***RIABILITAZIONE* IN ATEROSCLEROSI POLIDISTRETTUALE-**
CORSO TEORICO-PRATICO

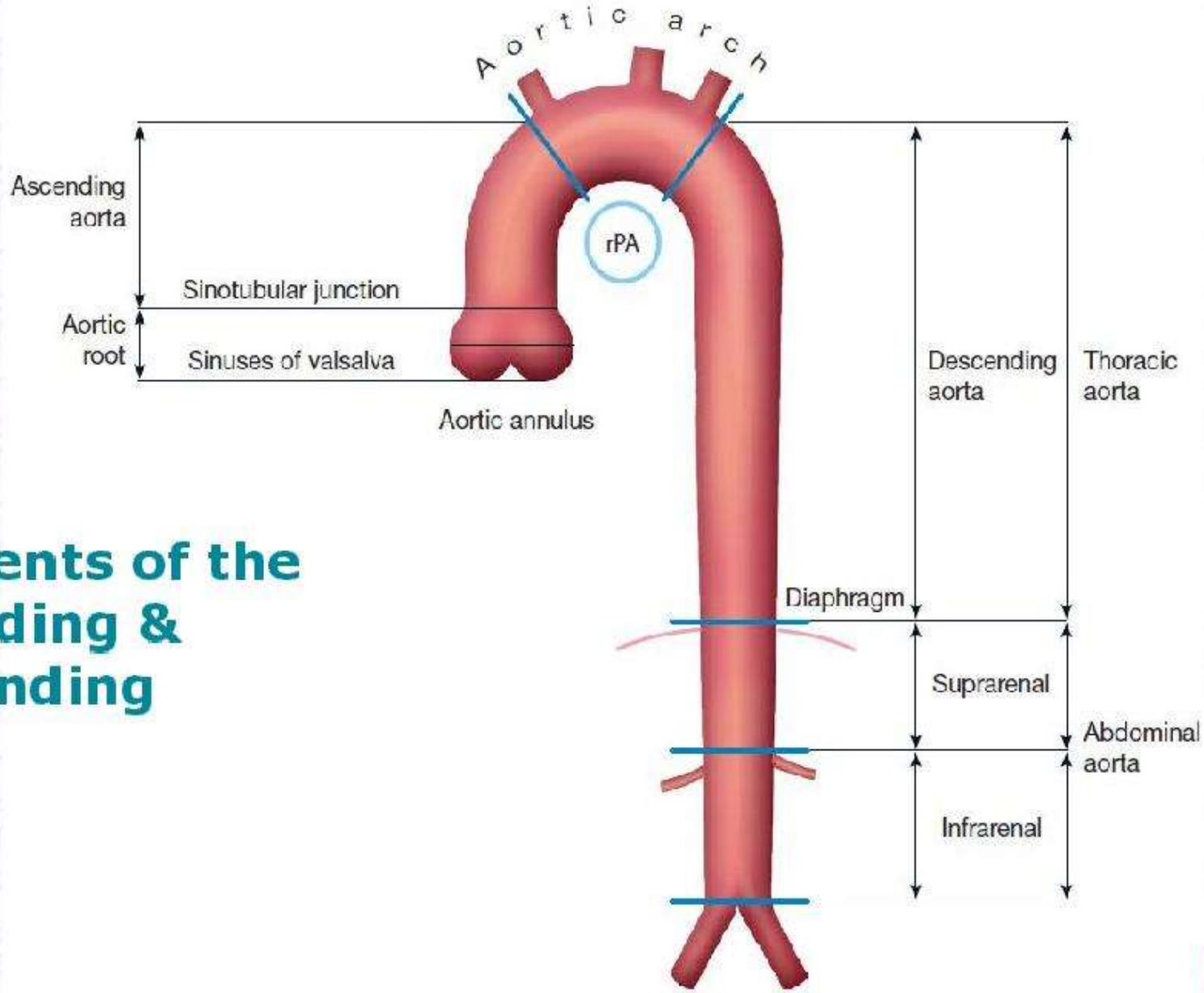
AICPR
FORMERLY GICR-IACPR
Associazione Italiana di Cardiologia Clinica, Preventiva e Riabilitativa

Regioni Campania/Basilicata

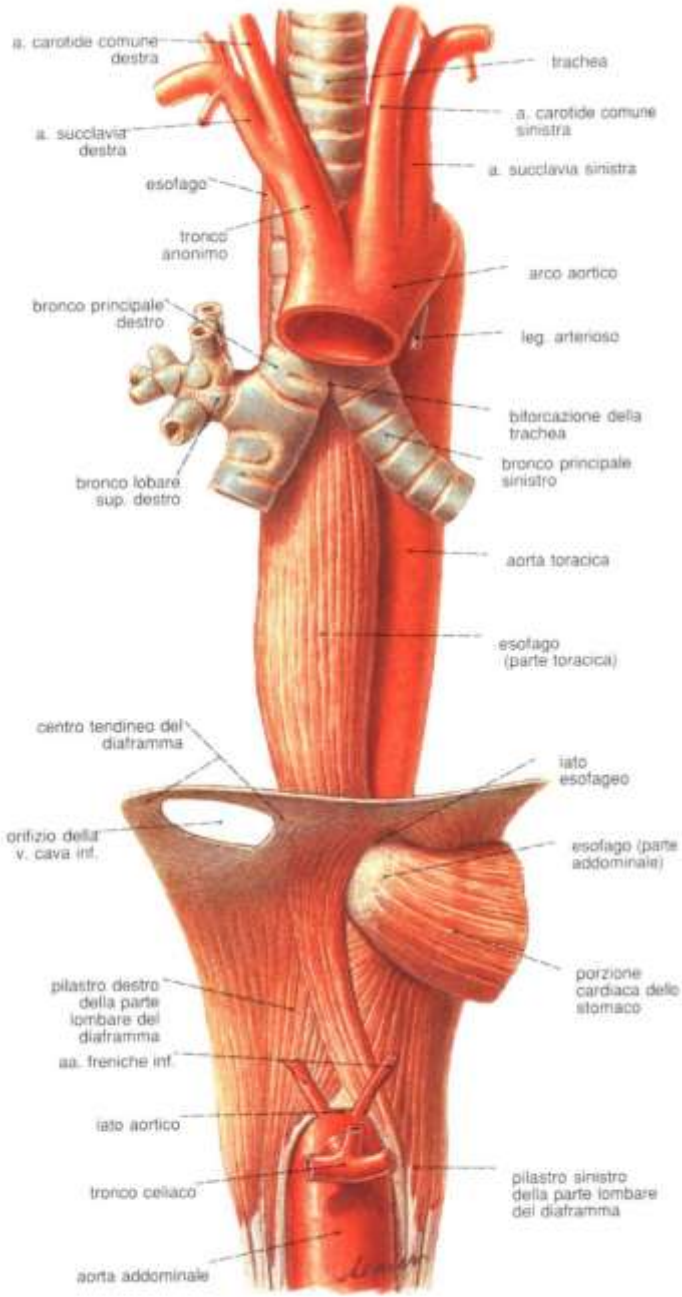
Anatomia funzionale e patologie dell'aorta

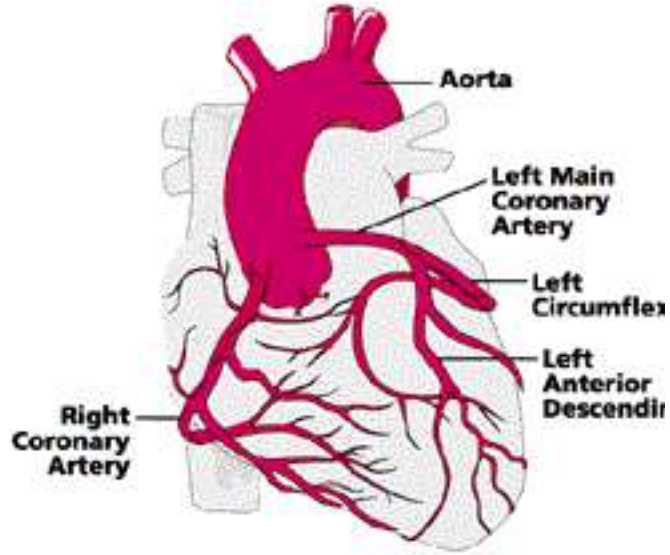
Dr. Michele Arcopinto
Dipartimento di Scienze Mediche Traslazionali – Univ. Federico II
UOC Medicina Interna ad indirizzo metabilico e riabilitativo

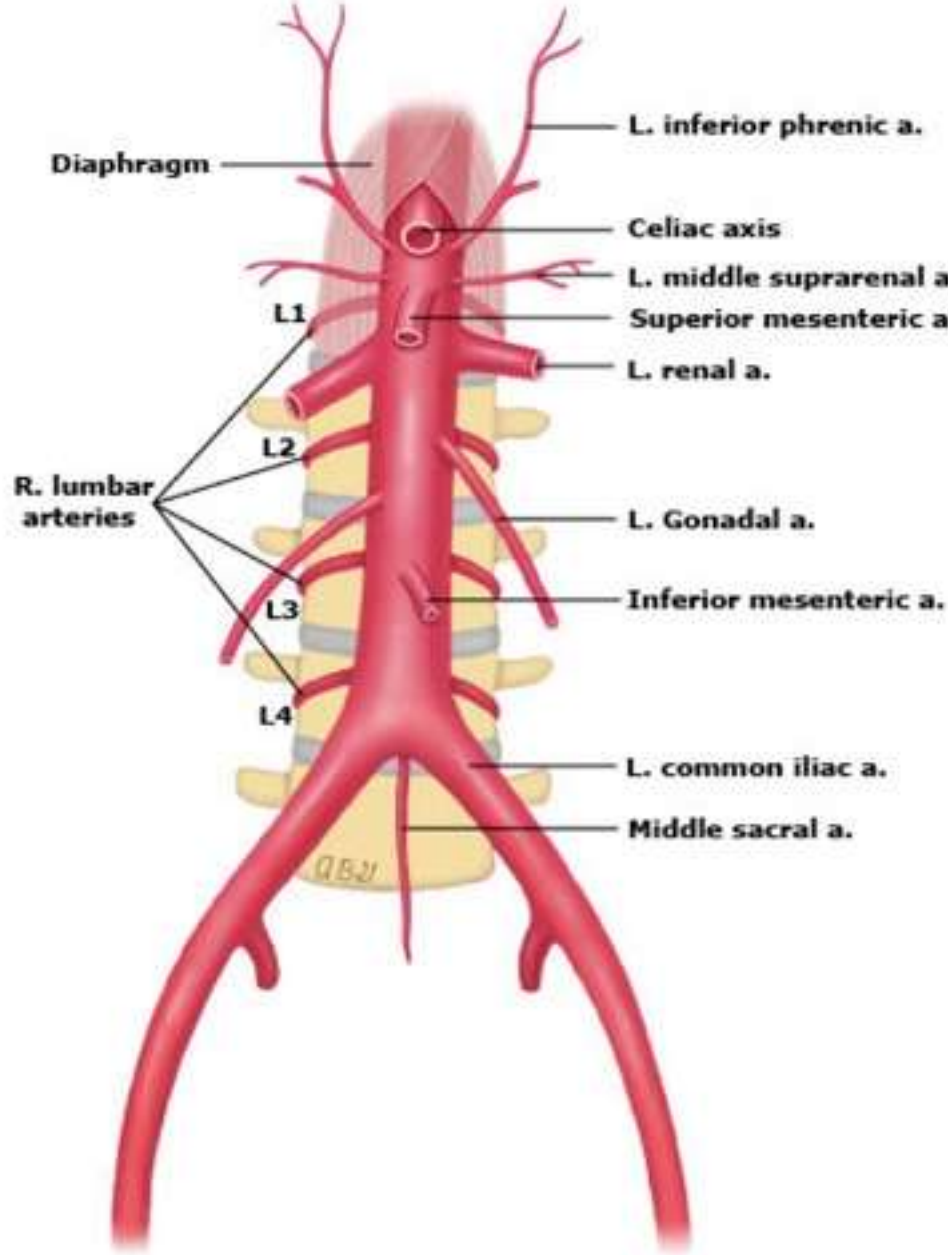
Segments of the ascending & descending aorta

