Pericardial effusion is defined as abnormal fluid accumulation within the pericardial sac. It is a potentially life-threatening condition and can occur secondary to a number of disease processes. Neoplasia, more specifically right atrial hemangiosarcoma, is the most common cause of pericardial effusion in dogs. Idiopathic pericardial effusion is also common in dogs, representing approximately 20% of cases. Regardless of the cause, the treatment involves pericardiocentesis, thoroscopic creation of a pericardial window (ie, pericardial window technique), partial pericardectomy via thoracoscopy (with or without mass excision), or subtotal pericardectomy via thoracotomy. It has been shown that dogs with an idiopathic pericardial effusion have an excellent prognosis when treated by subtotal pericardectomy via thoracotomy, in that MST was not reached in 1 study. However, the long-term outcome of idiopathic cases of pericardial effusion treated by a thoracoscopic pericardial window procedure has not been reported. The purpose of the study reported here was to retrospectively evaluate the DFI and MST of dogs with idiopathic and neoplastic pericardial effusion surgically treated either by the pericardial window technique or subtotal pericardectomy via thoracotomy. A secondary objective was to compare DFI and MST in dogs with and without a mass on preoperative echocardiography that underwent either surgical technique. We hypothesized that the surgical technique, via thoracoscopy or thoracotomy, used to palliate the clinical signs related to pericardial effusion does not affect the DFI and the long-term survival rate of dogs with idiopathic or neoplastic pericardial effusion.

**Abbreviations**

<table>
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<th>ABBREVIATIONS</th>
<th>DFI</th>
<th>Disease-free interval</th>
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<tr>
<td>MST</td>
<td>Median survival time</td>
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</table>
reviewed. Additional follow-up data were obtained via communication with referring veterinarians and clients. Animals were included in the study if pericardial effusion was present and a diagnostic workup was performed. Animals were excluded from the study if the owner declined treatment via thoracotomy or thoracoscopy or if the patient was euthanized. The treatment modality selected for each case was a function of surgeon preference, with the exception of cases treated between 1985 and 1996. During this period, the pericardial window technique was not performed at our institution.

**Medical records review**—Medical records for each dog were reviewed for signalment (age, sex, and breed), body weight, and clinical signs present at the time of initial evaluation. Data collected from the medical record included findings on CBC, serum biochemical analysis, urinalysis, coagulation profile (prothrombin time, partial thromboplastin time, and platelet count), thoracic radiography, abdominal ultrasonography, and echocardiography. In addition, results from cytologic examination and bacterial culture and antimicrobial susceptibility testing of the pericardial fluid as well as histologic evaluation of the pericardium were reviewed. Patients were classified as having idiopathic pericardial effusion if no specific cause for the effusion could be determined following diagnostic evaluation, surgery, and histologic examination. Patients were classified as having a neoplastic pericardial effusion if a neoplasia was identified grossly or during histologic examination.

**Statistical analysis**—All analyses were performed with a commercially available statistical software program.$ Signalment and clinical signs of dogs with neoplastic or idiopathic pericardial effusion were compared via a 1-way ANOVA to determine whether significant differences existed between dogs treated by the pericardial window technique or subtotal pericardectomy via thoracotomy.

The Kaplan-Meier actuarial survival analysis was used to determine DFI and MST for dogs treated via thoracotomy or thoracoscopy. Disease-free interval and survival time were established from the medical record or by telephone interview with the owner or the referring veterinarian. Disease-free interval was defined as the time from surgery to the time of recurrence of clinical signs related to pericardial effusion. Survival time was defined as the time from surgery to the time of last follow-up. Dogs that died of causes unrelated to the pericardial effusion, were lost to follow-up, or alive at the end of the study period were censored during the analysis. A log-rank test was used to compare DFI and MST between dogs treated by thoracotomy or thoracoscopy. Comparisons were made on the basis of surgical treatment, histopathologic diagnosis, and echocardiographic presence or absence of a mass. One dog in which echocardiography was not performed was eliminated from the echocardiographic survival analysis. A value of $P < 0.05$ was considered significant.

