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Peer-Reviewed Case Report

The Utility of Perioperative Transesophageal Echocardiography after Left Ventricular Assist Device Implant: A Case Report

Andrew Parks[1*], Bennet George[2], Alexis Shafii[2], Mikel Smith[2], and Maya Guglin[2]

[1] Department of Internal Medicine
[2] Gill Heart Institute
University of Kentucky, Lexington, KY

* Corresponding author: *abpark3@uky.edu*

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Abstract

Immediate post-operative evaluation of patients who have received a left ventricular assist device (LVAD) can be a daunting task. We present a case of a 51-year-old female who developed ventricular tachycardia soon after returning from the operating theater and describe the role transesophageal echocardiogram played in helping prompt urgent and definitive treatment.

Keywords: Transesophageal Echocardiography, Left Ventricular Assist Device, Mechanical Circulatory Support

Introduction

Left ventricular assist device (LVAD) implantation is increasingly used to mechanically support patients with end-stage heart failure. Though the long-term complications and management of patients post-LVAD implant have been thoroughly described, device-related complications can arise even hours after implantation. As such, any abnormality with LVAD pump flows in the perioperative period warrants urgent evaluation and prompt management for definitive treatment. We present a case of a patient with immediate post-operative LVAD flow issues evaluated promptly with transesophageal echocardiogram (TEE).

Case Report

A 51-year-old female with end-stage, nonischemic, dilated cardiomyopathy presented to our institution for consideration of advanced heart failure therapies. She was managed for her chronic systolic heart failure since 2007 with symptoms progressing to NYHA Class IV. Her ejection fraction was less than 20% with a left ventricular end-diastolic dimension of 6.5 cm. Despite optimal medical therapy including cardiac resynchronization therapy, the patient became inotrope dependent, developing worsening symptoms. She ultimately received mechanical circulatory support with a HeartMate II® LVAD (Thoratec Corporation, Pleasanton, CA). While in the operating theatre, a TEE was performed indicating the inflow cannula was well positioned in the left ventricular apex with no obstruction to flow (Figure 1). The interventricular septum appeared in a proper position, no pericardial effusion was appreciated, and the right ventricle was grossly normal in size and function. Upon transition from cardiopulmonary bypass to her LVAD, flows of 5 L/min were achieved at a pump speed of 8400 revolutions per minute (rpm).

