

Ultrasonographic identification of *Dirofilaria immitis* in the aorta and liver of a dog

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- *Dirofilaria immitis* has been identified in many aberrant locations in dogs, including the systemic arterial system, eyes, CNS, skin, muscles, peritoneal cavity, and bronchioles.
- Ultrasonography may be useful in identification of aberrant *D immitis*.

A 5-year-old 17-kg (38-lb) sexually intact male mixed-breed dog was referred to the teaching hospital because of suspected vena caval syndrome secondary to heartworm disease. The owner reported that the dog lived outdoors and had not been examined by a veterinarian during the past several years. Two weeks prior to referral, the dog suddenly became lethargic and anorectic. On physical examination, the dog was thin, icteric, and reluctant to move. Lung sounds were harsh, femoral pulses were weak, and a grade-III/VI systolic murmur, most audible at the right fourth intercostal space, was evident. The dog was approximately 10% dehydrated.

Biochemical abnormalities included mild azotemia, hypoalbuminemia, hyperbilirubinemia, and 10- and 20-fold increases in serum alkaline phosphatase and alanine transferase activities, respectively. Hematologic abnormalities included moderate normocytic, normochromic anemia and severe leukocytosis, characterized by neutrophilia with a left shift. Target cells and *Dirofilaria immitis* microfilariae were seen in a blood smear. Hemoglobinuria was detected; urine specific gravity was 1.021.

On radiographs of the thorax, the right ventricle appeared larger than normal; the main pulmonary outflow tract was prominent; pulmonary lobar arteries were tortuous, larger than normal, and truncated; and a diffuse, bronchointerstitial pattern, consistent with severe heartworm disease, was evident.¹ Hepatomegaly was evident on abdominal radiographs.

Electrocardiographic changes included increased P-wave amplitude and duration, consistent with right atrial enlargement. Echocardiographically, many heartworms were seen within the right atrium. During diastole, heartworms extended through the right atrioventricular valve into the right ventricle; the right ventricular lumen was increased in size, and the interventricular septum appeared flattened. The main pulmo-

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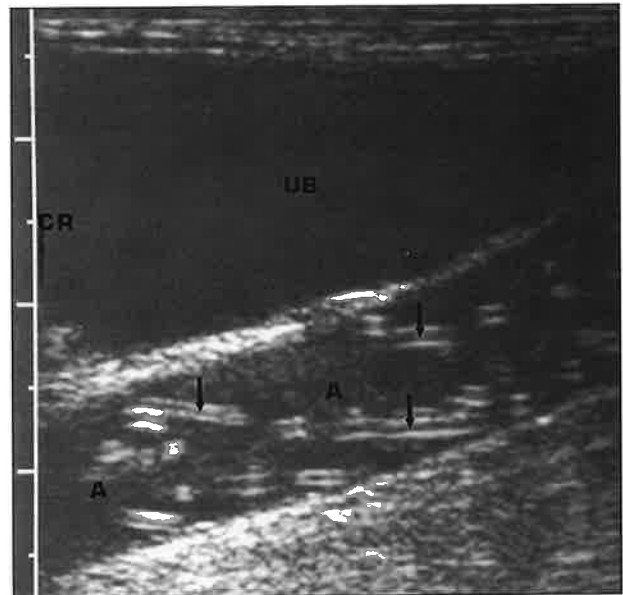


Figure 1—Ultrasonogram of a dog with heartworms in the systemic arterial system. The transducer was positioned in the median plane on the caudoventral aspect of the abdomen. Cranial (CR) is to the left. Multiple parallel hyperechoic lines (arrows) suggestive of adult heartworms fill the terminal portion of the aorta (A). UB = urinary bladder. Large scale bars = 1 cm.

nary artery was severely dilated and contained heartworms. During abdominal ultrasonography, several adult heartworms could be seen within the caudal vena cava and hepatic veins. The hepatic veins were dilated. Findings were consistent with a diagnosis of vena caval syndrome secondary to heartworm disease.²

