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CASE REPORT
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Lung Abscess in a Cat Successfully Treated without Surgery: Diagnostic Imaging Features

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ABSTRACT

***Background*:** Lung abscesses occur when the lung tissue necrotises due to various causes, such as bacterial infection, foreign bodies, or tumours, resulting in a pus-filled a cavity that forms a mass. Only one previous case of medical treatment for a lung abscess in cats has been reported, making it difficult to establish a well-defined treatment protocol. This report aimed to describe the radiographic, lung ultrasound, and computed tomography (CT) imaging features of lung abscesses, as well as the cytology and medical treatment involved.

***Case*:** A 11-year-old spayed female Persian cat was referred to the hospital with lethargy and frequent white, foamy vomiting. The patient had a preexisting chronic kidney disease and was under ongoing management. Thoracic radiographs revealed a soft tissue opacity mass in the left caudal lung lobe. Further diagnostic imaging examinatons were performed to determine the nature of a suspected tumour mass. Lung ultrasound showed a mass with a cavity containing anechoic fluid within consolidated lung parenchyma. CT imaging further revealed a well-defined mass with a central cystic lesion containing gas and peripheral contrast enhancement. Fine-needle aspiration (FNA) was successfully performed under ultrasound guidance without causing pneumothorax, revealing the presence of bacteria and neutrophils and leading to the diagnosis of a lung abscess. FNA results strongly suggested inflammation rather than a tumour; therefore, antibiotic treatment was initiated. Initially, doxycycline and clindamycin, which had been used in previously reported cases, were administered; however, persistent diarrhoea developed after 2 days. Doxycycline, known to cause gastrointestinal tract toxicity potentially, was then replaced with amoxicillin and clavulanate. The cat's clinical signs improved with antibiotic treatment, and the lung mass gradually decreased in size, resolving completely after 6 months without surgical intervention.

***Discussion*:** This report describes typical features of lung abscesses observed using radiography, lung ultrasound, and CT. Each diagnostic imaging modality has its own advantages and disadvantages. Although lung ultrasound and CT are more advanced than radiography and can provide detailed information about lesions, they are not suitable for follow-up. Lung ultrasound, though useful for obtaining cross-sectional views of the mass, is highly operator-dependent, making accurate monitoring of lesion size challenging. CT, the most advanced modality, requires general anaesthesia, which poses concerns for patients at risk of anaesthesia-related complications. Additionally, due to the higher radiation exposure compared with other modalities, performing multiple scans at short intervals is not feasible. Therefore, radiography remains the most effective tool for assessing size changes and treatment responses of such masses. Lung ultrasound can be helpful for providing more detailed information on lesions in cases where CT imaging is not feasible. In human medicine, medical management is the primary treatment option for lung abscesses. However, in veterinary medicine, only 1 case reported to date has been treated solely with medical management without surgical intervention. This case report describes a lung abscess that was successfully treated with medical management alone. It also raises the possibility of chronic kidney disease as an underlying cause of lung abscesses, which would require further research with larger sample sizes and systematic studies to investigate and confirm. Therefore, this case report documents the radiological features of a lung abscess, as observed using radiography, ultrasound and CT, as well as its medical management and potential underlying aetiology.

Keywords: chronic kidney disease, diagnostic imaging, fine-needle aspiration, lung abscess, lung ultrasound, radiography.

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INTRODUCTION

Lung abscesses are a type of liquefactive necrosis in which the lung tissue becomes necrotic, forming a cavity filled with pus after the formation of a bronchopulmonary fistula [18]. In veterinary medicine, they can be caused by trauma, bacterial or fungal infections, foreign bodies, neoplasia, or endobronchial obstruction [1,18]. In humans, major risk factors include aspiration in the oral cavity and poor oral hygiene [16]. Therefore, it is important to not only diagnose lung abscesses but also evaluate their underlying causes. Diagnostic imaging, including radiography, lung ultrasonography and computed tomography (CT), play a crucial role in the diagnosis of lung abscesses and in assessing their aetiologies [7,16].

