Lyme carditis–induced sinoatrial dysfunction after initiation of targeted oral antibiotic therapy: A case report

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Introduction

Lyme disease is a multisystem disease caused by the gram-negative spirochete bacterium *Borrelia burgdorferi*.[1] Transmitted by the *Ixodes* tick, it is the most common vector-borne condition in North America.[2] Lyme carditis primarily occurs in early disseminated disease and is pathologically associated with direct spirochete invasion of cardiac tissue with an exaggerated inflammatory response and conduction system involvement.[3,4] Historic estimates of Lyme carditis incidence have been as high as 10%, though recent studies are more conservative, reporting between 0.3% and 4%.[1,4] Resulting conduction abnormalities show a marked tendency toward atrioventricular nodal block, occurring in roughly 90% of cases.[5] Sinoatrial block, prolonged QT interval, paroxysmal atrial fibrillation, and transient bundle branch block are other electrophysiologic manifestations.[6] In this case, we present Lyme carditis resulting in isolated sinoatrial node dysfunction that manifested after greater than 1 week of targeted oral antibiotic therapy.

Case report

In August 2022, a 46-year-old active and otherwise healthy man living in a Lyme disease endemic region of the northeastern United States presented to the Electrophysiology clinic for evaluation of palpitations. The month prior, he had experienced a pinching sensation in his right thigh with an associated macular erythematous rash that occurred without finding an attached, engorged tick. He later developed high fevers, fatigue, and a second well-demarcated rash on the left flank. Serologic testing for Lyme disease at a local medical office done after symptom onset was positive for IgG and IgM titers. He had initially started cephalexin at home and was subsequently prescribed a 2-week course of oral doxycycline. During the second week of his antibiotic therapy, he noted palpitations and an uneasy feeling in his chest that occurred following exercise. He also experienced a similar sensation shortly after drinking a caffeinated beverage. At the time of his Electrophysiology appointment, he was on his 12th day of doxycycline, was asymptomatic, and had both an electrocardiogram and a transthoracic echocardiogram without abnormalities. He subsequently received mobile electrocardiogram monitoring (Kardia 5.25.0; AliveCor Inc., Mountain View, CA) to assess for rhythm abnormalities if symptoms recurred.

KEY TEACHING POINTS

- Carditis affects a minority (0.3%–4%) of Lyme disease patients and commonly causes atrioventricular nodal blockade, though other conduction abnormalities, including sinus arrhythmia, may occur,
- Arrhythmias secondary to Lyme carditis can occur despite targeted oral antibiotic therapy, and intravenous antibiotics with ceftriaxone as a first-line agent are indicated for appropriate management.
- Lyme carditis manifesting as isolated sinoatrial dysfunction might not result in detectable abnormalities on cardiac magnetic resonance imaging, for which the underlying cause is still unclear.
- Noninvasive ambulatory electrocardiographic monitoring may be reasonable when Lyme carditis–induced arrhythmias are intermittent and not detected on a standard 12-lead electrocardiogram, and may also be considered for assessing arrhythmia resolution after appropriate antibiotic therapy.

KEYWORDS Lyme carditis; Lyme disease; Sinoatrial dysfunction; Sinus arrhythmia; Mobile electrocardiography
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The following afternoon, he experienced palpitations and fatigue while at work. Mobile electrocardiography during that episode revealed sinus pauses with periods of both wide and narrow complex escape rhythm (Figure 1). He was instructed to present to the hospital for admission and further management.

During his initial hospitalization, he was asymptomatic and a standard 12-lead electrocardiogram exhibited sinus bradycardia at a heart rate of 48 beats per minute (Figure 2). Cardiac telemetry showed sinus bradycardia at a rate of 40–50 beats per minute with intermittent periods of sinus pause and junctional escape rhythm. His antibiotic coverage was broadened to intravenous ceftriaxone at 2 grams every 24 hours. Cardiac magnetic resonance imaging was obtained and did not identify any abnormalities (Figure 3). In consultation with Infectious Disease, he was diagnosed with partially treated early disseminated Lyme disease, considered to be the etiology of his sinoatrial nodal disease. Sinus bradycardia without other conduction abnormalities persisted while he received ceftriaxone. A peripherally inserted central catheter was placed before discharge, and the patient completed the remainder of a 21-day ceftriaxone course at home. Repeat Lyme disease IgM and IgG titers taken early during the hospitalization were positive.

