Double devices: Dysfunction or not?

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Introduction
The removal of the old batteries is generally the rule when performing an upgrade procedure or a box replacement owing to battery depletion. However, once they are abandoned in the pocket, the behavior of the old batteries at the end of service (EOS) may be completely unexpected. A recent case reported a syncopal episode that was caused by an old battery (having switched into VVI mode) perturbing the new implanted device. In contrast, we report a case of an asynchronous mode switch of an old abandoned battery, raising some concern about the likelihood of the induction of an R-on-T phenomenon (torsades de pointes).

Case report
An 87-year-old male patient was referred to our institution for a suspected lead dysfunction. The patient was implanted with a left-sided dual-chamber pacemaker device in 2005 (Medtronic Kappa DR) in another center because of a high degree of atrioventricular heart block. In his past medical history, the patient was treated for diabetes, was a former smoker, had a bilateral leg amputation, had only 1 functional kidney, and then developed symptomatic ischemic cardiomyopathy with a depressed left ventricular ejection fraction (LVEF 25%), permanent atrial fibrillation, and a complete left bundle branch block.

He then underwent, in June 2012, an upgrade comprising a new left-sided cardiac resynchronization therapy-defibrillator (CRT-D) (Medtronic D354 TRM, Medtronic Inc, Minneapolis, MN) with 3 newly implanted leads: another atrial lead, a left ventricular (LV) lead, and a defibrillator lead. The old pacemaker battery (Kappa DR) was left in place and abandoned in the pocket, still connected with its 2 leads: the original atrial and right ventricular (RV) leads implanted in 2005. No data were available in the report concerning the function and integrity of the old pacing leads that would explain the need for implanting a new atrial lead. In October 2016, the patient had a CRT-D battery replacement for a Medtronic AMPLIA CRT-D in another center (Figure 1), without any revision of the old battery or its leads. In May 2017, the patient was referred for a suspicious lead dysfunction; he was asymptomatic (NYHA I) and without any syncope. A super-response was observed, with complete recovery of left ventricular ejection fraction and no more hospitalization for acute heart failure.

Electrocardiography showed a CRT-D programmed into a VVIR 70 beats per minute (bpm) mode, with underlying atrial fibrillation and with asynchronous pacing spikes at 65 bpm (EOS) of the abandoned ipsilateral pacemaker (Figure 2). Device interrogation of the CRT-D initially revealed RV and LV lead impedance and threshold measurements to be within normal limits. No tachyarrhythmic episodes were detected. In this asymptomatic patient and given the major risk of infection in case of reintervention, it was initially decided not to remove the old battery.

However, telecardiology monitoring was proposed and 1 month later reported several episodes of (nonphysiological) nonsustained ventricular tachycardia with abnormal short V-V intervals, also associated with sound alert heard by the patient (Figure 3). The Signal Integrity Counter (SIC) went suddenly from 0 to 46 SIC per day. Owing to the short V-V intervals, we had a high degree of suspicion for implantable cardioverter-defibrillator (ICD) lead malfunction. Of note, there was a gradual ICD lead impedance

Figure 1 Fluoroscopic image in anteroposterior projection showing the presence of the 2 batteries on the left side.
increase from stable values to 1600 ohms the last month. R-wave amplitude measurements were not available in this pacemaker-dependent patient, and the LV pacing threshold capture monitoring was not activated. These elements were suggestive of a lead integrity problem, based upon the irregularity of the oversensing signals and the impedance increase. Given the fact that the patient had a super-response with resynchronization, and complete recovery of the LV function—without experiencing any appropriate therapy with the defibrillator—it was decided, in agreement with the patient, to perform a downgrade procedure. An opening of the pocket was then performed, with removal of the old Kappa battery and the AMPLIA CRT-D battery and then implantation and connection of the old RV pacing lead to a new CRT-P device (Medtronic VIVA CRT), while the now capped defibrillator lead was abandoned. The follow-up was uneventful after 6 months for this patient.

Discussion

Our case highlights the possible interaction of 2 implanted devices. A recent case reported the interference of an old pacemaker causing recurrent episodes of syncope in a pacemaker-dependent patient implanted with a contralateral CRT-D. A loss of ventricular capture was clearly demonstrated during the CRT-D device sensing test. The old battery was then removed.

The main difference in our case is the fact that the old battery converted to VOO mode at 65 bpm, which raises another question about the likelihood of the mode to induce torsades de pointes because of temporary asynchronous pacing by the old battery. One may suggest that the occurrence of a life-threatening “torsade-de-pointe” may be efficiently treated by the CRT-D if this situation happens. However, on the one hand, no defibrillation test was performed during the initial upgrade procedure or during the last reintervention. On the other hand, the correct detection of an occurring ventricular arrhythmia may also be disturbed by the presence and persistence of the unipolar asynchronous spikes of the old battery during the possible ventricular fibrillation episode. The company is also unable to give any precise information about the estimated residual longevity (months) of this EOS VOO mode before complete depletion of the battery.

Torsades de pointes are rarely observed, and this low probability in an old and fragile patient has to be balanced with the high risk of reintervention and infection in a pacemaker-dependent patient.

One has to note that the behavior of a battery in EOS may switch into a VOO mode instead of a VVI mode. Ventricular loss of capture in our case is unlikely, as the VOO mode for the old battery was 65 bpm, with a CRT-D device programmed into a VVIR mode at 70 bpm. The final decision to undertake another reintervention was based upon the high suspicion of a defibrillator lead fracture and reinforced our decision to downgrade the device and remove the old (and recent) batteries.

In this case, the observation of an asynchronous stimulation produced by the old battery led us to propose to the patient a remote monitoring of the device, which in turn allowed an early detection of the ICD lead fracture. Fortunately, no inappropriate therapy was delivered by the device, as they were all deactivated as soon as the problem of integrity on the ICD lead was detected with the telecardiology, and until a decision was made to downgrade the device. It was also opportune that the old RV pacing lead was still functional, allowing the downgrade procedure to be not complicated and without the necessity to reimplant a sixth lead. Finally, this case strongly emphasizes the clinical usefulness of

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**Figure 2** Surface electrocardiogram showing the presence of a biventricular device pacing at 70 beats per minute and concomitant asynchronous pacing from an old abandoned dual-chamber battery at 65 beats per minute.

**Figure 3** Telecardiology transmission report showing a nonphysiological recording of abnormal short VV intervals.

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**KEY TEACHING POINTS**

- The behavior of old batteries reaching the end of service is unknown (switching to a VVI or VOO mode).
- Removal of abandoned batteries should be recommended in most cases.
- The reintervention has to be balanced with the risk of subsequent complications in fragile patients.
remote monitoring of cardiac devices, not only in those complex situations but also in our daily practice for the regular follow-up of ICD.

**Conclusion**
This case highlights the possibility of a reversion to the asynchronous mode (VOO) of old batteries. Our report as well as the recent literature strongly supports the necessity of removing old batteries when performing an upgrade procedure.

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