CVS

PATHOLOGY

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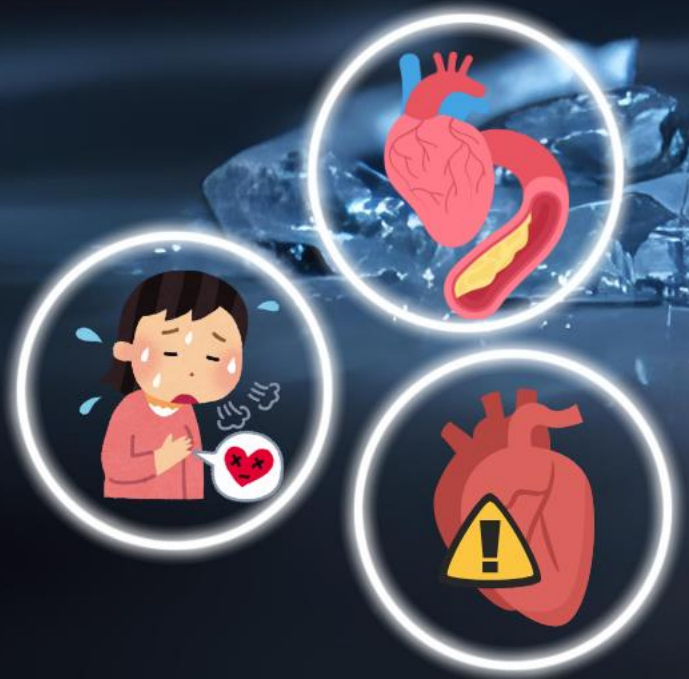

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ANEURYSMS AND DISSECTIONS

Color code

- Slides
- Doctor
- Additional info
- Important

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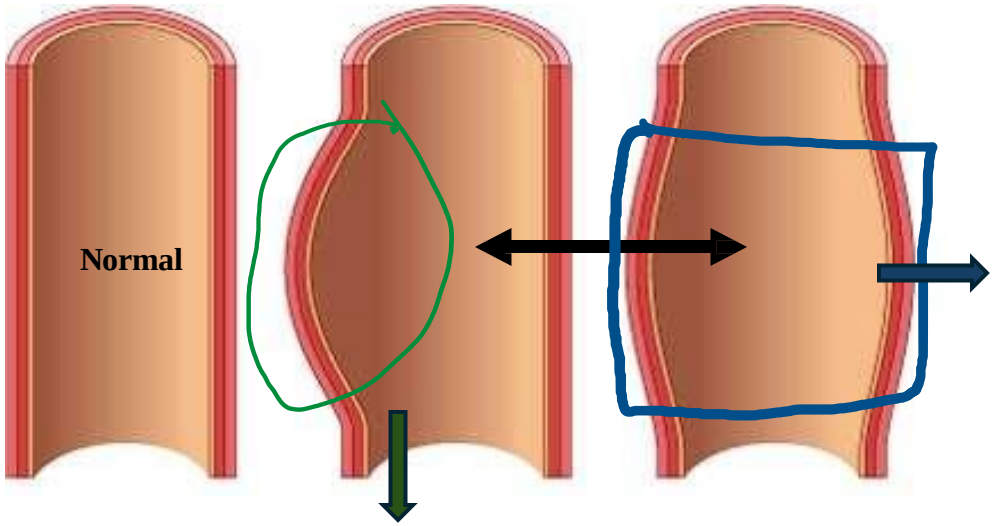
Aneurysm

- **localized abnormal dilation in the wall of artery or heart**



If the dilation involve the whole circumference of blood vessel we call it "**fusiform**"

If there was a dilatation or pouch in the wall that affect segment of the wall, we call it "**saccular**"

- Note that we use these terms to describe the shape of Aneurysm but they are not indicating specific disease or clinical manifestation.

- **Types:**

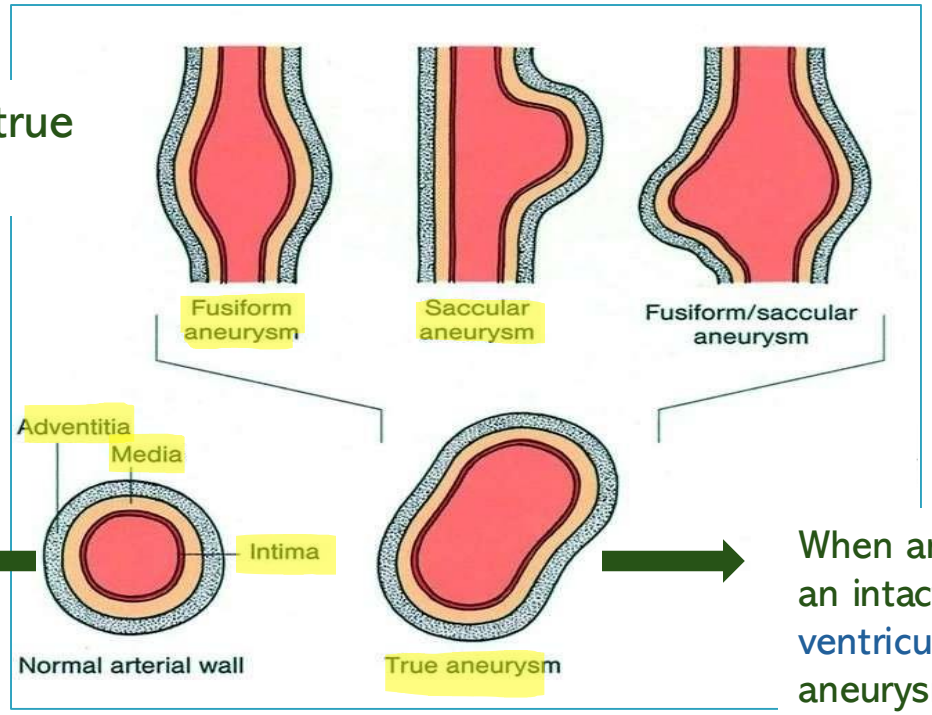
1-"true" aneurysm

- all three layers of arterial wall or heart are affected by dilatation

- Conditions that may result in true aneurysm:

e.g. Atherosclerotic, syphilitic, congenital aneurysms, ventricular aneurysms following transmural MI

Different shapes of true aneurysm



This is the normal artery with its layers

When an aneurysm involves all the layers of an intact arterial wall or the thinned ventricular wall of the heart, it is called “true aneurysm “

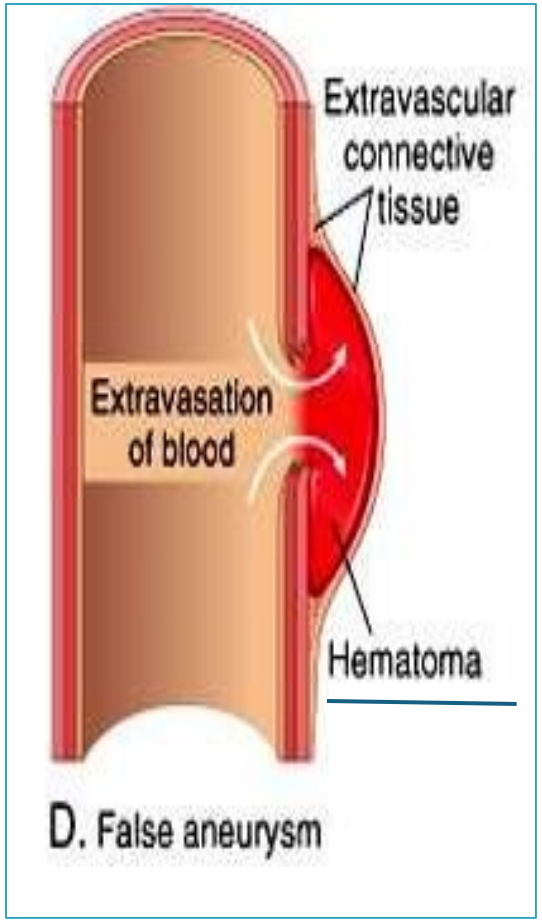
2- “false” aneurysm

- (a.k.a. pseudo-aneurysm)

→ **a breach in vascular wall leading to hematoma communicating with intravascular space ("pulsating hematoma")**

A false aneurysm results from a rupture or break in the wall of a blood vessel. This leads to extravasation of blood, which becomes confined by extravascular connective tissue, forming a hematoma.

It is not considered a true aneurysm because it does not involve all layers of the vessel wall.



→ E.g. ventricular rupture after MI contained by pericardial adhesion
If the blood from ventricular rupture enter connective tissue that surrounds the heart and form hematoma

→ E.g. a leak at the junction of a vascular graft with a natural artery.
there might be leakage of blood at the suture sites at both ends of a vascular graft, resulting in hematoma

Important

- **aneurysms are classified according to macroscopic shape and size into:**

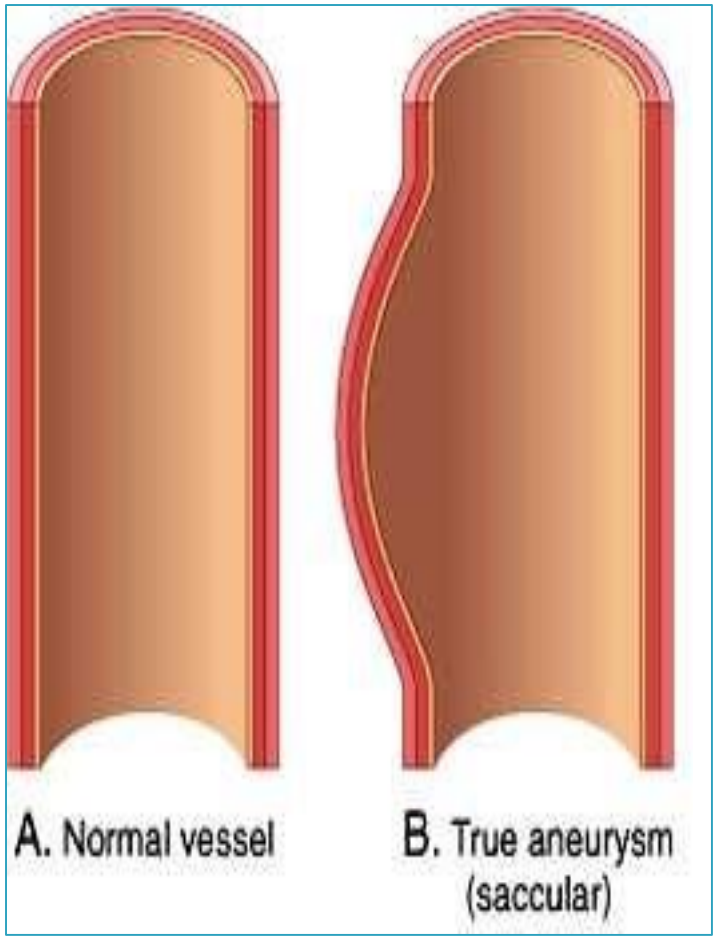
1 **saccular**

2 **fusiform**

- Note: shape and size are not specific for any disease or clinical manifestations

