Vascular disorders

Congenital abnormalities

berry aneurysms has been previously described

Arteriovenous Fistulas

Causes

- Congenital
- Acquired
    - Traumatic
    - Inflammatory
    - Therapeutic

Complications

- Intracranial hemorrhage
- High output heart failure

Arteriosclerosis

Thickening and loss of elasticity of arterial walls

Types

- Atherosclerosis
- Mönckeberg medial calcific sclerosis
- Arteriolosclerosis

Mönckeberg medial calcific sclerosis

calcific deposits in muscular arteries in persons older than age 50.

The radiographically visible, often palpable calcifications, do not encroach on the vessel lumen.

Arteriolosclerosis

- Hyaline and hyperplastic
- Seen in DM and hypertension
- Thickening of vessel walls with luminal narrowing that may cause downstream ischemic injury.

Atherosclerosis

Atheromas (*atheromatous or fibrofatty plaques*) which protrude into and obstruct vascular lumens and weaken the underlying media.

It causes half of all deaths

Classification of atheromataous plaque

Nomenclature and main histology	Sequences in progression	Main growth mechanism	Earliest onset	Clinical correlation
Type I (initial) lesion Isolated macrophage foam cells	I	Growth mainly by lipid accumulation	From first decade	Clinically silent
Type II (fatty streak) lesion Mainly intracellular lipid accumulation	II			
Type III (intermediate) lesion Type II changes and small extracellular lipid pools	III		From third decade	
Type IV (atheroma) lesion Type II changes and core of extracellular lipid	IV			Clinically silent or overt
Type V (fibroatheroma) lesion Lipid core and fibrotic layer, or multiple lipid cores and fibrotic layers, or mainly calcific, or mainly fibrotic	V	Accelerated smooth muscle and collagen increase	From fourth decade	
Type VI (complicated) lesion Surface defect, hematoma-hemorrhage, thrombus	VI	Thrombosis, hematoma		

