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CASE REPORT

Complex outflow anatomy in left lateral lobe graft and modified venous reconstruction in pediatric living donor liver transplantation

Nikolaos Benetatos, Irene Scalera, John R. Isaac, Darius F. Mirza and Paolo Muiesan

The Liver Unit, Queen Elizabeth Hospital, University Hospital Birmingham NHS Foundation Trust, Birmingham, UK

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graft outflow obstruction, hepatic vein anatomy of the left lateral liver, left hepatic vein, segmental pediatric liver transplantation, venous patch.

Correspondence
Paolo Muiesan MD, FRCS, FEBS, Liver & Intestinal Transplantation & HPB Surgery, Queen Elizabeth Hospital, Birmingham Children's Hospital, University Hospital Birmingham NHS Foundation Trust, 3rd Floor Nuffield House, Edgbaston, Birmingham B15 2TH, UK.
Tel.: +44 0121 371 4654;
fax: +44 121 414 1833;
e-mail: paolo.muiesan@uhb.nhs.uk

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Summary

Hepatic venous outflow reconstruction is of critical significance in pediatric patients undergoing living donor liver transplantation. Accurate knowledge of the anatomical variations is important to obtain appropriate size segmental grafts. The diameter of the hepatic veins and the potential risk of complications at the level of the anastomosis require an adequate primary vascular reconstruction. We describe a venous outflow reconstruction technique, in a living related left lateral lobe graft, with unfavorable hepatic venous anatomy.

Introduction

Living donor liver transplantation (LDLT) in pediatric patients may be technically challenging. The use of left lateral lobe (LLL) demands a meticulous surgical approach as optimal graft function is highly dependent from adequate venous outflow [1]. LDLT grafts are rarely rejected on anatomic findings, and certain surgical difficulties can be overcome with novel techniques [2]. Anatomical variations at this level should be evaluated carefully during the donor hepatectomy as inadequate outflow reconstruction could lead to severe graft dysfunction or loss. We present a case of LLL graft with a complex left hepatic vein (LHV) anatomy and the reconstruction technique used to achieve a wide orifice for a single outflow anastomosis.

Surgical technique

A 7-year-old girl (blood group: A positive, weight: 22.2 kg, height: 118 cm, BSA: 0.85 m^2) with metastatic pancreatoblastoma was referred to our department for liver transplantation. The pediatric patient had been diagnosed with pancreatoblastoma and multiple liver metastases 3 years earlier. The patient received six cycles of chemotherapy with excellent clinical response. The patient underwent staging laparotomy, a distal pancreatectomy and splenectomy. As the metastatic disease was confined to the liver, we offered the option of liver transplantation and LDLT was offered as an option at the time of listing. The only suitable live liver donor was the patient's 35-year-old mother (weight: 66.7 kg, height: 163 cm, BMI: 25.4, blood group: O positive). The LLL (segments 2 and 3, graft weight: 249 g) was an adequate graft providing a graft to recipient weight ratio – (GRWR) > 1. Preoperative liver imaging showed that the donor LLL was supplied by a single left portal vein and single left hepatic artery. Regarding the venous outflow, the most important feature was the presence of four vein branches (one main LHV, one superficial – LHV-S, and two accessories – LHV-A) converging near the confluence of the LHV with the middle hepatic vein (MHV) and inferior vena cava (IVC; Figs 1 and 2). Due to its anatomical variant, the LHV was difficult to isolate and this was possible only after the parenchymal division. The LHV was divided leaving a patch with two larger and two smaller venous orifices which were identified on the back table among multiple smaller venous orifices (Figs 2 and 3a). The LHV cuff was not safe for direct anastomosis, and a vein patch reconstruction using blood group O fresh iliac vein graft from a deceased donor was completed. The vein was trimmed and a U-shaped patch was fashioned (Fig 2). The side wall of the LHV was cut to obtain a sufficient venous diameter (Fig 2). The long limbs of the patch were approximated with running sutures at the LHV edges so that could be act as a cuff at the accessory vein orifices (Fig 3a). The venous orifices were stretched with a mosquito clamp prior to ligation to avoid a "purse-string" effect, and a small grow factor was left to allow further expansion of the Prolene sutures. At the end of reconstruction, a single wide outflow orifice was obtained (Fig 3b). At the recipient, the graft was implanted using the piggyback triangulation technique between the newly reconstructed patch and the triangle-shaped hepatic veins confluence of IVC (Fig 4).