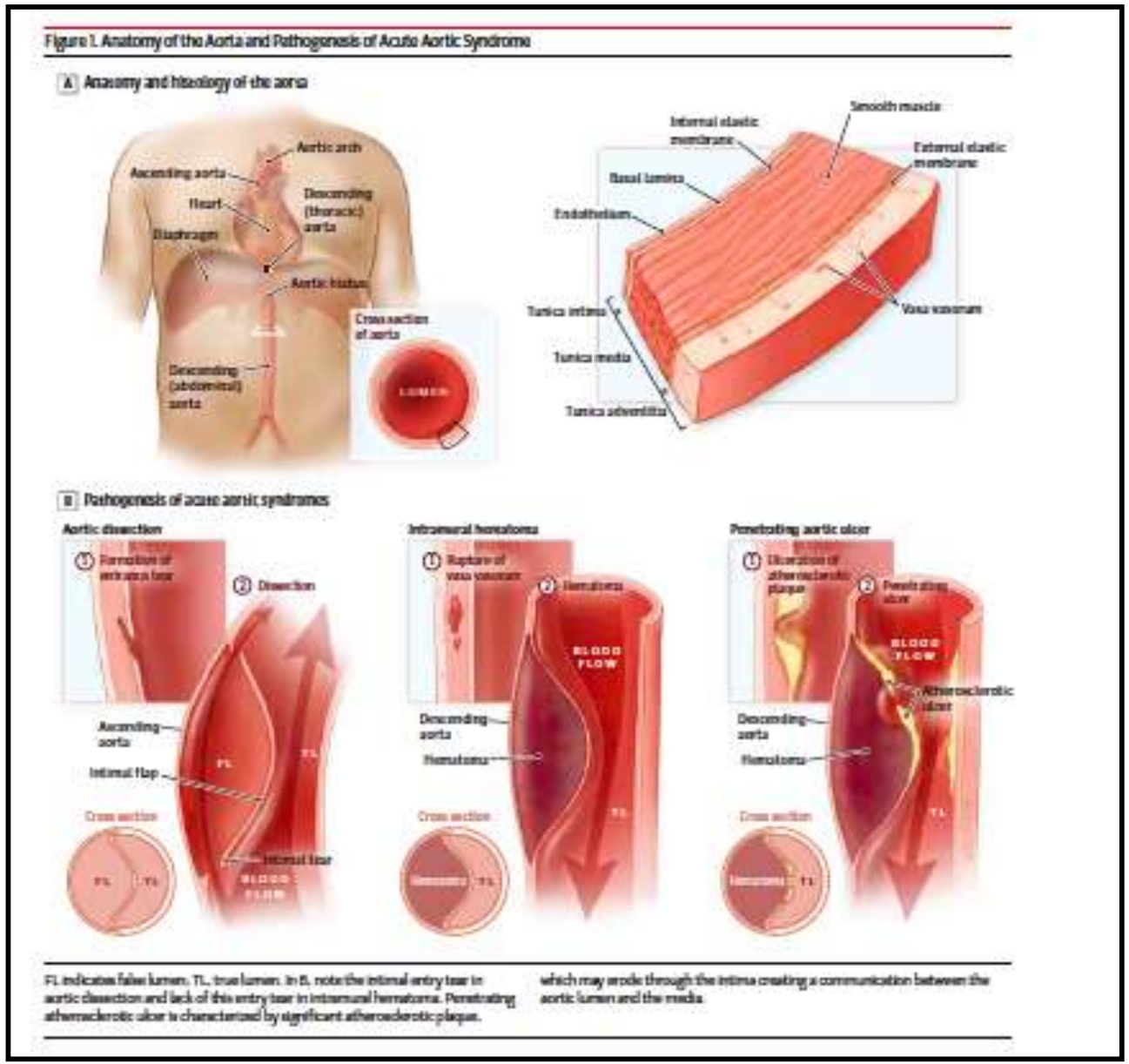


European Heart Journal (2014); 35:2873–2926 - doi:10.1093/eurheartj/ehu281


a. carotide comune destra
trachea
a. carotide comune sinistra
a. succlavia destra
a. succlavia sinistra
esofago
tronco anonimo
arco aortico
bronco principale destro
leg. arterioso
biforcazione della trachea
bronco principale sinistro
bronco lobare sup. destro
aorta toracica
esofago (parte toracica)
centro tendineo del diaframma
iato esofageo
orifizio della v. cava inf.
esofago (parte addominale)
porzione cardiaca dello stomaco
pilastro destro della parte lombare del diaframma
aa. freniche inf.
iato aortico
tronco celiaco
pilastro sinistro della parte lombare del diaframma
aorta addominale


Aorta
Left Main Coronary Artery
Left Circumflex
Left Anterior Descendi
Right Coronary Artery


L. inferior phrenic a.
Diaphragm
Celiac axis
L. middle suprarenal a
L1
Superior mesenteric a
L. renal a.
L2
R. lumbar arteries
L. Gonadal a.
L3
Inferior mesenteric a.
L4
L. common iliac a.
Middle sacral a.



a thin inner **tunica intima** lined by the endothelium;

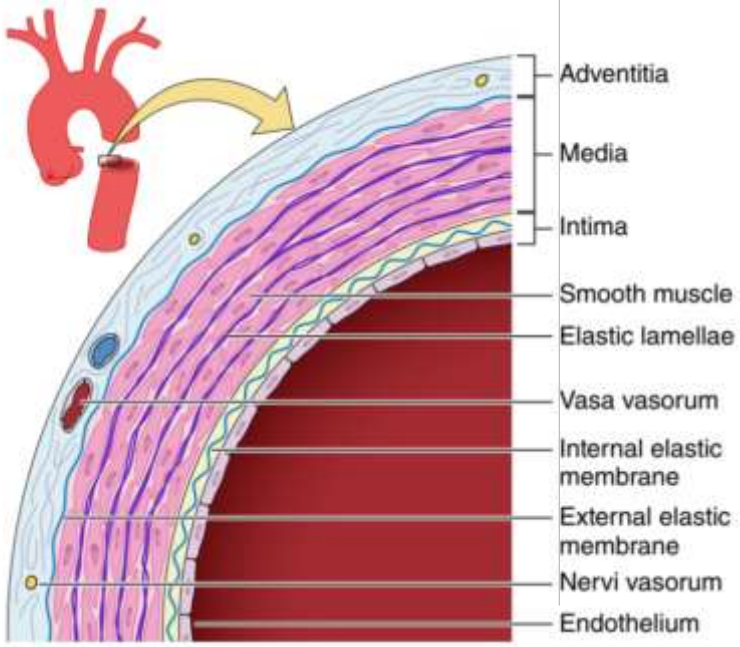
a thick **tunica media** characterized by concentric sheets of elastic and collagen fibres with the border zone of the lamina elastica interna and - externa, as well as smooth muscle cells;

the outer **tunica adventitia** containing mainly colla- gen, vasa vasorum, and lymphatics.

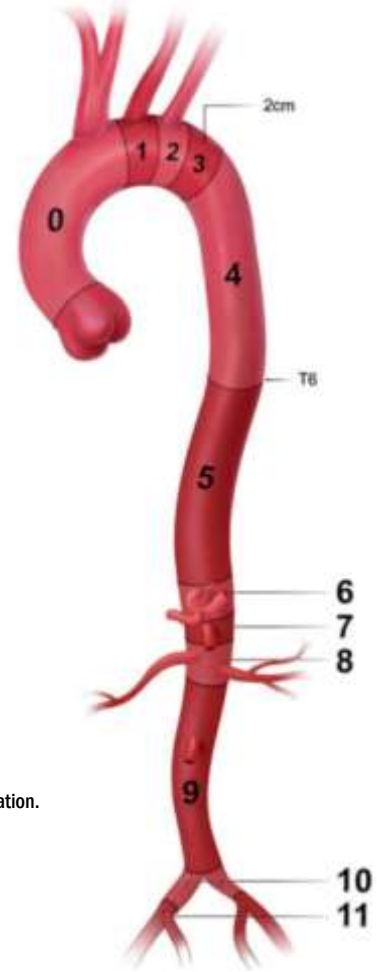
Mussa FF et al, JAMA, August 16 2016

Aortic Anatomy

Layers of the Aortic Wall



Zones of the Aorta



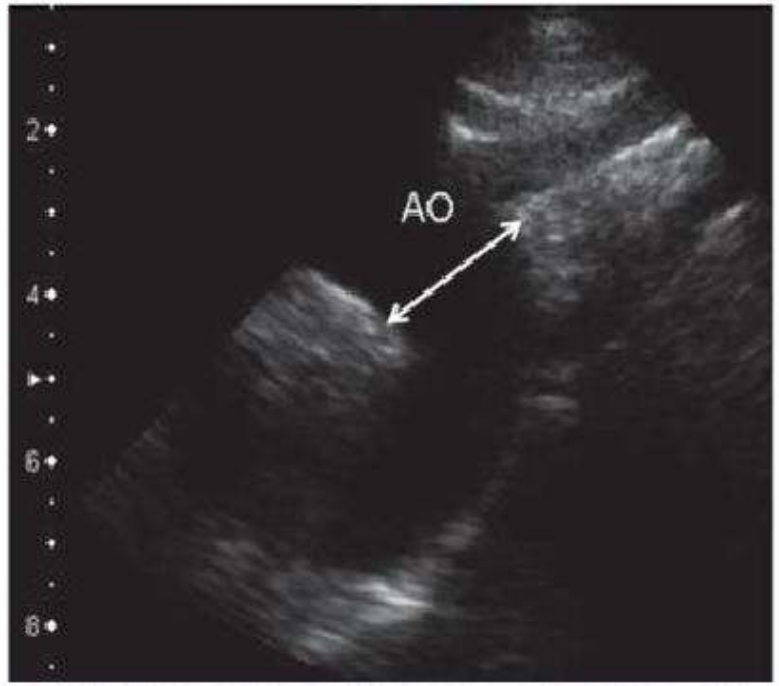
Abbreviations: BSA indicates body surface area; cm, centimeter; m, meter; and SD, standard deviation.

American Heart Association.

Parasternal long-axis and suprasternal imaging of the aorta indicating the points of diameter measurements of the aortic root and aortic arch for transthoracic echocardiography. Sinuses of Valsalva; sinotubular junction; ascending aorta. Also shown, the measurement of the aortic valvular ring.

