

 **IMAGING VIGNETTE**

MDCT Assessment of Mechanical Circulatory Support Device Complications



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THE RISING NUMBER OF PATIENTS WITH ADVANCED HEART FAILURE WHO RECEIVE DURABLE MECHANICAL CIRCULATORY SUPPORT (MCS) DEVICES requires improved recognition of device complications (1). Imaging is invariably needed because the clinical presentation is nonspecific. In our institution, we perform both a baseline echocardiographic study and a pump speed optimization test when left ventricular assist device (LVAD) dysfunction is suspected (2). Additionally, we obtain a contrast electrocardiogram (ECG)-gated multidetector cardiac computed tomography (MDCT) study to screen for complications in patients without significant impaired kidney function. With fast acquisition, superior spatial resolution, and superior image quality, ECG-gated MDCT could directly visualize the entire MCS systems (except for the pump interior) and



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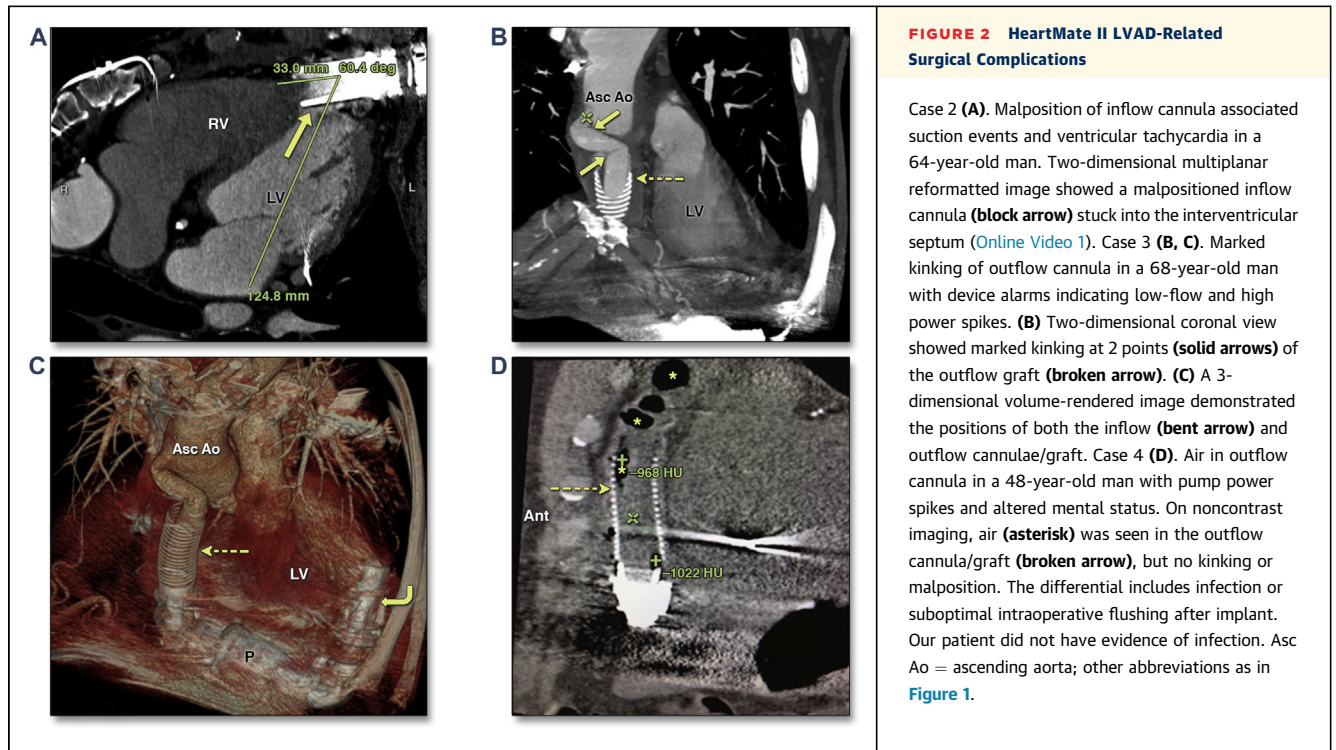