1- Saccular aneurysms

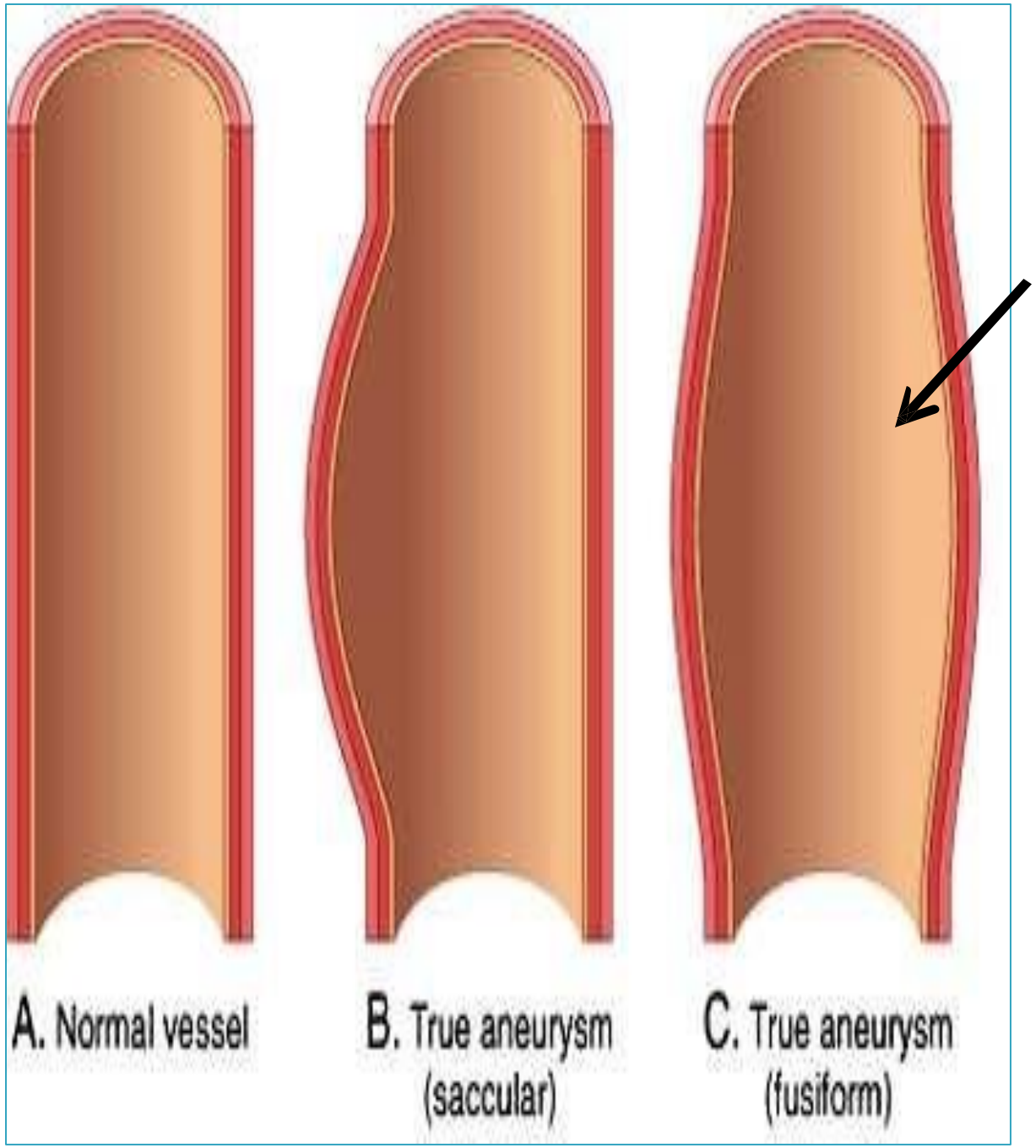
- spherical outpouchings
-involving only a portion of vessel wall
- may contain thrombi



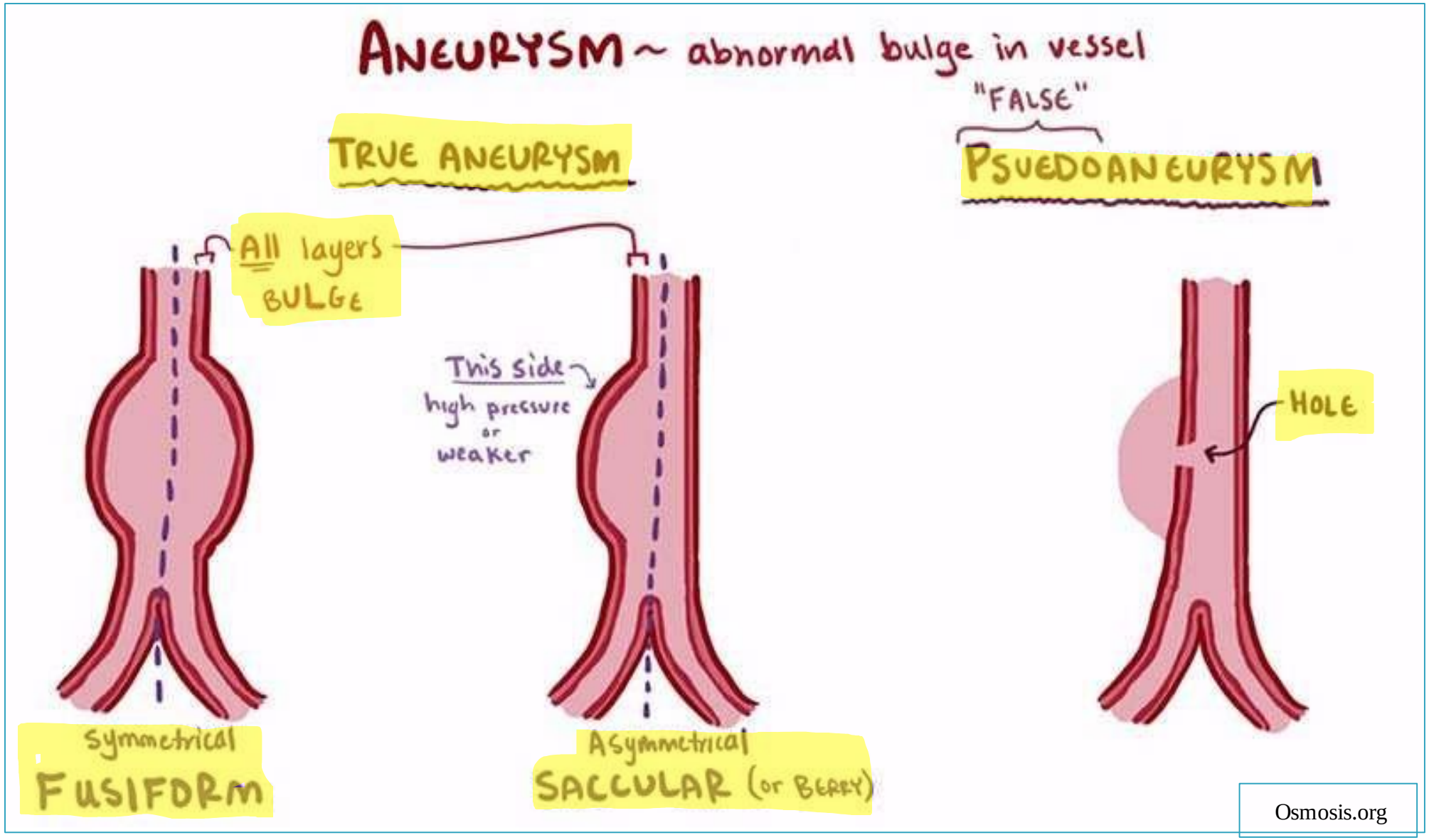
2- Fusiform aneurysms

- diffuse, circumferential dilation of a long vascular segment

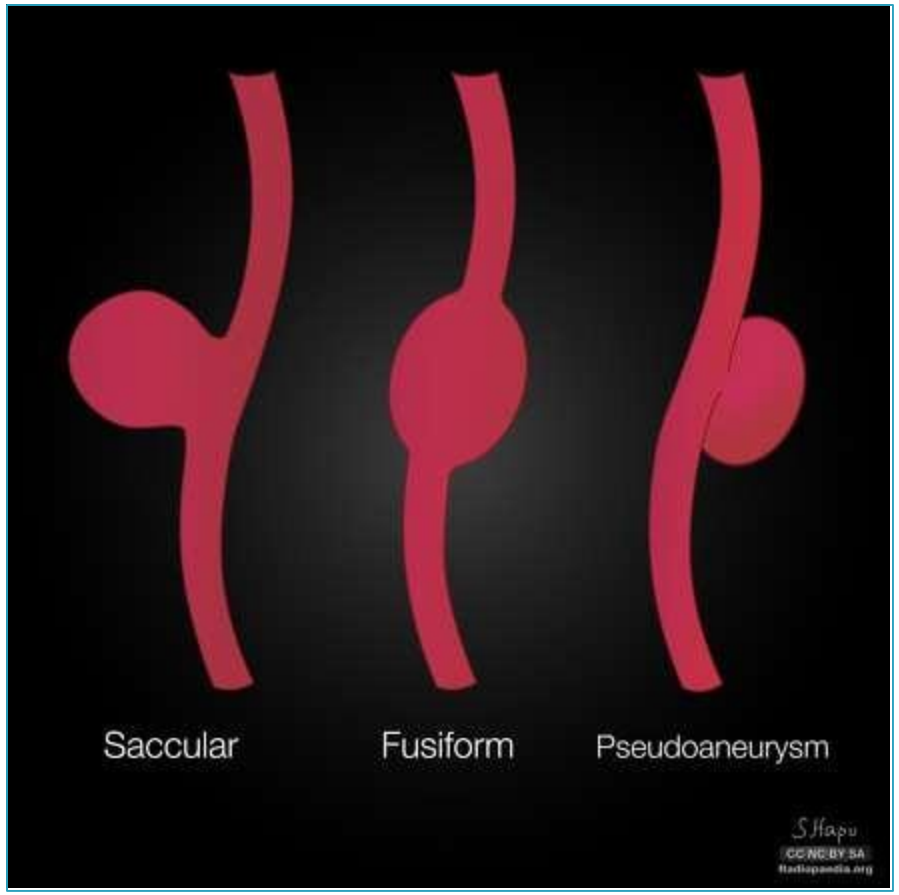
- they vary in diameter and length and can involve extensive portions of artery