Approximately 3 weeks after discharge, the patient's symptoms had completely resolved while he completed intravenous antibiotic therapy at home. A 14-day cardiac rhythm monitor demonstrated no clinically significant arrhythmia.

Discussion

Although Lyme carditis most commonly manifests as atrioventricular nodal block, all cardiac tissues are susceptible to spirochete invasion.[3] Seven published case reports have documented sinoatrial nodal dysfunction secondary to Lyme disease, including 2 reports of isolated sinus arrhythmias without other conduction abnormalities.[6–12] The mechanism by which this occurs is not fully understood but may relate to sinoatrial exit block rather than from defects in the automaticity of pacemaker cells, given the tendency of Lyme carditis to affect conduction pathways.[11]

The onset of symptoms attributed to sinus dysfunction occurred following greater than 1 week of appropriately targeted oral antibiotic therapy. Another published case reported symptom and arrhythmia onset following doxycycline initiation, but this occurred after the patient had completed a full 2-week course.[7] Consequently, a recent history of oral antibiotics should not be a deterrent to considering a Lyme carditis diagnosis when clinically appropriate. Guidelines for Lyme carditis management recommend empiric intravenous antibiotics even while serology testing is in process.[4] Ceftriaxone is considered to be the first-line agent and should be administered for a period between 10 and 28 days, though transitioning to an oral regimen may be considered after 10 days of intravenous therapy to complete a total antibiotic course of 14–21 days.[4] In both of these cases,

