Case Report

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Beneath The Rhythm: Deciphering The Subtle Perforation of The Right Ventricle by a Pacemaker Lead

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Abstract
Cardiac perforation by the lead of permanent pacemaker implantation (PPM) devices is a critical complication that often occurs within 24 hours after the implantation but can occur later. Here we report a case of 82-year-old female patient with perforation of the right ventricular wall due to RV lead after 3 months of pacemaker implantation, which was managed conservatively.

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Keywords: *Right ventricle perforation, pacemaker lead, permanent pacemaker, conservative management, pericardial effusion, sick sinus syndrome, cardiac device complications*.

Introduction

Cardiac perforation due to a pacemaker or defibrillator lead occurs at a rate of 0.4–2.0%.[1] The incidence of this complication from the time of surgery decreases over time. By convention, a perforation which is detected within the first 24 hours, is classified as acute. If it is detected within 30 days of implantation (between 5 days- 4 weeks), it is referred to as early (sub-acute); and, those detected after 30 days are referred to as late, delayed, or chronic perforation.[1,2] Most perforations manifest within a year but rarely cases have been reported as late as five years following implantation. The critical risk factors for lead perforation are not yet clear. Therefore there are many controversies in the management of lead perforation depending on the symptoms, chronicity, and functional status of the device.

Case Details

An 82-year-old female patient underwent permanent pacemaker implantation at our institute 3 months ago for sick sinus syndrome (tachy-brady syndrome), which caused multiple episodes of syncope before admission. She has shown improved symptoms since the implantation. The pacemaker, which is a Medtronic device, is set in DDDR (Dual-chamber rate-modulated pacing) mode, MRI conditional, with a lower rate of 60 bpm. The details of the settings are mentioned in Table 1.

After being asymptomatic for two and a half months after discharge, however, this time, she presented with complaints of shortness of breath for the last 2 weeks. It was followed by the appearance of a pitting type of pedal oedema in both lower limbs for past 5 days, and orthopnoea for the last 2 days.

On evaluation, the patient presented with biventricular heart failure and volume overload. The pulse rate was 130/min irregular, BP was 144/90 mmHg, oxygen saturation was 88% on room air, and respiratory rate was 24/min. (Figure 1).

ECG was suggestive of atrial fibrillation with fast ventricular rate. Chest x-ray P/A view suggestive of bilateral pleural effusion with cardiomegaly with PPM device, RA, and RV lead in situ. 2D Echocardiography showed moderate pericardial effusion with no e/o RA, RV collapse, or cardiac tamponade with RA lead in place and RV lead in pericardial space with LV and RV dysfunction. (figure 2:A-D).

Table 1. Pacemaker parameters.

Parameters	RA Lead	RV Lead (baseline)	RV lead (current)
Threshold	1.2 V at 0.5 ms	0.5 V at 0.5 ms	2.5 V at 0.4 ms
P/R wave	2.5 mv	11.2 mv	8.2 mv
Impedance	558 ohm	893 ohm	549 ohm

Table 2. Laboratory examinations of pericardial fluid.

Hb: 12.6 gm. / dl.	ESR:25mm/1hr	NT pro BNP:16,345 pg. /ml.
TLC: 7500/ cu.mm	CRP:3.95 mg/L	TSH: 6.76 mIU/L.
Platelet:2.3 lakh/cu.mm	Creatinine: 0.8 mg/dl.	Free T4: 1.28 ng. /dl.

On-device interrogation, we found that the RV lead threshold increased to 2.5 V at 0.4 ms, and the impedance value decreased to 549 ohms (Table 1).

The CECT Thorax revealed a pacemaker with one lead in the right atrium and the other perforating the apex of the right ventricle (5x6 mm) with no signs of any active contrast leak or extravasation into the pericardium. There are bilateral moderate pleural effusion, moderate pericardial effusion, and cardiomegaly with dilated right and left atria, as well as evidence of cardiogenic pulmonary oedema.

