


Venous outflow reconstruction in living-donor liver transplantation for Budd–Chiari syndrome involving vena cava

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Budd–Chiari syndrome (BCS) is a refractory veno-occlusive disease involving hepatic veins (HV) and/or inferior vena cava (IVC).¹ Unlike in the West, hepatic IVC is characteristically involved in most BCS patients in the Asia-Pacific region, for example, 93% in Japan² where ironically 90% of liver transplants (LT) are living-donor liver transplantation (LDLT). In deceased-donor LT, HV/IVC lesions in a patient can be totally replaced with a donor's healthy HV/IVC, but not by LDLT, leaving an unresolved dilemma of how to reconstruct HV/IVC in BCS-LDLT.

Conventionally, cavo-plasty, patch-plasty, or artificial graft replacement have been performed; however, once BCS lesions recur, patient mortality remains high.^{3–5} To prevent BCS recurrence, therefore, we developed a new technique for venous outflow reconstruction in LDLT. Briefly, the congested liver is excised with hepatic cava under veno-venous (VV)-bypass assistance (Figure 1a). On a back-table, hepatic IVC is isolated and scrutinized

from not only outside but also inside the vessel under good direct view (Figures 1b,c and 2c; Video S1). After resecting the lesion, only the healthy portion is harvested; reversed the cranio-caudal ends for extra safety (Figure 1c,d); and the originally-caudal end of the auto-cava, that is, the part farthest from BCS lesions, is anastomosed to the intrapericardial IVC root or directly to the right atrium if the IVC root is affected. The remaining gap of IVC is interposed with an artificial graft, if necessary (Figure 2d,e). Then HV is anastomosed to the healthy auto-cava end-to-side. We can thus create the hepatic venous outflow using only healthy blood vessels, thereby minimizing the potential risk of BCS recurrence.

We have performed this procedure in the current four BCS-LDLT patients with 0% disease recurrence and 100% patient survival. Our novel strategy, en bloc excision of the liver with hepatic cava; ex vivo harvest of the healthy part of auto-cava; and its auto-transplant

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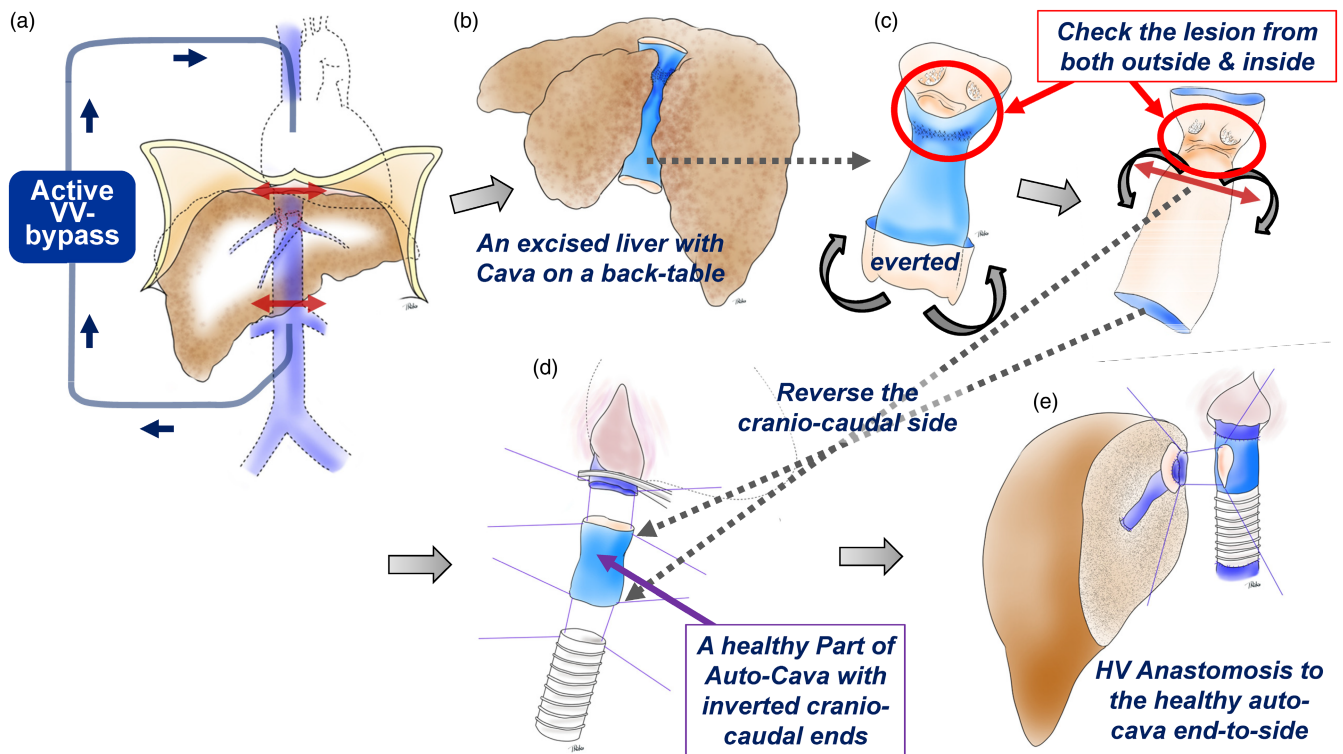


