

What Is Your Diagnosis?

In collaboration with the American College of Veterinary Radiology

Respiratory distress in a newly diagnosed diabetic cat

History

An elderly 2.5-kg intact female stray cat presented to a referral hospital weak and collapsed. Initial examination revealed moderate dehydration evidenced by moderate hyperchloremia (136 mmol/L; reference range [RR], 109 to 120 mmol/L), marked hypernatremia (172.3 mmol/L; RR, 149 to 154 mmol/L), and mild hyperlactatemia (2.1 mmol/L; RR, 0 to 2 mmol/L). The patient also had moderate hyperglycemia (345 mg/dL; RR, 80 to 120 mg/dL) and a metabolic acidosis (pH, 7.258; RR, 7.337 to 7.467; Hco₃, 8.1 mmol/L; RR, 18 to 24 mmol/L). Ketones were normal at 0.8 mmol/L (RR, 0 to 0.9 mmol/L for nonketotic diabetic cats), and retroviral testing (FeLV/FIV) was negative. A point-of-care ultrasound documented an enlarged uterus that was distended with echogenic fluid, consistent with a pyometra. At this time, no further diagnostics were performed, as the patient was determined to be unowned and resources were allocated toward treatment.

The cat was treated with IV lactated Ringer solution at 100 mL/kg/d, ampicillin-sulbactam at 30 mg/kg IV every 8 hours, and methadone at 0.1 mg/kg IV every 4 hours for analgesia. Once the cat was stabilized, an ovariohysterectomy was performed uneventfully. Postoperatively, the cat recovered well, but remained moderately hyperglycemic. Insulin glargine at 1 unit SC twice daily was initiated in conjunction with a high-protein, low-carbohydrate diet.

To assist with diabetes management, a continuous glucose monitor (CGM; FreeStyle Libre; Abbott) was placed on the patient's left craniodorsal thorax. Less than 15 minutes after application, the patient became dyspneic. Two-view thoracic radiographs were acquired to investigate the sudden change in respiratory characteristics (**Figure 1**).

Formulate differential diagnoses, then continue reading.

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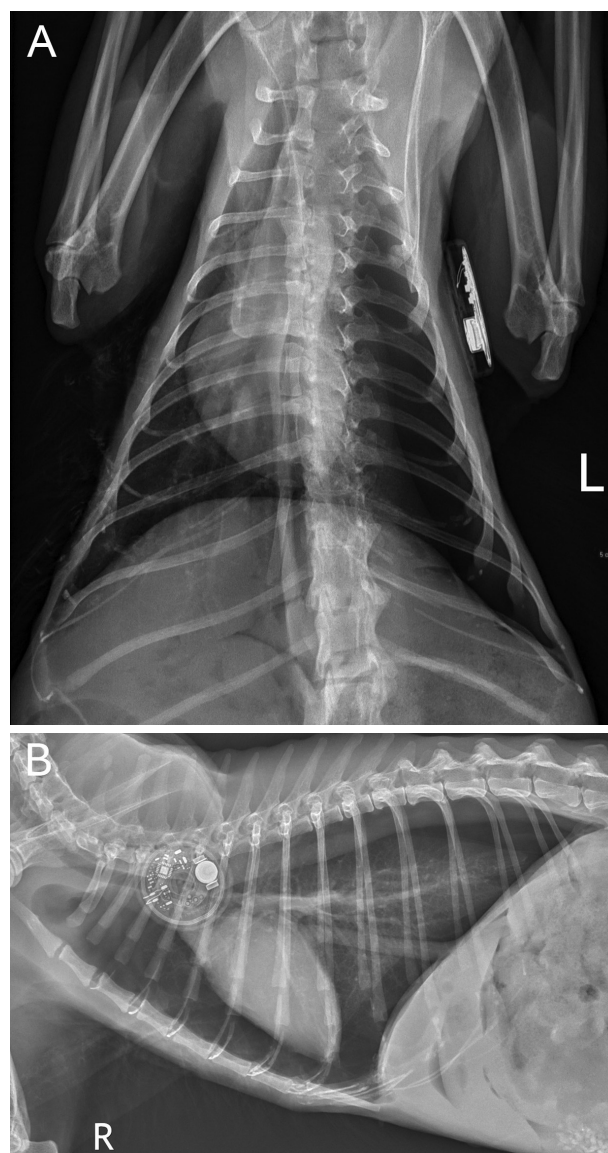


Figure 1—Ventrodorsal (A) and right lateral (B) thoracic radiographs of a geriatric cat that became acutely dyspneic following a routine, minimally invasive procedure to place a continuous glucose monitor.

