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What Is Your Diagnosis?

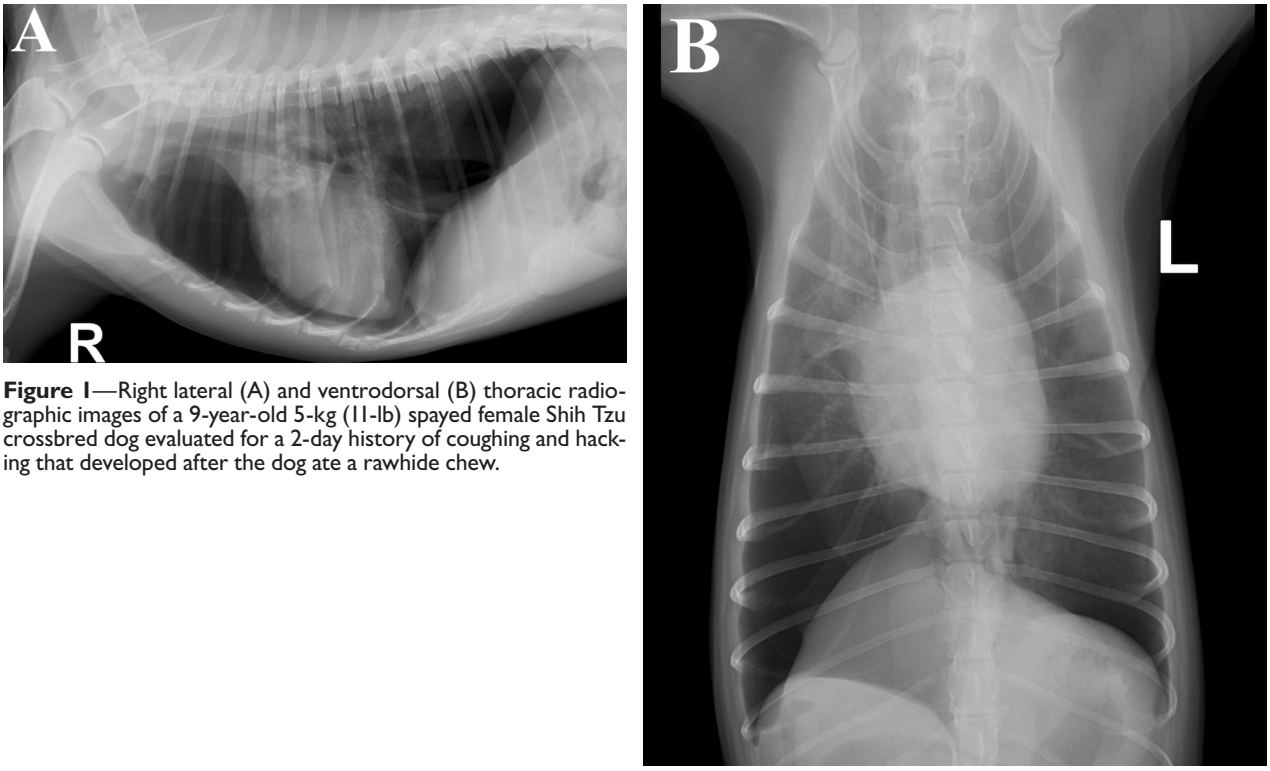

Figure 1—Right lateral (A) and ventrodorsal (B) thoracic radiographic images of a 9-year-old 5-kg (11-lb) spayed female Shih Tzu crossbred dog evaluated for a 2-day history of coughing and hacking that developed after the dog ate a rawhide chew.

History

A 9-year-old 5-kg (11-lb) spayed female Shih Tzu crossbred dog was evaluated for a 2-day history of coughing and hacking that developed after the dog ate a rawhide chew. The owners reported that the dog's coughing seemed to occur after excitement and was progressive. The dog had no known history of trauma or being around other dogs.

On physical examination, the dog was alert and responsive, had a body condition score of 5 (on a scale of 1 to 9), and had a grade 2/6 heart murmur. The dog was tachypneic (56 breaths/min; reference range, 10 to 35 breaths/min), with increased respiratory effort. Because of the dog's aggressive temperament, auscultation of its lungs was difficult, but revealed no obvious abnormalities. All other vital signs were within reference limits.

