

Pericardial Effusion

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Introduction

Pericardial effusion is the most common disease of the pericardium in dogs.¹ It is uncommonly seen in feline patients and is rarely of clinical significance.³ The prognosis for patients with pericardial effusion varies greatly depending on the etiology of the effusion. Similarly, treatment of pericardial effusion varies with its cause.² It is important for veterinarians to be able to diagnose this condition in a timely manner in order to intervene and prevent the decline of their patients.

History and Patient Presentation

The most common signalment of patients presenting with pericardial effusion are middle aged, large breed dogs. Golden Retrievers, German Shepherd Dogs, St. Bernards, and Labrador Retrievers are over-represented; however, any breed may be affected.⁵ The presentation of a patient with pericardial effusion varies depending on the chronicity of the effusion. Patients with acute pericardial effusion often present for severe weakness and/or collapse. Upon physical exam, patients with acute effusion typically have muffled or absent heart sounds, jugular venous distention as well as poor peripheral pulses; however, with small volume effusions, heart sounds may remain audible.² Patients with chronic pericardial effusion have a history of clinical signs consistent with right-sided heart failure, such as lethargy, exercise intolerance, dyspnea, and ascites.² Similar to patients with acute pericardial effusion, these patients may also have muffled heart sounds and jugular venous distention.² With chronic pericardial effusion, small amounts of fluid leak into the pericardial space over time. Because the pericardium is made of collagen and elastin, slow increase in pressure stretches the pericardium, allowing the heart to fill for adequately to maintain cardiac output despite the presence of pericardial fluid. However, as the

pericardium's ability to stretch to accommodate pericardial fluid is exceeded, cardiac output decreases and these patients can also present for collapse or syncope.

While pericardial effusion is the most common disease of the pericardium in dogs, felines rarely present for clinical signs related to pericardial effusion. Effusion is typically an incidental finding in a cat that suffers from congestive heart failure.³

Pathophysiology

Excess fluid in the pericardial space changes the dynamic of diastole, or the portion of the cardiac cycle that allows the heart chambers to relax and fill with blood. The build-up of fluid leads to excess pressure on the atria and ventricles. Because the normal pressure within the right side of the heart is low (4 – 8 mmHg)¹, signs secondary to right-sided heart failure are often seen. The low-pressure right atrium and ventricle cannot fully expand during diastole due to the excess fluid in the surrounding pericardium, resulting in decreased venous return to the heart. This decreased venous return results in hepatomegaly, ascites, respiratory distress due to pleural effusion, exercise intolerance, and lethargy. When the volume of fluid in the pericardial space increases intrapericardial pressure above that of the right atrium and ventricle, cardiac tamponade occurs.¹ During tamponade, the increased intrapericardial pressure causes the right atrium and ventricle to collapse, resulting in drastically decreased diastolic filling, stroke volume, and cardiac output.¹ In response to decreased stroke volume, heart rate and systemic vascular resistance increase to maintain blood pressure. However, as the pressure within the pericardium increases further, the left atrium and ventricle can also be compromised, causing a further decrease in cardiac output and a drop in systemic blood pressure.²

The volume of fluid needed to cause tamponade varies based on the speed at which it accumulates. The normal amount of fluid in the pericardial space is dependent upon the size of the dog, typically 0.25 +/- 0.15 milliliters of fluid per kilogram of body weight.¹³ As little as 25 milliliters of excess fluid that is leaked rapidly into the pericardial space of a small dog can cause cardiac tamponade. On the other hand, a large dog with slow, chronic effusion can acquire up to two liters of pericardial fluid before the pericardium's ability to expand is exceeded.¹

The pericardium is composed of two layers: the fibrous pericardium and the serous pericardium, which is further divided into visceral and parietal layers.¹ The outer fibrous pericardium is composed of layers of collagen and elastin fibers arranged in a viscous matrix⁶, and functions to keep the heart in correct anatomical position within the thorax, provide a frictionless barrier, prevent metastasis of infection or neoplasia, and aid in ventricular coupling.¹ When pressure is applied rapidly to the pericardium, such as in acute pericardial effusion, the fibrous layer of the pericardium cannot expand. However, when small amounts of pressure are applied to the pericardium over long periods of time, the collagen and elastin fibers rearrange within the ground matrix and the pericardium expands.⁶ This explains how a dog with chronic pericardial effusion may have large amounts of fluid within the pericardium at time of diagnosis.