In human medicine, lung abscesses are primarily treated with antibiotics. However, if the abscess is larger than 6 cm or if clinical symptoms persist for more than 12 weeks, surgical resection is considered [11]. In veterinary medicine, out of 7 previously reported cases, 6 underwent surgical treatment or euthanasia, whereas only 1 case was treated with antibiotics [4,7,9,12,15,17,19]. Selecting and administering correct antibiotics based on susceptibility tests is essential [15]. Treatment evaluation relies on the patient's clinical and radiographic responses, making radiographic monitoring crucial for assessing treatment effectiveness [11].

This report describes the diagnostic imaging features, including lung ultrasound and CT, radiographic monitoring, and pharmacological treatment approaches for feline lung abscesses.

CASE

A 11-year-old spayed female Persian cat presented with lethargy and frequent white foamy vomiting over 1 month. The patient had a history of ureteral surgery and was receiving ongoing treatment for chronic kidney disease (CKD). Thoracic radiography revealed an oval-shaped soft tissue opacity mass [47 mm (length) × 25 mm (height)] in the left caudal lung lobe with an ipsilateral left mediastinal shift, which was suspected to be concurrent with atelectasis (Figure 1A & B). Differential diagnoses included lung tumours, such as lung adenocarcinoma, and benign lung masses, such as granulomas, abscesses, and haematomas, concurrent with bronchopneumonia and secondary lung atelectasis.

Lung ultrasonography was performed to obtain additional information about the lung mass and showed a parenchymal lesion with a large cavitation lesion (10 × 8 mm) and a small amount of gas peripherally (Figure 1C). To further investigate the mass, CT was performed using a 16-slice CT scanner[1] [130 kVp, 100 mAs, 2 mm slice thickness, 0.6-s tube rotation time, and pitch of 0.6]. Contrast medium [600 mg iodine/kg iohexol[2]] was injected into the right cephalic vein. CT showed the left caudal lung lobe was abnormally small, with soft tissue attenuation, an air bronchogram, and abnormal dorsal positioning, consistent with lung atelectasis (Figure 2A & B). Additionally, multiple air-containing cystic lesions with rim contrast enhancement were identified, strongly suggesting lung abscesses (Figure 2C & D). The maximum attenuation values ranged from 15 to 120 Hounsfield unit (HU; mean, 60.17 HU). The lung lesion was in contact with the dorsal thoracic wall, allowing ultrasonography-guided fine-needle aspiration (FNA) to be performed without causing pneumothorax. The smear revealed inflammatory cells, mainly neutrophils, some of which appeared to surround bacteria (Figure 3). Clusters of mesothelial cells and groups of epithelial cells with moderate anisocytosis and anisokaryosis were observed in some smears. There were no findings indicating malignant disease, and the possibility of an abscess due to neutrophilic inflammation caused by a bacterial infection was considered high. Additionally, no anatomical or obvious respiratory abnormalities that could be considered the underlying cause of the lung abscess were identified on CT.

Empirical antibiotic therapy was initiated without antibiotic susceptibility testing due to the owner's financial constraints. Doxycycline[3] [5 mg/kg - PO, BID] and clindamycin[4] [10 mg/kg - PO, BID] were administered. Bromhexine[5] [0.5 mg/kg - PO, BID] was used as an expectorant, and theophylline[6] (10 mg/kg - PO, BID) was administered as a bronchodilator. Two days after starting the antibiotics, persistent diarrhea developed, and doxycycline was considered to be the cause. The antibiotic was then switched to amoxicillin/clavulanate[7] [AMC - 20 mg/kg, BID] and the antidiarrheal medication Furaberin[8] [10 mg/kg, BID] was added. The cat's clinical signs improved after the initiation of this treatment. The lung mass gradually decreased in size and resolved completely after 6 months without surgical intervention (Figure 4).

