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Case Report

Management of Pneumoperitoneum, Pneumothorax and Subcutaneous Emphysema in a Cat

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Abstract

Background and Objective: The occurrence of pneumoperitoneum, pneumothorax and generalized subcutaneous emphysema is infrequent in cats. This case report records a rare case of treated pneumoperitoneum, pneumothorax and generalized subcutaneous emphysema in a cat. **Materials and Methods:** A 3 years old intact female Persian cat was admitted with signs of respiratory distress and abdominal distension 4 days following falling from height. Clinical and radiographic examinations were carried out. For treatment of the cat, the air within the thorax, abdomen and subcutaneous tissue was evacuated and cat was kept under close observation and conservative oxygen and fluid therapies. **Results:** Clinically, the cat had respiratory distress, subcutaneous crepitating sound and abdominal distension. Radiographic examination revealed the presence of radiolucent gas opacity separating the skin from the underlying tissue over the head, neck and thorax. The lung was hyper-inflated with scalloped costophrenic angles, the heart was separated from the sternum by a large radiolucent area and the trachea was narrow and dorsally displaced. The caudal lung lobes were more radio-opaque compared to cranial ones. The radiolucent gas was seen occupying the abdomen. After treatment, the cat was greatly improved and returned to normal activity one week post-treatment. **Conclusion:** Pneumoperitonium, pneumothorax and generalized subcutaneous emphysema have characteristic clinical and radiographic findings. Although, the condition is self-limiting, unless other complications develop, evacuation of the escaped air within the thoracic and abdominal cavities may accelerate the recovery time.

Key words: Costophrenic angles, emphysema, hyper-inflated lungs, pneumomediastinum, Persian cat, pneumopericardium

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Pneumoperitoneum, pneumothorax and generalized subcutaneous emphysema are uncommon clinical findings in cats. Presence of free gas within body cavities may occur spontaneously when gas leaks from an internal organ such as the lung, or any other luminal organ such as the oropharynx, larynx, trachea, bronchial tube, esophagus or even the colon. Also it may occur as a result of traumatic or iatrogenic causes. The spontaneous onset in absence of provoking factors was reported to be very rare¹.

Pneumomediastinum is a rare condition where a free air or gas is located within the mediastinum². The condition may be a consequence to sharp penetrating trauma to the neck, mediastinal infection by gas-forming organisms or occurs secondary to accidental or iatrogenic trauma. Traumatic intubation, endotracheal tube cuff overinflation, positive-pressure ventilation, trans-tracheal wash procedures, esophageal dilatation and jugular venipuncture were reported as causes³. As the mediastinum communicates with the subcutaneous tissues in the neck through the thoracic inlet and with the retroperitoneum through the aortic hiatus, air may spread along these three communicating regions causing subcutaneous emphysema and/or pneumoperitoneum⁴. Air within the mediastinum may also progress to the pericardial sac causing pneumopericardium or the mediastinal air ruptures through the mediastinal tissues causing pneumothorax^{3,4}.

Pneumothorax is the condition where the air or gas is trapped inside the thoracic cavity between the thoracic wall and the lung and is usually causing lung collapse. In cats, pneumothorax is usually associated with lung disease; however, traumatic causes such as biting wounds and gunshots were also reported by Mooney *et al.*⁴. Secondary pneumothorax may occur as a result of ruptured cyst or bulla within lung parenchyma, rupture of the esophagus, trachea, bronchi or concurrent with rupture of the mediastinum².

In pneumoperitoneum, a free air is present within the abdominal cavity due to traumatic or spontaneous causes⁵. Traumatic causes mostly include vehicle impact, penetrating gunshot, biting abdominal wounds and iatrogenic pneumothorax⁶. Spontaneous pneumoperitoneum was most commonly associated with rupture of gastrointestinal tract the condition that necessitates urgent surgical intervention^{7,8}.

Subcutaneous emphysema results from accumulation of air or other gases in the subcutaneous tissue due to trauma or

soft tissue infection with anaerobic gas forming bacteria⁹. Moreover, spontaneous rupture of lung tissue or tracheobronchial tree is a common cause that should be suspected in any animal with generalized subcutaneous emphysema¹⁰.

There is scarce information about the management of pneumoperitoneum, pneumothorax and generalized subcutaneous emphysema in cats. This case report provides the guidelines for diagnosis and conservative treatment of such case.

