JACC: CASE REPORTS VOL. 2, NO. 3, 2020

MINI-FOCUS ISSUE ON HEART FAILURE

ADVANCED

CASE REPORT: CLINICAL CASE

Lawn Mower Versus Left Ventricular Assist Device

A Case of Traumatic Coronary Injury

Vishal N. Rao, MD, MPH,[a] Marat Fudim, MD, MHS,[a] Andrew Griffin, MD,[b] Jennifer A. Rymer, MD, MBA,[a] W. Schuyler Jones, MD,[a] Lynne M.H. Koweek, MD,[b] Tony P. Smith, MD,[b] Daniele Marin, MD,[b] Adam D. DeVore, MD, MHS,[a] for the Duke Heart Team

ABSTRACT

A 77-year-old man with history of ischemic cardiomyopathy and left ventricular assist device (LVAD) presented with abdominal pain after a lawn mower accident. Examination and imaging revealed a displaced LVAD driveline and a pericardial hematoma secondary to traumatic coronary artery injury. The patient was treated with coronary artery coil embolization. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2020;2:406–10) © 2020 The Authors. 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

A 77-year-old man with a past medical history of ischemic cardiomyopathy status post-HeartMate III (Abbott Laboratories, Abbott Park, Illinois) left ventricular assist device (LVAD) presented following a riding lawn mower accident.

The patient was riding his lawn mower when the bag containing his LVAD external controller and batteries fell and entangled with the rotating blades, pulling him abruptly onto the ground. After freeing the LVAD external components from the lawn mower blades, he experienced an immediate implantable cardioverter-defibrillator (ICD) shock alongside severe abdominal pain. He presented to the emergency department for urgent evaluation.

LEARNING OBJECTIVES

- To make a differential diagnosis of LVAD-related mechanical complications.
- To understand and identify external causes of coronary artery injury and perforation.

PAST MEDICAL HISTORY

The patient's history includes coronary artery disease with multiple myocardial infarctions, drug-eluting stent placements to the right coronary artery (RCA) and the left anterior descending artery (LAD), ischemic cardiomyopathy (ejection fraction <15%), status post-cardiac resynchronization therapy defibrillator, chronic atrial fibrillation status post-

From the [a]Division of Cardiology, Department of Medicine, Duke University Medical Center, Durham, North Carolina; and the [b]Department of Radiology, Duke University Medical Center, Durham, North Carolina. Dr. Rymer has received research grant support (but no salary support) from Boston Scientific and Abbott. Dr. Koweek has received departmental grant funding from Siemens and Heartflow, Google, and Mallinkrodt; and provides speaking/educational talks for Siemens and Heartflow. Dr. DeVore has received an educational grant from Abbott; and has served as a consultant for AstraZeneca, LivaNova, Mardil Medical, and Novartis. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, or patient consent where appropriate. For more information, visit the *JACC: Case Reports* author instructions page.

Manuscript received October 28, 2019; revised manuscript received December 13, 2019, accepted December 18, 2019.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2019.12.036

atrioventricular nodal ablation, amiodarone-induced lung injury, and status post-destination therapy HeartMate III LVAD implantation with a tricuspid valve ring.

CLINICAL EXAMINATION

He confirmed severe abdominal pain and denied chest pain, dyspnea, palpitations, lightheadedness, and syncope. Mean arterial pressures were between 90 and 100 mm Hg, heart rate was 70 beats/min, respiratory rate was 19 breaths/min, and oxygen saturation was 100%. Examination revealed an intact LVAD driveline that had been retracted by approximately 6 inches (15 cm).

DIFFERENTIAL DIAGNOSIS

The differential diagnosis included acute coronary syndrome, LVAD thrombosis, driveline malfunction or displacement, coronary artery perforation, and ventricular wall rupture.

INVESTIGATIONS

Electrocardiogram showed atrial fibrillation with biventricular-paced rhythm at 70 beats/min. LVAD interrogation demonstrated a 3-s pump stop after the accident. ICD device interrogation revealed atrial fibrillation with biventricular-paced rhythm followed by ventricular tachycardia and ventricular fibrillation with heart rates >290 beats/min that was treated with a 30 J defibrillation shock with restoration of atrial fibrillation with biventricular-paced rhythm at the time of the accident. The level of high-sensitivity troponin T was 717 ng/l (reference <6 ng/l).

