



Cause of the “power-on reset” phenomenon other than electric magnetic interference in a patient with a pacemaker

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ABSTRACT

A 67-year old male with a dual-chamber pacemaker visited for a regular check-up. An unfamiliar message emerged on the display just after placing the programmer wand. We could recognize that the pacemaker had already been in the safe back-up mode of DDI, and the programmer prompted a re-initialization request. We are so surprised because there was no indication of device malfunction the day before in daily monitoring and a 12-lead electrocardiogram revealed normally working in the DDD mode just before checking the device. The pacemaker was immediately re-programmed to the former setting. This phenomenon has not recurred for 12 months.

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1. Introduction

The power-on reset is a rare phenomenon known to occur after strong electromagnetic interference, which includes magnetic resonance imaging, ionic radiation, or cardioversion or electrocautery devices. It sometimes exposes patients who are dependent on pacemakers with slow intrinsic rates to dangerous complications by resetting the pacemaker mode to VVI or DDI. In contrast, there is another cause of power-on reset that is not explainable by electromagnetic interference in daily clinical practice. We present a rare power-on reset phenomenon that occurred during daily pacemaker examinations.

2. Case report

A 67-year-old man with a dual-chamber pacemaker (Biotronik, Etrinsa DR-T) implanted because of advanced atrioventricular block visited our clinic for a routine examination. After placing the programmer wand, an unusual message appeared (Fig. 1). We noticed

that the pacemaker had already been reprogrammed to the safe back-up mode of DDI with a lower rate of 70 bpm. We completed re-initialization to set a standard program for the device according to the guidance displayed on the monitor. Daily remote monitoring revealed that the measured pacemaker and lead function values were within acceptable limits and that sufficient battery life remained since the previous day (Fig. 2A). A 12-lead electrocardiogram (ECG) revealed atrial-sensed ventricular-paced rhythm just before the examination (Fig. 2B). Furthermore, there was no evidence indicating that the patient experienced obvious exposure to electromagnetic waves. We confirmed the absence of functional abnormality in the pacemaker and lead after re-initialization. This phenomenon has not recurred for at least 12 months.

3. Discussion

In the present case, we noticed the sudden safe back-up mode in a patient with a dual-chamber pacemaker just after placing a wand to check the device. All implantable electronic devices are central processing units controlled by a connection to random access memory. Due to the nature of the necessary changes in the memory to allow patient-tailored programming, unwanted memory changes that lead to inconsistent memory content are possible. When the device detects an inconsistency, depending on the severity, it can activate the automatic back-up mode. This back-up mode is stored in

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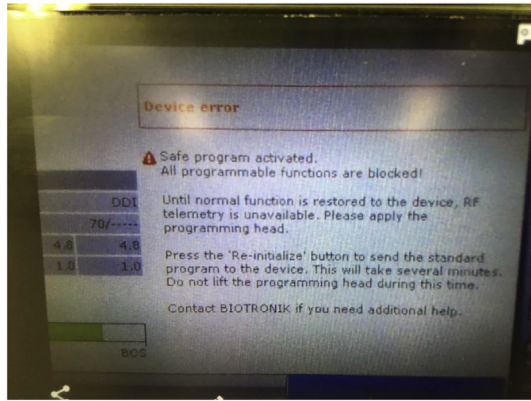


Fig. 1. Device error alert. The monitor showed that the safe back-up mode had been activated just after placing the telemetry wand.

an unalterable read-only unit [1]. The actual response by the back-up mode, the so-called power-on reset phenomenon, is device-specific. Usually, the pacemaker mode changes to VVI or DDI. These settings are similar and can avoid excessive battery depletion. In general, inconsistent memory content in the random access memory is caused by electromagnetic interference, including ionizing radiation, from sources such as radiation therapy, random natural cosmic radiation, or magnetic resonance imaging [2–4]. Unknown causes of power-on reset other than electromagnetic interference have also been reported [5]. In the present case, daily remote monitoring notified us regarding the normal function of the lead and device and a remaining battery capacity of more than 80% since the previous day. In addition, a 12-lead ECG recorded a pacemaker working normally in the DDD mode just before checking the device. These findings were inconsistent with power-on reset caused by electromagnetic interference and suggested a possible emerging error caused by the transmission itself. Unfortunately, we could not determine how to avoid this phenomenon because it could not be reproduced despite the repeated use of the same wand. In addition, we had no information about whether this phenomenon was device-

specific, manufacture-specific, or something that could randomly occur with any device because, to our knowledge, this was an extremely rare phenomenon. Practitioners should consider this rare cause of the power-on reset phenomenon in daily clinical practice.

4. Conclusion

Transmission interference might cause the power-on reset phenomenon in patients with cardiac implantable electronic devices.

Conflict of interest

None.

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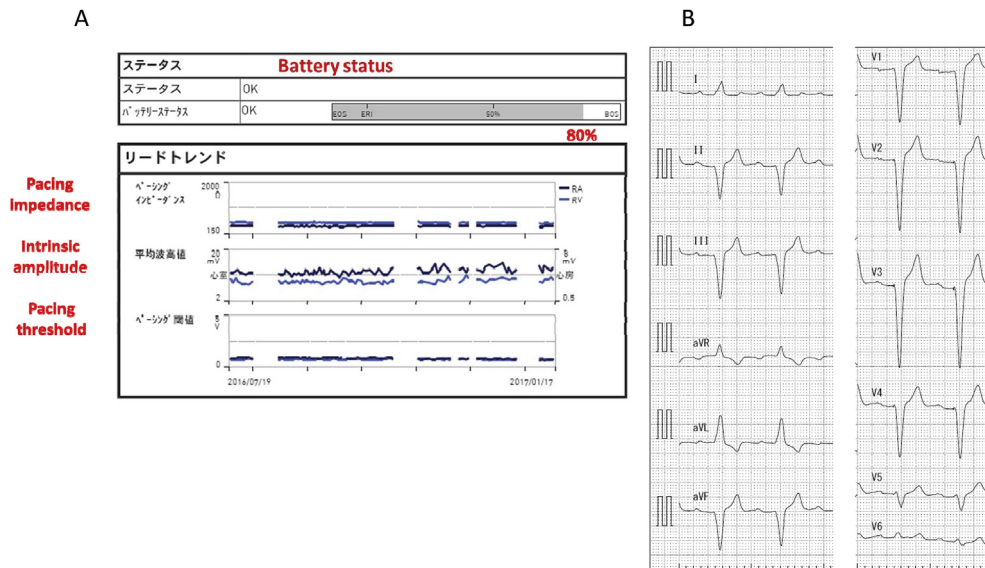


Fig. 2. Device monitoring and electrocardiogram results. (A) The results of daily monitoring the day before the examination. The 6-month trends of pacing impedance, intrinsic amplitude, and pacing threshold were within the normal ranges. The battery life was 80%. (B) A 12-lead electrocardiogram revealed the pacemaker working in the DDD mode just before the examination.