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Letter

Complete Pump Stop as the Presentation of Left Ventricular Recovery in a Patient With Left Ventricular Assist Device

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BACKGROUND

Left ventricular assist devices (LVAD) have become the standard of care in patients with end-stage heart failure with reduced ejection fraction. Low flow alarms and complete pump stoppage as a sign of myocardial function recovery leading to device explant have rarely been reported in the literature. We present a patient on LVAD support who showed left ventricle function improvement and a subsequent device explant.

LVADs are designed to alert patients about complications through an alarm system. Low flow alarms can occur for different reasons, such as hypovolemia, tamponade, right ventricular failure, uncontrolled hypertension, unstable cardiac rhythms, inflow cannula malposition, and inlet or outflow cannula obstruction.[1] From our knowledge, the presence of low flow alarms as a sign of myocardial recovery in patients with HeartMate 3™ (HM3) (Abbott, Chicago, IL, USA) has rarely been reported in the literature. Here we describe a case of a patient with HM3 as destination therapy who was asymptomatic with complete pump stop (no flow through the pump) as a sign of myocardial recovery confirmed by echocardiography, which led to LVAD explantation with no further consequences.

CASE

A 35-year-old African American male presented to the emergency department after experiencing frequent low-flow alarms for 4 hours. In the initial assessment, the patient was hemodynamically stable with a normal physical exam, and the intrinsic pulsatility of the HM3 was heard through auscultation. The patient had a history of heart failure with reduced ejection fraction (HFrEF) for 4 years secondary to nonischemic cardiomyopathy. At the time of the LVAD implant, the patient did not want a heart transplant. He was initially implanted with a HeartMate 2™ (HM2; Abbott), which was exchanged for a HM3 after 15 months of support for a pump thrombus that occurred two months prior to this current admission (**Figure 1**). It is unclear what is the exact cause of the pump thrombus. Patient was on aspirin 81 mg po daily and warfarin to maintain the international normalized ratio of 1.9–2.3. However, in the continuous-flow axial second generation pumps such as the HM2, thrombosis and hemolysis

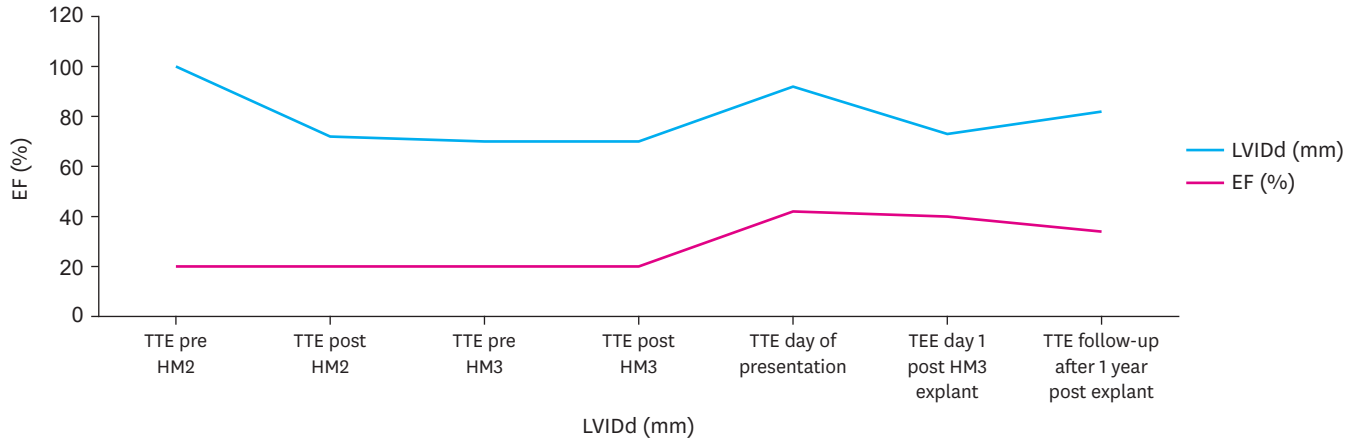

Figure 1. LVEF and LVIDd size.
LVEF = left ventricular ejection fraction; LVIDd = left ventricular internal dimension at the end of diastole; EF = ejection fraction; TTE = transthoracic echocardiogram; HM2 = Heart Mate 2™; HM3 = Heart Mate 3™; TEE = transesophageal echocardiogram.

occur more often due to the direct contact of blood and bearings and the narrow shafts which produces high shear on the blood.[2]

Laboratory hemoglobin: 10.5 g/dL; lactate dehydrogenase: 306 U/L, suggesting no thrombosis. The results of his chest X-ray and electrocardiogram were unremarkable compared to the baseline. A bedside transthoracic echocardiogram (TTE) showed a left ventricular ejection fraction (LVEF) of 42%, a left ventricular internal dimension at the end of diastole (LVIDd) of 4.8 cm, a tricuspid annular plane systolic excursion of 13 mm, S′ wave which is the tissue Doppler velocity of the tricuspid valve was 8.4 cm/s, and the aortic valve opening with every heart beats. No flow was noted through the inflow cannula, and the outflow cannula showed bi-directional flow with decreased velocities, but no thrombosis was noted. Left ventricular assist device interrogation demonstrated a pump flow of 0.0 liters per minute, a pump speed of 5,000 revolutions per minute (rpm), a low speed limit of 4,700 rpm, a pulse index of 3.0, and a pump power of 2.9 watts. Previous TTE done 2 months before (after HM3 implantation) showed a LVEF of 23% and LVIDd of 4.7 cm. A computed tomography angiography of the chest, abdomen, and pelvis was performed prior to LVAD explantation, which showed patent conduit and no evidence of thrombus formation or any organized enhancement or collection reflecting abscess formation (**Figure 2A and B**). It was decided to take the patient to the operating room, where the HM3 was explanted. Preoperatively, transesophageal echocardiogram (TEE) clearly demonstrated improved wall motion in all territories except the apex. This improved wall motion created a dynamic obstruction of the inflow cannula. On day 1 of HM3 explantation, the TEE showed a LVEF of 45% with a LVIDd of 3.3 cm. A decision was made not to implant a new device due to an improvement in LVEF and the evidence of left ventricular recovery.

