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Thoracic Aortic Disease

TAD

Thoracic Aortic Aneurysm TAA

Acute Aortic Syndrome AAS

Thoracic Aortic Aneurysm TAA

- What is a TAA?
- Who is at risk and what causes TAA?
- Is TAA inherited? What about genetic testing?
- What are the signs and symptoms of TAA?
- How is TAA diagnosed?
- What is the medical treatment for TAA?
- How often does TAA need to be monitored?
- When is surgery recommended for TAA?
- What are the surgical options for TAA?

What's a TAA?

- The aorta is the ultimate conduit, carrying, in an average lifetime, almost 200 million liters of blood to the body

Through its elasticity, the aorta has the role of a 'second pump' during diastole

In healthy adults, aortic diameters do not usually exceed 40 mm and taper gradually downstream.

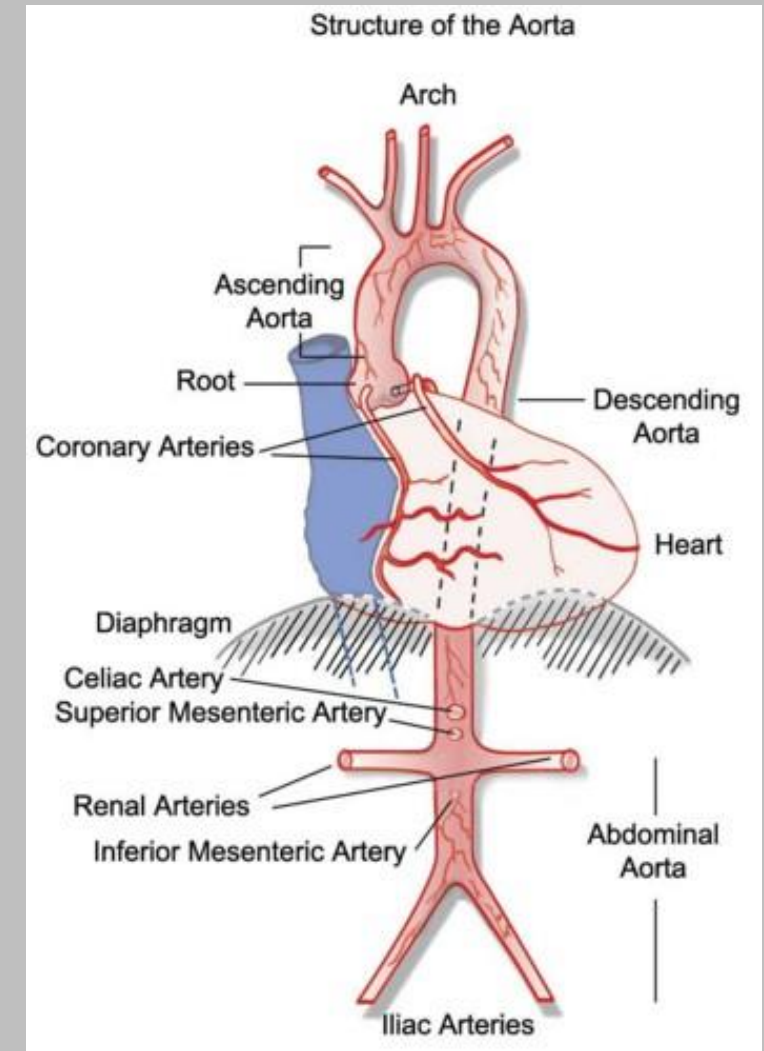
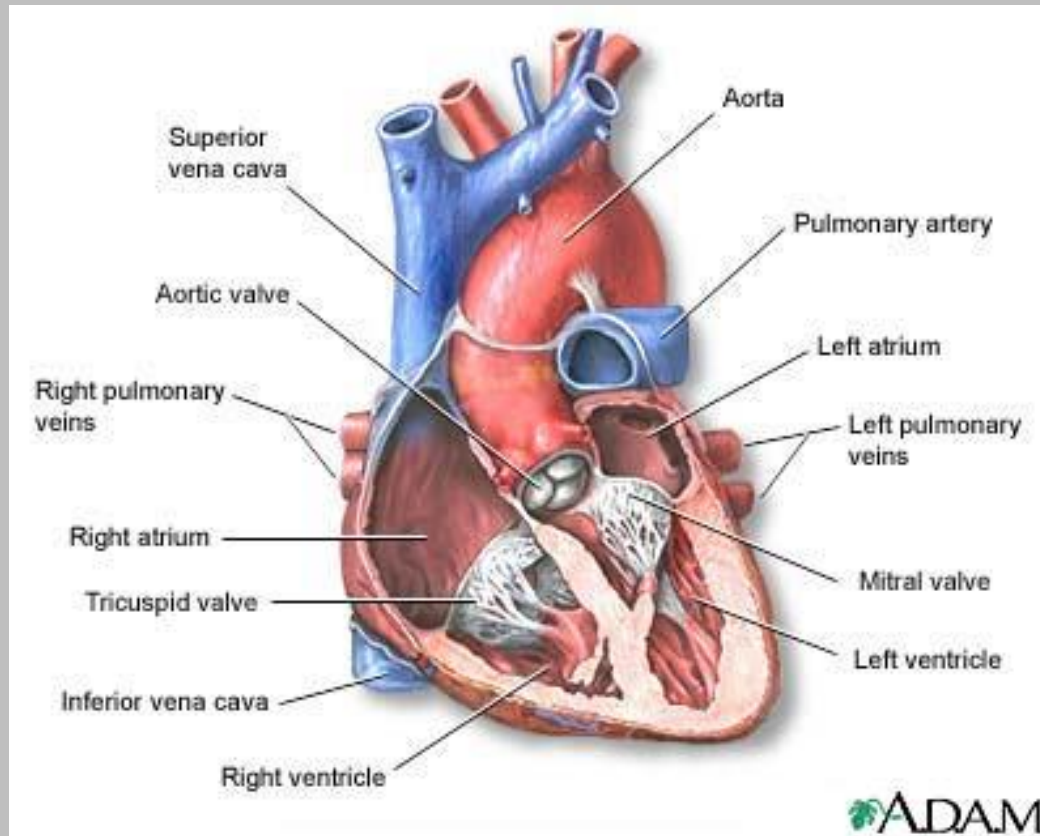
the size of aorta

They are variably influenced by several factors including

- age
- gender
- body size [height, weight, body surface area (BSA)]
- blood pressure

In this regard, the rate of aortic expansion is about 0.9 mm in men and 0.7 mm in women for each decade of life. [more than these number we go toward aneurysm](#)

Anatomy



the aorta begins from the outlet of ventricles

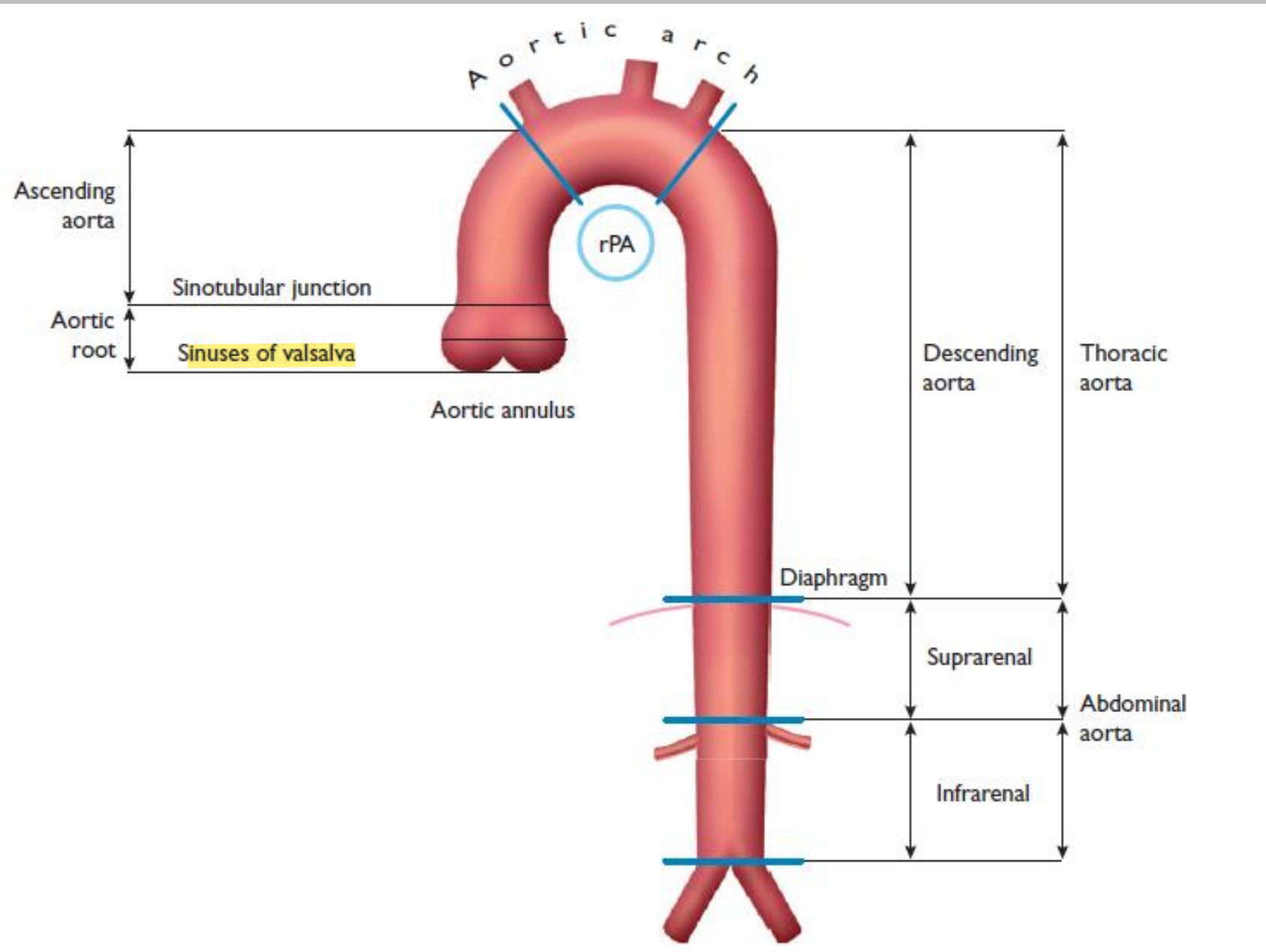
the root --> from the outlet of the left ventricle to the sinotubular junction

ascending aorta --> from the outlet of ventricles toward brachiocephalic artery

aortic arch --> from the brachiocephalic artery toward left subclavian

descending aorta --> distal to the left subclavian --> thoracic aorta (till the diaphragm) --> from the diaphragm it called abdominal aorta -->

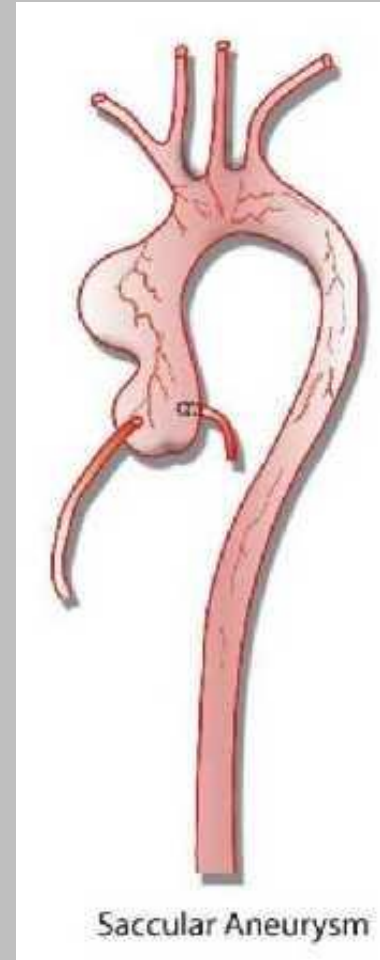
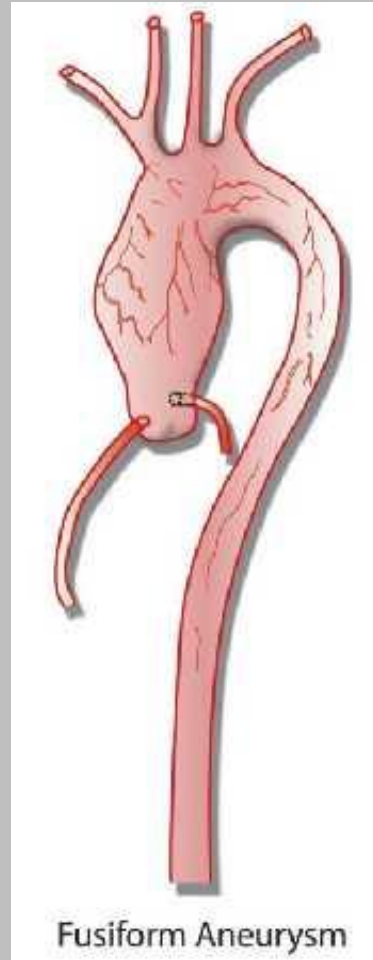
bifurcation of the abdominal aorta into suprarenal and infrarenal



Definitions

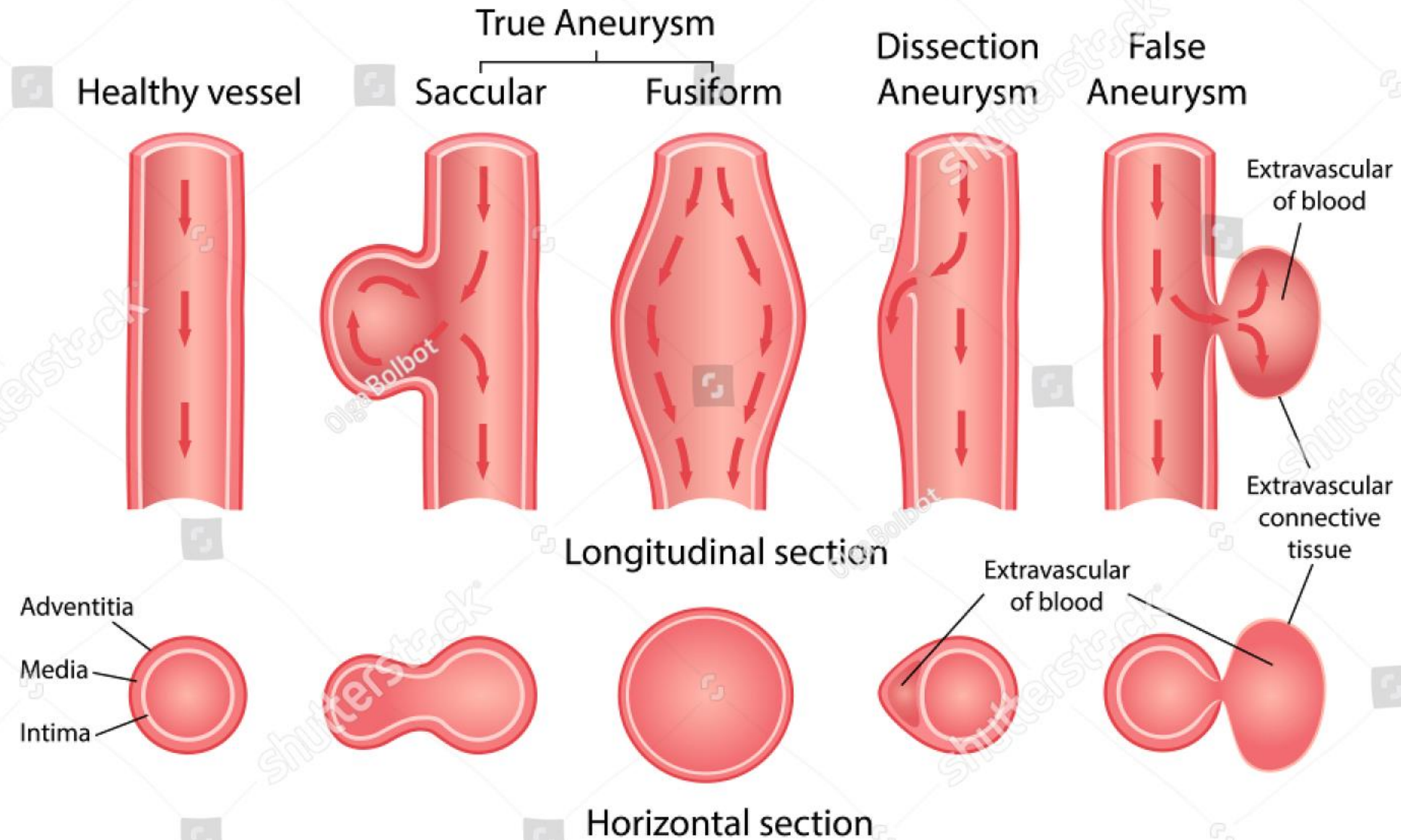
- Normal Dimensions
 - Mid-descending 26-28 mm
- Dilation (Ballooning, Bulging, Ectasia) up to 50% increase in size up to 40mm
- Aneurysm More than 50 %
 - **When the diameter exceeds 1.5 times normal**
- Types of aneurysm
 - Saccular dilatation only in one area
 - Fusiform dilatation in all directions

