

MINI-FOCUS ISSUE: HEART FAILURE

BEGINNER

IMAGING VIGNETTE: CLINICAL VIGNETTE

Left Ventricular Assist Device Outflow Cannula Obstruction



Importance of Multimodality Imaging

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ABSTRACT

One of the dreaded complications of left ventricular assist device implantation is mechanical obstruction of the device secondary to pump thrombosis or mechanical outflow cannula obstruction. We describe a case of outflow cannula obstruction caused by kinking and twisting of the outflow graft after surgical manipulation of the pump. (**Level of Difficulty: Beginner.**) (J Am Coll Cardiol Case Rep 2020;2:1454–6) © 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/>).

Our patient was a 66-year-old man with ischemic cardiomyopathy. He had a HeartMate II (Abbott, Abbott Park, Illinois) left ventricular (LV) assist device (LVAD) implanted in 2013, and he presented with dyspnea on exertion and low-flow, high-power LVAD alarms. He denied chest pain or dizziness. On physical examination, he appeared in no distress, his mean arterial pressure was 76 mm Hg, his heart rate was 80 beats/min, and his oxygen saturation on room air was 97%. No elevated jugular venous pressure or peripheral edema was noted. A 12-lead electrocardiogram showed no acute ischemic changes. His blood work-up was significant for a subtherapeutic international normalized ratio with an elevated lactic acid dehydrogenase level. The differential diagnosis included pump thrombosis, anticoagulation noncompliance, and hemolysis secondary to cannula malpositioning, kinking, or pannus formation on the inflow or outflow cannula. He was started on a bivalirudin infusion. Despite adequate anticoagulation, the lactic acid dehydrogenase levels continued to rise (from 787 U/l on admission to 1,505 U/l). A pre-pump exchange echocardiogram showed normal LV size with severely depressed LV function (LV ejection fraction 5% to 10%), with an inflow cannula velocity of 150 to 200 cm/s and an outflow cannula velocity of 180 to 220 cm/s. Given his prohibitive surgical risk for redo thoracotomy, he underwent pump exchange with a HeartMate II LVAD through a left subcostal incision. The outflow cannula velocity went up to 347 cm/s (peak gradient 48 mm Hg) intraoperatively and post-exchange on transesophageal echocardiogram (**Figure 1A**). Chest computed tomography angiography revealed outflow cannula obstruction secondary to kinking and twisting of the outflow graft (**Figures 1B and 1C**). Given the prohibitive risk for further surgical procedures and the patient's wishes, conservative management was pursued.

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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, including patient consent where appropriate. For more information, visit the *JACC: Case Reports* [author instructions page](#).

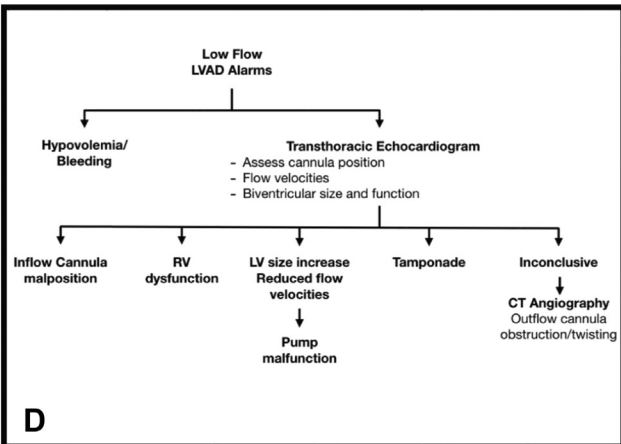
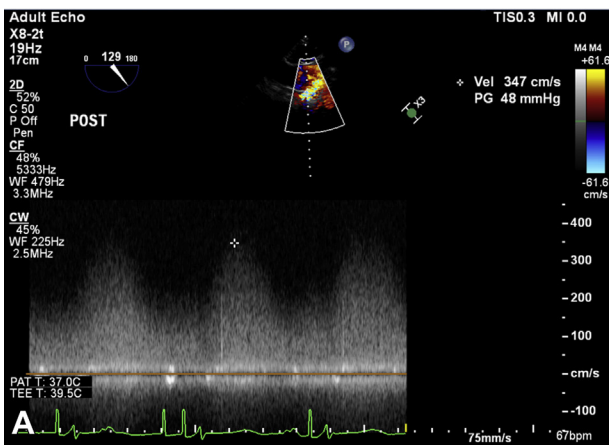
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LVAD outflow obstruction is usually caused by external compression from mediastinal tissue, twisting or kinking of the outflow graft, or accumulation of gelatinous protein matrix or biodebris (1,2). The outflow graft may be subject to twisting and kinking, resulting in decreased flow and hemodynamic instability, especially during surgical manipulation, as noted in our case. Multimodality imaging should be considered, including chest radiography and echocardiogram to assess biventricular function and size and cannula flow velocities, and, if results are equivocal, computed tomography angiography to delineate possible mechanical complications of LVAD (Figure 1D) (3). In our case, pathological examination of the explanted pump revealed fragments of thrombus on the inflow stator region, indicating that our patient had both pump thrombosis and outflow cannula obstruction as causes of the low-flow, high-power alarms. Extra attention during cardiac surgical interventions is needed to avoid outflow cannula mechanical obstruction.

**ABBREVIATIONS
 AND ACRONYMS**

LV = left ventricular
LVAD = left ventricular assist device

FIGURE 1 LVAD Outflow Cannula Obstruction



(A) Transesophageal (TEE) echocardiogram with continuous wave (CW) Doppler imaging demonstrating a high gradient across the outflow cannula, **(B)** computed tomography (CT) angiography, and **(C)** 3-dimensional rendering images showing left ventricular assist device (LVAD) outflow graft narrowing (arrows) consistent with kinking and twisting of the graft proximal to the anastomosis site at the ascending aorta. **(D)** Algorithmic approach to low-flow LVAD alarms. LV = left ventricular; RV = right ventricular.

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REFERENCES

1. Barac YD, Nevo A, Schroder JN, Milano CA, Daneshmand MA. LVAD outflow graft role in pump thrombosis. *ASAIO J* 2017;63:14-23.
2. Trankle CR, Grizzard JD, Shah KB, et al. Left ventricular assist device outflow graft compression: incidence, clinical associations and potential etiologies. *J Card Fail* 2019;25:545-52.
3. Estep JD, Stainback RF, Little SH, Torre G, Zoghbi WA. The role of echocardiography and other imaging modalities in patients with left ventricular assist devices. *J Am Coll Cardiol Img* 2010;3:1049-64.

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