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RHYTHM DISORDERS

CLINICAL CASE

Leadless Pacemaker Pitfalls

Navigating Implantation and Postprocedure Challenges

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ABSTRACT

BACKGROUND Leadless pacemakers (LPs) are implanted into the right ventricular septum, eliminating intravascular complications associated with traditional pacemakers. They attach to the myocardium using 4 curved, self-expanding nitinol tines.

CASE SUMMARY Our case highlights the rare occurrence of LP dislodgement into the pulmonary artery and the delayed development of a traumatic right ventricular apical pseudoaneurysm.

DISCUSSION LPs were designed to reduce the lead- and pocket-related complications that can be seen with conventional pacemakers. However, LPs carry a risk of dislodgement and embolization into the pulmonary artery compared with conventional pacemakers.

TAKE-HOME MESSAGES This case explores the complexities and risks involved in both the implantation and retrieval of LPs in high-risk patient populations and highlights the importance of meticulous technique in retrieving an acutely embolized LP from the right PA. (JACC Case Rep. 2025;30:102992) Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

An 81-year-old female patient with reported sinus node dysfunction underwent Micra (Medtronic) leadless pacemaker (LP) placement at an outside hospital. This procedure was complicated by the dislodgment of the pacemaker into the PA and development of a pericardial effusion requiring pericardiocentesis. Her course was further complicated by acute blood loss anemia with hemoglobin of 6.6 g/dL requiring blood transfusions. Initial attempts to

TAKE-HOME MESSAGES

- This case explores the complexities and risks involved in both the implantation and retrieval of LPs in high-risk patient populations.
- Although rare, complications following LP deployment, such as RV pseudoaneurysm in this case, pose several clinical challenges, particularly in patients with significant comorbidities.

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ABBREVIATIONS AND ACRONYMS

CPM = conventional pacemaker

LP = leadless pacemaker

PA = pulmonary artery

RV = right ventricular

TTE = transthoracic echocardiography

retrieve the device were unsuccessful, prompting her transfer to our institution for a higher level of care. Upon arrival, the patient was hemodynamically stable. Physical examination revealed moderate edema in the bilateral lower extremities extending to the knees, normal jugular venous pressure, and fine crackles in the bilateral lower lung fields. Her labs were significant for acute kidney injury with a creatinine level of 1.78 mg/dL (baseline 1.2 mg/dL). Hemoglobin was stable at 8 g/dL following transfusion of 2 units of packed red blood cells at the outside hospital.

PAST MEDICAL HISTORY

The patient has a past medical history of paroxysmal atrial fibrillation, deep vein thrombosis, sleep apnea for which she uses continuous positive airway pressure, chronic kidney disease, hypertension, and a history of open reduction and internal fixation of a left femoral fracture complicated by osteomyelitis and hardware infection (femur rod) requiring chronic suppressive antibiotics with doxycycline.

