Transesophageal Echocardiography–Guided *Dirofilaria immitis* Extraction from the Right Atrium in a Dog

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INTRODUCTION

Foreign-body retrieval of intracardiac catheters and metallic objects is achievable with fluoroscopy or multimodality imaging.[1,2] Not all foreign material is radiopaque, and echocardiographic guidance can aid in the successful removal of foreign bodies not readily viewed in the heart with fluoroscopy, such as nematode parasites. This report describes intraoperative transesophageal echocardiographic (TEE) imaging of a large mass of heartworms and successful extraction from the right atrium in a dog with *Dirofilaria immitis* infection.

CASE PRESENTATION

A 3-year-old, male, 20-kg, American pit bull terrier was referred for evaluation of ascites attributed to right heart failure. He had a 5-day history of lethargy, inappetence, increased respiratory sounds, and distended abdomen. The patient had been diagnosed with *D immitis* infection on the basis of a positive antigen test. At presentation, the animal had pale mucous membranes with a packed cell volume of 31% (normal range, 37%–56%), an elevated respiratory rate of 72 breaths/min with increased effort, a right-sided systolic heart murmur, and abdominal distension with mild ascites confirmed on ultrasound. Thoracic radiographic abnormalities included right-sided heart enlargement, dilation of the pulmonary trunk, and markedly distended and tortuous lobar pulmonary arteries with a caudodorsally distributed interstitial pulmonary pattern consistent with a diagnosis of heartworm disease and pneumonitis (Figure 1). Transthoracic echocardiography (Vivid E95 with 5.0-MHz transducer; GE Healthcare, Little Chalfont, United Kingdom) confirmed the presence of worms, characterized by numerous elongated hyperechoic parallel lines, predominately within the right atrium (Figure 2, Video 1). Severe pulmonary hypertension was suspected on the basis of echocardiographic evaluation that included elevated tricuspid valve regurgitation velocities (4.9 m/sec, 96.0 mm Hg), right ventricular enlargement (both wall thickening and chamber dilation) with flattening of the interventricular septum toward the left ventricle throughout the cardiac cycle, and pulmonary artery enlargement with a pulmonary trunk to aorta ratio of 1.5 (normal <1.0; Figure 2) and reduced right pulmonary artery distensibility index (13%; normal >29.5%).[3]

Heartworm extraction was recommended and was performed under general anesthesia. Approximately 1 hour before anesthesia, intravenous (IV) dexamethasone sodium phosphate 0.2 mg/kg was administered and diphenhydramine 2.2 mg/kg was administered via intramuscular injection. Briefly, the dog was premedicated with IV methadone 0.2 mg/kg followed by induction with IV etomidate 2 mg/kg and IV midazolam 0.2 mg/kg. Anesthesia was maintained with sevoflurane inhalant and a fentanyl constant-rate infusion (15 μg/kg/h). Intraoperatively, a cut-down to the right external jugular vein was made, and a four-wire endoscopic basket retrieval device (Olympus, San Jose, CA) was advanced into the right atrium under fluoroscopic guidance as previously described.[4] TEE images were obtained of the heartworms within the right atrium (Figure 3) and extending into both the cranial and caudal vena cava and coronary sinus (Video 2). Before heartworm extraction, TEE Doppler-derived tricuspid regurgitation velocities

VIDEO HIGHLIGHTS

Video 1: Transthoracic echocardiography in a left apical parasternal four-chamber view demonstrating a large mass of heartworms in the right atrium.

Video 2: Transesophageal echocardiography optimized for the right heart shows the worms in the right atrium and extending into both venae cavae.

Video 3: Transesophageal echocardiography demonstrates the endoscopic retrieval device extending from the cranial vena cava into the right atrium above the worms.

Video 4: Transesophageal echocardiography during the first pass of the retrieval device. The mass of worms was ensnared into the endoscopic retrieval device, resulting in most of the worms being pulled toward the cranial vena cava all at one time (time 00:14).

Video 5: Transesophageal echocardiography of the right atrium and ventricle after removal of the intracardiac heartworms.

View the video content online at www.cvcasejournal.com.

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Keywords: Canine, Foreign body, Heartworm disease, Retrieval

Conflicts of interest: The authors reported no actual or potential conflicts of interest relative to this document.

