Pneumothorax in horses: 40 cases (1980–1997)

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The purposes of the study reported here were to characterize pneumothorax in horses and to describe causes, clinical signs, results of diagnostic testing (radiography, ultrasonography, thoracocentesis, auscultation, and arterial blood gas analyses), and clinical outcome of horses with pneumothorax.

Criteria for Selection of Cases

Records of all horses admitted to the George D. Widener Hospital for Large Animals between January 1980 and July 1997 were reviewed. Horses were included in the study if pneumothorax was diagnosed by use of radiography, ultrasonography, thoracocentesis, or at necropsy.

Procedures

Information obtained from medical records of horses included in the study consisted of signalment, history, and clinical findings at the time of diagnosis of pneumothorax. Characteristics of respiration (eg, coughing, respiratory effort or distress, abdominal effort [pump], nostril flare, openmouthed breathing); mucous membrane color; rectal temperature; evidence of external trauma; results of radiography, ultrasonography, or both; and results of arterial blood gas analyses were also ascertained, when available, from the medical records. Results of thoracocentesis, if performed, were recorded. The methods by which pneumothorax was diagnosed, whether pneumothorax was unilateral or bilateral, and clinical outcome (ie, survived, died, or euthanatized) were ascertained for each horse. Horses were classified by the etiopathogenesis of the pneumothorax.

Results

Forty horses met the criteria for inclusion in the study. Twenty-five horses were Thoroughbreds, 6 were Standardbreds, 2 were Quarter Horses, 2 were Arabsians, and the remaining 5 were mixed breed. Twelve were sexually intact males, 12 were geldings, and 16 were sexually intact females. Ages ranged from 1 day to 20 years; however, 23 of the 40 were between 1 and 5 years of age, with a mean age of 4.82 years.

Horses were categorized by the suspected cause or underlying disease condition that led to the development of pneumothorax. Categories included pleuropneumonia (17 horses), open thoracic wounds (9), closed trauma to the thorax (7), surgery of the upper portion of the respiratory tract (3), idiopathic (3), and diaphragmatic hernia (1). Horses with pneumothorax secondary to pleuropneumonia (17 horses) had increased respiratory rate (15), fever (15), increased heart rate (14), signs of depression or anxiousness (12), cough (8), decreased lung sounds in the dorsal aspect of the thorax (8), increased respiratory effort or distress (7), and abnormal...
mucous membrane color (7). Only 3 horses had abdominal effort or nostril flare associated with respiration.

Horses with pneumothorax secondary to open thoracic wounds (9 horses) had increased respiratory rate (8), increased respiratory effort or distress (8), fever (6), increased heart rate (9), signs of depression or anxiousness (7), decreased lung sounds in the dorsal aspect of the thorax (6), abdominal effort or nostril flare (4), and abnormal mucous membrane color (3). All 9 horses had evidence of external trauma to the respiratory tract, which was in or near the axilla in 5 horses and on the lateral aspect of the thoracic wall in 4 horses. Subcutaneous emphysema was evident in 4 horses that had open thoracic wounds. Cough and openmouthed breathing were not associated with pneumothorax secondary to open thoracic trauma. In 2 horses, it was known how the trauma occurred (1 was impaled on a fence and 1 hit the rail at the racetrack), but in most instances, the horse was found with a laceration or penetrating wound to the thorax. Four of the horses with open wounds had fractured ribs that were diagnosed radiographically.

Pneumothorax was diagnosed in 3 horses in which decreased lung sounds were not specified as either unilateral or bilateral in 8 horses on the basis of clinical signs, and the diagnosis was confirmed by thoracocentesis (2 horses) or at necropsy (1), without radiographic or ultrasonographic evaluation.

Of the 14 horses that were evaluated with both ultrasonography and radiography, there was agreement on the diagnosis of pneumothorax for 12 of these horses. Pneumothorax was diagnosed by ultrasonography, but not radiography, in 1 horse and vice versa in another.

Twenty-seven horses were evaluated radiographically from which it could be determined that pneumothorax was bilateral in 14 horses and unilateral in 11 horses. The other 2 horses that did not have ultrasonographic or radiographic evaluations were not classified with either unilateral or bilateral pneumothorax.

Pneumothorax was diagnosed in 3 horses in which the underlying cause was not determined. These horses had increased respiratory effort or distress (3 horses), fever (2), abdominal effort associated with respiration or nostril flare (2), signs of depression or anxiousness (2), abnormal mucous membrane color (2), decreased lung sounds in the dorsal aspect of the thorax (2), subcutaneous emphysema (2), and increased respiratory and heart rates (1). One horse had fractures of the facial bones with sinus involvement.

