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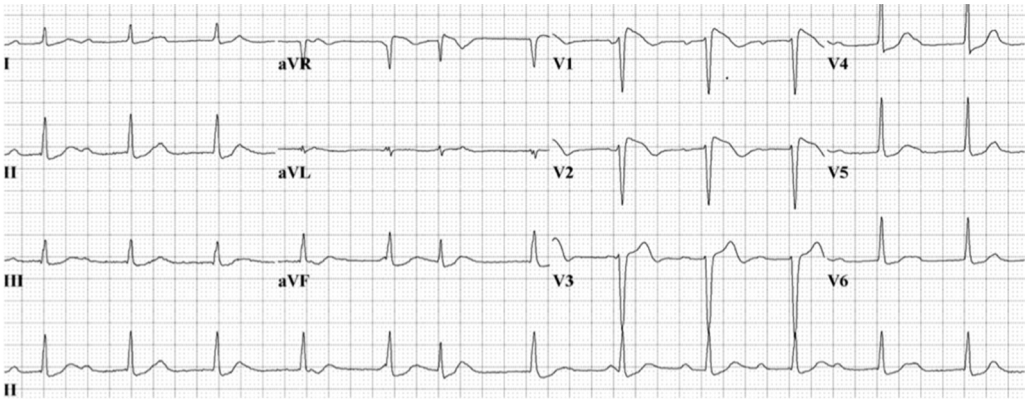

Figure 1. ECG of a 19-year-old man with syncope.

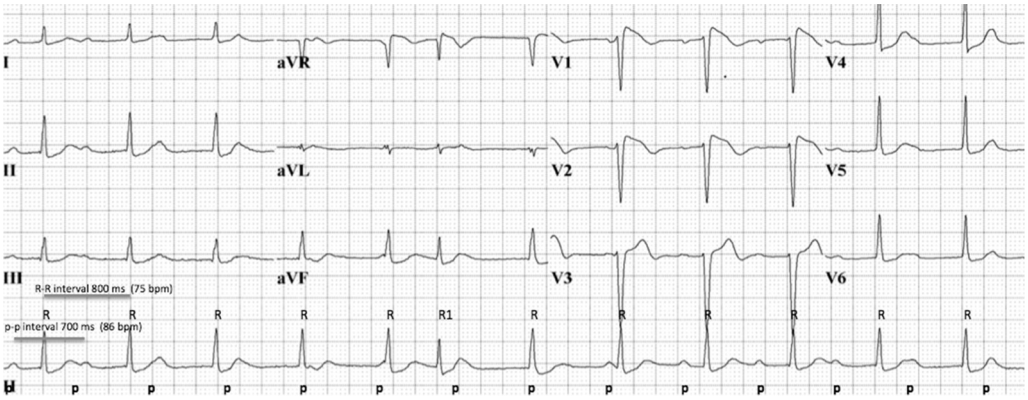

Figure 2. ECG demonstrating high-grade atrioventricular block with P waves labeled "P," QRS waves labeled "R," and a single conducted QRS complex labeled "R1."

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A 19-year-old man with no significant medical history was brought in by ambulance to the emergency department after a witnessed syncopal event. He was febrile, with an oral temperature of 38.1°C (100.6°F), and hemodynamically stable, with a normal electrolyte panel result and CBC count. Review of systems was pertinent for flulike symptoms and subjective fevers for the past week. An ECG is shown in Figure 1. What are the critical findings?

For the diagnosis and teaching points, see page 515.
To view the entire collection of ECG of the Month, visit www.annemergmed.com

ECG OF THE MONTH

(continued from p. 514)

DIAGNOSIS

ECG demonstrating high-grade atrioventricular block. The ECG demonstrates a consistent sinus rate at approximately 85 beats/min (labeled as P), and this is constant, with some P waves hidden within the QRS complexes (labeled R) or within the T wave (Figure 2). The first 5 and the last 6 QRS complexes on this tracing demonstrate a regular, ventricular rate of 75 beats/min. This phenomenon of unrelated and different rates in atria and ventricles is atrioventricular dissociation, and this can be observed in complete heart block. For the ECG to be labeled as complete heart block, the ventricular rhythm also needs to be regular because cardiac activity is maintained through an escape rhythm (either junctional or ventricular), and escape rhythms are regular and unaffected by atrial activity. This ECG, however, shows a single QRS complex arriving much earlier (labeled R1), and therefore complete heart block is not present for the entire duration of this 12-lead ECG. Some conduction must be present at the level of the atrioventricular node, and this results in early activation of the ventricle for this single beat. Even though the majority of the tracing shows complete heart block, and not second degree, we would then be obliged to label this as high-grade atrioventricular block because of the single conducted QRS complex (R1). Additionally, there was abnormal early repolarization, with 3-mm coved ST-segment elevation and a biphasic T wave in the right precordial leads V1 and V2, consistent with type 1 Brugada's pattern.