FIGURE 2 HeartMate II LVAD-Related Surgical Complications

Case 2 (A). Malposition of inflow cannula associated suction events and ventricular tachycardia in a 64-year-old man. Two-dimensional multiplanar reformatted image showed a malpositioned inflow cannula (**block arrow**) stuck into the interventricular septum ([Online Video 1](#)). Case 3 (B, C). Marked kinking of outflow cannula in a 68-year-old man with device alarms indicating low-flow and high power spikes. (B) Two-dimensional coronal view showed marked kinking at 2 points (**solid arrows**) of the outflow graft (**broken arrow**) of the inflow (bent arrow) and outflow cannulae/graft. Case 4 (D). Air in outflow cannula in a 48-year-old man with pump power spikes and altered mental status. On noncontrast imaging, air (**asterisk**) was seen in the outflow cannula/graft (**broken arrow**), but no kinking or malposition. The differential includes infection or suboptimal intraoperative flushing after implant. Our patient did not have evidence of infection. Asc Ao = ascending aorta; other abbreviations as in [Figure 1](#).

surrounding anatomy from multiple views ([Figure 1](#)), albeit with some radiation/contrast exposure. This *iPIX* illustrates the utility of MDCT in diagnosing a spectrum of post-implant complications, including cannula complications ([Figure 2](#), [Online Video 1](#)), pump and aortic root thrombosis ([Figure 3](#) and [4](#)), and surgical emergencies, among patients supported with LVAD, biventricular assist device, and total artificial heart ([Figure 5](#), [Online Videos 2](#) and [3](#)).

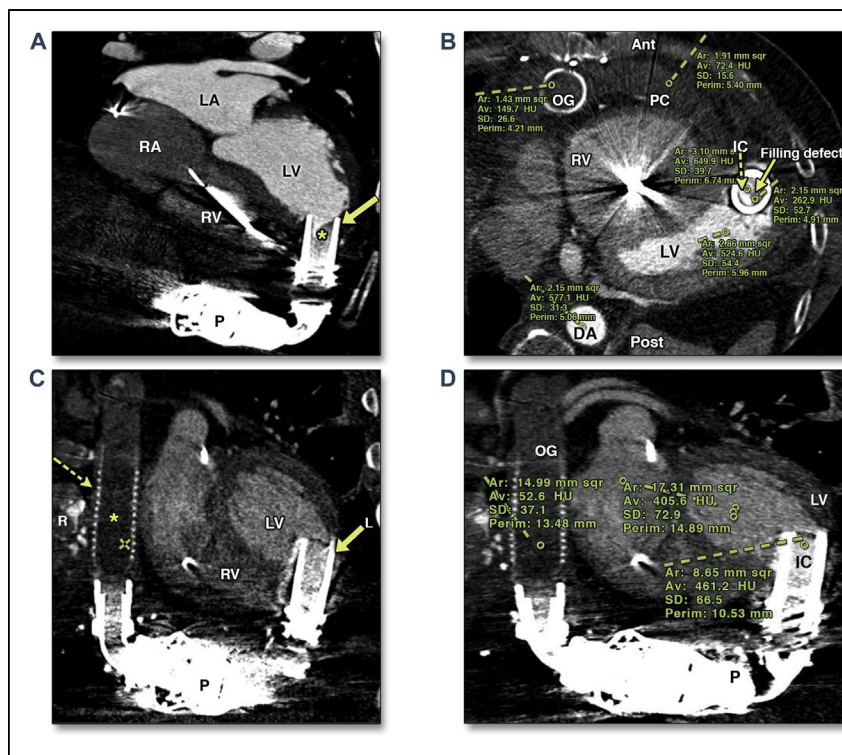


FIGURE 3 HeartMate II LVAD Thrombosis

Case 5 (A and B). Thrombus of inflow cannula (IC) in a 57-year-old man with power spike alarms 1 week post-implantation. Multiplanar reformatted (A) and axial (B) views showed a large filling defect (**asterisk**) in the external half of the IC (**block arrow**) that is due to stasis/slow-flow or thrombus as suggested by the much lower computed tomography (CT) attenuating number compared with the internal half of the cannulae and LV/DA (B). Successful device exchange confirmed presence of thrombus. Case 6 (C and D). Thrombus in LVAD outflow cannula/graft in a 58-year-old man with device alarms and clinical hemolysis. (C) Coronal oblique view revealed absence of contrast (**asterisk**) within the outflow cannula/graft (**broken arrow**). (D) Very low CT attenuating number is suggestive of thrombus. **Block arrow** (C) indicates IC with sub-optimal contrast enhancement similar to LV (D) is likely due to low-flow state. Successful device exchange confirms presence of thrombus with sparing of the IC. DA = descending aorta; OG = outflow graft; PC = pericardium; other abbreviations as in [Figure 1](#).

