

PERICARDIAL DISEASE

Revised by V'20 Cardio Group from Dr. John Rush

I. Introduction

Pericardial disease is significantly less common in dogs and cats than myocardial and valvular diseases; however, it is a key differential in horses and cattle. Acute pericardial disease leads to collapse and rapidly progressive low output signs. In contrast, a more slowly developing pericardial effusion can result in congestive heart failure signs with evidence of right-sided congestive heart failure.

II. Classification of Pericardial Disease

- **Congenital Issues**
 - Defect or absence of pericardium
 - PPDH (Peritoneopericardial diaphragmatic hernia)
 - Pericardial Cyst
- **Acquired Disorders**
 - Pericardial Effusion (transudate, exudate, idiopathic, infectious, hemorrhage)
 - Constrictive Pericardial Disease
 - Idiopathic
 - Infectious (Pericardial foreign body)
 - Neoplastic
 - Pericardial mass/cyst
 - Neoplasm

III. Normal Physiology

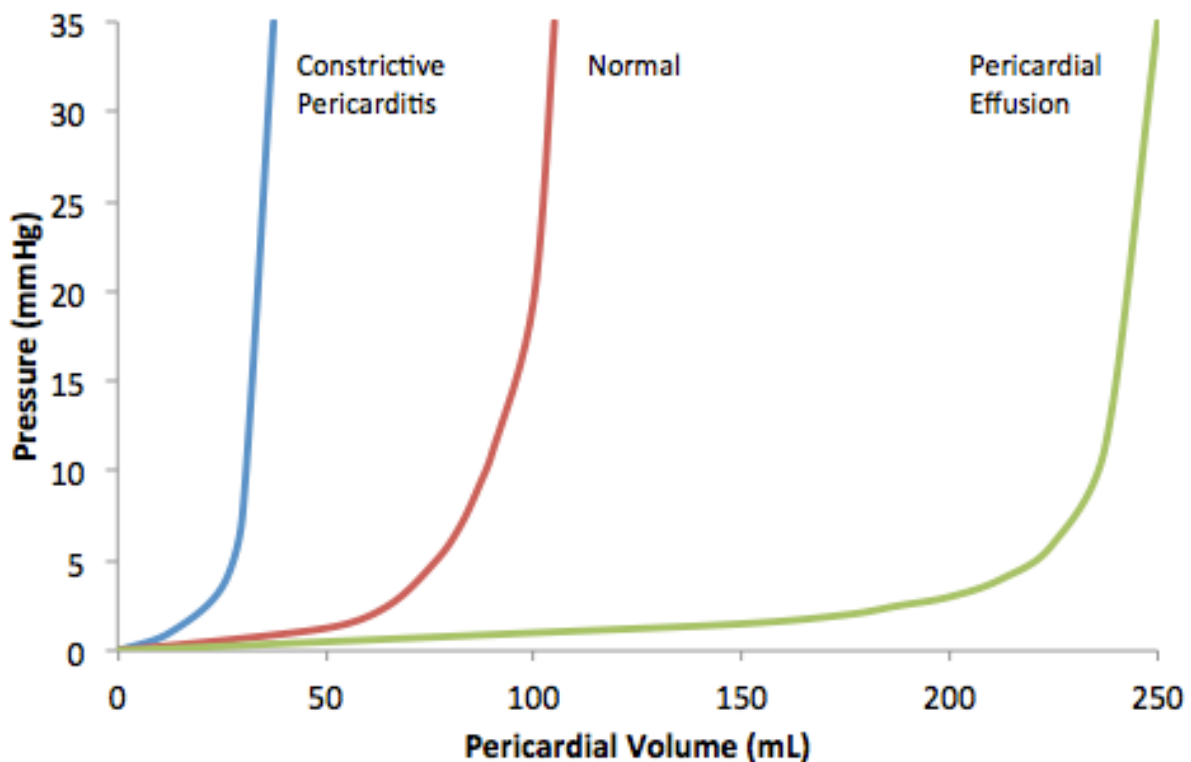
- **Anatomy:** The fibrinoserous membrane is thin, translucent, and forms a double envelope around the heart. The epicardium is a thin visceral membrane and the pericardium is a thick parietal membrane. The envelope holds a small volume of clear lymph-like fluid for lubrication.
- **Functions:** The pericardium is not essential for life but serves several functions when intact.
 - Stability: Ligamentous nature helps hold the heart in place
 - Friction: Lubrication minimizes friction around the heart
 - Dilation: Limits excessive ventricular dilation which maintains cardiac geometric stability

