Abstract
Living-donor liver transplant for a big hepatocellular carcinoma located in the caudate lobe is challenging owing to dissemination of cancer cells during recipient hepatectomy. We report a case of living-donor liver transplant using the right side of the liver of a living donor combined with inferior vena cava interposition graft after en bloc resection of the liver and retrohepatic inferior vena cava for hepatocellular carcinoma in the caudate lobe. A 50-year-old man with chronic hepatitis B cirrhosis developed hepatocellular carcinoma in the caudate lobe and segment 5. The diameters of the masses were 4.5 cm and 2.5 cm. His model for end-stage liver disease score was 17, and he had a moderate amount of ascites. For the recipient hepatectomy, en bloc resection of the entire liver, including retrohepatic inferior vena cava and reconstruction of inferior vena cava with Dacron graft, were performed. We then performed a transplant of the right lobe taken from the living donor. This technique can be a new alternative curative treatment option for hepatocellular carcinoma located on the hepatocaval confluence or close to the inferior vena cava. We should evaluate the long-term safety for cancer recurrence and infection of an artificial vascular graft in the milieu of immunosuppression after liver transplant.

Key words: Hepatocellular carcinoma, Living-donor liver transplant, Inferior vena cava, Artificial graft

Introduction
Liver resection has traditionally been considered as the only potentially curative treatment for hepatocellular carcinoma (HCC). Despite improved patient survival owing to advanced surgical techniques and better understanding of the anatomy of the liver, an approach to HCC that involves the hepatocaval confluence or inferior vena cava (IVC) remains challenging. Although liver resection with hepatic vascular exclusion and combined liver resection with partial or complete reconstruction of the retrohepatic IVC has been tried in a few series for this situation, these operations have extended operative times, the surgical risks are higher, and oncologic safety could not be guaranteed.

Liver transplant has recently been accepted as an effective treatment in select patients with HCC and its criteria have been expanded. Conventional deceased-donor liver transplant with resection of the retrohepatic IVC can be a good treatment option for treating HCC involving the IVC. However, if the status of the patient is not urgent, it is difficult to be allocated a liver for a deceased-donor liver transplant in the setting of an organ shortage. Therefore, living-donor liver transplant, combined with resection of the retrohepatic IVC, can be a good alternate treatment for these patients. We report on performing a living-donor liver transplant after total...
hepatectomy with resection of the IVC and reconstruction with a Dacron interposition graft in a patient who had HCC of the caudate lobe and segment 5 who developed decompensated hepatic cirrhosis.

**Case Report**

The recipient was a 50-year-old man with hepatitis B-related liver cirrhosis. He had been managed for ascites and hepatic encephalopathy, which had markedly progressed for the preceding 2 years. On dynamic computed tomography scan, HCC was detected in 2 separate hepatic segments (segment 5 and caudate lobe); the masses were 2.5 (Figure 1A) and 4.5 cm (Figure 1B). Although the mass occupied the entire caudate lobe and was compressing the IVC, there was no evidence of vascular invasion or distant metastases. Alpha fetoprotein level was 15.8 µg/L and the level of protein induced by vitamin K (PIVKA II) was 78.2 AU/L. The Child-Pugh score was 12 points, and the model for end-stage liver disease (MELD) score was 18. Transarterial chemoembolization and local ablative treatment (eg, radiofrequency ablation or percutaneous ethanol injection) were not applied before transplant because they were not a curative option owing to the large mass compressing the IVC. Therefore, living-donor liver transplant with en bloc resection of the retrohepatic IVC was planned to avoid tumor rupture or seeding of the tumor through the draining veins during manipulation. A Dacron graft (Boston Scientific Corp, Natick, MA, USA) was chosen to replace the IVC. The donor was his son (23 years old), and the son had a portal vein trifurcation anomaly. The donor underwent a right hemihepatectomy with preservation of the middle hepatic vein using the ordinary method. The right anterior and posterior portal veins were cut separately and united into a single orifice to anastomose to the recipient portal vein. The graft weight was 778 g and the graft-to-recipient weight ratio was 0.88. On the back table, the V5 and V8 hepatic vein branches were anastomosed to the autologous great saphenous vein in end-to-end and end-to-side fashions.

