

Heartworm removal using the basket catheter technique in a 1.85 kg cat with pulmonary hypertension and right-sided heart failure: A case report

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Abstract: Feline heartworm infection poses significant diagnostic and therapeutic challenges owing to its distinct clinical features compared to canine cases. Even a single worm can cause life-threatening complications, including pulmonary hypertension and right-sided heart failure. There is no definitive treatment available at present. A 5-month-old intact male domestic shorthair cat (1.85 kg) exhibited respiratory distress, pleural effusion and ascites. Clinical examination revealed a grade 4/6 systolic murmur, jugular vein distension and 7% dehydration. Despite negative antigen and antibody tests for heartworm, echocardiography revealed hyperechoic structures in the right atrium consistent with *Dirofilaria immitis*, alongside pulmonary hypertension and right-sided heart failure. A 10-cm-long immature female heartworm was surgically removed through jugular venotomy using a basket device under fluoroscopic guidance. Postoperatively, the cat developed persistent pulmonary hypertension, tricuspid regurgitation and refractory hypotension, leading to death on day five. Necropsy confirmed no residual heartworms and showed eosinophilic arteritis, pulmonary oedema, alveolar histiocytosis and thrombus formation, all of which are consistent with heartworm-associated pulmonary vascular disease. Although basket device-assisted removal is feasible, existing vascular damage and postoperative complications significantly affect prognosis. This case report describes a patient managed for clinical diagnostic and therapeutic purposes. All procedures were performed as part of standard veterinary clinical care, and informed consent for publication was obtained from the rescuer. Since this report did not involve experimental interventions, approval from an institutional animal ethics committee was unnecessary.

Keywords: *Dirofilaria immitis*; feline heartworm disease; heartworm-associated respiratory disease; surgical removal

Heartworm infection, caused by the nematode *Dirofilaria immitis*, primarily affects the heart and lungs of companion animals (Panprom et al. 2021). In cats, the infection differs substantially from that

in dogs, complicating diagnosis and treatment (American Heartworm Society 2014). Although dogs are the definitive host, cats are atypical hosts and show greater resistance to adult heartworm

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development (American Heartworm Society 2014). However, due to their smaller body size, even a few worms can lead to a severe infection (American Heartworm Society 2014). Infected cats often develop heartworm-associated respiratory disease (HARD), an acute inflammatory response to larvae (Litster and Atwell 2008; Dillon et al. 2017; Winter et al. 2017). In rare cases, larvae mature into adults in the distal pulmonary arteries and migrate to the right heart, causing severe pulmonary hypertension, right-sided heart failure and tricuspid valve insufficiency. Clinical signs include tachypnoea and sudden coughing, frequently leading to sudden death (Litster and Atwell 2008). The transient and nonspecific nature of these signs complicates early detection.

Even when feline heartworm infection is diagnosed, no definitive treatment has been established. Surgical removal of adult worms may be appropriate to reduce the parasite burden (Panprom et al. 2021). This report presents a case involving the surgical removal of an adult heartworm that ultimately resulted in death due to postoperative complications. Additionally, diagnostic and therapeutic limitations are discussed.

Case presentation

A 5-month-old presumed intact male domestic shorthair cat (1.85 kg) presented with respiratory distress, pleural effusion and ascites. The patient was a stray cat rescued in the Daejeon region, Republic of Korea. Physical examination revealed a grade 4/6 systolic heart murmur, marked jugular vein distension and 7% dehydration without superficial lymphadenopathy. A complete blood count showed leukocytosis (38 750/ μ l; reference: 2 870–17 020/ μ l) and a haematocrit of 33.5% (reference: 30.3–52.3%). Serum biochemistry revealed elevated blood urea nitrogen (14.6 mmol/l; reference: 5.7–11.8 mmol/l), alanine aminotransferase (324 IU/l; reference: 12–115 IU/l) and aspartate transaminase (60 IU/l; reference: 0–32 IU/l), with albumin at the lower limit of normal (22 g/l; reference: 22–39 g/l). Furthermore, heartworm antigen and antibody tests using the IDEXX SNAP Feline Triple and BIONOTE FHW Ag/Ab Test kits were both negative.