**Results**

Fifty-eight dogs met the entry criteria. Of these, 38 were male and 20 were female. Mean age at initial evaluation for all case animals was 114.7 months (mean, 9.6 years; range, 1.2 to 15.2 years). Mean body weight was 31.7 kg (69.8 lb; range, 8.2 to 75.2 kg [18.1 to 165.4 lb]). Golden Retrievers (14) and Labrador Retrievers (10) were the 2 most common represented breeds. The etiology of the pericardial effusion was neoplastic in 41 dogs and idiopathic in 17 dogs. The pericardial window technique was performed in 36 dogs (12 with idiopathic pericardial effusion and 24 with neoplastic pericardial effusion). Subtotal pericardectomy via thoracotomy was performed in 22 dogs (5 with idiopathic pericardial effusion and 17 with neoplastic pericardial effusion). Median follow-up time was 4.3 months (range, 0 to 50.0 months). Ten dogs were lost to follow-up at a median time of 6 months (range, 0 to 50 months). Seven of the 10 dogs had a neoplastic pericardial effusion, and 3 dogs had idiopathic pericardial effusion.

Clinical signs at the time of initial evaluation were not significantly different between dogs treated by the pericardial window technique (n = 36) and dogs treated by subtotal pericardectomy via thoracotomy (22) with the exception of lethargy, which was significantly ($P = 0.03$) more common in dogs treated by the pericardial window technique (Table 1). Echocardiography was performed on 57 dogs prior to surgery. A mass was evident on preoperative echocardiography in 31 cases (2 dogs with idiopathic pericardial effusion and 29 dogs with neoplastic pericardial effusion). A mass was not evident on preoperative echocardiography in 26 cases (15 dogs with idiopathic pleural effusion and 11 dogs with neoplastic pleural effusion). A specific histopathologic diagnosis was determined for 39 of 58 (67%) dogs, one of which did not undergo preoperative echocardiography (Table 2).

**Table 1**—Comparison of clinical signs at the time of initial evaluation in 58 dogs with pericardial effusion that underwent thoracoscopic creation of a pericardial window (n = 36) or subtotal pericardectomy via thoracotomy (22).

<table>
<thead>
<tr>
<th>Clinical sign</th>
<th>Pericardial window technique</th>
<th>Subtotal pericardectomy via thoracotomy</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lethargy*</td>
<td>31</td>
<td>13</td>
<td>0.03</td>
</tr>
<tr>
<td>Anorexia</td>
<td>21</td>
<td>10</td>
<td>0.42</td>
</tr>
<tr>
<td>Cough</td>
<td>8</td>
<td>4</td>
<td>0.71</td>
</tr>
<tr>
<td>Collapse</td>
<td>10</td>
<td>4</td>
<td>0.41</td>
</tr>
<tr>
<td>Ascites</td>
<td>24</td>
<td>16</td>
<td>0.63</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>21</td>
<td>11</td>
<td>0.54</td>
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</table>

*Significant ($P < 0.05$) difference in clinical sign between dogs that underwent the pericardial window technique versus subtotal pericardectomy via thoracotomy.

**Table 2**—Distribution of histopathologic diagnoses on the basis of whether a mass was evident [mass (n = 21) or no mass (17)] on echocardiography before thoracic surgery in 38 dogs with pericardial effusion.