To summarize…



To summarize…

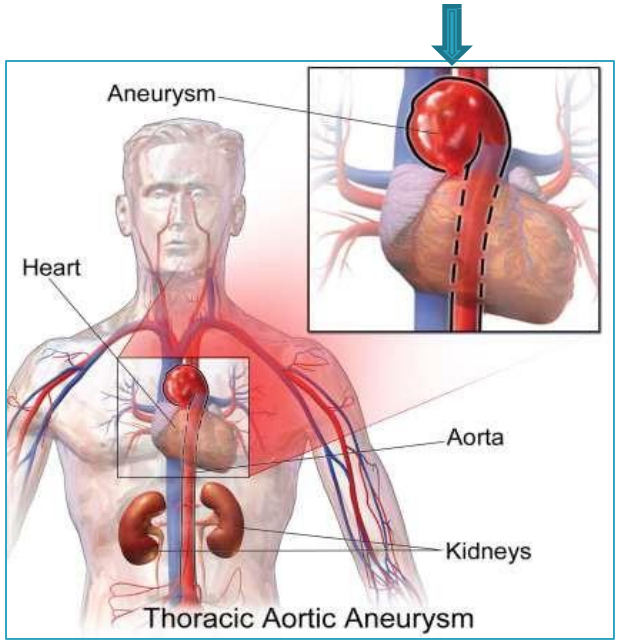


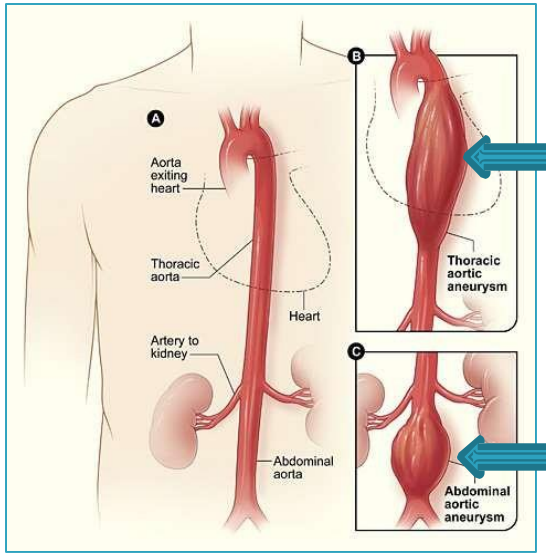
Aortic aneurysms

An aneurysm can affect any blood vessel or the heart.
However, it is more common in arteries, particularly the aorta (aortic aneurysm), which is the most important and clinically significant type.

In an aortic aneurysm, any part of the aorta may be affected:

- If the aneurysm occurs in the thoracic region, it is called a **thoracic aortic aneurysm**.
- If the aneurysm occurs in the abdominal region, it is called an **abdominal aortic aneurysm**.
- Additionally, an aneurysm may involve the beginning of the aorta and the annulus of the aortic valve.





Thoracic aortic aneurysm

Abdominal aortic aneurysm

To understand why the wall of the aorta becomes abnormal, it is important to first know the key components of its structure:
- The aorta has three layers: **tunica intima**, **tunica media**, and **tunica adventitia**.
- The tunica media of the aorta is thick and strong, consisting of **multiple layers of smooth muscle cells and elastic fibers**. These components enable the aorta to maintain its contractility and elasticity, allowing it to function efficiently under the high intraluminal pressure.

Abnormal and permanent dilation of the aorta results from **dysfunction of the tunica media.**
This dysfunction may occur due to elastin loss or issues affecting smooth muscle cells, such as destruction, atrophy, necrosis, or ischemia.

causes of tunica media weakness :

- **Inflammation (vasculitis):** Leads to the destruction of the tunica media in arteries.
- **Atherosclerosis:** Although the plaque originates in the intima, the atheroma can compress the underlying tunica media and compromise nutrient and waste diffusion into arterial wall .
- **Marfan disease:** An autosomal dominant mutation involving fibrillin, a crucial component in the formation of elastin. Dysfunctional elastin weakens the tunica media and may lead to aneurysm formation.
- **Hypertension:** Increases stress on the arterial wall, contributing to weakening of the tunica media.

Aortic aneurysms

- **The two most important causes are:**

1- Atherosclerosis :

- most common cause

→intimal plaques compress underlying media

→compromise nutrient and waste diffusion into arterial wall

→media degeneration and necrosis

→ thinning and weakening of media

→dilation of vessel

2- Cystic medial degeneration of arterial media

Cause destruction of tunica media

- causes include: hypertension; trauma; congenital defects (e.g., berry aneurysms); hereditary defects in structural components (Marfan); infections (mycotic aneurysms); vasculitis; immune-mediated….

Abdominal Aortic Aneurysm

- Atherosclerotic aneurysms occur most frequently in **abdominal** aorta (= AAA)
- common iliacs, arch, and descending parts of thoracic aorta can also be involved
- **Features:**
- **m/c in men**
- **rarely < age 50**
- **Atherosclerosis is a major cause of AAA**

- other contributors include:

1 Hereditary defects in structural components of the aorta:

(e.g., **Marfan disease by** defective fibrillin production affects elastic tissue synthesis)

2 An altered balance of collagen degradation and synthesis mediated by local inflammatory infiltrates and the destructive proteolytic enzymes

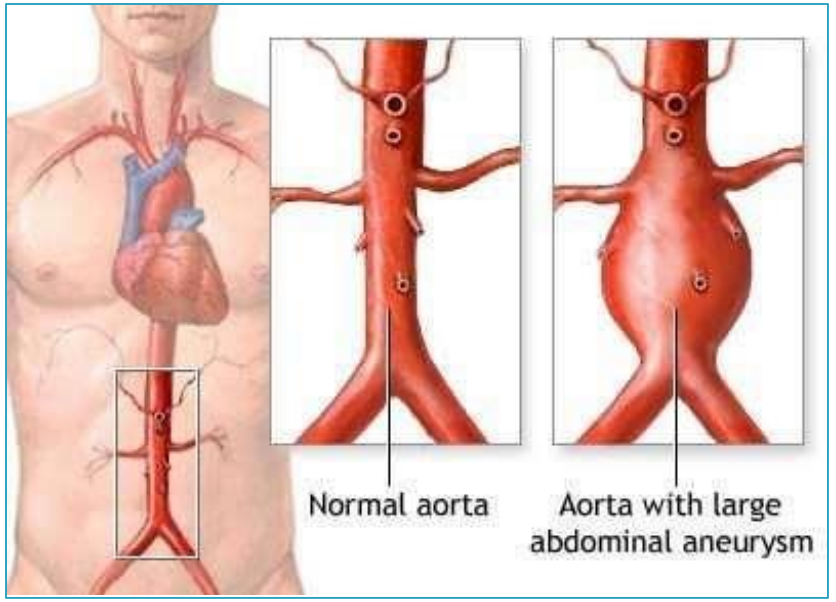
- (e.g. vasculitis)

AAA- Morphology

Might be small or large

- Usually below renal arteries and above bifurcation of aorta
- can be saccular or fusiform
- may be as large as 15 cm in diameter, and as long as 25 cm
- Microscopically: atherosclerosis(we may find atheroma in the intima , if the cause of aneurysm is atherosclerotic); thinning of media
- frequently contains a laminated mural thrombus

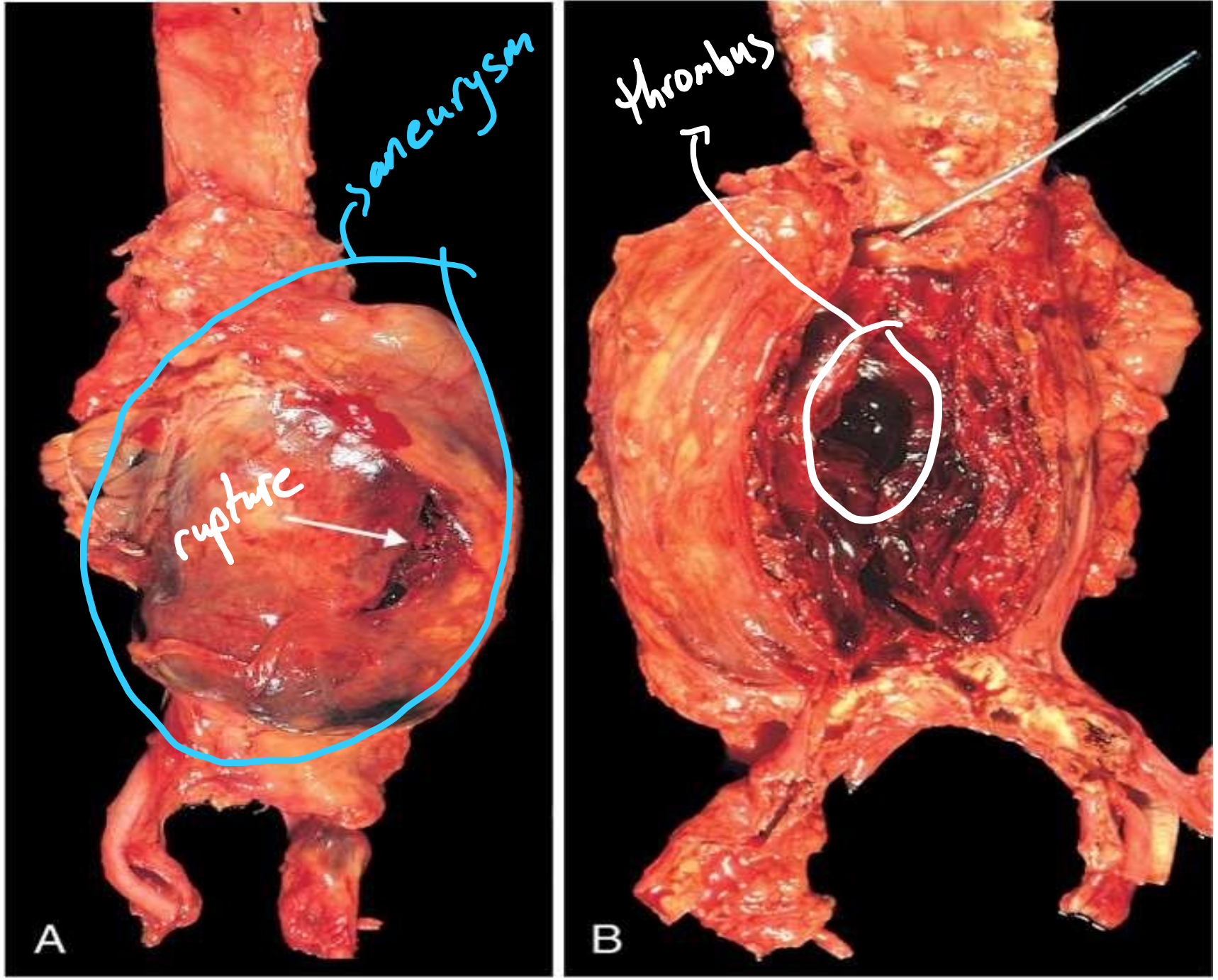
Diameter of aneurysm is more important than the length of aneurysm in regard of risk of rupture



