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CANINE SPIROCERCOSIS AND ASSOCIATED NEOPLASIA
Gad Baneth, DVM. Ph.D., Dipl. ECVCP
School of Veterinary Medicine, Hebrew University, P.O. Box 12, Rehovot
76100, Israel

Canine spirocercosis is a helminthic infection caused by the nematode Spirocerca lupi. It is transmitted to dogs primarily by several species of dung beetles or by vertebrate parathenic (transport) hosts that have ingested infected beetles. After larva penetration of the gastric mucosa and migration from the dog’s stomach, worms locate in the mediastinum between the caudal thoracic esophagus and the aorta. Inflammatory tissue forms a distinct nodular granuloma around the adult worms that protrudes into the esophageal lumen. Neoplastic transformation occurs in the granulomatous tissue of some infected dogs which develop a Spirocerca-associated sarcoma.

Spirocercosis has a worldwide distribution but it is most prevalent in warm climate. Published reports on canine spirocercosis have originated from many countries including: Israel, Greece, Iraq, Iran, India, Malaysia, South Africa, Morocco, Brazil, the Caribbean (Jamaica), Mexico and the USA (Texas). Coyotes, foxes, wolves, jackals and also domestic cats and wild felines have been described as hosts for S. lupi.

Adult S. lupi are large red worms (female: 6-7 cm long, males: 3-4 cm long) which locate in a nodule within the wall of the dog’s esophagus. The female sheds small (35x15 µm) embryonated eggs, which are transferred through a tract in the nodule into the esophageal lumen. The eggs pass through the gastrointestinal tract and are excreted in the feces. When eggs are ingested by the intermediate host, coprophagus beetles, they hatch and develop to the infective (L3) stage within 2 months. Carnivores are infected by ingestion of an infected beetle containing L3 stages. Alternatively, a variety of transport hosts including: mice, hedgehogs, lizards, birds, and rabbits may ingest beetles and remain infected with encysted larvae as parathenic hosts which transmit the infection to carnivores when killed and ingested as prey. The infective larvae are freed in the stomach of the definitive canine host. They penetrate the gastric mucosa and migrate within the walls of the gastric arteries to the thoracic aorta approximately 3 weeks after ingestion. About 3 months post-infection, the larvae migrate from the aorta to the esophagus at a point about midway between the diaphragm and the aortic arch. At that location, the worms provoke the development of granulomas as they mature to adults over the next 3 months.

Clinical and laboratory findings

Esophageal pathology is associated with regurgitation and/or vomiting. Chronic decreased intake of food results in considerable weight loss and emaciation. The clinical findings in dogs with chronic spirocercosis depend on the location and severity of the lesions. A study of 39 dogs from Greece described regurgitation (69%), painful swallowing (odynophagia; 59%) and excessive salivation (33%). In a retrospective study of 50 cases from Israel, the most common clinical signs were vomiting or regurgitation (60%), pyrexia
(22%), lethargy (22%), respiratory abnormalities (20%), anorexia (18%), melena (18%) and paraparesis (14%). Paresis and paralysis have been associated with aortic thrombomebolism in dogs with Spirocerca-induced aortic aneurisms and also with worm migration through the spinal cord. Pyothorax has also been associated with infection due to esophageal ulceration and leakage of its contents into the chest cavity.

Hematologic and serum biochemical abnormalities found in canine spirocercosis are usually not specific and commonly include a mild anemia, neutrophilic leukocytosis, and elevated alkaline phosphatase and creatine kinase activities.

Pathology

Death may occur due to rupture of an aortic aneurysm induced by migration of worms at an early stage of infection. In most of these cases, death occurs rapidly before any medical assistance can be given. In more chronic cases, esophageal granulomas and aortic scarring leading to aneurysms are the most frequent lesions encountered in spirocercosis. Spondylitis of the caudal thoracic vertebrae and the development of hypertrophic osteopathy are additional typical lesions. Aberrant migration of worms and nodule formation away from the esophagus have been reported in other thoracic organs, the gastrointestinal tract, the urinary system, and subcutaneous tissues. Infection with S. lupi has also been associated with salivary gland necrosis.

