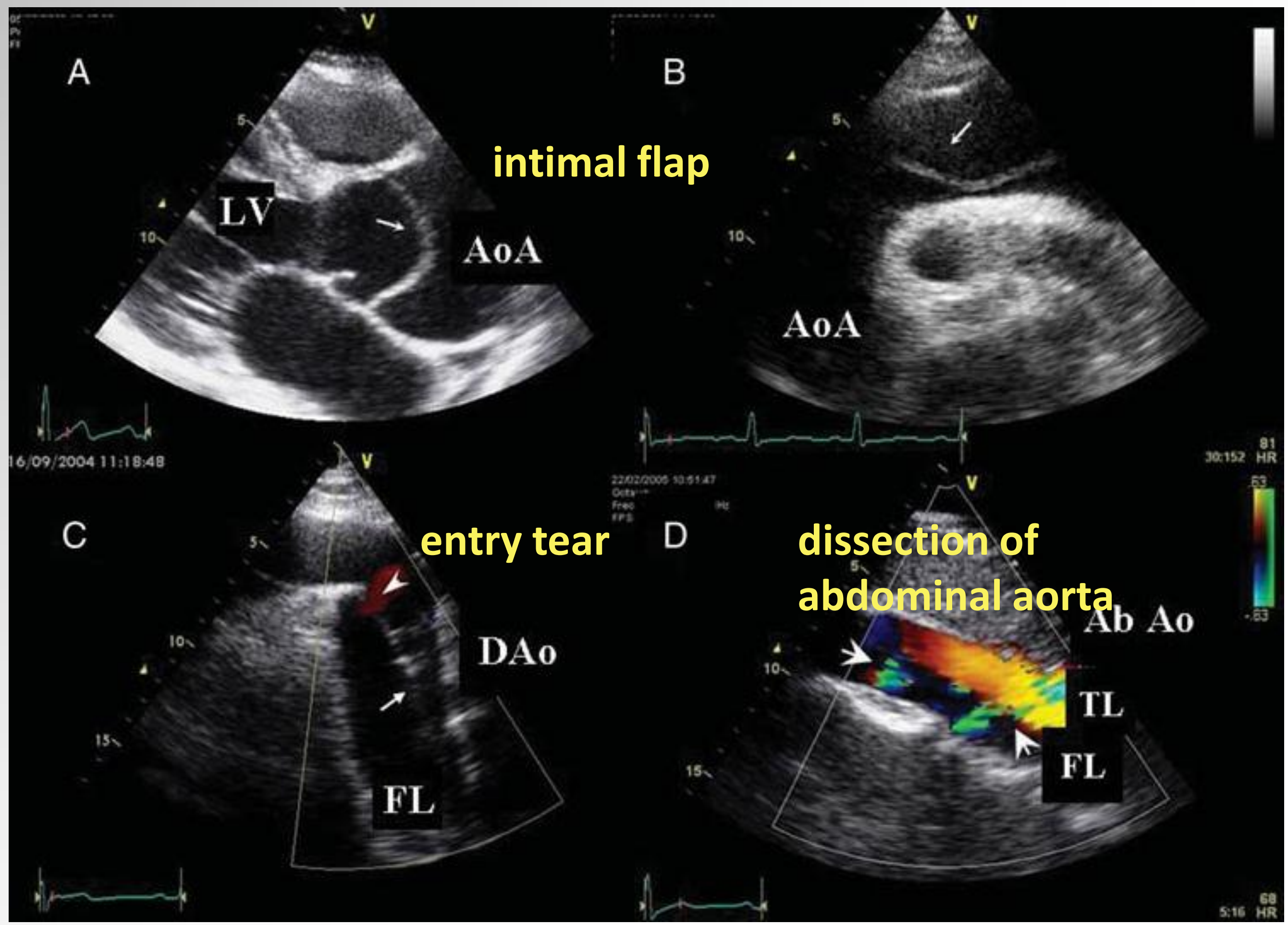
- the main intimal tear usually has a diameter > 5 mm
- TEE identifies the intimal tear in 78–100% of the cases.
- **colour Doppler may show a turbulent jet** directed toward the false lumen (**pulsed Doppler, flow velocity is usually >1.5 m/s in systole).**
- Secondary tears (mostly in descending aorta) in up to 20% of the cases, may be identified with TEE using colour Doppler

Figure 3 Anatomic specimen from a patient with type A aortic dissection. The entrance tear in the ascending aorta is clearly visible (arrow).

(A)



Aortic dissection diagnosis by transthoracic echo



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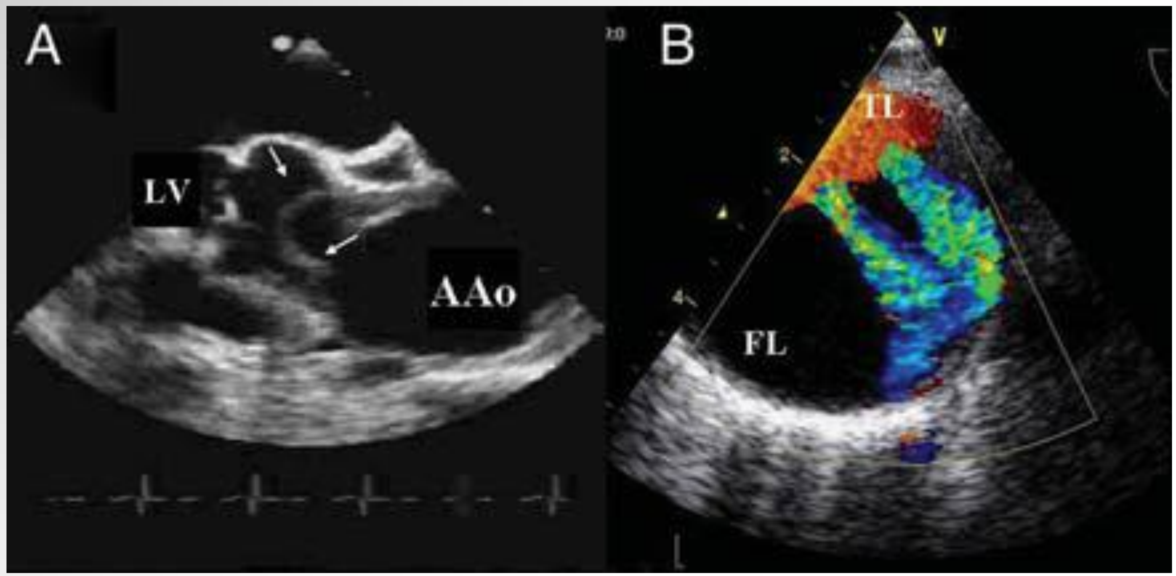
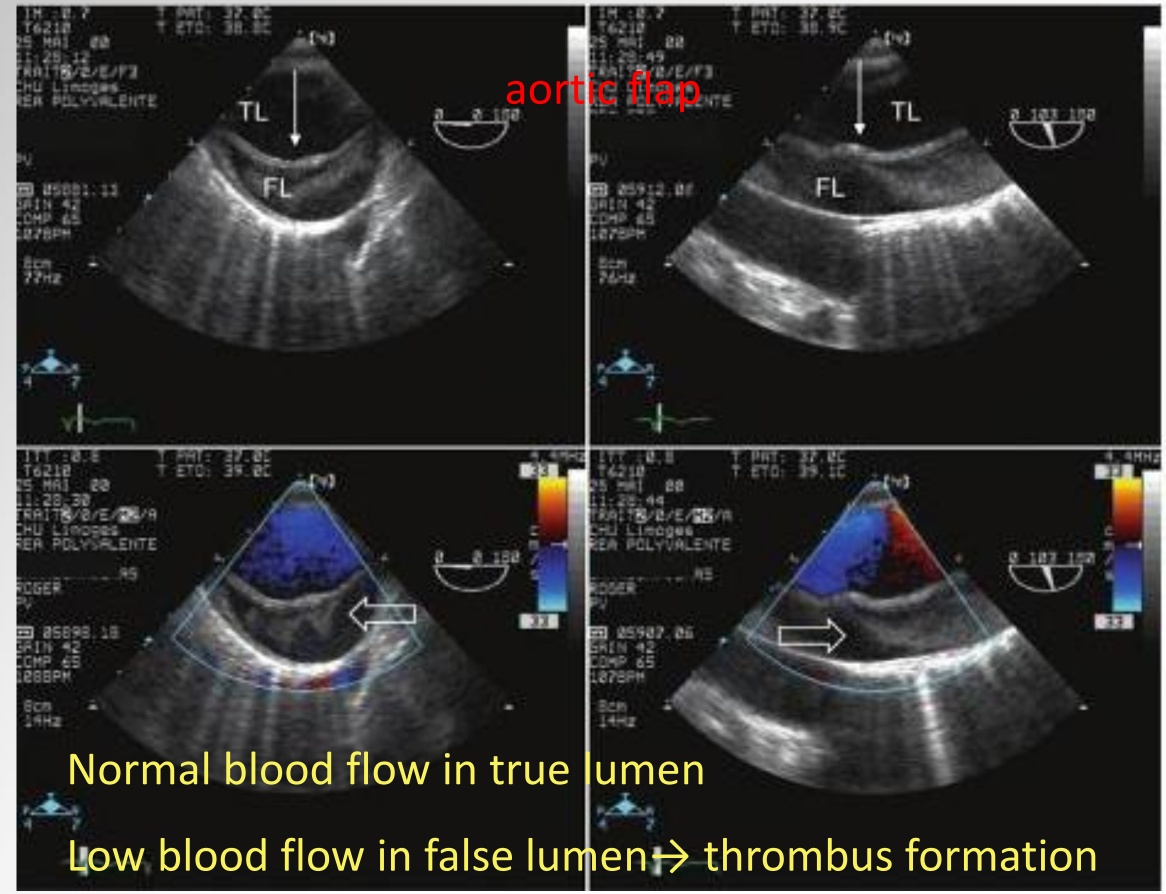
Aortic dissection diagnosis by transoesophageal echo

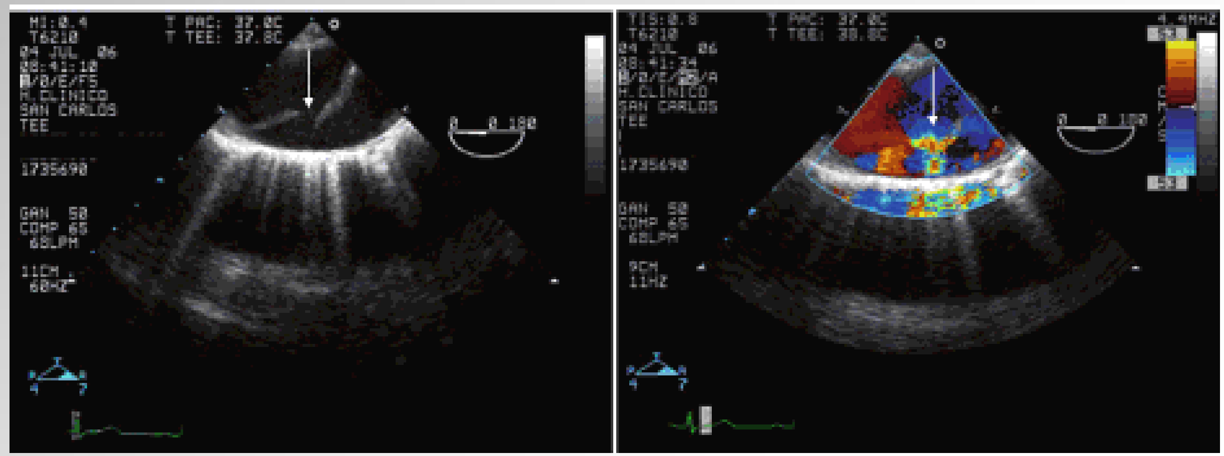


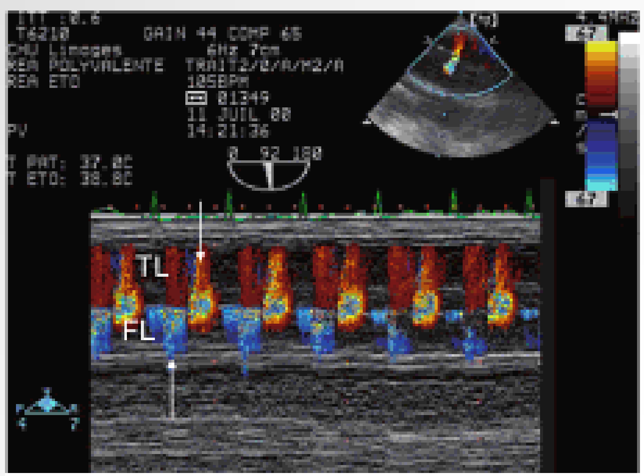
Type B acute aortic dissection



D. De Backer et al. (eds.), *Hemodynamic Monitoring Using Echocardiography in the Critically Ill*,
DOI: 10.1007/978-3-540-87956-5_20, © Springer-Verlag Berlin Heidelberg 2011

