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Emphysematous lesions in the right cranial lung lobe and torsion of the right medial lung lobe in a British shorthair cat: a case report

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ABSTRACT: A three-year-old male British shorthair cat that had exhibited progressive lethargy and intermittent dyspnoea for 14 days was referred for evaluation of acute respiratory deterioration. Clinical findings included rapid and shallow breathing, pale mucous membranes, sound suppression on the right side, and a subcutaneous haematoma in the right epigastric area. Serum biochemistry analysis showed leukocytosis and thrombocytosis. Radiographs revealed hydropneumothorax, a broken eighth right rib, atelectatic right cranial lung lobe (RCrL), and consolidation of the right middle lobe (RML). Doppler examination revealed sonographic changes in the echotexture of both lobes and venous flow was absent in the twisted RML. Furthermore, bronchoscopy showed proximal narrowing of the cat's RML bronchus. Exploratory surgery via medial sternotomy confirmed torsion of the RML and identified deteriorated gas-containing lesions in the collapsed RCrL. Both lung lobes were removed by standard lobectomy, and postoperative recovery was without major complications. Histopathological examination diagnosed multiple bullae and blebs, with significant subpleural haemorrhages in the atelectatic RCrL, whereas tissue congestion with haemorrhages, necrosis, and thrombosis typical for lung lobe torsion were observed in the RML. No other underlying aetiology was apparent. Two months post-operatively, the cat presented with similar acute onset of dyspnoea and spontaneous pneumothorax and was euthanised at the owner's request. The autopsy revealed identical new emphysematous changes in the contra-lateral lung lobes that had been absent at the time of surgery. Emphysematous lesions, regardless of their origin, should be considered in the etiopathology of lung lobe torsion.

Keywords: bullae; lobular emphysema; spontaneous pneumothorax; twisted lobe; lobectomy

Lung lobe torsion is a condition in which a lung lobe rotates around its longitudinal axis. This disorder is more common in dogs than in cats (Gicking and Aumann 2011). In addition to a traumatic aetiology, it has been associated with conditions such as chronic respiratory disease, pulmonary migrating foreign bodies, and chylothorax (Williams and Duncan 1986; Hoover et al. 1992; Gelzer et al. 1997; Neath et al. 2000; Da Silva and Monnet 2011). In cats, the torsion is associated with diaphragmatic or peritoneopericardial hernia, feline asthma and chylothorax (Kerpsack et al. 1994; Dye et al. 1998; Mclane and Buote 2011; Hambrook and Kundig 2012). Spontaneous torsion in cats has also been reported (Millard et al. 2008). The breed, age, and sex of affected cats have not been reported. In dogs, in which the condition is better documented, predisposition for lung lobe torsion is related to younger and middle-aged, large breed, deep-chested animals; the right middle lobe (RML) is most frequently affected (Hofeling et al. 2004; D'Anjou et al. 2005). However, it also occurs in small breeds, in which torsion is generally spontaneous and over-represented in the left cranial lobe (Rooney et al. 2001; Murphy and Brisson 2006). Chronic presentation of torsion as well as concurrent torsions have been reported (White and Corzo-Menendez 2000; Murphy and Brisson 2006). Lobectomy via thoracotomy or video-assisted thoracoscopic surgery (VATS) is indicated for both canine and feline

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lung lobe torsion. Post-surgically, recurrences of repositioned lobes have been reported, as well as torsions of other lobes (Johnston et al. 1984; Neath et al. 2000; Spranklin et al. 2003).

Crowding from bullae and blebs causes broad lobular emphysema. Bullae are divided into several subtypes, depending on the size and location (near the lung surface versus deep within the parenchyma). Blebs are superficial air pockets trapped inside visceral pleura and, therefore, more prone to deterioration when a sudden rise in intrathoracic pressure occurs (Brissot et al. 2003; Bertolini et al. 2009; Milne et al. 2010; Ruth et al. 2011). Bullae and blebs formation are reported as either primary idiopathic or secondary effects (i.e., a result of underlying disease or trauma) (Kramek et al. 1985; Grosslinger et al. 2000; White et al. 2003; Matsumoto et al. 2004). Coexisting pathologies such as chronic obstructive pulmonary disease, feline asthma, and fungal infections have also been reported (Lipscomb et al. 2003; Crews et al. 2008). Bilateral and multilobar lesions are present in more than 50% of reported cases (Lipscomb et al. 2003). There is no breed, sex, or age predisposition described in cats. The potential of conservative, non-surgical treatment is limited; partial or complete lung lobectomy is recommended.

