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Hemodynamic and Echocardiographic Assessment of Left Ventricle Recovery with Left Ventricular Assist Devices: Do We Explant?

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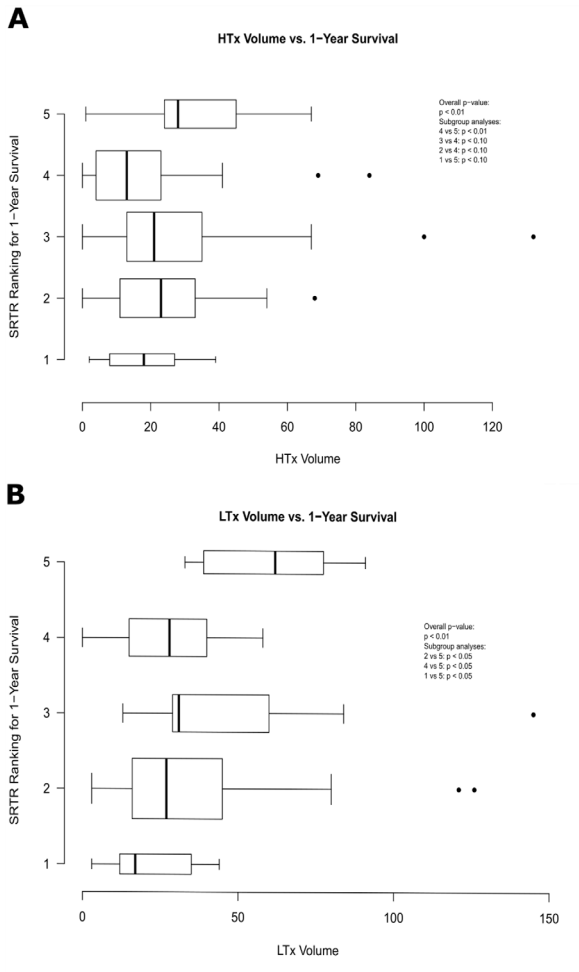
Introduction: Careful patient selection for left ventricular assist device (LVAD) explant after myocardial recovery involves echocardiographic and invasive hemodynamic assessment at safest minimal speed at rest and with exercise, indirect measures of cardiac function. Pressure-volume loop (PVL) analysis may supplement this process by directly assessing ventricular function.
Case Report: A 41 year old male underwent HeartMate3 LVAD placement 2.5 years prior for dilated cardiomyopathy. Post-LVAD, significant reverse remodeling on maximally tolerated guideline directed medical therapy (GDMT) was seen: left ventricular end diastolic diameter (LVEDD) was 4.2 cm (6.1cm pre-LVAD); ejection fraction (EF) was 40-45%. He was referred for exercise right heart catheterization for possible explant after developing incessant low flow LVAD alarms despite speed and medication adjustments. As part of an IRB-approved research protocol, PVLs of the resting right ventricle (RV) were obtained at multiple LVAD speeds. Clinical data were equivocal: chambers did not dilate, but rest cardiac index (CI) fell from 2.3 to 1.9 L/min/m^2 at a minimal speed of 4000 rpm. Filling pressures rose as speed decreased and increased to pathologic levels during exercise, which was reduced versus age- and sex-matched controls. Explant was not pursued given results and transplant was more aggressively pursued. Subsequent analysis of RV PVLs supported this decision (**Figure 1**). RV-pulmonary artery (PA) relationship was preserved at initial speed of 5100 rpm. With speed decrease, summed afterload rose as a function of increased filling pressures, but Ees failed to augment. As a result, ventriculo-vascular coupling was lost. RV volumes increased as well, detected via PVL only and not by echo. Based on these results, poor RV contractile reserve may have contributed to predicted failure to thrive post LVAD explant.
Summary: PVL analysis may provide additional information to help assess ventricular reserve in LVAD patients being considered for explantation.



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Flow Pattern of Artificial Pulse in Outflow Graft of the HeartMate 3 Left Ventricular Assist Device