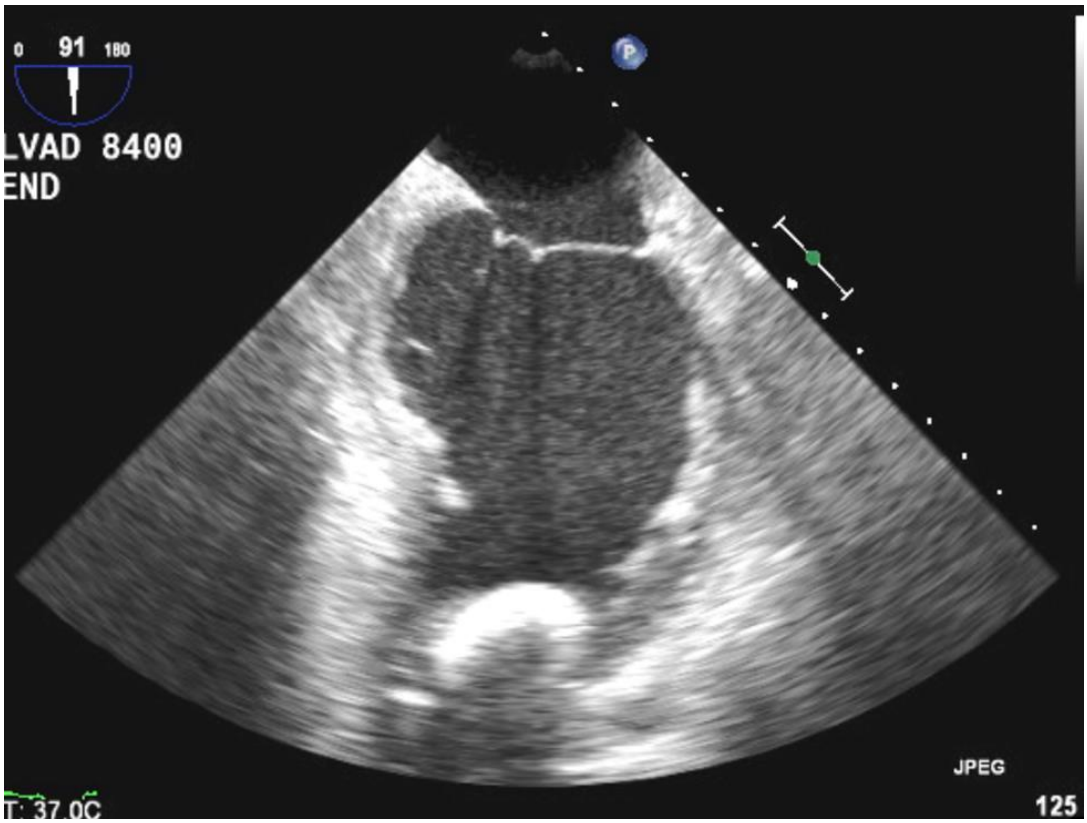
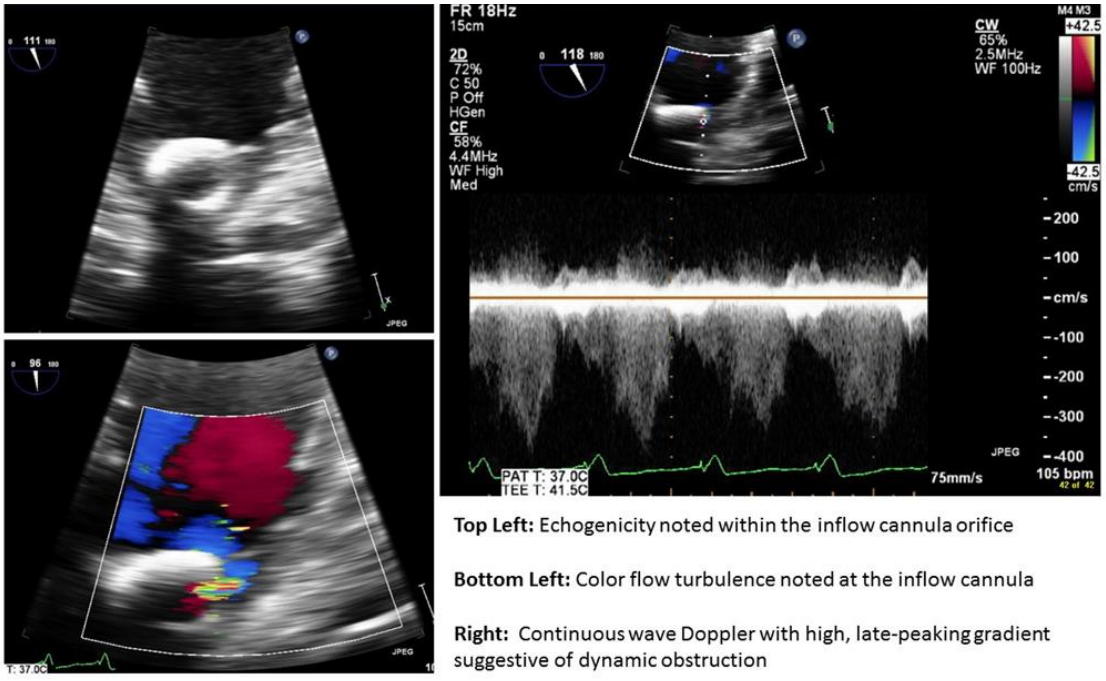


Figure 1. Intraoperative TEE demonstrating position of inflow cannula in the left ventricular apex with no obstruction to flow (mid-esophageal view at ~90°).