Management

After a thorough discussion with the cardiac surgeon and considering the patient's delayed presentation, vital status, advanced age, and frail body habitus, it was decided to manage the patient with medical treatment. This included rate-controlled medication, decongestive therapy, and oxygen support. The patient was continuously monitored for her symptoms and changes in effusion.

Pericardiocentesis was performed 5 days after admission, and 325 ml of haemorrhagic fluid was drained. There were blood clots in the aspirated pericardial fluid and the fluid was hemorrhagic in nature. It was sent to the lab for analysis to rule out

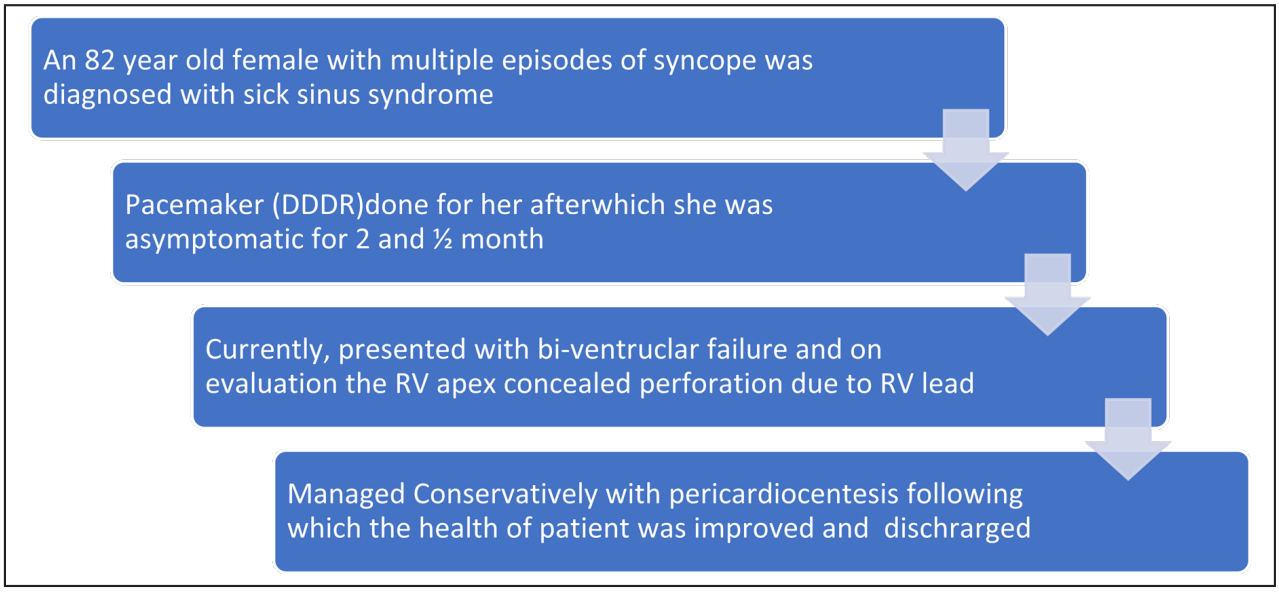

Figure 1. Timeline of the events

the possibility of infection. The analysis revealed that the fluid was transudate in nature and without infection (table 2). The lead placement was checked using cine fluoroscopy in AP and lateral position. (figure2:G,H) The patient was closely monitored in the intensive cardiac care unit for 3 days to check for any fluid re-accumulation. After that, the patient was transferred to the general ward and subsequently discharged. (figure 2: E, F).

Follow up

Following a one-month follow-up, the patient's symptoms improved. Echocardiography showed good left ventricle (LV) and right ventricle (RV) function with no pericardial effusion. The pacemaker (PPM) interrogation revealed consistent threshold levels as before, which we considered acceptable given the patient's age and frailty. The patient has been regularly followed up for the past two years and is doing well. (figure 3).

Discussion

Cardiac perforation due to pacemaker leads is a critical complication with a reported incidence of 0.4% to 2.0%.[2] This complication can occur at various intervals post-implantation, categorized as acute (within 24 hours), early (within 30 days), or late (beyond 30 days).[3] The majority of perforations present within a year of implantation, but late cases can occur up to several years post-procedure.[4] In this case, the patient presented 3 months after the PPM implantation. The management of lead perforation depends on the timing of presentation, symptoms, and the patient's overall health.