Thoracic radiographs showed mild right pulmonary artery enlargement, pleural effusion and ascites (Figure 1A). A total of 100 ml of pleural

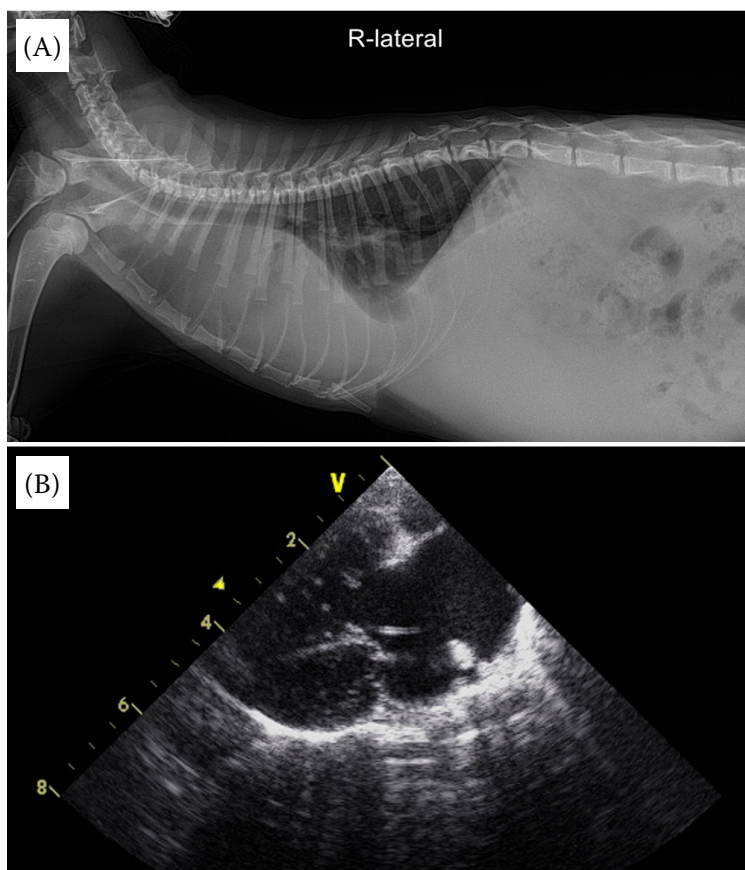


Figure 1. Diagnostic imaging findings before heartworm removal in a cat with heartworm disease

(A) Thoracic radiograph showing mild dilation of the right pulmonary artery, with pleural effusion and ascites. (B) Echocardiographic image of a mobile echogenic structure within the right atrium, consistent with an adult heartworm

fluid and 120 ml of ascitic fluid were removed via centesis. Echocardiography revealed oscillating echogenic shadows in the right atrium, suspected to be heartworms (Figure 1B). Moderate tricuspid regurgitation occupied approximately 70% of the right atrial lumen, with dilation of the right atrium, right ventricle (internal diameter: 1.48 cm) and main pulmonary artery. Pulmonary hypertension was confirmed by a pulmonary artery-to-aorta (PA:AO) ratio of 1.37 and a right pulmonary artery distensibility index of 26.67% (reference: <30%). Additionally, pulmonary artery flow showed reduced acceleration time (16.64 ms; reference: 55–66 ms) and an acceleration time/ejection time ratio of 0.13 (reference: 0.3).