Aortic Aneurysm



- true aneurysm means enlargement of the inner lumen caused by vessel wall expansion all the 3 layers of the lumen get dilated
- false aneurysm (also called pseudoaneurysm) means lumen enlargement caused by perforation (penetration) of all parts of the vessel wall forming an outer sack in communication with the inner lumen of the aorta not the 3 get dilated (maybe one or 2 but not the 3 layers) only part of the lumen

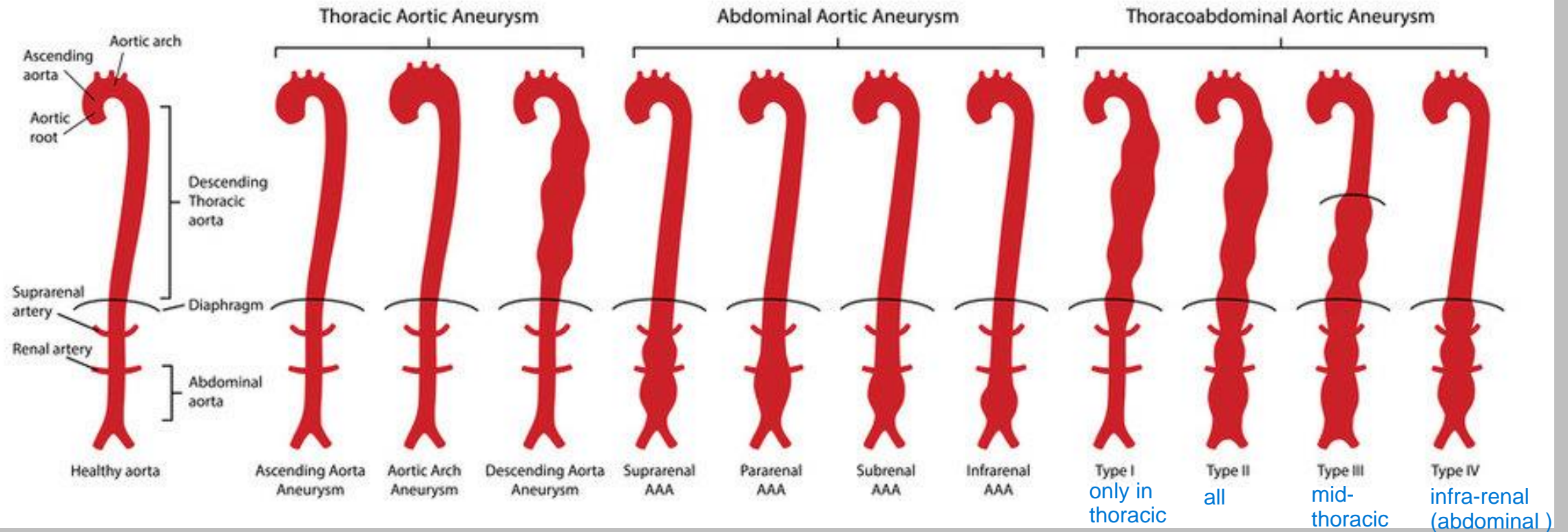
Types of Aneurysm



thoracic aneurysm



Classification of Aortic Aneurysm



Who is at risk and what causes TAA?

- The ageing of the aorta is accompanied by a loss of compliance, and an increase of wall stiffness caused by structural changes including an increase in the collagen content and decrease the elastin fibers and formation of intimal atherosclerosis with calcium deposits.

- cystic medial degeneration, in which the elastic fibers in the wall of the aorta degenerate, weakening the wall of the aorta and causing it to dilate and form an aneurysm
- In younger patients, TAA is often due to a genetic cause

marfan disease

Table 1. Causes of TAA.

Acquired	Degenerative
	<ul style="list-style-type: none">• Age• Hypertension• Smoking
	Autoimmune (inflammatory)
	<ul style="list-style-type: none">• Takayasu’s arteritis• Giant cell arteritis
	Infectious
	<ul style="list-style-type: none">• Syphilis
Genetic	Traumatic
	Connective tissue disorders
	<ul style="list-style-type: none">• Marfan syndrome• Loeys–Dietz syndrome• Ehlers–Danlos syndrome
	Familial TAA syndrome
Congenital	Bicuspid aortic valve

TAA, thoracic aortic aneurysm.

Table 1. Causes of TAA.

Risk Factors

- Smoking
- COPD
- HTN
- Male gender
- Older age
- High BMI
- Abnormal aortic valve (e.g., bicuspid valve)
- Family history

Epidemiology

- Thoracic aneurysms
 - Prevalence greater than 3-4% of those over 65
 - 6 cases per 100,000 person-years
 - Incidence increasing
 - In the top 15 causes of death
 - Thoracic aortic aneurysm – rupture 3.5/100,000 persons

Is TAA inherited? What about genetic testing?

autosomal dominant

- If Marfan syndrome is suspected based on physical features, then testing for the *FBN1* gene can be performed. Genetic testing can help to diagnose or rule out other conditions such as Loeys–Dietz and vascular Ehlers–Danlos syndromes
- First-degree relatives (parents, brothers, sisters, and children) of patients with TAA should be screened because family studies have found an approximately 20% chance of another first-degree relative having a TAA.

What are the signs and symptoms of TAA?

- Most people with TAA have no symptoms. TAAs are typically found incidentally when the patient is undergoing an imaging study for another reason. Aneurysms of the aortic root may lead to leakage of the aortic valve, so a heart murmur may be heard on physical examination.

Presentation

lip

- Aneurysm

- Most asymptomatic
- Superior vena cava syndrome
- Hoarseness
- Bronchial obstruction
- Dysphagia
- Hemoptysis
- Paralysis/paraplegia
- Lower extremity embolism

Diagnosis



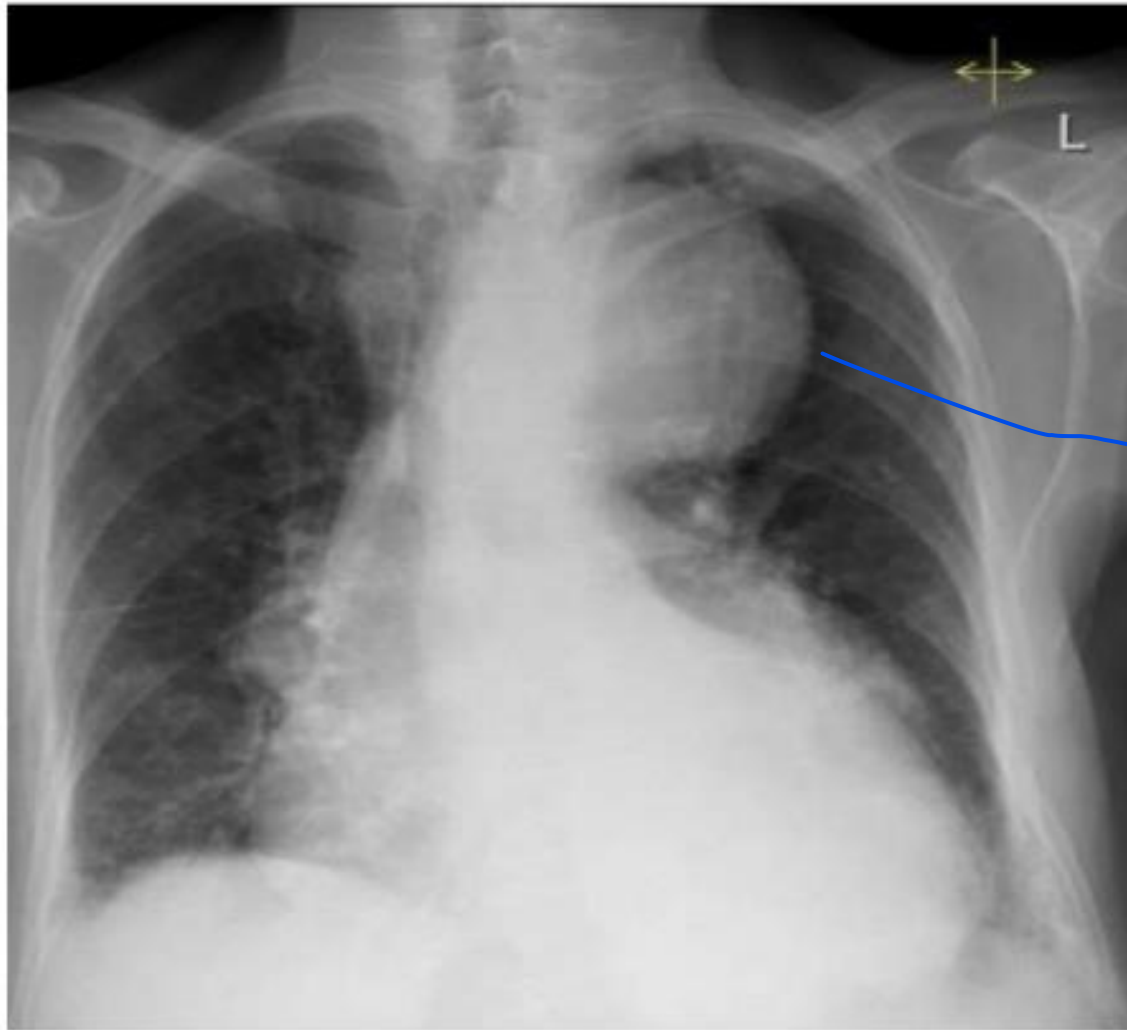
- Chest x-ray
 - Widened mediastinum
- Echocardiogram
 - Transthoracic – aortic root
 - Transesophageal – ascending and descending
- Aortography
 - Delineates the lumen
- CT scan
 - Most widely used diagnostic tool
- MRI
 - Avoids contrast dye

Echo is useful to look at the aortic root but may miss aneurysms farther away from the heart in the ascending aorta and aortic arch



How is TAA diagnosed?

- (CTA)
- (MRA) are the imaging tests of choice for diagnosing and measuring TAAs.
- Disadvantages of CTA include radiation exposure and the need for using intravenous (IV) contrast dye
- Disadvantages of MRA include the length of the test (45–60 minutes), the use of gadolinium for contrast,



wide mediastinum

saccular aneurysm

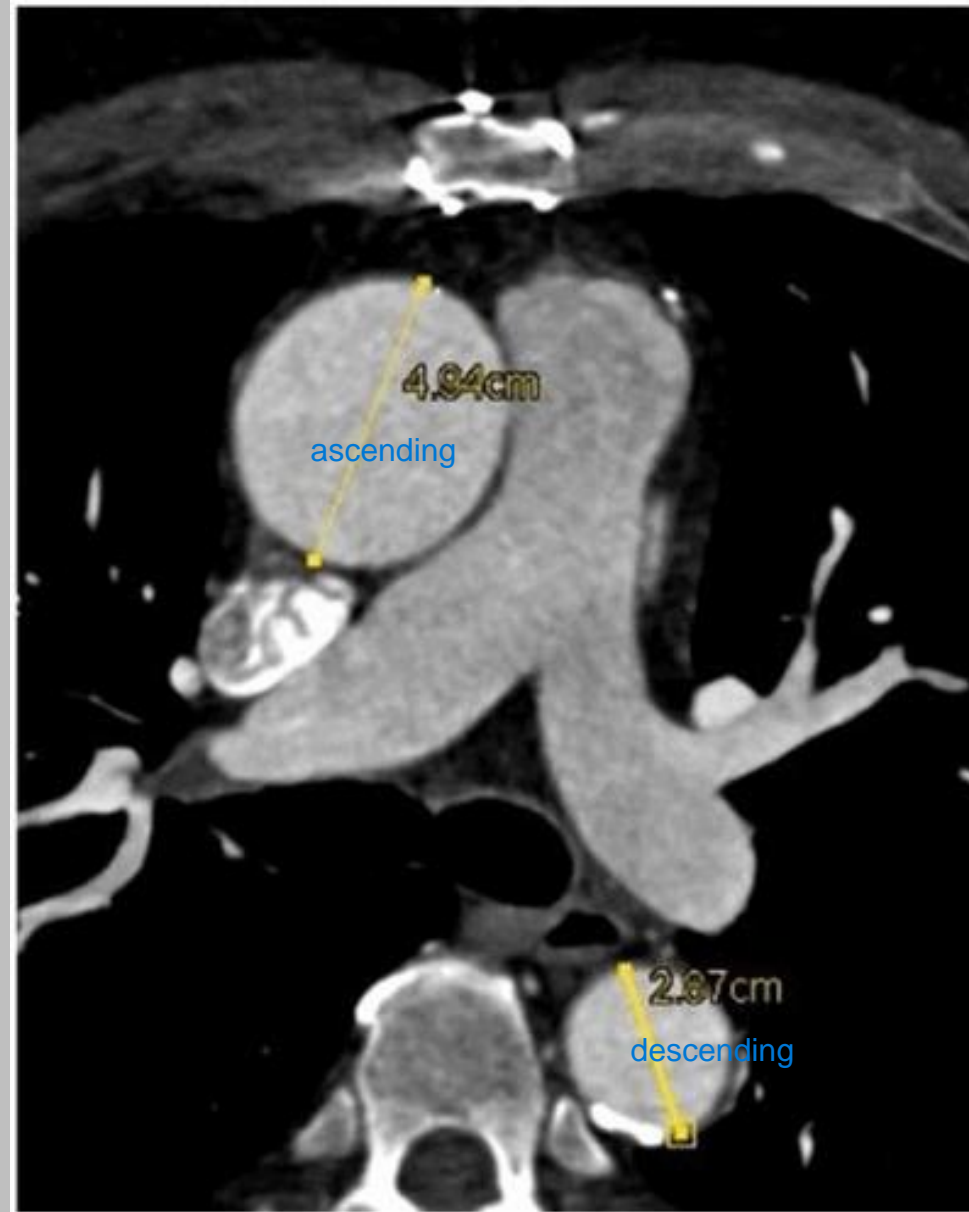
TAA. This huge aneurysm of the aortic arch and descending thoracic aorta was an incidental finding on this chest radiograph



wide mediastinum

Chest X-ray (postero-anterior projection) showing that the descending thoracic aorta is extremely dilated and tortuous.

CT scan
can measure the diameter
ascending aorta --> dilated
descending aorta --> normal



reconstruction of CT scan



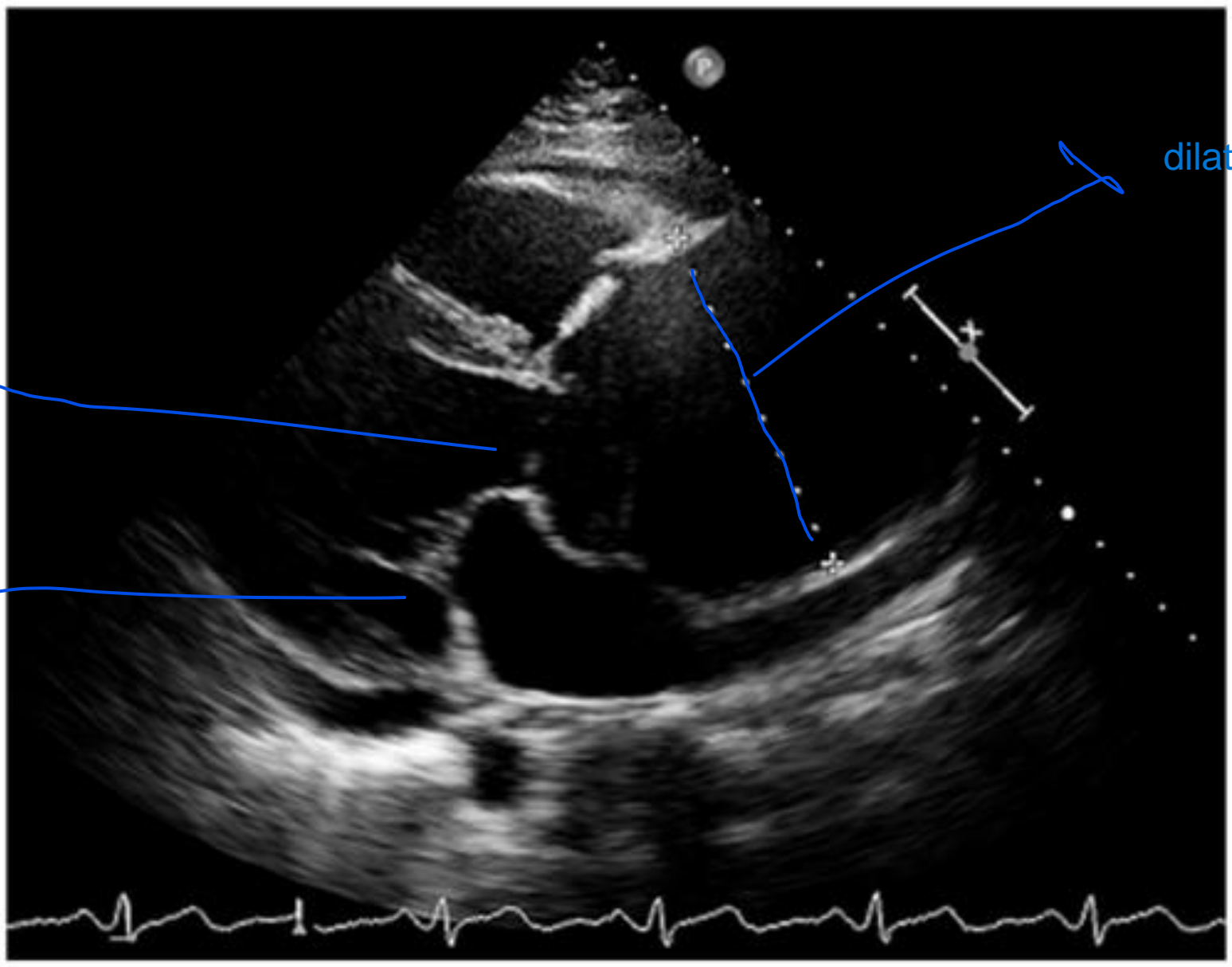
- Echocardiography may help in the diagnosis of TAA.
- Echo is useful to look at the aortic root but may miss aneurysms farther away from the heart in the ascending aorta and aortic arch.

