Case Report

Lungworm *Eucoleus aerophilus* (*Capillaria aerophila*) infection in a feline immunodeficiency virus-positive cat in France

Sarah Elhamiani Khata1,2, Dan Rosenberg1,3, Ghita Benchekroun1 and Bruno Polack4

Abstract

**Case summary** A 2-year-old domestic shorthair female outdoor cat living in France was diagnosed with a lungworm infection due to *Eucoleus aerophilus*. The history and clinical signs, in association with bronchoscopic examination, suggested chronic upper respiratory disease. Cytological examination of bronchoalveolar lavage fluid (BALF) was consistent with suppurative bronchitis. Direct microscopic examination of BALF enabled the identification of *E aerophilus* ova.

**Relevance and novel information** The cat was positive for feline immunodeficiency virus and had been treated with steroids for a suspected allergic bronchitis, suggesting that immunodeficiency was probably a facilitating factor for *E aerophilus* infection, as described in previous cases. This case report emphasises the importance of considering eucoleosis (capillariosis) in the differential diagnosis of respiratory disease in cats. To our knowledge, this is the first clinical case of *E aerophilus* infection described in a domestic cat in France.

Accepted: 4 May 2016

Introduction

*Eucoleus aerophilus* (*Capillaria aerophila*) is a nematode belonging to the Trichuridae family that parasitises the respiratory tract of dogs, cats, wild carnivores and occasionally people.1–3 The adult stages live under the epithelium of the trachea, bronchi and bronchioles of the infected host.4 Females produce barrel-shaped, asymmetric, bipolar plugs and non-embryonated ova inside the mucosa (64.91 ± 1.11–65.04 ± 1.50 μm long, 34.89 ± 3.34–36.96 ± 3.15 μm wide). The eggs go through the mucosa, get coughed up and swallowed by the host and then shed in the feces. The prepatent period is around 3–5 weeks and infection remains patent for 8–11 months. In optimal climatic conditions, larvae develop within the ova and reach the infectious stage in 30–45 days in the environment; the larvae inside the ova may survive up to 1 year. The ova can also develop in earthworms (facultative intermediate host). The definitive host is infected by direct ingestion of eggs or through an intermediate host. Eggs hatch in the host’s digestive tract and larvae migrate via blood vessels to the lungs.2,4–6

The prevalence of *E aerophilus* infection varies according to the host species and geographical areas. In domestic carnivores, prevalence rates range from 0–9% in some countries.3,5,7–11 Despite the worldwide distribution of *E aerophilus*, this parasite is still poorly...
known and eucoleosis (capillariosis) continues to be neglected. This lack of knowledge, in association with non-specific clinical signs, could explain why pulmonary eucoleosis is usually considered asymptomatic or subclinical in domestic carnivores. To our knowledge, no data are available on the occurrence of this parasite in France. Despite a worldwide distribution and a high prevalence in wildlife species, infection of domestic carnivores was considered sporadic until the past decade, but this appears to be an underestimation.

**Case description**

A 2-year-old neutered female domestic shorthair outdoor cat was presented for a 4 month history of respiratory signs. The cat was previously presented at a private veterinary practice for snoring, dysphonia and an initially non-productive cough but which had evolved to a productive cough. It was treated with corticosteroids, nebulisation therapy and several antibiotics, including marbofloxacine, doxycycline and cefovecine, but no improvement was achieved. The cat was not recently vaccinated but had been recently dewormed (praziquantel and pyrantel). It lived in a multi-cat household, consisting of 20 well-vaccinated and regularly dewormed rescue animals. All cats had free access to the outdoors, including a nearby a forest. None of the other animals showed clinical signs.

Abnormalities on physical examination included tachypnoea (80 breaths per min), tachycardia (>200 beats per min) and fever (40°C). Thoracic auscultation revealed severe bilateral wheezing and crackles, together with increased breathing sounds on tracheal auscultation and tracheal hypersensitivity.

