Symptomatic emphysematous lesions affecting the right cranial and medial lobes of the lungs in a British shorthair cat: a report of a single case

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ABSTRACT: A male British shorthair cat, three years old, was sent for an examination of acute respiratory deterioration after displaying growing lethargy and occasional dyspnoea for fourteen days. A subcutaneous haematoma was discovered in the right epigastric region, along with pale mucous membranes, sound suppression on the right side, shallow and fast breathing, and other clinical symptoms. Leukocytosis and thrombocytosis were detected in the serum biochemistry test. On the radiographs, we can see hydropneumothorax, a fractured eighth right rib, an atelectatic right cranial lung lobe (RCrL), and a consolidation of the right middle lobe (RML). The twisted RML did not have venous flow, and a Doppler scan showed sonographic alterations in the echotexture of both lobes. And bronchoscopy revealed that the cat's right middle lobe bronchus was narrowed around its mouth. Medial sternotomy, an exploratory procedure, verified RML torsion and located gas-containing lesions in the collapsed RCrL that had worsened. The patient had a routine lobectomy to remove both lung lobes, and there were no significant problems during or after the operation. In the atelectatic RCrL, histopathology revealed many bullae and blebs, along with substantial subpleural hemorrhages; in the RML, however, lung lobe torsion-typical findings such as tissue congestion, hemorrhages, necrosis, and thrombosis were seen. It did not seem that there was any other underlying cause. The owner requested euthanasia after the cat had comparable sudden onset of dyspnoea and spontaneous pneumothorax two months after surgery. The autopsy confirmed the presence of new emphysematous abnormalities in the opposite lobes of the lung, which were not present before surgery. When trying to determine what causes lung lobe torsion, it is important to take emphysematous lesions into account.

Keywords: lobular emphysema, twisted lobe, spontaneous pneumothorax, bullae, and lobectomy

INTRODUCTION:

Lung lobe torsion is a condition in which a lung lobe rotates around its longitudinal axis. This dis- order is more common in dogs than in cats (Gicking and Aumann 2011). In addition to a traumatic aeti- ology, it has been associated with conditions such as chronic respiratory disease, pulmonary migrat- ing 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, andsex 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-chest- ed 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 pre- sentation 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 sur- gery (VATS) is indicated for both canine and feline

oi: 10.17221/8586-VETMEDung 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

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broad lobular emphysema. Bullae are divided into several subtypes, depending on the size and location (near the lung surface versus deep within the parenchy- ma). Blebs are superficial air pockets trapped inside visceral pleura and, therefore, more prone to dete- rioration when a sudden rise in intrathoracic pres- sure 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 dis- ease or trauma) (Kramek et al. 1985; Grosslinger et al. 2000; White et al. 2003; Matsumoto et al. 2004). Coexisting pathologies such as chronic obstruc- tive 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 inter- mittent dyspnoea. The cat had been missing for three days prior to the examination. Clinically, the cat was apathetic, with rapid, shallow, open-mouth breath- ing and pale mucosal membranes. On thoracic aus- cultation, bronchovesicular sound suppression was present on the right side, with sharpened breathing and heart sound noted on the left side. The abdomi- nal 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 × 10^9/l) and thrombocytosis (580 × 10^9/l, reference range 175–500 × 10^9/l). Lateralthoracic X-rays showed evenly increasing radiopac- ity 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 tho- racocentesis, 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 mil- lilitres 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 sam- ple 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 en- vironment, the animal was pre-medicated with di- azepam (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 oxy- gen. 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 ce- fazolin 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 sutures of four metric polypropylene monofilament 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

