Biventricular assistance with the Jarvik FlowMaker: A case report

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After implantation of a left ventricular assist device (LVAD), right ventricular dysfunction and elevated peripheral vascular resistance may result in right ventricular failure and increased mortality. Right ventricular support may become necessary, as in the following case in which two Jarvik FlowMakers (Jarvik Heart, Inc, New York, NY) provided biventricular assistance.

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Clinical Summary

A 21-year-old man with end-stage idiopathic cardiomyopathy was referred to our hospital and approved for heart transplantation. He had a left ventricular ejection fraction lower than 20% with mitral and tricuspid regurgitation. Despite maximal medical therapy and balloon counterpulsation, LVAD support became necessary as a lifesaving measure. A Jarvik FlowMaker was implanted in the left ventricle through a midline sternotomy with outflow graft anastomosis to the ascending aorta.¹ On postoperative day 1, the cardiac index increased by 60%, from 1.5 to 2.3 L/(min · m²). The patient was extubated on day 3. Two days later, he had ventricular tachycardia that responded to drug therapy and cardioversion. Sepsis supervened, hepatic function deteriorated, and the white blood cell count rose to 28.2×10^3 cells/ μ L. On postoperative day 12, respiratory failure and bradycardia necessitated resuscitation and reintubation. Right ventricular function worsened, and tricuspid regurgitation became severe. A right atrial pressure greater than 20 mm Hg was required for adequate cardiac output. Hepatic function further deteriorated, and right ventricular support was clinically necessary. Because of the FlowMaker's unique suitability for intracardiac placement and its ease of implantation without cardiopulmonary bypass, this device was implanted for right ventricular support on postoperative day 15. A purse-string suture was

Figure 1. A, Configuration of biventricular FlowMaker system (right lateral viewpoint). B, Postoperative chest radiograph.

Figure 2. Echocardiograms showing atrial septal shift with left-sided support alone (A) and normalization of septum after placement of right-sided pump (B). *S*, Septum; *LA*, left atrium; *RA*, right atrium; *L*, left-sided pump; *R*, right-sided pump.

placed on the upper lateral wall of the right atrium, and the pump was inserted into the atrium (Figure 1). The cardiac index increased to greater than $3.0 \text{ L}/(\text{min} \cdot \text{m}^2)$, maintaining the central venous pressure at 5 to 10 cm H_2O . Unfortunately, because of progressive sepsis and hepatic failure, the patient died after 27 days of LVAD support and 12 days of biventricular support. Both pumps had a typical appearance at removal, and autopsy findings were unremarkable.

Discussion

Although implantable pulsatile LVADs can save patients with end-stage heart failure, these devices may impair right ventricular function. This problem is usually overcome by relieving the high left-sided pressures typical of severe heart failure. However, when left ventricular filling remains inadequate despite pharmacotherapy to enhance right ventricular function and lower pulmonary vascular resistance, a right ventricular assist device may be required. Unfortunately, implantation is frequently delayed until end-organ failure is irreversible, and the mortality remains high even when a physiologic cardiac output is achieved.

Continuous-flow LVADs unload the ventricle throughout the cardiac cycle. Pulsatility is generated by native ventricular contraction, which is generally improved by the unloading achieved by the FlowMaker. However, if impaired right-sided function and/or increased pulmonary vascular resistance occurs (as in this patient), impaired left ventricular filling will result. This will cause ventricular and atrial septal shifting (Figure 2). Attempts to en-

hance left-sided output by increasing device speed (in hopes of increasing flow) only worsen the situation.²

Implantable LVADs are not designed for right-sided support. However, the FlowMaker's intracardiac placement makes it uniquely suitable as an implantable support device for either the pulmonary or systemic circulation. Device placement was achieved in the right atrium without cardiopulmonary bypass. By directing the inlet toward the inferior vena caval–right atrial junction and keeping right atrial pressures at 5 to 10 cm H_2O , we were able to achieve reliable right ventricular unloading and deliver satisfactory blood flow to the left-sided pump.

This therapy failed to save our critically ill patient. More timely implantation of a FlowMaker right ventricular assist device, along with a pulsatile or nonpulsatile LVAD, may be lifesaving in future cases. A FlowMaker right ventricular assist device alone may also be appropriate for long-term or destination therapy for isolated right ventricular failure or for congenital heart disease involving compromised or absent right ventricular function.

References

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