Orthostatic Syncope from Compromised Flow after Heartware HVAD by Lateral Thoracotomy: Potential Role of Dynamic Echocardiographic Testing for Cannula Assessment

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INTRODUCTION

Blood flow through a continuous flow left ventricular assist device (LVAD) is typically dependent on both preload and afterload. However, inflow cannula position is equally important for ensuring adequate pump flow under normal loading conditions. As part of an investigational study, the HeartWare HVAD (Medtronic/Heartware Inc, Framingham, Massachusetts) device is being implanted via left lateral thoracotomy with postulated advantages of easier implantation, less perioperative bleeding, and sternal preservation for future cardiac transplantation.[1] The impact of this limited surgical approach on cannula position is not yet known. We describe a patient who underwent uncomplicated HVAD implantation via thoracotomy, who then later developed dramatic postural symptoms related to intermittent position-related cannula obstruction. The clinical diagnosis was bolstered by use of echocardiography during orthostatic testing.

CASE PRESENTATION

A 55-year-old man (body surface area, 1.96 m^2) with ischemic cardiomyopathy with left ventricular (LV) ejection fraction 10%, LV end-diastolic dimension 7.5 cm, ventricular tachycardia, and secondary pulmonary hypertension underwent HVAD as a bridge to transplant via thoracotomy. Intraoperative transesophageal echocardiogram immediately after HVAD insertion showed markedly decompressed LV, improved mitral regurgitation, intermittent aortic valve opening, and mild right ventricular (RV) systolic dysfunction at 2,600 rpm. Chest radiography showed appropriate inflow cannula position (Figure 1). One month after implantation, he experienced recurrent orthostatic syncope that was not attributable to clinical right heart failure or ventricular arrhythmias. Transthoracic echocardiogram showed stable findings compared with the intraoperative transesophageal study. Invasive hemodynamic testing confirmed adequate RV performance and left atrial preload (right atrial pressure, 7 mmHg; mean pulmonary artery pressure, 31 mmHg; pulmonary capillary wedge pressure, 10 mmHg; and cardiac index, 3.4 L/min/m^2). Chest computed tomography with contrast showed widely patent inflow and outflow cannulas in adequate anatomical position.

Each positional change (supine to sitting to standing) led to substantial perturbations in HVAD waveforms and flows accompanied by presyncopal symptoms. We performed echocardiography with HVAD interrogation in this setting (Figure 2). The echocardiographic images in the supine position (Video 1) show adequate LV cavity size with the inflow cannula in the midcavitary position (Figure 2, panel 1A) but reduced HVAD pulsatility due to a low preload state (Figure 2, panel 1C). In standing position (Video 2), the inflow cannula abuts the LV septum, increasing the risk for intermittent cannula obstruction. Inflow cannula flow velocities declined from supine to standing (Figure 2, column B) concordant with HVAD waveforms and decreased flow estimates at each position. There was no evidence for worsening RV function, septal shift, or LV collapse causing inflow cannula obstruction. Our concern for suboptimal inflow cannula position from time of thoracotomy remained, due to the early

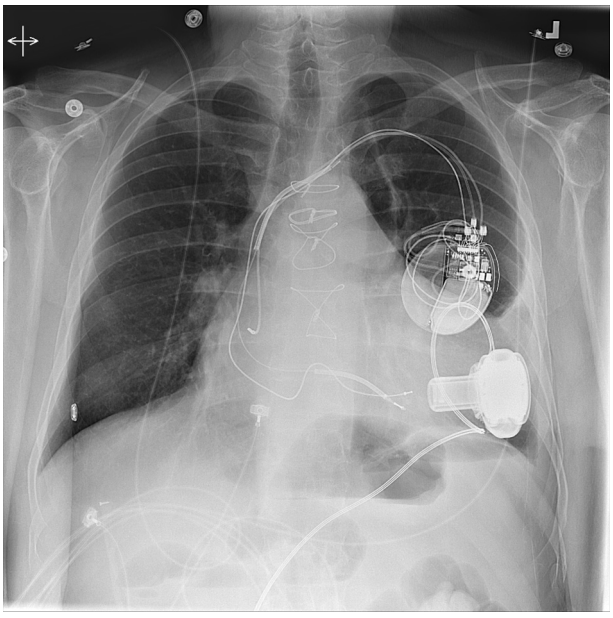

Figure 1 Anteroposterior view of portable chest radiograph (semiupright view) demonstrating HVAD position in the early postoperative period.

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Keywords: LVAD, Orthostatic syncope, Dynamic echocardiography

Conflicts of Interest: Dr. Richa Agarwal has received research funding from Thoratec and HeartWare Corporations. The remaining authors had no actual or potential conflicts of interest relative to this document.

