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Tachycardia with alternating pacemaker spikes: Is it pacemaker malfunction?

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ABSTRACT

A 67 year old female with diabetes mellitus type 2, chronic kidney disease, ischemic cardiomyopathy, status post biventricular implantable cardioverter-defibrillator presented to the Heart Failure clinic for routine follow up with a tachycardia with alternating pacemaker spikes.

Case presentation

A 67 year old female with diabetes mellitus type 2, chronic kidney disease, coronary artery disease, status post triple vessel coronary artery bypass graft in 2012, and ischemic cardiomyopathy (Left-ventricular ejection fraction 30–34%), status post biventricular implantable cardioverter-defibrillator (ICD) (Medtronic VIVA XT CRT-D, Minneapolis, MN) presented to the Heart Failure clinic for routine follow up.

She had no complaints and felt well overall. Her physical examination was notable for tachycardia (110 BPM) with clear lungs, normal heart sounds, no jugular venous distention, and no lower extremity edema. She was compliant with all her medications which include carvedilol, bumetanide, and digoxin.

Routine electrocardiogram (ECG) (Fig. 1) is shown below. She denied chest pain, shortness of breath, palpitations or shocks from her ICD. ICD settings at the time of the clinical visit include DDDR Mode, lower rate limit 60 beats per minute (BPM), upper rate limit 120 BPM, right atrial blanking 200 ms, right ventricular blanking 200 ms, paced atrioventricular(AV) delay 170 ms, sensed AV delay 110 ms. Lead sensitivity settings and thresholds are unchanged from previous interrogations.

What is the most likely explanation for the EKG findings in this patient?

a) Atrial lead dislodgment into the right ventricle with ventricular pacing from the atrial lead
b) Junctional tachycardia with complexes occurring in alternating blanking periods causing pacemaker spikes during every other QRS complex
c) Sampling error of the digital ECG failing to detect and display certain pacemaker spikes
d) Pacemaker crosstalk with resultant back-up safety pacing

Explanation

a) Atrial lead dislodgment into the right ventricle with ventricular pacing from the atrial lead- INCORRECT

The ICD interrogation showed unchanged lead parameters, which makes it very unlikely that the atrial lead was dislodged into the right ventricle. Furthermore, lead dislodgement is unlikely to appear in a repetitive cyclical alternating pattern as seen here. The axis and morphology of the QRS complexes are notably not consistent with RV septal or apical stimulation which would be seen with pacing from dislodged atrial lead. Finally, the complexes with pacing spikes appear morphologically indistinguishable from the complexes without pacing, suggesting that each complex has the same intrinsic trigger [1].

c) Sampling error of the digital EKG failing to detect certain pacemaker spikes- INCORRECT.

It is entirely possible that the EKG failed to detect certain pacemaker spikes. Klingfield et al. described this phenomenon where pacemaker stimulus outputs cannot be reliably detected by some EKG systems given that their duration is generally shorter than 0.5 ms and ordinary signal processing technique are usually in the 500 to 1000 Hz range [2]. However, it is highly unlikely that this failure would occur every other QRS complex as seen in this EKG.

d) Pacemaker crosstalk with resultant safety pacing- INCORRECT.

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0022-0736/

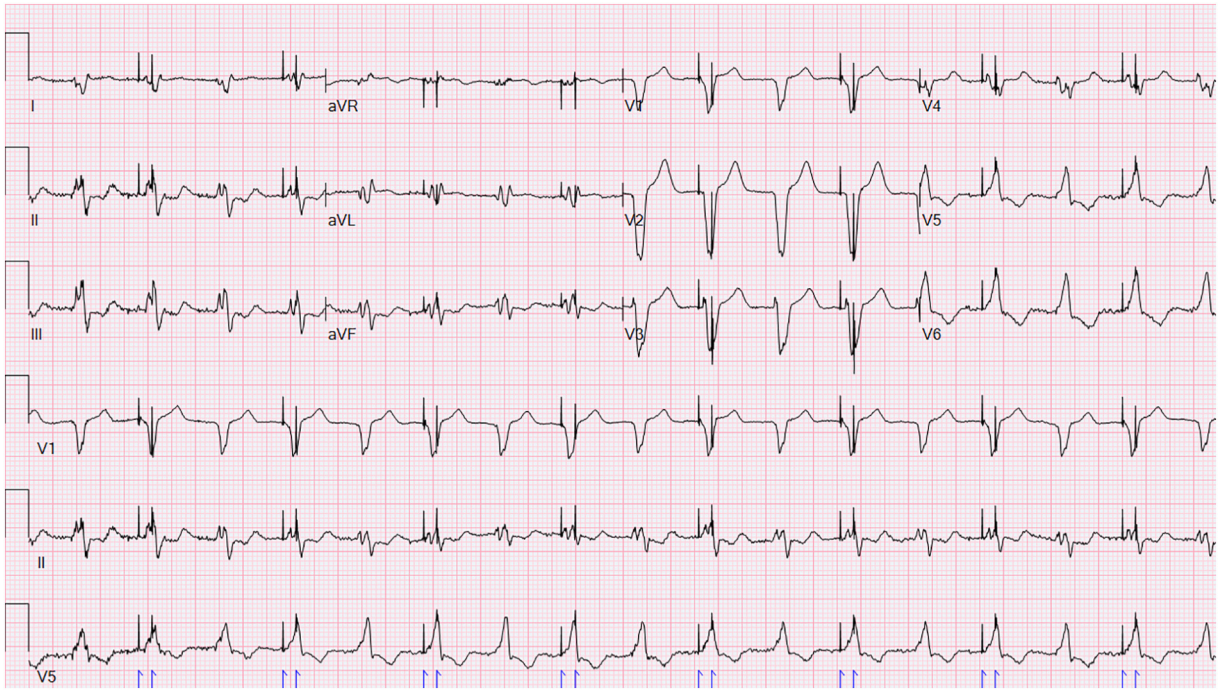

Fig. 1. Routine ECG.

