Super Pooky

Pyothorax/Pneumothorax in the Canine

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Class of 2021

Clinicopathologic Conference
June 5th, 2020

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Introduction

The space between the lungs and the body wall in thoracic cavities is referred to as a potential space. Normally, the amount of fluid in this potential space is approximately less than 5 mls of lubricating fluid or 0.1 ml/kg body weight[2,4]. This fluid acts to reduce the friction between the body wall and the lungs during inspiration and expiration. The entire cavity itself is lined by a serous membrane; the membrane over the lungs is called the visceral pleura and the parietal pleura covers the body wall and remaining structures[6]. The mediastinum is a division between the right and left sides of the thoracic cavity; however, in some animals this division is not a complete structure. There are fenestrations within the membrane that allow the two sides of the thoracic cavity to communicate and disease processes may start out unilaterally and then progress to bilaterally[2,11]. The pleural fluid formed and absorbed in that potential space is controlled by Starling's forces and the excess fluid is drained by pleural lymphatic drainage[6]. Interruptions in this normal physiological system can cause an excess of a substance to build up in the pleural space. An increase in the permeability of capillary walls, an increase of capillary hydrostatic pressure and a decrease in capillary colloid osmotic pressure can lead to pleural effusion[2]. Examples can include: pure transudate (protein: <2.5 g/dl, nucleated cells: <1000 cells/µl), modified transudate (protein: 2.5-3.5 g/dl, nucleated cells: 500-10,000 cells/ µl), exudate (protein: >3.0 g/dl, nucleated cells: >5,000 cells/ µl), blood, chyle, air, or tissue[4].

History and Presentation

Pooky Hill is a 4-year-old, intact female Labrador Retriever who presented to MSU-CVM Internal Medicine service on May 31st, 2019 after a 2-week history of increased respiratory effort. Pooky was running through her owner's wooded property on May 21st, when the owner heard her cry out. Her owner reported that he found Pooky with a thumb sized stick impaled into

her right cranial thorax and immediately took her to her primary veterinarian. The primary veterinarian removed the stick, performed a three-layer closure, and sent her home on Gentamycin and Dexamethasone. Her owner states that Pooky continued to be lethargic, painful, and anorexic throughout the week and returned to her primary veterinarian on May 28th. Pooky was hospitalized there and subsequently referred to MSU-CVM when her heart sounds became difficult to hear on auscultation and no improvement was noted.

On presentation to MSU-CVM, Pooky was dull and depressed. Her heart rate was 116 beats per minute, temperature was 101.6°F, and her respiratory rate was 88 breaths per minute. She exhibited a shallow breathing pattern and her lung and heart sounds were muffled ventrally on both sides of the thoracic cavity, with the right being worse than the left. The heart was auscultated and no murmurs or arrythmias were appreciated. Her blood pressures were mildly elevated with a systolic of 170mmHg, diastolic of 78mmHg, and a mean arterial pressure of 108mmHg. Her femoral pulses were fair to weak, mucous membranes were pink and tacky with a capillary refill time of 2 seconds, and a mild skin tent was present.

On tFast, a moderate amount of hypoechoic pleural effusion was noted; the right side of the thorax being worse than the left and poor glide signs were noted in the left dorsal thorax. Due to respiratory depression and pleural effusion a thoracocentesis was performed next. Butorphanol (0.2mg/kg IV x 2) was given to facilitate thoracentesis and a 600ml lactated ringers solution bolus was given. Therapeutic thoracentesis yielded approximately 1000ml of serosanguinous fluid with fibrin. An in-house cytology of the fluid showed diffuse neutrophils with numerous cocci (intracellular and extracellular). A sample of the fluid was sent to the laboratory for official analysis and culture. A complete blood count showed a moderate leukocytosis 44.2 K/ul (7-22), a mature neutrophilia 41.5 /ul (3.5-14.2), a mild monocytosis 1768 /ul (175-1700), and a mild

anemia 31% (34-60). A serum chemistry showed a mild hyperglycemia 136 mg/dl (75-125) and an increased anion gap 23 mmol/L (10-20). A NOVA showed a respiratory alkalosis with an increased pH 7.463 (7.35-7.42), a decreased pCO2 23.6 mm Hg (29-42), a TCO2 17.8 mEq/L (14-26), a HCO3 17.1 mEq/L (17-24), and an increased lactate of 5.6 mmol/L (<2.5). After initial triage, Internal Medicine transferred Pooky to MSU-CVM Surgical Department.

