Case report: Severe and progressive bronchopneumonia by *Aelurostrongylus abstrusus* in an adopted stray cat from Portugal

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Abstract The cat lungworm *Aelurostrongylus abstrusus* is the most common respiratory parasite of cats. This nematode has a worldwide distribution and is considered an emerging pathogen. Respiratory signs overlap with those of other pathologies, and some agents which co-exist in the same animal may concur in the clinical scenario. Nonetheless, feline verminous bronchopneumonia is underestimated by practitioners and is not commonly included in differential diagnosis in routine practice. The present report describes the clinical presentation of a 6-month old stray cat from central Portugal, which developed respiratory distress. A clinical improvement of lower respiratory signs was achieved after a course of doxycycline and prednisolone course. However, a relapse with a progressive decline in the respiratory functions occurred two weeks later. A further investigation led to the identification of an *A. abstrusus* infection that was treated with fenbendazole. Ten days after the treatment the cat became negative for *A. abstrusus* and further analyses performed in the followings 2 months showed improvement of the animal's pulmonary condition and negative results at the faecal examinations. These findings indicate that veterinarians should include aelurostrongylosis in the differential diagnosis of feline respiratory distress even in non-endemic

regions and should perform appropriate diagnostics procedures in the presence of compatible signs.

Keywords Cat · *Aelurostrongylus abstrusus* · Bronchopneumonia · Baermann test · Fenbendazole

Introduction

Aelurostrongylus abstrusus (Nematoda, Metastrongyloidea) is the most common feline lungworm affecting the respiratory tract of domestic cats (*Felis silvestris catus*) and, seldom, other felids (Traversa et al. 2010, 2013, 2016; Pennisi et al. 2015). Cats become infected by ingesting mollusc intermediate hosts or, more often, vertebrates acting as paratenic hosts, e.g. rodents, birds, reptiles (Traversa and Guglielmini 2008; Jezewski et al. 2013; Pennisi et al. 2015). Infected cats commonly present general distress and respiratory signs, cough and sneezing being the most common, although cardiovascular distress, such as reversible pulmonary hypertension, has also been reported (Dirven et al. 2012; Traversa and Di Cesare 2013, 2016). The disease seems to be more severe in young subjects, most likely due to the smaller lung volume and immature immune system, or in animals with other concurrent pathologies (Barrs et al. 1999; Pennisi, et al. 2015). According to with epidemiological surveys, in the last decades *A. abstrusus* has been described all over the world in domestic felids, showing a ubiquitous distribution, with different prevalence rates according to the geographic region (Traversa et al. 2010; Traversa and Di Cesare 2013, 2016; Pennisi et al. 2015). Furthermore, recent studies have shown an apparent increase of clinical cases in several regions, which may indicate an increasing importance of this pathology in feline clinical practice (Barrs

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et al. 1999; Payo-Puente et al. 2005; Ellis et al. 2010; Knaus et al. 2011; Gambino et al. 2016). The presence of the parasite in cats from Portugal has been previously reported (Peleteiro et al. 1989; Ferreira Da Silva et al. 2005), with high prevalence (i.e. 17.4%) in the north-west region of the country and in the urban area of Lisbon (i.e. 11.8–12%) (Waap and Gomes 2011; Nabais et al. 2014). Notwithstanding, veterinary clinicians often underestimate *A. abstrusus* occurrence and most of case reports did not recognize this parasite as the first responsible agent for pulmonary pathology.

Case history, diagnosis and results

In March 2016, a 6-month old short-hair female cat was presented to a private veterinary practice (located in Pereira do Campo village, region of Montemor-o-Velho, Portugal), for a general clinical exam after having been found and adopted from the street three weeks earlier. The cat weighed 1.2 kg and presented a 3/9 Body Condition Score (WSAVA Global Nutrition Committee). A routine deworming was performed with milbemycin oxime 4 mg/praziquantel 100 mg PO, and a 40 mg/0.4 ml spot-on formulation of imidacloprid was applied for the presence of fleas. Seven days later, the cat underwent to a physical examination for a cough as the presenting complaint and, at the pulmonary auscultation, crackles sounds were recorded.

