

# An under-recognized cause of pacemaker-mediated rhythm

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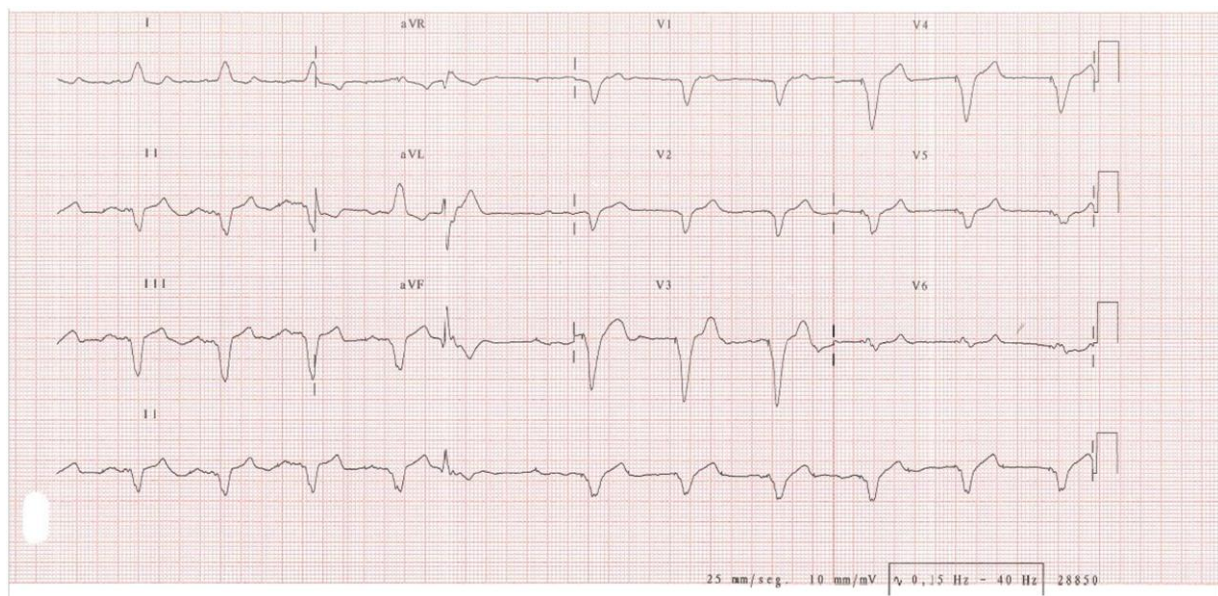
## Clinical Vignette

A 79-year-old man with a dual-chamber pacemaker (Biotronik<sup>®</sup>) implanted for sinus node dysfunction and Mobitz type II atrioventricular (AV) block (DDD 60–120 b.p.m.), paced and sensed AV interval 205 and 160 ms, respectively, consulted for vasovagal syncope.

On arrival at the emergency department, a 12-lead electrocardiogram (ECG) was performed (see [Figure 1](#)). The first four beats represent a sequential atrial pacing (AP)—ventricular sensing rhythm.

This is followed by a premature ventricular complex that results in retrograde P wave that falls within the post-ventricular atrial refractory period (PVARP). The subsequent AP (after VA interval times out) results in a pseudofusion. From there on, repetitive ventricular pacing (VP) with ventriculoatrial (VA) conduction (best seen in V1) and functional atrial non-capture occur for six cycles, which is consistent with repetitive non-reentrant ventriculoatrial synchrony (RNRVAS).

Atrioventricular intervals were reduced (185 and 150 ms, respectively), thus extending the VA interval, so that an AP event after a



**Figure 1** 12-lead ECG performed on arrival in the emergency department.

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retrograde *P* within PVARP would not result in functional non-capture and prevent RNRVAS. The patient remained asymptomatic, with normal parameters in the pacemaker follow-up visits. Repetitive non-reentrant ventriculoatrial synchrony has usually a benign nature and in this case, coexisted with a single episode of vasovagal syncope; however, it can cause pacemaker syndrome with neck palpitations, nausea, and pre-syncope in some patients.

### Question 1

Which one is not a basic requirement/programming feature that favours the development of RNRVAS?

- A. A single-chamber device
- B. Retrograde VA conduction
- C. High AV sequential pacing rates
- D. Long-programmed AV delay
- E. Long PVARP

Correct answer: A

Repetitive non-reentrant ventriculoatrial synchrony is characterized by a functional atrial undersensing due to retrograde atrial activation falling within the PVARP with subsequent functional atrial non-capture, as the pacing stimulus occurs during the absolute refractory period of the atrium.<sup>1</sup> A long-programmed AV delay would increase the lower rate limit (LRL), therefore not allowing completion of the atrial refractory period. Similarly, extending AV delay (e.g. AV search hysteresis) (see [Supplementary material online, Figure S1](#)) will result in a shorter VA interval unless LRL is lowered.

### Question 2

Which one is not a main difference between endless loop tachycardia (ELT) and repetitive RNRVAS?

- A. Endless loop tachycardia is promoted mainly by short PVARP
- B. Repetitive non-reentrant ventriculoatrial synchrony occurs in AV sequential pacing (DDD, DDDR, DDI, and DDIR)
- C. Special algorithms in all manufacturers are present to prevent and recognize ELT
- D. In RNRVAS, the retrograde *P* wave occurs inside the PVARP
- E. Algorithms that terminate ELT might include a lack of *P*-synchronous ventricular pacing

Correct answer: D

In RNRVAS, retrograde atrial activation falling within the PVARP,<sup>2</sup> thus being promoted by a long PVARP and subsequent functional atrial non-capture (requiring sequential pacing). Algorithms to identify or terminate RNRVAS are non-existent, in contrast to ELT; in which algorithms to terminate the events include automatic extension of PVARP or lack of *P*-synchronous ventricular pacing.<sup>1</sup>

### Question 3

Which of the following statements is not true regarding the clinical implications of RNRVAS?

- A. Yields false negative events during the identification of atrial high-rate episodes (AHREs)
- B. It can induce atrial tachycardia/atrial fibrillation owing to an AP close to atrial refractoriness
- C. Repetitive non-reentrant ventriculoatrial synchrony can be confused with lead dislodgement or malfunction leading to unnecessary lead revision
- D. Pacemaker syndrome can develop due to loss of optimal AV synchrony
- E. It can trigger an inappropriate mode switch, with associated mismanagement if there is an inaccurate diagnosis of AHRE

Correct answer: A

Under-recognition of RNRVAS has been shown in the ASSERT trial<sup>3</sup> due to false-positive AHRE detections during RNRVAS, which could lead to mismanagement. Its proarrhythmic consequences have been reported<sup>1</sup> owing to an AP event close to atrial refractoriness, which could induce atrial tachycardia/atrial fibrillation. It can trigger pacemaker syndrome, due to loss of AV synchrony, as the retrograde *P* wave is produced during ventricular diastole, in which the tricuspid valve is closed, thus causing neck palpitations and dizziness, among others.

## Supplementary material

[Supplementary material](#) is available at *European Heart Journal – Case Reports*.

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## Data availability

The data underlying this article are available in the article and in its online supplementary material.

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