Parasternal long-axis view

Suprasternal long-axis view



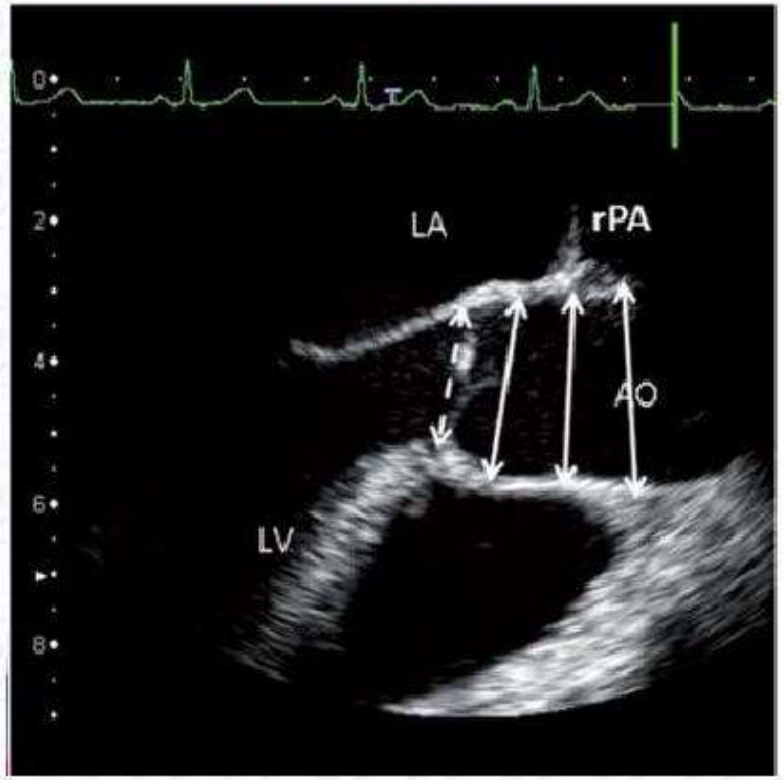
European Heart Journal (2014); 35:2873–2926 - doi:10.1093/eurheartj/ehu281

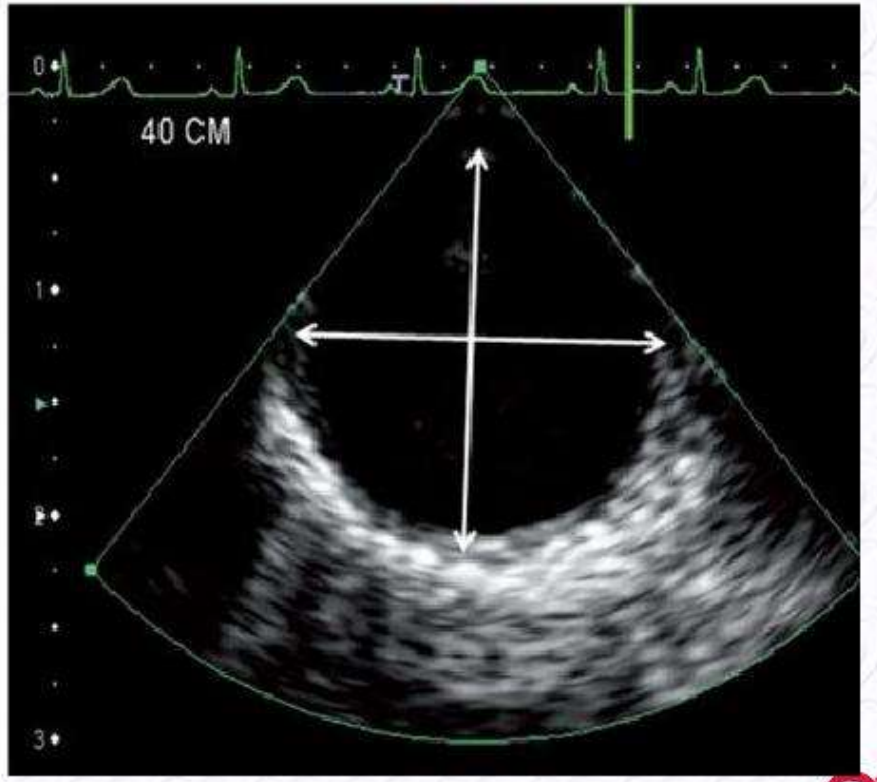
Transoesophageal echocardiographic long-axis and cross-sectional image of the ascending and descending aorta, indicating the points of diameter measurements: sinus of Valsalva, beginning of the ascending aorta, ascending aorta at the level of the right pulmonary artery. Also shown, the measurement of the aortic valvular ring.

Transoesophageal Echocardiogram

ascending aorta

descending aorta



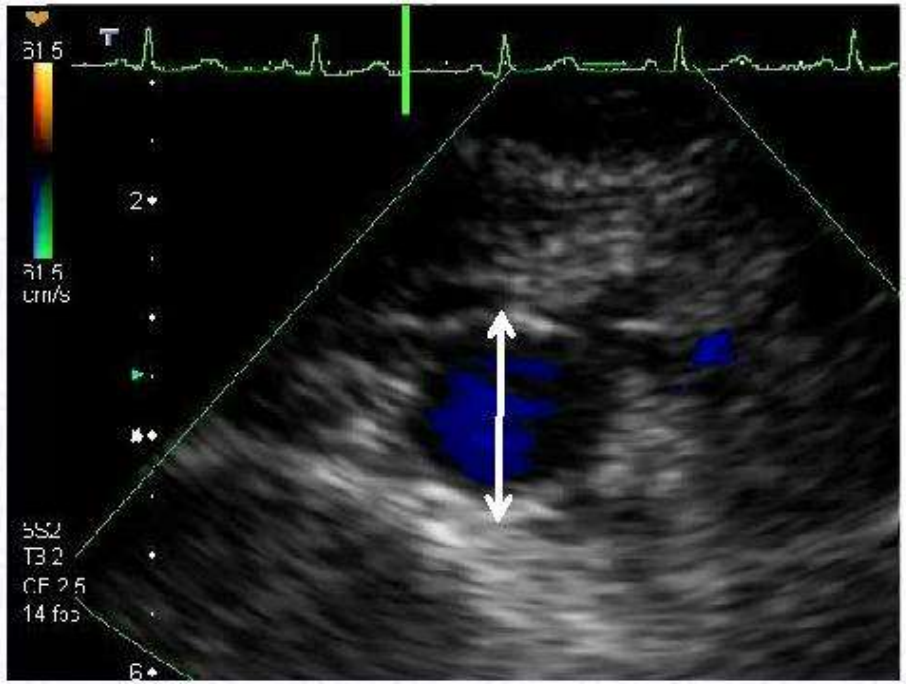


European Heart Journal (2014); 35:2873–2926 - doi:10.1093/eurheartj/ehu281

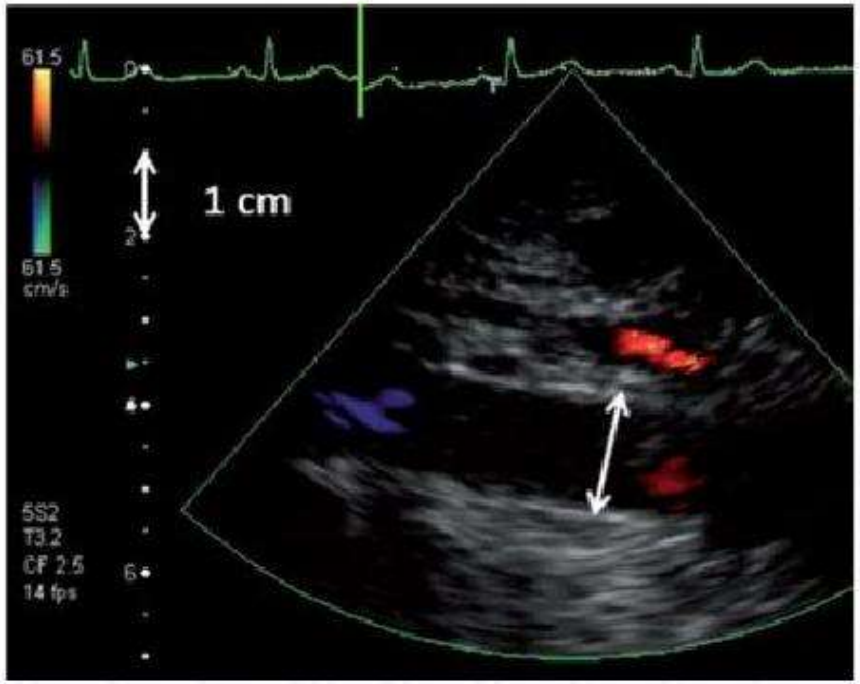
EUROPEAN SOCIETY OF CARDIOLOGY®

Cross-sectional and long-axis imaging of the abdominal aorta indicating the points of diameter measurements for ultrasound

Abdominal short-axis view



Abdominal long-axis view



European Heart Journal (2014); 35:2873–2926 - doi:10.1093/eurheartj/ehu281

Comparison of methods for imaging the aorta

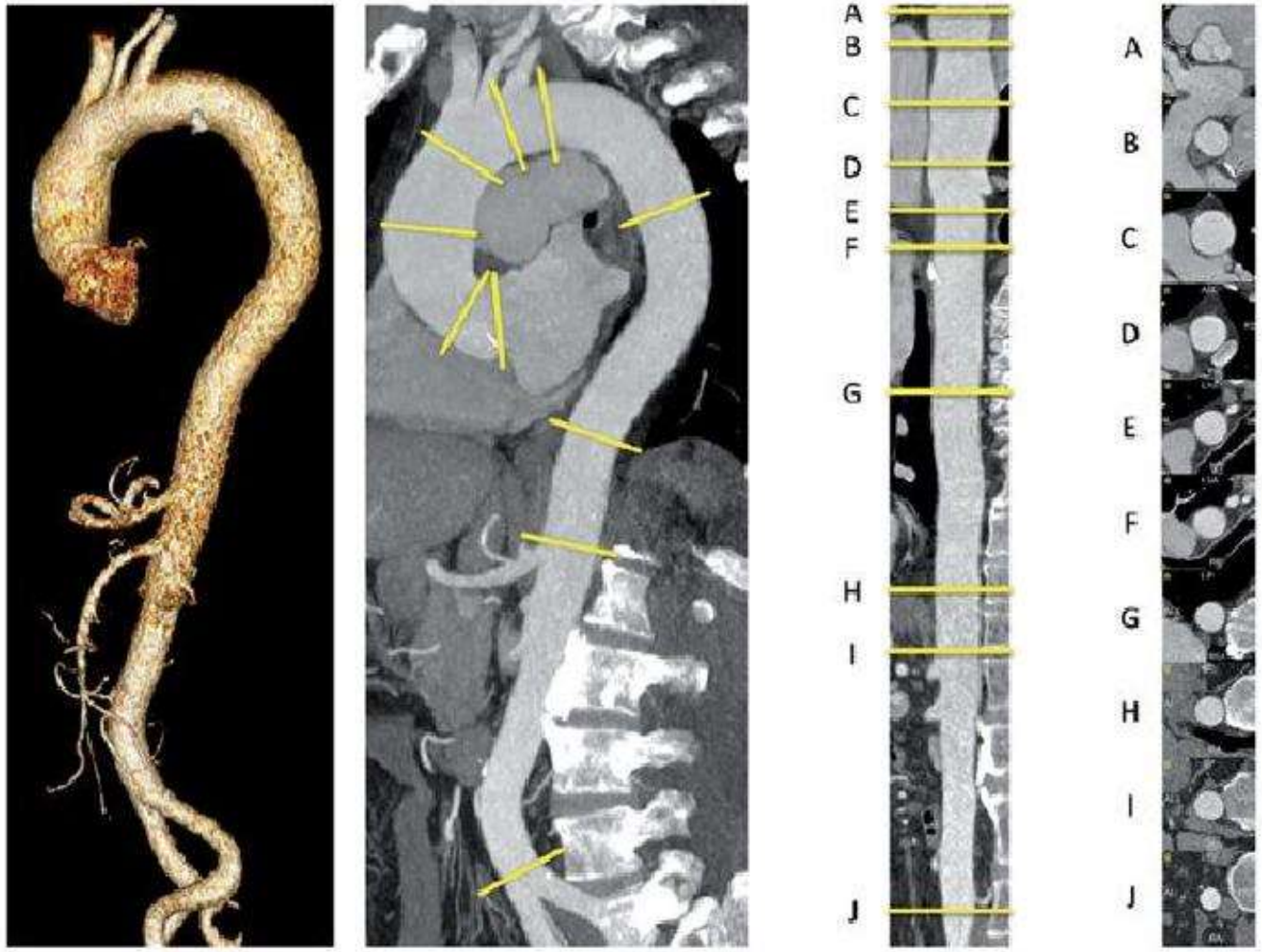
Advantages/disadvantages	TTE	TOE	CT	MRI	Aortography
Ease of use	+++	++	+++	++	+
Diagnostic reliability	+	+++	+++	+++	++
Bedside/interventional use	++	++	–	–	++
Serial examinations	++	+	++(+)	+++	–
Aortic wall visualization	+	+++	+++	+++	–
Cost	–	–	– –	– – –	– – –
Radiation	0	0	– – –	–	– –
Nephrotoxicity	0	0	– – –	– –	– – –

