Pathology in Practice

In collaboration with the American College of Veterinary Pathologists

Figure 1—Photograph of the grossly enlarged heart of a 17-year-old 4.5-kg spayed female American Shorthair cat that was evaluated because of weight loss, anorexia, vomiting, dehydration, and increased respiratory effort of unknown duration. The parietal pericardium and the epicardium are roughened with multifocal to coalescing, tan, raised, variably sized nodules (1 to 3 mm in diameter). Scale = 1 cm.

History

A 17-year-old 4.5-kg spayed female American Shorthair cat was evaluated because of weight loss, anorexia, vomiting, dehydration, and increased respiratory effort

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<https://doi.org/10.2460/javma.19.07.0362>

of unknown duration. The cat had a history of arthritis in both elbow joints and stifle joints and was an outdoor cat. On physical examination, the cat was moderately dehydrated and had a body condition score of 3/9. The cat showed signs of abdominal pain and had abdominal effort with respirations. Bloodwork revealed a stress leukogram, mild hyperproteinemia (8.4 g/dL; reference range, 6.1 to 7.7 g/dL), and mildly high serum concentrations of creatinine (2.1 mg/dL; reference range, 0.8 to 1.8 mg/dL). Due to the severity of clinical signs, the owners requested euthanasia (was performed via IV administration of sodium barbiturate) followed by necropsy.

Gross Findings

On necropsy, the cat was in fair body condition with diffuse muscle wasting. Within the coat were numerous 1 X 3-mm, laterally flattened arthropods (*Ctenocephalides felis*). The cat's thoracic cavity and pericardial sac contained clear, red, slightly viscous effusion with strands of fibrin. The lungs were wet and heavy and oozed clear fluid on cut section. The heart weighed 18 g, and the right and left ventricular free walls were 0.3 cm and 0.8 cm wide, respectively. The parietal pericardium and the epicardium were roughened with multifocal to coalescing, tan, raised, variably sized nodules (1 to 3 mm in diameter; **Figure 1**). On cut section, the myocardium of the ventricles and atria had multifocal to coalescing tan foci.

Formulate differential diagnoses, then continue reading.

Histopathologic Findings

Histologic examination of sections of the left and right atria and ventricles revealed a multifocal to coalescing inflammatory infiltrate composed primarily of neutrophils, lymphocytes, and macrophages that expanded and separated the myocardial fibers (**Figure 2**). Multifocal areas of the myocardium were completely obliterated by foci of necrosis surrounded by a mixed inflammatory cell population. The epicardium had varying areas of fibroblast infiltration and fibrosis. Results of Warthin-Starry silver stain revealed coccobacilli within cardiac muscle fibers and macrophages. *Bartonella* immunohistochemistry revealed multifocal positive intracytoplasmic

Figure 2—Photomicrographs of the left ventricular myocardium from the cat described in Figure 1. A—Cardiomyocytes are variably necrotic (arrows) and surrounded by neutrophils, lymphocytes, and macrophages. H&E stain; bar = 50 µm. B—Intracytoplasmic bacteria (arrow) are highlighted by positive immunohistochemical staining of *Bartonella* antigen. Anti-*Bartonella* spp–specific antibody with 3,3′-diaminobenzidine chromogen and hematoxylin counterstain; bar = 20 µm.

coccobacilli within macrophages. Other histologic findings included pulmonary edema likely due to left-sided congestive heart failure, lymphocytic and mildly neutrophilic pancreatitis with mild periductular fibrosis, and chronic lymphoplasmacytic interstitial nephritis.

Morphologic Diagnosis and Case Summary

Morphologic diagnosis: multifocal to coalescing severe, subacute, diffuse, necrosuppurative, and fibrinous pancarditis with myofiber necrosis, loss, and edema.

Case summary: pancarditis caused by *Bartonella* spp infection in a 17-year-old outdoor cat.