CLINICAL COURSE

Given the patient's occupation of farming and working with livestock, in addition to recreational hunting, enzyme-linked immunosorbent assay (ELISA) and Western blot were performed to test for recent *Borrelia burgdorferi* infection. Testing confirmed this diagnosis, and the heart block was presumed to be related to Lyme carditis. Intravenous ceftriaxone was initiated after positive ELISA results, and with continued antibiotic treatment, the fevers subsided and the type 1 Brugada's pattern resolved but a first-degree atrioventricular block remained. Despite appropriate antibiotic treatment, the patient continued to sustain symptomatic complete heart block with intermittent pauses after 1 week of therapy. Implantation of a single-chamber pacemaker was performed, with the understanding that this would be removed in the following 3 to 6 months for reversible atrioventricular block. The device was then successfully removed without complications 6 months later in the context of normal atrioventricular conduction. The patient sustained no ventricular arrhythmias per pacemaker interrogation after 6 months.

DISCUSSION

This case highlights the distinction of third-degree atrioventricular block and atrioventricular dissociation; atrioventricular dissociation is not a primary disturbance but instead is a sign of an underlying rhythm disturbance that inhibits the normal depolarization from the atrium to ventricle. Third-degree atrioventricular block is one cause of atrioventricular dissociation, in addition to the other major causes of atrioventricular dissociation: slowing of the dominant sinoatrial pacemaker and acceleration of a latent pacemaker, typically at the atrioventricular junction or below. Thus, patients with complete third-degree atrioventricular block always have atrioventricular dissociation; however, those with atrioventricular dissociation may or may not have third-degree atrioventricular block.

The most common manifestation of Lyme carditis is atrioventricular conduction block, which can fluctuate rapidly, presenting with all forms of atrioventricular block.[1] Lyme carditis may be the only presenting feature of infection and may occur without the other early features of Lyme disease, including erythema migrans. A diagnosis of Lyme carditis should be suspected in individuals with risk factors for *B burgdorferi* infection; serologic testing with ELISA and a confirmatory Western blot to detect serum immunoglobulin M or G antibodies to *B burgdorferi* establish the diagnosis.[2] There is low sensitivity (46.3%) for patients with acute disease and increasing sensitivity for those with early disseminated (98.7%) and late disease (99.4%). There is a high specificity for serologic testing (98.3% to 99.9%) across all 3 groups. Use of immunoglobulin M testing is recommended during the first 30 days of infection, after which only immunoglobulin G testing should be performed.[3]

Although the period is institution specific, results from ELISA and Western blot testing may take from 24 hours to 10 days to obtain. Antibiotic therapy should be initiated after initial serologic testing with a positive ELISA result. Recent trends in geographic distribution may be useful for providers and can be found online at the Centers for Disease Control and Prevention.[4]

Patients with positive Lyme serology results who have second- or third-degree atrioventricular block, have first-degree block with prolonged PR interval (≥300 ms), or are symptomatic (eg, chest pain, dyspnea, syncope) should be hospitalized, monitored with cardiac telemetry, and treated with intravenous antibiotics.[5] The drug of choice is intravenous ceftriaxone (2 g intravenously once daily for adults or 50 to 75 mg/kg intravenously once daily for children). Oral therapy with doxycycline, amoxicillin, or cefuroxime axetil may be considered for asymptomatic patients with first-degree atrioventricular block with a PR interval less than 300 ms. The indications for pacemaker placement are the same as for other causes of heart block. Because the atrioventricular block caused by Lyme disease is typically short-lived, temporary pacing is normally required as opposed to placement of a permanent pacemaker.[6]

PEARLS

Patients with complete third-degree atrioventricular block always have atrioventricular dissociation; however, those with atrioventricular dissociation may or may not have third-degree atrioventricular block.

When PR intervals seem to vary, march out the P wave on the rhythm strip. If it is difficult to discern, find the 2 most clear P waves and look for them buried in QRS or T-wave complexes.

Intravenous ceftriaxone is first-line treatment for patients presenting with Lyme carditis resulting in complete heart block, and temporary pacing may be needed in cases of heart block as a result of Lyme carditis that is refractory to antibiotic therapy.

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