circulation. If it is, then an SVAD should improve the overall circulation. However, if the left ventricular end-diastolic pressure is not high, then an SVAD is unlikely to improve hemodynamics. If the pulmonary circulation is primarily responsible for hemodynamic deterioration, then insertion of a VAD at a subpulmonary position is an option.² Much animal and computer modeling has been done to study the possibility of mechanically augmenting pulmonary blood flow in the Fontan baffle.⁵

The lack of a subpulmonary ventricle in the Fontan physiology may result in suboptimal filling of an SVAD. Therefore, we believe that it is important to ensure almost complete systemic ventricular decompression by setting the HeartMate II SVAD at higher revolutions per minute to encourage passive flow into the pulmonary arteries. Also, with a single ventricle, unlike in a biventricular heart, there is little concern, even at high revolutions per minute, of jeopardizing output of the pulmonary ventricle by shifting of the intraventricular septum. With these settings, central venous pressure decreased significantly with adequate systemic blood pressure (Table 1), yielding reasonable

end-organ perfusion pressure, which presumably contributed to the improvement in his PLE.

This is the first report of successfully discharging home a patient who has a failing Fontan circulation with an implantable VAD. Given the increasing cohort of adults and children with failing Fontan circulations, this case represents a significant evolution in therapy for single ventricle patients who will increasingly be receiving SVADs not only for support to transplant but also perhaps to destination.

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The use of the HeartWare HVAD for long-term right ventricular support after implantation of the HeartMate II device

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Biventricular support is required in approximately 6% to 30% of patients undergoing implantation of left ventricular assist devices (LVADs).¹ Although the routine application of a reliable, long-term implantable right ventricular assist device (RVAD) remains elusive, use of the HeartWare HVAD (HeartWare International, Inc, Framingham, Mass) and Jarvik 2000 (Jarvik Heart, Inc, New York, NY) for long-term totally implantable biventricular support has been reported.^{2,3} Although the only reports in existence detail the use of 2 HeartWare HVADs for

biventricular support, we report the use of this device for right ventricular support after implantation of a HeartMate II LVAD (Thoratec Corporation, Pleasanton, Calif).

CLINICAL SUMMARY

A 59-year-old African American woman with nonischemic cardiomyopathy and congestive heart failure was seen with acute, decompensated heart failure and rapidly deteriorating condition. After evaluation, the patient underwent emergency HeartMate II and CentriMag RVAD (Thoratec) implantation for biventricular failure. Postoperatively, the patient had several failed attempts at RVAD weaning and was subsequently listed status 1A for heart transplant. After transplant workup, numerous antibodies with a high panel-reactive antibody titer were noted, and the patient underwent several rounds of plasmapheresis, intravenous immune globulin, and bortezomib (Velcade). Despite these interventions, transplant was essentially excluded as a result of significant persistent allosensitization. An appeal was subsequently made for compassionate use of the HeartWare

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HeartMate II is manufactured by Thoratec Corporation, Pleasanton, Calif.

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FIGURE 1. A, Anterior protrusion of implanted HeartWare HVAD. B, Bilateral pectoralis flap closure after partial sternectomy. C, Prerelease chest radiograph.

HVAD for permanent right ventricular support. After approval, the patient underwent resternotomy, removal of the CentriMag RVAD (after 303 days of support), and placement of the HeartWare HVAD. Under cardiopulmonary bypass, the device was placed through an anterior right ventriculotomy in proximity to the right ventricular outflow tract. The previously placed HeartMate II LVAD was left undisturbed. After start-up of both devices, the patient was weaned from cardiopulmonary bypass, with device support incrementally increased in tandem. Final pump speed for the HeartWare HVAD was 2400 rpm (flow 3.5 L/min); that for the HeartMate II LVAD was 9000 rpm (4 L/min). Because of anterior location of the HeartWare HVAD, a partial sternectomy was required with temporary closure (Figure 1, A). A plastic surgeon then performed bilateral pectoralis flap closure on postoperative day 3 (Figure 1, B).

The patient was released from the hospital on postoperative day 28 after HeartWare HVAD placement (hospital day 331 after HeartMate II device insertion). The prerelease chest radiograph is shown in Figure 1, C. At 6-month follow-up, renal function and laboratory values are within reference ranges, and the patient has excellent functional capacity with minimal symptoms. There has been no evidence of hemolysis, and no changes have been made to pump speed settings and flows on either device.

DISCUSSION

This case highlights the challenges involved when patients require mechanical left ventricular support but have concomitant right ventricular failure. If transplant is not an option, there is no reasonable alternative without a reliable, long-term RVAD. Although therapy is individualized, we are extremely selective before proceeding with assist device implantation in patients with poor right ventricular function who are not transplant candidates. The patient described here was initially thought to be a transplant candidate before LVAD implantation; however, transplant was ruled out postoperatively because of sensitization.

This case also raises several important technical issues when using the HeartWare HVAD in the role of RVAD. Because the HeartWare HVAD was designed to interact with systemic resistance and not with the lower pulmonary resistance, important modifications are required. First, because the HeartWare HVAD is afterload sensitive, lower pump speed or outflow graft restriction is mandatory. Narrowing the outflow graft brings the low pulmonary vascular resistance closer to that of the systemic circulation; this is achieved by suturing a 3-cm long segment with 6-0 Prolene suture (Ethicon, Inc, Somerville, NJ) over a 5- to 7-mm Hegar dilator (Figure 2, A).² A patient with high pulmonary vascular resistance may require less restriction, and without a restrictor the lower pulmonary resistance may require

FIGURE 2. A, Outflow graft is restricted close to the HeartWare HVAD (arrow). B, Additional felt rings are used to decrease the intracavitary length of the inflow cannula.

pump speed to approach the lower operating limit of 1800 rpm. Implications include (1) lower accuracy of estimated flow at lower speeds, (2) less ability to correct suction conditions by lowering pump speed, and (3) increased potential for pump thrombosis or rotor instability. Second, the HeartWare HVAD inflow cannula length was designed for placement through the left ventricular apex and is not optimized for the right ventricle. Shortening the length of the inflow cannula to accommodate the shallower right ventricular cavity in the right ventricular outflow tract is achieved by placing additional felt rings under the fixation ring (Figure 2, B). Other locations that may potentially allow normal chest closure include placement into the right atrium or the diaphragmatic surface of the right ventricle.

For this patient, the goals for pump flows were 3 to 4 L/min through the RVAD and 5 to 6 L/min through

the LVAD. Anticoagulation strategy consisted of aspirin and warfarin sodium, with an international normalized ratio goal of 2 to 3. We were successful in this case; however, this is the first report of HeartWare HVAD use in the role of RAAD after HeartMate II implantation. Firm recommendations regarding the potential widespread applicability of this therapy are therefore limited.

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Complete resection of asymptomatic solitary right atrial metastasis from renal cell carcinoma without inferior vena cava involvement

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Metastatic cardiac tumors are considered a terminal state of primary malignancy. Therefore, the condition of patients, local recurrence, and other metastases should be considered regarding indications for surgery, which should aim to

improve the prognosis of patients in good condition with malignancies and prevent concomitant critical events.

Clinical Summary

A 61-year-old woman was referred to the Graduate School of Medicine with an incidentally discovered right atrial tumor. She had undergone radiotherapy and chemotherapy to treat bone metastasis after left nephrectomy for renal cell carcinoma and radical hysterectomy for uterine endometrial adenocarcinoma 1 year previously and was free of symptoms originating from the heart. A computed tomography examination for femoral pain revealed a cardiac tumor (Figure 1, A) without findings in the femur. Subsequent

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