

Cardio vascular system introductions

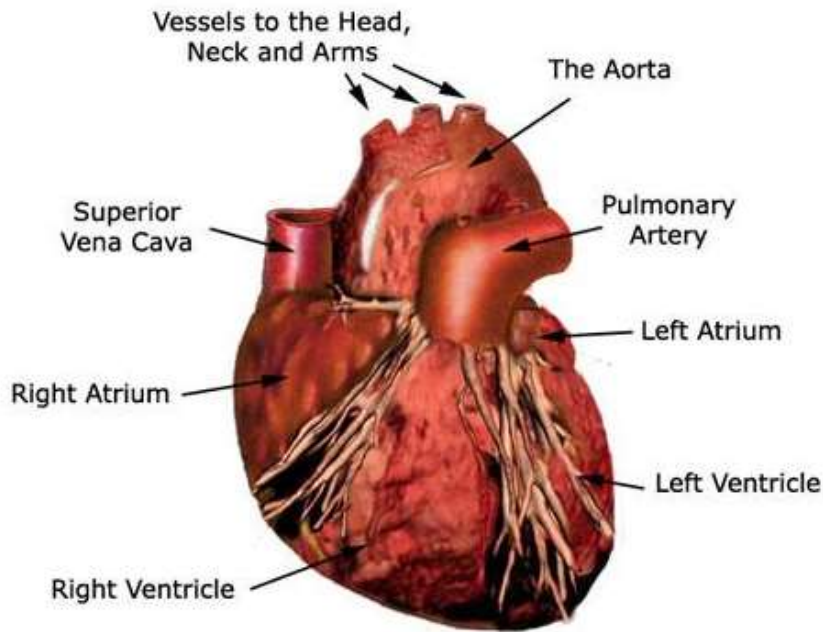
Cardiovascular pathology is the study of diseases that affect the heart and vascular structures. Diseases of the myocardium, endocardium, pericardium, and vascular structures as well as congenital cardiovascular anomalies and tumors of the cardiovascular system will be discussed.

NORMAL MORPHOLOGY

The heart is a conical, muscular organ that in mammals and birds has evolved into a four-chambered pump with four valves. During early fetal development, the heart is converted from an elongated muscular tube into a C-shaped structure by a process termed **looping**. Subsequently, septation occurs to produce the right and left atrial and ventricular chambers and separation of the common truncus arteriosus into the aorta and pulmonary artery. The wall of the heart is composed of three layers (the epicardium, the myocardium, and the endocardium).

Function of the Heart

- The heart is a **double pump**.
- The **right atrium** collects deoxygenated blood from all parts (vena cava).
- The **right ventricle** pumps deoxygenated blood to the lungs (for gas exchange = $\uparrow O_2$, $\downarrow CO_2$) (pulmonary artery)
- The **left atrium** collects oxygenated blood from the lungs (pulmonary vein)
- The **left ventricle** pumps oxygenated blood to all parts (aorta).
- The right and left side fill and empty in unison.
- Each chamber pumps the same volume of blood.
- The wall of the left ventricle is about three times thicker than that of the right ventricle.
- The left ventricle needs more cardiac muscle to give the blood a much stronger push.
- Blood pressure therefore **highest in left ventricle**



REACTION TO INJURY

Cardiac muscle cells respond to injury by a limited spectrum of reactions. Reversible morphologic alterations include cellular growth disturbances that lead to atrophy or hypertrophy. Various sublethal injuries or degenerations, such as fatty degeneration, lipofuscinosis, vacuolar degeneration, and myocytolysis, result in distinctive myocyte alterations. Lethal injury to myocytes results in necrosis or apoptosis. Apoptosis (programmed cell death of myocytes) is increasingly recognized for its role in the development of various myocardial lesions and cardiac diseases. These conditions include cardiac development, ischemic injury, several types of experimentally induced heart failure (ischemia-reperfusion, hypoxia, pressure-overload hypertrophy, and cardiotoxicity).

