Missed diagnosis: Dual right ventricular lead perforation resulting in chest pain

Daniel W. Nelson, BS, Caroline Vloka, BA, Jule Wetherbee, MD

From the Division of Electrophysiology, Aurora Advanced Healthcare, Grafton, Wisconsin.

Introduction

Pacemaker and implantable cardioverter-defibrillator (ICD) lead perforations are well described and may cause many complications. Delayed cardiac perforation (DCP) is a less recognized complication of device implantation and is believed to be rare. We present a case of DCP wherein 2 simultaneous ICD lead perforations occurred in the right ventricle (RV) and were overlooked on chest radiograph (CXR) and chest computed tomography (CT) images. In patients with implanted cardiac leads presenting with chest pain or dyspnea, physicians familiar with typical lead placement should review the radiology images, and not simply read the reports, to recognize lead perforations.

Case Report

An 86-year-old woman with a history of hypertension, congestive heart failure (CHF), and prior ICD implantation presented to the emergency department with severe, stabbing chest pain radiating to the back. The pain had started 2 hours earlier while she was sitting and was exacerbated by inspiration. She denied shortness of breath or cough. Her blood pressure was 198/64 mm Hg, heart rate 60 beats per minute, and oxygen saturation 99% on a 2-L nasal canula.

An electrocardiogram showed a left bundle branch block. A CXR report stated that there were no acute pulmonary findings and that an ICD device with intracardiac leads was present, without mention of lead position (Figures 1 and 2). The CT report noted a trace right pneumothorax, pneumomediastinum, small subsegmental pulmonary embolism in the right lower lobe, small right pleural effusion, and pulmonary nodule at the left lung base. A diagnosis of pulmonary embolus was made. Treatment with enoxaparin and warfarin was started. Serial cardiac enzyme results were negative. The patient's chest pain improved, and she no longer had pruritic symptoms. She remained hemodynamically stable on anticoagulants and was discharged 2 days later on enoxaparin and warfarin.

She was readmitted 2 days later with shortness of breath, palpitations, and constant, severe, substernal chest pain radiating to the abdomen. She had new onset atrial fibrillation (AF) with a heart rate of 200 beats per minute, so an electrophysiology consultation was obtained.

Chest CT images showed an ICD lead perforating the apex of the RV, with the tip residing in the left lower lung. On inspection of the chest CT images by the consulting electrophysiologist, a second perforated RV ICD lead was seen extending anteriorly and inferiorly out of the RV. A retrospective evaluation of the CT scan and CXR taken on the first admission demonstrated that both RV ICD lead perforations had been present at that time. Interrogation of the ICD showed that all ventricular tachycardia and ventricular fibrillation detection and therapies were programmed off and the RV pacing outputs had been programmed to minimum. Outside records were requested.

Both RV ICD leads had been implanted 3 months prior at another hospital as an upgrade to a biventricular ICD from a dual-chamber pacemaker previously implanted for sick sinus syndrome. The ICD had been implanted because of an ejection fraction of 35%, symptoms of CHF, and left bundle branch block with intrinsic QRS of 163 ms. Both RV ICD leads were active-fixation St. Jude Medical Durata 7122 leads (St. Paul, MN). The first RV ICD lead was positioned in the RV apex. The day after the ICD implantation, the patient complained of chest pain and the RV threshold was significantly higher. Two days later, a second RV ICD lead was placed in the RV septum. The first RV ICD lead was left in place with the screw retracted. Four weeks later, the patient received 6 inappropriate ICD shocks for noise. At that point, the RV output setting was reduced to minimum and ventricular tachycardia and ventricular fibrillation therapies were turned off. A CXR report did not mention lead position. No other data were available from the records obtained.