A diagnosis of heartworm infection with pulmonary hypertension and right-sided heart failure was made based on clinical findings and imaging. Before the procedure, the cat was receiving medical therapy for right-sided heart failure and pulmonary hypertension, including pimobendan (0.3 mg/kg p.o. b.i.d.), benazepril (0.25 mg/kg p.o. s.i.d.), furosemide (2 mg/kg p.o. b.i.d.), spironolactone (1 mg/kg p.o. b.i.d.), sildenafil (1 mg/kg p.o. b.i.d.), prednisolone (0.5 mg/kg p.o. b.i.d.) and doxycycline (5 mg/kg p.o. b.i.d.). These medications were maintained until the morning of surgery. Surgical intervention was performed 6 days after the initial diagnosis. Immediately before surgery, the systolic systemic blood pressure was 18.1 kPa. No antiplatelet or anticoagulant therapy was administered before the procedure. Premedication consisted of prednisolone (1 mg/kg s.c.) and midazolam (0.2 mg/kg i.v.). Anaesthesia was induced with alfaxalone (5 mg/kg) and maintained with isoflurane. Surgical removal of the heartworm was performed according to the American Heartworm Society guidelines (American Heartworm Society 2014). Due to the cat's small size, a sheathless technique was used to reduce procedure time and vascular risk. Venotomy was performed on the dilated right external jugular vein using surgical scissors, with cranial ligation applied to control bleeding by temporarily occluding venous return. Without an introducer sheath, a basket retrieval device was inserted directly through the venotomy and advanced under continuous fluoroscopic guidance. The basket was positioned at the right ventricle and deployed, retrieving a 10-cm-long immature adult female heartworm with a coiled tail morphology in a single attempt (Figure 2A,B).

Postoperative echocardiography showed persistent high-echogenicity shadows in the right ventricle, suggestive of residual heartworms or thrombi. On day 3, severe tricuspid regurgitation and right atrial dilation remained, and the PA:AO ratio was unchanged (1.37). To manage pulmonary hypertension and thrombotic risk, the cat was treated with prednisolone (2 mg/kg p.o. b.i.d.; Yuhan, Seoul, Republic of Korea), clopidogrel (18.75 mg p.o. b.i.d.) and sildenafil (2 mg/kg p.o. b.i.d.; Hanmi, Seoul, Republic of Korea). Additionally, pleural effusion was managed with regular thoracocentesis.

