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Leadless pacemaker retrieval from the left pulmonary artery in a patient with left persistent vena cava: a case report

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Abstract

Leadless pacemakers (LPMs) represent an important advancement in cardiac pacing, particularly for patients with venous access limitations or a history of device-related complications. Although implantation techniques are standardized, percutaneous retrieval of LPMs remains a challenging and rarely performed procedure. We present the case of an 85-

year-old male with persistent left superior vena cava (PLSVC) and multiple prior pacemaker interventions, who presented with leadless pacemaker dislodgement into a peripheral branch of the left pulmonary artery. The device was successfully retrieved percutaneously using a transfemoral approach involving two different-sized snares and a deflectable catheter system, overcoming significant technical challenges and secondary migration into the dilated coronary sinus. This case underscores the considerable procedural issues of LPM retrieval in complex anatomical settings and highlights the importance of tailored interventional strategies to ensure safe device extraction.

Keywords: Leadless pacemaker; Device dislodgement; Pulmonary artery retrieval; Persistent left superior vena cava; Percutaneous extraction.

Introduction

Leadless pacemakers (LPMs) have emerged as a promising therapeutic option for patients with bradyarrhythmia requiring permanent cardiac stimulation. Previous studies have demonstrated the safety and efficacy of LPMs(1–4), with their primary indication being in patients at high risk for infection or with compromised venous access(1,5–7). The LPM implantation technique is standardized and well-established(2,3), whereas LPM retrieval has been described in only a limited number of cases(6–10). The success of LPM retrieval depends on several factors, including the final position of the LPM, the time elapsed since implantation, and, in cases of dislodgement, the relative position of the distal cup to the proximal retrieval feature(8–11). This case report details the retrieval of a LPM from a branch of the pulmonary artery in a patient with left persistent superior vena cava (LPVC), a history of multiple previous device replacements, and malfunction of conventional transvenous systems.

Case presentation

An 85-year-old male, affected by chronic symptomatic sinus node disease, paroxysmal atrial fibrillation, and persistent left superior vena cava (PLSVC), presented with a history of pacemaker implantation. He had undergone single-chamber pacemaker (PM-VVI)

implantation in 1998 via the right subclavian vein, with a right ventricular (RV) lead that was later abandoned due to malfunction. In 2012, a new RV lead was implanted via the right subclavian vein. The patient was admitted to our cardiology department in September 2020 after a routine pacemaker follow-up revealed high ventricular pacing thresholds (4 V at 1 ms) and increased impedance. After excluding any reversible factors that could explain the worsening of the electrical parameters, a new pacemaker implantation was indicated. To preserve access to the left subclavian vein, a leadless pacemaker (LPM) was proposed via the right femoral vein. A Micra TPS leadless pacemaker (Medtronic Inc, Minneapolis, USA) was successfully implanted in the middle RV septum after two releases. Initial electrical measurements were satisfactory (RV capture threshold: 1 V at 0.24 ms; Impedance: 610 ohms; Sensing: 6.2 mV). The engagement of the LPM was confirmed using fluoroscopy, with 2 out of 4 tines engaged, and by the pull-and-hold test. Despite this, pre-discharge fluoroscopy revealed LPM dislodgement into the left pulmonary artery, in absence of symptoms. A chest CT confirmed the presence of the leadless device in a peripheral branch of the left pulmonary artery, without signs of perfusion deficits.

After a discussion between electrophysiologists and interventional cardiologists, an attempted LPM retrieval was planned. Three days later, an acute percutaneous LPM retrieval was performed via the right femoral vein. Initially, a 5 French pigtail catheter was used to visualize and localize the LPM in the left pulmonary artery via angiography (Figure 1). The pigtail catheter was then removed and an LPM introducer sheath was inserted. Through this sheath, a multipurpose (MP) catheter (Merit Medical, South Jordan, UT, USA) was advanced to perform selective angiography of the pulmonary artery. Using the MP catheter, a single-loop 18 mm snare was advanced to retract the LPM, but despite capturing the device three times, it could not be withdrawn into the sheath. As a result, the device migrated, as revealed by subsequent angiography, into the dilated coronary sinus, likely due to the PLSVC. At this point, the non-deflectable MP catheter was replaced with a deflectable Agilis NXT sheath (Abbott Inc, St. Paul, MN). A second smaller single-loop 7 mm micro-snarer was inserted, and both snares were used to engage the LPM at both the device body and the proximal retrieval feature. The LPM was successfully aligned with the delivery system and subsequently removed. No postoperative complications were observed. Two days after the retrieval procedure, the patient successfully underwent implantation of a conventional pacemaker via the left subclavian vein. The follow-up has been regular, and the patient is currently in good health.

