Lyme Disease and Anesthesia Considerations

Tammy Smit, MSNA, CRNA

This review seeks to examine the epidemiology, clinical presentation, diagnosis, and treatment of Lyme disease and focuses on the anesthetic implications of the infection. Lyme disease has become the fifth most common nationally notifiable disease and is the most commonly reported vector-transmitted infection in the United States. This emerging infectious disease is caused by Borrelia bacteria and is transmitted by the bite of Ixodes scapularis, a hard-body tick, also known as the deer tick or blacklegged tick.

Keywords: Carditis, Lyme disease, tick.

Lyme disease manifests in 3 stages—early localized, early disseminated, and late—and is treated by oral or parenteral antibiotics. The approach to a patient with Lyme disease who requires anesthesia to facilitate surgery can be considered on 3 fronts: (1) disease awareness (identification of early and late Lyme disease), (2) assessment of target-organ damage (in particular, the cardiac and neurologic systems), and (3) anesthetic-specific concerns regarding the choice of anesthetic technique and its impact on disease progression.

Epidemiology, Diagnosis, and Treatment

Lyme disease, first described in the region of Lyme, Connecticut, in the 1970s, has become the fifth most common nationally notifiable disease and the most commonly reported vector-transmitted infection in the United States. There have between 20,000 and 30,000 confirmed infections reported to the Centers for Disease Control and Prevention (CDC) each year since 2005. This emerging infectious disease is caused by the *Borrelia* bacteria, a spirochetal agent similar to syphilis, and, in particular, the species of *B burgdorferi sensu stricto* in the United States, and *B afzelii* and *B garinii* in Europe and Asia.[1] In the United States, *B burgdorferi* is transmitted by the bite of *Ixodes scapularis*, a hard-body tick also known as the deer tick or blacklegged tick. The risk of infection is greatest when bitten by the nymphal stage of the tick and when it has been attached for longer than 36 to 48 hours.[2]

The disease manifests in 3 stages: early localized, early disseminated, and late.[3] The early stage is characterized by the classic target or "bull's-eye" rash (erythema migrans) and nonspecific infective symptoms of malaise, fever, myalgia, headache, and fatigue. The rash is classically seen on the abdomen, groin, back, popliteal fossa, and axilla (Figure). If left untreated, the bacteria rapidly disseminate throughout the body (early disseminated phase). This stage primarily affects the musculoskeletal (multiple erythema migrans lesions, arthralgia, myalgia, joint swelling, arthritis) and neurologic (meningitis, unilateral cranial neuropathies, myelitis, and ataxia) systems, and later in the course of the infection the cardiac system

Figure. Pathognomonic Erythematous Bull's-eye Rash
(Image used by permission from the Centers for Disease Control and Prevention.)

(carditis, atrioventricular block, bundle branch block, and cardiac failure).[2] Patients with late Lyme disease, also referred to as untreated disseminated Lyme disease, may present with severe complications, such as severe chronic arthritis, months to years after their first infection.[4] Recently, a new Borrelia species (*Borrelia mayonii*) causing Lyme borreliosis has been described in the United States. Present in the upper Midwestern states (Minnesota, North Dakota, and Wisconsin), the infection presents atypically with nausea, vomiting, and a diffuse rash.[5]

Lyme disease is diagnosed on the basis of clinical history and physical examination and is confirmed with serologic testing. Lyme disease should be considered as a possible diagnosis in all patients with nonspecific infective symptoms and an erythematous rash, and who are resident in, or who have walked through, wooded areas where the disease is endemic (Northeast and upper Midwestern United States). Antibodies do not develop within the first 2 weeks of Lyme disease infection. The diagnosis is confirmed using a 2-tiered testing approach: first using an enzyme immunoassay or immunofluorescence assay and, if positive, Western blot testing.[6] If early disease is suspected, IgM and IgG immunoblots are used,

whereas IgG Western blot alone is used for suspected cases of late disease.