IV. Pathophysiology

- **Mechanism of Action:** Pericardial disease restricts diastolic filling of ventricle, with little impact on ventricular contractility.
- **Pericardial Effusion with Tamponade**
 - Specific Mechanism of Action: Fluid accumulation occurs until pericardial pressure is elevated above ventricular filling pressure. Venous pressure must increase to allow continued filling of the ventricles. Over time, there is decreased ventricular filling, decreased stroke volume, and increased right atrial pressure (cardiac tamponade.) The heart maintains cardiac output initially by increasing

contraction rate. Diastolic pressures eventually equilibrate with pericardial pressures due to equal compression of the atria and ventricles.

- Clinical Signs: These are based on underlying cause, and rate of fluid accumulation.
 - Acute Effusions: Lack of sufficient time for the pericardium to stretch and pressure builds rapidly with even small increases in pericardial volume.
 - Hypotension, poor perfusion, shock
 - Gradual Effusions: The pericardium has time to stretch and accumulate large volumes of fluid, and neurohumoral activation results in fluid retention. Fluid accumulation leads to activation of neurohumoral systems and fluid retention.
 - Signs of right-sided congestive heart failure



- **Pericardial Fibrosis with Constriction**
 - Specific Mechanism of Action: As with cardiac tamponade, diastolic ventricular volume is decreased, and venous, atrial, and ventricular diastolic pressures are increased. This can lead to right sided congestive heart failure. Unlike tamponade, the constriction is normally due to a thick and fibrinous pericardium and severe inelasticity.
 - Clinical Signs:
 - Pericardial Knock: An early diastolic heart sound caused by abrupt cessation of the filling phase with severe inelasticity. A pericardial knock is more commonly heard in horses/cattle, and less often dogs and cats.

- **Intrapericardial Mass Lesions**

- Specific Mechanism of Action: Depends on the size and location of the lesion, and if pericardial effusion or fibrosis are present.
- Clinical Signs:
 - Small Mass: May be clinically silent.
 - Large Mass: Signs related to local invasion or space occupation and displacement/compression of important structures.
 - Concurrent pericardial effusion: The most common reason that masses lead to clinical signs and can result in cardiac tamponade.

V. Congenital Disorders of the Pericardium

Congenital defects of the pericardium are rare. Most reported defects are holes in the left side of the pericardium. These defects generally remain subclinical, but herniation and strangulation of the heart is possible. Occasionally an animal is born with an absent pericardium, but this is not associated with significant clinical signs.

- **Peritopericardial diaphragmatic hernias (PPDH)**

- In small animals, observed congenital disorders are often peritopericardial in nature, specifically peritopericardial diaphragmatic hernias (PPDH).
- Specific Mechanism of Action: PPDH is caused by incomplete development of the ventral portion of diaphragm and incomplete fusion of the caudal pleuropericardial membrane. The result is a communication between the pericardial and peritoneal spaces through which organs can herniate. Typically, abdominal contents (liver, stomach, spleen, small intestine, rarely colon) enter the pericardial sac, causing it to stretch significantly and displace the heart.
- Clinical Signs: More serious cases may be discovered within the first year of the animal's life, but it is possible PPDH to go undetected in an otherwise healthy dog or cat.
 - Usually present with gastrointestinal issues (vomiting, diarrhea, anorexia, weight loss) that originate in the herniated organ(s).
 - Dilation of the pericardial sac may restrict expansion of the lungs and result in coughing or difficulty breathing.
 - Cardiac signs (shock, collapse, tamponade) are less common.
- Diagnosis:
 - Physical exam: Muffled/absent or displaced heart sounds; Inability to locate abdominal organs on palpation.
 - Thoracic radiographs:
 - Enlarged cardiac silhouette with caudal border of heart overlying diaphragm
 - Tracheal elevation
 - Fat or gas opacities overlying heart
 - Cranial abdominal organs observed in thorax (contrast study aid in visualization)
 - ECG: Abnormal QRS axis or small QRS complexes

- Treatment: Surgery is typically curative, but can be complicated by sepsis, cytokine release from necrotic strangulated tissue, or pulmonary edema following lung re-expansion.

