Optimizing cardiac device management: Leadless pacemaker implantation together with an implantable cardioverter-defibrillator lead in a diaphragmatic stimulation case

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Introduction

A 75-year-old woman received a single-chamber implantable cardioverter-defibrillator (ICD) 20 years ago after experiencing a syncopal episode. She had frequent premature ventricular contractions (PVCs) without any conduction electrical system disorders (Figure 1A), preserved left ventricular function, no significant valvular disease, and normal coronary arteries. An electrophysiological study revealed reproducible syncopal ventricular tachycardia with the same morphology as the PVCs. Owing to a pocket infection, the left-sided system was removed with complete transvenous lead extraction, and subsequently a new ICD was implanted on the right side after reassessment of the indication. The patient consistently refused cardiac magnetic resonance imaging owing to claustrophobia. Bilateral subclavian vein occlusion was observed over time. During follow-up, the patient experienced fainting episodes owing to frequent PVCs and correctly terminated ventricular tachycardia episodes by device therapy while on a low dose of bisoprolol (Figure 1B and 1C). Increasing pharmacological therapy led to an increase in ventricular pacing, resulting in symptoms such as palpitations and abdominal discomfort. This report highlights the complexities of managing patients with cardiac devices, emphasizing the innovative use of a leadless pacemaker to address unique challenges such as bilateral subclavian vein occlusion and the risks associated with device implantation and lead perforation. Additionally, this case underscores the importance of personalized, patient-centered solutions in cardiac device management, particularly in scenarios where conventional approaches are limited or contraindicated.

KEY TEACHING POINTS

- Life expectancy in patients with cardiac implantable electronic devices has increased over time, bringing with it the challenge of decisions that must be addressed in clinical practice.
- The management of cardiac implantable electronic devices and their complications is complex, and therapeutic strategies need to be contextualized on a case-by-case basis.
- Leadless pacemakers represent a valid and sometimes unique option versus traditional implantable intracardiac devices in specific situations.

Case report

A 75-year-old female patient, carrier of an ICD owing to reproducible syncopal ventricular tachycardia and with a history of infection and bilateral subclavian vein occlusion, was referred to our unit because of palpitations and abdominal jolts during the day, owing to increasing of ventricular pacing after enhancement of beta-blocker therapy to reduce ICD interventions for episodes of sustained ventricular tachycardia and burden of PVCs (Figure 1C). Device interrogation showed normal function with stable electrical parameters of the transvenous lead. However, during tests, reproducible diaphragmatic stimulation up to the capture threshold was elicited. Taking into account her clinical history, the only viable solution was to implant a leadless pacemaker. Electrocardiogram showed sinus bradycardia and first-degree atrioventricular block (Figure 1D). Echocardiogram was

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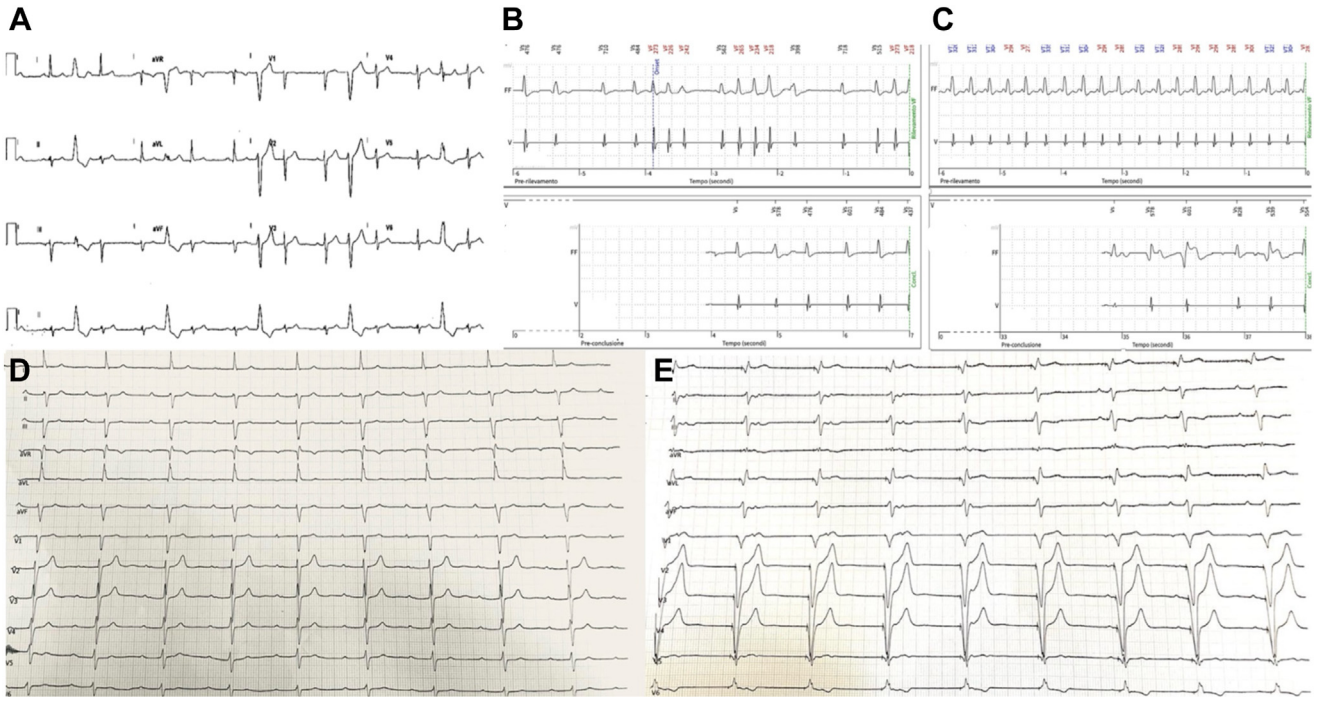