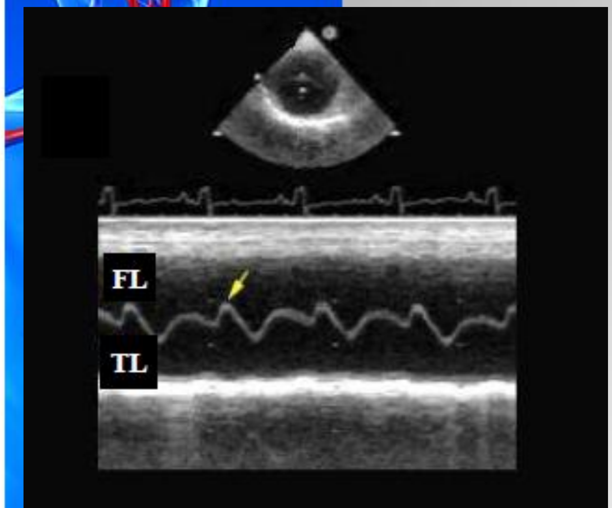
Descending aorta dissection – entry tear

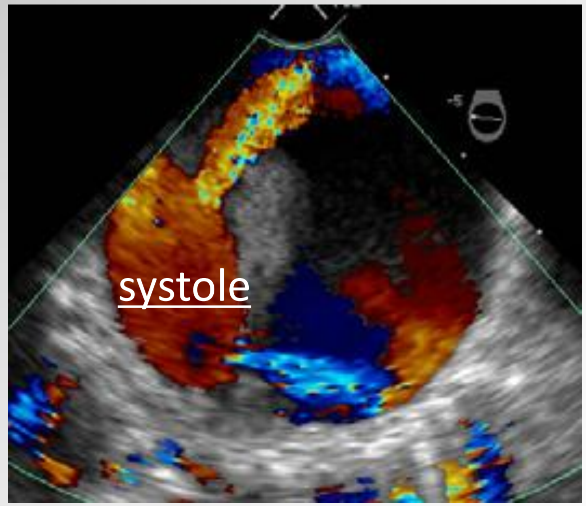




bidirectional flow through entry tear

Differentiation between true and false lumen





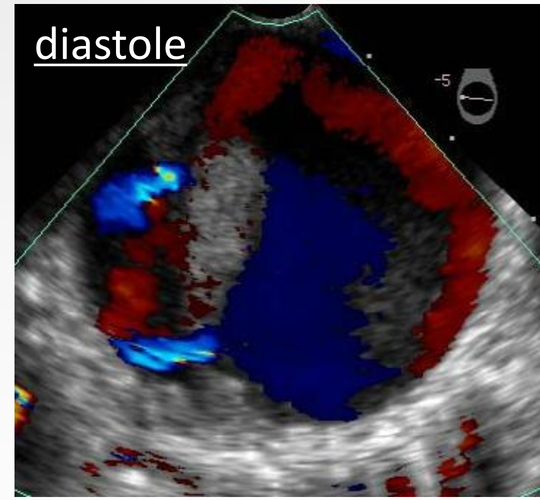


Table 3 Differentiation between true and false lumina

	True lumen	False lumen
Size	True < false	Most often: false > true lumen
Pulsation	Systolic expansion	Systolic compression
Flow direction	Systolic antegrade flow	Systolic antegrade flow reduced or absent, or retrograde flow
Communication flow	From true to false lumen in systole	
Contrast echo flow	Early and fast	Delayed and slow

	True lumen	False lumen
Global size	Small	Large
Size in systole	Increased	Decreased
Thrombus formation	No	Yes
Spontaneous contrast	No	Yes
Blood flow profile (color Doppler)	Laminar Early in systole	Swirling and turbulent, or absent Late in systole
External wall thickness	Normal	Reduced

European Journal of Echocardiography (2010) 11, 645–658

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Reverberation artefacts

- Reverberation artefacts in the aortic root can occur from the walls of the left atrium and in the ascending aorta from the right pulmonary artery.

- Using M-mode, the artefact can be seen to be double the distance from the probe as the original structure with movement, which is in time but twice the amplitude of the original structure .

- Colour flow mapping:
  - differential flow between true and false lumens in true dissection
  - simultaneously shows flow in both sides of linear reverberation artifacts.

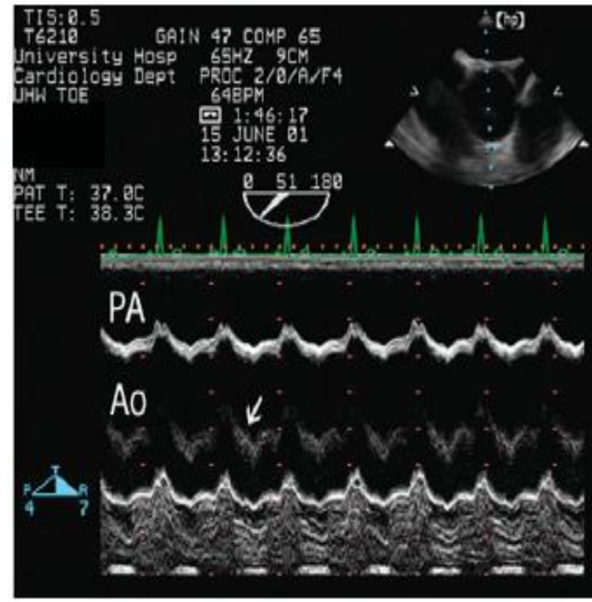


Figure 5 Reverberation artefact seen by M-mode transoesophageal echocardiography. An apparent linear echo in the aorta is seen (white arrow)—it mirrors the motion of the echo bright posterior aortic wall, is twice the distance from the probe, and has twice the amplitude of movement. PA, pulmonary artery; Ao, aorta.

Lethal complications of aortic dissection

- In all AAS, death can ensue from aortic rupture.

- In addition, the potential lethal complications of type A dissection arise from
  - ✓ (i) its proximity to the heart,
  - ✓ (ii) the intrapericardial nature of the aortic root, and
  - ✓ (iii) proximity to the head and neck vessels.

- Thus, the effects of type A dissection may include
  - ➢ acute severe AR (acute dilatation of the aortic root, aortic leaflet prolapse, dissection flap prolapse, pre-existing disease, e.g. bicuspid valve),
  - ➢ coronary ostial occlusion,
  - ➢ haemorrhagic pericardial effusion and tamponade, or
  - ➢ extension to the head and neck vessels causing stroke.

Mechanisms of AR: TEE contribution

Table 4 **Mechanisms of significant aortic regurgitation in aortic dissection**

* Dilatation of the aortic annulus secondary to dilatation of the ascending aorta
* Rupture of the annular support and tear in the implantation of one of the valvular leaflets
Asymmetrical dissections, the haematoma itself may displace a sigmoid below coaptation level
* Prolapse of the intima in the outward tract of the left ventricle through the valvular orifice
Previous aortic valve disease

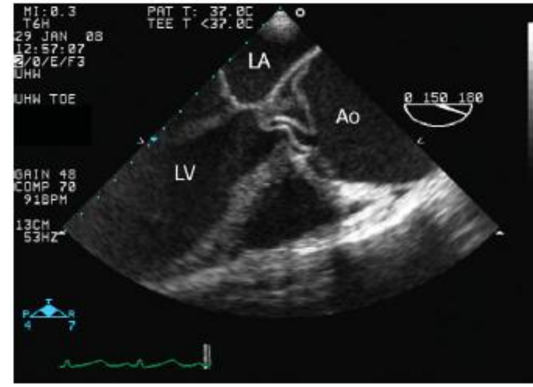
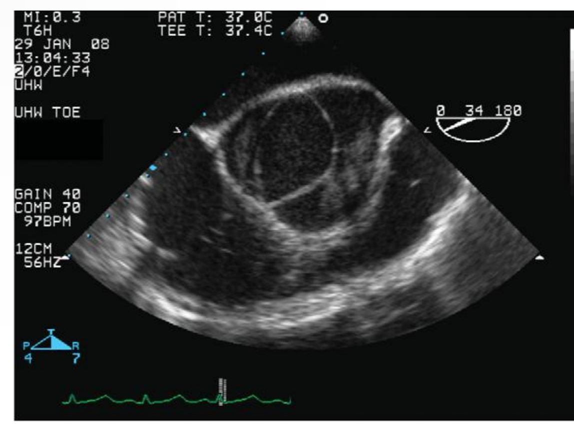
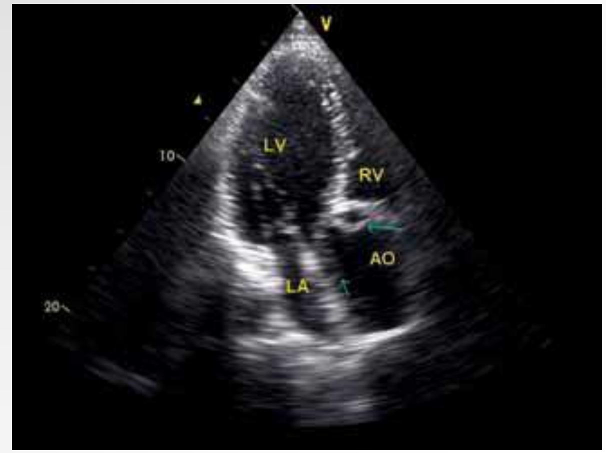


Figure 7 Prolapsing intimal flap, causing severe aortic regurgitation. Transoesophageal echocardiography in the same patient as in *Figure 1*. The flap interferes with closure of the aortic valve. LA, left atrium; LV, left ventricle; Ao, aortic root (which is severely dilated, also contributing to aortic regurgitation).