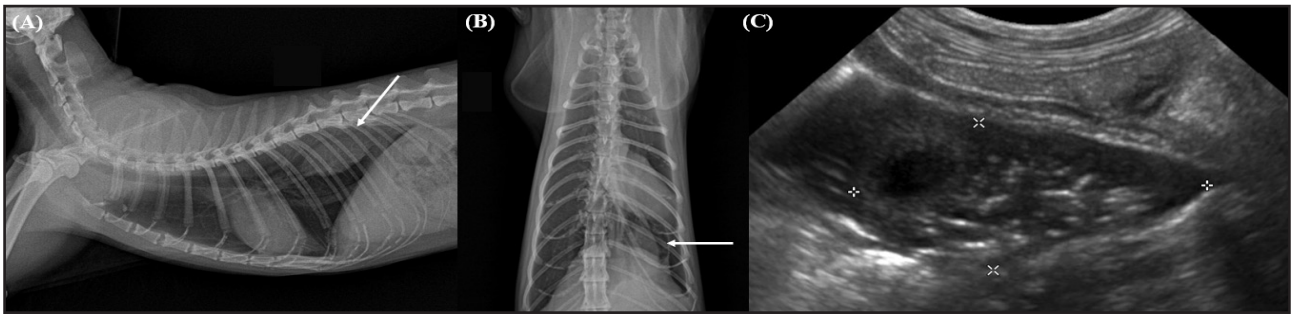

Figure 1. A- Right lateral and B -Ventrodorsal thoracic radiographs of the cat on the day of referral. A soft tissue opacity mas was observed in the left caudal lung lobe. C- Lung ultrasound of the left caudal lung lobe showed an oval-shaped mass (cross mark).

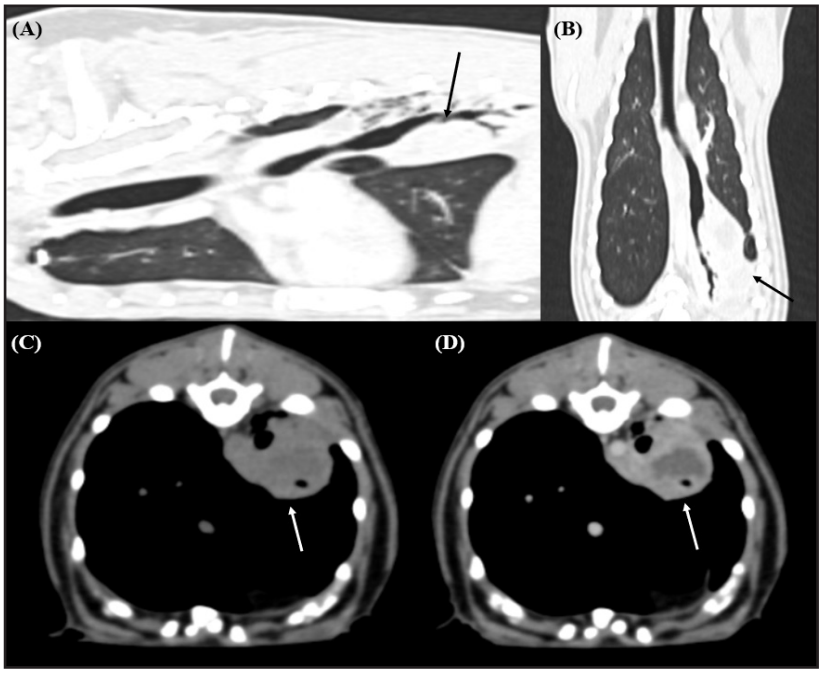

Figure 2. A- Sagittal and B- Dorsal images on contrast-enhanced computed tomography (lung window: window width, 1500; window level, -400). The air-containing cystic lesion with rim contrast enhancement (arrows) was identified pre-contrast (C) and contrast-enhanced (D) transverse images at the level of the 6th thoracic vertebra [abdomen window: window width, 400; window level, 60].

