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Images in Cardiology

Bidirectional Dynamic Change in Shunt Flow Across a Small Ventricular Septal Defect in a Patient With a Left Ventricular Assist Device

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A 50-year-old man implanted with a durable left ventricular assist device (LVAD; HeartMate 3, Abbott Laboratories, Chicago, IL) for idiopathic dilated cardiomyopathy was transferred to our hospital for further follow-up. He had not been diagnosed with any intracardiac shunts before LVAD implantation. On admission, echocardiography revealed a small left-to-right (L-R) shunt flow across the interventricular septum, indicating muscular ventricular septal defect (VSD). As the pump speed was raised during an echocardiographic ramp test for LVAD optimization, the L-R shunt flow at low pump speed (Fig. 1, A and D) gradually changed to a to-and-fro flow (Fig. 1, B and E), and finally to a continuous right-to-left (R-L) shunt flow at high pump speed (Fig. 1, C and F). Oxygen saturation simultaneously declined from 99% to 92% as the shunt flow changed from L-R to R-L. The LVAD pump speed was set at the point at which a balanced biventricular chamber size and L-R dominant shunt flow without oxygen desaturation were observed. Repair of the VSD was not considered, as the R-L shunt flow at rest could be avoided by optimization of the LVAD pump speed, and the patient had no clinical history of paradoxical thromboembolism. If systemic hypoxia due to R-L shunt manifests in the future, surgical repair will be necessary, as the position of the LVAD inflow cannula is close to the VSD, and percutaneous closure will be technically difficult.

Novel Teaching Points

- Bidirectional shunt flow across a small VSD is inducible by pump speed settings in patients with an LVAD.
- Optimization of LVAD pump speed is important to avoid hypoxemia and paradoxical thromboembolism due to R-L shunt in cases of residual intracardiac shunt, even if it is small.

Defects within atrial or ventricular septa theoretically can be sources of significant R-L shunt and hypoxemia after LVAD implantation. It is known that patent foramen ovale causes oxygen desaturation and paradoxical thromboembolism due to R-L shunt in patients with an LVAD.[1-3] Our patient did not have prior evidence of interventricular communication. Elevated right heart filling pressure due to secondary pulmonary hypertension might have masked a shunt flow before LVAD implantation in the present case. In fact, the patient showed severe isolated post-capillary pulmonary hypertension; mean pulmonary arterial pressure before LVAD implantation was high at 34 mm Hg, even under support with continuous infusion of dobutamine and an intra-aortic balloon pump. To-and-fro or R-L shunt flow in diastole have been documented in cases of large VSD or VSD with severe pulmonary hypertension.[4,5] The finding of continuous R-L shunt across a morphologically small VSD without advanced pulmonary hypertension might be unique to patients with an LVAD.

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Ethics Statement: The case we reported here has adhered to the relevant ethical guidelines.

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See page 985 for disclosure information.

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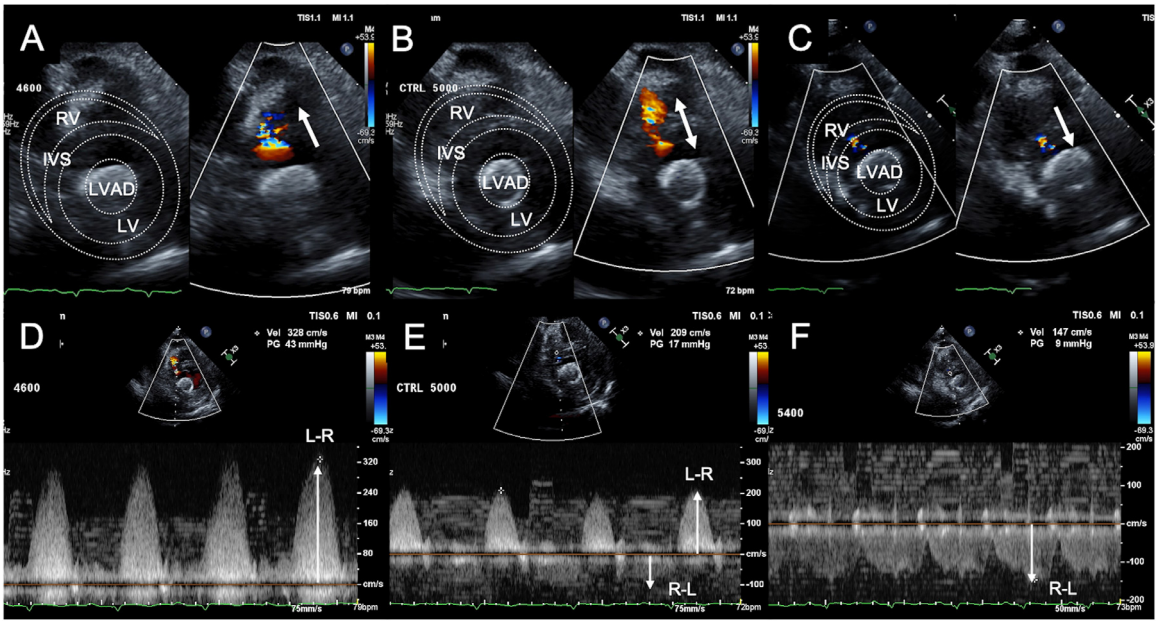

Figure 1. Echocardiographic images of ventricular septal defect (VSD) shunt flow at various left ventricular assist device (LVAD) settings. (**A-C**) The parasternal short-axis views with color flow Doppler and (**D-F**) continuous-wave Doppler signals across the VSD are shown. (**A, D**) Left-to-right shunting (L-R) at low speed (4600 rpm), (**B, E**) to-and-fro shunting at intermediate speed (5000 rpm), and (**C, F**) right-to-left shunting (R-L) at high pump speed (5400 rpm) through the VSD were detected. IVS, interventricular septum; LV, left ventricle; RV, right ventricle.

Changes of VSD shunt direction associated with LVAD pump speed adjustment in the present case demonstrate the risk of R-L shunt and hypoxemia at high pump speed under residual intracardiac shunt.

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Disclosures

The authors have no conflicts of interest to disclose.

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