Key Points

- Pulmonary blebs and bullae are the most common cause of spontaneous pneumothorax in dogs.
- Computed tomography is currently the “gold standard” for diagnosing pulmonary bleb and bulla lesions.
- Definitive treatment of pulmonary bleb and bulla lesions involves either partial or complete lobectomy of affected lungs.
- Prognosis with complete resection of pulmonary bleb and bulla lesions is generally very good with recurrence rates ranging from 0-8%.

Spontaneous pneumothorax (SP) is a form of pneumothorax that occurs in the absence of trauma or direct injury to the lungs. Spontaneous pneumothorax has been further classified as either primary or secondary based on the underlying lung pathology. Traditionally, primary spontaneous pneumothorax has been used to describe pneumothorax arising from pulmonary bullae, blebs, or emphysematous lesions and secondary spontaneous pneumothorax has been used to describe pneumothorax arising from underlying causes such as migrating or inhaled foreign bodies, parasites, abscesses, lobar emphysema, pulmonary thromboembolism, lower airway inflammation, and asthma.

Knowledge of the various causes of SP aids in the clinical management; however, determining the underlying cause is highly dependent on the type and accuracy of the particular diagnostic test (e.g. survey radiography, CT, thoracoscopy, lung biopsy, bronchial lavage) used to assess the lungs. In addition, classification of underlying causes as either primary or secondary can be somewhat controversial even with definitive histopathological information and as diagnostic imaging and tissue analysis techniques advance, the distinction as to what constitutes a primary versus secondary lesion (e.g. alpha-1 antitrypsin deficiency versus lower airway inflammation) is likely to evolve.

The most common cause for SP in dogs is pulmonary blebs and bullae. Pulmonary blebs are accumulations of air within the layers of the visceral pleura and are most commonly located at the lung apices. They form when air escapes from within the lung parenchyma and travels to the surface of the lung and becomes trapped between the layers of the visceral pleura. Grossly, blebs appear as “bubbles” or “blister-like” lesions on the surface of the lung that range in size up to several centimeters in diameter. Pulmonary bullae are air-filled spaces within the lung parenchyma that result from the destruction, dilatation, and confluence of adjacent alveoli. Bullae can vary in size with some being small, involving only a few alveoli, and others being very large, involving a majority of the lung. Bullae are confined by the connective tissue septa within the lung and the internal layer of the visceral pleura. Bullae have been classified into three types based on the size and connection with surrounding lung tissue.

The etiology of pulmonary blebs and bullae in dogs has yet to be determined; however, the relatively consistent signalment and similar histopathological findings from lesions of affected dogs suggests a common pathogenesis. A recent study by Wilke et al revealed decreased levels of alpha-1 antitrypsin in lung samples from dogs with spontaneous pneumothorax.
pneumothorax. A similar abnormality has also been found in humans with pulmonary blebs and bullae and may suggest similarities in etiology between species.

In humans, the etiology of pulmonary blebs and bullae (also described as emphysematous like changes ELC) is likewise not fully understood and a confounding issue with determining the significance of these lesions is that the actual site of air leakage is often not directly associated with the ELC but rather arises from visually normal areas of the lung suggesting a more diffuse pleural disease (pleural porosity). Various theories for the etiology of ELC in humans include 1) increased distensive forces at the apices of the lungs in tall, thin individuals; 2) changes in atmospheric pressure leading to increased transpulmonary pressure; 3) increased inflammation and degradative enzymes in the lower airways and alveoli due to cigarette smoking; 4) inactivation of alpha-1 antitrypsin leading to degradation of elastic fibers and progressive destruction of pulmonary parenchyma due to cigarette smoking; 5) distal airway inflammation creating partial obstruction that acts as a “check-valve” leading to hyperinflation of alveoli and eventual bulla formation; 6) abnormal anatomical branching of smaller diameter airways.

In dogs, pulmonary blebs and bullae occur most commonly in healthy, middle-aged, large or deep-chested dogs. Clinical signs typically include lethargy, coughing, tachypnea, exercise intolerance, increased respiratory effort, and various degrees of respiratory distress or dyspnea. For some dogs, respiratory signs may develop rapidly and be very obvious, whereas for others, initial clinical signs may be very nonspecific (e.g. anorexia, depression) and it is not until the pneumothorax progresses that respiratory signs develop.

The diagnosis of pneumothorax can be readily made with survey thoracic radiographs; however, identifying pulmonary blebs and bullae can be difficult since they are not usually apparent due to their relatively small size and location on the margins of the lungs. Nevertheless, serial thoracic radiographs should be taken to rule-out other potential causes of pneumothorax such as pulmonary neoplasia or abscesses.