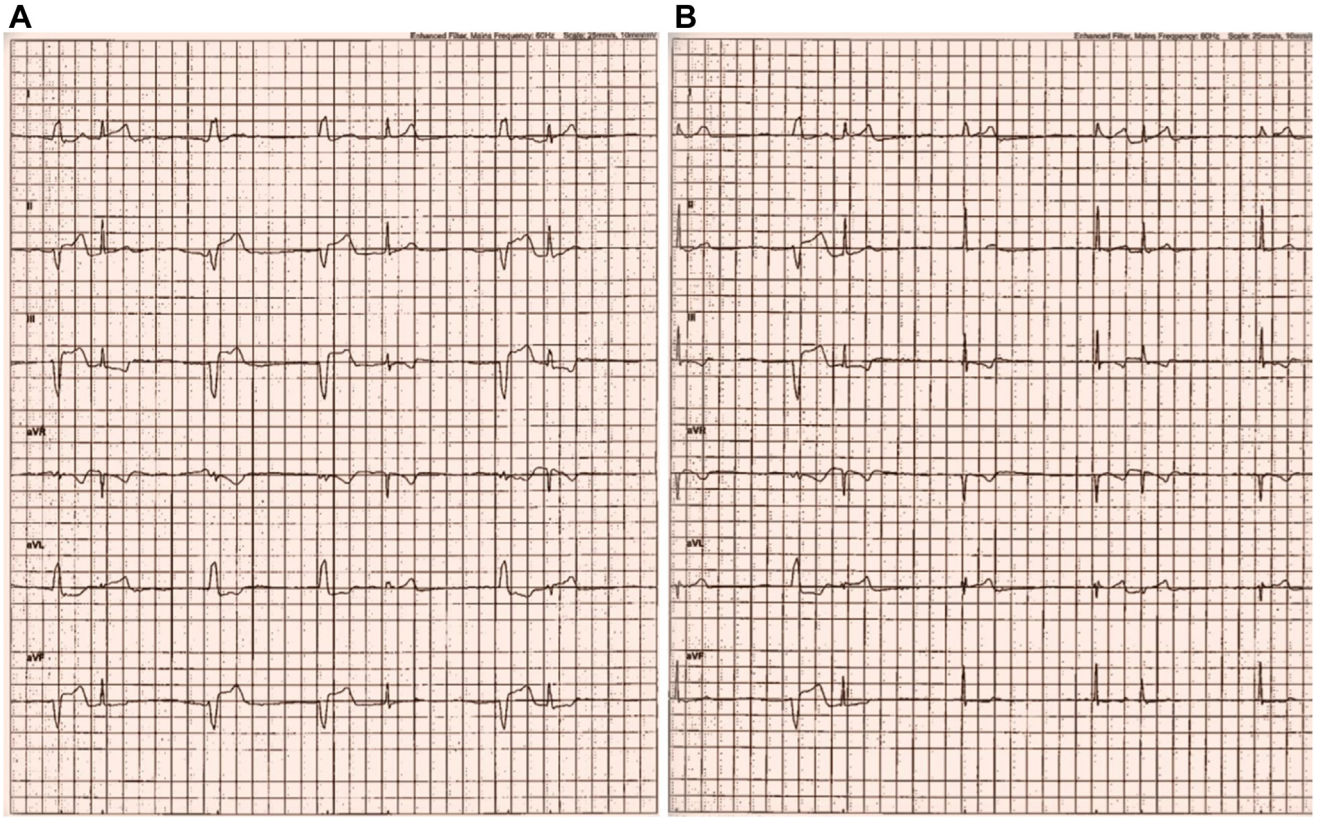

Figure 1 Mobile electrocardiographic monitoring. **A:** A p wave best visualized in lead I preceding a sinus pause of approximately 1.6 seconds followed by a wide complex escape rhythm with 1 intervening sinus beat. **B:** Periods of wide complex ventricular and narrow complex junctional escape bradycardia.

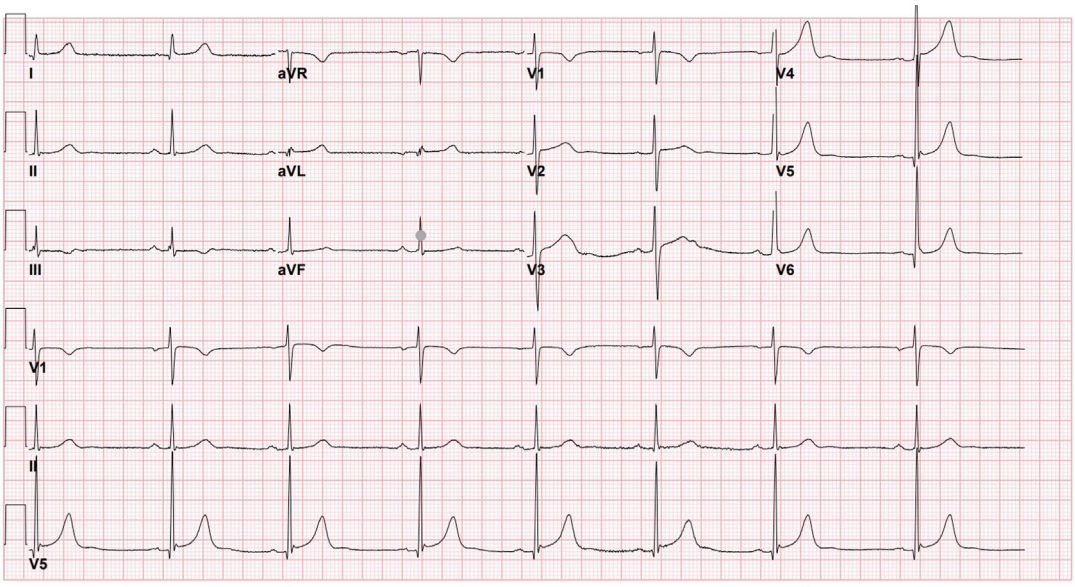

Figure 2 Twelve-lead electrocardiogram: bradycardic sinus arrhythmia with a ventricular rate of 48 and an early repolarization pattern.

electrocardiographic abnormalities resolved after appropriate treatment with intravenous ceftriaxone.