* **In these mechanisms it is usually possible to surgically 're-suspend' the native valve.**

Intimal flap prolapse in LVOT- severe AR



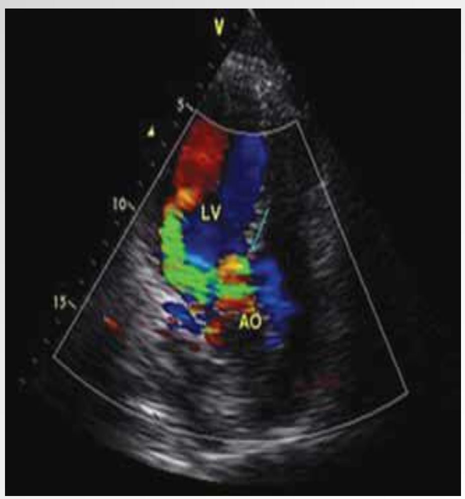


Figure 1. (A, B) Transthoracic echocardiograms showing an intimal flap prolapsing into the left ventricular outflow tract during diastole (arrow). (C) Color Doppler image in the apical five-chamber view shows severe aortic regurgitation (arrow). AO: Aorta; LA: Left atrium; LV: Left ventricle; RV: Right ventricle.

Arch Turk Soc Cardiol 2010;38(2):118-120

TEE:
Arterial involvement

- In 10–25% cases of dissection, the intimal flap propagates retrogradely to the origin of coronary arteries (RCA: most frequently affected). Coronary involvement is suggested by left ventricular regional wall abnormalities (DD: pre-existing CAD).
- TEE allows direct visualization of the coronary ostia and their spatial relationship to the proximal extent of the dissection flap; proximal flow can be seen with colour Doppler.
- The upper oesophageal views of the aortic arch can be used to identify the origin of the head and neck vessels and assess whether flow is from the true or false lumen.

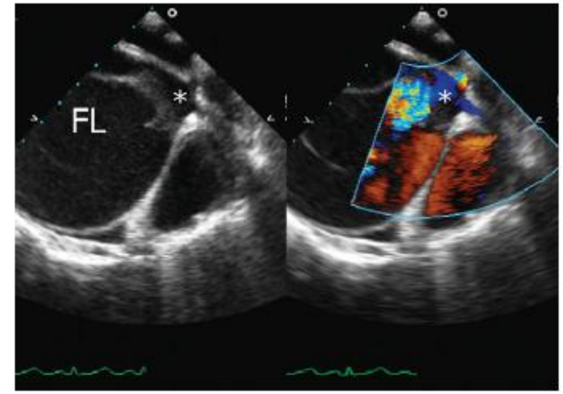
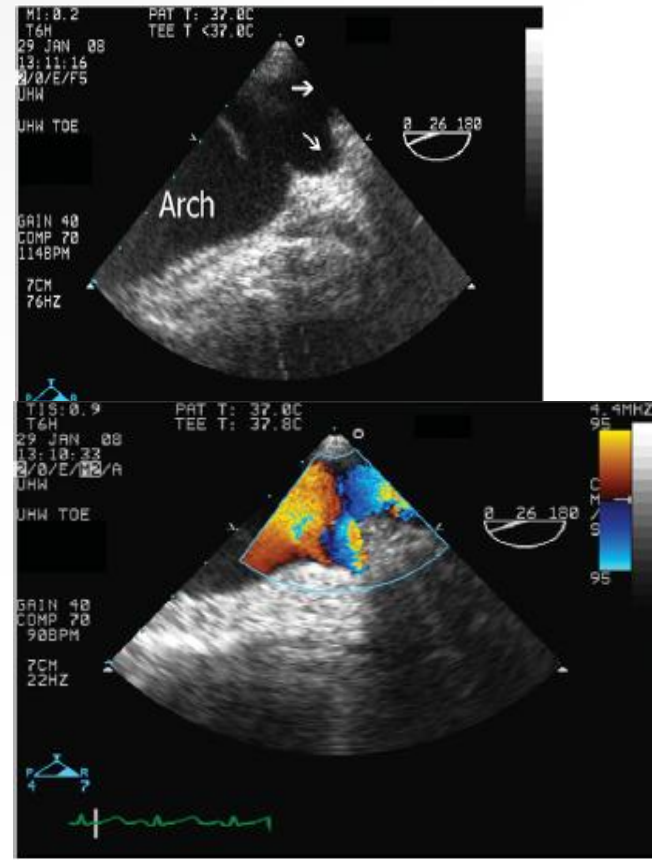
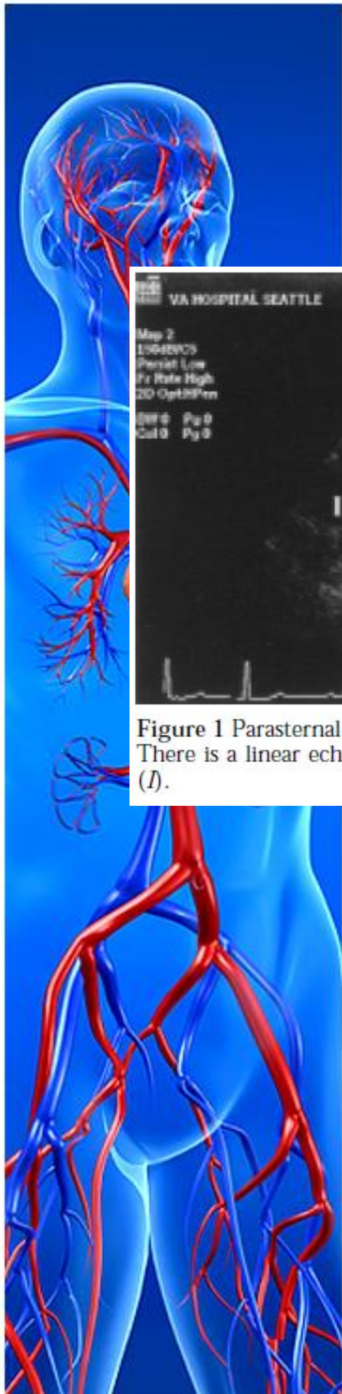


Figure 8 Visualization of the left coronary ostium. Transoesophageal echocardiography short-axis view: in the left panel, a small true lumen is seen, from which the left coronary artery (asterisk) arises. Separate origins of the left anterior descending and circumflex branches can be seen—this was invaluable information for the cardiac surgeon. In the right panel, colour flow mapping shows unobstructed flow from true lumen into the left coronary branches.



Transthoracic Contrast Echocardiographic Detection of Ascending Aortic Dissection

Denise McRee, BA, Miles Matsuda, BS, RDMS, John Stratton, MD, FACC, and Gary Martin, MD, *Seattle, Washington*



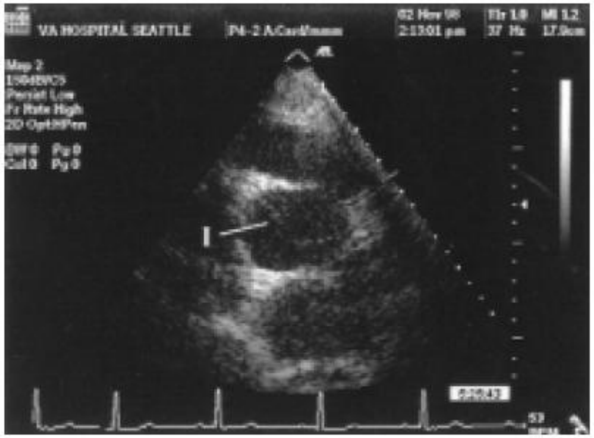


Figure 1 Parasternal short-axis view above the aortic valve. There is a linear echodensity that suggests an intimal flap (*I*).

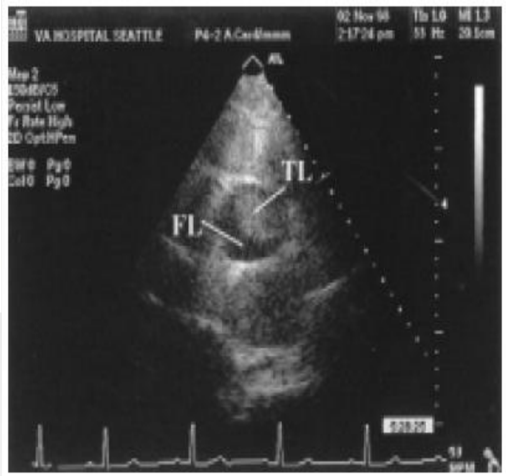
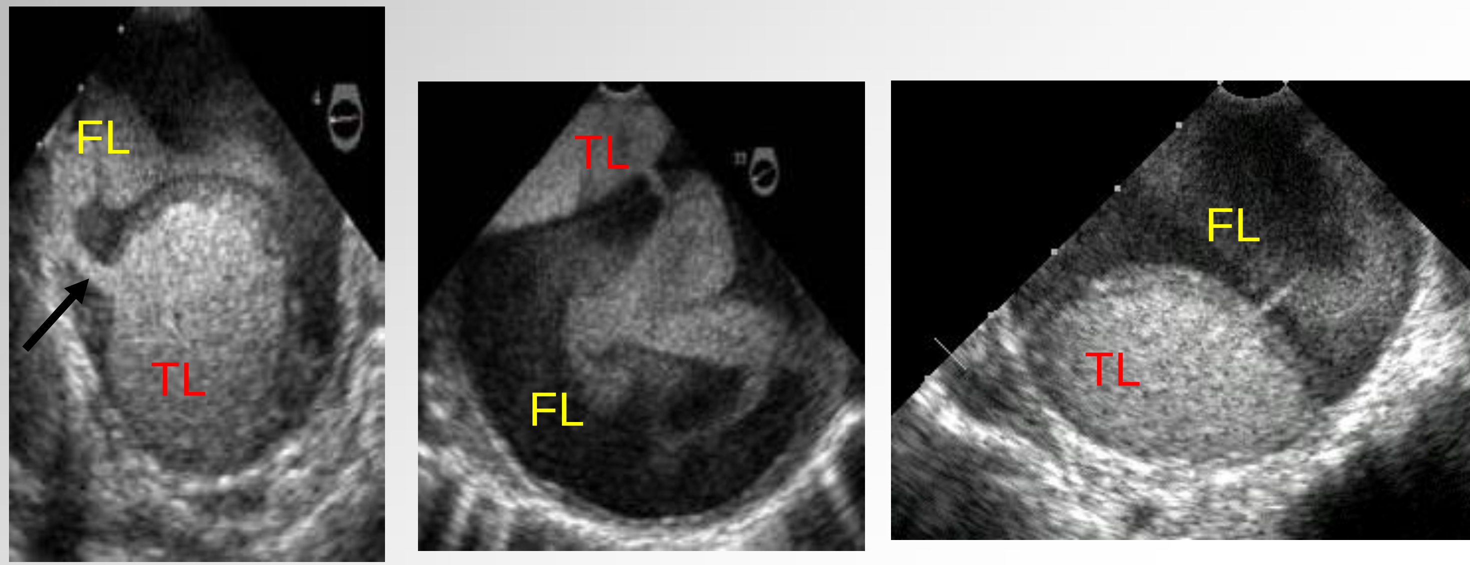


Figure 2 With contrast injection the true lumen (*TL*) and false lumen (*FL*) become more definitively separated.

Figure 3 After dissipation of the injected contrast material, the intimal flap (*I*) became more apparent.

Contrast agent



Contrast echographic agent for detection of small intimal tears (arrow), true lumen (TL), false lumen (FL).