VI. Acquired Disorders of the Pericardium

The two main non-congenital diseases of the pericardium are pericardial effusion and constrictive pericarditis. Constrictive pericarditis is uncommon, so this discussion of acquired pericardial disorders will focus on pericardial effusion

• Pericardial Effusion - Dogs

- Dogs are the species most commonly affected by pericardial effusion, and pericardial effusion is one of the most common cardiac emergencies in canines.
- Etiology: cardiac neoplasia
 - Middle-aged to old large breed dogs
 - Hemangiosarcoma (often originating in right atrial wall), with GSDs and Golden retrievers being predisposed.
 - Heart base tumors (chemodectoma, aortic body tumor, thyroid carcinoma) with predisposition in Boxers, bulldogs, and Boston terriers.
- Etiology: idiopathic
 - “idiopathic pericardial effusion” can also be known as benign pericardial effusion or idiopathic hemorrhagic pericardial effusion
 - These alternate names are misleading because even benign pericardial effusion may be accompanied by life-threatening cardiac tamponade and not all pericardial effusions are hemorrhagic.
 - Most common in middle-aged male dogs of medium/large breeds with an average onset of 6-8 years old.
 - Golden retrievers, GSDs, Great Danes, and St. Bernards may be predisposed
 - Thickening of parietal pericardium and epicardium is seen grossly, with fibrosis and mild inflammation on histology.
- Other etiologies: Mesothelioma (can be hard to differentiate from idiopathic pericardial effusion) and lymphoma (more commonly a cause of effusion in cattle and cats.)

• Pericardial Effusion – Cats

- Primary cardiac tumors and idiopathic pericardial effusion are uncommon
- Associated with:
 - Feline infectious peritonitis
 - Congestive heart failure
 - Renal failure
 - Metastatic neoplasia
 - Coagulopathies
 - Bacterial pericarditis

• Pericardial Effusion – Large Animals

- Associated with some viral infections (African swine fever)
- Associated with bacterial infections in cattle and horses
- Cattle may develop pericardial effusion in association with traumatic reticulitis and peritonitis from hardware disease.

- **Clinical Signs:**
 - In the history
 - Lethargy, weakness, exercise intolerance
 - Abdominal distension
 - Syncope
 - Tachypnea, coughing
 - On physical exam
 - Tachypnea, dyspnea
 - Mucous membrane pallor, prolonged capillary refill time
 - Diminished precordial impulse, muffled heart sounds
 - Pericardial friction rub
 - Tachycardia, arrhythmias, weak pulse, pulsus paradoxus
 - Jugular venous distension, hepatomegaly, splenomegaly
 - Positive hepatojugular reflex
 - Ascites
- **Diagnostic Approach to Pericardial Effusion**
 - Clinical Pathology - Bloodwork:
 - Hypoproteinemia, mild anemia, neutrophilic leukocytosis
 - Elevated hepatic enzymes (secondary to right heart failure)
 - Mild pre-renal azotemia
 - Signs associated with hemangiosarcoma include anemia, nucleated red blood cells, schistocytes, and elevated cardiac troponin I (in dogs)
 - FIP and FeLV tests should be performed in cats
 - Radiographs:
 - Severe globoid cardiomegaly with loss of cardiac chamber definition from pathologic long-term stretching of the fibrous pericardial sac
 - Well-defined edges to heart (due to lack of cardiac motion)
 - +/- Enlarged caudal vena cava
 - +/- Pleural effusion that interferes with cardiac silhouette
 - +/- Soft tissue opacity at heart base and/or tracheal displacement (due to heart tumors)
 - Electrocardiography:
 - 30-50% of cases have normal ECG
 - Diminished QRS amplitude (<1 mv)
 - Electrical alternans (Regular variation in QRS size or morphology)
 - Results from swinging motion of heart in fluid-filled pericardium
 - More common in cases of large effusions
 - Highly suggestive of pericardial effusion
 - Abnormal ST segment (usually elevated)
 - P-mitrale (left atrial enlargement)
 - Normal sinus rhythm or sinus tachycardia (ventricular or supraventricular arrhythmias possible)
 - Echocardiography:
 - Most sensitive and most specific means of diagnosing pericardial effusion
 - Best test to determine presence of neoplasia (imaged directly)
 - Effusion manifests as echo-free space between myocardium and pericardium that is observed circumferentially with 2D echocardiography

