CARDIOVASCULAR SYSTEM

Pathology Practical

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NORMAL ANATOMY AND HISTOLOGY

Objectives:

At the end of the practical sessions of the cardiovascular block, the medical students will be able to:

- Identify the morphologic gross features of:
  - Chronic venous congestion of the liver.
  - Myocardial Infarction.
  - Vegetations of rheumatic mitral and aortic valves.
  - Left ventricular hypertrophy (LVH).
  - Aneurysm of abdominal aorta (AAA).
  - Atheroma of aorta.

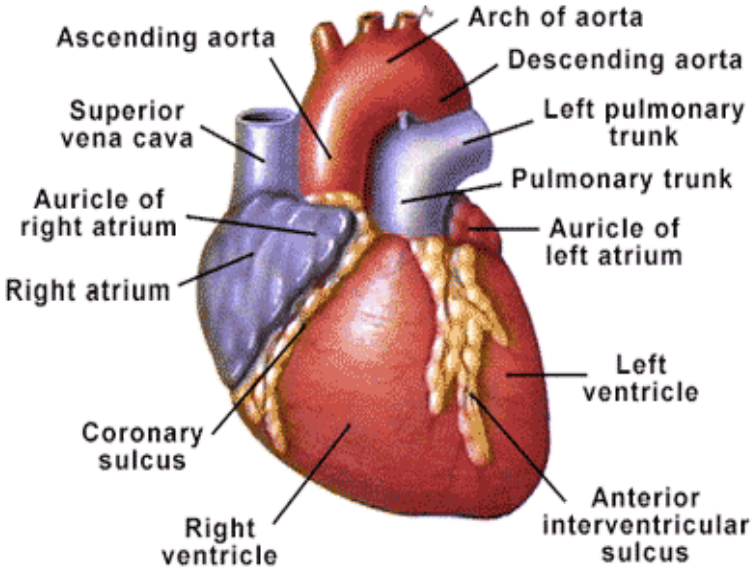
Objectives:

- Identify the morphologic histopathological features of:
  - Chronic venous congestion of the LIVER
  - Chronic venous congestion of the LUNG
  - Acute rheumatic myocarditis
  - Rheumatic valvulitis
  - Coronary atherosclerosis
  - Thromboangitis obliterans
  - Giant cell arteritis and leukocytoclastic vasculitis.

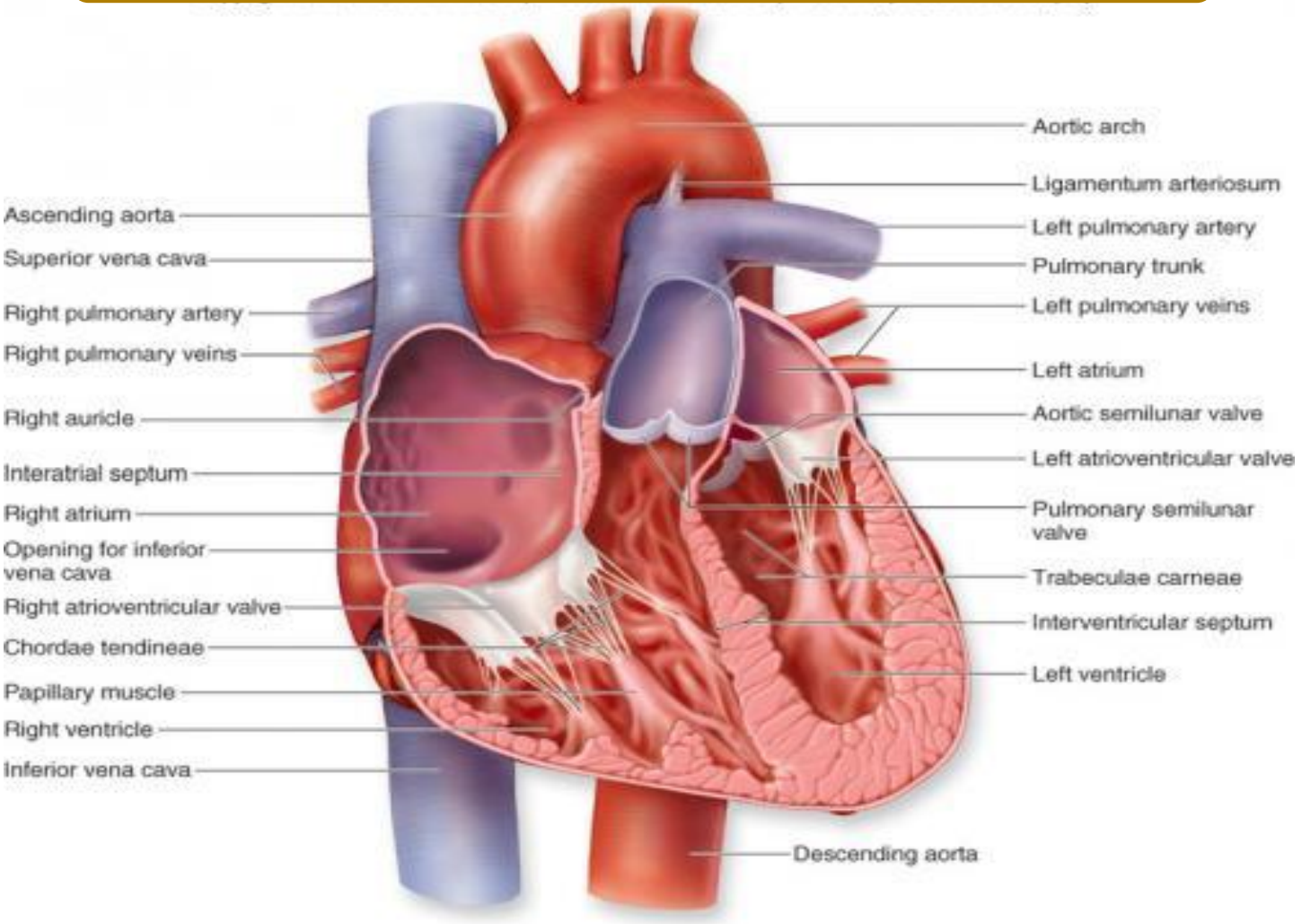
Anatomy of the Heart

- The heart serves as a **mechanical pump** to supply the entire body with blood, both providing nutrients and removing waste products.
- The great vessels exit the *base* of the heart.
- Blood flow:

  body→ sup & inf venae cava → right atrium→ right ventricle→ lungs → left atrium → left ventricle→ Aorta → body



Anatomy of the Heart – inside view

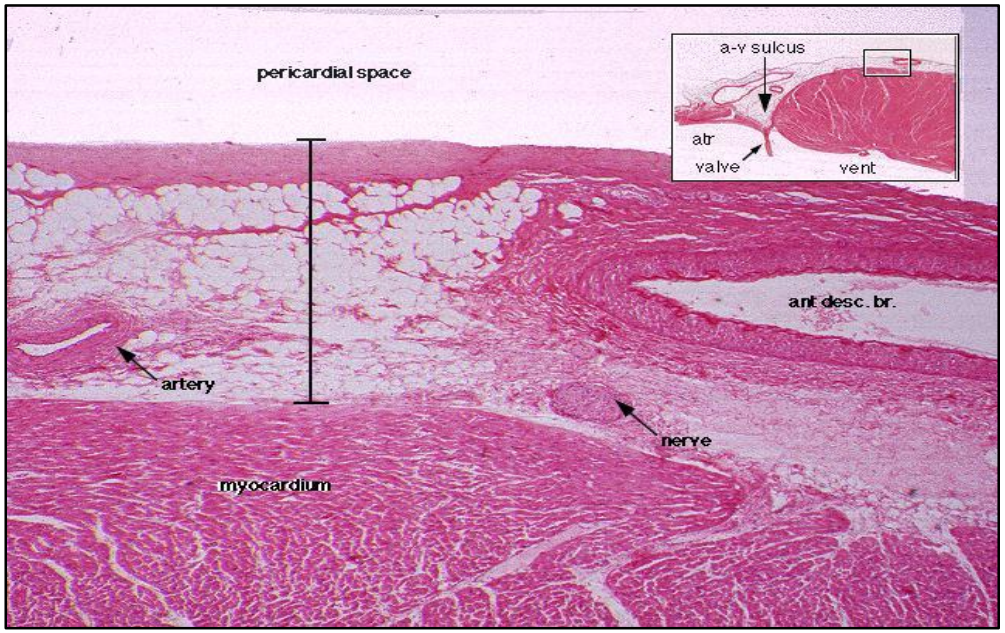


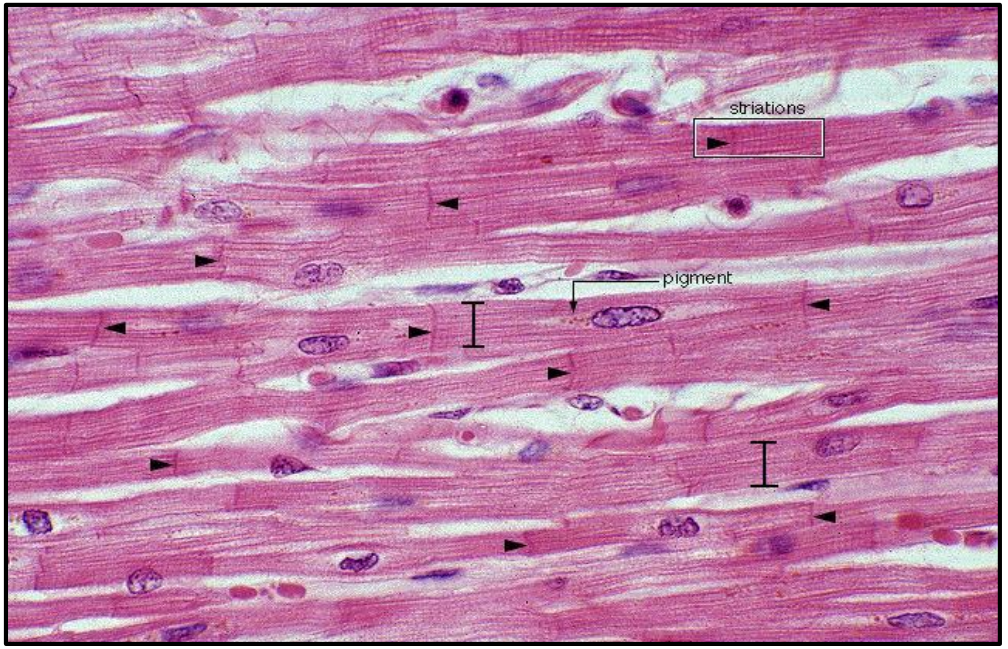
Histology of the Heart

- The heart consists of 3 layers
  - the **Endocardium,**
  - the **Myocardium,** and
  - the **Pericardium.**

- The **Pericardium** consists of arteries, veins, nerves, connective tissue, and variable amounts of fat.

- The **Myocardium** contains **branching, striated muscle cells with centrally located nuclei.** They are connected by **intercalated disks** (arrowheads).





PRACTICAL – 1

AORTIC ATHEROSCLEROSIS

ATHEROMA OF THE AORTA

- **An atheroma** *is a swelling in arterial walls and accumulation made up of:*
  - *(mostly) macrophages*
  - *debris*
  - *lipids (cholesterol and fatty acids)*
  - *calcium*
  - *variable amount of fibrous connective tissue.*

- ***The four major risk factors are:***
  - *Hyperlipidemia*
  - *Hypertension*
  - *Diabetes*
  - *Cigarette smoking*
  - *Obesity*

Atheroma of the Aorta - Gross

Gross views of atherosclerosis in the aorta.

Mild atherosclerosis composed of fibrous plaques

Severe disease with diffuse and complicated lesions including an ulcerated plaque

Atheroma of the Aorta - Gross

Severe atherosclerosis of the aorta:

The atheromatous plaques have undergone ulceration along with formation of overlying mural thrombus.

Atheroma of the Aorta - Gross

Complications:

*Thrombosis *Hemorrhage *Calcifications

*Aneurysmal dilatation with the distal ischemic events.

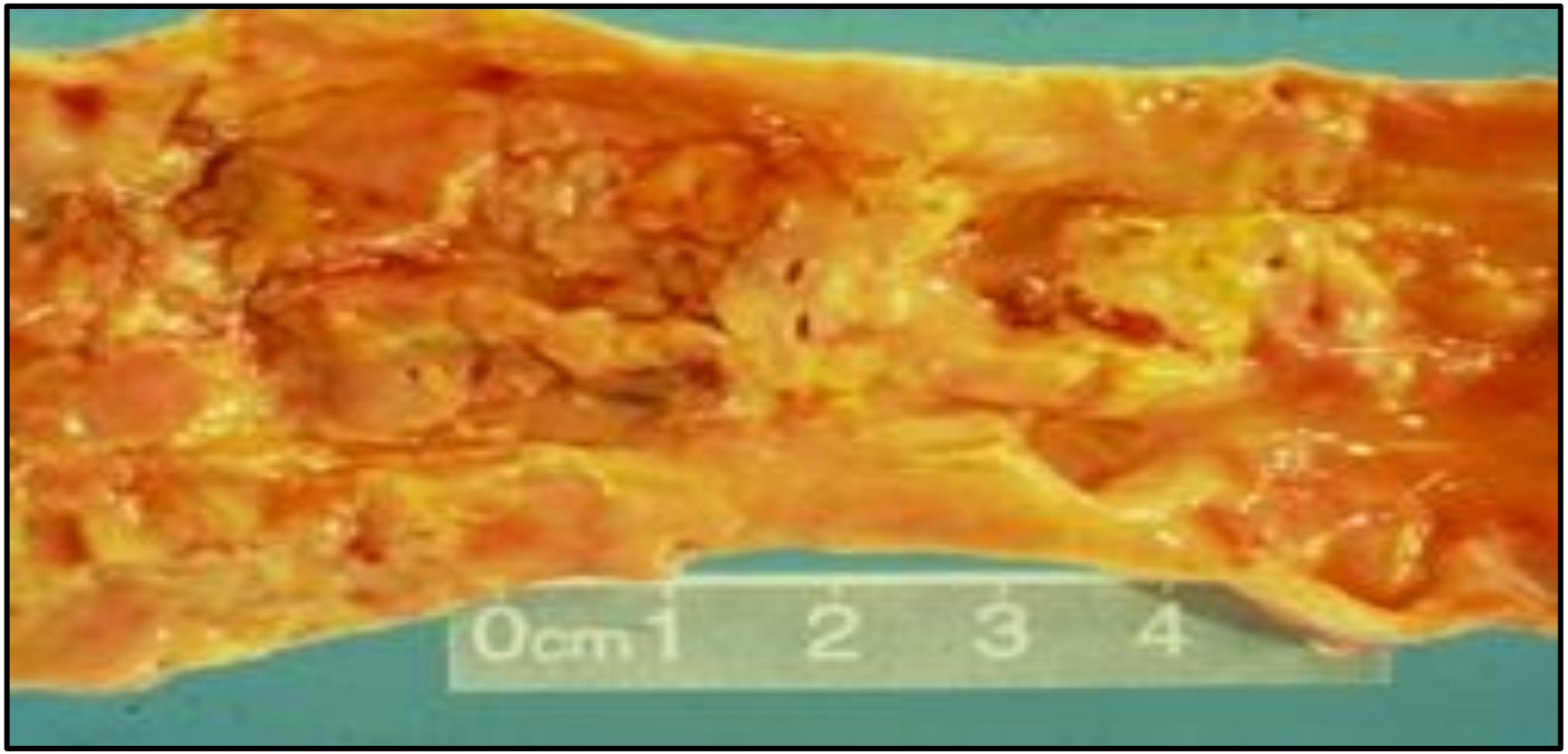
Atheroma of the Aorta - Gross

Aorta: complicated atheromatous plaques

Note the fissured-appearing endothelial surface and raised plaque-like structures from the surface.

Red clot material is adherent to the plaques in multiple areas. These clots consist of platelets held together by fibrin strands.

Atheroma of the Aorta - Gross



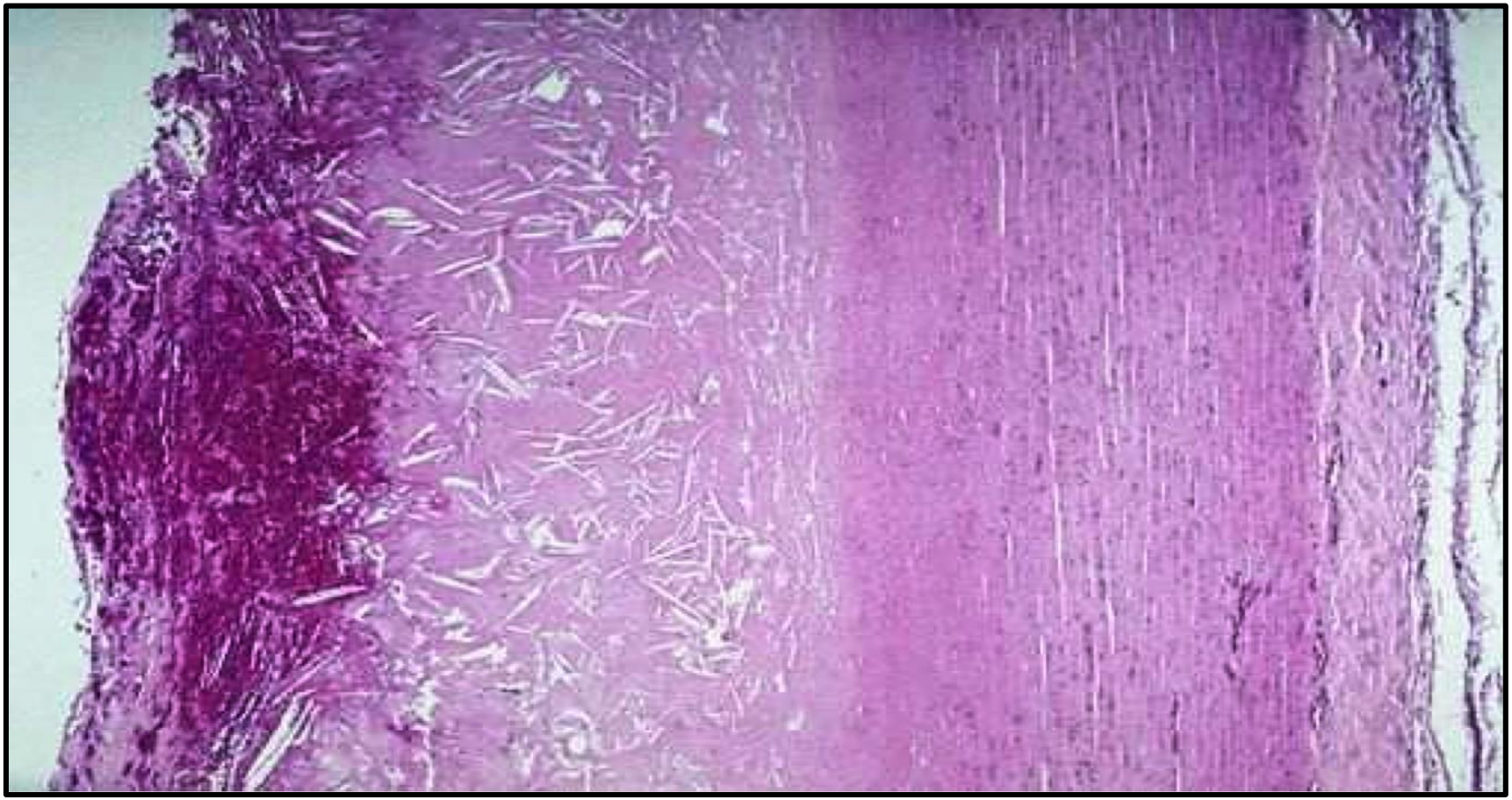
Aorta: complicated atheromatous plaques

Note the raised yellow plaques and the fissures in between the plaques. Dystrophic calcification is likely present as well

Atheroma of the Aorta - Gross

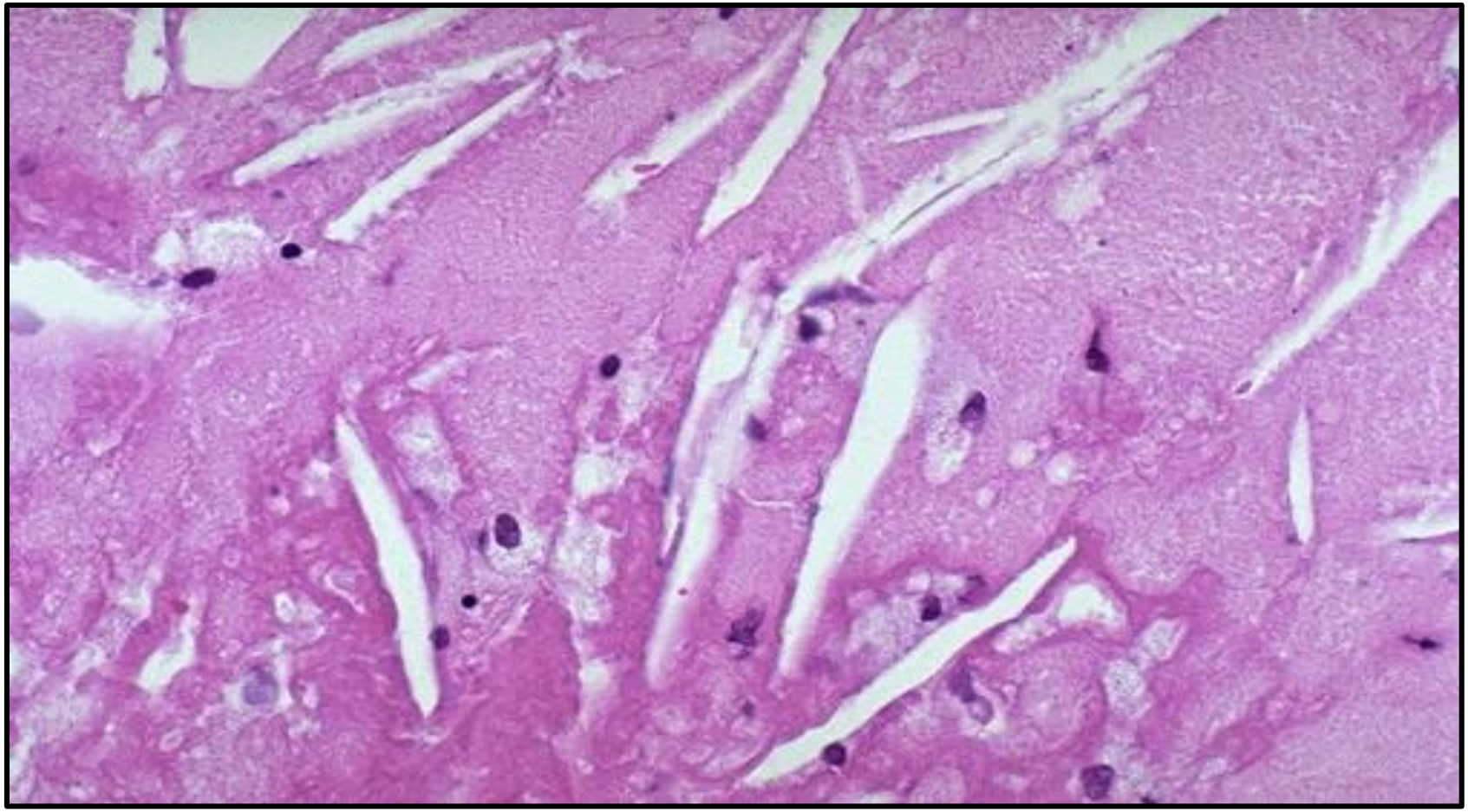
These three aortas demonstrate mild, moderate, and severe atherosclerosis from bottom to top. At the bottom, the mild atherosclerosis shows only scattered lipid plaques. The aorta in the middle shows many more larger plaques. The severe atherosclerosis in the aorta at the top shows extensive ulceration in the plaques.

Atheroma of the Aorta - LPF



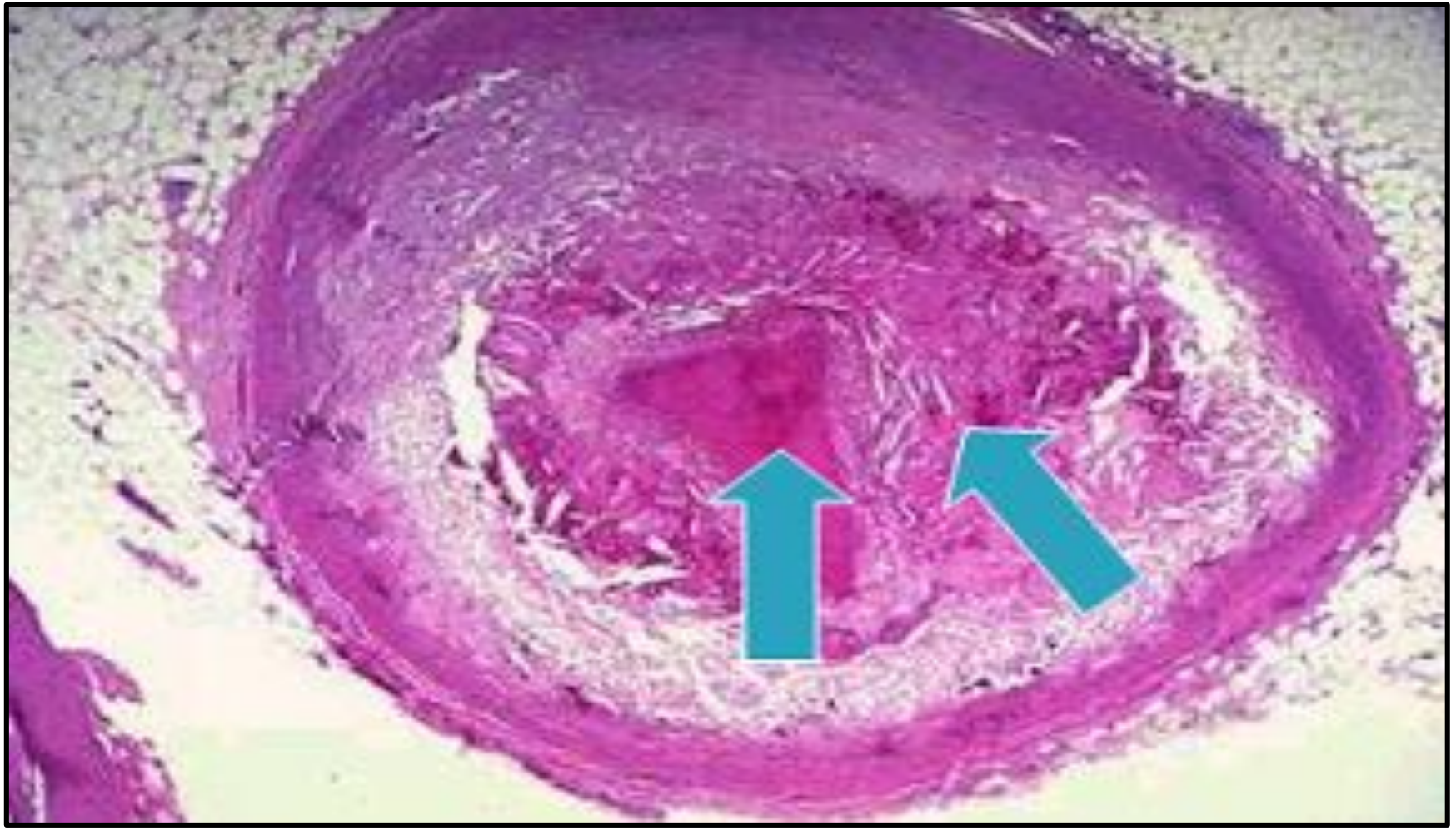
This microscopic cross section of the aorta shows a large overlying atheroma on the left. Cholesterol clefts are numerous in this atheroma. The surface on the far left shows ulceration and hemorrhage. Despite this ulceration, atheromatous emboli are rare

Atheroma of the Aorta



A high magnification of the aortic atheroma with foam cells and cholesterol clefts.