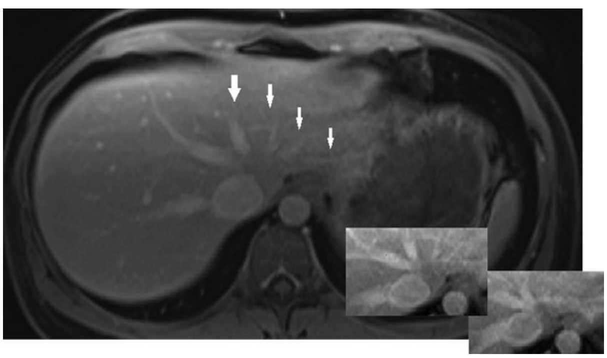

Figure 1 Magnetic resonance scan of the liver showing four left vein branches (arrows) from segments 2 to 3 converging near the confluence of the left hepatic vein with middle hepatic vein and inferior vena cava. At the right lower side, more cranial views have been added to delineate the hepatic vein anatomy at the confluence.

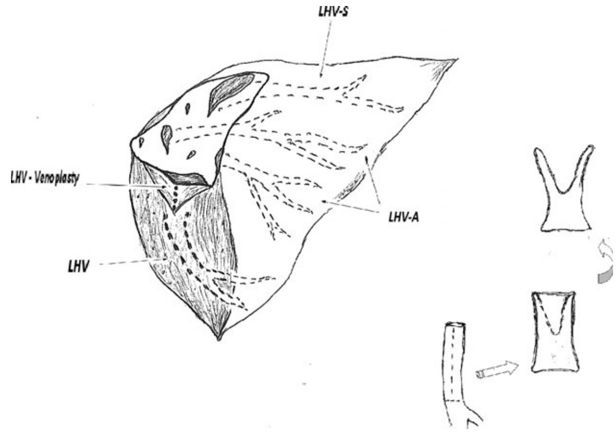

Figure 2 Schematic view of the left lateral lobe graft and the hepatic venous outflow. Two major vein branches [left hepatic vein (LHV) and superficial left hepatic vein] and two accessories (accessory left hepatic vein) converging at the cutline. In addition, several smaller orifices (<5 mm) are present. Because of the small diameter of the LHV orifice, a venoplasty was performed to maximize the caliber and to be able to suture it directly to the inferior vena cava using the triangulation technique. On the right, a schematic view of the "U"-shaped venous graft. A long vein graft was cut longitudinally and trimmed in to a "U"-shaped patch.

Discussion

Living donor liver transplantation and reduced split size grafts have expanded the donor pool for pediatric recipients. The use of short vascular pedicles and the relative anatomical variations render the above techniques challenging and demanding. Isolated venous outflow variations can be managed safely with technical modifications [2]. However, combined inflow and outflow anatomical anomalies can preclude donation [2,3]. When the LLL graft is used, the existence of several segmental veins emptying less than 1 cm from the IVC can add difficulty of vascular control and create the need for intraparenchymal dissection in the donor. In addition, a variant seen in 5–10% of cases, where the segment III hepatic vein joins the MHV individually, needs a different type of reconstruction than the all in one technique [3–7].

The high incidence of venous outflow complications in segmental grafts in pediatric LDLT may be attributed to a small anastomotic orifice twisting during regeneration or to stenosis of the suture line [8,9]. This leads to graft congestion, causing parenchymal injury and portal hypertension. Although successful treatment with radiological stents has been reported [10], failed management almost invariably leads to re-transplantation. Different techniques of reconstruction of hepatic vein tributaries [1,3,8,9,11,12], in

