

Compendium

Lung Lobe Torsion

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Abstract: Lung lobe torsion is a rare pulmonary disorder in small animals and in humans. Torsion occurs when the lung lobe rotates around the bronchus and vascular supply and remains in that position. Lung lobe torsion is a life-threatening condition. The patient may present in an acute, fulminant respiratory crisis; however, more subtle clinical signs have also been reported. Lung lobe torsion may be secondary to an underlying pathology or spontaneous and idiopathic. Surgical resection of the affected lung lobe is the treatment of choice. The prognosis depends on the underlying cause. This article reviews the incidence, pathophysiology, clinical signs, diagnostic approach, and treatment of lung lobe torsion in dogs and cats.

Lung lobe torsion is a rare, life-threatening pulmonary disorder in small animals¹⁻⁴ and in humans.⁵⁻⁷ It occurs when the lung lobe rotates around the bronchus and vascular supply and remains in that position.² A predisposition to lung lobe torsion has been reported in large, deep-chested dogs.^{1,2,8} The Afghan hound is overrepresented and reported to be 133 times more likely to develop lung lobe torsion than other breeds.¹ Lung lobe torsion has been documented in a case series of pugs, as well as in Yorkshire terriers, miniature poodles, beagles, and mixed-breed dogs.^{6,9-11}

Lung lobe torsion has been reported in cats, although the prevalence is much lower in cats than in dogs.^{2,12} Lung lobe torsion was documented in a 10-month-old Himalayan cat with peritoneopericardial diaphragmatic hernia and chylothorax,¹² as well as in a cat with chronic feline asthma.^{8,13}

Spontaneous lung lobe torsion has been described in animals in which no predisposing factors could be identified.^{1,2,6,10,14,15} A spontaneous torsion of the right middle lung lobe was recently reported in a domestic shorthaired cat.¹⁶

Pathophysiology

The most commonly affected lung lobes are the right middle and left cranial lobes, but torsion has been reported in all lung lobes.^{1,17,18} Mechanisms that have been proposed to increase the likelihood of a lung lobe torsion involve conditions that lead to increased mobility of a particular lung lobe.⁷ The long, narrow shape of the right middle lung lobe is thought to increase its mobility and predispose it to torsion.^{1,17,19,20} Pneumothorax, pleural effusion, previous thoracic surgery, thoracic trauma, and pathologic changes of the affected lobe(s) all increase the probability of lung lobe torsion by changing the spatial relationships among the lobes in the thorax.^{6,21,22}

Bronchial cartilage dysplasia was identified in a chow chow puppy with lobar emphysema and lung lobe torsion²³ and in a 7-week-old pug puppy with lung lobe torsion.^{23,24} It has been hypothesized that bronchial cartilage dysplasia may increase the mobility of individual lung lobes, possibly predisposing affected animals to lung lobe torsion.^{23,24}

Usually, the affected lobe twists at the vascular pedicle, causing occlusion of the airway and thin-walled veins while arterial inflow of blood continues, leading to engorgement of the lobe and filling of the alveoli with blood.^{2,21} Cases in which the torsion occurs in the middle of the lung lobe (i.e., midlobar) have also been reported.¹⁵ Pleural effusion, if not previously present, may develop due to seepage of fluid through the lobar pleura into the pleural cavity.^{2,21}

Over time, the torted lung lobe becomes atelectic.¹ Mechanisms for the atelectasis include compression of the lobe secondary to pleural effusion, accumulation of fluid and inflammatory infiltrates in the airway from vascular congestion, and progressive resorption of alveolar gases (resorption atelectasis).²⁵ Atelectasis results in a lower tidal volume and a compensatory increase in respiratory rate as the animal attempts to maintain an adequate minute ventilation.²⁶

Hypoxemia (i.e., decreased arterial oxygen content) may develop subsequent to lung lobe torsion.²⁵ In general, causes of hypoxemia include ventilation/perfusion mismatch, intrapulmonary shunting, alveolar hypoventilation, diffusion impairment, low mixed venous oxygen saturation, and low inspired oxygen tension.²⁶ Hypoxemia secondary to lung lobe torsion may be due to ventilation/perfusion mismatch, intrapulmonary shunting, and alveolar hypoventilation. Alveolar hypoventilation may result from decreased