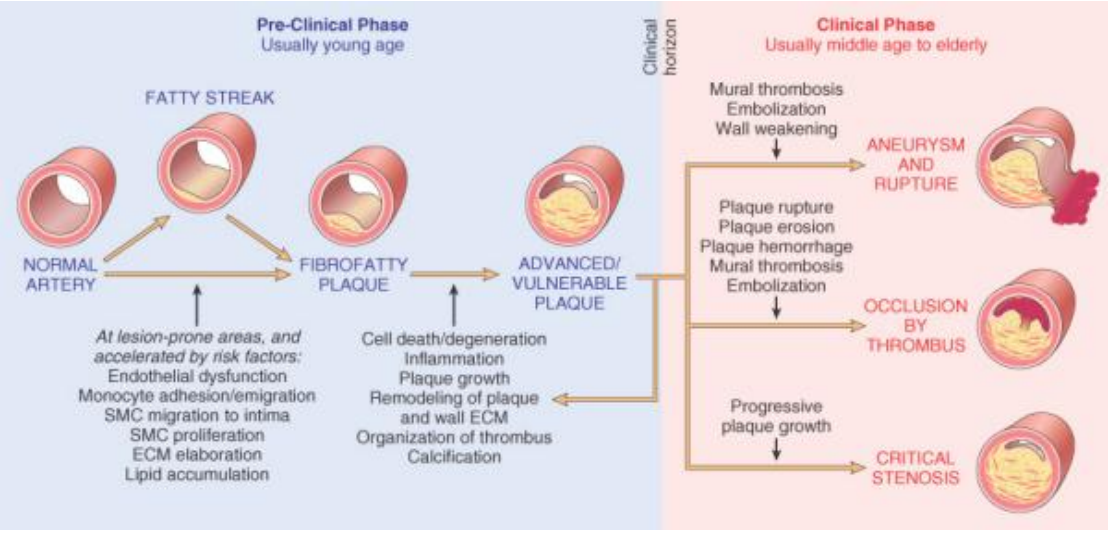
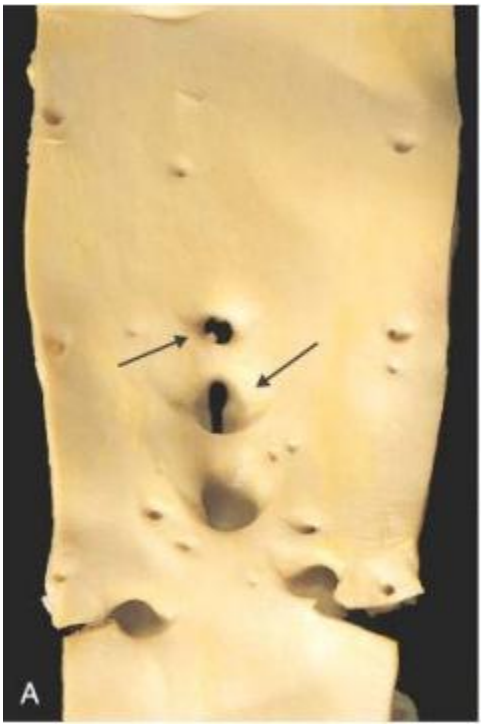
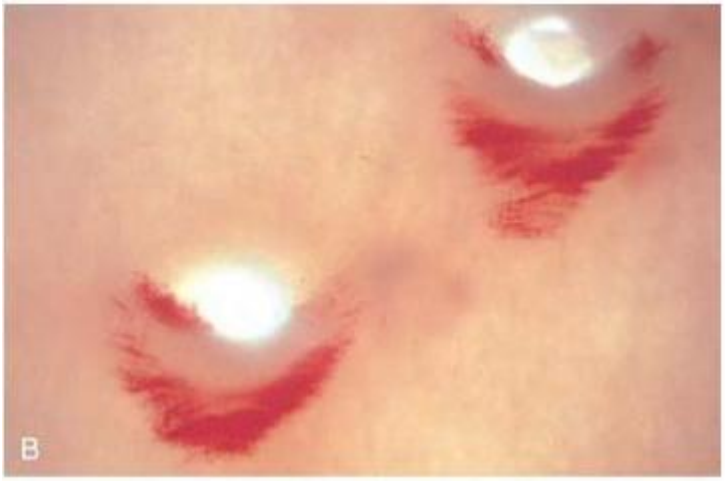


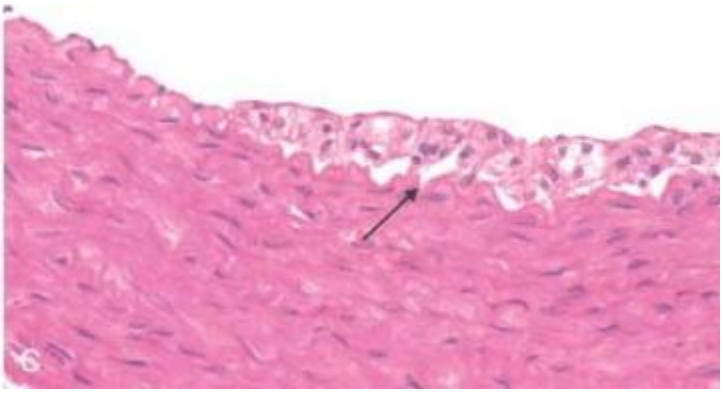
Figure : Schematic summary of the natural history, morphologic features, main pathogenetic events, and clinical complications of atherosclerosis in the coronary arteries.



Aorta with fatty streaks (arrows), associated largely with the ostia of branch vessels



Close-up photograph of fatty streaks from aorta of experimental hypercholesterolemic rabbit shown following staining with Sudan red



Photomicrograph of fatty streak in experimental hypercholesterolemic rabbit, demonstrating intimal, macrophage-derived foam cells *(arrow)*.

