Use of pericardial patch graft reconstruction of the right atrium for treatment of hemangiosarcoma in a dog

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- Atrial mass resection is possible in a limited number of dogs with hemangiosarcoma in which only the right atrial appendage or atrial free wall is involved.
- A pericardial patch graft can be used to reconstruct the right atrium after resection of large atrial tumors.
- Tumor-free margins can be obtained by use of this technique.

An 8-year-old 66-lb (30-kg) sexually intact male Golden Retriever was evaluated by the Veterinary Teaching Hospital at the University of Guelph for weakness, collapse, and dyspnea of 12 hours' duration. Physical examination revealed the dog was weak and unable to walk. The dog was moderately dehydrated (7%), tachycardic (180 beats/min), tachypneic (60 breaths/min), and had weak peripheral pulses and muffled heart sounds. Results of a CBC revealed mild anemia (Hct, 31%; reference range, 38 to 57%), mild hypoproteinemia (48 g/L; reference range, 55 to 76 g/L), and changes consistent with a stress leukogram. Results of biochemical analysis and urinalysis were not notable. Ventricular tachycardia was confirmed electrocardiographically; heart rate varied between 180 and 200 beats/min. Radiography of the thorax revealed mild cardiomegaly, and there was decreased radiographic detail on views of the abdomen. Abdominal ultrasonography revealed hepatic venous congestion and abdominal effusion. Cardiac ultrasonography revealed moderate pericardial effusion, mild right and left atrial enlargement, and mild mitral regurgitation.

Pericardiocentesis was performed and yielded 35 ml of sanguineous fluid. The pH of the pericardial fluid was 7.4, and cytologic evaluation revealed evidence of hemorrhage with some reactive mesothelial cells. Abdominocentesis yielded fluid consistent with ascites. Following pericardiocentesis, there was no improvement in the ventricular tachycardia. Treatment consisted of administration of lidocaine (2 mg/kg [0.9 mg/lb] of body weight, IV, followed by a constant rate infusion [30 µg/kg/min (13.6 µg/lb/min), IV]), magnesium sulfate (30 mg/kg [13.6 mg/lb], IV, during a 4-hour period), and procainamide (30 µg/kg/min [13.6 µg/lb/min], IV); treatment with these drugs failed to correct the arrhythmia. Further treatment, using sotalol hydrochloride (0.7 mg/kg [0.32 mg/lb], q 12 h), an orally administered class III antiarrhythmic and β-adrenergic blocking agent, was initiated. A sinus rhythm (150 beats/min) with only occasional premature ventricular contractions developed within 24 hours of treatment. The dog was discharged from the hospital, with instructions to the owner to maintain the dog on sotalol at the same dosage.

At the time of reevaluation 2 weeks later, a grade II/VI heart murmur was detected at the level of the left apex of the heart. Electrocardiography revealed normal sinus rhythm and a heart rate of 150 beats/min. Cardiac ultrasonography revealed no evidence of pericardial effusion; however, a right atrial mass was detected at this time. Abdominal ultrasonography and thoracic radiography revealed no evidence of metastatic disease.

Exploratory thoracotomy was performed through the right fourth intercostal space. The fifth rib was removed to improve exposure to the thoracic cavity. No gross evidence of pulmonary metastasis was noticed at surgery. A subphrenic pericardial incision was performed and a 2 × 3-cm mass of the right atrium was found. Fibrous adhesions were present between the pericardial sac and the mass. The pericardial sac was incised around the adhesion to allow complete inspection and manipulation of the mass. A purse string suture (using size 3-0 polypropylene) was placed around the middle of the auricular appendage, and the apex of the appendage was removed for intra-atrial palpation. The mass was found to be broad-based and involved most of the atrial free wall but not the cardiac valves and coronary vessels.