Chest radiographs demonstrated an intact LVAD pump with a displaced LVAD driveline (**Figures 1A and 1B**). Chest, abdomen, and pelvis computed tomography (CT) demonstrated an inferiorly located pericardial hematoma with a focal area of contrast extravasation (**Figures 2A to 2D**). Coronary CT angiogram demonstrated extravasation from a small acute marginal branch vessel arising from the RCA. In addition, there was a possible additional area of focal contrast extravasation most closely associated with a wrap-around LAD, although visualization was limited by notable metal artifact from the LVAD pump (**Figures 2A to 2D**). A transthoracic echocardiogram showed trivial anterior pericardial fluid and no evidence of tamponade.

MANAGEMENT

The patient was admitted for close surveillance. His hemoglobin declined from 14.0 to 10.2 g/dl over

ABBREVIATIONS AND ACRONYMS

CT = computed tomography

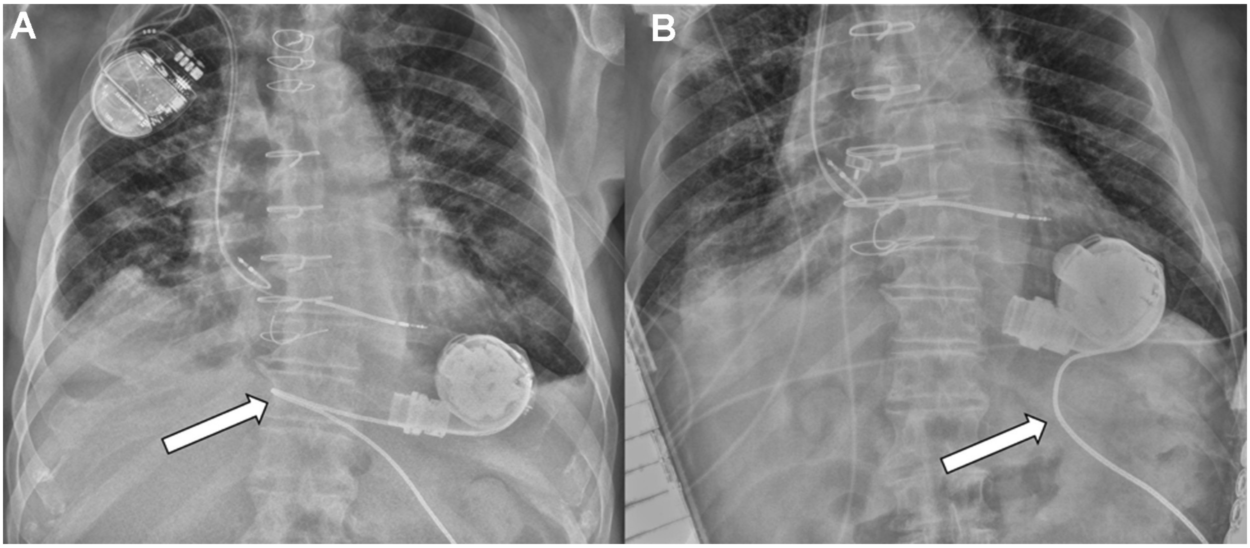
ICD = implantable cardioverter-defibrillator