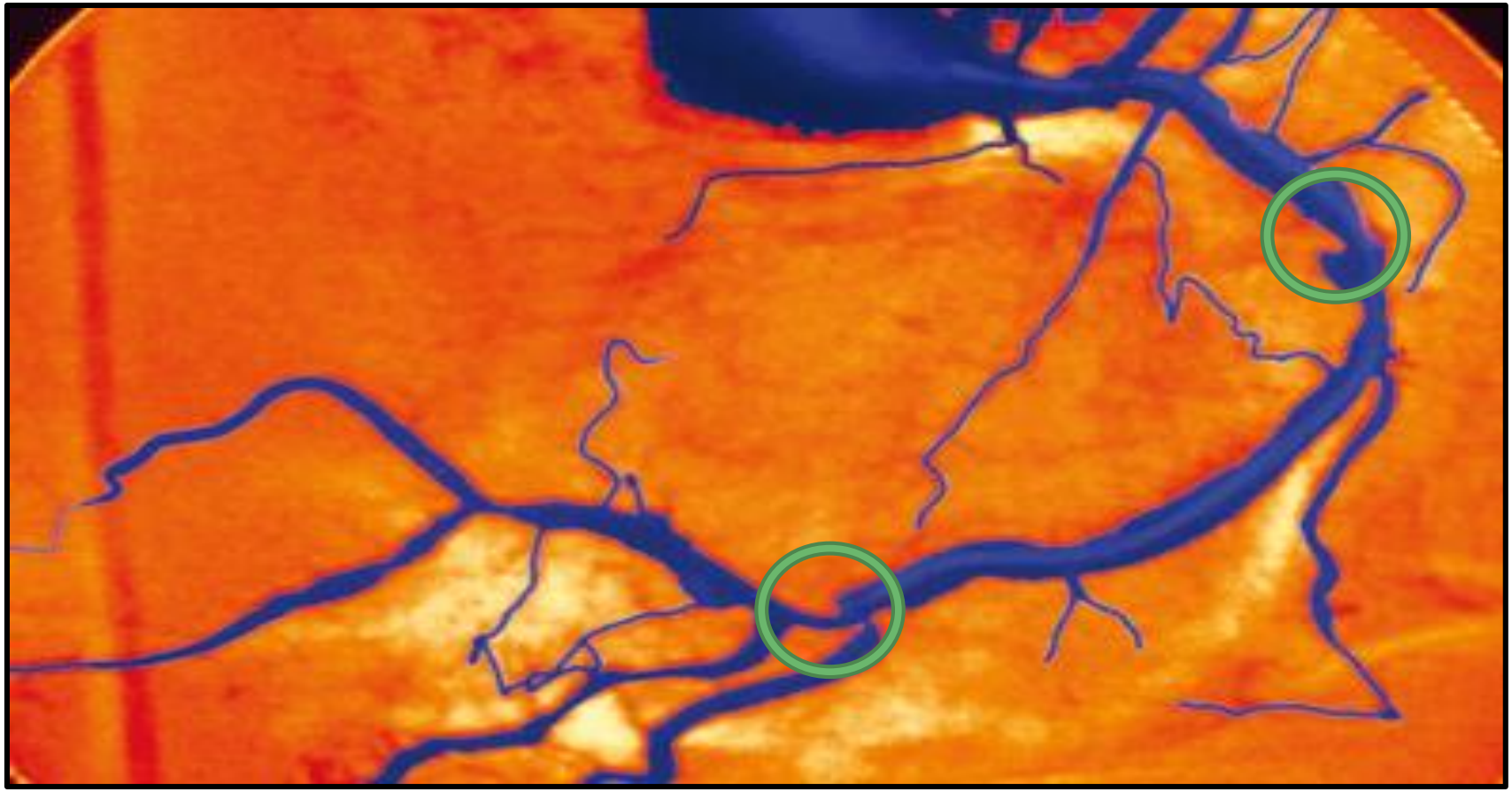
Atheroma of the Aorta - MPF



Aortic Atheroma with Thrombosis

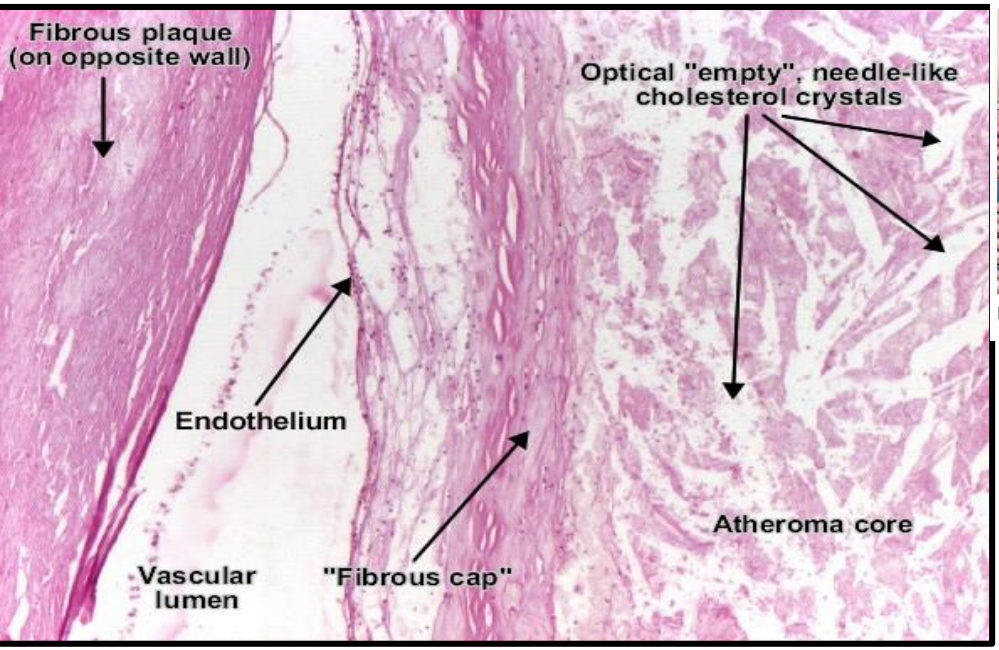
CORONARY ATHEROSCLEROSIS

Coronary Atherosclerosis - Gross



Coronary atherosclerosis. Coloured angiogram (X- ray) showing atherosclerosis in a coronary artery. The atherosclerosis is seen as the pinching in the blue- coloured artery at bottom centre

Coronary atherosclerosis - LPF



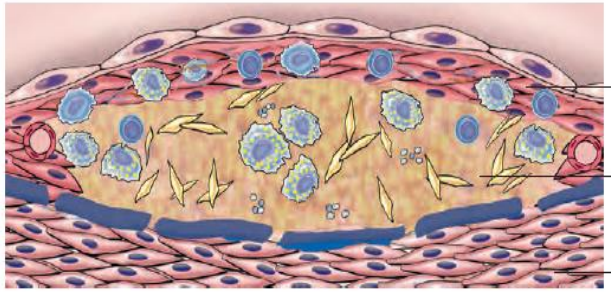
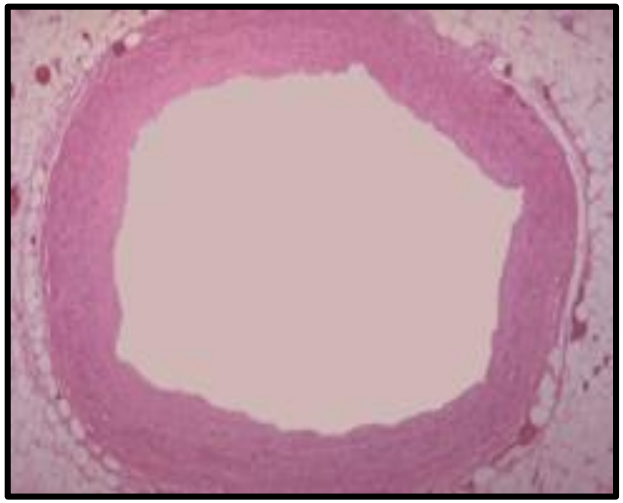


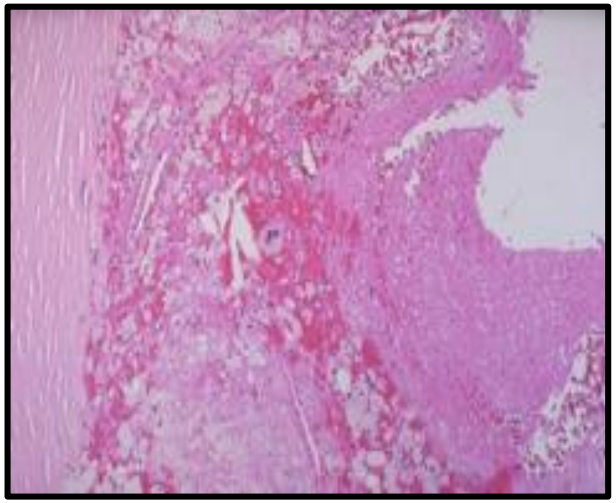
Figure 11-7 Basic structure of an atherosclerotic plaque. Note that atherosclerosis is an intimal-based process.

Coronary artery with atherosclerosis (fibro-lipid plaque). The atheromatous fibro-fatty plaque is characterized by the accumulation of lipids in the intima of the arteries, narrowing the lumen. Beneath the endothelium it has a "fibrous cap" covering the atheromatous "core" of the plaque, which consists in cholesterol crystals, cholesterol esters, fibrin, macrophages and smooth muscle cells, proteoglycans, collagen, elastin and cellular debris.

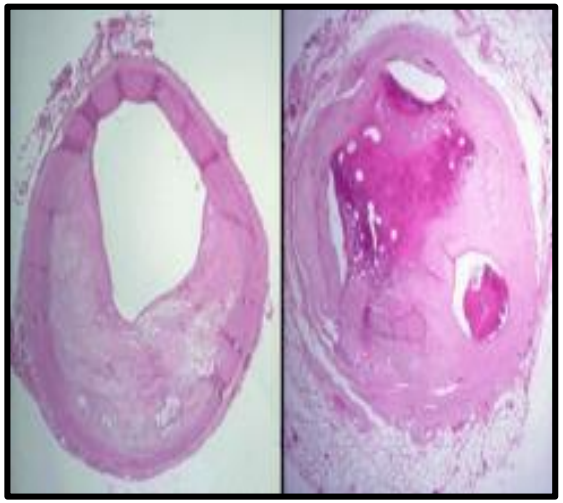
Coronary atherosclerosis - LPF



A normal coronary artery with no atherosclerosis and a widely patent lumen that can carry as much blood as the myocardium requires.

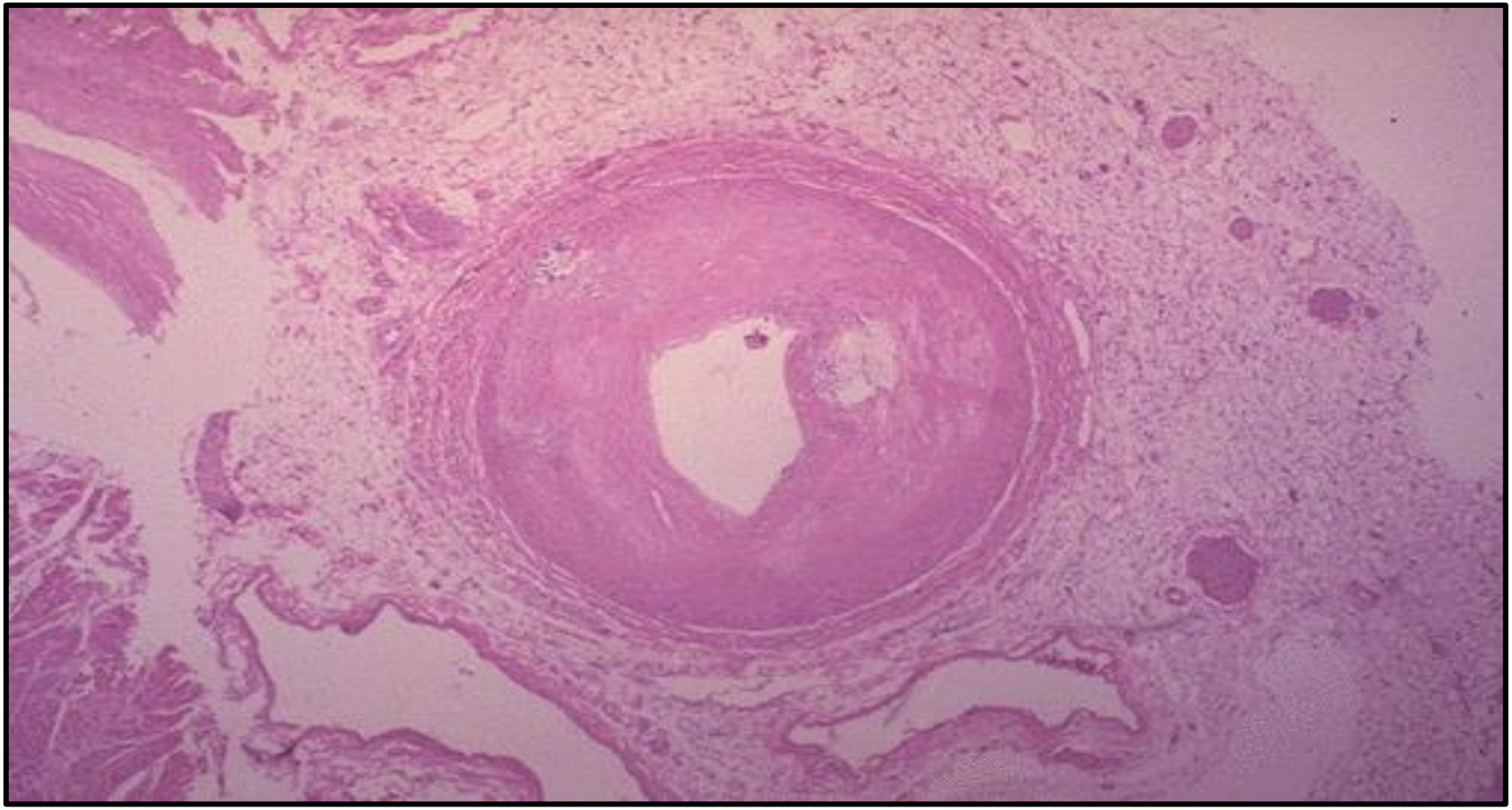


Atheromatous plaque in a coronary artery that shows endothelial denudation with disruption and overlying thrombus formation at the right. The arterial media is at the left



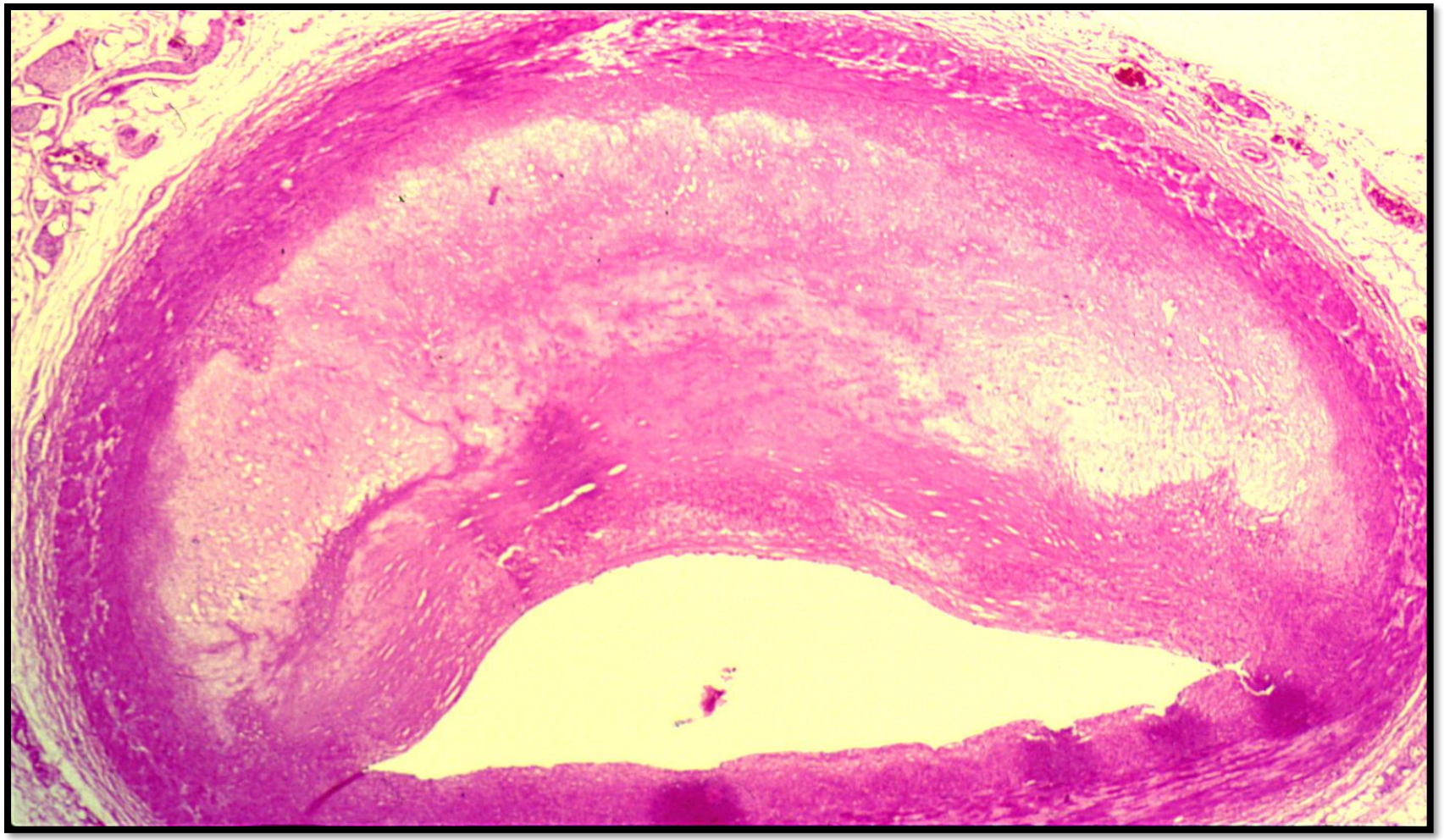
Occlusive coronary atherosclerosis. The coronary at the left is narrowed by 60 to 70%. The coronary at the right is even worse with evidence for previous thrombosis with organization of the thrombus

Coronary atherosclerosis - MPF



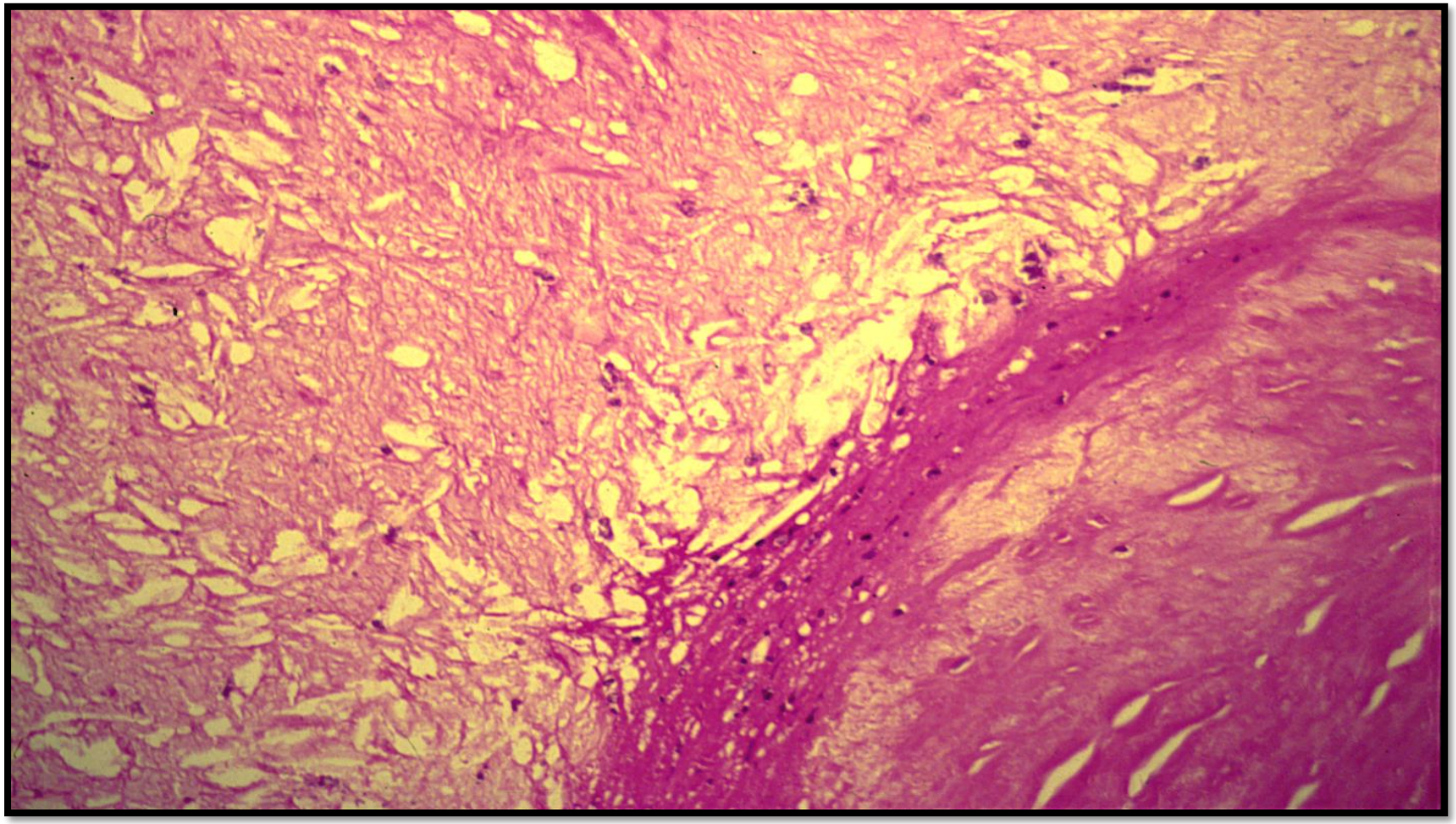
This distal portion of coronary artery shows significant narrowing. Such distal involvement is typical of severe coronary atherosclerosis, such as can appear with diabetes mellitus or familial hypercholesterolemia.

Coronary atherosclerosis - MPF



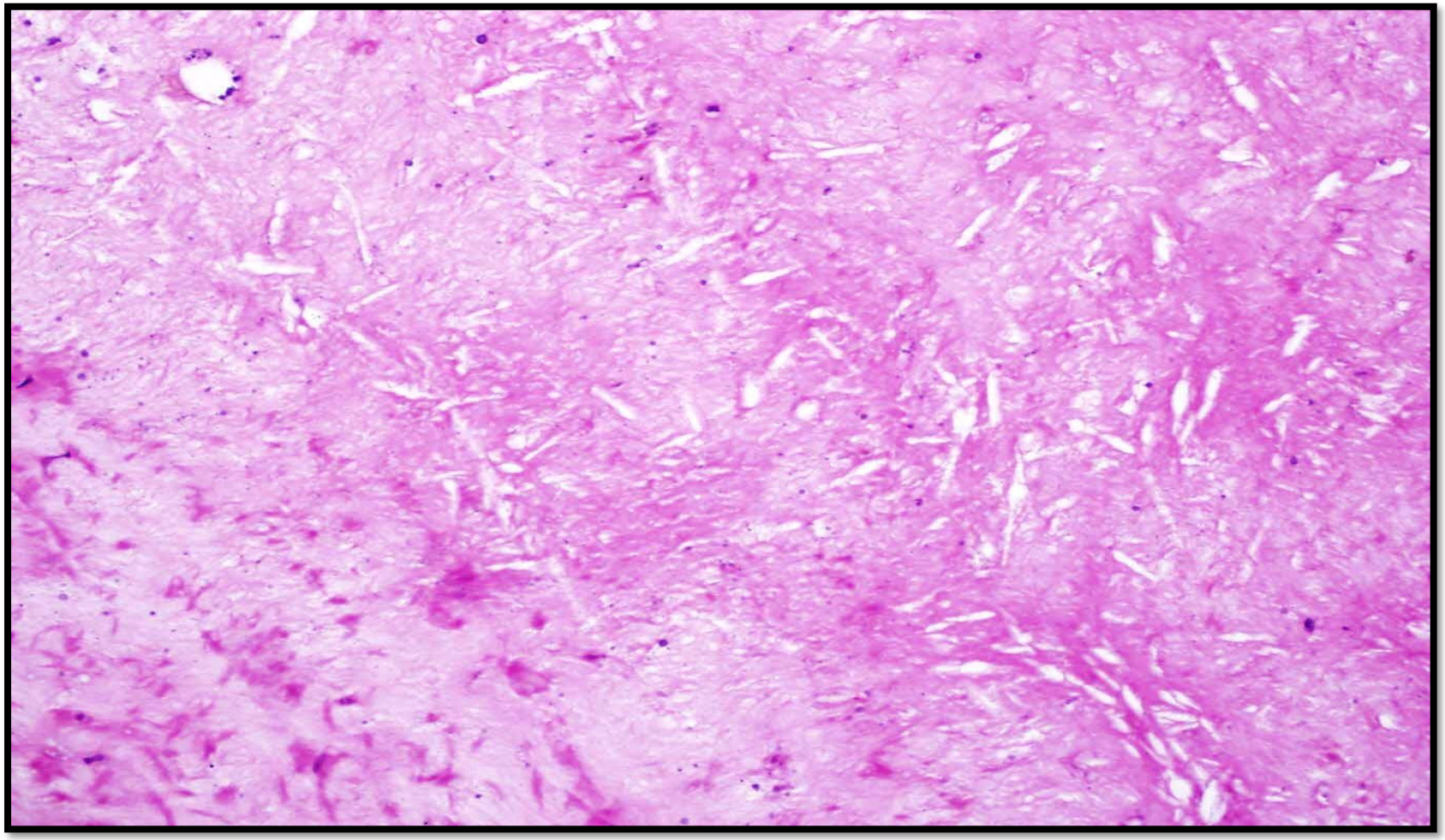
Severe coronary atherosclerosis with narrowing of the lumen

Coronary atherosclerosis - HPF



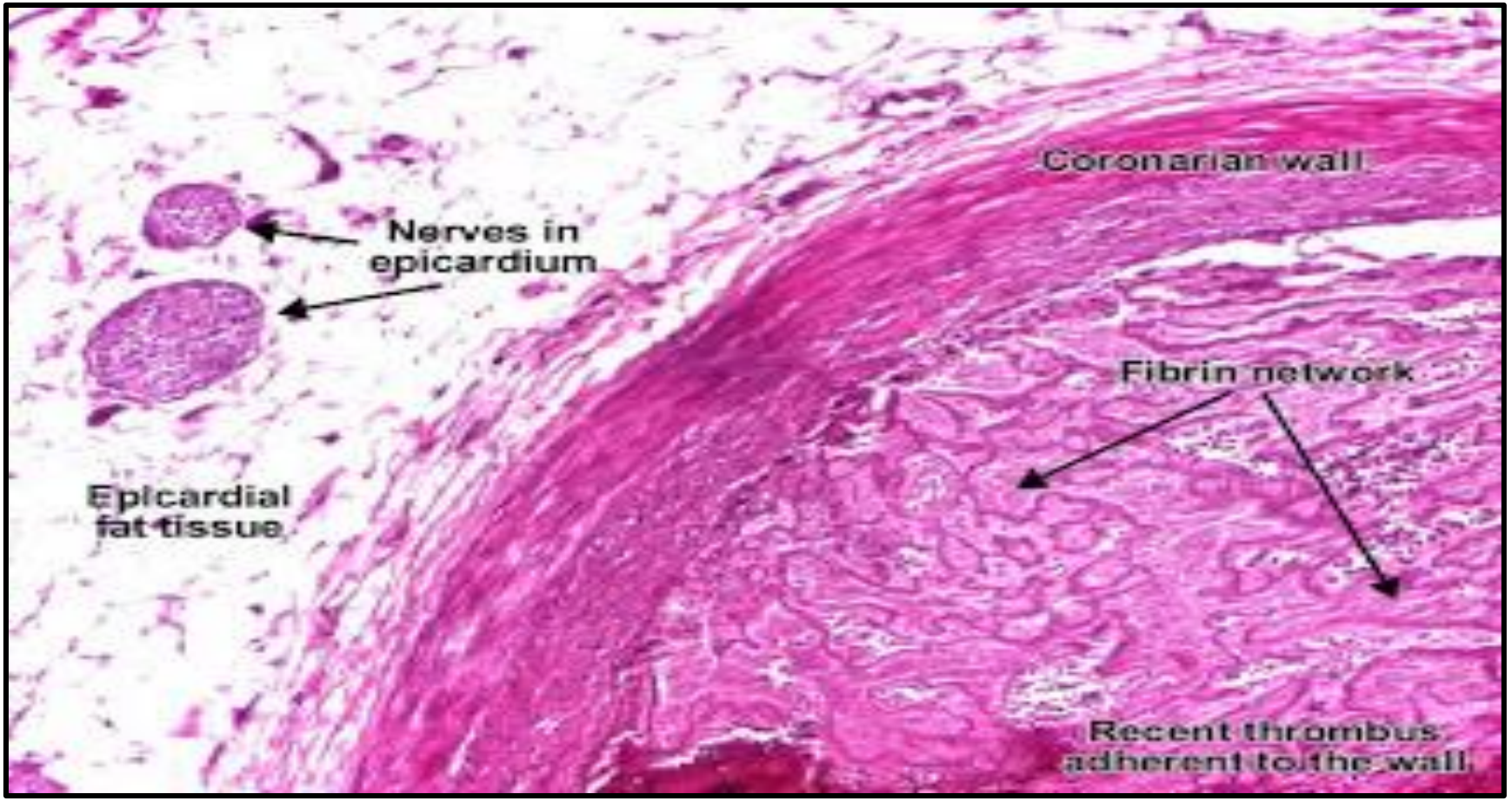
Partial occlusion of the lumen by an atheromatous plaque. The plaque consists of dissolved, cholesterol clefts, hyaline fibrous tissue and some blood capillaries.

Coronary atherosclerosis - HPF



The internal elastic lamina is thin and fragmented.
Pressure atrophy of the media opposition atheromatous plaque consists of cholesterol clefts, hyaline fibrous tissue and some blood capillaries.

Recent thrombus in a Coronary artery



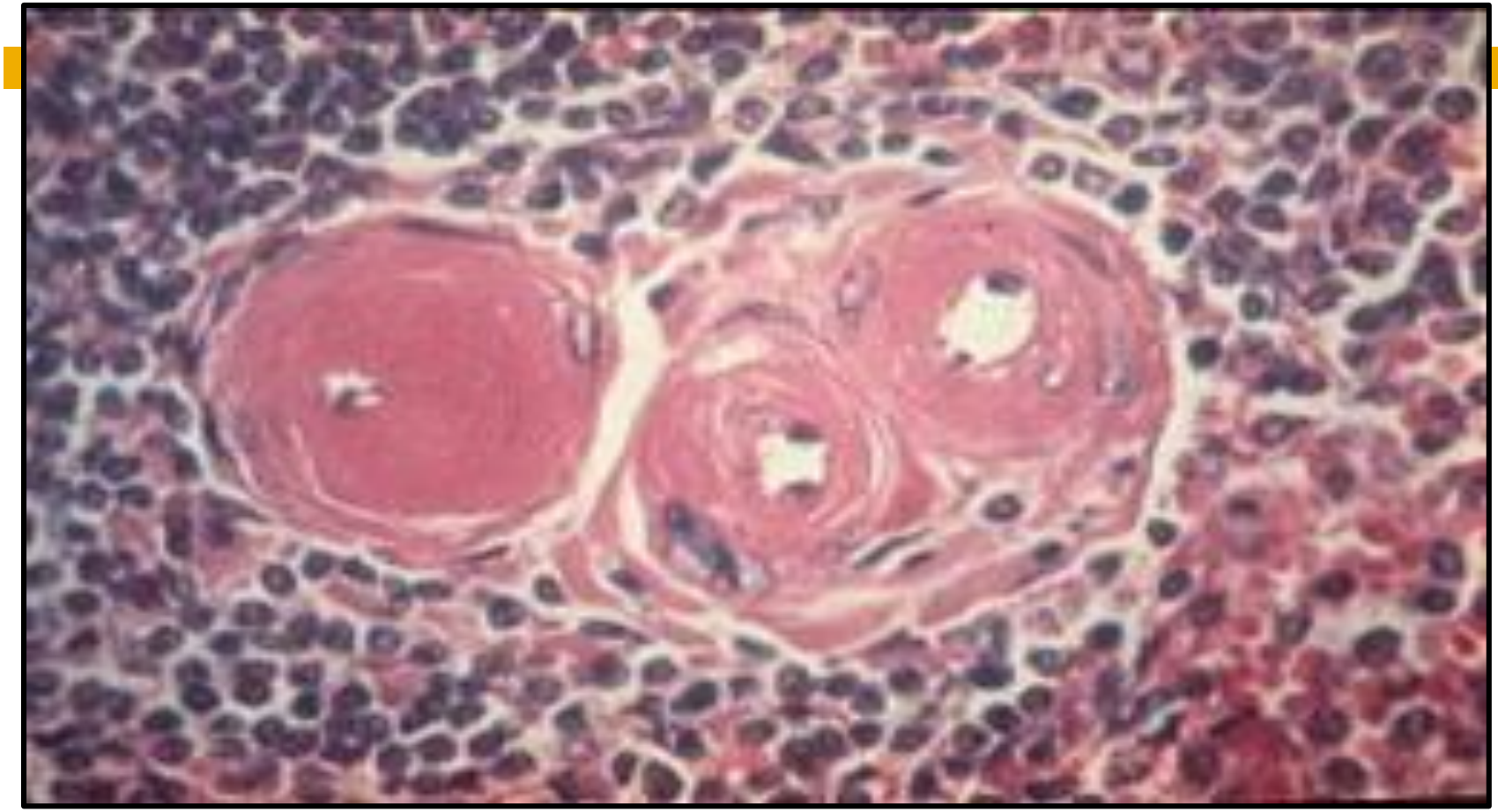
***Recent thrombus in a coronary artery**: The arterial lumen is completely obstructed by a recent thrombus - fibrin network (pink) containing red blood cells and platelets. The thrombus is developed on an ulcerated atherosclerotic (fibrous) plaque and is adherent to the arterial wall.*

Morphology of blood vessels in HTN:

In small Blood Vessels (Microangiopathy)

- Arteriolosclerosis
  - Hyaline arteriolosclerosis:
    - Seen in benign hypertension
    - Can also be seen in elderly and diabetic patients even without hypertension.
    - Can cause diffuse renal ischemia.
  - Hyperplastic arteriolosclerosis:
    - Characteristic of malignant hypertension.
    - Can show onion-skinning on histology causing luminal obliteration of vascular lumen

