

## A NEUROLOGICAL COMPLICATION AFTER LEFT-SIDED PNEUMONECTOMY IN A CAT

*Een neurologische complicatie na een linkerlonghelftresectie bij een kat*

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### ABSTRACT

**This case report describes ischemic neuromyopathy of the left hind limb as a postoperative complication after left-sided pneumonectomy for a squamous cell carcinoma of the left caudal lung lobe with secondary abscessation in a cat. We hypothesize about the possible causes of this postoperative complication and review the literature.**

### SAMENVATTING

In deze casuïstiek wordt een postoperatief ontstane ischemische neuromyopathie van de linkerachterpoot bij een kat beschreven. De kat onderging een linkerlonghelftresectie (pneumonectomie) vanwege een plaveiselceltumor met secundaire abscessvorming in de caudale lob van de linkerlong. De mogelijke oorzaken van de neuromyopathie en de literatuur worden kort beschreven.

### INTRODUCTION

Pneumonectomy involves removal of the left or right side of the lung. The left side of the lung constitutes approximately 42% of the total lung volume, the right side 58% (Nelson and Monnet, 2003). This procedure is indicated if all lobes on one side are affected by the disease process. After left-sided pneumonectomy, compensation occurs by recruitment of existing reserves and remodeling. But if more than 50% of the total lung volume is removed, as in right-sided pneumonectomy, new or regenerative alveolar-capillary growth will also occur (Nelson and Monnet, 2003). This also has been shown experimentally in cats (Rannels and Rannels, 1988). Indications for a left- or right-sided pneumonectomy are abscessation, neoplasia or extensive trauma (Nelson and Monnet, 2003). Pneumonectomies in cats in clinical cases have been described for neoplasia (Clements *et al.*, 2004; Liptak *et*

*al.*, 2004). The cat in the first case report underwent a left-sided pneumonectomy for resection of a well-differentiated pulmonary adenocarcinoma (Clements *et al.*, 2004). In the second case report, the cat underwent left-sided pneumonectomy for exploration of a left caudal lung lobe mass. Histology revealed a pulmonary squamous cell carcinoma (Liptak *et al.*, 2004).

Lung lobe abscessation can occur secondarily to neoplasia (Stann and Bauer, 1985), or it can occur secondarily to a foreign body, penetrating wound or chronic infections (McKiernan, 1982; Hoffer *et al.*, 1999).

Feline Aortic Thromboembolism (ATE) or ischemic neuromyopathy is a well-described entity in cats. Signs are usually **peracute** and consist of vocalization, lateralizing **paresis**, **pain**, cold extremities and absence of an arterial **pulse** in the hind limb(s) (also referred to as **four P's**) (Fox, 2000). It is a very debilitating disease, which requires aggressive therapy and has a high mortality rate (55-63%) (Laste and Harpster, 1995;

Stein *et al.*, 1995; Schoeman, 1999). In the majority of cats suffering from ATE, either pre-existing cardiac disease was present (11%) or abnormal auscultation (57%) was noted on presentation (Laste and Harpster, 1995). Electrocardiographic (ECG) changes have been reported in 85% of cats with ATE and usually cardiomegaly is present on thoracic radiography (89%) (Laste and Harpster, 1995; Fox, 2000). The most frequent underlying disease was feline hypertrophic cardiomyopathy (58%) with the left atrial size (as measured by M-mode) significantly increased in the majority of cases (33 cats of 63 with ATE) (Laste and Harpster, 1995).

Feline ATE has also been described secondarily to tumor embolism of an adenocarcinoma. On cytology of the embolus, signs of malignancy were noted (Sykes, 2003). And in a second case, paraneoplastic ATE was suspected to have caused the clinical signs of distal ATE in a cat without evidence of cardiac disease (Hogan *et al.*, 1999).

Thromboembolization after pneumonectomy in humans is a common, well recognized and very serious complication (Chen *et al.*, 2001). In contrast, metastatic arterial embolization is a rare complication (Fushimi *et al.*, 1998).

