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Original article

Parietal peritoneum as a vascular substitute for the reconstruction of donor inferior vena cava in living donor liver transplantation



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ABSTRACT

Living donor liver transplant is technically more difficult than deceased-donor liver transplant because of the shorter and narrower vascular stumps and presence of multiple biliary ducts in partial liver grafts. Division of the vascular structures quickly and precisely is a prerequisite to decrease ischemia time as well as to prevent narrowing in donor vascular structures. Intraoperative vascular complications of donor hepatectomy are under-reported. Here, we report a case of inadvertently cut donor inferior vena cava (IVC) during the division of right hepatic vein (RHV) leading to narrowing of IVC which was repaired successfully using a parietal peritoneal patch from the falciform ligament.

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Introduction

Living donor liver transplantation (LDLT) has obtained worldwide popularity, especially in countries with a shortage of deceased donors' organ pools. However, LDLT may cause morbidity in an otherwise healthy donor who generously takes such an important risk for their loved one. Therefore, donor safety is the primary concern. Modified right lobe grafts are presently preferred by most living donor liver transplant centers. Autologous (explant portal vein or hepatic vein) or cryopreserved (cadaveric iliac vessels) vascular grafts are usually used for neo-middle hepatic vein (MHV) reconstruction in right lobe liver grafts recipients. Similarly, vascular grafts are also used for reconstruction of neoportal vein when the portal vein stump is shorter or Y-type graft in the case of dual portal vein. However, cadaveric vascular grafts are not always available either due to less cadaveric donation or lack of facility to preserve the vascular graft. Synthetic vascular grafts may also be used but they are associated with suture line bleeding or long-term complications like migration or erosion. Although these long-term complications are rare and acceptable in case of patients or recipients, should not be accepted in a healthy donor scenario.

Living donors are selected to evaluate the suitability of the vascular anatomy so that vascular reconstructions are not required in living donor hepatectomy, obviously because of securing donor safety. Intraoperative vascular mishaps during donor hepatectomy requiring vascular reconstruction include the inappropriate plane of transection leading to injury to the middle hepatic vein, narrowing of portal vein stump, or narrowing in inferior vena cava. Literature regarding the management of these intraoperative vascular complications during donor hepatectomy is scarce. Managing these complications may be tricky, especially in selecting the ideal vascular substitute to prevent any long-term morbidity in healthy donors. Here, we described a method to reconstruct donor IVC using a peritoneal patch to prevent narrowing during donor hepatectomy.

Patient and method

A 39 years old healthy female without any significant past medical history except cesarean section 10 years back, was worked up as a liver donor for swap liver transplantation. Her pretransplant blood parameters were normal. Donor protocol computed tomography (CT) showed a Liver attenuation index (LAI) of +13 with a graft weight of 734 g and adequate remnant (34%). Portal vein anatomy was Type A as per Nakamura's classification [1] i.e., the main portal vein trunk branches into right and left portal veins at porta hepatis. The right portal vein (RPV) subsequently divides into anterior and posterior sectional branches at a variable length from the RPV origin. The right hepatic vein (RHV) diameter was 10.8 mm without the presence of any inferior hepatic vein. She underwent a pre-anesthetic check-up

Abbreviations: IVC, inferior vena cava; RHV, right hepatic vein; MHV, middle hepatic vein, CT, computed tomography; LAI, liver attenuation index; PTFE, polytetrafluoroethylene; AST, aspartate aminotransferase; ALT, alanine aminotransferase; SAP, serum alkaline phosphatase INR, international normalized ratio