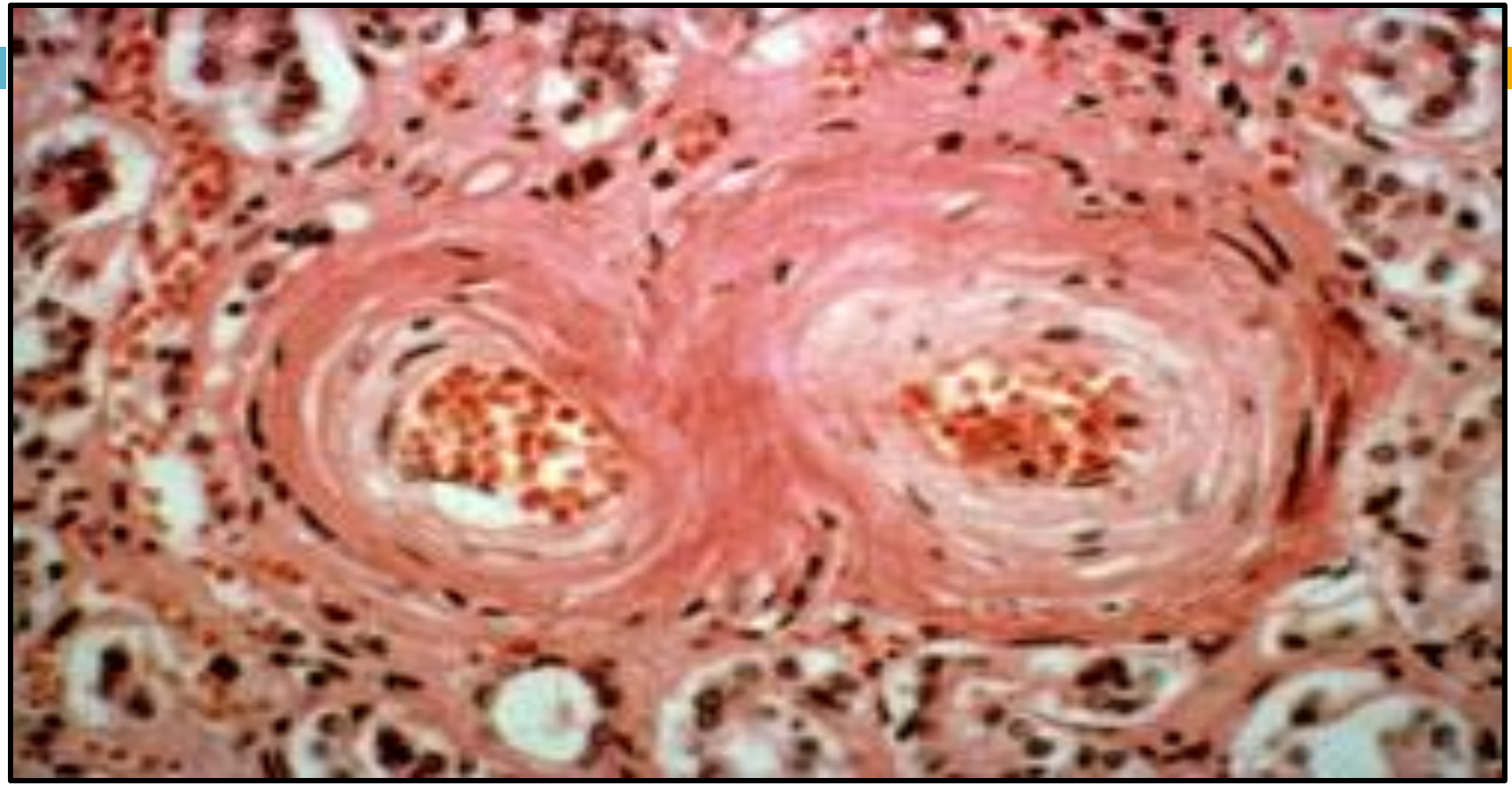
Hyaline arteriolosclerosis - HPF



Hyaline arteriolosclerosis

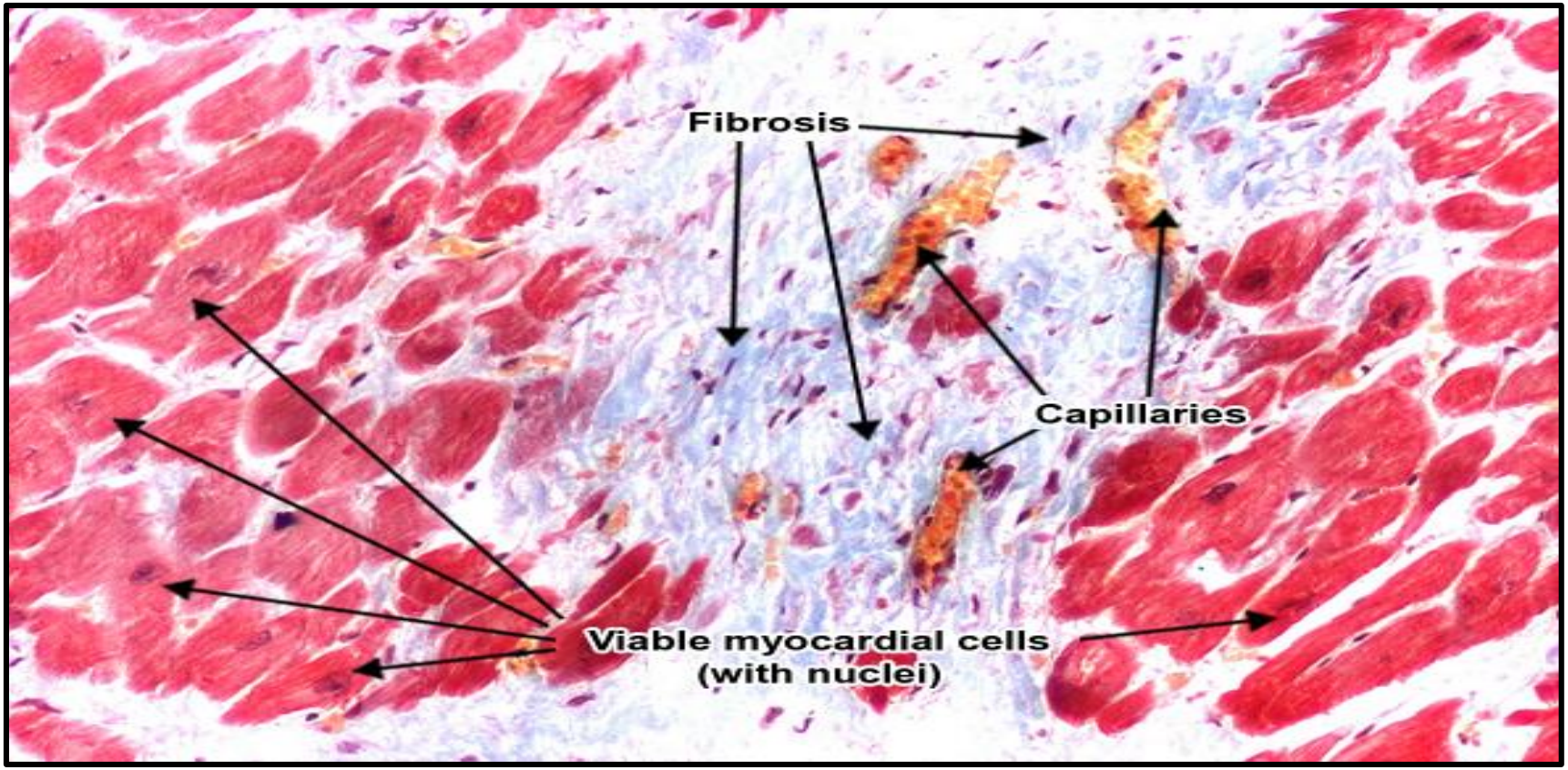
Arteriosclerosis (hardening of the arteries) involves both small and large vessels. It is commonly found in diabetics and hypertensives.

Hyperplastic arteriolosclerosis - HPF



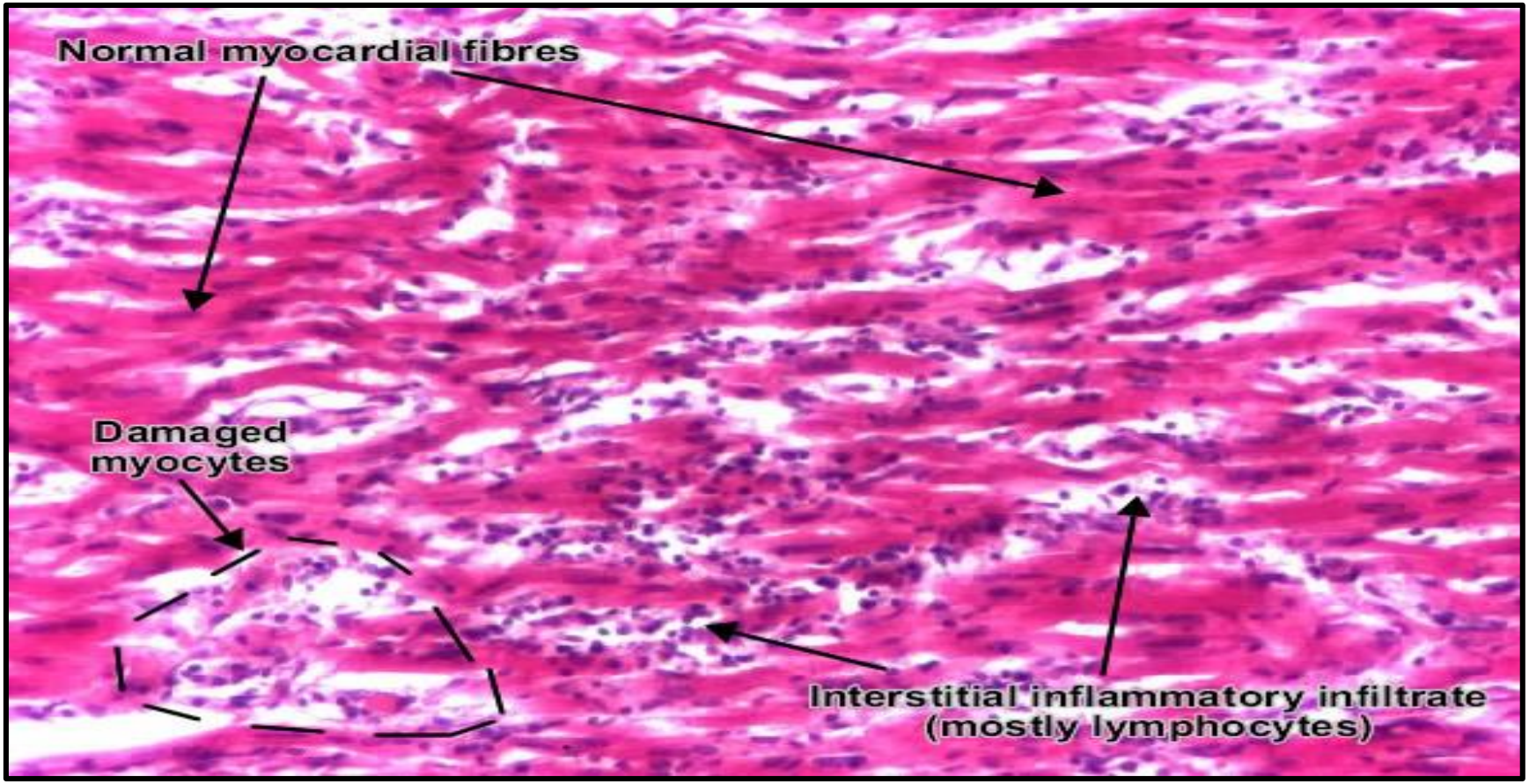
***Hyperplastic arteriolosclerosis**: This is the other type of small vessel arteriosclerosis. It is predominantly seen in **malignant** hypertension and renal disease associated with polyarteritis nodosa and progressive systemic sclerosis.*

Ischemic fibrosis of myocardium (diffuse ventricular myocardial fibrosis)



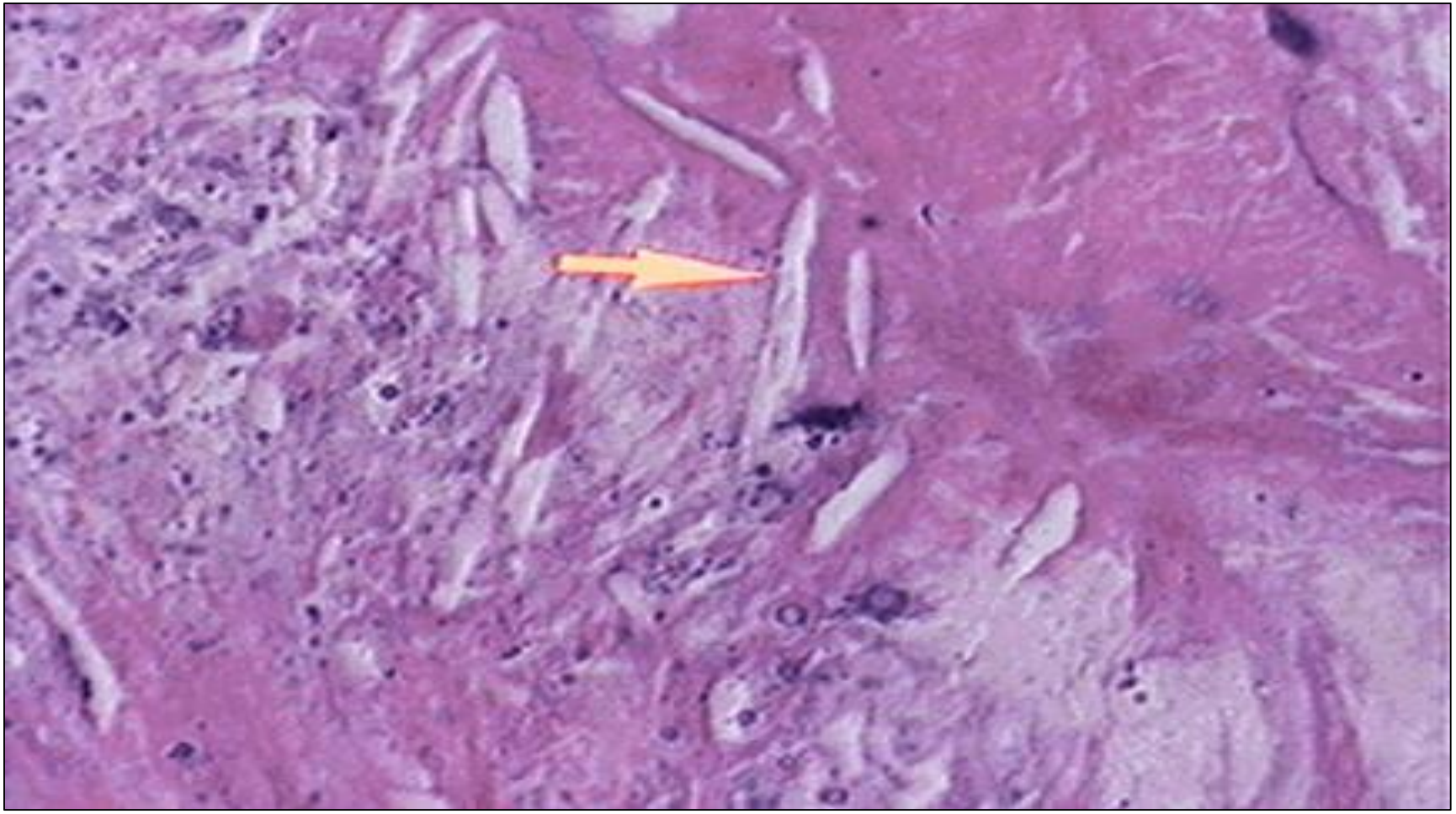
Diffuse myocardial fibrosis *(Ischemic fibrosis of the myocardium) Myocardial cells (red) intermingled with collagen-rich fibrosis (blue) which completely replaced the necrotic myocardial cells. Capillaries (with yellow-orange red blood cells) within fibrosis remained from repair by connective tissue process.*

Acute viral myocarditis - MPF



***Myocarditis** is an inflammation of the myocardium. Acute viral myocarditis is produced most often by Coxsackie B virus and echoviruses. Myocardial interstitium presents an abundant edema and inflammatory infiltrate, mainly with lymphocytes and macrophages.*

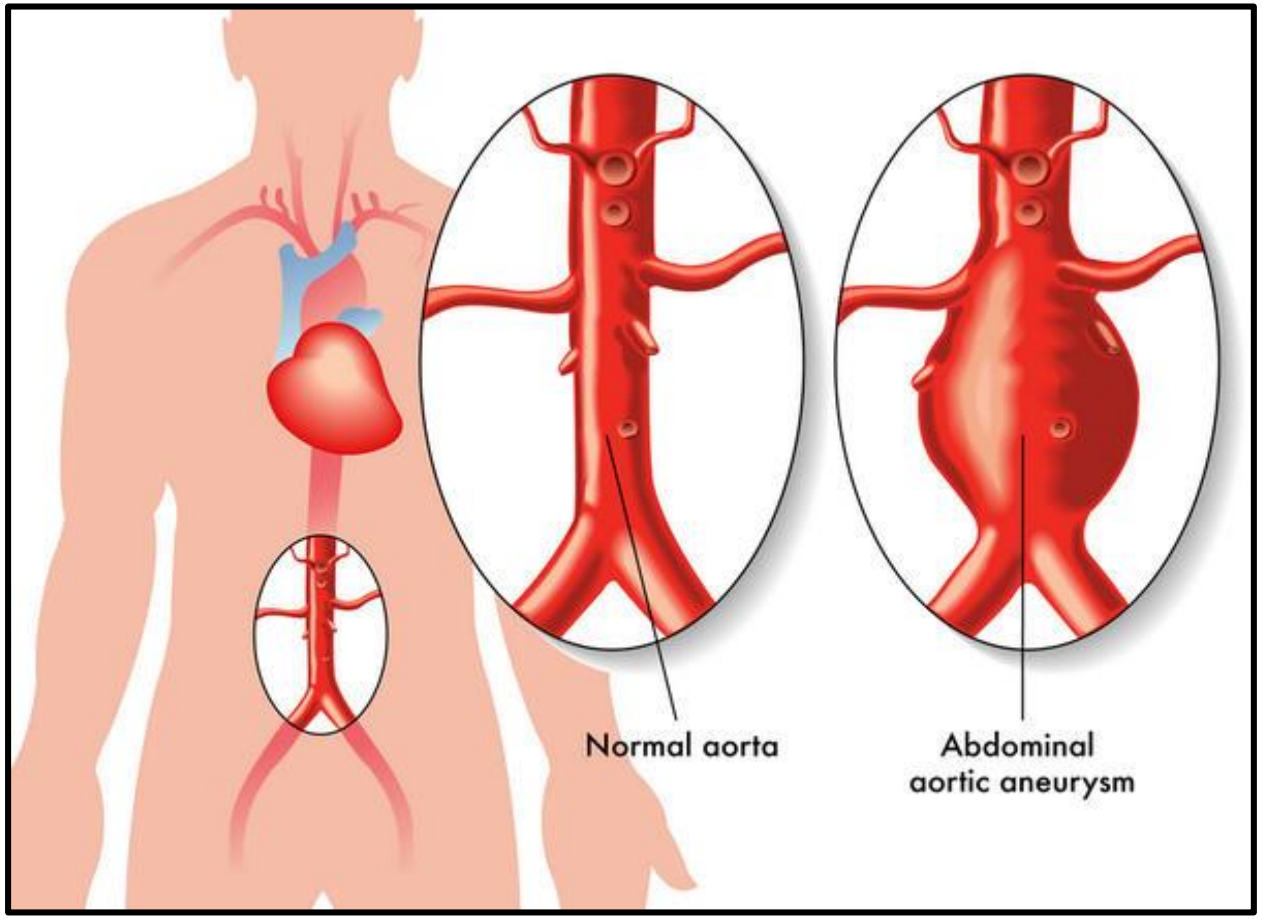
Aortic atherosclerosis - HPF



High power view of intimal aspect of atherosclerotic plaque showing stippling by blue calcific spherules, cholesterol crystal clefts, and fibrous cap.

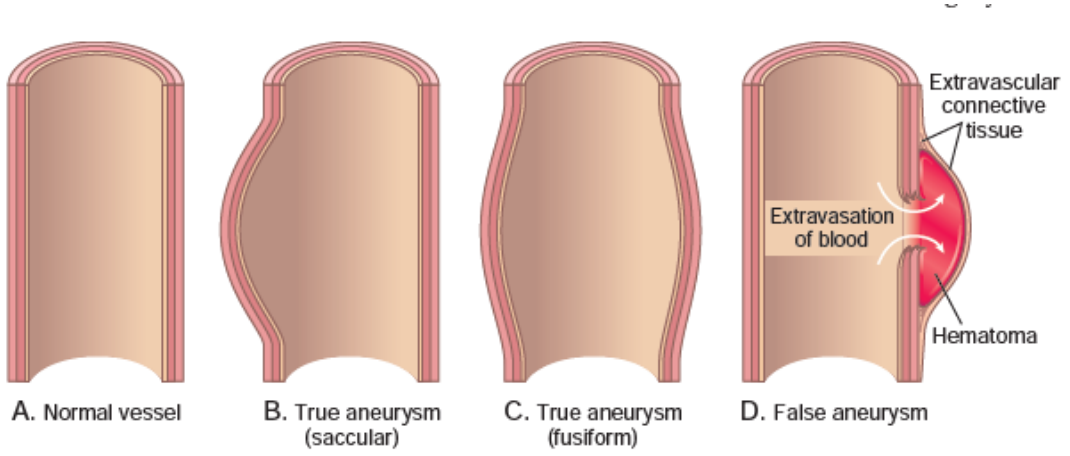
ANEURYSM OF ABDOMINAL AORTA

Abdominal Aortic Aneurysm



Aneurysm

- **Definition:**
  - An aneurysm is a localized abnormal dilation of a blood vessel
- It may be **congenital or acquired**
- **It is divided into:**
  - True aneurysm
  - False aneurysm "pulsating hematoma"



Abdominal Aortic Aneurysm (AAA)

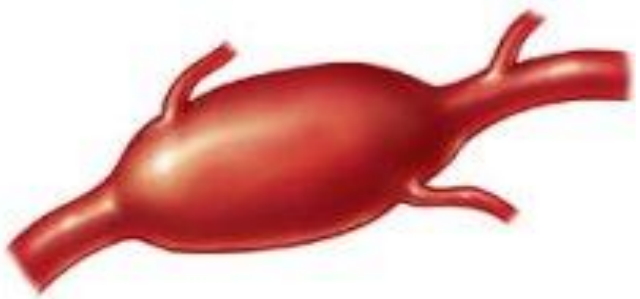
- Aneurysms is occurring as a consequence of atherosclerosis form most commonly in the abdominal aorta and common iliac arteries.
- AAAs occur more frequently in MEN and in SMOKERS, rarely developing before age 50.
- **Atherosclerosis (advanced)** is a major cause of AAA.
- Risk of rapture: is directly related to the size of the aneurysm:
  - < 4 cm: low risk of rapture
  - >4 cm: high risk of rapture

Abdominal Aortic Aneurysm (AAA)

- ***Clinical Features:***
  - Most cases of AAA are asymptomatic.
  - The other clinical manifestations of AAA include:
    - Rupture into the peritoneal cavity or retroperitoneal tissues with massive, potentially fatal hemorrhage.
    - Obstruction of a vessel branching off from the aorta, resulting in ischemic injury to the supplied tissue.
    - Embolism from atheroma or mural thrombus.
    - Compression of the ureter.

Types of Aneurysms

Saccular Aneurysm

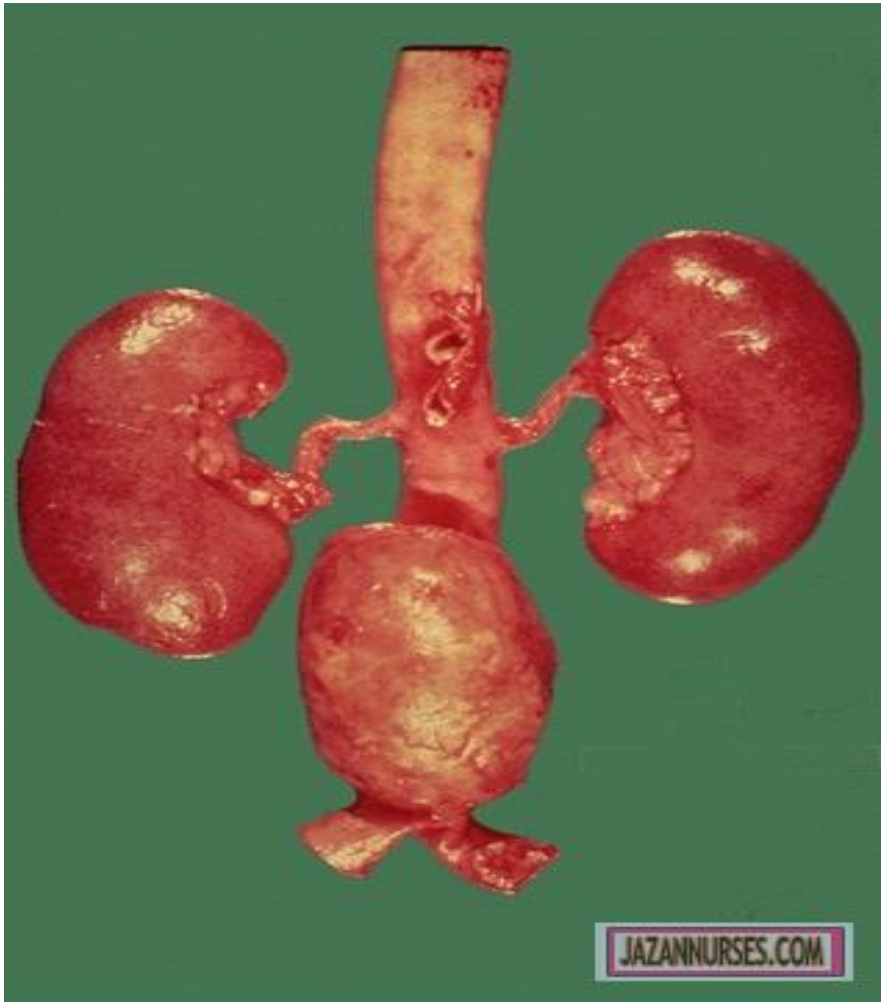


Fusiform Aneurysm

Ruptured Aneursym

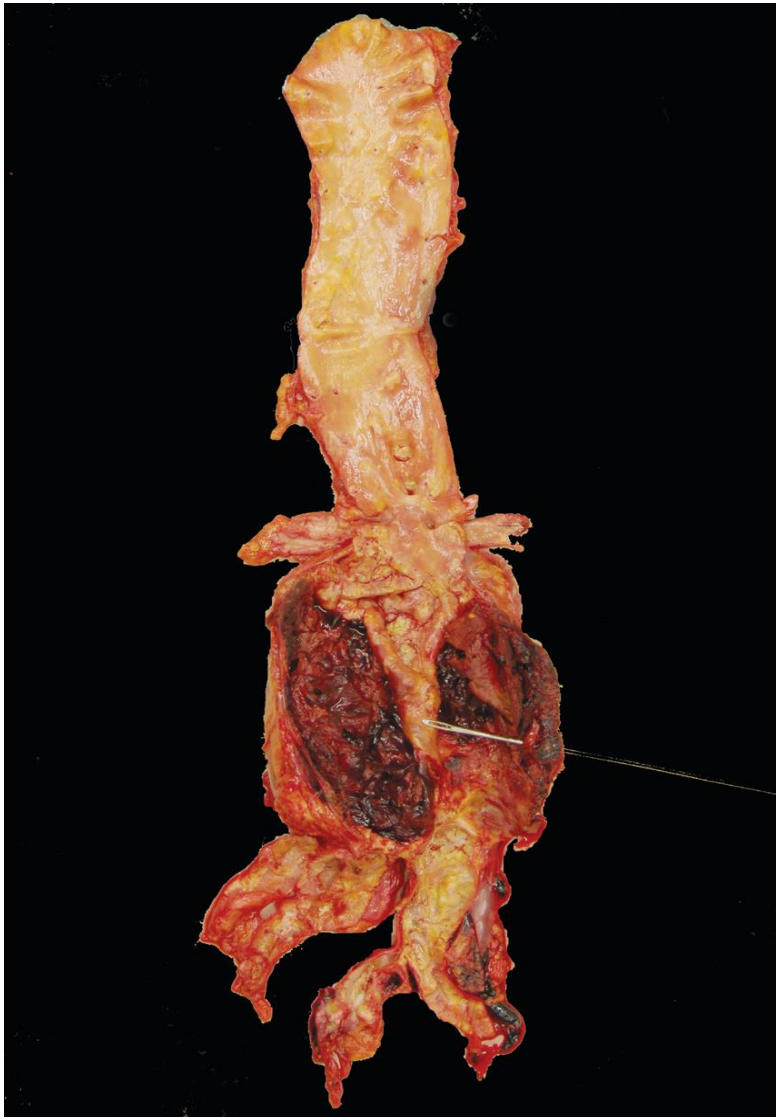
The most likely causes of aneurysms are atherosclerosis , mycotic, syphilitic and congenital

Abdominal Aortic Aneurysm



An example of an atherosclerotic aneurysm of the aorta in which a large "bulge" appears just above the aortic bifurcation.

Abdominal Aortic Aneurysm

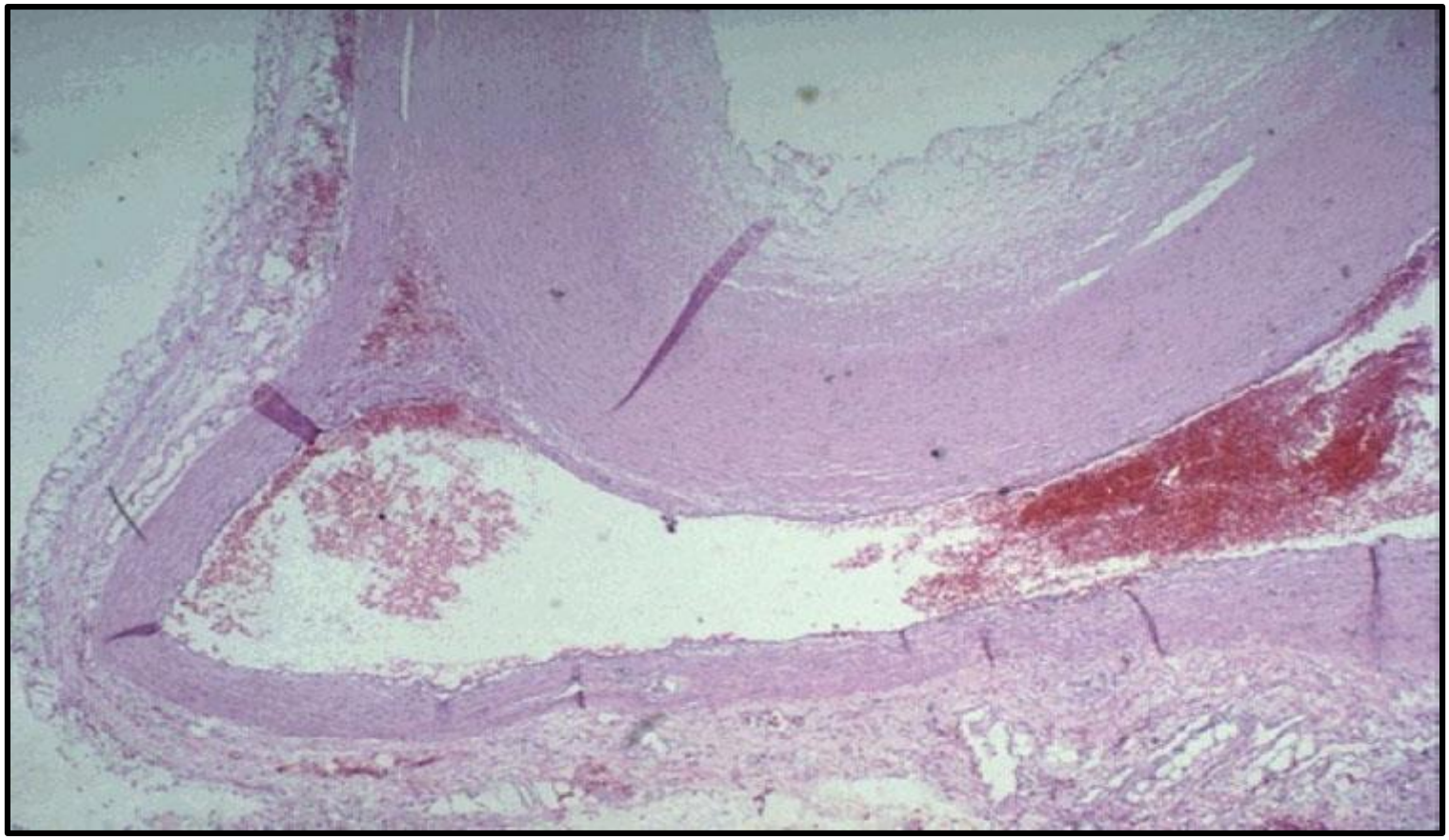


Abdominal aorta

Aneurysmal dilatation of the abdominal aorta with rupture , intraluminal thrombus and extensive aortic atherosclerosis .