In this case, a thorough evaluation of the patient was conducted for other potential systemic causes of pericardial effusion considering tuberculosis, hypoalbuminemia, renal dysfunction, and malignancy. There were no signs/symptoms of pericarditis clinically and also on ECG. Tuberculosis was unlikely due to a non-contributory history. The laboratory results showed that pericardial fluid was transudate in nature with normal ADA levels and CB NAAT report. Additionally, the ESR was only mildly raised. The patient's Liver function was within normal limits with normal serum albumin levels. There were no signs or symptoms of malignancy, and the patient responded well to decongestive therapy. Pericardial fluid showed no abnormal cells on fluid cytology. Considering her age, the autoimmune cause is unlikely.

RV lead perforation can present with a range of symptoms from asymptomatic to severe manifestations

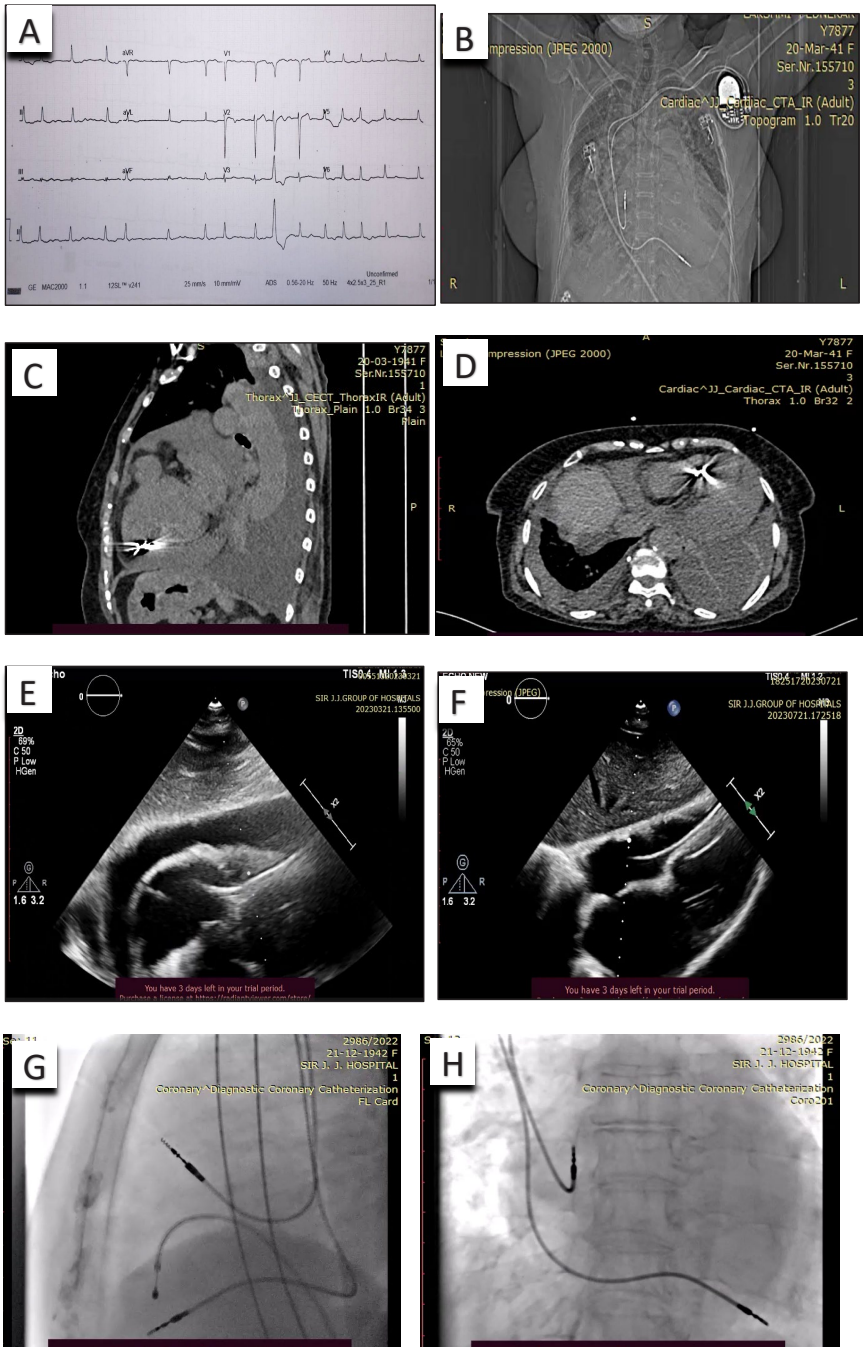

