Case Report

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Diagnosis of *Aelurostrongylus abstrusus* verminous pneumonia via sonography-guided fine-needle pulmonary parenchymal aspiration in a cat

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Abstract

Case summary A 9-year-old, male neutered, indoor–outdoor domestic shorthair cat from the northern Alabama countryside presented for a 3 week history of coughing, lethargy and an episode of self-resolving dyspnea that occurred 1 week prior to presentation. Three-view thoracic radiographs revealed a moderate-to-severe, diffuse, mixed bronchial to structured interstitial (miliary-to-nodular) pulmonary pattern in all lung lobes with peribronchial cuffing and multifocal areas of mild patchy alveolar opacity. Ultrasound-guided evaluation and fine-needle aspiration of the caudodorsal lung parenchyma was performed with sedation. Cytology revealed many widely scattered *Aelurostrongylus abstrusus* larvae and ova. Upon the confirmed diagnosis of *A abstrusus* verminous pneumonia, treatment with fenbendazole and selamectin resulted in complete resolution of clinical signs within 6 weeks of the initial diagnosis.

Relevance and novel information We report herein the first documented case in the Americas of *A abstrusus* verminous pneumonia diagnosed via cytologic evaluation of an in vivo, percutaneous ultrasound-guided fine-needle aspirate of affected lung. Additionally, to our knowledge, we offer the first account of the sonographic (pulmonary) features of the disease.

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Case description

A 9-year-old, male neutered domestic shorthair cat with outdoor access was evaluated for a 3 week history of lethargy and coughing. One week prior to presentation, the owner reported that the cat had an episode of self-resolving dyspnea. A complete blood count (CBC [IDEXX Procyte Dx Hematology Analyzer; IDEXX Laboratories]) performed by the referring veterinarian was normal. Referral veterinarian imaging included thoracic radiographs, which demonstrated a severe, diffuse, mixed, predominantly bronchial pulmonary pattern with structured interstitial (miliary-to-nodular) components. Although the exact methodology was not provided, a transtracheal wash with cytology had been performed and was evaluated by the referring veterinarian, and reportedly revealed mixed/suppurative inflammation. Culture of the bronchial fluid was negative for growth.

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When clinical signs did not resolve the cat was referred for further diagnostics.

At presentation the cat was bright, alert and responsive, with a body condition score of 3/5.[1] Bilaterally harsh lung sounds were auscultated. Repeated CBC (Cell-Dyn 3700; Abbott Laboratories) and serum biochemistries (Vet Axcel Clinical Chemistry System; Alfa Wassermann Diagnostic Technologies) revealed a moderate leukopenia (3.7 K/µl; reference interval [RI] 5.5–20.0 K/µl) and persistent moderate neutropenia (1702/µl; RI 2500–12,500/µl) with a left shift (bands 222/µl, RI 0–300/µl), mild lymphopenia (1369/µl; RI 1500–7000/µl) and mild hyperglycemia (178 mg/dl; RI 70–160 mg/dl). Repeat, three-view thoracic radiographs revealed a moderately progressed severe, diffuse, mixed bronchial-to-structured interstitial (miliary-to-nodular) pulmonary pattern in all lung lobes but most severe in the caudodorsal lung fields. Peribronchial cuffing was evident, with multifocal areas of poorly defined alveolar disease (especially in the perihilar and caudal dorsal lung fields) (Figure 1).

Differential diagnoses for a middle-aged-to-elderly cat with dyspnea and the combined radiographic abnormalities included feline asthma, allergic pneumonitis (secondary to inhaling irritants such as mold, smoke or household chemicals), feline heartworm eosinophilic pneumonitis or other verminous pneumonia (*Aelurostrongylus* species, *Eucoleus* species, *Filaroides* species and *Dirofilaria immitis*), and neoplasia (such as bronchogenic adenocarcinoma).