2468-6441

https://doi.org/10.1016/j.case.2020.05.005

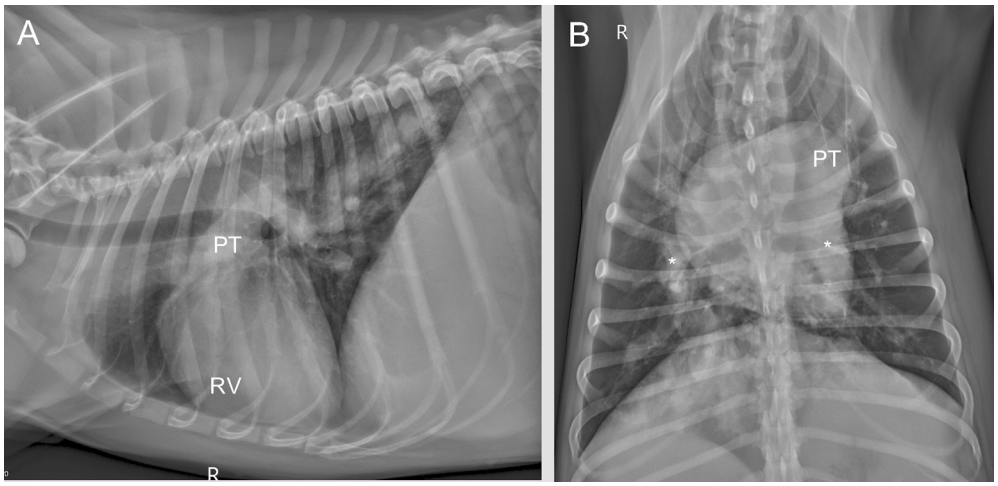

Figure 1 Right lateral and ventrodorsal thoracic radiographic images from a dog with heartworm disease **(A, B)** and right-sided heart enlargement, dilation of the pulmonary trunk (PT), and markedly distended and tortuous lobar pulmonary arteries (*asterisk*) with a caudodorsally distributed interstitial pulmonary pattern consistent with pneumonitis. *RV*, Right ventricle.

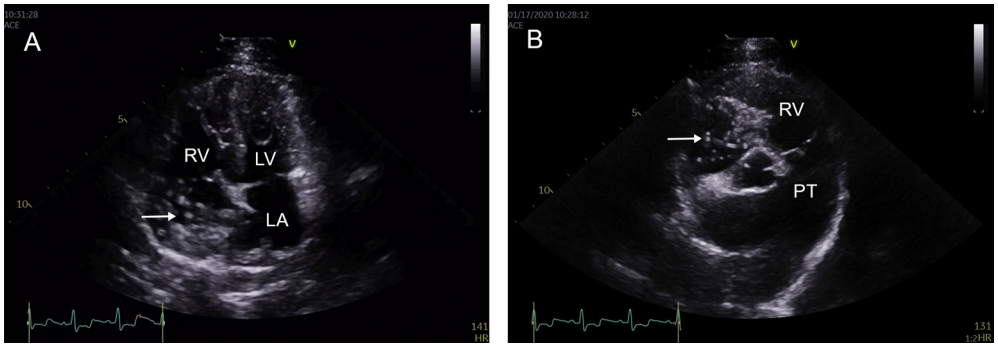

Figure 2 Transthoracic echocardiographic images obtained from **(A)** a left parasternal long-axis view to show a large mass of heartworms represented as parallel white lines in the right atrium (*arrows*) and **(B)** a right parasternal short-axis view at the base of the heart to show severe dilation of the pulmonary trunk (PT) and right and left pulmonary arteries **(B)**. *LA*, Left atrium; *LV*, left ventricle; *RV*, right ventricle.

under anesthesia were estimated at approximately 4 m/sec (incomplete envelopes due to the presence of worms), and pulmonary valve regurgitation peak velocities were approximately 3 m/sec (Figure 3). Initially, the endoscopic retrieval device could be seen in TEE images above the worms, pushing them away toward the right ventricle (Figure 4, Video 3). With additional manipulation of the device under fluoroscopy, the mass of worms was ensnared, but it was immediately recognized by the TEE operator that the worms were entwined into one large mass (Video 4). To prevent the large mass from becoming lodged in the cranial vena cava, the worms were released in the right atrium and recaptured in smaller numbers that could be more easily removed through the jugular venotomy site. After successful removal of 44 worms, TEE imaging was used to confirm that there were not any additional worms in the right atrium and ventricle (Figure 3, Video 5). The dog recovered from anesthesia with oxygen supplementation and without immediate complication, at which time sildenafil 2.5 mg/kg twice daily by mouth was initiated.

DISCUSSION

D immitis is a nematode parasite transmitted by mosquito vector, and infections are reported in animals and humans.[5,6] Infections in humans are typically associated with pulmonary granulomas and eosinophilia and often occur in warm climates where the parasite is endemic in animals.[6-10] In dogs, adult worms typically reside in the pulmonary arteries, resulting in pneumonitis and pulmonary hypertension.[11] A more severe form of heartworm disease occurs when the worms migrate from the pulmonary arteries into the right atrium and ventricle, resulting in hemolysis of red blood cells and obstruction of blood flow.[12] Removal of worms necessitates vascular access through a venotomy instead of through a vascular introducer to avoid damaging the worms as they are removed. Damage to worms can result in fragments left behind in vascular structures, embolization to the pulmonary arteries, and host reactions to inflammatory mediators.[5] Successful removal of intracardiac heartworms relies on imaging to identify the location of the worms and to select the optimal