Thus, to the best of our knowledge, this is the first report presenting simultaneous appearances of a pulmonary emphysematous disorder and lung torsion in a feline patient and the outcome of its surgical removal.

Case description

A three-year-old, 5.5-kg, castrated male, British shorthair, properly vaccinated and dewormed cat presented with acute respiratory deterioration after a two week history of progressive lethargy and intermittent dyspnoea. The cat had been missing for three days prior to the examination. Clinically, the cat was apathetic, with rapid, shallow, open-mouth breathing and pale mucosal membranes. On thoracic auscultation, bronchovesicular sound suppression was present on the right side, with sharpened breathing and heart sound noted on the left side. The abdominal cavity was tense and painful in the epigastric area, where a subcutaneous haematoma was present. Bloodwork (CBC) showed leukocytosis (21.5×10^9/l, reference range $5.5–19.5 \times 10^9$/l) and thrombocytosis (580×10^9/l, reference range $175–500 \times 10^9$/l). Lateral thoracic X-rays showed evenly increasing radiopacity in the dorsal-to-sternum direction, obscuring complete lung visualisation, with minimally elevated heart silhouette, in both right and left view. X-rays also showed lung lobe margins demarcated by free fluid, with gas retraction and a consolidated right cranial lobe (RCrL) seen in ventrodorsal position, as well as fracture of the right eighth rib. After thoracocentesis, consolidation of the right middle lobe (RML) with persistent, cranioventrally oriented air bronchograms was visible. No pneumomediastinum was evident. Eighty millilitres of air and seventy millilitres of serosanguinous fluid were evacuated with an 18-gauge butterfly needle attached to a three-way stopcock and a 50-ml syringe. The guide needle sample proved to be non-septic, non-specific exudate. Ultrasound examination revealed the fully visible, non-collapsed bronchus of atelectatic RCrL, which had lost normal reflectivity, and a diffuse effect of liver echogenicity in the rounded RML with gas-related hyperechoic artifacts. Doppler examination identified the absence of venous flow in the RML. Based on these examinations, lung lobe torsion, contusion injury, and emphysematous lung lesions were considered.

After support with fluids in an oxygen-rich environment, the animal was pre-medicated with diazepam (0.2 mg/kg *i.v.*; Diazepam, Slovakofarma, Slovak Republic) and buprenorphine (0.02 mg/kg *i.v.*; Bupaq Multidose, Richter Pharma, Austria) and inducted with propofol (1–6 mg/kg *i.v.*; Propofol-Lipuro, B. Braun, Germany) in supplemental oxygen. Bronchoscopy showed proximal narrowing of the RML bronchus with serosanguinous fluid emerging. The inducted animal was maintained in anaesthesia with isoflurane gas in oxygen, prepared for surgery, and preoperatively administered cefazolin natricum (22 mg/kg *i.v.*; Vulmizolin, Biotika, Slovak Republic). A tidal volume of 10 ml/kg at a frequency of 15 inspirations/minute was set. Pain management was supported by fentanyl citrate (0.4 µg/kg/min; Fentanyl Injection, Chiesi Pharma, Austria), administered as a constant rate infusion (CRI). Median sternotomy revealed a twisted and congested RML and atelectatic RCrL, with several collapsed gas-containing lesions and dispersed haemorrhagic spots on the surface (Figure 1). All other lung lobes and tracheobronchial lymph nodes appeared grossly normal. The affected lobes were isolated, and complete lobectomies using transfixing sutures of four metric polypropylene monofilament