After the perforations were diagnosed, the patient refused removal of the leads and requested a "do not resuscitate" order. The patient was evaluated by a psychologist and deemed competent. She was aware of the risk of anticoagulation with the presence of perforated leads, but she

KEYWORDS Cardiac lead imaging; Cardiac perforations; Delayed cardiac perforation; Dual right ventricular lead perforation; Implantable cardioverter-defibrillator (Heart Rhythm Case Reports 2017;3:100–103)

Conflicts of interest: None. Funding: None. **Address reprint requests and correspondence**: Dr. Jule Wetherbee, Aurora St. Luke's Medical Centers, 2801 W. Kinnickinnic River Parkway, Ste. 840, Milwaukee, WI 53215. E-mail address: publishing453@aurora.org.

 http://dx.doi.org/10.1016/j.hrcr.2016.09.012

KEY TEACHING POINTS

- Delayed cardiac lead perforations may present with various symptoms and complications, including chest pain, loss of capture, inappropriate implantable cardioverter-defibrillator shocks, pneumothorax, or pneumomediastinum.
- Simultaneous delayed cardiac perforations from 2 implantable cardioverter-defibrillator leads can occur. Risk factors for delayed cardiac perforation include small-diameter and active-fixation leads.
- Surgical intervention for cardiac lead perforation is an exceedingly rare necessity. Lead perforation is rare, and less-invasive modalities, including direct manual extraction with cardiac surgery backup and pericardiocentesis, are frequently efficacious.
- Cardiac lead perforations may be missed on chest radiographs and on computed tomography scans because of reverberation artifact and acoustic shadowing from metallic leads. In patients with implanted cardiac leads presenting with chest pain or dyspnea, physicians familiar with typical lead placement should review the radiology images, and not simply read the reports, to recognize lead perforations.

wished to continue anticoagulation therapy to prevent a stroke. Initially, the ventricular rate in AF was not controlled, and she developed recurrent CHF symptoms. She was started on amiodarone therapy, the AF terminated, and she maintained sinus rhythm. After 10 days, she was discharged on warfarin and enoxaparin.

The patient was readmitted 2 days later with weakness. The international normalized ratio was 3.9. Despite the perforations and full anticoagulation, she remained stable. After repeated conversations, she agreed to undergo removal of the perforated ICD leads and ICD device. Anticoagulation was discontinued, and the preoperative international normalized ratio was 1.4.

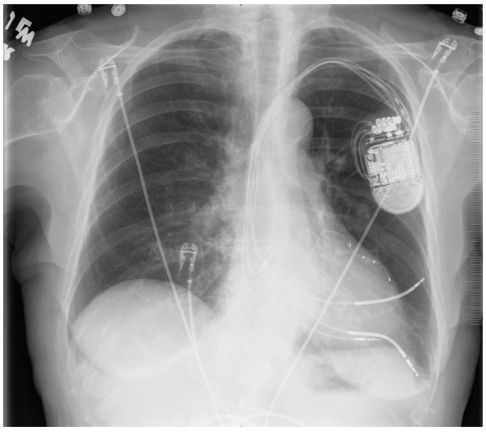

Figure 1 Chest radiograph showing unreported right ventricular implantable cardioverter-defibrillator lead perforations.

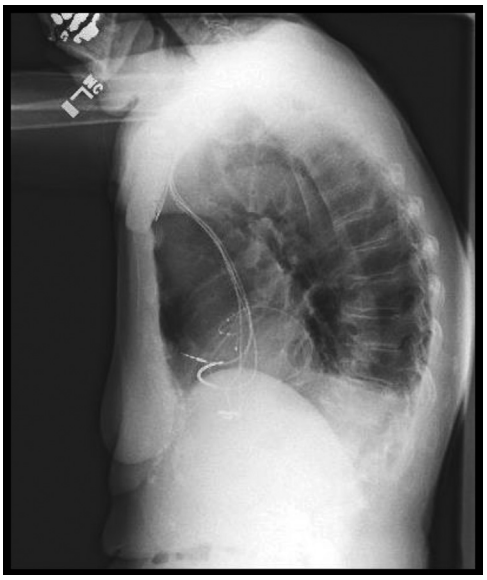

Figure 2 Lateral radiograph showing unreported right ventricular implantable cardioverter-defibrillator lead perforations.

The surgeon performed a left thoracotomy. Both leads extruded from the RV 4–5 cm beyond the pericardium (Figure 3). The pericardium was excised around both leads, and the exit points were secured with 4-0 pledgeted Prolene sutures (Ethicon, Somerville, NJ). The surgeon noted that the leads moved freely with each heartbeat but there was no evidence of blood leakage. Both leads were cut at the site of exit from the myocardium and removed by applying traction at the lead end located in the pocket. The remaining 2 pacemaker leads, 1 in the right atrium and 1 in the RV, were found to be functioning normally and were connected to a new dual-chamber pacemaker. The left ventricular lead, a St. Jude Medical Quartet 1458Q, was capped and left in place. It was not compatible with any biventricular pacemaker. An epicardial left ventricular lead was not placed, because of pericardial adhesions. The patient tolerated the procedure well and was discharged on postoperative day 4.