ECHO

aortic valve

mitral valve

dilated aorta



What is the medical treatment for TAA?

- In general, medications to slow the growth of TAAs and prevent dissection and rupture are limited

Treatment - Aneurysm

- Medical

- BP control
- Smoking cessation
- No heavy lifting

- Surgical

- Dacron tube graft
- Ascending – may need to replace valve
- Arch – graft
- Descending – graft, stent grafts

Treatment – Indications for Intervention

- Aortic size

- Ascending diameter ≥ 5.5 cm the risk of rupture increase after 6cm so we dont wait until it reach 6cm
- Growth rate ≥ 1 cm/yr (avg ascending 0.07 cm/yr; descending 0.19 cm/yr)

- Symptomatic aneurysm

- Traumatic rupture

- Pseudoaneurysm

- Large saccular aneurysm

- Mycotic aneurysm

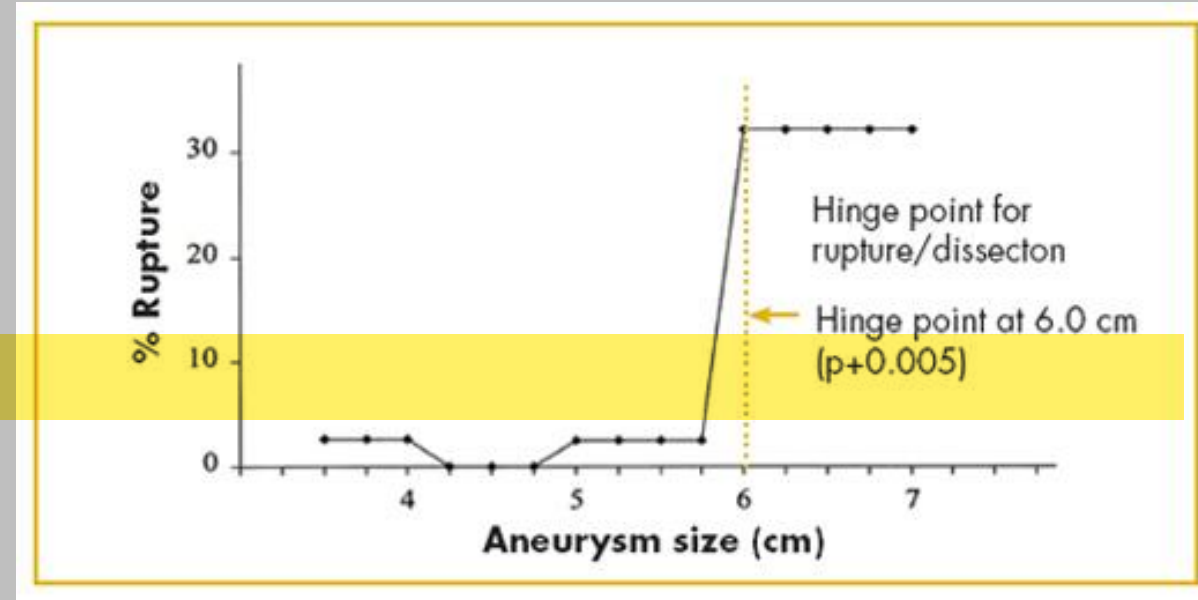
- Aortic coarctation

- Bronchial compression

- Aortobronchial or aortoesophageal fistula

The annual risk of rupture or dissection

- 2% for TAAs < 5 cm in diameter
- 3% for TAAs 5–5.9 cm
- 7% for TAAs > 6 cm
- surgery is recommended for TAAs ≥ 5.5 cm in most cases.



When is surgery recommended for TAA?

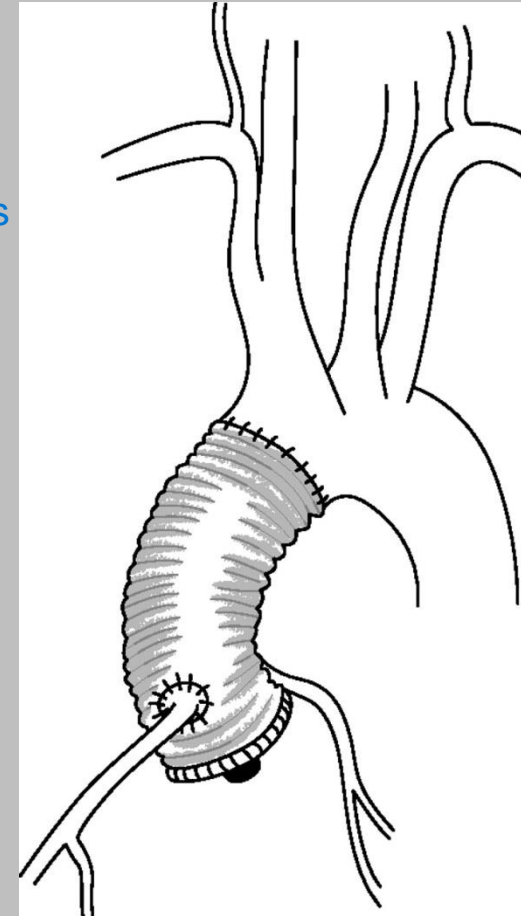
- 4.5 cm for patients with Marfan syndrome and 4.0 cm for patients with Loeys–Dietz syndrome.
- For patients with bicuspid aortic valve, lower threshold of 5.0 cm

-surgical indication in TAA :
in normal people --> >5.5
bicuspid aortic valve --> 5 cm
marfan --> 4.5
loeys-dietz syndrome --> 4 cm

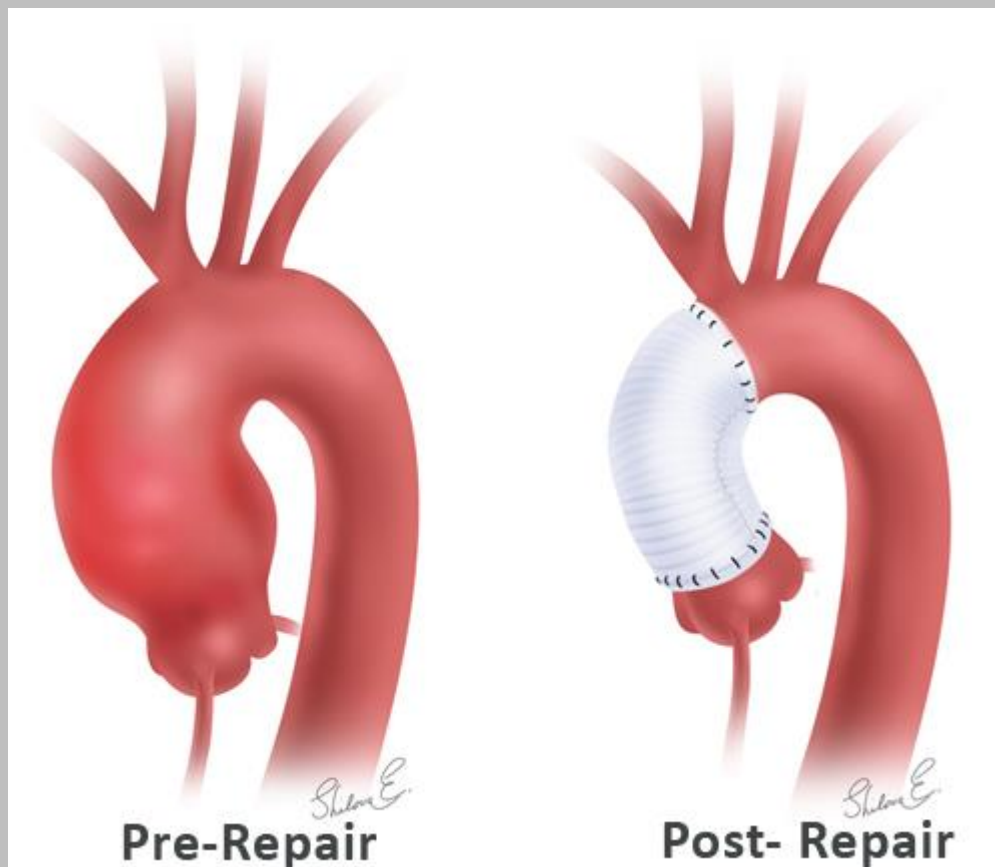
Treatment - Surgical

- Composite valve and graft replacement

root replacement (Bentall) --> inside the graft we have valve so we transplant coronaries

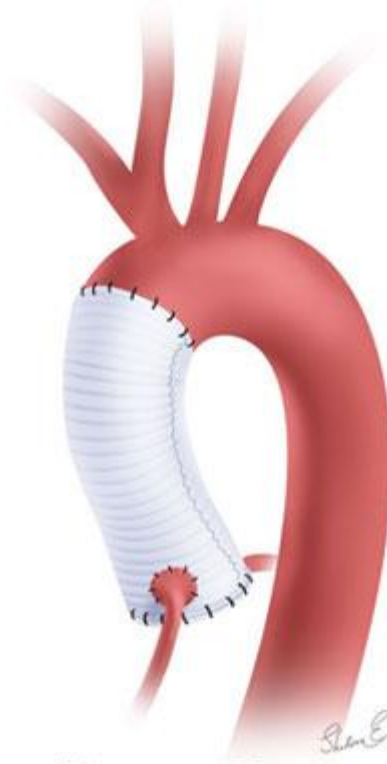


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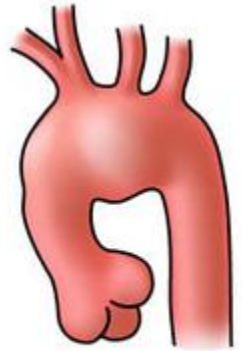