The procedure for the recipient’s hepatectomy was the same as that of an orthotopic liver transplant. After completion of total hepatectomy, including retrohepatic IVC, the gap of the IVC was interposed with a rifampicin-soaked 30-mm Dacron graft (Figure 2A). The cuffed right hepatic vein of the donor liver was anastomosed to the Dacron grafted IVC in an end-to-side fashion. After the portal vein was anastomosed, both the suprahepatic and
infrahepatic clamps and the clamp on the portal vein were released. Total clamp time of the IVC was 84 minutes, and veno-venous bypass was not needed during the entire anhepatic period for the liver graft. The hepatic artery anastomosis was completed. The pregrafted autologous saphenous vein draining from V5 and V8 was anastomosed to the Dacron graft in an end-to-side fashion (Figure 2B). The bile duct was anastomosed to the recipient's bile duct in an end-to-end type. Total operative time was 550 minutes. The intraoperative Doppler ultrasound examinations showed good blood flow in the portal vein and hepatic artery, and a triphasic wave was noted in the hepatic vein.

Histologic analysis of the explanted liver showed a 3.8 × 3.5 × 3.0 cm mass in the caudate lobe and a 2.5 × 2.5 × 2.4 cm mass in S5. Both tumors were moderately differentiated HCCs, and there was no microvascular invasion. There was no invasion of cancer cells into the IVC.

The patient was discharged on the 21st day after transplant without complications. As of this writing, the patient has been doing well with good graft function without any evidence of recurrence of HCC for 11 months since the transplant (Figure 3).

Discussion

In the present case, the IVC was compressed by its mass, and it was difficult to confirm the presence of invasion preoperatively. Although careful dissection of caudate lobe from the IVC and conventional recipient hepatectomy could be tried, it could have increased the risk of tumor rupture, massive intraoperative bleeding during dissection between the IVC and the caudate lobe, and there might have been spreading of the tumor cells into the systemic circulation. This was not our intent for curative treatment (although there was no consequent invasion to the IVC). Therefore, removal of the entire liver, combined with retrohepatic IVC, was needed to minimize mobilization and maximize oncologic safety. The IVC resection and reconstruction, combined with liver transplant for hepatic malignancy or extensive retroperitoneal tumor involving the IVC or for a patient in an urgent state, have been performed in select cases. In these cases, an autologous iliac vein, a deceased-donor vena cava or a prosthetic graft (including Dacron and polytetrafluoroethylene) have been used for reconstruction of the IVC. This procedure is similar to that of conventional deceased-donor liver transplant (except that we added an artificial vein graft); therefore, the feasibility of our procedure has been established. In most of the above cases, a veno-venous bypass was needed during the entire anhepatic period or during the IVC clamping. However, in the present case, the patient had good hemodynamic stability and no renal dysfunction or metabolic disturbance intraoperatively, including during the 84 minutes of the anhepatic period without veno-venous bypass.

Although an artificial vessel graft, including Dacron, has been used for caval reconstruction in vascular surgery and oncologic surgery, it is not recommended for liver transplant owing to concerns about graft infection in immunosuppressed patients, which can lead to sepsis, pseudoaneurysm formation, or disruption of the condition of the anastomosis. Good results have been reported using a prosthetic graft for venous drainage of the anterior section in a living-donor liver transplant. Moreover, some reports have indicated that a prosthetic graft can be used without serious infectious complications in patients with an infected aortic aneurysm and/or a traumatic penetrating vascular wound. Although it is known that graft infection is more common in a Dacron graft than in a polytetrafluoroethylene graft in the early postoperative period, a rifampicin-soaked vascular graft can effectively reduce the risk of graft-related bacterial infection. Therefore, we chose a rifampicin-soaked Dacron graft as a conduit.
Another concern of prosthetic grafts is patency of the graft. Generally, long-term results regarding graft patency and graft-related complications are acceptable. Although there is a lack of long-term results for graft patency, several case reports have shown good patency during 1- to 11-year follow-up, and one of the largest case series shows favorable results of late prosthetic caval graft patency (> 90%) at a median follow-up of 3 years with long-term anticoagulation therapy. In the case of an anastomotic stenosis, this can be safely managed with radiologic intervention.

The use of a prosthetic graft in a liver transplant has been reported in a few cases. Most of these cases were urgent (which required deceased-donor liver transplant), and another 2 cases of living-donor liver transplant had HCC beyond the Milan and UCSF criteria. Most of these cases showed favorable results regarding tumor recurrence or graft function during 1- to 5-year follow-up.

To the best of our knowledge, we report the first case of living-donor liver transplant with an interposition prosthetic graft of the IVC for the curative treatment of HCC within UCSF criteria. Our results suggest that this technique can be an alternate curative treatment for HCC of the hepatocaval confluence or close to the IVC.

In conclusion, living-donor liver transplant combined with retrohepatic IVC resection with reconstruction with a prosthetic graft is feasible for HCC involving, or next to, the IVC. Further investigations with larger series and longer follow-ups are needed to confirm the oncologic safety and graft patency.

References