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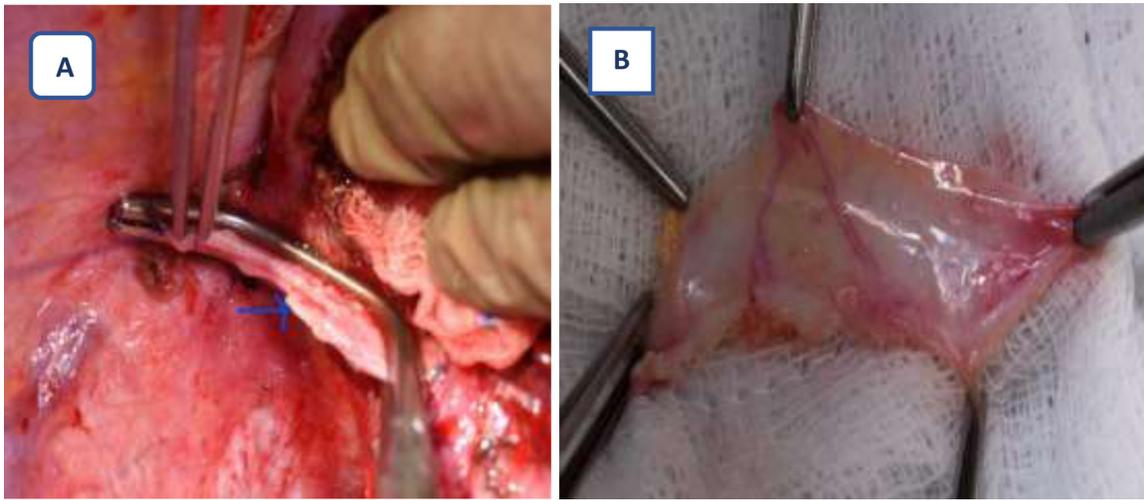


Fig. 1. A. During the division of RHV, an inadvertent cut was made more towards IVC (arrow) that would result in narrowing if the primary repair was attempted Fig. 1 A. During the division of RHV, an inadvertent cut was made more towards IVC (arrow) that would result in narrowing if the primary repair was attempted. Fig 1 B. Fascio-peritoneal patch was harvested from the falciform ligament..B. Fascio-peritoneal patch was harvested from the falciform ligament.

followed by donor hepatectomy with modified right lobe graft i.e. right lobe liver with neo- MHV reconstruction (segment 5 and 8 veins) as per our standard surgical technique [2,3]. The right lobe was mobilized and RHV was looped followed by portal dissection and transection of liver parenchyma. Hanging maneuver was used towards the end of the parenchymal transection. The estimated congestion area was 32%. Division of vascular structures was done in the following order hepatic artery, portal vein, followed by the RHV. During the division of the RHV, it was cut inadvertently more towards donor IVC, resulting in a short stump for the repair of IVC. Direct repair would lead to narrowing of IVC (Fig. 1A). Being a healthy donor, we did not use any synthetic material. We dissected a 4 × 2 cm fascio-peritoneal patch from the falciform ligament (Fig. 1B). The defect on the IVC was repaired with the peritoneal patch with continuous 6-0 polypropylene sutures (Fig. 2A). After releasing

the clamps, there was no suture line bleeding (Fig 2B). Intraoperative doppler did not reveal any narrowing or flow jet across or loss of normal phasicity in hepatic veins. She recovered uneventfully and liver function tests were as expected (Fig. 3). She was discharged on the 7th post-operative day. She is healthy and symptom-free at 3 months follow up and repeat imaging also did not reveal any narrowing of IVC or clot formation (Fig. 5).

Discussion

Improvement in surgical techniques and anesthesia care has improved the outcome of living donor liver transplantation substantially. However, literature regarding intraoperative complications of donor hepatectomy like vascular injuries or other structural injuries is scarce. Division of the vascular and biliary structures during donor

