Profound First-Degree Atrioventricular Block in a High-Level Basketball Athlete

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First-degree atrioventricular (AV) block (PR interval >200 ms) is commonly observed among screening electrocardiogram (ECG) in athletes. Profound first-degree AV block (PR interval >400 ms) and Mobitz type I (Wenckebach) second-degree AV block are generally uncommon and often require further workup on a case-by-case basis, particularly when there is concern for a structural cardiac abnormality. In this case, we present an example of an asymptomatic profound first-degree AV block with Mobitz type I (Wenckebach) second-degree AV block. Transthoracic echocardiogram and stress echocardiogram were unremarkable and the patient was cleared to participate in sports without any restriction. Physicians managing athletes should be aware of ECG features that require additional evaluation and cardiology consultation.

Keywords: Mobitz type I; Wenckebach, arrhythmia; PR interval

Cardiac screening is frequently incorporated into preparticipation physical evaluation (PPE) to identify risk factors for exercise-related cardiovascular events and sudden cardiac death.[1] Many collegiate, professional, and Olympic organizations incorporate electrocardiogram (ECG) into their cardiac screening processes.[1,5] Abnormalities in screening ECGs in athletes should be interpreted appropriately to help determine the presence of a potential cardiac disorder.[3,4] One common conduction abnormality in athletes is first-degree atrioventricular (AV) block (PR interval >200 ms). The prevalence of first-degree AV block among athletes in a baseline resting ECG is approximately 7.5%.[3,4] First-degree AV block is often related to increased vagal tone in highly trained athletes. Less commonly, athletes may have profound first-degree AV block (PR interval >400 ms) which could be related to increased vagal tone but could also result from abnormalities along the conduction pathway (eg, AV node block or delay below the AV node).[3] It is important that athletes with profound first-degree AV block undergo additional testing to determine the cause of the AV block before clearance for participation in sport.[3,8]

PATIENT

A high-level basketball player in his twenties presented for his annual PPE. He had no complaints including no syncopal or presyncopal episodes. The athlete did state that he had previous cardiac testing for a "slow heartbeat" as a teenager but was cleared to play and reported no symptoms of syncope or presyncope with and without exercise. He had an unremarkable American Heart Association 14-point cardiac history,[6] including no significant cardiovascular history in close relatives. This athlete did not have a diagnosis of COVID-19 over the past 2 years. On physical examination, the athlete had normal vital signs with a height of 198 cm, weight of 93 kg [body mass index (BMI) 23.7 kg/m^2], a heart rate of 56 beats per minute (bpm), and a blood pressure (BP) of 104/72 mmHg. He appeared well with no acute distress. His cardiac examination was normal other than bradycardia with no peripheral edema. There were no stigmata of Marfan syndrome (eg, anterior chest deformity, kyphoscoliosis, thumb, and wrist signs). His lungs were clear to auscultation bilaterally with no wheezing or rhonchi. His abdomen was soft, nontender, and nondistended.

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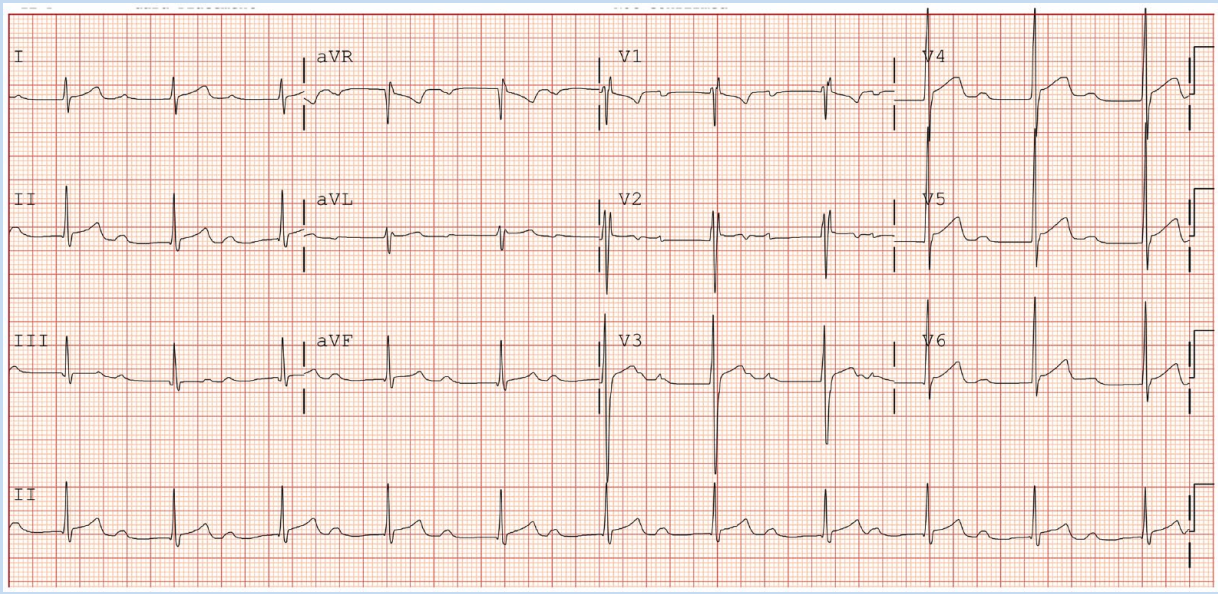

