A 66-year-old man, implanted Abbott dual-chamber pacemaker, was admitted to our hospital due to recurrent palpitation. ECG was recorded on admission, which created a diagnostic confusion: What accounts for the appearance of the VP in the setting of a stable intrinsic atrioventricular (AV) conduction? In this case, we will focus on the logical reasoning in the analysis of Pacing ECG.

**KEYWORDS**
 electrocardiography, implantable devices, noninvasive techniques, pacemaker mediated tachycardia

### EXPLANATIONS

Intermittent atrial undersensing appears to explain the confusion, but clues at R4 may not support it. There are spike-like signal (S1, black arrow in Figure 1) occurring on R4 and another spike-like signal (S2, hollow arrow in Figure 1) occurring on the subsequent ST segment in 100 ms. Potential explanations include (a) interference signals; (b) VP (S1)—premature atrial contraction (PAC, S2); (c) VP (S1)—ventricular pacing backup (VPb, S2); and (d) AP (S1)—ventricular safety pacing (VSP, S2). What is the diagnosis?

Figure 1 was recorded on admission, which created a diagnostic confusion: Normally, ventricular pacing (VP) had no reason to appear in the setting of a stable intrinsic atrioventricular (AV) conduction. What accounts for the appearance of the VP?

**Step 1—P7:** The first VP is generated due to the P7, which suggests that P7 is occurring outside the PVARP of R6 (white bar) and marked as AS.

**Step 2—P6 and R6:** As the R6-P7 interval (about 320ms) is longer than 275ms and less than 475ms (PVC response prolongs the PVARP by 200ms), the R6 cannot be marked as PVC, or P7 would be marked as atrial refractory event (AR). In Abbott, a VS in AR-VS sequence
FIGURE 1  The 12-lead ECG demonstrates the unreasonable appearance of atrial-tracked ventricular pacing under a stable intrinsic atrioventricular conduction

FIGURE 2  (a) The figure has the same S1–S2 sequence (hollow arrow) as in Figure 1, and a blocked PAC (hollow triangle); (b) the deductive reasoning to explain Figure 1
will be marked as PVC when AR-VS interval is longer than 280ms. Therefore, AR(P6)-VS(R6) interval (grid bar) should be less than 280ms (Of noted, PR intervals in Figure 1 are all about 280ms, so the actual AR-VS interval can be a little bit less or longer than 280ms due to the device measuring error) to guarantee R6 not marked as PVC.

**Step 3—VPb, P5, and R5:** R5 should be marked as PVC to prolong PVARP (red bar) to guarantee P6 marked as AR (R5-P6 interval 320ms). The only sequence that fits the condition is AR(P5)-VS(R5), and the P5-R5 interval should be longer than 280ms. To guarantee AR(P5), the key point is VP-VPb in R4. VPb recycles PVARP (white bar) which results in P5 falling in the PVARP and marked as AR, and AR(P5)-VS(R5) interval (grid bar) can be longer than 280ms due to the measuring error. These coincidences (1. VIP, 2. PVC response, and 3. VPb) lead to the “Unreasonable” Ventricular Pacings.

Inappropriate continuous ventricular pacing can cause adverse outcomes due to (a) atrioventricular asynchrony and (b) increased proportion of right ventricular pacing, which in turn cause ventricular filling and decreasing ejection volume and exacerbating heart failure (Patel & Mariani, 2017).

Extending AV interval or VIP extension can avoid such inappropriate ventricular pacings. After extending VIP extension from 100 to 150 ms, the above situation did not occur. This case should be distinguished from intermittent atrial undersensing, but there is no clear evidence to support it in Figures 1 and 2a, and the subsequent device programming showed no abnormalities in atrial sensing.

**CONFLICT OF INTEREST**
The authors declared that they have no conflicts of interest to this work.

**AUTHOR CONTRIBUTION**
All authors reviewed and approved the manuscript. Directed this study: Yubin Zhang, Tong Liu. Wrote the manuscript: Yubin Zhang. Gave suggestions on this study: Tong Liu, Panagiotis Korantzopoulos.

**ETHICAL APPROVAL**
The study was approved by the institutional review board of The First Affiliated Hospital, School of Medicine, Zhejiang University, Hangzhou, China. The patient provided written informed consent.

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**REFERENCES**
Bradycardia and Tachycardia. Bradycardia and Tachycardia Devices MerlinTM Patient Care System Help Manual.
Patel, H. C., & Mariani, J. A. (2017). An overlooked case of pacemaker-related heart failure. *Echo Research and Practice*, 4(4), K57–K60. [https://doi.org/10.1530/ERP-17-0057](https://doi.org/10.1530/ERP-17-0057)

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