

Cardiovascular System Pathology

The Cardiovascular System

- A closed system of the heart and blood vessels
 - The heart pumps blood
 - Blood vessels allow blood to circulate to all parts of the body
- The function of the cardiovascular system is to deliver oxygen and nutrients and to remove carbon dioxide and other waste products

The Heart: Coverings

- Pericardium – a double serous membrane
 - Visceral pericardium - Next to heart
 - Parietal pericardium - Outside layer
- Serous fluid fills the space between the layers of pericardium

The Heart Wall: 3 layers

- Epicardium
 - Outside layer
 - This layer is the visceral pericardium
 - Connective tissue layer
- Myocardium
 - Middle layer
 - Mostly cardiac muscle
- Endocardium
 - Inner layer
 - Endothelium

The Heart: Chambers

- Right and left side act as separate pumps
- Four chambers
 - Atria
 - Receiving chambers
 - Right atrium
 - Left atrium
 - Ventricles
 - Discharging chambers
 - Right ventricle
 - Left ventricle

- The pathology of the cardiovascular system is examined in the following order;
- I. Heart sac and heart pathology,
- II. Pathology of blood vessels,
- III. Pathology of lymph vessels.

HEART SAC AND HEART PATHOLOGY

Heart and heart sac anomalies

Acardia:

- This is the **absence of the heart** and the heart sac. This can be seen in one of the adjacent twins.

Hemiocardius:

- A twin fetus with a **rudimentarily formed heart**.

Acardius acephalus: The most common form, **with absence of the head, thorax and upper extremities**.

Acardius amorphus

- The least differentiated form, in which only **bones, cartilage, muscle, fat, and blood vessels are seen**.

Acardius acornus:

- This form lacks a thorax, with the umbilical cord insertion in the head. Despite the **absent heart, rudiments of thoracic structures** are often found.

Heart and heart sac anomalies

- **Ectopia cordis:** the heart may lie in *extrathoracic, presternal, or intra-abdominal positions*.
- In this case, the heart is either in the pericardium or completely naked.

Heart and heart sac anomalies

- Several locations of the aberrant heart have been described, including **cervical, abdominal** and, **pectoral**
- Ectopia cordis cervicalis
- Ectopia cordis abdominalis
- Ectopia cordis pectoralis

Heart and heart sac anomalies

Cor biloculare:

- A two-chambered heart.

Cor biloculare is due to failure of development of the walls that normally separate the two atria (interatrial septum) and the two ventricles (interventricular septum).

Cor triloculare biatriorum:

- Three-chambered heart
- Due to absence of the inter-ventricular septum.

Heart and heart sac anomalies

Persistent truncus arteriosus:

- Is a congenital heart disease that presents at birth.
- In this condition, **fails to divide into the pulmonary trunk and aorta.**
- This results in **one arterial trunk arising from the heart** and providing mixed blood to the coronary arteries, pulmonary arteries, and systemic circulation.

Heart and heart sac anomalies

Transposition of the great arteries:

- Is a congenital heart defect.
- In transposition of the great arteries,
- **The aorta** is connected to the **right ventricle**, and **the pulmonary artery** is connected to the **left ventricle**.

Failure of Closure of Fetal Cardiovascular Shunts

Interventricular Septal Defect.

- A ventricular septal defect indicates **failure of complete development of the interventricular septum** and allows the shunting of blood between the ventricles.
- The defect occurs in many species.
- Among breeds of dogs, English bulldog, English springer spaniel, and West Highland white terrier.

Failure of Closure of Fetal Cardiovascular Shunts

Atrial Septal Defect.

- **The failure of closure of the foramen ovale,**
- Faulty development of the **interatrial septum.**
- Although this defect occurs in all domestic animal species, dog breeds with greatest frequency of this defect are the boxer, Doberman pinscher, and Samoyed.

Failure of Closure of Fetal Cardiovascular Shunts

- In 1888 Fallot described in detail the four anatomical characteristics of **tetralogy of Fallot**, a congenital heart defect responsible for blue baby syndrome.

Heart and heart sac anomalies

Trilogy of Fallot:

- 1. Atrial septal defect (patent foramen ovale)** - Interatrial connection caused by an opening in the atrial septum causes right-to-left shunting of blood.
 - 2. Pulmonary valve stenosis**
 - 3. Hypertrophy of the right ventricle** - As a result of the increased effort needed to propel the blood through the stenotic pulmonary valve, hypertrophy of this cardiac chamber occurs and completes the trilogy of Fallot.
- Cyanosis is typically encountered in patients suffering from Trilogy of Fallot.