Diagnostic Imaging Findings and Interpretation

Radiologic findings included moderate bilateral pneumothorax characterized by retraction of atel-

ectatic lungs from the body wall, dorsal elevation of the cardiac silhouette from the ventral parietal pleura (**Figure 2**), and increased radiolucency of the peripheral thorax, with absence of regional pulmonary vasculature. The distribution of pleural gas was bilateral

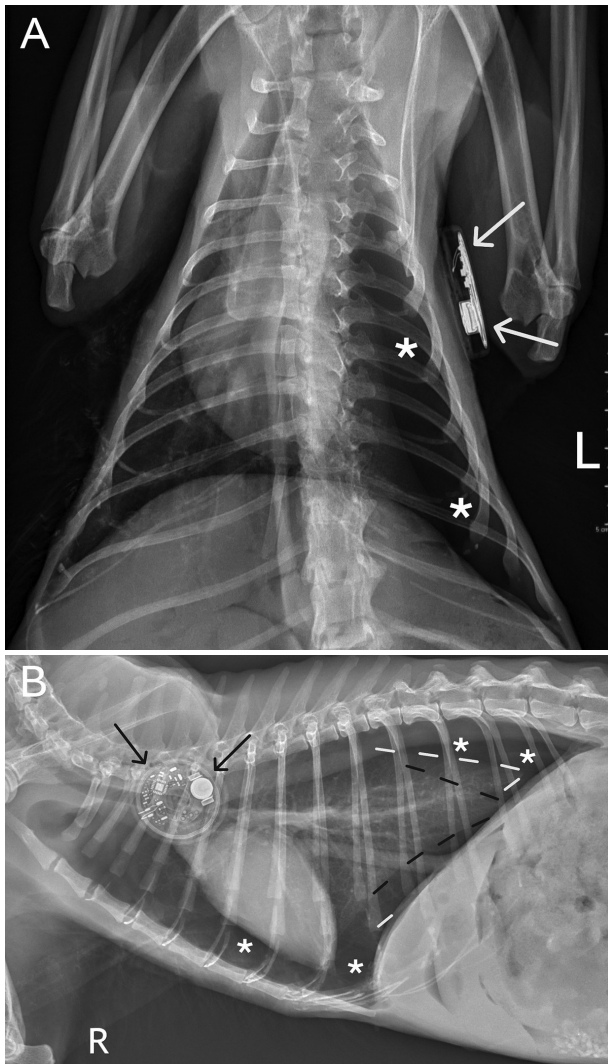


Figure 2—Ventrodorsal (A) and right lateral (B) radiographs of a dyspneic cat demonstrating an asymmetric but bilateral moderate pneumothorax that is worse on the left side. The ventrodorsal view is moderately rotated, characterized by rightward shifting of the sternbrae and leftward pointing of the spinous processes, leading to the false impression of rightward mediastinal shift (A). The pneumothorax is evidenced by dorsal elevation of the cardiac silhouette from the sternum (B), hyperlucent regions along the periphery of the thoracic cavity that are void of pulmonary markings (A and B; asterisks), and retraction of partially atelectatic right and left lungs from the parietal pleura with sharply demarcated caudodorsal margins (B; white and black dashed lines highlight the margins of different retracted lung lobes). A sizeable continuous glucose monitoring apparatus is fixated to the dermis along the left dorsal aspect of the cranial thoracic cavity (A and B; arrows). There is incidental nonspecific hepatomegaly as well as normal postoperative findings including mild pneumoperitoneum and reduced peritoneal serosal detail suggestive of steatitis and effusion.

but asymmetric, with a larger volume in the left thoracic cavity, adjacent to the CGM apparatus. The ventrodorsal radiograph was rotated, characterized by malalignment of the thoracic spinous processes with the sternum, contributing to the false impression of rightward mediastinal shift and making the right-sided pneumothorax a challenge to identify on this view.

Additional radiographic findings included patient underconditioning and postoperative changes such as a pneumoperitoneum/pneumoretroperitoneum and reduced peritoneal serosal detail. Other findings included mild nonspecific hepatomegaly and a moderately distended stomach that contained gas, fluid, and granular mineral-opaque material.

Because of the association between the acute dyspnea and application of the CGM coupled with the left-sided predominance of free pleural gas, the bilateral pneumothorax was thought to be iatrogenic secondary to penetration of the thoracic cavity by the CGM needle.

Treatment and Outcome

A thoracocentesis using a 21-gauge butterfly needle inserted into the left eighth intercostal space was performed with the patient in sternal recumbency, 140 mL of air was aspirated from the pleural space, and the CGM was removed. The cat became eupneic shortly after intervention. After an additional 2 days in hospital, the cat was adopted and had no recurrent respiratory signs.