+ means a positive remark and — means a negative remark. The number of signs indicates the estimated potential value

++(+) only for follow-up after aortic stenting (metallic struts), otherwise limit radiation

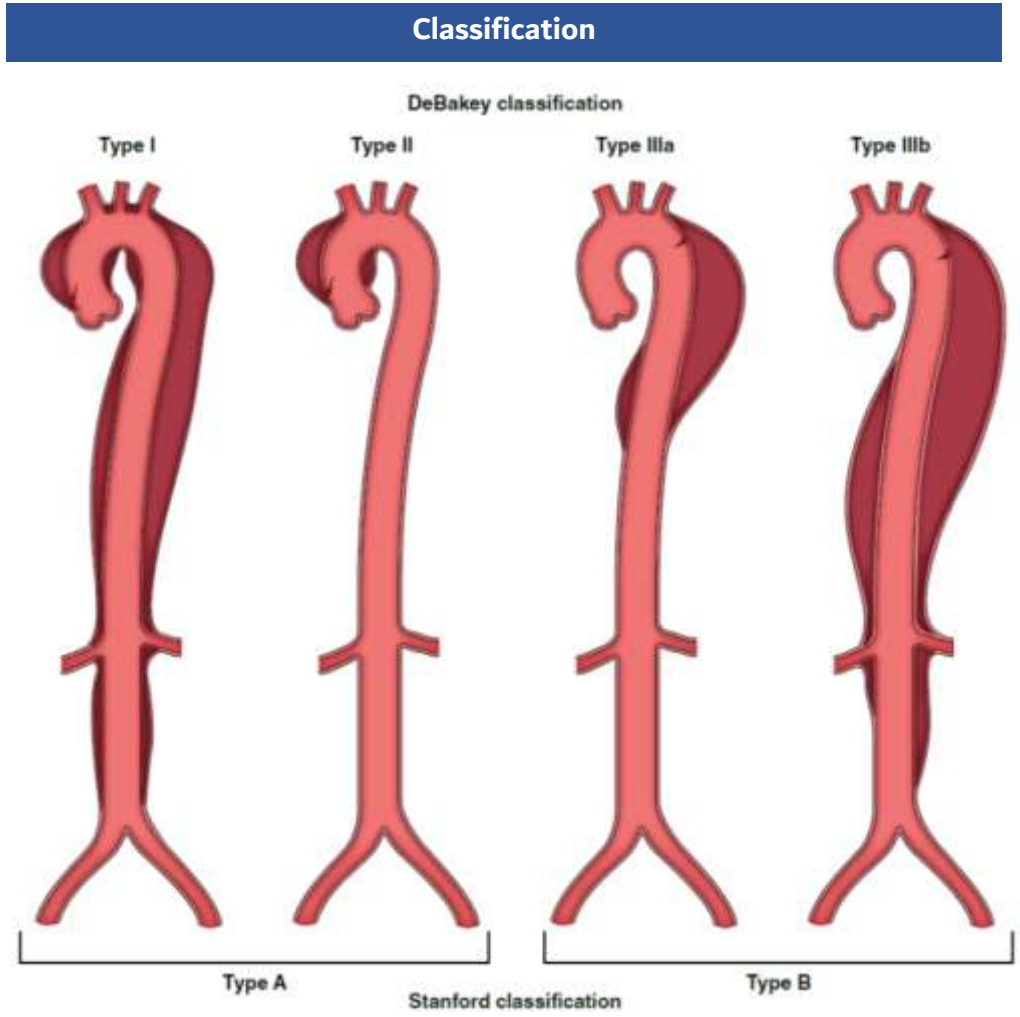
European Heart Journal (2014); 35:2873–2926 - doi:10.1093/eurheartj/ehu281

Thoracic and abdominal aorta in a three-dimensional reconstruction (left lateral image), parasagital multiplanar reconstruction (MPR) along the centreline (left middle part), straightened-MPR along the centreline with given landmarks (A – J) (right side), orthogonal to the centreline orientated cross-sections at the landmarks (A – J)



European Heart Journal (2014); 35:2873–2926 - doi:10.1093/eurheartj/ehu281

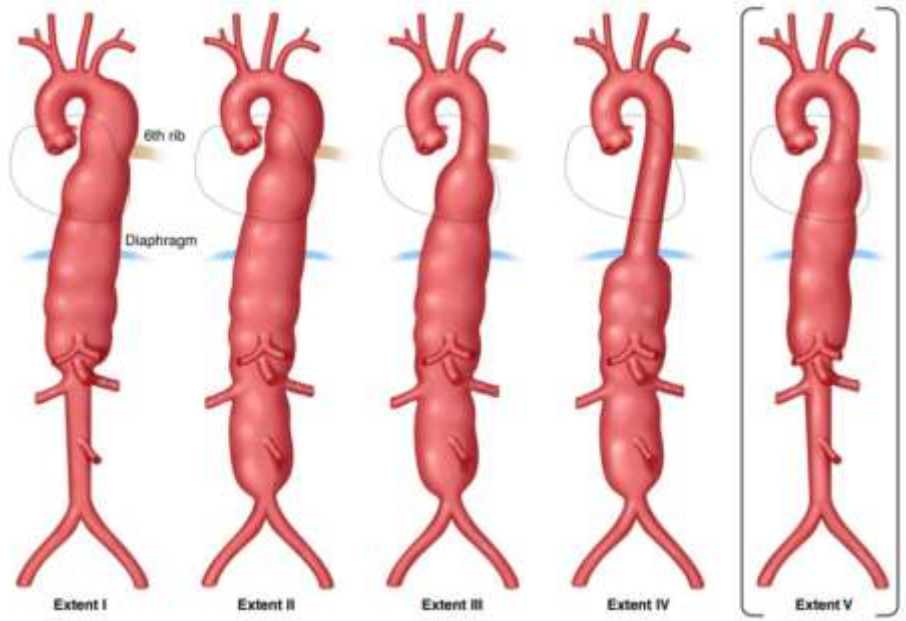
Aortic Dissection Classification



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

Thoracoabdominal Aortic Aneurysm Classification

Crawford Classification



Extent	Description
I	Below left subclavian to above celiac axis OR opposite superior mesenteric and above renal arteries
II	Below left subclavian to above iliac bifurcation
III	Below T6 to above the infrarenal abdominal aorta to the iliac bifurcation
IV	Below T12, tapering to above the iliac bifurcation
V	Below T6, tapering to just above the renal arteries

Predicts morbidity and mortality associated with aneurysm repair

American Heart Association.

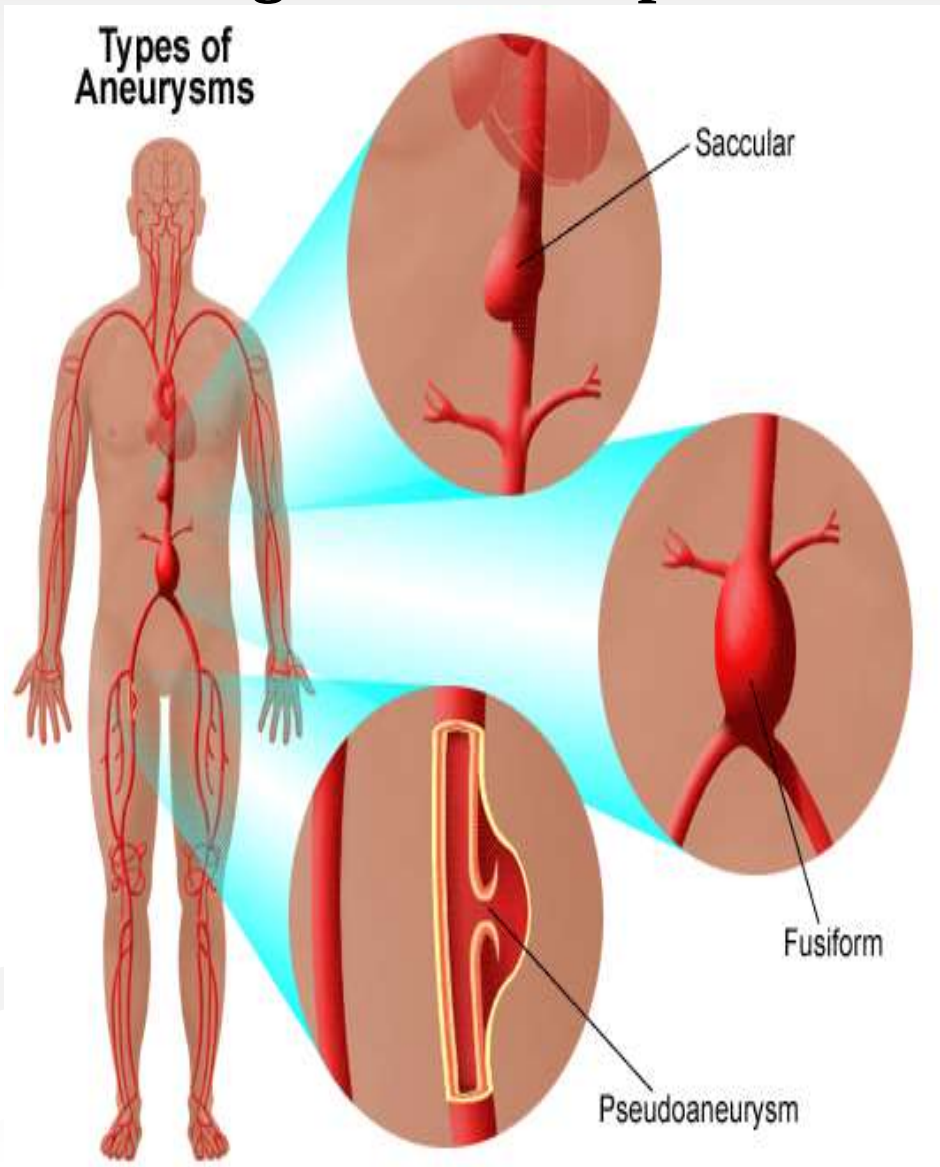
Isselbacher, E. M., et al. 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease. *Circulation.*

What are the classifications of aneurysms according to their shape ?