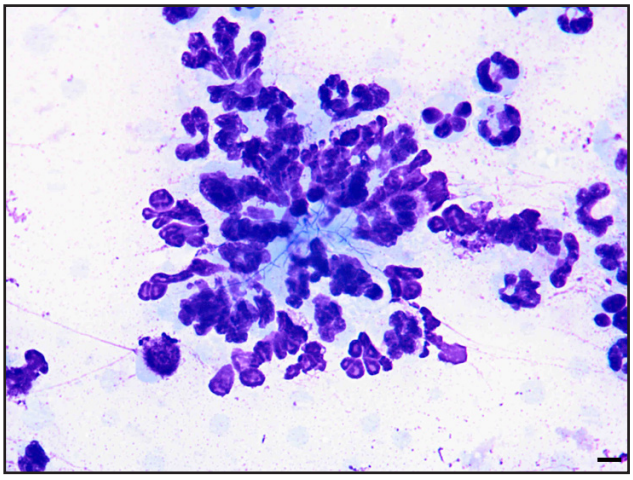

Figure 3. Cytology of the fine-needle aspirate sample collected from the lung mass revealed a large number of inflammatory cells, predominantly neutrophils. Clusters of neutrophils surrounding bacteria suspected to be filamentous bacteria were also frequently observed (Wright-Giemsa stain; 400x). [Scale-bar= 10 µm].

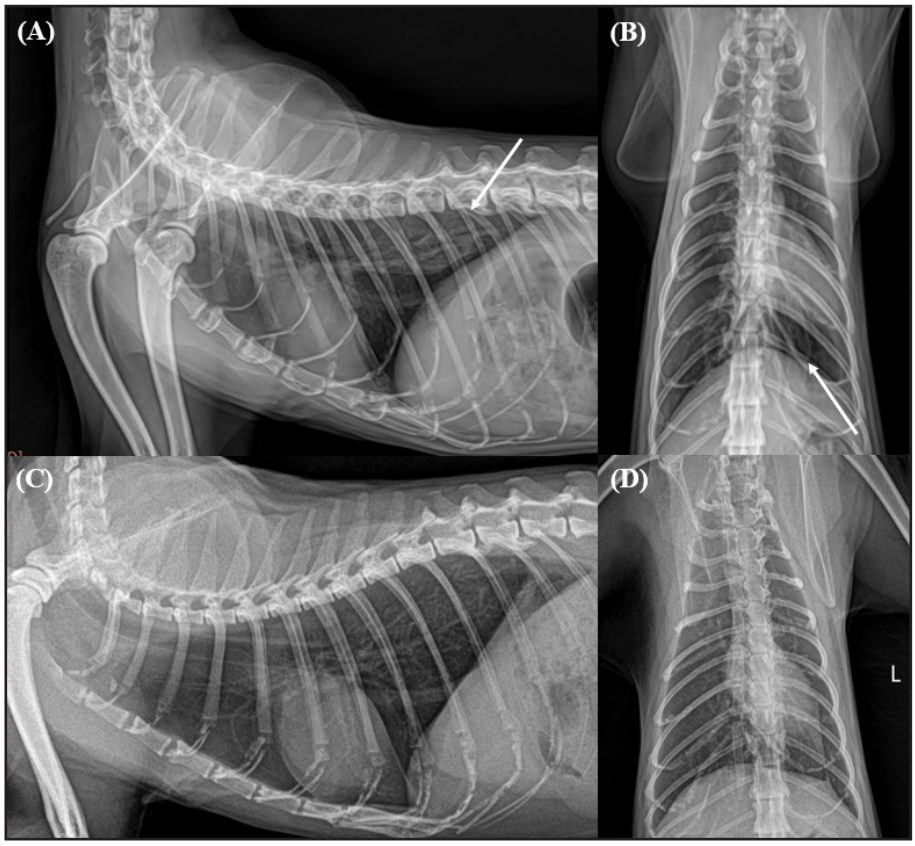

Figure 4. A- Right lateral and B- Ventrodorsal thoracic radiographs after 1 month of treatment. The lung abscess (arrows) appeared to have decreased in size but was still present. C- Right lateral and D- Ventrodorsal thoracic radiographs after 6 months of treatment. The lung abscess was completely resolved.