A 4 × 5-cm pericardial free graft was prepared by performing a partial subphrenic pericardiectomy. Fat was removed from the outer pericardial surface, using sharp and blunt dissection, and the inner surface was identified to allow internal placement at the time of grafting. The pericardial graft was sutured for 270 degrees around the ventral aspect of the mass (using size 4-0 polypropylene in a simple continuous pattern) to the grossly normal peripheral atrial wall, leaving approximately 5 mm between the mass and the graft (**Fig 1**). Temporary venous inflow occlusion was performed by tightening preplaced Rumel tourniquets around the cranial and caudal venae cavae and azygos vein. A stab incision was made in the atrium, and Metzenbaum scissors were used to completely resect the mass adjacent to the sutured graft. The free edges of the graft and dorsal atrial wall were approximated with a Satinski clamp, and the Rumel tourniquets were released. The dorsal edge of the graft and atrium was sutured (using size 4-0 polypropylene in a simple continuous pattern), and the Satinski clamp was removed. No blood leakage was noticed from the surgical site.

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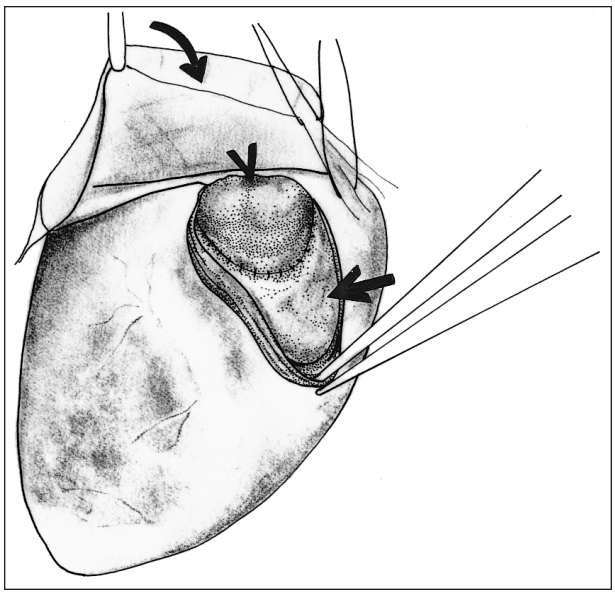

Figure 1—Schematic representing the intraoperative right atrial mass (arrowhead) and autologous pericardial patch graft (straight arrow). The graft is sutured to grossly normal peripheral atrial wall approximately 270 degrees around the ventral aspect of the mass. The remaining pericardial tissue is retracted dorsally (curved arrow).

Total inflow occlusion time was 2 minutes. A thoracic drain was placed, and intercostal nerves were blocked with bupivacaine, followed by routine closure of the thoracic cavity. Cefazolin (30 mg/kg [13.6 mg/lb], IV, q 8 h) was administered during and after surgery until the chest drain was removed.

After surgery, mild pneumothorax and infrequent heart block were evident and resolved within 24 hours. Postoperative analgesia included administration of meloxicam (0.1 mg/kg [0.045 mg/lb], SC, q 24 h) and oxymorphone (0.05 mg/kg [0.02 mg/lb], IV, as needed for signs of pain). The thoracic drain was removed 2 days after surgery, and the dog was discharged from the hospital 4 days after surgery. Meloxicam and sotalol were continued for 5 and 14 days, respectively, following discharge from the hospital. Histologic examination of the resected mass confirmed it to be a **hemangiosarcoma (HSA)**. Evaluation of the surgical margins indicated they were clear of any neoplastic cells.

Reevaluations performed at 2 and 6 weeks after surgery included physical examination, electrocardiography, cardiac and abdominal ultrasonography, and radiography of the thorax; all results were normal. Three months after surgery, the dog was reevaluated because of signs of lethargy of several days' duration. Physical examination findings at this time revealed pale mucous membranes, moderate abdominal distention, and a palpable mass in the cranial portion of the abdominal cavity. Left forelimb lameness was also evident, and signs of pain were elicited on deep palpation of the humerus. Radiography of the thorax revealed pleural effusion and multiple pulmonary nodules, suggestive of metastasis. Abdominal ultrasonography revealed free abdominal fluid and multiple masses throughout the liver. Results of a CBC confirmed the dog was anemic (Hct, 20%; reference range, 38 to 57%). A whole blood transfusion was administered, and the dog was discharged the same day. The dog died at home 4 weeks later.