Pneumothorax secondary to surgery of the upper portion of the respiratory tract was diagnosed in 3 horses. All 3 horses had a routine tracheostomy performed; laryngostomy had also been performed on 1 horse. These horses had signs of depression or anxiousness (3 horses), increased respiratory effort or distress (2), abnormal mucous membrane color (2), openmouthed breathing (1), decreased lung sounds in the dorsal aspect of the thorax (1), subcutaneous emphysema (1), and an abdominal component to respiration (1). Cough, fever, and nostril flare were not observed in these horses.

Pneumothorax was diagnosed in 1 horse secondary to surgical repair of a diaphragmatic hernia. Pneumothorax was diagnosed at the time of routine postoperative radiographic evaluation of the hernia repair, and the horse had none of the clinical signs previously described, with the exception of an increased heart rate. The horse had a generalized decrease in lung sounds.

Abnormal mucous membrane color was recorded in 18 of the 40 horses; this was detected in horses with pneumothorax secondary to closed trauma of the thorax (4/7 horses), pleuropneumonia (7/17), open thoracic wounds (3/9), idiopathic pneumothorax (2/3), and surgery of the upper portion of the respiratory tract (2/3). Color abnormalities of mucous membranes included blue or purple (7 horses), congested, toxic, or injected (5), pale or white (3), hyperemic or dark (3), and cyanotic or gray (2).

Pneumothorax was diagnosed by radiographic examination, ultrasonographic examination, and auscultation of the thorax in 92.5% (25/27 horses), 87.5% (21/24), and 38.2% (13/34) of horses, respectively. Thirty-seven horses were evaluated using radiography, ultrasonography, or both. Radiography and ultrasonography of the thorax were performed on 14 horses, radiography alone on 13 horses, and ultrasonography alone on 10 horses. Pneumothorax was diagnosed in 3 horses on the basis of clinical signs, and the diagnosis was confirmed by thoracocentesis (2 horses) or at necropsy (1), without radiographic or ultrasonographic evaluation.

Of the 14 horses that were evaluated with both ultrasonography and radiography, there was agreement on the diagnosis of pneumothorax for 12 of these horses. Pneumothorax was diagnosed by ultrasonography, but not radiography, in 1 horse and vice versa in another.
abnormal lung sounds heard on auscultation included decreased or dull lung sounds in the ventral aspect of the thorax (without concomitant decrease in lung sounds in the dorsal aspect of the thorax), friction rubs, coarseness or harshness, crackles, wheezes, squeaks, and muffled heart sounds. One horse was described as having lung sounds that were normal on auscultation.

On the basis of auscultation, 3 horses were assessed as having unilateral pneumothorax, and 3 horses were assessed as having bilateral pneumothorax; no assessment was recorded for the other horses diagnosed with pneumothorax by auscultation. Radiography of the thorax was performed in all 6 of these horses, but in only 2 cases, the assessment of unilateral versus bilateral pneumothorax (determined by radiography) agreed with the auscultation findings. Two of these 6 horses also had ultrasonographic examinations; however, the examiner did not specify on which side of the thorax pneumothorax was identified. Therefore, it could not be determined if auscultation and ultrasonographic examination findings were in agreement on the determination of a unilateral or bilateral pneumothorax.

Arterial blood gas analyses were performed at the time of the initial diagnosis of pneumothorax for 9 horses: 4 horses that had closed trauma to the thorax, 4 that had open thoracic wounds, and 1 that had pleuropneumonia. The pH of arterial blood ranged from 7.216 to 7.46, PaCO₂ ranged from 37.9 to 65.5 mm Hg, PaO₂ ranged from 40 to 432.1 mm Hg, and HCO₃⁻ ranged from 21.5 to 35.1 mmol/L. Some horses may have received oxygen, although the timing of administration was not clearly documented. The most common abnormality detected was respiratory acidosis with or without hypoxemia. Four horses had uncompensated respiratory acidosis, and 3 horses had compensated respiratory acidosis. For 2 horses, it was questionable whether the blood sample was arterial.

Pneumomediastinum, as determined by radiography, was evident in 9 horses, was not evident in 11 horses, and was not specified in 7 horses. There were 2 horses with pneumomediastinum in each of these categories of pneumothorax: open thoracic wounds, closed trauma to the thorax, surgery of the upper portion of the respiratory tract, and idiopathic. One horse with pneumothorax secondary to pleuropneumonia also had pneumomediastinum. In horses that did not have radiography performed, it could not be assessed whether pneumomediastinum was present.