Failure of Closure of Fetal Cardiovascular Shunts

- ***Tetralogy of Fallot:***
- Is a combination of four congenital abnormalities.
- The four defects include:
 1. **A ventricular septal defect (VSD),**
 2. **Pulmonary valve stenosis,**
 3. **Overriding aorta**
 4. **Right ventricular hypertrophy** (A thickened right ventricular wall).
- Tetralogy of Fallot is a complicated cardiac anomaly seen in all animal species with four lesions

Failure of Closure of Fetal Cardiovascular Shunts

- **Eisenmenger complex:**
- The wall between the ventricles is open (*Ventricular septal defect*)
- *Displacement of the aorta and pulmonary artery*
- *Hypertrophy of the right ventricle .*
- Excessive cyanosis

Failure of Normal Valvular Development

Pulmonic Stenosis.

- Pulmonary stenosis (also called **pulmonic stenosis**) is when the **pulmonary valve** (the valve between the right ventricle and the pulmonary artery) is too small, **narrow**, or stiff.
- Pulmonic stenosis has been recognized as a **frequently occurring anomaly in dogs** and is inherited in the beagle.
- Other breeds in which this lesion is frequent are basset hound, boxer, Chihuahua, Chow Chow, cocker spaniel, English bulldog, Labrador retriever, mastiff, Newfoundland, Samoyed, schnauzer, and terrier.

PERICARDIAL DISEASE

- Non-inflammatory lesions of the pericardium
- ***Hydropericardium***: The pericardial sac normally contains a very small quantity of clear, serous fluid.
- *Any excess in the volume of clear fluid is referred to as hydropericardium.*

Hydropericardium

- Hydropericardium is often part of *generalized anasarca* and is thus seen in many **cachectic** illnesses, perhaps as the result of **hypoalbuminemia**, and in **congestive heart failure**

Hemopericardium

- ***Hemopericardium:*** *The term hemopericardium is limited to accumulations of pure blood in the pericardial cavity, and should not apply to mixtures of blood and serous fluid.*

Hemopericardium

- **Traumas** and **costal fractures** on the heart and pericardium.
- **Rupture** of aneurysms developed in the coronary arteries,
- **Haemorrhages** related tumors that form around the heart,
- **Blood clotting disorders** (vit K inadequacy or absence, Dikumarol poisoning)

Hemopericardium

- If the blood collected in the heart sac is too large or suddenly filled, the heart remains **under pressure** and **stops** within a short time.
- This event is called **“Heart Tamponade”**.

Hemopericardium

- A small amount of bleedings that do not affect the cardiac motions is eliminated by *lymphogen resorption* or a *resorptive inflammation*.
- In this case, adhesions due to common scarring occur.

Serous atrophy of pericardial fat

- In cachexia of any cause
- There is progressive mobilization of depot fat
- The lipid vacuoles are reduced in size, they are replaced by proteinaceous fluid
- Increase in interstitial fluid
- The depots are converted to gray, gelatinous masses that may be flecked by small white foci of fat necrosis.

Pericarditis

- The term pericarditis refers to the **inflammation** of the mesothelium layer covering the inner face **of the heart sac**.
- Pericarditis occurs during the process of many diseases such as, **pleuritis** and **peritonitis**.
- In other words, pericarditis has also infectious character.
- Except traumatic pericarditis, the disease occur in pericard **hematogenously**.
- The majority of pericarditis is exudative.

Pericarditis

- Pericarditis is divided into four groups according to the mechanism (pathogenesis);
 - A. Traumatic pericarditis,**
 - B. Infectious or secondary pericarditis,**
 - C. Sterile pericarditis,**
 - D. Special inflammation of the heart sac.**

Traumatic pericarditis

(Pericarditis traumatica)

- This type of trauma is usually a disease specific to **cattle**.
- In cattle, pericarditis is usually caused by long, **thin sharp foreign bodies** (wire, needles, nails) that **penetrate the reticulum, diaphragm** and **pericardial sac** resulting in traumatic pericarditis.
- These cases are rarely found in sheep and goats and other animal species.