Many adult heartworms were also identified ultrasonographically within the abdominal aorta, extending from the level of the left renal artery to the internal iliac and femoral arteries (Fig 1). The right kidney was irregular, and corticomedullary definition was decreased. The liver was larger than normal, and multiple, 1- to 3-cm-diameter, irregularly marginated, coalescing, hypoechoic nodules were seen within the left lateral lobe. Within hypoechoic areas of several nodules, paired, parallel, hyperechoic lines, consistent with the appearance of adult heartworms, could be seen (Fig 2). A small amount of anechoic peritoneal fluid was detected.

Contrast echocardiography was performed by injecting agitated saline (0.9% NaCl) solution intravenously to check for intra- and extracardiac right-to-left shunts that might explain why adult heartworms

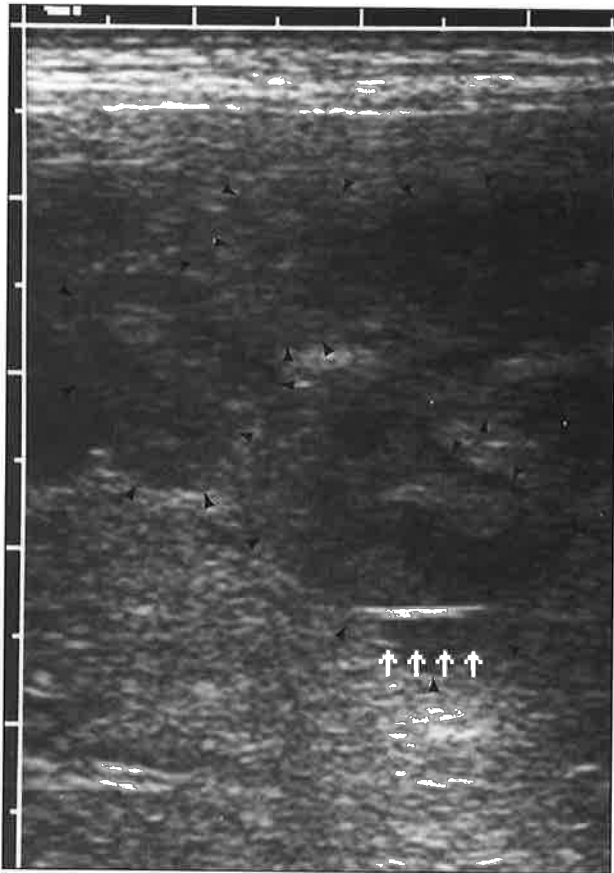


Figure 2—Ultrasonogram of the caudoventral portion of the left lateral lobe of the liver of the dog in Figure 1. Arrowheads indicate multiple, coalescing, hypoechoic, irregularly marginated nodules. White arrows indicate parallel, hyperechoic lines characteristic of an adult heartworm. Large scale bars = 1 cm.

were detected in the arterial system.³ However, no right-to-left shunts were identified.

Supportive care was provided. The following day, 450 ml of whole blood was administered, and an embolectomy procedure was performed.⁴ Fifty-eight adult heartworms were removed from the caudal vena cava and right atrium. We had planned to allow the dog to recover from the embolectomy for 1 week and then attempt to remove heartworms from the abdominal aorta.^{5,6} However, the second day after the embolectomy, the dog's Hct decreased from 20 to 14%, and the dog became more lethargic and had a grand mal seizure. The owners elected to have the dog euthanized because of its deteriorating condition.