Thoracic radiographs did not reveal any abnormalities. Bronchoscopy under general anaesthesia (butorphanol 0.2 mg/kg IV, constant rate infusion of propofol) revealed a larynx oedema, a tracheal inflammation and an abundant mucoid to mucopurulent secretion. Cytological examination of the bronchoalveolar lavage fluid (BALF) showed a moderate cell density, a high amount of mostly degenerative neutrophils (>90%) and intracellular bacteria (coccobacilli), suggesting suppurative bronchitis (Figure 1). Additionally, direct microscopic examination of the BALF was performed, and numerous *E aerophilus* ova were observed (Figures 2 and 3).

An in-clinic ELISA (IDEXX) for the detection of both feline immunodeficiency virus (FIV) antibodies and feline leukaemia virus antigens was performed and revealed an FIV infection. Complete blood cell count showed moderate leucocytosis (27.3 × 10^9 cells/l; reference interval [RI] 6.0–11.0) due to a mature neutrophilia (23.6 × 10^9 cells/l; RI 3.0–11.0) and a mild monocytes (0.8 × 10^9 cells/l; RI 0.04–0.5). The cat was hospitalised and received fluid therapy, amoxicillin/clavulanic acid (Augmentin, 20 mg/kg IV q12h; GlaxoSmithKline), prednisolone (Dermipred, 0.5 mg/kg PO q24h; Sogeval), fenbendazole (Panacur, 50 mg/kg kg PO q24h; Intervet), theophylline (Sepvapulmyl, 4 mg/kg PO q12h Sogeval) and nebulisation therapy. The cat was discharged after 4 days. The antibiotic, corticosteroid and nebulisation therapy had been continued for 21 days and the anthelminthic treatment for 10 days (ie, a 14 day course of fenbendazole in total). Three weeks after discharge, the cat was in a good clinical condition, although some...
wheezing was still present on tracheal auscultation. Coproscopic examination of samples from the cat was negative for *E aerophilus* ova. The owner was advised to pursue the antibiotic therapy. At the 7 week follow-up, the owner reported that the cat started coughing again 10 days earlier. Coproscopic analysis was positive for *E aerophilus* ova, most probably indicating reinfection or recurrence. A 14 day course of fendendazole (Panacur; Intervet) was repeated in association with amoxicillin/clavulanic acid (Kesium; Sogeval) for 10 days. The owner was lost to follow-up after 2.5 months.

Discussion

Infection with *E aerophilus* appears mostly asymptomatic or subclinical in domestic carnivores. However, a recent study carried out in Italy showed the occurrence of clinical signs in 87.5% and 72.7% of dogs and cats, respectively, indicating that the prevalence of clinical disease might be underestimated. Clinical signs associated with eucocules mimic those of an unspecified chronic bronchitis of varying severity and include coughing, nasal discharge, sneezing, wheezing, bronchovesicular sounds, dyspnoea and weight loss. The cough is usually dry and chronic but can evolve to moist and productive, especially when secondary bacterial infection is present. A heavy infection might become lethal owing to bronchopneumonia or respiratory failure. In one case, the bronchial patterns remained present even after efficient antimycosal treatment and hence could be associated with *E aerophilus* infection. Clinical signs, thoracic radiographs, bronchoscopy, haematological and biochemistry profile modifications are all lacking specificity in the diagnosis of pulmonary eucocules. Therefore, the diagnosis is based on the identification of ova in the faeces by performing a coproscopic flotation test and/or in the BALF by direct microscopic examination. However, even the identification of ova in faeces has considerable
limitations such as the variable and intermittent excretion of eggs in the faeces and possible misdiagnosis due to sample contamination by eggs from other capillarid or trichuroid species, especially in cases of mixed infections.12,16,18 The number of excreted ova decreases after 2–3 months during the last stages of infection. Therefore, BALF examination and the coproscopic flotation can both lack sensitivity for E. aerophilus diagnosis, especially as most cases, including the present one, are presented several weeks to months after the onset of clinical signs. Multiple faecal samplings have to be performed to increase the test’s sensitivity, with a minimum of three samples recommended.16 Recent studies have demonstrated an interest in molecular tests in the diagnosis of trichuroid infections, as differentiation between species by morphological examination is difficult,18,19 Molecular diagnosis could avoid the lack of specificity and sensitivity associated with the abovementioned detection methods and appears to be an interesting complementary tool.18

