Canine Vector-Borne Diseases: *Bartonella* and *Rickettsia rickettsii*

Katherine A. Sayler, MEd and A. Rick Alleman, DVM, PhD

**Canine Bartonellosis**

*Bartonella* was discovered in 1909 by a scientist in Peru, A. L. Barton, who recognized and described organisms that parasitized erythrocytes in the blood of infected humans. The organism, first named *Bartonia*, was later renamed *Bartonella bacilliformis*, now recognized as the type species for the genus. For many years, this organism was the only member of the group. However, in 1993, a similar group, *Rochalimaea*, was combined with *Bartonella*, and organisms were renamed *B. quintana*, *B. henselae*, *B. vinsonii*, and *B. elizabethae*. The genus now includes 20 species & subspecies.

*Bartonella* are gram negative hemotropic bacteria that invade erythrocytes and endothelial cells of a variety of mammalian hosts. The organisms are well adapted to their hosts resulting in persistent infections and long-lasting bacteremia. Based on current knowledge, it is suspected that *B. vinsonii* subsp. *berkhoffii* is the species that most frequently causes disease in dogs. However, it is clear that other *Bartonella* spp. can infect dogs and at least two other species have been reported to cause clinical disease. It is widely accepted that the organism is vector transmitted and there is good evidence that multiple tick species and possibly fleas can transmit the organism.

*Bartonella* spp. infect erythrocytes and endothelial cells of the mammalian host and cause chronic infections that may be well-tolerated by the animals for months to years. The factors that might result in disease manifestation are not completely understood, but it is suspected, as with other tick-borne pathogens, that stress factors, parturition, and coinfection with other pathogens are likely explanations. Experimental inoculation of SPF dogs with *B. vinsonii* subsp. *berkhoffii* results in immune-suppression with a reduction in circulating CD8+ lymphocytes and increase in CD4+ lymphocytes. The role of Bartonella infection in the manifestation of disease caused by other tick-borne pathogens is one of great interest. Serological surveys testing for antibodies to *B. vinsonii* subsp. *berkhoffii* have resulted in varied results ranging from approximately 3.6% to 36% of animals with previous exposure or potential chronic infection. Seropositivity in a population of 1920 dogs from North Carolina and surrounding states was on the lower end, 3.6%. In the southeastern US, seropositivity to infection with *B. henselae* was 10% in healthy dog and 26% in sick dogs, indicating a more frequent exposure to *B. henselae* than to *B. vinsonii* in the southeastern part of the country. In general, higher seropositivity is seen in groups of dogs that either have heavy tick exposure, cattle exposure or live in more rural areas. The seropositivity to Bartonella also appears to be higher in sick animals and animals that are seropositive for other tick-borne diseases such as Ehrlichiosis, Anaplasmosis, Babesiosis and Lyme disease. All of these pathogens have the ability to establish long-term (months to years), subclinical infections in the dog, complicating the ability of the clinician to establish a cause and effect association in animals presenting with clinical illness.

**Clinical Findings**

The clinical findings associated with canine Bartonellosis can be varied and can also be determined by the presence or absence of coinfection. One of the first recognized disease stated induced by Bartonella infection was endocarditis. This presentation may be more frequently encountered in large breed dogs, with Boxer dogs being particularly susceptible. Fever of
unknown origin, lameness and possible bone pain may be seen intermittently in these animals for some time prior to diagnosis. Other disease syndromes associated with Bartonella infection include polyarthropathy, lymphadenopathy (granulomatous lymphadenitis), cutaneous vasculitis, rhinitis, epistaxis, immune-mediated hemolytic anemia, hemoglobinuria, splenomegaly or hepatic disease (peliosis hepatitis). It is important to note that animals coinfected with other tick-borne diseases may not experience resolution of clinical signs until both diseases are treated.

**Laboratory Findings**

The laboratory findings associated with clinical Bartonellosis are those frequently encountered in many hemoparasitic diseases in dogs. Thrombocytopenia, anemia and leukocytosis are common hematologic abnormalities in these animals. Thrombocytopenia is seen in about half of the dogs with clinical Bartonellosis and about 1/3 of the animals have an eosinophilia. Hemoglobinuria without an accompanying hematuria can be seen in animals with intravascular hemolysis. Few, if any, abnormalities are observed on biochemical profiles.

**Pyogranulomatous lymphadenitis (right) and Splenitis (left) from animals with Bartonellosis**

**Diagnosis**

Suspicion of canine Bartonellosis is initially observed in animals presenting with the above mentioned clinical and hematological abnormalities. Infection can be confirmed by blood or tissue culture, serological evaluation and PCR analysis. Since some *Bartonella* spp. are difficult to culture, most cases are confirmed by serology and/or PCR analysis. In acute cases of granulomatous lymphadenitis tissue specimens stained with Warthin-Starry silver stain allowed visualization of the organism, however, in chronic cases the organisms are in low numbers and not readily visible by light microscopy. Using serology, a titer of 1:64 or greater would indicate exposure or active infection. Recent studies suggest that coinfection in dogs is much more prevalent than previously realized. Therefore, it is advisable to test animals for multiple tick-borne pathogens, particularly in dogs where clinical signs do not completely subside after appropriate antimicrobial therapy.
Treatment

Currently, the recommended treatment for canine Bartonellosis is azithromycin at a dose of 10 mg/kg PO, once daily for 4 to 6 weeks. Doxycycline is probably not effective in treating infected animals. If therapy is effective in clearing the organism, antibody titers will rapidly decline within 3 to 6 months, and eventually, animals cleared of infection will seroconvert to a negative status. Persistent antibody titers may indicate an incomplete response to antimicrobial therapy. Testing for other tick-borne agents should be performed in animals that have clinical evidence of disease despite appropriate therapy.