Diagnostic Approach

Once Pooky was transferred to the Surgery Department, she was sent to radiology for imagining of her thoracic cavity. A dorso-ventral view was taken because of the state of respiratory distress she was suffering from. Along with the DV view, right and left lateral projections were radiographed. These images showed a moderate amount of pleural effusion that was causing retraction of the right cranial, right middle, and right caudal lung lobes from the body wall and a dorsal deviation of the intrathoracic trachea. An alveolar pulmonary pattern was apparent which could be a component of pneumonia or more likely due to atelectasis. A foreign body was not definitely identified at this time[12]. After the initial radiographs, Pooky was anesthetized with Methadone (0.2mg/kg IV) and Alfaxalone (1.5mg/kg IV) and maintained on Isoflurane. Pooky also received two boluses of Fentanyl (5mcg/kg IV), Unasyn (10mg/kg IV) and a total of 155ml IV of lactated ringers solution. Due to the administration of butorphanol earlier that day, Alfaxalone had to be given frequently to keep Pooky in the correct surgical plane. Pooky was then shaved on both sides of her thorax and was sterilely prepped for placement of two Mila silicone chest tubes. A total of 240ml of air and 557ml of serosanguinous fluid was removed from her thorax. Radiographs were taken to check the placement of the two silicone chest tubes. The radiographs showed a decrease in the pleural effusion but an increase of gas causing dorsal displacement of the cardiac silhouette and retraction of the lung lobes. The

right chest tube entered the thoracic cavity at the 6th intercostal space and terminated in the cranial 1/3 of the thorax and the left chest tube entered the thoracic cavity at the 7th intercostal space and crossed midline caudal to the cardiac silhouette and terminated within the dorsal 2/3rds of the thorax[12]. Pooky was then transferred to ICU to be monitored throughout the weekend with the plan to perform a thoracic computed tomography on Monday in attempt to locate a foreign body. She was continued on Fentanyl (3mcg/kg/hr IV), Unasyn (30mg/kg IV Q8), Enrofloxacin (15mg/kg IV Q24), Gabapentin (7mg/kg PO Q8), Cerenia (1mg/kg IV Q24) and her chest tubes were aspirated Q4 or as needed in case of her respiratory rate increasing.

Pathophysiology

Thoracic empyema, or more commonly known as pyothorax, is an accumulation of fluid within the pleural space that may or may not be purulent. The most common cause of pyothorax in the dog may be regionally dependent; an example would be migrating grass awns in hunting or working dogs. Although the actual incidence is not known and in some cases the identification of the cause remains unknown[9]. Only 2%-19% of cases have a reported identification of the cause of the disease[2]. Causes of pyothorax include migrating foreign bodies, trauma, penetrating thoracic wounds, extension of bacterial pneumonia, perforations of the esophagus, hematogenous spread, or spread of infections from the mediastinum, cervical, or lumbar regions[2,6,9]. Disruption by any of these processes causes an inflammatory response in the thoracic cavity leading to vasoactive mediators and cytokine release which subsequently cause a change in the permeability of the capillary walls or impair the lymphatic drainage system[9].

With no breed, age, or sex predisposition, the signalment of a diagnosed pyothorax can look very non-specific. Some overrepresented groups include male hunting, sporting, or working dogs of medium-to-large breeds but has been seen in neonates and females. These animals

present in a wide array of nonspecific clinical signs including lethargy, tachypnea, fever, anorexia, either acutely or after several weeks of initial insult[5]. More chronic pleural effusions will present with muffled heart and lung sounds, hyperventilation, and shallow breathing due to the restriction of expanding the lungs fully, bradycardia and in some cases the animal may present in signs of sepsis. These signs include dehydration, pale mucous membranes, increased capillary refill time, hypothermia, and even systemic inflammatory response syndrome (SIRS)[9].

Diagnosis of pyothorax relies heavily on the history and physical exam of the patient with a definitive diagnosis coming from a cytologic examination of the fluid. The gold standard in diagnosing would be a culture and sensitivity of the fluid, but in initial triage a simple gram-stained slide can help direct the case in an emergency. The fluid can be anything from clear to opaque to cream of tomato soup color and may include flocculent material or a malodorous smell[2]. Bacteria in the fluid can be intracellular and extracellular and neutrophils are the predominate cell type seen. The most common bacteria seen in pyothorax are *Nocardia, Bacteroides, Actinomyces, Pasteurella,* and *Clostridium.* These infections are often mixed and cause the glucose content to be low in the fluid[1].