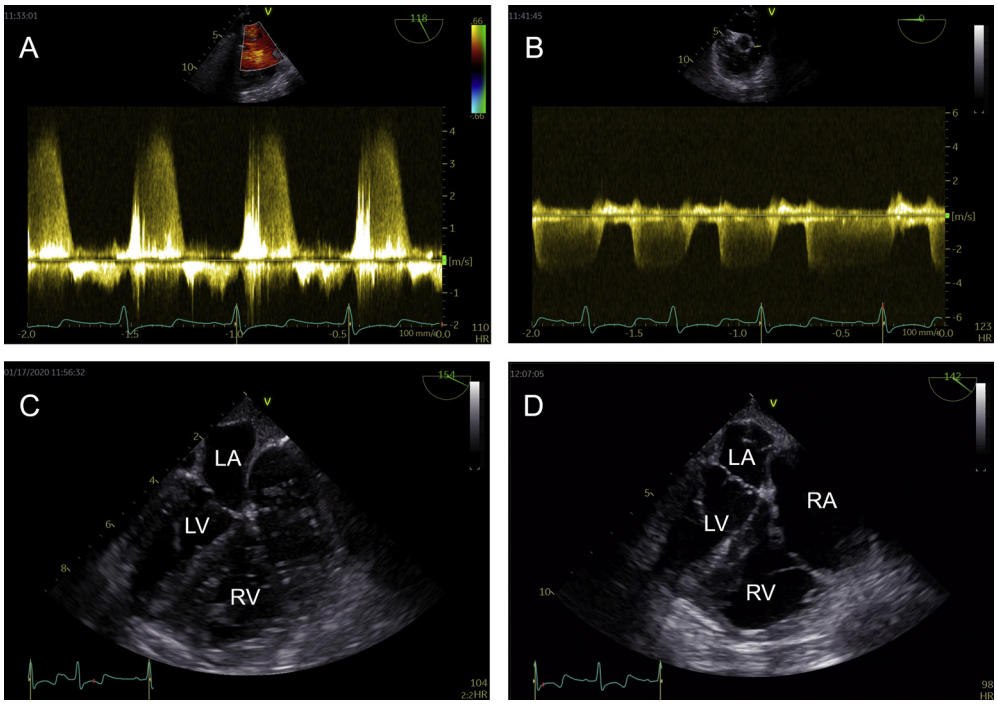

Figure 3 TEE images obtained intraoperatively that document elevated tricuspid regurgitation velocities **(A)**, elevated pulmonary regurgitation velocities **(B)**, and a four-chamber view of the heartworms in the right atrium (RA) at the beginning of the procedure **(C)** and after the 44 worms were removed **(D)**. *LA*, Left atrium; *LV*, left ventricle; *RV*, right ventricle.

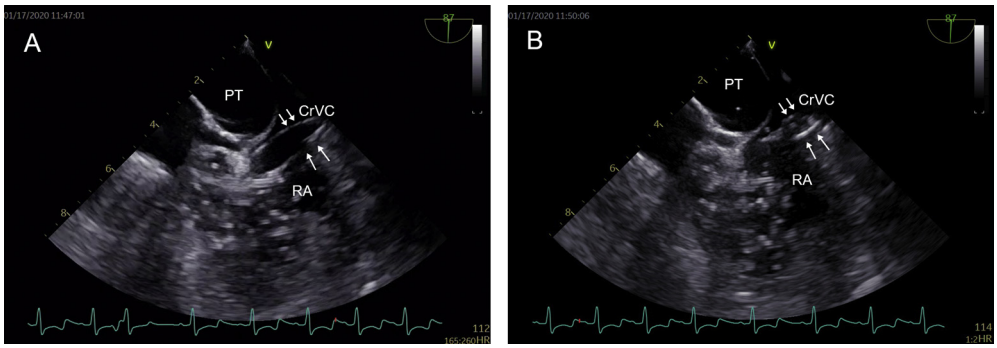

Figure 4 TEE images obtained intraoperatively that show the endoscopic basket retrieval device (*arrows*). **(A)** Initially, the device was empty and can be seen pushing the worms down into the right atrium (RA). **(B)** After additional manipulation and with TEE guidance, the worms, represented as parallel white lines, can be seen within the device before extraction. *CrVC*, Cranial vena cava; *PT*, pulmonary trunk.

method of extraction. If retrieval is guided by fluoroscopic imaging alone, the location of radiolucent objects cannot be known with certainty. Although repeated passes of the device may be necessary to remove heartworms with any imaging modality, intraoperative TEE imaging can be used to confirm location and monitor removal during the procedure. Intraoperative TEE imaging can mitigate the challenges of removing large worm burdens and aids in confirmation that the majority, if not all, heartworms have been removed from within the heart.

CONCLUSION

We demonstrate how intraoperative TEE imaging was useful in the successful removal of intracardiac heartworms (*D immitis*), a type of radiolucent foreign material that cannot be seen with fluoroscopic imaging alone.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2020.05.005.

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