Transplant International ISSN 0934-0874

CASE REPORT

Utilization of autologous vein graft for replacement of the inferior vena cava in living-donor liver transplantation for obliterative hepatocavopathy

Masafumi Shimoda, Shigeru Marubashi, Keizo Dono, Atsushi Miyamoto, Yutaka Takeda, Hiroaki Nagano, Koji Umeshita and Morito Monden

Department of Surgery, Osaka University Graduate School of Medicine, Osaka, Japan

Keywords
hepatic outflow, inferior vena cava stenosis, metallic stent, obliterative hepatocavopathy, reconstruction.

Correspondence
Keizo Dono, MD, PhD, Department of Surgery, Osaka University Graduate School of Medicine, 2-2 Yamadaoka, Suita, Osaka 565-0871, Japan. Tel.: +81 6 6879 3251; fax: +81 6 6879 3259; e-mail: kdono@surg2.med.osaka-u.ac.jp

Received: 8 May 2007
Accepted: 12 June 2007

doi:10.1111/j.1432-2277.2007.00519.x

Summary

Obliterative hepatocavopathy (OHC) is a subtype of Budd-Chiari syndrome in which stenosis or obstruction of the retrohepatic inferior vena cava (IVC) is observed. Although IVC replacement is necessary in OHC patients, there are hardly any graft vessels available for IVC reconstruction during living-donor liver transplantation (LDLT). Here, we describe a novel technique of IVC reconstruction using only the autologous blood vessels in an OHC patient during LDLT. In this case, sufficient drainage of the hepatic outflow and reconstruction of the venous return from the lower half of the body were simultaneously required. Therefore, we substituted the retrohepatic IVC with the suprarenal IVC of the recipient, and we reconstructed the IVC continuity by using the autologous internal jugular vein and external iliac vein. The operation was safe, and the postoperative venous drainage from the hepatic tributaries was in good condition. This procedure might be an option for IVC replacement during LDLT.

Introduction

Budd-Chiari syndrome (BCS) is a rare clinical condition that results from the obstruction of hepatic venous outflow [1–3]. The obstruction may occur at any level from the peripheral hepatic veins to the inferior vena cava (IVC). IVC obstruction (referred to as obliterative hepatocavopathy, OHC), with or without obstruction of the hepatic veins, is more common in the East than in the West [4,5]. Although it assumes a relatively indolent course, IVC obstruction often leads to hepatocellular carcinoma (HCC) [5]. Liver transplantation for the treatment of this nonclassical type of BCS warrants serious consideration from the perspective of controlling HCC and resolving liver cirrhosis.

During liver transplantation for the treatment of BCS, it is necessary to reconstruct hepatic tributaries to maintain a sufficient outflow from the liver. In addition, IVC reconstruction along with liver transplantation may be necessary in some OHC cases when the collateral venous flow is insufficient; this is performed to prevent renal dysfunctions, lower limb edema, and ascites. Compared to whole liver transplantation wherein the IVC of the deceased donor is available, the selection of vessel grafts to be used as a substitute is crucial for IVC reconstruction during living-donor liver transplantation (LDLT). When only a small area of the IVC is diseased, it is possible to perform cavoplasty by using autologous or donor vein patches to widen the orifice of the hepatic tributaries [6,7]. However, IVC replacement becomes necessary when the degree of IVC stenosis or obstruction is extensive or when a metallic stent has been implanted in the diseased IVC during previous intervention. Although cryopreserved IVC graft, if available, or a synthetic conduit can be used, the associated risks concerning the graft endurance cannot be ignored. To date, autologous vessel grafts would be a practical option for IVC replacement in LDLT; however, the relevant surgical techniques have not

been reported. Here, we report a novel surgical technique for reconstructing the hepatic outflow tract by using autologous vein grafts (recipient's partial IVC and other vessel grafts) during LDLT for an OHC patient.

Case report

A 40-year-old woman who was diagnosed with OHC complicated by multiple HCC was admitted to our hospital for liver transplantation in November 2005. Initial examinations including inferior vena cavography, which was performed in 1994, revealed stenosis of the retrohepatic IVC and occlusion of three hepatic veins. The outflow from the right and middle hepatic veins drained into the left hepatic vein, and that from the liver drained into the pericardial venous sinus. Based on these findings, spiral zigzag metallic stents were inserted into the retrohepatic IVC and left hepatic vein in 1998. HCC was first diagnosed in 1995; since then, the patient has undergone repeated interventions more than 10 times to control the HCC lesions. However, as further interventions were not expected to improve her prognosis, she was referred for liver transplantation; her husband was willing to donate his liver. Informed consent was repeatedly obtained from the patient and her family members. Preoperative inferior vena cavography revealed that the IVC stent was patent (Fig. 1). An IVC occlusion test was performed simultaneously. The IVC pressures before and after occlusion were 16 and 54 cmH_2O, respectively; this led us to conclude that IVC reconstruction was necessary for this patient.