Abnormalities identified on serum biochemical analyses were high activities of aspartate aminotransferase (77 U/L; reference range, 14 to 49 U/L), alanine aminotransferase (76 U/L; reference range, 22 to 74 U/L), and creatine kinase (393 U/L; reference range, 43 to 261 U/L). Results of a CBC were unremarkable. Thoracic radiography was performed **(Figure 1)**.

Formulate differential diagnoses and treatment strategies from the history, clinical findings, and Figure 1—then turn the page →

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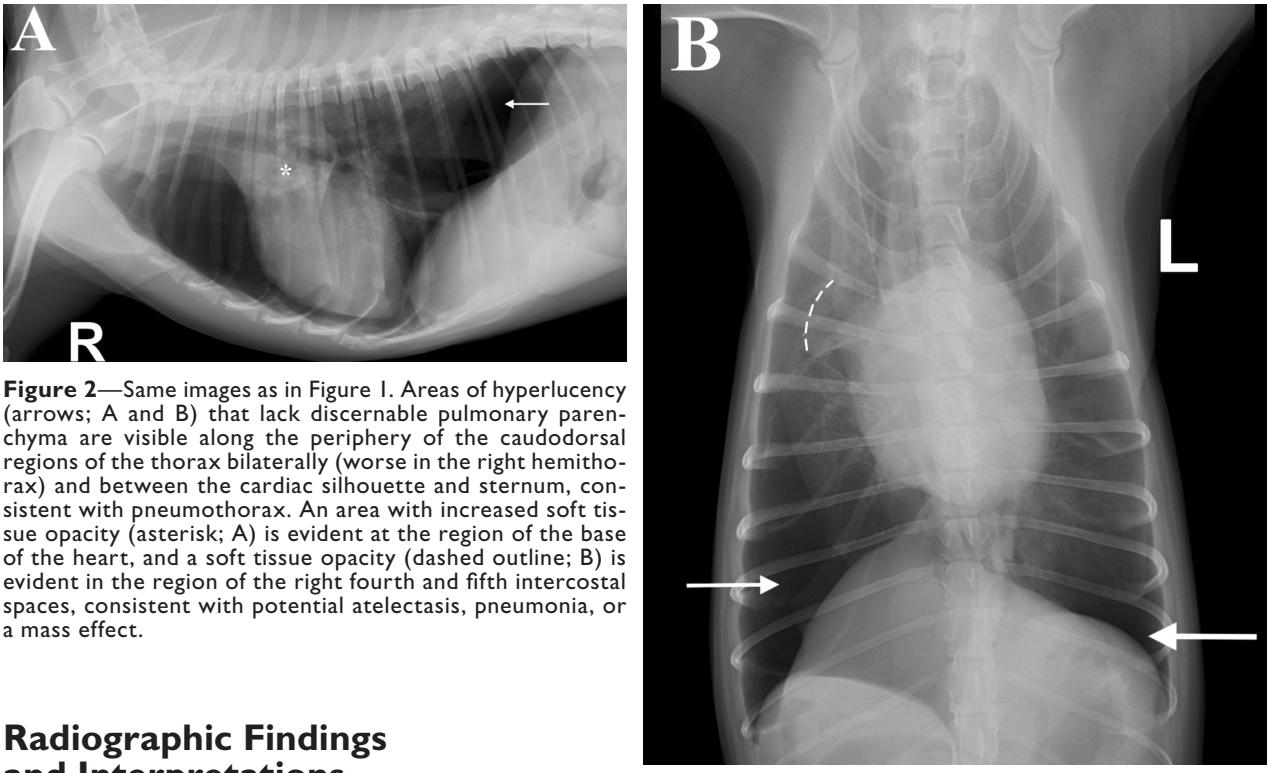

Figure 2—Same images as in Figure 1. Areas of hyperlucency (arrows; A and B) that lack discernable pulmonary parenchyma are visible along the periphery of the caudodorsal regions of the thorax bilaterally (worse in the right hemithorax) and between the cardiac silhouette and sternum, consistent with pneumothorax. An area with increased soft tissue opacity (asterisk; A) is evident at the region of the base of the heart, and a soft tissue opacity (dashed outline; B) is evident in the region of the right fourth and fifth intercostal spaces, consistent with potential atelectasis, pneumonia, or a mass effect.