Thoracic and abdominal sonography were performed with a BioSoundEsoate MyLab50 ultrasound machine and microconvex ultrasound probe with available frequencies from 5 to 8 mHz. Abdominal sonography was normal. Thoracic sonography revealed many B-lines (comet tail artifact, a subtype of reverberation artifact) with intermittent, well-defined, small (2–3 mm), hypoechoic nodules, intermittent irregular pleural margins and multifocal, intermittent, variously sized (2–4 mm) 'shred' signs (Figure 2).[2–4] The cat was sedated (dexmedetomidine 4.7 µg/kg IM). Following aseptic preparation of the clipped skin, percutaneous ultrasound-guided

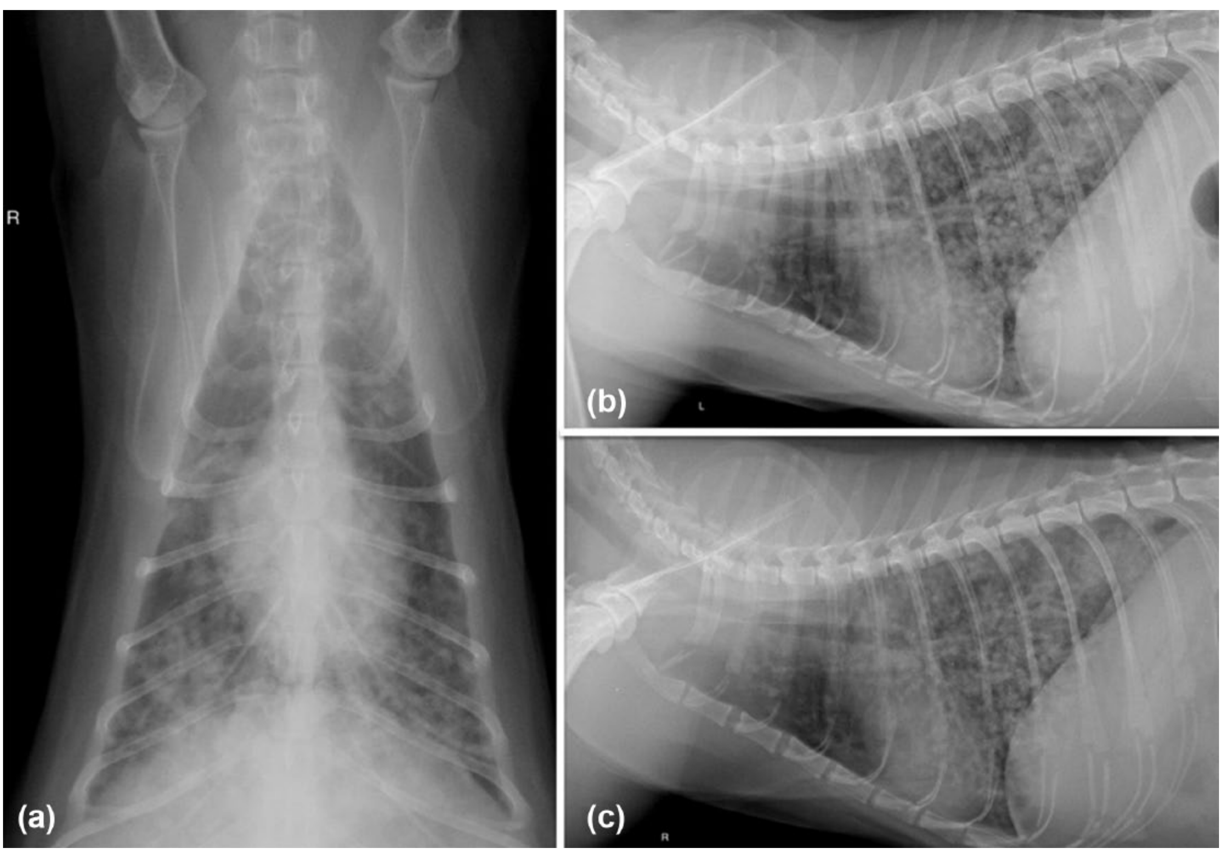

Figure 1 Three-view thoracic radiographs of a 9-year-old male neutered cat taken 3 weeks following the onset of lethargy, coughing and an episode of dyspnea. (a) Ventrodorsal, (b) left lateral and (c) right lateral radiographic projections. Note the severe diffuse, mixed bronchial-to-structured interstitial (miliary-to-nodular) pattern with peribronchial cuffing in all lung lobes. Note also the mild alveolar opacity present throughout the caudodorsal lung fields. The pulmonary pattern causes border effacement of the caudal pulmonary lobar vasculature, great vessels and, to a lesser degree, the caudal border of the cardiac silhouette, especially on the lateral projections. Note the normal extrapulmonary and extrathoracic structures

