

REVIEW ARTICLE

The Value of the Surface ECG for the Diagnosis and Management of Lyme Carditis: A Case Report

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Abstract: Lyme carditis (LC) is an early-disseminated manifestation of Lyme disease, most commonly presenting as a high-degree atrioventricular block (AVB). The degree of AVB can fluctuate rapidly within minutes, and progression to third-degree AVB is potentially fatal if not recognized and managed promptly. However, the AVB in LC is often transient and usually resolves with appropriate antibiotic therapy. LC should be on the differential diagnosis in young patients presenting with new high-degree AVB and factors that increase the index of suspicion for Lyme disease. The Suspicious Index in Lyme Carditis (SILC) score helps clinicians risk-stratify for LC. A systematic approach to the diagnosis and treatment of LC minimizes the unnecessary implantation of permanent pacemakers.

Keywords: Lyme carditis, atrioventricular block, SILC, infectious disease, neurological, joint.

1. INTRODUCTION

Lyme disease is an infectious disease most commonly caused by the *Borrelia burgdorferi* bacteria and transmitted by the *Ixodes* tick [1]. Lyme disease can have multiple end-organ system manifestations, including cardiac, joint, and neurological, in the early disseminated phase [2]. Lyme carditis (LC), affecting 0.3% to 4% of Lyme disease cases, mainly presents as a high-degree atrioventricular block (AVB) within one to two months of the initial infection [3-7]. AVB secondary to LC is usually supra-Hisian/intranodal with narrow complex escape, and only rarely infra-Hisian [7, 8].

Both direct myocardial invasion by the bacteria and the resultant immunologic and inflammatory responses contribute to the pathophysiology of LC [9]. Metabolic processes, anatomic location, and tissue tropism of the bacteria have been hypothesized to explain the prevalence of AV nodal involvement in LC [10, 11]. Alternatively, selection and survivorship bias could underlie the high proportion of AVB as the primary captured electrocardiographic abnormality in LC. Other conduction system disturbances (for example, bundle branch blocks) may be relatively asymptomatic such that the patient does not seek medical attention; conversely, widespread pathology affecting the whole Purkinje system and resulting in sudden cardiac death may represent a missed diagnosis of LC without an adequately high index of suspicion and autopsy [12-15].

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Notably, the degree of AVB can fluctuate rapidly from minor forms of AVB to complete AVB with a very slow AV junctional escape rhythm within minutes [4, 7, 8, 16]. Progression to third-degree AVB is potentially fatal if not recognized and managed promptly [4, 7, 8, 12-14, 16-18]. However, the AVB in LC is often transient, with a similarly striking speed of recovery with appropriate antibiotic therapy [10, 19, 20].

Several research groups, including our own, have recently published on the restoration of normal conduction in patients with LC upon the initiation of antibiotics [10, 19-21]. To illustrate the electrocardiographic evolution and management of high-degree AVB due to LC, we present the following case of a patient with LC from our center.

2. CASE DESCRIPTION

A 40-year-old male presented to the emergency department with palpitations. He reported no past medical history and no recreational drugs. His occupation with the military entailed extensive work outdoors, his dog was found to have ticks, and he had a history of several tick bites around the home. Two weeks prior to presentation, he had found a tick attached to his abdomen. He did not have the pathognomonic bull's-eye *erythema migrans* rash, arthralgias, or neurologic symptoms. He also denied fever/chills, dyspnea, chest pains, and pre-syncope. The electrocardiographic progression during the first 9 days is shown in Fig. (1).

3. CLINICAL COURSE

The first electrocardiogram (ECG) showed second-degree AVB with 2:1 and 4:1 AV conduction and asympto-