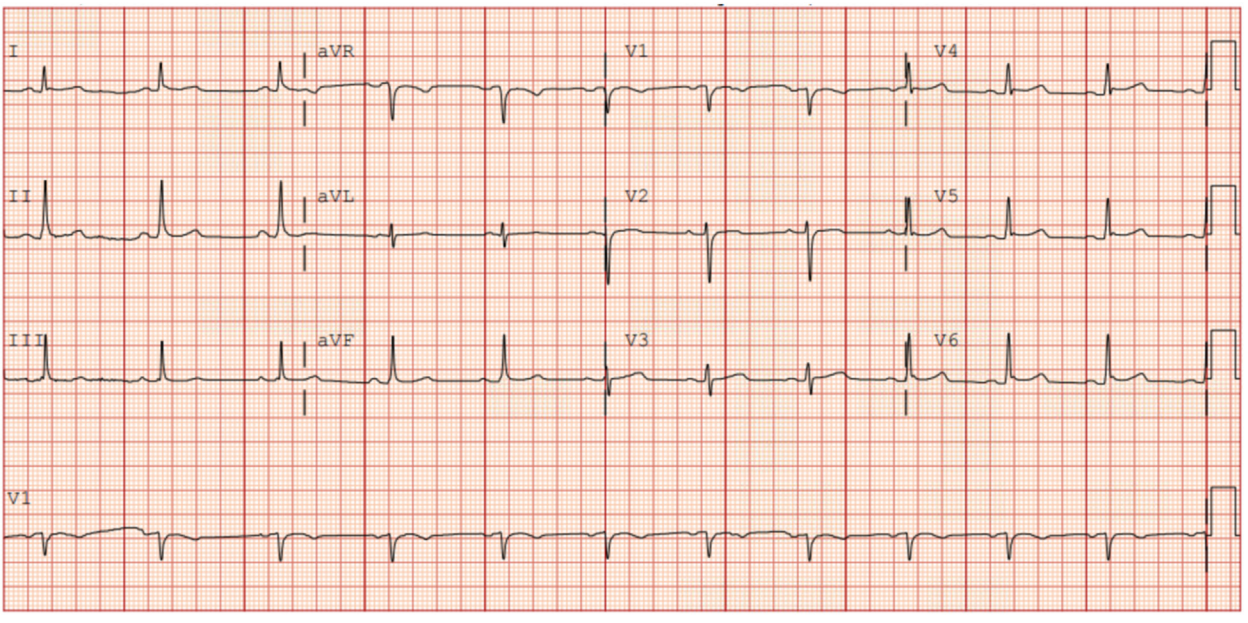
INVESTIGATIONS

An electrocardiogram on arrival to our institution revealed normal sinus rhythm (Figure 1) and telemetry throughout her admission was most consistent with sinus node dysfunction. A chest x-ray scan showed dislodgment of the LP to the left PA (Figure 2). Transthoracic echocardiography (TTE) on arrival demonstrated a preserved ejection fraction, normal right ventricular (RV) size and function, no significant valvular disease, and a trivial pericardial effusion.

MANAGEMENT/INTERVENTION

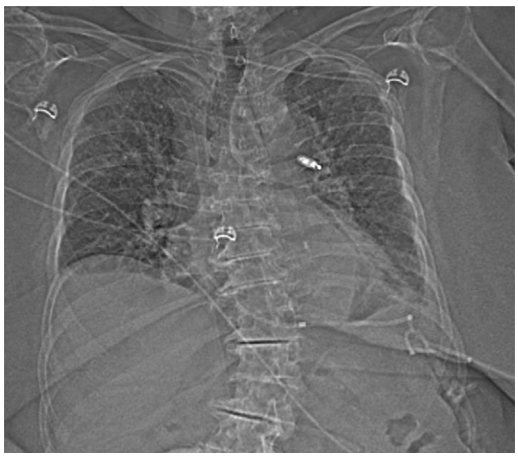
The extraction of the embolized LP device presented numerous challenges. A dedicated retrieval tool for the LP is currently unavailable, necessitating extraction through the 23-F introducer sheath using standard snares to capture the device. Extracting the device from the PA is even more complex due to maneuvering across the tricuspid valve into the RV and then into the PA through the pulmonic valve. After the introducer sheath was advanced into the