Fatty streaks

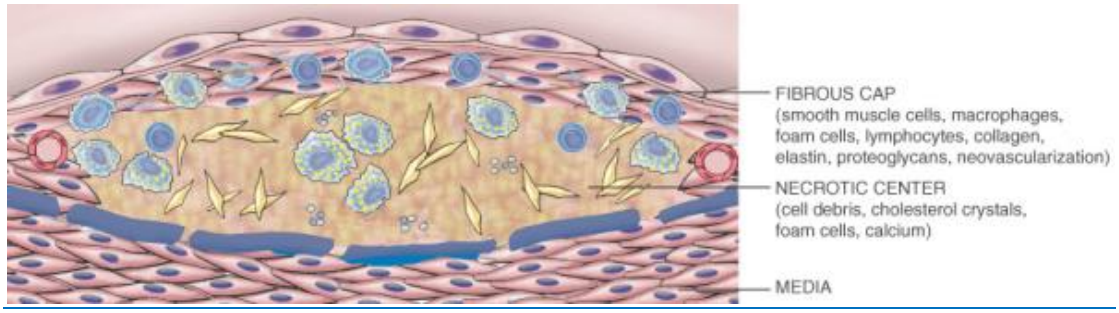
- The earliest lesion of atherosclerosis.
- Composed of lipid-filled foam cells .
- Not significantly raised and thus do not cause any disturbance in blood flow.
- Contain T lymphocytes and extracellular lipid in smaller amounts than in plaques.
- Appear in the aortas of some children younger than age 1 year and all children older than age 10 years, regardless of geography, race, sex, or environment
- not all fatty streaks are destined to become fibrous plaques or more advanced lesions

Atherosclerotic plaques

- elastic arteries (e.g., aorta, carotid, and iliac arteries)
- large and medium-sized muscular arteries (e.g., coronary and popliteal arteries).
- *Symptomatic atherosclerotic disease most often involves the arteries supplying the heart, brain, kidneys, and lower extremities*
- *Myocardial infarction (heart attack), cerebral infarction (stroke), aortic aneurysms, and peripheral vascular disease (gangrene of the legs) are the major consequences of atherosclerosis*

Morphology

The key processes in atherosclerosis are intimal thickening and lipid accumulation. An atheroma (derived from the Greek word for gruel) or atheromatous plaque consists of a raised focal lesion initiating within the intima, having a soft, yellow, grumous core of lipid (mainly cholesterol and cholesterol esters), covered by a firm, white fibrous cap



the abdominal aorta is usually much more involved than the thoracic aorta, and lesions tend to be much more prominent around the origins (ostia) of major branches.

