An In-Depth Look: CANINE PERICARDIAL EFFUSION

Canine Pericardial Effusion: Diagnosis, Treatment, and Prognosis*

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ABSTRACT: Most cases of pericardial effusion can be diagnosed with a thorough physical examination. Physical examination findings may include muffled heart sounds, pulsus paradoxus, and jugular venous distention. Radiographs may show a globoid cardiac silhouette. Echocardiography is reliable in diagnosing pericardial effusion. Pericardiocentesis is indicated for the emergency treatment of pericardial tamponade. Pericardiectomy may improve survival in some dogs. The prognosis varies greatly, depending on the underlying cause.

Pericardial effusion can result in life-threatening clinical signs and commonly requires emergency care. This article focuses on the diagnosis, treatment, and prognosis of dogs with pericardial effusion.

DIAGNOSIS

History

The history of a dog with pericardial effusion varies, depending on whether the effusion is acute or chronic. Dogs with chronic pericardial effusion typically have signs secondary to right-sided heart failure, including lethargy, exercise intolerance, respiratory difficulty, weight loss, and abdominal distention. These signs may be progressive as the ability of the pericardium to stretch is exceeded. Dogs with acute pericardial effusion typically present with a history of acute collapse or weakness secondary to decreased cardiac output. Collapse sometimes occurs shortly after physical exertion, and syncope may also be noted.

Physical Examination

Although no single physical examination finding is pathognomonic of pericardial effusion, a combination of several classic findings is highly indicative of the diagnosis. A combination of muffled heart sounds, jugular venous distention, and poor pulse quality or pulsus paradoxus should result in a very high index of suspicion for the presence of pericardial effusion, particularly in middle-aged or older large-breed dogs. Other physical examination findings may include tachycardia, hepatomegaly, ascites, and tachypnea or dyspnea.

Jugular venous distention occurs secondary to increased right atrial filling pressures. All dogs with pericardial tamponade have jugular venous distention. Dogs with thick haircoats may require hair clipping to allow detection of jugular venous distention. Many dogs with pericardial effusion may have muffled heart sounds resulting from attenuation of the sound by the effusion, but affected dogs can also have normal heart sounds.

* A companion article on pathophysiology and cause begins on p. 400.
Fungal cause of pericardial effusion.

One report found that cardiac troponin I levels are more elevated in dogs with pericardial effusion caused by hemangiosarcoma than in dogs with pericardial effusion resulting from other causes. Further studies are required to confirm the findings and elucidate the degree of troponin I elevation that is consistent with a diagnosis of hemangiosarcoma.

Radiography

Mild to severe enlargement of the cardiac silhouette is commonly observed on thoracic radiographs. The size of the cardiac silhouette increases in conjunction with the chronicity of the effusion and the associated fluid volume. The cardiac silhouette frequently appears globoid or rounded. Pleural effusion may be present, and the caudal vena cava may be enlarged secondary to right-sided congestive heart failure. In addition, the edges of the cardiac silhouette may be very “sharp” due to decreased motion artifact from cardiac contraction (Figure 1). Some dogs may also show evidence of metastatic disease. Abdominal radiography may reveal hepatomegaly or decreased abdominal detail due to ascites, either of which may occur secondary to right-sided congestive heart failure caused by pericardial effusion.

Electrocardiography

Sinus tachycardia is a frequent electrocardiographic finding. Ventricular premature contractions occur less frequently; however, they are common during or after pericardiocentesis. In dogs, low-voltage QRS complexes (<1 mV) in all limb leads may occur because of increased electrical impedance caused by pericardial effusion. Low-voltage QRS complexes have been reported in approximately 50% of dogs with pericardial effusion. Electrical alternans occurs in 6% to 60% of cases (Figure 2). Electrical alternans is characterized by a cyclic change in R-wave amplitude (e.g., 1:1, 2:1) caused by the motion of the heart in the pericardial sac. A normal electrocardiogram does not rule out pericardial effusion.