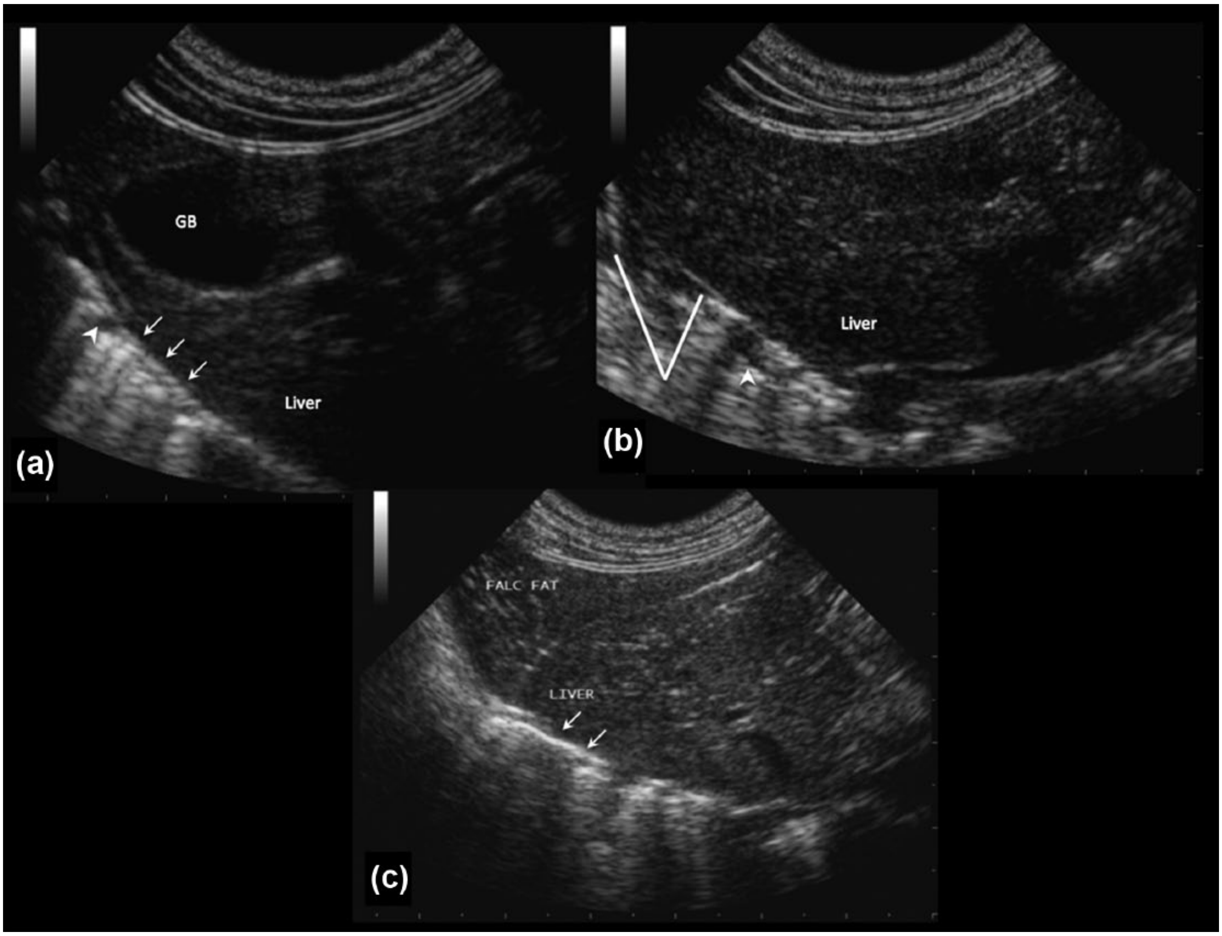

Figure 2 Transabdominal thoracic sonography of the same cat shown in Figure 1, performed immediately following thoracic radiographic evaluation. Images depict the diaphragmatic hepatic view of the caudal lung fields. (a) The right caudal lung field. The liver and gall bladder (GB) are to the right of the diaphragm (arrows). Note the multiple (>3), hyperechoic B-lines (comet tail artifacts) emanating to the left of the image into the distal field from the pleuropulmonary–diaphragmatic junction. These are indicative of consolidated lung fields and mixed interstitial pulmonary pathology within the right caudal lung field. (b) Similar images as (a) of the right caudal lung field. The gall bladder is not within the image field of view. Note a larger nodule (arrowhead) and 'shred' sign (denoted by the white 'V'). In all sonographic images, the margins of the pleura are irregular. In real time, multifocal, intermittent 'shred' signs were noted. A shred sign is consistent with alveolar parenchymal disease in contact with aerated sections of lung producing irregular sonographic borders. (c) The left caudal lung field. Note that findings within the left caudal lung lobe were similar to that of the right. Falciform fat (labeled 'falc fat') and the liver are to the right of the pleuropulmonary–diaphragmatic interface (arrows)

fine-needle aspiration of the sonographically affected lung parenchyma was performed. A 5 ml syringe with 1 ml room air within the syringe chamber was attached to a 22 G × 1.5 inch fine needle (without stylet). Approximately one-half the length of the needle was gently inserted through the skin at the right proximal third of the eighth intercostal space and was directed with ultrasound guidance into the affected pulmonary parenchyma/nodules. Negative pressure (1–4 ml) was applied, while 3–5 to and from movements were performed within the