Comments

Pneumothorax, or accumulation of air in the pleural space,^{1,2} can be life-threatening, as it impairs ventilation, oxygenation, and lung compliance, causing a restrictive breathing pattern with rapid shallow breaths and paradoxical abdominal effort.¹ Pneumothorax can be either spontaneous (eg, idiopathic or from conditions such as lower airway disease) or traumatically induced (eg, puncture wounds or iatrogenic thoracic wall penetration),^{2,3} as seen in this case.⁴

Computed tomography, ultrasonography, and radiography have demonstrated efficacy in diagnosing pneumothorax.¹ Computed tomography is considered the gold standard for detecting free pleural gas and is the most sensitive diagnostic at determining the inciting cause, documenting almost 2.5 times more causative lesions than radiographs alone.³ However, compared to other modalities, CT is less available, is expensive, and necessitates sedation. Ultrasound is practical and useful in diagnosing pneumothorax through the detection of an abnormal “curtain sign” and lack of a “glide sign”; however, as the diagnostic utility is highly dependent on the user, it is rarely used as a sole modality. Considering these variables, and because thoracic radiographs are a widely available, affordable, and accurate tool for the detection of pneumothorax, they remain the most common modality implemented.³

Out of the standard radiographic projections, lateral views acquired during expiration are considered the most useful for detecting pneumothorax, although they reduce visualization of pulmonary

parenchymal detail. The left lateral view is the most effective at detecting small-volume pneumothorax, while the right lateral view is more sensitive at determining differences in the volume of free pleural air present.² If the clinic has a mobile radiographic unit, an expiratory horizontal beam ventrodorsal radiograph obtained with the patient in right lateral recumbency has proven to be the most sensitive view.²

Radiographic evidence of pneumothorax depends on the volume of pleural gas present. If scant air is present, the only sign may be either a thin curvilinear radiolucency between the thoracic wall/diaphragm and lungs or a collection of air contouring to the cardiac apex.^{1,2} As the volume of gas increases, the radiographs demonstrate dorsal displacement of the cardiac silhouette from the sternum, radiolucency without pulmonary markings around the periphery of the thoracic cavity, and retraction of the lungs, with an overall increase in pulmonary opacity due to atelectasis.² Though in this case it was a challenge to determine the unilateral or bilateral nature of the pneumothorax on the ventrodorsal view alone, there was evidence on the lateral view to suggest bilateral involvement, including discrete margins of the individually retracted right and left caudal lung fields with adjacent thoracic radiolucency void of pulmonary markings.

In this case, the ventrodorsal view was moderately rotated. This obliquity, which is a common issue encountered with poorly compliant or dyspneic patients, can lead to the false interpretation of mediastinal shift. Specifically in this case, the rotation created the false impression of rightward mediastinal shift away from the side containing more pleural air, which may lead to an erroneous diagnosis of tension pneumothorax. However, other findings in this case that refuted the possibility of a tension pneumothorax included a lack of diaphragmatic tenting and only moderate, not severe, pulmonary atelectasis.

Again, this asymmetrically distributed bilateral pneumothorax was thought to be iatrogenic owing to penetration of the thoracic cavity by the CGM needle. Though the application apparatus uses a short needle (5.5 to 6.7 mm), feline skin has been reported to be only 0.4 to 2 mm in thickness,³ which in cachexic or emaciated patients may increase the possibility of accidental thoracic penetration.^{4,5} In fact, in addition to this case, there have been other recent reports of iatrogenic pneumothorax occurring from thoracic CGM placement in an emaciated dog⁴ and an underconditioned cat.⁵ Similarly to this case, the pleural gas in these other reports^{4,5} was also distributed either entirely or primarily on the side nearest the CGM; thus, the finding of either a unilateral or asymmetric pneumothorax in a patient that underwent a recent CGM application is a sign that may suggest an iatrogenic cause.

Prior to these reports, the majority of side effects related to CGM application in cats were minor, with accidental detachment and mild dermatological reactions being the most common.^{4,5} Given that the more common complications are mild, coupled with how CGMs are of great clinical value by allowing for accurate measurements of interstitial glucose while reducing patient stress, CGMs continue to grow in popularity among veterinarians managing diabetes mellitus.³⁻⁵ It is plausible that, as CGM usage rises, iatrogenic pneumothorax during placement will

become a more frequently documented side effect in the emaciated population; thus, awareness of this possibility is crucial for patient safety.^{4,5}

Although there are no documented guidelines for sensor placement,⁴ to avoid possible iatrogenic pneumothorax in emaciated or cachexic patients, it may be prudent to either apply the sensor to the dorsal neck⁴ or forego application of CGM sensors altogether in this population. If the dorsal neck location is not an option in a thin patient and the CGM is considered an essential part of management, a preprocedural sonographic assessment to determine the soft tissue thickness on the dorsolateral thorax has been suggested.⁴

Overall, this case represents a presumably uncommon but serious iatrogenic complication following thoracic application of a CGM sensor in an emaciated cat. As reports of this complication in underconditioned small animal patients increase, it is recommended that veterinarians warn owners of this potentially life-threatening side effect prior to the application process and use their best judgment when determining the application location.⁴

Keywords: diabetes, pneumothorax, complication, continuous glucose monitor, emaciated

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