LAD = left anterior descending artery

LVAD = left ventricular assist device

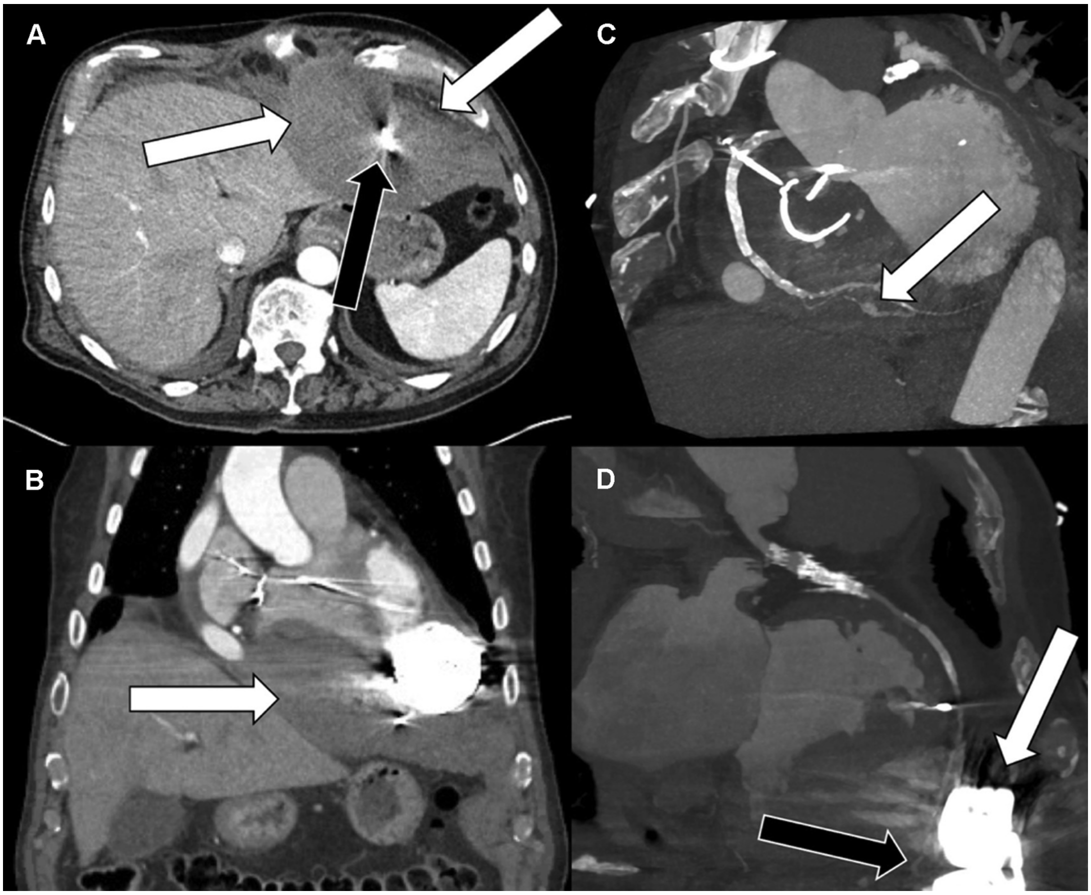
RCA = right coronary artery

FIGURE 1 Chest Radiographs Before and After Lawn Mower Accident



Comparison of upright posteroanterior chest radiographs **(A)** 1 week before and **(B)** after the riding lawn mower accident demonstrating inferolateral displacement of the left ventricular assist device driveline **(arrows)** with cranial shift in inflow cannula orientation.

FIGURE 2 **CT Images of Pericardial Hematoma and Adjacent Coronary Artery Extravasation**



Contrast-enhanced computed tomography (CT) images in **(A)** axial and **(B)** coronal planes showing pericardial hematoma **(white arrows)** surrounding the left ventricular assist device driveline **(black arrow).** **(C)** Maximum intensity projection image of the right coronary artery from the computed tomography angiogram of the heart showing focal area of extravasation arising from the acute marginal branch of the right coronary artery **(white arrow).** **(D)** Maximum intensity projection image of the left anterior descending artery from the computed tomography angiogram of the heart showing questionable area of contrast extravasation from the distal left anterior descending artery **(black arrow),** although visualization is obscured by the adjacent left ventricular assist device **(white arrow).**

