Utilization of Cardiac Computed Tomography Angiography for the Diagnosis of Left Ventricular Assist Device Thrombosis

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The use of left ventricular assist devices (LVADs) in the management of advanced heart failure has grown substantially in recent years, with implantation of these devices increasing 10-fold since the approval of a continuous-flow device for destination therapy in January 2010. With the significant increase in use of this technology comes the potential for an increased incidence of complications associated with these devices. One such complication that can be fatal if not urgently recognized is device thrombosis, which has been reported to occur in approximately 1% of patients receiving the HeartMate II LVAD. Cardiologists, radiologists, and other health care professionals must become increasingly more adept at diagnosing this complication to allow rapid institution of appropriate therapy. We report a case of a patient presenting with LVAD thrombosis diagnosed with cardiac computed tomography angiography (CTA).

Patient Presentation
A 45-year-old white man with a history of a nonischemic cardiomyopathy presented with refractory cardiogenic shock requiring implantation of a continuous-flow LVAD because the patient’s body mass index precluded cardiac transplantation. Two months after implant, the patient presented with “low flow” alarms and hemolysis (elevated lactate dehydrogenase and undetectable haptoglobin) despite therapeutic anticoagulation. An echocardiogram showed the aortic valve opening with every cardiac cycle and low flow velocity through the inflow cannula, suggesting inadequate unloading of the left ventricle. A CTA of the chest was obtained by means of helical scanning with 2-mm-thickness retracted images during the arterial phase of intravenous contrast administration. Additional delayed images were also obtained. The CTA demonstrated complete thrombosis of the outflow graft with contrast being ejected directly from the left ventricle into the aorta (Figures 1 and 2). Contrast is subsequently seen refluxing into the totally occluded outflow graft (Figure 3). The patient exhibited adequate native cardiac function as assessed by invasive hemodynamic monitoring with a cardiac index of 3.6 L/min per m² and normal filling pressures. Because of massive thrombosis and an overheating system controller, the pump was disconnected from its power source to prevent thromboembolic events. Explantation of the LVAD was not performed to avoid precipitating hemodynamic instability. The patient remains stable in the outpatient setting, with contingency plans for orthotopic heart transplantation if required.

Discussion
This case illustrates the use of cardiac CTA for diagnosis of LVAD thrombosis. No standard algorithm exists for the timely and accurate diagnosis of this clinical entity. Other potentially useful diagnostic modalities have been previously described, including the use of blood and urine tests to evaluate for evidence of hemolysis, echocardiography, and analysis of device data (ie, flow, power, and speed rates). To our knowledge, the successful diagnosis of LVAD thrombosis using cardiac CTA has not been well described. Although cardiac CTA has been used to identify cannula malposition, only 1 prior case series documented outflow graft thrombosis with the use of cardiac CTA. Further research and consideration are needed to determine the optimal algorithm to diagnose this potentially life-threatening LVAD complication.

Disclosures
Dr Drazner participated in a clinical registry (ESP) for Thoratec Corporation; Dr Markham received grant support from Thoratec Corporation.

References
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**Figure 1.** Complete thrombosis of the outflow graft.
Figure 2. Axial image of contrast being ejected into the aorta directly from the left ventricle.

Figure 3. Contrast refluxing into the occluded outflow graft.
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