<table>
<thead>
<tr>
<th>Variable</th>
<th>No mass</th>
<th>Mass</th>
</tr>
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<tbody>
<tr>
<td>Pericarditis</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Mesothelioma</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Hemangiosarcoma</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Histiocytic sarcoma</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Carcinoma</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Distribution of histopathologic diagnoses was not significantly ($P = 0.075$) different between dogs with or without a mass on preoperative echocardiography.
The median DFI for dogs with idiopathic pericardial effusion that underwent subtotal pericardectomy via thoracotomy (n = 5) was not reached during the study period (Figure 1). Dogs with idiopathic pericardial effusion that underwent the pericardial window technique (n = 12) had a significantly (P = 0.045) shorter median DFI of 11.6 months, compared with those treated by subtotal pericardectomy via thoracotomy. Median DFI for dogs with neoplastic pericardial effusion that underwent subtotal pericardectomy via thoracotomy (n = 17) or the pericardial window technique (24) was 3.8 and 2.7 months, respectively (P = 0.51; Figure 2).

The MST for dogs with idiopathic pericardial effusion that underwent subtotal pericardectomy via thoracotomy (n = 5) was not reached during the study period (Figure 3); the 3-year survival rate for these dogs was 100% (2 dogs were lost to follow-up at 17.8 and 23.0 months after surgery). Dogs with idiopathic pericardial effusion that underwent the pericardial window technique (n = 12) had a significantly (P = 0.044) shorter MST of 13.1 months, compared with those treated by subtotal pericardectomy via thoracotomy. The 1-, 2-, and 3-year survival rates of dogs with idiopathic pericardial effusion that underwent the pericardial window technique were 58%, 33%, and 33%, respectively; 2 dogs died of hypotension during the surgical procedure. Four dogs with idiopathic pericardial effusion that underwent the pericardial window technique were euthanized because of recurrence of clinical signs at 1.8, 2.0, 11.5, and 12.8 months after surgery. The dog that had a recurrence at 12.8 months had a carcinoma in the pericardium and epicardium at the time of euthanasia. One dog with idiopathic pericardial effusion that underwent the pericardial window technique was lost to follow-up at 50 months after surgery.

For dogs with neoplastic pericardial effusion, the MST following subtotal pericardectomy via thoracotomy (n = 17) or the pericardial window technique (24) were 4.0 and 2.7 months, respectively (P = 0.76; Figure 4). Two dogs treated by subtotal pericardectomy via thoracotomy
were lost to follow-up at 6.6 and 7.6 months after surgery. Five dogs treated by the pericardial window technique were lost to follow-up at 0.1 (3 dogs), 4.6, and 5.4 months after surgery. The 1- and 2-year survival rates for dogs treated by the pericardial window technique were 9% and 0%, respectively. The 1- and 2-year survival rates for dogs treated with subtotal pericardectomy via thoracotomy were 6% and 0%, respectively.

The DFI and MST for all dogs with a mass on preoperative echocardiography were 3.5 and 3.7 months, respectively. By comparison, the DFI and MST for all dogs without a mass evident on preoperative echocardiography were 11.6 (P = 0.036) and 13.1 (P = 0.028) months, respectively. The MST for dogs without a mass evident on preoperative echocardiography that underwent subtotal pericardectomy via thoracotomy (n = 11) was not reached in the study period, whereas the MST was 13.1 months (15) for these dogs that underwent the pericardial window technique (P = 0.13; Figure 5). The 1-, 2-, and 3-year survival rates were 58%, 58%, and 58%, respectively, for the dogs without a mass that were treated by subtotal pericardectomy via thoracotomy and 51%, 25%, and 25%, respectively, for the dogs without a mass that were treated by the pericardial window technique. For dogs without a mass on preoperative echocardiography, mesothelioma was diagnosed for 4 dogs that were treated by subtotal pericardectomy via thoracotomy and for 3 dogs that were treated by the pericardial window technique (Table 2). The MST for dogs with a mass on preoperative echocardiography that were treated by subtotal pericardectomy via thoracotomy (n = 11) was 2.0 months, whereas it was 4.2 months (20) for dogs treated by the pericardial window technique (P = 0.10; Figure 6). The 1-, 2-, and 3-year survival rates were 15%, 7%, and 7%, respectively, for the dogs treated by the pericardial window technique. No dogs with a mass on preoperative echocardiography that underwent subtotal pericardectomy via thoracotomy survived to 1 year.