Figure 2. (A) ECG showing AF with fast ventricular rate with occasional VPC. (B) Chest X-ray shows pulmonary edema with cardiomegaly, bilateral blunted costophrenic angles, and a PPM pulse generator over the left side of the thorax with RA and RV leads in situ (Note: the RV lead position is beyond the heart border). (C) CECT Thorax sagittal cut section and. (D)Transverse cut section showing hyperdense RV lead tip within the pericardial space with moderate pericardial effusion. (E, F) 2D Echocardiogram subcostal view image before and after pericardiocentesis (Note: the RV lead position traversing across RV apex into pericardial space). (G, H) Lead placement was checked using cine fluoroscopy in AP and lateral position.

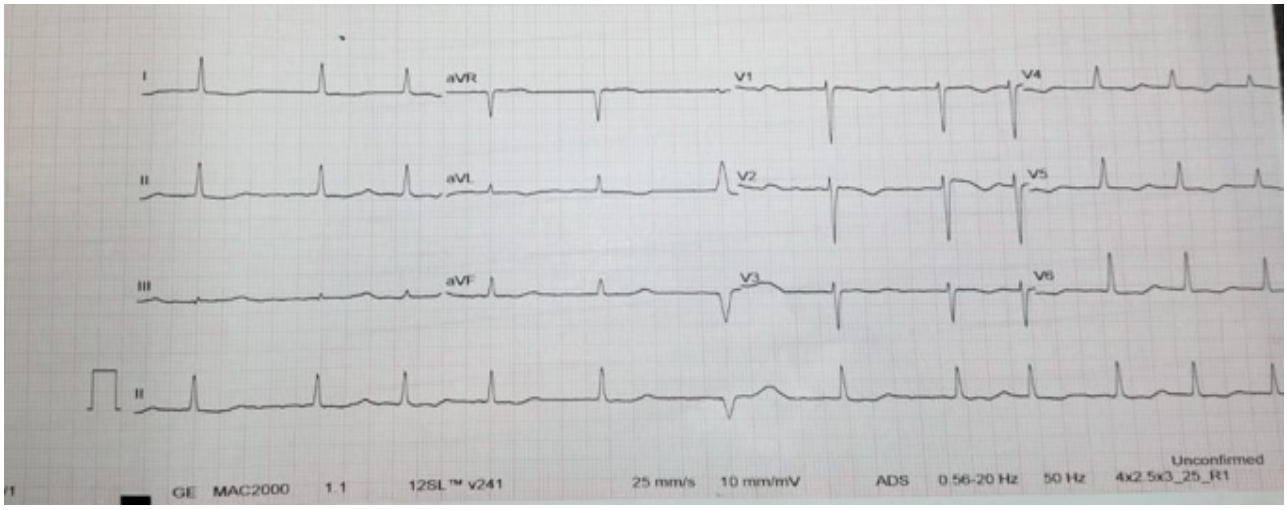

Figure 3. ECG on follow-up after a month.

like chest pain, dyspnoea, or signs of cardiac tamponade. Clinicians should maintain a high index of suspicion, especially in patients with persistent symptoms post-device implantation.[5,6] This patient had symptoms of biventricular failure.