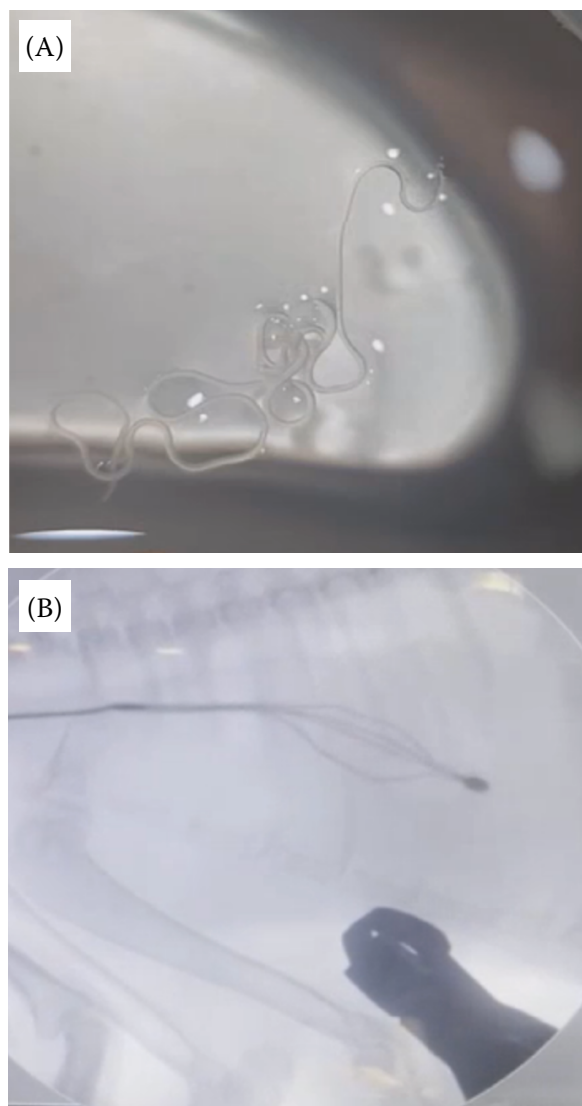


Figure 2. Heartworm retrieval procedure and extracted adult heartworm

(A) Fluoroscopic image showing retrieval of an adult heartworm using a basket device at the target site. (B) Extracted heartworm with a coiled-tail morphology, measuring 10 cm, from the right ventricle

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Despite these measures, blood pressure remained at 9.3 kPa. Dobutamine (2 µg/kg/min) was administered for inotropic support, followed by norepinephrine (0.05 mg/kg/min) to maintain vascular tone. However, blood pressure did not improve, and the patient died on postoperative day 5.

Necropsy revealed no remaining heartworms. Lung histopathology showed severe subacute eosinophilic arteritis, thrombus formation, pulmonary oedema, alveolar histiocytosis and type II pneumocyte hyperplasia (Figure 3), confirming heartworm-associated pulmonary vascular disease.

DISCUSSION

As mentioned earlier, the patient was a stray cat rescued in the Daejeon region, Republic of Korea. In a Korean prevalence study of stray cats using nested PCR, Daejeon represented the largest regional sample size, with a reported prevalence of 5.9% (Park et al. 2014). However, feline heartworm infection is often characterised by a low antigen burden and frequent single-worm infections, which may lead to an underestimation of infection prevalence even when molecular diagnostic methods are applied.