The patient had suddenly developed severe abdominal pain, shocked and collapsed

Dissecting aortic aneurysm - LPF



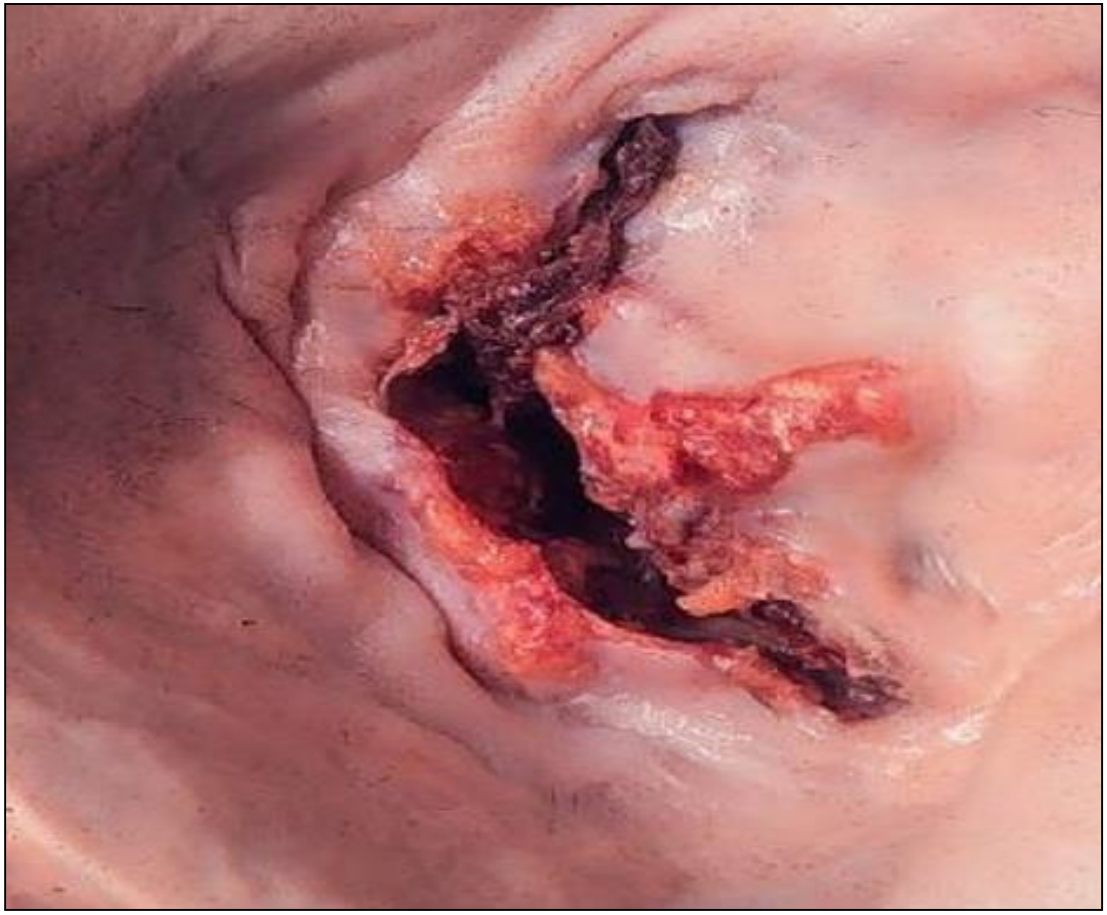
A dissecting aortic aneurysm occurs when blood enters the aortic wall through a defect and moves between two layers of the wall, stripping the inner layer from the outer layer. Usually associated with atherosclerosis, inflammation, and degeneration of the connective tissue of the tunica media

Vegetations of rheumatic fever on mitral and aortic valves

Chronic Rheumatic Mitral Valvulitis - Gross

large vegetations/hemorrhage along the free margins of the mitral valve.

Mitral stenosis secondary to rheumatic valvulitis- Gross



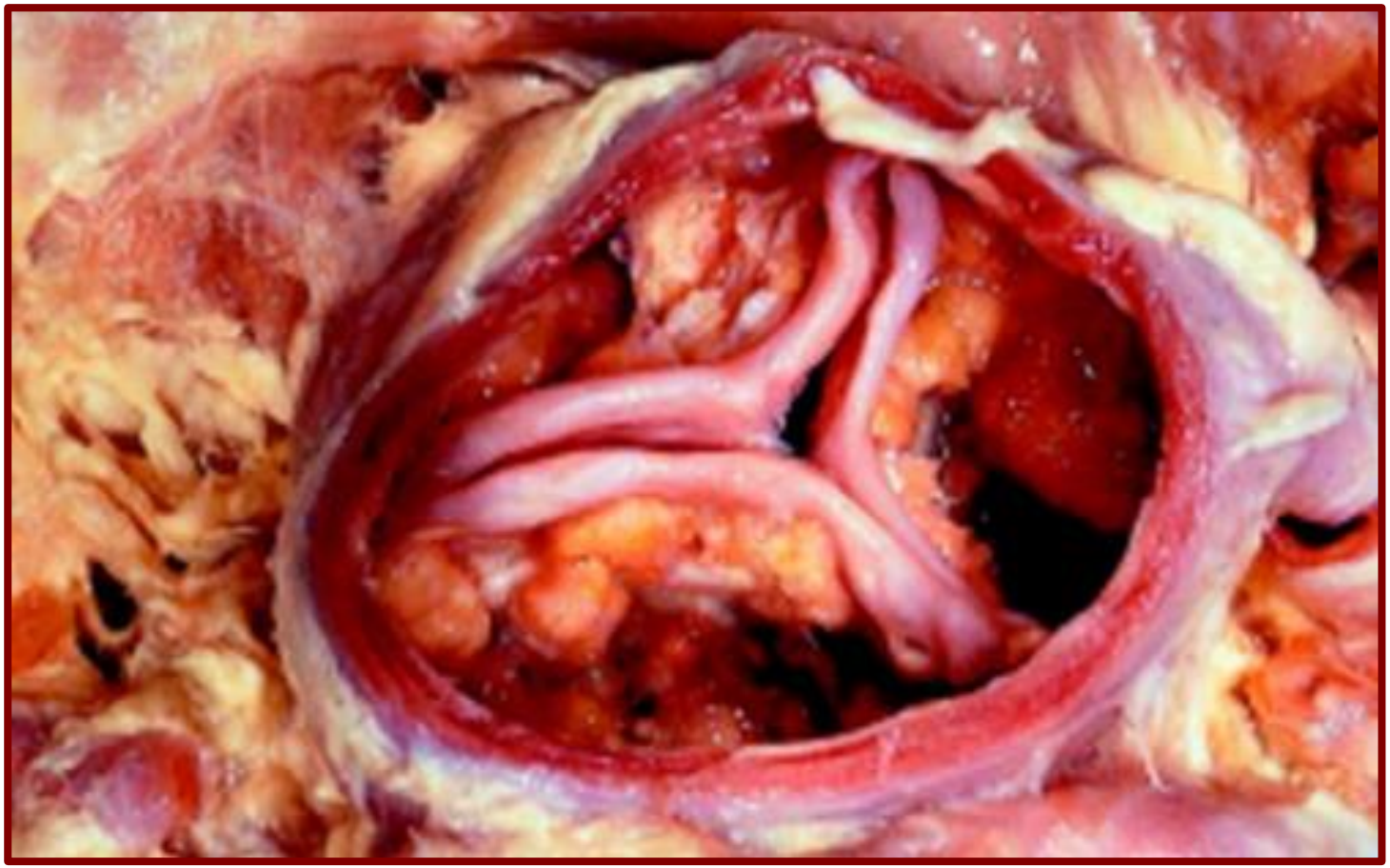
- *Fused valve cusps and leaflets.*
- *Vegetations.*
- *Fish-mouth deformity.*
- *Valve cusps fibrosis.*

Chronic Rheumatic Mitral Valvulitis - Gross

Chronic rheumatic mitral valvulitis

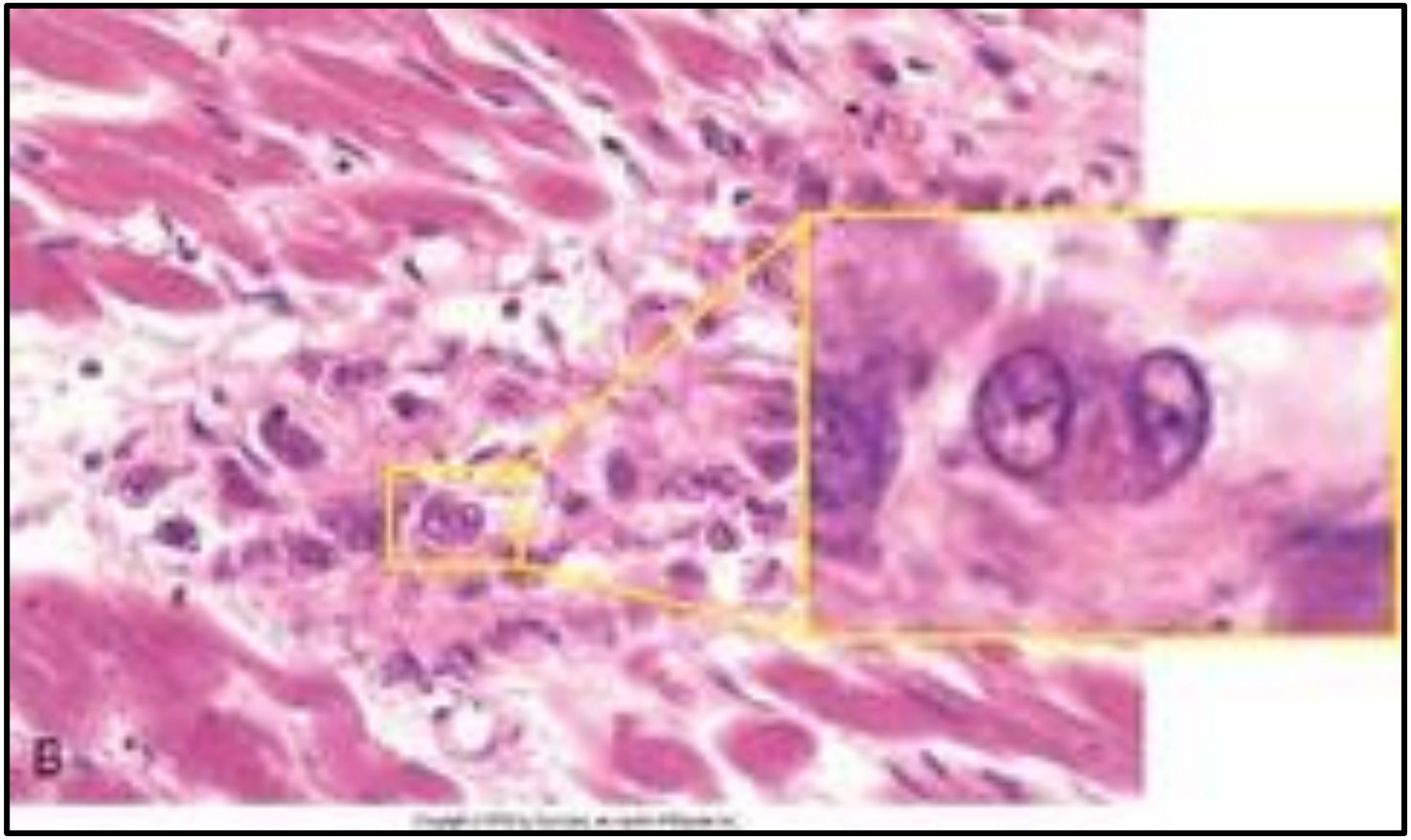
the valve leaflets are thick, fibrotic, fused. Short, thickened, fused chordae tendinae ➡ stenosis and / or incompetence

Rheumatic Aortic Valvulitis - Gross



Gross pathology of rheumatic heart disease Aortic stenosis:
Aorta has been removed to show thickened, fused aortic valve leaflets

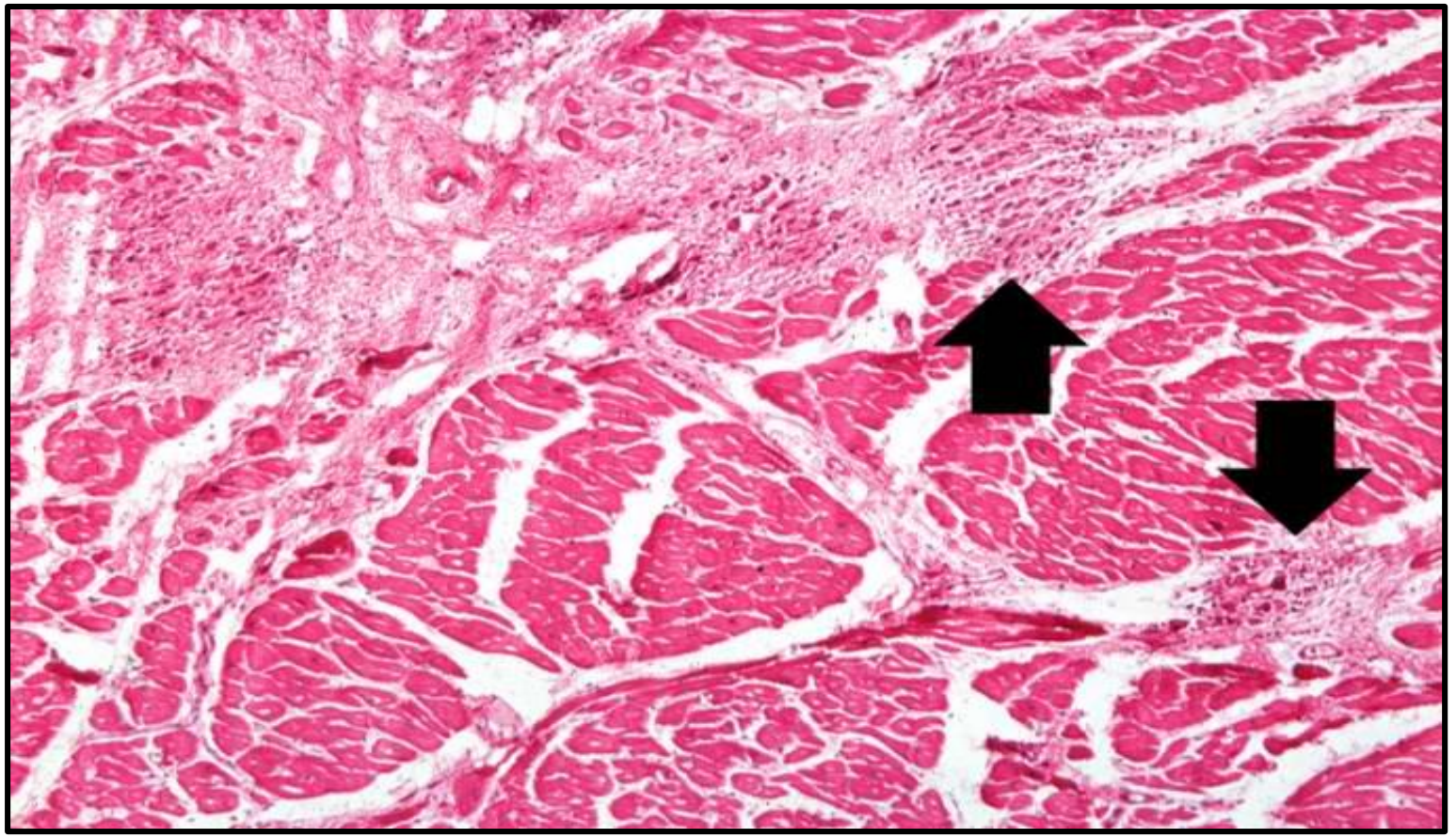
Acute Rheumatic Carditis - HPF



An Aschoff nodule at high magnification.

It affects mainly the left side of the heart and in particular the posterior wall of the left atrium. The most characteristic component is the Anitschkow cells originated from macrophage. Several appear here as large cells with two or more nuclei that have prominent nucleoli.

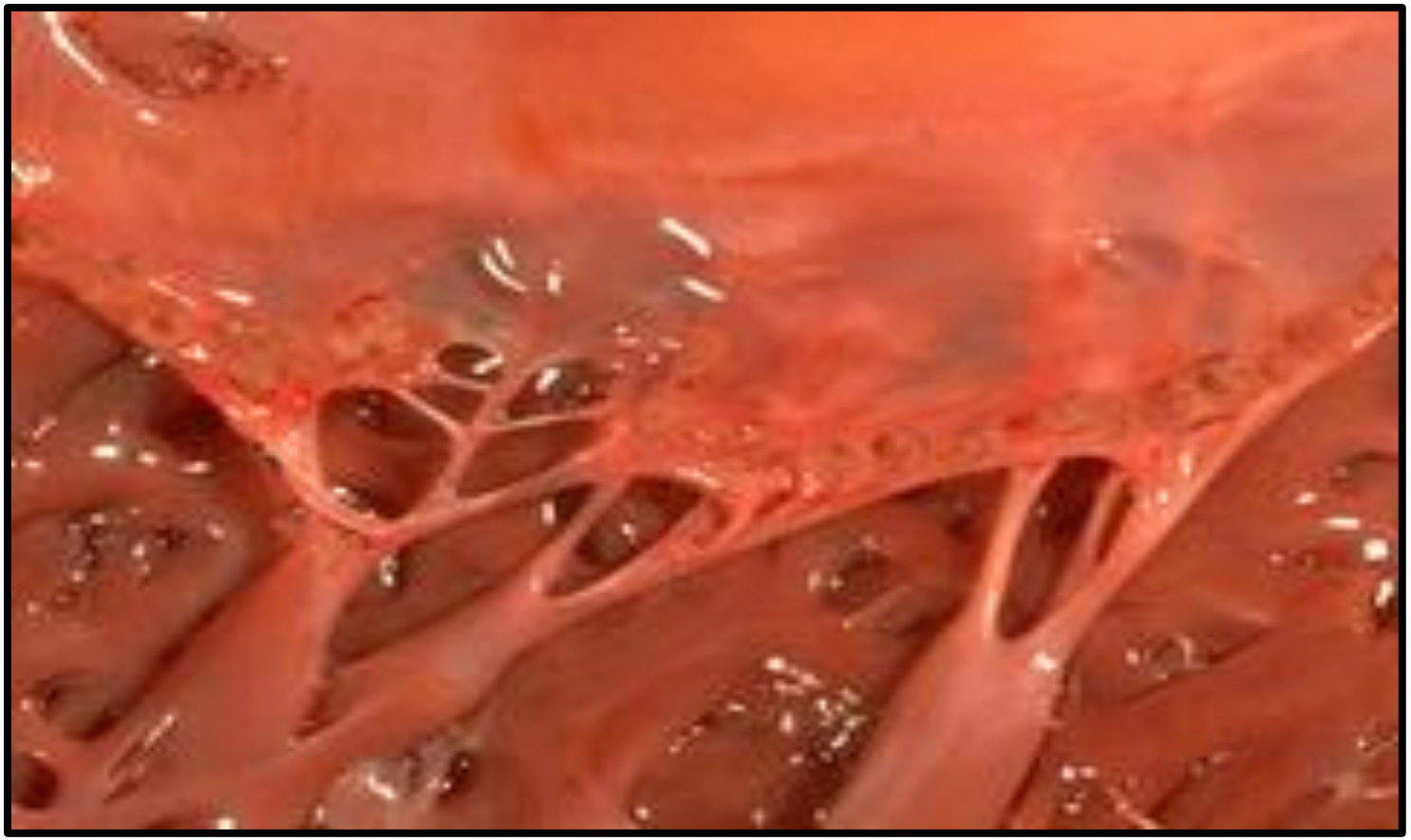
Rheumatic Valvulitis - LPF



The valve is thickened by dense hyalinized fibrous tissue with vascularization and chronic inflammatory cell infiltrate. The myocardium showing cellular accumulations - Aschoff bodies (arrows) -within the interstitium of the myocardium.

Acute rheumatic myocarditis

Acute Rheumatic Mitral Valvulitis - Gross

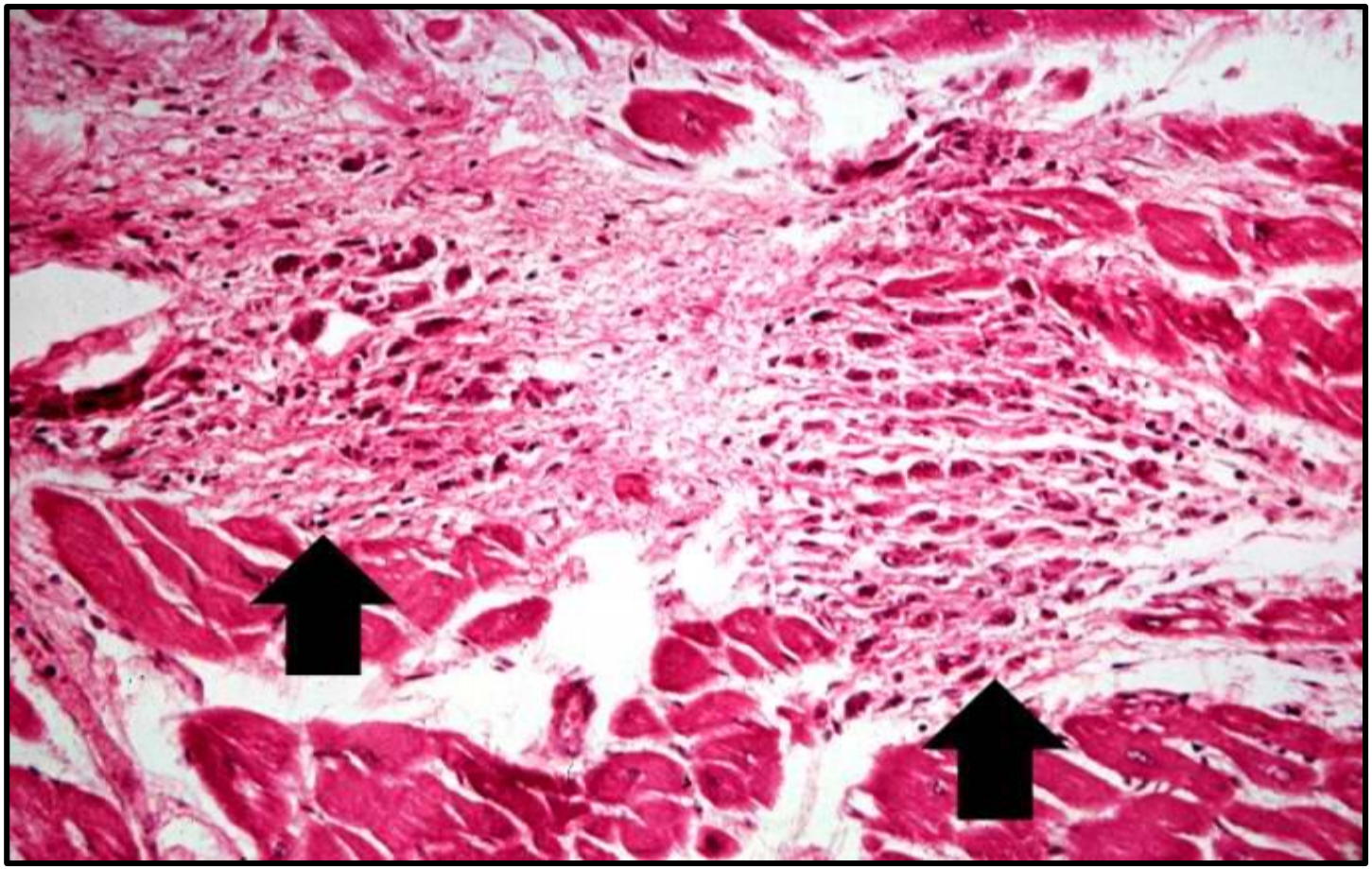


The small verrucous vegetations are associated with acute rheumatic fever. These warty vegetations are multiple, firm, adherent, small , 1-3 mm in- diameter and form along the line of valve closure over areas of endocardial inflammation. Affects mainly Aortic & Mitral valves

Acute Rheumatic Mitral Valvulitis - Gross

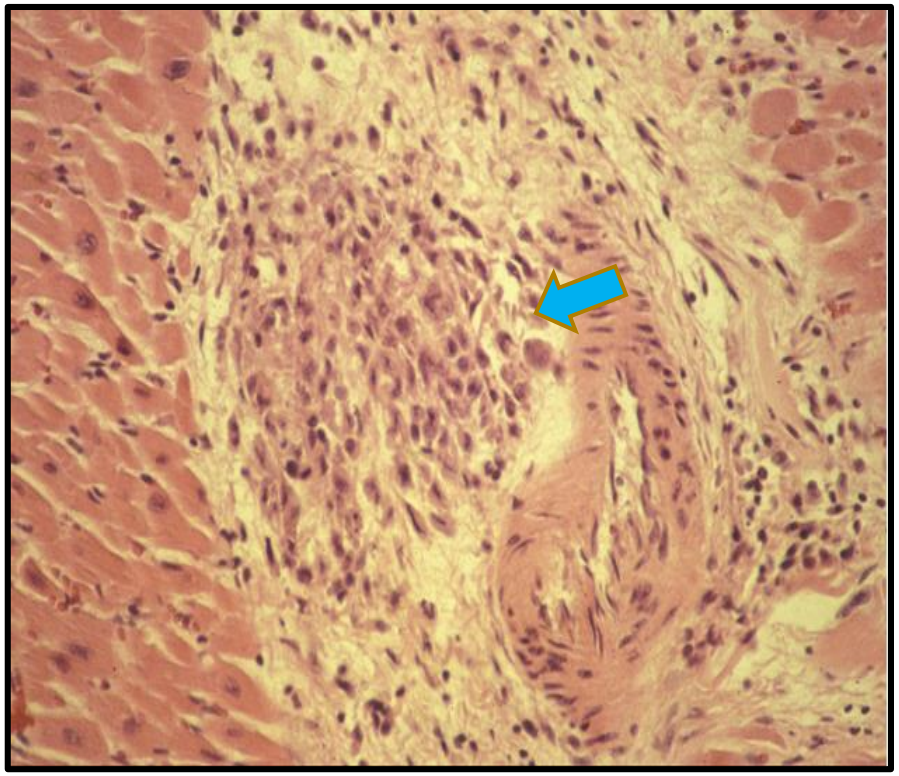
Close-up view of an opened-out rheumatic mitral valve showing severe thickening and retraction of the cusps. The chordae tendineae are shortened and fused into short thick cords. This rigid valve would have been stenosed

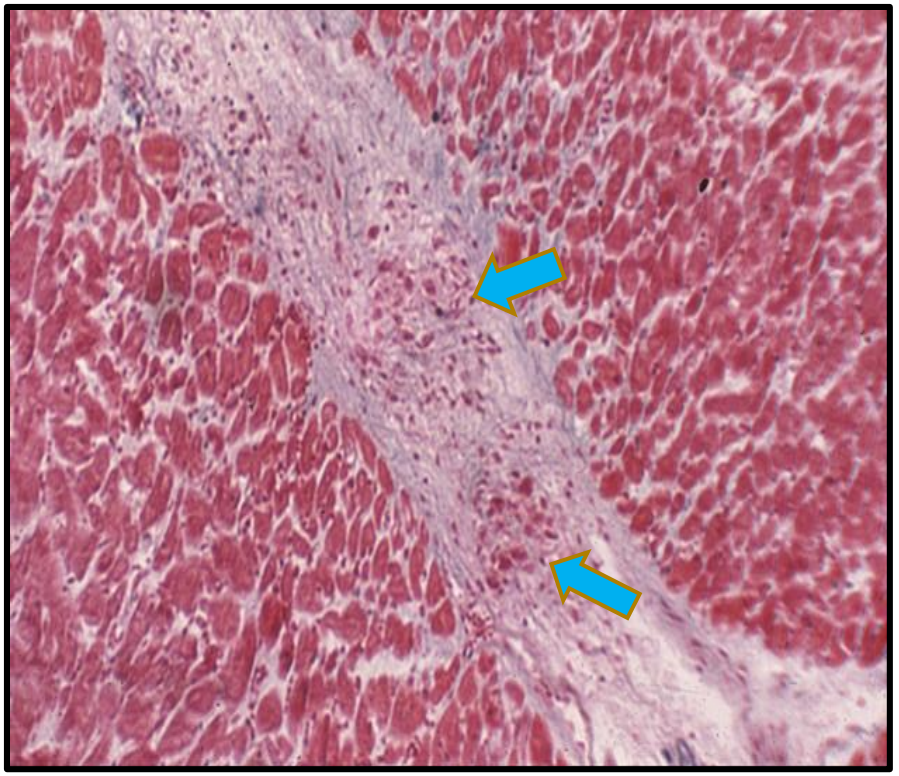
Acute Rheumatic Carditis - HPF



Microscopically, acute rheumatic carditis is marked by a peculiar form of granulomatous inflammation with so-called "Aschoff nodules" seen best in myocardium,

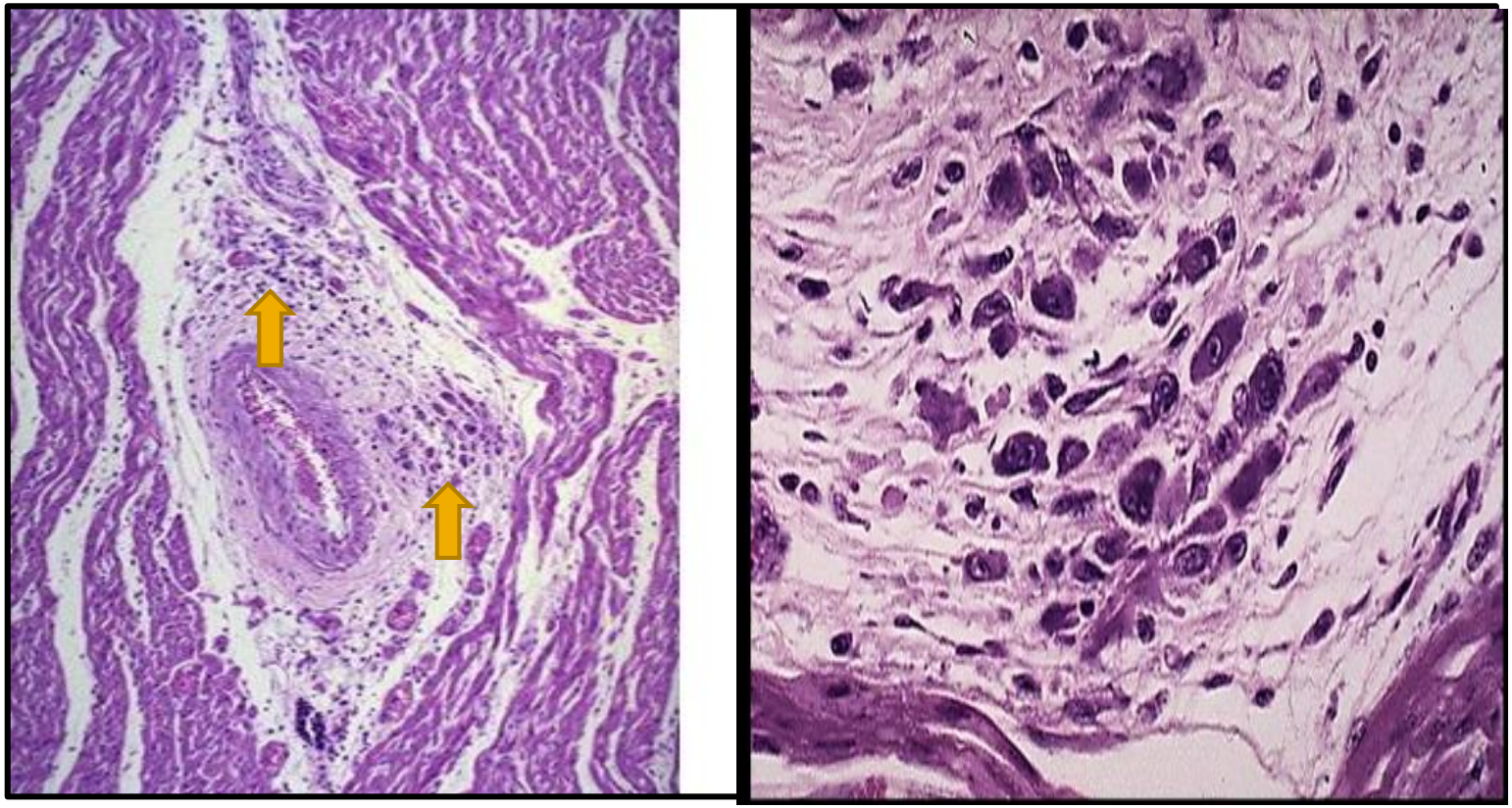
RHEUMATIC MYOCARDIITIS (ASHOFF NODULE)





Aschoff nodule *consists of a focus of fibrinoid necrosis, few lymphocytes, macrophages and few small giant cells with one or several nuclei (Aschoff giant cell).*

RHEUMATIC MYOCARDIITIS (ASHOFF NODULE)



Aschoff bodies *in the intermuscular fibrous septa. They are oval in shape and seen in relation to blood vessels.*

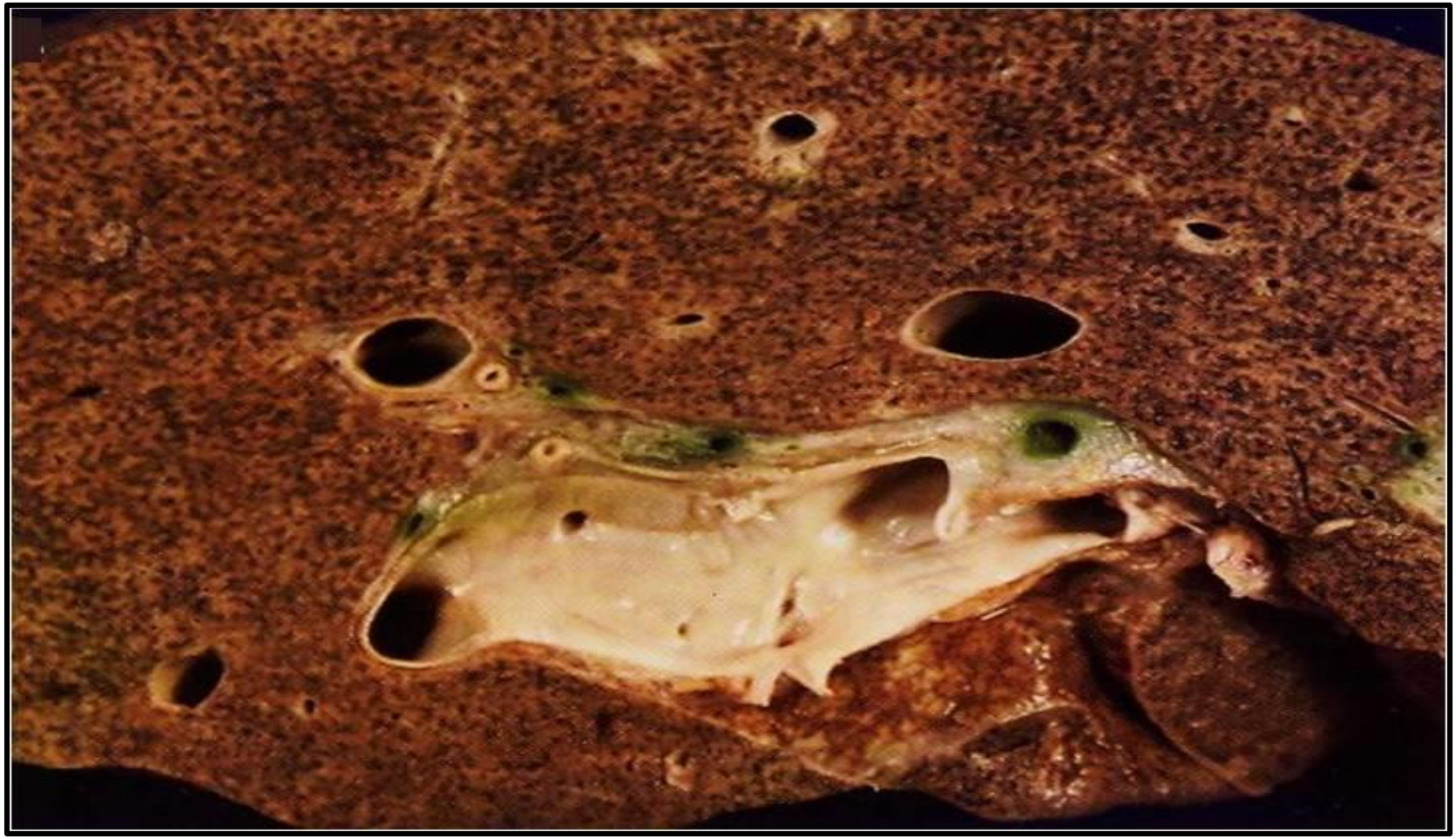
Each consists of a focus of fibrinoid necrosis, few lymphocytes, macrophages and few small giant cells with one or several nuclei (Aschoff giant cell).