Other radiographic findings included pulmonary contusion, increased interstitial pattern or density; pleural effusion (fluid or hemorrhage); possible foreign body, atelectasis, and parenchymal disease or consolidation. Ultrasonographic findings (other than pneumothorax) included pulmonary contusion, hemothorax, consolidation, loculated or fibrinous fluid, atelectasis, diaphragmatic hernia, evidence of anaerobic or necrotizing pleuropneumonia, probable bronchopleural fistula, and abscess formation.

Twenty-two horses (9 with pleuropneumonia, 7 with open thoracic wounds, 3 with closed trauma to the thorax, 2 with idiopathic pneumothorax, and 1 with surgical repair of the upper portion of the respiratory tract) were treated for pneumothorax. Horses were treated by removal of air from the pleural space via thoracocentesis and aspiration. Two of these horses subsequently had surgery to resolve the source of pneumothorax definitively by repair of an open thoracic wound. One horse had suction applied, but no air was aspirated despite clear radiographic evidence of pneumothorax. Clinical signs (increased respiratory rate or effort, heart rate, and attitude) improved following aspiration of air in 12 of the treated horses, 2 horses appeared unaffected by treatment, and 1 horse worsened following the procedure, then collapsed and died. Clinical response to treatment was not recorded for 6 horses. The appearance of pneumothorax on either radiographs or ultrasonographic images improved or resolved in 7 horses and was unchanged in 8 horses (horses were evaluated shortly after aspiration was performed). Seven horses were not reevaluated immediately following aspiration, or the results of reevaluation were not recorded. Two horses that had pleuropneumonia had recurrences of pneumothorax after initial improvement or resolution. Of the 40 horses with pneumothorax, 55% (23 horses) survived, 30% (12) were euthanatized, and 12.5% (5) died. Only 6 horses with pneumothorax secondary to pleuropneumonia survived, 9 were euthanatized, and 2 died. Two horses with pneumothorax secondary to laryngostomy or tracheostomy survived, and 1 died. Of the 9 horses that had pneumothorax caused by an open thoracic wound, 7 survived, and 2 were euthanatized. Seven horses had pneumothorax secondary to closed trauma to the thorax: 4 survived, 2 were euthanatized, and 1 died. Two of the horses that had idiopathic pneumothorax survived, and the third died; the 1 horse that had pneumothorax associated with a diaphragmatic hernia survived. Nine of the horses that died or were euthanatized were examined at necropsy. Six of these 9 horses had pneumothorax secondary to pleuropneumonia. Necropsy findings included pneumothorax, thoracic effusions, fibrin deposition on pleural surfaces, pulmonary and mediastinal abscesses, bronchopleural fistulas, and bronchopneumonia. Two horses that had pneumothorax secondary to closed chest trauma were examined at necropsy, and findings included fractured ribs, pleuritis, serosanguineous effusion, pericarditis (with a pericardial tear), and septicemia. The remaining horse that was examined at necropsy had idiopathic pneumothorax. The necropsy examination in this horse revealed pneumothorax, subcutaneous emphysema, mediastinal emphysema, and a postsurgical scrotal abscess. Eight horses that died or were euthanatized either did not have a necropsy examination (5 horses) or necropsy reports were not available for review (3).

**Discussion**

Pneumothorax develops when air or gas enters the pleural space. Pneumothorax may develop as the result of a defect in the pulmonary parenchyma (closed pneumothorax) or in the thoracic wall (open pneumothorax). Pneumothorax is well described in the literature in humans and dogs, and methods for classifi-
Pneumothorax has been described as rare in horses and is most often the result of trauma associated with open or closed thoracic wounds. In addition to developing secondary to trauma, pneumothorax has been reported to develop in horses secondary to thoracic surgery, severe pleuropneumonia, thoracocentesis, severe subcutaneous emphysema, pneumomediastinum, lung biopsy procedures, and rupture of alveoli or bronchial structures. In our study, 17 horses had pneumothorax secondary to open thoracic wounds, surgery, or closed trauma to the thorax would be considered traumatic. We did not attempt to assign the classification of tension pneumothorax to the horses of this study, although it might be possible to determine which horses had tension pneumothorax on the basis of clinical signs that were recorded.