Descending order

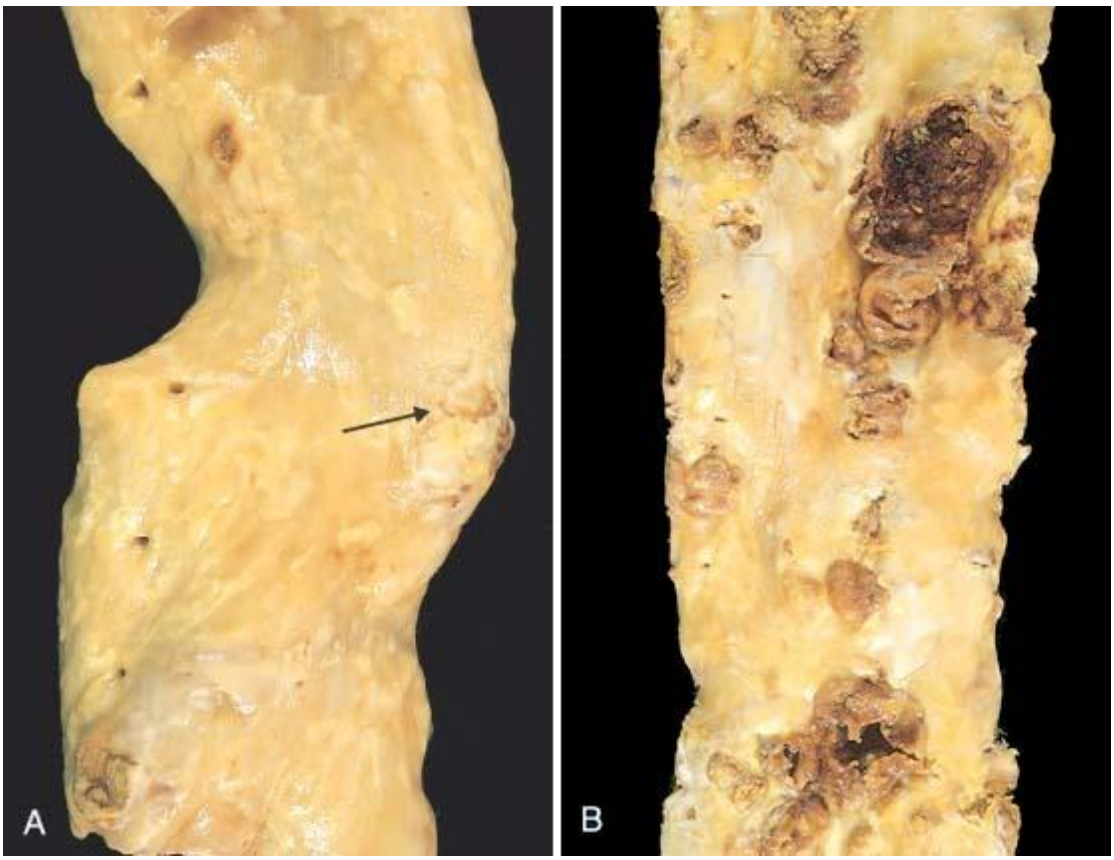
lower abdominal aorta

coronary arteries

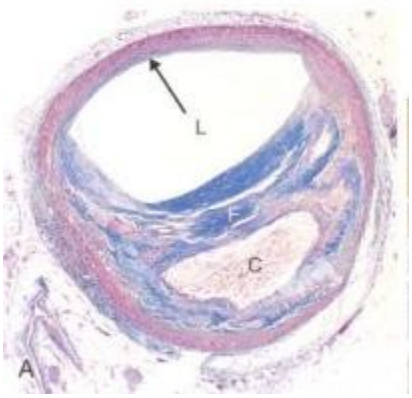
popliteal arteries

internal carotid arteries,

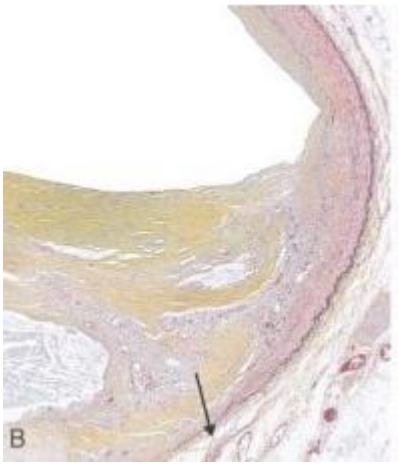
circle of Willis.



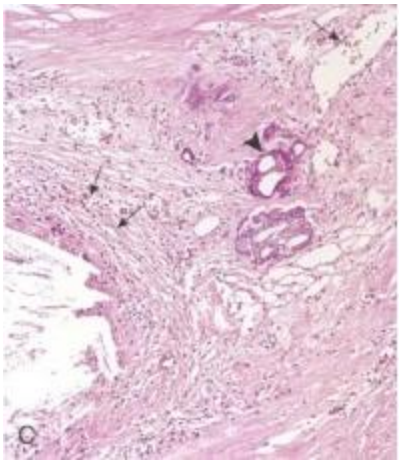
Gross views of atherosclerosis in the aorta. *A,* Mild atherosclerosis composed of fibrous plaques, one of which is denoted by the *arrow. B,* Severe disease with diffuse and complicated lesions.



Overall architecture demonstrating fibrous cap (F) and a central necrotic (largely lipid) core (c)



Higher-power photograph of a section of the plaque shown in *A,* stained for elastin (black), demonstrating that the internal and external elastic membranes are destroyed and the media of the artery is thinned under the most advanced plaque *(arrow).*



C, Higher-magnification photomicrograph at the junction of the fibrous cap and core, showing scattered inflammatory cells, calcification *(broad arrow),* and neovascularization *(small arrows)*.