Contrast enhanced echo in aortic dissection

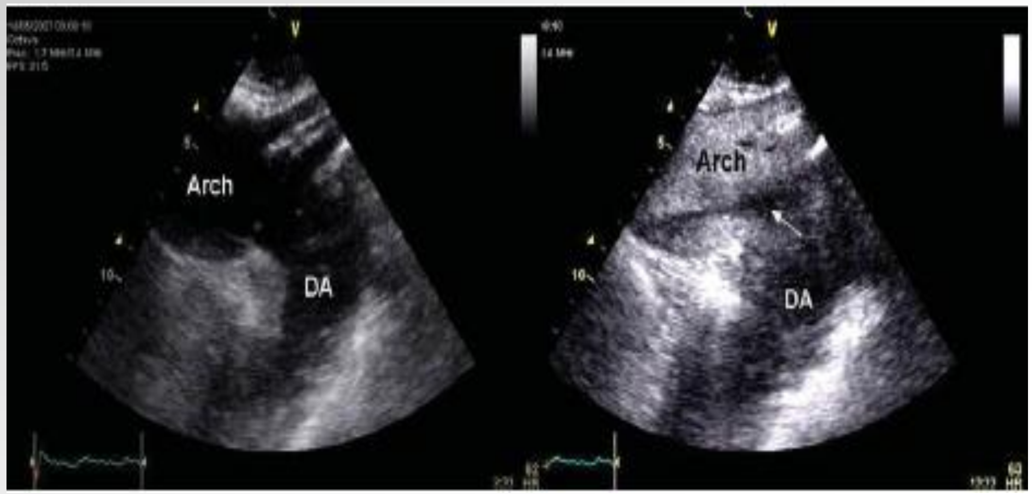
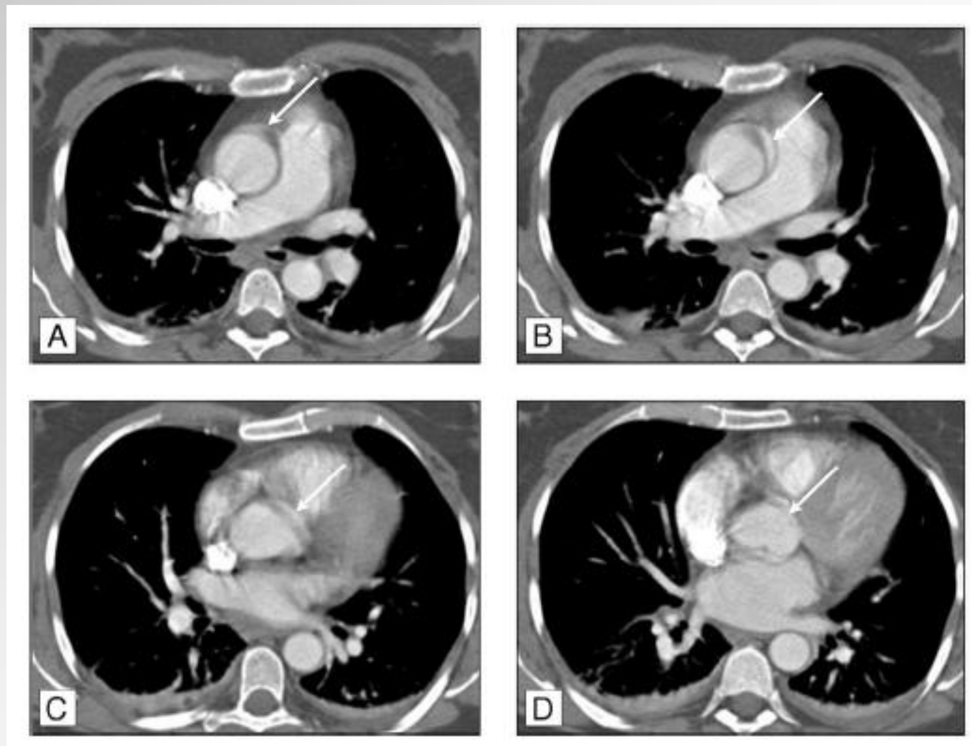


Figure 3 Suprasternal view of transthoracic echocardiography in a patient with Type B dissection. Left panel: with non-enhanced study, intimal flap is not visualized. Right panel: intimal flap (white arrow) and two lumina are visualized in aortic arch.

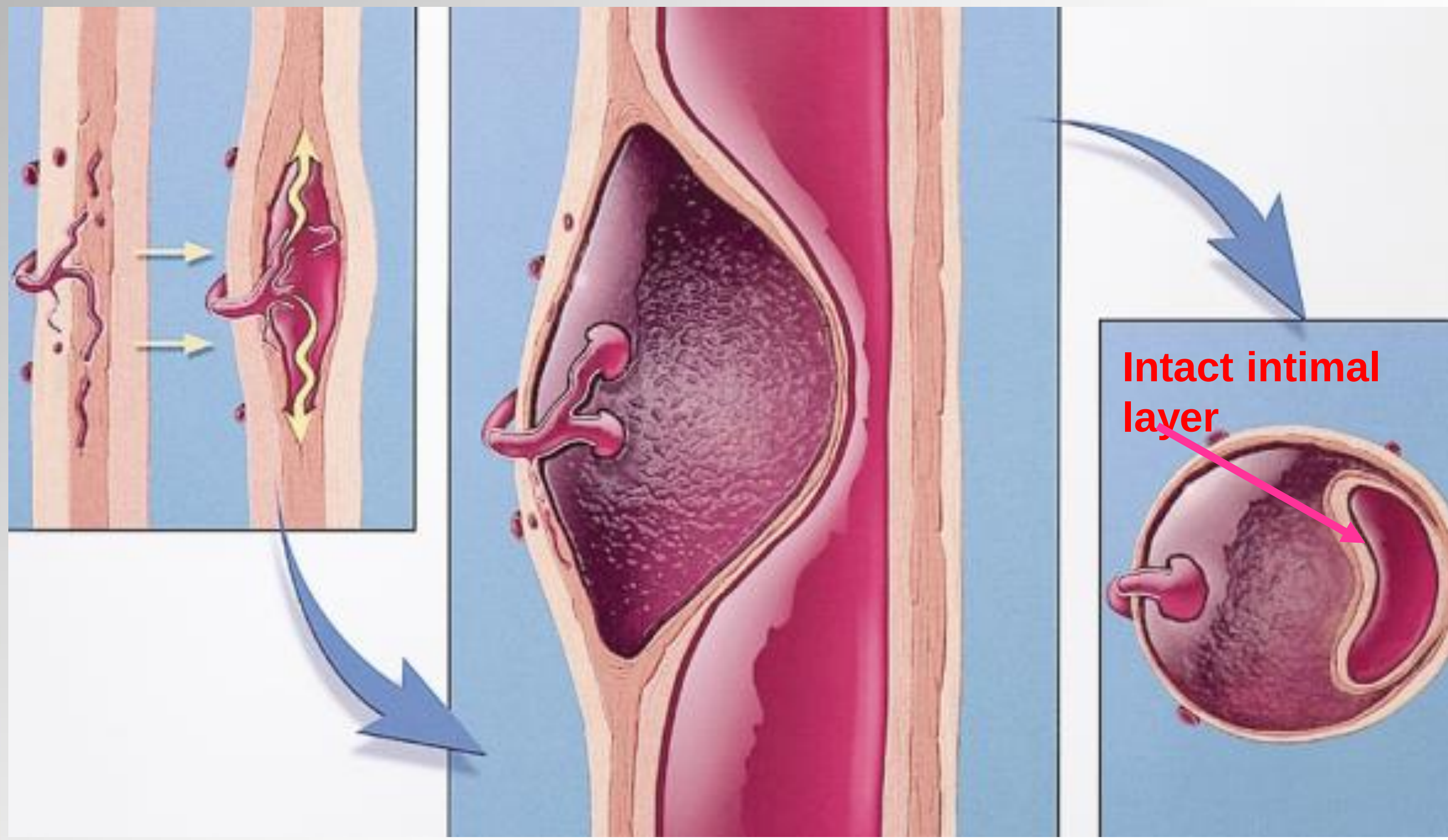
European Heart Journal (2010) **31**, 472–479

CT motion artefacts (no ECG gating) mimicking ascending aorta dissection



Presse Med. 2011; 40: 43–53

Intramural Hematoma (IMH) Dissection without tear



Events leading to intramural hematoma, from rupture of vasa vasorum feeding aortic media to creation of intramedial hematoma with intact intimal layer.

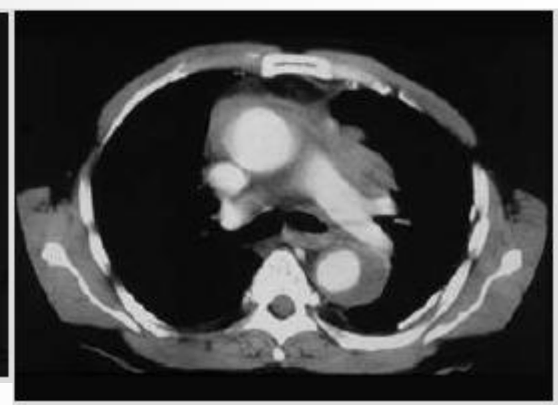
"Atypical" Aortic Dissection (intramural haematoma)

Typical = Dissection flap and false lumen

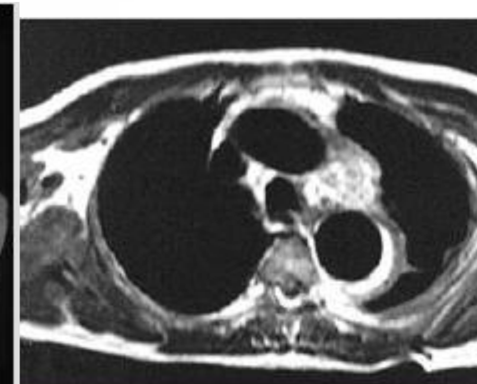
"Atypical" = No dissection flap; Medial haematoma

TEE

CT



MRI



Intramural heamatoma IMH

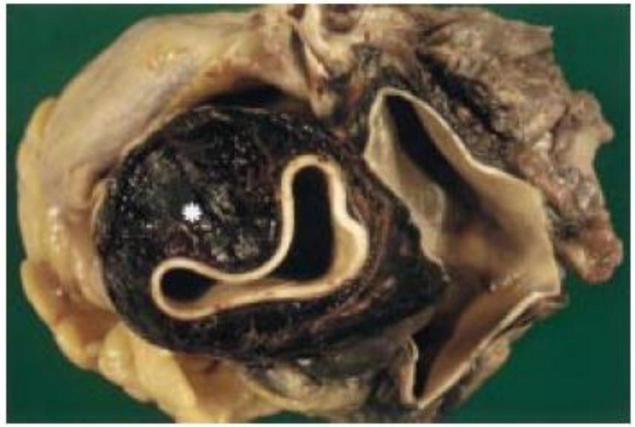


Figure 6 *Anatomical cross section of the ascending aorta. An intramural aortic haematoma can be observed (asterisk).*

Figure 8 *Histological section (Mason's technique) of a patient with intramural haematoma. Splitting of the aortic media by a haematoma (asterisk) is well documented.*

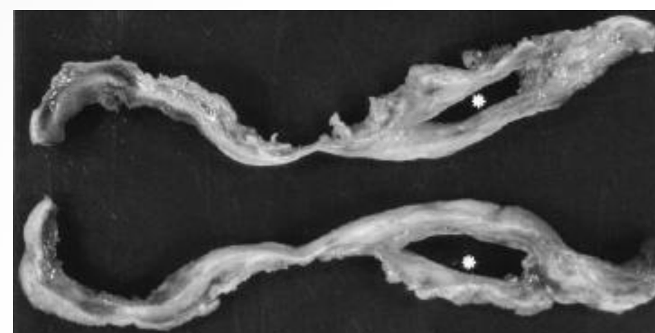


Figure 2. Patient 1. TEE scan (**top**) and corresponding anatomic specimen (**bottom**) showing intramural aortic hematoma (**asterisks**) in the descending thoracic aorta. TR = thrombus.