MATERIALS AND METHODS

Case history: A 3 years old intact female Persian cat was admitted to the clinic of Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University, Egypt during 2016. The cat was off food and had signs of respiratory distress, abdominal distension and a history of falling from height 4 days prior to admission.

Clinical examination: Rectal temperature, heart and respiratory rates, pulse oximetry percentage and capillary refilling time were measured. Clinical examination of the chest, oro-pharynx and abdomen was performed and all abnormal findings were recorded.

Radiographic examination: Both thoracic and abdominal plain radiographs were done with an X-ray machine (Fischer, Stuttgart, Germany). The radiographic setting factors were 50 kVp and 10 mA. Both ventro-dorsal and lateral views were performed.

Treatment: A18 G catheter attached to double way valve linked to a 50 mL syringe was used to evacuate the accumulated gases from the right hemithorax. The catheter was inserted at the level of 4th intercostal space during expiration to avoid lung injury. Approximately 280 mL of air were evacuated from the thorax. A similar abdominal catheter was inserted at the level of the umbilicus and approximately 450 mL of air were evacuated from the abdominal cavity. In addition, approximately 60 mL of air were evacuated from the subcutaneous tissue.

Conservative medical management included cage rest, liquid oxygen supplement (Aquagen®, Aquagen Inc., UT, USA) five drops orally three times daily and intravenous fluid therapy supplementation.

RESULTS

Clinical findings: Upon physical examination, the cat was depressed and reluctant to move. Generalized pallor of the mucous membranes was noticed with a delayed capillary refilling time (>4 sec). The cat had a shallow rapid open-mouth respiration ($84 \text{ breaths min}^{-1}$), tachycardia ($130 \text{ beats min}^{-1}$) and normal rectal temperature (37.7°C). A marked abdominal distention with a distinct crackling sound was felt upon abdominal palpation. This distention hindered the palpation of abdominal organs with a marked tympanic drum-like sound upon abdominal percussion. This tympanic sound was also extended to the thorax and neck indicating the presence of generalized subcutaneous emphysema.

Upon careful examination, no evidence of skin wounds, trauma and/or musculoskeletal involvement was reported. Examination of the oropharyngeal cavity revealed no remarkable lesions. Thoracic auscultation revealed a loud wheezed on both cycles of respiration and muffled sound of the heart. The pulse oximetry percentage was markedly reduced (75%, reference value $> 90\%$).

Radiographic findings: Thoracic radiography revealed a large amount of radiolucent gas opacity separating the skin from the underlying tissue over the head, neck and thorax. On ventro-dorsal view, the lung was hyper-inflated with scalloped costophrenic angles. On lateral radiograph, the heart was separated from the sternum by a large radiolucent area and the trachea was narrow and dorsally displaced. The caudal lung lobes were more radio-opaque compared to the cranial lung lobes (Fig. 1, 2).

Abdominal radiography showed accumulation of large amount of gas which acted as a contrast medium to clearly visualize the abdominal organs. The diaphragm was seen as a thin curvilinear radiodense structure separating the abdomen from the thoracic cavity. The radiolucent gas within the abdomen separated the liver from the abdominal wall. Both right and left kidneys were visualized as radiodense structures in the sublumbar region (Fig. 3).

The cat was diagnosed to have pneumoperitoneum, pneumothorax and generalized subcutaneous emphysema, that necessitate a conservative management.

Follow up: One hour after evacuation, the respiratory distress was markedly improved and the cat exhibited a deep inspiration with a rapid expiration ($54 \text{ breaths min}^{-1}$) and wheezes became less loud. The heart rate was slightly



Fig. 1: Ventro-dorsal thoracic radiograph demonstrating the subcutaneous emphysema

The radiolucent gas opacity is separating the skin from the underlying subcutaneous tissue (White arrows). Note the scalloping of the lung lobes at the costodiaphragmatic angles (Black arrows)



Fig. 2: Lateral thoracic radiograph of the cat affected with pneumothorax and subcutaneous emphysema

Notice the subcutaneous radiolucent emphysema, movement of the heart away from the sternum and hyper-inflated lung

decreased although tachycardia was still recorded ($110 \text{ beats min}^{-1}$). The pulse oximetry percentage was increased to 85%.