FIGURE 1 Admission ECG



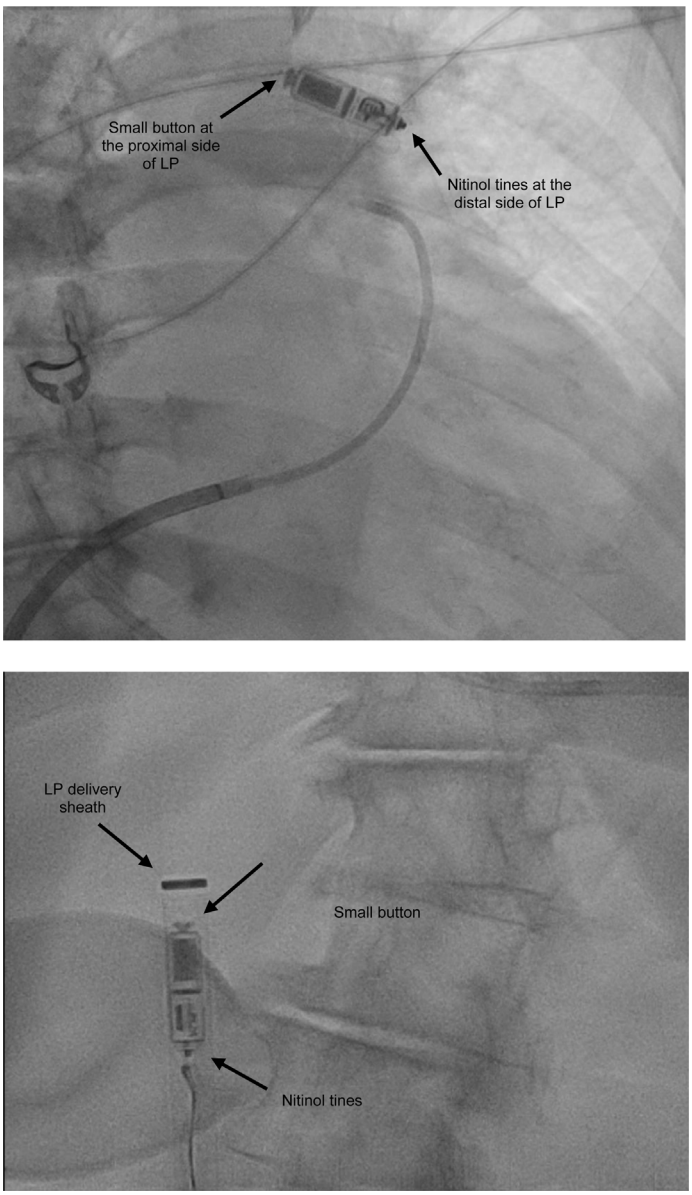
Electrocardiography on admission demonstrating normal sinus rhythm.

FIGURE 2 Post-Procedure CXR Following LP Placement



Chest x-ray scan showing dislodgment of the leadless pacemaker in the left pulmonary artery.

FIGURE 3 Intraprocedural Fluoroscopy During LP Retrieval



Initial positioning of the leadless pacemaker (LP) in the left pulmonary artery (top). Successful repositioning of the LP to overcome nitinol tines getting stuck at the pulmonary valve and the subsequent extraction of the device using the delivery sheath (bottom).

inferior vena cava via the right femoral vein, a Cook sheath was placed into the introducer to prevent bleeding back. A balloon-tipped catheter was then sailed into the RV and PA. An exchange-length Glidewire (Terumo) was advanced into the left PA. An 8-F FR4 guide was then advanced over the Glidewire past the LP, and a 6-F gooseneck snare was used through the FR4 guide to retrieve the device with the snare latching at the midsection.

Despite snaring the button on the LP's proximal end and midsection, navigating through the pulmonic valve posed a challenge. When snared from the proximal end, the nitinol tines snagged the valve cusps, and when snared from the midsection, a T formation caught on the valve and could not be pulled through. Consequently, the device was released to facilitate repositioning. The device was then successfully snared via the distal end (nitinol tines), smoothly pulling it through the pulmonary valve and retracting it into the introducer sheath (**Figures 3 and 4**). Given the patient's clinical and electrical stability without any concerning pathologic heart block, sinus pauses, or symptomatic bradycardia, reimplantation of a pacemaker was deferred with plans for close outpatient follow-up. She was discharged with an event monitor.

FOLLOW-UP

The event monitor did not reveal any evidence of symptomatic sinus pauses that would require reinsertion of a pacemaker placement. Unfortunately, she was readmitted 4 months after her initial presentation due to worsening edema and orthopnea concerning acute decompensated heart failure exacerbation. Repeat TTE at that time showed a large echo density within the pericardial space, causing compression of the RV free wall, raising concerns for a contained rupture (**Figure 5**). This was not seen on

FIGURE 4 Successful Retrieval of a Leadless Pacemaker Using a Snare at the Distal End

Successful retrieval of the device by snaring it at the distal end.

her prior TTEs. A computed tomography scan of the chest revealed an RV apical pseudoaneurysm adjacent to the interventricular septum, protruding anterosuperiorly and measuring 2.2 × 2.2 × 1.8 cm, with the neck of the defect measuring 10 mm (Figure 6). No prior computed tomography was available for comparison. This pseudoaneurysm was thought to represent a delayed presentation of a traumatic pseudoaneurysm that occurred during her initial Micra placement. A multidisciplinary meeting with interventional cardiology, cardiothoracic surgery, and cardiac imaging was arranged to discuss the management of her RV pseudoaneurysm. Options included transcatheter repair vs surgical repair vs conservative management with serial follow-ups. Given the location, size, and minimal pseudoaneurysm neck, interventional cardiology did not feel transcatheter repair would have a high likelihood of success. In addition, there was concern regarding manipulating the site and initiating bleeding. Cardiothoracic surgery felt that this defect should be followed, and if there was evidence of enlargement or leakage, they would offer surgical intervention. Ultimately, a conservative approach was recommended with serial follow-up. She continues to follow up with cardiology and cardiothoracic surgery with routine imaging.