Lyme disease can be prevented by protecting against tick bites. Repellents such as N,N-diethyl-meta-toluamide (DEET) can be applied to the skin, and repellents containing permethrin can be applied to hiking clothing. When returning from an area that may have ticks, check your body for the presence of any ticks.

The treatment of Lyme disease is determined by the disease stage at presentation. Antibiotic prophylaxis in asymptomatic patients is recommended only when (1) the bite was caused by *I scapularis*; (2) the tick has been attached for more than 36 hours; (3) prophylaxis can be started within 72 hours of tick removal, and (4) the geographic locale where the tick was acquired has a *B burgdorferi* infection rate of 20% or higher.[7] For early local infections, treatment with an oral antibiotic such as amoxicillin (500 mg 3 times per day), azithromycin (500 mg once daily), cefuroxime axetil (500 mg twice daily), or doxycycline (100 mg twice daily) is recommended for 10 to 14 days.[2,8,9] Once the infection has disseminated and the patient presents with neurologic or cardiac symptoms, parenteral ceftriaxone (2 g/d) or cefotaxime (2 g every 8 hours) or oral doxycycline (200 to 400 mg in 2 divided doses daily) are recommended for 14 to 21 days.[2,3,8,9]

Many experts recommend the use of doxycycline because of its efficacy in treating other tickborne infections such as human granulocytic anaplasmosis or bartonella. However, there are major side effects associated with its use. In addition to gastric irritation and photosensitivity, doxycycline causes abnormalities of developing bone and teeth in children younger than 8 years of age. In these cases, amoxicillin or cefuroxime should be used.

In 1998 a Lyme disease vaccine (LYMErix), manufactured by SmithKline Beecham, was approved by the US Food and Drug Administration.[10] The vaccine, which was administered in 3 doses, was directed against the outer surface protein A of *B burgdorferi* and showed an 80% efficacy. In 2002 the vaccine was withdrawn, reportedly because of poor sales. The search for an effective second-generation Lyme disease vaccine still continues.[10]

Of late, there has been advocacy for the recognition of chronic Lyme disease, also referred to as posttreatment Lyme disease syndrome, as a clinical entity. These patients present with nonspecific symptom clusters of chronic fatigue, myalgia, arthralgia, and mood and memory disturbances.[11,12] Current literature has been unable to identify a pathogenic infective role for *B burgdorferi* in these patients, and therefore the long-term use of antibiotics as a therapeutic modality has not been supported.[13,14] However, alternate mechanisms such as central sensitization (characterized by extreme sensitivity to painful stimulation and pain in response to nonpainful stimulation)[15] and immunomodulation (upregulation of chemokines and the development of antineural antibodies)[16,17] that may be caused by the bacteria continue to be investigated.[18]

The interested reader is referred to the websites of the CDC (http://www.cdc.gov/ticks) and the Infectious Disease Society of America (IDSA, http://www.idsociety.org/lyme), which provide excellent resources on the disease. In addition, the IDSA periodically updates its Lyme disease guidelines, and these should be consulted to determine the most current diagnostic and management recommendations. New guidelines are expected in 2018.

Anesthetic Implications of Lyme Disease

The approach to a patient with Lyme disease who requires anesthesia to facilitate surgery can be considered on 3 fronts: (1) disease awareness, (2) assessment of target-organ damage, and (3) anesthetic-specific concerns.

• ***Disease Awareness.*** Caregivers should have a high degree of suspicion for the presence of Lyme disease in patients who live in, or have hiked through, endemic areas. Infected patients in whom the diagnosis has not yet been made or has been missed may present for invasive investigations such as biopsies or arthroscopies or for larger surgical interventions such as joint replacement or pacemaker insertion.[19] It is incumbent on all anesthetic practitioners to obtain a full clinical history and to undertake their own careful physical examination of each of their patients. Early infection, with symptoms and a rash that appears soon after taking a hike through an endemic area, is very likely to be diagnosed. However, late or disseminated disease can be missed or misdiagnosed, particularly when the patient does not recall or report having been in an area of risk.