Radiographic images showed a broncho-interstitial diffuse pattern (Fig. 1), while a blood smear revealed intra-erythrocytic inclusions, and a *Mycoplasma haemofelis* infection was suspected. Packed cell volume was low, with 32%, evaluated by microhematocrit method. Further analysis to identify the pathogen was not performed due to owner financial constraints. For the above reasons, the cat received doxycycline (10 mg/kg/bid for 21 days), prednisolone (1 mg/kg/bid for 6 days) and its exercise was restricted.

Although a week later the clinical conditions of the cat had improved (e.g. crackles were present only in the caudal pulmonary fields) and the microhematocrit value was 40%; four days later, the animal's conditions worsened suddenly. In particular, the cat showed exacerbate cough episodes, severe respiratory distress, respiratory sounds, abdominal respiratory movements and lethargy. Thoracic radiographs revealed a severe alveolar pattern (Fig. 2a). The complete blood count was normal, without eosinophilia. Thus, a Baermann's test was applied on a fresh faecal sample in the following way (Euzeby 1981). About 5–10 g of faecal sample was placed in a woven gauze and suspended in a conic fundus cup, being after submersed in tap water, for 36 h. After this time, the faecal sample was removed carefully to avoid mixing the solution. The first third of this solution was centrifuged at 1500 rpm, for 5 min. The sediment was observed under microscope. Nematode larvae (Fig. 2b) retrieved at the Baermann's examination were stored in 70% ethanol and sent to the Faculty of Veterinary Medicine, Teaching Veterinary Hospital, University of Teramo, Italy where they were morphologically and morphometrically identified as *A. Abstrusus* (Crisi et al. 2016; Traversa and Di Cesare 2016). Then, genomic DNA was extracted from the Baermann sediment using the commercial kit “Qiagen stool minikit” (Qiagen GmbH, Hilden, Germany), and the larvae identity was confirmed upon diagnostic DNA-based assays as previously described (Traversa et al. 2008; Di Cesare et al. 2014). Treatment with fenbendazole at 50 mg/kg sid for 5 days was immediately started after the first parasitic identification at the veterinary practice (i.e. before the confirmation achieved upon morphometry and genetic assays performed in Italy). Ten days after the start of the treatment with fenbendazole the health status of the cat was markedly improved with only sporadic cough episodes, associated with exercise. The Baermann examination performed scored negative. Clinical and radiographic follow-

Fig. 1 Thoracic radiographs at the first medical appointment. **a** Ventro-dorsal thoracic radiograph; **b** right lateral thoracic radiograph: presence of a moderate-to-severe, mixed broncho-interstitial diffuse pulmonary pattern in all lung lobes, with alveolar opacity

Fig. 2 Moment of *Aelurostrongylus abstrusus* diagnosis. **a** Right thoracic radiograph at the moment of lungworm identification, with severe bronchopneumonia and diffuse alveolar pattern; **b** first-stage (L1) *Aelurostrongylus abstrusus* larvae ($\times 20$), light microscopy

Fig. 3 Right lateral thoracic radiographs of the felid affected with aelurostrongylosis. **a** At week two after treatment implementation, focal alveolar pattern arrangement; **b** mixed broncho-interstitial lung

pattern, with decreased nodular arrangement at week four; **c** a clear radiographic image demonstrating the feline's recovery at week eight

ups were performed at two, four and eight weeks after lungworm identification (Fig. 3). Two months after the first physical examination, pulmonary signs disappeared and radiographic images demonstrated a full recovery. Again, the Baermann's test repeated at six and eight weeks after fenbendazole administration, was negative.

Discussion

Recently, feline lungworm bronchopneumonia caused by *A. abstrusus* has been documented based on epidemiologic surveys and it was argued that the geographic range of the cat lungworm is now expanding (Traversa and Di Cesare 2016).