HEART FAILURE

Right Sided Heart Failure

Chronic venous congestion of the liver

NUTMEG LIVER – Cut surface

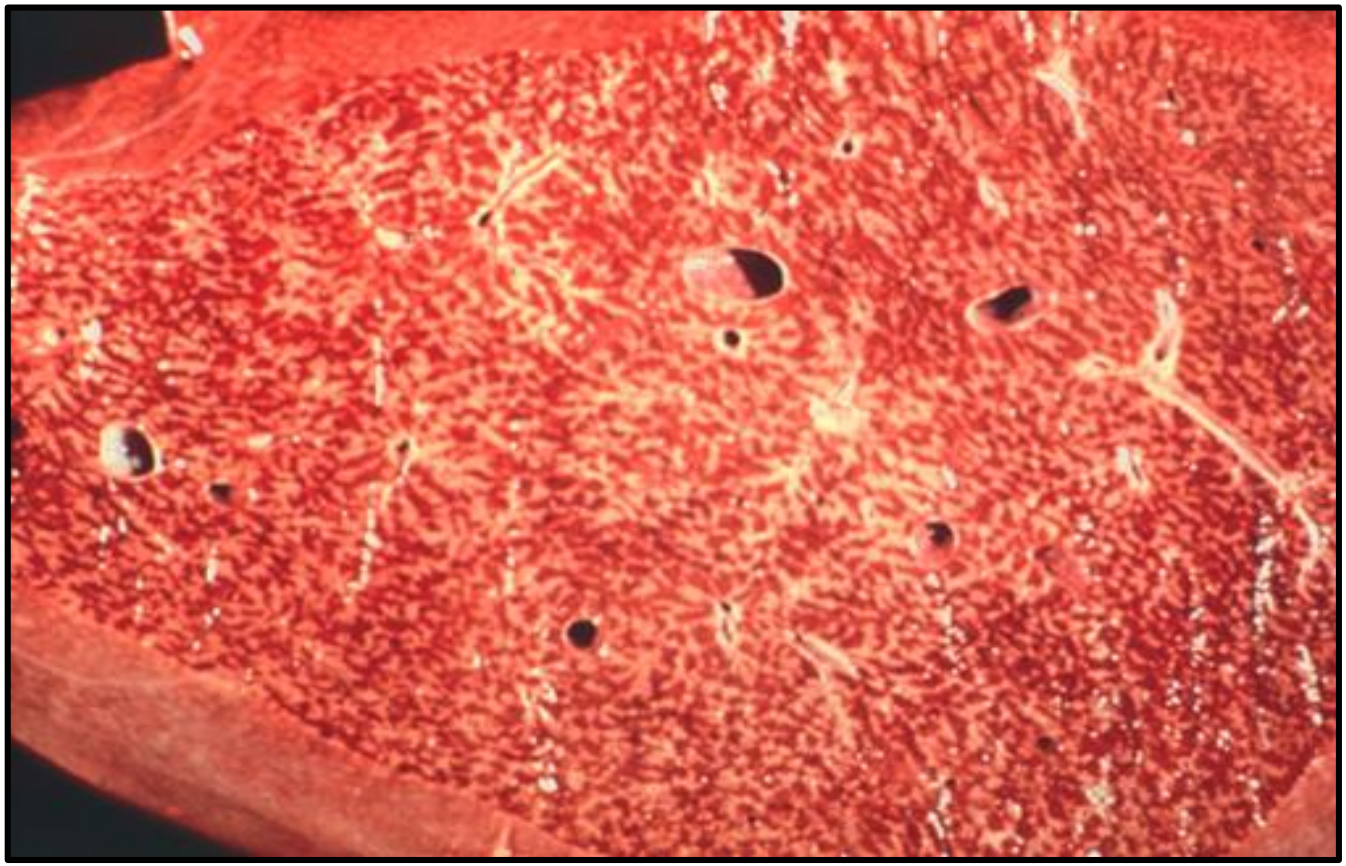


Section of liver showing alternating pale and dark areas with a nutmeg like appearance possibly due to passive congestion secondary to right sided heart failure.

NUTMEG LIVER – Cut surface

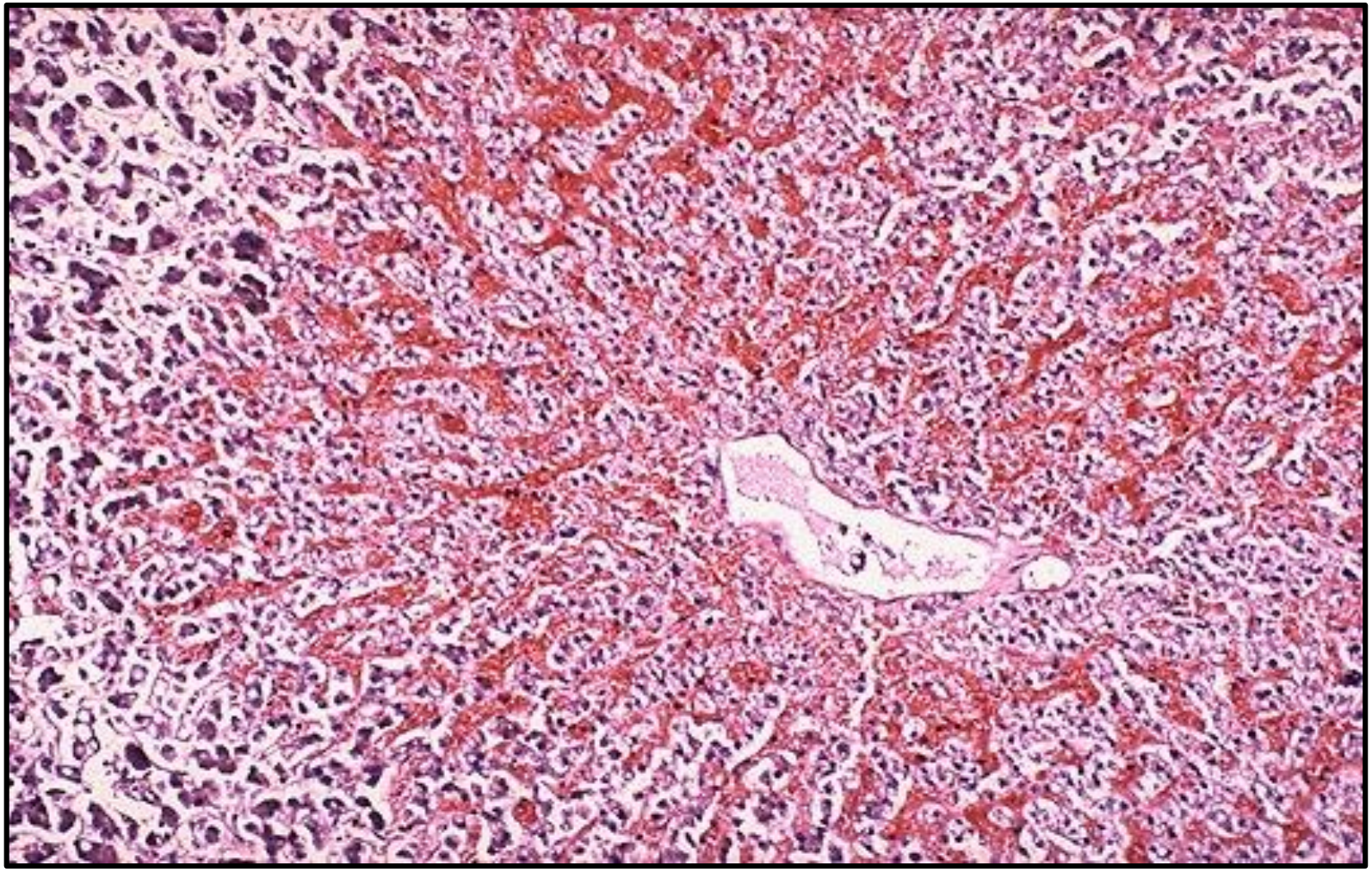
The hepatic parenchyma contains a faintly nodular pattern and nutmeg staining due to chronic passive congestion due to Right sided heart failure.

Chronic Congestion of the Liver - CS



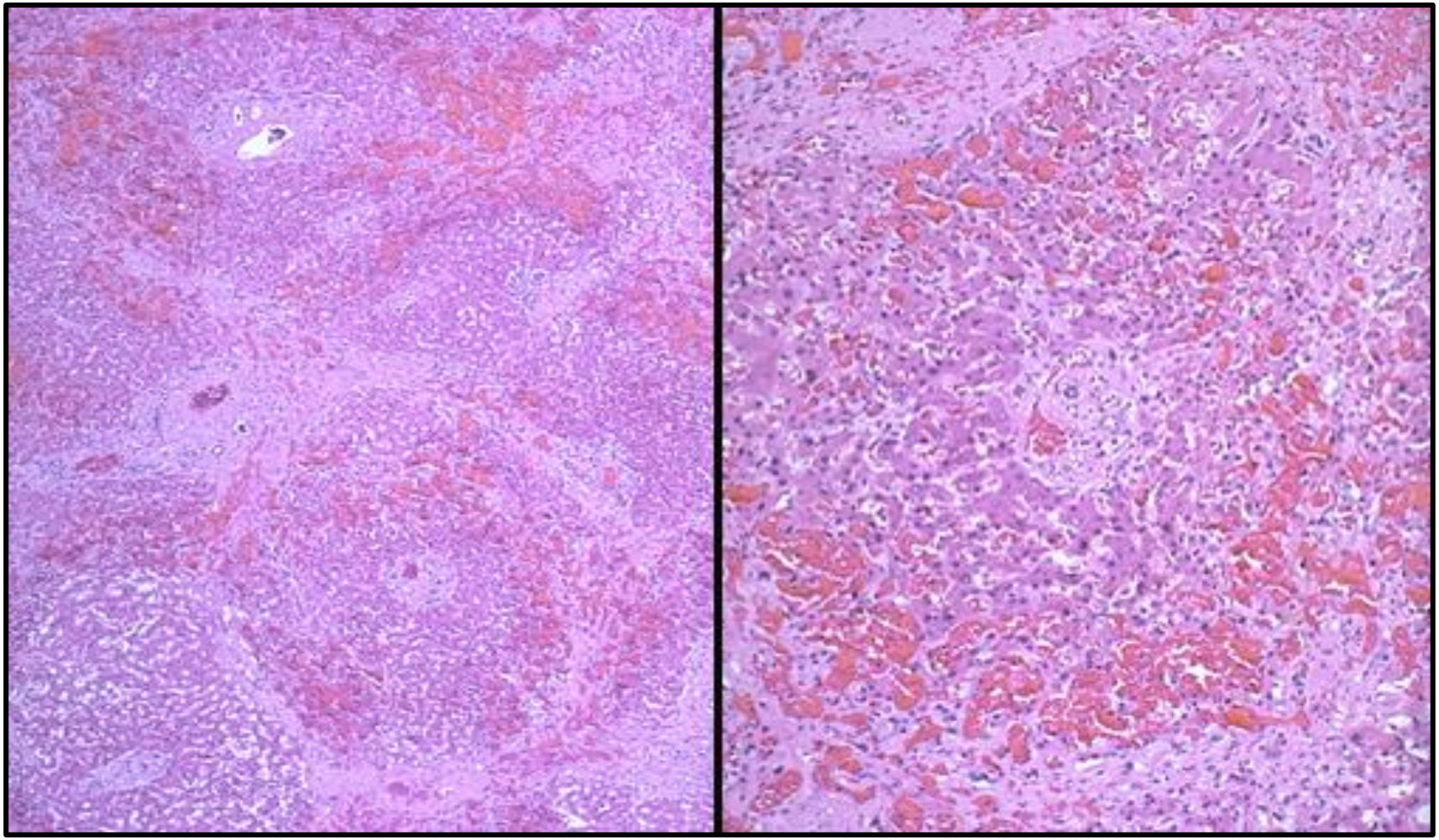
A gross view of nutmeg appearance of liver characteristic of centrolobular or necrosis or passive congestion of the liver. The central areas of the liver are congested and take on a sort of dusky appearance. They are soft in consistency and they are surrounded by the paler areas of fatty liver that are more normal in appearance microscopically.

Chronic Congestion of the Liver - LPF



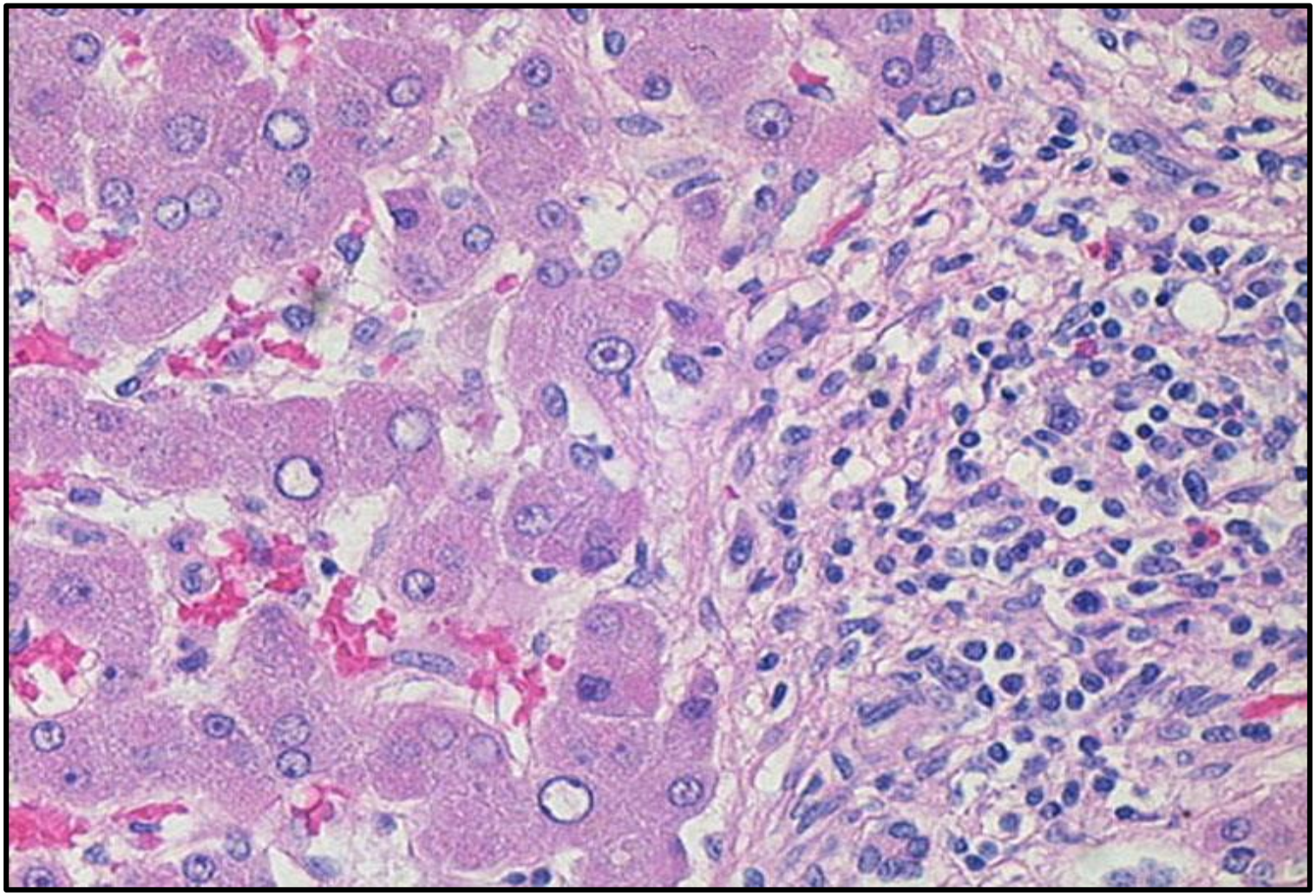
The central portion of liver lobules shows congestion and dilatation of central veins and blood sinusoids, with atrophy and necrosis of liver cells.

Chronic Congestion of the Liver - LPF



Central veins dilated and congested , necrotic hepatocytes , kupffer cells and steatosis

Chronic Congestion of the Liver - HPF

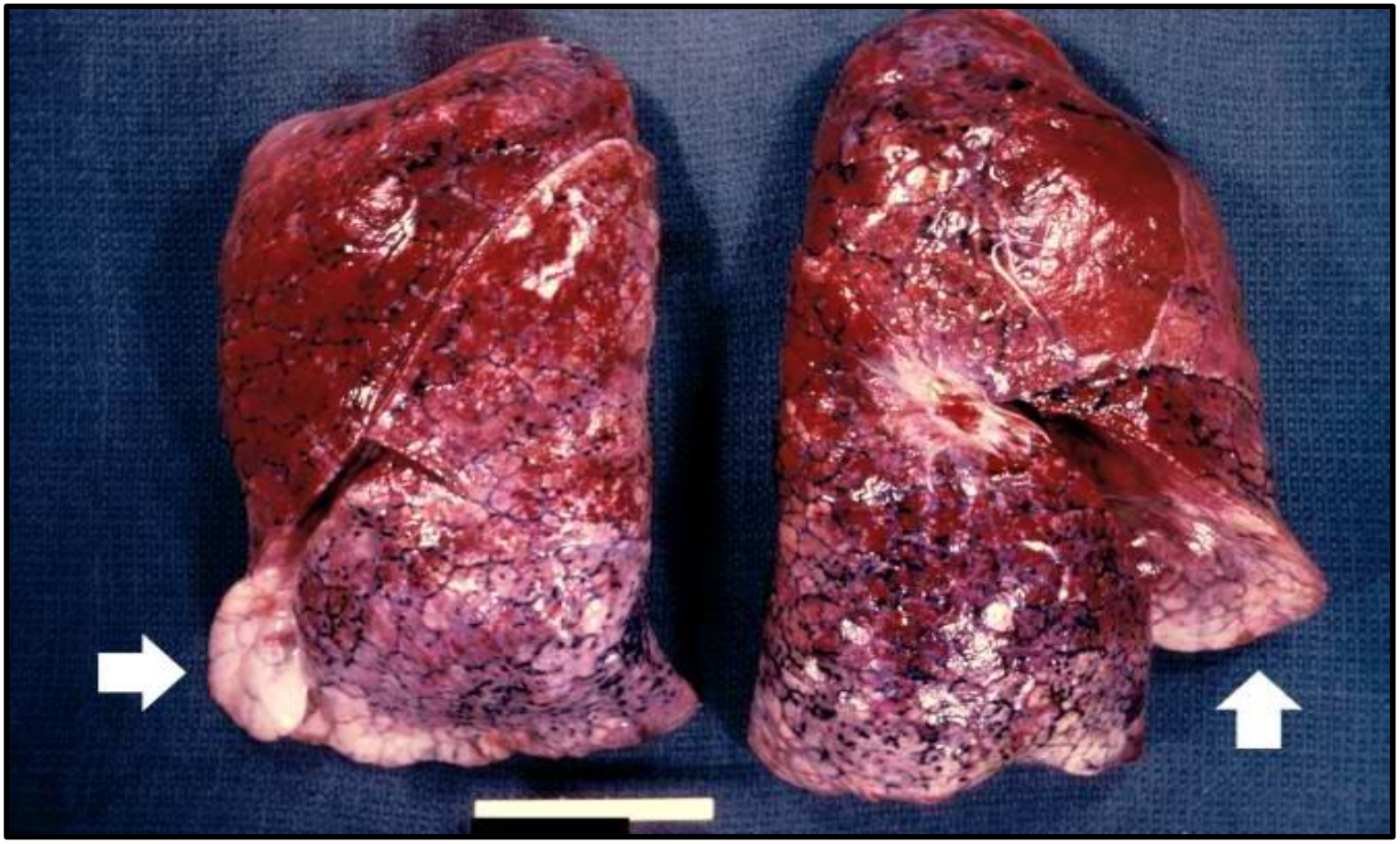


The central portion of liver lobules shows congestion and dilatation of central veins and blood sinusoids, with atrophy and necrosis of liver cells.

Left Sided Heart Failure

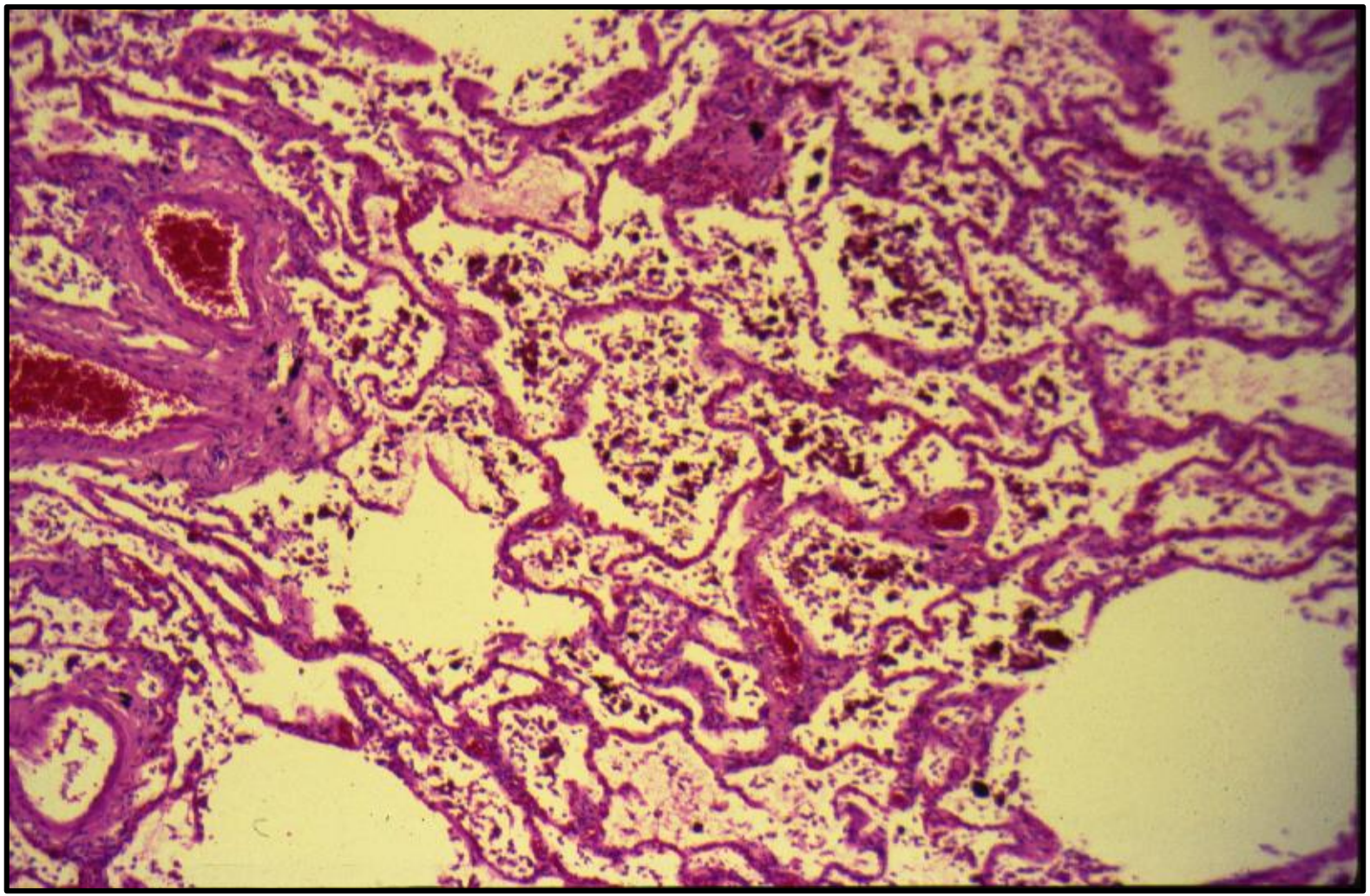
Chronic venous congestion of the lung

Chronic venous congestion of the lung - Gross



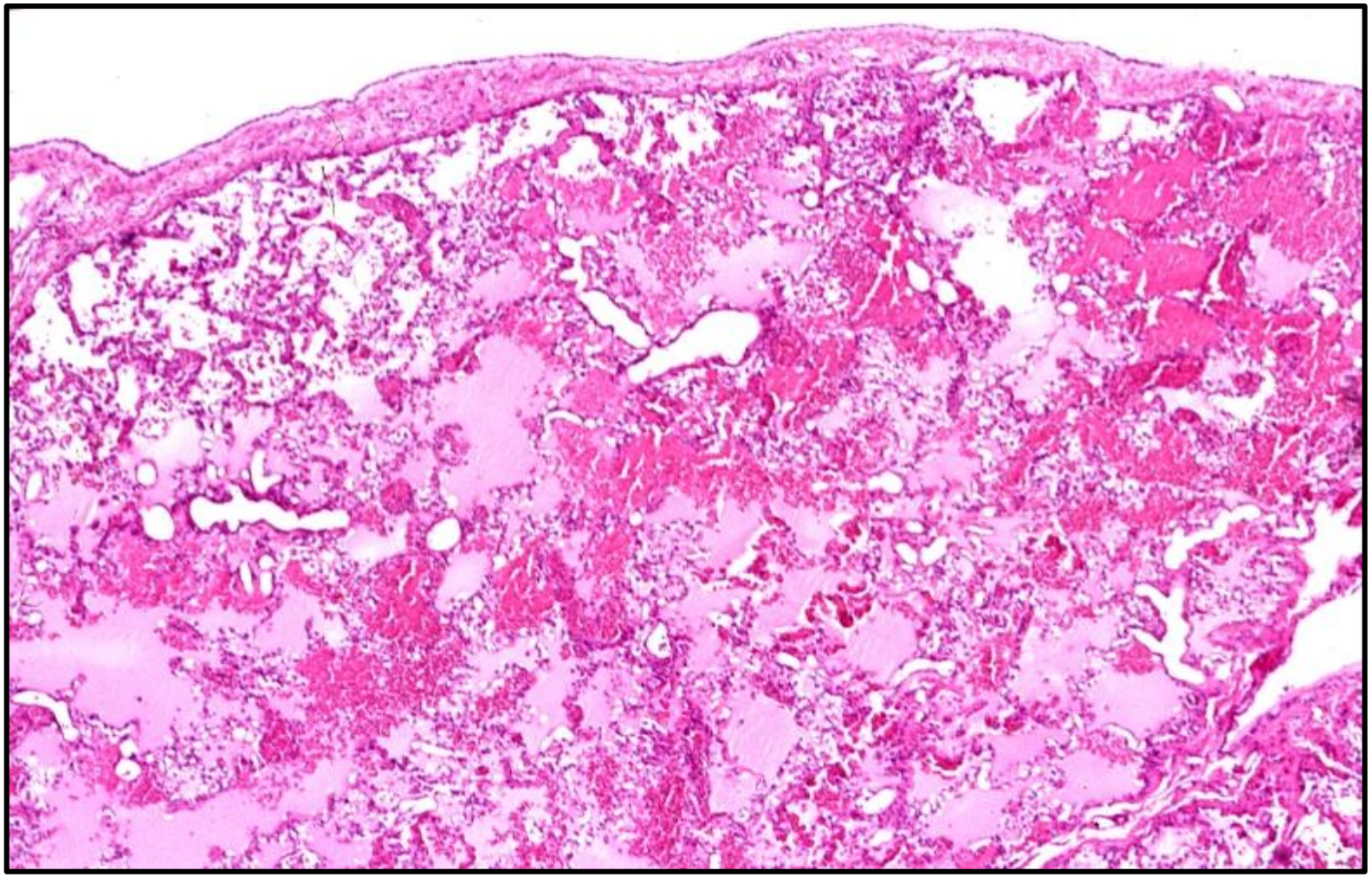
This is a gross photograph of lungs that are distended and red. The reddish coloration of the tissue is due to congestion. Some normal pink lung tissue is seen at the edges of the lungs (arrows).