Radiographic Findings and Interpretations

Thoracic radiography revealed hyperlucent areas lacking visible pulmonary parenchyma and vasculature along the periphery of the caudodorsal regions of the thorax bilaterally (worse in the right hemithorax) and between the cardiac silhouette and sternum **(Figure 2)**. An increase in soft tissue opacity was evident at the region of the base of the heart, with a triangular soft tissue opacity superimposed just ventral to the tracheal bifurcation on the right lateral radiographic image. On the ventrodorsal view, a subtle, curved soft tissue opacity was evident in the region of the right fourth and fifth intercostal spaces, consistent with potential atelectasis, pneumonia, or a mass effect.

On the basis of radiographic findings, the primary differential diagnosis was spontaneous pneumothorax, which is usually caused by a ruptured bulla or bleb.[1] Thoracocentesis was performed on the right side of the thorax, and 300 mL of air was removed. Thoracic radiography was repeated the following day and revealed moderately improved pneumothorax with a small pocket of air in the caudal aspect of the right hemithorax. Because of the improvement, the dog was discharged for observation at home; however, the dog was returned the next day because of dyspnea and tachypnea. A thoracic focused assessment with sonography for trauma (TFAST; not shown) revealed the absence of glide sign (ultrasonographic visualization of lung margins gliding along the thoracic wall during respiration) in the left hemithorax, indicating pneumothorax.[2] Left-sided thoracocentesis was performed, and approximately 250 mL of air was removed.

Thoracic radiography was repeated and revealed that the caudal lobar region in the right hemithorax remained hyperlucent and hypovascular **(Figure 3)**. However, the retracted lobar pulmonary margins appeared to be more visible, and there appeared to be pulmonary parenchyma and vasculature extending to the periphery of the dorsocaudal aspect of the right hemithorax. Thus, the pneumothorax was considered nearly resolved. In addition, there was a leftward shift of the heart, and an abnormal curvilinear soft tissue opacity superimposed on the caudal vena cava was more notable (compared with the appearance on initial radiographic images) in the caudal aspect of the thorax. Differential diagnoses included a large pulmonary bulla or pleural thickening.

The dog underwent general anesthesia for placement of bilateral indwelling thoracostomy tubes and thoracic CT. Through the thoracostomy tubes, 130 mL of air was evacuated from the right hemithorax and 96 mL from the left prior to CT. The dog was positioned in sternal recumbency, and thoracic CT was performed with a 16-slice CT scanner, with volume image data acquired before and after IV injection of iodinated contrast medium (iohexol [350 mg of iodine/mL solution], 600 mg of iodine/kg [273 mg/lb]). On postcontrast CT, there was a large, gas-filled structure with a few internal soft tissue septations in the caudodorsal aspect of the right hemithorax **(Figure 4)**. The right middle lobar bronchus was identified entering this structure, with the proximal aspect of the bronchus truncated and coursing in an abnormal caudodorsal direction. The remaining aerated lungs appeared clinically normal. There was minimal free gas identified in the pleural space bilaterally, and no pleural effusion was detected. There was a moderate amount of gas in