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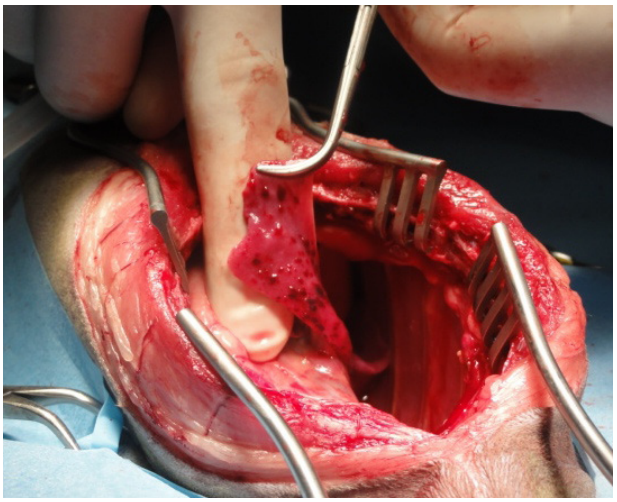

Figure 1. Lobular emphysema: intraoperative view

(Surgipro, Covidien, US) and oversewn sutures with 1.5 metric polypropylene monofilament (Premilene, B. Braun, Germany) were performed, without repositioning the RML. The chest cavity was filled with warm saline solution, and the lungs were checked for air leaks. The circumsternebral closure was made in a figure eight pattern using five metric polyester braided ultra-high polyethylene (Fiberwire, Arthrex Inc., Germany). A right-sided thoracic drain (14 Fr) was inserted and fixed using three metric Premilene suture in a Chinese finger-trap pattern. Postoperatively, a loosely placed bandage was applied around the patient's chest, and a three-bottle continuous suction system was installed. After microbiological culture submission, the removed lobes were processed and stored in 10% formalin solution. Postoperatively, the cat was treated with oxygen therapy and pain management was maintained with ketamine (5 μg/kg/min; Narketan, Vetoquinol SRO, Czech Republic) CRI for the first 24 h and buprenorphine (0.02 mg/kg) subcutaneously every 6 h for three days, at which point the chest drain was removed. A thoracic radiograph was taken 24 h after drain removal and the animal was discharged four days post-operatively. Cefadroxil (20 mg/kg *p.o.*; Cefa Cure, Intervet, The Netherlands) every twelve hours was chosen as the antibiotic therapy for the following seven days until negative culture results from pleural effusion and lung tissue were received. Nonsteroidal analgesics (Robenacoxib [1 mg/kg *p.o.*; Onsior, Novartis, Finland]) every 24 h were also administered for the first three days of home convalescence. The owners confirmed a good, complication-free recovery during the convalescence period.

Histopathology revealed atelectatic collapse of the RCrL with multiple, diffuse, subpleural bullae that were empty or contained haemorrhages. Pleural thickening with haemorrhages in the surrounding alveoli was present. The RML was congested with multiple emphysematous lesions and regions of haemorrhage, necrosis, and thrombosis typical for lung lobe torsion. No infection or other underlying disease was apparent. The cat was presented again two months after the surgery with a similar acute onset of dyspnoea and spontaneous pneumothorax and was euthanised at the owner's request. Post-mortem examination revealed identical emphysematous changes, in the cranial and caudal part of the left cranial lobe.

DISCUSSION AND CONCLUSIONS

In the present case, the presence of haematomas with unresorbed air in the twisted lobe demonstrated that trauma and lobe torsion occurred no more than two to three days prior to presentation of the patient. We presume trauma to be a potential underlying cause of the RML torsion; however it remains unclear, whether the affected pulmonary lobes suffered pleural collapse before the trauma happened, or whether the trauma was a trigger of this condition. The cat manifested apathy and intermittent dyspnoea for two weeks before its deterioration and presentation at our clinic. This indicates that some of the lung lesions could have collapsed earlier and that trauma only potentiated a pre-existing condition. The primary or idiopathic nature of the lesions was confirmed by negative culture and pathohistology findings.

Emphysematous lung lesions are often overlooked due to the nature of their symptoms and only become visible with acute deterioration related to underlying disease, trauma, or a simultaneous condition such as lung torsion. In one report, bronchopulmonary dysplasia with lack of surfactant was suggested as the underlying cause, but not clearly demonstrated (Milne et al. 2010). Co-existing pulmonary disease was not found in our patient pre- or intra-operatively nor confirmed by pathohistology and autopsy two months later. Trauma was not witnessed by owners but was confirmed by clinical, diagnostic imaging and surgery findings. An interesting aspect of the described case is that the lung lobe torsion was right-sided,

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contrary to the predominant reports of left-sided torsion in cats and small breeds of dogs (D'Anjou et al. 2005; Seiler et al. 2008). Bronchial cartilage dysplasia predisposes dogs to lung lobe torsions; the involvement of this dysplasia is also believed to play a role in the pathogenesis of lobar bullous emphysema (Stogdale et al. 1982; Hoover et al. 1992; Matsumoto et al. 2004). In our case, similar findings were neither confirmed pathohistologically, nor could we find published reports of such a phenomenon in feline patients.