Neoplastic transformation of S. lupi granulomas to fibrosarcoma or osteosarcoma is a frequent finding associated with spirocercosis. The mechanism of tumorgenesis in spirocercosis remains to be elucidated. It is assumed that dogs with S. lupi-associated esophageal neoplasia have a long lasting infection. During this process, chronically inflamed tissue undergoes a neoplastic transformation. Local esophageal neoplasia with occasional metastases to distant organs is sometimes found. Most dogs detected with S. lupi-associated esophageal neoplasia do not have fecal egg shedding at the time of diagnosis. A mice xenograft model of S. lupi-associated sarcoma has been developed for further research on the pathogenesis and treatment of this condition.

Diagnosis

1. Fecal examination
A definite diagnosis of spirocercosis is made by detection of characteristic ellipsoid embryonated eggs in direct fecal smears or by various fecal flotation methods. Flotation with a 1.27 specific gravity sugar suspension has been recommended for the best egg yield. Repeated fecal examinations are warranted when the first examination is negative and spirocercosis is still suspected since the shedding of eggs is often intermittent. Egg shedding usually stops shortly after specific medical treatment with avermectins is instituted.

2. Radiography
Thoracic survey radiographs of affected dogs show esophageal granulomas as areas of increased density in the caudodorsal mediastinum. Contrast esophograms may outline megaesophagus with granulomas protruding into the esophageal lumen. Spondylitis of the caudal thoracic vertebrae is frequently observed on radiographs.

3. **Endoscopy**

Esophagoscopy and gastroscopy allow direct visualization of the nodules, which appear as broad-based protuberances with a nipple-like orifice. The shape of nodules may vary from a barely conspicuous shallow protuberance into the esophageal lumen to a ball-shaped mass occluding most of the luminal diameter and forming a megaesophagus caudal to their location. Nodules may be solitary or multiple, and in some cases nodules are located in the gastric wall with a normal appearing esophagus. Whereas granulomas are usually surrounded by smooth esophageal mucosa, neoplastic masses of *S. lupi*-associated sarcomas often have rough edges and are commonly ulcerated with a visible inflammatory response. It is imperative to differentiate between granulomas and neoplastic masses as the latter do not respond to anti-helminthic therapy and a surgical intervention could be considered. Endoscopic guided biopsy of *S. lupi*-neoplasia are often not rewarding as the biopsy specimens frequently include mostly mucoa and areas of inflammatory response and are not representative of the underlying neoplasia. However, neoplastic masses in the esophagus commonly look irregular and ulcerated whereas granulomas tend to have smooth surfaces with a relatively normal appearing mucosa. Therefore, clinical judgment often needs to be exercised when having to distinguish between esophageal granuloma or neoplasia. In the case of neoplasia, further investigation for the presence of distant metastases should be performed.

**Treatment, medical management and surgery**

Food intake may be attempted at upright standing position in the case of regurgitation due to megaesophagus. Serving liquid food or meshed food mixed with water in a blender could be useful. Temporary installation of a gastric PEG tube may be needed in some cases.

The avermectins doramectin and ivermectin are currently the main drugs used for therapy of spirocercosis. Doramectin at 400 µg/kg subcutaneously every 14 days has been shown to be effective in stopping the shedding of eggs initially and the regression of granulomas subsequently. The regression of granulomas can be followed by repeated endoscopy and therapy should continue until granulomas can no longer be visualized.

Surgery is often warranted when *S. lupi*- associated sarcoma is detected. Although esophageal surgery has been considered to be problematic due to scarring and motility disruption, a procedure of partial esophagectomy with excision of esophageal tumors associated with spirocercosis has been shown to successfully prolong the survival of dogs with this condition and provide these animals with a good quality of life for several months to years.
Prevention

Dogs should be prevented from ingesting beetles or potential parathenic hosts in order to avoid infection with *S. lupi*. In addition, dog feces must be cleared rapidly and access of beetle vectors to fecal material should be prevented. A preventative regimen of doramectin injected subcutaneously every 2 months is used in some endemic regions. This regimen is employed in attempt to kill the developing migrating larvae at an early stage of the parasite life cycle in the dog, before the formation of clinical symptomatic disease. However, experimental infection of dogs with *S. lupi* one month after doramectin was not effective in preventing the establishment of infection. The experimentally infected treated dogs did have a less severe disease as compared to untreated infected controls, with a delay in granuloma formation and decreased egg shedding. An effective oral prophylactic regimen is desirable and awaits further research.

References