Iatrogenic Palpitations during Exercise in a Patient with a Dual Chamber Implantable Cardioverter-Defibrillator and Lead Dysfunction

Kanae Hasegawa, MD, Shinsuke Miyazaki, MD, Kenichi Kaseno, MD and Hiroshi Tada, MD

Summary

Implantable cardioverter-defibrillators (ICDs) are an effective treatment to prevent sudden cardiac death; however, lead dysfunction is one of the important complications in ICD recipients. Careful device programming is required in accordance with the individual situation in patients with lead dysfunction. We herein present a patient in whom programming to AAI triggered palpitations during exercise.

Key words: Lead failure

Lead dysfunction is a commonly encountered issue in patients with an implantable cardioverter-defibrillator (ICD). Careful device programming is required in accordance with the individual situation in patients with lead dysfunction. We herein present a patient in whom programming to AAI triggered palpitations during exercise.

Case Report

A 44-year-old man with a dual chamber implantable cardioverter-defibrillator (ICD) for early repolarization syndrome was admitted to our hospital due to repetitive inappropriate ICD shocks. He underwent a single chamber ICD implantation 9 years prior to utilizing a dual-coil active fixation Linox SD lead (Biotronik, Berlin, Germany). The generator was exchanged (Itrevia 5 DR, Biotronik) 2 years prior and an atrial bipolar lead (Solia S45, Biotronik) was added. The setting of the ICD was the DDI mode at 40 beats per minute (bpm). Figures 1A, 1B show the 12-lead electrogram and intracardiac recordings at rest. The noise on the ventricular lead (arrowheads) and an electrical abnormality (ventricular lead impedance, 1070Ω) suggested an ICD lead failure. All shock therapies were turned off and the ICD was programmed to AAI at 70 bpm, because all previous ventricular fibrillation (VF) episodes occurred at the time of sinus bradycardia during sleep. However, the patient reproducibly suffered from palpitations owing to successive premature contractions during exercise in the hospital (Figure 2, outlined and black arrows).

Figure 3 shows the intracardiac tracing during the palpitations. In the dual chamber Biotronik ICD, programming to the AAI mode automatically triggers a 75 ms (default setting) post-ventricular atrial blanking (P-VAB) period, which is a refractory period enforced in the atrium after ventricular sensing and pacing in order to prevent crosstalk in DDD pacemakers. The noise from the fractured ventricular lead produced a P-VAB on the atrial lead, and the original atrial beats (Figure 3, arrowheads) fell into the P-VAB window. Consequently, the device did not register the intrinsic P wave, and it delivered an atrial pacing stimulus just after the normal QRS complex. This resulted in an aberrant conduction (Figure 3, outlined arrows) followed by premature ventricular contractions (Figure 3, black arrows). After reprogramming the P-VAB to 0 ms, all premature contractions and palpitations during exercise completely disappeared. The patient underwent a subcutaneous ICD (Boston Scientific Inc., Natick, MA, USA) implantation.

Discussion

ICDs are an effective treatment to prevent sudden cardiac death; however, lead dysfunction is one of the important complications in ICD recipients because of the serious consequences if not diagnosed and treated promptly. The exact incidence of lead failures is unknown due to the reporting bias; however, it ranges from 0.28% to 1.14%, when recalled models are excluded from the analysis.1) On the contrary, another report showed that lead malfunctions due to a conductor failure or insulation breach occur in up to 40% of indwelling transvenous leads in 8 years after implantation.2) Failures occur more commonly in active young patients, or in patients with a longer life expectancy who expose the leads to greater cumulative physical stress. With an increasing number of ICD recipients, the opportunity that clinicians will encounter lead dysfunction...
Figure 1. A: A 12 lead electrocardiogram in the supine position (at rest) shows normal sinus rhythm without any premature contractions. B: Intracardiac electrograms in the supine position show noise (arrowheads) on the ventricular lead. RV indicates right ventricle.