Echocardiography

Echocardiography is considered the “gold standard” for establishing a diagnosis of pericardial effusion. From the right parasternal view, an echo-free space is evident between the pericardial sac and epicardium (Figure 3). In some cases, a left parasternal view may allow better visualization of the right side of the heart, which may aid in identifying right atrial masses. A fluid volume as small as...
10 to 15 ml can be detected using ultrasonography. Diastolic collapse of the right atrium or ventricle can be detected and is diagnostic of pericardial tamponade. Although echocardiography cannot provide a definitive diagnosis, in many diseases, the location and appearance of a mass are sufficiently consistent to allow strong assumptions to be made regarding its origin. A cavitated, soft tissue mass arising from the right atrium is almost certainly a hemangiosarcoma (Figures 4 and 5). A mass arising from and encircling the ascending aorta is likely a heart-base tumor. Transthoracic two-dimensional echocardiography reportedly has an 80% sensitivity for a diagnosis of cardiac masses. In most cases, clinicians with basic ultrasonographic skills can readily identify pericardial effusion. However, visualization and definitive identification of masses often require an exhaustive echocardiographic examination from both sides of the thorax and a higher level of echocardiographic skill.

**Fluid Analysis**

Analysis of fluid obtained from pericardiocentesis is rarely helpful in establishing the cause of pericardial effusion. The effusion typically has a hemorrhagic appearance despite the underlying cause. One study of 50 dogs with pericardial effusion found that cytologic examination could not reliably distinguish between pericardial effusion due to neoplasia and that due to other causes. The use of pericardial fluid pH as a marker of malignancy has also been suggested. However, reports have found that pH cannot be accurately used to identify the underlying cause in most cases. Fluid analysis may be

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**Figure 1.** Thoracic radiographs of a dog with pericardial effusion showing a large globoid cardiac silhouette with sharp margins and an enlarged caudal vena cava.

**Figure 2.** Lead II electrocardiogram of a dog with pericardial effusion and electrical alternans. The QRS complex is smaller than normal, and there is a cyclical change in the QRS complex height. This was recorded at 25 mm/sec and 1 cm/mV.
diagnostic in cases of infection or lymphosarcoma; therefore, although cytologic evaluation has a low diagnostic yield, we still recommend it when a mass that is not consistent with hemangiosarcoma is observed.

**TREATMENT**

**Pericardiocentesis**

Pericardiocentesis is indicated as an emergency treatment of cardiac tamponade (see box on page 409). Cases of pericardial effusion that do not demonstrate clinical or echocardiographic signs consistent with cardiac tamponade may not require pericardiocentesis. Reported complications associated with pericardiocentesis include ventricular premature contractions, laceration of the coronary artery, and sudden death. Some cases of idiopathic pericardial effusion resolve after one or more pericardiocenteses. Most authors do not recommend long-term diuretic therapy to aid the resolution of ascites because diuretics can result in a decrease in preload with a resultant catastrophic decrease in cardiac output if cardiac tamponade recurs.

**Surgical Treatment**

Pericardiectomy can be a definitive treatment of idiopathic pericardial effusion and a palliative treatment of malignant pericardial effusion. When pericardial effusion recurs after one or more therapeutic pericardiocenteses, surgical treatment becomes an option. Surgery may be used to remove the pericardium and obtain a biopsy specimen or resect a mass of uncertain origin. Surgery is also an option for the management of traumatic pericardial effusion. Because of the poor long-term prognosis for affected patients, many owners...
Pericardiocentesis: Step-by-Step

Required equipment and anesthetics

- 14–18-gauge over-the-needle catheter
- 2% lidocaine in syringe for a local or intercostal block
- Extension tubing
- Scalpel
- Three-way stopcock
- Syringe for fluid aspiration
- Electrocardiograph
- Lidocaine (2 mg/kg) to treat possible ventricular arrhythmia

Patient preparation

- Some patients may require sedation for the procedure to be performed safely. Dogs with a history of collapse, particularly large breeds, may require only local anesthesia.
- Obtain baseline blood samples, including the packed cell volume and activated clotting time or prothrombin time, if indicated.
- The procedure is preferably performed with the patient sternally recumbent, although the patient can also be laterally recumbent.
- Pericardiocentesis from the right side of the thorax is preferred to avoid the large coronary arteries on the left side.
- If echocardiography is available, use it to determine the optimal site for pericardiocentesis. If echocardiography is unavailable, choose a site over the palpable cardiac beat or just caudal to or below the elbow at the level of the costochondral junction (approximately the fifth or sixth intercostal space).
- Clip and aseptically prepare the selected site.
- Administer a small bleb of lidocaine by infiltrating the subcutaneous tissue and intercostal muscles to the level of the pleura.
- Attach the patient to an electrocardiograph to watch for arrhythmia.