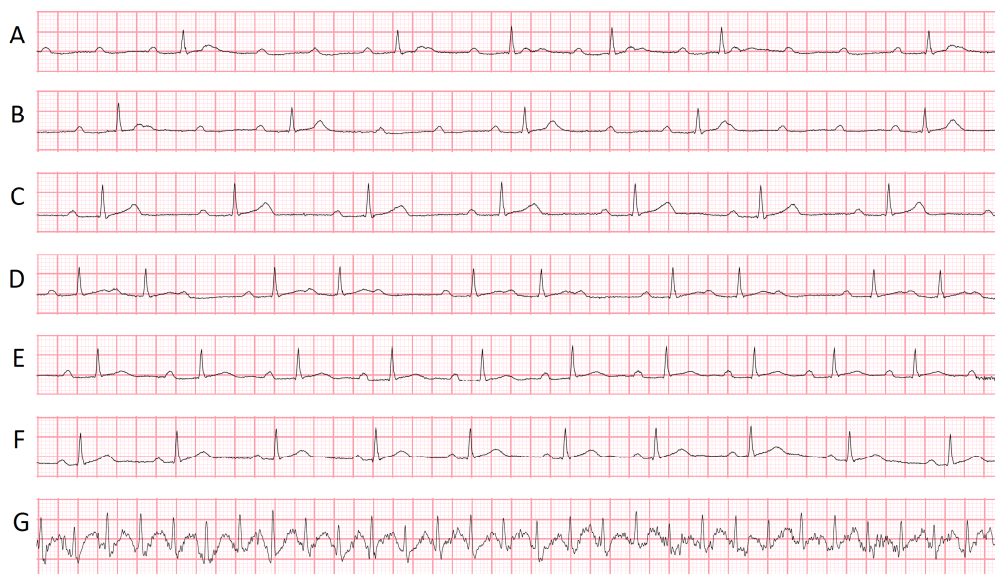


Fig. (1). The electrocardiographic (ECG) progression of a patient with Lyme carditis presenting with high-degree atrioventricular block (AVB). (A) Second-degree AVB with 2:1 and 4:1 AV conduction resulting in a rate of 40 beats per minute (bpm) (day 1). Intravenous ceftriaxone was started for the empiric treatment of Lyme carditis. (B) Second-degree AVB with 4:1 AV conduction at 29 bpm (day 2). (C) First-degree AVB (PR interval 320 ms) at 45 bpm (day 2). (D) Second-degree AVB Mobitz I (day 2). (E) First-degree AVB (PR interval 315 ms) at 66 bpm (day 4). (F) Normal sinus rhythm with a PR interval at 205 ms (day 9). (G) Stress test ECG recording showing 1:1 conduction at 181 bpm. (A higher resolution / colour version of this figure is available in the electronic copy of the article).

Table 1. The Suspicious Index in Lyme Carditis (SILC) score evaluates the likelihood that a patient's high-degree atrioventricular block is caused by Lyme carditis. The variables in the SILC score can be associated with the mnemonic "CO-STAR". The total summed score indicates low (0-2), intermediate (3-6), or high (7-12) suspicion of Lyme carditis. Reproduced with permission from [22].

Variable	Value
Constitutional symptoms*	2
Outdoor activity/endemic area	1
Sex: Male	1
Tick bite	3
Age < 50 years	1
Rash: Erythema migrans	4

*Note: Fever, malaise, arthralgia, and dyspnea.

matic bradycardia at 40 bpm. While Lyme serology was being processed, given the likelihood of LC in the context of a recalled tick bite and the new development of a high-degree AVB, he was empirically treated for the presumptive diagnosis of LC. He received intravenous ceftriaxone and stayed on telemetry monitoring. He was transferred to a tertiary care hospital for further management. Upon his arrival, he was in second-degree AVB with 4:1 AV conduction at 29 bpm. Initial infectious and autoimmune workup, including blood cultures, ANA, C3, C4, and ANCA, returned negative.

By the fourth day of admission, ECG consistently showed first-degree AVB. He was in normal sinus rhythm by Day 9. An exercise stress test on day 10 revealed normal 1:1 cardiac conduction in heart rate >180 beats per minute. Resting echo identified normal left and right ventricular size and function. Cardiac magnetic resonance imaging showed no

late gadolinium enhancement suggestive of fibrosis. He was in normal sinus rhythm with a PR interval of 186 ms at the time of discharge.

Upon discharge, he had received 10 days of intravenous ceftriaxone and was stepped down to oral doxycycline 100 mg po bid for 11 days to complete a total 21-day course of antibiotics. Serology results available post-discharge confirmed Lyme IgM/IgG EIA reactive, IgM Western blot reactive, and IgG Western blot weakly reactive.

4. DISCUSSION

To facilitate the recognition of LC by clinicians who are less familiar with Lyme, our group has extensively published on the Suspicious Index in Lyme Carditis (SILC) score (Table 1) and proposed an algorithm for the systematic approach