The overall distribution of histopathologic diagnosis was not significantly different between dogs treated by subtotal pericardectomy via thoracotomy and dogs treated by the pericardial window technique (P = 0.14; Table 3). The 2 most common histopathologic diagnoses for neoplasia were hemangiosarcoma (n = 10) and mesothelioma (10). For dogs treated by subtotal pericardectomy via thoracotomy, those with a histopathologic diagnosis of pericarditis (n = 5) had an MST that was not reached, whereas dogs with a histopathologic diagnosis of mesothelioma (6) had an MST of 10.3 months (P = 0.002). For dogs treated by the pericardial window technique, dogs with a histopathologic diagnosis of pericarditis (n = 12) had an MST of 2.0 months, whereas dogs with a histopathologic diagnosis of mesothelioma (4) had an MST of 8.6 months (P = 0.79).

**Discussion**

Thoracoscopic creation of a pericardial window (ie, pericardial window technique) is effective for palliation of clinical signs related to pericardial effusion in dogs. However, in the present study, long-term outcome for dogs with idiopathic pericardial effusion that underwent the pericardial window technique was significantly shorter, compared with that of dogs treated by subtotal pericardectomy via thoracotomy.
In accordance with previous studies, dogs in the present study were mostly large breed and older, with Golden Retrievers and Labrador Retrievers seemingly overrepresented. No significant differences in signalment were noted between dogs treated by subtotal pericardectomy via thoracotomy or the pericardial window technique in our study.

Idiopathic pericardial effusion has been shown to have an excellent prognosis when treated via thoracotomy. In the study reported here, dogs with idiopathic pericardial effusion that underwent the pericardial window technique had a significantly shorter DFI and MST than did dogs treated by subtotal pericardectomy via thoracotomy. The reason for this difference is not known, but it is possible that the excised pericardium was too small for accurate histopathologic diagnosis and therefore not representative of the underlying disease or that the pericardial window was too small to palliate clinical signs in the long term.

Thoracoscopic creation of a pericardial window that is approximately 4 to 5 cm in diameter has been recommended to palliate the clinical signs associated with pericardial effusion in dogs. This recommendation is based on a study by Jackson et al., in which all dogs had immediate resolution of cardiac tamponade following thoracoscopic-pericardial pericardectomy. In that study, 77% of dogs had neoplastic pericardial effusion and long-term follow-up was available for only 2 dogs with idiopathic pericardial effusion. Consequently, no conclusions could be made regarding the long-term outcome of dogs with idiopathic pericardial effusion that underwent the pericardial window technique. However, results from the present study suggest that long-term outcome in these dogs may not be as good as when dogs are treated by subtotal pericardectomy via thoracotomy. One possible reason for this is that a pericardial window may not be large enough and might heal on to the epicardium in the long term, allowing the effusion to recur, resulting in cardiac tamponade. Postmortem evaluation was not available in the present study to clearly document the cause of failure; however, a few owners described recurrence of clinical signs similar to those reported prior to surgery. In human patients, pericardial windows of 6 × 10 cm are recommended to palliate clinical signs related to neoplastic pericardial effusion. Whether a 4- to 5-cm pericardial window is large enough to palliate clinical signs in dogs in the long term is not known; however, it may be advisable to create a larger pericardial window or perform a subtotal pericardectomy when performing thoracoscopic pericardectomy. A subtotal pericardectomy is possible with thoracoscopy and might be necessary for dogs with a preoperative diagnosis of idiopathic pericardial effusion. A subtotal pericardectomy is more technically demanding and can be performed with or without lung ventilation. A subtotal pericardectomy via thoracoscopy might improve long-term outcome in dogs with idiopathic pericardial effusion. Future study is required to confirm or reject this assertion.

