Ex Vivo Liver Resection Followed by Autotransplantation to a Patient With Advanced Alveolar Echinococcosis With a Replacement of the Retrohepatic Inferior Vena Cava Using Autogenous Vein Grafting

A Case Report and Literature Review

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Abstract: Alveolar echinococcosis (AE) of the liver is a rare disease. In advanced cases of this parasitic disease, the inferior vena cava (IVC) can be invaded; in these cases, the optimal treatment is liver transplantation and replacement of the IVC. Considering the donor shortage and the drawbacks of immunosuppressive therapy, ex vivo liver resection followed by autotransplantation may be the first choice for these patients.

We report the first case of advanced AE successfully treated by an ex vivo liver resection, followed by autotransplantation with a replacement of the retrohepatic IVC using autogenous vein grafting. This graft included the following regions: the bilateral great saphenous vein, part of the retrohepatic inferior vena and the middle hepatic vein with no invasion, the inferior mesenteric vein, and part of the side wall of the infrahepatic vena cava. This patient had an uneventful postoperative recovery; currently, she has been enjoying a normal life and is 12 months postoperative with no immunosuppressive therapy or AE recurrence.

In conclusion, ex vivo liver resection followed by autotransplantation with a replacement of the retrohepatic IVC using autogenous vein grafting might be a useful surgical practice for advanced AE.

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Abbreviations: AE = alveolar echinococcosis, DCD = donation after cardiac death, GRWR = graft-to-recipient weight ratio, ICU = intensive care unit, IVC = inferior vena cava, PTCD = percutaneous transhepatic cholangial drainage.

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INTRODUCTION

Hepatic alveolar echinococcosis (AE) is a rare but potentially life-threatening parasitic disease that is characterized by a slow-growing neoplasm with infiltrative growth that includes strong adhesions and invasions to the adjacent structures. It has also been characterized as a chronic, serious, and sometimes lethal parasitic infection that is caused by Echinococcus multilocularis. Although medical therapy may stabilize the lesion in some cases, a definitive cure can only be obtained by a liver resection of the localized masses. Most cases are impossible or difficult to resect due to an advanced stage, which is characterized by an infiltration of the retrohepatic vena cava and biliary tract; only 35% of patients are eligible for partial liver resection, and liver transplantation should be accepted as a life-saving treatment option in patients with AE for whom there is no other medical or surgical treatment option.2,3 However, liver transplantation in patients with hepatic AE remains highly controversial due to shortages of donor organs. Ex vivo liver resection followed by autotransplantation was pioneered by Rudolf Pichlmayr in 1999, who tried to open a new platform for unresectable hepatobiliary malignancies and explore new pathways for liver surgery.1 Ex vivo liver resection and hepatic autotransplantation allow the treatment of otherwise unresectable hepatic AE and expand the scope of liver surgery.2 However, for patients with invasions to the inferior vena cava (IVC), the only treatment option is liver transplantation with a replacement of the IVC, and then, there is a question as to which of the following is the best choice to reconstruct the IVC: a cryopreserved venous graft, an artificial vessel or an autogenous vein.

CASE PRESENTATION

Pretransplant Evaluation and Treatment

A 44-year-old woman with a yellowish discoloration of the skin and eyes due to advanced stage AE was transferred to our center; she came from Lhasa, the capital of the Tibetan autonomous region, which is a pasturing area in southwestern China. Three years ago, the patient was diagnosed with AE by an enhanced computerized tomography (CT); an indirect
echinococcal hemagglutination test was positive, and an anti-\textit{E. granulosus} IgG test was positive. She refused to accept a liver resection and only took albendazole (400 mg) 3 times daily; however, the patient’s status worsened due to the jaundice, abnormal coagulation, and an increasing amount and prolonged duration of menstruation. A standard laboratory biochemical analysis revealed the following results: hemoglobin: 49 g/L, total bilirubin: 269.5 \( \mu \) mol/L, direct bilirubin: 248.1 \( \mu \) mol/L, aspartate aminotransferase: 106 IU/L, alanine aminotransferase: 55 IU/L, albumin: 25 g/L, prothrombin time: 18 seconds, and international normalized ratio: 1.59. An enhanced abdominal CT indicated a large lesion in the right lobe and segment IV; the target invaded the left bile duct, and the left biliary ducts were dilated due to the obstruction (Figure 1A). A CT scan of the head and lungs found no extra-liver targets; therefore, the treatment in the hospital included a transfusion and persistent percutaneous transhepatic cholangial drainage (PTCD). After multidisciplinary discussions, with nearly 3 months of persistent drainage, the patient’s liver function recovered to a normal level. Then, the ex vivo liver resection followed by autotransplantation strategy was introduced to the patient and her family.