Pre-Repair



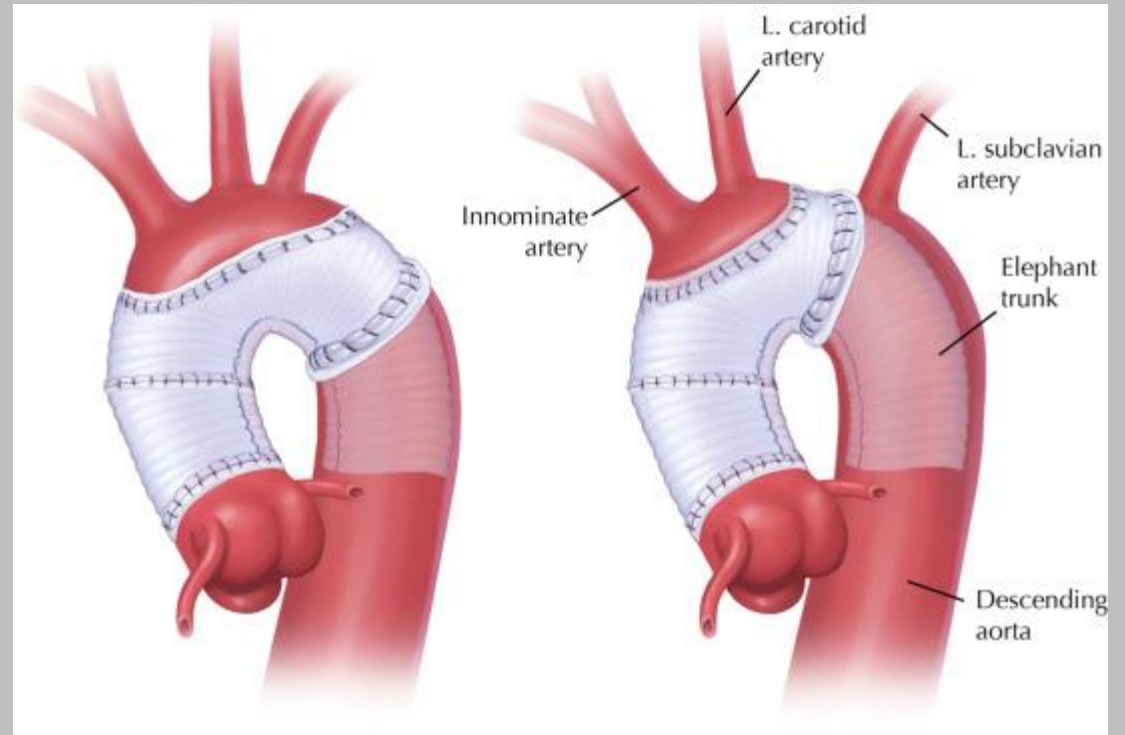
Post-Repair

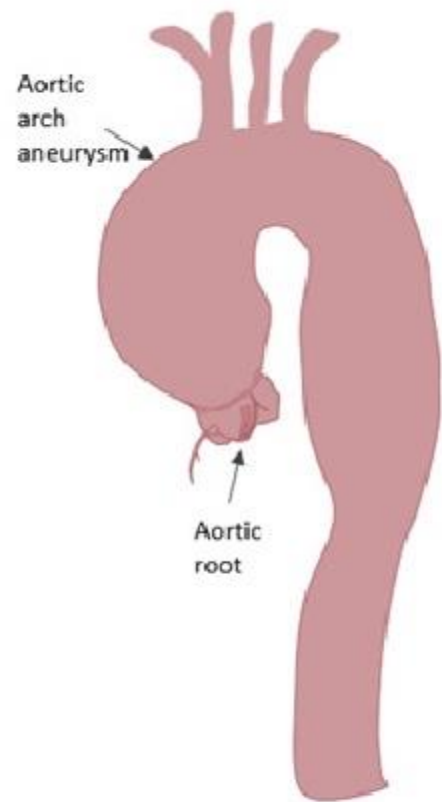


Aortic Arch
Aneurysm

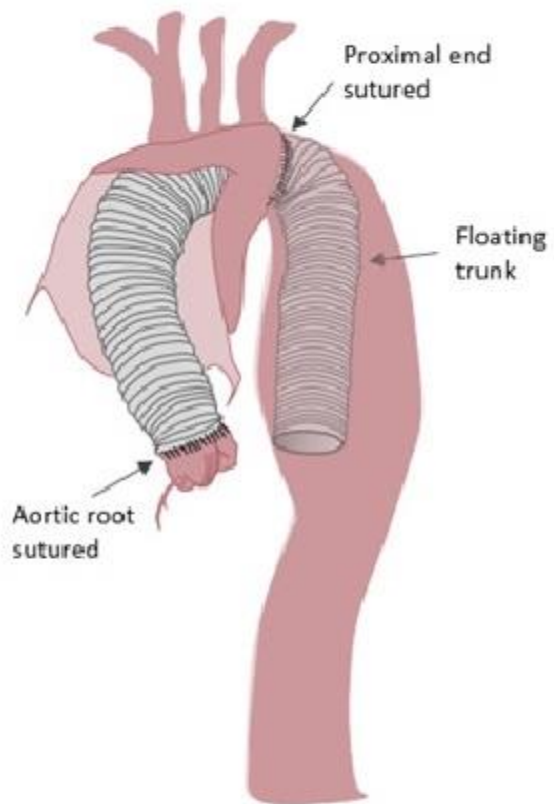


Aneurysm Replaced
with Prosthesis

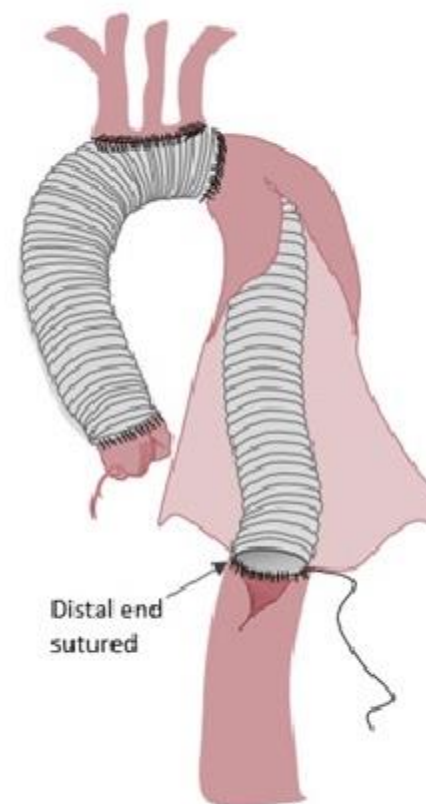




COMPLEX ANEURYSM



STAGE - 1



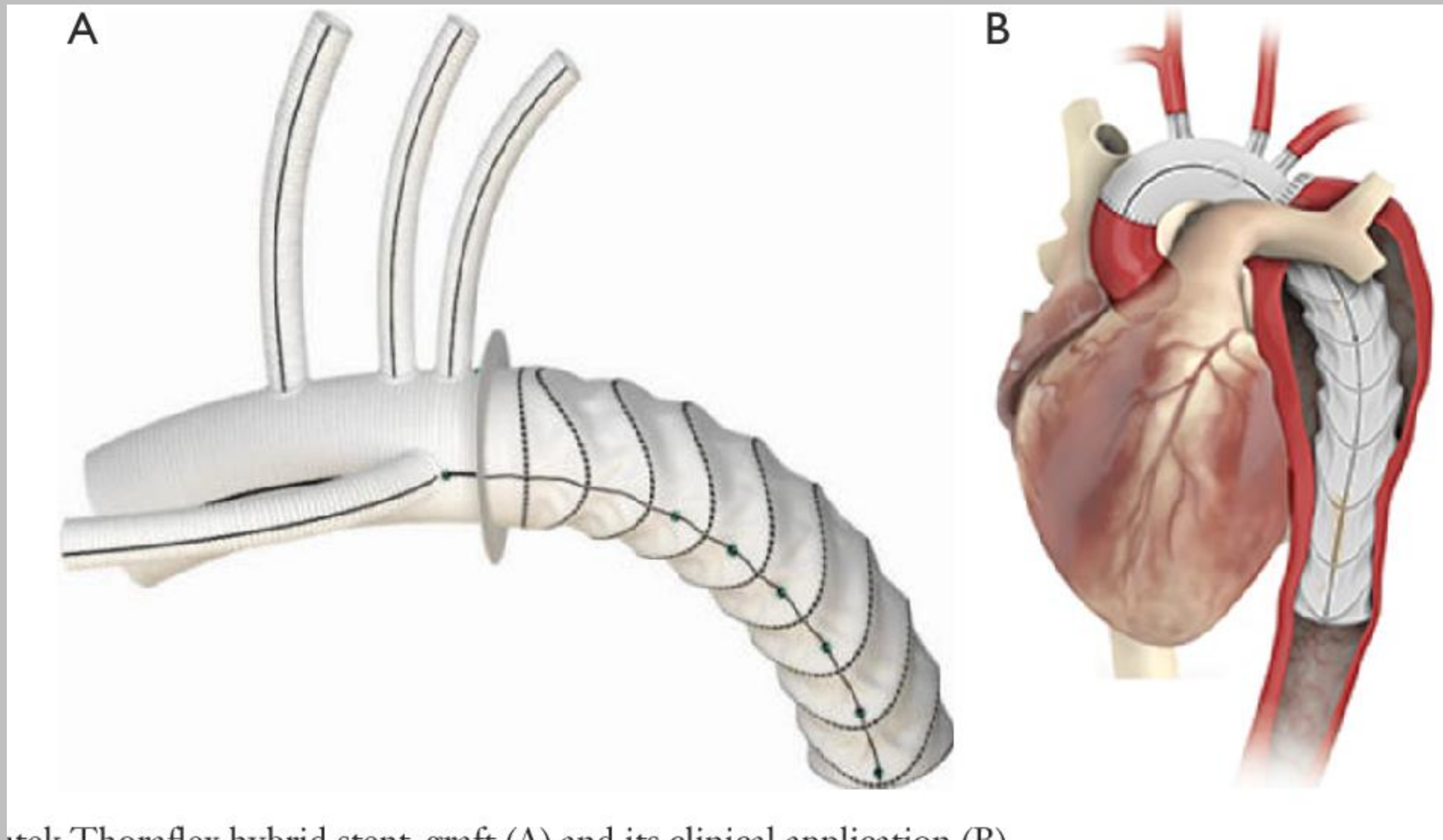
STAGE - 2



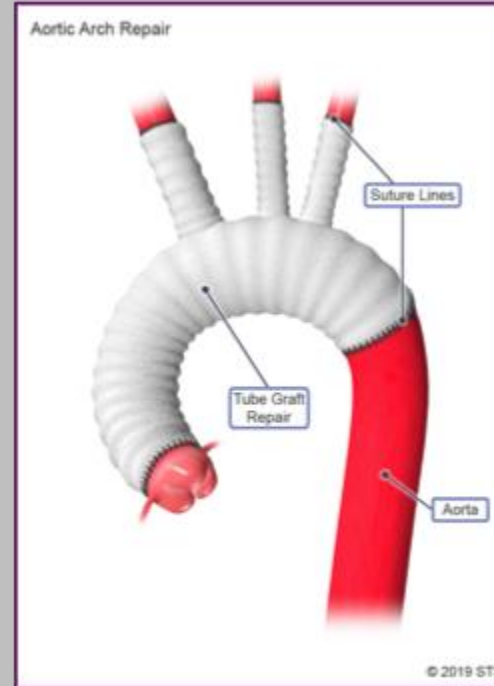
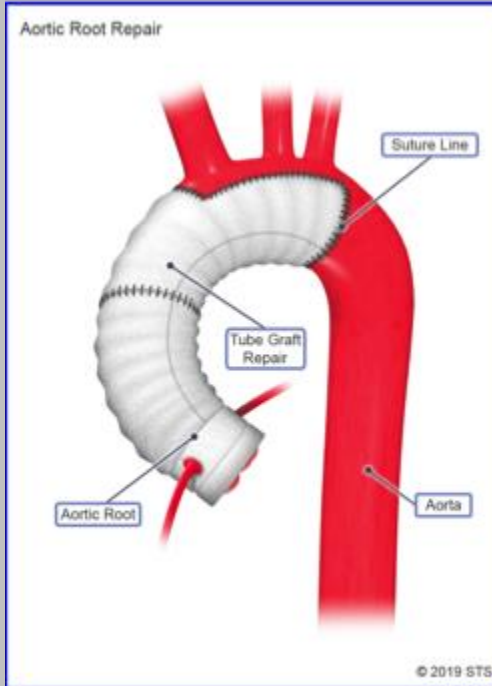
COMPLETED REPAIR

if its thoracoabdominal we put the graft and leave part of it inside the aorta (elephant trunk)

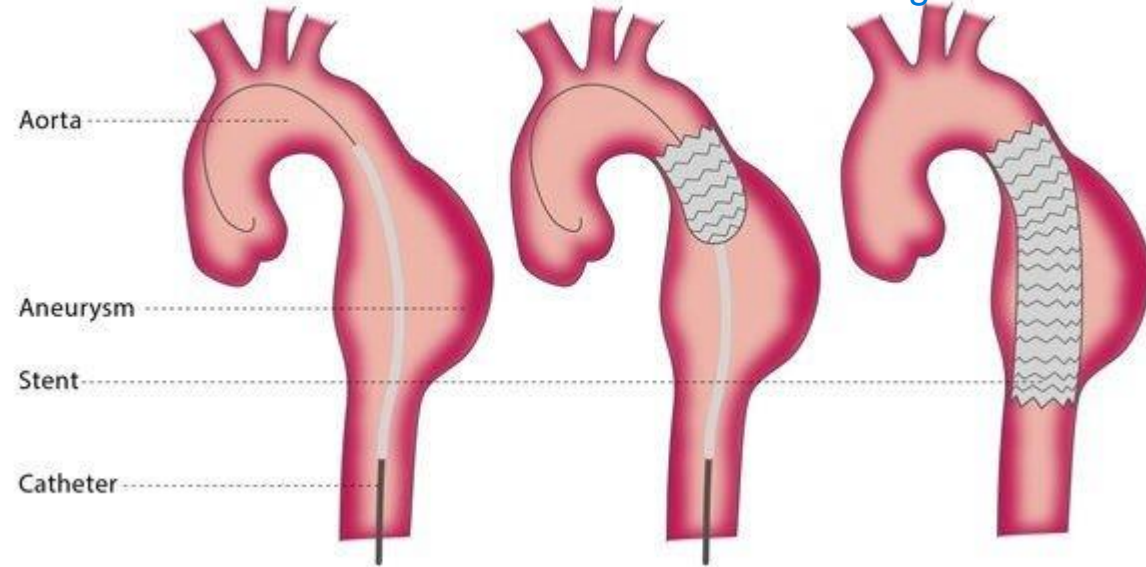
frozen elephant trunk

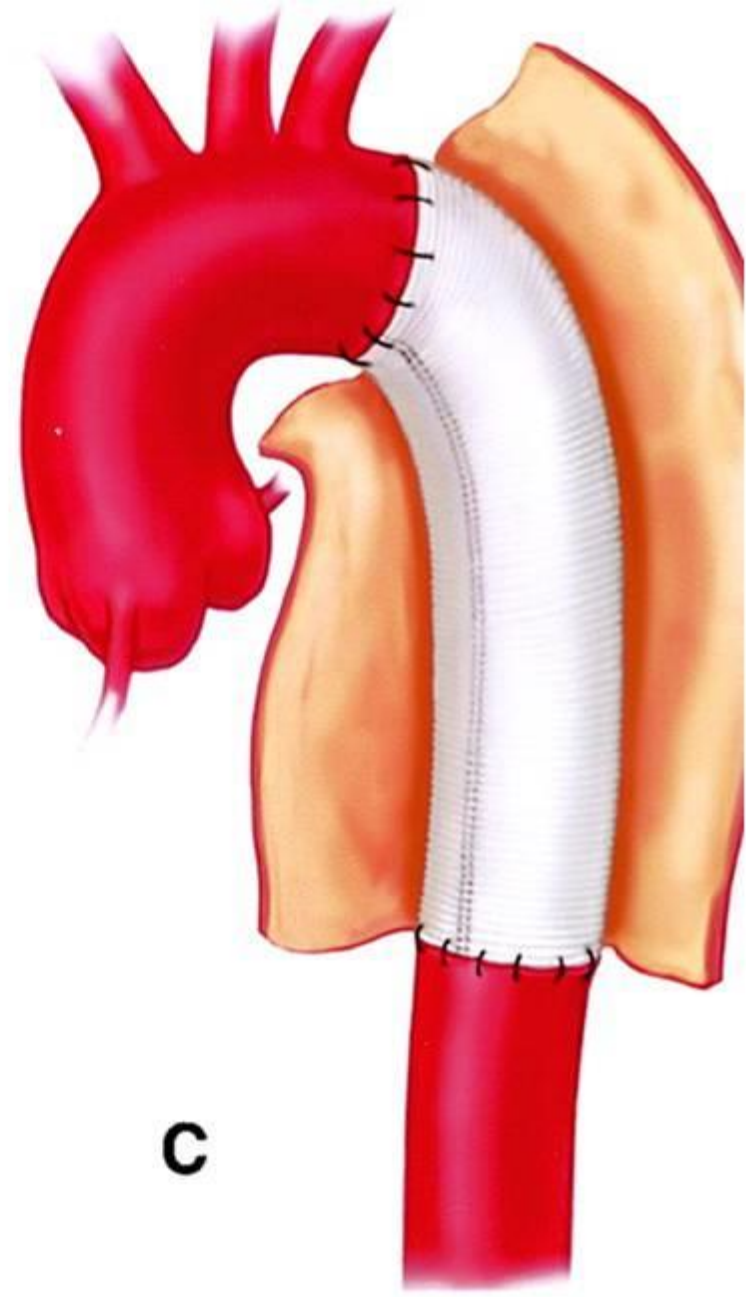


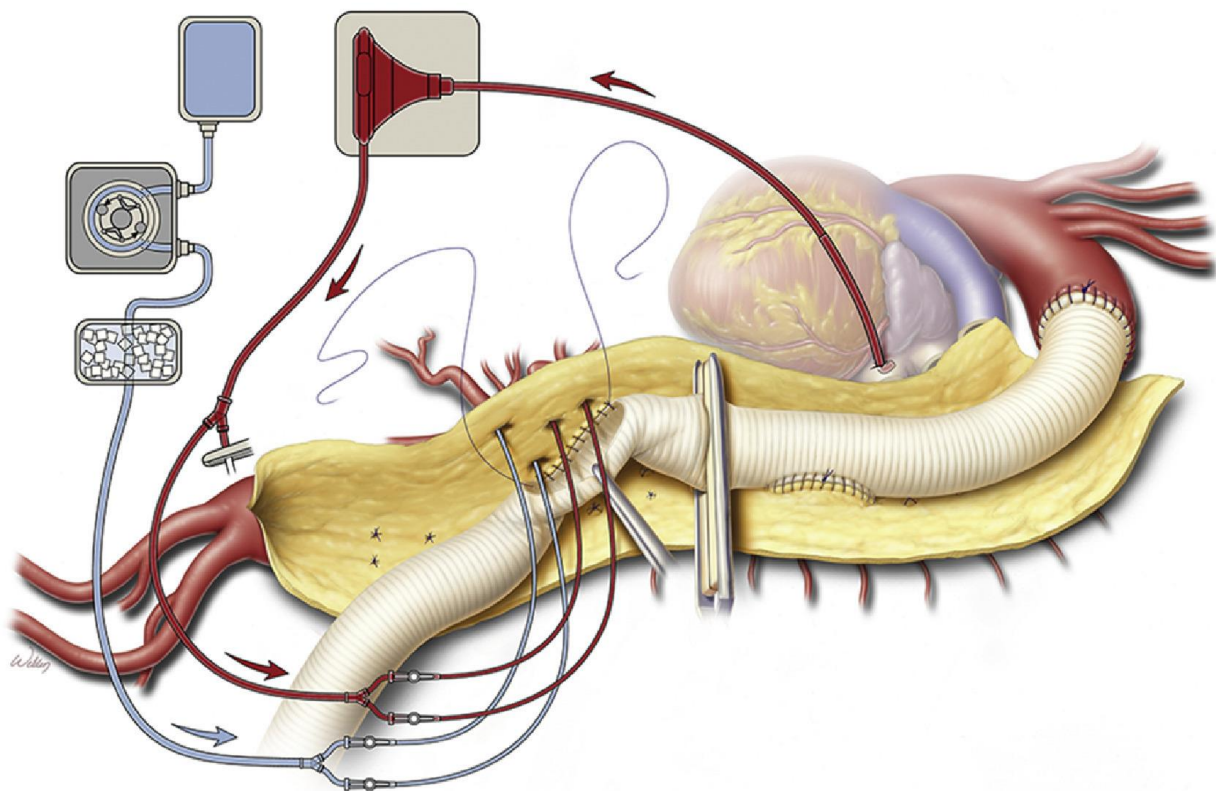
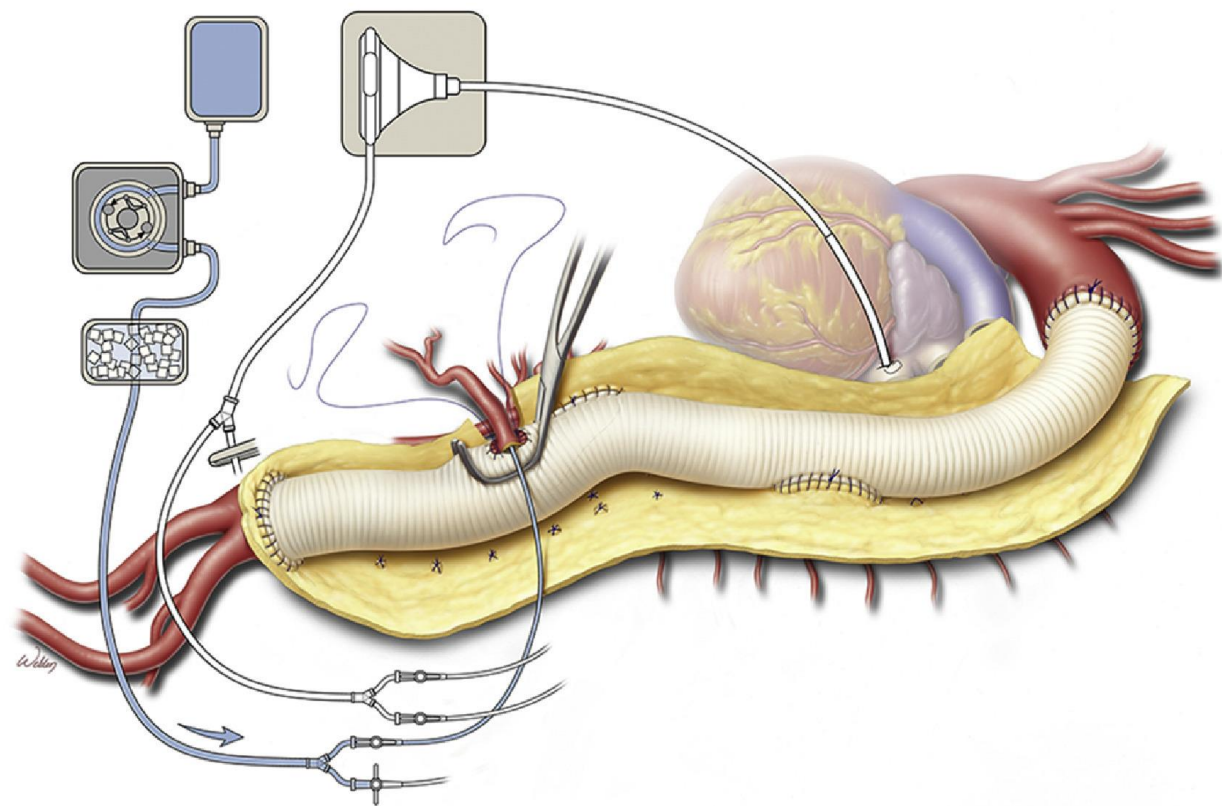
Atok Thoraflex hybrid stent-graft (A) and its clinical application (B)