Computed tomography (CT) is currently the most accurate imaging modality for detecting pulmonary blebs and bullae. The advantages of CT include the ability to scan very thin slices at high resolution, the ability to minimize soft tissue superimposition with cross-sectional imaging, the ability to more accurately differentiate different tissue densities, and the ability to view structures in multiple planes or as three dimensional images allowing for more accurate evaluation. CT very is useful for surgical planning and potentially identifying lesions in areas of the lungs that are difficult to visualize (e.g. dorsal aspect accessory lung lobe) despite having full access to the thorax via median sternotomy. To improve the ability to detect small or subtle lesions on the periphery of the lungs, the chest should be evacuated of air prior to CT to allow the lungs to fully expand. In a recent study, CT was used to evaluate 12 dogs with spontaneous pneumothorax due to pulmonary bullae and blebs. In this report, CT was superior to radiography in identifying the affected lung lobe(s) and the correlation of CT and radiography with the surgical findings was (k=0.735) and (k=0.306) respectively. In the 10 dogs with lesions confirmed at surgery, CT correctly identified lesions in 9 dogs compared to only 2 with radiography. When looking specifically at the lung lobes involved, CT correctly identified 13 of the 17 affected lobes, versus only 4 of 17 for radiography.

Initial treatment for SP should focus on stabilization with strict rest, oxygen supplementation, and thoracic drainage. Thoracocentesis should be performed as necessary to maintain adequate ventilation. For dogs with more rapid accumulation of air, a thoracostomy tube should be placed to allow for more efficient drainage. Unfortunately, thoracic drainage is not a reliable means of definitively treating pneumothorax caused by pulmonary blebs and bullae.
in dogs due to the persistent and recurrent nature of the leakage (recurrence rate ranging from 25-50%) and surgical treatment should be considered once other obvious causes of pneumothorax have been ruled-out.

Definitive treatment for pulmonary blebs and bullae involves partial or complete lung lobectomy. Lesions may be present on multiple lung lobes so a median sternotomy approach is recommended so that the entire thorax can be explored. Each lung lobe should be carefully examined for lesions responsible for pneumothorax. If an obvious lesion cannot be identified, filling the pleural space with sterile saline and submerging the lungs can help determine the site of leakage. The most difficult part of the procedure is identifying the source(s) of leakage, and despite the entire thorax being exposed, leaks may not always be obvious due to changes in positioning and ventilation of the lungs during surgery. Once a lesion is identified, partial or complete lung lobectomy is most efficiently performed with an automatic stapling device although can be performed with conventional suturing techniques as well. Choice of staple cartridge length (30, 45, 60 mm) and staple arm length (2.0, 2.5, 3.5, 4.8 mm) is based on the thickness and vascularity of the lung tissue to be removed. Alternatively, thoracoscopy can be used as a minimally invasive means of diagnosing and treating pulmonary blebs and bullae. In a recent report, 3 dogs with pulmonary bulla were treated with partial lung lobectomy using an endoscopic linear stapling device without complications or recurrence for 18-29 months after surgery. Overall, results for surgical treatment of pulmonary blebs and bulla are generally very good with recurrence rates ranging from 0-8%.

For dogs in which surgical treatment is not an option, conservative treatment with a pleurodesis agent may be considered. Various agents (e.g. talc, tetracycline, blood) have been described; however, the efficacy in sealing leaks and creating consistent adhesions between the visceral and parietal pleural is limited and their use specifically for pulmonary blebs and bullae has not been reported. In addition, the hospitalization time and potential complications associated with prolonged thoracostomy tube drainage should be considered when using a pleurodesis agent. In humans with small (< 2cm dia.) pulmonary blebs and bulla, definitive therapy using talc pleurodesis is effective for preventing recurrence and is an established form of treatment for select patients.

Histopathological examination of bleb and bulla lesions from dogs has revealed a consistent pattern of focal abnormalities including subpleural emphysema, atelectasis, muscular hypertrophy of the respiratory ducts, increased foreign particulate matter, and varying degrees of inflammation. It is not clear whether the muscular hypertrophy found surrounding the respiratory ducts is the cause or result of bleb and bulla formation; however, it does suggest a chronic change and indicates that the lesions may exist for some time before clinical signs develop. The consistent histological changes support the idea that blebs and bullae represent a distinct or “primary” form of disease in dogs but with an underlying cause that has yet to be definitively determined.

References:
17. Wilke VL, Robinson NA: Histological characteristics of spontaneous pneumothorax in the dog. Vet Surg 2010;39:E60