DISCUSSION

In veterinary medicine, only seven cases of lung abscesses have been reported, with just one case treated solely with medication without surgical intervention or euthanasia. In some cases, the causes were suspected to be foreign body ingestion or a history of pneumonia; however, the majority of cases had unknown causes [4,6,8,12,15,17,19]. In a previous feline case, the patient was also undergoing treatment for CKD without any other identifiable factors [15].

Lung abscesses are typically characterized by multiple abscesses resulting from lung gangrene and necrotizing pneumonia [20]. In humans, several studies have reported that inflammation causes immune cell dysfunction and increases susceptibility to infections. In CKD, reduced glomerular filtration rate can lead to higher concentrations of proinflammatory cytokines, increasing susceptibility to inflammation and leading to further complications, the most common of which is lung disease [3,14]. In veterinary medicine though, no association has been reported between CKD and pulmonary abscesses. However, CKD may be the underlying cause of lung abscesses in cats, warranting further research.

In a previous case, the diagnosis of lung abscess was made through FNA and sampling of resected lung tissue in only one reported case [15]. In most cases, lung abscesses have been diagnosed after surgical removal or necropsy [7,9,12,17,19]. In this case, although the diagnosis was also made using FNA, diagnostic imaging also allowed the identification of the lung mass and concurrent complications such as lung atelectasis. Moreover, among the many possible differential diagnoses for this lung mass, diagnostic imaging indicates an increased likelihood of it being a lung abscess, facilitated safe FNA, and allows noninvasive monitoring of the success of the treatment. In the present case, lung ultrasonography was performed to determine whether the mass was parenchymal or cystic. Ultrasound can be performed

without general anesthesia and can provide additional information about the mass, such as the detection of fluid collection or septation, prior to CT imaging [10]. Ultrasound findings of abscesses vary [10] but often show surrounding cellulitis or soft tissue oedema and often contain fluids. The abscess cavity is typically round but may have an irregular shape and is often characterised by anechoic or hypoechoic purulent material. Owing to the fluid-filled pus, acoustic enhancement posterior to the abscess is a common feature [8,10]. In the present case, lung ultrasound revealed a round cavity filled with hypoechoic fluid within a consolidated lung lobe, confirming that it was not a typical parenchymal mass. In a previous case, a patient referred for dyspnoea was initially presumed to have a lung tumour based on radiographic findings, but necropsy after euthanasia revealed a lung abscess [19]. Lung ultrasound can provide valuable diagnostic assistance in patients who cannot undergo CT. CT is an advanced imaging modality that provides detailed cross-sectional images [2]. Radiographically, pulmonary abscesses appear as cavitary lesions with well-demarcated fibrous walls [10]. Lung masses, such as cysts, haematomas, abscesses, and tumours, appear as soft tissue radiopacities on radiographs, making differentiation challenging [10]. Miscellaneous conditions, such as haematoma, pneumocytoma, lung abscess, and inflammatory myofibroblastic tumours, can mimic pulmonary cancer [6]. Despite advancements in CT equipment and imaging, differentiating these masses remains a challenge [6]. However, recent studies have begun to outline the distinguishing features for each type of mass [6]. Pulmonary abscesses often appear as cavities within single or multiple lung masses or nodules [6]. In the chronic phase, they may also present as subsolids and are frequently found in consolidated lung areas [6]. In most cases, the cavity interiors are smooth, with walls less than 15 mm thick, although irregular and thick walls can also be observed [6].

In this case, CT revealed that the mass was filled with fluid and mixed with air bubbles, exhibiting hypoattenuation upon contrast administration, which is characteristic of an abscess. Although FNA confirmed the abscess diagnosis in this patient, lung ultrasound-guided FNA carries risks, such as pneumothorax and bleeding, making it difficult to apply in all patients [15]. Therefore, imaging examinations play an even more critical role in diagnosis. Radiography is a valuable monitoring tool. Although lung ultrasound provides a cross-sectional view of the mass, it is not suitable for tracking its overall size over time [13]. Although detailed, CT scans are impractical for regular use because of the need for anaesthesia and the risk of radiation exposure. Radiographs, however, are less burdensome and appropriate for monitoring changes in the size of the mass through lung transparency. In this patient, the lung mass was first identified using radiography, and the treatment process was monitored, and resolution was confirmed through follow-up radiography.

