



Dystrophic mineralisation in chronic exogenous lipid pneumonia in cats

Claudia Mallol¹, Yvonne Espada^{1,2}, Albert Lloret³,
Raúl Altuzarra¹, Carlo Anselmi¹ and Rosa Novellas^{1,2}

Journal of Feline Medicine and Surgery Open Reports
1–7

© The Author(s) 2019

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/2055116919850255

journals.sagepub.com/home/jfmsopenreports

This paper was handled and processed
by the European Editorial Office (ISFM)
for publication in *JFMS Open Reports*



Abstract

Case series summary Exogenous lipid pneumonia with mineralisation of the lung parenchyma was diagnosed in three cats with radiographs, CT and/or bronchoalveolar lavage cytological findings. All three cats had a common clinical history of chronic constipation and long-term forced oral administration of mineral oil. All three cases showed radiographic findings compatible with aspiration pneumonia, with an alveolar pattern in the ventral part of the middle and/or cranial lung lobes. Minor improvement of the radiographic lung pattern in the follow-up studies was seen in two cats, and a miliary 'sponge-like' mineralised pattern appeared in the previously affected lung lobes months to years after the diagnosis. In one cat, patchy fat-attenuating areas in the consolidated lung lobes were present on thoracic CT. Cases 1 and 2 showed respiratory signs at the initial presentation, while in case 3 the radiographic findings were incidental and the cat had never exhibited respiratory signs.

Relevance and novel information This is the first report to describe dystrophic mineralisation of the lung in exogenous lipid pneumonia and also the first to describe the CT features in cats. Exogenous lipid pneumonia should be included in the differential diagnosis in cases of miliary 'sponge-like' mineral opacities in the dependent part of the lung lobes on thoracic radiographs or CT in cats, especially in cases of chronic constipation, previously exposed to mineral oil.

Keywords: Exogenous lipid pneumonia; chronic pneumonia; lung mineralisation; constipation; mineral oil

Accepted: 11 April 2019

Introduction

Exogenous lipid pneumonia (ELP) results from inhalation or aspiration of oily material. Only isolated cases of ELP have been reported in cats,^{1–3} dogs⁴ and horses.⁵ Chronic forced administration of mineral oil used for treatment of constipation and hair balls is the most common cause of ELP in cats.^{1–3} Clinical signs are non-specific and can vary from absent to severe, depending on the amount and quality of the lipid aspirated.^{1,2,6} Treatment of ELP is largely supportive after cessation of the inciting agent. Prognosis depends on the extension of the lesions and the progression to permanent changes such as fibrosis.^{1,2}

We report the clinical and imaging findings in three cats with ELP that received mineral oil as a treatment for chronic constipation.

Case series description

Case 1

A 4-year-old neutered male domestic shorthair cat was referred to our institution for evaluation of chronic constipation and acute respiratory distress following forced

¹Servei de diagnòstic per la imatge, Hospital Clínic Veterinari, Universitat Autònoma de Barcelona, Bellaterra, Barcelona, Spain

²Departament de Medicina i Cirurgia Animals, Facultat de Veterinària de la Universitat Autònoma de Barcelona, Bellaterra, Barcelona, Spain

³Servei de medicina interna, Hospital Clínic Veterinari, Universitat Autònoma de Barcelona, Bellaterra, Barcelona, Spain

Corresponding author:

Claudia Mallol DVM, Carrer de l'Hospital s/n, Veterinary Hospital Clínic, UAB, 08193 Bellaterra, Barcelona, Spain
Email: claudiamallol@gmail.com



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons

Attribution-NonCommercial 4.0 License (<http://www.creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