Pericarditis traumatica

- If the foreign body gets **stuck directly into the heart**, death occurs soon.
- In this case, one of the coronary vessels or the ventricular wall of the heart is punctured.
- Regarding the developing bleeding, the heart sac is slowly filled with blood. So, the animal dies as a result of **heart tamponade**.
- If pericarditis traumatica **persists for several days**, the animal dies with severe edema or infection in 2-3 days. In this case, death is the result of asphyxia or toxemia.
- **In cases of chronic pericarditis traumatica, the animal was saved from death.** However, it is weak in terms of condition. It can never recover and its efficiency is very low. Therefore, it is referred to the **slaughter in a short time**.

Infectious (Secondary) Pericarditis

- This type of pericarditis occurs during the course of many infections in the body. The agents come in a **hematogenous** way.
- It also occurs as a retrograde lymphogen from the lymph nodes
- Such pericarditis are classified according to the **nature of the exudate**;
 1. **Serous and sero-fibrinous** pericarditis,
 2. **Fibrinous** pericarditis
 3. **Purulent** pericarditis
 4. **Gangrenous** pericarditis
 5. **Haemorrhagic** pericarditis

Serous and Sero-Fibrinous pericarditis (Pericarditis serosa et serofibrinosa)

- An acute inflammation.
- The exudate in the heart sac is **serous**. However, *sometimes fibrin* is present in the sac.
- It occurs in more slow infections and occurs in all animal species.
- **Pleuritis, peritonitis and arthritis** occur with pericarditis.
- For example; Septicemia of newborns (E. coli and Salmonella inf.), Pasteurellosis, Bovine and Horse plague, Horse Influenza, Swine swollen, Swine fever, Infantile disease, Swine disease, Dog youth disease and Leptospirosis, Also common cold and allergic factors .

Serous and Sero-Fibrinous pericarditis (Pericarditis serosa et serofibrinosa)

- Pericarditis begins with severe **hyperemia** of the vessels.
- A large amount of **exudate** exudates from the expanding vessels into the sac. This exudate is rich in **leukocyte** and **fibrin**.
- Inner side of the heart sac is **swollen** and the cells are poured into the exudate in the sac.
- **The exudate accumulated** in the sac begins to coagulate in the form of fibrin nets and pellets in a short time. In other words, ***pseudomembrane*** formation is observed.
- Most of the pericarditis remains at this stage. And it heals with the organization of pseudomembrane.

Fibrinous Pericarditis (Pericarditis fibrinosa)

- It is a subacute and chronic inflammation of the heart sac **with fibrin**. It is a type of inflammation that occurs frequently in animals and humans.

Fibrinous Pericarditis (Pericarditis fibrinosa)

- Fibrinous pericarditis is usually the result of **hematogenous microbial infections**, but it may arise by lymphatic permeation from an inflammatory process in adjacent tissue.
- In *cattle*, fibrinous pericarditis is commonly part of pasteurellosis, blackleg, contagious bovine pleuropneumonia, clostridial hemoglobinuria, and some of the neonatal coliform infections that enter via the umbilicus. Fibrinous pericarditis in adult *sheep* is usually part of pasteurellosis; in lambs, it is usually part of pasteurellosis or caused by streptococci.

Fibrinous Pericarditis

(Pericarditis fibrinosa)

- The exudation of fibrin usually begins about the base of the heart and extends from there to cover, both the pericardium and epicardium.
- The fibrin is **gray-white**, but it may be flecked with **blood**, or **yellow** if a large number of leukocytes are added to the exudate.
- When the leaves are drawn apart, the exudate is drawn out into **villus like projections** to give an appearance responsible for the names “**cor villosum**,” “shaggy heart,” and “bread-and-butter pericarditis”

Fibrinous Pericarditis (Pericarditis fibrinosa)

- Fibrinous exudate can be removed
- Mesothelium can be regenerated.
- *Restorative processes compete with the processes of organization.*
- *Within a week or so, there will be well-formed fibrous tissue* in the deepest parts.
- **If the course is prolonged**, organization and **scarring** will result in focal or diffuse fibrous **adhesions** between the pericardial surfaces, with partial or complete obliteration of the sac.

Purulent Pericarditis

(Pericarditis purulenta)

- Purulent pericarditis almost invariably denotes the presence of **pyogenic bacteria**, either as primary pathogens or as opportunists in *fibrinous pericarditis*.
- It occurs almost solely in cattle as a result of *traumatic perforation by a foreign body originating in the reticulum*, but it is observed in cats and horses in association with empyema (pyothorax).