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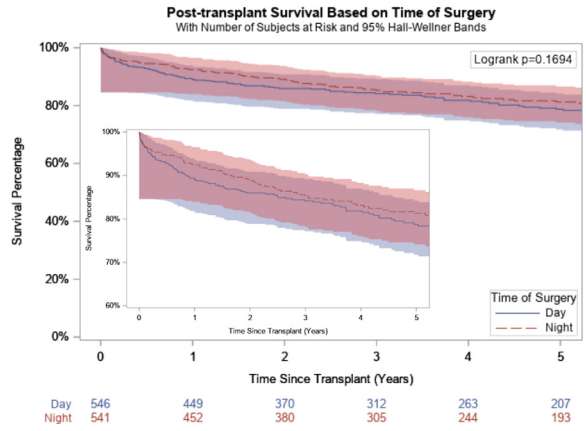
Introduction: The HeartMate 3 (HM3) is a widely used mechanical circulatory support device designed for patients with advanced left ventricular failure. A feature of the HM3, called artificial pulse, which changes the fixed speed of the rotor 30 times/min in cyclical fashion promotes pump washout and partially restores arterial pulsatility. Despite its increased utilization, little is known about the flow pattern of this artificial pulse in the outflow graft of the HM3. In what follows, we show the spectral Doppler profile of the outflow graft in a patient with a HM3.
Case Report: A 40-year-old male with a history of non-ischemic cardiomyopathy and stage D heart failure was admitted for cardiogenic shock. The patient underwent HM3 implantation for bridge-to-decision therapy. Transesophageal echocardiogram demonstrated a ventricular assist device (VAD) cannula in the appropriate position at a LVAD speed of 5,000 revolutions per minute. The spectral Doppler analysis revealed a periodic cyclic reduction in peak velocity followed by an increase in peak velocity (Figure). This echocardiographic finding suggests that the artificial pulse system was functioning properly and that the outflow graft was patent.
Summary: This is the first case report showing the flow pattern of artificial pulse in outflow graft of the HM3. In patients where the outflow graft can be visualized and interrogated, analysis of the flow pattern can assist in assessing the function of the HM3.



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Hemodynamic and Echocardiographic Assessment of Left Ventricle Recovery with Left Ventricular Assist Devices: Do We Explant?

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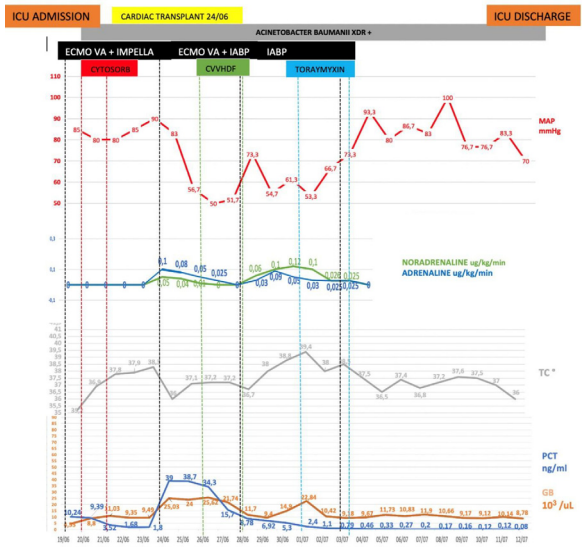
Introduction: Explantation of left ventricular assist devices (LVAD) after left ventricular (LV) recovery is estimated to occur in 1-2% of cases. Herein, we present a case of hemodynamic and echocardiographic assessment of LV recovery during outflow graft balloon occlusion leading to LVAD explantation.
Case Report: A 56-year-old female with medical history of systolic heart failure due to non-ischemic cardiomyopathy with LVEF 25%. She underwent an urgent HeartMate 3 LVAD implant after an admission for cardiogenic shock. Post LVAD course was complicated by driveline infection. History was notable for admissions due to low-flow alarms in the setting of dehydration. On echocardiogram, progressive LVEF improvement was noted although with suboptimal images. CT angiography did not demonstrate any occlusion of the cannulas. Right heart catheterization showed

stable cardiac index despite minimal flow on LVAD. Cardiopulmonary testing was favorable. After multi-disciplinary discussion, patient underwent LVAD wean study in the cath lab under hemodynamic and transesophageal echo (TEE) guidance with therapeutic anticoagulation. LVAD was turned off for 10 minutes with outflow graft occluded by Armada 14 mm x 20 cm peripheral balloon. Wiring of the outflow graft from aorta and balloon occlusion were visualized by TEE (Figure). The left and right ventricular function were similar to baseline with no change in mitral regurgitation. Cardiac index was normal (Figure). Patient subsequently underwent successful LVAD explant. She is doing well with NYHA class I symptoms and LVEF 45-50% noted upon 3-months follow-up

Summary: LVAD explantation is a feasible option in LV recovery after appropriate hemodynamic and echocardiographic assessment. TEE is an essential tool, especially in patients with suboptimal windows. Outflow graft balloon occlusion can be used if there is concern about falsely poor results related to backflow or ongoing LVAD support at low speed leading to falsely improved results



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Successful HeartMate 3 Decommissioning Following Myocardial Recovery from Chronic Heart Failure

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Introduction: HeartMate 3 (HM3) removal has been reported in <5 cases but to our knowledge decommissioning of this pump has not previously been reported. Here we report the first successful case of HM3 decommissioning after successful myocardial recovery on the HM3 left ventricular assist device (LVAD).