Thoracic endovascular aortic repair (TEVAR) for descending not ascending



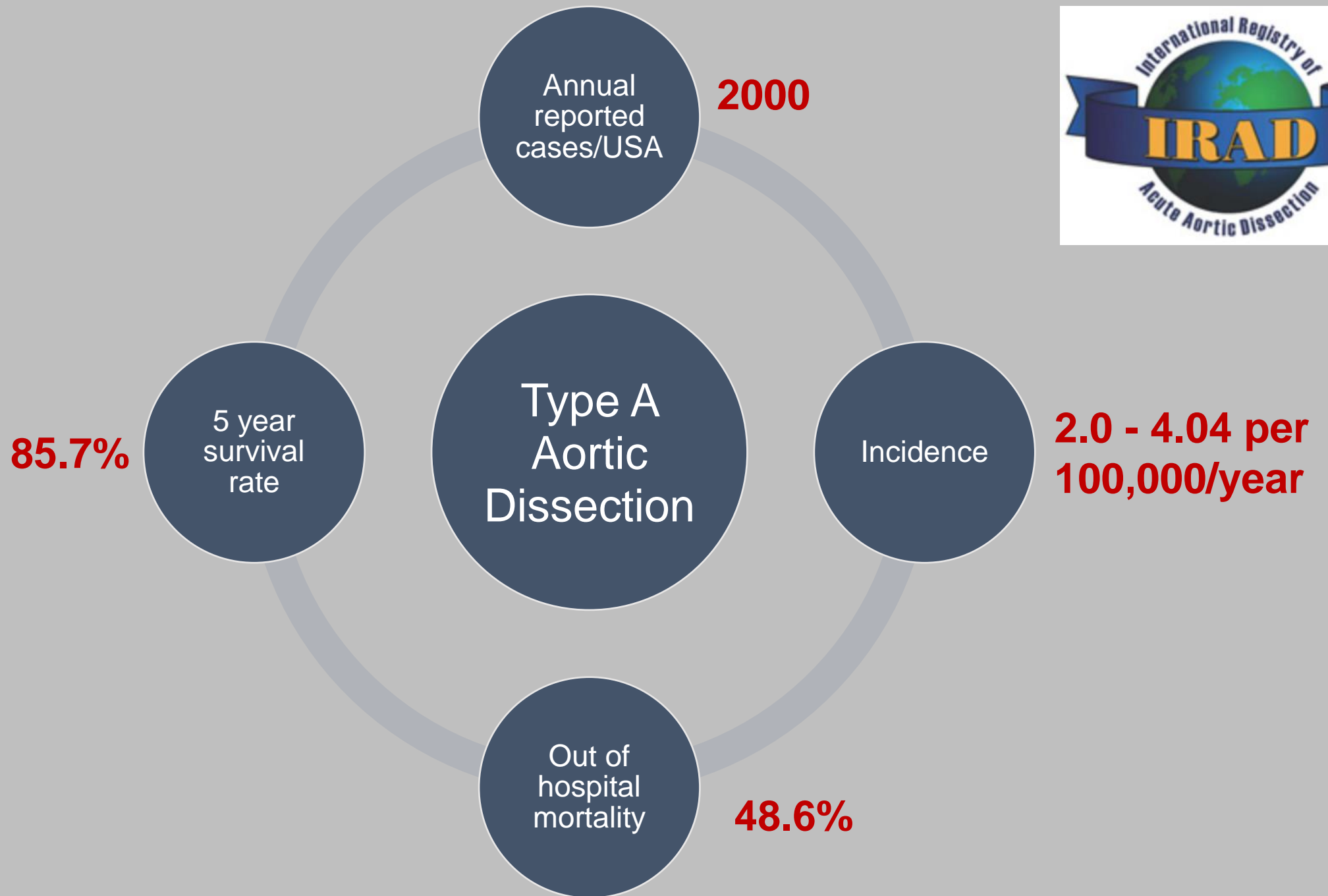


A**B**

Acute Aortic Syndrome (AAS)

same treatment

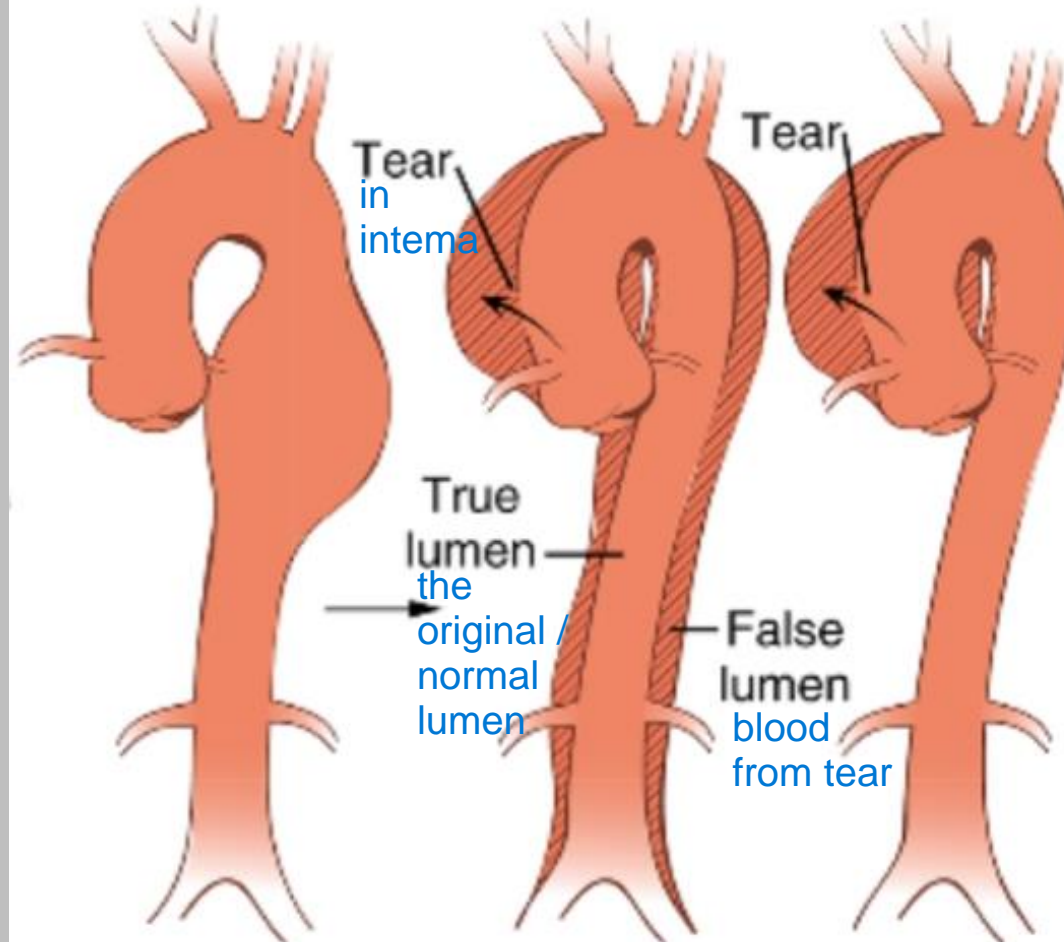
- Aortic dissection (AD)
- Intramural hematoma (IMH)
- Penetrating atherosclerotic ulcer (PAU) and
- Traumatic aortic injury (TAI)



Aneurysm vs dissection

Aortic aneurysm

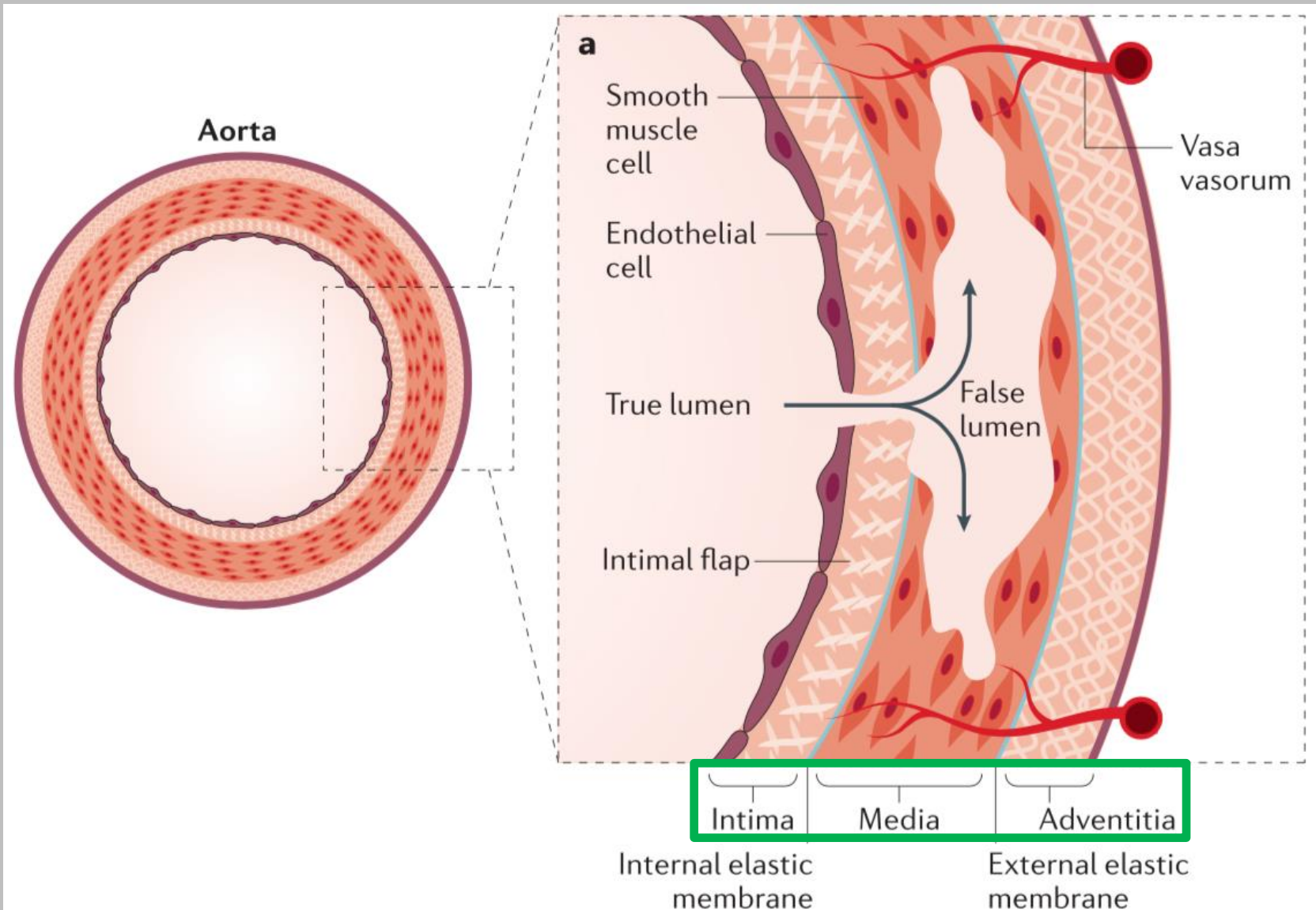
Aortic dissection



the vessel from the false lumen doesn't have blood supply --> end in end organ damage



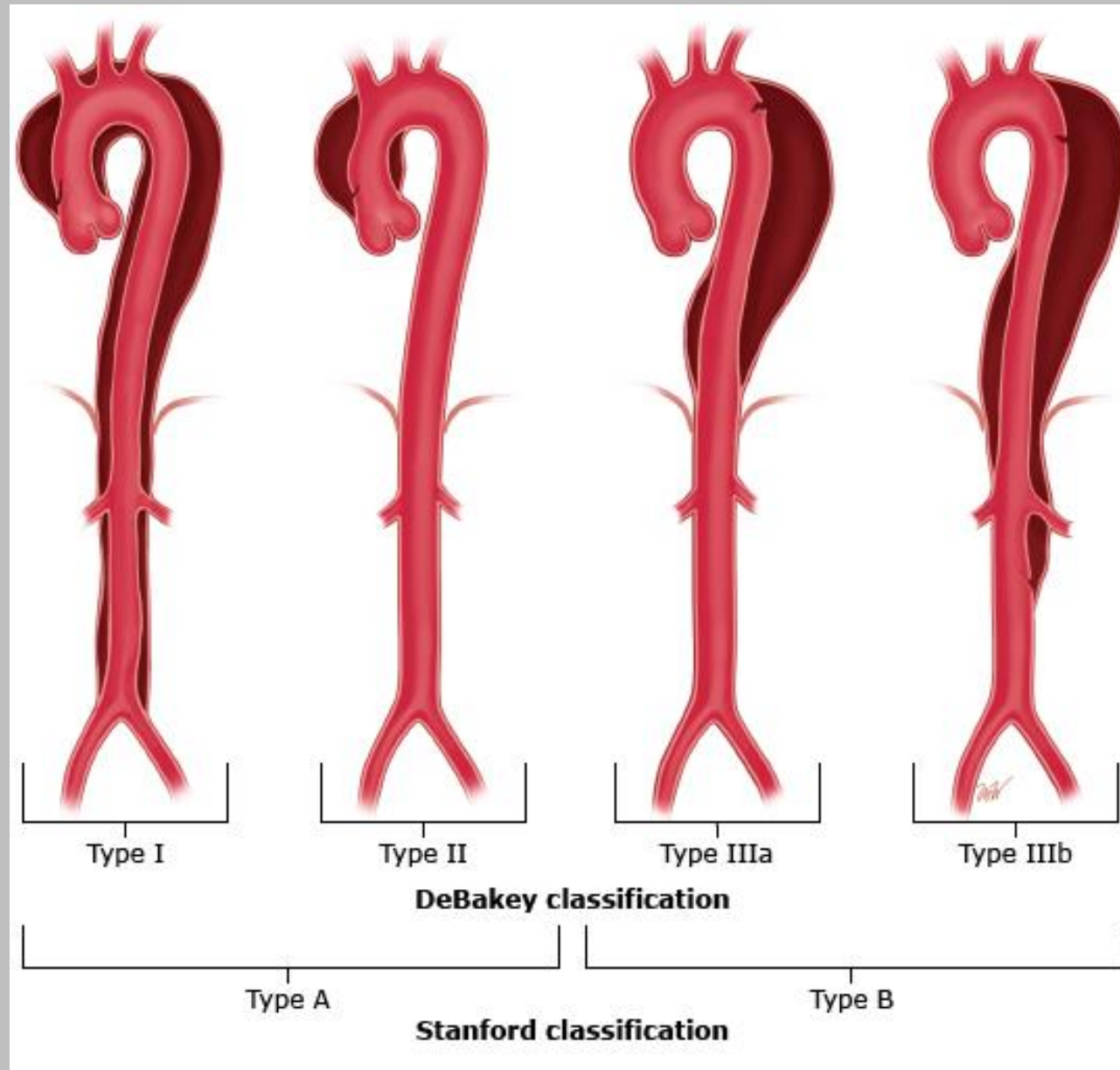
Aortic anatomy and dissection



Background

- Aortic dissection is a tear in the wall of aorta
 - Tear involves inner and middle layers of the aortic wall with propagation of a false lumen within the middle layer
- Aortic dissections are classified by the area of aortic involvement
 - Type A: involving the ascending aorta surgical / mortality is estimated to be 1%–2% per hour for the first 48 hours
 - Type B: all other dissections non-surgical / have a high mortality, up to 70% at 30 days for high-risk groups

stand for A --> involve the ascending aorta / surgical
stand for B --> involve the descending aorta / not surgical



DeBakey classification:
-type 1 --> all
-type 2 --> only ascending (to brachiocephalic
-type 3a --> thoracic
-type 3b --> thoracoabdominal

Epidemiology of Aortic Dissection

- Acute aortic dissection is rare
- The true incidence is hard to define because aortic dissections can be instantly fatal in the pre-hospital setting; death is often attributed to other causes
- The incidence of acute aortic dissection is higher in men and older adults

- Immediate death following a short period of symptoms, or no symptoms occurs in an overwhelmingly high percentage of patients with acute aortic dissection.
- Some investigators report the immediate mortality to be as high as 40%.
- Mortality results from aortic rupture, pericardial tamponade leading to cardiogenic shock, acute aortic valve regurgitation, and acute myocardial ischemia in the case of coronary ostia involvement.

aneurysm in coronaries

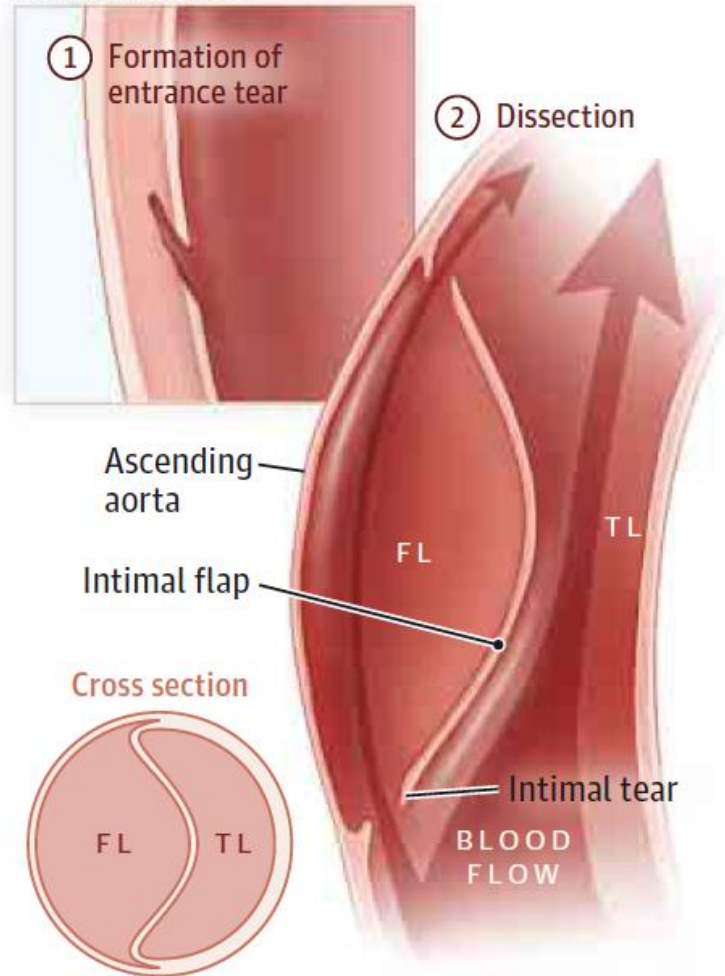
stroke --> aneurysm in carotid

- The diagnosis of acute type A aortic dissection requires a high index of suspicion. Up to 30% of patients are initially misdiagnosed
- In-depth history taking and a detailed physical examination are essential in the diagnosis of type A aortic dissection.