Pericarditis purulenta

- **The suppurative pericardial fluid** may appear as thin, cloudy exudate; as frank, creamy pus; or as a mixture of pus and masses of fibrin. The color depends on the organisms present, but usually varies from yellow to green, being irregularly dirty gray when putrefactive bacteria are present.

Gangrenous pericarditis (Pericarditis gangrenosa)

- This type of inflammation of the heart sac is caused by *traumatic pericarditis* as it becomes *purulent and putrefactive*.
- On the inside of the sac, there is a thick colored fibrin layer. And it also contains **bad-smelling gas bubbles inside**. The exudate in the heart sac is green-yellow, dark red or brownish-brown and has a bad odor.

Haemorrhagic pericarditis (Pericarditis haemorrhagica)

- This kind of inflammation is recognized by the mixing of **blood in the exudate** with fibrin in the sac. Occasionally, the inflammation may start bleeding directly.
 - Anthrax and Pasteurellosis in cattle;
 - Bradzot disease, Infectious Necrotic Hepatitis in sheep;
 - Infectious purpura in dogs ;
 - generally, seen in pericardial tuberculosis and malignant tumor.

Sterile Pericarditis

- ✓ Infectious/granulomatous inflammation of pleura causes **sterile serous effusion** in pericard because of **irritation**. This type of **inflammation of the pleura** can gradually spread to **the pericardial sac**.
- ✓ Steril pericarditis occurs in **tumor implants** in **gout disease of poultry** and in the resorption of the fluid collected in the pericardial sac.

MYOCARDIAL DISEASE

- **Dystrophic ve Degenerative Myocardiopathie**
 - Disorders and degenerative changes in the heart muscle that are not related to inflammation and developmental disorders.
- A. Dystrophic myocardiopathie
 - B. Degenerative myocardiopathie

A. Dystrophic myocardiopathie

- **Atrophia cordis**
- **Hypertrophia cordis**
- **Dilatatio cordis**
- **Brisket disaese**
- **Round heart disease**
- Cardiac aneurysm
- Pigmentation

Atrophia cordis

- Cardiac atrophy is a decrease in the size.

Hypertrophia cordis

- **a. Concentric hypertrophy in the heart**
(The heart muscle thickens at the same rate on all sides.)

- b. Eccentric hypertrophy in the heart**
(It is the enlargement of the ventricles with expansion and is mostly observed in the right ventricle.)

- c. Pseudo-hypertrophy in the heart**
(It involves the collection of excess fat in the interstitium of the heart muscle.)

Hypertrophia cordis

- Causes of hypertrophy in heart muscle can be grouped into two groups;

I. Causes of physiological hypertrophy,

a. Overwork

(running horses, hunting dogs, etc.)

b. Overload towing

(forcing animals to be transported with heavy loads)

c. Severe pregnancy states

(twin in the uterus, triplets, and more normal than normal puppies)

Hypertrophia cordis

II. Causes of pathological hypertrophy

- **The thickening** of the semilunar **valvule** of the aorta or narrowing of the **ostiums**, **prevention of blood flow** in the arteries, common **chronic interstitial nephritis** in the kidneys
- **Stenosis** of arteria pulmonalis, **the thickening** of the semilunar valvule of the arteria pulmonalis, insufficiency or stenosis in mitral valves, **parasitic infestations** (*D.immitis*) in dogs, chronic emphysema or chronic interstitial pneumonia in lungs, large amounts of exudate or transudate in chest cavity, pleuritis chronica adhesive
- **Disorders involving all the heart valves**, increased blood viscosity, chronic anemia (especially in humans)

Dilatatio cordis

- Pathological **expansion** of one or both **ventricles**.
- Dilatation is seen usually in **right ventricle**.
- Because, in the left ventricle there is a resistance to enlargement and the wall is already thick.
- Dilatation in the heart can occur **acute and chronic**.
- In acute form it develops within a few hours or several days.
- In chronic form it occurs within months. There is also thickening of the ventricle wall in chronic dilatation. **In other words, there is always a hypertrophy in the heart in chronic heart dilatation.**

Brisket Disease

“High-altitude disease” of cattle

- *This disease is caused by pulmonary hypertension that results in **dilation and hypertrophy of the right ventricle** with the ultimate development of cardiac decompensation and right-sided congestive cardiac failure.*
- Edematous swelling of the venter, as is typical of congestive heart failure in cattle, is responsible for the synonym *“brisket disease.”*
- It is also known as '**Mountain Disease**' since it is seen in mountainous areas up to 3000-4000 meters. It is also known as '**High Altitude Disease**' since it can be seen in high plateaus up to 2500 meters.