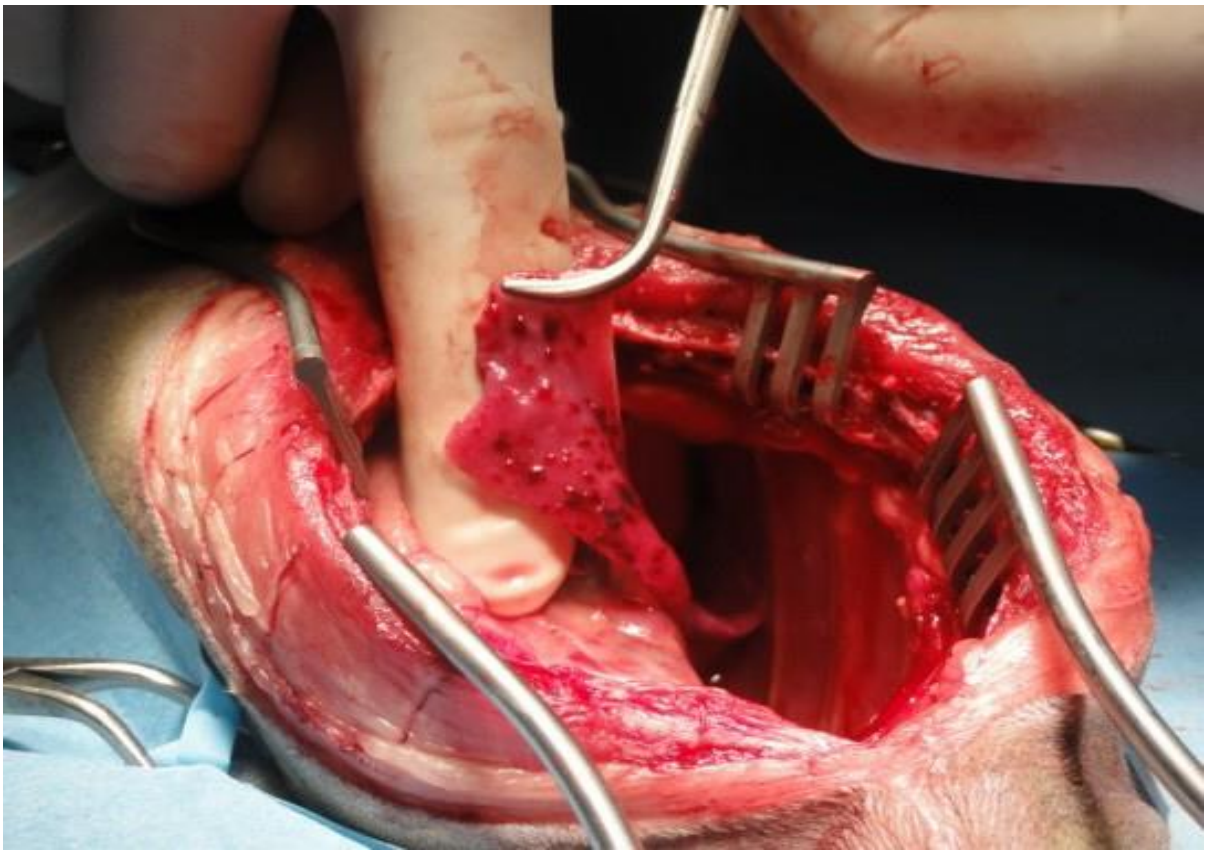

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Figure 1. Lobular emphysema: intraoperative view

(Surgipro, Covidien, US) and oversewn sutures with
1.5 metric polypropylene monofilament (Premilene, B. Braun, Germany) were performed, without repo- sitioning 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 polyes- ter 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 ap- plied around the patient's chest, and a three-bottle continuous suction system was installed. After mi- crobiological culture submission, the removed lobes were processed and stored in 10% formalin solu- tion. Postoperatively, the cat was treated with oxy- gen 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 con- valescence. The owners confirmed a good, complica- tion-free recovery during the convalescence period.Histopathology revealed atelectatic collapse of the RCrL with multiple, diffuse, subpleural bul- lae that were empty or contained haemorrhages. Pleural thickening with haemorrhages in the sur- rounding alveoli was present. The RML was con- gested 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 pre- sented 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 iden- tical 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 demon- strated 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 over-
looked due to the nature of their symptoms and only become visible with acute deterioration re- lated to underlying disease, trauma, or a simul- taneous 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 con- firmed by clinical, diagnostic imaging and surgery findings. An interesting aspect of the described

case is that the lung lobe torsion was right-sided,
doi: 10.17221/8586-VETMED 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 pathohistologi- cally, 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 tomog- raphy (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-thora- centesis 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 diagno- sis as well as forming a part of therapeutic treat- ment. Although more invasive compared to VATS lobectomy, in smaller patients with limited working space, an open thoracotomy with standard lobecto- my 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 man- ner 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-excel- lent; 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 forma- tions 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 assem- bly 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

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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 func- tion, but it is not always curative, especially in pa- tients in which the lung tissue is broadly affected by diffuse emphysema. In such patients, long-term success is unlikelydoi: 10.17221/8586-VETMED

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