Two-dimensional radiology is of insufficient sensitivity to diagnose the size and spread of bullae and blebs. It is even less reliable in cases where air has leaked into the thoracic cavity or where observations are complicated by pleural effusion. More specific radiographic findings are seen in lung lobe torsion when gas and liquid artifacts are removed; however, signs of lung attenuation can be variable (Siems et al. 1998). Computed tomography (CT) evaluation has superior characterising abilities for both conditions, regardless of tissue features and their distribution, or bronchus patency and its position (Au et al. 2006; Seiler et al. 2008; Schultz et al. 2009; Ruth et al. 2011). Although we lack such technology at our facility, the diagnostic power of CT was partially replaced by sonography and bronchoscopy. Conclusive pre- and post-thoracentesis sonographic controls as well as subsequent bronchoscopy proved to be beneficial in managing the patient. Although sampling of the non-septic exudate was helpful in determining differentials, it was also not specific enough to distinguish primary from secondary conditions. Fine needle aspiration of the lung lobe tissue was not performed, given the low quality of the lung lobe cytological samples.

Explorative thoracotomy was indicated as a method for confirming and completing diagnosis as well as forming a part of therapeutic treatment. Although more invasive compared to VATS lobectomy, in smaller patients with limited working space, an open thoracotomy with standard lobectomy seems to be the more efficient method. Because of the involvement of two lobes we preferred median sternotomy over intercostal thoracotomy to explore the lung surface and perform the subsequent volume reduction. The scientific literature indicates no differences between the two surgical approaches regarding the duration of thoracic drain placement, length of hospital stay, and the need for additional analgesia (Ringwald and Birchard 1989). Sternotomy closure in our patient was made with Fiberwire suture, which appears to be faster in facilitating reduction and less traumatic than the use of cerclage wire. Suturing in a figure-eight manner is stable, with the least displacement at higher loads, highlighting that if the tensile strength of the suture is adequate, osteochondral healing depends not on the tissue material itself, but rather on suture characteristics (Pelsue et al. 2002; Davis et al. 2006).

Postoperatively, no problems with recovery arose, but we did not obtain a long-term period without remission of the primary cause. Long-term outcome for lobe torsion disorder in surgically treated animals appears to be fair-to-guarded, with an overall survival rate of approximately 50% in the first postoperative months (Neath et al. 2000). In surgical patients with lobular emphysematous lesions, the long-term outcome is good-to-excellent; however a risk of continuing air leakage from disseminated lesions persists (Brissot et al. 2003; Lipscomb et al. 2003). According to the published literature, there is a minimal rate of recurrence in dogs treated with surgery (Puerto et al. 2002); but useful quantities of clinical data are missing in cats. Prognostic factors in both pathologies are associated with general animal condition at the time of surgery, the lobes involved, underlying disease, and histopathology results. Pulmonary collagen defects, reported by Kramek et al (1985), predispose animals with emphysematous formations to recurrent pneumothorax, which could be accompanied by higher mortality rates. This observation suggests that additional efforts are necessary to better understand genetic variations affecting pulmonary microstructure and assembly properties. The percentage of reported firm pleural adhesions that arise after pleurodesis is likely to have limited preventive ability (Jerram et al. 1999), an issue that still needs to be discussed and improved to achieve acceptable post-surgical outcomes.

Cats rarely present gas-containing lesions and lung lobe torsion independently, and we report a case with their simultaneous development. More sensitive diagnostics would have been possible with CT scan examination. Lobectomy is the primary method of treatment for restoration of lung function, but it is not always curative, especially in patients in which the lung tissue is broadly affected by diffuse emphysema. In such patients, long-term success is unlikely.

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Spolupráce podle čl. 36 nařízení Evropského parlamentu a Rady č. 178/2002

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