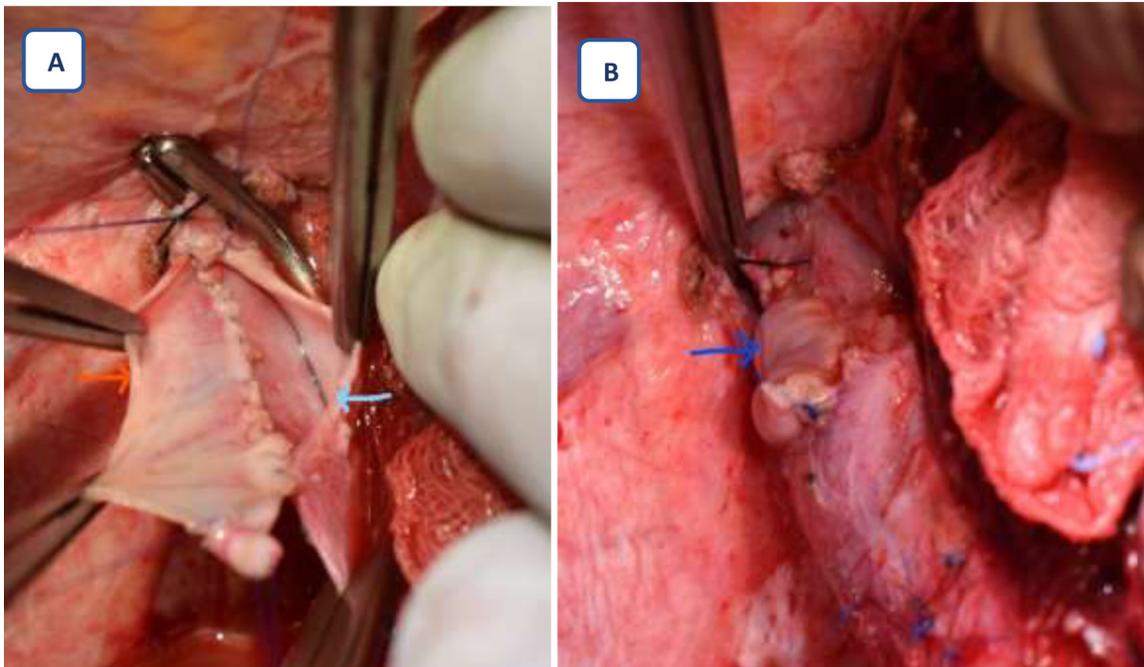


Fig. 2. A. Completed posterior layer anastomosis using polypropylene suture. IVC (blue arrow); peritoneal patch (red arrow) Fig. 2.B. Final appearance after completed patch (arrow) repair after releasing the clamp.

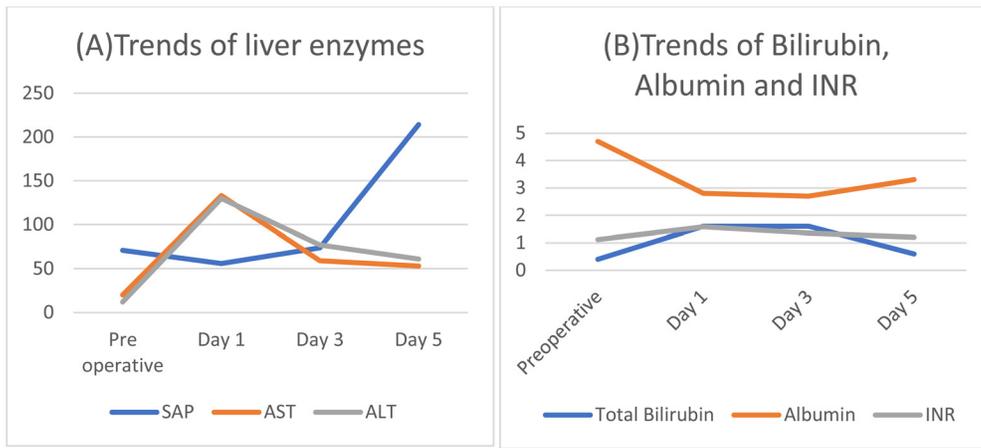


Fig. 3. Trends of laboratory parameters (A) liver enzymes (IU/ml) (B) Bilirubin(mg/dl), Albumin(g/dl) and INR.

hepatectomy is the most crucial irreversible step and is like a double-edged sword. Cutting the structures more towards the donor side may cause narrowing of the structures (Fig. 4) or cut too far away may create a short stump in the graft, which may cause a problem during implantation. Back bleeding from the RHV sometimes obscures visibility and may result in inadvertent injury in IVC. So, cutting the structures at the right place to avoid both the complications, is a prerequisite for a good donor as well as recipient outcome.

Inadvertent cut during the division of RHV may lead to narrowing of IVC (Fig. 4). Sometimes, a transverse closure of a longitudinal defect may not establish the same cylindrical shape of the IVC and may lead to turbulent flow. Kubota et al. showed that closure of a 20–30% defect in the IVC resulted in a 49–64% decrease in the cross-sectional area [4]. Even a little bit of narrowing is not acceptable, especially in healthy liver donors.