Postmortem examination revealed hemothorax and large masses in the mediastinal area. Multiple soft, dark red 1- to 2-cm masses were found throughout the thoracic cavity and within the lung parenchyma. Numerous masses were seen throughout the omentum, mesentery, spleen, and liver parenchyma. Metastases were also present within the left humerus and tenth rib. No gross lesions were evident on examination of the right atrial reconstruction site; polypropylene sutures were still evident. The graft appeared thickened on palpation. Histologic examination of the multiple lesions confirmed metastatic HSA. Light microscopy performed on tissues obtained from the site of cardiac reconstruction revealed myocardial fibers at both ends of a band of collagenous connective tissue. Atrophy of the myocardial fibers was present at the junction with the graft. No evidence of neoplastic cells was detected at the surgical site; however, one section of the right atrium revealed a metastatic lesion.

Pericardial effusion is common in cases of right atrial HSA. Neoplasia has been reported as the most common cause of pericardial effusion, with HSA cited as the most prevalent neoplasm.[1-3] Reported survival time for animals with right atrial HSA varies, but even when surgery is performed, most affected dogs die less than 4 months after diagnosis.[1,3-6] Reported surgical options for atrial HSA in dogs include palliative pericardiectomy with or without atrial mass resection. Thoracotomy and pericardiectomy are usually required to establish a definitive diagnosis in instances of pericardial effusion whether the cause of the effusion is idiopathic or neoplastic.[3] Palliative pericardiectomy has been recommended as a preventative measure against recurrence of cardiac tamponade when the tumor is deemed inoperable.[1] Dunning et al, [3] in a retrospective study including 46 dogs with pericardial effusion, found that pericardiectomy alone did not affect the risk of recurrence of clinical signs or survival times in dogs with neoplasia. The median survival time (after initial diagnosis) for dogs with atrial HSA (n = 11) in that study was 16 days, and all dogs died within 7 months. Another study of 22 dogs[7] that had pericardiectomies included 2 instances of cardiac HSA; survival times (after pericardiectomy) for these 2 dogs were 1 and 4 months.

In addition to pericardiectomy, atrial mass resection has been reported for treatment of atrial HSA in dogs.[1,3,4,6] Atrial mass resection is considered possible in a limited number of patients in which only the right atrial appendage or atrial free wall is involved. Masses must not involve the heart valves, coronary vessels, or outflow tract, and resection must allow primary reconstruction of the defect. It is rarely possible to obtain tumor-free margins when performing simple resection followed by primary closure. In the dog of our report, despite the large size of the mass and its location (atrial free wall rather than the atrial appendage), the use of an autologous pericardial patch graft to reconstruct the right atrium resulted in tumor-free margins.

In humans, the use of autologous or bovine peri-

cardial patch grafting is common and has been reported for correction of congenital heart defects, valvular reconstruction, reconstruction of postischemic or traumatic defects of the heart and other organs such as the trachea, as well as for cardiac reconstruction following neoplastic resection.[8-19] In dogs, pericardial patch grafting has been reported for clinical and experimental use. Breznock and Wood[20] reported the clinical use of a pericardial patch grafting technique for correction of pulmonic stenosis in dogs. A modification of this technique was later reported by Shores et al.[21] The use of pericardial patch grafting has been reported for correction of tetralogy of Fallot in a dog,[22] and bovine pericardial monocusp patches have been used experimentally for correction of right ventricular outflow tract disease in dogs.[23] To the authors' knowledge, the use of autologous pericardial sac grafting for reconstruction of an atrial defect following resection of a tumor has not been reported in the veterinary literature. Hjelms and Gavin[24,25] performed histologic evaluation of transannular pericardial autografts in growing and adult dogs. At necropsy 6 to 14 months later, the grafts were found to be 2 to 14 times thicker than the initial grafts because of apposition of collagenous tissue. Changes such as small aneurysms, cartilaginous metaplasia, and dystrophic calcification were also evident.[24,25] Histologic changes after use of pericardial patch grafting for tracheal reconstruction were similar and characterized by replacement of the graft by mature scar tissue.[16] In the dog of our report, collagenous repair tissue was noticed at the site of grafting, and atrophy of normal myocytes was present at the junction of the graft and remaining atrium. Grossly, the grafted tissue appeared thicker than the original pericardium. Pericardial patch grafting was relatively easy and successfully used in this dog to reconstruct the right atrium after complete local resection of a right atrial HSA.

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