• ***Assessment of Target-Organ Damage.*** Lyme disease is a multisystem disease process, and care should be taken to identify systems that have been affected as well as attempting to quantify the nature and degree of the injury. The systems most pertinent in a patient who is to undergo anesthesia are the cardiac and neurologic systems, and consultation with the relevant specialties (cardiology or neurology) should be considered on a case-by-case basis.

The primary cardiac manifestation of Lyme disease is a carditis that occurs in 1.5% to 10% of cases, more commonly in men.[20] Lyme disease carditis most often presents with a cardiac conduction disturbance, in particular, with atrioventricular (AV) blocks. Close to 50% of cases present with a third-degree block; 16%, with second-degree blocks; and 12%, with first-degree AV blocks.[21] Importantly, 2 of every 5 patients with third-degree heart block require temporary pacing.[22] In addition, patients may demonstrate escape rhythms with broad QRS complexes and fluctuating bundle branch blocks.[23] These blocks tend to resolve as the underlying inflammation

recedes. There is evidence that Lyme disease may cause both pericarditis and myocarditis, cardiac failure, and in rare cases degenerative valvular disease.[24]

It is important that these patients are investigated with electrocardiography as part of their preoperative assessment. Cases of conduction abnormalities should be reviewed by a cardiologist for further management and possible pacing. Should patents with conduction abnormalities require surgery, transcutaneous pacing must be immediately available. Echocardiography is indicated to assess for the presence of a pericarditis or a pericardial effusion as well as to determine ventricular contractility. When signs of cardiac failure are present, a cardiologist should assess the need for the initiation of antifailure therapy (ie, diuretics, angiotensin-converting enzyme inhibitors, β-blockers).

Neurologic involvement in early disseminated Lyme disease (neuroborreliosis) may occur in as many as 15% of untreated patients.[25] The inflammatory response to the presence of *B burgdorferi* in the nervous system causes focal inflammation, leptomeningitis, vasculitis, radiculitis, and nerve demyelination.[26] This leads to a wide range of clinical presentations, the most common of which are headaches, cranial nerve palsies (in particular, bilateral upper and lower seventh cranial nerves), and meningitis. *Borrelia* encephalopathy, which rarely occurs, has also been described and is associated with disturbances in mood, personality, sleep, memory, and concentration.[3] As part of the preoperative assessment, a careful mental assessment of the patient should be undertaken and all existing neurologic deficits should be documented. This may require additional investigation by means of nerve studies or radiologic imaging (computing tomography or magnetic resonance imaging). From a medicolegal viewpoint, it may be prudent to avoid nerve blocks or regional techniques, particularly in regions affected by the disease. However, should there be a clear advantage to using a regional technique, patients should be actively engaged in the decision-making process and specific informed consent should be obtained.

• ***Anesthesia-Specific Concerns.*** Concern has been expressed that central neuraxial blockade may be contraindicated in patients with systemic infection because this may introduce infective agents into the central nervous system.[27] This may be an important consideration if the patient is in the early stages of their infection of if there are no signs of central nervous system involvement. Where the infection is widely disseminated or there is already central nervous system involvement, it would seem unlikely that performing a neuraxial block would have much impact on the disease course. To the author's knowledge, there is no literature reporting adverse events in patients with Lyme disease who receive neuraxial techniques, and one report specifically describes a pregnant patient with Lyme disease and babesiosis who successfully underwent cesarean delivery using neuraxial anesthesia.[28] Of interest is that on the fourth postoperative day, this patient sustained a dissection of the left coronary circumflex artery that was thought to be unrelated to Lyme disease or babesiosis. If the decision is made to perform a neuraxial technique, the clinician must discuss the risk-benefit considerations of the decision with the patient.

