weeks, with improvement in hepatic function. Although the renal function improved, the creatinine clearance was poor. The patient underwent intermittent dialysis through side access ports on the right VAD tubing. Assessment of cardiac recovery was performed with serial echocardiograms, demonstrating persistent severe biventricular failure. The decision was made to list the patient for heart and kidney transplantation. On November 12, 2001, the patient underwent successful double organ transplantation. The postoperative course was uneventful, with no major complications. The patient was discharged to a rehabilitation center for several months of recovery. He was then discharged to home and remains alive and well more than 1 year later.

Discussion

The management of postinfarction VSD remains a therapeutic challenge. Surgical mortality remains high, and initial repairs may be plagued by persistent heart failure, VSD recurrence, and arrhythmia.² As such, this entity continues to be the subject of cardiothoracic surgical debate regarding the timing and type of surgical repair.

One novel approach to this entity includes the use of a ventricular assist device (VAD) for cardiac support, circulatory stability, and maintenance of end-organ perfusion. The role of the VAD may be as an adjunct to an attempted repair. In this scenario, the postinfarct VSD is repaired, coronary bypass grafting is performed, and the VAD is placed for ventricular unloading and maintenance of adequate cardiac output. The use of implantable VADs for this condition was described by Faber and colleagues³ with the HeartMate (Thoratec Laboratories, Pleasanton, Calif) and

Novacor (WorldHeart Corp, Ottawa, Ontario, Canada) systems. Another scenario, however, is to place the VAD without attempting an initial repair. The rationale behind this approach is to avoid operating on fresh infarct and to establish prompt circulatory control. The BVS 5000 VAD has the advantage that it can be placed with or without cardiopulmonary bypass. In addition, inflow to the VAD can be easily accomplished at the atrial level. This is an ideal cannulation strategy for a VSD, in which it is important to avoid a shunt at the ventricular level. As demonstrated in our case, mechanical cardiac support was successful in restoring hemodynamic stability and reversal of multiorgan system failure.

In conclusion, the postinfarction VSD may be managed in a variety of ways. This case demonstrates the novel use of the BVS 5000 VAD with biatrial cannulation for the uncorrected postinfarction VSD as a bridge to transplantation.

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Urgent inferior vena cava replacement with an autologous pericardium tube graft

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Surgical interventions involving the suprarenal inferior vena cava (IVC) are uncommon. They are usually required after the partial or complete resection of the IVC for the management of malignant and nonmalignant diseases.^{1,2} Three surgical techniques have been reported: patch angio-

plasty,³ replacement with spiral saphenous vein graft,¹ and replacement with extended polytetrafluoroethylene (ePTFE) grafts.^{1,2,4} We report on an emergency case in which the accidentally transected suprarenal IVC was replaced with an autologous pericardial tube.

Clinical Summary

A 42-year-old male man had right-sided flank pain and elevated liver enzymes. Abdominal ultrasonography and computed tomographic scan demonstrated a 5-cm right renal mass (renal cell carcinoma). Results of the metastatic workup were negative, and the patient underwent a laparoscopic right radical nephrectomy.

The laparoscopic dissection of the renal tumor was difficult and eventually complicated by severe bleeding, which could not be controlled laparoscopically. The abdomen was opened, and by manual tamponade of the undersurface of the liver and infusion of blood and intravenous fluids, blood pressure could be maintained.

The cardiothoracic surgical team was consulted. A standard median sternotomy was performed and extended to the laparot-

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Figure 1. Photograph depicting construction of distal pericardiocaval anastomosis. Proximal anastomosis of pericardial tube graft to intrahepatic IVC has been completed (arrow).

omy. The patient was placed on cardiopulmonary bypass (CPB) by cannulation of the aorta, superior vena cava, right atrium, and right femoral vein. Transesophageal echocardiography and aortic venting were used to detect and prevent air embolism in case of a patent foramen ovale. The liver was mobilized by releasing the falciform and right triangular ligaments. This provided excellent visualization of the proximal IVC, transected at the level of the undersurface of the liver. The stapled distal IVC had retracted inferiorly.

A 3 × 5-inch rectangular piece of autologous pericardium was harvested for the reconstruction. The proximal pericardiocaval anastomosis was circumferentially constructed with a running 5-0 Prolene suture (Ethicon, Inc, Somerville, NJ). The retracted distal IVC was then clamped above the renal veins, and the staple lines were resected. The distal pericardiocaval anastomosis was constructed with a 5-0 Prolene suture (Figure 1). The autologous pericardial tube was finally closed longitudinally with a 5-0 Prolene suture, creating a segment of neo-IVC. The IVC was unclamped, and flow was reestablished. The diameter of the neo-IVC was at least 2 cm at its narrowest point. The patient was weaned from CPB without difficulty.

After the operation, the patient required 4 weeks of hemodialysis for acute renal failure. Results of lower extremity Doppler examination were negative for deep vein thrombosis and venous congestion. The patient was discharged with a regimen of warfarin sodium and is doing well clinically 6 months after surgery. The patient declined follow-up imaging.

Discussion

Transection of the IVC during laparoscopic nephrectomy was a true nightmare, but instant laparotomy and compression provided time to establish CPB. Normothermic CPB was used. The right atrial and femoral vein cannulation, combined with vacuum-assisted venous drainage, eliminated the need for deep hypothermia and circulatory arrest. TEE and aortic venting were used to detect

and prevent air embolism. Mobilization of the liver provided exposure, and vacuum-assisted venous atrial drainage provided a bloodless field. End-to-end reanastomosis of the cava was not possible. It turned out to be technically simple and quick to create an IVC tube from a rectangular pericardial patch. Sewing to the intrahepatically retracted and fragile proximal end of the cava was possible because of good exposure and compliant tissue.

Various materials (xenopericardium, hepatic vein, omentum, peritoneofascia, ePTFE) have been used to reconstruct or replace the IVC. Autologous pericardium was our choice in this urgent situation. It is nonallogenic, biologic in origin, malleable, expandable under venous pressure, hemostatic, durable, readily available, and free. In addition, morphologic, immunohistologic, and fibrinolytic features of the autologous pericardium make it a well-suited replacement for the IVC. In their study, Iha and colleagues⁵ observed that autologous pericardium differed significantly from other biologic (porcine, equine, and bovine pericardium) and synthetic (ePTFE) grafts. Their animal data showed that autologous pericardium had less endothelial lining contraction and subendothelial fibrosis, along with better fibrinolytic activity. This has led us to believe that an endothelialized autologous pericardial tube graft would be well suited to the low-flow system of the IVC because of its low thrombogenicity and low risk of contracture and narrowing.

Patch angioplasty with autologous pericardium was originally described in patients with Budd-Chiari syndrome.³ When replacement of the IVC was required, however, ePTFE tube grafts were more commonly used.^{1,2} These grafts were patent up to 5 years.¹ Our main concern relating to the choice of ePTFE was immediate hemostasis. Spiral saphenous vein grafts are not commonly used for IVC replacement and are time consuming, and early patency rates have been poor.¹ The approach described here (management of CPB and use of autologous pericardium for the reconstruction) has also been successfully used for elective renal tumor resection with IVC tumor thrombus.

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