In November 2005, LDLT was performed using the right posterior segment of the liver as the graft. After preparing the hilar structures of the recipient's liver, it was fully mobilized to expose the IVC. As the upper end of the IVC stent was at the level of the suprahepatic IVC, dissection of the diaphragmatic crus was not required. The diaphragm was adhered to the right side of the suprahepatic IVC; therefore, the IVC was circumferentially dissected from the diaphragm and encircled. Veno-venous and porto-venous bypasses were established. The portal vein was dissected at the level of the bifurcation. Subsequently, a German clamp was applied to the suprahepatic IVC, followed by clamping of the infrahepatic IVC. After the IVC was transected immediately below and above the IVC stent, the native liver was excised along with the IVC (Fig. 2a). The length of the IVC defect was

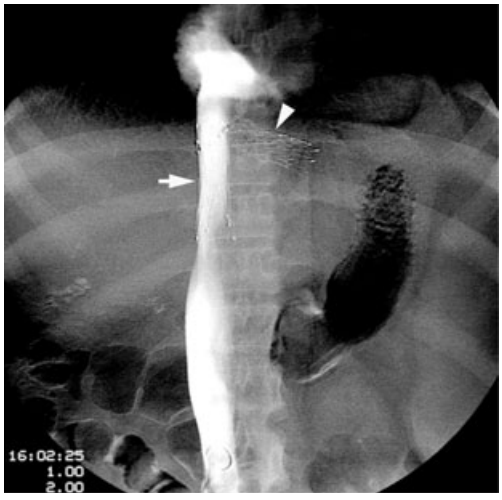

Figure 1 Inferior vena cavography before transplantation revealed that the inferior vena cava (IVC) was patent. The stents inserted into the IVC (arrow) and the left hepatic vein (arrowhead) are visible.

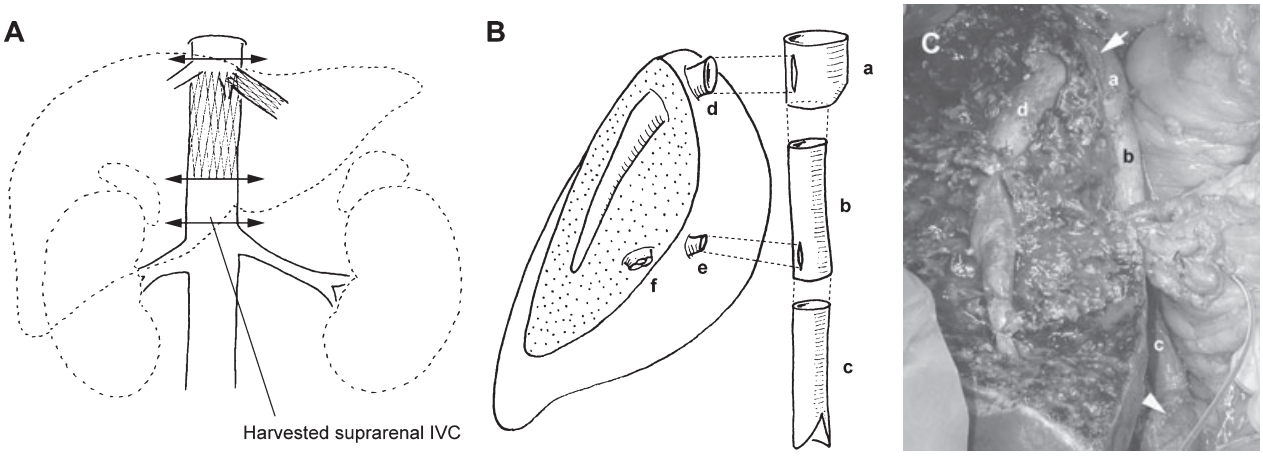

Figure 2 (A) The level of transection of the inferior vena cava (IVC). (B) Schematic representation of the IVC reconstruction by using autologous vein grafts. (C) A photograph showing the complete anastomoses of the vessel. The suprarenal IVC graft (a), right external iliac vein graft (b), left internal jugular vein (IJV) graft (c), right hepatic vein (d), inferior right hepatic vein (e), Glisson's sheath (f), anastomoses of the right hepatic vein and the IVC graft (arrow), and of the IJV and the suprarenal IVC (arrowhead) are indicated.

8 cm. The left internal jugular vein (IJV) and the right external iliac vein (EIV) of the recipient were harvested. The IVC was exposed distally until the renal vein was visible; subsequently, the suprarenal portion of the IVC, measuring 4-cm length, was harvested (Fig. 2a).