Interest in vascular substitutes has increased worldwide with fastly expanding oncological surgeries requiring vascular resection as well as in transplantation. Living tissue substitutes to reconstruct veins use autologous blood vessels from patients (the umbilical, portal, renal, or great saphenous veins). However, they may not be suitable in the living donor scenario, as they increase additional donor site morbidity. Cryopreserved blood vessels from deceased donors

(the femoral vein/artery, inferior vena cava, and aorta) can also be used as a vascular substitute [5–8]. Countries with a less cadaveric donation or lack of facility of cryopreserver may not have the liberty to use it. Additionally, synthetic materials like polytetrafluoroethylene (PTFE) have been used in vascular anastomosis [9,10]. PTFE grafts are readily available but have drawbacks of accidental gastric penetration/migration and nondegradable foreign body [11]. Some surgeons also prefer using anticoagulation postoperatively with synthetic materials, which may not be suitable in living donor scenarios as it can cause additional donor morbidity.

Peritoneal patches have been successfully used to replace venous defects in various reports [12–19]. Peritoneal patches can be effective venous grafts as they are rapidly available and have no additional donor site morbidity, especially in living donor scenarios. Moreover, they do not require any preoperative planning and can be procured from the same abdominal cavity quickly. So, these can be very useful in case of unexpected intra-operative vascular complications. However, there may be some concern regarding thrombogenicity and long-term patency. However, a recent animal study using peritoneum as vascular graft by SH Yoon et al. [20] showed that gradual graft remodeling occurred and was substantially replaced by the neo-media. They also showed that the graft was finally replaced by

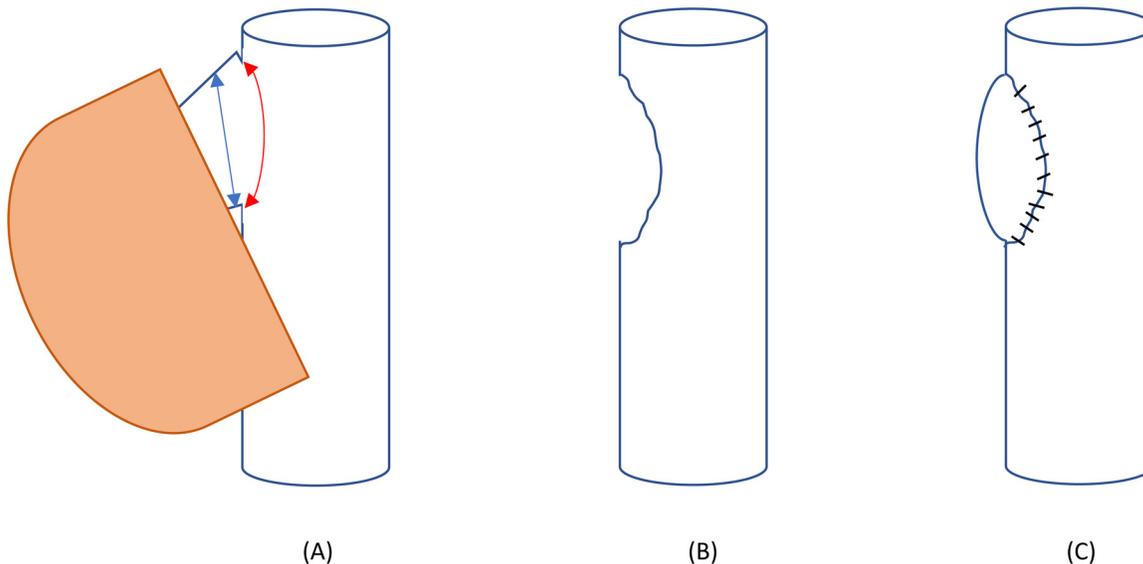


Fig. 4. Schematic diagram showing (A) completed parenchymal transection, before the division of RHV (blue arrow-ideal division line, red arrow-wrong line of division) (B) Inadvertent cut resulting defect in IVC (C) repaired with peritoneal patch.

