PATHOLOGY

بسم الله الرحمن الرحيم

FINAL | Lecture 5

Aneurysms & Dissections

وَلَقَدْ خَلَقْنَا الْإِنسَانَ وَنَعْلَمُ مَا تُوَسْوِسُ بِهِ نَفْسُهُ ۖ وَنَحْنُ أَقْرَبُ إِلَيْهِ مِنْ حَبْلِ الْوَرِيدِ

اللهم إنّا نعوذ بك من شرور أنفسنا ومن سيئات أعمالنا

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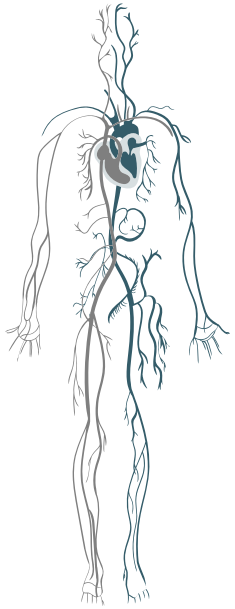

وَلِلَّهِ الْأَسْمَاءُ الْحُسْنَى فَادْعُوهُ بِهَا

المعنى: الذي قام بنفسه فلم يحتج إلى أحد، وقام كل شيء به، فكل ما سواه محتاج إليه بالذات.

الورود: ورد في القرآن (٣) مرات.

الشاهد: ﴿ٱللَّهُ لَآ إِلَٰهَ إِلَّا هُوَ ٱلۡحَيُّ ٱلۡقَيُّومُۚ﴾ [البقرة:٢٥٥].

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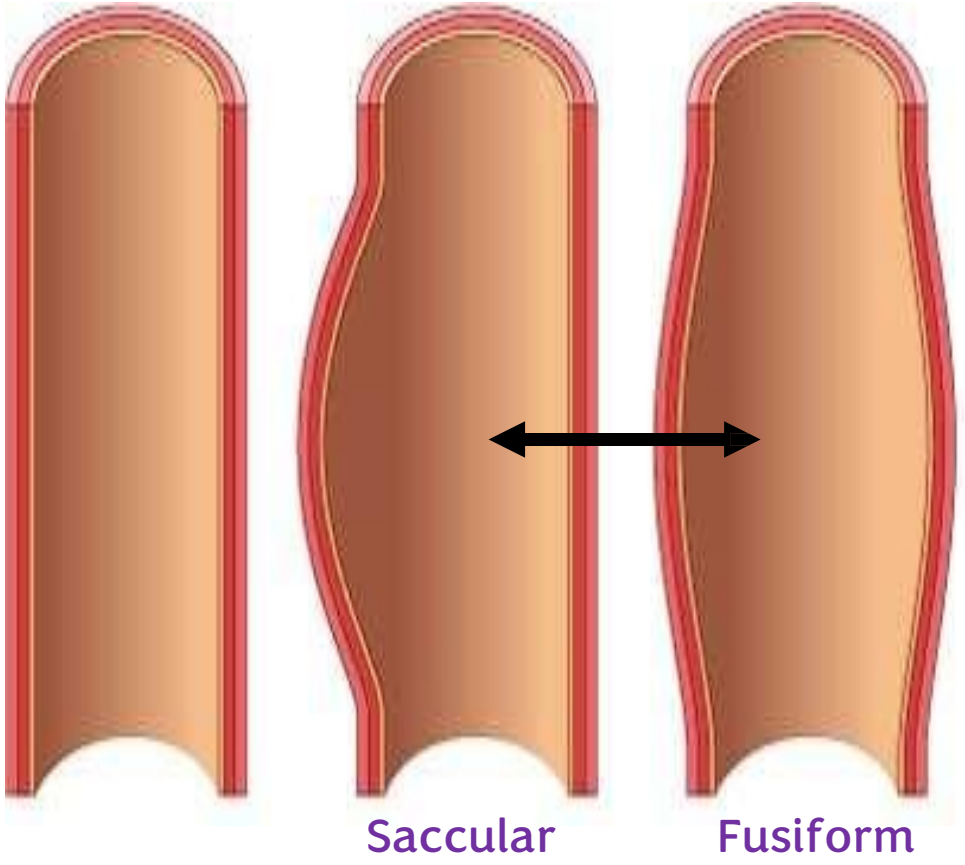
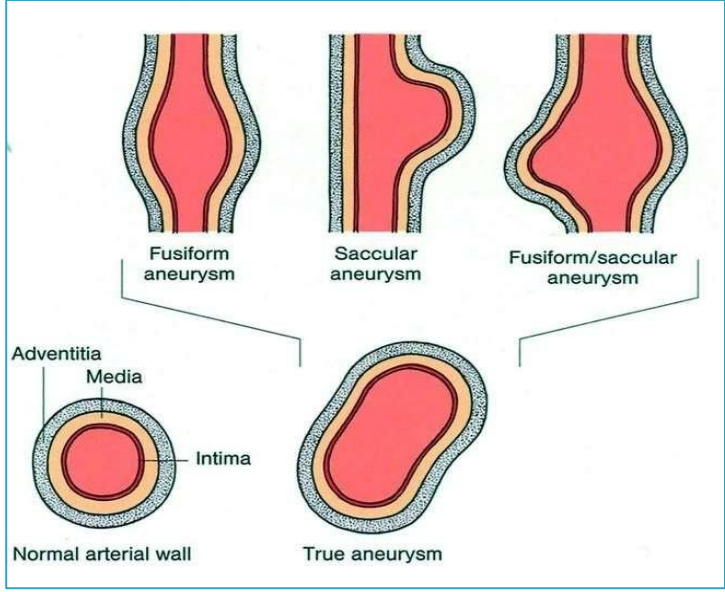
اضغط هنا لشرحٍ أكثر تفصيلًا

Aneurysm

- Definition: Localized abnormal dilation of artery or heart
- In the second image, we see a dilation affecting only **one portion** of the vessel wall. In the third image, the dilation involves the **full circumference**.
- We use the terms **saccular** and **fusiform** to describe aneurysm shapes



Types of Aneurysms



1. "True" aneurysm

- **All three** layers of arterial wall or heart remain intact
- Examples: Atherosclerotic, syphilitic, congenital aneurysms, ventricular aneurysms following transmural MI
- Examples include **Berry aneurysms—small aneurysms involving the Circle of Willis** (a vascular ring at the base of the skull). These aneurysms develop due to a **congenital structural weakness** in the vessel wall.
- The dilation occurs because of this structural weakness in the vessel wall, and since the weakness is permanent, the dilation is **permanent** as well.

Types of Aneurysms

2. False Aneurysm a.k.a. **pseudo-aneurysm**

- A breach in vascular wall leading to hematoma communicating with intravascular space ("**pulsating hematoma**")
- Examples:
  - Ventricular rupture after MI contained by pericardial adhesion
  - A leak at the junction of a vascular graft with a natural artery
- Not all three vessel wall layers are intact; instead, there is a **defect in the vessel wall**.