Abdominal aortic aneurysm and complications

A: rupture
B: thrombosis

Large aneurysm:
if the length is approximately 25cm and the diameter in severe cases 15 cm



possible consequences of aneurysm:

- Compression of adjacent structures (size effect of aneurysm)

for example if the aortic aneurysm compresses ureter

- Thrombosis due to stasis and turbulence -----> this may lead to arterial embolus -----> vessel occlusion and organs ischemia

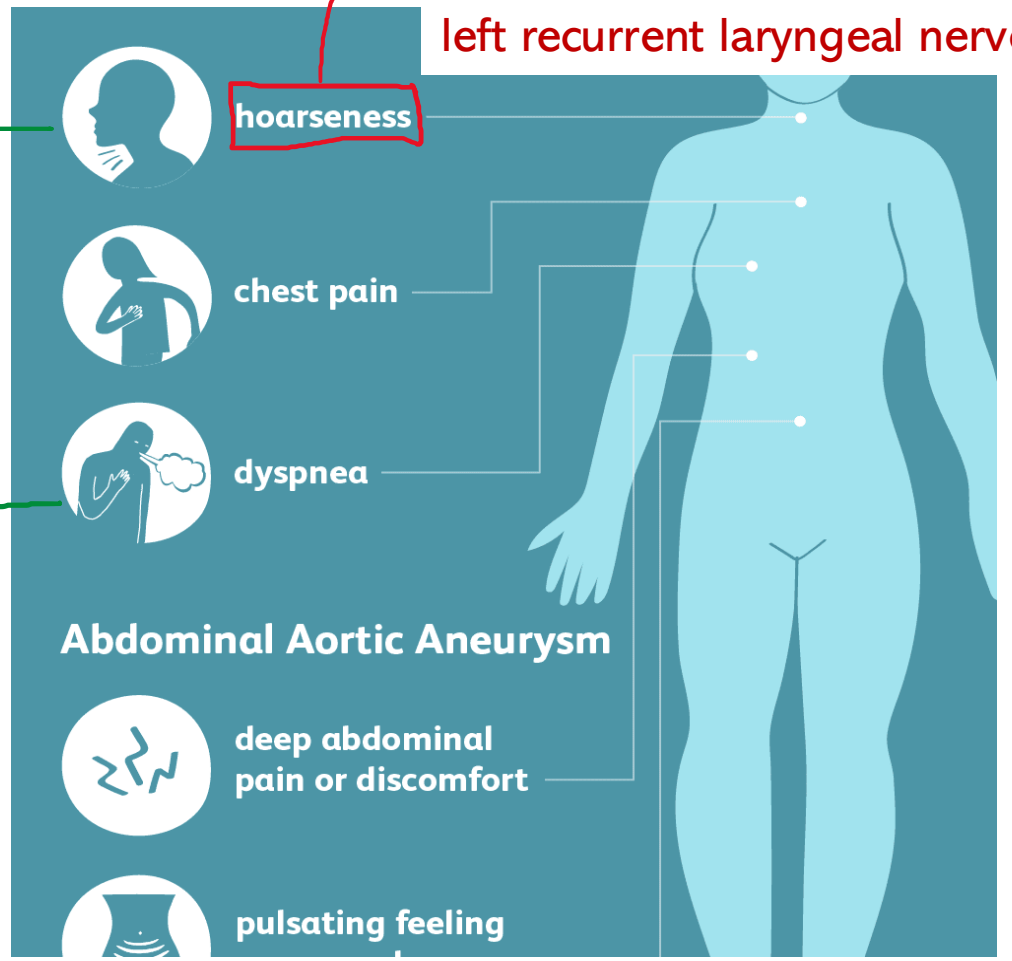
- Rupture : result from weakening of the vessel wall and the high blood pressure exerted on it , leading to potentially life-threatening outcomes

Symptoms of aortic aneurysm

Symptoms of an aneurysm are often nonspecific, making it crucial to conduct a thorough examination and take a detailed medical history to identify the underlying cause.

Hoarseness of voice is result from compression of left recurrent laryngeal nerve

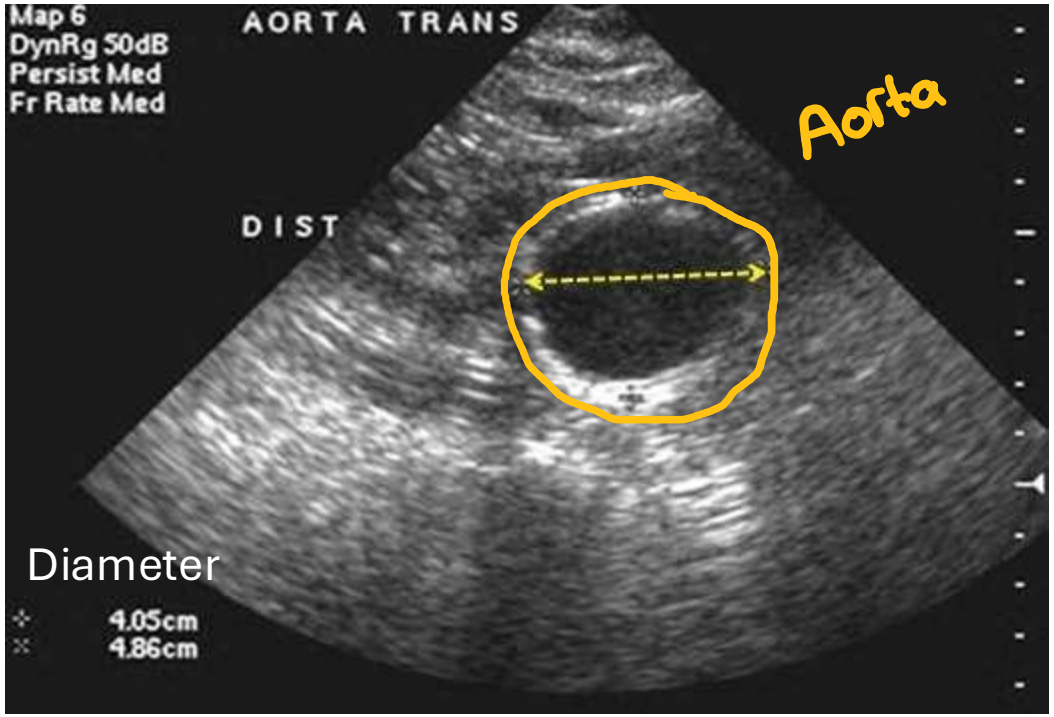
Thoracic aortic aneurysm



Clinical assessment of AAA

This is an ultrasound image checking the Aorta

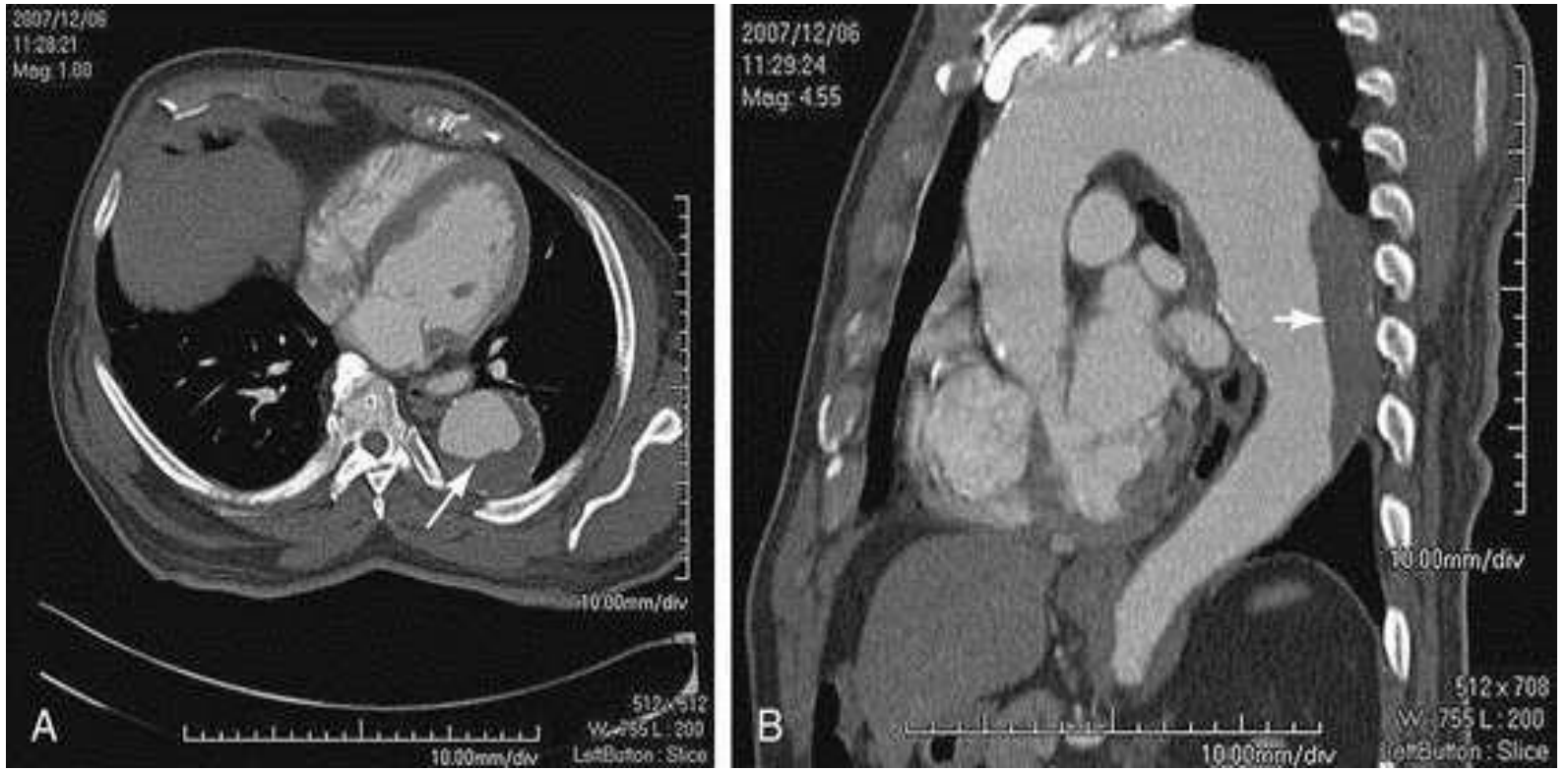
- Notice the yellow arrow, which measures the diameter of the Aorta, in this image it is 4.86 cm
- Why measuring the diameter is important?
- 1. Important in diagnosis; is it an aneurysm or not
- 2. Determine if the patient needs a surgical intervention or can be kept on conservative management.
- As the diameter increases, the surgical intervention need increases.
- The golden number is 5 cm (more explanation below)



Extra : In the context of aortic aneurysms, the "golden number" of **5 cm** refers to a critical threshold in the diameter of the aorta. Once an aneurysm reaches this size, the risk of complications, such as rupture or dissection, increases significantly.
Below 5 cm: Risk of rupture is relatively low, **At or above 5 cm**: Risk rises significantly, prompting consideration for surgical intervention.