- **The first classification is :**

★ **Fusiform Aneurysm :**
dilation of the entire circumference of the artery

★ **Saccular Aneurysm :**
localized balloon- shaped outpouching projects from one side of the artery



Interventions of thoracic aortic aneurysm (TAA)

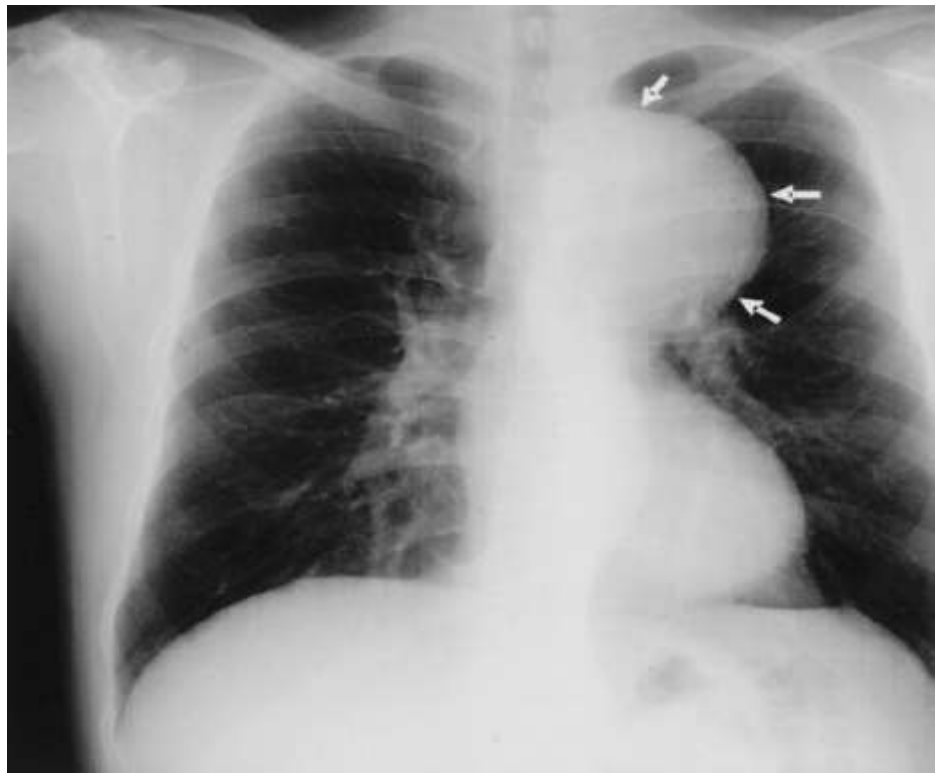
Recommendations	Class	Level
Interventions on ascending aorta		
Surgery is indicated in patients who have aortic root aneurysm, with maximal aortic diameter ≥50 mm for patients with Marfan syndrome.	I	C
Surgery should be considered in patients who have aortic root aneurysm, with maximal ascending aortic diameter: ≥45 mm for patients with Marfan syndrome with risk factors. ≥50 mm for patients with bicuspid valve with risk factors. ≥55 mm for other patients with no elastopathy.	IIa	C
Lower thresholds for intervention may be considered according to body surface area in patients of small stature or in the case of rapid progression, aortic valve regurgitation, planned pregnancy, and patient's preference.	IIb	C
Interventions on aortic arch aneurysms		
Surgery should be considered in patients who have isolated aortic arch aneurysm with maximal diameter ≥55 mm.	IIa	C
Aortic arch repair may be considered in patients with aortic arch aneurysm who already have an indication for surgery of an adjacent aneurysm located in the ascending or descending aorta.	IIb	C

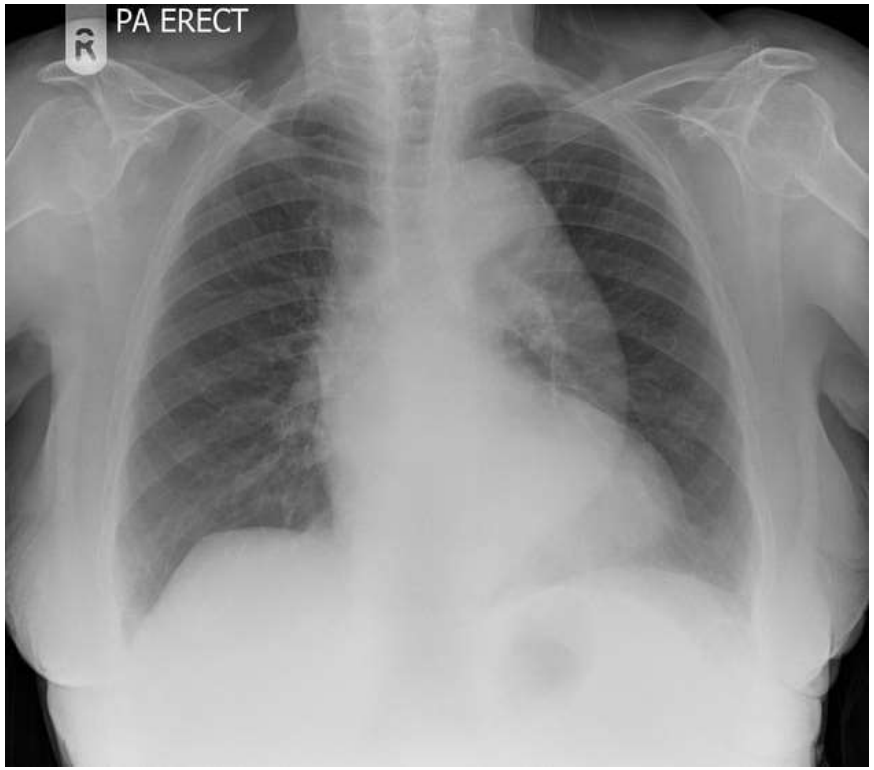
Diagnostic work-up of thoracic aortic aneurysm (TAA)

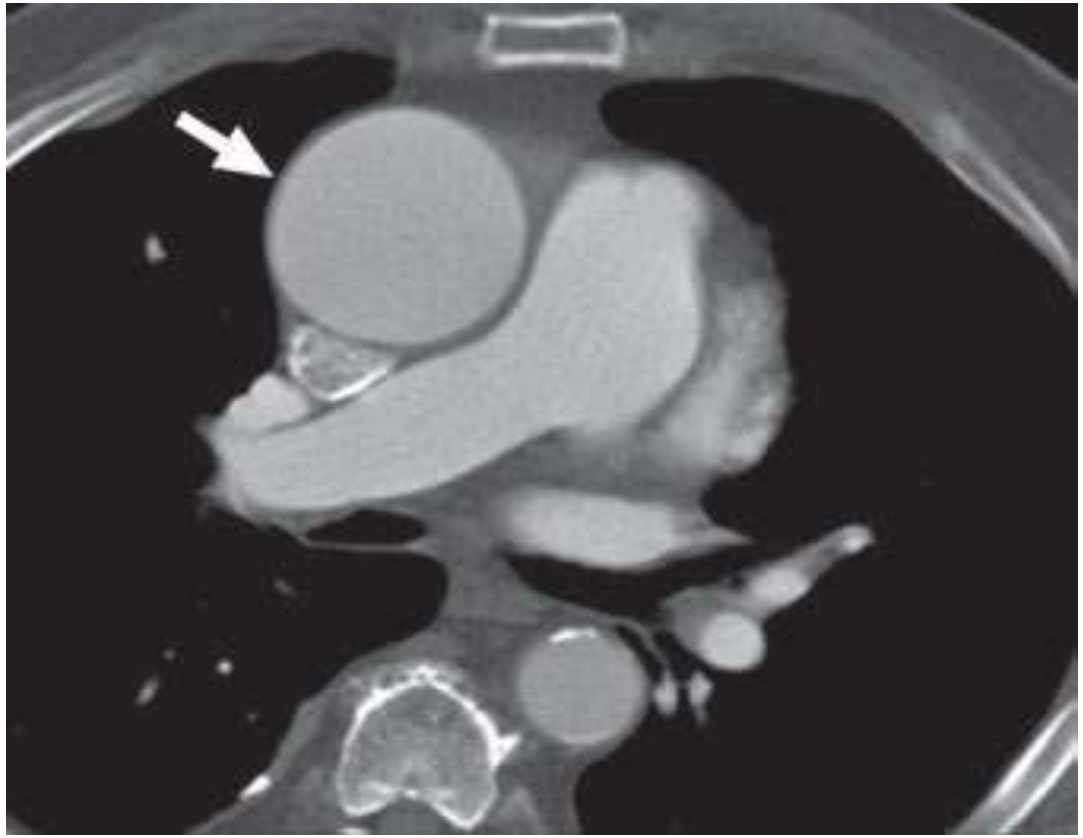
Recommendations	Class	Level
Interventions on descending aortic aneurysms		
TEVAR should be considered rather than surgery when anatomy is suitable.	IIa	C
TEVAR should be considered in patients who have descending aortic aneurysm with maximal diameter ≥55 mm.	IIa	C
When TEVAR is not technically possible, surgery should be considered in patients who have descending aortic aneurysm with maximal diameter ≥60 mm.	IIa	C
When intervention is indicated, in case of Marfan syndrome or other elastopathies, surgery should be indicated rather than TEVAR.	IIa	C

TEVAR = Thoracic EndoVascular Aneurysm Repair

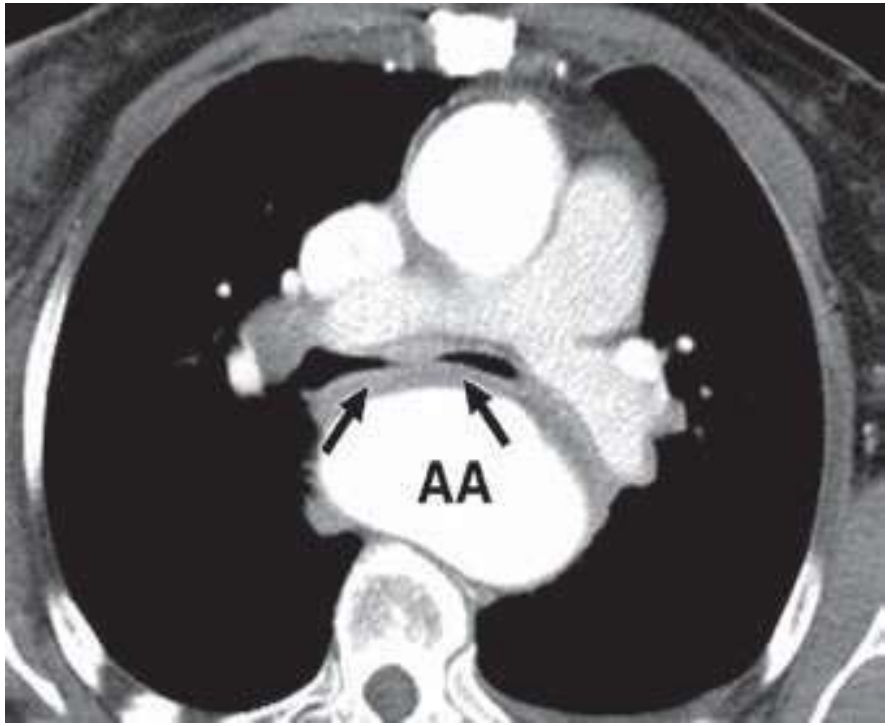
European Heart Journal (2014); 35:2873–2926 - doi:10.1093/eurheartj/ehu281




PA ERECT

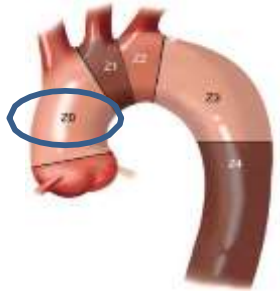


55-year-old asymptomatic woman with incidentally detected ascending aortic aneurysm. **Contrast-enhanced CT image shows incidental ascending aorta aneurysm with widening of aorta to 5.5 cm** (*arrow).*



70-year-old woman with shortness of breath. Contrast-enhanced CT image shows large fusiform descending aortic aneurysm (AA) causing extrinsic compression of adjacent bronchi with luminal narrowing (*arrows).*

Saccular aortic root aneurysm—(a) short axis reconstructed CT image showing a giant aneurysm of the aortic root, originating from the right sinus of Valsalva. (b) Coronal reconstructed CT image shows the saccular aneurysm with narrow neck originating from the right sinus of Valsalva.