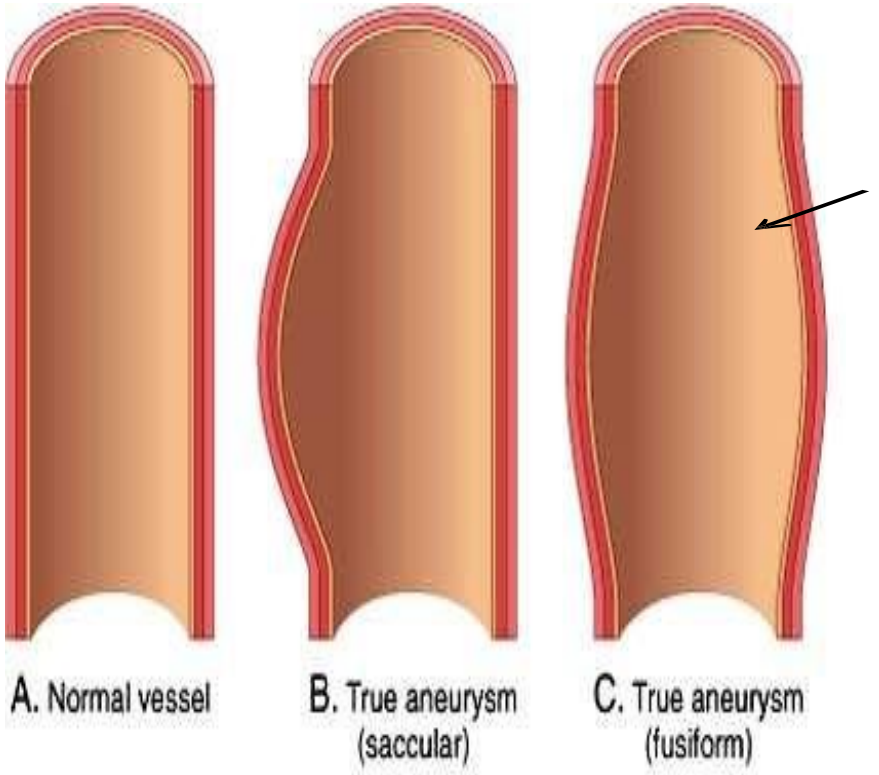
False Aneurysm Explanation

- Blood escapes the vascular lumen and is contained by **extravascular connective tissue**.
- This collection of blood is essentially a **hematoma**, which is why a false aneurysm resembles a **contained hematoma**.
- For example, when a vessel **ruptures**, the resulting defect can form a false aneurysm.
- A **vascular graft** is a transplanted segment of blood vessel placed into a new location and requires **suturing**. One possible complication is **leakage**, and if this leakage is contained by surrounding connective tissue, a **false aneurysm (hematoma)** can form.

❖Both true and false aneurysms can **rupture**, leading to internal bleeding.

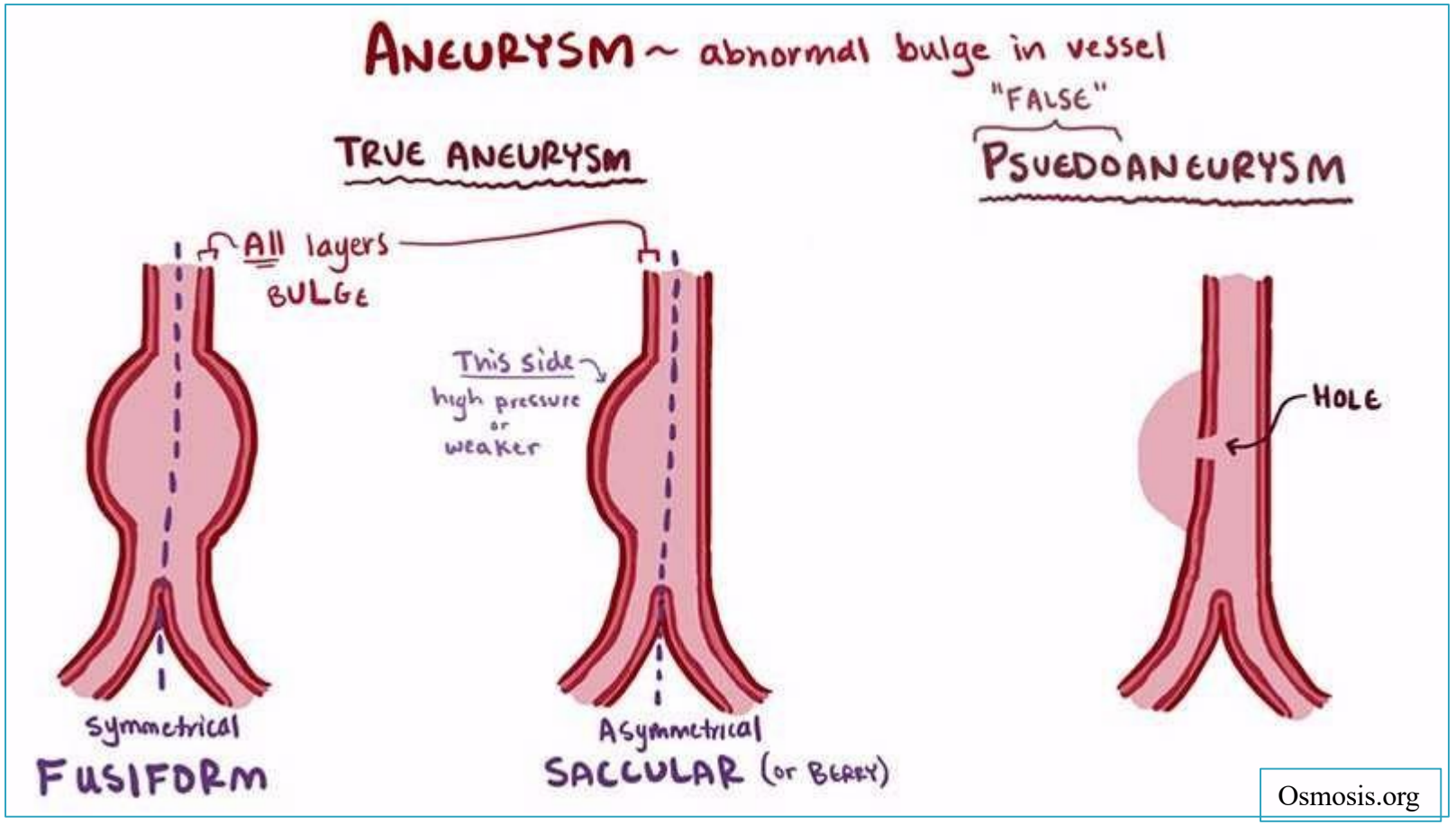
True Aneurysms Classification According to Microscopic Shape