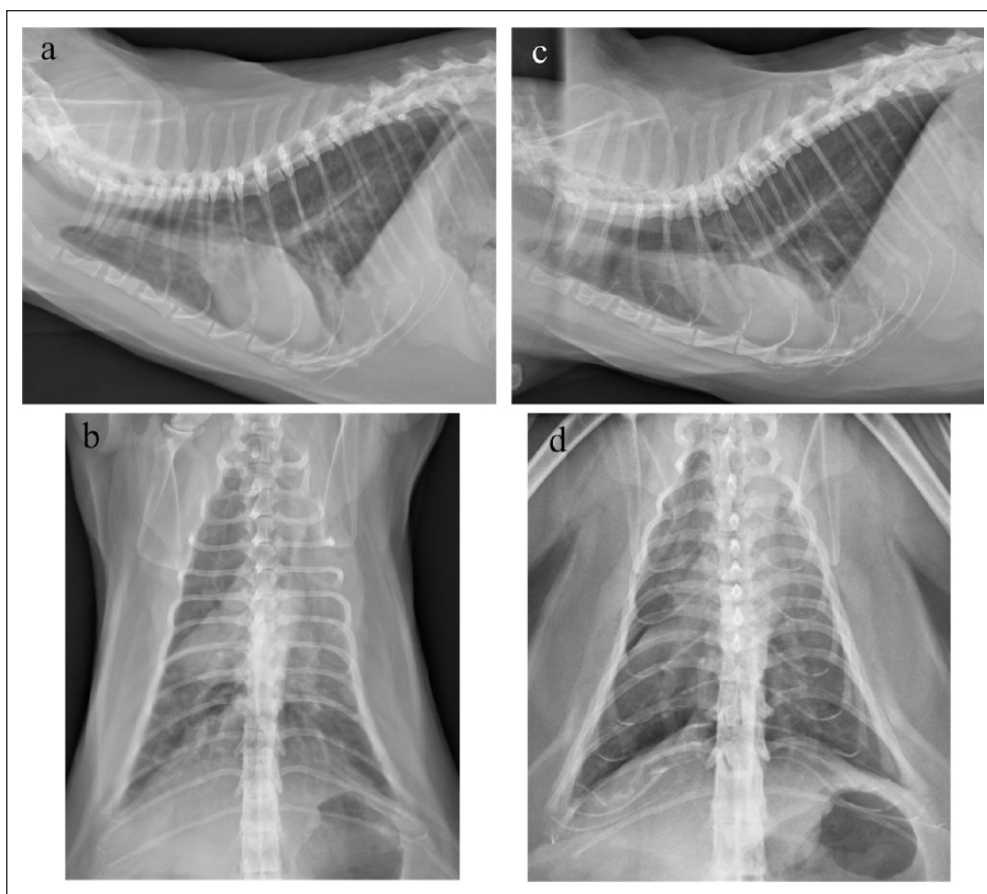


Figure 1 Case 1: right lateral and ventrodorsal views of the thorax at (a,b) initial presentation and (c,d) 15 days later. (a,b) Increased soft tissue opacity of the right middle and left cranial lung lobes is visible at initial presentation, with a lobar sign and air bronchograms indicating an alveolar pattern. (a) Note the ventral distribution of the lung pattern in the right lateral view, commonly seen in aspiration pneumonia. (c,d) The alveolar pattern in the right middle and left cranial lung lobes is still present in the follow-up radiographs, with only mild improvement of the radiographic findings

mineral oil administration. The cat had been treated conservatively with mineral oil (PO q12h) and a low-residue diet for a 3 year period. Rectal enemas were occasionally performed in case of an episode of constipation.

The cat showed low body condition score (BCS), abdominal breathing, tachypnoea (80 breaths per minute) and cyanotic mucous membranes on physical examination. Thoracic radiographs revealed an alveolar pattern in the right middle and left cranial lung lobes, with a ventral distribution (Figure 1a,b).

Aspiration pneumonia was suspected and supportive treatment based on oxygen, antibiotics, systemic corticosteroids, bronchodilators and intravenous (IV) fluids was established. Mineral oil was immediately discontinued. The patient improved clinically and was discharged with antibiotics, inhaled corticosteroids and bronchodilators 4 days later.

There was only a mild improvement of the lung changes on the follow-up thoracic radiographs 2 weeks after the initial onset (Figure 1c,d). Bronchoalveolar lavage (BAL) under general anaesthesia showed

marked macrophagic inflammation with a neutrophilic component. The majority of the macrophages contained multiple round, clear and different-sized vacuoles compatible with lipid droplets (Figure 2). Both fungal and bacterial culture yielded no growth. Constipation episodes persisted 1 year later and subtotal colectomy was performed. Thoracic radiographs were obtained before surgery and a miliary 'sponge-like' mineralised pattern was visible in the previously affected lung lobes (Figure 3). The alveolar pattern in the right middle lung lobe was still present. The cat was still alive while writing this case series, 7 years after the initial presentation, and no recurrence of the respiratory signs had been noted.