Chest X-ray is often the first imaging modality to identify lead displacement or perforation. Echocardiography is useful for assessing pericardial effusion or signs of tamponade and evaluating lead position and complications. Computed Tomography (CT) offers detailed anatomical imaging to confirm perforation and visualize surrounding structures.[7] Fluoroscopy can be used during the diagnosis and management phases to guide lead repositioning or extraction.[8]

Immediate Management involves ensuring the patient is hemodynamically stable. If there is significant cardiac tamponade or severe symptoms, emergency pericardiocentesis may be required to relieve pressure.[9]

In many cases, percutaneous lead revision or extraction can be performed, especially when the perforation is identified early and the patient is stable.[10] The decision between revision and extraction depends on lead fixation, the extent of perforation, and associated complications. Extraction of the lead can be considered if the perforation is severe, associated with significant symptoms, or if there are signs of endocarditis or other complications. Recent studies highlight the safety and effectiveness of percutaneous lead extraction techniques.[11] The extraction may involve the use of mechanical sheaths and graspers, with fluoroscopic guidance.

For chronic or complicated cases, surgical intervention might be necessary.[12] In cases where extraction is not required or feasible, repositioning the lead to a different anatomical location within the RV or even into the coronary sinus may be considered. This approach requires careful guidance and imaging to avoid further complications.[13]

Patients who have experienced RV lead perforation should be monitored closely with regular follow-up visits, including echocardiograms or other imaging as needed, to ensure the lead remains in the proper position and to monitor for potential late complications.[14] Advanced cardiac devices often include remote monitoring systems to detect changes in lead performance or complications early.[15]

Independent predictors of cardiac perforation include: Patients over 80 years of age, female sex, body mass index (BMI) less than 20, patients who are on oral steroids in the week before implantation, placement of a ventricular lead in an apical position, use of a temporary pacemaker in conjunction with a permanent pacemaker, using a helical screw active fixation lead in the right ventricle and longer fluoroscopy times increases the risk of perforation.[16]

Factors that may reduce the risk of perforation include: Pulmonary hypertension, Right ventricular systolic pressure greater than 35 mmHg, and BMI greater than 30.[16]

Careful patient selection and preoperative assessment can help identify individuals at higher risk for lead-related complications, guiding more tailored approaches during device implantation[17] and ensuring optimal implantation techniques can reduce the risk of perforation.[18]

Summary

The management of RV lead perforation requires a multidisciplinary approach, balancing immediate intervention with long-term follow-up. The latest guidelines emphasize the importance of early detection, the use of advanced imaging techniques, and the availability of percutaneous and surgical options for lead management. Continuous advancements in technology and techniques are likely to further improve outcomes and safety for patients with this complication

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Conflict of Interest Statement

The authors declare no conflict of interest.

Consent to Participate

A well-informed written consent was obtained from the patient and relatives before the procedure.

Ethical Approval

Not applicable.

We declare that the paper is not under consideration elsewhere and none of the paper's contents have been published previously.

List of Abbreviations

AF	Atrial Fibrillation
BMI	Body Mass Index
CT	Computed Tomography
CECT	Contrast Enhanced Computed Tomography
DDDR	Dual-chamber rate-modulated pacing
ECG	Electrocardiogram
LV	Left Ventricle
PPM	Permanent Pacemaker
RV	Right Ventricle
RA	Right Atrium
VPC	Ventricular Premature Complex