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**

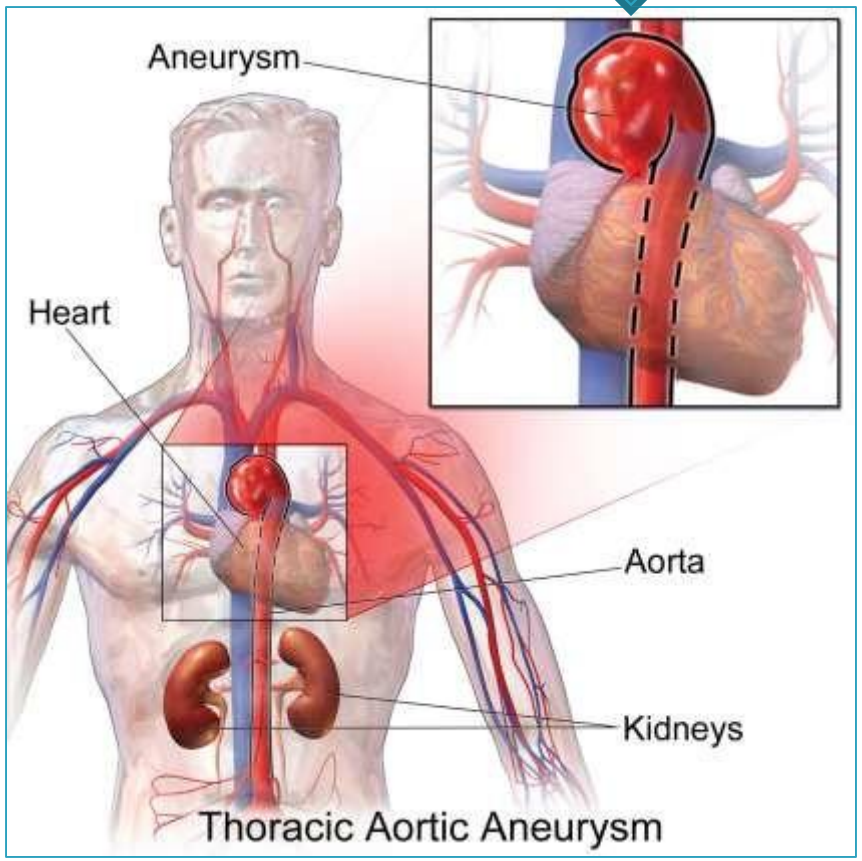


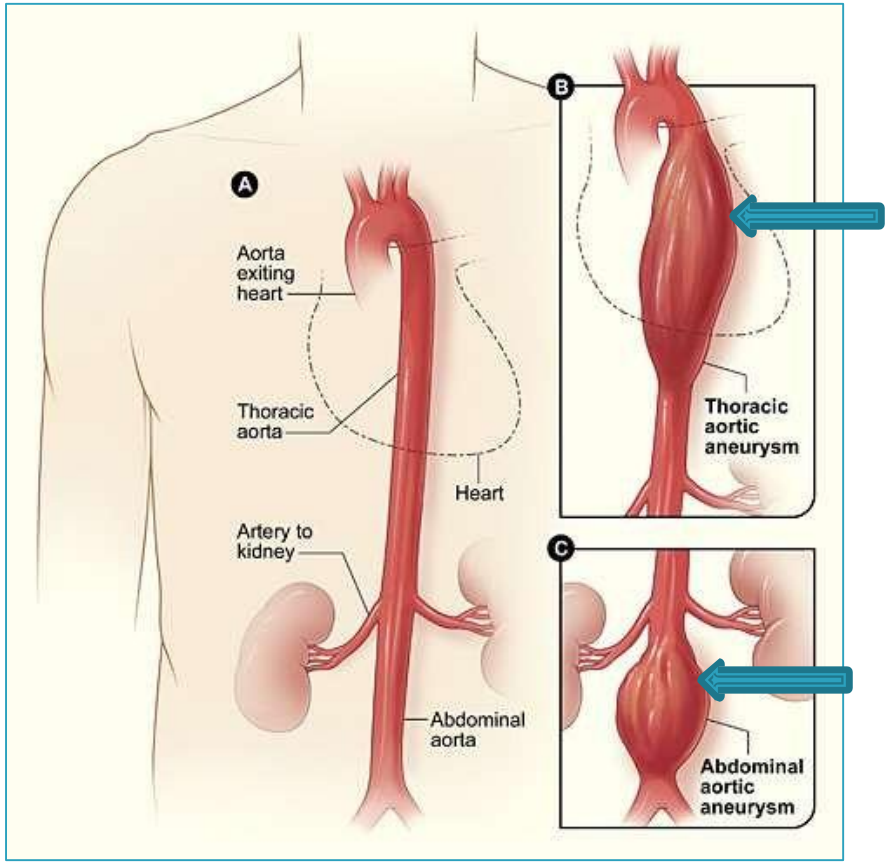
- Note: shape and size are not specific for any disease or clinical manifestations

To summarize...



Aortic aneurysms





Aortic Aneurysms: Clinical Features and Complications

- Aortic aneurysms can involve **any part of the aorta—ascending, arch, descending, or abdominal**.
- For example, if the normal diameter is about **3 cm** but an aneurysmal segment expands to **15 cm in diameter** and **20 cm in length**, it becomes a dangerously unstable lesion.
- The major outcome is **rupture**, because the wall is **abnormally weak**.
- This is especially likely in patients with **hypertension, cardiovascular disease, or atherosclerosis**, all of which weaken the vessel wall.
- Another consequence is **compression**, because the aneurysm behaves like a **mass**.
  - In the aortic arch, it may compress the **left recurrent laryngeal nerve**, causing **hoarseness**.
  - It may also cause **chest pain**, **dyspnea**, or **dysphagia** due to pressure on surrounding structures.

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. Degeneration of Arterial Media

- Causes include:
  - Hypertension
  - Trauma
  - Congenital defects (e.g., **berry** aneurysms)
  - Hereditary defects in structural components (Marfan)
  - Infections (**mycotic** aneurysms)
  - Vasculitis
  - Immune-mediated…
- We focus on the **tunica media**, because it is responsible for the **strength and elastic recoil** of the vessel wall.

Abdominal Aortic Aneurysm (AAA)

- Atherosclerotic aneurysms occur most frequently in **Abdominal** aorta (= AAA)
- common iliacs, arch, and descending parts of thoracic aorta can also be involved
- **Pathogenesis:**
  - Most common in **men**
  - Rarely < age 50
  - **Atherosclerosis** is a major cause of AAA

Abdominal Aortic Aneurysm (AAA)

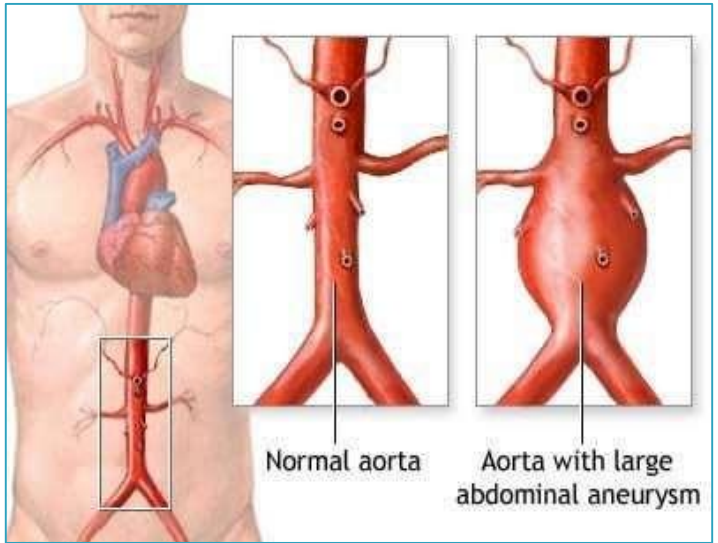
- Most commonly located **below the renal arteries** and **above the aortic bifurcation**.
- It may compress the **ureters**, **vertebrae**, or **exiting nerves**, producing symptoms depending on the site of pressure.
- Aneurysms promote **stasis**, leading to formation of a **large mural thrombus**.
- This thrombus can **embolize**, obstruct downstream vessels, and cause **ischemia or infarction**.

Abdominal Aortic Aneurysm

- 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 inflammation and the destructive proteolytic enzymes
     - (e.g., **Vasculitis**)
- In **Marfan syndrome**, an autosomal dominant disorder, the patient has a **defect in fibrillin**, a protein essential for **elastin synthesis**.
- Because elastin is a major structural component of the **aortic media**, this defect leads to **weakening** and **aneurysm formation**.
- Any condition that alters the balance between **collagen synthesis and degradation**, such as **vasculitis**, can cause similar damage.
- **Mycotic aneurysms**, caused by **infection of the vessel wall**, can also weaken the vessel wall in this way.

AAA – Morphology

- 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; thinning of media
- Frequently contains a laminated mural thrombus