Figure 2. Twelve lead electrocardiogram in a standing posture during exercise. Successive premature contractions (arrows) were observed accompanied by palpitations. The morphology of the first (outlined arrows) and second (black arrows) beats were different, but the morphology of the successive premature contractions was similar.
ICD lead failures can occur as the result of a body/lead interaction, suboptimal implant technique, or intrinsic/random defects occurring anywhere along the lead.\(^3\) The recalled Medtronic Sprint Fidelis (Medtronic, Dublin, Ireland) and St. Jude Medical Riata (St. Jude Medical, Saint Paul, MN, USA) series of leads serve as examples of conductor and insulation failures, respectively. Moreover, a multicenter registry indicated a high rate of Linox lead failures, particularly in female patients.\(^4\) A recent study clarified that the failure rate of the Linox was 3.2%/year (7-year survival rate, 81.0%) and that the survival probability was significantly lower than that of the other leads and was comparable to that of the Sprint Fidelis lead in the Asian population\(^5\) as well as Western countries.\(^6\) Although the precise mechanism of the lead failure is unknown, the causes of Linox lead failures were speculated to include insulation damage and conductor fractures.

Oversensing with normal pacing impedance is the initial electrical abnormality with either a conductor fracture or an insulation breach. Because lead failure-related oversensing is often rapid, it presents most commonly with inappropriate detection of VF. Patients with inappropriate shocks often present with multiple and closely spaced shocks without antecedent symptoms. Acute management of patients presenting with inappropriate shocks in normal rhythm centers depends on the prompt inactivation of the ventricular tachycardia/VF detection using the ICD’s programmer.\(^7\) Furthermore, proper ICD programming for lead failures is essential. Long-term management of most patients with confirmed lead failures centers on the decision to extract or add a lead. Extraction is the appropriate option in some patients, but the morbidity is probably higher with extractions than with the insertion of a new ICD lead alone.\(^8\) Recently, subcutaneous ICDs have become available for lethal arrhythmias, and clinical trials have proven their effectiveness in detecting and treating VF and ventricular tachycardia.\(^9\) Its unique design avoids requiring endovascular leads, and thus, eliminates many of the complications associated with the traditional transvenous ICDs. Considering the potential risk of extraction-associated morbidity and mortality in patients with chronically present transvenous leads, subcutaneous ICDs are currently a more reasonable choice.

The refractory period is the interval following a paced or sensed event in the chamber containing the pacing or sensing lead, during which the inhibited or triggered pacemaker is not reset. The P-V AB is triggered by ventricular sensing or pacing and is implemented in DDD, DDI, and VDD modes. The P-V AB algorithms vary among the different manufacturers, and this is automatically programmed even during the AAI mode in dual chamber Biotronik ICDs. In the present case, the fractured ventricular lead produced artificial R waves, which resulted in iatrogenic premature beats due to the automatically programmed P-V AB. Although each ICD manufacturer has its own specific device setting, physicians need to pay maximal attention to the device reprogramming in these unusual situations. This case highlights the importance of careful device programming in patients with ICD lead failures.

Acknowledgments

We would like to thank Mr. John Martin for his help in the preparation of the manuscript.

Disclosures

Conflicts of interest: none declared.
References

1. Liu J, Brumberg G, Rattan R, Patel D, et al. Longitudinal follow-up of implantable cardioverter leads. Am J Cardiol 2014; 113: 103-6.

2. Kleemann T, Becker T, Doenges K, et al. Annual rate of transvenous defibrillation lead defects in implantable cardioverter-defibrillators over a period of >10 years. Circulation 2007; 115: 2474-80.

3. Swerdlow CD, Kalahasty G, Ellenbogen KA. Implantable cardiac defibrillator lead failure and management. J Am Coll Cardiol 2016; 67: 1358-68.

4. Padfield GJ, Steinberg C, Karim SS, et al. Early failure of the Biotronik Linox implantable cardioverter defibrillator lead. J Cardiovasc Electrophysiol 2015; 26: 274-81.

5. Kawada S, Nishii N, Morimoto Y, et al. Comparison of longevity and clinical outcomes of implantable cardioverter-defibrillator leads among manufacturers. Heart Rhythm 2017; 14: 1496-503.

6. Noti F, Lam A, Klossner N, et al. Failure rate and conductor externalization in the Biotronik Linox/Sorin Vigila implantable cardioverter-defibrillator lead. Heart Rhythm 2016; 13: 1075-82.

7. Fujiishi T, Niwano S, Murakami M, et al. Efficacy and limitations of tachycardia detection interval guided reprogramming for reduction of inappropriate shock in implantable cardioverter-defibrillator patients. Int Heart J 2016; 57: 304-9.

8. Mulpuru SK, Pretorius VG, Birgersdotter-Green UM. Device infections: management and indications for lead extractions. Circulation 2013; 128: 1031-8.

9. Aziz S, Leon AR, El-Chami MF. The subcutaneous defibrillator: a review of the literature. J Am Coll Cardiol 2014; 63: 1473-9.