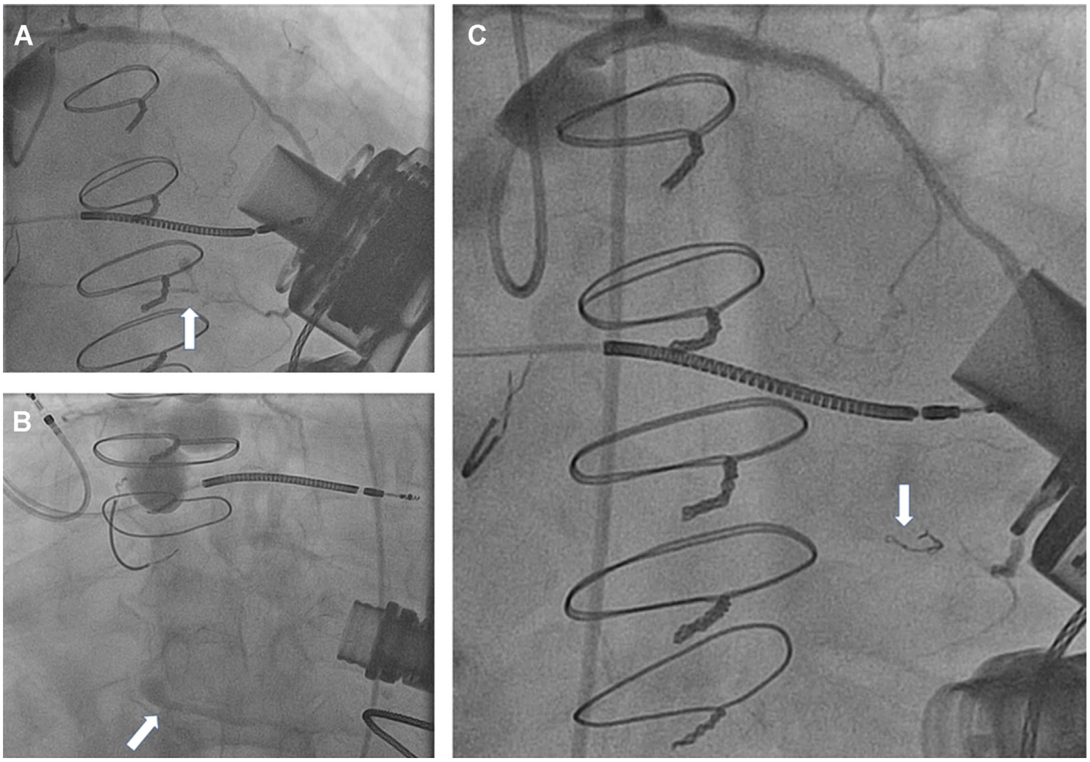
3 days. Thoracic exploration was not pursued in light of his high surgical risk. On hospital day 4, he underwent coronary angiography, which confirmed ongoing contrast extravasation from the LAD, and no immediate extravasation was identified from the RCA. Vascular interventional radiology and interventional cardiology performed coil embolization of the distal LAD at the focus of abnormality (coronary perforation or aneurysm) with successful resolution of contrast extravasation (**Figures 3A to 3C**). Cine videos display the LAD coronary angiography with contrast extravasation (Video 1) and post-coil embolization (Video 2). The patient received empirical intravenous vancomycin for 2 weeks because of the persistent pericardial hematoma.

DISCUSSION

LVADs have improved mortality and quality of life for patients with end-stage heart disease (1,2). LVAD components include an inflow cannula seated at the left ventricular apex, a mechanical pump to circulate blood, an outflow graft attached to the aorta to deliver blood to systemic circulation, a tunneled driveline cable to operate the pump by an external controller, and batteries to power the controller and pump (3).

Previously published work described external trauma resulting in LVAD driveline fracture, hematoma, left ventricular pseudoaneurysm, bleeding from the LVAD outflow graft, kinked inflow cannula,

FIGURE 3 Invasive Coronary Angiography and Left Anterior Descending Artery Coil Embolization



(A and B) Coronary angiography of the left anterior descending artery demonstrating coronary artery perforation or aneurysm **(arrow, A)** with extracardiac contrast extravasation **(arrow, B)**. **(C)** Angiography post-coil embolization demonstrates resolution of contrast extravasation **(arrow)**.

pump displacement, and sewing ring separation (4). Other reports have described LVAD mechanical parts contained within an abdominal hematoma following trauma (5). CT angiography serves as a useful noninvasive tool in the diagnosis of LVAD-related mechanical complications, such as aortic root or LVAD device thrombosis, outflow graft displacement or kinking, inflow cannula malposition, or separation of LVAD components (6,7).