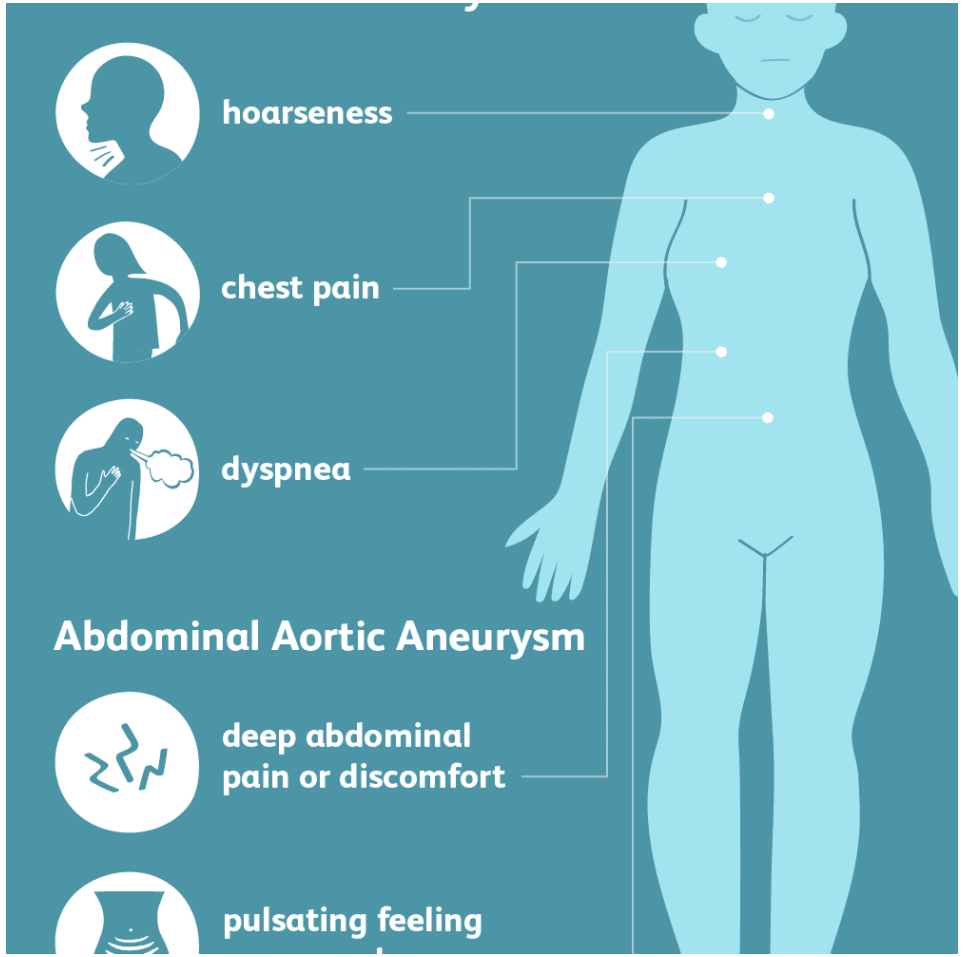


Abdominal aortic aneurysm and complications

A: rupture
B: thrombosis

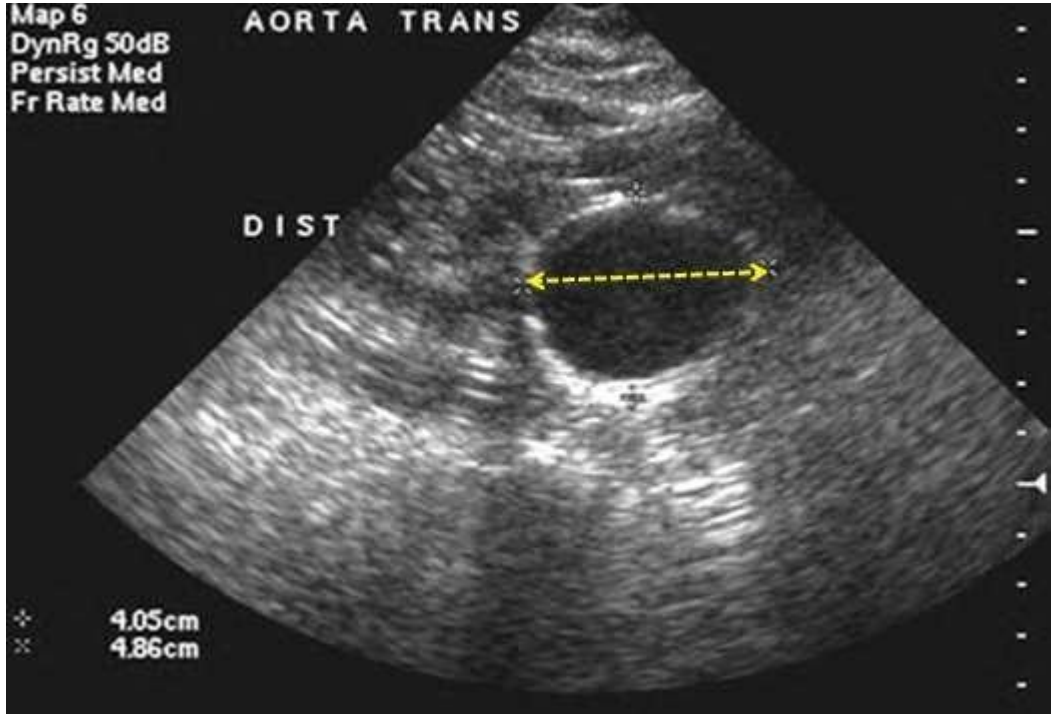
- This slide shows an **abdominal aortic aneurysm** and highlights its complications:
  - **Rupture**, which in this case resulted in **death**.
  - **Image B** shows the **opened aorta**, revealing a **large mural thrombus**, another major complication.

Symptoms of aortic aneurysm



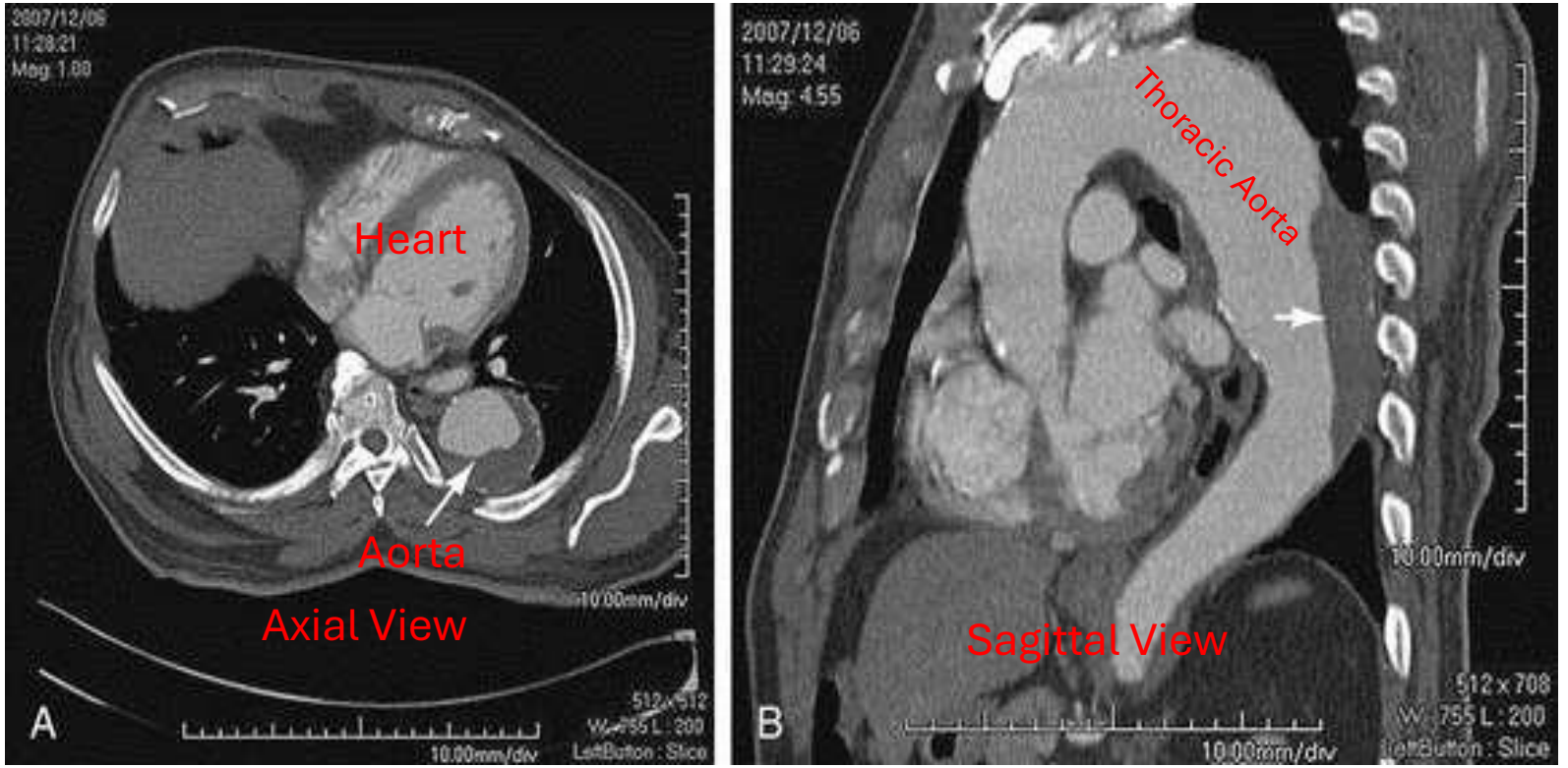
Clinical Assessement of AAA

- This radiological image demonstrates how imaging is used to:
  - **Diagnose aneurysms**,
  - **Monitor their size and progression**, and
  - **Determine whether immediate surgery or conservative management is needed**.
- **Echocardiography** can be used to **measure the aortic diameter**.



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

In a CT scan, the color inside the heart is the same as the color inside the aorta because this represents blood, and this is called the signal of the blood.



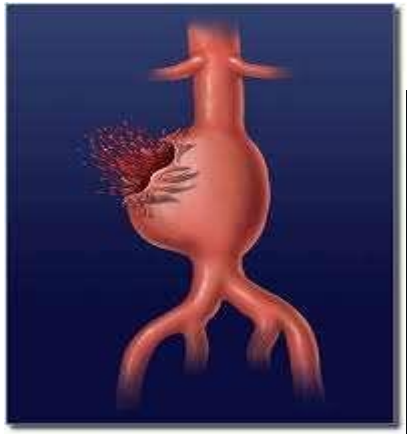
The diameter of the aorta is large, this represents an aortic aneurysm

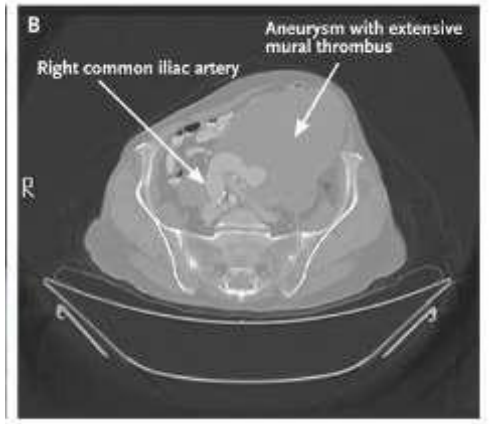
The white arrow represents a mural thrombus inside the aneurysmal segment of the aorta.