Several therapeutic protocols with different molecules have been cited in the literature, including fenbendazole, abamectin, ivermectin and levamisole.3,6,13 A recent experimental prospective study also assessed the efficacy and safety of treatment with imidacloprid 10%/moxidectin 1% spot-on (Advocate; Bayer Animal Health) in naturally infected cats. A single administration of this spot-on treatment appeared to be safe and effective. The single dose and ease of application are of great advantage, especially in indocile or feral animals.13 More recently, a case of co-infection by E. aerophila and Troglostrongylus brevior was efficiently treated with a single dose of a solution containing emodepide 2.1%/praziquantel 8.6% spot-on (Profender; Bayer Animal Health).20 Supportive drugs can be added to improve the clinical signs.5,15 The present cat was treated with fenbendazole and this enabled a complete remission of the clinical signs and a negative coproscopic examination. However, clinical signs were present 6 weeks after discharge, associated with a positive coproscopic examination showing E. aerophilus ova. This could be explained either by a reinfection due to the living conditions (ie, multi-cat household and free outdoor access) or a recurrence due to a partial response to fenbendazole. Given the possible direct cycle and the zoonotic potential of E. aerophilus, sanitary measures are imperative for disease control, especially under group housing conditions.4,7,12,15

A few cases of human respiratory eucoleosis due to E. aerophilus have been documented: eight cases in Russia and Ukraine, and solitary cases in Morocco, Iran and France.4,21 The owner of the cat described in this report has been advised to treat all congeners and to isolate the sick cat, also because of its FIV-positive status. In order to detect reinfection promptly, faecal examinations should be performed 6–12 months after a successful therapy,15 especially when concurrent diseases with possible associated immunodepression are present. Owners have to be informed of the possible recurrence of the clinical signs.

Conclusions

This report describes a case of respiratory eucoleosis due to E. aerophilus in a domestic cat. To our knowledge this is the first clinical case of a domestic carnivore infection described in France. Bronchoscopy combined with BALF and tracheal mucus microscopic examination was useful in establishing the diagnosis. This report highlights the importance of including parasitic aetiologies in the differential diagnosis of respiratory complaints, especially when a refractory response to usual treatments occurs and immunodeficiency is present. Allergic bronchitis is considered the first cause of chronic coughing in cats, but in the light of this report, steroidal therapy should be delayed until the exclusion of any possible infectious origin. Considering the zoonotic aspect of E. aerophilus and its increasing spread, efforts have to be made to improve the knowledge and the diagnosis of this parasite.

Acknowledgements

We thank the students (Dr Ramade, Dr Duhamelle and Dr Bensemmane), the veterinarians and the nurses who contributed to the diagnosis and treatment of the cat described in this case report. We are also grateful to Professor Kachani and Dr Tafflin for their contributions to this manuscript.