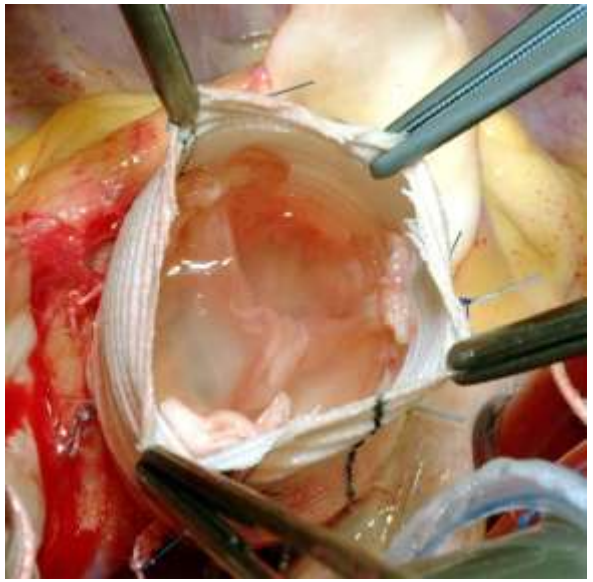


Zone 0 – proximal anastomosis

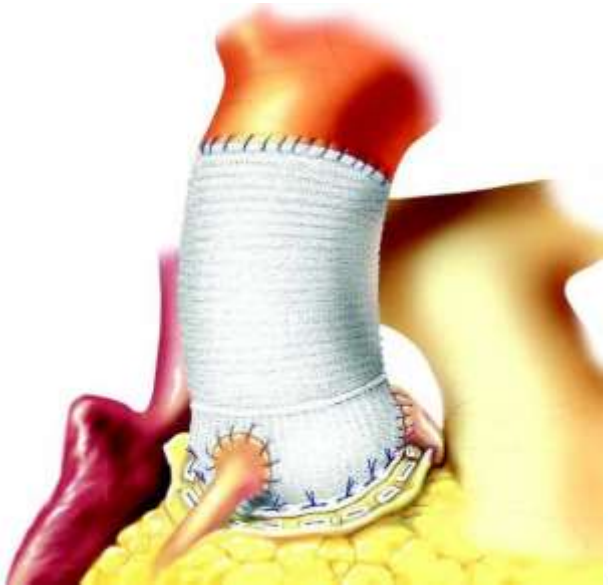
If the root is torn or dilated then replace root

Surgical Options to Manage aortic root

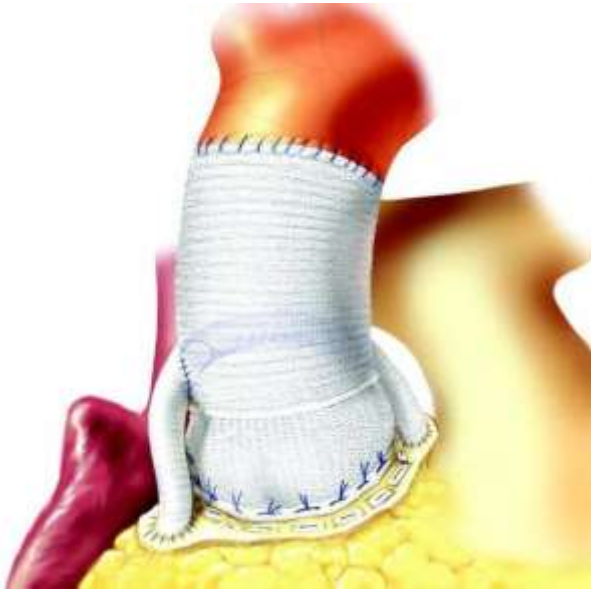
Valve sparing aortic root replacement



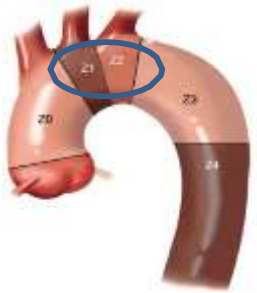
Bentall



Modified Cabrol



Aortic root surgery was not associated with increased in hospital mortality, but decreased the likelihood of re-intervention due to late aortic root intervention (Di Eusanio M et al. Ann Thorac Surg 2014;98:2078–85)



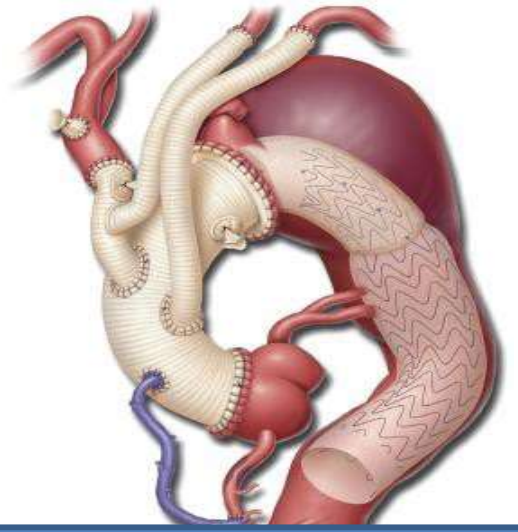
Zone 1 or 2

If a tear is in Zone 1 or 2 you need to replace the Arch

Elephant Trunk

Elephant trunk technique for replacement of the aortic arch was advocated by Miyamoto S. et.al (Ann Thorac Cardiovasc Surg. 2006;12:412-6.)

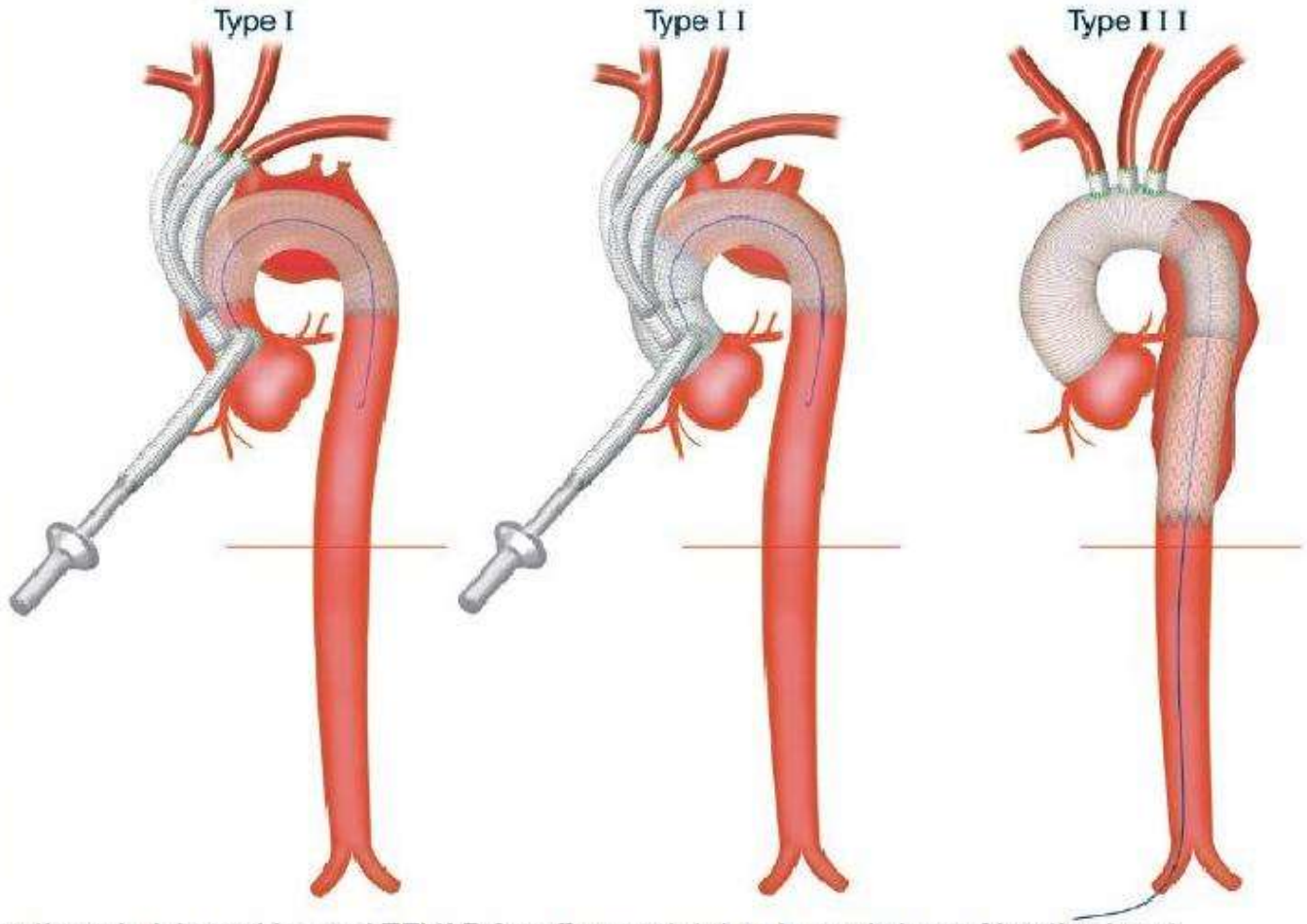
Frozen Elephant Trunk (FET)



FET combines conventional surgical replacement of the ascending aorta and the aortic arch with endovascular repair of the descending aorta.

Associated with similar satisfactory early and mid-term outcomes. Leads to single-stage treatment in a significant number of patients aortic disease. Facilitates endovascular second-stage treatment in patients with residual DTA disease (Di Eusanio M.Ann Thorac Surg 2015;100: 88–94.)

Different methods for aortic arch debranching



Type I: Total aortic arch debranching and TEVAR for off-pump total arch repair (use of beating heart cardiopulmonary bypass optional).