References

1. Laborderie J, Barandon L, Ploux S, et al. Management of subacute and delayed right ventricular perforation with a pacing or an implantable cardioverter-defibrillator lead. *Am J Cardiol*. 2008;102(10):1352-1355. doi:10.1016/j.amjcard.2008.07.025
2. Fahy GJ, Kleman JM, Wilkoff BL, Morant VA, Pinski SL. Low incidence of lead related complications associated with nonthoracotomy implantable cardioverter defibrillator systems. *Pacing Clin Electrophysiol*. 1995;18(1 Pt 2):172-178. doi:10.1111/j.1540-8159.1995.tb02499.x
3. Matsuura Y, Yamashina H, Higo M, Fujii T. Analysis of complications of permanent transvenous implantable cardiac pacemaker related to operative and postoperative management in 717 consecutive patients. *Hiroshima J Med Sci*. 1990;39(4):131-137
4. Hirschl DA, Jain VR, Spindola-Franco H, Gross JN, Haramati LB. Prevalence and characterization of asymptomatic pacemaker and ICD lead perforation on CT. *Pacing Clin Electrophysiol*. 2007;30(1):28-32. doi:10.1111/j.1540-8159.2007.00575.x
5. Waddingham PH, Elliott J, Bates A, et al. Iatrogenic cardiac perforation due to pacemaker and defibrillator leads: a contemporary multicentre experience. *Europace*. 2022;24(11):1824-1833. doi:10.1093/europace/euac105
6. Demo H, Megaly M. Late perforation of a passively fixated pacemaker lead through the right ventricle. A report and review of the literature. *J Cardiol Cases*. 2017;16(5):148-150. doi:10.1016/j.jccase.2017.07.00
7. Haque MA, Roy S, Biswas B. Perforation by permanent pacemaker lead: how late can they occur?. *Cardiol J*. 2012;19(3):326-327. doi:10.5603/cj.2012.0059

8. Issa ZF, Issa TZ. Feasibility and Safety of Percutaneous Lead Revision for Subacute and Delayed Cardiac Device Lead Perforation. *JACC Clin Electrophysiol*. 2021;7(1):26-35. doi:10.1016/j.jacep.2020.07.024
9. Ahmed A, Shokr M, Lieberman R. Subacute Right Ventricular Perforation by Pacemaker Lead Causing Left-Sided Hemothorax and Epicardial Hematoma. *Case Rep Cardiol*. 2017;2017:1264734. doi:10.1155/2017/1264734
10. Saunderson CED, Hogarth AJ, Papaspyros S, Tingerides C, Tayebjee MH. An unusual cause of a haemothorax following pacemaker implantation: A case report. E*ur Heart J Case Rep*. 2022;6(5):ytac185. Published 2022 May 1. doi:10.1093/ehjcr/ytac185
11. Migliore F, Leoni L, Torregrossa G, et al. Asymptomatic right ventricular perforation by an implantable cardioverter defibrillator lead detected by the home monitoring system. *J Electrocardiol*. 2010;43(6):673-675. doi:10.1016/j.jelectrocard.2010.07.022
12. Marazzato J, Caravati F, Blasi FBM, et al. Ventricular pacemaker lead in the left hemithorax: Mechanisms and evidence-based management of a late-onset hazardous complication. *Clin Case Rep*. 2021;9(8):e04617. Published 2021 Aug 10. doi:10.1002/ccr3.4617
13. Kondoh H, Funatsu T, Taniguchi K. Late left ventricular perforation by active fixation pacemaker lead implanted in the right ventricular septum. *J Card Surg*. 2012;27(4):530-531. doi:10.1111/j.1540-8191.2012.01479.x
14. Forleo GB, Zeitani J, Perretta T, et al. Acute left hemothorax as a late complication of an active-fixation pacemaker lead. *Ann Thorac Surg*. 2013;95(3):1081-1084. doi:10.1016/j.athoracsur.2012.07.064
15. Pojar M, Vobornik M, Novy J. Left hemothorax: an unusual complication of delayed right ventricular perforation by a permanent pacemaker lead. *J Card Surg*. 2013;28(3):325-327. doi:10.1111/jocs.12080
16. Mahapatra S, Bybee KA, Bunch TJ, et al. Incidence and predictors of cardiac perforation after permanent pacemaker placement. *Heart Rhythm*. 2005;2(9):907-911. doi:10.1016/j.hrthm.2005.06.011
17. Selcuk H, Selcuk MT, Maden O, et al. Uncomplicated heart and lung perforation by a displaced ventricular pacemaker lead: a case report. *Pacing Clin Electrophysiol*. 2006;29(4):429-430. doi:10.1111/j.1540-8159.2006.00366.x
18. Carlson MD, Freedman RA, Levine PA. Lead perforation: incidence in registries. *Pacing Clin Electrophysiol*. 2008;31(1):13-15. doi:10.1111/j.1540-8159.2007.00943.x.