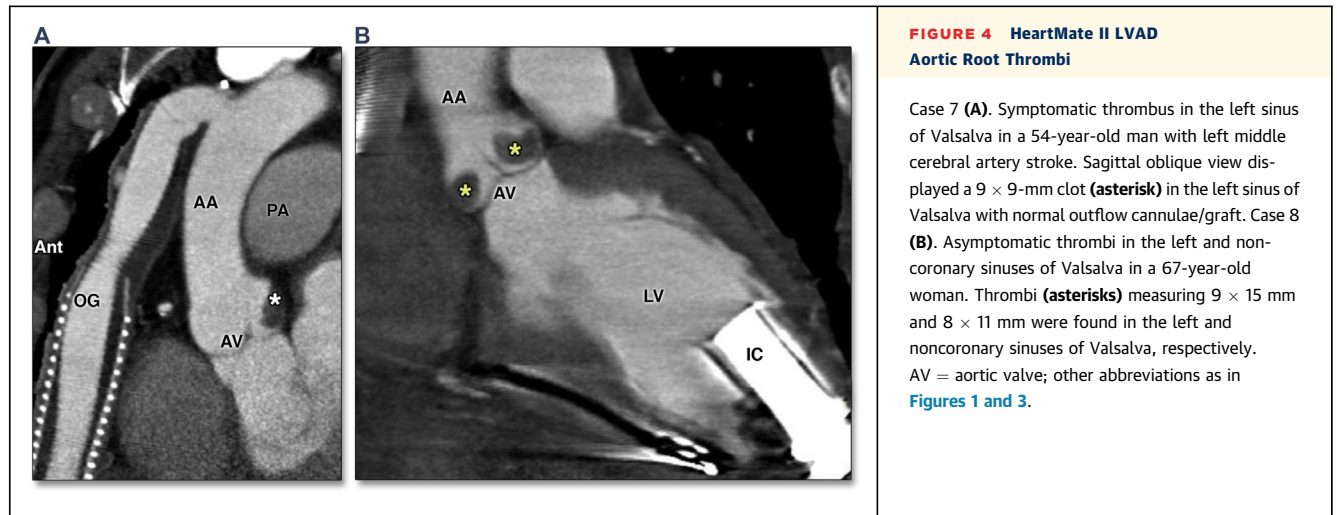


FIGURE 4 HeartMate II LVAD Aortic Root Thrombi

Case 7 (A). Symptomatic thrombus in the left sinus of Valsalva in a 54-year-old man with left middle cerebral artery stroke. Sagittal oblique view displayed a 9 × 9-mm clot (asterisk) in the left sinus of Valsalva with normal outflow cannulae/graft. Case 8 (B). Asymptomatic thrombi in the left and non-coronary sinuses of Valsalva in a 67-year-old woman. Thrombi (asterisks) measuring 9 × 15 mm and 8 × 11 mm were found in the left and noncoronary sinuses of Valsalva, respectively. AV = aortic valve; other abbreviations as in Figures 1 and 3.