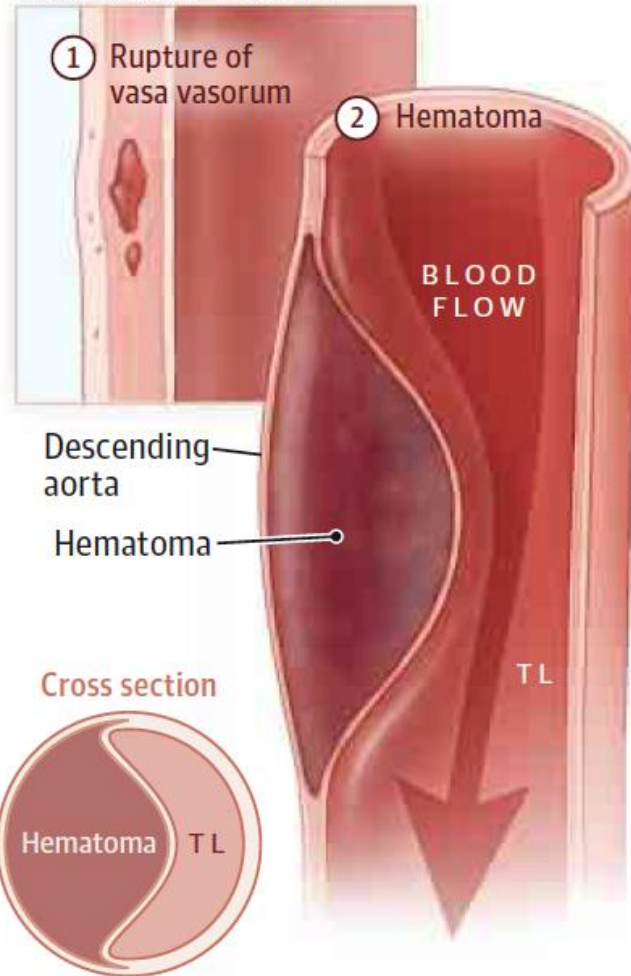
Acute aortic syndrome

B Pathogenesis of acute aortic syndromes

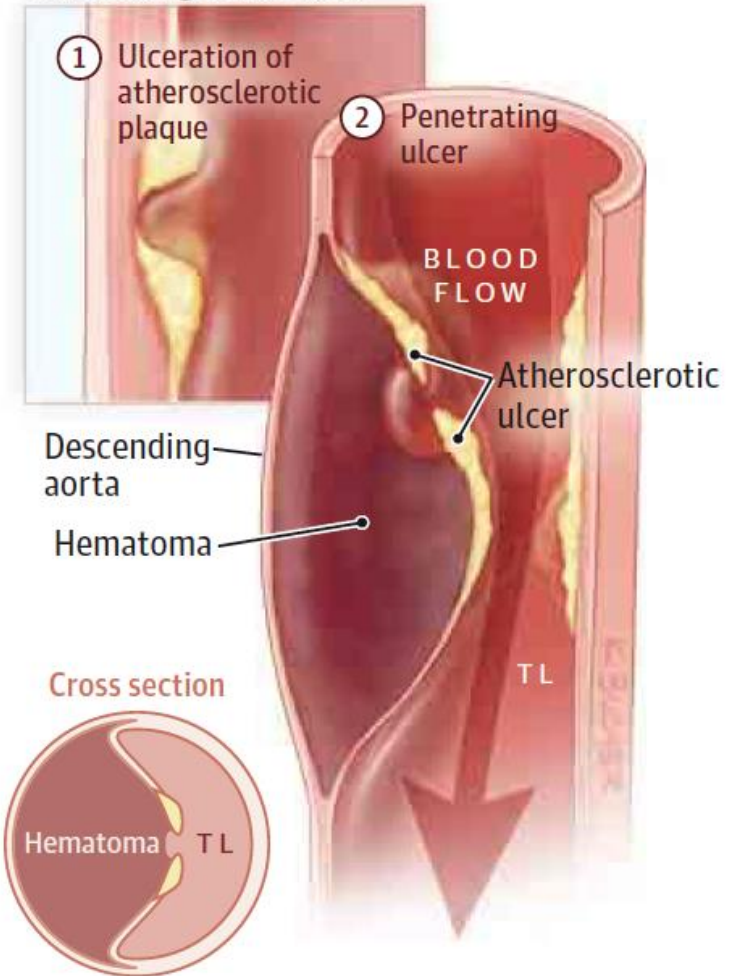
Aortic dissection



Intramural hematoma



Penetrating aortic ulcer



Risk factors for aortic dissection

Lifestyle and cardiovascular risk factors

- Long-term hypertension
- Old age
- Dyslipidemia
- Pregnancy-induced hypervolemia
- Weight-lifting
- Smoking
- Cocaine abuse

Congenital and connective tissue disorders

same to TAA

- Bicuspid aortic valve
- Marfan syndrome
 - FBN1 & FBN2
- Loeys-Dietz syndrome
- Ehlers-Danlos syndrome
- Turner syndrome

ov,

Trauma

- Aortic transection
- Motor vehicle deceleration injury
- Falling from height

Iatrogenic

- Cardiac catheterization
- Arterial cannulation for cardiopulmonary bypass
- Aortic cross-clamping during valvular or aortic surgery
- Intra-aortic balloon pumps

Vascular inflammation

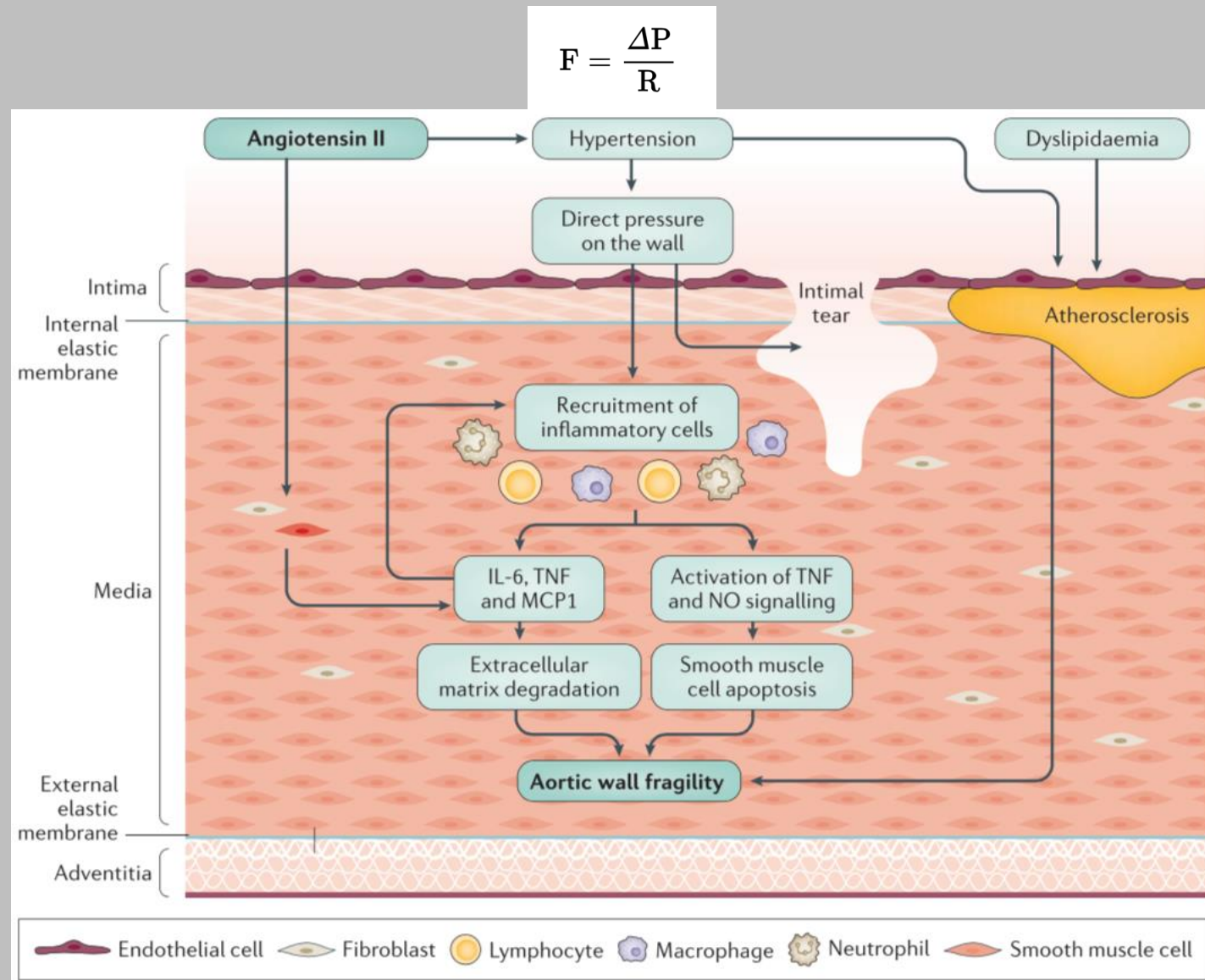
- Autoimmune disease
 - Giant cell arteritis
 - Takayasu arteritis
 - Bechet disease

Aortic aneurysm

Infectious disease

- Syphilis
- Tuberculosis

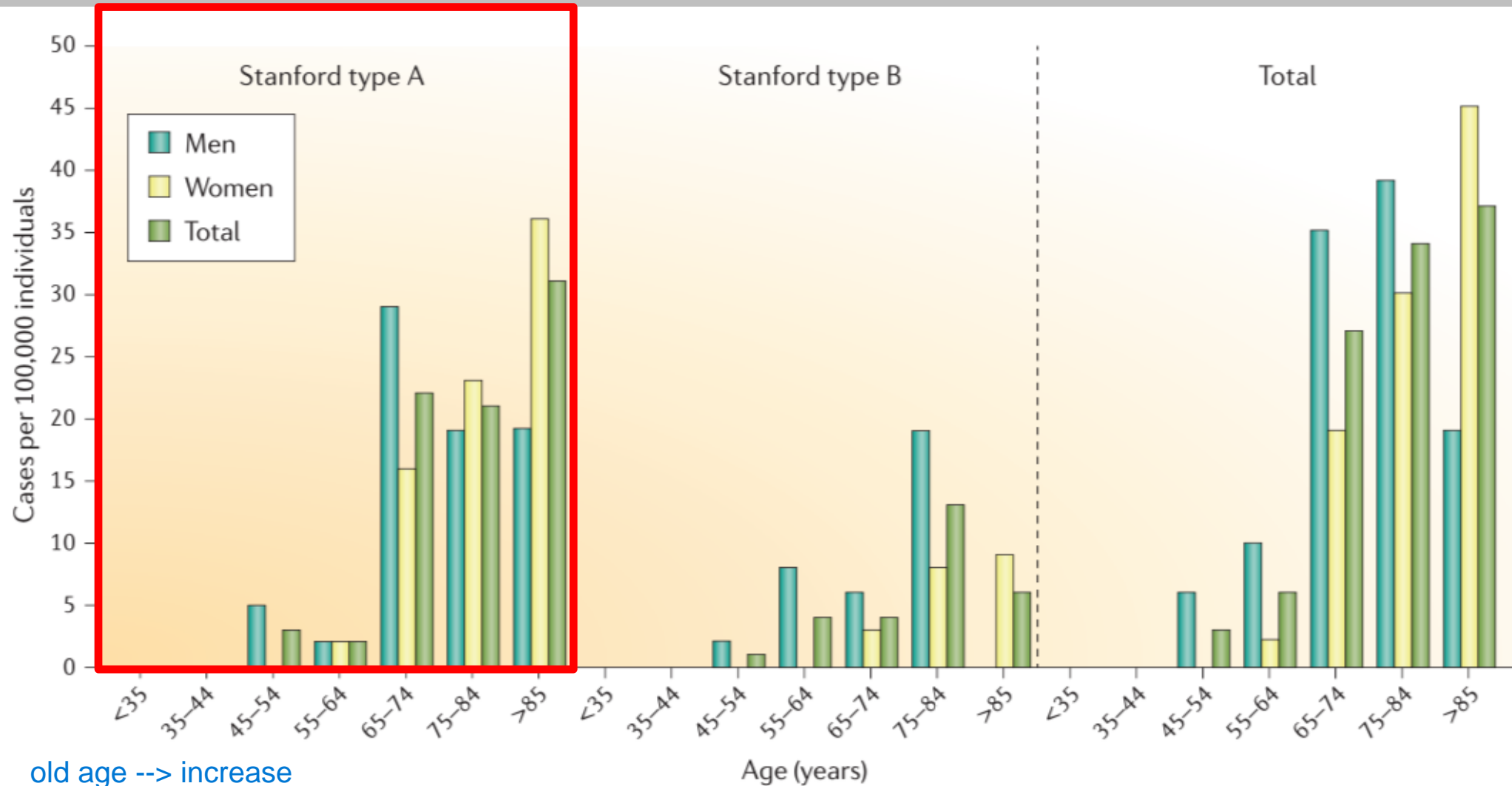
Aortic intimal pathophysiology



inflammation (due age / atherosclerosis) --> smooth muscle apoptosis and extracellular matrix degradation --> decrease the elastin and increase the collagen fiber --> the wall more fragile