Shortly upon the transfer to the intensive cardiac care unit, the patient sustained a transient run of ventricular tachycardia which aborted spontaneously. Subsequently, the LVAD alarmed indicating low flow (< 2.5 L/min). Attempts at volume resuscitation were made with minimal improvement in the LVAD flow. An urgent, repeat TEE was performed bedside due to clinical concern of the inflow cannula being malpositioned (Figure 2). Roughly an hour was spent surveying the LVAD inflow cannula in multiple views. Prominent muscle bundles around the left ventricular apex were appreciated early during the exam, along with mobile echoes within the orifice of the cannula suggestive of muscle or thrombus material. However, the presence of obstruction was difficult to document with pulsed or color flow Doppler, due to flow masking by the cannula. Eventually, turbulent flow in the cannula was documented along with an aliased pulse signal of systolic flow along with a peak gradient of approximately 40-50 mmHg by continuous wave Doppler. The continuous wave velocity envelope was late peaking suggestive of a dynamic obstruction.



Top Left: Echogenicity noted within the inflow cannula orifice

Bottom Left: Color flow turbulence noted at the inflow cannula

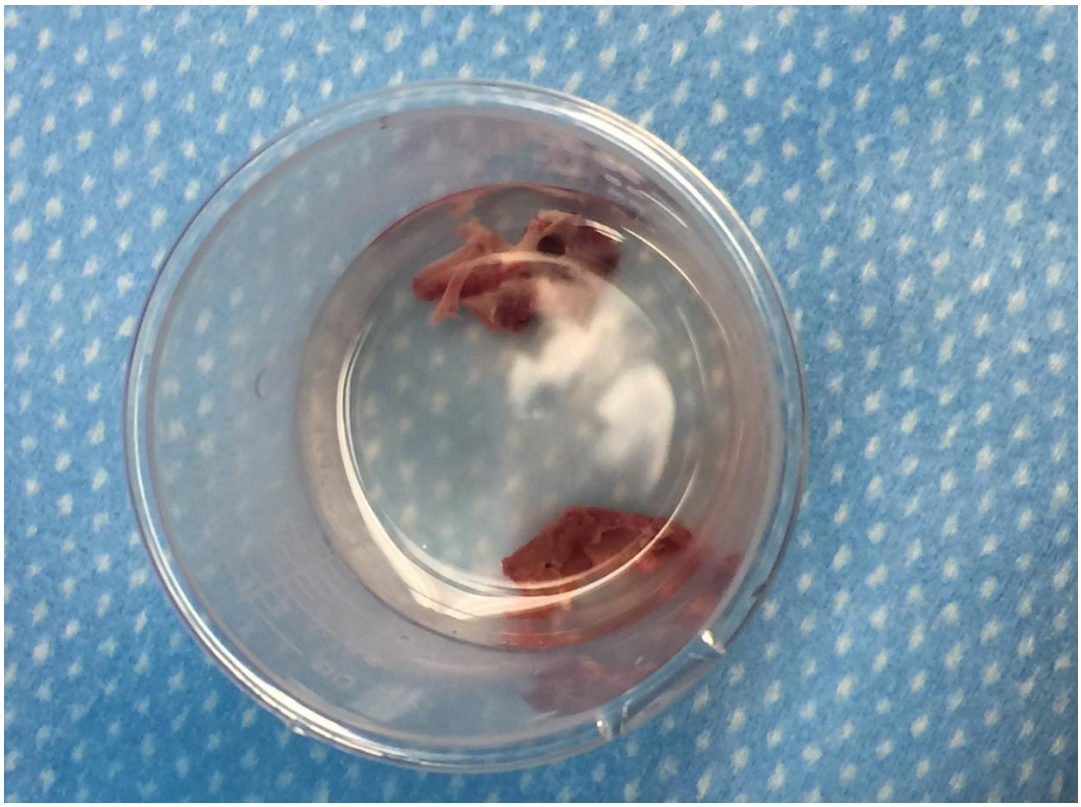
Right: Continuous wave Doppler with high, late-peaking gradient suggestive of dynamic obstruction