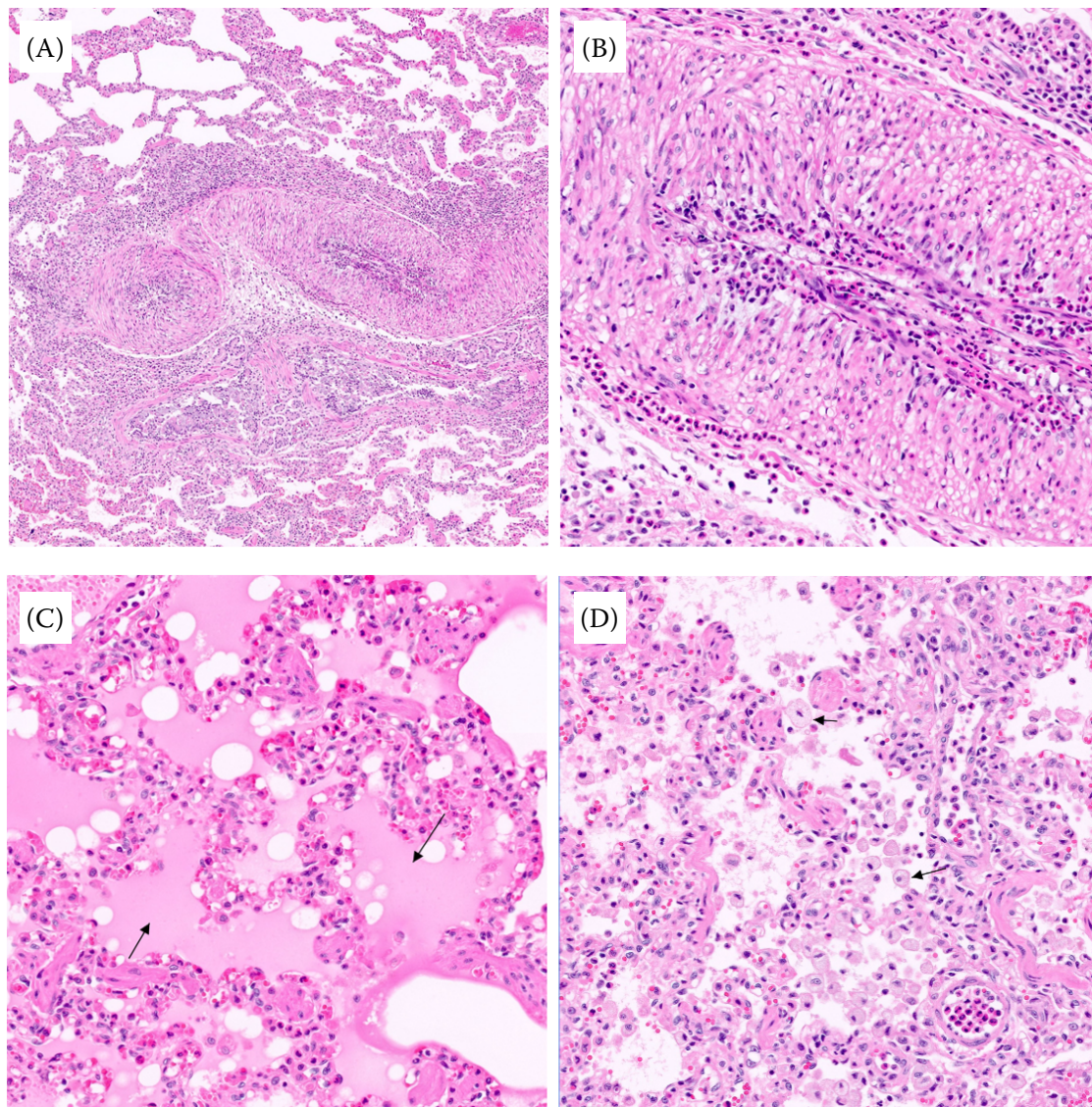


Figure 3. Histopathological examination of lung tissue showing severe subacute eosinophilic arteritis with thrombus formation, pulmonary oedema, alveolar histiocytosis and type II pneumocyte hyperplasia

(A) Pulmonary artery with inflammation and adjacent alveolar structures [haematoxylin and eosin (H&E), ×10]. (B) Pulmonary artery with eosinophilic inflammation (H&E, ×40). (C) Pulmonary alveolar oedema (black arrows) (H&E, ×40). (D) Pulmonary alveolar macrophages (black arrows) (H&E, ×40)

Diagnosing feline heartworm infection has several limitations (American Heartworm Society 2014). Thoracic radiographs may reveal pulmonary artery abnormalities, such as dilation, distortion, or truncation. However, cats rarely exhibit right ventricular hypertrophy, unlike dogs (Litster and Atwell 2008; American Heartworm Society 2014; Garrity et al. 2019). Echocardiography offers clear insight by identifying highly echogenic “=” shapes that represent the body wall of adult heartworms in the right ventricle or pulmonary artery (Atkins et al. 2008). Diagnostic options include antigen and antibody assays. Antigen testing is the gold standard for dogs but is less reliable for cats. It detects antigens from female adult heartworms, but male-only infections and low worm burdens are common in cats, often yielding false negatives (American Heartworm Society 2014). Antibody testing is more effective for screening, as it detects antibodies produced in response to heartworm exposure. However, a positive result indicates prior exposure but does not confirm active infection. Furthermore, microfilariae detection, routinely used in dogs, is rarely effective in cats, as their immune system often suppresses or clears microfilariae (American Heartworm Society 2014). Herein, all serological and microfilariae tests were negative; however, echocardiography confirmed the diagnosis with characteristic findings.