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Clinical signs that have been associated with pneumothorax include evidence of an external wound or other trauma, tachypnea, dyspnea, cyanosis, restless-ness, apprehension, and expansion of the thorax. Classically, auscultation of the thorax reveals decreased or lack of lung sounds in the dorsal aspect of the thorax; tympany or hyperresonance on percussion may also be detected, although the presence of subcutaneous emphysema can hinder effective auscultation and percussion. In our study, clinical signs varied among horses and were nonspecific. In general, all horses had some evidence of respiratory difficulty (e.g., increased respiratory rate or dyspnea), but the classic sign of decreased or lack of lung sounds in the dorsal aspect of the thorax was detected in 19 of 40 horses. Acute signs of respiratory distress were observed primarily in horses that had an acute onset of pneumothorax or in instances where tension pneumothorax might have been more likely to develop, such as with closed thoracic trauma or surgery of the upper portion of the airway. Many of the horses that developed pneumothorax secondary to pleuropneumonia may have had a slower onset of gas accumulation in the thorax. Horses with severe pleuropneumonia that are examined at necropsy often have extensive pathologic changes of the pleural space and lungs. Pleural fluid may range from serosanguineous to purulent; adhe-sions and fibrin deposition on the visceral and parietal pleura may be extensive. The lungs may be severely consolidated, and bronchopleural fistulas may be evident. It has been speculated that slow leaks of air from lung tissue that may be necrotic or has developed a fistula may be the source of pneumothorax in horses with pleuropneumonia. The slower development of pneumothorax in these horses, compared with horses that develop pneumothorax secondary to an acute event, may explain the difference in clinical signs.

The mediastinum of horses is usually described as incomplete, with small fenestrations located in the caudal and ventral portions. It has traditionally been expected that because of these fenestrations, pneumothorax would most often develop bilaterally. However, these fenestrations may sometimes be absent in adult horses, or the fenestrations may become occluded with inflammatory exudate; this would explain why pneumothorax may develop unilaterally in horses. In our study, 19 horses had bilateral pneumothorax, and 17 horses had unilateral pneumothorax. Bilateral pneumothorax was more often seen in horses in all categories except pleuropneumonia. Horses with pleuropneumonia typically had unilateral pneumothorax rather than bilateral pleuritis (11 vs 4 horses, respectively), which may be related to the accumulation of inflammatory exudate and fluid in the thoraces in these horses.

Radiography and ultrasonography are excellent means of diagnosing pneumothorax in horses. Radiography may be somewhat superior to ultrasonography, because the ability to detect bilateral pneumothorax is not dependent on performing a bilateral examination of the thorax. With ultrasonography, the focus of the evaluation is usually the ventral regions of the thorax. Unless an examination is directed at the dorsal regions of the thorax or there are severe pathologic changes over a wide area of the lung fields or pleural space, pneumothorax may not be detected with ultrasonography. Likewise, when pathologic changes appear to be limited to 1 side of the thorax on the basis of auscultation, the other side of the thorax may not be evaluated ultrasonographically. Additional technical complexities exist that involve the differentiation of free gas in the pleural space versus air within the pulmonary parenchyma that could complicate the diagnosis of pneumothorax by ultrasonography, particularly with an inexperienced evaluator. Detection of pneumothorax is more easily accomplished in horses with concurrent pleural effusion, because a gas-fluid interface can be imaged. Pneumothorax without concurrent pleural effusion is more difficult to detect ultrasonographically, because gas that is free in the pleural cavity and air within the lungs both have similar characteristic hyperechoic reflection and reverberation artifacts.

Auscultation of the thorax was not a particularly effective means of diagnosing pneumothorax when used as the sole means of evaluation in the horses of this study. Decreased lung sounds in the dorsal aspect of the thorax were detected in approximately 59% of horses with pneumothorax in which results of thoracic...
Auscultation were recorded, but in only 2 of 40 horses, the diagnosis was made solely on the basis of auscultation findings. Auscultation is complicated when pleuropneumonia is present, because many other abnormal lung sounds may be detected (as a result of pathologic changes in the pulmonary parenchyma and pleural space). Subcutaneous emphysema also hinders auscultation. Auscultation is important as an adjunct to other diagnostic tools but should not be relied on as the sole means of diagnosing pneumothorax.

Treatment of pneumothorax by aspiration of air from the pleural space appeared to be successful in alleviating clinical signs in approximately 55% of horses in this study that were treated; however, results of treatment were not recorded in approximately 27% of the horses. A correlation was not detected between alleviation of clinical signs and improvement of the appearance of pneumothorax on radiographic or ultrasonographic images; this may be because the degree of pneumothorax cannot be quantified to a level that has clinical importance using these 2 diagnostic techniques. Multiple recurrence of pneumothorax was observed in 2 horses with pleuropneumonia that initially had improvement or resolution of pneumothorax, which most likely related to an ongoing disease process in the lung.

Pneumothorax associated with pleuropneumonia has a poor prognosis; in our study, 8 of 17 horses with pneumothorax and concurrent pleuropneumonia died or were euthanized. In contrast, when the remainder of the horses in this study were considered as a group (ie, those without pleuropneumonia), 69.6% (16/23 horses) survived. Although clinical signs are suggestive of pneumothorax, a definitive diagnosis is best determined by use of radiography or ultrasonography.

References