Pericardial effusion is defined as the accumulation of fluid within the pericardial space. As the pressure within the pericardial space increases, right sided cardiac filling is impaired, resulting in decreased stroke volume with subsequent decreases in cardiac output and ultimately decreased oxygen delivery to the tissues (shock). These manifestations of pericardial effusion are referred to as cardiac tamponade. Successful emergency management of dogs with life threatening pericardial effusion depends on early triage, a thorough physical examination, point of care diagnostic imaging techniques, and subsequent pericardiocentesis or placement of an indwelling pericardial drain.

Key etiologic and pathophysiologic points
Pericardial fluid accumulation and cardiac tamponade in the dog most often occurs secondary to a neoplastic process. Hemangiosarcoma (HSA) is most commonly identified in the region of the right atrium or right atrial appendage while chemodectoma (common in brachycephalic breeds) is most often identified at the heart base. Mesothelioma and any metastatic tumor are additional neoplastic causes. Although location and breed are frequently suggestive of tumor type, definitive diagnosis is dependent on a biopsy specimen.

Idiopathic pericardial effusion tends to be an inflammatory process and is frequently recognized in similar breeds to those that frequently develop HSA. Significant efforts in recent years have been directed towards developing diagnostic tests to help differentiate malignant from benign pericardial effusion (idiopathic). Pericardial fluid pH was initially thought to aid in making this differentiation, however, pericardial fluid pH has now been clearly shown to be of little diagnostic value. Recent evidence suggests that blood concentrations of cardiac troponin I (cTnI) are significantly higher in dogs with masses consistent with HSA than in dogs without evidence of an underlying cause (idiopathic).8

Vitamin K1 antagonists (anticoagulant rodenticides and coumadin) can also result in pericardial effusion. Therefore; it is the authors’ practice to always perform an ACT or other point-of-care coagulation assessment at the cage side prior to pericardiocentesis. If significant coagulopathy is present and patient condition permits, correction of coagulopathy with blood products (fresh frozen plasma or fresh whole blood) is indicated prior to pericardiocentesis. Subsequent institution of Vitamin K1 therapy for 4 weeks is indicated.

Left atrial tear is an uncommon consequence of chronic mitral regurgitation and left atrial dilatation, however, it has been recognized as a cause of acute pericardial effusion in the dog. An infectious cause of pericardial effusion is fungal disease (coccidiomycosis). Bacterial pericarditis and pericardial effusion secondary to trauma also occur, but are uncommon.

Numerous additional conditions such as congestive heart failure, uremia, decreased oncotic pressure, and a host of systemic inflammatory processes frequently result in small volume pericardial effusion accumulations without evidence of cardiac tamponade.

Key clinical diagnostic points
Triage and physical examination in pericardial effusion
The most common presenting complaints from the owners of dogs with pericardial effusion and cardiac tamponade are lethargy, anorexia, collapse or syncope, abdominal distention, and dyspnea. Major body systems assessment of the dog with pericardial effusion will likely reveal compromise to one or all of the major body systems. Assessment of the cardiovascular system may frequently reveal the following:

- Pale mucous membranes: due to vasoconstriction and poor peripheral perfusion
- Slow CRT: due to decreases in cardiac output
- Increased heart rate: due to compensatory activation of the sympathetic nervous system
- Poor pulse quality: due to decreased stroke volumes and low blood pressure

Assessment of the respiratory system will frequently reveal increased respiratory rate and effort.

Assessment of the central nervous system will frequently reveal a decreased level of consciousness secondary to decreased oxygen delivery to the brain. Any one or combination of these findings should necessitate movement to the treatment area for further assessment including full physical examination, measurement of blood pressure, oxygen saturation, cardiac rhythm (ECG), and placement of an intravenous catheter from which a small blood sample for PCV / TS / Blood Glucose +/- Venous Blood Gas and Electrolytes can be rapidly acquired. If possible, blood for CBC, serum biochemical profile, and coagulation profile or ACT should also be collected. Concurrently, a second team member will be able to collect a full medical history.