The hepatic outflow tract was constructed on the back table (Fig. 2b). To prevent any postoperative blocking of the hepatic outflow, we used the suprarenal IVC graft of the recipient as a drain from the implanted liver. An orifice was created on the lateral side of the IVC graft, and the lower end of the IVC was trimmed and approximated to match the orifice of the EIV graft. While the donor liver was perfused with Belzer UW solution (ViaSpan; Barr Laboratories, Pomona, NY, USA), the orifice of the right hepatic vein was anastomosed to the lateral orifice of the IVC graft using a Prolene running suture. The lower orifice of the IVC graft was anastomosed to the upper orifice of the EIV graft. Subsequently, the orifice created on the lower side of the EIV graft was anastomosed to the inferior aspect of the right hepatic vein. Finally, the IJV graft was anastomosed in an end-to-end manner with the lower end of the EIV graft. After the donor liver was implanted, the suprahepatic IVC stump was anastomosed to the IVC graft using a 4-0 Prolene running suture. The portal vein catheter was removed, and the portal vein trunk was anastomosed to the right portal vein of the donor; subsequently, reperfusion was performed. A longitudinal slit was created in the lower end of the IJV graft, and the suprarenal IVC stump was trimmed to perform an end-to-side anastomosis of these veins using a 5-0 Prolene running suture (Fig. 2c). The operation lasted 14 h, and 2700 ml of blood was lost. No complications occurred during the operation.

Intra-operative and postoperative Doppler ultrasonography showed good venous drainage from the right hepatic vein. Continuous heparin infusion was started from postoperative day 1 with a target activated coagulating time in the range of 150–180 s. From postoperative day 26, heparin was substituted with warfarin potassium, with a target INR in the range of 1.5–2.5. The postoperative course was uneventful. It is now 1 year and 5 months since the transplantation, and the patient is recovering well without any episode of graft dysfunctions or HCC recurrence.

Discussion

Our case simultaneously required sufficient drainage of hepatic outflow and reconstruction of the venous return tract from the lower half of the body. We achieved these requirements by using autologous vein grafts. Cryopreserved IVC has been reportedly used for IVC reconstruction in LDLT [8]. The advantages of using cryopreserved IVC as a vein graft are as follows: it is readily accessible, a sufficient length and diameter can be obtained, and it is easy to process for connection with other veins. The short-term endurance of cryopreserved vein grafts is acceptable. Sugawara *et al.* [9] reported that at a median follow-up of 9 months, anastomotic stricture or thrombosis was not observed when cryopreserved vein grafts were used to reconstruct hepatic tributaries in LDLT. In contrast to the favorable short-term outcome, Kuang *et al.* [10] reported that the long-term result of using cryopreserved vein grafts was unfavorable. They used cryopreserved saphenous and iliac veins as interpositions for reconstructing the portal vein and hepatic artery during LDLT. During the subsequent follow-up period of more than 36 months, eight of the nine grafts showed complications including aneurysm, thrombosis, and stricture. Millis *et al.* [11] reported a high incidence rate (51%) of stenosis or thrombosis of reconstructed portal veins when a cryopreserved iliac vein was used to reconstruct the portal vein in LDLT ($n = 37$). Therefore, the use of cryopreserved veins for the reconstruction of IVC in LDLT may be avoided when the recipients are relatively young and when alternative vein grafts can be used. Meanwhile, autologous nonvascular tissue grafts including the pericardium and the rectus fascia sheath have been utilized [12,13]. However, till date, these grafts have not been commonly used; further, their patency in the short and long terms remains unclear. Occasionally, synthetic conduits are used for IVC reconstruction in hepatectomy for large liver tumors involving the IVC. However, as synthetic grafts are prone to infection and thrombosis, they might not have been suitable for this case [14,15].

On the basis of findings of these reports, we selected autologous vein grafts for IVC interposition. When a right lobe liver graft is used for LDLT, our team often use the IJV and EIV of the recipient for reconstruction of the middle hepatic vein, and we have achieved good patency results. We believe that the use of unilateral IJV and EIV has been justified by the previous reports [16,17]. However, in this case, both IJV and EIV were not suitable for interposition of the retrohepatic IVC because a sufficiently high diameter of the vessel graft was required to achieve adequate hepatic outflow from the tributaries of the implanted liver. Therefore, we used the suprarenal IVC of the recipient as a substitute for the retrohepatic IVC; this technique was first reported by Yamamoto *et al.* [18] during ante-situm hepatectomy with IVC resection. Their team used a synthetic conduit to repair the IVC defect; however, we used autologous IJV and EIV for interposition for the abovementioned reasons. While this novel procedure was being performed, IVC reconstruction along with LDLT was safely accomplished using only autologous vein grafts, which may be

considered more suitable for venous interposition than other allogenec grafts or nonvascular tissue grafts; further, the hepatic venous outflow from the implanted liver was successfully maintained. Moreover, this procedure is not very complicated except with regard to the establishment of porto- and veno-venous bypasses, which is necessary for all cases requiring IVC resection, and harvesting of the suprarenal IVC of the recipient.