Abnormalities of the Position of the Heart

Ectopia cordis:

1. Most frequently seen in cattle - (sub cutis, neck)
2. Heart is outside of the thoracic cavity
3. Usually secondary to sternal cleft or failure of thoracic cavity to
4. Some animals can survive for several days to many years close normally .

Dextrocardia:

1. Heart is on the right side rather than the left
2. Often associated with total or partial situs inversus (mirror image of normal left to right symmetry). Also naming (laterally right

Heart)

Golden heart:

The heart is completely on the right side and doesn't effect on the functions of heart.

Congenital cardio vascular anomalies:

there are many type of congenital defect but any types will lead to disturbances in blood flow and include the following:

1-patent ducts anomalies .

2-atrial septal defect

3-transpositions of aorta and pulmonary artery

4-ventricular septal defect

5-aortic coarctation(narrowing or constriction

CIRCULATORY DISTURBANCES

Hemorrhage is a frequent lesion of the pericardium, endocardium, and myocardium. Hemorrhages vary in size from petechiae (1- to 2-mm diameter), to ecchymoses(2- to 10-mm diameter), to suffusive (diffuse). Animals dying from septicemia, endotoxemia, anoxia, or electrocution often have prominent epicardial and endocardial hemorrhages. Horses dying of any cause usually have agonal hemorrhages on the pericardial and endocardia surfaces.

Layers of heart

1-pericardial.

2-myocardium.

3-endocardial .

****Inflammatory Diseases of the Pericardium**

Infectious Process

Extending **outward** from the myocardium

Extending **inward** from the pleural space or mediastinum

Septicemias – most common

1-hydropericardium (its accumulations of clear to light yellow watery serous fluid in the pericardial sac ,and it occurs in disease that have generalized edema such as congested heart failure ,pulmonary hypertension ,septicemia and anemia.

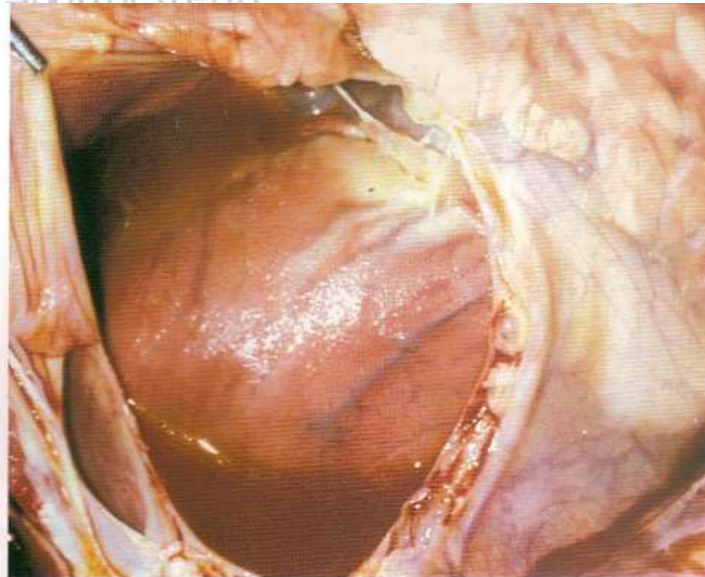


Fig. 10-25 Hydropericardium, pericardial sac, pig.

2-pericarditis(inflammations of pericardial sac and in most cases it caused by infections .viruses are usually responsible also other organism ex bacteria and fungi can be involved ,myocarditis can also be present especially with viral disease ,the appearance of pericarditis varies depending on its cause(**acute pericarditis include**)

a- With viral pericarditis the exudates is typically fibrins, imparting are irregular (even shaggy) appearances to the pericardial surface (so called bread –and butter pericarditis.

b-With bacterial pericarditis the exudates is fibrin Purulent (suppurative) often with areas of frank pus.

c-traumatic pericarditis(hard ware disease):it's a disease of cattle resulting from penetrating of the reticular wall and diaphragm by metal object such as nails and wire and the directions of F.B travel usually anterior ventral through diaphragm and pleura and then in to pericardium of heart so causes pericarditis and fibroin purulent pleuritis

d-Fibrinous Pericarditis – usually hematogenous

Lesions:

Gross: Accumulation of fluid and fibrin within pericardial space. Surfaces of epicardium and pericardial sac may be slightly opaque. Fibrinous adhesions which can be broken down (torn apart) easily, "Bread and Butter."