- Patients with advanced coronary calcification appear to be at increased risk for coronary events

The **advanced lesion** of atherosclerosis is at risk for the following pathological changes that have clinical significance:

- Focal **rupture, ulceration**, or **erosion** of the luminal surface
  - Result in exposure of highly thrombogenic substances that induce thrombus formation
  - Discharge of debris into the bloodstream, producing microemboli composed of lesion contents **(cholesterol emboli or atheroemboli)**.
- **Hemorrhage** into a plaque, especially in the coronary arteries,
  - initiated by
    - rupture of the overlying fibrous cap
    - rupture of the thin-walled capillaries that vascularize the plaque.
  - hematoma may expand the plaque or induce plaque rupture.
- Superimposed **thrombosis**,
  - The most feared complication,
  - occurs on disrupted lesions (those with rupture, ulceration, erosion, or hemorrhage)
  - may partially or completely occlude the lumen.
  - Thrombi may heal and become incorporated into and thereby enlarge the intimal plaque.
- **Aneurysmal dilation**
  - Due to atrophy of the underlying media, with loss of elastic tissue, causing weakness and potential rupture.

RISK FACTORS

	Major	Lesser, Uncertain, or Nonquantitated
Nonmodifiable	○ Increasing age	○ Obesity
	○ Male gender	○ Physical inactivity
	○ Family history	○ Stress ("type A" personality)
	○ Genetic abnormalities	○ Postmenopausal estrogen deficiency
		○ High carbohydrate intake
Potentially Controllable	○ Hyperlipidemia	○ Alcohol
	○ Hypertension	○ Lipoprotein Lp(a)
	○ Cigarette smoking	○ Hardened (trans)unsaturated fat intake
	○ Diabetes	○ *Chlamydia pneumoniae*

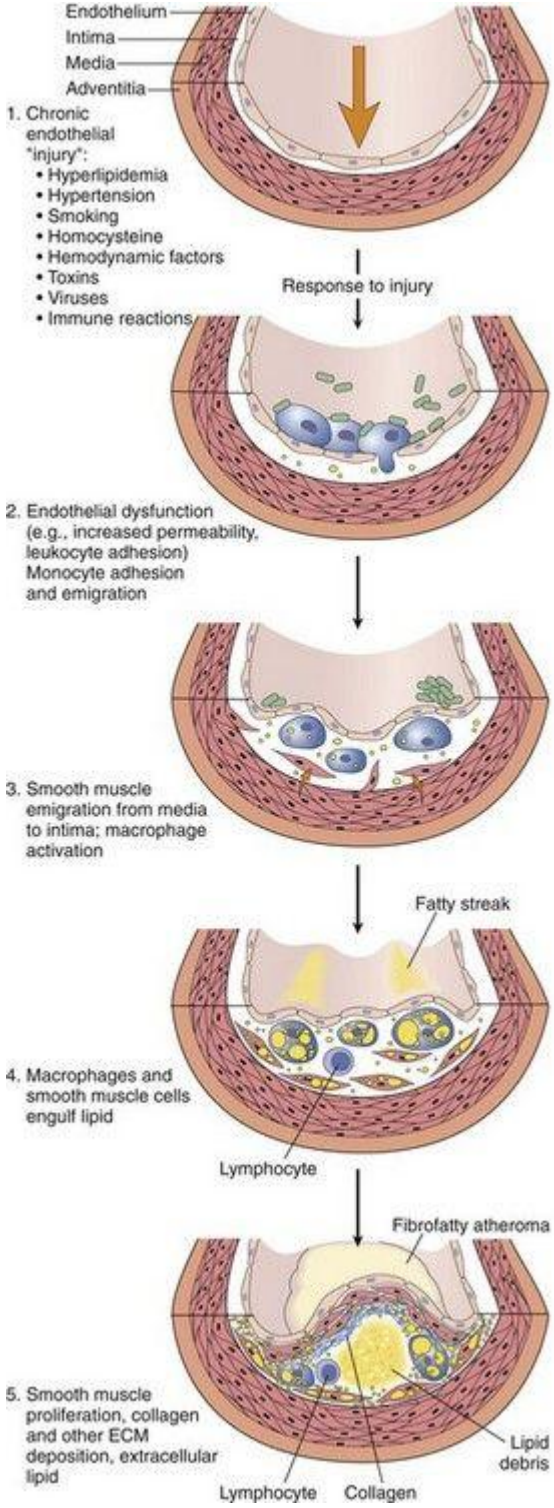
Even those who live "the prudent life" and have no apparent genetic predispositions are not immune to this killer disease.