In summary, this case illustrates that during LDLT, IVC reconstruction by using autologous suprarenal IVC, IJV, and EIV may be safely performed with minimal complications. This technique may be beneficial for patients undergoing IVC reconstruction along with LDLT.

Authorship

M.S., S.M., K.D., A.M., Y.T., H.N., K.U. and M.M. were all involved in the treatment of the patient, data collection and analysis. M.S., S.M. and K.D. wrote the paper. K.D. and M.M. supervised the study.

References

1. Senzolo M, Cholongitas EC, Patch D, Burroughs AK. Update on the classification, assessment of prognosis and therapy of Budd-Chiari syndrome. *Nat Clin Pract Gastroenterol Hepatol* 2005; **2**: 182.
2. Slakey DP, Klein AS, Venbrux AC, Cameron JL. Budd-Chiari syndrome: current management options. *Ann Surg* 2001; **233**: 522.
3. Valla DC. The diagnosis and management of the Budd-Chiari syndrome: consensus and controversies. *Hepatology* 2003; **38**: 793.
4. Okuda H, Yamagata H, Obata H, *et al.* Epidemiological and clinical features of Budd-Chiari syndrome in Japan. *J Hepatol* 1995; **22**: 1.
5. Okuda K, Kage M, Shrestha SM. Proposal of a new nomenclature for Budd-Chiari syndrome: hepatic vein thrombosis versus thrombosis of the inferior vena cava at its hepatic portion. *Hepatology* 1998; **28**: 1191.
6. Yamada T, Tanaka K, Ogura Y, *et al.* Surgical techniques and long-term outcomes of living donor liver transplantation for Budd-Chiari syndrome. *Am J Transplant* 2006; **6**: 2463.
7. Chardot C, Saint Martin C, Gilles A, *et al.* Living-related liver transplantation and vena cava reconstruction after total hepatectomy including the vena cava for hepatoblastoma. *Transplantation* 2002; **73**: 90.
8. Yan L, Li B, Zeng Y, *et al.* Living donor liver transplantation for Budd-Chiari syndrome using cryopreserved vena cava graft in retrohepatic vena cava reconstruction. *Liver Transpl* 2006; **12**: 1017.
9. Sugawara Y, Makuuchi M, Akamatsu N, *et al.* Refinement of venous reconstruction using cryopreserved veins in right liver grafts. *Liver Transpl* 2004; **10**: 541.
10. Kuang AA, Renz JF, Ferrell LD, *et al.* Failure patterns of cryopreserved vein grafts in liver transplantation. *Transplantation* 1996; **62**: 742.
11. Millis JM, Seaman DS, Piper JB, *et al.* Portal vein thrombosis and stenosis in pediatric liver transplantation. *Transplantation* 1996; **62**: 748.
12. Togo S, Tanaka K, Endo I, *et al.* Caudate lobectomy combined with resection of the inferior vena cava and its reconstruction by a pericardial autograft patch. *Dig Surg* 2002; **19**: 340.
13. Kóbori L, Doros A, Németh T, *et al.* The use of autologous rectus facia sheath for replacement of inferior caval vein defect in orthotopic liver transplantation. *Transpl Int* 2005; **18**: 1376.
14. Szilagyi DE, Smith RF, Elliott JP, Vrandecic MP. Infection in arterial reconstruction with synthetic grafts. *Ann Surg* 1972; **176**: 321.
15. Christenson J, Eklof B. Synthetic arterial grafts. I. General complications. *Scand J Thorac Cardiovasc Surg* 1977; **11**: 37.
16. Crile G. Excision of cancer of the head and neck. *JAMA* 1906; **47**: 1780.
17. Lee SG. Techniques of reconstruction of hepatic veins in living-donor liver transplantation, especially for right hepatic vein and major short hepatic veins of right-lobe graft. *J Hepatobiliary Pancreat Surg* 2006; **13**: 131.
18. Yamamoto Y, Terajima H, Ishikawa Y, *et al.* In situ pedicle resection in left trisegmentectomy of the liver combined with reconstruction of the right hepatic vein to an inferior vena caval segment transpositioned from the infrahepatic portion. *J Am Coll Surg* 2001; **192**: 137.