Dogs treated with subtotal pericardectomy via thoracotomy with a histopathologic diagnosis of pericarditis had a 100% survival rate in the present study, and survival time was significantly longer than that for those dogs that had mesothelioma. However, for dogs treated by the pericardial window technique, there was no significant difference in survival rate between dogs with pericarditis and mesothelioma, which may indicate that the diagnosis of mesothelioma was missed on histologic evaluation. This explanation is supported by a recent report on 5 Golden Retrievers with previously diagnosed idiopathic pericardial effusion that developed mesothelioma following initial surgical intervention. The final diagnosis in all cases was eventually made and confirmed at necropsy. Unfortunately, necropsy confirmation was not available in our study.

Given the possibility of a missed diagnosis in dogs with mesothelioma treated by the pericardial window technique, we recommend biopsy of all pleural surfaces and accessible lymph nodes as well as subtotal pericardectomy for patients with a preoperative diagnosis of idiopathic pericardial effusion. Additionally, it is now a routine procedure in our cases to perform pericardoscopy once the pericardium is opened to visualize the right atrial appendage and aortic root. This allows us to confirm that no masses are macroscopically evident at those locations, which would affect the clinical diagnosis and prognosis.

Echocardiography is accurate in the detection of heart base and right atrial masses in dogs with pericardial effusion. Results of echocardiography often play a major role in an owner's decision to move forward with surgery or not. Results from the present study are consistent with those of MacDonald et al., who found that preoperative echocardiography failed to detect cardiac masses in a few cases. Observation of a mass on echocardiography has a worse long-term prognosis. This is in agreement with findings in previous studies. Treatment modality did not have an effect on long-term outcome of dogs with or without a mass on preoperative echocardiography. Because hemangiosarcoma has a poor long-term prognosis, it is not surprising that the treatment modalities had no effect on long-term survival rate in our study. This finding suggests that the pericardial window technique is an effective option to palliate clinical signs in dogs with a mass evident on preoperative echocardiography. However, in dogs without a mass evident on preoperative echocardiography, the proportion of dogs surviving after treatment by subtotal pericardectomy via thoracotomy at 24 and 48 months. Therefore, clinicians may need to be more prudent when considering the pericardial window technique for treatment of pericardial effusion in dogs without a mass on preoperative echocardiography.

Several limitations must be acknowledged in the present study. The first is the retrospective manner in which information was collected and analyzed. Data are subject to owner and referring veterinarian recollection, which may limit accuracy. Additionally, necropsies were obtained on only a few dogs; therefore, the exact cause of death in all dogs was not necessarily known. Finally, because of the low number of cases in some categories, our ability to detect significant differences may have been hindered. However, we were able to
From this month’s AJVR

Incidence of bacteremia following upper gastrointestinal endoscopy and biopsy in healthy dogs before, during, and after treatment with omeprazole

Katherine R. Jones et al

Objective—To determine the incidence of bacteremia, as detected by routine methods for bacterial culture of blood samples, following routine endoscopic biopsy of the stomach and duodenum in healthy research dogs and to determine whether treatment with omeprazole affected that incidence.

Animals—8 healthy purpose-bred research dogs.

Procedures—All dogs underwent gastroduodenoscopy with biopsy at 4 points: twice prior to treatment with omeprazole, once following 15 days of omeprazole treatment (20 mg, PO, q 12 h), and once 14 days after treatment ceased. Blood samples were aseptically obtained at 3 points during each procedure (before, immediately following, and 24 hours after endoscopy), and routine aerobic and anaerobic bacterial culture of blood was performed.

Results—96 cultures were attempted for each culture method, yielding positive results of aerobic culture for 2 dogs at separate time points and no positive results of anaerobic culture.

Conclusions and Clinical Relevance—Routine gastrointestinal endoscopy with biopsy in healthy dogs did not result in a detectable bacteremia in most dogs. Treatment with the gastric acid–suppressing medication omeprazole did not affect the incidence of bacteremia as detected via standard techniques. (Am J Vet Res 2013;74:239–242)

References