Type II: Total aortic arch debranching and TEVAR in combination with ascending aortic replacement in patients with proximal disease extension for total thoracic aortic repair

Type III: Total aortic arch replacement with conventional elephant trunk technique and distal extension by TEVAR in patients with distal disease extension, for total thoracic aortic repair.

www.escardio.org/guidelines European Heart Journal (2014); 35:2873–2926 - doi:10.1093/eurheartj/ehu281

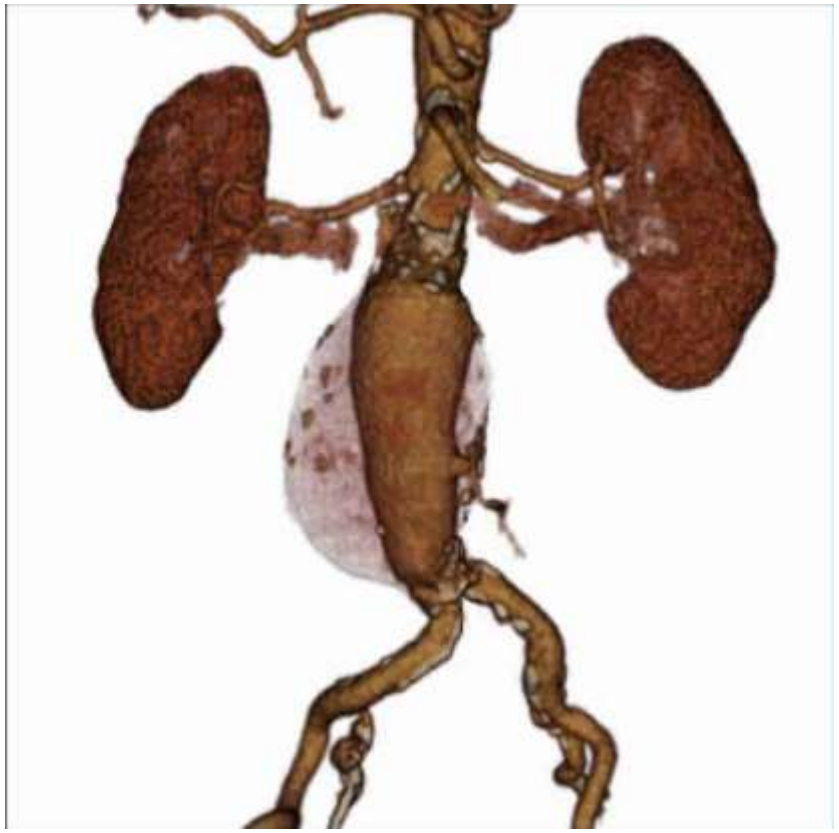
EUROPEAN SOCIETY OF CARDIOLOGY®

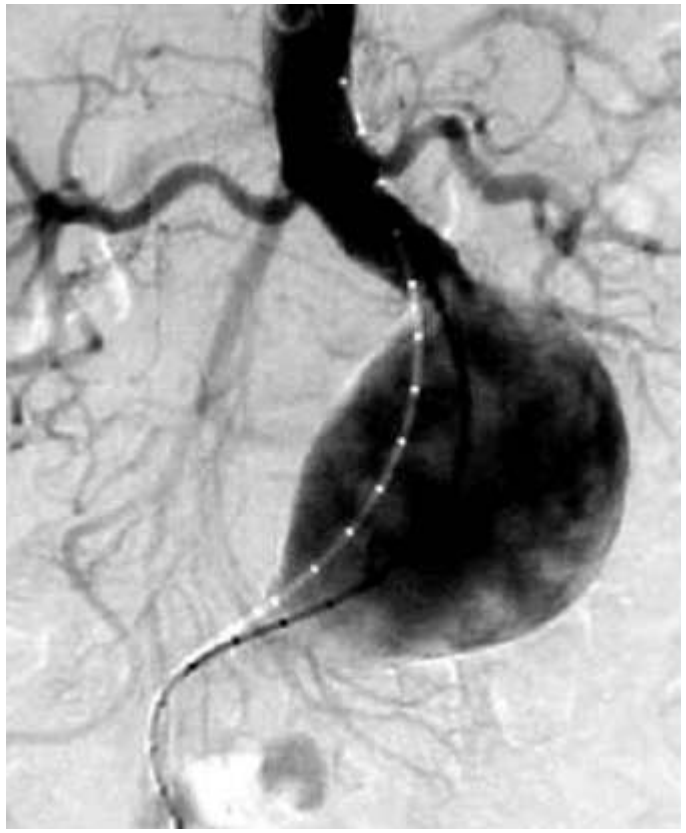
Aneurismi Aorta Addominale (AAA)

- Normal size: 2 cm
- AAA: 3 cm
- Prevalence: 1.3% in men aged 45-54

  BUT 12.5% in age 75-84
- Risk factors: Same as CAD but mainly hereditary and tobacco
- Natural history: Gradual expansion; mural thrombus
- Complications: Rupture; thromboembolism; compression or erosion of adjacent structures

AAA



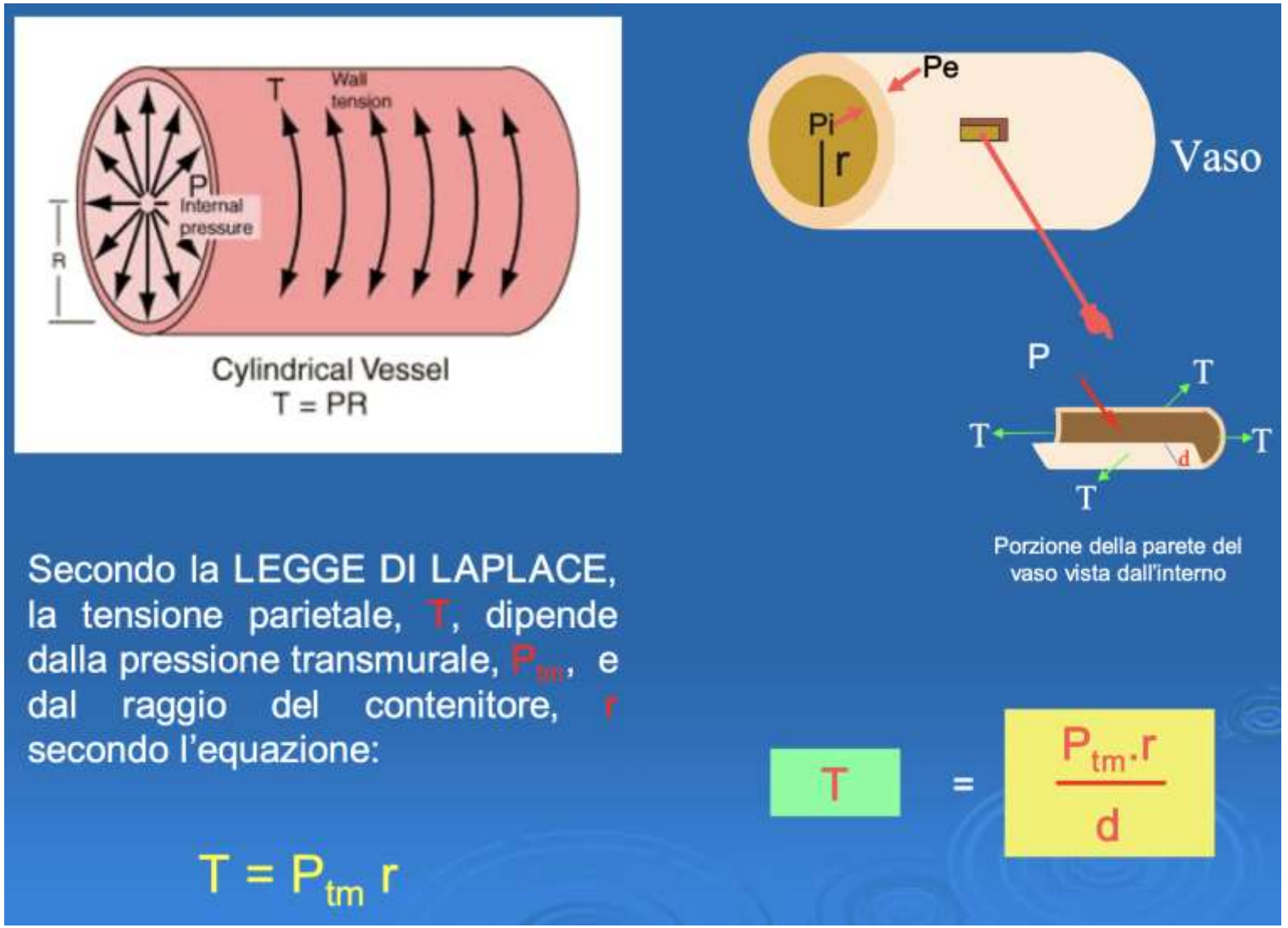


Natural History

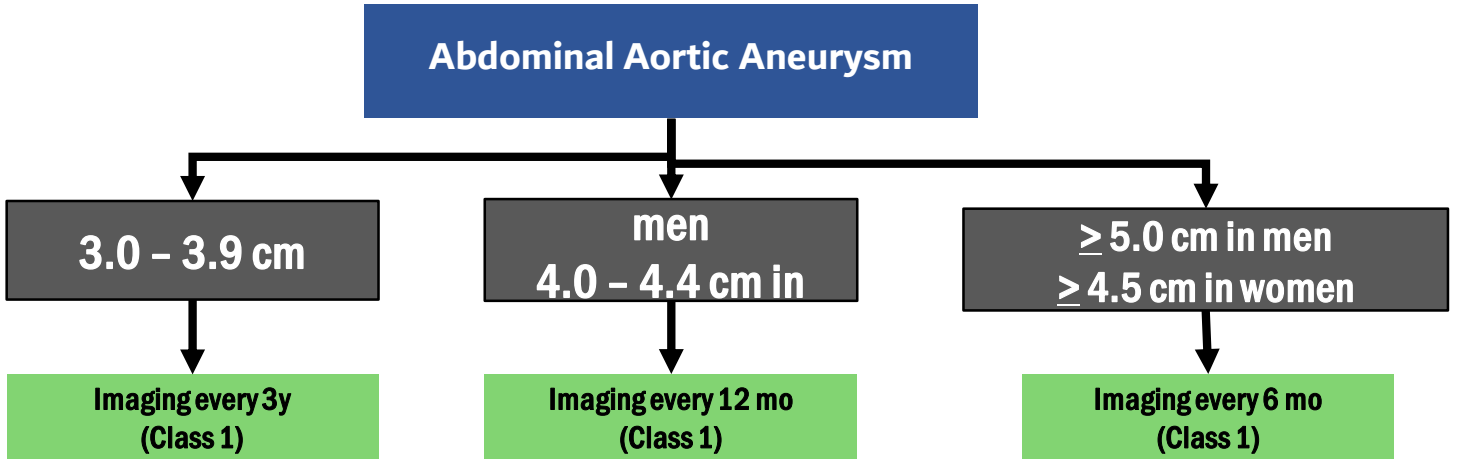
- **Yearly Growth Rates:**
  0.19 cm for AAA 2.8 to 3.9 cm
  0.27 cm for AAA 4.0 to 4.5 cm
  0.35 cm for AAA 4.6 to 8.5 cm

- **Rupture Rate at 5 years:**
  AAA >6 cm – 43% vs. 20% for smaller AAA

- **Estimated Risk of Rupture:**
  0 in AAA less than 4.0 cm
  0.5 to 5% for AAA 4.0 to 4.9 cm
  3 to 15% for AAA 5.0 to 5.9 cm
  10 to 20% for AAA 6.0 to 6.9 cm
  20 to 40% for AAA 7.0 to 7.9 cm
  30 to 50% for AAA 8.0 cm



Frequency of Surveillance Imaging of Abdominal Aortic Aneurysms Based on Current Aortic Diameter



Abbreviations: cm indicates centimeter; mo, month; and y, year.