Thoracic diagnostic imaging can be used to confirm the diagnosis of pleural effusion in conjunction with the cytology of the fluid. Signs on radiographs include retraction of lung lobes from the chest wall, loss of visualization of the cardiac silhouette, interlobular fissures visible, and rounding of costophrenic angles[2]. Initially, ultrasonography can be used in cases to facilitate an emergency thoracentesis if the patient is in respiratory distress. Computed tomography (CT) is being utilized more often because of its ability to locate foreign bodies and the possible path of migration that may not be seen on radiographs. Some pathological changes can be identified on CT but not during surgery, yet some pathological changes were identified surgically but not on

CT. CT was able to detect more abnormalities in most cases and helped to determine a surgical or medical plan of action[10].

Gas or air buildup in the same pleural space as where pleural effusion happens is called pneumothorax. Normally, there is a negative pressure gradient in the thoracic cavity that leads to air exchange, but this can be interrupted by several processes. The most common process is through blunt trauma (i.e., falling a far distance, kicked by a horse or cow, vehicular accidents), that causes a closed pneumothorax by damaging the pulmonary parenchyma without a communicating wound to the outside[3]. Less commonly, a pneumothorax can be open and may allow air into the thoracic cavity as the animal inspires and may cause that lung to collapse and ventilation is reduced. These are more commonly known as an open pneumothorax and may be caused by a gun shot, penetrating wounds, lacerations from broken ribs, or bite wounds. Spontaneous pneumothorax is seen without any trauma and may be without an underlying pulmonary disease (primary) or caused by pulmonary neoplasia, parasites, pneumonia, abscess, or granulomatous infection (secondary)[3]. Tension pneumothorax is seen after pulmonary damage within a closed pneumothorax causes a continuous leakage of air during inspiration. The damaged tissue acts as a one-way-valve that leaks air into the pleural space and it cannot be expired out. This increase of air disrupts the normal pressure in the thoracic cavity to be greater than that of the atmospheric pressure. This buildup of pressure can push the mediastinum to the opposite hemithorax and if not treated quickly, collapse of vessels and even death[7].

Diagnosis of pneumothorax is similar to pyothorax with a thorough history and physical exam being key and then followed by diagnostic imaging and thoracentesis. Clinical signs are similar to pleural effusion cases with tachypnea, shallow rapid breathing, anxiety, lethargy, pale mucous membranes, or exercise intolerance. Pneumothorax on radiographs can be described as

lung lobes retracted from the thoracic wall, atelectasis, dorsal deviation of cardiac silhouette on lateral view, and gas seen in the pleural space[7].

Treatment and Management

If the patient is in respiratory distress, stabilization is the first step to treatment of both pyothorax and pneumothorax. A tFast and emergency thoracentesis of either fluid or air must be performed to assure the patient can exchange oxygen. Once the patient is stabilized and it is confirmed what substance is in the pleural space, treatment can continue. With pyothorax, a fluid analysis, culture, and sensitivity should be collected first before the patient is immediately started on broad spectrum systemic antibiotics. Once the culture and sensitivity results return, the antibiotic course may be altered. Pyothorax in the canine can be managed medically through thoracentesis when necessary or placement of a thoracostomy tube that is drained when necessary, intermittently, or by continuous suction. The pleural space can be lavaged to assist in breaking down adhesions and helping to remove the bacteria[5]. Cytology can help determine if the correct treatment is being utilized due to neutrophils and bacteria seen decreasing over three to five days[6]. If no clinical improvement is seen within two to three days, surgical intervention can be utilized. Exploratory thoracoscopy or thoracotomy can be used to visualize the thoracic cavity and identify pathology or cause for the disease process. Lacerations to lung lobes should be repaired and lobes that do not inflate or are diseased should be removed via lobectomy. After medical or surgical treatment of pyothorax, an indwelling thoracotomy tube should remain in place until the amount of fluid removed is <3-5ml/kg/day and the amount of air is zero. The tube itself can cause some inflammation in the thoracic cavity and the amount of fluid removed may never reach zero[2,4]. Antimicrobial therapy should be continued two to three weeks after radiographic resolution.