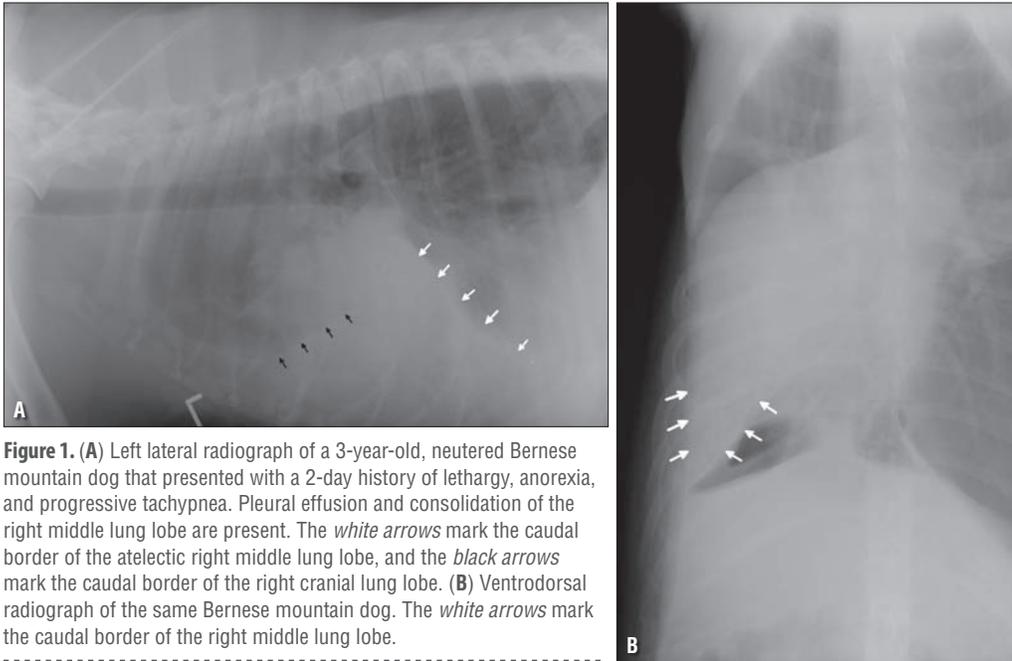


Figure 1. (A) Left lateral radiograph of a 3-year-old, neutered Bernese mountain dog that presented with a 2-day history of lethargy, anorexia, and progressive tachypnea. Pleural effusion and consolidation of the right middle lung lobe are present. The *white arrows* mark the caudal border of the atelectic right middle lung lobe, and the *black arrows* mark the caudal border of the right cranial lung lobe. (B) Ventrodorsal radiograph of the same Bernese mountain dog. The *white arrows* mark the caudal border of the right middle lung lobe.

air movement through an airway that is partially occluded by a twisted bronchus; alternatively, airway secretions may occlude air flow to a torsed lung lobe that remains perfused. Intrapulmonary shunting is likely to occur if the lobar veins are only partly occluded, allowing some venous return from an unventilated lung. Dead space ventilation, an extreme form of ventilation/perfusion mismatch, develops if venous return from a torsed lung lobe is zero but obstruction of the bronchus is incomplete.²⁶

Clinical Signs and Diagnostic Approach

Historical findings are often nonspecific but may be helpful in establishing the diagnosis. Recent trauma, thoracic surgery, or other current or previous thoracic disease(s) should raise suspicion that lung lobe torsion may be present. The clinical signs and physical findings vary but are usually related to the respiratory system.^{1-4,6,8-10,11,14,15,17-21,24}

Clinical signs may include acute or chronic coughing, hemoptysis, dyspnea, and epistaxis.^{1,16} Systemic signs are typically nonspecific and may include anorexia, lethargy, and fever.^{1-3,10,11,17} Gastrointestinal signs such as vomiting and diarrhea may occur.¹⁻³ Polyuria and polydipsia have been reported in an affected Afghan hound.¹⁷ Physical examination findings may include dyspnea, dull heart and lung sounds ventrally (pleural effusion), dull lung sounds dorsally (pneumothorax), weakness, signs of shock, and cyanosis.

A diagnosis of lung lobe torsion cannot be made based on history and physical examination findings alone. Results of routine laboratory tests such as a complete blood cell count and serum chemistry profile may be normal or show unspecific changes such as a neutrophilic leukocytosis (with or without a left shift), mild anemia, hypoproteinemia, hyperbilirubinemia, and an elevated serum creatinine level.^{1,2,8,10,11,24}

Radiographic evaluation of the thorax is considered the most important diagnostic test in the confirmation of lung lobe torsion (**FIGURE 1**).²⁴ Pleural effusion is generally present.^{1,2} If pleural effusion is present, thoracocentesis and drainage of the effusion should be performed. Radiography should then be repeated to evaluate for the presence of lung lobe consolidation. Air bronchograms may be seen on radiographs in acute torsions, but this air slowly dissipates as the airways fill with infiltrate (edema fluid and blood).^{1,3,6,20} The hallmark for the diagnosis of lung lobe torsion is abnormal bronchial alignment indicating malposition of the affected lobe within the chest.^{3,4,6} Mediastinal shift, pneumothorax,

and pneumomediastinum have also been reported.¹⁷ Other conditions that may lead to similar changes on chest radiographs include pulmonary thromboembolism, pulmonary contusions, neoplasia, pneumonia, pleural hemorrhage, coagulopathy, diaphragmatic hernia, pyothorax, and pulmonary abscesses.¹⁸