## CASE DESCRIPTION

### Work up

A 13-year-old female domestic shorthair cat was referred to the Department of Medicine and Clinical Biology of Small Animals with the complaint of anorexia of 2 weeks' duration. On clinical examination, dehydration (5%) was noted. On auscultation, dampening of cardiac tones on the right side was noted and, on one occasion, a gallop rhythm was heard. On non-invasive Doppler blood pressure monitoring, a mean arterial pressure of 120mmHg was found. She also had an old, mature cataract lesion in her right eye.

On a first examination (January 19th), all complete blood count (CBC) values were within normal limits, in the biochemistry panel there was a marked increase in lactate dehydrogenase (LDH) (806 units; reference 0-192 units), with an increase of LDH-1 (31.7%; reference 0-8 %) and a decrease of LDH-5 (31.8%; reference 40-66.3%), and LDH2-4 were within reference values.

On a second CBC performed 4 days later: a leukocytosis (31,130; reference 5,000-19,000) with neutrophilia (28,640; reference 2,500-12,500), a leftshift (311; reference 0-300) and a lymphopenia (1,245; re-

ference 1,500-7,000) were evident. The cat was FeLV and FIV negative.

On thoracic radiography, consolidation of the left caudal lung lobe and atelectasis of the left cranial lung lobe were seen. Differentials at this time included: neoplasia, abscess and lung lobe torsion. Thoracic ultrasonography revealed a consolidated left caudal lung lobe with an irregular border on its dorsal aspect. Anechoic cavities were seen scattered through the entire lobe. Ultrasound guided fine needle aspiration of the left caudal lung lobe was performed and yielded purulent material. A presumptive diagnosis of a lung lobe abscess was made at this time and surgical exploration was advised to the owners. Abdominal ultrasound revealed no abnormalities.

Fluid therapy, Lactated Ringer's (at a rate of 60 ml/kg BW/24 hours) and antibiotic therapy with a combination of enrofloxacin 5 mg/kg BW (Baytril, Bayer, Brussels, Belgium) and clavulanic acid potentiated amoxicillin (12.5 mg/kg BW SC sid, Synulox RTU, Pfizer Animal Health, Nossegem, Belgium) were instituted.

### Surgery

No premedication was administered because pre-anesthetic evaluation revealed a poor general condition. After placement of a 22 G intravenous catheter in the accessory cephalic vein, induction of anesthesia was performed using a 50/50 mixture of diazepam (Valium, Roche) and ketamine (Anesketin, Eurovet) intravenously. A 3 mm endotracheal tube (Rush, Germany) was placed after local anesthesia of the larynx with a 2% lidocaine spray (Xylocaine, Astra Pharmaceuticals). Anesthesia was maintained with isoflurane (Forene, Abbott) in oxygen using a commercial circle system with 10 mm pediatric tubes (Dräger, Narkosespiromat 656). A positive end expiratory pressure (PEEP) ventilation mode was instituted. Monitoring included capnography (Datex capnomac ultima), pulseoximetry (Nellcor), electrocardiography (Lifescope, Nihon) and non-invasive blood pressure measurement (Dinamap).

The left caudal lung lobe was approached through a left 5th intercostal thoracotomy. The cranial and caudal parts of the left cranial lung lobe were packed off with moistened laparotomy sponges. There were fibrous adhesions between the lung lobe, diaphragm and the thickened mediastinum. The adhesions to the diaphragm were bluntly severed to remove the lung lobe. The attached mediastinum was resected with the lung lobe. The caudal lung lobe was removed in a routine

manner. The pulmonary vasculature was partly occluded intraluminally by tissue. The cranial lobe was inspected and an attempt was made to inflate it manually. As it remained collapsed, the decision was made to resect the cranial lobe. The vessels were doubly ligated and the bronchus was closed using interrupted horizontal mattress sutures, after which it was oversewn with a simple continuous suture pattern (all in 3-0 polydioxanone, PDSII, Ethicon, Neuilly, France). The thoracic cavity was lavaged with sterile isotonic lavage fluid preheated to body temperature. No air leaks were noted and the thorax was closed in a routine manner. A thoracostomy tube (COOK© Veterinary products, Strombeek-Bever, Belgium) was placed (7th intercostal space and tunneled subcutaneously for 3 cm), and secured by means of a Chinese finger trap suture in ethilon 3-0 (Ethicon, Neuilly, France). The ribs were approximated with 5 simple interrupted sutures (PDSII 2-0, Ethicon, Neuilly, France). The muscle layers were anatomically apposed using 2-0 polydioxanone (PDSII 2-0, Ethicon, Neuilly, France), the subcutis was closed with a continuous suture pattern and the skin with simple interrupted sutures (ethilon 3-0, Ethicon, Neuilly, France).