A second diagnostic method is CT angiography, which provides multiple detailed views of the aneurysm.

The Clinical Consequences of AAA

- **Rupture** → massive hemorrhage
  - 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)

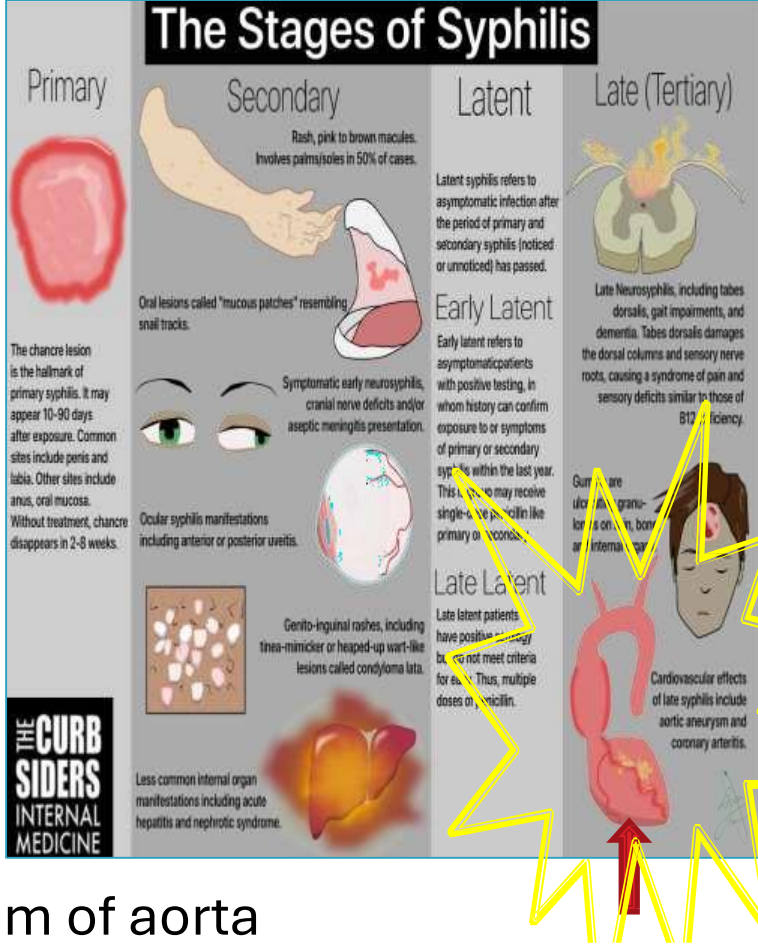




Mycotic Aneurysms

- Infection of an artery that weakens its wall is called a **mycotic aneurysm.**
- It is not limited to **fungal infection**; it can be caused by **any microbial infection**. The term **"mycotic aneurysm"** is a **misnomer**, because it originated from early cases in which **fungal infections were first recognized** as a cause of aneurysms.
- Can originate from:
  1. Embolization of a **septic thrombus** (infective endocarditis)
  2. Extension of adjacent suppurative process.
     - Where infection in an abscess spreads to adjacent arterial wall.
  3. Circulating organisms infecting arterial wall.
     - Bacteremia seeding a pre-existing aneurysm or an atherosclerotic plaque.

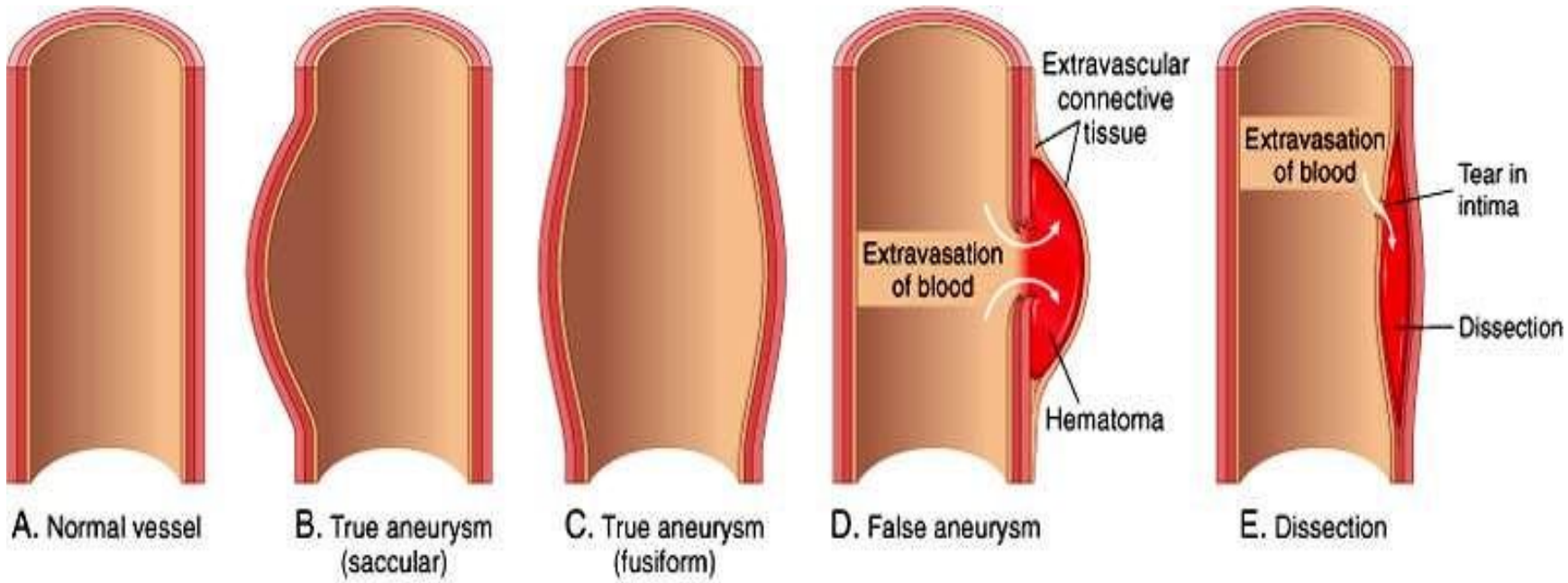
Syphilitic Aneurysm



- Syphilis is a sexually transmitted disease caused by spirochetes ***T. pallidum*.**
- Syphilis has three stages: primary, secondary & tertiary.
- Syphilitic Aneurysm: A rare complication of the **tertiary stage** of syphilis
- Rare: thanks to early recognition and treatment of syphilis, since it is simply treated by antibiotics.
- Tertiary stage of syphilis is related to **exaggerated immune response** which can cause **obliterative endarteritis** of vasa vasorum of aorta leading to the following Consequences:
  - Ischemic medial injury (ischemia of tunica media)
  - Aneurysmal dilation of aorta and aortic annulus
  - Eventually valvular insufficiency