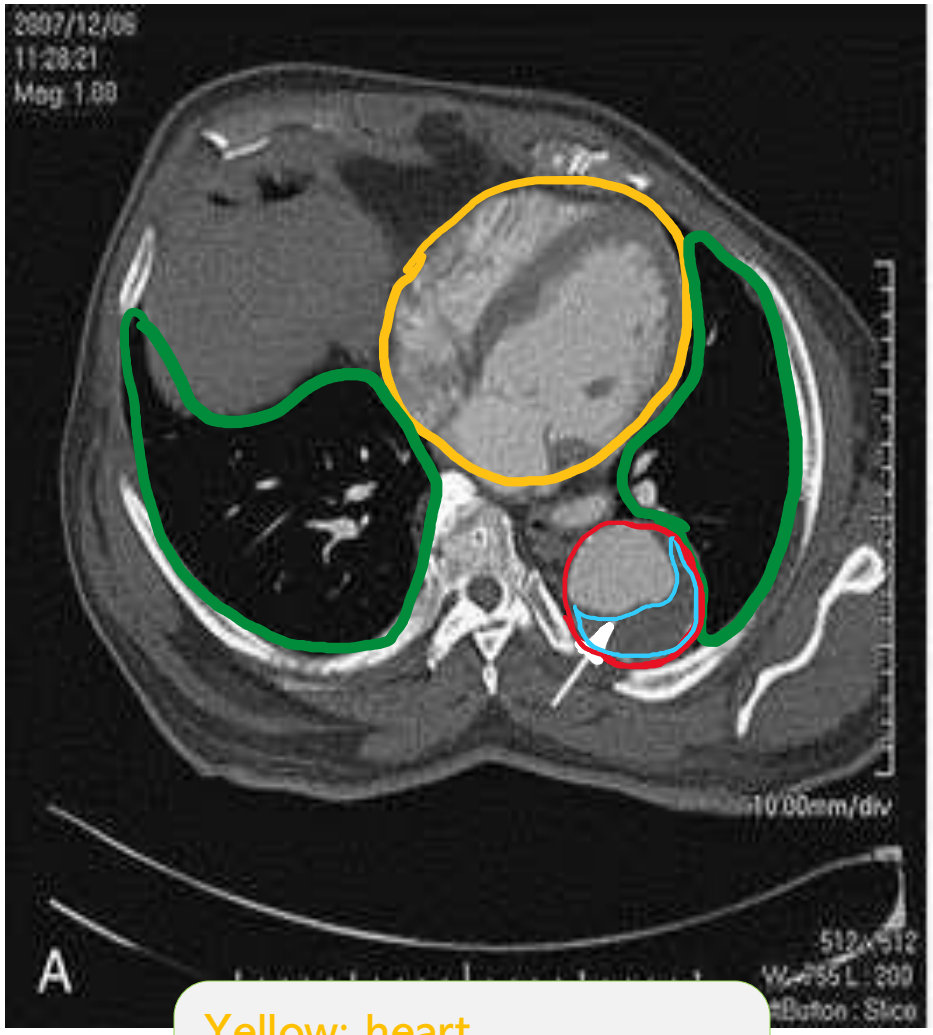
Many Radiological images can be used by cardiologists and cardiovascular surgeons to evaluate the aorta look in for aortic aneurysm, such as : ultrasound, CT scan, ECO, CT angiography

Maximum intensity projection CT angiographic images show an aneurysmal descending thoracic aorta with considerable mural thrombus (*arrow*)



We are looking at the thoracic cavity
In an inferior view

- The different colors seen in these images are due to the angiographic contrast speed that is used, and the density of structures.
- What is important here, inside the Aorta we can see 2 different shades of color, the lighter one represents the blood, and the darker one represents a **Thrombus** (marked in light blue in both images)

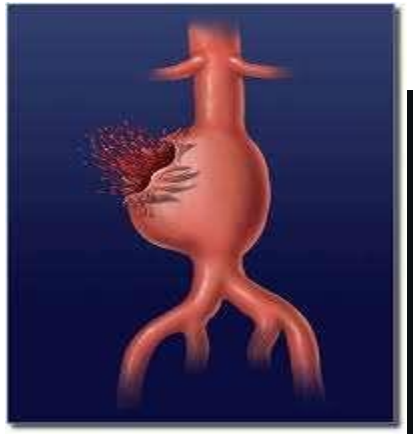


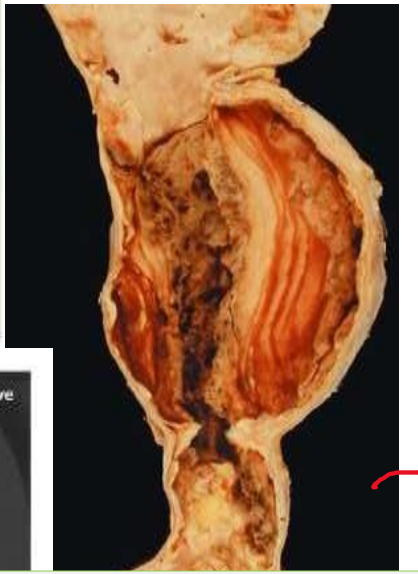
Red : descending Aorta

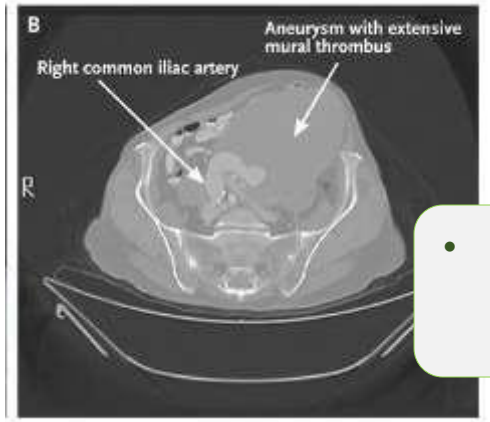
Yellow: heart
Green : lungs
Red : descending Aorta

The clinical consequences of AAA

- **Rupture** →massive hemorrhage (**rupture is one of the most important consequences, and the first thing we think of as a complication) .**
  - risk is directly related to size (≥5 cm)
  - mortality for **un**ruptured aneurysms =5%
  - if rupture mortality rate > 50%
- **Obstruction** of downstream vessel→ **ischemic** injury
- **Embolism** → mural thrombus
- **compression** on adjacent structures (e.g. ureter or vertebrae)
- **abdominal mass** (often pulsating)







- This pic showes a large aneurysm, inside it a large thrombus

- Abdominal mass

Mycotic aneurysms

- **Infection of an artery that weakens its wall is called a mycotic aneurysm**
- **can originate from:**

(1) **embolization of a septic thrombus (infective endocarditis)**

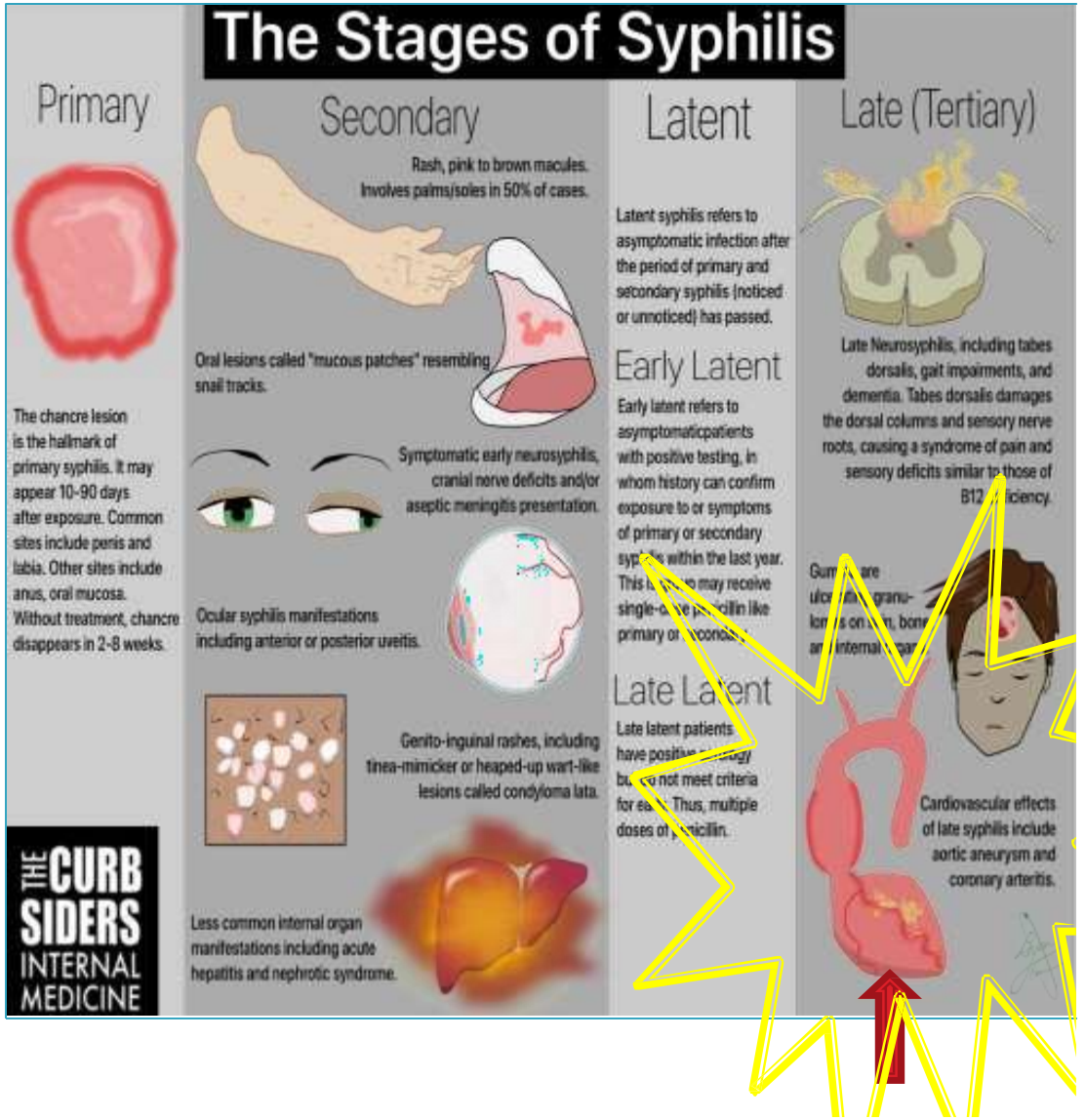
(2) **extension of adjacent suppurative process (abscess adjacent to the vessel wall)**

(3) **circulating organisms infecting arterial wall**

- Mycotic = infection
- However it is a misnomer because **it is not fungal** (mycotic)
- In addition to the mentioned ways of how the organisms can reach the wall of the blood vessels, we can also add " **sepsis** " .