Case 2

A 4-month-old entire female Persian cat was referred to our institution for chronic constipation and acute vomiting. The cat had been treated with mineral oil (PO q12h) and rectal enemas with partial response since the beginning of the clinical signs. Physical examination revealed

low BCS, crackles in all lung lobes in the lung auscultation and abdominal discomfort on palpation. Thoracic radiographs showed diffuse increased soft tissue opacity within the lungs, more marked in the cranioventral aspect of the thorax, with an alveolar pattern in the right and left cranial and the right middle lung lobes. There was also a focal alveolar pattern with a perihilar distribution in the caudal and accessory lung lobes (Figure 4a,b). Severe diffuse colon distension was noted in the abdominal radiographs. Marked scoliosis of the lumbar spine, partial fusion of the L5–S1 vertebral bodies and decreased pelvic diameter were also noted, so secondary obstructive megacolon was suspected. Rectal enema was performed and supportive treatment based on antibiotics, systemic corticosteroids, bronchodilators and IV fluids was established for the suspected aspiration pneumonia. Mineral oil was immediately discontinued. The patient

improved after 2 days and was discharged with antibiotics, systemic corticosteroids, lactulose and a low-residue diet.

Two months later, follow-up thoracic radiographs showed an alveolar pattern (similar to that previously described) with granular mineral opacities and 'sponge-like' appearance of the previously affected lung lobes (Figure 4c,d). Multiple recurrent episodes of respiratory signs were recorded during a year, which partially responded to systemic corticosteroid and bronchodilator therapy. Owing to the refractory medical management, subtotal colectomy was elected as the treatment for the obstipation 1 year later. CT of the thorax was performed prior to surgery, showing an alveolar pattern with air bronchograms in all lung lobes, with a ventral distribution in the cranial and middle lobes, and a perihilar distribution in the caudal and accessory lung lobes. Within the consolidated lobes, patchy ill-defined fat-attenuating areas and punctiform mineral-attenuating structures were present (Figure 5). Three years later, neither the respiratory signs nor the constipation reappeared.

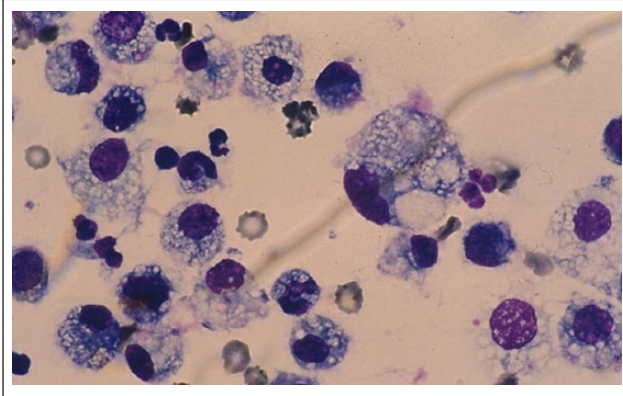


Figure 2 Cytology of the bronchoalveolar lavage of case 1. Quick Panoptic Stain reveals activated macrophages with lipid droplets within the cytoplasm

Case 3

A 6-year-old neutered male domestic shorthair cat was referred to our institution for acute non-ambulatory tetraparesis secondary to a traumatic event. General physical examination was unremarkable. Postural reactions were absent in the right limbs and decreased in the left limbs in the neurological examination. Mild cervical hyperesthesia was noted. Previous to the MRI study and as part of the pre-anaesthetic protocol, thoracic radiographs were obtained. Increased soft tissue and granular mineral opacity were present in the caudal aspect of the right middle lung lobe (Figure 6). Previous aspiration of mineral oil was suspected as a result of the radiographic