- Heart may swing within pericardial sac
- Diastolic right atrial and ventricular collapse is indicative of cardiac tamponade
- Pericardiocentesis:
 - Best therapy for cardiac tamponade (provides immediate relief)
 - Sample is obtained with patient in lateral or sternal recumbency using a 5-cm long needle (16 or 18 gauge) attached to tubing, a stopcock, and a large syringe, inserted into the 4th or 5th intercostal space
 - Gentle suction applied via the syringe until pericardial fluid is obtained
 - Complications:
 - Coronary artery laceration (avoid by tapping right side of thorax)
 - Ventricular arrhythmias (pay attention to ECG, move needle/catheter if observed)
 - Exsanguination into pleural space (an issue in cases of intrapericardial hemorrhage)
 - Effusion should be subjected to fluid analysis, cytology, and culture/sensitivity testing to generate a series of differentials
 - Transudate/modified transudate: Secondary to CHF, hypoalbuminemia
 - Exudate: More common in large animals, with causes including traumatic reticuloperitonitis (hardware disease), infection extending from pleuritis, disseminated infection, idiopathic, immune-mediated, uremia
 - Hemorrhagic (hemopericardium): most pericardial effusions in dogs
 - Neoplastic (hemangiosarcoma, heart base tumor, mesothelioma, lymphoma, metastatic)
 - Idiopathic
 - Difficult to distinguish between hemangiosarcoma, heart base tumor, and idiopathic hemorrhagic effusions due to their similar protein content, red cell count, and nucleated cell count.
- Other Techniques:
 - Central venous pressure: Less than 5-cm of water in normal animals, but in animals with pericardial-related heart failure: 10 to 15-cm of water
 - MRI, CT, angiographic contrast studies: Can identify cardiac masses or show filling defect of heart
 - Intracardiac tumor in auricular wall
 - Vascular blush of heart base tumor
 - Use to assess for surgical interventions
 - Cardiac troponin I: especially elevated in dogs with hemangiosarcoma)

VII. General Therapy for Pericardial Effusion

Therapy is highly dependent on the underlying disease process. Pericardial effusions due to systemic or metabolic processes will likely resolve with correction of the underlying process. Cardiac tamponade necessitates pericardiocentesis to allow the heart to regain diastolic capabilities but is contraindicated in patients who are actively hemorrhaging into the

pericardial sac. Creating a hole in the pericardium provides an avenue for the patient to develop a hemothorax.

Cardiac medications are typically not indicated because pericardial effusion is a disease of diastolic dysfunction, although clinically significant supraventricular or ventricular tachyarrhythmias may necessitate medical management. Arteriolar vasodilators should be avoided because hypotension is often associated with cardiac tamponade. Use caution with diuretics and vasodilators because excessive preload reduction will further decrease cardiac output.

VIII. Specific Therapy for Pericardial Effusion Based on Etiology

- **Idiopathic:**
 - Conservative management with pericardiocentesis because 50% of dogs will recover with one or two therapeutic pericardiocentesis.
 - Dogs requiring repeated pericardiocentesis often benefit from pericardiectomy.
- **Cardiac Mass Lesions:**
 - Pericardial cysts or abscesses may be surgically resected
 - Pericardial granulomas are typically due to fungal infection and should have treatment directed at the underlying agent.
 - Hemangiosarcoma typically has metastasized by the time of diagnosis. Surgical attempts alone are associated with short survival times while surgery combined with doxorubicin treatment may yield survival times of up to 6 months.
 - Heart base tumors are often difficult to excise, but pericardiectomy can relieve cardiac tamponade.
- **Infectious Pericarditis:**
 - Aggressive antibiotic management for bacterial etiology is indicated.
 - Indwelling pericardial catheters may be placed for continuous drainage, intermittent lavage, and antibiotic instillation.
- **Pericardial Hemorrhage:**
 - Pericardiocentesis is not indicated in patients with active hemorrhage unless the cardiac tamponade is immediately life threatening. This is because creating a hole in the pericardium provides an avenue for the patient to develop hemothorax.
 - Conservative management, including cage rest and carefully monitored fluid therapy, is appropriate.