Funding

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

Conflict of interest

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

References

1 Di Cesare A, Castagna G, Meloni S, et al. Mixed trichuroid infestation in a dog from Italy. Parasit Vectors 2012; 5: 128–133.
2 Travessa D, Di Cesare A, Lia RP, et al. New insights into morphological and biological features of Capillaria aerophila (Trichocephalitida, Trichuridae). Parasitol Res 2011; 109: S97–S104.
3 Conboy G. Helminth parasites of the canine and feline respiratory tract. Vet Clin North Am Small Anim Pract 2009; 39: 1109–1126.
4 Bowman DD, Hendrix CM, Lindsay DS, et al. Feline clinical parasitology. 1st ed. Ames: Iowa State University Press, 2002, pp 338–340.
5 Travessa D, Di Cesare A, Milillo P, et al. Infection by Eucoles aerophilus in dogs and cats: is another extra-intestinal parasitic nematode of pets emerging in Italy? Res Vet Sci 2009; 87: 270–272.
6 Barrs VR, Martin P, Nicoll RG, et al. Pulmonary cryptococcosis and Capillaria aerophila infection in an FIV-positive cat. Aust Vet J 2000; 78: 154–158.
7 Mugnaini L, Papini R, Gorini G, et al. Pattern and predictive factors of endoparasitism in cats in Central Italy. Rev Med Vet 2012; 163: 89–94.
8 Spada E, Proverbo D, Della Pepa A, et al. Prevalence of faecal-borne parasites in colony stray cats in northern Italy. *J Feline Med Surg* 2013; 15: 672–677.

9 Waap H, Gomes J and Nunes T. Parasite communities in stray cat populations from Lisbon, Portugal. *J Helminthol* 2013; 30: 1–7.

10 Krone O, Guminsky O, Meinig H, et al. Endoparasite spectrum of wild cats (*Felis silvestris* Schreber, 1777) and domestic cats (*Felis catus* L) from the Eifel, Pfalz region and Saarland, Germany. *Eur J Wildl Res* 2008; 54: 95–100.

11 Mircean V, Titilincu A and Vasile C. Prevalence of endoparasites in household cat (*Felis catus*) populations from Transylvania (Romania) and association with risk factors. *Vet Parasitol* 2010; 171: 163–166.

12 Traversa D, Di Cesare A and Conboy G. Canine and feline cardiopulmonary parasitic nematodes in Europe: emerging and underestimated. *Parasit Vectors* 2010; 3: 62–83.

13 Traversa D, Di Cesare A, Di Giulio E, et al. Efficacy and safety of imidacloprid 10%/moxidectin 1% spot-on formulation in the treatment of feline infection by *Capillaria aerophila*. *Parasitol Res* 2012; 111: 1793–1798.

14 Foster SF, Marti P, Allan GS, et al. Lower respiratory tract infections in cats: 21 cases (1995–2000). *J Feline Med Surg* 2004; 6: 167–180.

15 Burgess H, Ruotsalo K, Peregrine AS, et al. *Eucoleus aerophilus* respiratory infection in a dog with Addison’s disease. *Can Vet J* 2008; 49: 389–392.

16 Foster SF, Martin P, Braddock JA, et al. A retrospective analysis of feline bronchoalveolar lavage cytology and microbiology (1995–2000). *J Feline Med Surg* 2004; 6: 189–198.

17 Nevarez A, Lopez A, Conboy G, et al. Distribution of *Crenosoma vulpis* and *Eucoleus aerophilus* in the lung of free-ranging red foxes (*Vulpes vulpes*). *J Vet Diagn Invest* 2005; 17: 486–489.

18 Di Cesare A, Castagna G, Otranto D, et al. Molecular detection of *Capillaria aerophila*, an agent of canine and feline pulmonary capillariosis. *J Clin Microbiol* 2012; 50: 1958–1963.

19 Guardone L, Deplazes P, Macchioni F, et al. Ribosomal and mitochondrial DNA analysis of *Trichuridae* nematodes of carnivores and small mammals. *Vet Parasitol* 2013; 197: 364–369.

20 Di Cesare A, Iorio R, Crisi P, et al. Treatment of *Troglostrongylus brevior* (Metastrongyloidea, Crenosomatidae) in mixed lungworm infections using spot-on emodepside. *J Feline Med Surg* 2015; 17: 181–185.

21 Laloševic D, Laloševic V, Klem I, et al. Pulmonary capillariosis miming bronchial carcinoma. *Am J Trop Med Hyg* 2008, 78: 14–16.