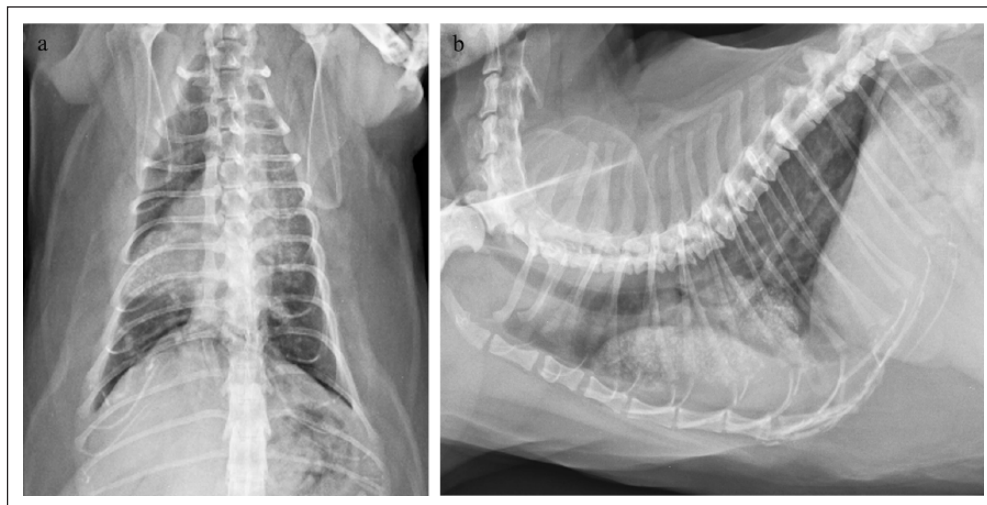


Figure 3 Case 1: (a) ventrodorsal and (b) right lateral views of the thorax 1 year after the initial presentation. A miliary mineralised 'sponge-like' pattern is visible, affecting the previously consolidated lung lobes