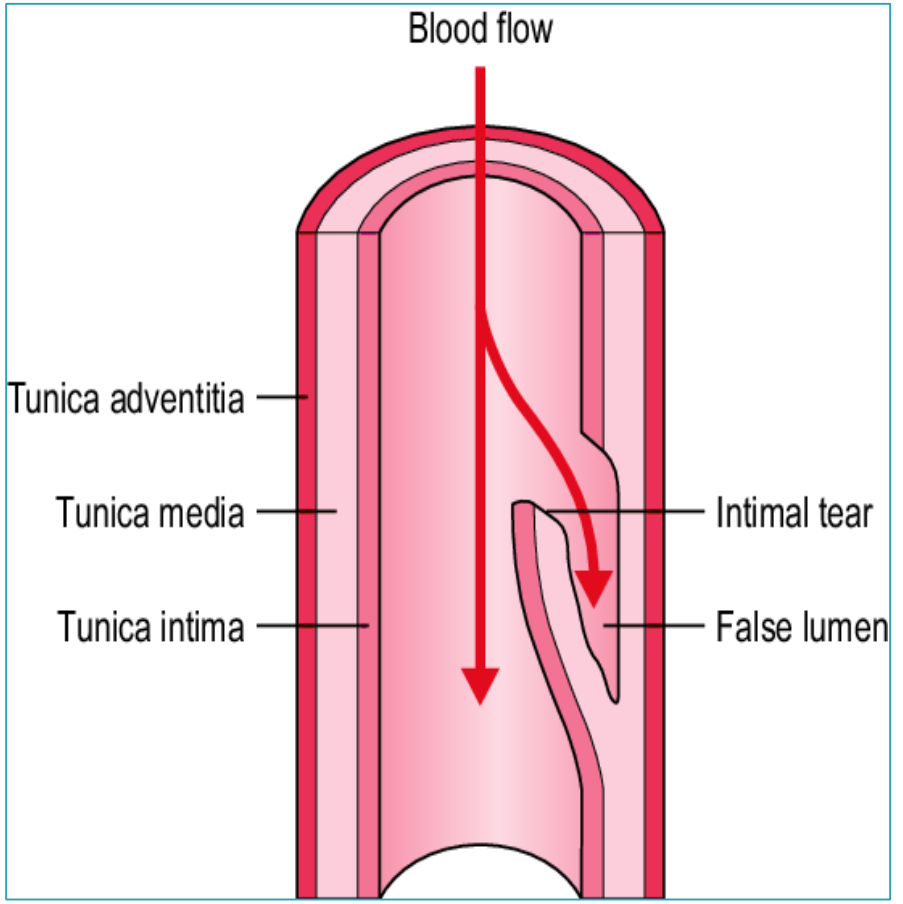
❖Note that the aneurysm here is caused by **immune response** not by the microorganism invasion, thus it is not a mycotic aneurysm.

Aneurysm versus dissection …



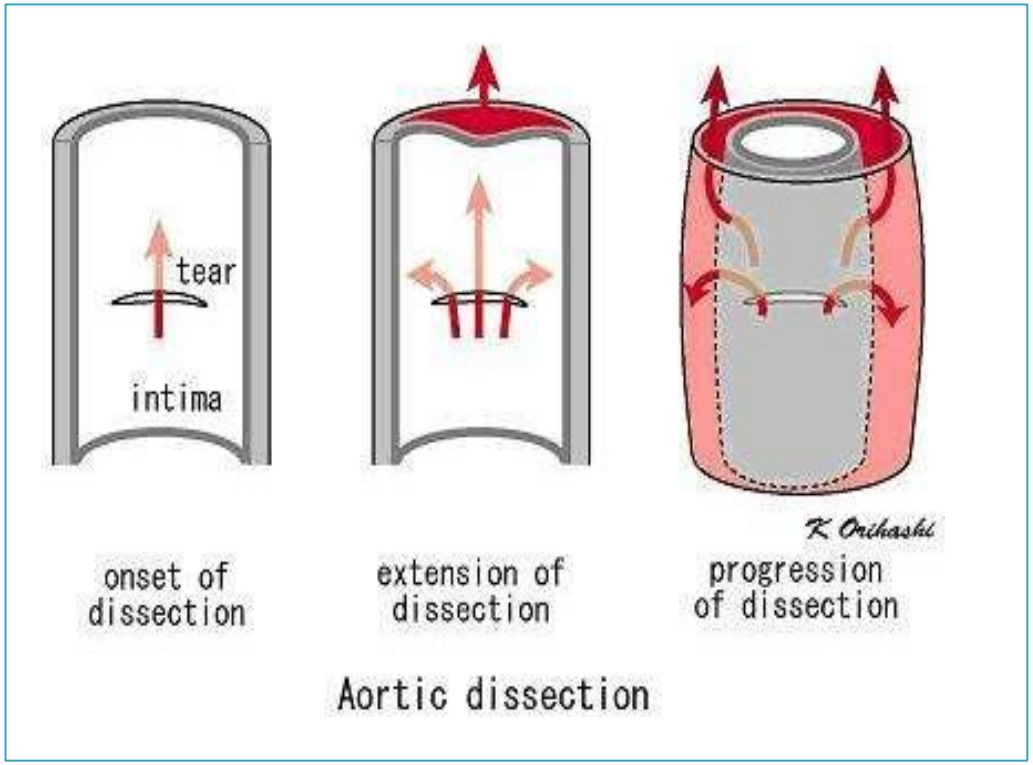
Arterial Dissection

- A dissection is an **intimal tear** that allows blood to enter and separate the layers of the tunica media.
- **Pathogenesis:**
  - Blood flowing under **high pressure** enters an **intimal tear** (often caused by hypertension or other mechanical stress). Part of the blood tracks into the tear and **extends into the tunica media**, where the force of blood flow causes the dissection to **propagate**, creating a **false lumen**.
  - Blood flows into the false lumen, reducing flow in the **true lumen**. In the **aorta**, this diversion of blood can significantly compromise effective circulation and may become life-threatening.



Consequences

- **Full rupture of the vessel**, leading to **internal hemorrhage** and, if severe, **hypotensive shock**.
- **Turbulent flow** within the false lumen, which promotes **thrombus formation**.
- **Ischemia of the lower limbs** due to **compression of the true lumen**, producing **weak distal pulses**.
- Progressive dilation and **aneurysms of the dissected segment** over time as the media weakens.
- Additional consequences include **extension of the dissection along the vessel**, **aortic regurgitation** when the **ascending aorta** is involved, and **compression of nearby organs**.

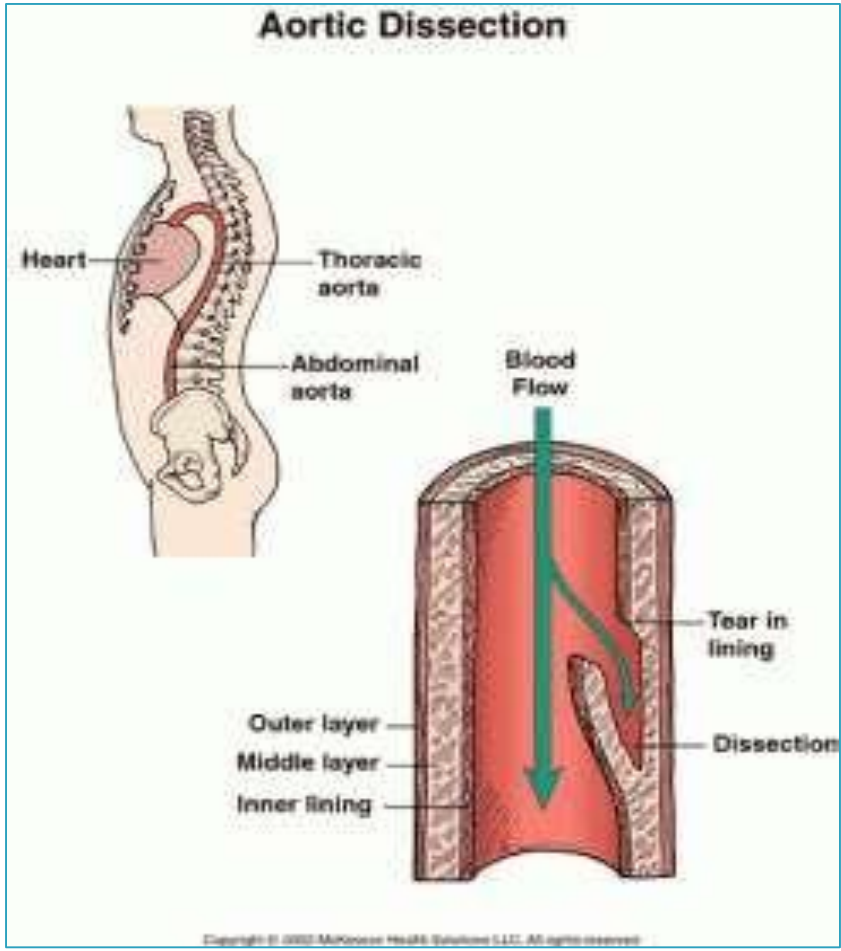


Arterial Dissection

- 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; due to rupture
  - Cardiac tamponade (In case of hemorrhage into the pericardial sac)



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** structural proteins
   - (e.g., Marfan syndrome, Ehlers-Danlos syndrome, vitamin C deficiency, copper metabolic defects)