PATHOGENESIS

the response to injury hypothesis:

atherosclerosis is a chronic inflammatory response of the arterial wall initiated by injury to the endothelium. Moreover, lesion progression is sustained by interaction between modified lipoproteins, monocyte-derived macrophages, T lymphocytes, and the normal cellular constituents of the arterial wall

- Chronic endothelial injury with resultant endothelial dysfunction, yielding
  - increased permeability,
  - leukocyte adhesion,
  - thrombotic potential
- Accumulation of lipoproteins, mainly LDL, with its high cholesterol content, in the vessel wall
- Modification of lesional lipoproteins by oxidation
- Adhesion of blood monocytes (and other leukocytes) to the endothelium, followed by their migration into the intima and their transformation into macrophages and foam cells
- Adhesion of platelets
- Release of factors from activated platelets, macrophages, or vascular cells that cause migration of SMCs from media into the intima
- Proliferation of smooth muscle cells in the intima, and elaboration of extracellular matrix, leading to the accumulation of collagen and proteoglycans
- Enhanced accumulation of lipids both within cells (macrophages and SMCs) and extracellularly


Endothelium
Intima
Media
Adventitia
1. Chronic endothelial "injury":
• Hyperlipidemia
• Hypertension
• Smoking
• Homocysteine
• Hemodynamic factors
• Toxins
• Viruses
• Immune reactions
Response to injury
2. Endothelial dysfunction (e.g., increased permeability, leukocyte adhesion) Monocyte adhesion and emigration
3. Smooth muscle emigration from media to intima; macrophage activation
Fatty streak
4. Macrophages and smooth muscle cells engulf lipid
Lymphocyte
Fibrofatty atheroma
5. Smooth muscle proliferation, collagen and other ECM deposition, extracellular lipid
Lipid debris
Lymphocyte
Collagen

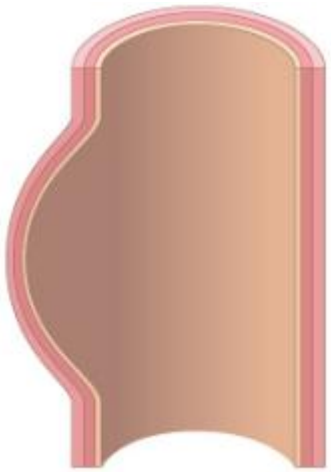
Aneurysms and Dissections

Aneurysm

a *localized abnormal dilation of a blood vessel or the wall of the heart*.

True aneurysm

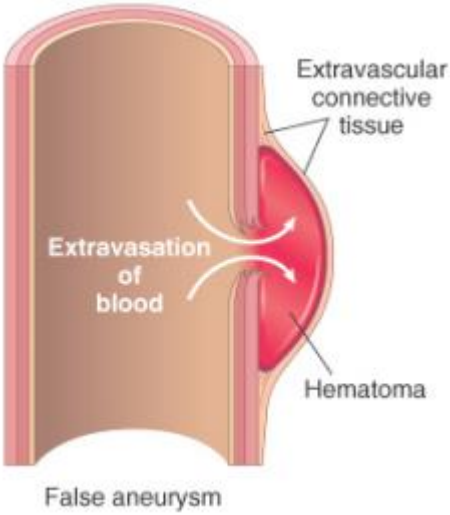
- bounded by arterial wall components or the attenuated wall of the heart
    - Atherosclerotic,
    - syphilitic
    - congenital
    - left ventricular aneurysm that follow MI.