Chronic venous congestion of the lung - LPF



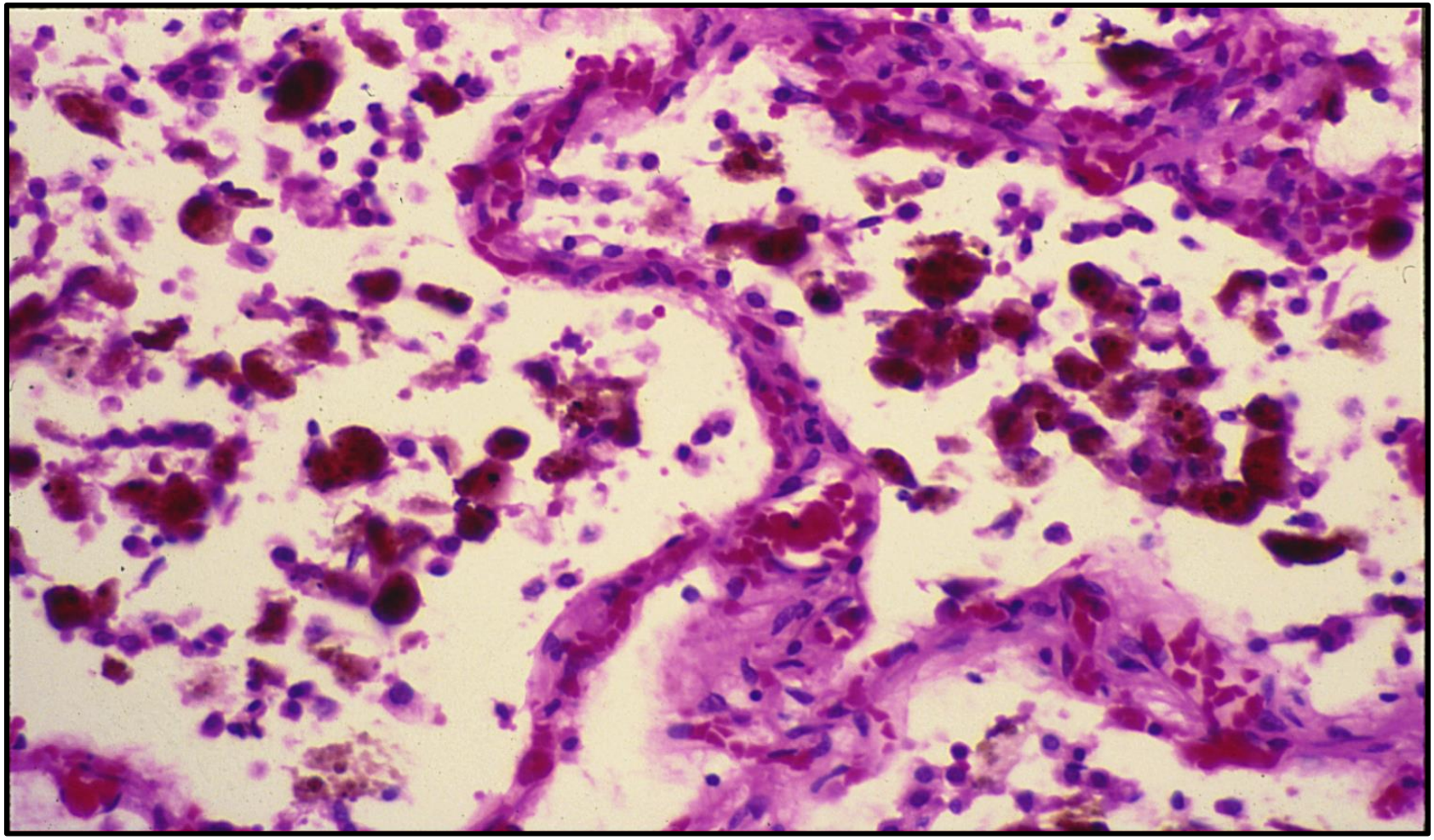
The alveolar walls are thickened by dilated and engorged capillaries.

Chronic venous congestion of the lung - LPF



Lung, pulmonary edema in patient with congestive heart failure due to heart transplant rejection

Chronic venous congestion of the lung - HPF



The alveoli contain edematous fluid, red blood cells and large alveolar macrophages (heart failure cells), which are filled with haemosiderin pigment derived from red cells breakdown.

PRACTICAL – 2

A: MYOCARDIAL DISEASE:

- HYPERTROPHY
- MYOCARDIAL INFARCTION

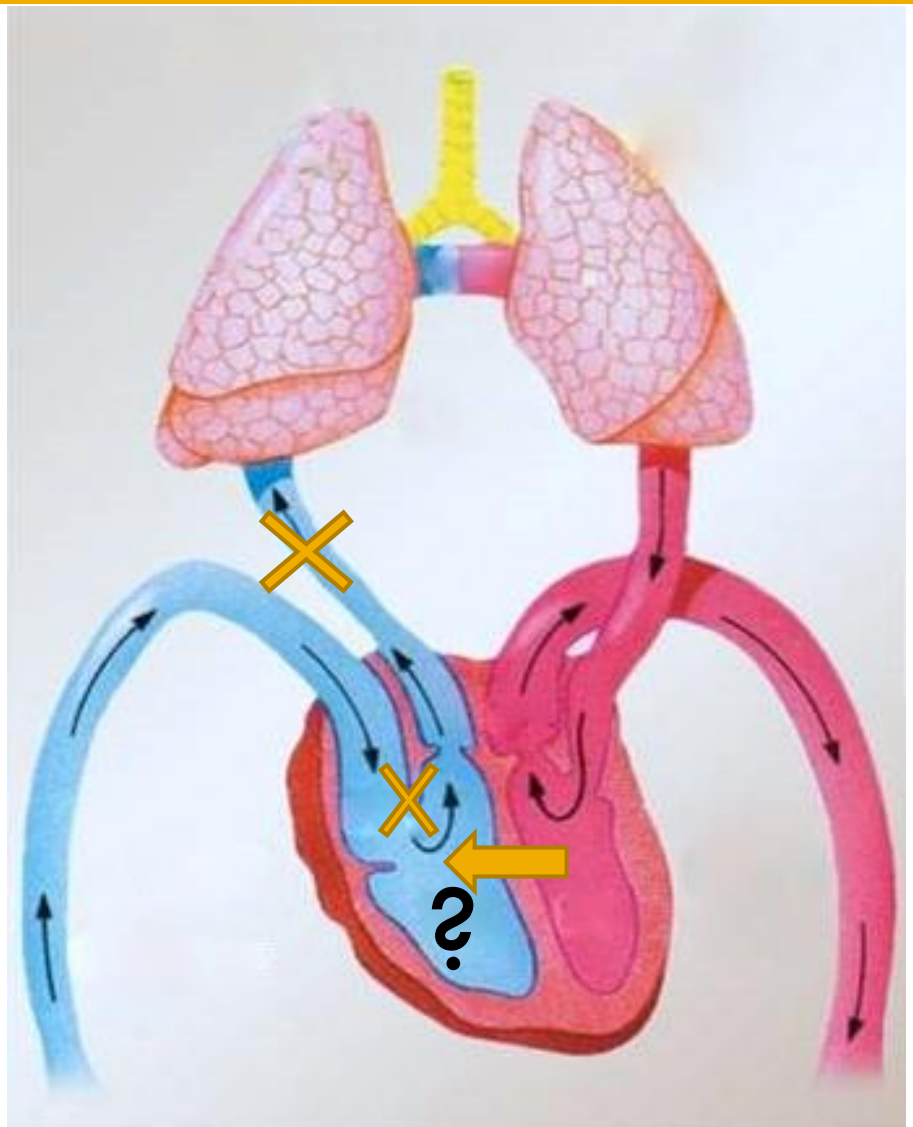
B: VASCULITIS

MYOCARDIAL HYPERTROPHY

The ventricle is working against high pressure, or "pumping" higher than normal volume leading to myocardial hypertrophy.

Left ventricular hypertrophy :

Right ventricular hypertrophy :



Causes of ventricular hypertrophy

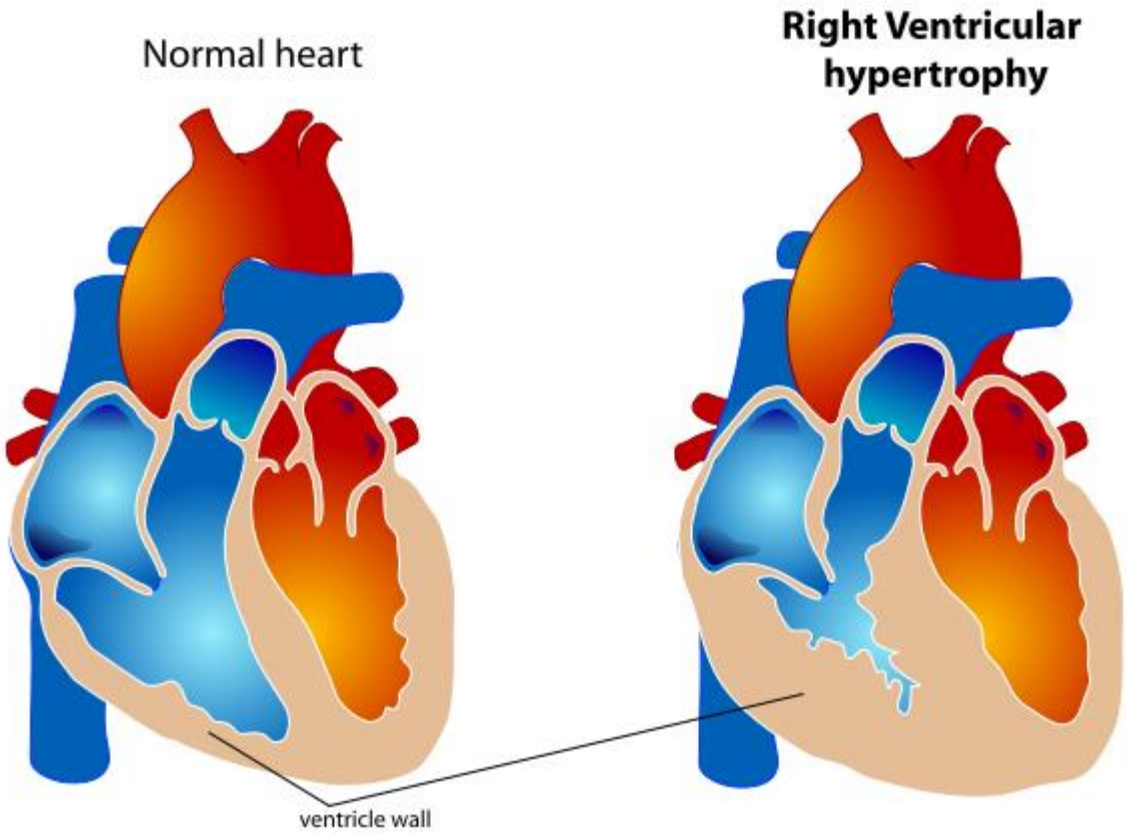
Left ventricular hypertrophy :

- Systemic hypertension
- Aortic valve stenosis

Right ventricular hypertrophy:

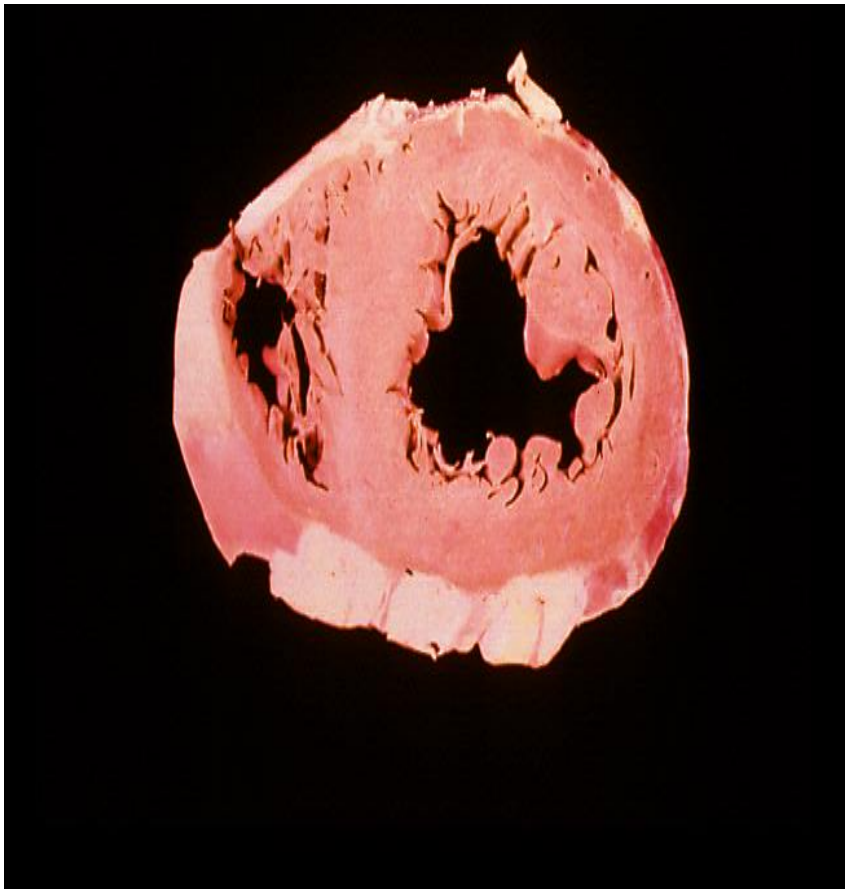
- Pulmonary hypertension
  - asthma, COPD
  - pulmonary thromboembolic disease
  - primary pulmonary hypertension
- Pulmonary valve stenosis
- Left-to-right shunts (volume overload)

Right ventricular hypertrophy



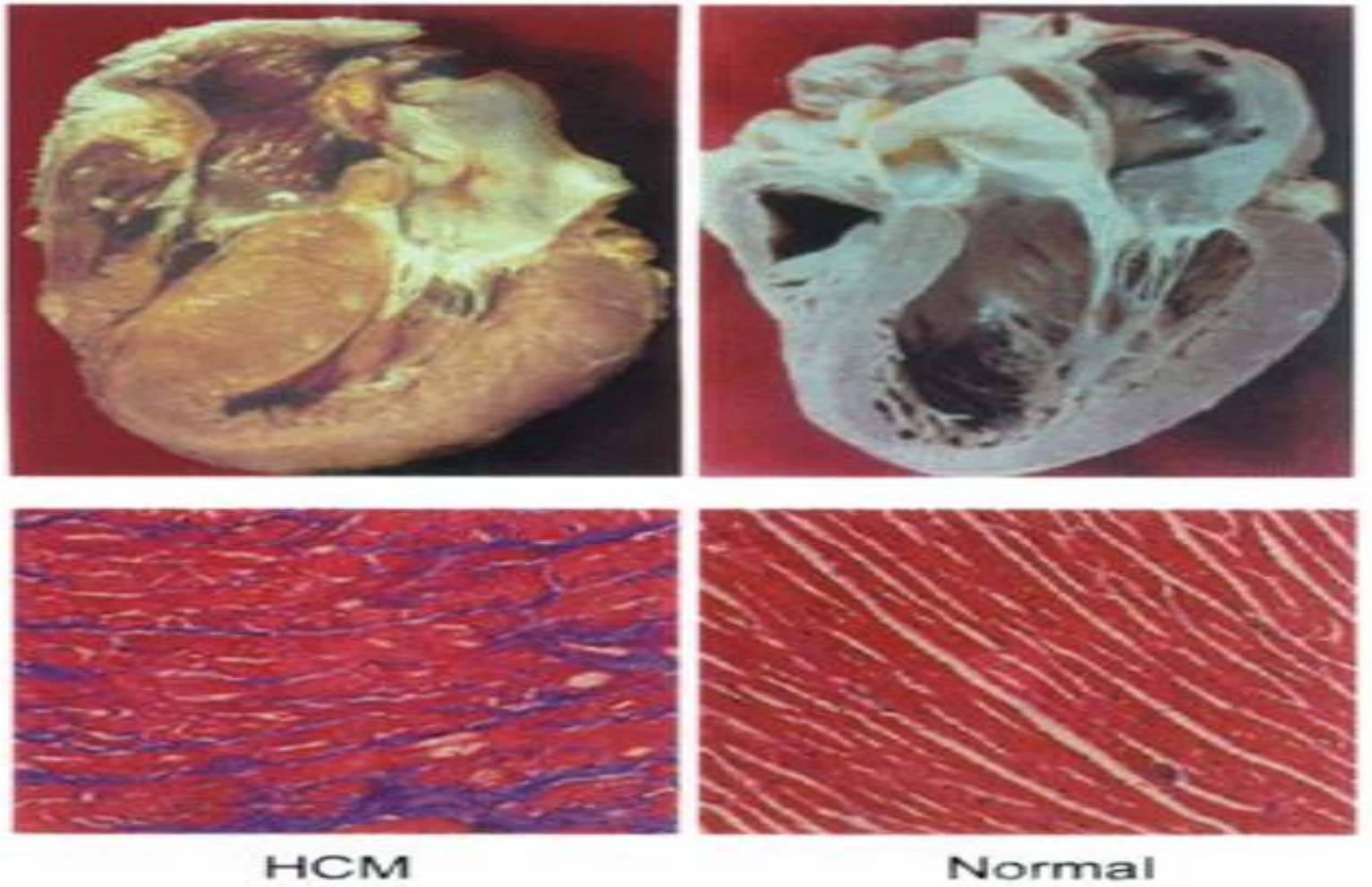
Normal and hypertrophied left ventricle – cross section

Left ventricular hypertrophy



Normal ventricles

Normal and hypertrophied left ventricle - CS



Histopathology showing significant myofiber disarray and interstitial fibrosis

Histopathology showing Normal myocytes

Left ventricular hypertrophy - Gross

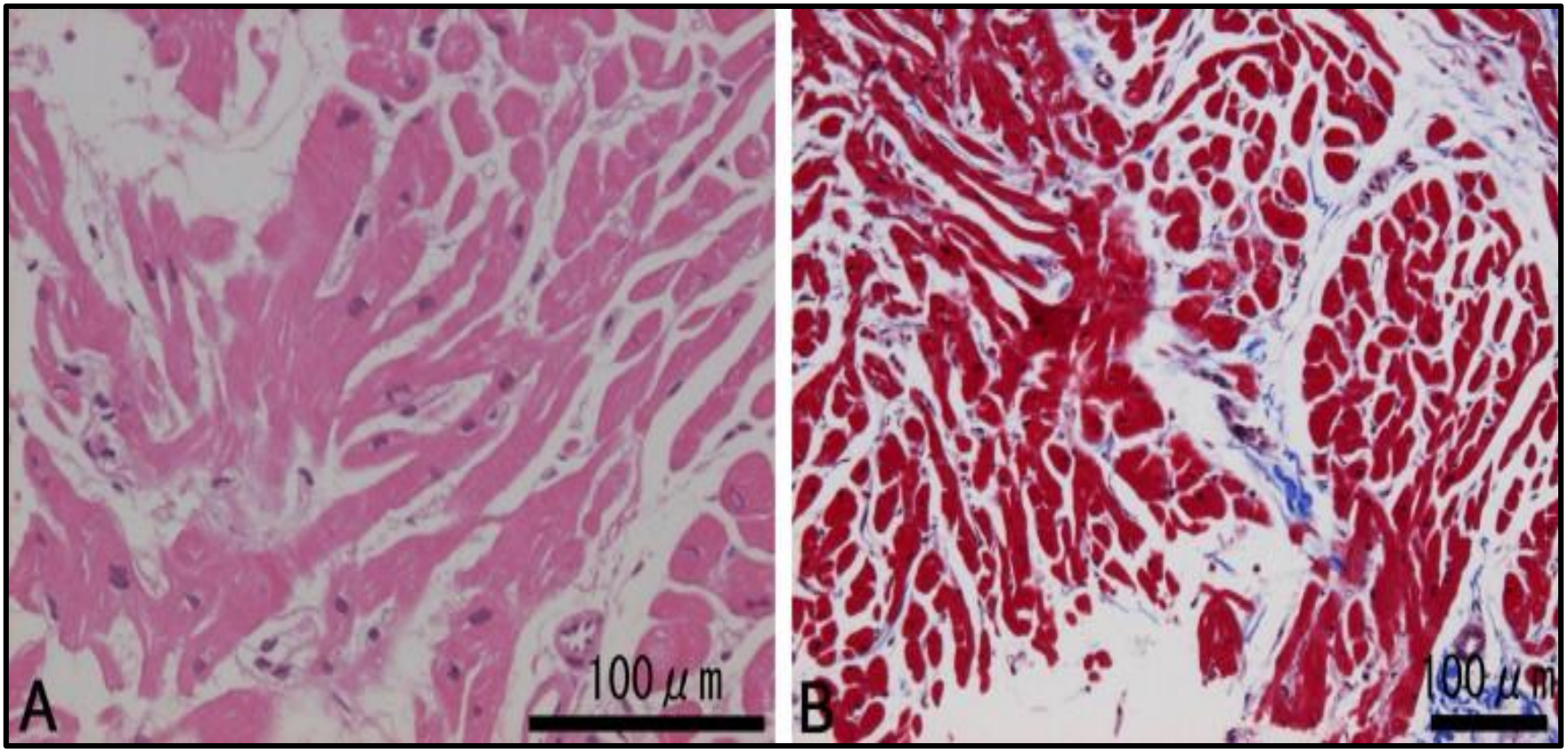
Heart from a hypertensive patient. The left ventricle is very thick (over 2 cm). However the rest of the heart is fairly normal in size as is typical for hypertensive heart disease. The hypertension creates a greater pressure load on the heart to induce the hypertrophy

Left ventricular hypertrophy - Gross

This cross section view of the heart shows the left ventricle in the left of the picture.

The left ventricle is grossly thickened secondary to severe hypertensive. The myocardial fibers have undergone hypertrophy.

Hypertrophic Cardiomyopathy - LPF

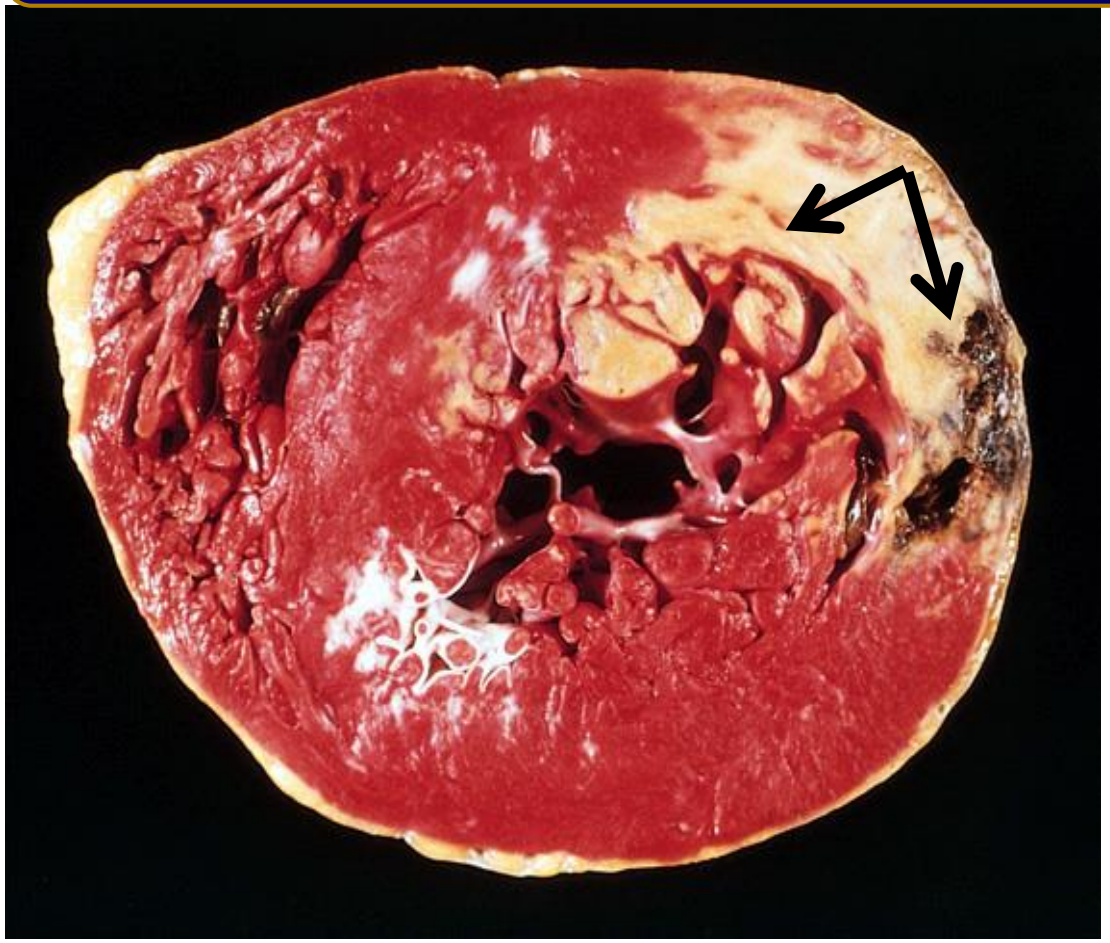


haematoxylin-eosin stain ***Masson's trichrome stain***

Histopathology of heart sections of ventricular septum showing significant myofiber disarray and slight interstitial fibrosis indicating hypertrophic cardiomyopathy (HCM).

MYOCARDIAL INFARCTION

Acute Myocardial Infarction - CS



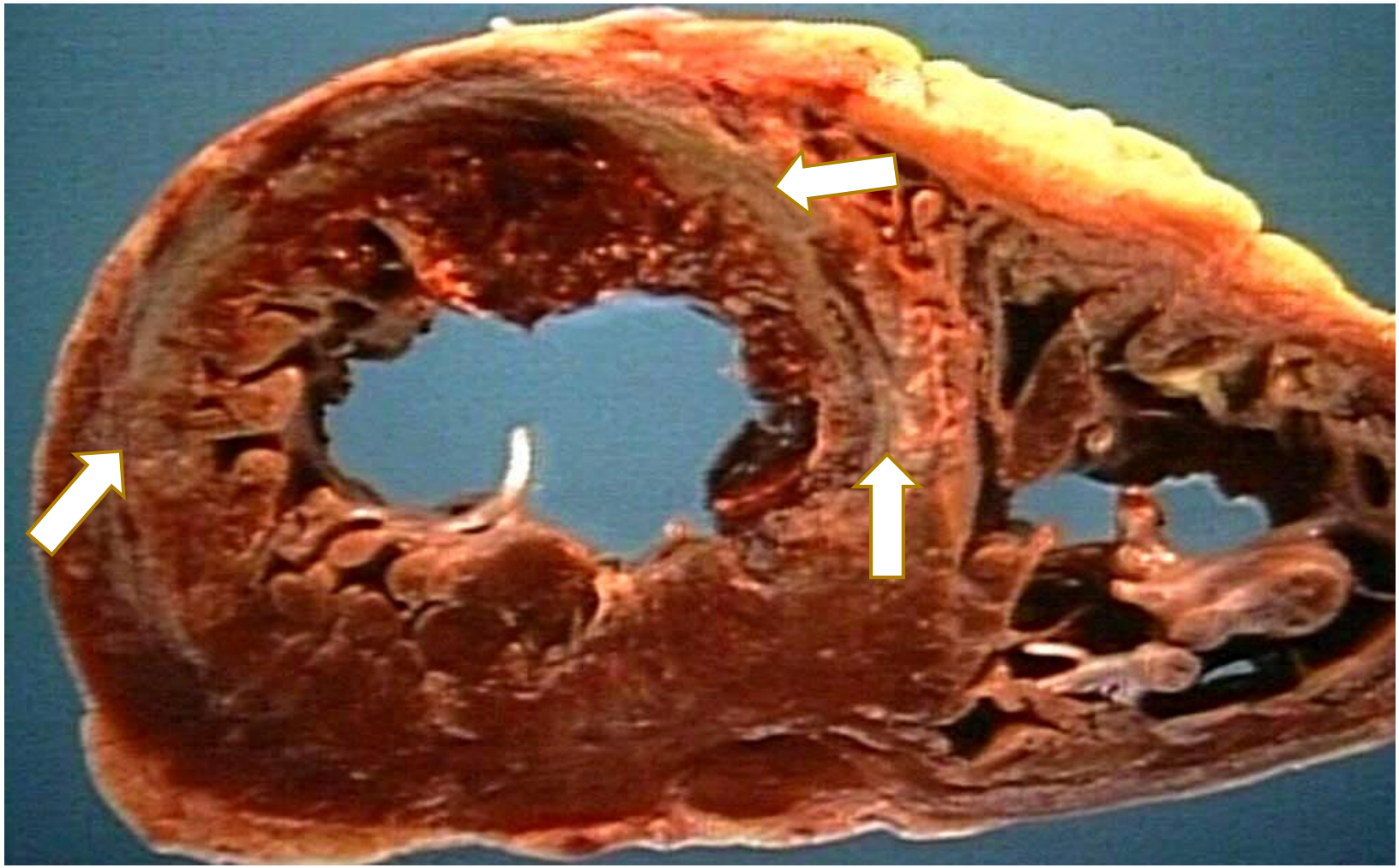
DIAGNOSIS (CAUSE OF DEATH)?

Complications:

1: Arrhythmias.
2: Cardiac Shock.
3: Pericarditis.
4: Heart Failure.
5: Ventricular Aneurysm.
6: Myocardial Rupture.

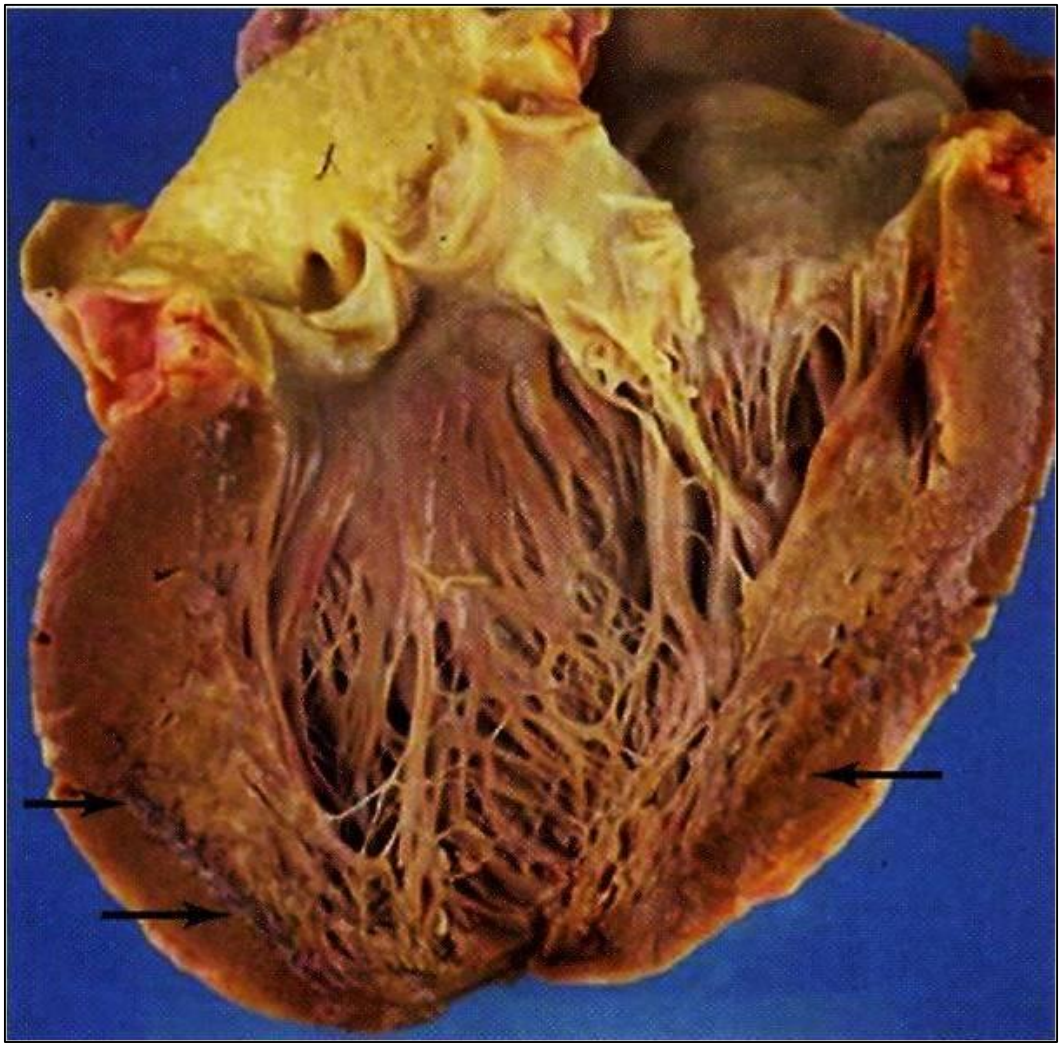
Cross section of the left and right ventricles shows a pale and irregular focal fibrosis in the left ventricular wall with increased thickness .

