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CASE REPORT

Congenital cardiac malformation with three-chambered right atrium and a persistent left cranial vena cava in a dog☆

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Abstract This report describes an unusual congenital abnormality in a dog in which multiple distinct membranes were observed within the right atrium, creating obstruction to venous return from both the cranial vena cava and the caudal vena cava. A persistent left cranial vena cava was also identified. In addition to a membrane in the typical location for cor triatriatum dexter, the dog also had a perforated membrane separating the main right atrial body and tricuspid valve from a more cranial right atrial chamber and the right cranial vena cava. Balloon dilation was performed successfully to alleviate the obstruction to systemic venous return created by the two membranes. Due to the unusual anatomic features, angiography plus echocardiography was useful to completely characterize the congenital abnormality prior to intervention.

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Abbreviations

ASD	atrial septal defect
CaVC	caudal vena cava
CrVC	cranial vena cava
CTD	cor triatriatum dexter
LA	left atrium
LV	left ventricle
LVIDd	left ventricular internal dimension in diastole
RA	right atrium
RV	right ventricle
TEE	transesophageal echocardiogram

A 21-month old spayed female Miniature Schnauzer dog was initially presented with the primary complaint of left hind limb swelling. Physical examination was within normal limits aside from a prominent right superficial cervical lymph node and left hind limb edema. Abnormalities on serum chemistry testing included hypoproteinemia (4.7 g/dL, normal range: 6.0—8.4 g/dL), hypoglobulinemia (2.2 g/dL, normal range: 2.5—5.8 g/dL), and elevated serum gamma glutamyl transpeptidase at 10 U/L (normal range: 0—5 U/L). The dog was serologically negative for heartworm, *Ehrlichia*, *Anaplasma*, and *Borrelia burgdorferi*. The dog was isosthenuric (urine specific gravity = 1.012) with no evidence of urinary tract infection. Thoracic radiographs showed probable right heart enlargement, a dilated caudal vena cava (CaVC), and a possible persistent left cranial vena cava (CrVC) taking an anomalous course to the right heart (Fig. 1). Abdominal ultrasound findings included enlarged lymph nodes and free abdominal fluid. Fluid obtained via abdominocentesis was consistent with a modified transudate with total solids of 2.6 g/dL. Fine needle aspirate of an enlarged abdominal lymph node was consistent with mild reactive lymphoid hyperplasia. The dog was treated with a 10-day course of amoxicillin 50 mg PO, q 12 h and a single dose of prednisone (5 mg PO). Echocardiography subsequently identified a membrane in the right atrium. Cor triatriatum dexter (CTD) was suspected and the dog was referred for possible catheter-based intervention.

On presentation to the Tufts Cummings School of Veterinary Medicine Cardiology service the dog was bright, alert, and responsive. Abnormal physical exam findings included bilateral jugular venous distension, an enlarged right superficial cervical lymph node, and marked left hind limb edema that affected the entire leg and extended into the inguinal area bilaterally. The swelling was most severe over the dog's inner thigh and was associated with skin bruising. The limb was neither painful nor cold and no lameness was present. Femoral arterial pulses were strong bilaterally. Cardiac auscultatory findings included a regular heart rhythm with a heart rate of 120 bpm and a grade I/VI left basilar systolic murmur.

Echocardiography[d] confirmed the presence of a perforated membrane spanning the right atrium (RA), cranial to the usual location for cor triatriatum dexter, and this membrane divided the RA into caudal and cranial chambers. Two small perforations within this right atrial membrane were apparent utilizing color Doppler examination (Fig. 2; Videos 1 and 2). On the short axis right parasternal echocardiographic view, the caudal chamber of the RA appeared dilated. The peak flow velocity through one of the perforations was 2.5 m/s during atrial systole with a peak instantaneous pressure gradient of 25 mmHg. The left atrium (LA) appeared small and compressed by the enlarged RA on one side, and it was also compressed on the left side by a dilated vessel, presumed to be a dilated coronary sinus from the presence of a persistent left cranial vena cava (CrVC). An echocardiographic contrast study was performed with injection of agitated saline into the left cephalic vein; the contrast material was visualized entering two chambers of the RA but it was not apparent in the presumed left CrVC. This unexpected finding, together with the unusual location of the intra-atrial membrane, resulted in the recommendation of angiography, prior to the anticipated balloon procedure, to confirm the nature of the membrane seen on echocardiography. A brief examination of the abdomen with ultrasound revealed dilated hepatic veins and a dilated caudal vena cava (CaVC) and a small volume of ascites.

The following day, under general anesthesia, a 9-Fr sheath introducer[e] was placed into the right jugular vein via a modified Seldinger technique. Venography using iohexol contrast[f] performed via the introducer in the right jugular vein showed contrast flowing into the right CrVC and then

[d] GE Heathcare, General Electric, Fairfield, CT, USA.
[e] Cordis Avanti Sheath Introducer, Cordis Corporation, Bridgewater, NJ, USA.
[f] Omnipaque, GE Healthcare, General Electric, Fairfield, CT, USA.