Circulation: Heart Failure

UNDER PRESSURE

Right Ventricular Pressure-Volume Analysis During a Left Ventricular Assist Device Speed Optimization Study

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Significant gaps remain in our understanding of right ventricular (RV) dysfunction after left ventricular assist device (LVAD) implantation.[1] Persistent RV dilation and dysfunction due to increased venous return likely plays a key role. Another suggested mechanism implicates changes in RV geometry and orientation of the interventricular septum that result from postimplantation LV decompression (interventricular interaction). We present a case where the pressure-volume loops suggest against this interaction contributing to the development of post-LVAD RV failure.

A 22-year-old female presented with cardiogenic shock following a viral respiratory illness and underwent a HeartMate 3 (Abbott Laboratories, Abbott Park, IL) LVAD implant. Guideline-directed medical therapy was initiated and optimized over the following months with ongoing LV reverse remodeling noted on echocardiography (LV ejection fraction 45%–50%). About 4 months later, she presented with low-flow alarms. Echocardiogram identified increasing RV dilation and a shift of the interventricular septum towards the LV. Her LVAD speed was sequentially decreased from 5400 to 5000 rpm, diuretics discontinued and fluid intake was encouraged, but the alarms persisted.

Right heart catheterization was notable for low filling pressures (right atrial pressure 5, pulmonary artery pressure 18/9 [mean of 13], and pulmonary capillary wedge pressur 9 mm Hg, respectively, with a cardiac index of 2.5 L/min per m^2). A conductance catheter (CD Leycom, Hengelo, the Netherlands) was placed in the RV, and the LVAD speed was incrementally reduced from 5000 to 4100 rpm. At 4100 rpm, hemodynamic parameters were unchanged, although the echocardiogram showed the septum to be midline with a visibly less dilated RV. With increasing speed, there was increased compliance and a fixed systolic function despite the significant differences in septal position (Figure). Additionally, RV stroke work increased considerably with increased LVAD speeds, further indicating increased overall RV pump performance.

Despite LV reverse remodeling during LVAD support, the RV may not exhibit the same reductions of size.[2] Hence, a dilated RV on an echocardiogram is not synonymous with RV failure or congestion. In our patient, we have demonstrated evidence that LV unloading by LVAD support increases RV compliance. Moreover, LV unloading during LVAD support did not impair RV systolic function, reiterating that interventricular interactions are substantially less during systole than diastole.[3] If confirmed in additional studies and RV phenotypes, these findings are paradigm shifting in that they show interventricular interactions are not a major cause of post-LVAD RV failure.

ARTICLE INFORMATION

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Disclosures

None.

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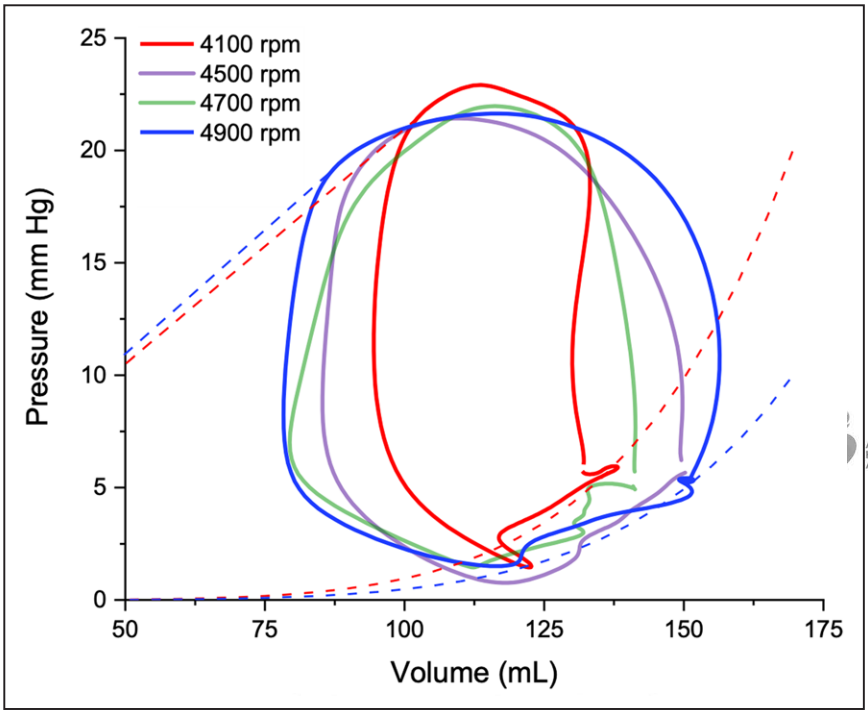

Figure. Right ventricular (RV) pressure-volume (PV) loops performed during a left ventricular assist device speed ramp test. With increasing left ventricular assist device speed, the end-diastolic PV relationship (dashed lines going through the bottom right corner of each loop) shifts rightward indicating increased compliance. The end-systolic PV relationship (dashed lines going through left upper corner of loops) is relatively unchanged, indicating preserved systolic function. Correspondingly, RV stroke work (the area inside the PV loop) increases, indicating increased overall RV contractile performance.