lesions. The collected material was sprayed onto glass slides for evaluation by an on-site, board-certified veterinary clinical pathologist. All samples were grossly and subjectively productive. When necessary, color flow Doppler evaluation was intermittently used to evaluate adjacent vascular supply and to avoid the vascular structures. The procedure was repeated twice more at the eighth and seventh intercostal spaces, respectively, for a total of three passes so that adequate material could be obtained.[5] Based on follow-up sonographic evaluation, no evidence of pleural gas or fluid was noted.[4,6] In addition, periprocedural sonographic monitoring within the first 10 mins of the procedure revealed no progression of the parenchymal disease. Thus, the procedure was deemed sonographically negative for associated parenchymal hemorrhage

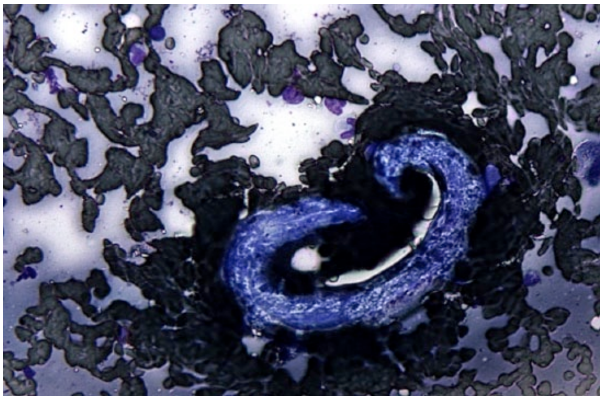

Figure 3 Cytologic sample obtained via pulmonary ultrasound-guided fine-needle aspirate containing *Aelurostrongylus abstrusus* larva. Just to the right of the center of the image is a large, curved, basophilic larva with a kinked tail (far right) and non-rhabditiform esophagus (left) extending approximately half of the length of the parasite, consistent with a stage 1 *A abstrusus* larva. The background consists of blood and proteinaceous debris interspersed with occasional non-degenerate neutrophils and alveolar macrophages. Modified Wright's stain

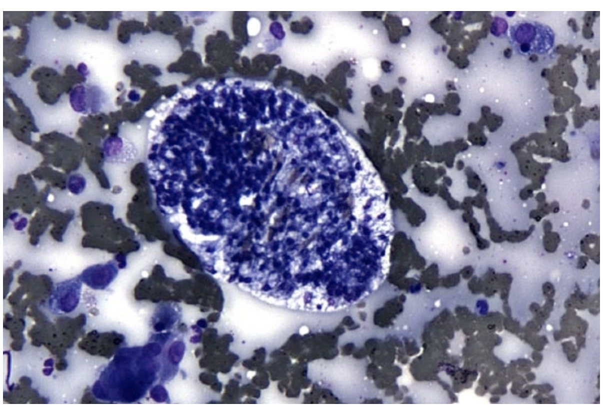

Figure 4 Cytologic sample obtained by way of ultrasound-guided pulmonary fine-needle aspiration showing *A abstrusus* ova. At the center of the image is a large, oval egg containing numerous basophilic-staining blastomeres surrounded by abundant non-degenerate neutrophils and alveolar macrophages (characterized by their abundant, vacuolated cytoplasm) on a background of blood and proteinaceous debris. Modified Wright's stain