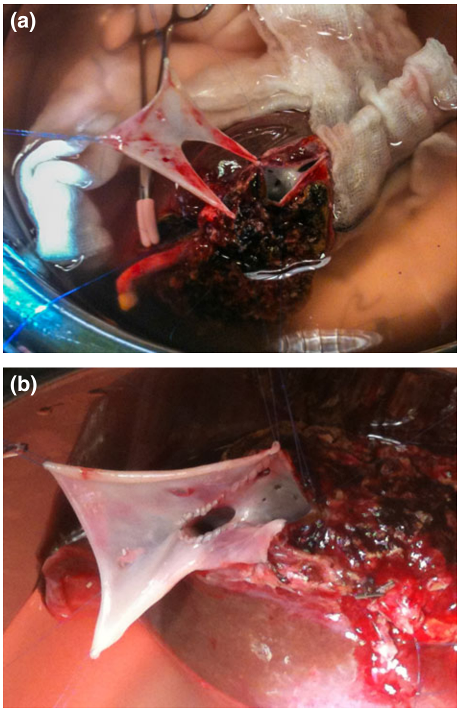

Figure 3 (a) The U-shaped vein patch fashioned. The venous orifices were stretched with a mosquito clamp prior to ligation to avoid a "purse-string" effect. The long limbs of the patch approximated with running sutures at the left hepatic vein (LHV) side edges, to create a wide vein flap sheet; this was sutured around the outflow channel of the liver graft to act as a triangular vein patch. A small grow factor was left to allow expansion of the Prolene sutures. (b) The "U"-shaped vein patch acts as a cuff at the accessory vein orifices. The patch can help vessel orientation and position of the graft in the cavity in the pediatric recipient operation. At the end of reconstruction, a single wide outflow orifice was obtained. The venoplasty at the side wall of the LHV optimizes the caliber of the orifice. The venous patch can be refined to adjust the size of the new orifice to the recipient inferior vena cava diameter.

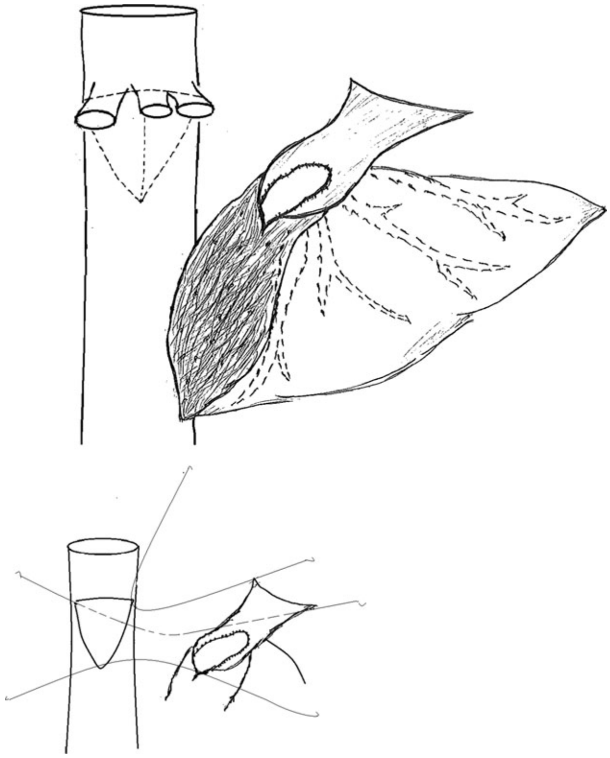

Figure 4 Schematic view of the orientation of the graft during the implantation and the use of the reconstructed wide orifice to maximize venous outflow. The newly reconstructed venous patch was trimmed to fit the triangle-shaped hepatic veins confluence of the inferior vena cava, and the graft was implanted using the piggyback triangulation technique.

distinct variants in LLL venous anatomy [4–6], have been described to avoid graft congestion. The surgical difficulty in these anatomical variations depends on the cutting distance of the LLL veins from the MHV and IVC, from the vessel diameter, and from the extraparenchymal length of the LLL veins [3,5,7].

We described a case of LDLT, where separate large veins form the LHV at the level of the IVC, a variant seen in 5–14% of cases [3–6]. A long patch of a single orifice vein was impossible to obtain without compromising the MHV, as all tributaries were close to the cutting line. The U-shaped reconstruction using a fresh vein graft from a deceased donor was ideal for creating a satisfactory size anastomosis, considering that venous outflow complications are often the result of anastomotic kinking [9] and that precise positioning of the graft and orientation of the vessels in the recipient operation are essential factors to maintain optimal venous drainage [1,9].