FIGURE 1 Schematic illustration of our surgical technique. (a) The pericardium is opened, in which the IVC root is taped and secured. Then the congested liver is excised en bloc with the hepatic IVC under veno-venous (VV)-bypass assistance as needed (VV-bypass is sometimes unnecessary in chronic BCS with well-developed collaterals, typically azygos and/or hemiazygos veins). To prevent splanchnic congestion, the portal vein is also cannulated to return the splanchnic venous outflow to the superior vena cava via VV-bypass. (b) On a back-table, the hepatic cava is isolated/retrieved from the explanted liver. (c) After examining the lesion from the outside, the cava is everted and also scrutinized from the luminal side. After resecting the diseased portion and then returning the inside/outside eversion, only the healthy part of auto-IVC graft is harvested. (d) Further, to make doubly sure, the cranial side is inverted inferiorly, and the originally caudal end of the auto-cava, that is, the part farthest from the BCS lesions, is anastomosed to the IVC root in the pericardium or directly to the right atrium if the IVC root is affected. (e) Then the liver graft is put-in, and the HV is anastomosed to the healthy auto-transplanted cava in an end-to-side fashion. The remaining gap of IVC is interposed with an artificial graft, if necessary. BCS, Budd–Chiari syndrome; HV, hepatic vein; IVC, inferior vena cava.

venous/caval reconstruction, appears safe and feasible for BCS-LDLT.

AUTHOR CONTRIBUTIONS

K.H. performed the surgery, wrote the manuscript, and managed the patient. T.N., M.K., Y.M., S.K., S.O., and T.I. joined the surgery, managed the patient, and prepared the

clinical details of the case including the video and images. K.Y., K.M., and E.H. supervised the surgery and edited the manuscript. All authors reviewed the manuscript prior to submission.

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to disclose.