Comments

Differential diagnoses for severe necrosuppurative pancarditis include mutated coronavirus of feline infectious peritonitis, *Streptococcus canis*, FIV, and *Bartonella* spp.^{1–3} The diagnosis of bartonellosis was made based on characteristic inflammatory lesions in the heart, positive silver staining of coccobacilli in myofibers by Warthin-Starry staining, and positive antigen by an immunohistochemical assay targeting *Bartonella* spp within intralesional macrophages.

Bartonella species are fastidious, intracellular, gram-negative bacteria that infect a wide range of domestic and wild mammals and are the cause of cat scratch disease in humans.⁴ Although *Bartonella* spp have been identified in wild felids with clinical manifestations comprising myocardial edema and cardiomyocyte degeneration, a seroepidemiologic and bacteriologic study⁴ indicates domestic cats are the main reservoirs for *B henselae*. In humans, *B henselae* causes cat scratch disease, which is characterized by lymphadenopathy (particularly in areas of the scratch or bite) and fever and can progress to endocarditis and meningoencephalitis. Additionally,

in immunocompromised individuals, infection with *Bartonella* spp causes angioproliferative diseases such as bacillary angiomatosis and bacillary peliosis.⁵

Bartonella spp are generally transmitted by vectors including fleas, ticks, mites, flies, and lice.^{4,6} The vectors that transmit these bacteria vary depending on the species, hosts, and reservoirs. The cat flea (*Ctenocephalides felis*) is the primary vector of *B henselae* for domestic cats.^{5,6} Cat fleas are both mechanical and biological vectors of *Bartonella* spp through ingestion of a blood meal from an infected cat and by supporting the replication of the bacteria within the flea gut.⁵ Infection with *Bartonella* spp causes long-lasting bacteremia in cats, which may persist for months to years.⁴

An epidemiological study⁴ shows an association between warm humid climates that support the survival of vectors and increased prevalence of antibodies against *B henselae* in cats. The frequency of the disease in a particular environment may be related to the presence and abundance of vectors (eg, cat fleas) that facilitate cat-to-cat transmission of the organism.⁵

In general, no specific clinical signs are associated with *Bartonella* spp infection. In fact, naturally infected cats often show no signs and have limited clinical or pathologic changes.⁷ Serologic diagnosis of *Bartonella* spp is of little or no clinical importance because many cats, particularly stray cats, are likely to be seropositive.⁸ A definitive diagnosis of *Bartonella* spp infection can be achieved by culture of the organism from blood or infected tissues, immunohistochemical detection of the antigen in tissues with the use of special stains (eg, May-Grünwald Giemsa and Warthin-Starry silver stain), or PCR assay performed on blood or tissue samples.⁷

Cats with bartonellosis may have a range of cardiomyopathy including endocarditis, pyogranulomatous myocarditis, and moderate to severe myocardial thickening.^{9,10} Other clinical manifestations of the disease in naturally infected cats may include lymphadenitis, stomatitis, and anterior uveitis.^{4,7}

Antimicrobial agents are not usually recommended for the treatment or prevention of *B henselae* in cats because antimicrobial treatments only reduce the level of bacteremia but do not clear the disease.^{4,6} Currently, no vaccines are available to prevent *Bartonella* infections in animals or humans. Therefore, the most effective control measures are ectoparasite control and limiting contact with stray cats to break the cycle of cat-to-cat transmission and reduce transmission to other animals and humans.⁴

For the cat of the present report, *Bartonella* spp immunohistochemistry was used to confirm the diagnosis. A detailed patient history of exposure to potential vectors of the organisms (eg, having fleas, being an outdoor cat, or having close contact with stray cats) can be important to narrowing the differential diagnosis list. Infection with *Bartonella* spp is likely underreported as a cause of subclinical cardiac disease in cats, but bartonellosis should be considered a differential diagnosis in cats with arrhythmias, cardiomyopathies, congestive heart failure, or sudden death.¹⁰

Acknowledgments

Dr. Adetunji was financially supported by the College of Veterinary Medicine & Biomedical Sciences, Texas A&M University, College Station, TX.

The authors declare that there were no conflicts of interest.

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