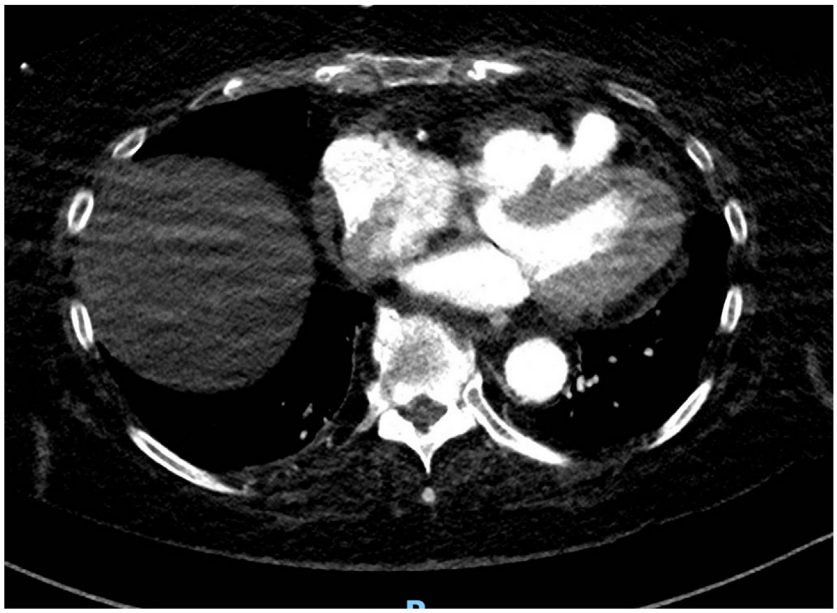
DISCUSSION

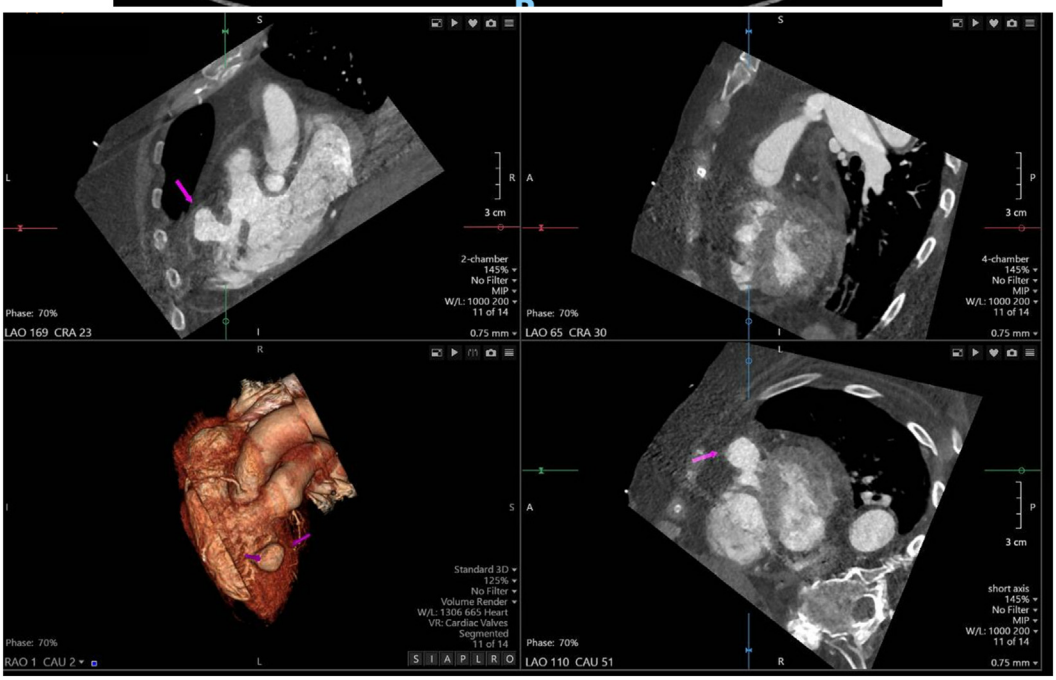
Conventional transvenous ventricular permanent pacemaker (conventional pacemaker [CPM]) implantation, which involves placing a pacing lead permanently in the ventricle, is associated with a 15%

FIGURE 5 Echocardiogram Obtained 4 Months After Initial Device Deployment

Echocardiogram showing a large echo density within the pericardial space, causing compression of the right ventricular free wall.