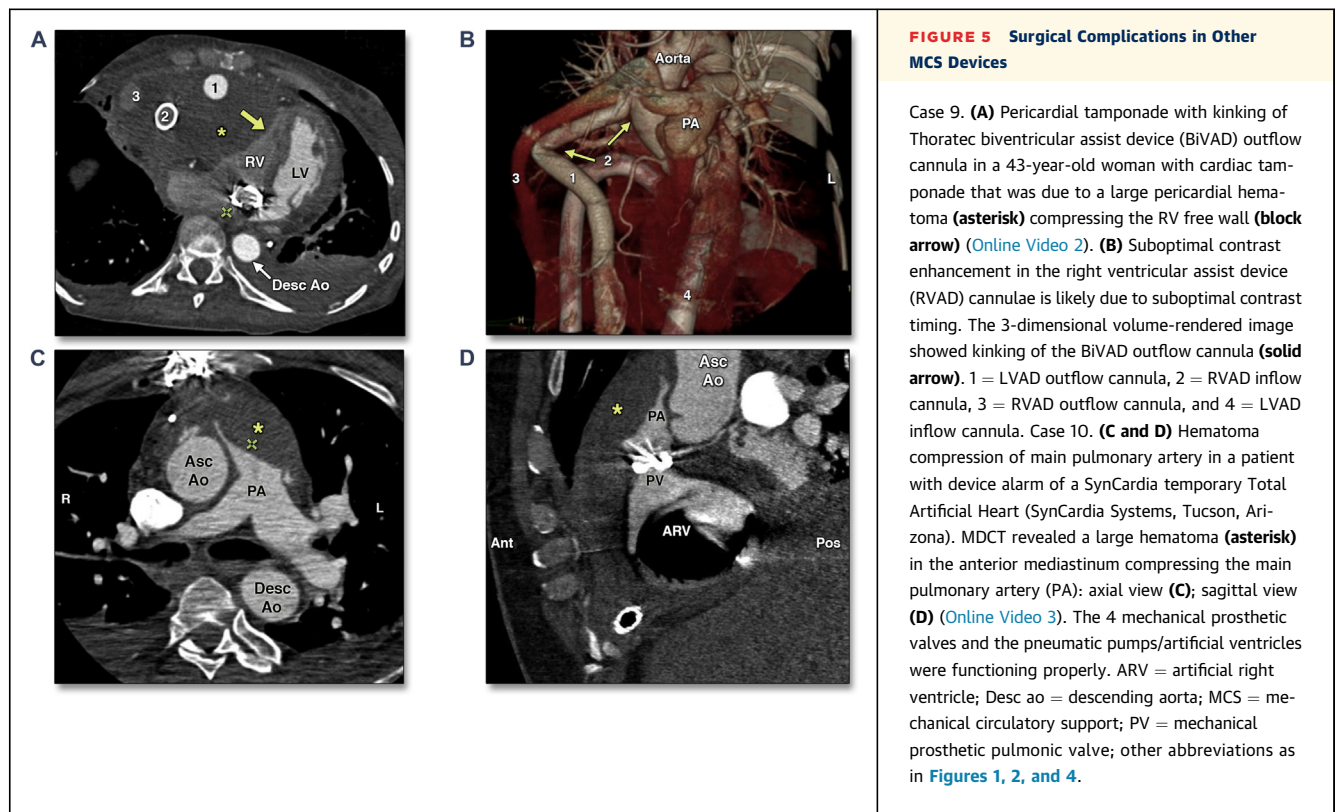


FIGURE 5 Surgical Complications in Other MCS Devices

Case 9. (A) Pericardial tamponade with kinking of Thoratec biventricular assist device (BIVAD) outflow cannula in a 43-year-old woman with cardiac tamponade that was due to a large pericardial hematoma (asterisk) compressing the RV free wall (block arrow) (Online Video 2). (B) Suboptimal contrast enhancement in the right ventricular assist device (RVAD) cannulae is likely due to suboptimal contrast timing. The 3-dimensional volume-rendered image showed kinking of the BIVAD outflow cannula (solid arrow). 1 = LVAD outflow cannula, 2 = RVAD inflow cannula, 3 = RVAD outflow cannula, and 4 = LVAD inflow cannula. Case 10. (C and D) Hematoma compression of main pulmonary artery in a patient with device alarm of a SynCardia temporary Total Artificial Heart (SynCardia Systems, Tucson, Arizona). MDCT revealed a large hematoma (asterisk) in the anterior mediastinum compressing the main pulmonary artery (PA): axial view (C); sagittal view (D) (Online Video 3). The 4 mechanical prosthetic valves and the pneumatic pumps/artificial ventricles were functioning properly. ARV = artificial right ventricle; Desc ao = descending aorta; MCS = mechanical circulatory support; PV = mechanical prosthetic pulmonic valve; other abbreviations as in Figures 1, 2, and 4.

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REFERENCES

1. Kirklin JK, Naftel DC, Kormos RL, et al. Fifth INTERMACS annual report: risk factor analysis from more than 6,000 mechanical circulatory support patients. *J Heart Lung Transplant* 2013;32:141-56.
2. 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.

KEY WORDS LVAD (left ventricular assist device), MDCT (multidetector cardiac computed tomography)

APPENDIX For supplemental videos and their legends, please see the online version of this article.