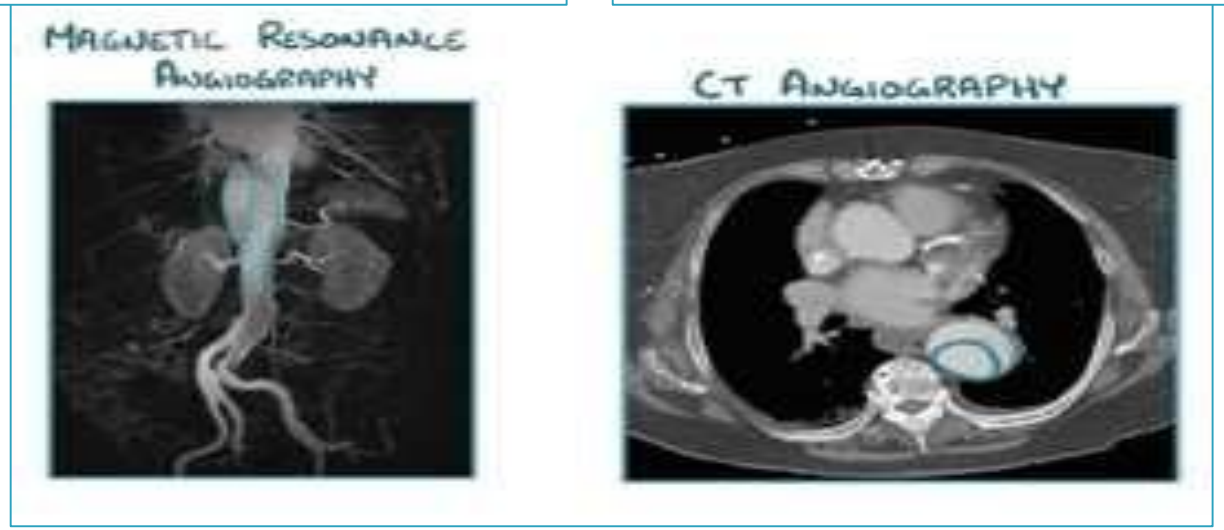
Marfan Syndrome

- The most common among inherited or acquired connective tissue disorders associated with aortic dissection
- Autosomal dominant disease of **fibrillin**, an ECM scaffolding protein required for normal elastic tissue synthesis
- **Manifestations** include**:**
  - Skeletal abnormalities (elongated axial bones)
  - Ocular findings (lens subluxation)
  - **Cardiovascular** manifestations (aortic aneurysms and dissections)

Manifestations of Aortic Dissection

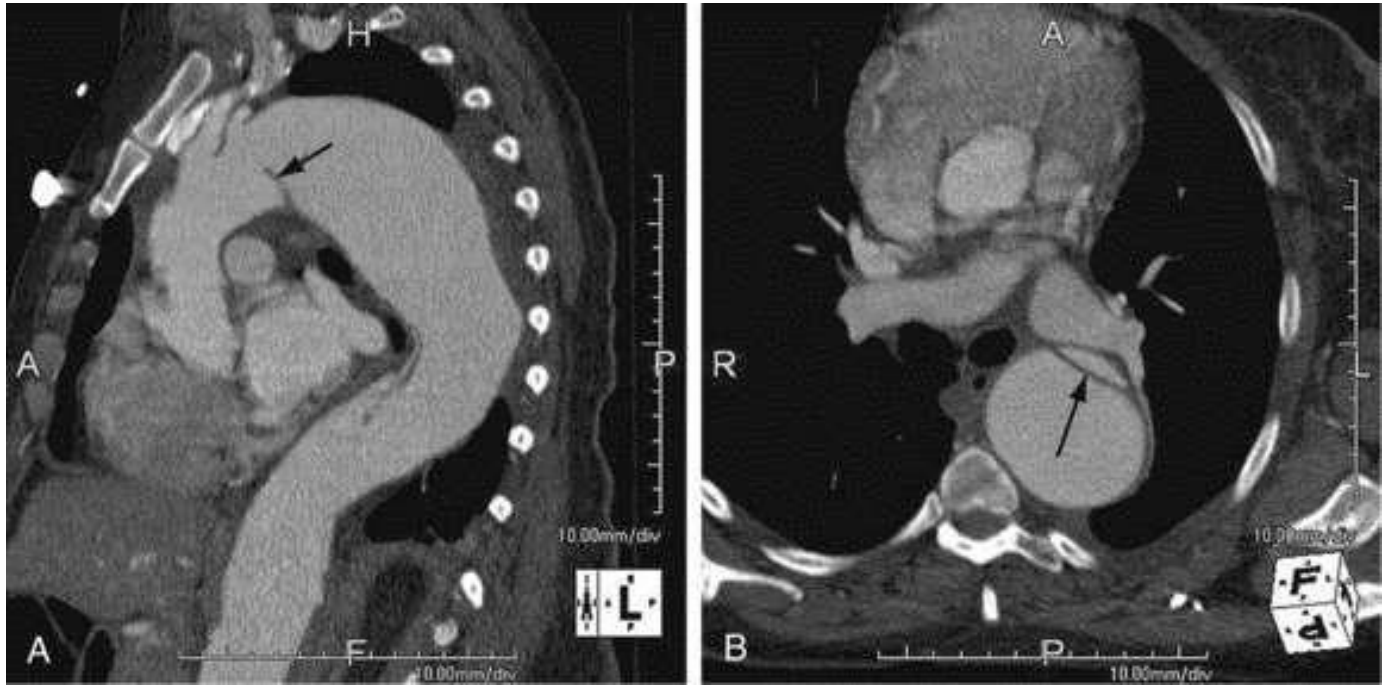
- Sharp chest/back pain
- Weak pulses in downstream arteries
- If ruptures into pericardium → cardiac tamponade
- Hypotension
- Shock
- Death