Concern has been expressed that general anesthesia may suppress the immune system. A strong body of evidence has emerged demonstrating that volatile anesthetic agents adversely affect the function of neutrophils, macrophages, and natural killer cells.[29] Whereas this effect may be of benefit in patients facing ischemic-reperfusion injury suppression of the immune system, it may have important implications in patients undergoing tumor surgery (eg, increase in recurrence risk)[30] and may increase the risk of postoperative wound infections.[29] Although intravenous agents such as ketamine and thiopental have been found to reduce the efficacy of natural killer cells and increase the number of circulating tumor cells,[31] this effect has not been described with propofol, which has been shown to inhibit the adhesion of cancer cells.[32] It may therefore be prudent to avoid the use of volatile anesthesia in patients with active disease and to rather make use of propofol-based total intravenous anesthesia. When patients who have initiated antibiotic therapy for Lyme disease undergo prolonged surgery or are subsequently unable to receive oral antibiotics (eg, being ventilated), intravenous antibiotics should be used to cover scheduled doses. It may further be prudent to provide closer postoperative monitoring of patients with cardiac or neurologic symptoms.

Conclusion

Lyme disease is emerging as an important vector-transmitted infection in the United States and is associated with substantial morbidity. Anesthetic practitioners should be aware of the clinical presentations of the disease as well as have a clear understanding of the anesthetic implications of the disease. Preoperative assessment should include a full history and examination, as well as a careful evaluation of the damage that may have been sustained by organs affected by the disease. The impact that the choice of anesthetic technique may have on disease progression should be considered and discussed with the patient.

REFERENCES

1. Baranton G, Postic D, Saint Girons I, et al. Delineation of Borrelia burgdorferi sensu stricto, Borrelia garinii sp. nov., and group VS461 associated with Lyme borreliosis. *Int J Syst Bacteriol.* 1992;42(3):378-383.
2. Sanchez E, Vannier E, Wormser GP, Hu LT. Diagnosis, treatment, and prevention of Lyme disease, human granulocytic anaplasmosis, and babesiosis: a review. *JAMA.* 2016;315(16):1767-1777.
3. Wright WF, Riedel DJ, Talwani R, Gilliam BL. Diagnosis and management of Lyme disease. *Am Fam Physician.* 2012;85(11):1086-1093.
4. Rahn DW. Lyme disease: clinical manifestations, diagnosis, and treat-