Brisket Disease

- There are species differences in the hypertensive response to hypoxia
- Sheep and dogs are hyporesponders, humans are intermediate, **whereas cattle and pigs are hyperresponders.**
- **Young cattle are more susceptible** than adults, and the morbidity rate is highest in animals exposed to high altitudes for the first time.

Brisket Disease

- Cause of **atmospheric density** and **pressure** are **low** at high altitude.
- **Hypoxia and anoxia** formation cause the disease to develop.
- **Dystrophy, anemia, pneumonia** and other lung diseases are among the **preparatory reasons**.
- It is also reported that hypoproteinemia related to the lack of pastures in mountainous regions and some poisonous plants that grow in such regions are among the preparatory reasons.

Brisket Disease

Macroscopically;

- **The hairs** covering the body are **dull and rough**.
- There is excessive **swelling in V. jugularis**.
- There is a prominent edema especially in the chest area, under the skin(neck and abdomen).
- Mucous membranes are **cyanotic**.
- **The heart was enlarged and the right ventricular wall was thickened.**
- There is severe passive hyperemia in liver and spleen.
- Transudate accumulation may be observed in pericardium, pleura and peritoneum.

Brisket Disease

Microscopically;

- **Intramuscular edema** in the heart,
- **Muscular fibers degenerative** appearance, intracellular edema,
- Edema in the lung,

❖ Polycythemia in clinical blood examination

B. Degenerative myocardiopathies

- Parenchymal degeneration in cardiac muscle,
- Fat degeneration in the cardiac muscle,
- Hyaline degeneration in cardiac muscle.

Special Myocardiopathies

- White Muscle Disease (Enzootic Muscular Dystrophie)
- Foot and Mouth Disease,
- Sudden Heart Failure
(Sudden Cardiac Arrest, Sudden Cardiac Death)
- Mulberry Heart Disease,
- Transport Necrosis,
- Myocardiopathie related to alcoholism in humans

White Muscle Disease

- Nutritional myopathies are *principally diseases of calves, lambs, swine, and foals.*
- *It is a* nutritional myopathy caused by a selenium or (less commonly) vitamin E deficiency.
- Young animals aged 1 to 8 weeks are the most sensitive to the disease.

White Muscle Disease

- In many cells, *vitamin E- and selenium-containing enzymes are required as physiologic antagonists to a group of chemically varied substances known as free radicals.*
- *Free radicals may initiate cellular injury by causing peroxidation of membrane lipids.*
- So, In the **absence of** sufficient protection by **selenium and/or vitamin E**, cellular membranes are damaged by lipid peroxide.

White Muscle Disease

- Macroscopic lesions are quite characteristic.
- Gross changes **included chalky-white appearance** of entire endocardium of **right ventricle** and subendocardial plaques in the **interventricular septum** and **left ventricular Wall** and **Papillary muscle**.
- Degenerations in skeletal muscles are mostly in the back, rump, front and hind leg muscles and locate symmetrically.

White Muscle Disease

- The lesions in the **diaphragm** are in lines and stripes.
- The affected muscle groups are **edematous, swollen and crispy**. **Calcification** is also seen.

White Muscle Disease

- Microscopically;
- Microscopic changes include loss of striations followed by swelling, hypereosinophilia, glassy or hyaline appearance (**Zenker's degeneration**).
- The calcification of degenerated muscle can be seen.
- Macrophage and lymphocyte infiltrations are seen in degeneration regions.

White Muscle Disease

- In some areas, there are **multinucleated myogen giant cells** that are related to regeneration.
- It is also noteworthy that the areas where muscle tissue is **necrosed** are filled by young **connective tissue cells**.

Foot and Mouth Disease

- Especially, lesions occurring in young cattle begin with hyaline degeneration in the form of stains or lines in heart muscle fibers and rapidly progress towards necrosis.

Foot and Mouth Disease

- Most of the time there is healing with scars, and these scars (“tiger stripes” or “tiger heart”) can be found after slaughter.
- Histological examination of the acute and subacute resorption periods, muscle degenerations and lymphohistiocytes and plasma cell infiltrations are coexisting.