Physical examination should still be centered on the major body systems, but subtle findings supportive of pericardial effusion may be noted including:

- Jugular venous distention: due to right sided congestive heart failure.
• Muffled heart sounds normal lung sounds: unlike pleural effusion which will frequently cause decreased heart and lung sounds, pericardial effusion will frequently only cause decreased heart sounds.
• Abdominal distention: ascites and hepatic engorgement may result from longstanding (days) pericardial effusion due to right sided congestive heart failure. Abdominocentesis will frequently reveal a relatively clear fluid will low cellularity and a protein concentration greater than 2.5g/dL but less than 3.5g/dL most consistent with a modified transudate.
• Pulsus paradoxus: An inspiratory fall of arterial systolic blood pressure of more than 10mmHg resulting in variation in pulse intensity with respiratory cycle due to increased venous return during inspiration, increased right sided filling, shifting of the interventricular septum to the left with decreased left sided diastolic filling and subsequent decreased left sided stroke volume.²
• Other physical examination findings specific to the underlying cause of the effusion such as fever in septic or fungal pericarditis.

Pericardial effusion causing cardiac tamponade should be HIGHLY suspected based on signalment, history, and physical examination findings, supported by diagnostic testing such as abdominocentesis and electrocardiography (+/- radiography) and confirmed through point of care diagnostic imaging techniques.

Diagnostic techniques

Abdominocentesis
See above.

Electrocardiography
Assessment of ECG in patients with pericardial effusion may reveal sinus tachycardia +/- ventricular arrhythmias. Ventricular arrhythmias may result from decreased myocardial oxygen delivery or aberrant conduction associated with the underlying cause of the effusion. QRS complexes <1mV in amplitude and the presence of electrical alternans (regular or irregular variation in QRS complex amplitude associated with the heart moving within the pericardium to and from the positive pole of lead II) are supportive of pericardial effusion.⁴

Echocardiogram
Echocardiogram is the diagnostic test of choice for confirmation of the presence of pericardial effusion in the dog. Many dogs with pericardial effusion have SEVERE cardiovascular compromise and can be on the verge of death. The stresses associated with radiographic imaging may put cause these patients to decompensate. Consequently, in the ideal world, radiographic imaging should be avoided initially. The authors have found that the presence of a small, portable ultrasound machine with a mid-range frequency transducer placed at the primary treatment station in the emergency room / treatment area to be of great utility for identifying conditions like pericardial effusion, pleural effusion, and to assess patients with acute abdomen for the presence of abdominal fluid. Echocardiographically, pericardial effusion appears as a hypoechoic space located between the hyperechoic pericardium and the right ventricular wall when viewed through the right cardiac notch. The presence of pericardial effusion provides excellent contrast to aid in the diagnosis of cardiac masses, however, pericardiocentesis should NOT be delayed in a patient with signs of shock simply to aid the diagnosis.

Thoracic radiography
As previously mentioned, thoracic radiography can be an extremely stressful procedure for dogs with cardiac tamponade. However, not all practices are equipped with ultrasound capabilities. If thoracic radiography is performed in dogs with suspected pericardial effusion, ventrodorsal positioning should be avoided. A dorsoventral projection can be acquired with minimal stress. Lateral thoracic radiographs may also be performed. Supportive radiographic findings include an enlarged, globoid cardiac silhouette. Acute effusions may not cause severe enlargement of the cardiac silhouette because the pericardium has not had time to stretch. Concurrent pleural effusion may be present. The other primary differential for a globoid heart is dilated cardiomyopathy (DCM) or other underlying cardiac disease. Key findings to try to differentiate DCM from pericardial effusion include:
• Heart sounds: Heart sounds in dogs with DCM are frequently normal in contrast to the decreased heart sounds seen in pericardial effusion. A systolic murmur may be noted in dogs with DCM and is uncommon in dogs with pericardial effusion.
• ECG: Atrial fibrillation is common in dogs with DCM. Atrial fibrillation is uncommon in dogs with pericardial effusion. Electrical alternans may be seen in dogs with pericardial effusion.⁴
• Cardiac Silhouette: The silhouette of the heart on thoracic radiographs of dogs with pericardial effusion tends to be extremely round with sharp borders. The silhouette of the heart in dogs with cardiomyopathy can be round, but often, there are still some dimples or “waist” associated with the divisions between the chambers and the borders of the cardiac silhouette tend not to be as sharp because of motion artifact.
• Pulmonary infiltrate: Pulmonary edema is common in DCM and uncommon in pericardial effusion.
• Pulsus paradoxus: Pulmonary edema is common in DCM and uncommon in pericardial effusion.