At necropsy, the peritoneal cavity contained 500 ml of clear, amber fluid and tissues were icteric. In the caudoventral portion of the left lateral lobe of the liver, there were multifocal to coalescing, irregular, dark-brown nodules that involved < 10% of the parenchyma. A single heartworm was identified within 1 of the hepatic lesions. A large number of heartworms were found in the caudal portion of the aorta and the internal and external iliac and femoral arteries. More than 100 heartworms were found throughout the pulmonary arteries and their branches, and a large, chronic thrombus occluded the right caudal lobar artery. The kidneys had

focal areas of cortical scarring, with depressions in some areas. Congenital cardiovascular anomalies were not identified. Heartworms were not located in the thoracic aorta or branches of the aorta supplying the head and cervical region. The brain was grossly normal.

Histologically, hepatic nodules consisted of necrotic hepatocytes, infiltrates of degenerating neutrophils, fibrin, and fibrous connective tissue. An adult heartworm was identified in the center of 1 nodule. Minimal hepatocellular necrosis was evident, and bile canaliculi were plugged with bile. Renal tubules contained eosinophilic material typical of hemoglobin, and tubular epithelial cells contained hemosiderin. The intima of the pulmonary arteries was hyperplastic. In the right caudal lung lobe, a pulmonary artery was occluded with a laminated fibrin thrombus, and there was evidence of chronic infarction with interstitial fibrosis.

Dogs with aberrantly located adult heartworms have been reported since 1856.⁷ Heartworms have been found in eyes,^{8,9} subcutaneous interdigital cysts,¹⁰ intramuscular cysts and abscesses,¹¹ bronchioles,¹² the peritoneal cavity,⁷ and the CNS, including the lateral ventricles¹³ and the epidural space of the vertebral column and brain.¹⁴⁻¹⁷ Adult heartworms have also been found in the left atrium, left ventricle, and systemic arterial system, including the right middle and rostral cerebral arteries¹³ and branches of the abdominal aorta.^{6,11,12,18,19} Except for 1 case in which an antemortem diagnosis was made by means of selective angiography, all previous cases of heartworms involving the arterial system in dogs have been identified at necropsy.⁶

The mechanism for aberrant location of heartworms has not been determined. Typical heartworm infection in dogs involves deposition of third-stage larvae during feeding by mosquitoes. Third- and fourth-stage larvae can be found in subcutaneous and muscle tissues throughout the body for approximately 4 months before fourth-stage larvae molt into immature adults and enter the venous circulation.^{9,15,20} Heartworm microfilariae are small enough to flow through a capillary bed, but third- and fourth-stage larvae and adults are not.^{9,21} Adult heartworms lack mechanical structures for penetration of, and migration through, vessel walls and most likely arrive in aberrant locations as a result of migration of third- and fourth-stage larvae.^{7,9} Adult heartworms were found in the systemic arterial system in dogs with cardiovascular shunts (2 with septal defects and 1 with a patent ductus arteriosus), suggesting that cardiovascular shunts are a possible cause of aberrant location of heartworms.^{18,19} However, most dogs with adult heartworms in the systemic arterial system did not have any cardiovascular shunts.^{7,12,13,18}

Clinical signs and diagnostic findings in this dog were typical of vena caval syndrome.^{1,2,4} Icterus and high hepatic enzyme activities in dogs with vena caval syndrome are believed to be a result of intravascular hemolysis, centrilobular hepatic necrosis secondary to hepatic venous congestion and decreased hepatic perfusion, and granulomatous inflammation caused by microfilariae.^{4,22} To our knowledge, inflammatory hepatic nodules secondary to aberrant adult heartworms have not been previously described.

Dogs with heartworms in the systemic arterial sys-

tem have been reported to have signs of ischemia secondary to parasitic thromboemboli.^{6,13,19} In this dog, weak femoral pulses were initially attributed to primary cardiac disease, but were likely attributable to a combination of low cardiac output and physical obstruction of the aorta and its branches by heartworms.

A single report⁵ describes ultrasonographic identification of adult heartworms in the aorta of a cat. The heartworms were successfully removed surgically. To our knowledge, ultrasonographic identification of heartworms within the systemic arterial system of a dog has not been described previously.

*Spiral basket, Mill-Rose Laboratories, Mentor, Ohio.

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