Figure 1 **A:** Electrocardiogram (ECG) at baseline before first implantable cardioverter-defibrillator (ICD) implantation showing sinus rhythm with frequent premature ventricular contractions. **B:** Strip of an episode of nonsustained ventricular tachycardia. **C:** Episode on remote monitoring, showing an episode of ventricular tachycardia correctly interrupted by ICD on low dose of bisoprolol. **D:** ECG at the admission in hospital showing sinus bradycardia and first-degree atrioventricular block and left anterior fascicular block. **E:** ECG at hospital discharge with an atrial-guided rhythm (pacemaker leadless pacing in VDD mode).

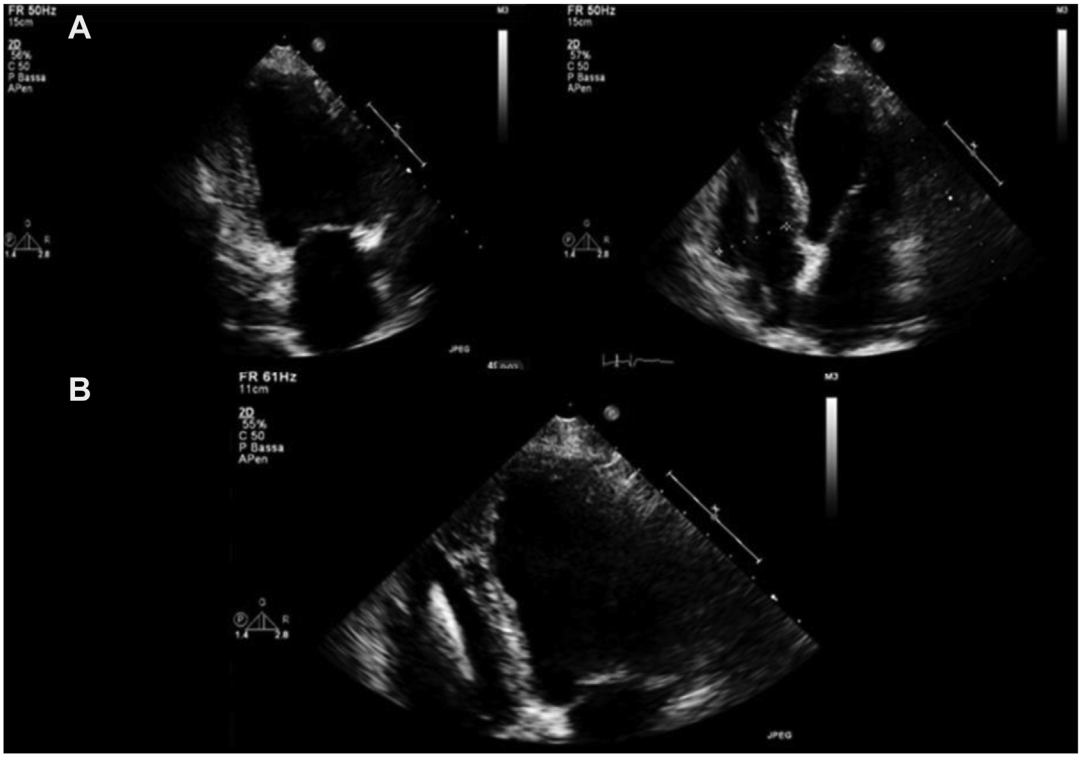

Figure 2 Transthoracic echocardiogram. **A:** Two-chamber view on the right and 4-chamber view on the left. **B:** Four-chamber view with apical zoom.