Postoperatively, the cat remained in intensive care for 24 hours. Fluid therapy was continued (60 ml/kg BW/24 hours). She received buprenorphinum (30 µg/kg BW IM qid, Temgesic, Schering-Plough, Hull, UK) for analgesia. The cat was maintained on clavulanic acid potentiated amoxicillin and enrofloxacin for 4 days postoperatively.

### Postoperative complication

The cat was released from hospital on the fourth day postoperatively (January 29th). At home the owners noticed decreased use of the left hind limb. After telephone consultation, the cat was brought back in for further evaluation and examination. On clinical examination the cat showed diminished use of the left hind limb. Conscious proprioceptive deficits and subjectively lower temperature were noted in the left hind limb. The metatarsal pads appeared reddish blue (cyanotic). No pulse could be palpated in the femoral artery bilaterally. She had a severely diminished withdrawal reflex and normal patellar reflex in her left hind limb. No deficits were noted in the right hind limb.

A six-lead electrocardiogram was taken with the cat in right lateral recumbency (Nihon Cohden Cardiofax V Ecaps 12). The heart rate was 200bpm, with a regular sinus rhythm. No abnormalities were noted in

the P-QRS-T complex, and the electrical axis was within normal limits.

An echocardiogram was performed with the cat also in right lateral recumbency (GE Vingmed CFM 800, 7.5MHz transducer). Measurements were performed through a right parasternal short axis view. The diastolic and systolic thickness of the interventricular septum was normal, as was the diastolic diameter of the left ventricle. The systolic diameter of the left ventricle was slightly diminished. The left ventricular free wall could not be measured because the margins were not clearly delineated due to adjacent consolidated lung lobes. The short axis view with the aorta and the left atrium could not be obtained because of the displacement of the heart to the left. It was not possible to visualize the two optimally at the same time to perform measurements. Subjectively, the left atrium appeared dilated. The fractional shortening was elevated. The presumptive diagnosis of hypertrophic cardiomyopathy could not be confirmed.

The cat was placed on aspirin therapy (6 mg/kg BW, q72h). Neurologic signs progressed in her left hind limb despite treatment. Dyspnea was also noted. On thoracic radiography, a localized area of consolidation was noted in the right caudal lung lobe, with neoplasia and abscess as main differentials, with neoplasia being the most likely differential. Twenty-two mls of clear, blood tinged, exudative fluid were drained from the chest cavity (Protein 14 g/L, SG 1.017), after which the dyspnea subsided. On cytological examination (Romanowski stain) neutrophils, macrophages, erythrocytes and reactive mesenchymal cells were seen, but no definitive diagnosis of the cause for the effusion could be drawn from the cytology. No bacteria were seen. The histological evaluation of the resected lung lobe was diagnosed as carcinoma, probably squamous cell carcinoma (SCC) of the lung with metastases in the lobar blood vessels.

After 4 hours, the cat again became dyspneic. The left hind limb paresis had not improved despite therapy. Because of the worsening clinical condition of the cat, the recurring dyspnea, the progressing hind limb paresis and concurrent bad prognosis of both the ATE and a lung SCC, the owners elected to euthanize the cat. An autopsy was not allowed.

### DISCUSSION

The cat in the present report had a squamous cell carcinoma of the left caudal lung lobe. SCCs are found in 4-5% of feline malignant lung neoplasia and have a metastasis rate of 100% (Stann and Bauer, 1985). Fur-

thermore, overall prognosis for cats with lung tumors is poor, as diagnosis is usually late in the disease process, because the signs of illness are usually masked by the natural behavior of the cat (Mehlhoff and Mooney, 1985). In one study of 86 cats, 75.6% had evidence of metastatic disease (Hahn and McEntee, 1997). The differential diagnosis on radiography in the present case also included lung lobe torsion and abscessation due to non-neoplastic causes, therefore surgery was performed.