Micro: Usually only mild inflammation with fibrin on the surface involving the pericardial sac and epicardium in acute disease processes. Variable numbers of neutrophils and macrophages are seen.

*Cause: (usually hematogenous infections)

Outcome:

Early death - often - due to pathogenicity of organism and septicemia. Fibrous adhesions may occur

E-Purulent or Suppurative Pericarditis

Gross: Fluid and liquefied inflammatory debris accumulated within the pericardial sac, usually very malodorous.

Micro: Moderate accumulations of neutrophils and other inflammatory cells on the surface of the pericardial sac and epicardium. Fibrous connective tissue present beneath the layer of inflammatory cells, but dependent upon the time frame of the disease process.

Causes: Associated with various pyogenic bacteria
Often complication of traumatic reticulopericarditis

Note: Either fibrinous or suppurative pericarditis may undergo organization which produces fibrous adhesions of the pericardium to the epicardi.

F-Constrictive Pericarditis

Definition: Chronic inflammatory lesion of pericardium accompanied by extensive fibrous proliferation and eventual formation of fibrous adhesions across the pericardial space.

Results: Compensatory myocardial hypertrophy due to interference of cardiac filling results in eventual congestive heart failure (usually right heart).

Chronic pericarditis range from delicate adhesions to dense, fibrotic scars that obliterate the pericardial space, in extreme cases the heart is so completely encased by dense fibrosis that it cannot expand normally during diastole so called (chronic constrictive pericarditis).

***Sequela of Pericarditis**

1- Effective resolution depends on the extent of the disease and severity .

2-**Mild fibrinous pericarditis** - May resolve completely .

3-**Severe fibrinous pericarditis** - May resolve with only focal or diffuse thickenings of the pericardium or epicardium or focal adhesions may occur.

-**Suppurative pericarditis** - Seldom resolves completely. The resolution that occurs often results in massive adhesions of pericardium to heart (restrictive or constrictive pericarditis) producing congestive heart failure.

Hemopericardium

Definition: accumulation of blood in pericardial space .

Causes:

- 1- Aortic rupture within pericardial sac (horse, turkey)
- 2- Atrial rupture (dog)
- 3- Rupture of the pulmonary artery
- 4- Iatrogenic - intracardiac injections
- 5- Bleeding from a tumor within pericardial sac.

Sequela:

Acute:

Produces cardiac filling and cardiac output
(cardiac shock)

"Cardiac tamponade" - acute

Right heart more sensitive than left heart

Atrium collapse and unable to fill with blood

Chronic – pericardial sac can expand



Disease of myocardium layer:

Myocarditis : inflammations of myocardium with resulting injury and the heart appear normal or dilated ,the ventricular myocardium is typically flabby and often mottled by patchy or diffuse foci of pallor and or hemorrhage mural thrombi can be present, major causes of myocarditis include infections with viruses (influenza),fungi(candida),drug hypersensitivity.....extra.

Types of inflammations that produces myocarditis:

1-suppurative myocarditis.

2-necrotizing myocarditis.

3-hemorrhage myocarditis.

4-lymphocytic myocarditis.

5-hypersensitivity myocarditis .

Microscopically: active myocarditis shows an interstitial inflammatory infiltrate, with focal necrosis of myocytes adjacent to the inflammatory cell.

1-lymphocytic myocarditis:

It's most common type of myocarditis in acute phase the inflammatory lesions either resolve leaving no residual changes or heal by progressive fibrosis.

2-hypersensitivity myocarditis:

Have interstitial and perivascular infiltrates composed of lymphocytes macrophage and a high proportions of eosinophil

3- Giant –cell myocarditis.

It's a morphologically distinctive entity characterized by wide spread inflammatory cellular infiltrates containing multinucleated giant cells formed by macrophage fusions interspersed with lymphocytes eosinophil and plasma cell .giant cell myocarditis probably represents the aggressive end of the spectrum of lymphocytes myocarditis.