Discussion

LPMs offer a valuable alternative to conventional pacemakers, particularly for patients with challenging venous anatomy or those at high risk of infection. Their safety and efficacy are well-established, supported by a standardized implantation procedure that has demonstrated promising outcomes across various clinical settings(1–4). Although LPM dislodgement remains low(5), as the global number of implants increases–partly due to the development of new leadless devices–the frequency of device retrievals is expected to rise. Therefore, standardized procedural protocols for safe retrieval are crucial. The Micra TPS was specifically designed with a small proximal feature at the end of the device, allowing it to be easily engaged with a snare to retract the device into the introducer sheath. However, our case highlights how an LPM retrieval procedure can be technically difficult. During the intervention, the patient encountered three main challenges: the LPM dislodged into a branch of the pulmonary artery; the device rotated with the retrieval feature button facing the cardiac wall; the presence of a LPVC with a dilated coronary sinus. These factors are only some examples of possible anatomical and mechanical variables that can complicate the procedure and influence its outcome. The key point in our case was the use of two different-sized snares to engage the device and align it with the delivery system. This approach is not always considered in other reported cases. For instance, Terricabras et al. successfully retrieved an LPM from the pulmonary artery using only one snare to engage the proximal retrieval feature(6). On the other hand, Romeo et al. reported a case of an LPM dislodgement three days after implantation, retrieved through two snare leads(7). Sterlinski et al. also described an LPM dislodgement in the pulmonary artery in a patient with congenitally corrected transposition of the great arteries, ventricular septal defect, pulmonary stenosis, and dextrocardia; in this case, a single snare was enough for the retrieval(8). Afzal proposed a tine-based retrieval approach for LMPs dislocated in the pulmonary artery, with the use of snares and additional tools such as an MP sheath and a supportive guide to advance distally through the pulmonary vasculature(9,10). Despite these promising strategies, the retrieval of LPMs, whether due to end-of-life issues or device dislodgement/failure, remains a challenging procedure(11). The development of new, dedicated tools is crucial to facilitate the retrieval process. Ongoing research and innovation are required to effectively respond to the demand for a new era of cardiac pacing, increasingly dominated by leadless technology.

Declarations

Acknowledgements

This manuscript was drafted with the assistance of artificial intelligence tools, such as ChatGPT 4 (OpenAI, San Francisco, CA, USA), Mage (Mage, New York, NY, USA), in keeping with established best practices (Biondi-Zoccai G, editor. ChatGPT for Medical Research. Torino: Edizioni Minerva Medica; 2024). The final content, including all conclusions and opinions, has been thoroughly revised, edited, and approved by the authors. The authors take full responsibility for the integrity and accuracy of the work and retain full credit for all intellectual contributions. Compliance with ethical standards and guidelines for the use of artificial intelligence in research has been ensured.

Conflict of Interest

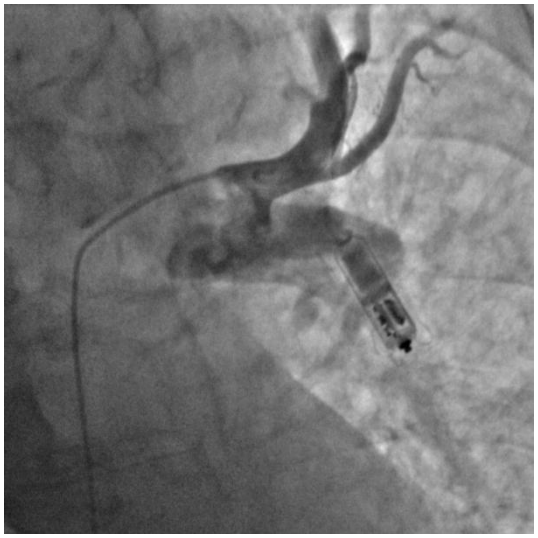
The Authors declare that there is no conflict of interest.

Disclosure

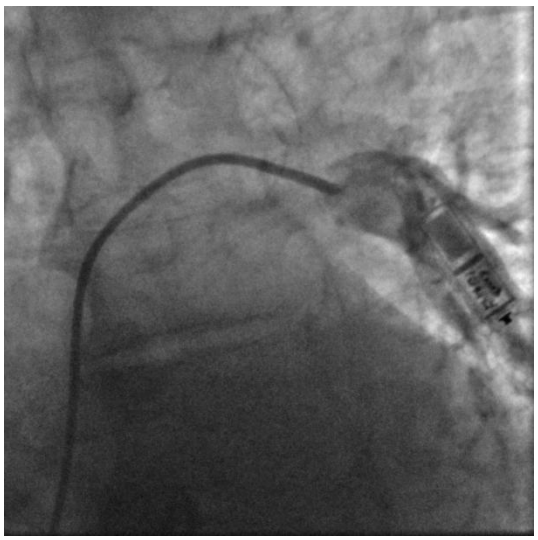
Giuseppe Biondi-Zoccai has consulted, lectured and/or served as advisory board member for Abiomed, Advanced Nanotherapies, Aleph, Amarin, AstraZeneca, Balmed, Cardionovum, Cepton, Crannmedical, Endocore Lab, Eukon, Guidotti, Innovheart, Meditrial, Menarini, Microport, Opsens Medical, Synthesa, Terumo, and Translumina, outside the present work. All other authors report no conflict of interest.