The preoperative evaluation included an ECOC score, an imaging scan, and laboratory tests; a preoperative MRI and CT scan depicted the 12.7 \( \times \) 11.4 cm lesion in the right lobe of the liver, invading the right, middle hepatic vein, and the retrohepatic segment of the IVC (Figure 1B and C). Additionally, the right lesion had invaded the left intrahepatic vascular tree and bile duct in the first porta hepatis (Figure 1D). Due to the large target in the right lobe, compensatory hypertrophic growth of the left lateral lobe occurred to meet the requirements of metabolism, the CT indicated that the volume of the enlarged left lateral lobe was 390 mL, and the predictive GRWR was 0.78%. Due to the intrahepatic dissemination, a liver transplantation was chosen as the preferred method of definitive treatment. An ex vivo liver resection followed by autotransplantation was the best choice for this patient due to a shortage of liver grafts from donation after cardiac death (DCD) or living donors. The main preoperative discussion in our group was the use of autogenous veins for the IVC construction. A bilateral great saphenous vein was considered first, part of the retrohepatic inferior vena and the middle hepatic vein with no invasion was considered second, the inferior mesenteric vein followed, and part of the side wall of the infrahepatic vena cava was the last consideration. The surgical procedure and this report have been approved by the ethics committee of West China Hospital of Sichuan University.

### Surgical Practice

This surgery was a collaboration among the liver surgery center, the liver transplantation center, and the vascular center. Our transplantation center has performed over 1050 cases of liver transplantation; of these cases, over 310 cases of living donor liver transplantations have been performed. The surgical practice was based on liver transplantation, and the Mercedes incision was chosen for the abdominal exploration. The large AE target in the right lobe and strong widespread adhesions with the surrounding tissues, the right hemidiaphragm, and the invasion into the retrohepatic segment of the IVC made the recipient hepatectomy more difficult than what is required for other liver diseases (Figure 1E).

Intraoperative confirmation of the invasion to the IVC forced us to perform an IVC resection in the liver and then replace part of the resected IVC with a combination of autogenous vein grafting (Figure 1F). As soon as the liver was completely resected, the liver graft was perfused with 4000 mL of 4°C University of Wisconsin solution via the portal vein. Then, an intraoperative ultrasound sonography was used to make the incision and to guide the parenchyma transaction using an ultrasound knife. The procedure for the parenchyma transaction was similar to liver graft harvesting from living donors, which has been introduced in our previous studies.\(^6\)\(^7\)

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**FIGURE 1.** A: An enhanced CT indicated a large lesion in the right lobe that invaded the left bile duct, and the left biliary ducts were dilated due to the obstruction; B and C: a preoperative MRI scan indicated an invasion of the right and middle hepatic vein and the retrohepatic segment of the IVC; D: a preoperative MRI scan indicated an invading left intrahepatic vascular tree and bile duct in the first porta hepatis; E: a large alveolar echinococcosis target in the right lobe and strong widespread adhesions with surrounding tissues made the recipient hepatectomy more difficult than in patients with other liver diseases; F: the intraoperative findings confirmed the invasion and circumvolution of the retrohepatic segment of the inferior vena cava. CT = computerized tomography, IVC = inferior vena cava.
The total size of the resected left liver graft was 360 g, and the graft-to-recipient weight ratio (GRWR) was 0.72%. Concurrently, the resected part of the IVC was reconstructed with an artificial blood vessel, and then an end-to-side anastomosis was made between the portal vein and the artificial blood vessel for the portacaval shunt (Figure 2). Our third group (vascular surgeon) tried their best to reconstruct the retrohepatic segment of the IVC using the following autogenous veins: the bilateral great saphenous vein, part of the retrohepatic inferior vena and the middle hepatic vein with no invasion, the inferior mesenteric vein, and part of the side wall of the infrahepatic vena cava. Together, these veins made a vena cava vessel that was 5 cm long and 3 cm in diameter, which was then implanted into the patient with end-to-end anastomosis (Figure 3A–H). There are triangular openings in the upper anatomy, and the main reason was a lack of autogenous veins; this opening can also be used to reconstruct the anatomy with the left hepatic vein. The left hepatic vein was directly anastomosed end to side to the suprahepatic IVC with the triangular opening. Venous and arterial reconstructions were performed with the standard method that was mentioned previously regarding the left lobe living donor liver transplantation; the left portal vein was sutured end to end to the main portal vein. The proper hepatic artery was reconnected by end-to-end anastomosis to its left branch (Figure 4A and B), and the left hepatic biliary duct was then drained by a Roux-en-Y hepaticojejunostomy.

During the 102 minutes of the hepatic phase, the patient’s hemodynamics remained nearly stable; all of the surgical procedures lasted for 17 hours. The patient was transfused with 7 units of erythrocyte suspension, 1 unit of platelets, and 1800 mL of fresh-frozen plasma, and the blood loss was approximately 3000 mL. The resected specimen was 780 mL in volume and 760 g in weight. The final pathology report confirmed AE with clear margins.

Postoperative Management

The patient was transferred to the liver transplantation intensive care unit (ICU) and was closely observed and treated. The liver function recovered to normal within 15 days (Figure 5 with no severe complications (grade III or IV according to the Clavien classification system), and renal function was not impaired during the close monitoring. A low-molecular-weight heparin sodium anticoagulation solution (0.6 mL, bid, ih) was used from 2 days after surgery until discharge with no signs of postoperative bleeding, and the patient was given warfarin (2.5 mg, qd, po) for the last 3 months. An ultrasound was used to monitor the cleanliness of the anastomosis of the vessels or the presence of seroperitoneum. An enhanced CT scan on day 14 after the operation indicated the patency of the IVC and no obstruction (Figure 6). There was no requirement for antirejection drugs, such as tacrolimus, mycophenolate mofetil, or prednisone, and no albendazole was required. After 5 months of close follow-up, the patient had recovered very well and had returned to normal life and work 3 months after the surgery.