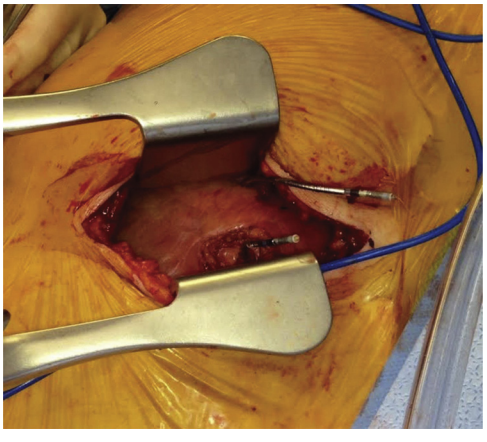

Figure 3 Dual right ventricular implantable cardioverter-defibrillator leads seen protruding from the myocardium during surgery.

Two months later, a CXR showed complete resolution of the pleural effusion, pneumothorax, and pneumomediastinum. The patient continued on guideline-directed medical therapy, and her ejection fraction improved to 65%. Her case was reclassified 6 months later as New York Heart Association class 1.

Discussion

To our knowledge, this is the first case of simultaneous cardiac perforations from 2 ICD leads. A pleural effusion, pneumothorax, and a pneumomediastinum were caused by the perforations. Complications of pacemaker and ICD lead perforations are well described and can occur with both active fixation and passive lead insertion.[1,2] Cardiac perforations from intracardiac leads can result in pleuritic chest pain, pericardial effusion, hemothorax, lung perforation manifested by pneumomediastinum and pneumothorax, diaphragmatic or chest wall pacing, diaphragm or chest wall perforation, cardiac tamponade, or death.[3–6] Despite being on anticoagulation therapy, our patient did not develop noticeable bleeding or pericardial effusion. Not all patients with lead perforation on anticoagulation are as fortunate. A late lead perforation previously reported resulted in pericardial effusion and cardiac tamponade.[7]

Female sex, age >80 years, lead location, lead stiffness, and caliber size are risk factors for cardiac lead perforation.[8,9] DCP, defined as the migration and perforation of implanted leads 1 month or more after implantation, is a less well-recognized complication of device implantation and is believed to be rare.[10] Small-diameter, active-fixation leads were associated with a higher risk of DCP.[8] DCP of small-diameter ($\leq$8 F) leads occurred 1.6% of the time, and DCP of active-fixation leads occurred 1.4% of the time.[8] No DCP occurred with standard diameter ($>$8 F) or passive-fixation leads.[8] Our patient's perforated ICD leads were both small-diameter (6.3 F), active-fixation leads.

Lead perforations in the right atrium and RV traditionally were reported to be 0.1%–0.8% for pacemakers and 0.6%–5.2% for ICDs.[11] There is a large discrepancy in the reported rates of RV lead perforations, ranging from 0.51% to 6%.[2,12] The difference in reported rates may stem from different definitions of what represents a lead perforation as interpreted on a CXR or CT scan by a radiologist. Reverberation artifact and acoustic shadowing from metallic leads may cause cardiac perforations to be missed on CT scans. Retrospective review of our patient's records revealed that the correct diagnosis had been missed on prior CXRs and CT scans. In a similar reported case, an atrial lead protrusion was diagnosed 5 years after lead implantation.[13] Retrospective CT scan examination showed that the perforation had been present 4 years earlier.

Surgical intervention for cardiac lead perforation is an exceedingly rare necessity. In 1 study of 3815 patients who received an RV lead implant, only 14 were diagnosed with a cardiac perforation, of which 1 required surgical removal.[14] The remaining leads were successfully removed via direct manual traction with cardiac surgery backup.[14] Another study showed that of 2535 patients who received an ICD, 5 patients presented with cardiac tamponade, of which only 2 required surgical intervention.[15] Less-invasive treatment modalities, including direct manual extraction with cardiac surgery backup and pericardiocentesis, help explain the low rate of surgical intervention. Because of our patient's advanced age and dual lead perforation, we were not comfortable with percutaneous removal and chose a surgical approach.