Figure 1. Screening electrocardiogram demonstrates a heart rate of 66 beats per minute and PR interval of 480 ms with early repolarization pattern [elevation of the QRS-ST junction (J-point) by >0.1 affecting the inferior and lateral leads].

An ECG (Figure 1) revealed a heart rate of 66 bpm, PR interval of 480 ms, QRS duration of 98 ms, rSr' pattern in V1, and an early repolarization pattern with left ventricular hypertrophy (LVH) by voltage criteria. As a part of his routine screening, he had unremarkable blood tests (complete blood count, comprehensive metabolic panel, thyroid-stimulating hormone, and lipid panel) and transthoracic echocardiogram (TTE). His TTE revealed normal size left ventricle with moderate concentric LVH with an intraventricular septal thickness of 1.4 cm, and a normal ejection fraction (63%). The right ventricle was moderately dilated with right ventricular base diameter of 4.6 cm and normal systolic function. There was no significant valvular pathology. As he had an asymptomatic profound first-degree AV block, further cardiac evaluation was recommended.

A multidisciplinary evaluation included consultation with cardiologists with expertise in cardiac imaging and electrophysiology (EP). A stress echocardiogram resulted in a resting ECG similar to athlete's original ECG at PPE. During the stress echocardiogram, the patient achieved a peak heart rate of 171 bpm (85% predicted maximum heart rate). His BP peaked from 104/72 to 132/82 mmHg during the test. No chest pain was experienced during testing. There were no ECG or echocardiogram changes during testing to suggest ischemia or arrhythmia with stress (Figure 2). First-degree AV block improved with exercise (Figure 2).

The athlete was cleared to participate in sports as he did not show signs of a structural heart abnormality and his AV block did not worsen with exercise.

The athlete participated during the following season without symptoms. At 1-year follow-up at the athlete's yearly PPE, he was found to have a Mobitz type I (Wenckebach) second-degree AV block with a heart rate as low as 37 bpm before exercise (Figure 3). Again, at that time, he did not have symptoms of palpitation, syncope, or presyncope. His TTE and stress ECG/echocardiogram were unremarkable. He had no symptoms during exercise stress testing. His first-degree AV block and Mobitz type I (Wenckebach) second-degree AV block improved during exercise (Figure 4). He was evaluated by an electrophysiologist to discuss the progression of his AV block. No additional testing or management was recommended. He was cleared to participate in sport without any limitations. After an additional 1 year of close follow-up and participation in competitive sports, he remained highly functional and asymptomatic.

DISCUSSION

ECG among athletes often show abnormalities that may be physiologic.[3,4,6] AV blocks, specifically first degree, are common electrophysiologic abnormalities in athletes, with prevalence of about 7.5% amongst athletes.[3,4] Profound first-degree AV block (PR interval >400 ms) is less common and typically athletes are asymptomatic.[2-4,6] Electrophysiological studies have shown that PR interval prolongation could be due to conduction delay located in multiple locations through the conduction system with the AV node being the most commonly affected location.[2-4,6-8] Increased vagal tone is the most common cause in an athletic population, but occasionally the cause is an abnormality intrinsic to the AV node and conduction system.[2-4,6-8] It has long been believed that AV block in athletes is related to increased parasympathetic tone. However, a recent