DISEASES OF THE ENDOCARDIUM

The endocardium is the innermost layer of the heart. It lines the chambers and extends over projecting structures such as the valves, chordae tendineae, and papillary muscles. The atrial endocardium is thicker than the ventricular endocardium. Purkinje fibers are distributed throughout the ventricles in the sub endocardium.

Type of Endocardial Disease:

1-sub acute.

2-acute type.

Endocarditis (inflammations of endocardial layer and it caused by bacteria infections, or fungi infections and the lesions caused uremia, vascular damaged endocardial ulcerations and if the lesions in vulva are termed (vulvar endocarditis although some lesions extended to the wall of atrium or ventricles and termed (mural endocarditis).

Grossly appearances: The affected vulvas have large adhering friable yellow –gray mass of fibrin (termed vegetation) which can largely occlude the vulva orifice and in chronic cases the fibrin deposit are organized by fibrous connective tissue to produced irregular nodular mass termed (wart like lesions).

Micro appearances: the lesion consist from accumulations layers of fibrin and numerous embedded bacteria colonies under line by a zone of infiltrated leucocytes and a granulations tissue.

Pathogenesis of endocarditis

the lesions include friable, bulky and potentially destructive vegetation containing fibrin, inflammatory cell and microorganisms are present on heart valve, the aortic and mitral valve are the most common site of infections, the vegetation may be single or multiple and may involve more than one valve and the can erode into the underlying myocardium to produce an abscess cavity (ring abscess) ,the appearance of vegetation is influenced by the infecting organism, the degree of host response and antibiotic therapy, fungi endocarditis for example tends to causes larger vegetation than those caused by bacteria infections.



Fig. 10-34 Endocardial mineralization, Johne's disease, heart, left atrial endocardium, cow. The left atrial (LA) endocardium is white, thick, and wrinkled from mineralization.

Heart failure (congestive heart failure):

It's a condition that occurs when the heart is unable to pump blood at a rate that meets the metabolic requirement of the peripheral tissue, inadequate cardiac output is usually accompanied by increased congestions of the relevant venous circulations.

Type of heart failure:

1-left-sided heart failure (in this type the morphological and clinical effects of left sided primarily result from progressive damming of blood

within the pulmonary circulations and the consequences of diminished peripheral blood pressure and flow and it occurs due to systemic hypertension, mitral and aortic valve disease and primary disease of myocardium, the symptoms are primarily related to pulmonary congestion and edema.

2-right-sided heart failure (its most commonly due to left-side heart failure or to primary pulmonary disease, it is associated with peripheral edema and visceral congestion).

CARDIAC HYPERTROPHY

Definition: Reversible increase in the **mass** but **not number** of myocardial cells.

Types of Hypertrophy:

1-Concentric Cardiac Hypertrophy (Pressure Overload Hypertrophy)

Defined as an increase in the mass of the ventricle without accompanying increase in end diastolic volume.

Causes:

- 1-Pressure overloads.
- 2-Aortic stenosis (LVH).
- 3-Pulmonic stenosis (RVH).
- 4-Pulmonary hypertension.

2-Eccentric Cardiac Hypertrophy (Volume Overload Hypertrophy)

Defined as an increase in myocardial mass accompanied by an increased end diastolic volume.

Causes:

- 1-Volume overloads
- 2- Local pathological changes

- a-valvular insufficiency
- b-congenital defect with shunt
- 3-. Increased blood volume

The blood vessels

Arteriosclerosis: hardening of the arteries and it's a generic term reflecting arterial wall thickening and loss of elasticity, the arteriosclerosis affects small arteries and arterioles the two anatomic variants ,hyaline and hyperplastic are both associated with vessel wall thickening and luminal narrowing that may cause downstream ischemic injury , Arteriosclerosis is most often associated with hypertension and diabetes mellitus, Arteriosclerosis is characterized by intimal fibrosis of large elastic arteries

Arteriosclerosis is an age-related disease that occurs frequently in many animal species but rarely causes clinical signs. The disease develops as chronic degenerative.