IMH

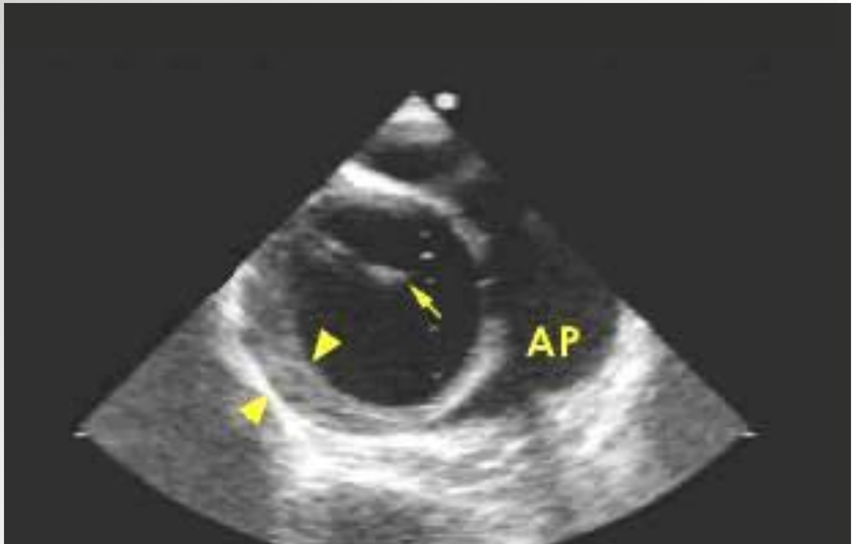
- Circular or semilunar thickening of the aortic wall >5 mm (>7mm*), with no dissection flap, entry tear, or false lumen.
- may contain echolucent zones
- May be distributed in layers
- There should be no flow within
- DD with CT / MRI :intraluminal thrombus or a dissection with thrombosed false lumen.
- *In practice, the term IMH is used loosely to mean a thrombosed false lumen regardless of a small intimal defect (*)*

Circulation 1995;92:1465-72.

J Am Coll Cardiol 1994;23:658-64.

European Journal of Echocardiography (2010) 11, 645–658

*Circulation 2010,121:e266-e369 ACCF/AHA guidelines



Intramural haematoma in ascending aorta (large arrows). The small arrow shows a reverberation of the aortic wall. AP: pulmonary artery.

Intramural haematoma in descending aorta (arrows) with a typical semilunar morphology. AOD: Descending aorta.

IMH characteristics

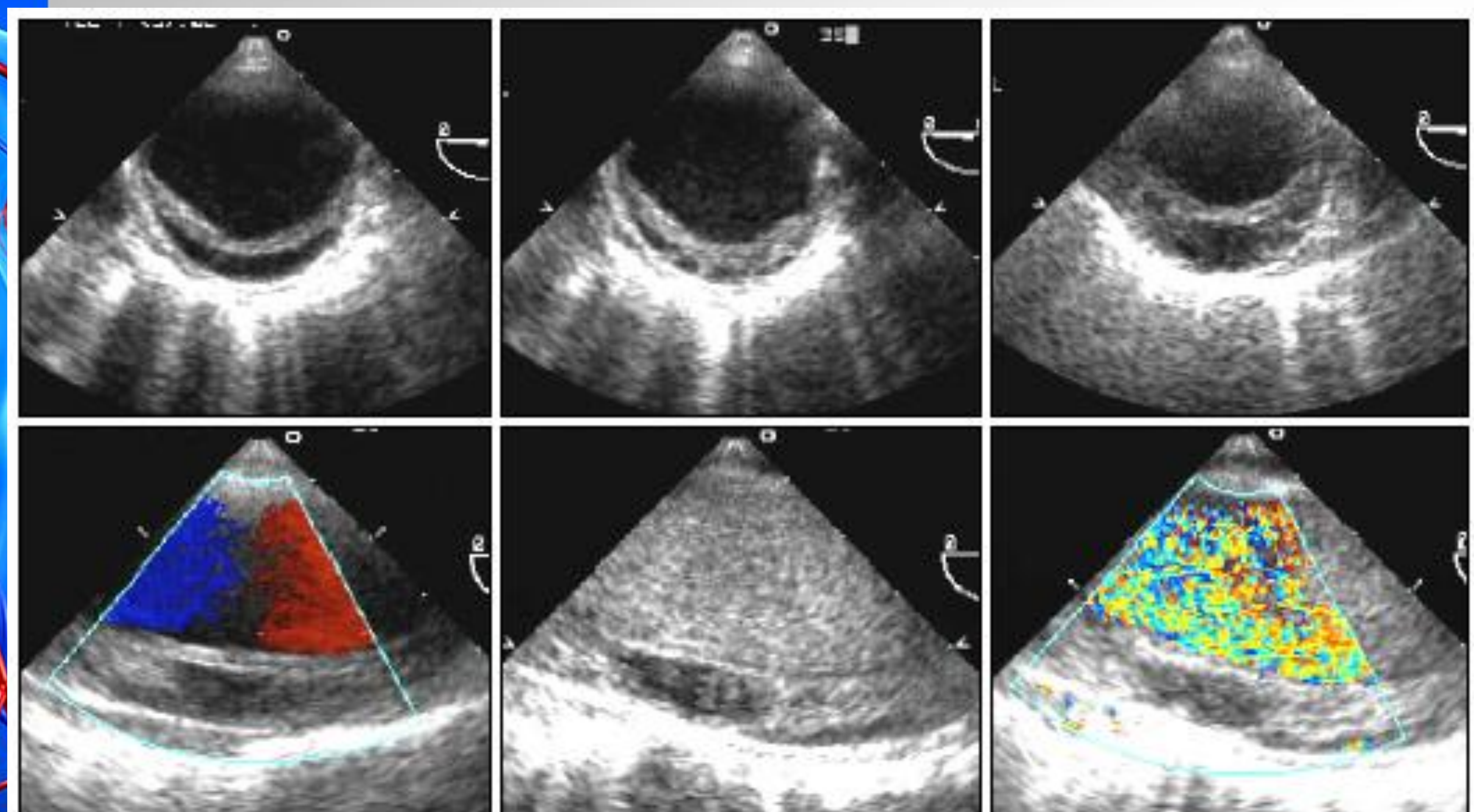
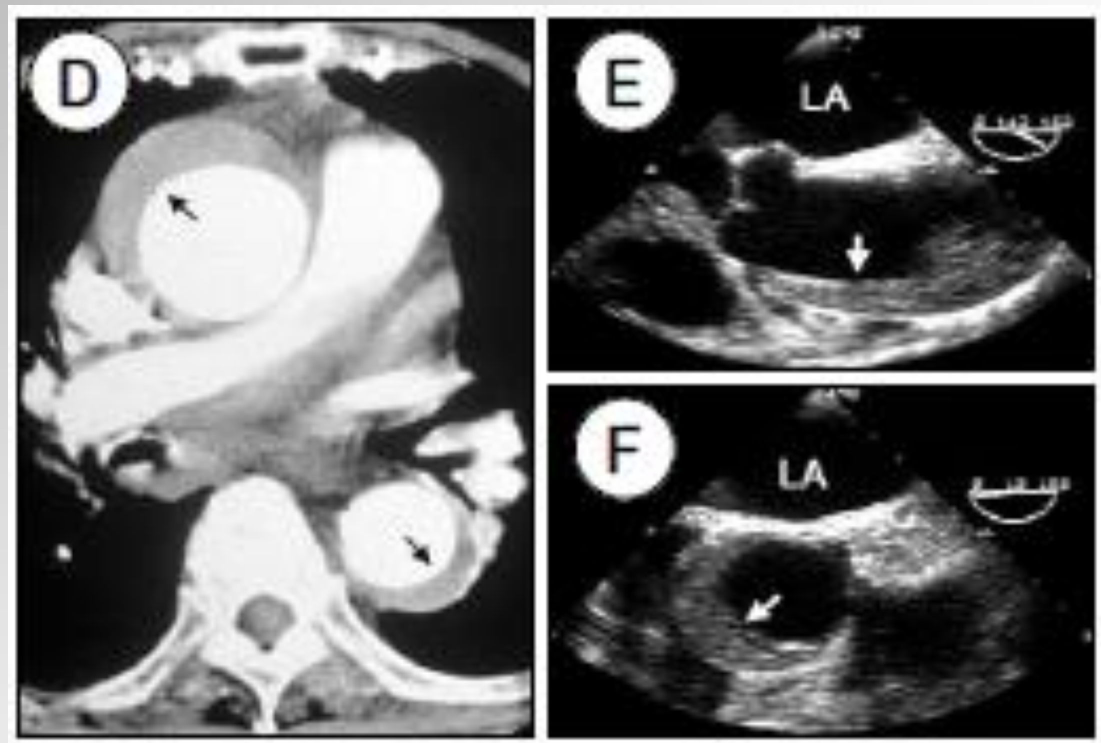


Fig. 5. Transesophageal echocardiographic images showing various patterns of an 'echo-free space' or 'echo-lucent area' in patients with aortic intramural hematoma, which do not show any evidence of flow communication in color Doppler mapping or contrast echocardiography.

intramural hematoma (D, E, F).



High risk imaging features of IMH

Table 3 High risk features in IMH

Location: type A
Age > 70 years
Hematoma thickness > 10 mm
Presence of penetrating ulcers
Aortic dimension > 4.5 cm
Presence of rebleed
Presence of extension

Int J Cardiovasc Imaging (2010) 26:65–76

IMH: in hospital mortality according to site

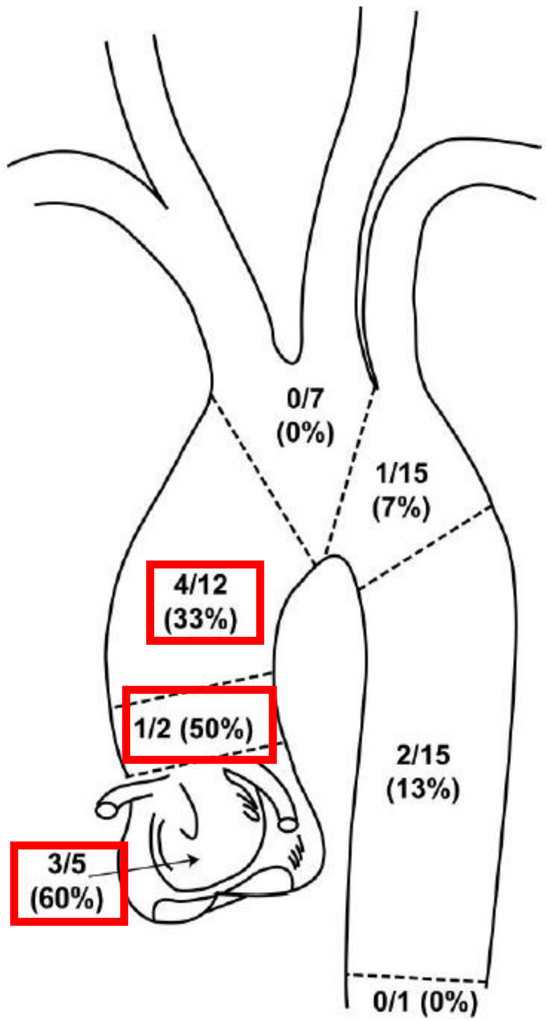


Figure 4. In-hospital mortality for IMH according to site of origin. IMH was defined after the first imaging test failed to demonstrate IMH or dissection but the second test confirmed IMH or the first study showed IMH but no evidence of dissection.