Using this technique, we were able to include all the LLL veins in one wide orifice and to obtain sufficient length for an end to side anastomosis to the IVC. On the other hand, the venoplasty applied at LHV orifice offered the advantage of a wide ostium of this branch which could be directly anastomosed to the IVC caudally with the triangulation technique.

The concept of our approach was to achieve a short direct anastomosis of the U graft with IVC minimizing the possibility of twisting or kinking [10] and to avoid stenosis of the suture line at the level of LHV as the original size of the LHV orifice was not satisfactory. The hepatic vein reconstruction using this technique could decrease the possibility of late outflow obstruction because of the short length of the patch and the direct anastomosis of the wide orifice of the LHV with the IVC.

In summary, LDLT is an established approach to expand the donor pool for pediatric patients. Adequate outflow is a critical factor for optimal graft function through the growth of the child to adulthood. Knowledge of the hepatic vein anatomical variations, the use of a safe approach in both donor and recipient operations, and the implementation of different surgical techniques are essential to maintain a good quality outflow. The application of our technique offers a practical approach which takes into account not only the early but also the possibility of late onset complications of outflow obstruction due to changes in graft volume and position associated with growth. This may facilitate the decision to accept a live donor candidate even in the presence of this kind of complex LLL venous anatomy.

Authorship

NB: wrote the manuscript, assisted with the donor graft vein reconstruction and performed the drawings. IS: assisted with the donor liver resection. JI: assisted with donor liver resection. DFM: performed the recipient operation. PM: performed liver donor resection, vein reconstruction of the donor graft and critically revised the manuscript.

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References

1. Sakamoto S, Egawa H, Kanazawa H, *et al.* Hepatic venous outflow obstruction in pediatric living donor liver transplantation using left-sided lobe grafts: Kyoto University experience. *Liver Transpl* 2010; **16**: 1207.
2. Varma V, Mehta N, Kumaran V, Nundy S. Indications and contraindications for liver transplantation. *Int J Hepatol* 2011; **2011**: 121862. Epub 2011 Oct 5.
3. Hwang S, Kim KH, Kim DY, *et al.* Anomalous hepatic vein anatomy of left lateral section grafts and customized unification venoplasty for pediatric living donor liver transplantation. *Liver Transpl* 2013; **19**: 184.
4. Reichert PR, Renz JF, D'Albuquerque LA, *et al.* Surgical anatomy of the left lateral segment as applied to living-donor and split-liver transplantation: a clinicopathologic study. *Ann Surg* 2000; **232**: 658.
5. Cheng YF, Huang TL, Chen CL, *et al.* Variations of the left and middle hepatic veins: application in living related hepatic transplantation. *J Clin Ultrasound* 1996; **24**: 11.
6. Wind P, Douard R, Cugnenc PH, Chenallier JM. Anatomy of the common trunk of the middle and left hepatic veins: application to liver transplantation. *Surg Radiol Anat* 1999; **21**: 17.
7. Yan JQ, Becker T, Neipp M, *et al.* Surgical experience in splitting donor liver into left lateral and right extended lobes. *World J Gastroenterol* 2005; **11**: 4220.
8. Kilic M, Aydinli B, Aydin U, Alper M, Zeytunlu M. A new surgical technique for hepatic vein reconstruction in pediatric live donor liver transplantation. *Pediatr Transplant* 2008; **12**: 677.
9. Tannuri U, Mello ES, Carnevale FC, *et al.* Hepatic venous reconstruction in pediatric living related donor liver transplantation – experience of a single center. *Pediatr Transplant* 2005; **9**: 293.
10. Buell JF, Funaki B, Chronin DC, *et al.* Long-term venous complications after full-size and segmental pediatric liver transplantation. *Ann Surg* 2002; **236**: 658.
11. Sakamoto S, Shigeta T, Hamano I, *et al.* Graft outflow venoplasty on reduced left lateral segments in living donor liver transplantation for small babies. *Transplantation* 2011; **91**: e38.
12. Concejero A, Chen CL, Wang CC, *et al.* Donor graft outflow venoplasty in living donor liver transplantation. *Liver Transpl* 2006; **12**: 264.