ment. *Semin Arthritis Rheum.* 1991;20(4):201-218.
5. Pritt BS, Respicio-Kingry LB, Sloan LM, et al. Borrelia mayonii sp. nov., a member of the Borrelia burgdorferi sensu lato complex, detected in patients and ticks in the upper midwestern United States. *Int J Syst Evol Microbiol.* 2016; 66(11):4878-4880.
6. Theel ES. The Past, Present, and (Possible) Future of serologic testing for Lyme disease. *J Clin Microbiol.* 2016;54(5):1191-1196.
7. Clark RP, Hu LT. Prevention of Lyme disease and other tick-borne infections. *Infect Dis Clin North Am.* 2008;22(3):381-396.
8. Sanchez JL. Clinical manifestations and treatment of Lyme disease. *Clin Lab Med.* 2015;35(4):765-778.
9. Treatment of Lyme disease. *JAMA.* 2016;315(22):2461-2462.
10. Shen AK, Mead PS, Beard CB. The Lyme disease vaccine—a public health perspective. *Clin Infect Dis.* 2011;52(suppl 3):s247-s252.
11. Lantos PM. Chronic Lyme disease. *Infect Dis Clin North Am.* 2015;29(2):325-340.
12. Lantos PM. Chronic Lyme disease: the controversies and the science. *Expert Rev Anti Infect Ther.* 2011;9(7):787-797.
13. Lantos PM, Auwaerter PG, Wormser GP. A systematic review of Borrelia burgdorferi morphologic variants does not support a role in chronic Lyme disease. *Clin Infect Dis.* 2014;58(5):663-671.
14. Oliveira CR, Shapiro ED. Update on persistent symptoms associated with Lyme disease. *Curr Opin Pediatr.* 2015;27(1):100-104.
15. Batheja S, Nields JA, Landa A, Fallon BA. Post-treatment Lyme syndrome and central sensitization. *J Neuropsychiatry Clin Neurosci.* 2013;25(3):176-186.
16. Aucott JN, Soloski MJ, Rebman AW, et al. CCL19 as a chemokine risk factor for post-treatment Lyme disease syndrome: a prospective clinical cohort study. *Clin Vaccine Immunol.* 2016;23(9):757-766.
17. Ajamian M, Cooperstock M, Wormser GP, Vernon SD, Alaedini A. Anti-neural antibody response in patients with post-treatment Lyme disease symptoms versus those with myalgic encephalomyelitis/chronic fatigue syndrome. *Brain Behav Immun.* 2015;48:354-355.
18. Phillips SE, Harris NS, Horowitz R, Johnson L, Stricker RB. Lyme disease: scratching the surface. *Lancet.* 2005;366(9499):1771.
19. Smith BG, Cruz AI, Jr., Milewski MD, Shapiro ED. Lyme disease and the orthopaedic implications of lyme arthritis. *J Am Acad Orthop Surg.* 2011;19(2):91-100.
20. Wang G, van Dam AP, Schwartz I, Dankert J. Molecular typing of Borrelia burgdorferi sensu lato: taxonomic, epidemiological, and clinical implications. *Clin Microbiol Rev.* 1999;12(4):633-653.
21. van der Linde MR. Lyme carditis: clinical characteristics of 105 cases. *Scand J Infect Dis Suppl.* 1991;77:81-84.
22. Forrester JD, Mead P. Third-degree heart block associated with Lyme carditis: review of published cases. *Clin Infect Dis.* 2014;59(7):996-1000.
23. Reznick JW, Braunstein DB, Walsh RL, et al. Lyme carditis: electrophysiologic and histopathologic study. *Am J Med.* 1986;81(5):923-927.
24. Lelovas P, Dontas I, Bassiakou E, Xanthos T. Cardiac implications of Lyme disease, diagnosis and therapeutic approach. *Int J Cardiol.* 2008;129(1):15-21.
25. Marques AR. Lyme Neuroborreliosis. *Continuum.* 2015;21(6 Neuroinfectious Disease):1729-1744.
26. Ramesh G, Didier PJ, England JD, et al. Inflammation in the pathogenesis of Lyme neuroborreliosis. *Am J Pathol.* 2015;185(5):1344-1360.
27. Kotzé A, Hinton W, Crabbe DC, Carrigan BJ. Audit of epidural analgesia in children undergoing thoracotomy for decortication of empyema. *Br J Anaesth.* 2007;98(5):662-666.
28. Sultan P, Green C, Riley E, Carvalho B. Spinal anaesthesia for caesarean delivery in a parturient with babesiosis and Lyme disease. *Anaesthesia.* 2012;67(2):180-183.
29. Yuki K, Eckenhoff RG. Mechanisms of the immunological effects of volatile anesthetics: a review. *Anesth Analg.* 2016;123(2):326-335.
30. Cassinello F, Prieto I, del Olmo M, Rivas S, Strichartz GR. Cancer surgery: how may anesthesia influence outcome? *J Clin Anesth.* 2015;27(3):262-272.
31. Katzav S, Shapiro J, Segal S, Feldman M. General-anesthesia during excision of a mouse-tumor accelerates postsurgical growth of metastases by suppression of natural-killer cell-activity. *Isr J Med Sci.* 1986;22(5):339-345.
32. Siddiqui RA, Zerouga M, Wu M, et al. Anticancer properties of propofol-docosahexaenoate and propofol-eicosapentaenoate on breast cancer cells. *Breast Cancer Res.* 2005;7(5):R645-R654.

AUTHOR

Tammy Smit, MSNA, CRNA, is a clinical nurse anesthetist, Huguley Hospital, Fort Worth, Texas. She is a graduate of Texas Wesleyan School of Nurse Anesthesia. She is a professional speaker. Email: tammyc2009@att.net.

DISCLOSURES

The author has declared no financial relationships with any commercial entity related to the content of this article. The author did discuss off-label use within the article.