In veterinary medicine, to date, there are 4 reported cases of lung abscess treatment, with only 1 case treated with antibiotics [15]. In the other 3 cases, surgical resection was opted [4,9,17]. Antibiotic treatment of lung abscesses in veterinary medicine is not well established. In a previous case of a feline lung abscess, doxycycline [8.0 mg/kg - PO, BID] and orbifloxacin (6.4 mg/kg - SID) were used [15]. Doxycycline was chosen because it is a broad-spectrum antibiotic that is frequently used to treat feline lower airway diseases. Orbifloxacin, a fluoroquinolone antibiotic, was selected because bacilli, considered to be anaerobic, were detected in the FNA samples [15]. In the current case, the patient was treated with doxycycline [5 mg/kg - PO, BID] and clindamycin [10 mg/kg - PO, BID], as described in a previous study. Clindamycin, a lincosamide antibiotic, was chosen for its efficacy against bacterial infections. However, the patient experienced persistent diarrhoea, and doxycycline, which can cause gastrointestinal tract toxicity, was discontinued and replaced with AMC (20 mg/kg - BID) [5]. AMC is also used to treat systemic infections, otitis media, streptococcal pharyngitis, pneumonia, cellulitis, urinary tract infections, and animal bites. Medical treatment was successful in this cat.

This study has some limitations. First, there was a lack of follow-up after 1 month of antibiotic treatment. When the patient returned to the hospital 6 months after starting antibiotics, the lung abscess had resolved. This situation occurred because the patient originally received CKD management, which was conducted at the referring hospital. Second, the choice of antibiotics was not guided by antibiotic sensitivity testing of the sample obtained through FNA. Additional cases are required to determine the optimal choice of antibiotics.

In conclusion, diagnostic imaging plays an important role in diagnosing lung abscesses and monitoring them with antibiotics without surgery. CKD may be an underlying cause of lung abscesses in cats; however, further research is required.

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REFERENCES

1 **Adamama-Moraitou K.K., Patsikas M.N. & Koutinas A.F. 2004.** Feline lower airway disease: a retrospective study of 22 naturally occurring cases from Greece. *Journal of Feline Medicine and Surgery*. 6(4): 227-233. DOI: 10.1016/j.jfms.2003.09.004.

2 **Bhalla A.S., Das A., Naranje P., Irodi A., Raj V. & Goyal A. 2019.** Imaging protocols for CT chest: A recommendation. *Indian Journal of Radiology and Imaging*. 29(3): 236-246. DOI: 10.4103/ijri.IJRI_34_19.

3 **Bollenbecker S., Czaya B., Gutiérrez O.M. & Krick S. 2022.** Lung-kidney interactions and their role in chronic kidney disease-associated pulmonary diseases. *American Journal of Physiology Lung Cell Molecular Physiology*. 322(5): L625-L640. DOI: 10.1152/ajplung.00152.2021.

4 **Crisp M.S., Birchard S.J., Lawrence A.E. & Fingeroth J. 1987.** Pulmonary abscess caused by a *Mycoplasma* sp. in a cat. *Journal of American Veterinary Medical Association*. 191(3): 340-342.

5 **Eljaaly K., Alghamdi H., Almehmadi H., Aljawi F., Hassan A. & Thabit A.K. 2023.** Long-term gastrointestinal adverse effects of doxycycline. *The Journal of Infection Developing Countries*. 17(2): 281-285. DOI: 10.3855/jidc.16677.

6 **Furuya K., Yasumori K., Takeo S., Sakino I., Uesugi N., Momosaki S. & Muranaka T. 2012.** Lung CT: Part 1, Mimickers of lung cancer-spectrum of CT findings with pathologic correlation. *American Journal of Roentgenology*. 199(4): W454-463. DOI: 10.2214/AJR.10.7262.