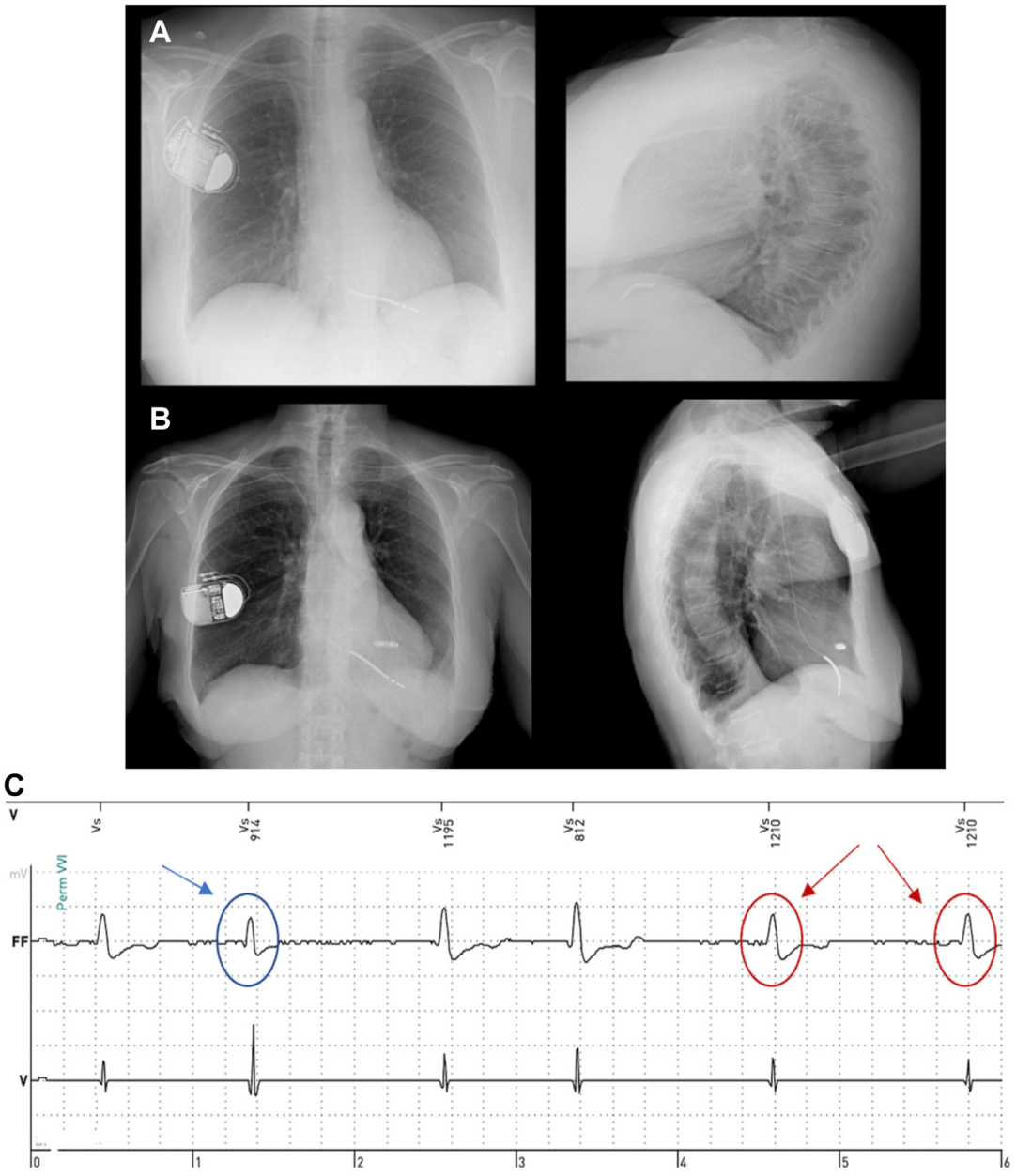

Figure 3 **A:** Anteroposterior (AP) and laterolateral (LL) view of chest radiograph of the patient some years before showing the initial position of implantable cardioverter-defibrillator (ICD) transvenous lead. **B:** Postimplant AP and LL chest radiograph showing leadless pacemaker together with the previous transvenous lead, which was slightly more advanced than before, consistently with a delayed microperforation in a chronic setting; also, ICD generator is different because the patient underwent a generator elective replacement. **C:** Morphology of spontaneous (*circled in blue*) and leadless pacemaker–induced (*circled in red*) rhythm at ICD interrogation.

performed, which documented absence of pericardial effusion (Figure 2), and chest radiography showed slightly more advanced lead position than years before (Figure 3). Leadless pacemaker implantation (Micra TPS; Medtronic, Minneapolis, MN) was successfully performed with a right femoral venous access at the midseptal location, ensuring an adequate distance from the previous catheter placement. Programming was performed using an accelerometer-based atrial sensing to maintain atrioventricular synchrony.[1,2] The ICD was set to avoid intervention, and antitachycardia therapies were activated. Ventricular tachycardia was not induced in order to assess the risk of undersensing in a double devices carrier case. Morphologic discriminator was turned off, leaving only the onset and stability criteria to avoid potential failure in recognizing the tachycardia, based on a dynamic morphologic discriminator. Electric parameters including sensing of spontaneous and leadless pacemaker-induced rhythm were recorded by ICD, at 6.5 mV and 8 mV, respectively. Also, ICD and leadless pacemaker pacing output were recorded, at 1 V @ 1.5 ms and 0.38 V @ 0.24 ms, respectively (Figure 3C). The patient was discharged 2 days later in stable hemodynamic conditions, with the

electrocardiogram shown in Figure 1E and the chest radiograph shown in Figure 3B indicating no acute procedural complications. Pharmacological therapy was adjusted, replacing low-dose bisoprolol with high-dose metoprolol. During follow-up, the patient was asymptomatic thanks to resetting the ventricular pacing percentage of the transvenous ICD (ventricular pacing came from the leadless pacemaker), with consequent reduction of ICD therapies and burden of PVCs owing to enhancement of pharmacological therapy.

Discussion