Figure 1

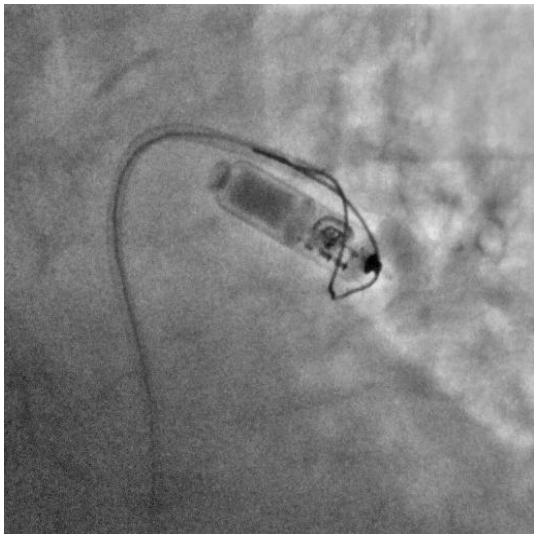
A. Pulmonary artery angiography using a pigtail catheter.



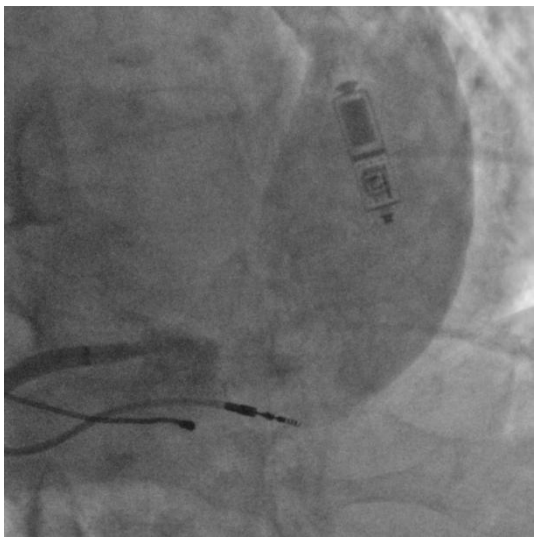
B. Pulmonary artery angiography using a multipurpose catheter.



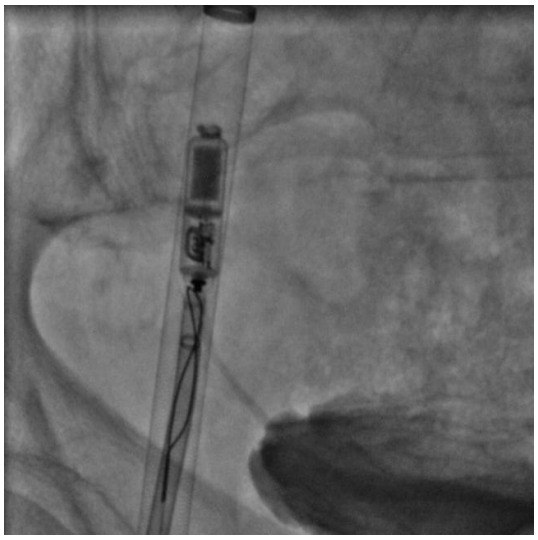
C: Attempted retrieval of the leadless pacemaker using a single-loop snare.



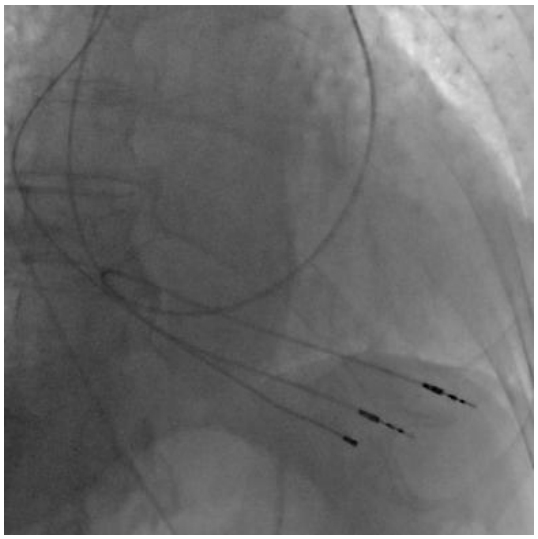
D. Secondary dislodgement of the leadless pacemaker into the dilated coronary sinus.



E. Successful alignment and retrieval of the leadless pacemaker into the delivery sheath using two single-loop snares.



F. Fluoroscopic image of the final conventional pacemaker implantation.



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