Zoonosis

Transmission of *B. henselae* from dogs to people via scratch or bite wounds has been suggested. In addition, people can become infected with *B. vinsonii* subsp. *berkhoffii*. However, the extent to which the canine can serve as a reservoir for infection in people is not well characterized.

*Rickettsia rickettsii* (Rocky Mountain Spotted Fever)

**Tick Vectors:** Primarily *Dermacentor variabilis* (the American dog tick) and *D. andersoni* (the Rocky mountain wood tick) are the primary tick vectors. However, both *Rhipicephalus sanguineus* (the brown dog tick) and *Amblyomma americanum* (the Lone Star tick) have also been reported to occasionally transmit the organism.

**Distribution:** *Dermacentor variabilis* (the American dog tick) is widely distributed in the United States from a line drawn from Montana to South Texas extending eastward to the Atlantic coast. It has also been reported in western California and southwestern Oregon. *D. andersoni* (the Rocky mountain wood tick) inhabits a large region in the northwestern United States extending from the Cascade Mountains to the Rocky Mountains.

Illness and clinical signs associated with *Rickettsia rickettsii* pathogens in dogs:

1) *Rickettsia rickettsii* is the causative agent of Rocky Mountain spotted fever (RMSF).  

-Clinical signs: Both clinical and subclinical infections can occur in dogs. Fever is the first and most consistent clinical finding. Other clinical findings primarily occur because of the widespread vasculitis that results from the organism invading and replicating in endothelial cells of small veins and arteries. Purebred dogs, particularly German shepherds may be more prone to developing clinical disease.  

-Vasculitis in affected tissues and organs can cause various clinical signs depending on the areas affected. Some common clinical findings seen early in the course of the disease include hyperemia of ears, lips, extremities, penile sheath and scrotum. Edema may also occur in some of these same areas. Petechial and ecchymotic hemorrhages are frequently noted on surfaces of mucous membranes such as the oral cavity and genitalia. Ocular hemorrhage may also be seen and some animals develop epistaxis or melena. Altered gate and neurological signs may occur as a result of arthritis, myositis, meningitis or cerebral or spinal

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edema. Mortality can occur in untreated cases.

-Onset: For reasons still unknown, ticks do not appear to transmit infection until they have been attached to a host for a minimum of 5 to 20 hours. \(^2\) Fever can occur as early as 2 to 3 days after tick attachment, but may not develop until up to 14 days after attachment.

-Clinical pathology: As with many vector-borne diseases, the most consistent laboratory finding is thrombocytopenia. \(^2\) Other laboratory findings with include an initial neutropenia followed by a moderate neutrophilia. There may also be a mild left-shift, and toxic changes are often seen in neutrophils. Hypercholesterolemia and hypoalbuminemia are among the more consistent biochemical abnormalities found in infected dogs. \(^3\)

**Diagnostic Tests:**

Serology: Serology is the primary method for the diagnosis of RMSF. Because of cross-reactivity of antibodies to nonpathogenic organisms in the spotted fever group and the possibility of subclinical infections in dogs, caution should be used in interpreting positive antibody titers. The assay most commonly used by most commercial labs is an Immunofluorescent antibody (IFA) test. \(^2\) Active infection in clinically ill dogs can be serologically confirmed by a fourfold increase in titer when evaluating acute and convalescent IgG titers taken 2 to 3 weeks apart. Normal dogs usually have reciprocal titers of less than 64. \(^2\) Acutely affected animals may not have increased levels of IgG at the time of initial presentation, so a reciprocal titer of <64 does not necessarily rule out infection. Conversely, a single reciprocal IgG titer of 1,024 would indicate active infection. Alternatively, a single, increased IgM titer would also indicate active infection.

PCR: PCR analysis is species specific and can distinguish infection with *R. rickettsii* from other rickettsial agents in the spotted fever group. However, due to the low number of circulating organisms, conventional PCR analysis has resulted in a significant number of false negative results. \(^2\) A nested PCR is a more sensitive method of genetic analysis and can be performed using whole blood or biopsies taken from affected tissues.

**Treatment:**

- Tetracyclines (tetracycline, oxytetracycline or doxycycline) are the drugs of choice for Rocky Mountain Spotted fever. Therapy must be continued for a minimum for 7 days. \(^4\) Choramphenical or enrofloxacin have also been used in cases where tetracyclines are not an option.

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