•In IRAD, which registered 1010 patients with acute aortic dissection, 58 (5.7%) had IMH.

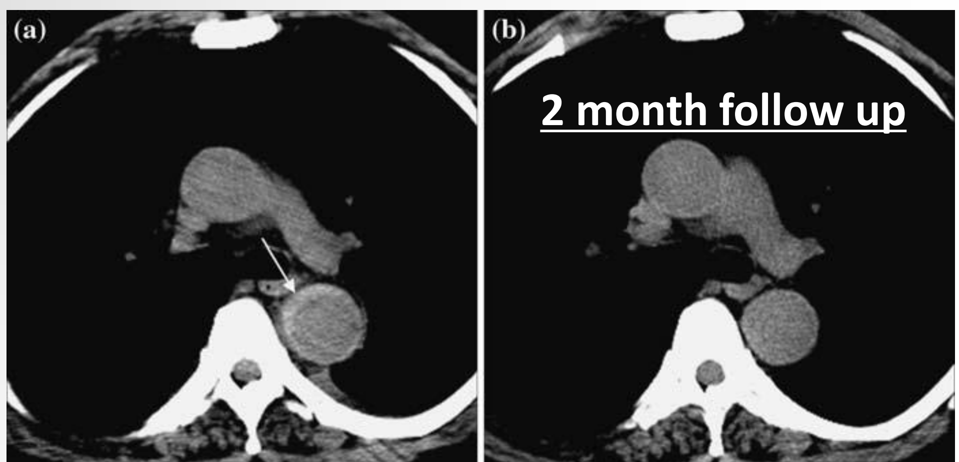
•This cohort tended to be older (68.7 versus 61.7 years; P 0.001) and more likely to have distal aortic involvement (60.3% versus 35.3%; P 0.0001).

•The investigators demonstrated an association between increasing hospital mortality and the proximity of IMH to the aortic valve, regardless of medical or surgical treatment (9 of 12 deaths occurred in the ascending
•aorta) .

(*Circulation*. 2005;112:3802-3813.)
Circulation. 2005;111:1063–1070.

Natural History of IMH I: Complications

- Acute IMH accounts for 5–20% of all AAS (in Asian studies 30-40%)
- Regression in 10%
- Progression towards overt false lumen dissection 28-47%
- Early aneurysm formation or rupture 20-45%



Int J Cardiovasc Imaging (2010) 26:65–76
Eur J Vasc Endovasc Surg (2009) 38, 659–665

Natural History of IMH II: regression (medical/ TEVAR)

- Spontaneous reabsortion under medical treatment of IMH less common

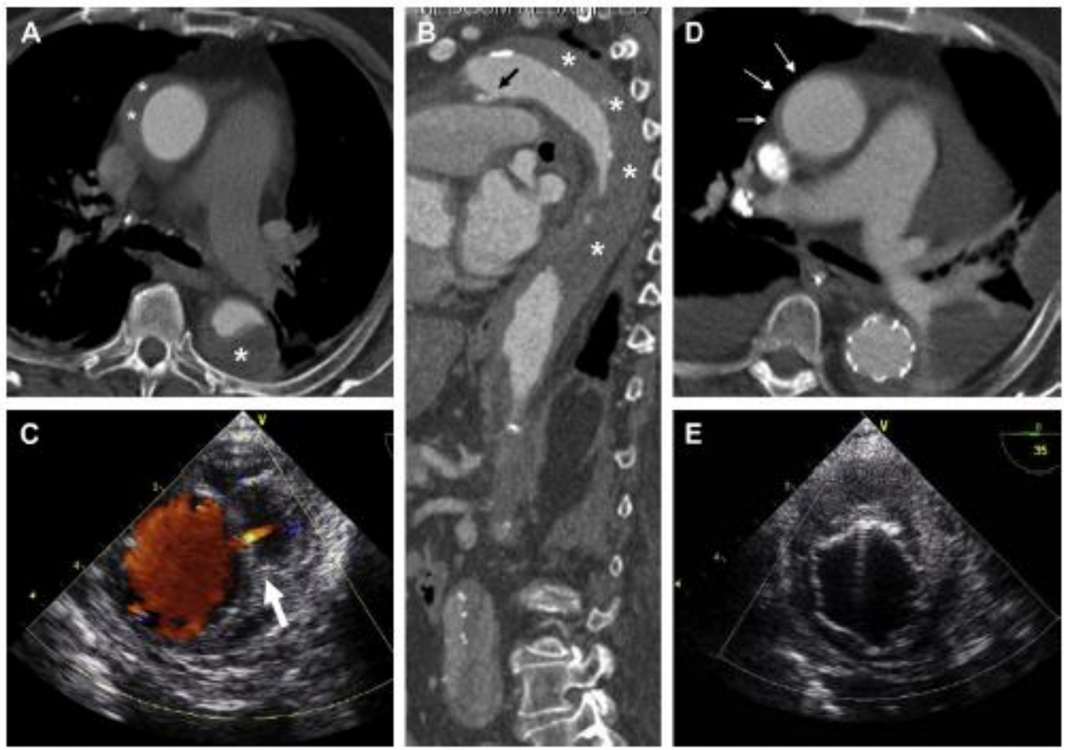
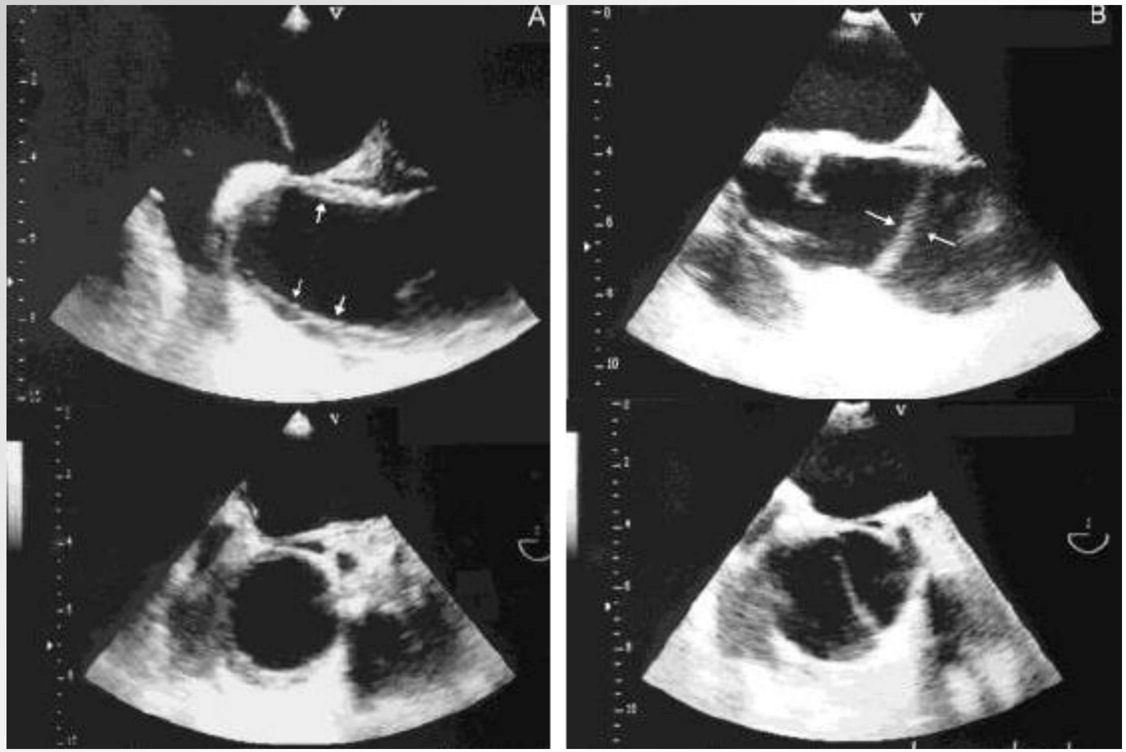


Figure 2 A. Contrast-enhanced CT of a patient presenting with acute aortic syndrome showing type A-IMH (asterisk) with evolving dissection in the descending aorta. B. Multiplanar reconstruction of the CT in parasagittal orientation delineates small intimal disruption/plaque rupture as the initial site of the IMH (arrow, asterisk-IMH). C. Transesophageal echocardiography showing active bleeding from the aortic lumen into the hematoma (arrow). D. Result after TEVAR with stent-implantation into the distal arch. Note complete reabsorption of the type A-IMH, as well as near-total resolution of descending thoracic aortic IMH. E. TEVAR result shown by intraoperative TEE, showing elimination of flow into the IMH.

Evolution of type A IMH to Dissection

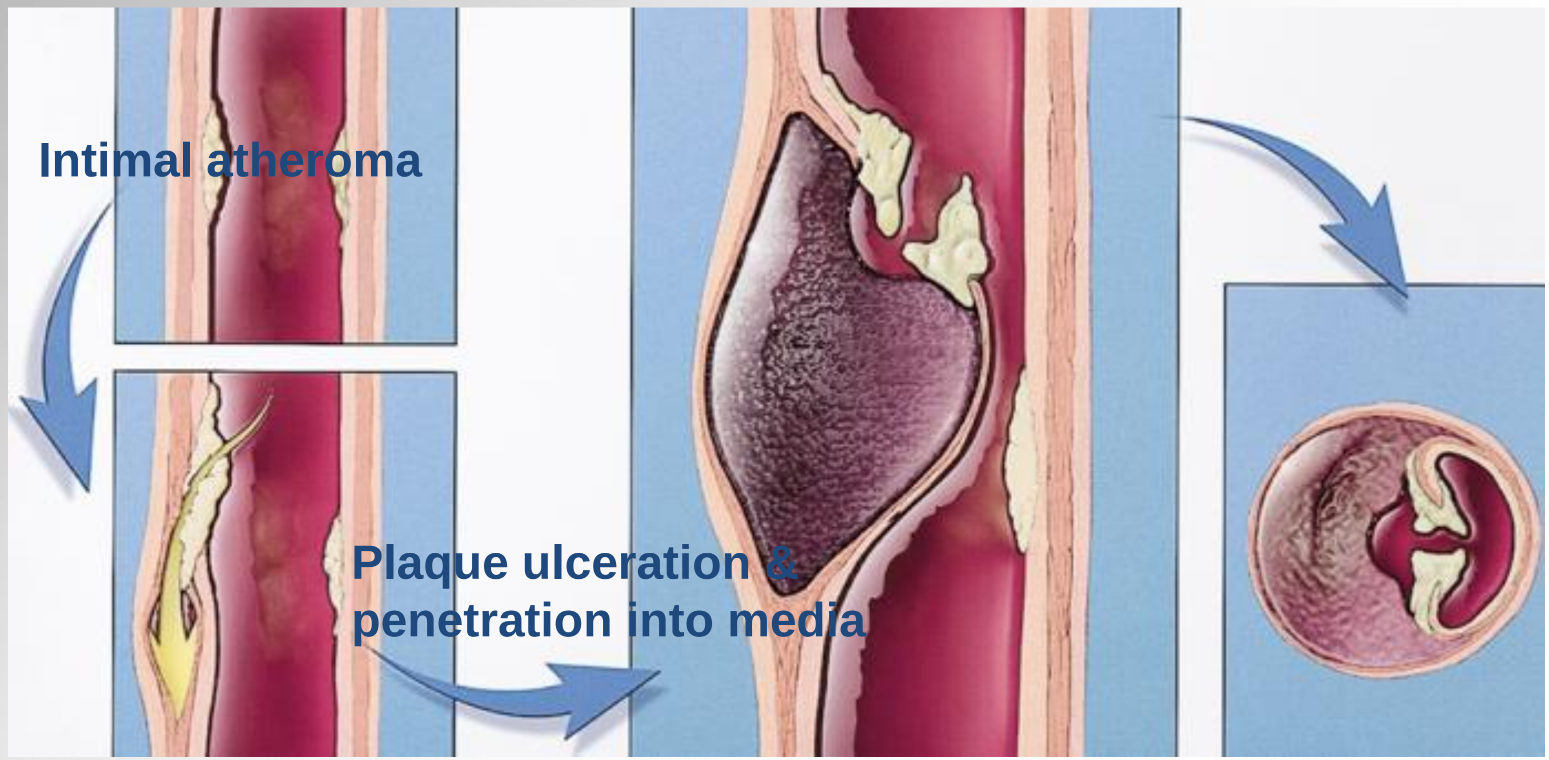


IMH: is it really dissection without a tear?