Grossly: The lesions are seen as slightly raised, firm, white plugs.

Microscopically: initially the intima is thickened by accumulations of mucopolysaccharide, and then proliferations of s,m,c in tunica media, and fibrous tissue infiltrations and fragmentations of internal elastic lamina are common

Type of Arteriosclerosis:

1-hyaline Arteriosclerosis.

2-hyperplastic Arteriosclerosis.

-hyaline Arteriosclerosis(this vascular lesions consist of a homogeneous pink hyaline thickening of the wall of arterioles with loss of underlying structural detail and narrowing of the lumen ,and this type is more generalized and more severe in patients with hypertension .

-hyperplastic Arteriosclerosis (related to more acute or severe elevations of blood pressure and it is a characteristic of (but not limited to) malignant hypertension typically when diastolic pressure over 120mm/hg and associated with acute cerebral or renal injury

and it characterized by fibrinoid deposit and vessel wall necrosis (necrotizing arterioles) particularly prominent in kidney.

Atherosclerosis:

Is an intima –based lesion organized into a fibrous cap and an atheromatous (gruel –like) core and composed from inflammatory cell, lipids, and necrotic debris Atherosclerosis, the vascular disease of greatest. , atherosclerosis is characterized by intimal and medial lipid deposits in elastic and muscular arteries, and arterial medial calcification has characteristic mineralization of the walls of elastic and muscular arteries.

importance in human beings, occurs only infrequently in animals and rarely leads to clinical disease, such as infarction of the heart or brain. The principal alteration is accumulation of deposits (atheroma) of lipid, fibrous tissue, and calcium in vessel walls, which eventually results in luminal narrowing. Many studies have established that the pig, rabbit, and chicken are susceptible to the experimental disease produced by the feeding of a high-cholesterol diet; the dog, cat, cow, goat, and rat are resistant.

Grossly: arteries of heart are thicken, firm, yellow-white colour.

Microscopic: lipids globules accumulated in cytoplasm of smooth muscle often called (foam cell) and also presence of macrophage, necrosis, and fibrosis may develop in some arterial lesion.

Vasculitis: inflammations of vessel wall although there are frequently systemic manifestations (fever ,malaise,...)specific sign depended on the vascular bed that is involved.

Arteritis

occurs as a feature of many infections and immune-mediated diseases Often, all types of vessels are affected rather than only arteries, and then vasculitis or angiitis is the term applied to the lesions. In inflamed vessels, Arteritis and vasculitis can develop from endothelial injury caused by either infectious agents or immunemediated mechanisms or may be caused by local extension of suppurative and necrotizing inflammatory processes.

Grossly

the vascular injury is reflected by severe edema of the intestinal wall and mesentery accompanied by notable accumulation of serous fluids in body cavities. wall and results in loss of elasticity ("hardening of the arteries") and luminal narrowing. The abdominal aorta is most frequently affected, but other elastic arteries and peripheral large muscular vessels may be involved.

Causes of arteritis:

- 1-parastic infections.
- 2-viral infections .
- 3-bacterial infections.
- 4-fungal infections.

Venous disease:

- 1-dilatations of vein (venous dilatations from awakened vascular wall).
- 2-phlebitis (inflammations of vein and may arise from systemic infections ,irritant substances, local extended of infection).
- 3-omphalitis (navel ill):
Inflammations of umbilical vein often occur in neonatal farm animal due to bacterial infections immediately following delivery.