Thoracic ultrasonography is a useful adjunctive tool for the diagnosis of lung lobe torsion (**FIGURE 2**).^{1,13,18} Ultrasonography may allow the diagnosis to be established in the absence of conclusive radiographic signs.^{13,18} A torsed lung lobe may appear hypoechoic, rounded, and surrounded by pleural effusion.^{13,18}

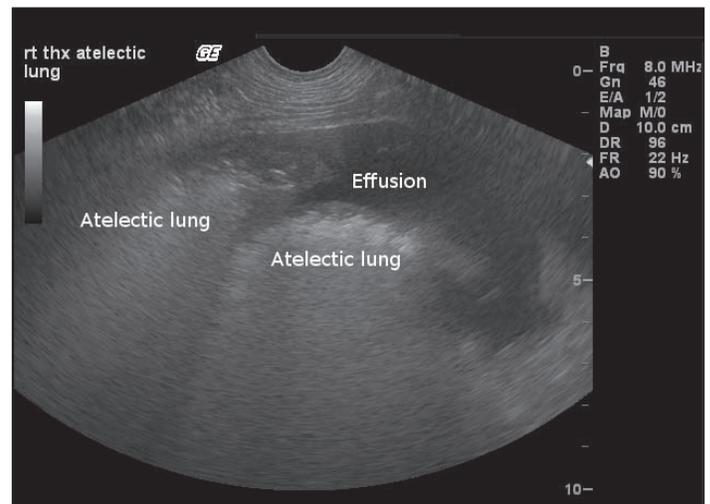


Figure 2. Ultrasonographic image of the right thorax of the dog in Figure 1. A large amount of pleural effusion and an atelectic lung lobe were visualized. The dog underwent a median sternotomy that revealed torsion of the right middle and caudal aspect of the left cranial lung lobes. Lobectomy of the affected lung lobes was performed. The dog recovered fully.

As the pulmonary parenchyma becomes consolidated, the torsed lung lobe may resemble normal liver tissue on ultrasonography, with the fluid-filled bronchi resembling hepatic vessels. This has been referred to as *hepatization* of the torsed lung lobe.²⁷ Evaluation of the vascular supply to the lobe with color or power Doppler imaging may be useful.¹⁸

Positive-contrast bronchography or bronchoscopy may allow visualization of bronchial occlusion within a torsed lung lobe.^{2,6,28} Viscous propylidone is generally used for bronchography and is designed to not be dispersed and eliminated quickly.²⁹ Positive-contrast bronchography has fallen out of favor due to safety concerns and has generally been supplanted by bronchoscopy. Computed tomography (with or without angiography) and magnetic resonance imaging may be helpful.^{13,24} Use of these ancillary modalities may be limited due to the need for anesthesia, which could be detrimental in patients with respiratory compromise, and lack of availability.

Fluid analysis of the pleural effusion may reveal sterile inflammation, blood, or chyle. A chylous or inflammatory effusion may be the underlying cause of the lung lobe torsion.¹⁷ However, chylothorax has also been reported secondary to lung lobe torsion.¹⁷ Therefore, the nature of the effusion is unreliable in helping determine the etiology of a lung lobe torsion.

Treatment

The need for emergency management and stabilization is dictated by the clinical presentation of the patient. Oxygen therapy is indicated in animals that present with respiratory compromise.²¹ An intravenous (IV) catheter should be placed and IV fluid therapy initiated in patients with signs of circulatory shock.²¹ Thoracocentesis to remove pleural effusion or relieve pneumothorax may be indicated.²¹ Pain medications should be administered to traumatized patients. Systemic opioids and local anesthesia (e.g., for rib fractures) individually or in combination are effective choices. In patients that present in severe respiratory distress unresponsive to oxygen therapy, rapid induction of anesthesia and intubation may be required for initial stabilization.