Pericardial effusion may result from a variety of diseases and disorders. One study states that 58% of canine pericardial effusions are caused by neoplastic effusion, with 60 – 75% of the neoplastic effusions attributed to hemangiosarcoma.¹ Hemangiosarcoma is commonly found on the right auricle of the heart, and bleeding from this tumor can cause hemorrhage into the pericardial space.¹ Other neoplasms that cause canine pericardial effusion include aortic body tumors and mesotheliomas.¹ Aortic body tumors, or chemodectomas, are found at the base of the heart and arise from chemoreceptors in the pulmonary artery and aorta.¹ These tumors are locally

invasive and can cause neoplastic effusion. Mesotheliomas grow from the pleura, peritoneum, and pericardium and are often diffuse. Pericardial mesothelioma can lead to neoplastic effusion within the pericardium.¹

Idiopathic pericardial effusion is defined as “sterile, often hemorrhagic effusion in the pericardial space” and represents 19% of all canine pericardial effusion.¹ Idiopathic pericardial effusion is a diagnosis of exclusion; all other causes of pericardial effusion, such as neoplasia and infection, must be ruled out prior to diagnosing an animal with idiopathic pericardial effusion. Upon histological examination, the epicardium and pericardium are inflamed and thickened.¹ Middle aged, male, large breed dogs such as German Shepherds, Golden Retrievers, and Great Danes are predisposed to the development of idiopathic pericardial effusion.

Infectious pericardial effusion is seen infrequently. The majority of infectious pericardial effusion occurs in large breed dogs secondary to grass awn migration, typically *Hordeum* grass, or foxtail.⁸ *Actinomyces* and *Nocardia* are the most common bacterial isolates causing infectious pericardial effusion secondary to grass awn migration.¹ Fungal infection of *Coccidioides immitis* is also a reported cause of pericardial effusion.⁹

Pericardial effusion may also occur as a result of right sided heart failure. The coronary arteries that supply the myocardium drain into the right atrium.¹⁰ In right-sided heart failure, the right atrium and ventricle are unable to receive the normal volume of venous return. This lack of venous return leads to passive congestion, and the build-up of fluid results in ascites, hepatomegaly, and pleural effusion. Similarly, the coronary arteries are no longer able to return the blood from the myocardium to the right atrium.¹⁰ Passive congestion occurs and results in effusion within the pericardium. The volume of pericardial effusion associated with right heart failure is typically scant and does not cause clinical signs or require pericardiocenteses.¹

Severe mitral valve disease and secondary left atrial rupture can result in clinically significant pericardial effusion. Myxomatous degeneration of the mitral valve leads to back flow of blood from the ventricle into the atrium upon myocardial contraction. The increased volume of blood within the atrium raises atrial pressures. To compensate, the atrium expands, causing the wall of the atrium to weaken. Over time, the back flow, or 'jet,' of regurgitant blood jetting against the weakened atrial wall can result in atrial perforation.¹

Congenital causes of pericardial effusion are rare, however, they have been documented. The most common congenital defect of the pericardium in dogs and cats is peritoneopericardial diaphragmatic hernia, or PPDH. PPDH occurs during fetal development and results in incomplete separation of the abdominal and thoracic cavities.¹ Although frequently an incidental finding, PPDH can cause clinical signs, usually related to the gastrointestinal tract.¹ Typically, only a miniscule amount of pericardial effusion is associated with PPDH.¹ A less frequent congenital cause of pericardial effusion is the formation of pericardial cysts.¹ These are very rare and are generally of no clinical significance; however, rupture of the cysts can lead to severe pericardial effusion.¹

Other rare causes of pericardial effusion include traumatic right atrial rupture and resultant hemorrhage into the pericardium, coagulopathies such as seen with anticoagulant rodenticides, and uremia.¹ Uremia causes serositis and myocarditis due to exposure to uremic metabolites that are normally removed from circulation by the kidneys.¹ The inflamed serosa and myocardium can lead to pericarditis and subsequent effusion.