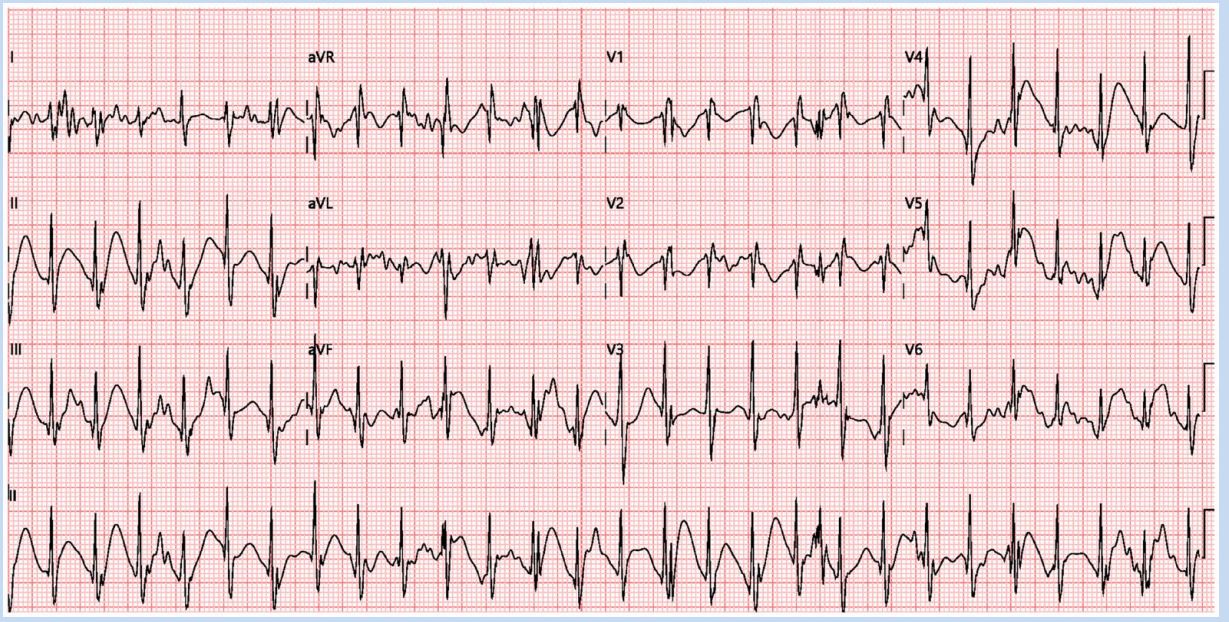

Figure 2. Stress electrocardiogram showing a heart rate of 171 beats per minute, achieving 85% of the maximum heart rate and shortening of the PR interval.

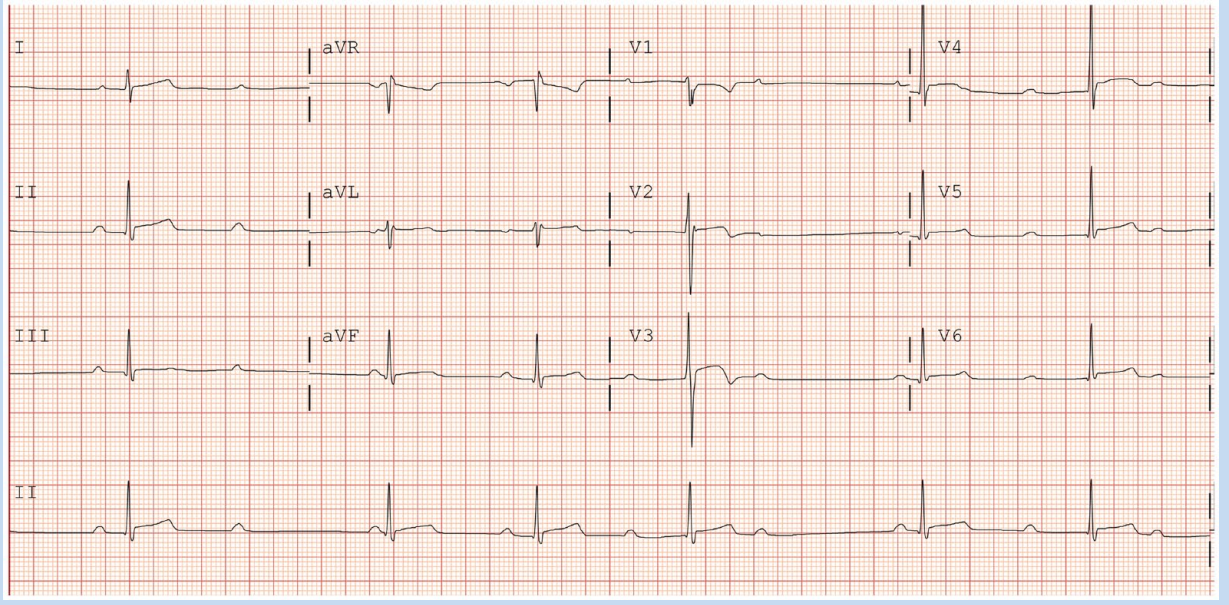

Figure 3. Screening electrocardiogram demonstrates a heart rate of 37 beats per minute and Mobitz type I (Wenckebach) second-degree atrioventricular block.

study has shown that in animal models, AV block is also in part due to transcriptional remodeling of ion channels of the AV node.[7] There is still much to be learned about the pathophysiology of this process in human athletes.

