ECG for Students and Associated Professionals

Syncope in a patient with a dual-chamber pacemaker: What is the possible mechanism?

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1. Case presentation

A 90-year-old woman with hypertension and a history of a dual-chamber, rate-modulated (DDDR) pacemaker implantation 9 years previously presented to the hospital with complaints of syncope, moderate shortness of breath, and a headache. She denied any other symptoms. Her vital signs were as follows: blood pressure, 110/80 mmHg; pulse, 35 beats/min (bpm); and respiratory rate, 18 breaths/min. One month before presentation, she had undergone pacemaker replacement due to battery depletion at another hospital. The electrocardiogram (ECG) on admission is shown in Fig. 1. Pacemaker interrogation showed the following parameters: programmed mode, DDDR with a base rate of 60 bpm; atrial impedance, 410 Ω; ventricular impedance, 540 Ω; atrial sensing threshold, 0.5 mV; ventricular sensing threshold, 2.0 mV; and battery voltage, 2.6 V. The paced and sensed atrioventricular intervals (AVIs) were 150 and 120 ms, respectively. The pacemaker was switched to AAI mode, and the corresponding ECG is shown in Fig. 2.

What is your diagnosis?

A. Atrial lead dislodgement
B. The atrial and ventricular leads are switched
C. Ventricular noncapture
D. Crosstalk
E. Pacemaker undersensing

2. Commentary

The correct answer is B. In patients with a previously implanted device, pacemaker malfunction is a very rare cause of syncope. On initial evaluation, the pacing spike in our patient only appeared after QRS complexes on the ECG at admission, which is suggestive of undersensing; however, pacemaker interrogation showed normal sensing thresholds and impedances. Undersensing can be due to various factors such as low sensitivity settings, lead insulation defects, event falls within a refractory period (i.e., functional undersensing), too slow of a slew rate, and malfunction of the pacemaker circuitry [1].

The most common causes of noncapture include lead displacement, an insulation defect, wire fracture, electrolyte disturbance, and exit block (a high capture threshold). Atrial noncapture can be detected by the absence of a P-wave and the sudden appearance of a wide complex QRS, whereas during ventricular noncapture, paced output occurs without depolarization of the ventricle, which results in an asystolic pause [1].

Crosstalk is characterized by the inhibition of ventricular output due to the ventricular channel sensing of an atrial pulse. It is seen on the ECG strip as paced atrial P-waves without ventricular output. Crosstalk is rarely seen with current dual-chamber pacemakers because of the ventricular blanking period [2].

In the present case, the pacing spikes were evidently synchronized with the QRS complexes, with a 150-ms interval between two spikes. This pattern only occurs when the leads are switched (Fig. 1). Moreover, the period without pacing only contains F-waves, which strongly suggests that atrial events inhibit

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output from the ventricular channel of the pacemaker. When the atrial and ventricular leads are switched, the designated sensed event in the ventricular channel is actually an atrial event. Ventricular pacing through the atrial lead can cause atrial fibrillation, hypotension, and clinical heart failure due to 1:1 retrograde atrial activation. Atrial lead dislodgement to the ventricle should be briefly considered; however, since ventricular pacing in such a situation would be inhibited or within the atrioventricular safety window, this diagnosis is incorrect. The diagnosis of switched leads in a permanent pacemaker is usually made within a few hours or days after implantation, but this complication is rarely overlooked in the long-term, as in the present case [2–4].

In conclusion, the possibility that the atrial and ventricular leads of a pacemaker generator are switched should be considered, especially in patients who present early after battery replacement.

**Conflict of interest**

None.

**References**

[1] Wang PJ, Al-Ahmad A, Hsia HH, Zei PC. Modes of pacemaker function. In: Kusumoto FM, Goldschlager NF, editors. Cardiac pacing for the clinician. New York: Springer Science Media, LLC; 2008. p. 73–107.

[2] Kaya Z, Akbuga K, Aribas A, Can I. Is it a typical crosstalk: need for re-implantation? J Arrhythm 2015;31:116–7.

[3] Al Hamdi A, Jastrzębski M, Hawas JM. Atrial and ventricular lead switch at the pacemaker header: why did asystole first occur 3 years later? Pacing Clin Electrophysiol 2013;36:1431–3.

[4] Jastrzębski M. Pacemaker malfunction due to atrial and ventricular leads switched in the header: two faces of the same mistake? Pacing Clin Electrophysiol 2008;31:733–5.