True aneurysm

False aneurysm (also called pseudoaneurysm)

- a breach in the vascular wall leading to an extravascular hematoma that freely communicates with the intravascular space ("pulsating hematoma").
    - post-myocardial infarction rupture that has been contained by a pericardial adhesion
    - a leak at the junction of a vascular graft with a natural artery.



Causes of aortic aneurysms

- atherosclerosis
- cystic medial degeneration

<u>other causes for vessel aneurysms</u>

Trauma (traumatic aneurysms or arteriovenous aneurysms),

Congenital defects *berry* aneurysms,

Infections (mycotic aneurysms, see below); syphilis; or trauma.

Arterial aneurysms can also be caused by systemic diseases, as in some vasculitides.

mycotic aneurysm

caused by infection:

(1) from embolization and arrest of a septic embolus at some point within a vessel, usually as a complication of infective endocarditis;

(2) as an extension of an adjacent suppurative process

(3) by circulating organisms directly infecting the arterial wall.

Complications

- Thrombosis
- Rupture

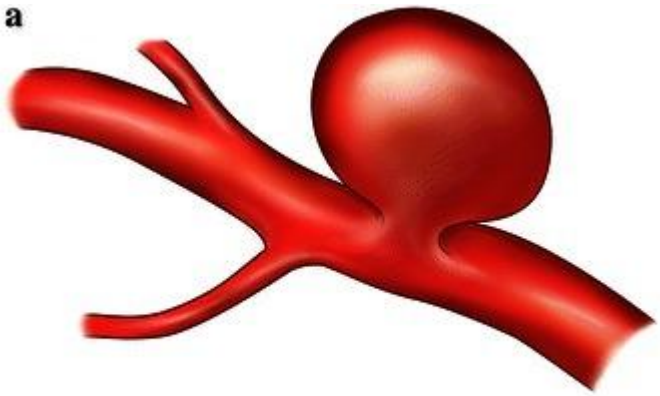
aneurysms can be classified (of no clinical significance)

Saccular aneurysms

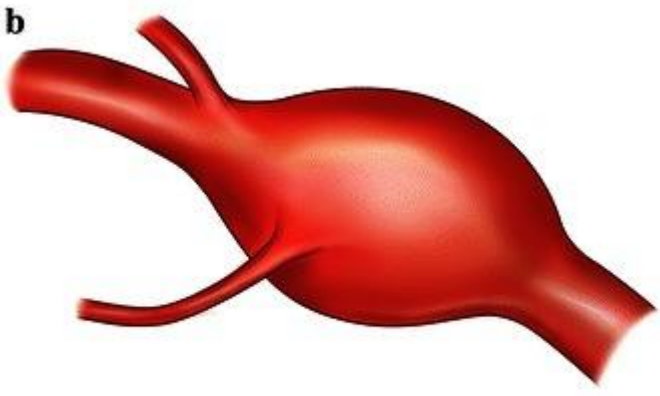
- spherical
- involving only a portion of the vessel wall
- vary in size from 5 to 20 cm in diameter
- partially or completely filled by thrombus.

Fusiform

- involving a long segment
- vary in diameter (up to 20 cm) and in length: many involve the entire ascending and transverse portions of the aortic arch, whereas others may involve large segments of the abdominal aorta or even the iliacs.



Saccular Aneurysm



Fusiform Aneurysm

ABDOMINAL AORTIC ANEURYSMS (AAA)

AAAs rarely develop before age 50 and are more common in men

Caused by

- Atherosclerosis (most common)

- genetic defects in a connective tissue component responsible for the strength of the aorta can themselves produce aneurysms and dissections (Marfan syndrome)
-

Atherosclerotic aneurysm **affects mostly abdominal aorta; however it may involve** common iliac arteries, the arch, and descending parts of the thoracic aorta