and pneumothorax. During the recovery period (approximately 30 mins), the cat was monitored closely for clinical signs of respiratory distress and pallor.

Cytologic evaluation revealed high cellularity aspirate samples consisting of innumerable macrophages and non-degenerate neutrophils admixed with fewer eosinophils. Numerous multinucleated giant cells were observed, along with several clusters of respiratory endothelial cells. Widely scattered larvae, measuring approximately 350 µm, were observed throughout the smears and, occasionally, were seen in concentric coils. Some of these larvae possessed distinctly notched tails (Figure 3). Also present were multiple oval structures measuring approximately 80 µm × 70 µm, with a frothy interior, containing numerous round basophilic structures consistent with blastomeres (Figure 4). Long, beaded, filamentous, extracellular rods were noted on one slide. These findings were consistent with pyogranulomatous-to-eosinophilic inflammation with intralesional *A abstrusus* larvae and ova, with possible additional concurrent nocardiosis. Additional acid-fast staining was performed to confirm the presence of *Nocardia* species; in the interim, a Baermann test was performed and confirmed the presence of *A abstrusus*.

The cat was hospitalized for treatment and observation. Intravenous trimethoprim sulfa for presumed nocardiosis (16.7 mg/kg diluted in 2 ml D5W IV q12h for 7 days) was instituted pending acid-fast staining of cytologic samples. In addition, the cat was placed on oral prednisolone to decrease inflammation associated with parasite death (0.5 mg/kg PO q24h for 10 days). Fenbendazole was instituted to eliminate the *A abstrusus* (50 mg/kg PO q24h for 14 days), in addition to monthly topical selamectin.

A repeat CBC 5 days following initial diagnosis demonstrated resolved neutropenia (2829/µl; RI 1500–7000/µl), improving leukopenia (4.1 K/µl; RI 5.5–20.0 K/µl) and moderate lymphopenia (861/µl; RI 1500–7000/µl). Acid-fast staining of the filamentous organisms identified during cytology was negative for *Nocardia* species and was obtained on the seventh day of hospitalization. No episodes of respiratory distress or coughing were noted during the hospitalization period. The cat's attitude and appetite improved. A repeated Baermann test 2 weeks following initial hospitalization was negative for *A abstrusus* larvae. The patient was discharged on day 16 of hospitalization, with clinically normal behavior, a normal resting respiration rate (23–42 breaths per min)[7] and normal lung auscultation bilaterally. Six weeks following initial diagnosis, recheck thoracic radiographs demonstrated almost complete resolution of the previously described pulmonary pattern. A residual, but much improved, mild-to-moderate, mixed bronchial and unstructured interstitial pulmonary pattern persisted within the right caudal dorsal and accessory lung lobes (Figure 5). The cat was bright, alert and responsive, with no abnormal lung sounds heard upon auscultation. All coughing and lethargy had resolved.

Discussion

We report herein the first documented case of *A abstrusus* infection diagnosed by ultrasound-guided lung aspirate