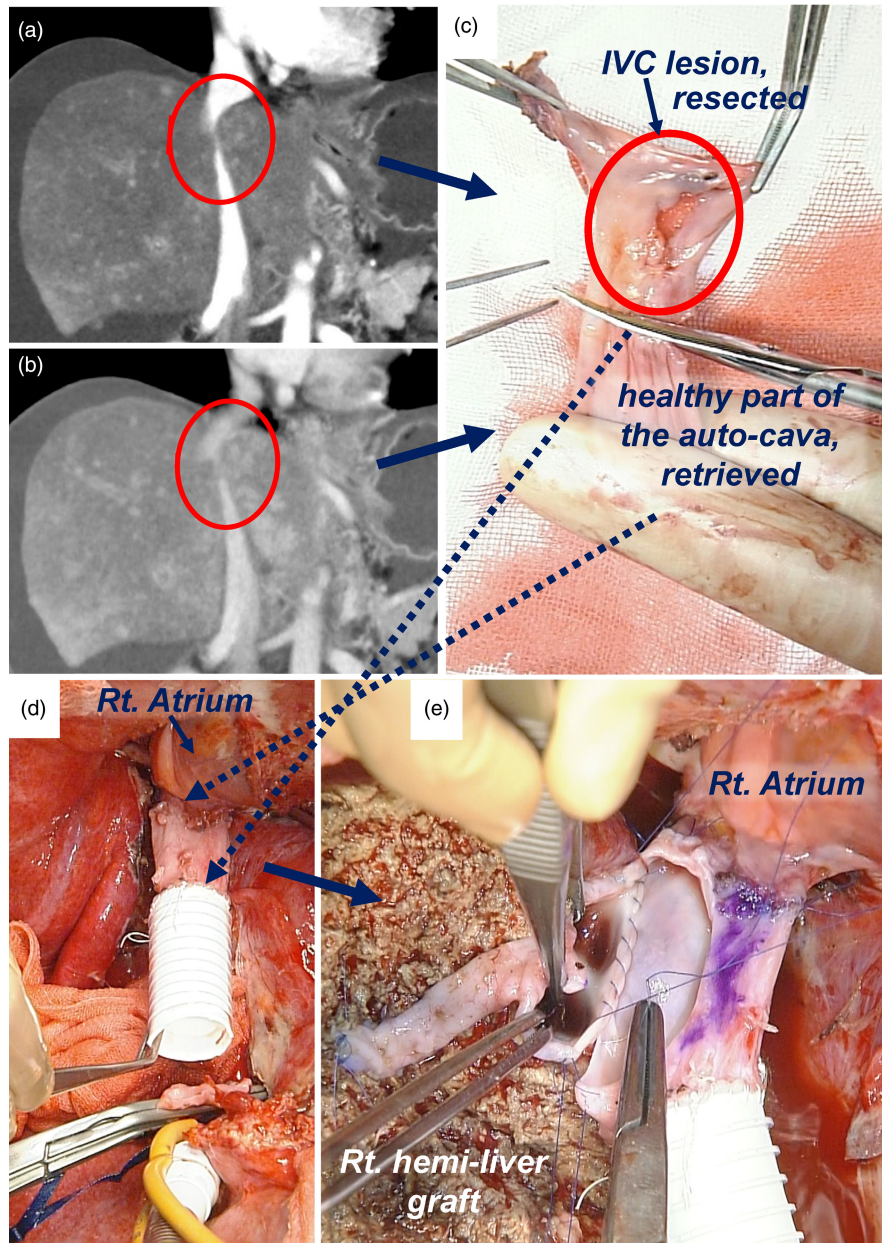


FIGURE 2 Pre- and intraoperative images of the IVC lesion and reconstruction. (a, b) Early/arterial and delayed/venous phases of coronal scan images, respectively, of the preoperative dynamic CT focusing on the IVC lesion. In this case, the IVC lesion was more clearly delineated in the early rather than delayed phases, but not enough to completely identify all the lesions. (c) A representative image showing IVC inspection from inside the vessel (lumen side). Under good direct vision on a back-table, the lesions, for example, obliterated, thrombosed, fibrotic, or even just thickened, can be easily and reliably identified. (d) An image representing IVC reconstruction using the harvested auto-IVC graft, corresponding to [Figure 1d](#). In this case, a ringed expanded polytetrafluoroethylene (ePTFE) graft was used for IVC interposition. (e) An image displaying HV anastomosis of a right hemi-liver graft to the auto-transplanted cava using continuous suture with 5-0 prolene. It is also important to open the IVC wide enough to create a large anastomotic orifice extending halfway around the right (graft) side. This procedure intrinsically reduces the potential risk of post-transplant BCS recurrence by using the autologous IVC that is confirmed healthy from both inside and outside the vessel. Furthermore, to ensure extra safety, the cranial and caudal ends of the harvested auto-IVC are reversed, and the originally caudal end, which is farthest from the BCS lesion and thus considered the healthiest, is anastomosed to the IVC root in the pericardium, that is, the most downstream anastomosis. The patient was discharged 3 weeks post-transplant with no surgical complications. She has been doing well for 2 years afterward with no BCS recurrence. BCS, Budd–Chiari syndrome; CT, computed tomography; HV, hepatic vein; IVC, inferior vena cava.

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REFERENCES

1. Garcia-Pagán JC, Valla DC. Primary Budd–Chiari syndrome. *N Engl J Med*. 2023;388(14):1307–16. <https://doi.org/10.1056/NEJMra2207738>
2. Okuda H, Yamagata H, Obata H, Iwata H, Sasaki R, Imai F, et al. Epidemiological and clinical features of Budd–Chiari syndrome in Japan. *J Hepatol*. 1995;22(1):1–9. [https://doi.org/10.1016/0168-8278\(95\)80252-5](https://doi.org/10.1016/0168-8278(95)80252-5)
3. Pahari H, Chaudhary RJ, Thiagarajan S, Raut V, Babu R, Bhangui P, et al. Hepatic venous and inferior vena cava morphology no longer a barrier to living donor liver transplantation for Budd–Chiari syndrome: surgical techniques and outcomes. *Transplant Proc*. 2016;48(8):2732–7. <https://doi.org/10.1016/j.transproceed.2016.08.009>
4. Ara C, Akbulut S, Ince V, Karakas S, Baskiran A, Yilmaz S. Living donor liver transplantation for Budd–Chiari syndrome: overcoming a troublesome situation. *Medicine (Baltimore)*. 2016;95(43):e5136. <https://doi.org/10.1097/MD.00000000000005136>
5. Yoon YI, Lee SG, Moon DB, Ahn CS, Hwang S, Kim KH, et al. Surgical techniques and long-term outcomes of living-donor liver transplantation with inferior vena cava replacement using atriocaval synthetic interposition graft for Budd–Chiari syndrome. *Ann Surg*. 2019;269(4):e43–e45. <https://doi.org/10.1097/SLA.0000000000002847>

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