In contrast to canines, the most common cause of feline pericardial effusion is congestive heart failure. In one study, 75% of pericardial effusion in cats was caused by congestive heart

failure³, and can be attributed to passive congestion. Unlike dogs, the amount of pericardial effusion is often small and rarely causes clinical signs.³

Diagnostic Approach and Considerations

The history of a dog with pericardial effusion depends on the chronicity and severity of the effusion, as well as the underlying cause.² Dogs with chronic pericardial effusion present for signs related to right-sided heart failure and poor cardiac output such as ascites, lethargy, and exercise intolerance. Patients presenting with acute pericardial effusion often have a history of recent collapse.² Classic findings upon physical examination of a patient with pericardial effusion include muffled heart sounds, jugular venous distention, poor pulse quality or pulsus paradoxus, tachycardia, ascites, and dyspnea.² Laboratory testing is often non-remarkable in patients with pericardial effusion.² Abnormalities in the hemogram can occur as a result of the underlying cause of the pericardial effusion, but not generally due to the pericardial effusion itself. For example, schistocytes and acanthocytes may appear in patients with pericardial effusion secondary to hemangiosarcoma.² Complete blood count may reveal a mild anemia due to chronic disease or blood loss, and a mild leukocytosis.² Other laboratory tests include coagulation profiles to rule out coagulopathies and anticoagulant ingestion, culture for bacterial causes of pericardial effusion, such as *Nocardia* species, titers for fungal causes such as *Coccidioides immitis*.²

Radiographs are often very helpful in the diagnosis of pericardial effusion, particularly chronic effusions. The classic radiographic sign of pericardial effusion is an enlarged cardiac silhouette, typically globoid or rounded, with no distinct chamber enlargement discernable.² Chronic cases with large volume effusions can exhibit an extremely enlarged cardiac silhouette.

Right sided heart failure caused by pericardial effusion can lead to the appearance of pleural effusion on radiographs along with distention of the caudal vena cava.²

A classic finding on electrocardiography of a patient with pericardial effusion is changes in R-wave amplitude, known as electrical alternans.² This change in the ECG is caused by the heart 'swinging' in the pericardium, causing larger R waves when it is moving toward the lead, and smaller R waves as it is moving away from the lead.¹⁴ Electrical alternans reportedly occurs in 6% - 60% of cases². Other common ECG findings include tachycardia, ventricular premature complexes, and low-voltage QRS complexes.² However, a patient with pericardial effusion may have a normal ECG.

The gold standard for diagnosis pericardial effusion is echocardiography.² The standard view used to obtain diagnosis is the right parasternal view.² A hypoechoic space is visualized between the hyperechoic pericardium and the epicardium.² Echocardiography is very sensitive in the diagnosis of pericardial effusion; it can be utilized to detect as little as 10-15 milliliters of pericardial fluid. Other findings indicative of pericardial effusion include the collapse of the right atrium or ventricle.² Echocardiography can also be used to identify right atrial masses, such as with hemangiosarcoma, or heart-based tumors like chemodectomas.² For novice clinicians, ultrasound of the heart via the diaphragmatico-hepatic view can be used to detect pericardial effusion.¹² This view is performed below the xyphoid and shows the heart through the diaphragm, thereby avoiding interference from the air-filled lungs.¹²

The pericardial fluid obtained from pericardiocentesis is often hemorrhagic and, as such, is rarely useful in determining the underlying cause of effusion.² However, cytology and culture of the fluid is recommended because it can be useful in cases of infectious pericardial effusion or lymphosarcoma.⁷ Although the fluid is often hemorrhagic, it typically will not clot.⁷

Identification of hemorrhagic fluid that clots is likely frank blood rather than fluid in the pericardium, which is indicative of cardiac rupture.⁷

Differential Diagnoses

Based on radiographic changes of a globoid cardiac silhouette, decreased cardiac output and respiratory difficulty, a reasonable differential in a middle-aged large breed dog is dilated cardiomyopathy, or DCM. Like pericardial effusion, DCM may cause globoid enlargement of the cardiac silhouette, often with no discernable chamber enlargement.¹¹ Dogs with congestive heart failure due to DCM present with dyspnea, exercise intolerance, tachycardia, weak pulses, ascites, and jugular venous distention.¹¹ DCM can be excluded by echocardiogram.

Echocardiogram of these patients reveals myocardial dysfunction, or a hypokinetic heart, with dilation of chambers; however, pericardial effusion is not commonly seen.¹¹ Other differential diagnoses include hypertrophic cardiomyopathy in cats, congestive heart failure, heartworm disease, arrhythmias, and congestive heart failure due to valvular degeneration in dogs. These can also be quickly ruled out by echocardiogram. Other disease processes that may cause similar clinical signs as pericardial effusion (such as collapse) include neuromuscular diseases or hypoglycemia. A simple blood glucose test can confirm or rule out the presence of hypoglycemia. Neuromuscular disorders can be more difficult to diagnose; however, patients with neuromuscular diseases do not typically have pericardial effusion or muffled heart sounds.¹⁵ A thorough history and physical exam can help focus the direction of the examination.