In this case, our athlete presented with an ECG showing profound first-degree AV block. We followed both of the international criteria for electrocardiographic interpretation in athletes: Consensus Statement[3] and the Eligibility and Disqualification Recommendations for Competitive Athletes with Cardiovascular Abnormalities guidelines recommended by the American Heart Association and American College of Cardiology.[8] The consensus statement notes that a PR interval

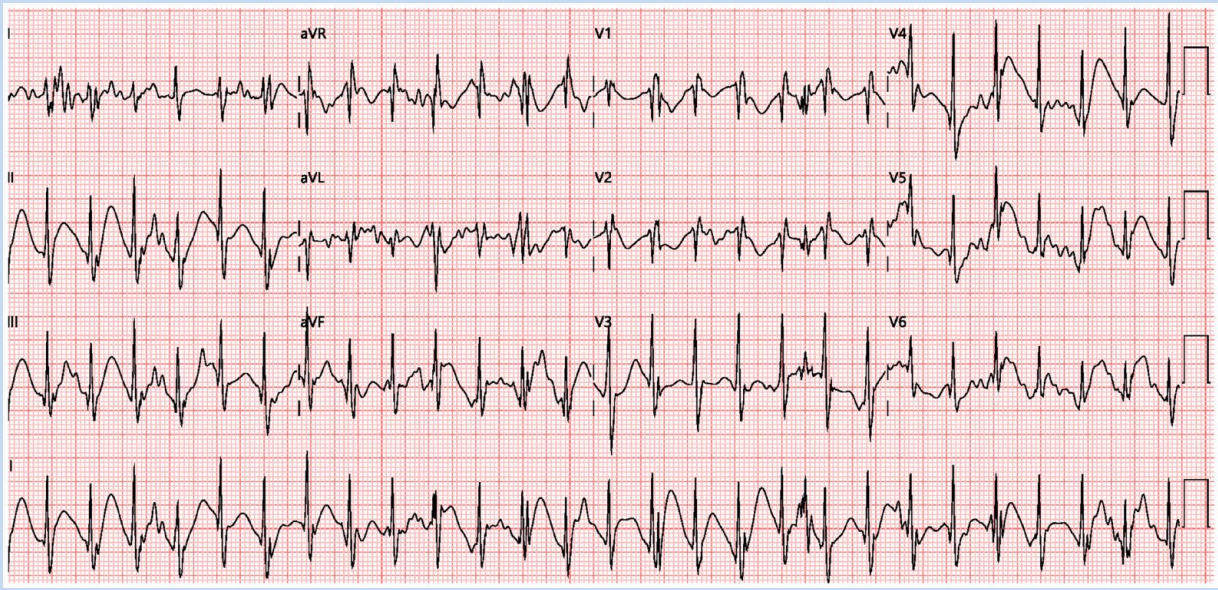

Figure 4. Stress electrocardiogram showing a heart rate of 145 beats per minute. Mobitz type I (Wenckebach) second-degree atrioventricular block at baseline improved with exercise. No significant exercise-induced cardiac arrhythmia was detected.

>400 ms constitutes a high-risk screening ECG requiring further workup.[3] TTE is a preferred starting modality to evaluate heart structure. In addition, a stress exercise test (ECG and/or echocardiography) should be obtained. In some patients, a few months of detraining could be considered to determine whether vagal tone reduction leads to improvement in arrhythmia. However, due to the otherwise normal workup and his high level of play, detraining was not employed in this case.

With the adrenergic response to exercise and higher heart rates, the PR interval should shorten if the cause is supranodal. If the PR interval does not shorten, a formal cardiology/EP consultation should occur as a structural cause of this first-degree AV block should be investigated further. In addition, the stress ECG helps to ensure the athlete's AV block does not progress to one of higher degree or another arrhythmia. At that time, there was no evidence of conduction disease on resting ECG and was consistent with Mobitz type I (Wenckebach) second-degree AV block which is a sign of physiological/nodal AV block. On testing, the AV block and PR prolongation again corrected with exertion during his stress testing, supporting physiological mechanism of AV block rather than structural or conduction related.

The Eligibility and Disqualification Recommendations state that asymptomatic athletes with no structural heart disease and first-degree AV block (PR interval <300 ms) can participate in all competitive sports unless there are findings that indicate that the athlete is at risk for progression to a higher degree block,[8] such as in this case with a PR interval >300 ms. After further studies, this athlete did not have structural heart disease nor worsening of block with exercise; thus, no athletic restrictions were recommended. Importantly, we involved a sports cardiologist and electrophysiologist in this case and through shared decision-making, determined that the athlete could reasonably participate in competitive sports with close follow-up.

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