The patient continued to stay stable and was discharged on guideline-directed medical therapy (GDMT). The patient was followed in the clinic 2 weeks after discharge and was tolerating GDMT. The patient denied having heart failure symptoms. In his follow-up visit after 1 year, the patient reported no congestive symptoms, and TTE showed LVEF of 34% and LVIDd of 5.3 cm. The patient has not had any hospital admissions due to heart failure decompensation and continues to be compliant with GDMT. Subsequently, a multigated acquisition showed an LVEF of 48%, and the patient has remained asymptomatic to date.

DISCUSSION

Ventricular assist devices are designed to alert patients when complications develop. Low-flow alarms may signify LVAD-specific complications (cannula or outflow graft blockage, suction events, or any pump complication such as failure, stoppage, and driveline damage) or LVAD-related complications (hypovolemia, arrhythmias, right ventricular failure, and uncontrolled hypertension).[3,4] The initial approach for low flow alarms is to first assess the clinical stability. If the patient is clinically unstable, a low-flow alarm should mean LVAD malfunction until proven otherwise. An echocardiogram and electrocardiogram are part of the first assessment to evaluate inadequate pre-load (inferior vena cava collapse), arrhythmias, or right heart failure. The investigations reported in our case excluded major causes of low-flow alarms. However, the echocardiogram parameters pointed to an improvement in the ejection fraction that correlated with the clinical findings and led to the final decision of LVAD explantation. Further research is indicated to identify factors that predispose individuals to cardiac recovery.

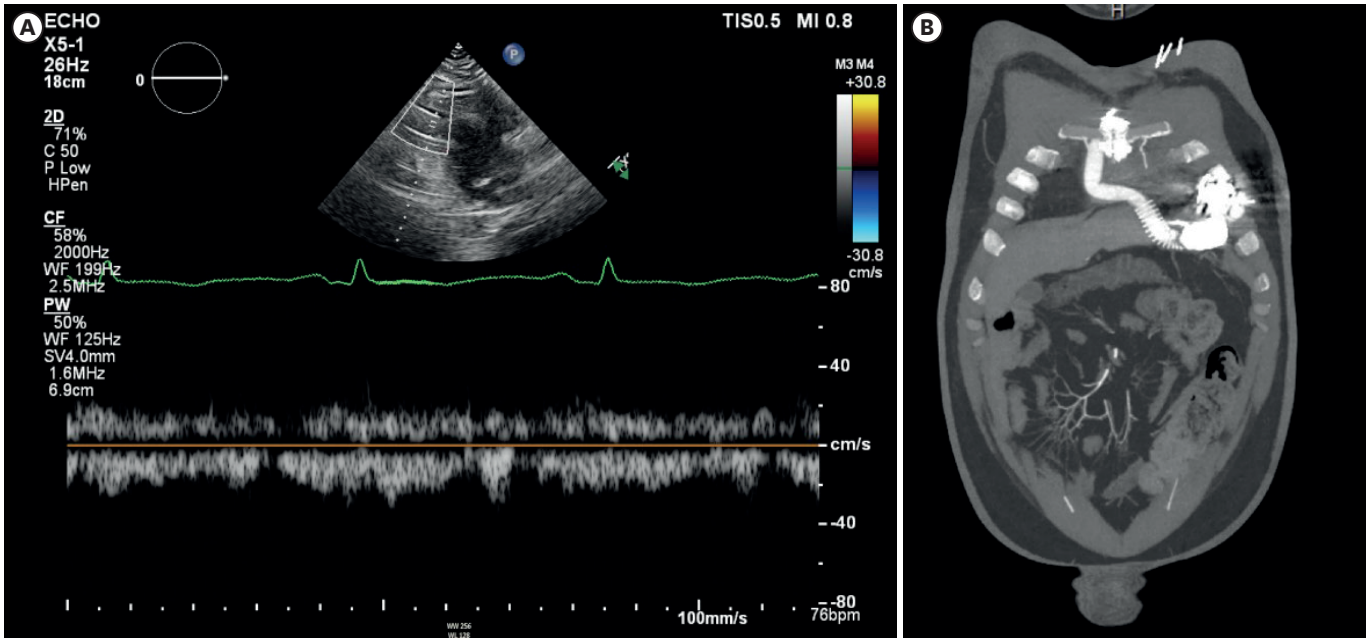

Figure 2. Echocardiographic and CT characterization of pump stop event with no thrombosis. (A) Doppler through outflow graft at pump stop. (B) CT with contrast showing no thrombus at pump stop.
CT = computed tomography.

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Conflict of Interest
The authors have no financial conflicts of interest.

Author Contributions
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