7 **Hesselink J.W. & Van den Tweel J.G. 1990.** Hypertrophic osteopathy in a dog with a chronic lung abscess. *Journal of American Veterinary Medical Association*. 196(5): 760-762. DOI: 10.3855/jidc.16677.

8 **Huyler A., Mackenzie D. & Wilson C.N. 2022.** Lung abscess diagnosed by ultrasound. *Clinical and Experimental Emergency Medicine*. 9(1): 70-71. DOI: 10.15441/ceem.21.069.

9 **Hylands R. 2006.** Veterinary diagnostic imaging. Ruptured lung lobe abscess secondary to a localized alveolar disease. *The Canadian Veterinary Journal*. 47(2): 181-182.

10 **Kraft C., Lasure B., Sharon M., Patel P. & Minardi J. 2018.** Pediatric Lung Abscess: Immediate Diagnosis by Point-of-Care Ultrasound. *Pediatric Emergency Care*. 34(6): 447-449. DOI: 10.1097/PEC.0000000000001547.

11 **Kuhajda I., Zarogoulidis K., Tsirgogianni K., Tsavlis D., Kioumis I., Kosmidis C., Tsakiridis K., Mpakas A., Zarogoulidis P., Zissimopoulos A., Baloukas D. & Kuhajda D. 2015.** Lung abscess-etiology, diagnostic and treatment options. *Annals of Translational Medicine*. 3(13): 183. DOI: 10.3978/j.issn.2305-5839.2015.07.08.

12 **Leighton R.L. & Olson S. 1967.** Hypertrophic osteoarthropathy in a dog with a pulmonary abscess. *Journal of American Veterinary Medical Association*. 150(12): 1516-1520.

13 **Liu F., Liu D., Tian J., Xie X., Yang X. & Wang K. 2020.** Cascaded one-shot deformable convolutional neural networks: Developing a deep learning model for respiratory motion estimation in ultrasound sequences. *Medical Image Analysis*. 65. 101793. DOI: 10.1016/j.media.

14 Mukai H., Ming P., Lindholm B., Heimbürger O., Barany P., Anderstam B., Stenvinkel P. & Qureshi A.R. 2018. Restrictive lung disorder is common in patients with kidney failure and associates with protein-energy wasting, inflammation and cardiovascular disease. *PLoS One*. 13(4): e0195585. DOI: 10.1371/journal.pone.0195585.

15 Nishi R., Ohmi A., Tsuboi M., Yamamoto K. & Tomiyasu H. 2022. Successful treatment of a lung abscess without surgical intervention in a cat. *Journal of Feline Medicine and Surgery Open Reports*. 8(1): 20551169221086434. DOI: 10.1177/20551169221086434.

16 Puligandla P.S. & Laberge J.M. 2008. Respiratory infections: pneumonia, lung abscess, and empyema. *Seminars in Pediatric Surgery*. 17(1): 42-52. DOI: 10.1053/j.sempedsurg.2007.10.007.

17 Robinson D.A., DeNardo G.A. & Burnside D.M. 2023. What is your diagnosis? Pulmonary abscess. *Journal of American Veterinary Medical Association*. 223(9): 1259-1260. DOI: 10.2460/javma.2003.223.1259.

18 Seo H., Cha S.I., Shin K.M., Lim J., Yoo S.S., Lee J., Lee S.Y., Kim C.H. & Park J.Y. 2013. Focal necrotizing pneumonia is a distinct entity from lung abscess. *Asian Pacific Society of Respirology*. 18(7): 1095-1100. DOI: 10.1111/resp.12124.

19 Walker J.R. & Nakamura R.K. 2014. What is your diagnosis? Pulmonary abscess. *Journal of American Veterinary Medical Association*. 245(3): 277-278. DOI: 10.2460/javma.245.3.277.

20 Yazbeck M.F., Dahdel M., Kalra A., Browne A.S. & Pratter M.R. 2014. Lung abscess: update on microbiology and management. *American Journal of Therapeutics*. 21(3): 217-221. DOI: 10.1097/MJT.0b013e3182383c9b.