Mulberry Heart Disease of swine (Diatetic Microangiopathie)

- The name “mulberry heart” is vaguely suggested by the *extensive hemorrhages on the surface of the heart.*
- The disease occurs in pigs only, chiefly those 2-4 months of age and in excellent condition, but it has been observed in animals from 3 weeks to 4 years of age.
- Although the reason is not completely clear; *vit. E and selenium deficiency are emphasized.*

Mulberry Heart Disease

- Large amounts of fluid around the heart and lungs.
- **Haemorrhagic** and **pale areas** in heart muscle.
- Fluid in the abdomen with pieces of fibrin.
- Pale muscle areas (necrosis) particularly in the lumber muscles and hind muscles of the leg which contain excesses amounts of fluid.

Mulberry Heart Disease

- *Hemorrhages, linear and ecchymotic, are present beneath the **epicardium**. They may be few, or they may be extensive and involve the epicardium of all chambers, the **myocardium**, and beneath the **endocardium** of the papillary muscles and septum.*

MYOCARDITIS

- *Myocarditis, or inflammation of the myocardium, is a common lesion found in a wide variety of systemic diseases.*
- It is rarely primary
- It occurs hematogenously in many infectious diseases, and also by direct extension from inflammatory lesions of the endocardium and pericardium.

MYOCARDITIS

- The inflammation in the heart muscle, primarily related to the hematogenous origin of the disease agents, starts and settles in the interstitial area.
- The heart muscle is subsequently and secondary affected.
- In the meantime, some intoxications and nutrition disorders, first heart muscle is affected and dystrophic disorders occur.

MYOCARDITIS

- A. Myocarditis nonpurulenta (Lymphocytaria - Paranchymatosa)
- B. Myocarditis purulenta (Apostomatosa)
- C. Myocarditis necroticans
- D. Myocarditis allergica
- E. Special myocarditis

MYOCARDITIS

- **A. Nonpurulent myocarditis** occurs generalized and acute infectious and toxic diseases.
- Therefore, it is often not possible to conclude serous myocarditis to specific causes.

MYOCARDITIS

- However, the diseases can be listed as follows.
- **In cattle:** Foot and Mouth Disease, C.G.B., Blackleg, Rinderpest, etc.
- **In horses:** Infectious viral anemia, parasitic invasions, etc.
- **In dogs:** Acute form of Distemper, Leptospirosis, H.C.C. etc.
- **In cats:** Agranulocytosis etc.
- **Chickens:** Salmonellosis, Pullorum etc.
- **In pigs:** Aujeszky's disease (pseudorabies), Teschen disease, Swine erysipelas etc.

MYOCARDITIS

- Microscopical lesions** in nonpurulent myocarditis;
- In some cases; hyperemia and interstitial edema (**serous myocarditis**), myofibrillary **degeneration**, separation of myofibrils and small amounts of **mononuclear cell infiltration**.
 - In some cases; Hyaline degeneration in muscles, fibrocyte proliferations in chronic cases and multiple lymphohistiocytic cells infiltrations

MYOCARDITIS

- **B. Purulent myocarditis**
- These factors are either **hematogenous** (metastatic) or **directly located in the heart muscle**.
- *Pyogenic bacteria, which may originate from any other suppurative focus in the body, reach the heart as bacteria embolism.*

MYOCARDITIS

- In cattle; myocarditis may be caused **by a pus** and inflammation in the organs such as lung, uterus, endocardium, intestine, umbilical cord, etc.
- **Directly, traumatic pericarditis usually plays a role as a precursor.**

MYOCARDITIS

In purulent myocarditis, macroscopically,

- **Yellowish gray small puss** foci are occasionally seen in the heart muscle. They have varying diameters ranging from the needle to the lentil size. And this condition is called “Myocarditis purulenta disseminata”.
- **Microscopy** of such case pus focus and abscess formed by **neutrophil leukocytes** are seen.

MYOCARDITIS

- **C. Necrotic myocarditis:**
- It is always secondary.
- Inflammation is caused by "*necrosis bacillus (Spherophorus necrophorus)*".
- Necrobacillosis reach **hematogenously** from mammary, uterus, vagina and liver in cattles; umbilical cord in calves.

MYOCARDITIS

- **Macroscopically**; the lesion in myocardium is *dirty-yellow-brown* in color, the environment is surrounded by an irregular and hyperemic halo. This necrosis tissue that can be crushed between the fingers can sometimes be a perforated view due to gas formation.
- **Microscopically**; There is a demarcation site with *coagulation necrosis and neutrophil leukocyte infiltration* around it.