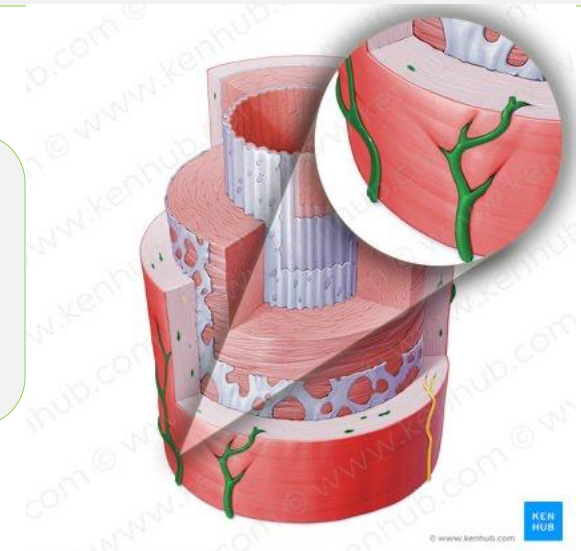
Syphilitic Aneurysm

- **Syphilis** is caused by The spirochetes T. Pallidum
- A rare complication (early recognition and treatment of syphilis)
- Tertiary stage of syphilis can cause obliterative endarteritis of vasa vasorum of aorta
- ischemic medial injury
- aneurysmal dilation of aorta and aortic annulus
- eventually valvular insufficiency

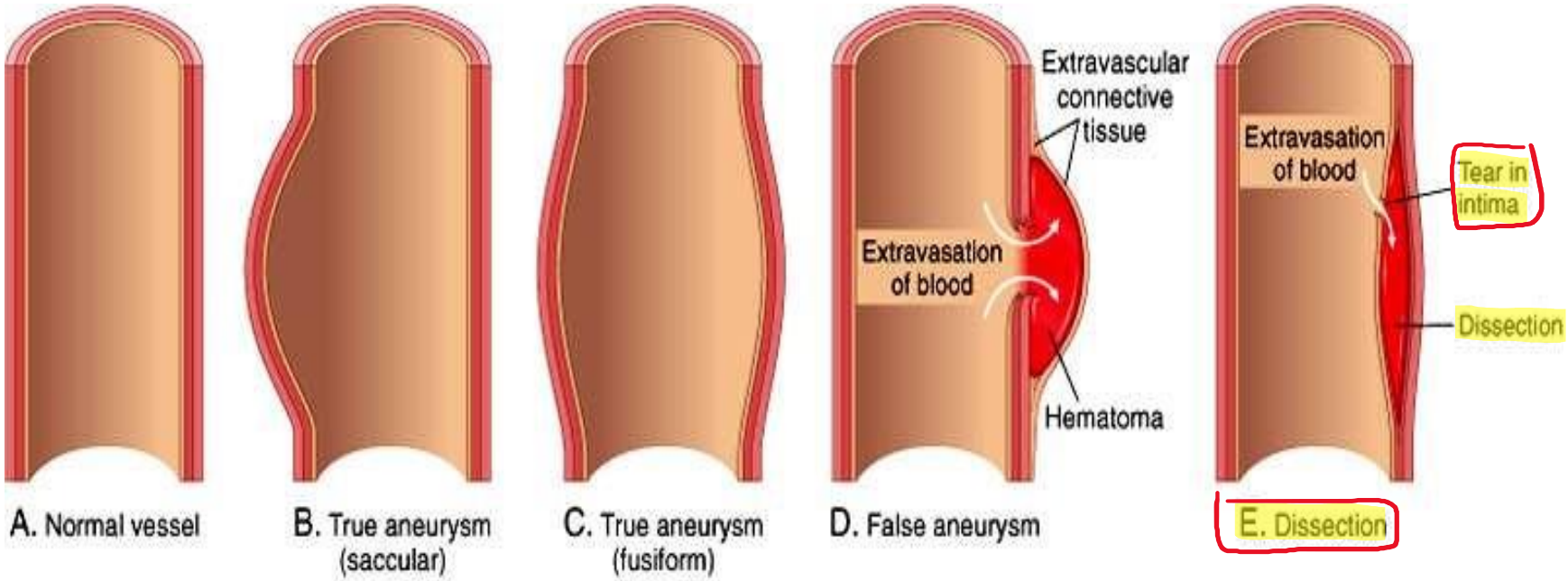


- Syphilis is a sexually transmitted disease
- It has three stages , previously it was fetal with high prevalence, and caused many complications , it was commonly progressing to secondary and tertiary phases .
- Nowadays, thanks for Antibiotics and early diagnosis, the second and tertiary phases occurrence is **Rare** .
- Back to the pathophysiology > during the tertiary stage , **inflammation of vasa vasorum** occurs, with time it will be distrusted and obliterated, if the Vasa vasorum is closed > loss of blood supply to the wall of media tunica (since it is the " vessel of vessel " >> media becomes **thinner and weaker due to ischemia > abnormal dilatation**
- Very important : It is not a direct or actual infection of Aorta , because at stage 3 the microorganisms are not found (active) in the wall of the aorta , and **what happens is inflammation of Vasa vasorum** > ischemia of the wall of blood vessel > weakening >> abnormal dilatation
- **So Syphilitic Aneurysm is not a mycotic infection , since it is not an actual infection**

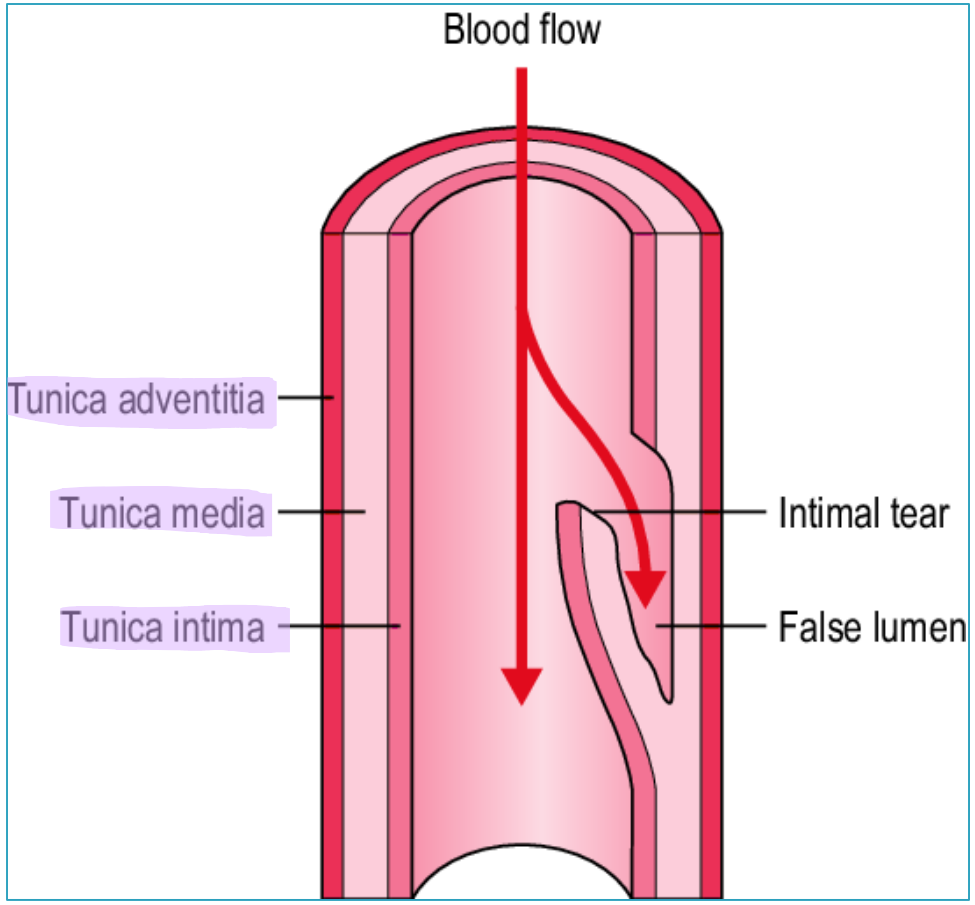
Extra : Vasa Vasorum : Vasa vasorum are small blood vessels that comprise a vascular network supplying the walls of large blood vessels, called " vessels of vessels "



Aneurysm versus dissection …



Arterial dissection



- Intima undergoes high pressure which leads to its rupture.
- **Rupture only in intima tunica**, the blood enters from the lumen into the wall itself " bleeding in the wall"

- What is tunica intima?
- Remember that the BV wall consists of three layers : adventeia > media > intima
- The intima is the most inner layer