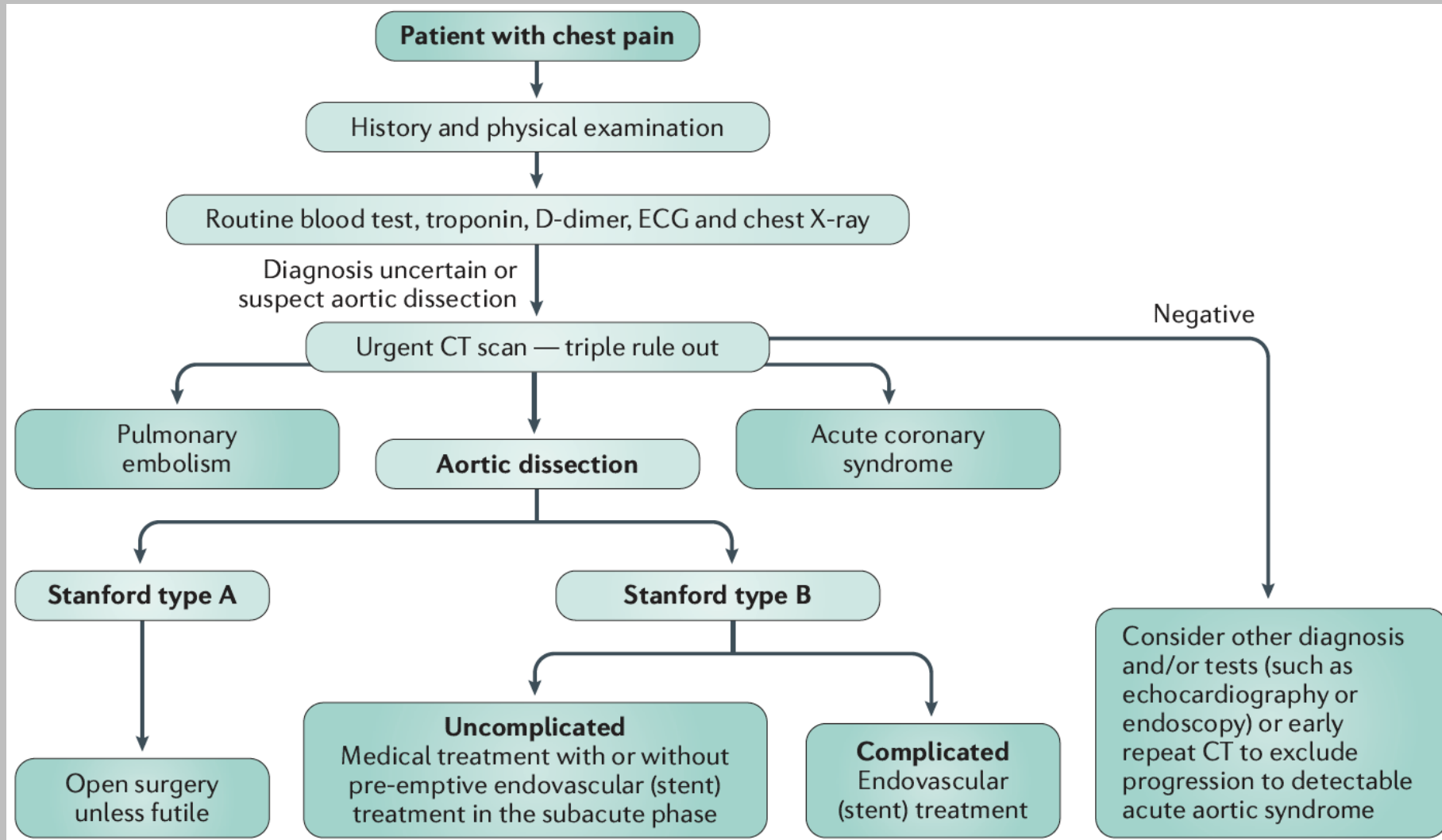
Aortic dissection epidemiology

the age is the major risk factor



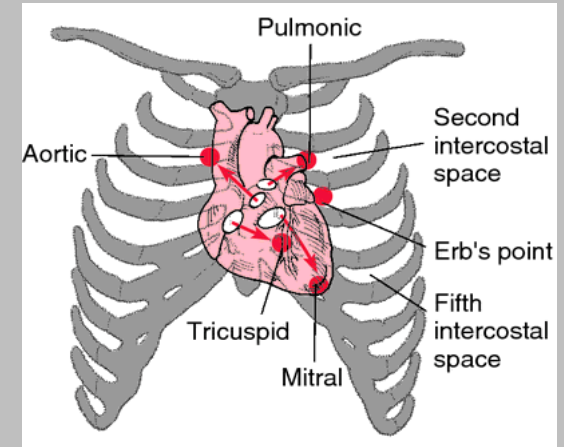
old age --> increase

Diagnostic algorithm



Physical exam / preop evaluation

- Anterior chest or interscapular pain of extreme intensity
 - Accompanied sweating, vomiting, fainting
- Diastolic murmur (if aortic valve insufficiency)
- Pulsus paradoxus (if tamponade)
- Cardiogenic shock (if aortic insufficiency, tamponade, major coronary occlusion)
- Hypovolemic shock (aortic rupture)
- Abdominal bruit
- Loss of peripheral pulses / bilateral BP differential of $>20\text{mmHg}$
- Hemiplegia, hemiparesis, or paraplegia
- Evaluation of preoperative state of all organ systems



Clinical Presentation

- If undiagnosed and untreated, acute aortic dissection can have a very high mortality
 - For untreated type A dissection, mortality is estimated to be 1%–2% per hour for the first 48 hours
 - Type B dissections can also have a high mortality, up to 70% at 30 days for high-risk groups

Clinical Presentation

- Common presentations :
 - Chest pain (90%)
 - Sudden, severe, sharp, stabbing, or tearing chest pain (40%–50%)
 - Pain radiating to the back (47%–64%)
 - Chest pain with a widened mediastinum on chest radiograph (60%)
 - Pulse deficits or differences in blood pressure between the arms (19%–34% for type A)
 - Chest pain with new aortic regurgitation (32%–76%)

- As many as 33% of acute type A aortic dissection patients present with symptoms of end organ malperfusion, which substantially impacts outcomes.
- Cerebral, peripheral, and visceral malperfusion can occur separately or in combination and have been shown to be independent predictors of postoperative outcomes

Clinical Presentation

Less common presentations for dissection include:

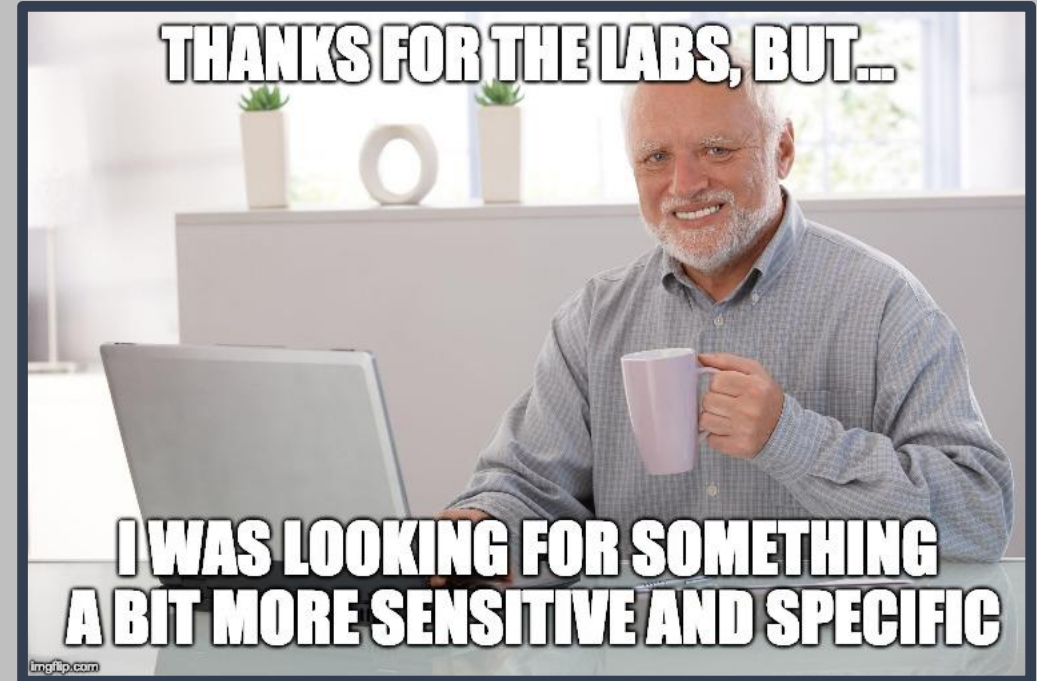
- Pain that radiates to the abdomen and lower extremities (17%)
- Ischemic complications such as renal infarction (14%), mesenteric ischemia (5%), spinal cord ischemia (3%)
- Inferior myocardial infarction (1%–7%)

Physical Examination

- The classic physical examination findings for acute aortic dissection (e.g., diastolic murmur, blood pressure differential between arms, focal neurologic deficit) are seen in fewer than half of all patients with acute aortic dissection

Diagnostics - Laboratory

- Current Tests:
 - Inflammatory markers:
 - C-reactive protein
 - IL-6
 - Cardiac stress or damage:
 - Troponin
 - Creatinine kinase
 - Pro-BNP
 - Thrombosis / fibrinolysis
 - D-dimer



Diagnostic Testing for Dissection

- Conventional chest radiographs show widening of the aorta in 63% of type A dissections, while 11% show no abnormality
- The comparable values in type B dissections were 56% and 16%

the chest xray --> not beneficial

the diagnostic tool of choice --> CT scan and ECHO (if cant do CT scan)

Diagnostic Testing for Dissection

- Due to the limited sensitivity of chest radiographs, especially in type B dissections, a normal chest radiograph should not be used to rule out acute aortic dissection
- In this patient, a right hilar fullness was noted. Without access to the actual chest radiograph, it is difficult to comment on how or whether this finding should have influenced the clinicians in this case

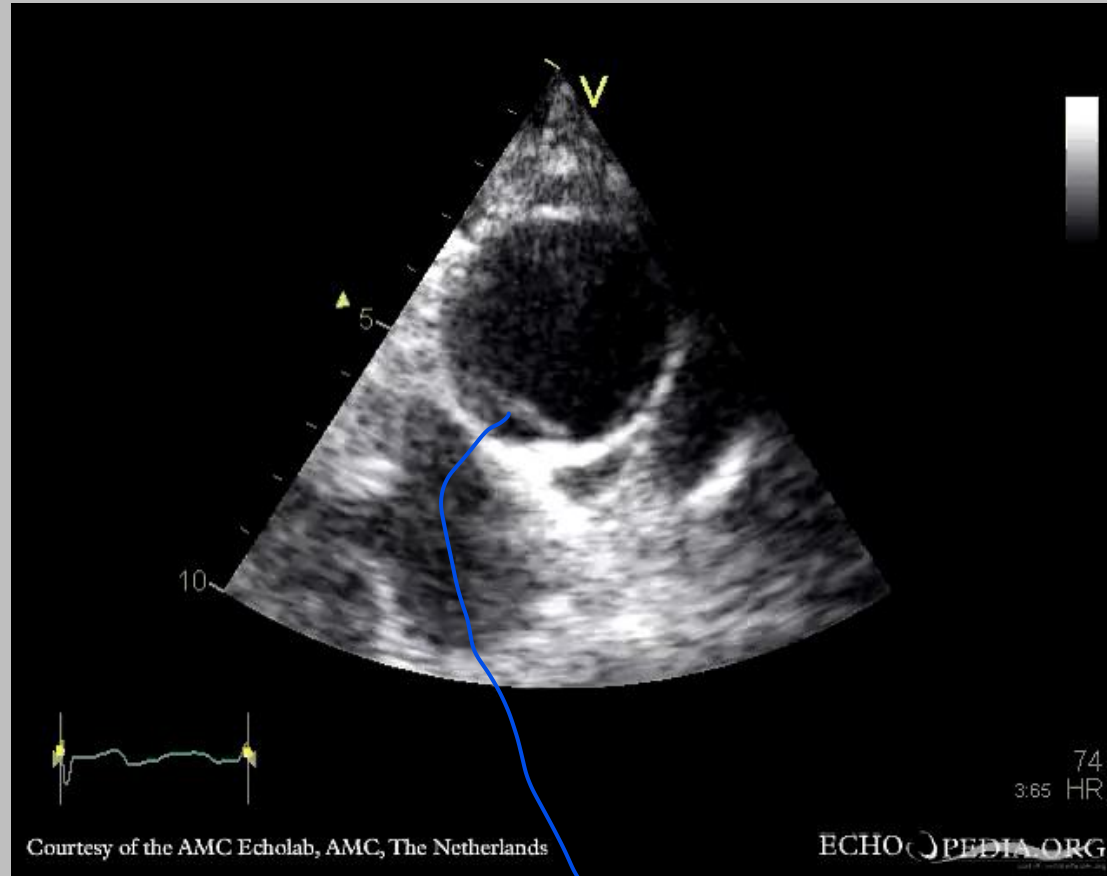
- Computed Tomography
- The sensitivity and specificity of this imaging modality approach 100% (82%-100% and 90%-100%, respectively)
- Transesophageal Echocardiography if we cant do CT scan
- TEE is especially useful in patients wherein contrast is absolutely contraindicated. The sensitivity of TEE in acute type A aortic dissection approaches 100% with a lesser specificity of 70% to 100% due to reverberation artifacts.⁴⁸ TEE is less useful for the definitive diagnosis of acute type A aortic dissection

not sensitive in
type B

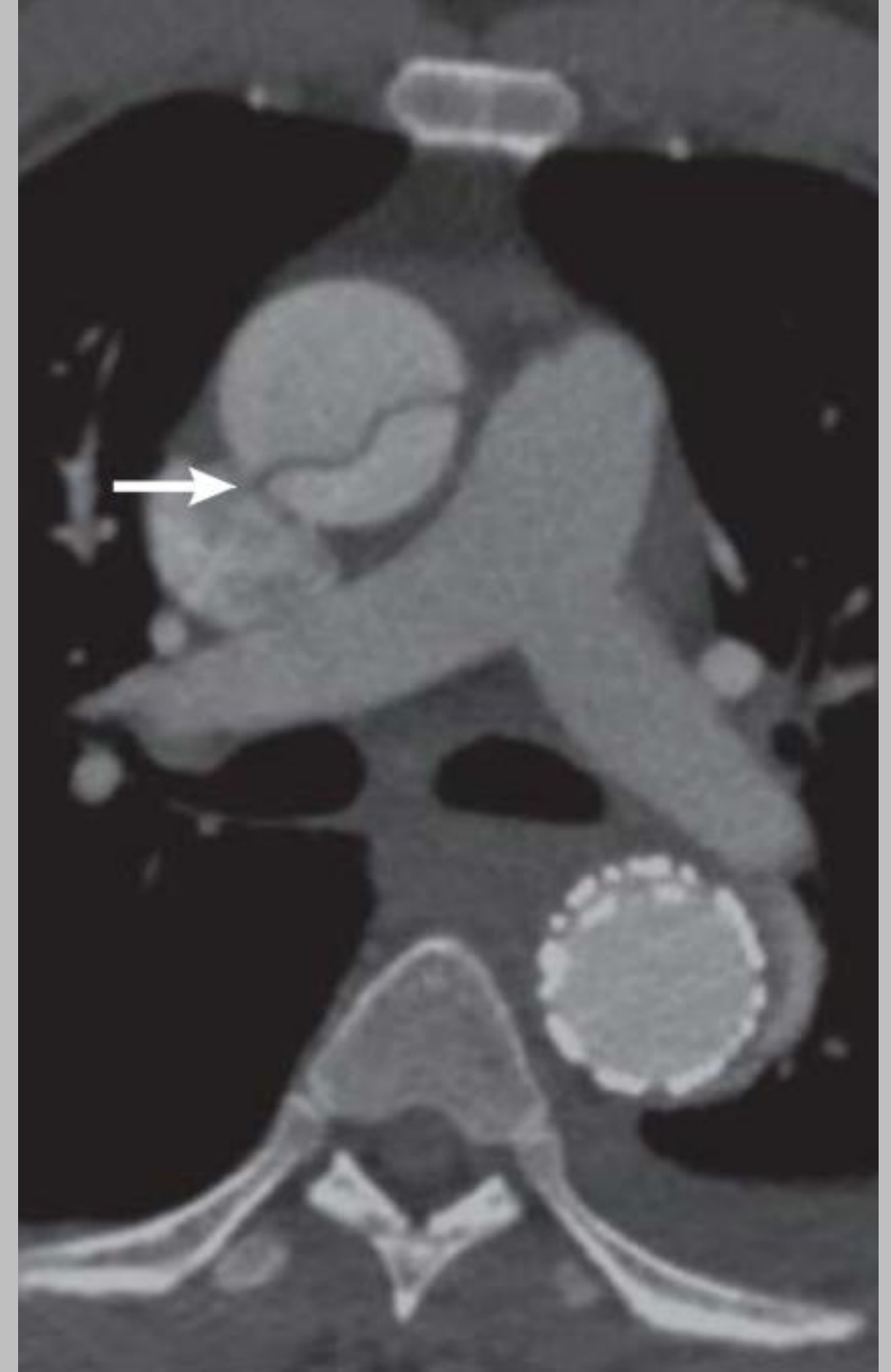
- The use of MRI in the diagnosis of acute type A aortic dissection is limited because it is not as readily available as CTA and is time consuming, although it can definitely be diagnostic and provide all the information needed to plan operative repair

Diagnostics - Imaging

ECHO



flap of dissection



Estimation of Pretest Risk of Thoracic Aortic Dissection

High Risk Conditions

1

- Marfan Syndrome
- Connective tissue disease*
- Family history of aortic disease
- Known aortic valve disease
- Recent aortic manipulation (surgical or catheter-based)
- Known thoracic aortic aneurysm
- Genetic conditions that predispose to AoD†

* Loeys-Dietz syndrome, vascular Ehlers-Danlos syndrome, Turner syndrome, or other connective tissue disease.

†Patients with mutations in genes known to predispose to thoracic aortic aneurysms and dissection, such as *FBN1*, *TGFBR1*, *TGFBR2*, *ACTA2*, and *MYH11*.

Estimation of Pretest Risk of Thoracic Aortic Dissection

High Risk Pain Features

2

Chest, back, or abdominal pain features described as pain that:

- is abrupt or instantaneous in onset.
- is severe in intensity.
- has a ripping, tearing, stabbing, or sharp quality.