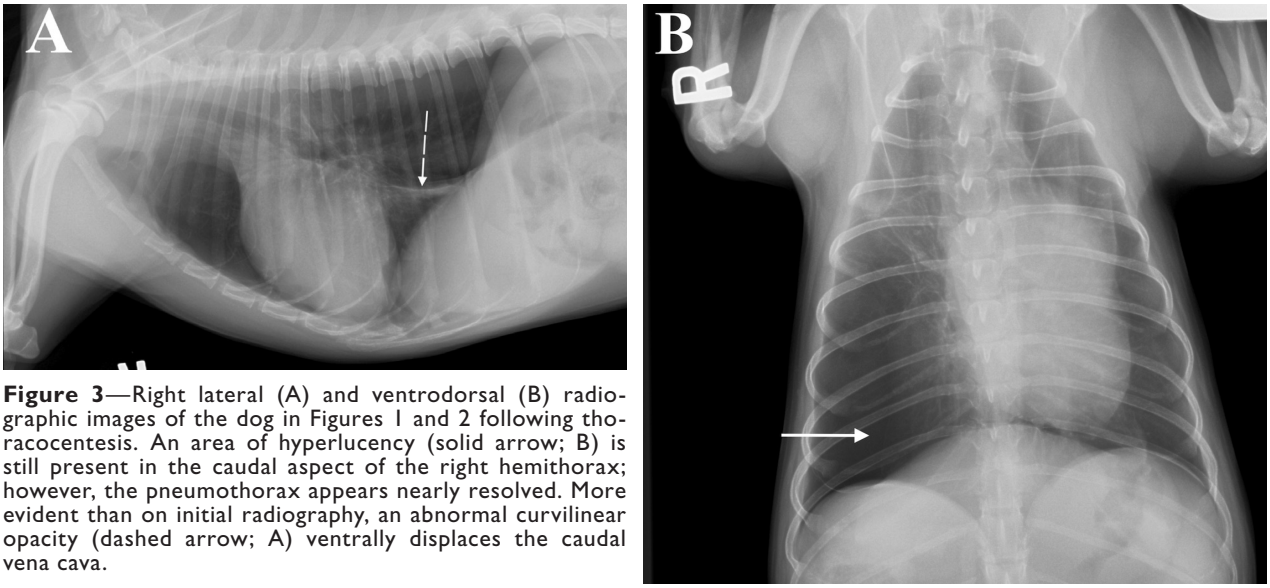

Figure 3—Right lateral (A) and ventrodorsal (B) radiographic images of the dog in Figures 1 and 2 following thoracocentesis. An area of hyperlucency (solid arrow; B) is still present in the caudal aspect of the right hemithorax; however, the pneumothorax appears nearly resolved. More evident than on initial radiography, an abnormal curvilinear opacity (dashed arrow; A) ventrally displaces the caudal vena cava.

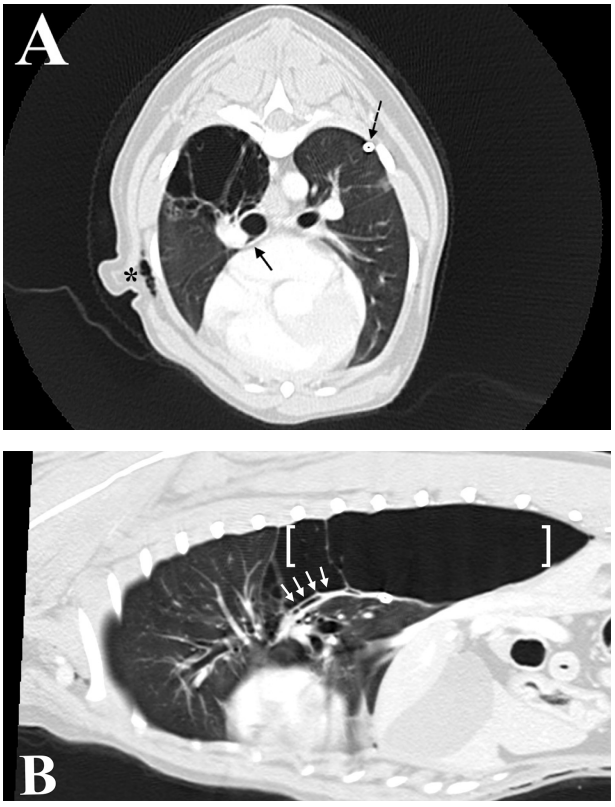

Figure 4—Transverse (A) and sagittal (B) postcontrast CT images at the level of the right middle lobar bronchus in the thorax of the dog in the previous figures. The right middle lobar bronchus (solid arrows; A and B) abruptly terminates as it courses in an abnormal caudodorsal direction; on the sagittal view, it courses through an air-filled structure (brackets; B) in a caudodorsal orientation, consistent with a malpositioned and markedly abnormal right middle lung lobe. In the soft tissue of the right side of the thoracic wall, a moderate amount of gas (asterisk; A) is evident, consistent with the indwelling thoracostomy tube on that side. The indwelling thoracostomy tube on the left side (dashed arrow; A) is also evident.

the soft tissue of the thoracic wall, spanning from the fifth to ninth intercostal spaces on the right and from the sixth to ninth intercostal spaces on the left, consistent with bilateral indwelling thoracostomy tubes. The most likely differential diagnoses for the pulmonary abnormalities were chronic torsion of the right middle lung lobe and severe bullous emphysema. Exploratory thoracotomy was recommended.