²
Pericardiocentesis can be a stressful procedure. Use of cardiovascularly sparing sedatives (narcotics and benzodiazepines) may alleviate patient stress and facilitate safe pericardiocentesis. Numerous techniques have been described for pericardiocentesis in the dog including, but not limited to the use of a large-gauge over-the-needle catheter, through the needle catheter, and catheters placed using the Seldinger technique. Numerous commercial pericardiocentesis trays / kits are also available. The authors prefer to use a 14-16g, 5.5” over-the-needle catheter (Abbocath T, Hospira Inc. Lake Forest, IL) with two additional small side-holes or a commercial multi-lumen intravenous catheter placed using the Seldinger technique (Arrow Triple Lumen Central Venous Catheter, Arrow International, Reading, PA). The former is much less expensive while the latter may be left in place for ongoing drainage.

ECG should be monitored during and after pericardiocentesis for the presence of arrhythmias induced by catheter-associated irritation of the epicardium and decreased myocardial oxygen delivery experienced during cardiac tamponade. Lidocaine should be readily available, as should a defibrillator.

Pericardiocentesis is most often performed from the right hemithorax because injury to the left coronary artery is unlikely, and the cardiac notch is slightly larger. The patient can be positioned in sternal recumbency (preferred by most) or laterally. Full surgical preparation should be performed between the 2nd to the 8th ribs and from the mid-thorax to the level of the sternum. A fenestrated drape should be placed. Aseptic technique should be practiced at all times. The apex beat of the heart should be palpated (most often between the 4th and 5th ribs just above the costochondral junction) and lidocaine should be infiltrated locally off of the cranial edge of the rib (to avoid the intercostal neurovascular bundle). Ultrasound guidance can also be used to identify the optimal location for pericardiocentesis. A small skin incision (<5mm) should be made in the proposed insertion site and the catheter advanced through this incision (off the cranial edge of the rib). Upon the appearance of fluid in the flash chamber, the catheter and stylet should be advanced together for 2-3mm and the catheter fed over the stylet into the pericardium. Initially, a small fluid sample should be placed in an ACT or clot tube. A sample retrieved from the ventricle should clot (unless the underlying condition is anticoagulant rodenticide intoxication) while one that has been in the pericardial space for any appreciable period of time should not. A fluid sample should be saved for cytologic analysis and culture and the pericardium should be evacuated.

Monitoring

Patient response to decompression of significant pericardial effusion is often very rapid and very gratifying as vital signs and physical examination findings improve dramatically. Monitoring for recurrence of fluid accumulation by frequent reassessment of major body systems, physical examination and echocardiography is useful. Placement of a central venous catheter and monitoring of central venous pressure can also be a useful technique in that re-accumulation of pericardial fluid will result in a rise in central venous pressure.

Key prognostic points

Prognosis for dogs with pericardial effusion will depend on the underlying cause of the disease. Surgical removal of a mass on the right atrial appendage will at least temporarily alleviate signs of recurrent pericardial effusion. Surgical removal of right atrial / appendage HSA followed by chemotherapy will prolong life in dogs with pericardial effusion. Pericardecotomy will temporarily palliate clinical signs of pericardial effusion for most neoplastic processes, and will most often be curative for idiopathic pericardial effusion. Thoracoscopic pericardecotomy or creation of a pericardial window may have similar effects. Treatment with fresh frozen plasma, vitamin K1, and pericardiocentesis will be curative for dogs with anticoagulant rodenticide intoxication. Culture and sensitivity based antimicrobial therapy +/- surgical debridement is indicated for the management of infectious pericarditis. Dogs with left atrial tear secondary to chronic mitral valve regurgitation and left atrial dilation carry a guarded prognosis. Surgical repair of such a lesion has been described.

Summary

Triage and careful attention to physical examination findings supported by ancillary diagnostic tests and point-of-care diagnostic imaging are the keys to the rapid identification of pericardial effusion in the dog. Rapid identification of problems and institution of treatment will maximize the likelihood of a positive outcome.

References/suggested reading