Three days following the conservative therapy, the clinical signs were markedly improved, while thoracic radiographs revealed mild subcutaneous emphysema, pneumothorax and pneumoperitoneum. Almost half the amount of previously



Fig. 3: Lateral abdominal radiograph demonstrating the accumulation of radiolucent air within the abdomen

The diaphragm is a thin curvilinear radiopaque line between thoracic and abdominal cavity (White arrow). The liver is moved away from abdominal wall by the radiolucent air (Black arrow)

suctioned gas was evacuated. One week later, the cat had greatly improvement with little evidence of pneumothorax or pneumoperitoneum. The pulse oxymetry percentage was increased to 92%. The cat had returned to normal activity, normal appetite, therefore the conservative therapy was stopped.

DISCUSSION

Subcutaneous emphysema, pneumoperitoneum and pneumothorax are uncommon clinical findings that were diagnosed in a Persian cat 4 days after falling from height.

The presence of generalized subcutaneous emphysema and pneumoperitoneum in association with pneumothorax was assumed to occur as a result of a primary pneumomediastinum, especially with absence of oropharyngeal lesions or external wounds.

A possible explanation may include that falling from height may have resulted in alveolar rupture. The air resulted from the ruptured alveoli may have escaped to the perivascular and peri-bronchial adventitia. The difference in the pressure between the peripheral lung parenchyma and the mediastinum forces the air to spread along the peri-bronchial connective tissue and eventually to the mediastinum. Similar explanation for the progression of pneumomediastinum has been previously reported¹⁰.

Mediastinum is the potential space centrally located between the right and left pleural cavities containing the heart, trachea, esophagus, vagus nerve, thymus, great vessels and lymphatics. The mediastinum is incomplete; it is

communicated cranially with the cervical facial planes through the thoracic inlet and caudally with the retroperitoneal space through the aortic hiatus^{3,10}.

Pneumomediastinum can be easily diagnosed on thoracic radiographs through identification of the mediastinal great vessels and esophageal and tracheal walls that are normally not seen but become visible because of the negative contrast provided by the surrounding gas⁸. However, in the present cat, pneumomediastinum was assumed to progress to pneumothorax especially that the cat was admitted 4 days after the accident. Pneumothorax was manifested radiographically in the present cat by the collapsed lung lobes. The edges of the lung lobes were retracted from the sternum, diaphragm and diaphragmaticolumbar recess, with presence of air opacity outlining the lung edges. The lungs have an increased opacity that might be resulted from either partial or complete atelectasis¹.

The presence of generalized subcutaneous emphysema may be explained as the escaped air within the thorax may have dissected to the subcutaneous tissue of the head, neck and thorax through the thoracic inlet. While the presence of the pneumoperitoneum could be explained by escaping of the air caudally to the abdomen through the aortic hiatus¹.

Surgical intervention (thoracotomy/lobectomy) was not advised in the presented cat especially that the origin of escaped air could not be identified. Spontaneous pneumomediastinum has been reported to be benign and self-limiting both in human and veterinary practice. Spontaneous resolution of cases managed conservatively usually occurs over 2 weeks^{10,11}. Thoracotomy and/or laparotomy could be advised where the existing causes of pneumomediastinum and/or pneumoperitoneum were definitely detected¹²⁻¹⁴.

In the present case, evacuations of the escaped air within the thoracic and abdominal cavities together with conservative medicinal management were successful in accelerating the recovery time. Spontaneous healing of the ruptured alveoli was evident by the clinical improvement at 1 week follow-up examination and manifested by improvement of respiratory function (deep inspiratory pattern), increased oxygen saturation percentage measured by pulse oximetry probe and by absence of radiographic signs of pneumomediastinum and/or pneumothorax. This case report recommends the radiographic examination for all suspected cases of pneumothorax and/or pneumoperitoneum for accurate diagnosis and prognosis. The main limitation of this study was the small number of the study population.

CONCLUSION

This case report records pneumothorax secondary to pneumomediastinum and progressed to a generalized subcutaneous emphysema and pneumoperitoneum in a cat. Both clinical and radiographic findings are characteristic for these affections. Although the case is self-limiting unless other complications develop, evacuation of the escaped air within the thoracic and abdominal cavities may accelerate the recovery time.

SIGNIFICANCE STATEMENTS

This study will help the researchers to uncover the critical areas of management of pneumoperitoneum, pneumothorax and subcutaneous emphysema in cats that many researchers were not able to explore. Thus a new theory on management of pneumoperitoneum, pneumothorax and subcutaneous emphysema in cats may be arrived at veterinary practice.

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