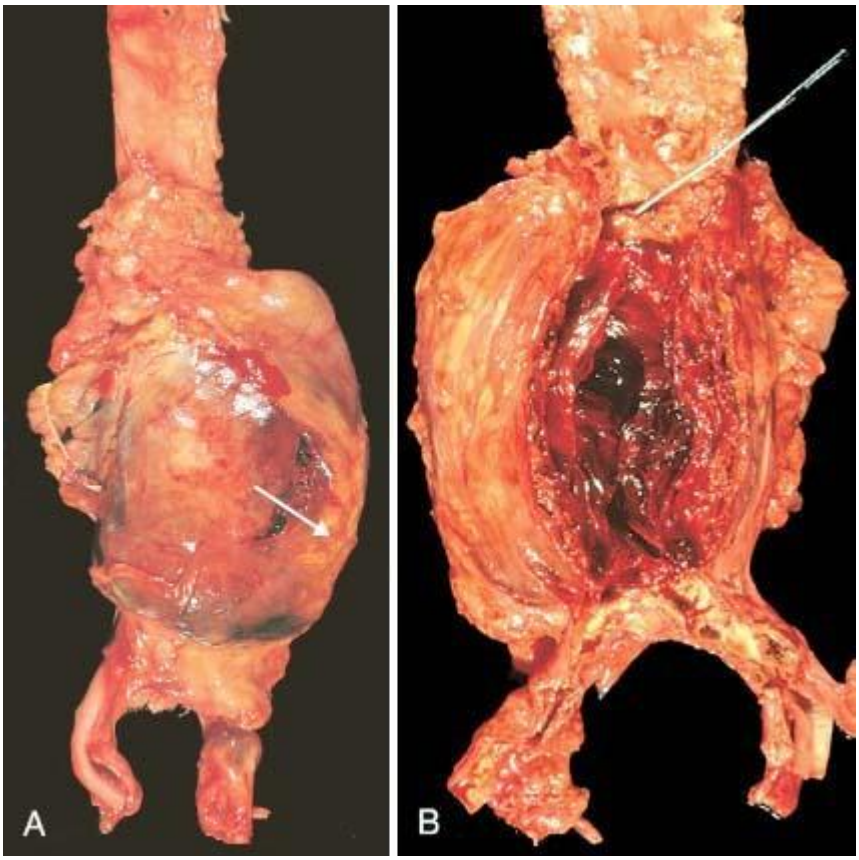
Morphology

below the renal arteries and above the bifurcation of the aorta

saccular or fusifrom

up to 15 cm in diameter

up to 25 cm in length



Inflammatory abdominal aortic aneurysms are characterized by dense periaortic fibrosis containing an abundant, inflammatory reaction rich in lymphocytes and plasma cells with many macrophages and often giant cells. Their cause is uncertain.

Mycotic abdominal aortic aneurysms are atherosclerotic AAAs that have become infected by lodgment of circulating organisms in the wall, particularly in bacteremia from a primary *Salmonella* gastroenteritis.

The clinical consequences of AAAs include:

- Rupture into the peritoneal cavity or retroperitoneal tissues with massive, potentially fatal, hemorrhage
- Obstruction of a vessel, particularly of the iliac, renal, mesenteric, or vertebral branches that supply the spinal cord leading to ischemic tissue injury
- Embolism from atheroma or mural thrombus
- Impingement on an adjacent structure, such as compression of a ureter or erosion of vertebrae
- Presentation as an abdominal mass (often palpably pulsating) that simulates a tumor

SYPHILITIC (LUETIC) ANEURYSMS

- A complication of endarteritis obliterance seen in tertiary syphilis.
- Affects the thoracic aorta

Clinical features are due to:

(1) Compression of mediastinal structures

(2) Respiratory difficulties due to compression of the lungs and airways,

(3) Difficulty in swallowing due to compression of the esophagus,

(4) Persistent cough due to irritation of or pressure on the recurrent laryngeal nerves,

(5) Pain caused by erosion of bone (i.e., ribs and vertebral bodies),

(6) Aortic valve dilation with valvular insufficiency or narrowing of the coronary ostia causing myocardial ischemia,

(7) Rupture.

Most patients with syphilitic aneurysms die of heart failure induced by aortic valvular incompetence.