Grimm M, Loewe C, Gottardi R, Funovics M, Zimpfer D, Rodler S, et al. Novel insights into the mechanisms and treatment of intramural hematoma affecting the entire thoracic aorta. *Ann Thorac Surg* 2008;86:453–6.

High resolution ECG gated CT angiography applying multiplanar reconstractions revealed small atherosclerotic plaque ruptures at the free lateral wall or the concavity of aortic arch: cause of IMH

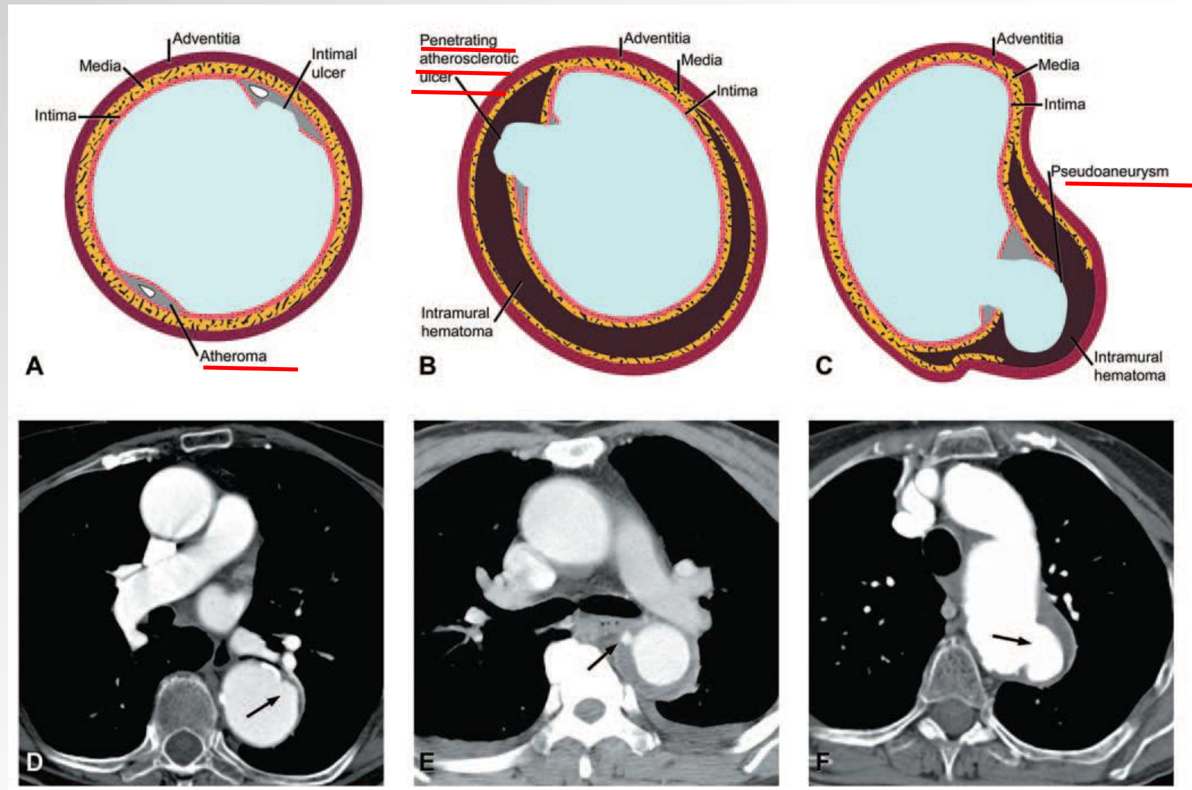
penetrating aortic ulcer



Events leading to penetrating aortic ulcer from formation of extensive aortic atheroma confined to intimal layer, through lesion progression to deep ulceration of plaque with penetration into media, to entrance of blood from aortic lumen into media and splitting of media with intramural hematoma. Hematoma formation may extend along media, resulting in long-segment intramural hematoma.

PAU vs atheromatous ulcers

- Atheromatous ulcers are usually small, confined to the intima and do not cause symptoms, although these lesions may eventually progress to PAU .
- **PAU extends beyond the aortic intima and therefore is seen outside the aortic lumen**, usually surrounded by an IMH of variable extent, which has a smooth interface with the contrast in the lumen.



APPLIED RADIOLOGY January–February 2010

Penetrating aortic ulcer

- 2.3-7.6% of acute aortic syndromes
- PAU occur predominantly in the descending thoracic and abdominal aorta .
- They occur more commonly in the elderly and there is often widespread atheromatous disease.
- PAU is usually a focal lesion appearing as an outpouching of the aortic wall with jagged edges. Concomitant aneurysms of the descending aorta may be found.
- If a PAU extends to dissection, the dissection is usually shorter, limited by neighbouring fibrosis and calcification. The flap is usually thicker, may be calcified, and is less mobile than in a true dissection

Figure 9 Anatomical cross section of the descending thoracic aorta. A penetrating atherosclerotic aortic ulcer is indicated by an arrow.

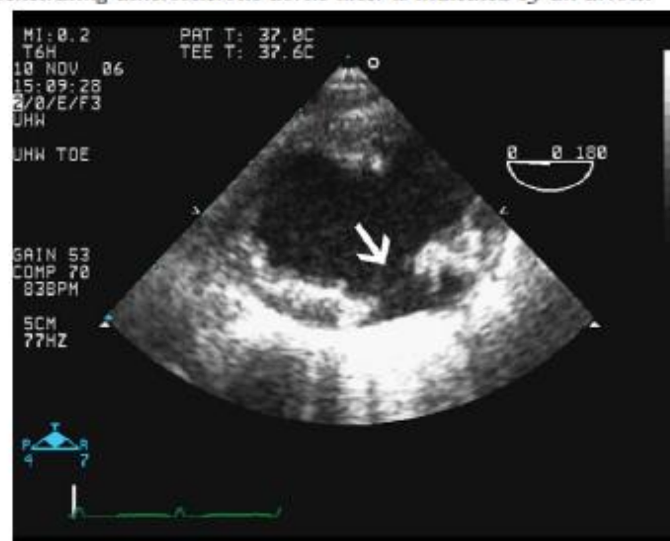


Figure 3 Penetrating atherosclerotic aorta. A transoesophageal echocardiography image of the descending aorta showing severe atheroma with a localized, bulge associated with plaque rupture (white arrow).

Eur J Vasc Endovasc Surg (2009) 38, 659–665

Penetrating atherosclerotic ulcer

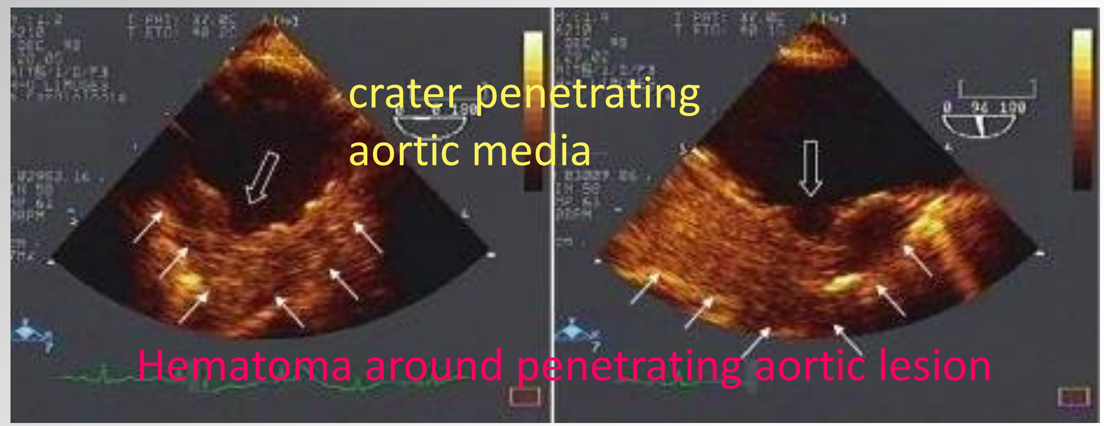
- Penetrating atherosclerotic ulcer is caused by erosion of an intimal atherosclerotic plaque into the media

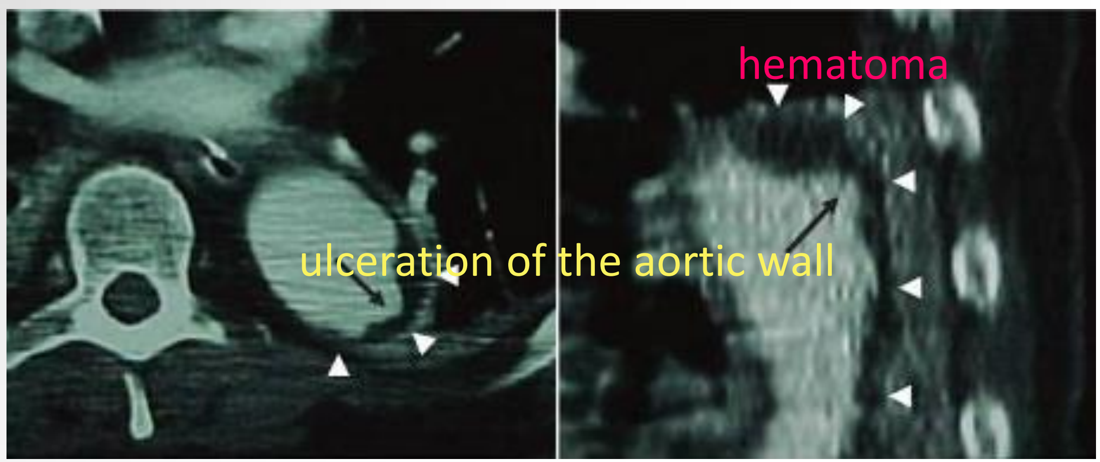
- Erosion into the vasa vasorum may lead to IMH formation and possibly dissection.

- Adventitial erosion may cause aneurysm formation or rupture. Rupture has been reported in up to 42% of cases.

Figure 3 Penetrating atherosclerotic aorta. A transoesophageal echocardiography image of the descending aorta showing severe atheroma with a localized, bulge associated with plaque rupture (white arrow).