Disease of lymph vessels:

- 1-hereditary lymph edema.
- 2-dilatations of lymph vessels.
- 3-inflammations of lymph vessels (nodular suppurative lymphangitis, granulomatous lymphoangitis)

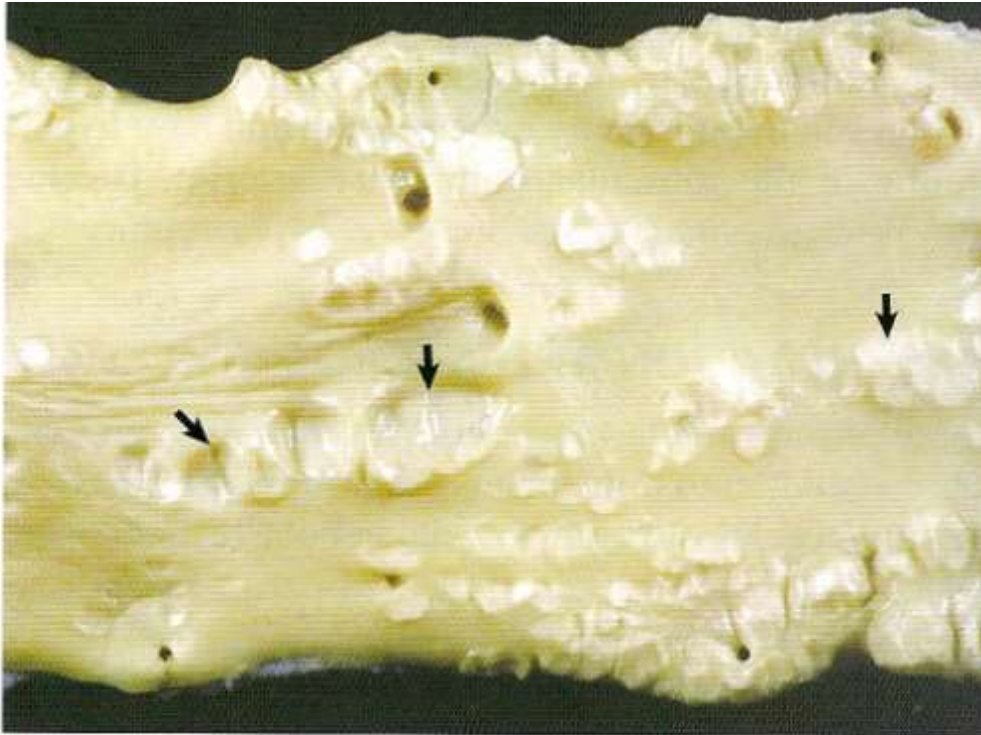


Fig. 10-84 Johne's disease, arteriosclerosis, aorta, cow. Multiple prominent, white, mineralized foci are in the tunica



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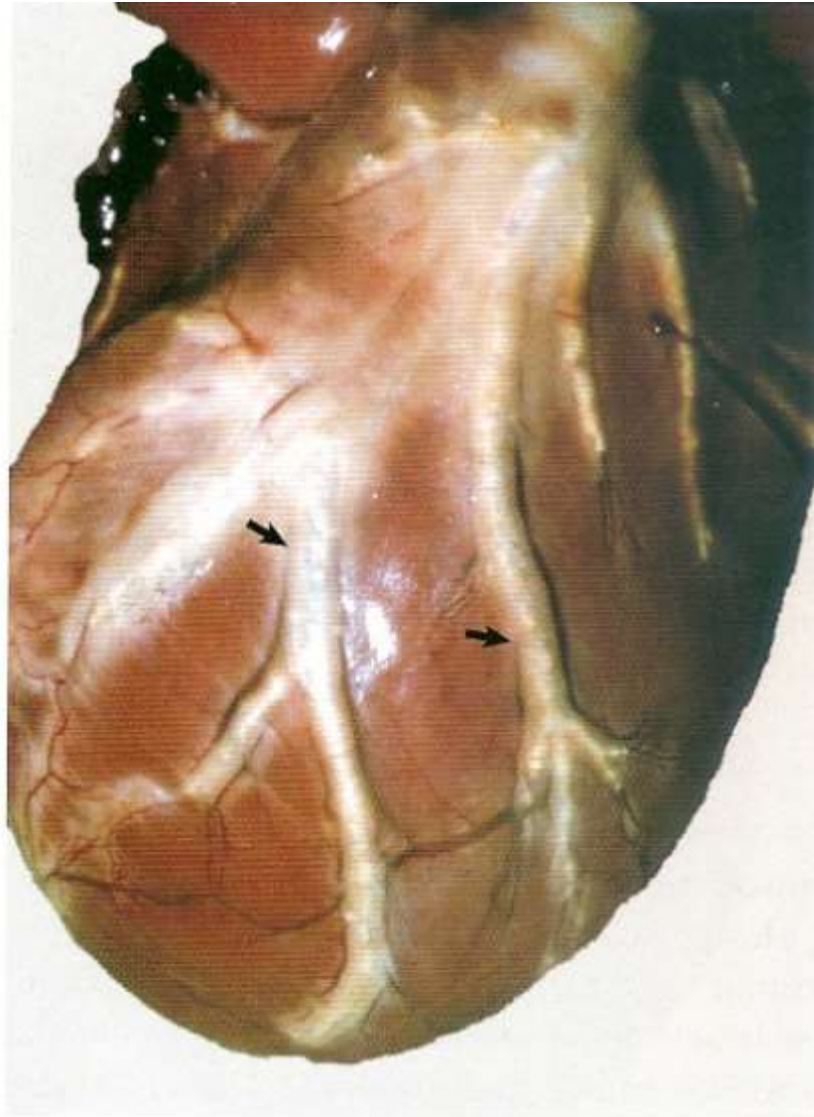