2468-6441

http://dx.doi.org/10.1016/j.case.2017.01.005

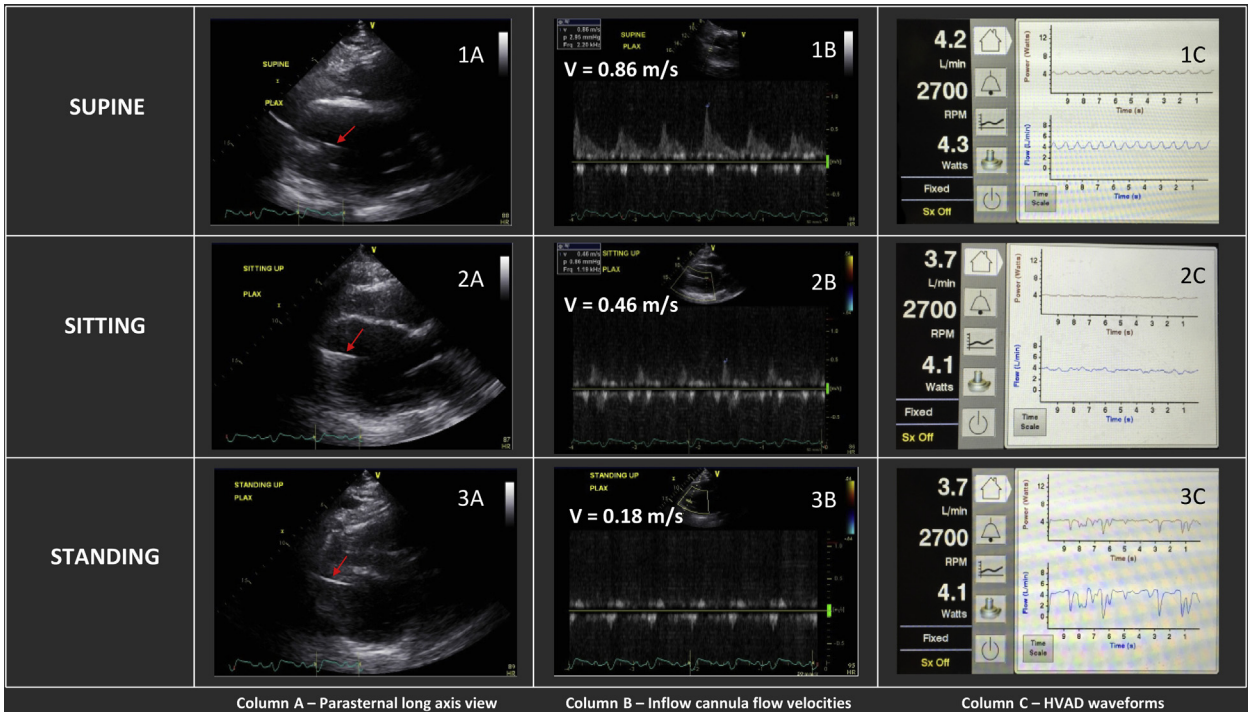

Figure 2 Transthoracic echocardiography showing LV size and inflow cannula velocities along with HVAD waveforms at each position (supine, sitting, and standing). The *arrows* in column A point to the inflow cannula.

manifestation and persistence of symptoms, which could not be fully abated by changing the patient's loading conditions.

This patient did not undergo LVAD revision. Since he was listed for transplantation, we opted to pursue a more conservative strategy and maintain a higher preload state rather than surgical revision, which would require a traditional sternotomy. He continued to experience these events despite higher preload and often manifested a degree of congestive heart failure on LVAD support. He underwent successful transplantation over a year later.

DISCUSSION

Echocardiography provides pivotal information for managing LVAD patients and is increasingly used for diagnosing complications such as LVAD thrombosis and right heart failure. Although echocardiography is an indirect diagnostic tool, we describe its use for assessing inflow cannula position and velocities during orthostatic testing, when there may be suspicion for mechanical or functional flow limitation, despite adequate intraoperative and radiographic appearance of the cannulae. Echocardiographic assessments during tilt table testing have been described elsewhere in a patient with decreased HeartMate II LVAD (St. Jude Medical/Thoratec Corporation, Pleasanton, CA) filling from poor venous return coupled with severe RV dysfunction.[2] Our case description, however, suggests cannula malposition and dynamically altered flow beyond the usual preload determinants, which became obvious with changes in patient posture and therefore highlights the interaction between the inflow cannula position and body habitus. Using echocardiography in a dynamic fashion should be considered in cases when questions of cannula position arise, as we learn more about the impact of newer surgical techniques for LVAD performance.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.case.2017.01.005.

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