Myocardial Infarction



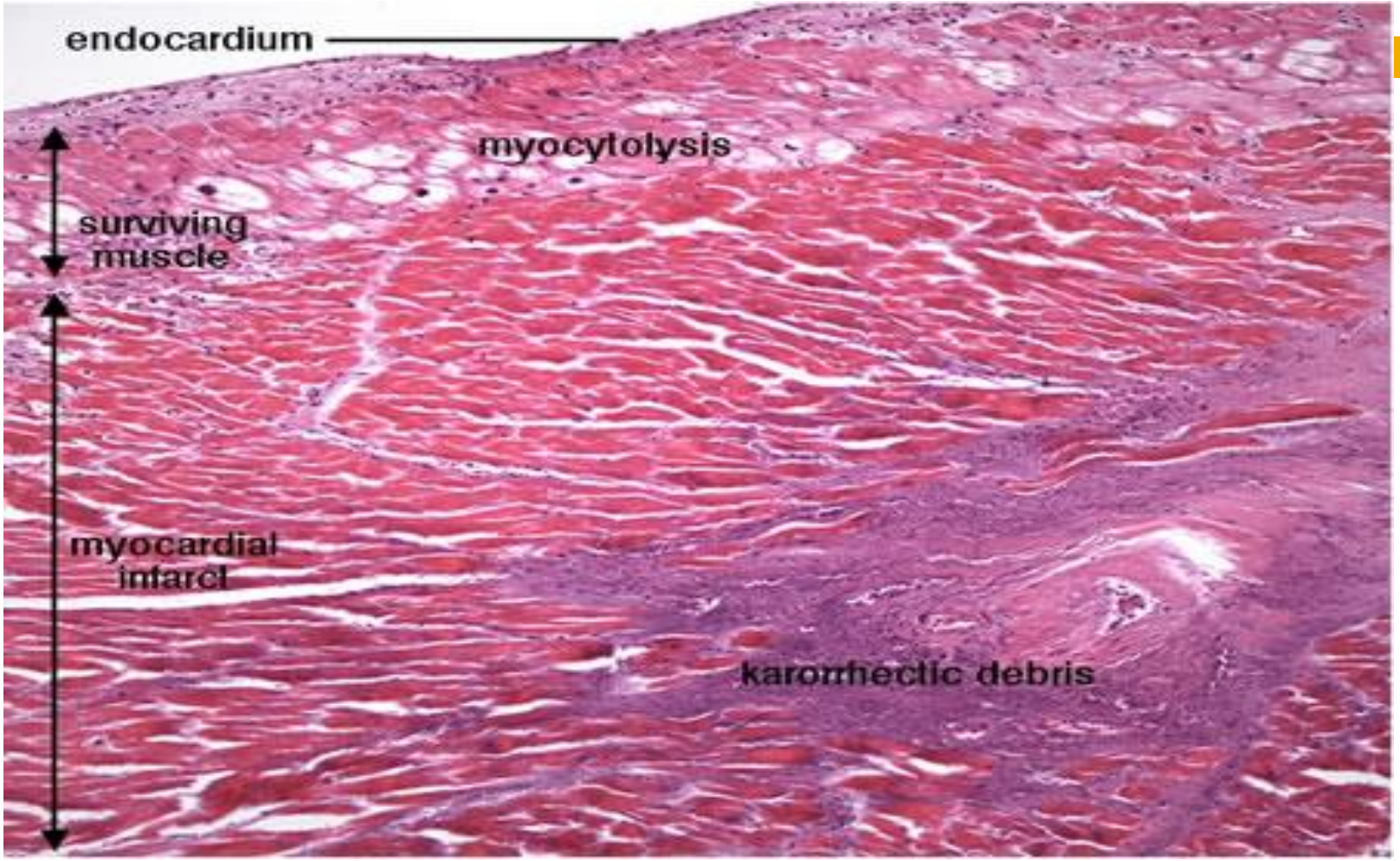
Cross section of the left and right ventricles shows a pale and irregular focal fibrosis in the left ventricular wall with increased thickness .

Myocardial Infarction - CS



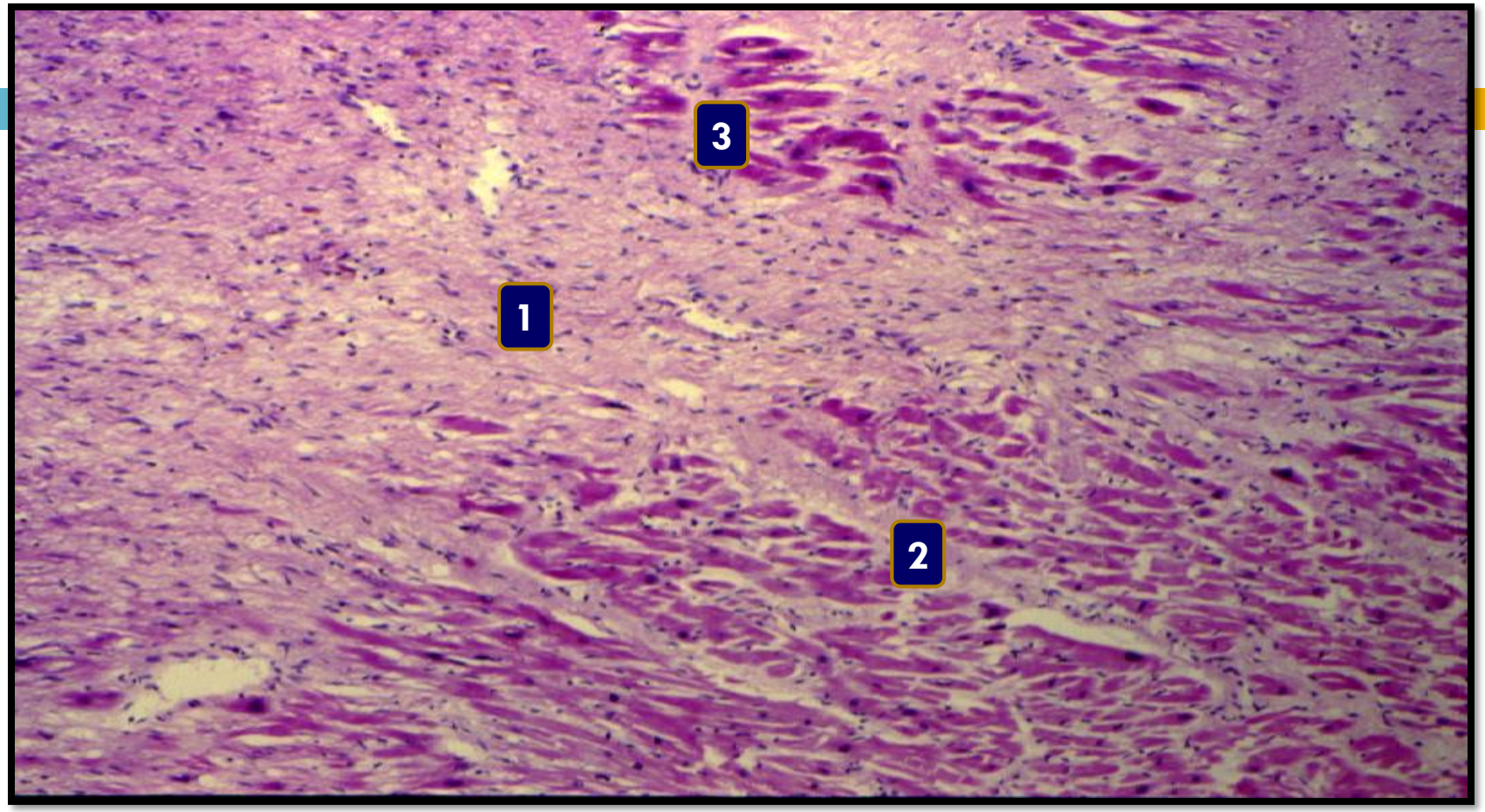
Complications that might occur : arrhythmias , ventricular aneurysm, rupture of myocardium, cardiac tamponade and others .

Myocardial Infarction - LPF



Transmural myocardial infarct at 2 weeks

Myocardial Infarction - LPF

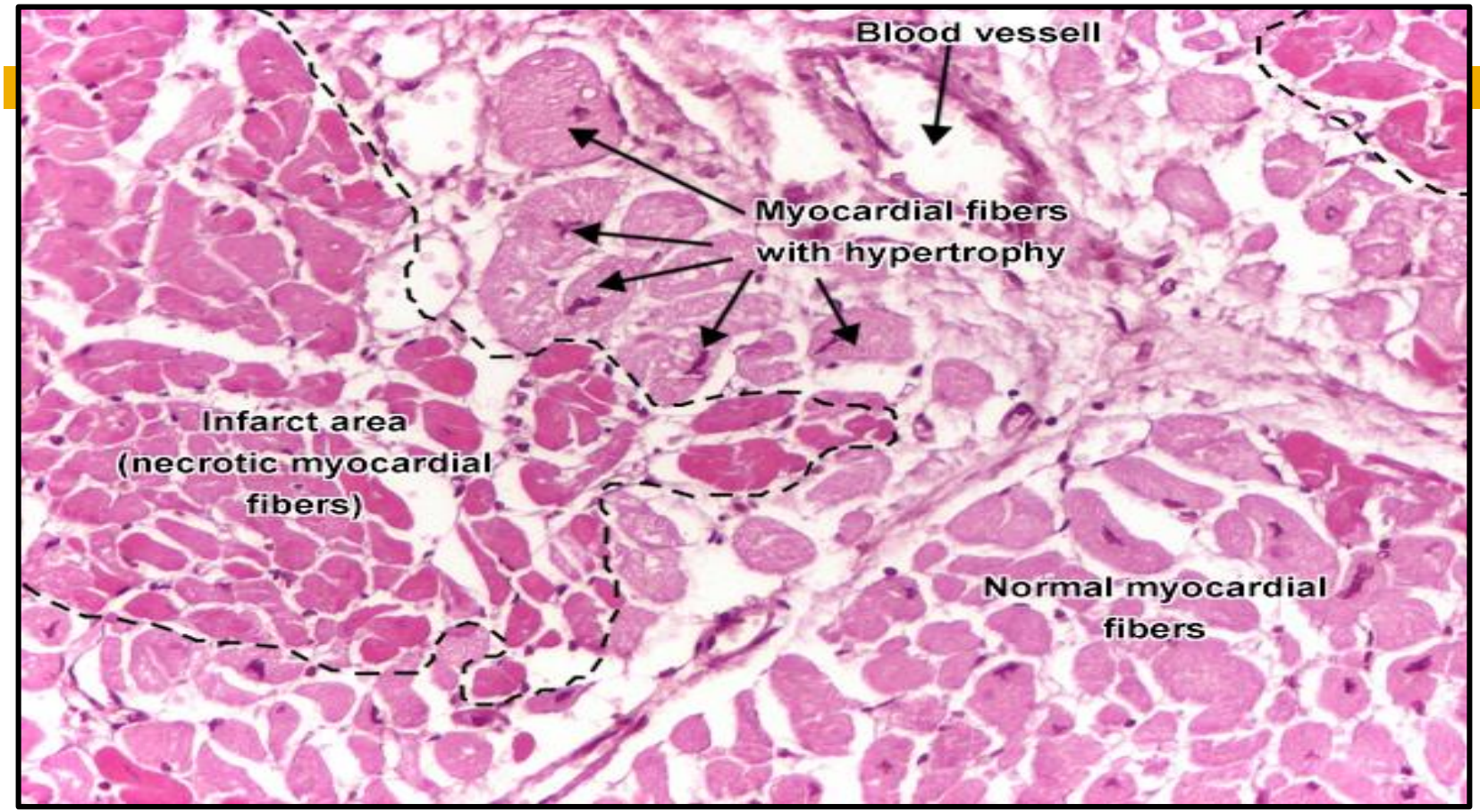


1- ***Patchy coagulative necrosis of myocardial fibers.*** *The dead muscle fibers are structureless and hyaline with loss of nuclei and striations.*

2- ***Chronic ischemic fibrous scar*** *replacing dead myocardial fibers .*

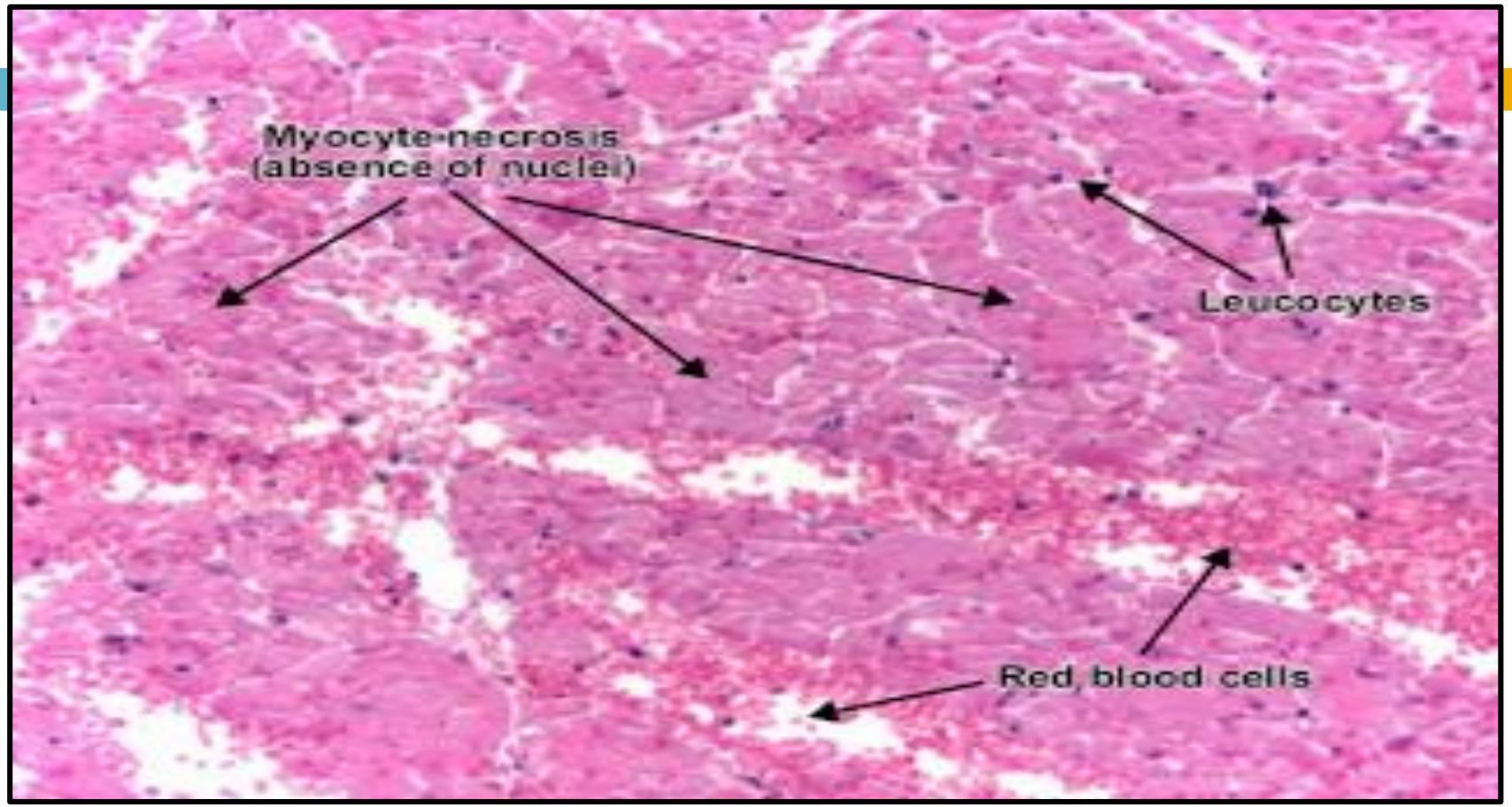
3- ***The remaining myocardial fibers*** *show enlarged nuclei due to ventricular hypertrophy .*

Myocardial Infarction - LPF



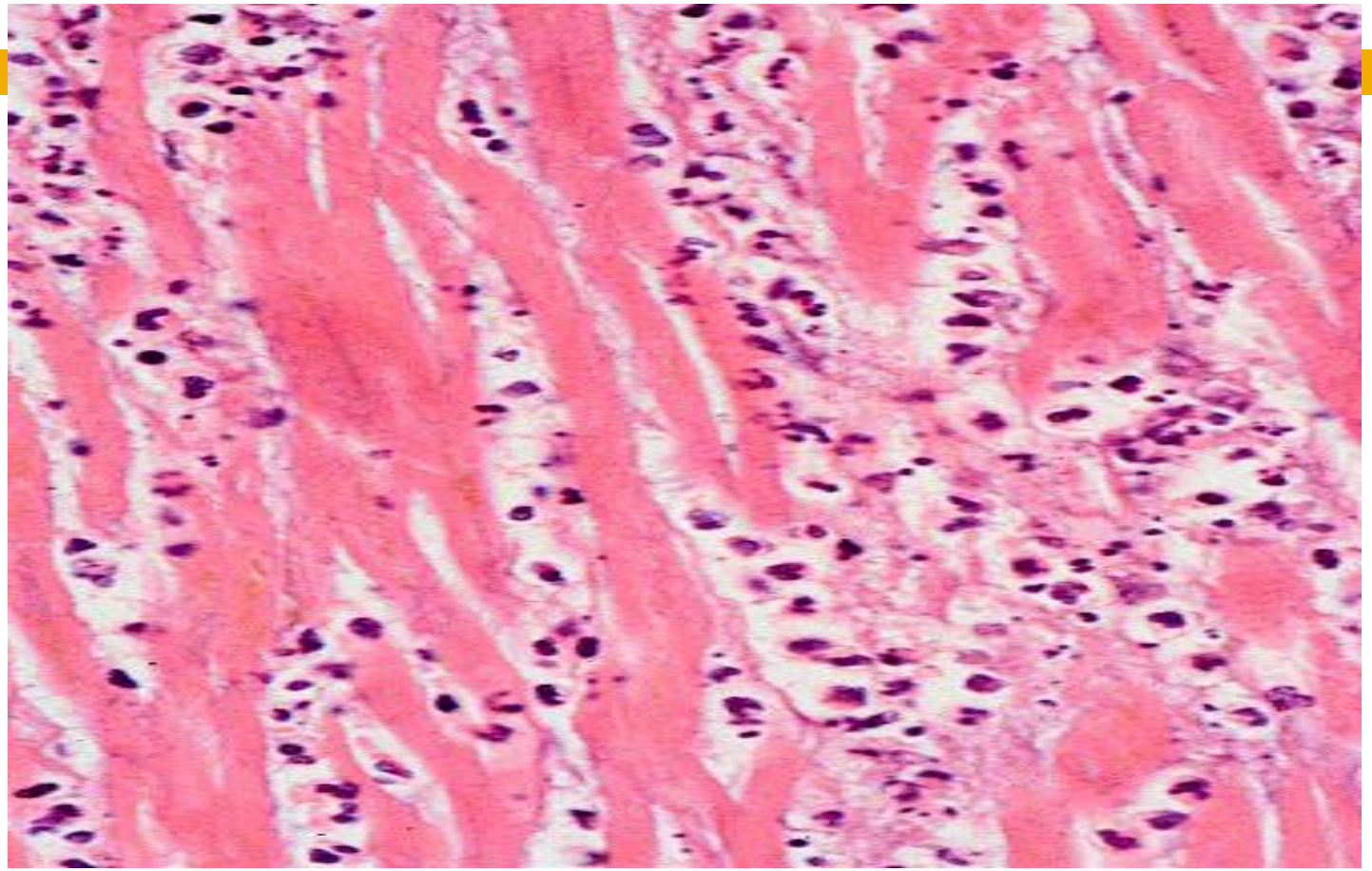
Myocardial infarct *- circumscribed area of ischemic necrosis - coagulative necrosis. In the first 12 - 24 hours, myocardial fibers are still well delineated, with intense eosinophilic (pink) cytoplasm, but lost their transversal striations and the nucleus (left side of the picture). Notice a few myocardial fibers showing hypertrophy (increased size of the fiber, irregular shape of the nuclei)*

Myocardial Infarction - LPF



***Recent myocardial infarct** (in the first 12 - 24 hours): myocardial fibers are still well delineated, with intense eosinophilic (pink) cytoplasm, but lost their transversal striations and the nucleus. The interstitial space may be infiltrated with red blood cells.*

Myocardial Infarction - HPF



***Acute myocardial infarct**, histology. This 3-4 day old infarct shows necrosis of myocardial cells and is infiltrated with **polymorphnuclear** leukocytes.*

Myocardial Infarction - HPF

Microscopic image of Myocardial Infarction

THROMBOEMBOLISM / VASCULITIS

Thromboangitis oblitrans (Buerger's disease)

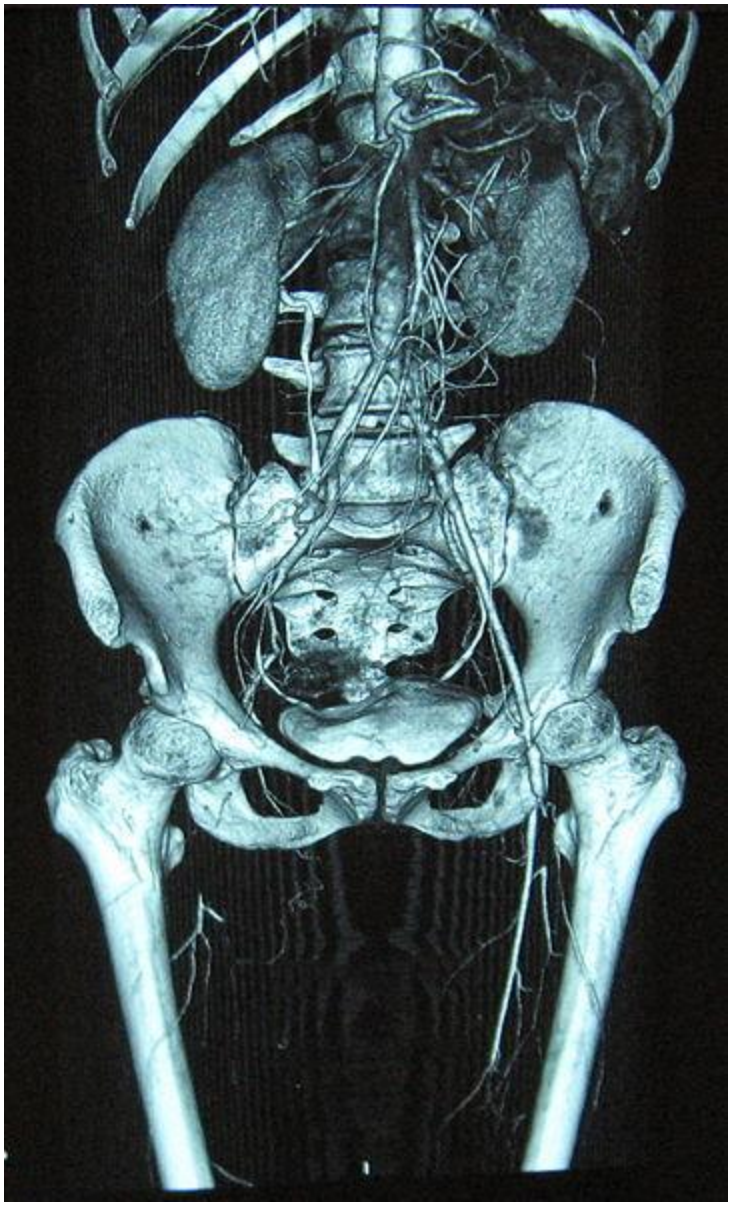
Thromboangitis oblitrans (Buerger`s disease)

Thromboangiitis obliterans (Buerger's disease) is a non atherosclerotic, segmental, inflammatory, vaso-occlusive (thrombotic) disease that affects the small- and medium-sized arteries and veins of the upper and lower extremities.

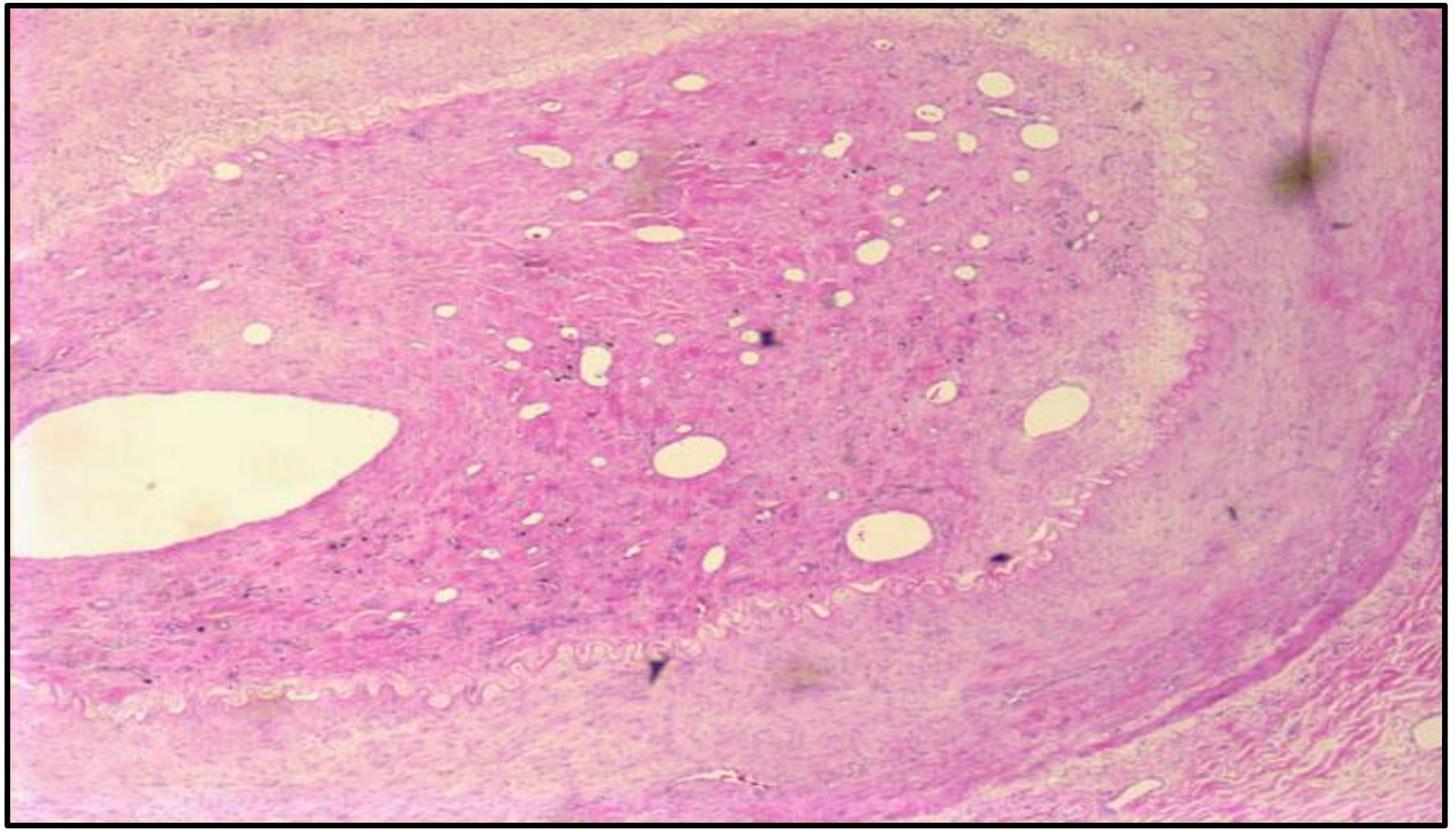
THROMBOANGITIS OBLITERANS (BUERGER'S DISEASE)

- *Pathologic findings of an acute inflammation and thrombosis (clotting) of arteries and veins of the hands and feet (the lower limbs being more common)*

- *Complete occlusion of the right and stenosis of the left femoral artery*



THROMBOANGITIS OBLITERANS (BUERGER'S DISEASE) - LPF



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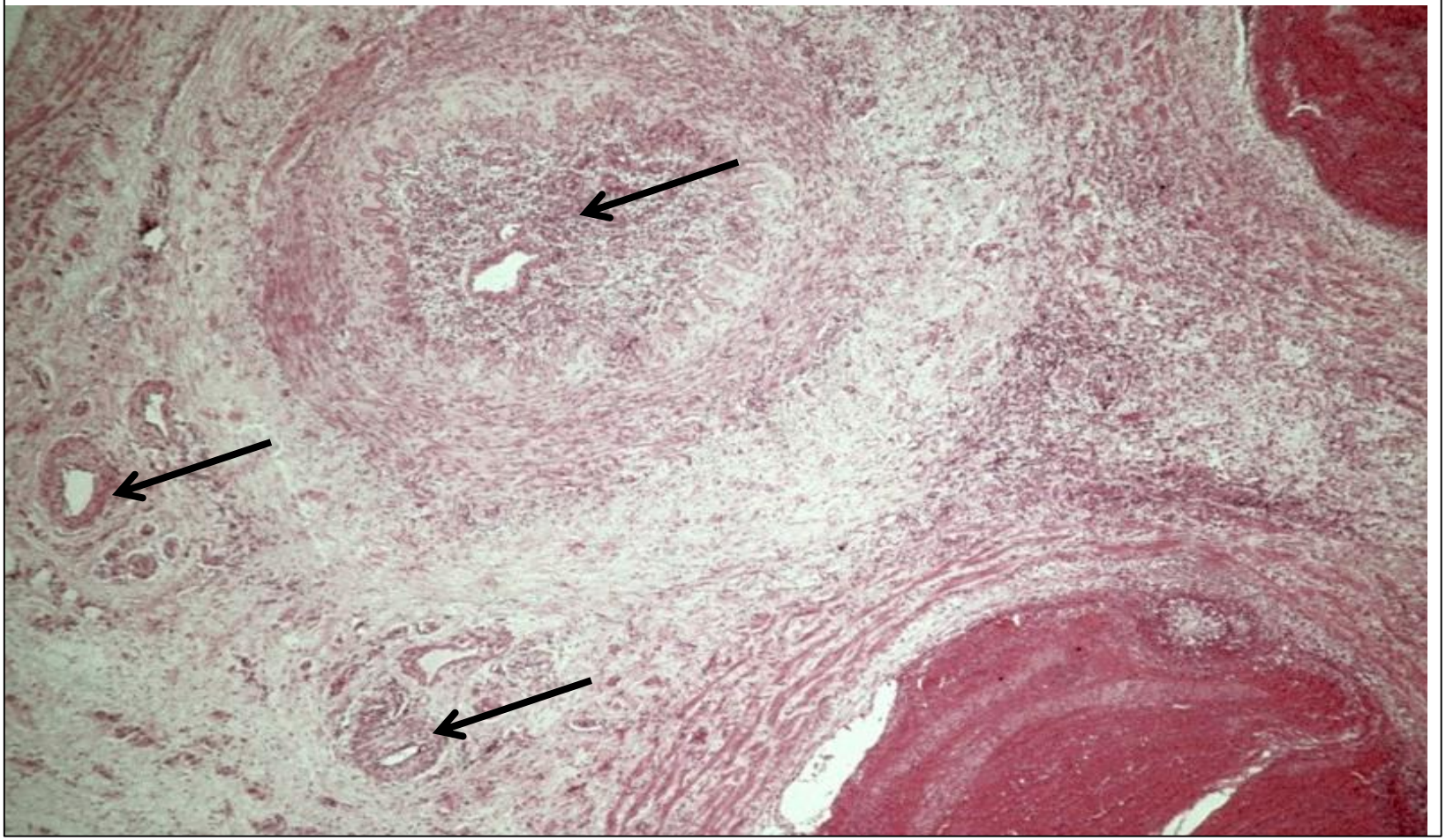
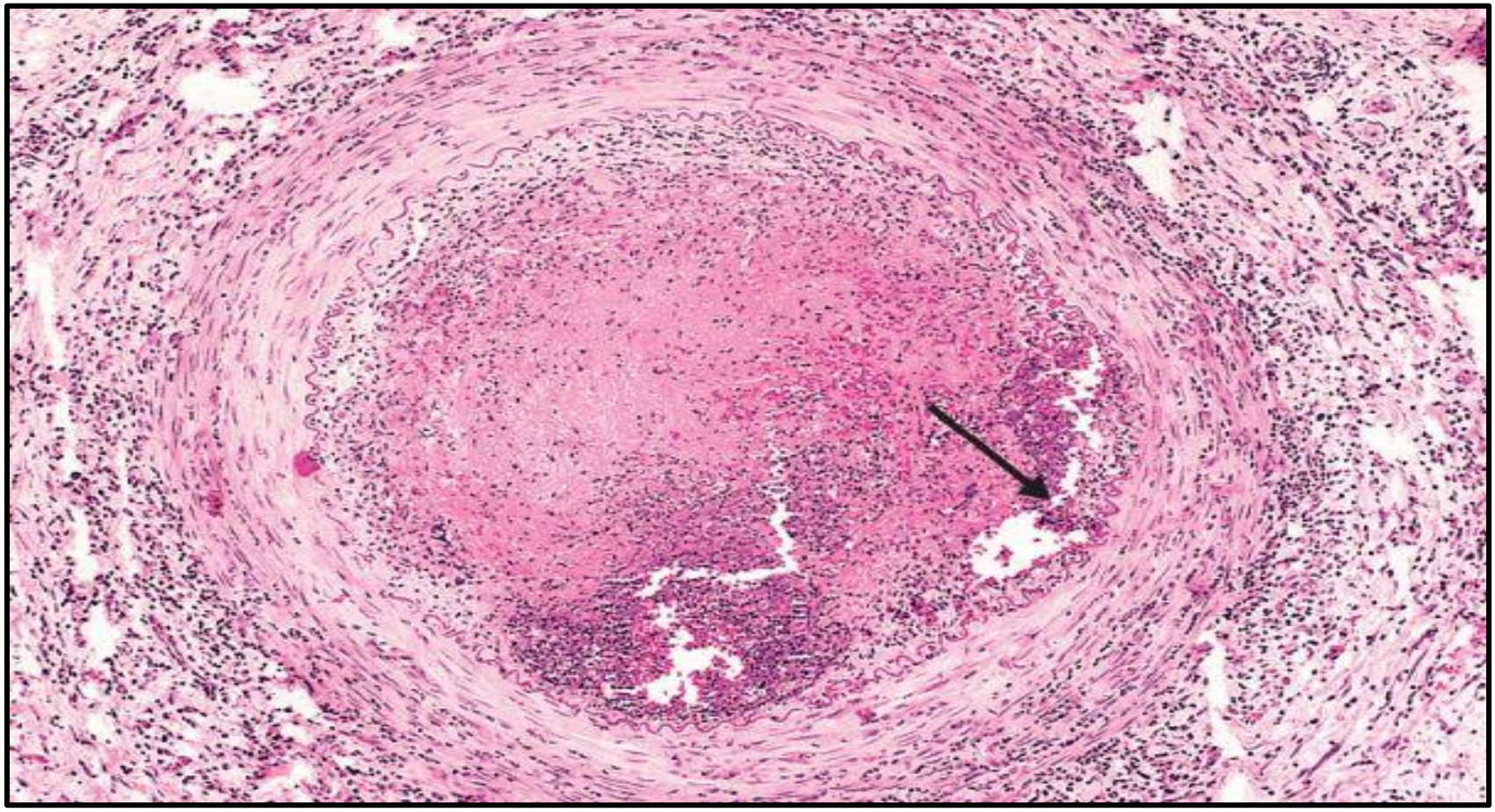
THROMBOANGITIS OBLITERANS (BUERGER'S DISEASE)



Large number of small blood vessels in the dermis show occlusive organized thrombi with recanalization and fibrosis around blood vessels.

