Overdrive Pacing Suppresses Ectopy and Minimizes Left Ventricular Assist Device Suction Events

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A 20-year-old man with idiopathic dilated cardiomyopathy underwent placement of a HeartMate II (Thoratec Corporation, Pleasanton, Calif) axial-flow left ventricular assist device (LVAD) as a bridge to cardiac transplant. The immediate postoperative phase was without complications. The LVAD was initially set at 8500 rpm. Under echocardiography guidance, a ramp-up study was performed to optimize the LVAD settings for the patient. At 10,000 rpm, the LVAD generated a flow of 5.0 to 5.5 L/min. Over the next few days, the patient experienced frequent suction events, defined as movement of the interventricular septum toward the inflow cannula. These events required setting adjustments to 9800 rpm, followed by 9600 rpm. The number of suction events subsequently decreased; however, the flow rate was adversely affected and decreased to 3.6 to 4.2 L/min with the new settings.

The patient’s underlying electric rhythm was atrial standstill versus a fine atrial fibrillation with a junctional escape rhythm at 60 bpm. It was observed that the patient had suction events after a premature ventricular contraction (PVC) or when he went into ventricular bigeminy. Echocardiography revealed that the septal movement was directed toward the inflow cannula after a PVC (Figure A and B) and was directed away from the inflow cannula after his normal junctional beat (Figure C and D and supplemental Movies 1 and 2). The patient had a preexisting single right ventricular (RV) lead implantable cardioverter defibrillator. Echocardiography revealed that RV paced beats moved the septum away from the inflow cannula during systole (Figure E and F and supplemental Movies 3 and 4). Furthermore, overdrive pacing at 70 bpm resulted in suppression of ventricular ectopy and resolution of the suction events, thereby allowing the LVAD to be readjusted to the original setting of 10,000 rpm, with subsequent improvement in flows. The improvement in septal motion was confirmed with M-mode echocardiography (Figure G and H).

Although pacing has been reported to improve LVAD function in patients with older-generation LVADs and conduction abnormalities, to the best of our knowledge, this case represents the first report of RV pacing improving the function of an axial flow LVAD. Mechanisms explaining how RV pacing may improve LVAD function are not known. It may be that RV pacing and the subsequent dyssynchronous motion of the septum away from the inflow cannula during systole helps prevent the septum from obstructing LVAD filling—such techniques have been described for patients with refractory hypertrophic obstructive cardiomyopathy.3 Even though RV pacing causes left ventricular (LV) dyssynchrony—the negative effects of which would be less significant in the presence of an LVAD—it is possible that the initial right-sided activation of the septum may also enhance RV systolic function by improving RV synchrony. Improvement in RV function would thus increase circulation from the RV to the left ventricle, resulting in improved LV filling and a lower likelihood of a suction event. The possibility that RV pacing may improve RV function is certainly provocative, given that RV dysfunction is common after implantation of a LVAD.4 Finally, an additional mechanism may be that suppression of PVCs by overdrive pacing allows for more LV filling time compared with premature beats, thereby providing a larger LV end-diastolic volume and reducing the risk of a suction event. Given that a number of patients with LVADs have preexisting implantable cardioverter defibrillators with RV pacing capability, further studies of the role of RV pacing in improving axial flow LVAD function are warranted.

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References


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Figure. A and B, Parasternal long-axis and apical 4-chamber transthoracic echocardiogram views demonstrating the suction of the septum into the LVAD inflow cannula (*) after a PVC. C and D, Parasternal long-axis and apical 4-chamber views demonstrating the relationship between the septum and LVAD inflow cannula after a normal beat (arrow line). E and F, Parasternal long-axis and apical 4-chamber views demonstrating greater distance between the septum and LVAD inflow cannula with RV pacing (arrow line). G, M-mode through the RV and LV demonstrating septal motion with PVCs (arrowhead). H, M-mode demonstrating suppression of PVCs with RV pacing.
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Supplemental Material

Supplemental Movies: 1. Parasternal long axis transthoracic echocardiogram video of junctional rhythm with ventricular ectopy. 2. Apical four chamber transthoracic echocardiogram video of junctional rhythm with ventricular ectopy. 3. Parasternal long axis transthoracic echocardiogram video of RV paced rhythm. 4. Apical four chamber transthoracic echocardiogram video of RV paced rhythm.