Diagnosis & clinical assessment

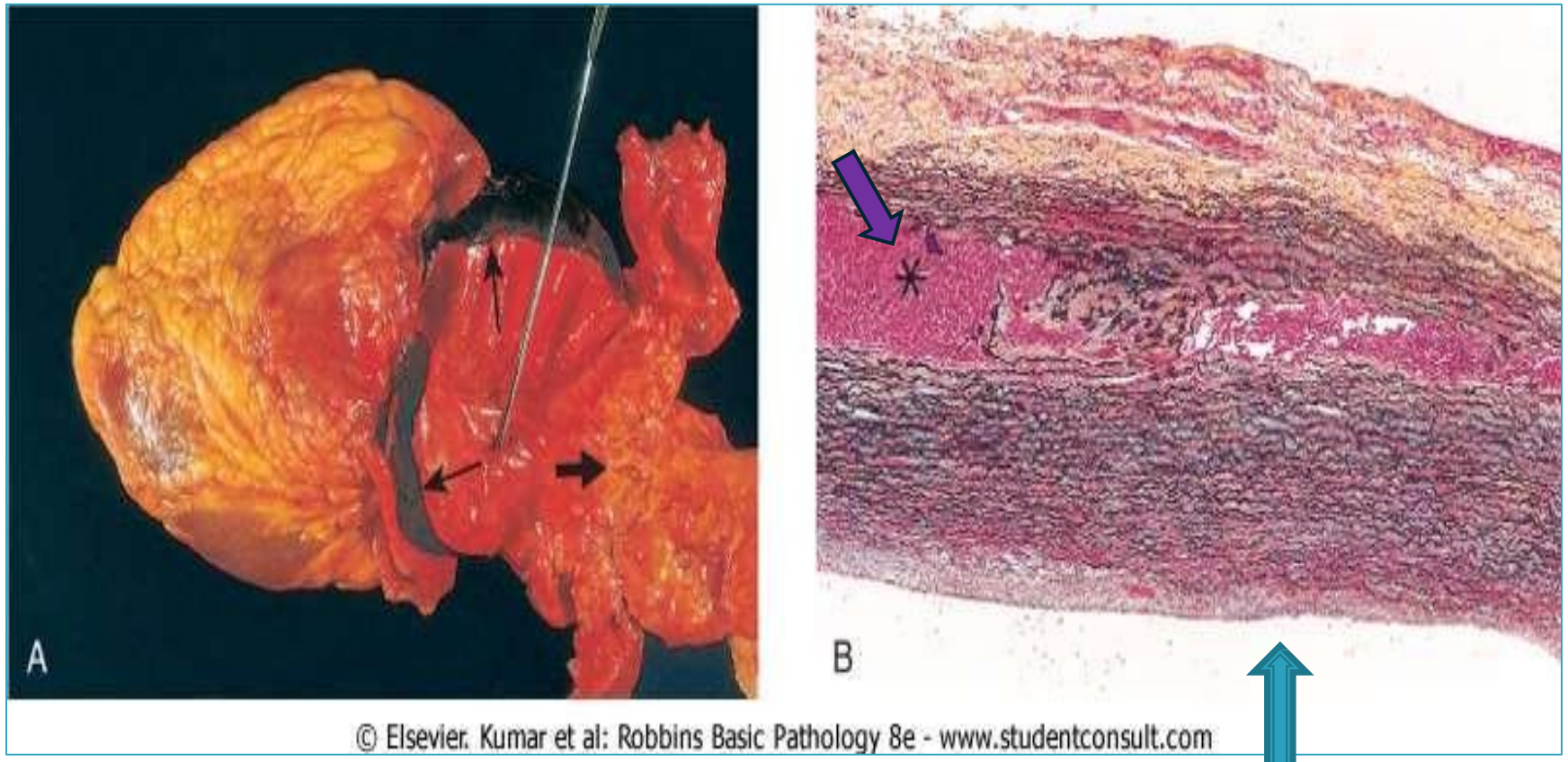


Radiology in different forms is used in the **assessment and diagnosis.**
These include: **chest X-ray, MRI angiography, transesophageal echocardiography,** and **computed tomography (CT) angiography.**

Sagittal (A) and axial (B) contrast-enhanced CT images show a type B dissection (arrow) and aneurysm (wide diameter) of the descending aorta. B: shows the formation of false lumen



Aortic dissection



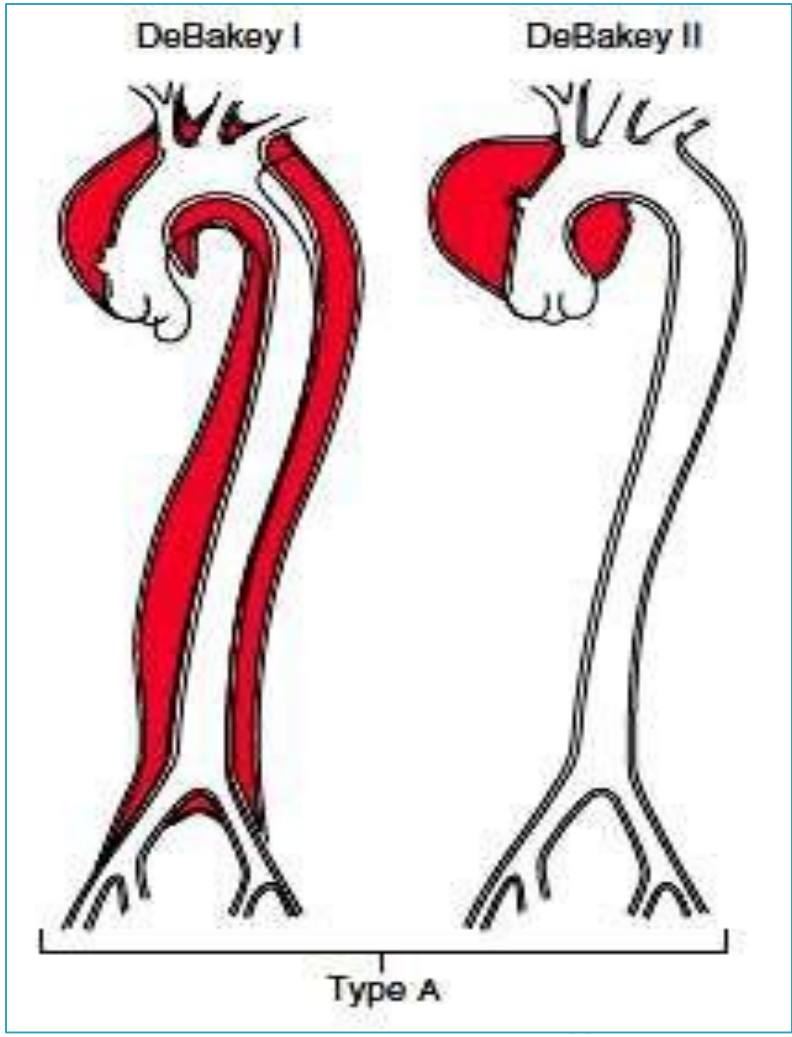
Picture A shows a **segment of the aorta that has been opened**, revealing the **dissection**, with a **metallic probe marking its location**.

Silver stain: display elastic fibers in black color. Note that the elastic content is markedly decreased in the area designated with *

Aortic Dissections are Generally Classified into Two Types:

1. Type A dissections:

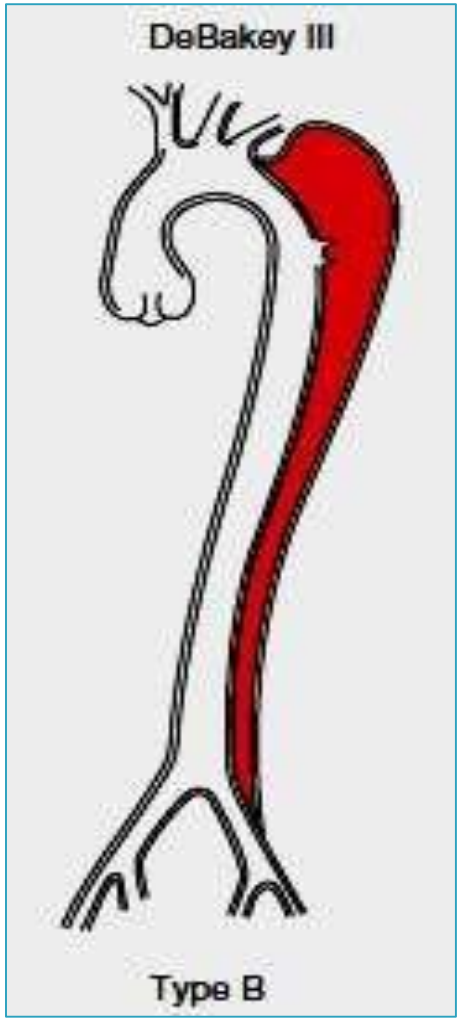
- More common
- More dangerous; Dissection of aortic branches → less blood flow → **less upper part supply**
- **Proximal** to takeoff of major aortic branches (Brachiocephalic, L. common carotid, L. subclavian)
- Involve either ascending aorta only (II of the DeBakey classification) or both ascending and descending aorta (type I DeBakey)



Aortic Dissections are Generally Classified into Two Types:

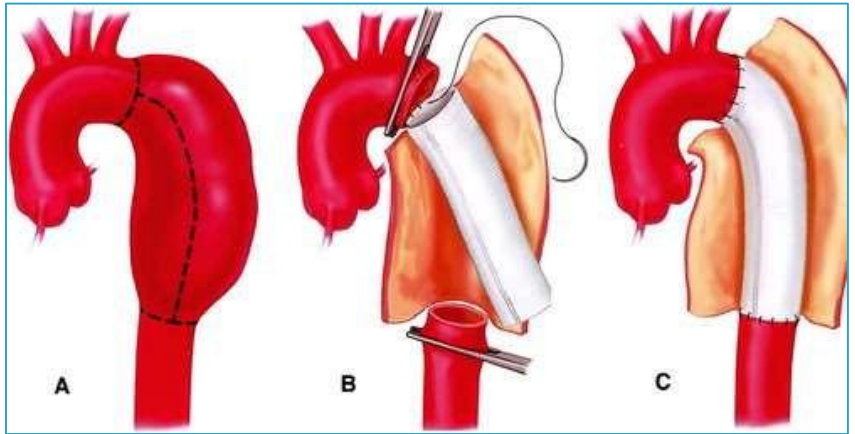
2. Type B dissections:

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



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
- However, it is still considered **highly fatal**, as patients often develop the disease **on top of pre-existing cardiovascular conditions**.



PATHOLOGY QUIZ

LECTURE 5

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Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	Slide #20	Axial & Sagittal View tags flipped	Corrected
V1 → V2	Slide #32 Slide #35	Sentence was chopped Ascending & Descending aorta (Type II DeBakey)	Fixed it Ascending & Descending aorta (Type I DeBakey)