MYOCARDITIS

D. Myocarditis allergica

- In animals, the presence of lesions similar to those of human heart and related to *rheumatism* has not been established yet.
- However, periarteritis nodosa lesions are seen. Accordingly, it is thought that there may be *allergic inflammations* caused by antigen-antibody reactions in animals.

MYOCARDITIS

- **E. Tuberculosis** is rarely seen in diseases of the special infectious granuloma group located in the heart muscle. It has also been reported in some reports that there may be diseases such as **glanders, actinomycosis, aspergillosis.**

Parasites in Heart muscle

- Parasites are common in heart.
- **Sarcosporidiosis** (cattle, sheep, goats, pigs and infrequently carnivores),
- **Cysticercosis** (C.cellulosa / pig; C.inermus / cattle; C.ovis / sheep),
- **Fasciola hepatica** (sheep - in some cases hematogenous to the heart.),
- **Filaria and Strongylus**,
- **Diroflaria immitis** (In the heart, especially in the right ventricle, lives in the pulmonary arteries and causes obturation.)
- **Echinococcus** cysts (cattle, sheep, goats),
- **Toxoplasmosis** (It usually develops in relation to the generalization of lung, liver and brain lesions in dogs.).

ENDOCARDIUM

Calcification in Endocardium

- Calcification of the elastic fibers of the endocardium. It is mostly seen in cattle, horses and dogs. It is more common in older animals.
- **Metastatic calcification** occurs in cases of **deficiency in calcium metabolism**. This is seen in hypervitaminosis D, uremia and nutrition disorders.
- Calcification, which is related to the causes affecting the endocardium, also develops **dystrophic calcification**.
- Therefore, it is observed in diseases such as **White Muscle Disease**, Leptospirosis, Tuberculosis etc.

ENDOCARDITIS

- **Inflammation** of the inner layer of the heart (**endocardium**).
- It can occur for a variety of reasons.
- It is *usually bacterial in cause, the exceptions being occasional parasitic or mycotic lesions.*
- Dystrophic disorders of the endocardium can also be converted to endocarditis

ENDOCARDITIS

According to the **the location** of the inflammation;

- Endocarditis valvularis
- Endocarditis parietalis
- Endocarditis chordalis

ENDOCARDITIS

According to the **pathological - anatomical features** of the inflammation;

- Endocarditis (Thromboendocarditis) simplex superficialis,
- Endocarditis polyposa et ulcerosa
- Endocarditis verrucosa
- Endocarditis chronica fibrosa
- Endocarditis calcificans

ENDOCARDITIS

- In spite of all these classifications, endocardium inflammations can easily infiltrate to many areas and transform from one form to another.
- For these reasons, endocarditis is usually examined under two headings.
- **a. Endocarditis valvularis**
- **b. Endocarditis parietalis**

Endocarditis valvularis

- Endocardial inflammation is located in the heart valves.
- Endocarditis in animals are mostly located in the **mitral valve**
- Less is seen in the **aortic valves** and the **tricuspidal valve**.
- Endocarditis valvularis events are almost bacterial origin.
- Generally, they are seen in septicemia and pyemia.

Endocarditis valvularis

- **In cattles;** *Corynebacterium pyogenes*, *Streptococcus* species, *Staphylococcus aureus*, *E. coli* serotypes
- **In horses;** *Streptococcus equi*, *Bact. viscosum equi*, umbilical cord infections, *Meningococci*, Infectious Viral Anemia
- **In dogs;** Non-hemolytic *Streptococ* species, *E. coli* serotypes, *Staphylococcus* species, *Pseudomonas aeruginosa*
- **In Sheep and Goats;** *Pseudotuberculosis ovis*, *Streptococcus fecalis*.
- **In pigs;** *Erysipel*, *Corynebacterium pyogenes*
- ✓ Common in all animal species; *Salmonella*, *Pasteurella*, *E. coli* infections, and all pyogenic disease

Endocarditis valvularis

- Valvular endocarditis is classified according to the lesions seen in necropsy;
 - 1. Endocarditis valvularis simplex**
 - 2. Endocarditis valvularis polyposa et ulcerosa**
 - 3. Endocarditis valvularis verrucosa**
 - 4. Endocarditis valvularis fibrosa**