Arterial *dissection*

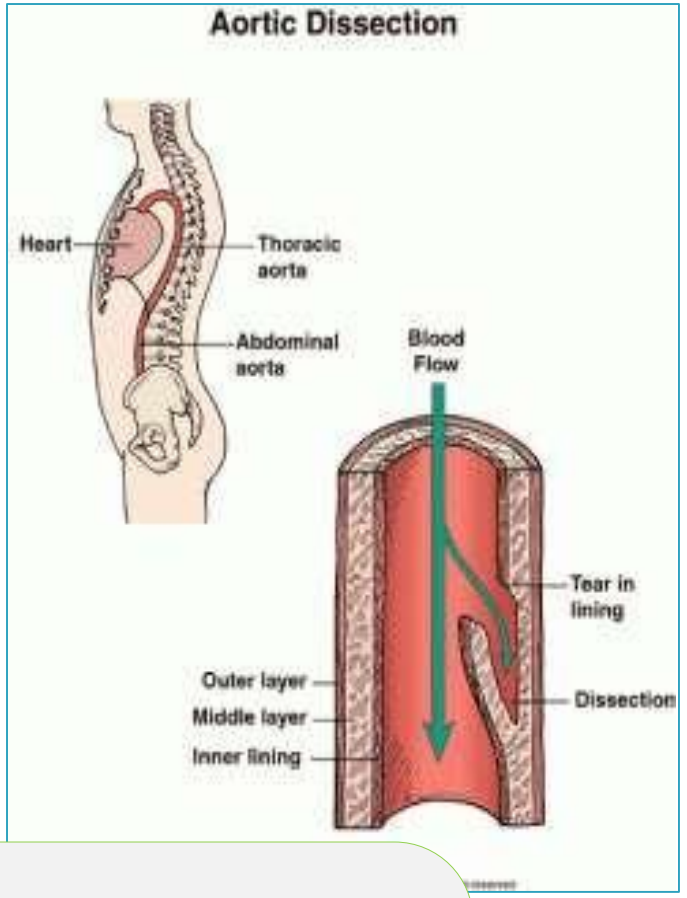
- **Extravasation of blood that enters the wall of artery through an intimal tear, as a hematoma dissecting between its layers.**
- often but not always aneurysmal
- Both true and false aneurysms as well as dissections can rupture, often with catastrophic consequences

Aortic dissection

- A catastrophic event whereby blood dissects apart the media to form a blood-filled channel within aortic wall
- Complications are :

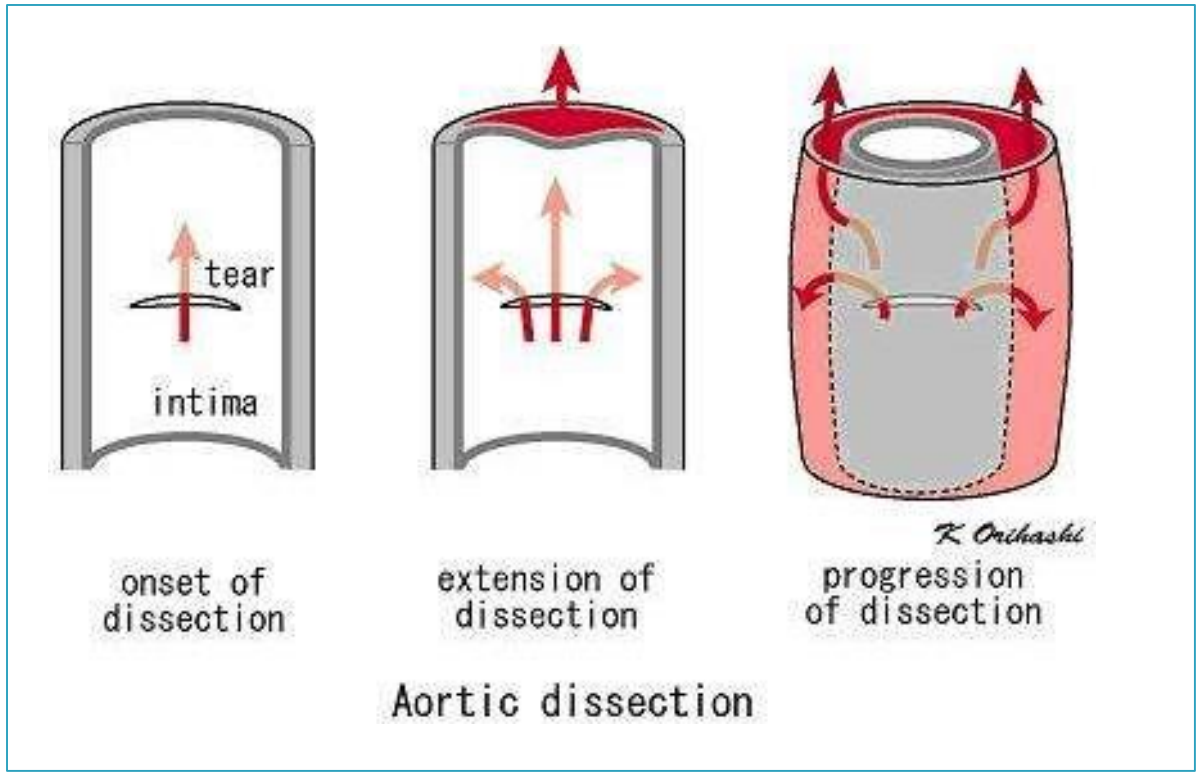
  - massive hemorrhage

  - cardiac tamponade, **since the Aorta is close to the heart** (hemorrhage due to rupture into the pericardial sac)



- Why it is a catastrophic event?
- It takes an amount of blood from the circulation and keeps it in the wall, this will cause hypovolemia >> hypovolemic shock .
- Additionally, the teared area is weak >> rapture of the whole aorta (whole layers) >> massive internal bleeding >> shock >> death .

Consequences…



Pathogenesis of Aortic dissection

- 1- Hypertension is the major risk factor
- pressure-related mechanical injury and/or ischemic injury.
- 2- Atherosclerosis complications
- 3- Inherited or acquired connective tissue disorders causing abnormal vascular ECM
- (e.g., Marfan syndrome, Ehlers-Danlos syndrome, vitamin C deficiency, copper metabolic defects)

Ehlers-Danlos syndrome : connective tissue disease

Marfan syndrome

- The most common among inherited or acquired connective tissue disorders assosiated with aortic dissection
- Autosomal dominant disease of **fibrillin**, an ECM scaffolding protein required for normal elastic tissue synthesis
- Manifestations include: **(it involves many organs)**
- skeletal abnormalities (elongated axial bones)
- ocular findings (lens subluxation)
- cardiovascular manifestations (**such as aneurysm and dissection)**

Manifestations of aortic dissection

- Sharp chest/ back pain
- Weak pulses in downstream arteries
- If ruptures into pericardium → cardiac tamponade, **usually fetal**
- Blood pressure difference between Rt & Lt arms (sometimes)
- Hypotension **(hypotension shock and death)**
- shock

Diagnosis & clinical assessment

- Diagnosis: history taking, examination of the patient, doing some radiological evaluation to diagnose dissection .

Chest X-ray

Transesophageal Echocardiogram

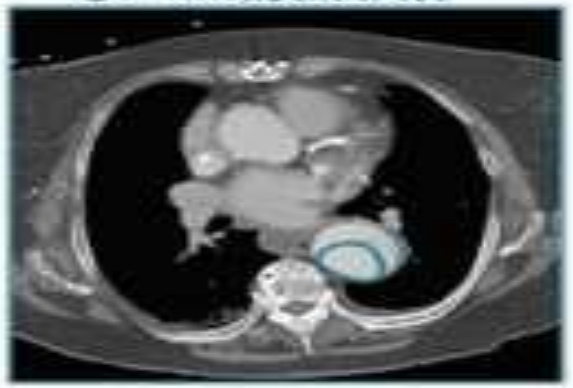
false

in dissection and not aneurysm.

MR

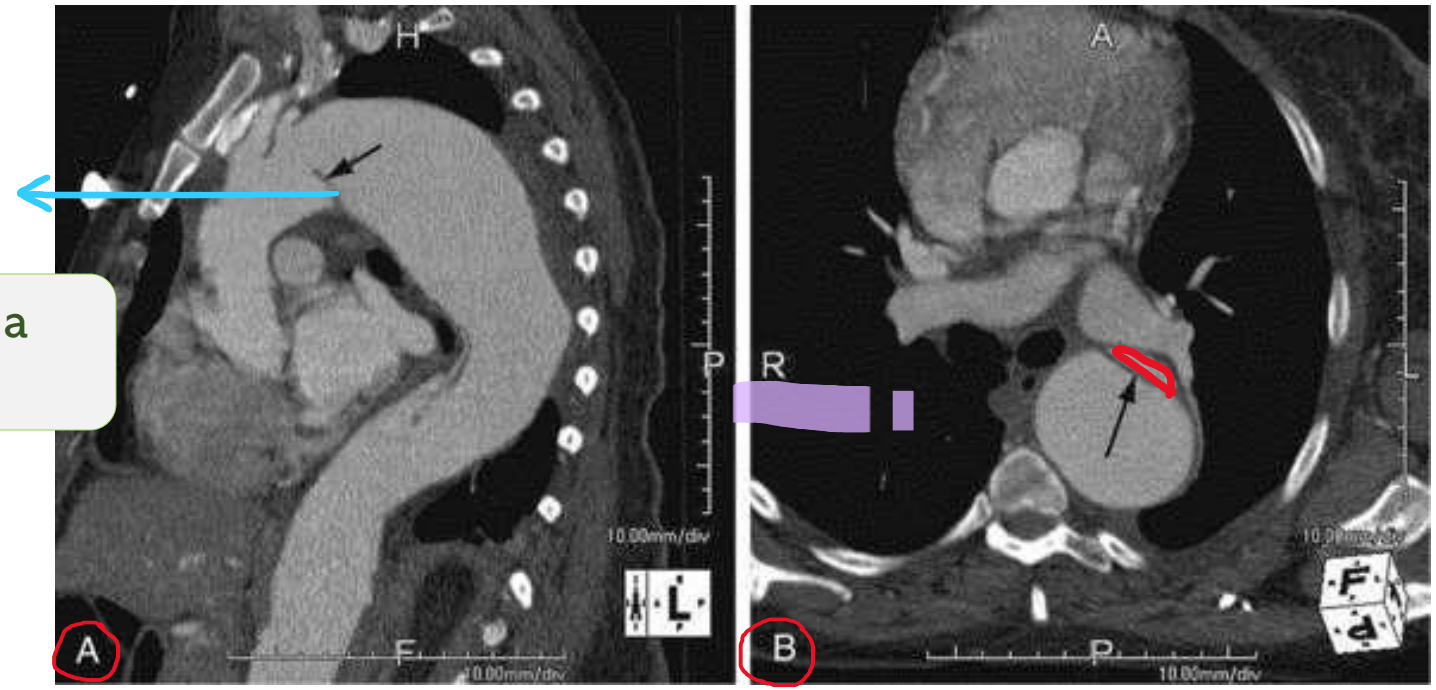
Magnetic Resonance Angiography

CT Angiography



Sagittal (A) and axial (B) contrast-enhanced CT images show a type B dissection (*arrow*) and aneurysm of the descending aorta