American Heart Association.

Surgery vs. EVAR

AAA repair is indicated if: • AAA diameter exceeds 55 mm.[f] • Aneurysm growth exceeds 10 mm/year.	I	B	373,363
If a large aneurysm is anatomically suitable for EVAR, either open or endovascular aortic repair is recommended in patients with acceptable surgical risk.	I	A	397,398
If a large aneurysm is anatomically unsuitable for EVAR, open aortic repair is recommended.	I	C	
In patients with asymptomatic AAA who are unfit for open repair, EVAR, along with best medical treatment, may be considered.[g]	IIb	B	388,399

Therapy

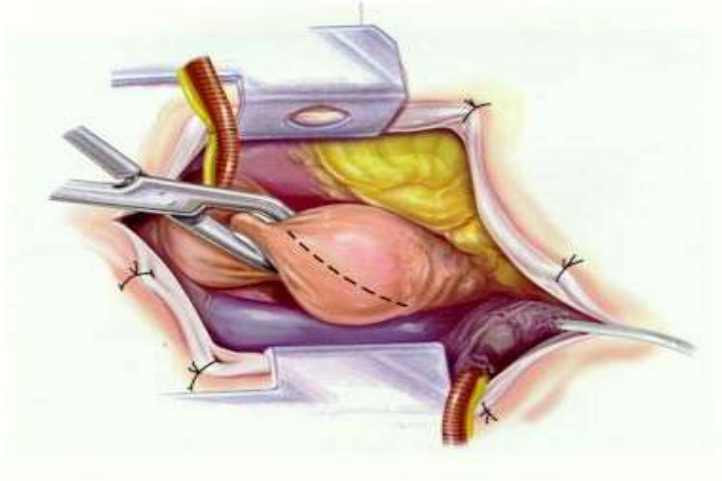
Surgery

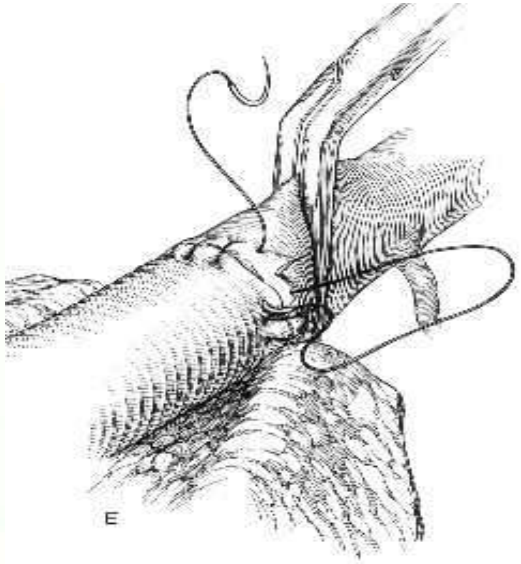
- Peri-operative mortality 2.7-5.6%
- 40-70% mortality for ruptured AAA surgery
- Significant morbidity (5-12 weeks before returning to normal life style)

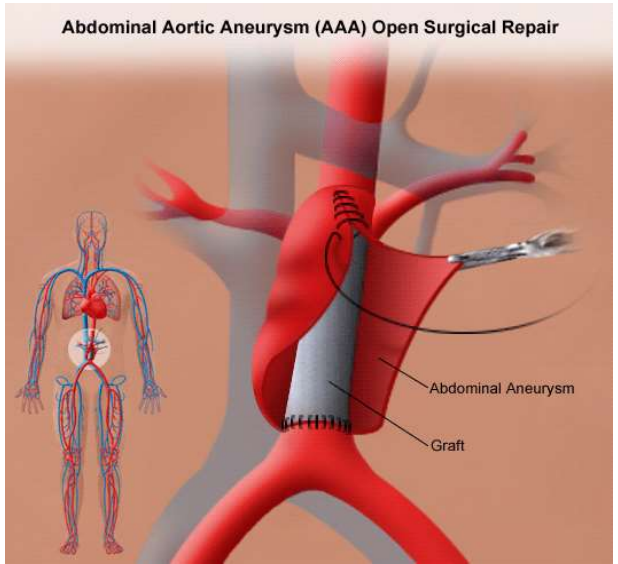
Abdominal Aortic Aneurysm - Open Repair

- The aneurysm is exposed, the aorta is clamped just above and below the aneurysm to stop the flow of blood, the aneurysm is opened and a Dacron graft is placed within the anuerysm

- The aneurysm sac is then wrapped around the graft to protect it



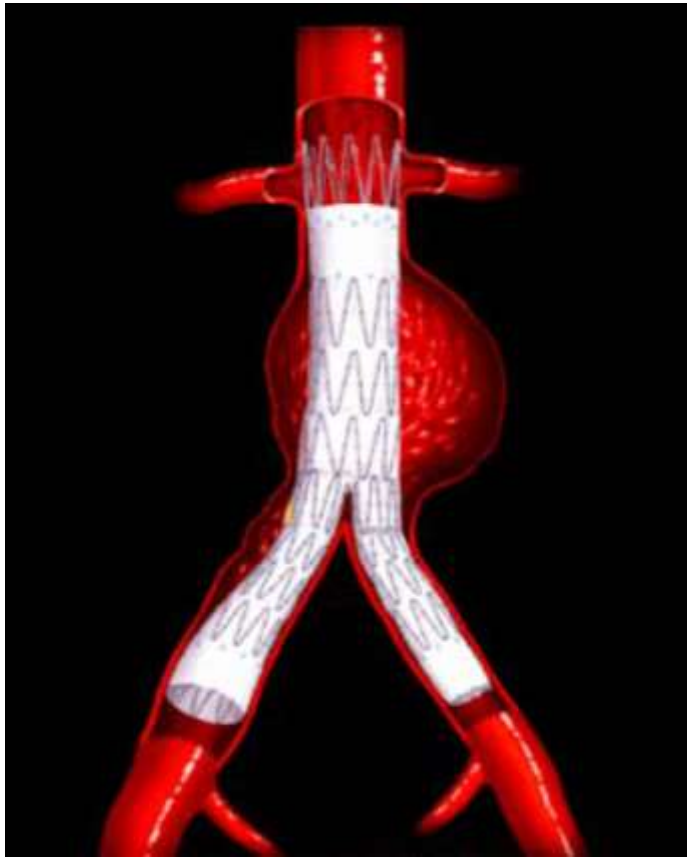




Therapy

EVAR

- Peri-operative mortality 1.0-2.4%
- Recovery within 1-3 days



Therapy - EVAR

classification of Endoleaks

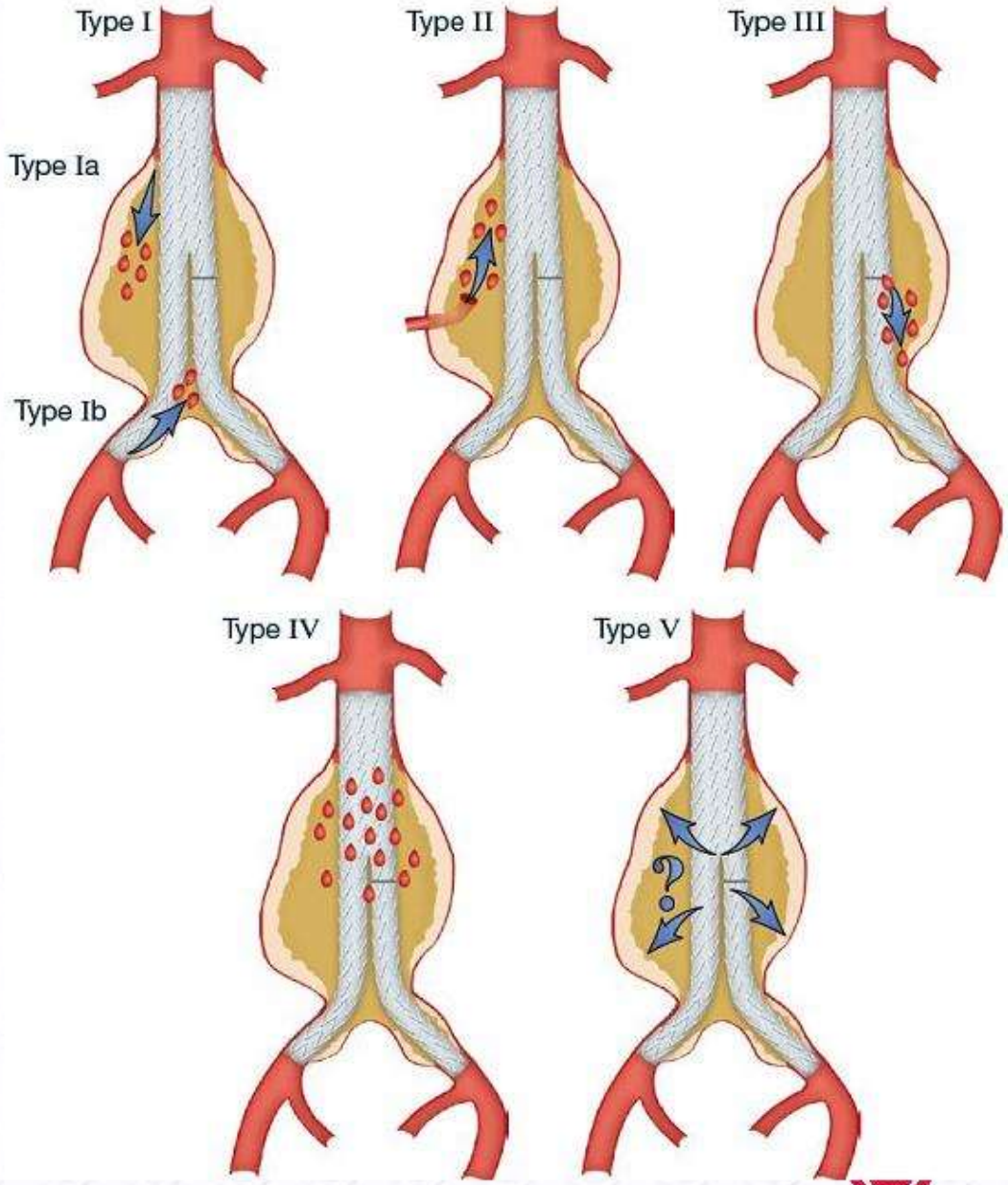
Type I: Leak at graft attachment site above, below, or between graft components (Ia: proximal attachment site; Ib: distal attachment site).

Type II: Aneurysm sac filling retrogradely via single (IIa) or multiple branch vessels (IIb).

Type III: Leak through mechanical defect in graft, mechanical failure of the stent-graft by junctional separation of the modular components (IIIa), or fractures or holes in the endograft (IIIb).

Type IV: Leak through graft fabric as a result of graft porosity.

Type V: Continued expansion of aneurysm sac without demonstrable leak on imaging (endotension, controversial).



European Heart Journal (2014); 35:2873–2926 - doi:10.1093/eurheartj/ehu281

https://www.youtube.com/watch?v=qUpXJBoAoWI