Procedure

- With a #11 blade, make a small stab incision through the skin to facilitate catheter placement.
- Advance the catheter through the skin perpendicular to the thoracic wall.
- Advance the catheter and stylet until fluid is seen in the hub of the catheter. In patients with pleural effusion, this fluid (which is usually a modified transudate and amber or slightly red) is typically encountered first. Advance the catheter further. When the pericardial space has been entered, a tissue “pop” may be noted or a hemorrhagic fluid typical of pericardial effusion is often seen.
- Once the tip of the catheter has entered the pericardial space, advance it approximately 0.5 inch and remove the stylet.
- Connect the extension set to the catheter, and aspirate the pericardial fluid.
- Examine a sample of the pericardial fluid for evidence of clotting, which may indicate inadvertent cardiac puncture or ongoing hemorrhage. Compare the packed cell volume of the peripheral blood with that of the pericardial effusion to determine whether cardiac puncture has occurred.
- If the catheter tip or stylet contacts the heart, ventricular premature contractions may occur. If this occurs, slightly withdraw the catheter and continue gentle aspiration.
- Once all the fluid has been removed, slowly withdraw the catheter.

Patient monitoring after pericardiocentesis

- Because arrhythmia is common after pericardiocentesis, continuous cardiac monitoring is indicated, if it is available.
- If signs of shock (tachycardia, poor pulse quality) recur, reevaluate the dog for recurrence of cardiac tamponade.

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Ref: 15,16,17,18,19,20

Decline surgery when a right atrial mass is detected using echocardiography or pulmonary metastasis is detected using thoracic radiography. Cases of peritoneopericardial diaphragmatic hernia (PPDH) can be definitively treated using surgery. In other cases, the goal is to allow drainage of the pericardial fluid into the pleural space, which allows superior lymphatic drainage and may reabsorb the accumulating effusion, and to prevent the recurrence of cardiac tamponade.

Traditional surgical approaches include median sternotomy or right lateral thoracotomy. Subtotal pericardiectomy can be performed with either approach. The advantages of open thoracotomy include complete removal of the pericardium below the level of the phrenic nerve, accurate identification of masses arising from the right atrium, and the ability to excise the right auricular appendage when the mass is isolated to that part of the heart.15,16

Thoracoscopic pericardiectomy is available to treat recurrent pericardial effusion. Thoracoscopic pericardiectomy offers the advantage of a decreased morbidity rate compared with that associated with traditional thoracotomy. Disadvantages of thoracoscopic pericardiectomy include the inability to visualize the entire right atrium and perhaps unfounded concerns that the relatively small pericardial window created may close over time.17,18

The use of percutaneous balloon pericardiotomy to manage pericardial effusion has also been described.19,20 It offers the advantage of being minimally invasive and may be useful in patients with a poor long-term progno-
sis resulting from previously identified neoplasia. The main disadvantages of this technique include the inability to obtain a tissue biopsy specimen and the possible recurrence of pericardial effusion due to closure of the pericardial window. Because the heart is not directly visualized, it may be more predisposed to serious complications than when other techniques are used.

Adjuvant Therapies
Chemotherapy may be useful in some cases of malignant pericardial effusion. Intracavitary chemotherapy has been used to treat malignant mesothelioma. There is little information on the efficacy of chemotherapy to treat malignant pericardial effusion.