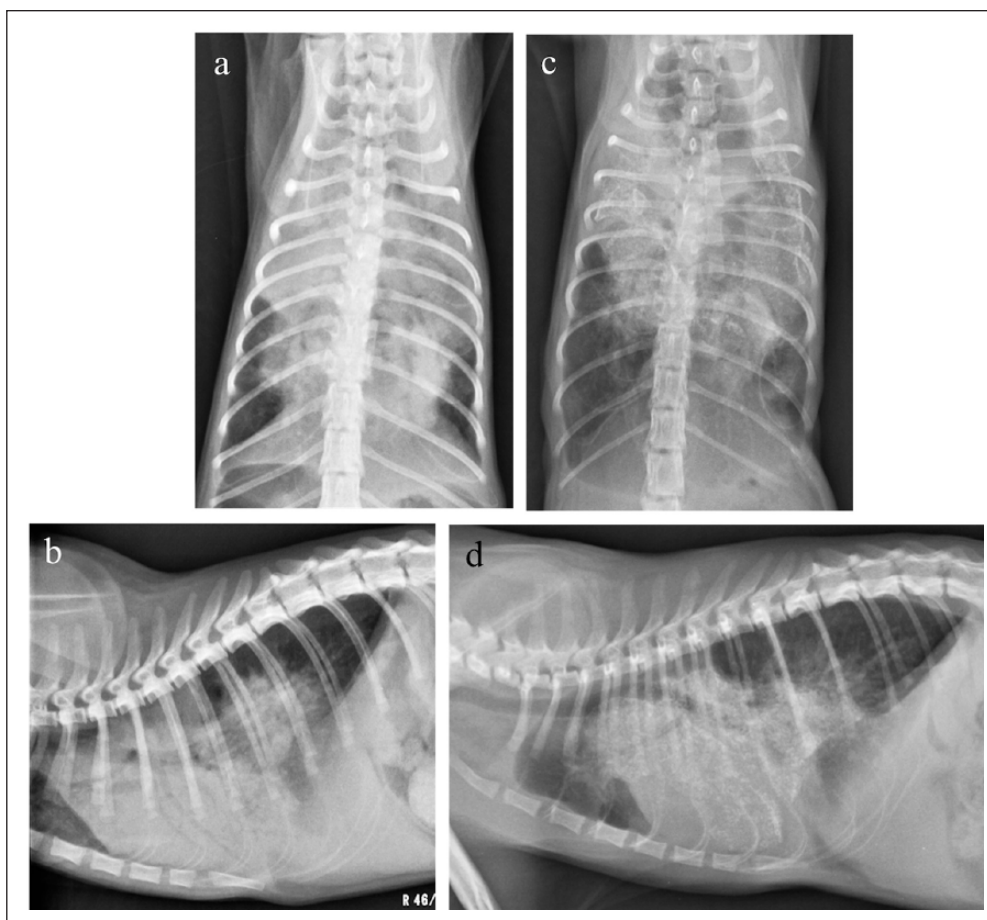


Figure 4 Case 2: (a,b) ventrodorsal and right lateral views of the thorax at initial presentation and (c,d) 2 months later. (a,b) A diffuse increase in soft tissue opacity of the lungs is visible, causing border effacement of the cardiac silhouette and with the presence of air bronchograms, indicating an alveolar pattern. (b) Note the cranioventral and perihilar distribution of the lung pattern in the right lateral view, where air bronchograms are clearly visible and a lobar sign between both left and right cranial lung lobes is present. (c,d) A miliary mineralised 'sponge-like' pattern is visible in the previously affected lung lobes and the diffuse alveolar pattern persists 2 months later. (c,d) Note the compensatory hyperinflation of the aerated caudodorsal lung field

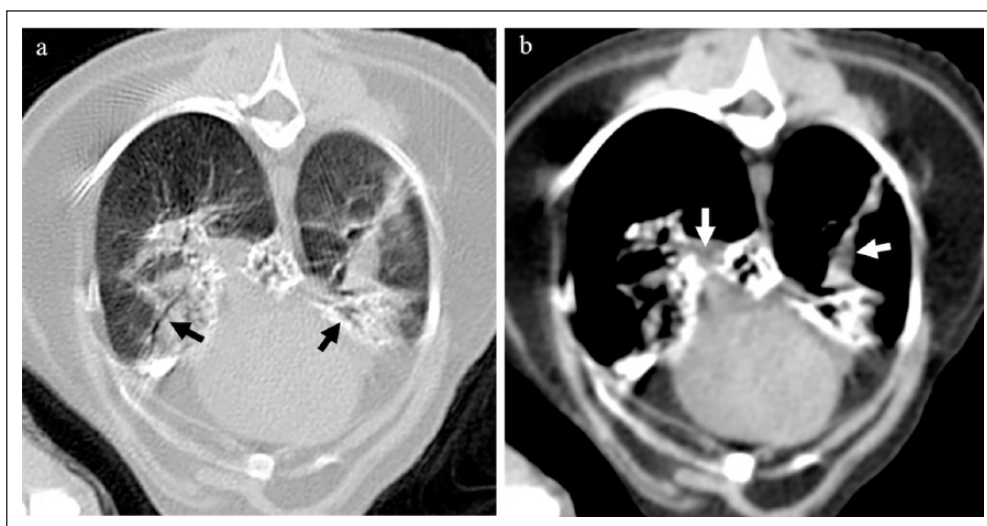


Figure 5 CT images of case 2 in (a) a transverse plane displayed in a lung window (window level -500 and window width 1400) and (b) in a soft tissue window (window level 40 and window width 350) at the same level, showing the caudal and accessory lung lobes. (a) There is a ventral distributed alveolar pattern with punctiform mineral-attenuating areas in both caudal and accessory lung lobes. Note the air bronchograms in both caudal lung lobes (black arrows) in the lung window. (b) Patchy ill-defined fat-attenuating areas (white arrows) are visible within the consolidated lung lobes in the soft tissue window