Surgical resection of the affected lung lobe is the treatment of choice in small animals.² Although performed in people, derotation of the affected lung lobe is generally discouraged in small animals due to the potential for ischemia-reperfusion injury.^{6,30} In addition, lung lobe torsion leads to damage of the pulmonary parenchyma of the affected lobe, which is usually too advanced at the time of presentation for the lobe to be saved.^{10,22}

Dogs and cats may tolerate removal of up to 50% of their lung mass.²² Because the right lung possesses slightly greater than 50% of the total lung mass, complete right pneumonectomy is not recommended. Complete left pneumonectomy may be performed if the right lung is healthy. A lung lobectomy is performed via a standard intercostal approach from the affected side or a median sternotomy.²² A median sternotomy allows better visualization and facilitates assessment of both sides of the thorax.²²

After the affected lobe is identified and isolated, the lobar pedicle should be clamped with noncrushing forceps before derotation to prevent the release of reactive oxygen species into

the bloodstream.³¹ The lobar artery should be triple ligated and divided first, followed by the vein.²² The pulmonary arteries are typically cranial and dorsal to the bronchi, whereas the veins are caudoventral.²² The bronchus is then clamped, divided, closed, and oversewn.²² The closure should be checked with saline solution to ensure that there are no leaks. Stapling devices are available that allow more rapid clamping and division of the bronchus,²² affording convenience, speed, and possibly superior closure compared with manual closure.³²

Intraoperative placement of a thoracostomy tube is advised to allow for removal of air and fluid during the postoperative period. Also, local analgesics can be administered via a thoracostomy tube, which may decrease the need for systemic analgesia. Additional therapies, including antibiotics, oxygen, and IV fluids, are usually indicated during recovery from surgery. The patient should be monitored postoperatively for the development of pneumothorax, hemothorax, and torsion of another lung lobe. The thoracostomy tube is usually removed after air accumulation has stopped for a 24-hour period and fluid production is minimal (≤ 2 mL/kg/d).²² Thoracic radiography should be repeated before the thoracostomy tube is removed.

Animals in which lung lobe torsion is idiopathic or secondary to thoracic trauma generally have a fair to guarded prognosis.¹ The long-term prognosis for patients with lung lobe torsion associated with chylothorax is poor.¹ In patients with an identifiable underlying cause (e.g., pulmonary neoplasia), the prognosis depends on the underlying condition.²

Conclusion

Lung lobe torsion in dogs and cats is an uncommon disorder. Lung lobe torsions pose a diagnostic challenge in that the clinical signs, physical findings, and laboratory abnormalities are nonspecific. Surgical resection of the affected lung lobe is the treatment of choice; successful medical therapy has not been reported.

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1. What breed of dog is most commonly affected by lung lobe torsion?

- a. Afghan hound
- b. German shepherd
- c. pug
- d. beagle

2. Torsion is most commonly reported to affect the _____ lung lobes.

- a. left caudal and right caudal
- b. left cranial and right cranial
- c. left cranial and right middle
- d. left caudal and right cranial

3. Which of the following is not thought to be a predisposing factor to the development of lung lobe torsion?

- a. recent thoracic surgery
- b. recent abdominal surgery
- c. pneumothorax
- d. pleural effusion

4. _____ is not a cause of hypoxemia.

- a. Ventilation/perfusion mismatch
- b. Low inspired oxygen concentration
- c. Diffusion impairment
- d. Hyperventilation

5. _____ is not a common finding on plain thoracic radiographs of an animal with a lung lobe torsion.

- a. Pleural effusion
- b. Cardiomegaly
- c. Pulmonary infiltrate
- d. Air bronchogram

6. Ultrasonographically, a torsed lung lobe may appear

- a. hyperechoic, rounded, and surrounded by air.
- b. hypoechoic, rounded, and surrounded by pleural effusion.
- c. hypoechoic, tapered, and surrounded by pleural effusion.
- d. hyperechoic, tapered, and surrounded by air.

7. Emergency intervention for a dyspneic patient with a lung lobe torsion does not include

- a. oxygen therapy.
- b. analgesia.
- c. urinary catheterization.
- d. shock IV fluid therapy.

8. Dogs and cats can tolerate removal of up to _____ of their total lung mass.

- a. 15%
- b. 25%
- c. 40%
- d. 50%

9. One advantage of a median sternotomy compared with an intercostal approach to the thorax may be

- a. better visualization of both sides of the thoracic cavity.
- b. faster recovery.
- c. a smaller incision.
- d. simpler anesthetic management.

10. Which statement regarding treatment and prognosis of lung lobe torsion is false?

- a. Prognosis depends on the underlying etiology, if one can be determined.
- b. Medical treatment with oxygen, IV fluids, and rolling the patient to derotate the affected lobe is the preferred treatment strategy.
- c. Surgical treatment with a thoracotomy is always indicated for definitive therapy.
- d. Thoracocentesis is a therapeutic procedure, and analysis of the pleural effusion may be helpful in the diagnosis.