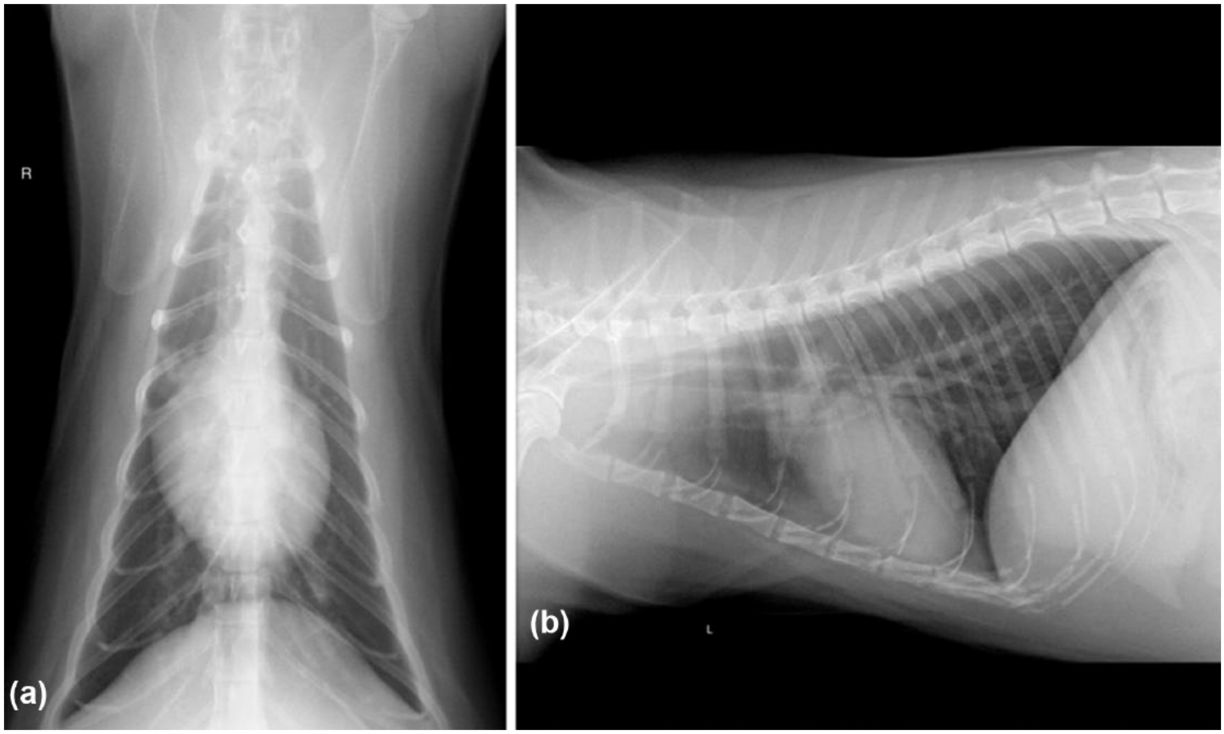

Figure 5 Two-view thoracic radiographs taken 6 weeks following the diagnosis and medical management of *Aelurostrongylus abstrusus*. Note the degree of improvement of the previously described mixed pulmonary pattern compared with Figure 1. A mild, diffuse mixed bronchial and unstructured interstitial pattern persists within the right caudodorsal and accessory lung fields. Consideration was given to resolving verminous pneumonia with excellent clinical response to medical management with mild residual pulmonary parenchymal pathology and/or fibrosis. No clinical signs were apparent at the time of imaging

in the Americas, with subsequent successful medical management and outcome. Previously, the diagnosis of *A abstrusus* via fine-needle biopsy is described in two cats.[8,9] In people, a broad spectrum of parasitic infections can have thoracic manifestations, but sonography and sonographic diagnosis are seldom used for screening.[10] We describe herein the radiographic features, and, for the first time in the veterinary literature, to our knowledge, the associated sonographic pulmonary parenchymal features of *A abstrusus*. Image-guided percutaneous fine needle aspiration is less invasive than fine-needle biopsy or excisional biopsy, and may be associated with lower morbidity and mortality, as in the case of image-guided percutaneous biopsy in people and percutaneous fine-needle aspiration biopsy in dogs and cats.[11,12] Indications for image-guided interventions include the establishment of the benign or malignant nature of a lesion, obtaining material for microbiologic analysis in patients with known or suspected infections, staging malignancy in cases of known or suspected malignancy, and establishing the nature and extent of diffuse parenchymal disease.[11]