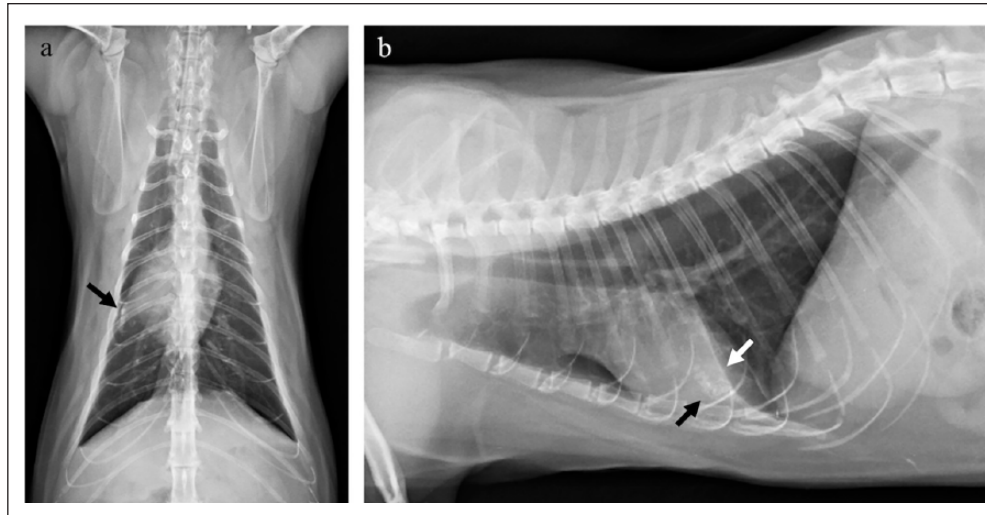


Figure 6 Case 3: (a) ventrodorsal and (b) left lateral views of the thorax. There is increased soft tissue opacity and granular mineral opacity in the caudal aspect of the right middle lung lobe (black arrows). A lobar sign is visible between the right middle and right caudal lung lobes in the left lateral view (white arrow)

changes and the referring veterinarian was contacted for further information. The cat had a previous history of chronic diarrhoea, tenesmus and recurrent rectal prolapse 5 years previously. Among others, long-term treatment with mineral oil had been established by the referring veterinarian for the intestinal problems. No respiratory signs had ever been reported. The MRI findings were compatible with an acute non-compressive nucleus pulposus extrusion lateralised to the right at the level of C2–C3 and a treatment based on IV fluids and cage confinement was established. The patient was discharged 4 days later with mild improvement but still showing severe right hemiparesis. Six months later, neurological examination showed mild right-sided proprioceptive deficits. No respiratory signs have been reported 1 year later.

Discussion

Exogenous lipid pneumonia is a particular form of aspiration pneumonia, resulting from accumulation of oily compounds of mineral, vegetable or animal origin within the alveoli.^{1,2,4} Mineral oil, such as paraffin oil, has been widely used as a laxative for constipation in cats.¹ The tasteless and mild nature of the mineral oil makes it less irritating to mucosal surfaces without eliciting a cough reflex when aspirated.⁴ It may also inhibit mucociliary transport, subsequently reaching easily the bronchial tree and reducing its clearance from the respiratory tract.⁶

These characteristics of the mineral oil explain the chronic and subclinical behaviour of the disease when small amounts of lipids are aspirated, such as in case 3, where the radiographic findings were incidental and the cat had never exhibited respiratory signs. More than half

of the patients in human medicine are asymptomatic on presentation. There is also frequently a discrepancy in the severity between the radiological and clinical findings in people, with extensive imaging findings in asymptomatic patients.⁶ Cases 1 and 2 showed extensive radiological changes and only the first exhibited severe respiratory signs on presentation. Similarly to what has previously been reported, cases 1 and 2 showed an absence of or minor improvement in the radiographic lung pattern. This may be explained by the inability of the macrophages to metabolise the lipid material, degenerating and releasing the oil back into the alveoli.⁴

The diagnosis of ELP is based on a history of exposure to oil, imaging findings indicating aspiration pneumonia and the presence of lipid-laden macrophages on BAL analysis. BAL may be normal or show lipid-laden macrophages, with or without other inflammatory cells.⁶ In case 1, BAL demonstrated lipid droplets within the cytoplasm of the macrophages, confirming the suspected diagnosis of ELP. All three cases had a common clinical history of gastrointestinal disorders and long-term forced oral administration of mineral oil. Furthermore, in 2/3 cases, radiographic findings were clearly associated with administration of the lipid.

Radiographic features of ELP in the literature are described as non-specific, including a mixed interstitial to alveolar pattern involving mainly the dependent portion of both cranial lobes and the right middle lung lobe,^{1,6} occasionally forming masses or nodules.^{4,7} However, to our knowledge, no mineral opacity within the lungs has been described in cases of ELP. All three cats showed a pulmonary pattern and a distribution compatible with aspiration pneumonia, with an alveolar pattern in the ventral part of the middle and/or cranial

lung lobes. Perihilar distribution has also been reported,² similar to case 2, in which the cranioventral aspect of the thorax was also affected.

High-resolution CT is the best imaging modality for the diagnosis of ELP in people.^{6,8} Multiple different non-specific pulmonary patterns have been described for ELP on CT in people, but the most characteristic finding is the presence of fat-attenuating areas in the consolidated lungs.⁸ This feature has been described in dogs,³ and was also present in case 2, where the alveolar pattern within the affected lung lobes showed negative attenuating areas. To our knowledge, no descriptions of the CT features have been previously described in cats.