THROMBOANGITIS OBLITERANS (BUERGER'S DISEASE) - HPF



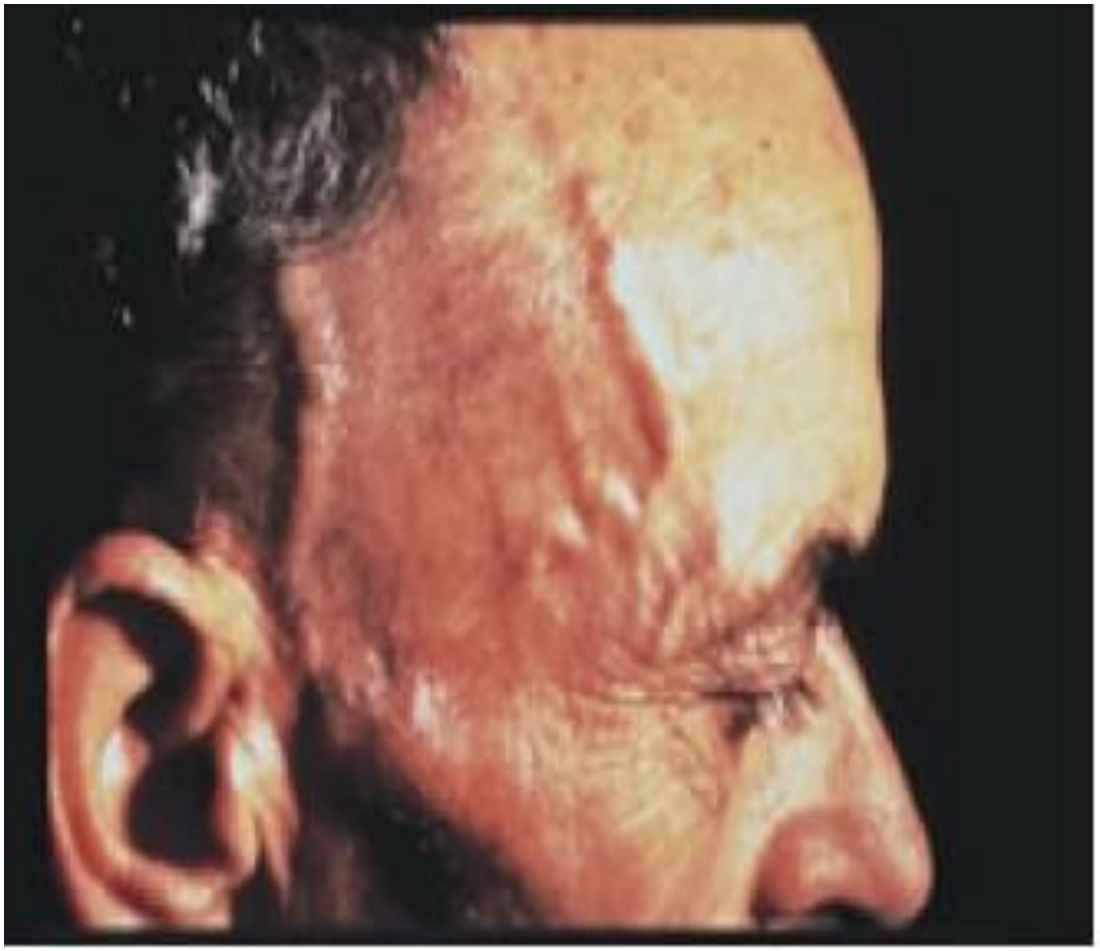
Thromboangitis obliterans (Buerger disease). The lumen is occluded by a thrombus containing abscesses (arrow), and the vessel wall is infiltrated with leukocytes.

Thromboembolism

Atheroma with thrombosis

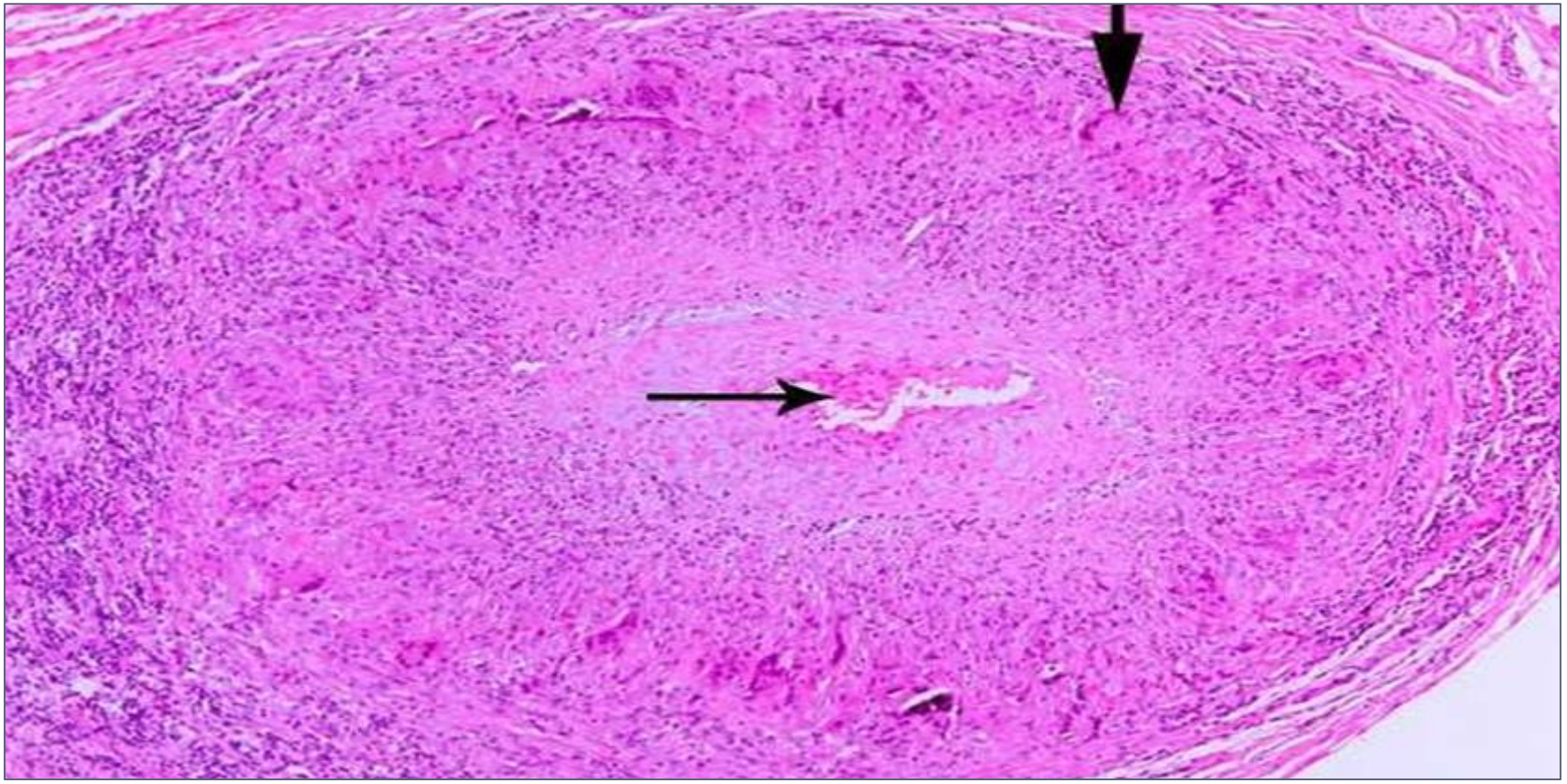
GIANT CELL (TEMPORAL) ARTERITIS

GIANT CELL / TEMPORAL ARTERITIS



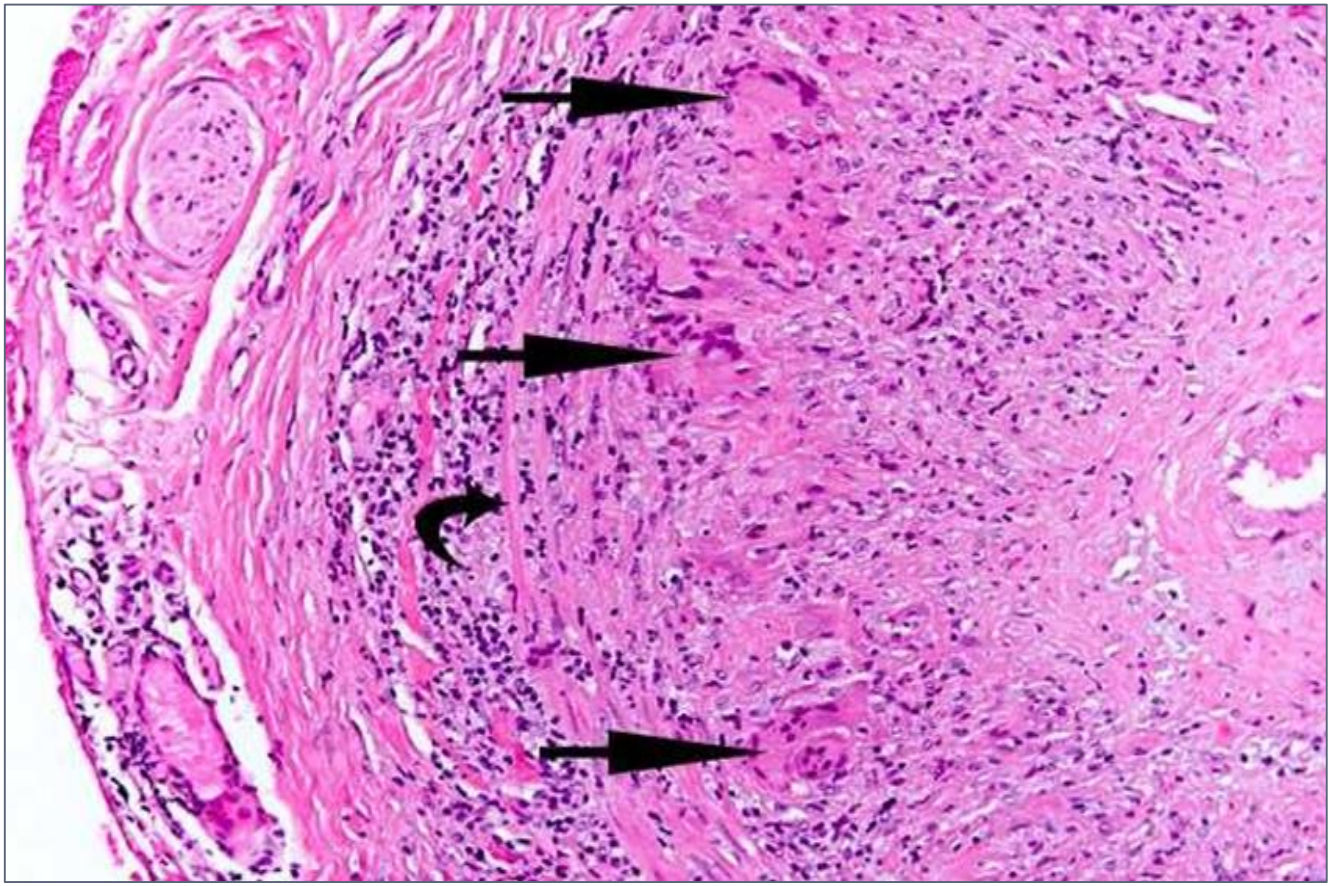
Tender and thickened scalp veins

GIANT CELL / TEMPORAL ARTERITIS - LPF



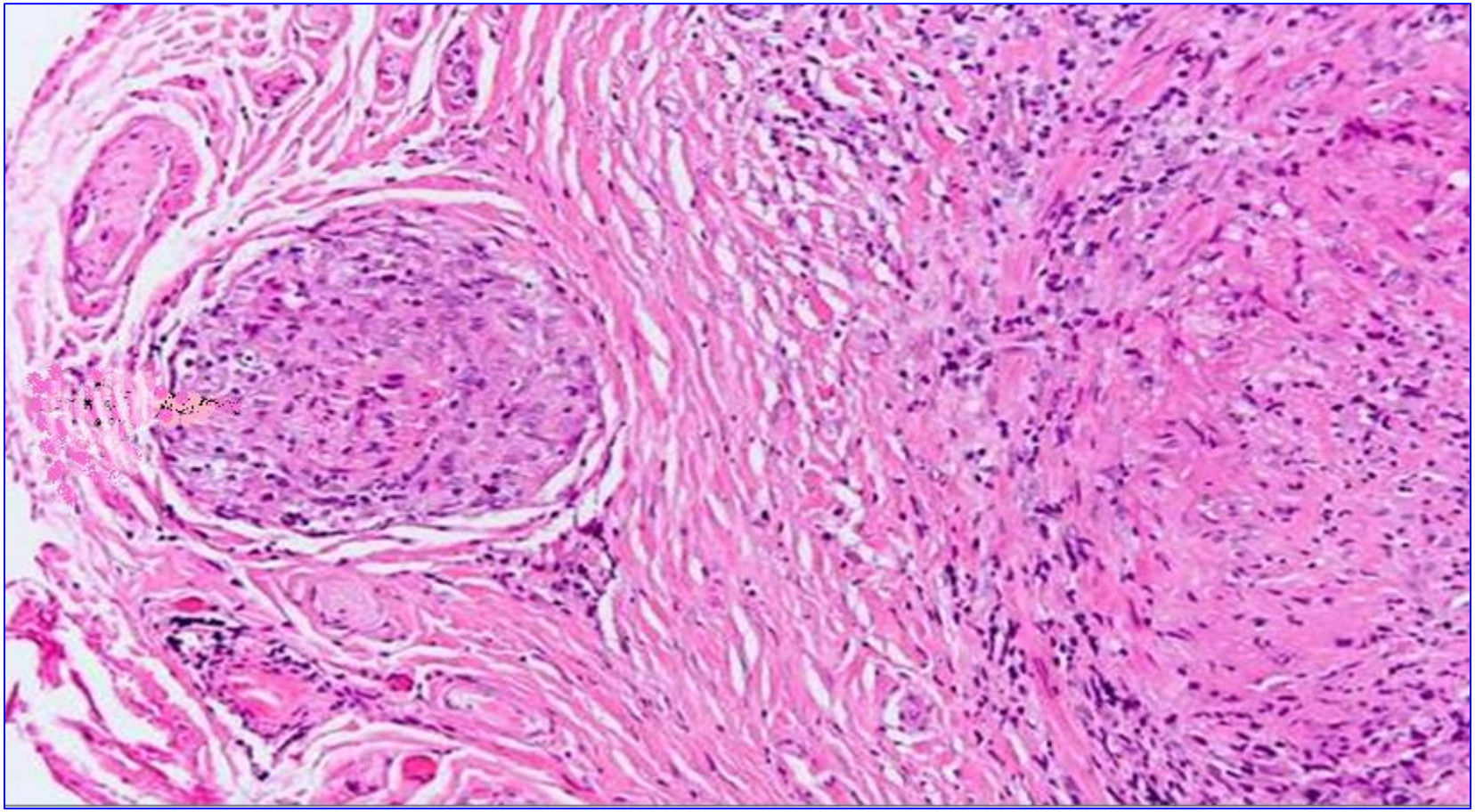
Circumferential involvement of the vascular media is present (vertical arrow pointing downward). Also note the presence of chronic lymphocytic inflammation in the media and adventitia. Reactive intimal fibroplasias lead to luminal stenosis with <10% of its original luminal diameter (thin arrow in the center).

GIANT CELL / TEMPORAL ARTERITIS - HPF



Giant cells can be of Langhans type or foreign-body type (three arrows) and may show fragments of disrupted internal elastic lamina. Note the presence of dense chronic lymphocytic inflammation traversing through circumferential smooth muscle fibers (curved arrow) of vascular media.

GIANT CELL (TEMPORAL) ARTERITIS - HPF



The inflammation can be granulomatous in addition to both acute and chronic inflammatory cells. This photomicrograph shows a single granuloma in the adventitia of the artery. Acute inflammation when present is generally mild and represents an early stage of the disease.

GIANT CELL (TEMPORAL) ARTERITIS - HPF

Disruptions of the elastic lamina with inflammation and giant cells.

***Segmental** inflammatory lesions with **intimal thickening** , granulomatous inflammation with giant cells and chronic inflammatory cells and **internal elastic lamina** fragmentation*

LEUKOCYTOCLASTIC / HYPERSENSITIVITY VASCULITIS

(MICROSCOPIC POLYANGITIS)

Hypersensitivity vasculitis – Clinical sign

Can be a feature of a number of immune disorders, such as *Henoch-Schönlein purpura*.

Hypersensitivity vasculitis might be complicated with glomerulonephritis and hemoptysis due to pulmonary capillaritis

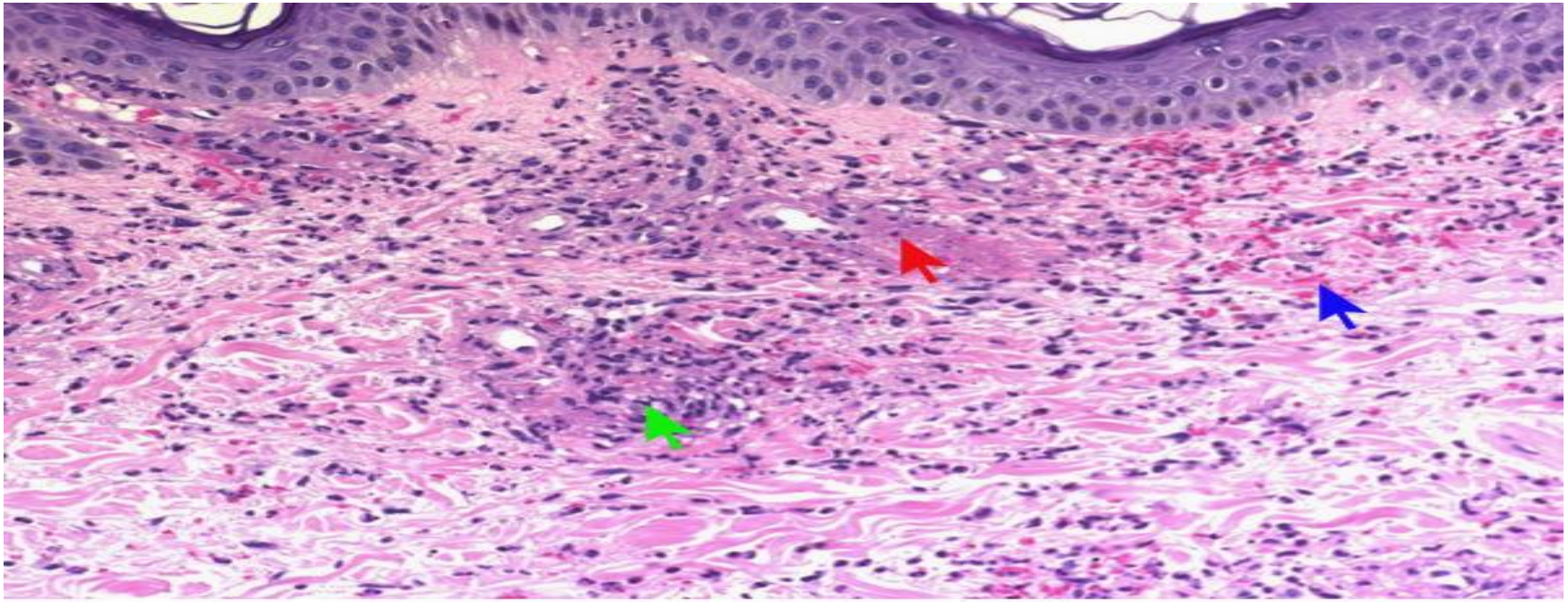
Leukocytoclastic vasculitis - Clinical sign

Can be a feature of a number of immune disorders, such as *Henoch-Schönlein purpura*.

Leukocytoclastic vasculitis

The purpuric eruption (Subcutaneous bleeding patches) of the foot tends to be most pronounced on dependent areas.

Leukocytoclastic vasculitis - HPF



Fibrinoid type necrosis

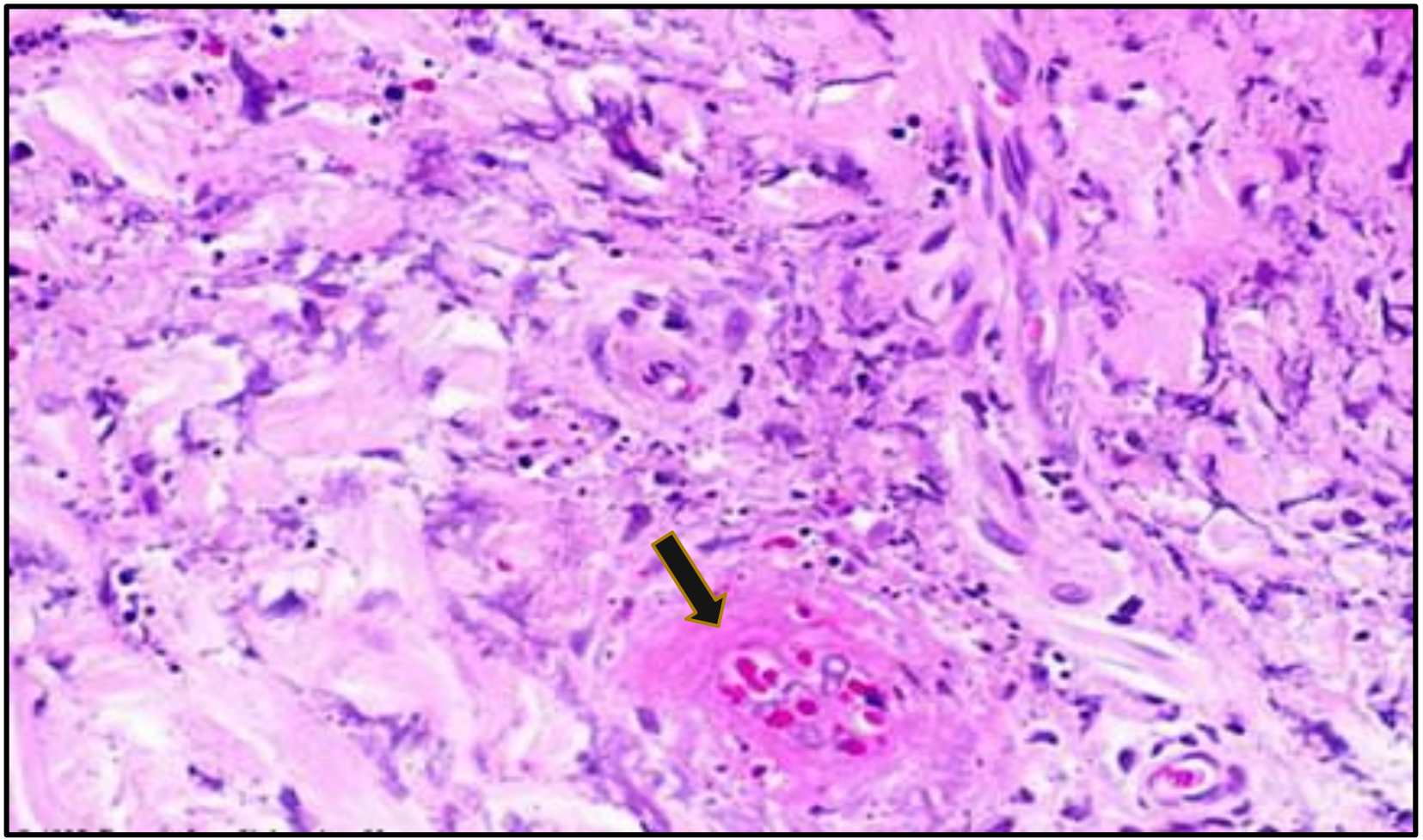
Red cell extravasation

Inflammation

Vasculitis, leukocytoclasis (high power)

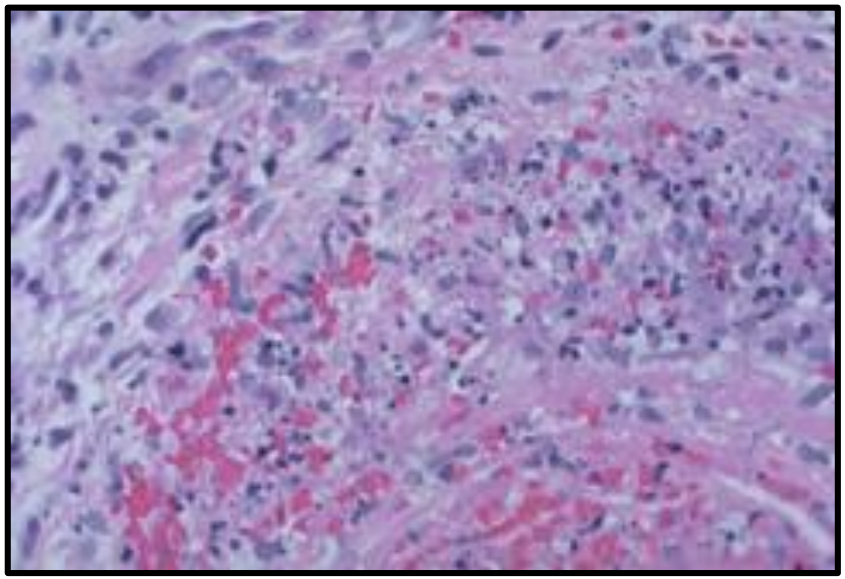
Section of the skin shows fibrinoid necrosis of blood vessels with extravasation of RBCs , neutrophilic infiltration with debris (leukocytoclasis /nuclear dust)

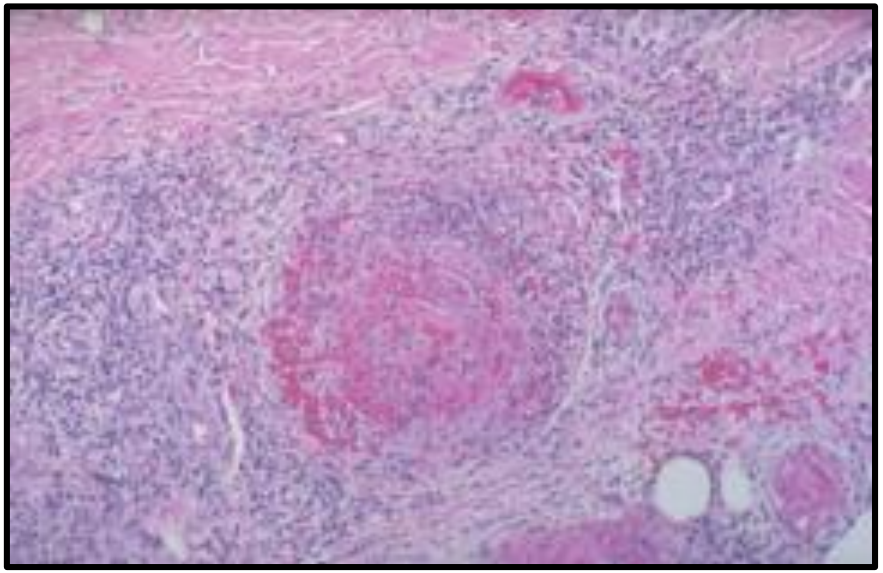
Leukocytoclastic vasculitis - HPF

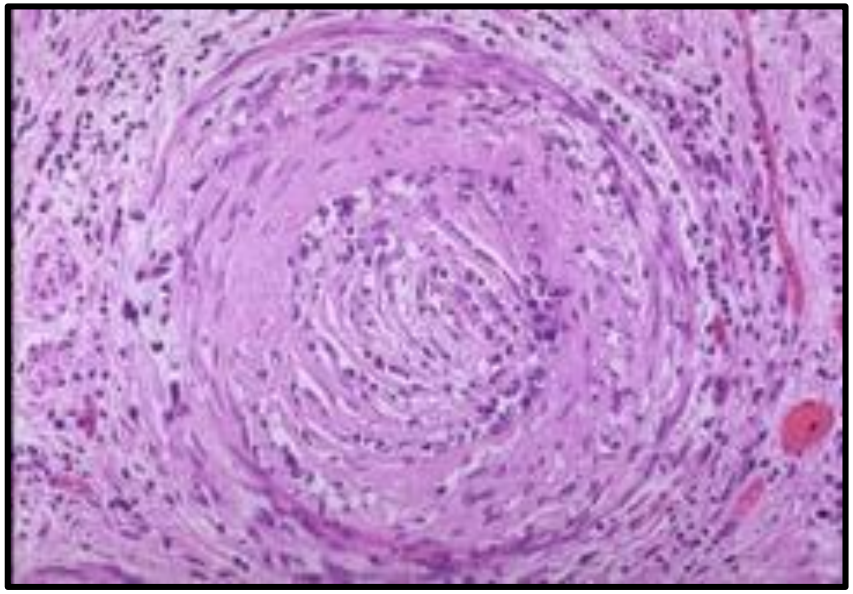


Fibrinoid necrosis of small dermal vessels is present, necessary to establish the diagnosis of leukocytoclastic vasculitis.

Severe vasculitis – Microscopic views







This muscular artery shows a more severe vasculitis with acute and chronic inflammatory cell infiltrates, along with necrosis of the vascular wall


THE END