FIGURE 6 **CT Scan of the Chest 4 Months Following Device Deployment**





Computed tomography scan of the chest revealed a right ventricular apical pseudoaneurysm adjacent to the interventricular septum, protruding anterosuperiorly and measuring 2.2 × 2.2 × 1.8 cm, with the neck of the defect measuring 10 mm.

complication rate within the first 3 years.[1-3] These complications include pneumothorax, hemothorax, infection, valve impingement, pocket complications, pericardial effusion, and need for lead revision. LPs were designed to reduce these lead- and pocket-related complications. The IDE (Investigational Device Exemption) study reported a 4% complication rate within 6 months postimplantation associated with LP.[4] In the PAR (Micra Post-Approval Registry) registry, which reflects real-world settings, the major complication rate at 12 months was 2.7% for the LP group vs 7.6% for a historical CPM cohort. However, LPs carry a risk of dislodgement and embolization into the PA compared with CPM.[5]

A study by Roberts et al[6] monitored patients for 30 days post-LP placement, revealing a major complication rate of 1.51% (95% CI: 0.78%-2.62%). Major complications included cardiac effusion/perforation (0.13%), device dislodgement (0.13%), and sepsis (0.13%). Prompt retrieval of dislodged LPs is crucial. During Micra device retrieval, care must be taken to avoid injury to the pulmonic and tricuspid valves, adjacent vasculature, and cardiac chambers.

In this report, we delineate a case illustrating methods for safely retrieving an acutely embolized leadless Micra pacemaker from the right PA. In our experience, it is important to reposition the LP device in order to snare it via the distal end (nitinol tines) to avoid risking the nitinol tines getting stuck on the pulmonary valve or T formation leading to obstruction.

This case also highlights the rare complication of RV perforation during initial deployment of the device, resulting in contained RV pseudoaneurysm, and large pericardial effusion necessitating pericardial drain placement. Diagnosing a pseudoaneurysm can be challenging, both clinically and through imaging. It often requires a high index of suspicion. Initial TTE may miss the diagnosis due to its limited sensitivity, particularly given the slow progression of the aneurysm, as seen here, in which the pseudoaneurysm only became apparent months later with follow-up imaging. Advanced techniques like cardiac magnetic resonance or computed tomography are typically necessary for accurate detection.

Managing a pseudoaneurysm in these circumstances presents numerous challenges. Data from the Micra Coverage with Evidence Development (Micra CED) study indicate that LP are more commonly utilized in elderly patients and those with comorbidities compared with transvenous pacemakers.[7] Because LPs are implanted in a population with more health issues, many of these patients are at high risk for surgical correction of the aneurysm. Addressing an RV pseudoaneurysm with interventional techniques is also complex, given the considerable risk of rebleeding due to manipulation and an overall low success rate. Additionally, the presence of an RV pseudoaneurysm in pacemaker-dependent patients can elevate the risks associated with reimplantation of either a traditional pacemaker or LP in the future.

CONCLUSIONS

Despite LP advantages over CPMs, these devices present their own challenges, such as pericardial effusion, risk of dislodgement, and embolization. Our case highlights the importance of meticulous technique in retrieving an acutely embolized LP from the right PA, emphasizing the need for precise repositioning of the device during extraction to prevent further complications. Furthermore, the management of complications such as RV pseudoaneurysm is particularly challenging, especially in patients with significant comorbidities who are often not suitable for surgical interventions. This case underscores the complexities and risks associated with both the implantation and retrieval of LPs in a high-risk patient population.

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The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS leadless pacemaker, leadless pacemaker dislodgment, RV pseudoaneurysm

APPENDIX For a supplemental figure, please see the online version of this paper.