Penetrating atherosclerotic ulcer





Natural History of PAU: Complications

- Conflicting data on disease behaviour
  - Worse prognosis for symptomatic pts

- Complications
  - Development of localized IMH (due to arrosion of aortic vasa vasorum by the ulcer): 48% progression rate vs 8% for IMH alone, PAU size >20mm diameter, depth >10mm
  - (Pseudo) aneurysm formation
  - Progression to overt aortic dissection or rupture in up to 40% of pts

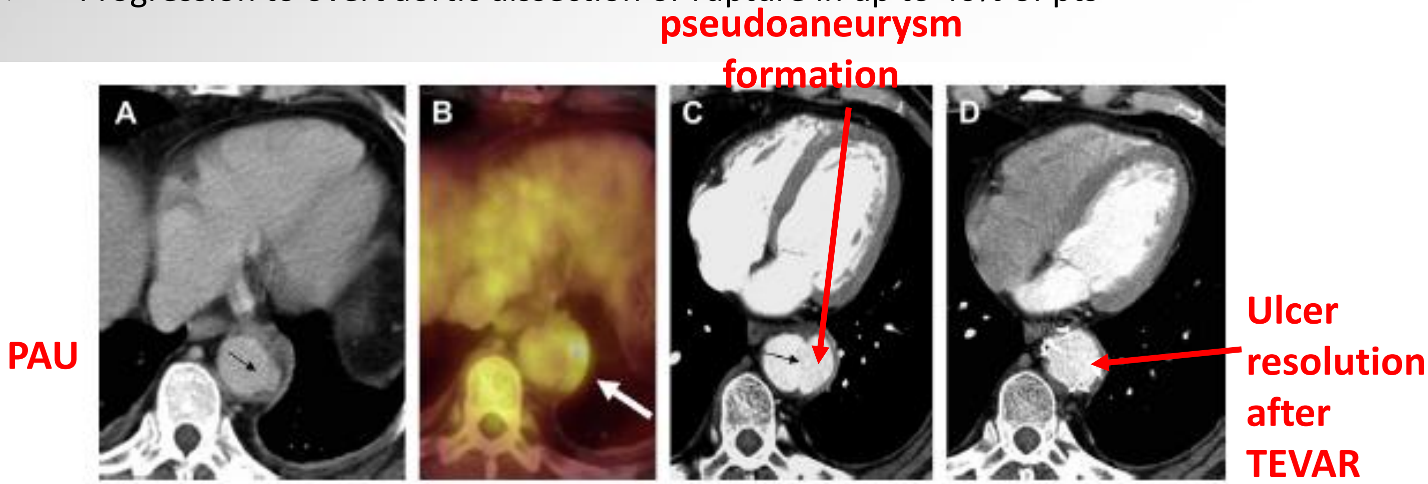
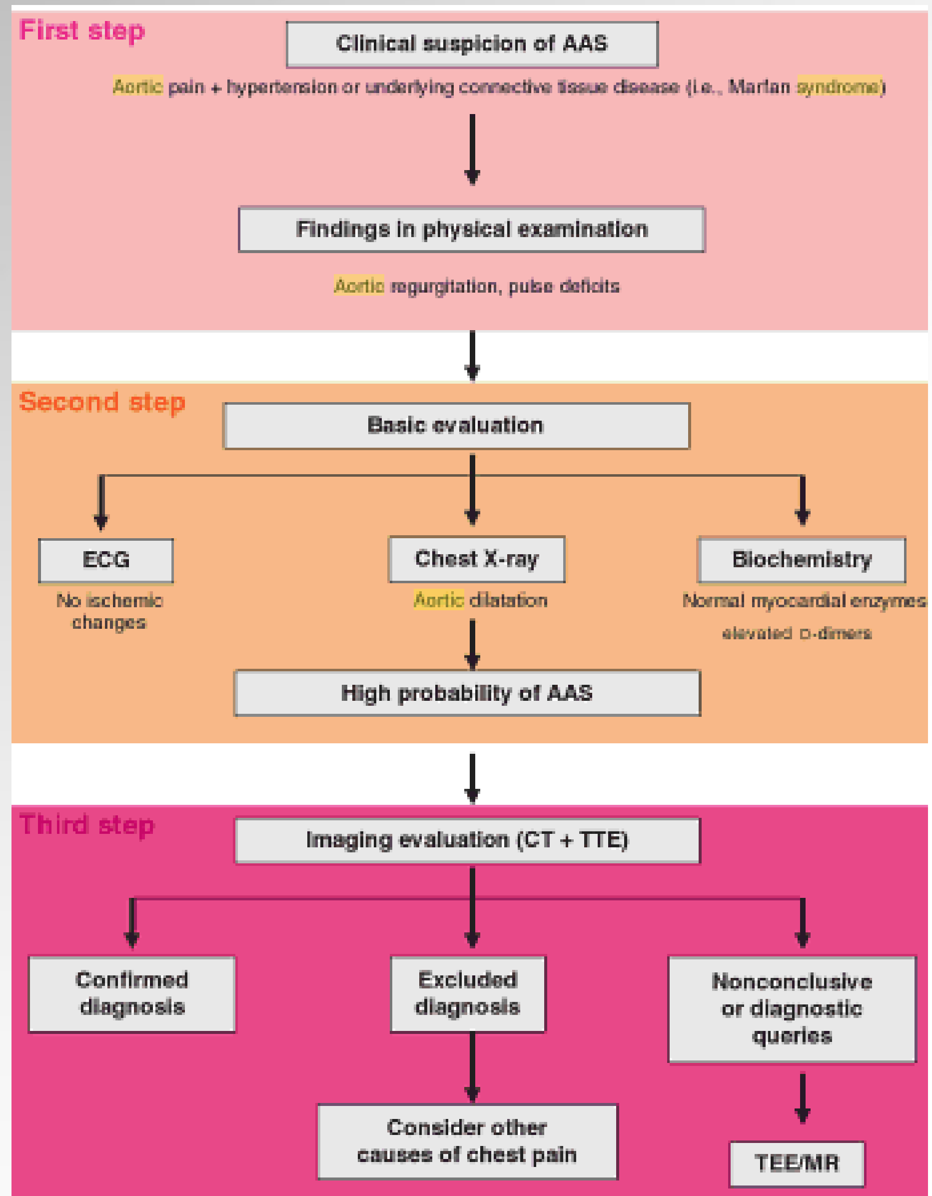


Figure 3 A. Penetrating aortic ulcer (arrow) in an acute aortic syndrome patient. B. Fused PET-CT image showing increased glucose metabolism within the PAU (arrow). C. Progression towards pseudoaneurysm formation (arrow) under medical treatment. D. Result after TEVAR with complete resolution of the ulcer.

Eur J Vasc Endovasc Surg (2009) 38, 659–665

Diagnostic workup for assessing patients with suspected acute aortic syndrome



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REVIEW ARTICLE

Role of Echocardiography in Acute Aortic Syndrome

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acute aortic syndrome;
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intramural hematoma;
penetrating aortic ulcer;
transesophageal echocardiography;
transthoracic echocardiography

Acute aortic syndrome (AAS) is a summary term for three life-threatening acute aortic pathologies: aortic dissection, intramural hematoma, and penetrating aortic ulcer. Transthoracic echocardiography (TTE) is a screening tool for assessing chest pain in an emergency setting, diagnosing AAS with suboptimal sensitivity. However, TTE is very important in assessing potentially high-risk AAS features, e.g., pericardial effusion, left ventricular regional wall motion abnormalities, dilated aortic root, and aortic regurgitation; and diagnosing other conditions with similar clinical AAS features, e.g., acute coronary syndrome and acute pulmonary embolism. Computed tomography (CT) is the gold standard for diagnosing AAS. Multidetector CT has higher sensitivity and specificity compared to conventional CT. Transesophageal echocardiography (TEE) is for intraoperative guidance and perioperative monitoring of AAS, and if a local TEE expert is available, diagnosing AAS.

TEE in the diagnosis and risk stratification of AAS.

- The primary aim of TEE is to
  - identify the intimal flap,
  - false lumen, and
  - entry tear,
  - delineate the extent of aortic dissection,
  - and identify IMH or PAU.

- Secondary objectives are to provide important information to cardiac surgeons,
  - such as the AR severity and its mechanism,
  - branch involvement of coronary/head and neck,
  - extravasation of blood

Acute aortic syndromes treatment options

- Acute aortic syndromes (dissection or IMH) involving the **ascending aorta are surgical emergencies**; in selected cases, hybrid approaches of an endovascular and open combination may be considered.

- Conversely, acute aortic pathology confined to the **descending aorta is subject to medical treatment unless complicated** by organ or limb malperfusion, progressive dissection, extraaortic blood collection (impending rupture), intractable pain, or uncontrolled hypertension.

European Heart Journal (2012) 33, 26–35

Are all techniques equally accurate?

2006 META-ANALYSIS

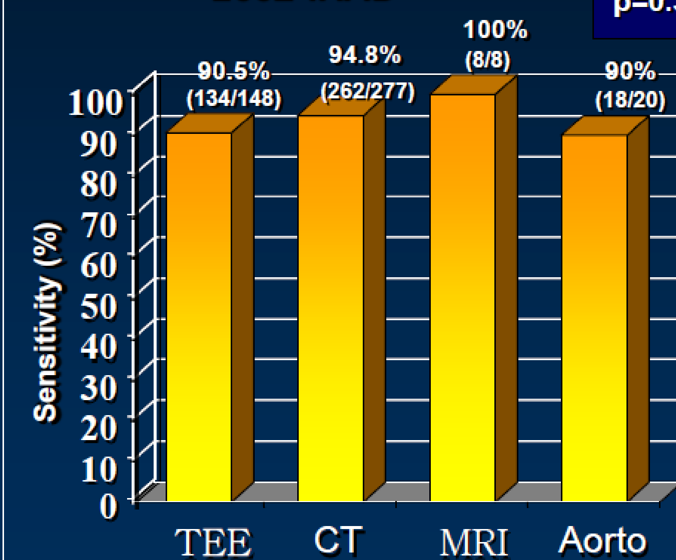
16 studies: 1139 patients

	Sens	Spec
TEE	98%	95%
CT	100%	98%
MRI	98%	98%

Arch Inter Med 2006;166:1350-6

2002-IRAD

p=0.39



Januzzi et al. *Am J Cardiol* 2002

Imaging of thoracic aorta

Table II. Imaging the thoracic aorta

Modality	Advantages	Disadvantages

MDCT angiography	• Rapid image acquisition (20–30 seconds)
	• 3D reconstruction allows multiple views/orientations
	• Ability for post image processing
	• Faster imaging times reduce time to diagnosis in potentially unstable patients
		• Need for iodinated contrast
		• Radiation exposure (10–20 mSv) –
		  ▪ of concern in young patients requiring serial imaging
		• Image artifacts—particularly in aortic root
		  ▪ may be improved by ECG gating
		• Aortic size can be overestimated due to oblique cuts through lumen.

MRI/MR angiography	• No Radiation • No iodinated contrast • 3 D, multi planar and high resolution • Dynamic and functional information available • May be appropriate for serial imaging over many years.	• Caution with use of gadolinium in renal failure • Need for breath hold • Time consuming (10–30minutes at minimum) depending on center • Not for use in unstable patients (distance of equipment/staff for resuscitation from patient)
Transesophageal echocardiography	• No radiation • No iodinated contrast • Can be performed at the bedside, • Immediate information availability • Excellent evaluation of valve function, pericardial effusion and left ventricular function • Can visualize aorta from root to gastroesophageal junction junction • Doppler interrogation of true and false lumen	• Cannot visualize entire aorta • May be limited by technical difficulties • Semi-invasive • Requires conscious sedation and patent/secure airway

American Heart Journal. 2011;34(3):38-46.e1.

Which technique to use?

The decision to use a specific technique depends on two major factors:

- availability of the techniques and
- experience of the imaging staff.

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