DISCUSSION

AE is endemic in the northern hemisphere, especially in western China. AE is characterized as a slow-growing parasitic disease that usually invades tissues and organs without clinical
signs or symptoms and resembles a slow-growing liver cancer due to the invasion of surrounding structures and metastasis to distant organs, by either locoregional progression or hematogenous spread. Surgery is the first choice for all patients with AE of the liver, and radical resection of the entire hepatic parasitic lesion is the most likely curative procedure. However, in China, because of a lack of medical resources and because hepatic AE is considered to be a nonmalignant disease, many patients commonly refuse surgery when they have early-stage disease. Thus, many patients miss the best time to undergo resection, even though it should be considered the first choice for early-stage AE patients. Liver transplantation would be the best choice for these cases due to echinococcal dissemination into the host tissues, especially important vascular tissues such as the hepatic hilus, veins, or the IVC. In recent years, over 5 AE patients in our center were too advanced to undergo traditional surgical procedures, and there was no choice except liver transplantation. The optimal choice for a source for liver transplantation for AE is a related deceased donor and rarely living donors; however, due to the shortage of grafts from deceased donors and considering the donors’ safety, the LT for AE patients was limited. From 1996 to today, the WHO informal working group guidelines for echinococcosis state that transplantation should be avoided in patients who could benefit from any other type of treatment; even at the end-stage of the disease, WHO contraindicated liver transplantation in those patients with any possible residual lesions after the transplantation. The main reasons for these recommendations are the requirement for strong immunosuppressive therapy after transplantation and the low level of the anti-infection drug, albendazole, which may enhance the development of the parasitic lesions. However, in our present case, “ex vivo” liver resection followed by autotransplantation of the patient’s own liver and replacement of the IVC with the autogenous veins (the bilateral great saphenous vein, part of the retrohepatic inferior vena and the middle hepatic vein with no invasion, the inferior mesenteric vein, and part of the side wall of the infrahepatic vena cava) was considered the solution of choice. Thus, liver autotransplantation without immunosuppressive therapy may be the ideal choice to facilitate a radical approach; furthermore, no residual target remained, and no albendazole was necessary. Part of the side wall of the infrahepatic vena cava was the last choice for the retrohepatic IVC reconstruction, especially considering the risks for IVS stenosis, thrombogenesis, or renal function damage. The advances of “ex vivo” resection/autotransplantation in AE are more obvious than in liver cancers due to the high rate of recurrence of large-sized and invasive tumors. Thus, we propose that AE may be a specific indication for ex vivo liver resection with better results than in cancer.

The following quote may have been said in jest 20 years ago yet has proven true today: “You should rather resect the parasitic lesions from the diseased liver of the patients after removing it from the patient’s body and re-transplant it.” The success of performing ex vivo resection of AE lesions and autotransplantation of the remaining liver is likely to become an important treatment option.
example of the best indication for the technique. Ex vivo resection (“bench-resection”) of the liver followed by autotransplantation was proposed in the early 1990s by Rudolf Pichlmayr and his group in Hannover. Compared with allotransplantation, the advantages of autotransplantation, including no necessary donor and no necessary immune suppression; these advances were more remarkable for the replacement of the IVC with autogenous veins. In our literature review, although over 60 liver transplantations for advanced AE were reported, fewer than 10 cases used the “ex vivo” resection/autotransplantation technique to treat AE disease, and most of the surgeries were performed in mainland China. However, until now, no case replaced the IVC with autogenous veins, so our present study may be the first of its nature. Due to its advantages, this procedure should be popularized.

This procedure was made possible and easier by the careful preparation of the patient, particularly the use of percutaneous drainage. This drainage may have improved the function of the remaining liver tissue prior to surgery and may have prevented bacterial infection and limited the volume and pressure of the necrotic cavity in the liver, thereby alleviating biliary complications and making an “in situ” resection of the AE lesions possible. The PTCD in our present case was successful; the liver function recovered to normal after 3 months of persistent drainage, and the pretransplantation procedures were also very important. The percutaneous drainage decreased jaundice, solved the obstructive liver function damage, and provided enough time for the remnant liver to grow. Another factor for autotransplantation is the large hepatomegaly that can develop in the left lobe of the liver without cirrhotic changes. Such hepatomegaly has been explained as a slow progression of the parasitic tumor accompanied by liver regeneration to compensate for the loss of a functional liver.

Our first case experience indicates that performing an ex vivo liver resection followed by autotransplantation with a replacement of the retrohepatic IVC with an autogenous vein graft in a patient with an advanced AE is feasible and provides good results. With no alloimplants and no immunosuppressive regimen needed, this technique may also provide an excellent outcome.

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