This wouldn't explain the fact that the pacemaker spikes are occurring every other QRS complex and they do not seem to be affecting the QRS.

b) **junctional tachycardia rhythm with complexes occurring in alternating blanking periods causing pacemaker spikes during every other QRS complex - CORRECT ANSWER**

The EKG shows a regular wide QRS rhythm which does not change despite the pacing spikes (Fig. 2). Intrinsic P waves are not identified. Every other complex shows two pacemaker spikes, one occurring just before the QRS complex and the second one the middle of the QRS complex. Both spikes do not appear to be changing the morphology or the rate of the QRS complexes which appear identical to those without the pacemaker spikes.

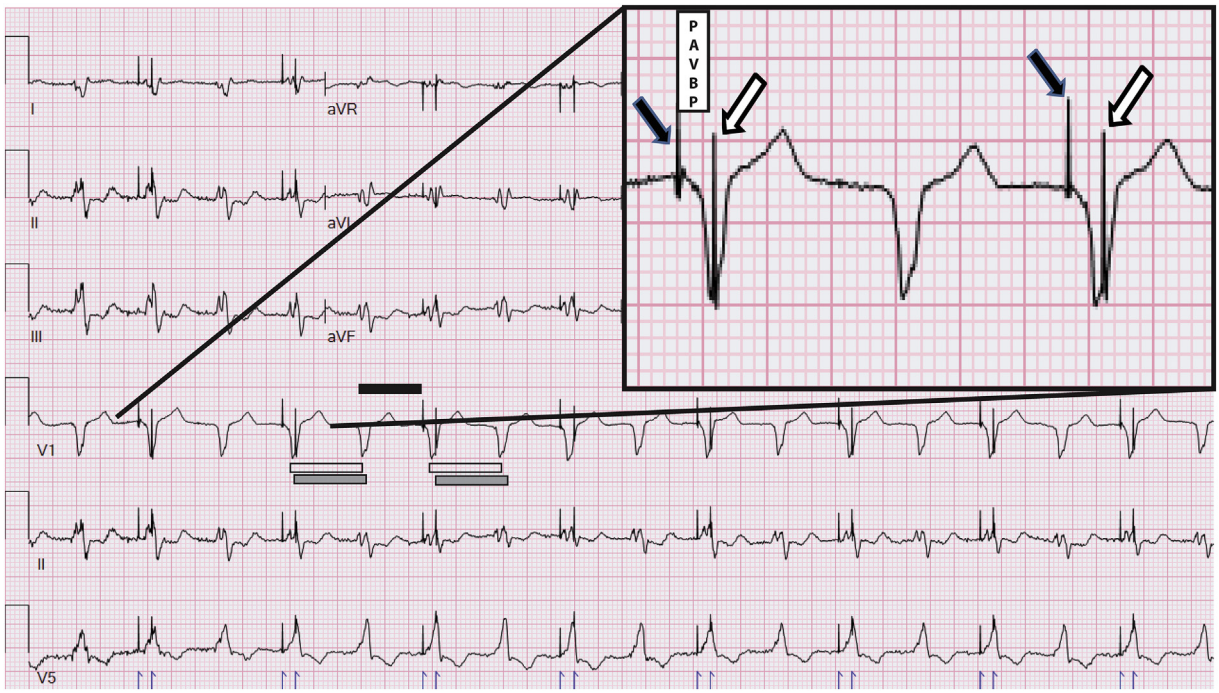

Fig. 2. Labeled ECG. Transparent rectangles = RR interval of junctional rhythm. Black rectangle = A pacing interval at upper rate limit of 120 bpm. Grey rectangles = same interval if applied from the preceding ventricular pacing stimulus. Insert: Magnification of the complexes with and without the pacing stimuli. PAVBP: post atrial pacing ventricular blanking period. Black arrow- electronic atrial pacing stimulus. White arrow- electronic ventricular safety pacing.

This can best be explained by an underlying accelerated junctional rhythm at a rate slightly slower than the device upper rate limit of 120 bpm (black rectangle in Fig. 2). In the complexes with two pacemaker spikes, the spontaneous junctional QRS complex occurs immediately after the electronic atrial pacing during the post-atrial pacing ventricular-blanking period (PAVBP), immediately followed by a ventricular pacing stimulus delivered by the device. The ventricular stimulus occurs toward the end of the QRS complex during a time when the ventricular myocardium is likely to be refractory and is, therefore, unable to be captured or affected by the pacing spike.

After the ventricular pacing-spike occurs, the device starts counting, allowing enough time to detect the next spontaneous junctional complex, and thus the device does not pace (grey rectangle). The timer starts counting from the onset of the spontaneous QRS using the same interval, and here the timer is exceeded without detecting atrial activity and thus the atrial lead paces. The spontaneous junctional complex again occurs coincidentally following the atrial spike (without being affected by it) and it again falls in the PAVBP. The cycle then repeats itself giving us the resultant EKG seen in this patient (Fig. 2).

One potential cause for the accelerated junctional rhythm is digoxin toxicity [3]. The patient had chronic kidney disease and has been on digoxin. Unfortunately, a digoxin level was not checked during this clinic visit. Moreover, 12-lead ECG was not recorded during biventricular pacing and the patient did not return for follow up. Therefore, we have not been able to corroborate the Idioventricular origin of the rhythm.

Disclosures

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