The stray cat of the present report probably became infected through ingestion of intermediate and/or paratenic hosts for food survival, and because it is at the age of intense preying activity in felines. Although this cat showed clinical signs compatible with aelurostrongylosis, the parasite had not been considered in differential diagnosis, because of the routine deworming with a compound containing milbemycin oxime performed after the first physical examination and because of the absence of clinical

reports of aelurostrongylosis in the center of Portugal (Peleteiro et al. 1989; Ferreira Da Silva et al. 2005). In this case, clinical signs and radiographic features were suggestive of lung involvement and the clinician opted for an empiric therapy, in light also of the features of blood smear examination. Indeed, the cat responded well to doxycycline, and prednisolone mediated cough episodes, indicating a good recovery of the animal, until a relapse came. Nevertheless, the control radiograph showed that radiographic signs were worsening and a complete blood count was carried out. Although peripheral eosinophilia is considered common in *A. abstrusus* infected cats (Center et al. 1999) the kitten described here did not show an increase in eosinophilic count, a similar finding was observed in a recent case series, in which only one cat out of 26 showed eosinophilia (Crisi et al. 2016).

The present clinical case underlines how cats presenting a clinical picture compatible with aelurostrongylosis should always be examined with appropriate diagnostic methods before excluding the infection even in non-endemic areas or when other diseases are suspected. In a clinical setting, the Baermann technique is the gold standard for the diagnosis of this parasitic disease, as it can be performed in the clinics, with results in 24 h. However,

fresh faecal samples should be used, and sampling of three consecutive days is recommended. Moreover, during the pre-patency larvae are not present in the faeces and, even in the patency, the larval shedding can be intermittent (Traversa et al. 2010). Therefore, under a practical standpoint, the presence of clinical signs that could be compatible with the infection should alert veterinarians to perform the Baermann examination and to repeat it in case of negative results. Moreover, an accurate morphological and morphometric analysis of the L1s is always mandatory to achieve a specific diagnosis and to differentiate the L1s of *A. abstrusus* from those of other lungworm with overlapping morphological features (e.g. parasites of the genus *Troglostrongylus*) (Traversa and Di Cesare 2016).

Bronchoalveolar lavage is indicated as an alternative diagnostic method for lungworm infection, and it is considered a good tool for a clinical investigation where other respiratory pathologies are considered, such as a neoplasia, bacterial bronchitis, mycotic pneumonia and feline allergic bronchitis (Payo-Puente et al. 2005), but it is expensive and requires anaesthesia. Other examinations such as radiology, echocardiography and computer tomography have been reported to be useful to evaluate the severity of the pulmonary lesions (Lacava et al. 2016). A molecular assay has also been developed for the diagnosis of feline aelurostrongylosis (Di Cesare et al. 2014). Molecular approaches are able to overcome the constraints of classical diagnosis (Traversa et al. 2008), and allow to achievement of a certain identification of the parasite, as in the clinical case described herein. A certain and early diagnosis of *A. abstrusus* infection is of importance considering that infected animals should be treated with an efficacious compound in order to prevent, or to treat, respiratory signs. Indeed, the treatment of choice may vary upon the severity of clinical signs in infected animals, their age and weight as well as by the specie/species of lungworm involved. Indeed, mixed infection by *A. abstrusus* and other lungworm (e.g. *Capillaria aerophila* and *Troglostrongylus brevior*) have been described (Di Cesare et al. 2014). The cat received at referral only one dose of milbemycin oxime as prophylactic deworming, and this compound at 2 weeks of interval has been described for *A. abstrusus* treatment (Dirven et al. 2012). Thus, the presence of live L1s of *A. abstrusus* in the faeces after almost thirty days from the therapy is not surprising.

Once aelurostrongylosis diagnosis was achieved, fenbendazole was chosen for use in this clinical case as it is known to have efficacy against *A. abstrusus* when administered orally at 50 mg/kg body weight for 3 consecutive days and as it is licensed in some countries (e.g. UK) for treating *A. abstrusus* infection (Barrs et al. 1999; Traversa et al. 2009). In the present clinical case, the treatment with fenbendazole (50 mg/kg sid) was performed for 5 days

confirming the efficacy of this parasiticide in treating the infection.

The emergence of lungworm infections in the feline population should encourage practitioners to be vigilant for lungworm infection in cats living in both endemic and in non-endemic territories. From a clinical perspective, routinely deworming (even with a product that has shown good performances against feline lungworms), doesn't allow the clinician to rule out *A. abstrusus* infection and any cat manifesting respiratory distress and/or at risk to be infected (e.g., free-roaming animals, kittens), although asymptomatic, should be tested for lungworm disease.

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Compliance with ethical standards

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

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