PROGNOSIS
The prognosis for dogs with pericardial effusion varies greatly, depending on the underlying cause. Congenital PPDH generally has a favorable prognosis. The prognosis for dogs with pericardial effusion secondary to hemangiosarcoma is generally poor, with the average duration of survival reportedly being 1 to 3 months. Many dogs initially respond to pericardiocentesis, but signs recur shortly after effusion recurs. Because aortic body tumors are slow growing, the prognosis for dogs with these tumors can be fair to good (129 days without pericardiectomy; 661 days with pericardiectomy). Dogs with mesothelioma that is treated using pericardiectomy may also have a fair to good prognosis. The mean duration of survival after a diagnosis of mesothelioma and subsequent pericardiectomy is reportedly 13.6 months, with 80% of patients surviving 1 year and 40% surviving 2 years. The prognosis for pericardial effusion due to other types of neoplasia is generally poor to guarded.

Infectious pericardial effusion has a guarded to good prognosis and typically requires a combination of surgical pericardiectomy and antimicrobial or antifungal therapy.

Fluid from pericardial effusion secondary to congestive heart failure rarely accumulates in a large enough volume to require pericardiocentesis, and the prognosis is dictated by the severity of the underlying heart disease. Dogs with rupture of the left atrium secondary to myxomatous degeneration have a poor prognosis resulting from the severity of the underlying heart disease and the high likelihood of recurrence. In the short term, affected dogs may respond to aggressive therapy for heart failure.

Constrictive pericarditis should be treated using pericardiectomy and therapy directed toward the underlying cause if one is identified. The long-term prognosis for dogs with constrictive pericarditis is guarded; six of nine dogs did not survive the perioperative period in one study.

Idiopathic pericardial effusion has a good to excellent prognosis. It may spontaneously resolve after one or more therapeutic pericardiocenteses or require surgical pericardiectomy. In one study, 50% of patients were alive 1,500 days after the initial diagnosis. Another study reported a 72% survival rate after 18 months. In general, surgical pericardiectomy using one of the discussed techniques is indicated in dogs with chronic pericardial effusion.

CONCLUSION
Pericardial effusion can result in cardiac tamponade, which requires emergency pericardiocentesis. The prognosis associated with pericardial effusion varies greatly, depending on the underlying cause. Surgical or thorascopcic pericardiectomy can be used as definitive or palliative treatment of pericardial effusion.

REFERENCES
5. Which is not an electrocardiographic finding associated with pericardial effusion?
   a. sinus tachycardia  
   b. tall, tented T waves  
   c. low-voltage QRS complex  
   d. electrical alternans

6. Which statement regarding echocardiography in dogs with pericardial effusion is correct?
   a. It is difficult to visualize effusion volumes less than 100 ml.  
   b. If a mass is present, it can usually be visualized.  
   c. A cavitated mass originating from the right atrium is most likely a hemangiosarcoma.  
   d. Visible masses arising from and encircling the aorta are usually carcinomas.

7. Which statement regarding treatment of pericardial effusion is correct?
   a. Pericardiocentesis is frequently successful as the sole therapy in dogs with pericardial effusion.  
   b. Surgery is curative in up to 75% of dogs with right atrial hemangiosarcoma.  
   c. Animals with a PPDH should be treated using thoracotomy to perform pericardiectomy.  
   d. Dogs with recurrent idiopathic pericardial effusion can best be treated by pericardiectomy.

8. Which is not recommended in performing pericardiectomy?
   a. thoracotomy  
   b. thoracoscopy  
   c. percutaneous balloon pericardiectomy  
   d. transabdominal pericardiectomy

9. Which list of conditions associated with canine pericardial effusion is in order of prognosis, from best to worst?
   a. PPDH, idiopathic effusion, heart-base tumor, hemangiosarcoma  
   b. idiopathic effusion, heart-base tumor, hemangiosarcoma, PPDH  
   c. heart-base tumor, hemangiosarcoma, PPDH, idiopathic effusion  
   d. hemangiosarcoma, PPDH, idiopathic effusion, heart-base tumor

10. Which statement regarding pericardial effusion is correct?
    a. Hemangiosarcoma is best diagnosed by cytologic examination of pericardial fluid.  
    b. Infectious pericardial effusion is usually successfully treated solely with oral antimicrobial therapy.  
    c. Congestive heart failure secondary to pericardial effusion rarely results in fluid volumes large enough to require pericardiocentesis.  
    d. Heart-base tumors are usually treated with complete resection combined with pericardiectomy.