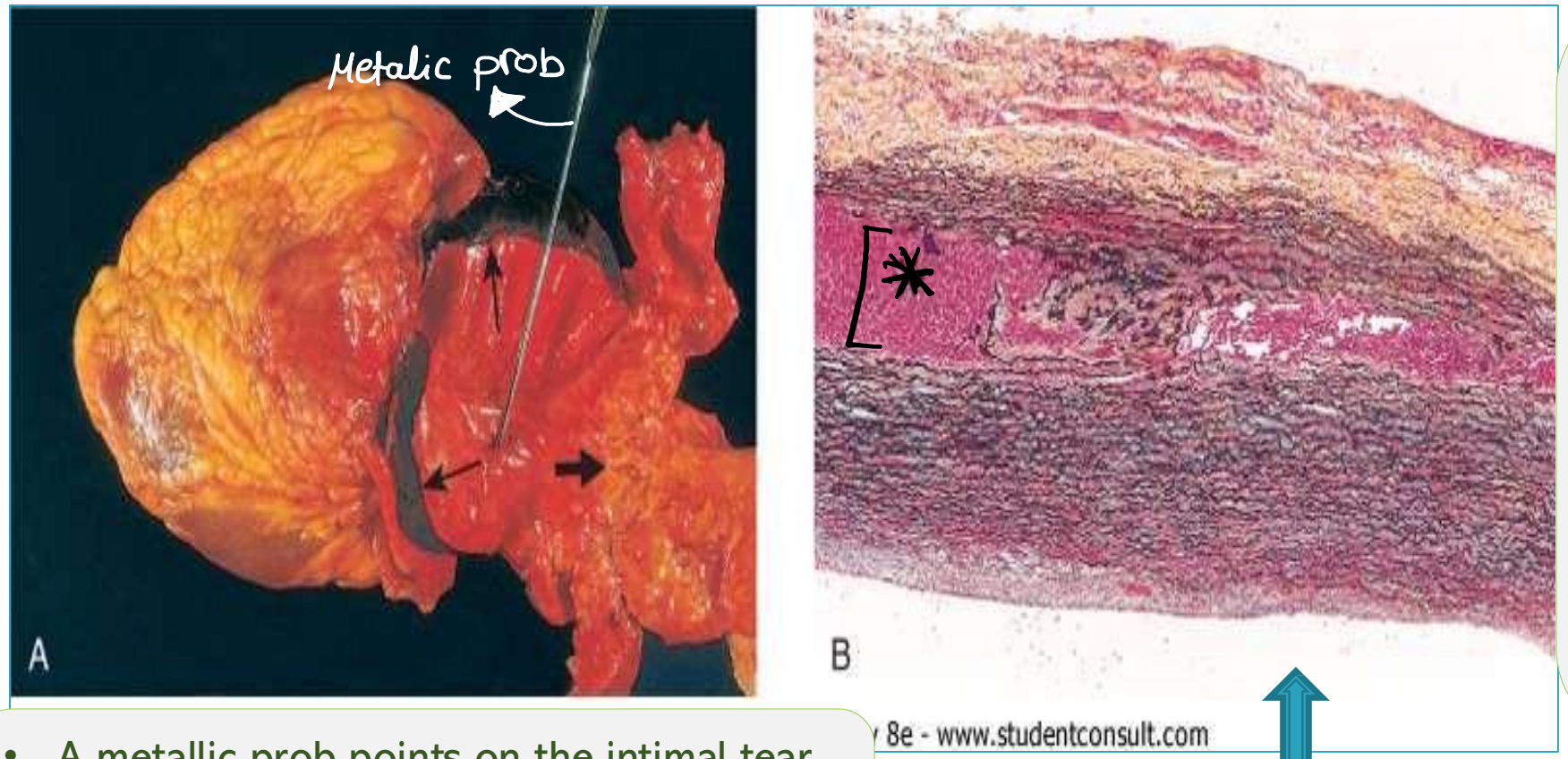
both



- The arrow shows a tear in intima

The red area is the false lumen

Aortic dissection



- A metallic prob points on the intimal tear
- The rest of the wall of the aorta is full of blood >> dissection

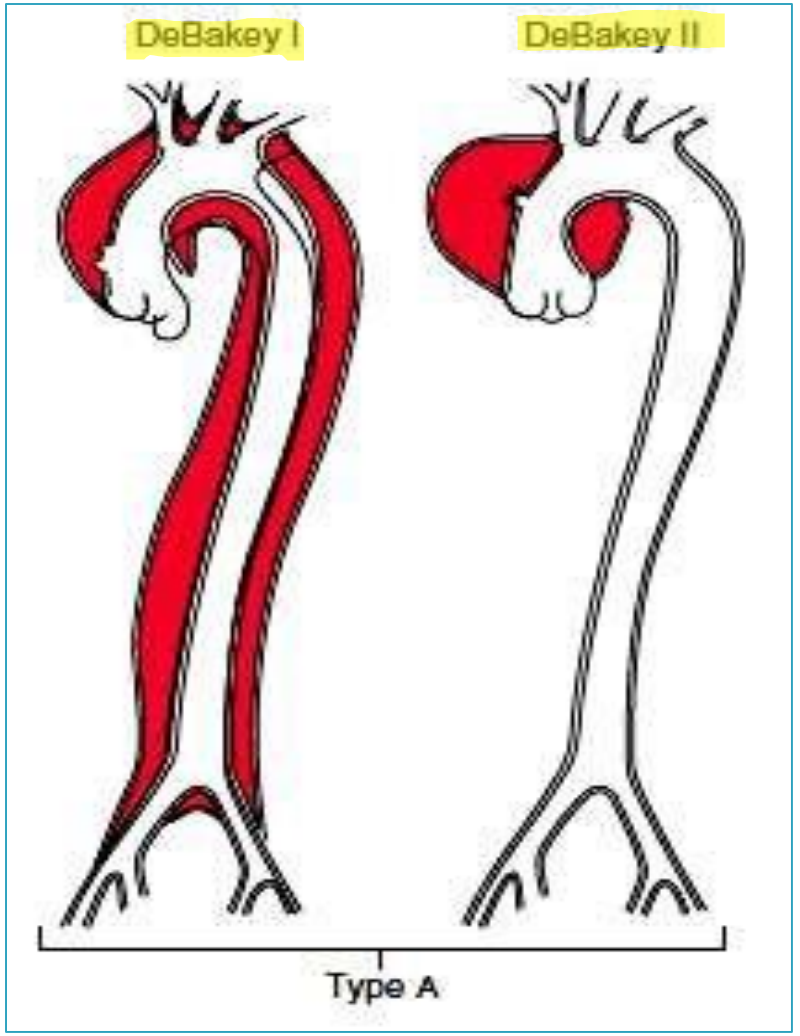
- The black fibers represent **elastin fibers** in tunica media
- The area marked by the star has **no elastin fibers as you can see, and it is the site of dissection (blood collection in media)**

Silver stain: display elastic fibers in black color

Aortic dissections are generally classified into two types:

1- Type A dissections **(proximal type)**

- **More common**
- **More dangerous**
- Proximal to takeoff of major aortic branches
- involve either ascending aorta only II
  or both ascending and descending I
  aorta (types I and II of the DeBakey classification)

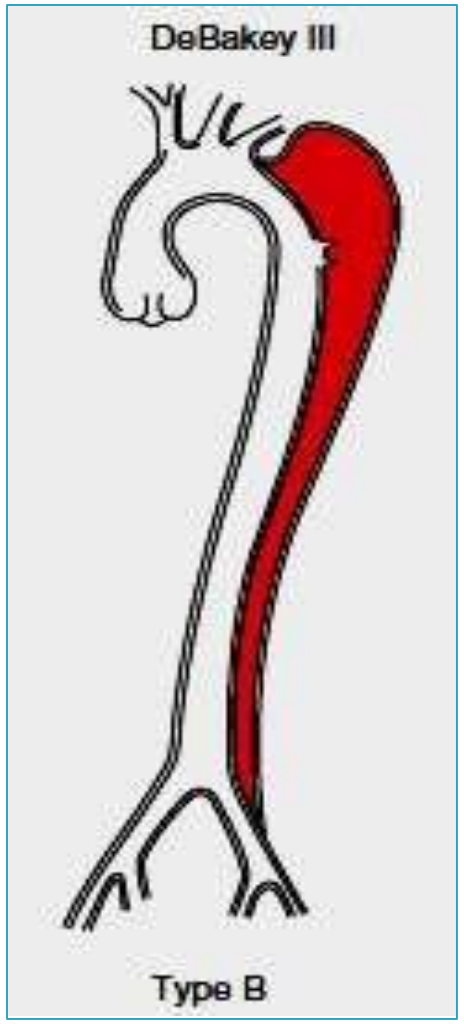


- Both subtypes have the same beginning (before aortic arch branches)
- It is called proximal -----> because it is proximal to the aortic branches (before branches)

2- type B dissections :

- Distal to take off of major aortic branches
- Does not involve ascending aorta
- usually beginning distal to subclavian artery
- Also called DeBakey type III

- Both types are fetal, but **type A is more dangerous,** because the blood loss occurs before giving major organ branches (since it is proximal (before) branching sites)

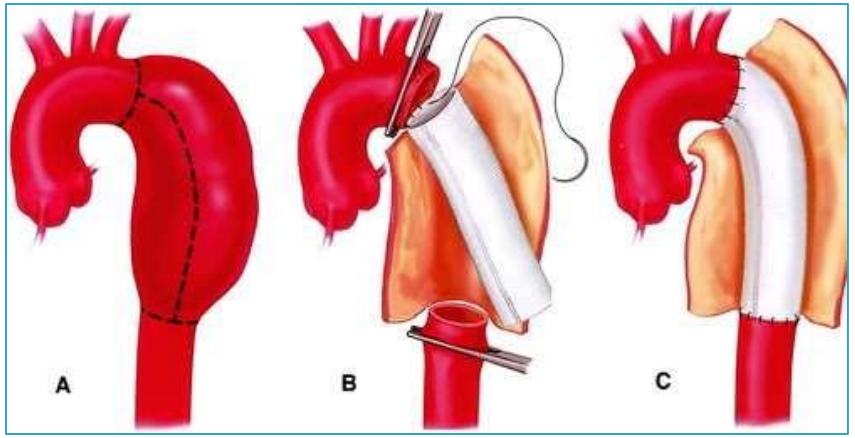


Clinical course

- Previously, aortic dissection was typically fatal, but prognosis has markedly improved Rapid diagnosis and institution of:

1- Antihypertensive therapy

2 - Surgical procedures involving plication of aorta, wall reconstruction with synthetic graft



Additional sources

VERSIONS	SLIDE #	BEFORE CORRECTION	AFTER CORRECTION
V1→ V2			
V2→V3			

امسح الرمز و شاركنا بأفكارك لتحسين أدائنا!!