The cat presented with abnormal blood parameters: LDH was severely increased at the initial evaluation. Possible causes were myocardial disease or muscular disease. However, no lameness or cardiac abnormalities were detected at this time. The anorexia of two weeks' duration might possibly have contributed to muscle wasting and therefore increased LDH. Other sources for increased LDH are erythrocytes, the pancreas and the kidney. On a second evaluation, the CBC showed signs of acute infection, which was consistent with the diagnosis of a lung lobe abscess.

The cat in this case report suffered from a complication after surgery. This complication could have been cardiac related, surgery related or neoplasia related. The most common presentations of aortic thromboembolism are paraparesis or monoparesis, and in the majority of the cases radiographic and electrocardiographic abnormalities can be found, suggesting that cardiomyopathy is the underlying cause for this syndrome (Laste and Harpster, 1995; Fox, 2000). However, in this cat the electrocardiogram and the radiographic cardiac contour were all within normal limits. But an intermittent gallop rhythm could be ausculted and the left atrium appeared subjectively enlarged on echocardiography. Therefore, cardiac related ATE cannot be ruled out. Admittedly, it would have been preferable if an echocardiography had been performed prior to surgery, but the findings as they were postoperatively would probably not have influenced the decision to operate.

The embolus itself could have been further investigated by ultrasonography, cytology or possibly even angiography. This would have given additional information about the site of occlusion, percentage of occlusion and possibly cause of the occlusion. However, as the prognosis for the cat was grave, no further investigations were instituted.

There have been two case reports of ischemic neuro-myopathy in a cat secondary to neoplasia. In the first the authors suggested paraneoplastic thrombocytosis induced thromboembolism to be the cause of his symp-

toms (Hogan *et al.*, 1999). This cat had a normal thrombocyte count (351,000; range 180,000–430,000/ $\mu$ L) which leads to the assumption that this was not the underlying cause in this cat. In the second, malignant cells were found in the thrombus on cytological evaluation (Sykes, 2003). As cytology was not performed in this cat, this cannot be ruled out in the present case.

In dogs, ATE has been described secondary to neoplasia (Boswood *et al.*, 2000; Santamarina *et al.*, 2003). In a case series of 6 dogs, all patients were found to have underlying disease. In two cases neoplasia was considered to be the most likely etiology, although the specific mechanism of thrombosis could not be identified (Boswood *et al.*, 2000). In a separate case report, the thromboembolism was caused by the invasion of a pheochromocytoma into the caudal vena cava (Santamarina *et al.*, 2003). Direct tumoral ingrowth extending to the iliac bifurcation did not cause the ATE in our patient. Another etiology, aside from cardiac disease and neoplasia, has been described in the dog: migrating larvae of *Spirocerca lupi* were thought to be responsible for the formation of the ATE (Gal *et al.*, 2005).

In human medicine, pulmonary arterial thrombosis is a well recognized complication after lung lobe resection in human surgery. The most common site for thrombosis is a pulmonary artery, but case reports of aortic and cerebral thrombosis also exist (Zurcher *et al.*, 1996). Arterial tumor embolization is rare, through it has been described as a serious complication of neoplastic disease and the majority of these cases are connected to pulmonary localizations (Stein *et al.*, 1995; Zurcher *et al.*, 1996).

We hypothesize that in this case a surgery induced thromboembolization occurred, which might also have included tumoral cells; the occlusion of the vessels and the indications of metastatic disease in the histology report support this assumption. However, a cardiomyopathy related thromboembolism cannot be ruled out, especially because of the presurgically noted occasional galloprhythm heard on auscultation. Surgery could have contributed to the development of ATE, however.

## CONCLUSION

Several conclusions can be drawn from the present case: pneumonectomy is feasible in cats, but owners should be aware of the grave prognosis of feline pulmonary neoplasias. ATE can occur after pulmonary oncological surgery, irrespective of the etiology.

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