A abstrusus is a sporadically identified metastrongyloid nematode of cats responsible for cardiorespiratory disease in Europe and the Americas.[13] The parasite is transmitted indirectly in a life cycle that incorporates mollusks and snails as intermediate hosts, and rodents, frogs, lizards, snakes, and birds as paratenic hosts.[14,15] Cats are infected when they consume an intermediate or paratenic host containing larvae; these larvae then migrate to the lungs, mature to their adult forms, and produce larvae that migrate to the pharynx and are passed into the feces, thus completing the cycle.[13] The hatching of eggs and migration of larvae are responsible for most clinical signs.[13] Clinical signs associated with *A abstrusus* are uncommon but are primarily associated with parenchymal pulmonary infiltration and the subsequent inflammatory response.[13] Respiratory signs can include coughing, sneezing, progressive dyspnea and death.[13,15] The Baermann fecal test is considered to be the gold-standard diagnostic technique in living patients to achieve a diagnosis, followed by other copromicroscopic techniques and bronchoalveolar lavage cytology.[13,16,17] *A abstrusus* can be easily detected at necropsy via histology of affected lung lobes.[18]

Rarely, *A abstrusus* has been detected by other diagnostics. There is one documented case of *A abstrusus* obtained by lung impression of an affected kitten during necropsy; a female larva was found in the bloodstream of another stray cat during a blood parasite survey.[19,20] Radiographic findings in the cat of this report were classic, prompting sonographic pulmonary evaluation and the interventional procedure. At our institution, thoracic sonography combined with fine-needle aspiration is often performed to obtain samples for cytology and culture, especially when radiographs support the presence of severe pulmonary disease such as severe bronchial, interstitial or alveolar opacities. We consider sonographic-guided fine-needle pulmonary aspiration to be a viable, quick, relatively safe and easily performed test when severe disease is radiographically present. In addition, it is our experience that mild-to-moderate radiographic findings of pulmonary disease can have easily identifiable sonographic lesions that may be amenable to sonographic aspiration, especially when evaluation is performed by trained ultrasound personnel. Pulmonary fine-needle aspiration may be especially useful in unstable patients for which conventional testing may delay diagnosis and treatment. The Baermann technique takes considerable time to complete (at least 6 h) and is unable to diagnose parasitic infections during the prepatent period, while bronchoalveolar lavage requires general anesthesia and has a mortality rate of up to 6% in cats with respiratory compromise.[13,21] An additional weakness of both transtracheal washes and the Baermann technique is the tendency of *A abstrusus* to shed variable numbers of ova and larvae during its life cycle, which can result in false negatives when using either or both of these diagnostic tests.[13]

There is limited literature available regarding the safety of pulmonary aspiration in cats with verminous pneumonia, and a prospective clinical study would be ideal for complete assessment of this procedure's clinical performance, diagnostic efficacy and safety in patients afflicted with this disease. Multiple studies assessing risk associated with fine-needle aspiration in canine and feline patients with fungal and neoplastic disease revealed minimal risk of clinical signs secondary to aspiration and a high diagnostic yield when the aspirate was sonographically guided.[12,22] Three veterinary studies of pulmonary aspiration assisted with an imaging modality had only one animal with clinical pneumothorax out of 97 cases (an incidence of 1.03%).[12,22,23] Another study evaluating pulmonary aspiration without imaging guidance had a higher rate of clinical pneumothorax (6.2%).[24] Complications associated with pulmonary fine-needle aspiration biopsy with a 20 G Wescott-type needle include a risk as high as 17% for pneumothorax and a mortality rate of 2.1% secondary to pneumothorax.[12] Greater risk was associated with larger needle gauge, and although more tissue may be obtained with a larger needle, blood contamination can hamper the diagnostic quality of the sample.[12] In people there is a 1.6% incidence of dyspnea due to tension pneumothorax secondary to endoscopic sonographically guided fine-needle aspiration of large pulmonary mass lesions.[6] Complications were not noted in the cat of this report but can include pneumothorax, pulmonary parenchymal hemorrhage, pulmonary parenchymal lacerations and inadvertent cardiac puncture. The cat of the current report was sedated, further reducing the risk of associated complications. Motion from breathing, in our opinion, did not hamper the ability to effectively perform the aspirate.

Conclusions

We describe our positive experience with, and the clinical utility of, percutaneous ultrasound-guided fine-needle aspiration of the pulmonary parenchyma of a cat with *A abstrusus*, which resulted in a rapid definitive diagnosis. The safety of pulmonary aspirates in cats with pulmonary parasitism is not well assessed in the veterinary literature; owners should be counseled regarding potential complications.

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