Chronic consolidation and mineralisation of the lung lobes was the characteristic finding in all three cases herein. Pathological mineralisation of the pulmonary parenchyma is rare, and may occur via a metastatic mechanism, in which calcium deposits in normal tissues, or via a dystrophic mechanism, occurring in previously damaged, degenerated, necrotic or fibrotic lung tissue.⁹ In ELP, chronic accumulation of lipid in the alveoli triggers a pyogranulomatous or foreign body type inflammatory reaction and fibrosis.⁷ Therefore, a dystrophic mechanism may explain the mineralisation in our cases.

Dystrophic mineralisation of the lungs has been described in chronic pyogranulomatous pneumonia caused by mycobacteria in cats.^{10–12} Unlike in our cases, perihilar lymphadenomegaly was the most common finding in mycobacterial infections, and radiographic changes represent usually a multisystemic disease.¹¹ However, non-tuberculous mycobacteria (NTM) infections may be confined to the thoracic cavity, causing consolidation and mineralisation of the lungs,¹⁰ similar to cases 1 and 2. There are various reports in the literature of NTM infections as a complicating factor of ELP in people, dogs and cats.^{13–15} Lipid-rich environments seem to be essential in some fast-growing species of NTM, acting as a mechanical protection and contributing to the growth and pathogenicity of the organisms.^{13,15} In our patients, an underlying mycobacterial infection was considered unlikely considering the clinical presentation and the absence of progression of the pulmonary lesions years later not receiving proper treatment for mycobacteriosis.

Multifocal mineral opacities thorough the lung fields have also been described in cases of broncholithiasis in cats.^{16,17} Broncholithiasis is defined as the presence of calcified material within the bronchial lumen, usually as a result of mineralisation of inspissated bronchial secretions in chronic diffuse inflammatory lower airway disease.^{16,18} In contrast to our cases, this condition is commonly associated with a bronchial pattern and signs of obstruction of the airways (bronchiectasis, emphysema).^{17,18} Moreover, the CT study in case 2 revealed a

parenchymal location of the mineral-attenuating areas, unlike the intraluminal bronchial location in cases of broncholithiasis.

Idiopathic mineralisation in the lung occurs in pulmonary alveolar microlithiasis, a rare disease characterised by intra-alveolar calcium deposits.¹⁹ The deposition occurs in the absence of calcium metabolism disorders, usually as an incidental finding.^{20,21} In contrast to our cases, pulmonary lesions are commonly diffuse with a 'sandstorm appearance' and not associated with inflammation.²⁰ Other differential diagnoses for mineralised lung foci include aspiration of contrast media or pulmonary neoplasia with calcification. The clinical history allows exclusion of the first, because none of the three cats received any contrast media and, in 2/3 cases, an alveolar pattern preceded the mineralisation. Although there is a high incidence of mineralisation in bronchopulmonary tumours in cats,²² imaging findings usually include a solitary mass (frequently cavitated) in the caudal lungs, pleural effusion and signs of tracheobronchial lymph node enlargement.^{22,23} Besides, there was only mild or no progression of the pulmonary lesions in our cases, making the possibility of a tumour unlikely.

Conclusions

ELP should be included in the differential diagnosis in cases of mineral opacities in the dependent part of the lung lobes in cats, especially in cases of chronic constipation and previous history of exposure to mineral oil. Mineral oil is unsafe owing to the risk of ELP and should be avoided in cats. We recommend the use of other treatment options for the management of constipation.

Conflict of interest The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding The authors received no financial support for the research, authorship, and/or publication of this article.

ORCID iD Claudia Mallol  <https://orcid.org/0000-0001-7579-6005>

Raúl Altuzarra  <https://orcid.org/0000-0002-8498-1744>

References

- 1 De Souza HJM, Dos Santos AE, Reis Ferreira AM, et al. **Chronic lipidic pneumonia in a cat.** *Feline Pract* 1998; 26: 16–19.
- 2 Chalifoux A, Morin M and Lemieux R. **Lipid pneumonia and severe pulmonary emphysema in a Persian cat.** *Feline Pract* 1987; 17: 6–10.
- 3 Snyder PS and Neuwirth-Roberts L. **Obstipation and presumed lipid pneumonia in a cat.** *Feline Pract* 1997; 25: 14–19.
- 4 Carminato A, Vascellari M, Zotti A, et al. **Imaging of exogenous lipid pneumonia simulating lung malignancy in a dog.** *Can Vet J* 2011; 52: 310–312.