Estimation of Pretest Risk of Thoracic Aortic Dissection

High Risk Examination Features

3

- Pulse deficit
- Systolic BP limb differential $> 20\text{mm Hg}$
- Focal neurologic deficit
- Murmur of aortic regurgitation (new or not known to be old and in conjunction with pain)

Acute AoD Management Pathway

STEP 1: Immediate post-diagnosis management and disposition considerations

- Arrange for definitive management:
 - Appropriate surgical consultation
 - Inter-facility transfer if indicated based on institutional capabilities
- If transfer required, initiate aggressive medical management until transfer occurs.

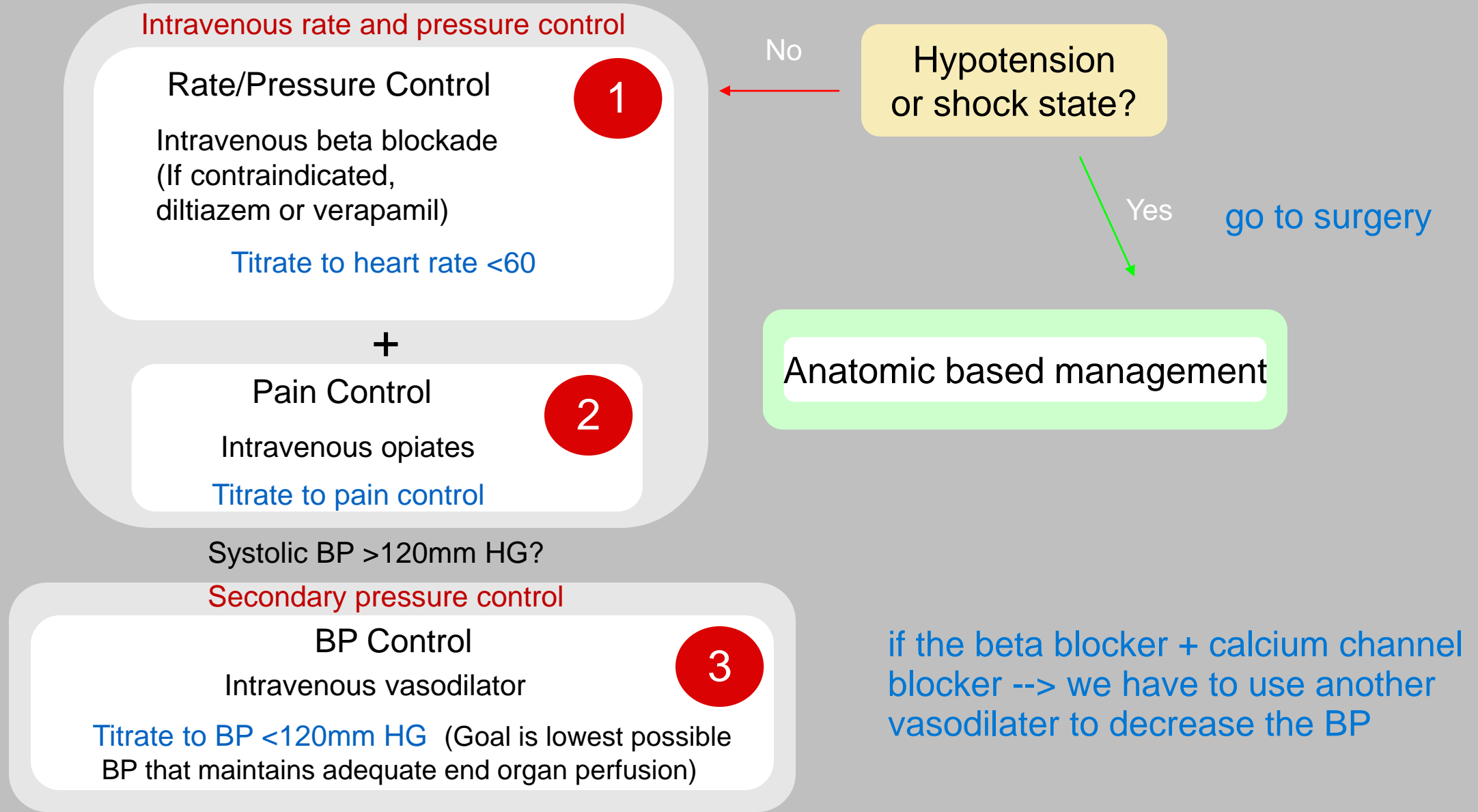
Acute AoD Management Pathway

STEP 2: Initial management of aortic wall stress

- Obtain accurate blood pressure prior to beginning treatment.
- Measure in both arms.
- Base treatment goals on highest blood pressure reading.

Acute AoD Management Pathway

STEP 2: Initial management of aortic wall stress



Acute AoD Management Pathway

STEP 2: Initial management of aortic wall stress

Anatomic based management

Type A dissection

- 1 Urgent surgical consultation
+
Arrange for expedited operative management
- 2 Intravenous fluid bolus
 - Titrate to MAP of 70mm HG or Euvolemia
 - (If still hypotensive begin intravenous vasopressor agents)
- 3 Review imaging study for:
 - Pericardial tamponade
 - Contained rupture
 - Severe aortic insufficiency

Type B dissection

- 1 Intravenous fluid bolus
 - Titrate to MAP of 70mm HG or Euvolemia
 - (If still hypotensive begin intravenous vasopressor agents)
- 2 Evaluate etiology of hypotension
 - Review imaging study for evidence of contained rupture
 - Consider TTE to evaluate cardiac function
- 3 Urgent surgical consultation

conservative management (less invasive) and endovascular

-surgery
- control HR and BP
-do a anatomical diagnosis (imaging)

Acute AoD Management Pathway

STEP 3: Definitive management

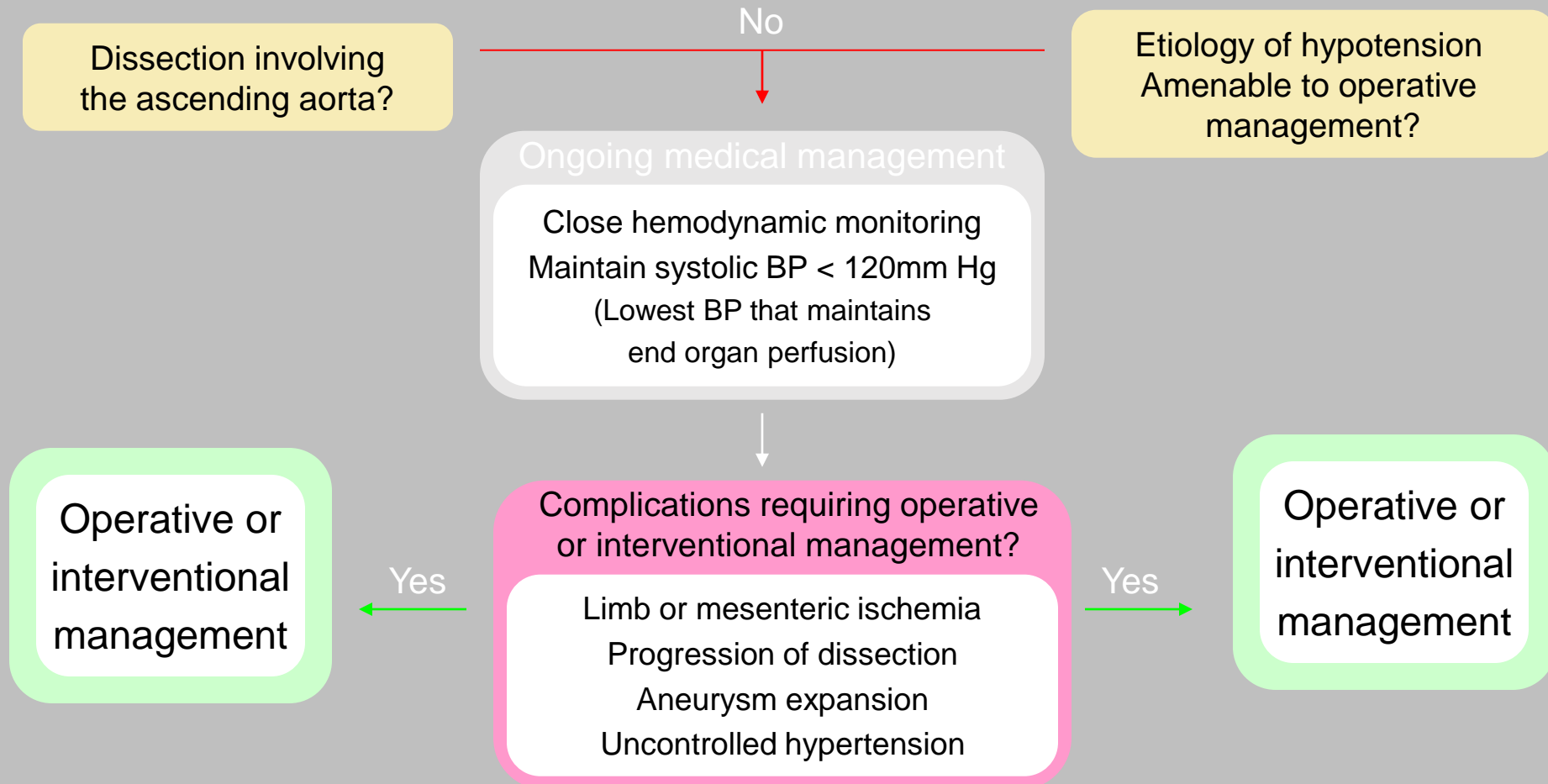
- Depending on the results from the pressure control or anatomic based management, continued treatment will involve either:
 - ongoing medical management, or
 - operative or interventional management.

Acute AoD Management Pathway

STEP 3: Definitive management

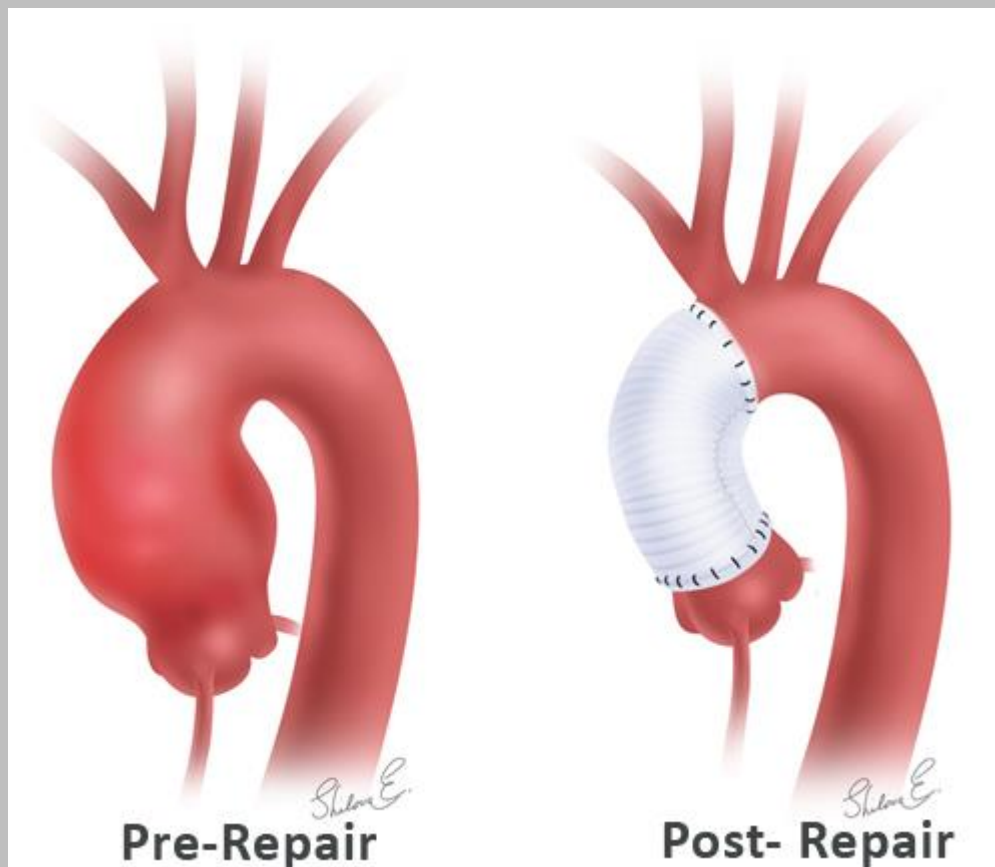
Based on results from intravenous rate and pressure control:

Based on results from anatomic based management:



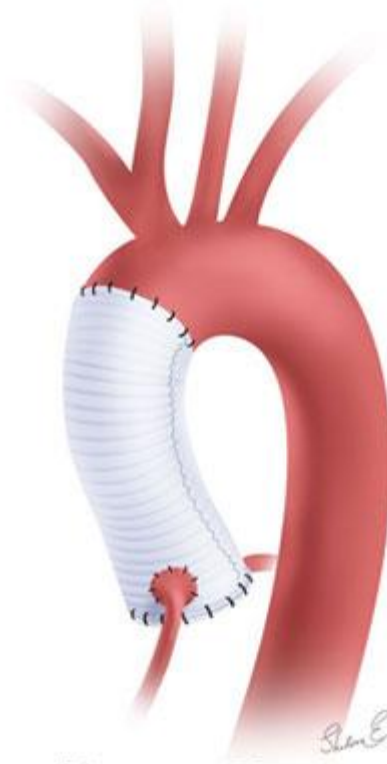
Treatment - Dissection

- Type A
 - Surgical
- Type B
 - Medical
 - Surgical
 - Acute with rupture, leak or distal ischemia.

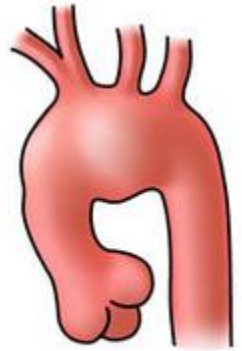




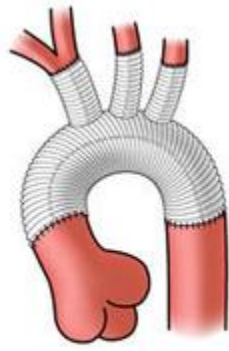
Pre-Repair



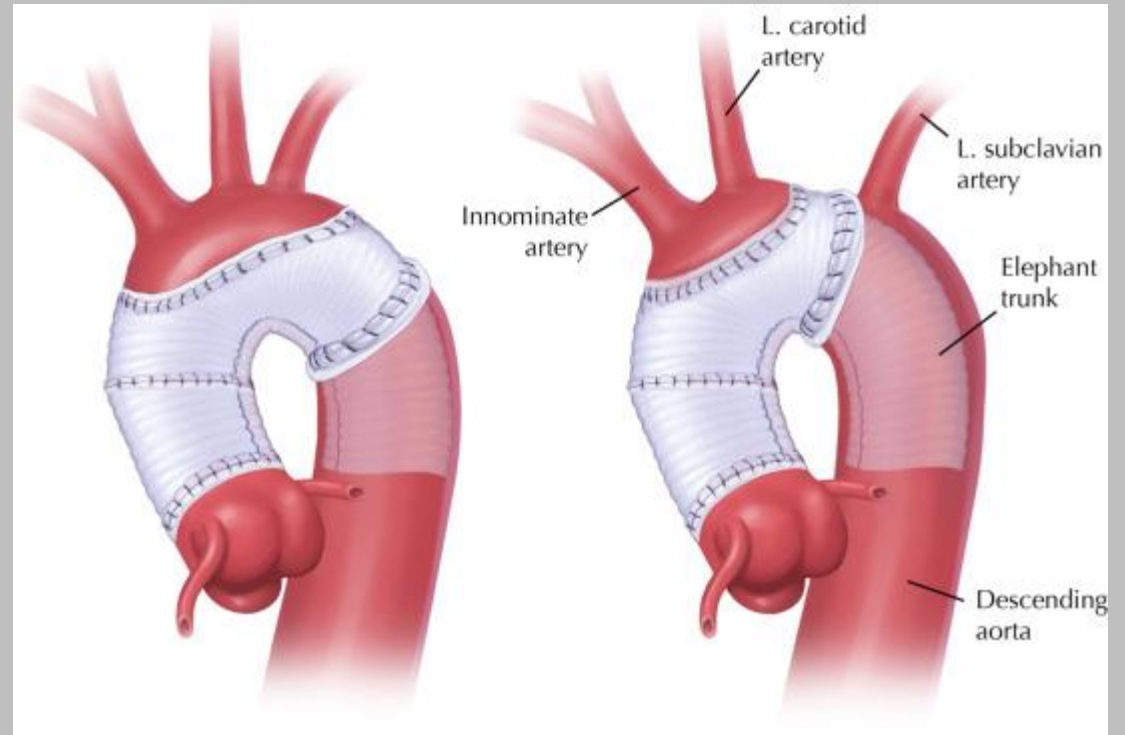
Post-Repair



Aortic Arch
Aneurysm



Aneurysm Replaced
with Prosthesis



Thank You for your Attention