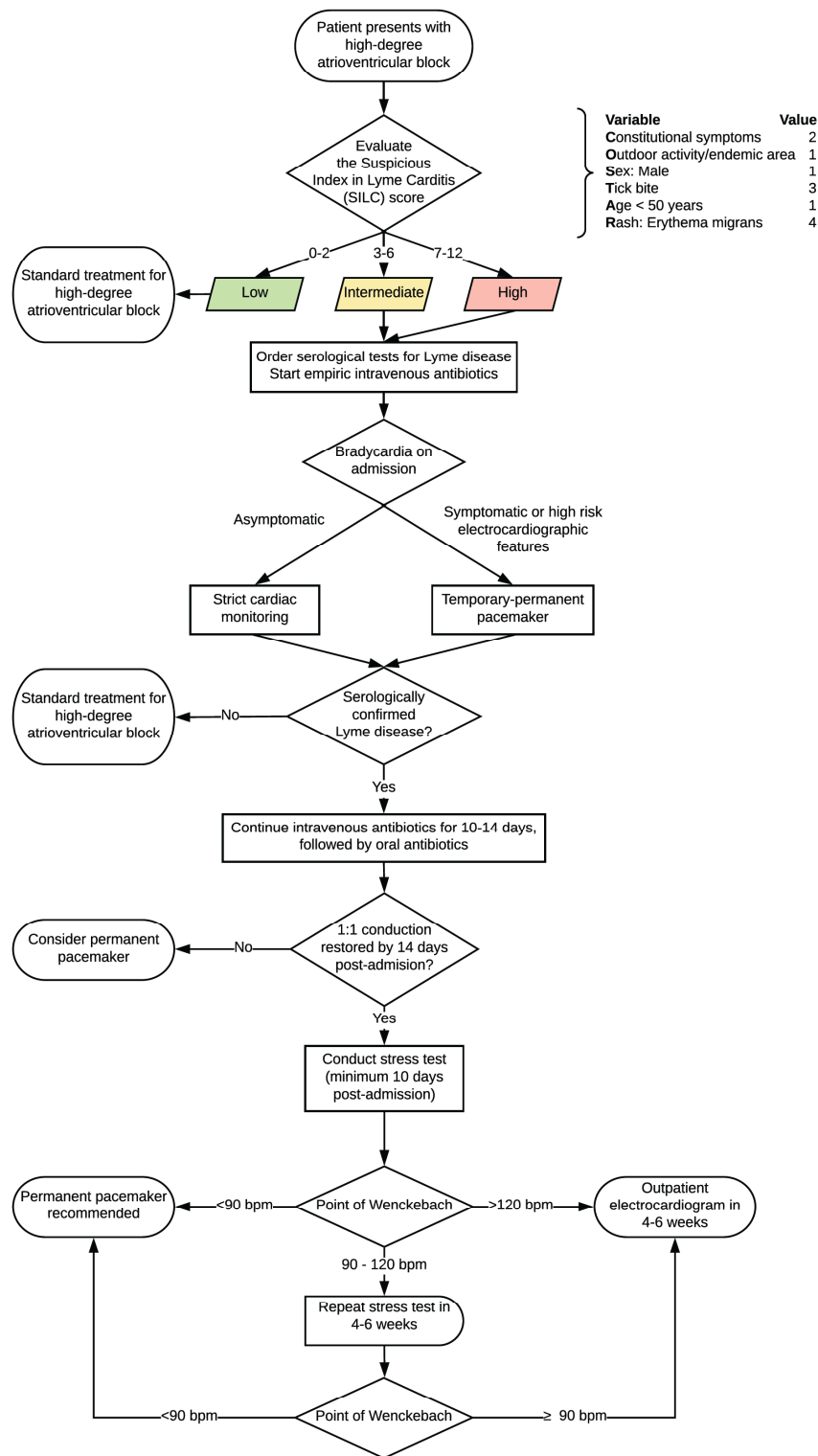


Fig. (2). Systematic approach to the diagnosis and management of Lyme carditis and high-degree atrioventricular block. Modified with permission from [22]. (A higher resolution / colour version of this figure is available in the electronic copy of the article).

to the diagnosis and management of high-degree AVB in LC (Fig. 2) [22]. The SILC risk score evaluates the likelihood that a patient’s high-degree AVB is caused by LC by assigning weights to risk factors, where the final summed score classifies patients to be low risk (0-2), intermediate-risk (3-6), or high risk (7-12) [23]. The patient in the aforemen-

tioned case had outdoor activities/endemic area (1 point), male sex (1 point), recalled tick bite (3 points), and age <50 years (1 point), for a total SILC score of 6 points. Therefore, he was categorized to be at intermediate risk for LC as the cause of his high-degree AVB.

The SILC score has important clinical utility in facilitating the prompt initiation of intravenous antibiotic therapy for those at intermediate-to-high risk for Lyme while confirmatory testing is pending. In this case, the results of the Lyme blood work were not available until after the patient was discharged, many days after the resolution of the conduction disturbances. Waiting for serological corroboration of Lyme disease to begin treatment would have resulted in a significant delay of definitive management.

Strict cardiac monitoring was implemented for this patient's asymptomatic bradycardia. However, the patient was also pre-emptively transferred to a hospital with the capability to implant a temporary-permanent pacemaker if he were to develop symptomatic bradycardia or high-risk electrocardiographic features. Temporary-permanent pacemakers are a particularly favourable option in LC given the anticipated imminent resolution of the AVB with antibiotics and the ease of early ambulation [24]. Nevertheless, if 1:1 AV conduction is not restored by 14 days post-admission, then a permanent pacemaker is recommended.

Patients with serologically-confirmed Lyme disease should continue with 10-14 days of intravenous antibiotics. If 1:1 conduction is restored by 14 days post-admission, then the stability of AV conduction is assessed by a stress test (not sooner than 10 days post-admission) [22]. If 1:1 AV conduction is maintained >120 beats per minute, as was the case in this patient, then antibiotic therapy can be transitioned to an oral regimen. Else, if the point of Wenckebach is 90-120 beats per minute, then a repeat stress test in four to six weeks is advisable before deciding on permanent pacing. Lastly, if conduction fails at <90 beats per minute on the stress test, then a permanent pacemaker is recommended [22].

CONCLUSION

LC should be on the differential diagnosis in young patients presenting with new high-degree AVB and factors that increased the index of suspicion for Lyme disease, such as outdoor activity/endemic area and recalled the history of a tick bite. The conduction defects due to LC often resolve completely with antibiotic treatment. A systematic approach to the diagnosis and treatment of LC minimizes the unnecessary implantation of permanent pacemakers.

CONSENT FOR PUBLICATION

All authors have participated in the work and have reviewed and agree with the content of the article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

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