Fig. 10-82 Coronary atherosclerosis, hypothyroidism heart, left ventricle, dog. The affected coronary arteries prominent and cordlike (arrows) with thickened walls. Th

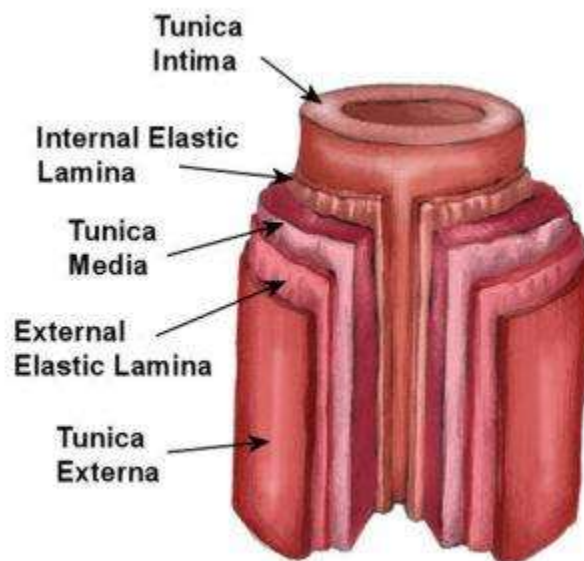
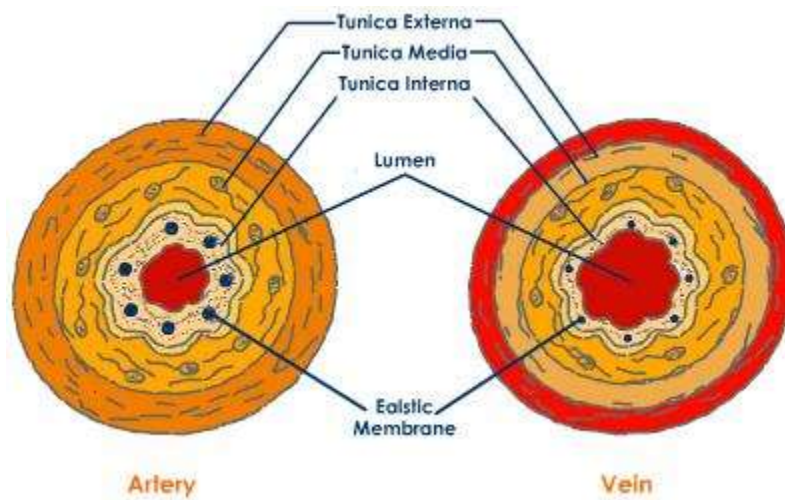
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Cardiac neoplasms:

1- hemangio sarcoma (tumor of right atrium).

2- Malignant lymphoma.

3- lymphosarcoma (tumor of myocardium).



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