

A rare, but correctable, malfunction of a pacemaker

# An unusual case of upper rate behaviour

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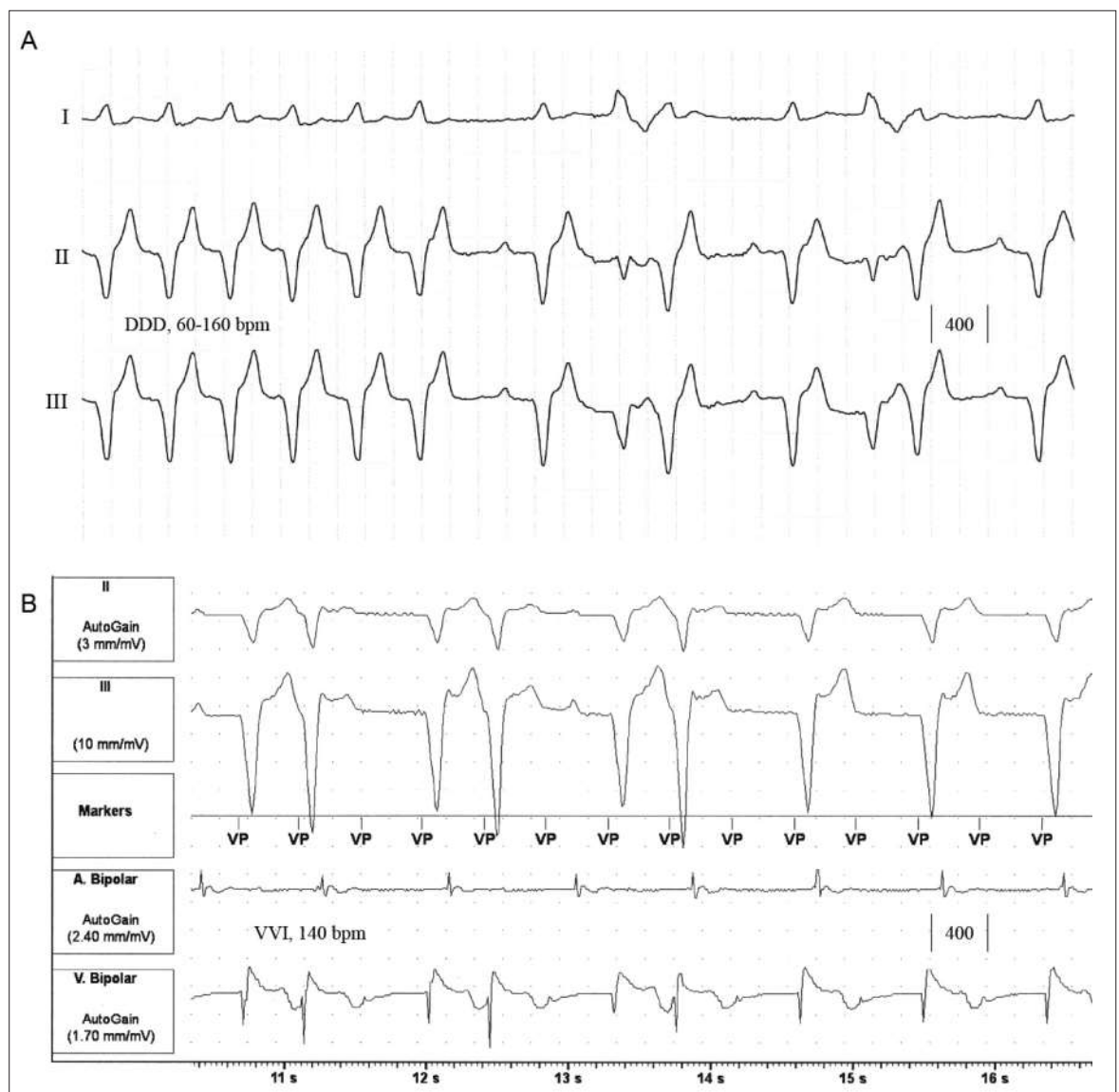
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## Case report

A 67-year-old patient was admitted because of sudden onset of dyspnoea during physical exertion. Six years

ago, the patient was implanted with a dual-chamber pacemaker [Saint Jude Medical Zephyr™ XL DR, Saint Jude Medical (SJM), Inc., St. Paul, MN 55117, USA] because of high-degree atrioventricular (AV) block due to Lyme



**Figure:** Tracing A: ECG at exercise stress test with sudden onset of a 2:1 block and occasional appearance of late coupled beats with a different QRS morphology (most likely delayed afterdepolarisations) at a heart rate of 135 bpm. Tracing B: Pacing in VVI mode (maximum output of 7.5 volts and maximum pulse width of 1.5 milliseconds) with loss of 1:1 ventricular capture and onset of first 3:2 followed by 2:1 ventricular capture at heart rate of 140 bpm.

carditis. An exercise stress test revealed a sudden onset of a 2:1 block at a heart rate (HR) of 135 bpm (fig. 1, tracing A). Interrogation of the pacemaker revealed normal and stable parameters for atrial and ventricular sensing, pacing thresholds and lead impedances. The maximum tracking rate (MTR) was programmed at 160 bpm and the total atrial refractory period (TARP) to 340 ms (corresponding to a HR of 176 bpm). Pacing in DDD and VVI mode at different HR (unipolar and bipolar pacing up to maximum output of 7.5 volts and maximum pulse width of 1.5 milliseconds) revealed loss of 1:1 ventricular capture at HR above 140 bpm (figure, tracing B). However, using the noninvasive programmed stimulation (NIPS) module of the pacemaker with the same output settings, 1:1 ventricular capture could be observed at any HR up to the shortest tested stimulation cycle length of 300 ms (corresponding to a HR of 200 bpm). With the support of the pacemaker manufacturer, the pacemaker's software was reset, which restored normal function of the device.

## Discussion

In dual-chamber pacemakers loss of 1:1 AV conduction at fast HR, also called upper rate behaviour, is determined by the MTR and the TARP [1]. In the present case, however, the symptomatic rate drop during exercise was due to an error in the device's software, which prevented 1:1 delivery of the electrical impulse at HR above 135 bpm. With technical support from SJM, the reason for the error was found in a random memory corruption of the pacemaker's software which set the runaway protection (RAP) value to 132.3 bpm. The RAP cir-

cuit is a fail-safe mechanism that defines the maximum pacing rate and prevents inappropriate delivery of rapid pacing pulses at extremely short cycle lengths. When the required pacing rate exceeds the RAP value, the RAP circuit prevents the pacemaker from delivering pacing pulses and so generates "exit block". The device continues to display ventricular pace markers on the ventricular channel but will deliver pacing pulses only when the RAP circuit timer has recovered [2]. When the device is initially manufactured the RAP value is at 132.3 bpm (reset value) and then is programmed typically to a nominal value of approximately 190 bpm. The RAP value is not reported by the device and can be altered when the memory is corrupted by electromagnetic interference [2]. The RAP value can only be reprogrammed via a password-protected engineering interface on the standard programmer, as performed in our case. Up to now only five cases with this specific problem have been reported to the pacemaker manufacturer and occurred in SJM Zephyr™, Victory™, and Identity™ devices.

### Disclosure statement

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### Authors' contribution

SAM wrote the initial manuscript. MM and AM edited the manuscript. All authors were responsible for the patient's care. All authors read and approved the final manuscript.

### References

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