Treatment and Management Options

Pericardiocentesis is necessary for the emergency treatment of cardiac tamponade.² Relief of pressure from the pericardium can be achieved by removing the excess effusion, allowing for the chambers to expand and cardiac output to improve. Pericardiocentesis may be avoided if the patient is not exhibiting clinical signs of cardiac tamponade. It is important to note the complications associated with pericardiocentesis, which are ventricular premature contractions, laceration of the coronary artery, puncture of the heart, arrhythmias, and sudden death.² Risk can be minimized by using echocardiography, performing pericardiocentesis from the right hemithorax to avoid the majority of the coronary arteries¹⁰, and having electrocardiography attached to the patient to monitor for arrhythmias.

In some cases of idiopathic pericardial effusion, a single pericardiocentesis is curative. Some cardiologists suggest the use of broad-spectrum antibiotics as well as anti-inflammatory dosages of prednisone (1 mg/kg/day for two to four weeks) in cases of idiopathic pericardial effusion to reduce the risk of reoccurrence.¹⁶ In cases of idiopathic pericardial effusion that do not resolve after initial pericardiocenteses and medical therapy, surgical intervention is indicated. Surgery can be performed to remove part of the pericardium to allow the effusion to drain into the thorax and prevent cardiac tamponade. This method is also useful for palliative treatment of pericardial effusion due to neoplasia², or to obtain a biopsy of the pericardium. The goal of pericardectomy is to decrease fluid accumulation and avoid recurrence of cardiac tamponade.² With other causes of pericardial effusion, such as right auricular hemangiosarcoma or atrial rupture, surgery is indicated but often declined by owners due to poor prognosis.² One paper reported the successful treatment of traumatic right atrial rupture in a year old dog who had been hit by a car by utilizing digital hemostasis and placing sutures along the laceration.⁴ However,

most traumatic ruptures are discovered post-mortem. Congenital causes of pericardial effusion such as PPDH or pericardial cysts can be treated definitively by surgical intervention.²

Surgical options include pericardial window and subtotal pericardectomy, and full pericardectomy.² For recurring cases of idiopathic pericardial effusion, a thoracoscopic pericardectomy can be performed to create a small pericardial window through which the effusion can drain. This method decreases morbidity. However, the whole heart cannot be inspected and a mass could be missed. There is also a possibility that the window may close over time.² Subtotal pericardectomy via open thoracotomy allows removal of all of the pericardium below the phrenic nerve and visualization of the entire heart.² Full pericardectomy may be utilized in cases of diffuse neoplastic infiltration of the pericardium, such as with mesothelioma.²

Expected Outcome and Prognosis

Prognosis can vary greatly, depending on the underlying disease. Good to excellent prognoses are given to patients with PPDH after surgical intervention.² Likewise, dogs with mesothelioma that is treated with pericardectomy have a good prognosis.² Patients with pericardial effusion due to hemangiosarcoma carry a poor to grave prognosis, as the rate of metastasis is nearly 100% by the time of diagnosis¹. Dogs with pericardial effusion secondary to chemodectomas are generally fair to good, as chemodectomas are slow growing and rarely metastasize.² Infectious pericardial effusion can have a good prognosis, though it often requires surgical intervention and antimicrobial or antifungal therapy.² Pericardial effusion secondary to congestive heart failure typically has a poor to grave prognosis, depending on the severity of heart disease. Dogs with left atrial rupture due to mitral valve degeneration have a grave

prognosis and a high likelihood of recurrence.² Idiopathic pericardial effusion generally has a good to excellent prognosis after pericardiocentesis and/or surgical intervention.²

Conclusion

Pericardial effusion is not uncommon in canines and very rare in feline patients. The most common causes of pericardial effusion in dogs are right auricular hemangiosarcoma and idiopathic pericardial effusion, while the most common cause in cats is congestive heart failure. This condition can be easily diagnosed with a thorough history and physical exam, along with the use of radiographs and ultrasonography. It is imperative to identify the underlying cause of pericardial effusion, as it will direct the treatment and determine the prognosis for the patient.

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