Case Report: A 24-year-old female underwent HM3 implantation in October 2019 for idiopathic cardiomyopathy resulting in chronic heart failure (EF 10-15%, LVEDD 6.3cm, PCWP 25mmHg, cardiac index 1.3L/min/m^2 requiring milrinone). She received our recovery protocol after HM3 implantation (aggressive heart failure medications maximized LVAD unloading and testing of underlying myocardial function) and her LV dimensions reduced and her ejection fraction (LVEF) gradually improved. On low speed echo testing her LVEDD was 3.8cm, LVESD 3.0 cm and EF 55% and so after 632 days of support the decision was made to proceed with HM3 decommissioning. In July 2021 the patient underwent HM3 decommissioning. Through minimally invasive surgery the outflow tract was stapled, the pump turned off, and the distal part of the driveline excised, with no hemodynamic compromised. After a post-operative hospital stay of 24 days she was discharged home with no need for surgical re-intervention. The patient has been followed at the clinic and is now > 3 months post decommissioning with no complications. She is asymptomatic, physically active, back at work full time and swims regularly without complaints. Her kidney and liver function are back to baseline, with most recent serum creatinine <1mg/dL, and normal liver function test. She is tolerating increment doses of pharmacological guideline directed medical therapy. Her more recent LVEDD is 50mm, LVESD 36mm and LVEF is 45%. Anticoagulation has been with warfarin (INR maintained 2-3). To date she has had no arrhythmias or thromboembolic complications.

Summary: We present the first reported case of HM3 decommissioning and to date the patient reports higher quality of life after decommissioning. This suggests minimally invasive surgical decommissioning of the HM3 is feasible after myocardial recovery.

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Cardiogenic Shock Following Successful CTO Revascularization

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Introduction: The role of urgent mechanical circulatory support (MCS) in chronic total occlusion (CTO) percutaneous coronary intervention (PCI) is not well studied. This case highlights myocardial recovery in a patient with ventricular fibrillation following a CTO PCI supported with MCS.

Case Report: A 45 year-old man with recent non-ST elevation myocardial infarction, found to have triple vessel coronary artery disease treated with drug-eluting stent to LAD and OM1, due to patient preference, presents for an elective revascularization of CTO of RCA. Left ventricular function at time of discharge from his prior hospitalization was preserved.

Revascularization of CTO was accomplished with placement of Resolute Onyx 3.5x38 mm stent and Resolute Onyx 3.0x26 mm stent to the mid RCA and a Resolute Onyx 3.0x22 mm stent to the distal RCA. There were no complications, and the patient was transferred to a telemetry floor. Soon after transfer he suffered cardiac arrest with ventricular fibrillation. He was defibrillated with return of spontaneous circulation however remained hemodynamically tenuous. Bedside echocardiogram demonstrated severe biventricular dysfunction. Coronary angiography showed stable anatomy with patent stents. Given declining hemodynamic status an Impella CP was placed emergently via the left femoral artery. He was transferred to the cardiac critical care unit where he subsequently developed monomorphic ventricular tachycardia with further hemodynamic deterioration. He was cannulated for VA ECMO and hemodynamic stability was achieved. Due to ongoing hemolysis, Impella CP was exchanged for an axillary Impella 5.5.

As results of medical management and aggressive supportive care, subsequent echocardiograms demonstrated recovery of left and right ventricular function. He was decannulated from VA ECMO and Impella 5.5 after four days. Outpatient transthoracic echocardiogram performed four weeks later demonstrate preserved biventricular function. LV ejection fraction was measured at 55% and global longitudinal strain -16.7%. RV longitudinal strain -21.4%. He is tolerating guideline-directed medical therapy for heart failure.

Summary: This case describes ventricular fibrillation following CTO revascularization and highlights the positive outcomes associated with early recognition of deteriorating cardiogenic shock and rapid escalation of mechanical circulatory support.

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Assessing Cardiac Recovery for Decommissioning of LVAD Support: Structure versus Function

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Introduction: Recovery of left ventricular (LV) function during LVAD support occurs in only 1-3% of patients. Assessment for recovery and LVAD removal is desirable given the risks of infection, stroke, and device malfunction. This case of a patient with an LVAD, with recovered LV