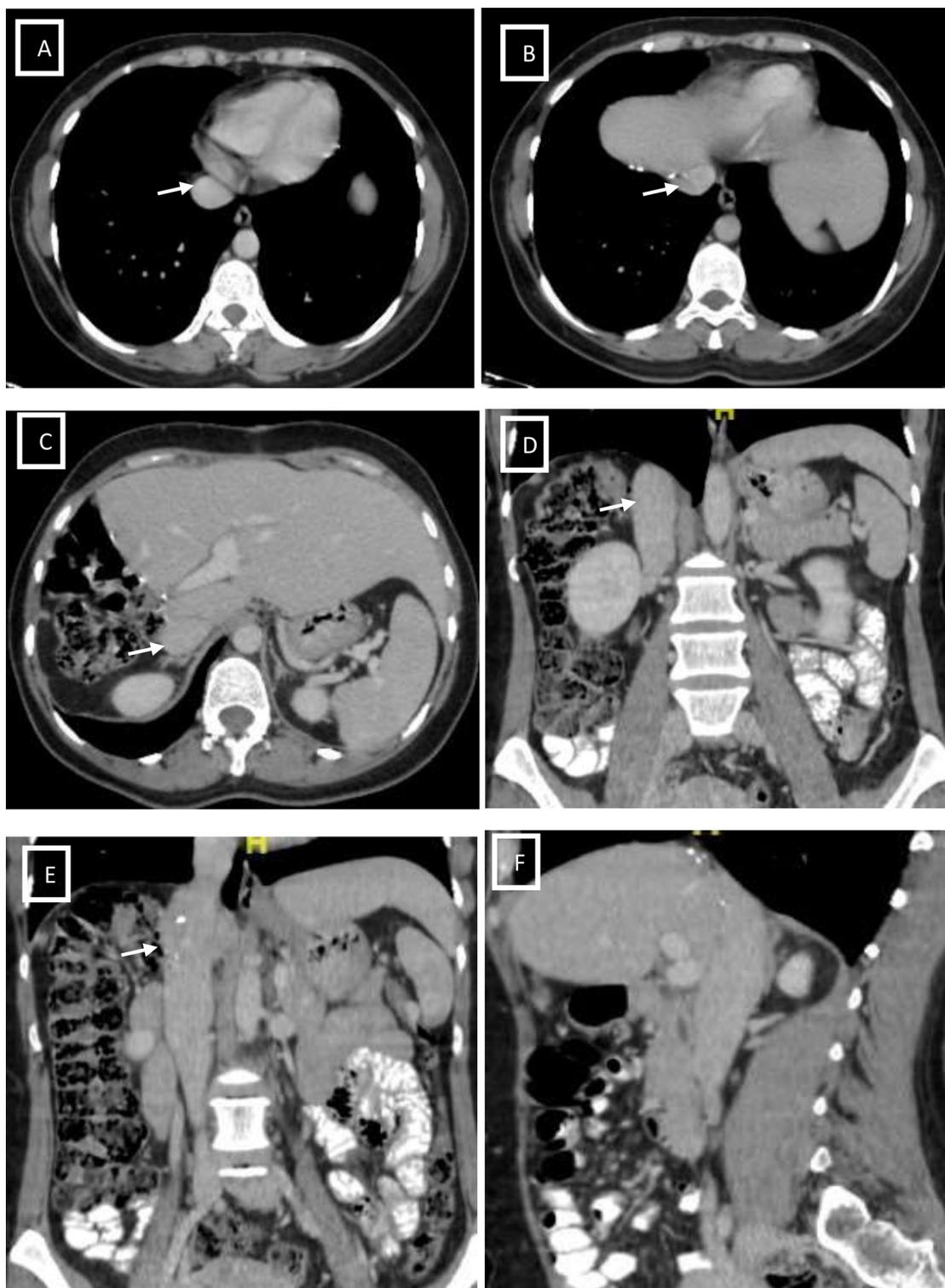


Fig. 5. Follow-up CT scan of the donor. (A–C): Axial images at different levels showing no narrowing or thrombus in IVC (white arrow); (D, E): Coronal images showing no narrowing of IVC (white arrow); (F): Sagittal image showing no narrowing in IVC.

fibrosis with many neendothelial cell proliferation in the newly remodeled graft, indicating vascular collaterals. These results suggest that peritoneal grafts can be promising vascular substitutes for venous reconstruction.

In conclusion, peritoneal patch can safely be used as a vascular substitute in healthy liver donors. Centers with no facility of cryopreserver or less cadaveric donations can use this technique for vascular reconstruction in case of unexpected vascular accidents.

Funding source

None declared.

Consent

Informed consent was obtained for publication of this case.

Ethical approval

All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Declaration of Competing Interest

All the authors declare that they have no conflict of interests.

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