Most treatment and management practices of pneumothorax overlap with the treatment and management of pyothorax. Stabilization is always first, followed by a thoracentesis to identify what is in the pleural space. Diagnostic imaging follows to determine the cause of the accumulation of air or gas. A thoracotomy tube should be placed to intermittently remove the excess air until negative pressure is reached. If spontaneous pneumothorax is diagnosed or the pneumothorax is unresolved after two-three days, surgery is the next step in treatment[7].

Prognosis depends on the chronicity and severity of the clinical signs seen. If the patient was showing signs of sepsis or the tension pneumothorax was affecting the blood flow in the thoracic cavity, the prognosis may be poor. If the appropriate treatment methods were utilized and the appropriate antibiotics used the prognosis is good. Dogs have an 83% survival rate with the utilization of various treatments and management practices[2].

Case Outcome

On Monday, June 3rd, 2019 Pooky was sedated with Dexmedetomidine (4mg/kg IV) and Fentanyl (3mcg/kg bolus) for a CT with contrast of her thoracic cavity. CT showed pleural effusion with concurrent pleuritis, mild pneumomediastinum, subcutaneous emphysema and edema and moderate atelectasis of all lung lobes. There was also a probable abscess within the right deep pectoral muscle with concurrent myositis and lymphadenopathy of multiple lymph nodes. Again, no foreign body was visualized on the imaging[13]. The fluid culture and sensitivity reported a growth of *Enterobacter cloacae* and *Staphylococcus intermedius* with a faint growth of *Clostridium perfringens.* Pooky was continued on Enrofloxacin (15mg/kg IV Q24) and Clindamycin (20mg/kg PO Q8) was added to her treatments while Unasyn was discontinued. On Wednesday, it was noted that Pooky was not improving and a fluid analysis of the thoracic fluid showed degenerate neutrophils. An exploratory thoracoscopy was planned for that afternoon to

explore the thoracic cavity and rule out any foreign bodies. A small animal anesthesia panel revealed a low hematocrit and a leukocytosis. Pooky was blood typed and prepped for a median sternotomy in case the thoracoscopy was inconclusive. Pooky received premedication of Dexmedetomidine (1mcg/kg IV) and Methadone (0.2mg/kg IV) and induced with Midazolam (0.28mg/kg IV) and Ketamine (0.13mg/kg IV). She was maintained on Isoflurane, LRS, Fentanyl, Lidocaine, Ketamine, and a bolus of Vetstarch throughout surgery. A 3 cm incision was made caudal to the xiphoid cartilage into the abdomen and then an endoscopy port was passed into the diaphragm dorsal to the ventral body wall. An endoscopy camera was passed through the port into the thoracic cavity and once focused a foreign object (stick) was visualized. A 4 cm incision was made on the right lateral-ventral thorax in between rib 8 and 9 to retrieve the 6cm stick using curved carmalts. Fibrous adhesions from the thoracic body wall to the lungs were broken down by blunt dissection and the entire thorax was flushed using sterile saline and explored for any pathology. A 20Fr x 55cm (22in) Mila chest tube was placed in between the 7th and 8th rib on the right side and secured to the skin with suture. After negative pressure was achieved through the chest tube, Pooky was taken to ICU to recover. Pooky's pain was managed with Fentanyl (3mcg/kg/hr IV CRI) initially and transitioned to oral Gabapentin (7mg/kg PO Q8), Tylenol 4 (2mg/kg PO Q8) and for rescue if needed, Hydromorphone (0.05mg/kg IV). That evening, an excess amount of air was aspirated from Pooky's chest tube, but no increase in her respiration was noted. The next morning, radiographs diagnosed Pooky with a pneumothorax[8]; management remained the same with the chest tube being aspirated intermittently.

Pooky remained in ICU until the amount of fluid removed was <1.5mls/kg/day and the air removed was zero. Her chest tube was removed on June 11th , and she was discharged that day with strict activity restrictions and information on how her owner could recognize a change

in her respiration. She was sent home with Gabapentin (7mg/kg PO Q8), Tylenol 4 (2mg/kg PO Q8), Enrofloxacin (13.6mg/kg PO Q24), Cefpodoxime (15mg/kg PO Q24) and instruction to return to MSU-CVM in 9-10 days to remove her sutures and check her healing. Pooky returned home after her incision check with a clean bill of health and remains happy and healthy today.

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