Figure 2. Post-operative TEE images

As a result of the TEE findings, the patient was promptly taken back to the operating room where the pump was disassembled and the inflow Flex graft was transected. A large ridge of septal muscle was noted to partially obstruct the inflow cannula. The inflow cannula was removed from its collar and this septal ridge of myocardium was excised (Figure 3). The pump was reassembled with a new inflow cannula and upon weaning from cardiopulmonary bypass to transition to the HeartMate II®, the LVAD flows significantly improved. Repeat

intraoperative TEE demonstrated adequate alignment of the inflow cannula without further evidence of obstruction and flows of approximately 5.6 L/min at 8400 RPM. The patient had a successful post-operative course void of further LVAD low-flow alarms or recurrent ventricular tachycardia.

Figure 3. Gross anatomy of the ridge of myocardium excised



Discussion

Blood flow abnormalities in patients with LVAD can be broadly categorized into pre-pump obstruction (as with our patient), intra-pump obstruction, and post-pump obstruction (i.e. complication related to the outflow graft or aortic anastomosis stenosis)[1]. Obstruction can occur as a result of clot formation within the device itself, external compression leading to “kinking” or shearing of the outflow graft, hypotension from any cause including right ventricular failure, or obstruction of the inflow cannula secondary to contact with the endocardium. It is well known that ventricular arrhythmias can lead to suction events causing myocardial damage with subsequent inflow cannula obstruction, however, this is less likely in this case as the patient was generally electrically stable and the obstruction was caused by a large ridge of septal muscle. Cases of inflow cannula obstruction related to malpositioning, hypovolemia, or cannula thrombus have also been well reported[2,3]. Prolapsing papillary muscle has been reported in several case reports[4-6]. To our

knowledge, there are no prior case reports of dynamic trabecular obstruction of the LVAD inflow cannula immediately following LVAD placement. A similar finding of dynamic inflow cannula obstruction was observed by Birati et al, however, this occurred in a patient four years after LVAD placement and was speculated to be related to left ventricular remodeling and septal enlargement after an ablation for ventricular tachycardia[7].

Echocardiography, namely transesophageal echocardiography, is an integral part of successful LVAD implantation allowing for appropriate visualization of cardiac structures and great vessels during anesthesia initiation, assessing impediments to successful LVAD implantation (e.g. intracardiac shunts, intracardiac thrombus, significant aortic insufficiency, right ventricular failure, etc.), and monitoring the heart during de-airing and successful LVAD initiation[8, 9]. More relevant to our case, echocardiography allows for thorough examination of the position and flow profiles of both the inflow and outflow cannulas. Appropriate cannula position of the LVAD is critical to allowing optimal laminar flow of blood to the device. This should be visualized by color flow Doppler imaging with interrogation of the flow demonstrating velocities ≤ 1.5 m/s[10]. The complex interaction of the right and left ventricles in relation to correct cannula positioning is improved with direct visualization afforded by TEE[11].

Since post LVAD implantation complications are common, an appropriate and timely evaluation is warranted. The ability to combine anatomic imaging with physiologic assessment by Doppler makes TEE an ideal bedside test. The establishment of a normal range of values and flow profiles of the inflow and outflow cannulas are necessary as there is increased reliance on Doppler velocities. Doppler velocities, however, can be influenced by a number of variables, including cannula type, pump speed, and ventricular volumes. Regardless, as the detection of device malfunction noninvasively is limited to TEE as the principal imaging modality, it should be employed liberally.

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