No reliable treatment protocol exists for diagnosed feline heartworm infection (American Heartworm Society 2014). Melarsomine, the standard treatment for canine heartworm infection, is not recommended for cats (Panprom et al. 2021). Regardless of dose, it is toxic in felines, and no studies have shown improved survival with adulticide therapy. Accordingly, surgical or interventional removal of heartworms may be considered as a therapeutic option in selected feline cases, particularly when severe clinical signs persist or response to medical management is limited (American Heartworm Society 2014). In this case, the decision to pursue surgical intervention was primarily based on the limited clinical improvement observed despite initiating medical management immediately after diagnosis. The cat received standard medical therapy for pulmonary hypertension and right-sided heart failure associated with heartworm infection. However, pleural effusion persisted, necessitating repeated thoracocentesis, and adequate stabilisation of the systemic condition could not be achieved. Moreover, medical management alone was insuf-

ficient to effectively control disease progression. Therefore, surgical removal of the heartworm was selected as a treatment strategy, primarily to mitigate heartworm-associated pulmonary inflammatory responses, alongside alleviating potential mechanical obstruction and reducing the haemodynamic burden on the cardiovascular system.

Surgical removal techniques include direct extraction with instruments such as Ishihara or tripod forceps and loop-based capture using snares or basket devices. A 2013 retrospective study compared the efficacy and safety of tripod grasping forceps versus a basket retrieval device (Yoon et al. 2013). Both were effective, though the number of worms retrieved and success rate varied by device (Yoon et al. 2013). In this case, a basket device was successfully used via right jugular venotomy to remove the heartworm. Basket devices are more flexible, are available in various diameters and were initially developed for removing foreign objects from the oesophagus or stomach and extracting urinary tract stones (Salimi et al. 2009). Unlike forceps, basket devices lack sharp claws and instead capture heartworms using a loop mechanism, enabling intact retrieval of multiple worms (Yoon et al. 2013). Preserving worm integrity during surgery is crucial, as ruptured worms can release parasitic fluids, potentially inducing circulatory collapse. The basket device can be opened in the atrium and advanced into the ventricle to retrieve worms, minimising valvular damage compared to forceps. In this case, no additional heartworms were found at necropsy, supporting the device's efficacy.

Furthermore, postoperative echocardiography revealed floating echogenic structures within the right atrium that lacked the characteristic echogenic appearance of heartworms and were interpreted as thrombi rather than residual parasites. This finding highlights an important diagnostic pitfall, as post-interventional thrombus formation may closely mimic residual heartworms on follow-up imaging.

Despite the apparent removal of the worm, tricuspid regurgitation and right heart burden persisted. This indicates that obstruction by the worm was not the cause; persistent regurgitation was likely attributable to annular dilation resulting from right ventricular hypertrophy or irreversible valvular damage. Similar tricuspid valve changes have been reported in dogs with chronic heartworm disease (Iizuka et al. 2009). The patient died

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five days post-surgery without significant clinical improvement, likely due to the severity of the underlying immune-mediated pulmonary vascular disease and right-sided heart failure rather than procedure-related complications.

Surgical intervention is a viable treatment for feline heartworm infection, especially in cases with severe symptoms such as pulmonary hypertension and right-sided heart failure, even if complete removal of heartworms is not possible. This case highlights the potential benefit of alleviating mechanical obstruction and reducing the parasitic burden on the cardiovascular system by extracting adult worms. Herein, the clinical outcome was poor, likely due to pre-existing cardiovascular damage and postoperative complications.

There are no standardised guidelines for surgical indications in feline heartworm infections. These unclear criteria highlight the need for prospective studies to refine patient selection, clarify surgical indications, and investigate postoperative outcomes. Thus, this study is crucial for developing protocols and enhancing survival rates in affected cats.

In conclusion, the physical removal of heartworms using a basket device may be an effective treatment strategy in select feline cases. However, this report demonstrates that even with successful removal, prognosis may remain poor with severe cardiovascular damage. The case reinforces the need for clear surgical criteria, especially in cats with severe pulmonary hypertension and right-sided heart failure. Prospective studies are needed to refine case selection, guide intervention timing and establish standardised treatment protocols.

Conflict of interest

The authors declare no conflict of interest.

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