Cardiac magnetic resonance imaging can provide diagnostic assistance in Lyme carditis, typically depicting subendocardial-sparing late gadolinium enhancement.[1,13] In this case, such imaging did not have abnormal findings. One other reported case of Lyme carditis with isolated sinoatrial dysfunction was assessed using cardiac magnetic resonance imaging and also failed to detect an abnormality.[7] A possible explanation for the lack of imaging findings is that spirochete invasion is limited to atrial tissue, where thin walls reduce detectability.[7] However, this theory may not correlate with pathologic studies on autopsy samples that consistently show Lyme carditis manifesting as pancarditis.[3]

Symptomatic bradycardia or situations in which a bradycardic heart cannot meet metabolic demands are potential indications for permanent pacemaker placement.[14] However, clinicians should remain aware of Lyme disease as a possibly reversible cause of cardiac conduction abnormalities without an expectation of recurrence.[4] Appropriate diagnosis and treatment of Lyme carditis may be instrumental for reducing the risk of unnecessary cardiac implantable electronic device placement and help to avoid the associated healthcare costs and potential physical and psychological harms.[4]

The patient's Suspicious Index in Lyme Carditis score was between 5 and 9, as it was not possible to determine whether their rash was consistent with erythema migrans, which correlates with a moderate-to-high risk of Lyme carditis.[5] Although this score was designed to stratify Lyme carditis risk in high-degree atrioventricular block, there may be utility in its application to cases of sinus dysfunction as well.

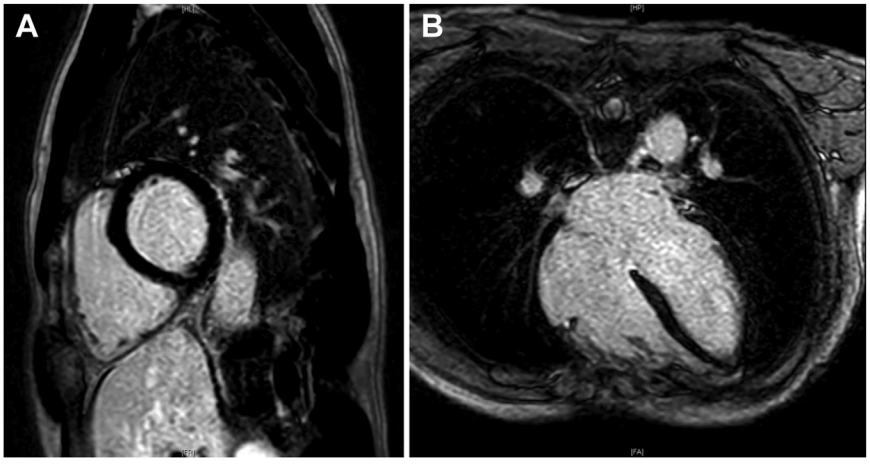

Figure 3 Cardiac magnetic resonance imaging. Sagittal (**A**) and transverse (**B**) images negative for late gadolinium enhancement or other abnormalities suggestive of myocarditis.

Patients at risk for Lyme disease who exhibit a nonconcerning electrocardiogram might benefit from a period of remote cardiac monitoring, as in this case, where sinoatrial dysfunction was initially identified on a mobile device. As well, continuing outpatient cardiac monitoring for a period following the completion of intravenous targeted antibiotics might also be beneficial to evaluate for treatment failure and ensure the resolution of conduction abnormalities.

A limitation of this case is a lack of stress testing following the restoration of 1:1 conduction at not less than 10 days after admission, which would have been useful to assess for chronotropic incompetence.[4] However, this would likely have been more beneficial for assessing sinoatrial node function and not atrioventricular conduction, as high-degree atrioventricular block was not a characteristic of this case. Another limitation is that an invasive electrophysiologic study to further characterize the arrhythmia was not performed.

Conclusion

Lyme carditis is a potential cause of sinoatrial dysfunction and may occur in patients who have recently been treated with oral antibiotics. Further research is likely necessary to determine if a lack of abnormalities on magnetic resonance imaging is characteristic of isolated sinoatrial disease. Cases of Lyme carditis should be managed with intravenous antibiotics. Having an appropriate clinical suspicion of Lyme carditis as a possible reversible cause of cardiac conduction abnormalities may help to reduce the risk of unnecessary permanent pacemaker implantation.

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