Treatment and Outcome

A right lateral thoracotomy with a fifth intercostal space approach was performed. The right middle lung lobe was malpositioned dorsal to the right caudal lung lobe and twisted 180° about the hilus. The right middle lung lobe appeared to have coalesced into a large bleb that was 8 X 4 X 1 cm, with little remaining parenchyma present. A right middle lung lobectomy was performed, and the bilateral indwelling thoracostomy tubes were replaced. Histologic examination of the removed lung lobe revealed marked chronic emphysema with fibrosis, presumably attributable to chronic lung lobe torsion (LLT). However, congenital lobar overinflation with secondary torsion could not be ruled out entirely. The dog recovered and was discharged 2 days after the surgery.

One month after surgery, the dog was returned for unrelated reasons. During the examination at that point, auscultation of the dog's lungs revealed clinically normal bronchovesicular sounds and no crackles, wheezes, or dyspnea. The owner reported that none of the previous respiratory signs had recurred during the time since surgery.

Comments

Lung lobe torsion is characterized by the rotation of a lung lobe along its long axis at the hilus, causing compression and constriction of the bronchus

and vascular supply.[3–8] Lung lobe torsion can occur either spontaneously or secondary to predisposing factors (eg, disease, trauma, or surgery[5,7]), which are thought to increase mobility of a particular lung lobe leading to torsion.[3] The right middle and left cranial lung lobes are more commonly affected.[3,5,6] Breeds that have a large, deep-chested conformation have previously been reported[5,6] to have greater risk of spontaneous LLT, compared with that in small-breed dogs. It has been suggested that LLT in small-breed dogs is usually a secondary condition.[5,6] In addition, Pugs may have a higher incidence than other small-breed dogs.[5] Clinical signs of LLT include respiratory distress, dyspnea, coughing, and, in some cases, anorexia, vomiting, and diarrhea.[6]

In our experience, radiography and CT are the most common imaging techniques used in diagnosing LLT. The diagnosis is made by visualizing an abruptly terminating and frequently malpositioned bronchus in conjunction with radiographic findings suggestive of secondary changes (eg, pleural effusion or lobar alveolar opacification[4,5,8]). A vesicular gas pattern in the affected lung lobe may be more characteristic of, but not pathognomonic for, LLT. Compared with radiography, CT has greater sensitivity in detecting LLT because CT allows for more thorough visualization of pulmonary structures, including in the presence of concurrent conditions (eg, pulmonary or intrathoracic masses or fluid) that may obscure the radiographic differences in density between bronchial air and lung parenchyma.[4] The primary advantage of CT is the ability to visualize the precise location of a lobar bronchus without superimposition of surrounding structures, which is unavoidable with radiography. Findings on CT for LLT may include pleural effusion, an abruptly terminating bronchus, emphysema of the affected lung, and absent contrast enhancement in the rotated lung lobe.[4] Although necrotic, cystic, and thromboembolic tissues lack contrast enhancement, usually only parts of the lung lobe are affected in those conditions.[4] Presence of contrast enhancement does not completely rule out LLT, such as with early stages of LLT or partial torsion in which arterial blood supply is still preserved.[4] Vesicular emphysema and a proximally occluded bronchus are more easily recognized with CT and virtual bronchoscopy than with radiography.[8] Nonetheless, even with CT, diagnosing LLT can be challenging if there is a 360° torsion. A definitive diagnosis of LLT can only be made with direct visual inspection during thoracotomy, thoracoscopy, or necropsy.[5] Surgical treatment with thoracotomy is required and provides good visualization of the affected lobe, which facilitates removal of the lobe.[3]

In the dog of the present report, findings on initial radiography were considered attributable to spontaneous pneumothorax, which is commonly caused by bullous emphysema. However, repeated radiography revealed a possible structural abnormality, believed to have been a large bulla or thickened pleura, in the caudal aspect of the right hemithorax. With use of CT, we gained precise visualization of the right middle lung lobe as well as the unexpected LLT and bullous emphysema that were subsequently confirmed during thoracotomy. Findings of concurrent severe bullous emphysema and LLT are unusual, and it was unclear whether emphysema was a cause or sequela of LLT in the dog of the present report.

Acknowledgments

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