- 5 Scarratt WK, Moon ML, Sponenberg DP, et al. **Inappropriate administration of mineral oil resulting in lipid pneumonia in three horses.** *Equine Vet J* 1998; 30: 85–88.
- 6 Marchiori E, Zanetti G, Mano CM, et al. **Exogenous lipid pneumonia. Clinical and radiological manifestations.** *Respir Med* 2011; 105: 659–666.
- 7 Gondouin A, Manzoni P, Ranfaing E, et al. **Exogenous lipid pneumonia: a retrospective multicentre study of 44 cases in France.** *Eur Respir J* 1996; 9: 1463–1469.
- 8 Marchiori E, Zanetti G, Mano CM, et al. **Lipoid pneumonia in 53 patients after aspiration of mineral oil: comparison of high-resolution computed tomography findings in adults and children.** *J Comput Assist Tomogr* 2010; 34: 9–12.
- 9 Chan ED, Morales DV, Welsh CH, et al. **Calcium deposition with or without bone formation in the lung.** *Am J Respir Crit Care Med* 2002; 165: 1654–1669.
- 10 Foster SF, Martin P, Davis W, et al. **Chronic pneumonia caused by *Mycobacterium thermoresistibile* in a cat.** *J Small Anim Pract* 1999; 40: 433–438.
- 11 Bennett AD, Lalor S, Schwarz T, et al. **Radiographic findings in cats with mycobacterial infections.** *J Feline Med Surg* 2011; 13: 718–724.
- 12 Major A, O'Halloran C, Holmes A, et al. **Use of computed tomography imaging during long-term follow-up of nine feline tuberculosis cases.** *J Feline Med Surg* 2018; 20: 189–199.
- 13 Couto SS and Artacho CA. ***Mycobacterium fortuitum* pneumonia in a cat and the role of lipid in the pathogenesis of atypical mycobacterial infections.** *Vet Pathol* 2007; 44: 543–546.
- 14 Jouannic I, Desrues B, Léna H, et al. **Exogenous lipid pneumonia complicated by *Mycobacterium fortuitum* and *Aspergillus fumigatus* infections.** *Eur Respir J* 1996; 9: 172–174.
- 15 Leissinger MK, Garber JB, Fowlkes N, et al. ***Mycobacterium fortuitum* lipid pneumonia in a dog.** *Vet Pathol* 2015; 52: 356–359.
- 16 Talavera J, del Palacio MJF, Bayon A, et al. **Broncholithiasis in a cat: clinical findings, long-term evolution and histopathological features.** *J Feline Med Surg* 2008; 10: 95–101.
- 17 Valls Sanchez F, Stewart J, Bovens C, et al. **Broncholithiasis associated with lower airway inflammation and subsequent pyothorax in a cat.** *JFMS Open Rep* 2018; 4. DOI: 10.1177/2055116917746798.
- 18 Byrne P, Berman JS and Allan GS. **CT findings in two cats with broncholithiasis.** *JFMS Open Rep* 2016; 2. DOI: 10.1177/2055116916676176.
- 19 Brummer DG, French TW and Cline JM. **Microlithiasis associated with chronic bronchopneumonia in a cat.** *J Am Vet Med Assoc* 1989; 194: 1061–1064.
- 20 Brix AE, Latimer KS, Moore GE, et al. **pulmonary alveolar microlithiasis and ossification in a dog.** *Vet Pathol* 1994; 31: 382–385.
- 21 de Brot S and Hilbe M. **Pulmonary alveolar microlithiasis with concurrent pleural mesothelioma in a dog.** *J Vet Diagn Invest* 2013; 25: 798–802.
- 22 Aarsvold S, Reetz JA, Reichle JK, et al. **Computed tomographic findings in 57 cats with primary pulmonary neoplasia.** *Vet Radiol Ultrasound* 2015; 56: 272–277.
- 23 Ballegeer EA, Forrest LJ and Stepien RL. **Radiographic appearance of bronchoalveolar carcinoma in nine cats.** *Vet Radiol Ultrasound* 2002; 43: 267–271.