Coronary perforation was previously classified by Ellis et al. (8). Risk factors for coronary perforations most commonly involve percutaneous coronary intervention, with type III perforations associated with worse adverse cardiac events (8-10). This case draws attention to the risk of external trauma involving a durable LVAD that resulted in coronary injury and pericardial hematoma. Following surgical implantation of an LVAD, a patient's pericardium is no longer intact, and adhesions can form on or around the heart structures, including the coronary arteries. We believe the coronary injury occurred as the patient fell to the ground after his bag containing the external controller and batteries entangled with the lawn mower blades, abruptly pulling out the indwelling driveline and displacing the LVAD apparatus within his thorax. The mechanism of coronary injury involved sudden displacement of the LVAD, resulting in extrinsic tearing of the coronary arteries by post-surgical adhesions between the coronary arteries, the LVAD components, and the chest cavity in the absence of an intact pericardium.

FOLLOW-UP

Two months after the accident, the patient denied any further incidents, ICD shocks, angina, or abdominal pain. His hemoglobin returned to a baseline of 14.1 g/dl. Repeat CT angiogram showed intact LVAD inflow cannula and outflow graft, absence of coronary blood extravasation, and reduced pericardial hematoma size.

CONCLUSIONS

Traumatic displacement of the LVAD driveline may result in direct coronary artery injury. Coronary CT angiography serves as a useful tool to interrogate coronary anatomy when traumatic LVAD-related mechanical complications are suspected, although metal artifact may limit diagnostic image quality. Multiplanar reconstructions and attention to driveline location with focused attention on the distal vessels in the area of hematoma can help improve diagnostic yield. Similarly, on invasive angiography, angulation to visualize the coronary arteries and surrounding regions away from overlying support devices can improve diagnostic yield. CT angiography may also investigate LVAD-related mechanical complications that are not always apparent on invasive coronary angiography. Used together, these modalities can be complementary.

ADDRESS FOR CORRESPONDENCE: Dr. Vishal N. Rao, Division of Cardiology, Duke University Hospital, 2301 Erwin Road, DUMC 3845, Durham, North Carolina 27710. E-mail: vishal.rao@duke.edu.

REFERENCES

1. Slaughter MS, Rogers JG, Milano CA, et al. Advanced heart failure treated with continuous-flow left ventricular assist device. N Engl J Med 2009;361:2241-51.

2. Mehra MR, Uriel N, Naka Y, et al. A fully magnetically levitated left ventricular assist device - final report. N Engl J Med 2019;380:1618-27.

3. DeVore AD, Patel PA, Patel CB. Medical management of patients with a left ventricular assist device for the non-left ventricular assist device specialist. J Am Coll Cardiol HF 2017;5:621-31.

4. Sarsam SH, Meyers DE, Civitello AB, et al. Trauma in patients with continuous-flow left ventricular assist devices. Am J Cardiol 2013;112:1520-2.

5. Lee G, Schettle SD, Stulak JM. Floating LVAD hardware in an infected hematoma following a traumatic fall. Heart Lung 2020;49:58-9.

6. Shroff GS, Ocazionez D, Akkanti B, et al. CT imaging of complications associated with continuous-flow left ventricular assist devices (LVADs). Semin Ultrasound CT MR 2017;38:616-28.

7. Raman SV, Sahu A, Merchant AZ, Louis LB, Firstenberg MS, Sun B. Noninvasive assessment of left ventricular assist devices with cardiovascular computed tomography and impact on management. J Heart Lung Transplant 2010;29:79-85.

8. Ellis SG, Ajluni S, Arnold AZ, et al. Increased coronary perforation in the new device era. Incidence, classification, management, and outcome. Circulation 1994;90:2725-30.

9. Shimony A, Zahger D, Van Straten M, et al. Incidence, risk factors, management and outcomes of coronary artery perforation during percutaneous coronary intervention. Am J Cardiol 2009;104:1674-7.

10. Al-Lamee R, Ielasi A, Latib A, et al. Incidence, predictors, management, immediate and long-term outcomes following grade III coronary perforation. J Am Coll Cardiol Intv 2011;4:87-95.

KEY WORDS cardiac assist devices, cardiomyopathy, computed tomography, coronary vessel anomaly, left ventricular assist device, percutaneous coronary intervention

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