Conclusion

A more cautious approach is warranted when reading a CXR or chest CT scan in a patient with a history of implanted cardiac leads presenting with chest pain or dyspnea, to prevent overlooking cardiac lead perforations. Moreover, physicians familiar with typical lead placement should review the radiology images, and not simply read the reports, to help recognize lead perforations.

Acknowledgments

The authors gratefully acknowledge the editorial assistance of Susan Nord and Jennifer Pfaff of Aurora Cardiovascular Services, Milwaukee, WI, and the figure preparation of Brian Miller and Brian Schurrer of Aurora Research Institute, Milwaukee, WI.

References

1. Fisher JD, Fox M, Kim SG, Goldstein D, Haramati LB. Asymptomatic anterior perforation of an ICD lead into subcutaneous tissues. Pacing Clin Electrophysiol 2008;31(1):7–9.
2. 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.
3. Lau EW, Shannon HJ, McKavanagh P. Delayed cardiac perforation by defibrillator lead placed in the right ventricular outflow tract resulting in massive pericardial effusion. Pacing Clin Electrophysiol 2008;31(12):1646–1649.
4. Dilling-Boer D, Ector H, Willems R, Heidbüchel H. Pericardial effusion and right-sided pneumothorax resulting from an atrial active-fixation lead. Europace 2003;5(4):419–423.
5. Akyol A, Aydin A, Erdinler I, Oguz E. Late perforation of the heart, pericardium, and diaphragm by an active-fixation ventricular lead. Pacing Clin Electrophysiol 2005;28(4):350–351.
6. Geyfman V, Storm RH, Lico SC, Oren JW 4th. Cardiac tamponade as complication of active-fixation atrial lead perforations: proposed mechanism and management algorithm. Pacing Clin Electrophysiol 2007;30(4):498–501.
7. Nakanishi H, Kashiwase K, Nishio M, Wada M, Hirata A, Ueda Y. Recurrent pericardial effusion caused by pacemaker lead perforation and warfarin therapy at 7 years after implantation. Europace 2012;14(2):297.
8. Rordorf R, Canevese F, Vicentini A, Petracci B, Savastano S, Sanzo A, Gandolfi E, Dore R, Landolina M. Delayed ICD lead cardiac perforation: comparison of small versus standard-diameter leads implanted in a single center. Pacing Clin Electrophysiol 2011;34(4):475–483.
9. Cano Ó, Andrés A, Alonso P, Osca J, Sancho-Tello MJ, Olagüe J, Martínez-Dolz L. Incidence and predictors of clinically relevant cardiac perforation associated with systematic implantation of active-fixation pacing and defibrillation leads: a single-centre experience with over 3800 implanted leads. Europace 2016. pii: euv410 [Epub ahead of print].
10. Refaat MM, Hashash JG, Shalaby AA. Late perforation by cardiac implantable electronic device leads: clinical presentation, diagnostic clues, and management. Clin Cardiol 2010;33(8):466–475.
11. Khan MN, Joseph G, Khaykin Y, Ziada KM, Wilkoff B. Delayed lead perforation: a disturbing trend. Pacing Clin Electrophysiol 2005;28(3):251–253.

12. Turakhia M, Prasad M, Olgin J, Badhwar N, Tseng ZH, Lee R, Marcus GM, Lee BK. Rates and severity of perforation from implantable cardioverter-defibrillator leads: a 4-year study. J Interv Card Electrophysiol 2009;24(1):47–52.
13. Sadamatsu K, Enomoto N, Tsuji M, Tashiro H. Progressive atrial lead perforation developed 5 years after pacemaker replacement. J Cardiol 2009;53(1):150–153.
14. Migliore F, Zorzi A, Bertaglia E, Leoni L, Siciliano M, De Lazzari M, Ignatiuk B, Veronese D, Verlato R, Tarantini G, Iliceto S, Corrado D. Incidence, management, and prevention of right ventricular perforation by pacemaker and implantable cardioverter defibrillator leads. Pacing Clin Electrophysiol 2014;37 (12):1602–1609.
15. Polin GM, Zado E, Nayak H, Cooper JM, Russo AM, Dixit S, Lin D, Marchlinski FE, Verdino RJ. Proper management of pericardial tamponade as a late complication of implantable cardiac device placement. AM J Cardiol 2006;98(2): 223–225.