With cardiac electronic device implant, 12% of patients experience complications within 2 months after transvenous device implant, such as infection, local hematoma, lead perforation or fracture, pneumothorax or hemothorax after vein puncture, vein stenosis or occlusion, endocarditis, or valve trauma. Many of these complications can occur chronically as well.[3] Risk factors for lead perforation comprise lead characteristics, physician expertise, and patient-related factors.[4,5] The right approach may require inactivation of the channel, reduction of output, or repositioning of dislodged lead.[6] This case presented unique challenges owing to the patient's bilateral subclavian vein occlusion and a history of device-related infection, which limited conventional management strategies like lead repositioning or output modification. The complexity of the patient's condition, combined with the elevated risks associated with lead extraction in women,[7] necessitated a departure from traditional approaches. Advanced imaging could have provided additional insights into the complications but was not feasible owing to the patient's specific conditions. These considerations were pivotal in guiding us toward the adoption of a leadless pacemaker. Opting for this solution was a strategic decision aimed at minimizing the increased risks tied to extraction procedures in patients with complicated venous anatomy and specific demographic factors. Leadless pacemakers represent one of the most important technological advances in the field of cardiac pacing. With continued aging of the population, the demand for pacing is likely to continue to increase. It is important to offer an individual, tailored approach when cardiac electronic device implant therapy is considered, especially in the elderly population.[8–10] All these observations allow consideration of the leadless option even in patients who had previously undergone pacemaker extraction and require reimplantation or in patients with a pre-existing transvenous pacing or defibrillation system where extraction is not feasible.[10]

Conclusion

Managing patients with intracardiac devices has become increasingly complex over the years. Leadless pacemakers represent a valid option for specific complex scenarios in which conventional vascular access is not feasible bilaterally or in patients with a history of infection, and concomitant presence of an ICD transvenous lead is feasible and effective.

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