Management of venous stenosis in living donor liver transplant recipients

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Author contributions: Xu MQ and Yan LN contributed equally to this work; Xu MQ, Yan LN and Yang J designed research; Lu WS, Li X and Xu MQ contributed to interventional procedures; Xu MQ, Yan LN, Shi ZR, Li B, Wen TF, Wang WT and Yang JY contributed to clinical LDLT work; Yang J and Xu MQ wrote the paper.

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Received: June 28, 2009 Revised: September 1, 2009 Accepted: September 8, 2009 Published online: October 21, 2009

Abstract

AIM: To retrospectively evaluate the management and outcome of venous obstruction after living donor liver transplantation (LDLT).

METHODS: From February 1999 to May 2009, 1 intraoperative hepatic vein (HV) tension induced HV obstruction and 5 postoperative HV anastomotic stenosis occurred in 6 adult male LDLT recipients. Postoperative portal vein (PV) anastomotic stenosis occurred in 1 pediatric left lobe LDLT. Patients ranged in age from 9 to 56 years (median, 44 years). An air balloon was used to correct the intraoperative HV tension. Emergent surgical reoperation, transjugular HV balloon dilatation with stent placement and transfemoral venous HV balloon dilatation was performed for HV stenosis on days 3, 15, 50, 55, and 270 after LDLT, respectively. Balloon dilatation followed with stent placement via superior mesenteric venous approach was performed for the pediatric PV stenosis 168 d after LDLT.

RESULTS: The intraoperative HV tension was corrected with an air balloon. The recipient who underwent emergent reoperation for hepatic stenosis died of hemorrhagic shock and renal failure 2 d later. HV balloon dilatation via the transjugular and transfemoral venous approach was technically successful in all patients. The patient with early-onset HV stenosis receiving transjugular balloon dilatation and stent placement on the 15th postoperative day left hospital 1 wk later and disappeared, while the patient receiving the same interventional procedures on the 50th postoperative day died of graft failure and renal failure 2 wk later. Two patients with late-onset HV stenosis receiving balloon dilatation have survived for 8 and 4 mo without recurrent stenosis and ascites, respectively. Balloon dilatation and stent placement via the superior mesenteric venous approach was technically successful in the pediatric left lobe LDLT, and this patient has survived for 9 mo without recurrent PV stenosis and ascites.

CONCLUSION: Intraoperative balloon placement, emergent reoperation, proper interventional balloon dilatation and stent placement can be effective as a way to manage hepatic and PV stenosis during and after LDLT.

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Key words: Living donor liver transplantation; Venous obstruction; Anastomotic stenosis; Venoplasty; Stent

Peer reviewer: Dr. Ursula M Gehling, Department of Hepatobiliary Surgery and Visc., University Hospital Hamburg-Eppendorf, Martinistrasse 52, Hamburg 20246, Germany

Yang J, Xu MQ, Yan LN, Lu WS, Li X, Shi ZR, Li B, Wen TF, Wang WT, Yang JY. Management of venous stenosis in living donor liver transplant recipients. World J Gastroenterol 2009; 15(39): 4969-4973 Available from: URL: http://www.wjgnet.com/1007-9327/15/4969.asp DOI: http://dx.doi.org/10.3748/wjg.15.4969

INTRODUCTION

Vascular complications after liver transplantation (LT) include occlusion or stenosis at the site of anastomosis in the hepatic artery, portal vein (PV) and hepatic vein (HV). Venous obstruction after LT, including HV outflow obstruction and PV stenosis, is a relatively uncommon but important complication after LT especially living donor liver transplantation (LDLT) and split liver transplantation (SLT). The incidence of HV

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obstruction varies from 5.3% in a series of LDLTs to 12.9% in a series of reduced-size livers. It occurs more frequently in pediatric liver transplants where a small graft may twist around the HV anastomosis. When hepatic outflow obstruction occurs, hepatic congestion can cause massive ascites and hepatic dysfunction. With the increase in cases of LDLT and SLT, management of HV outflow obstruction has become an important issue.

PV stenosis is a relatively rare complication after LT and it sometimes leads to life threatening events due to gastrointestinal bleeding or graft failure. PV stenosis affect 2%-14% of transplant recipients in children. With LDLT, left lobe segments are frequently used as grafts. During left lobe graft transplantation, the extrahepatic PV slants to the right posterior, and the PV rotates backward to the left anterior into the liver. Stenotic areas almost always exist near the flexion. As the liver graft grows, it may kink or compress the flexion.

Recently, interventional procedures including balloon dilatation and stent placement have been widely accepted as treatments of choice for the management of venous obstruction after LT. Since the first successful treatment using percutaneous balloon dilatation by Raby et al., several methods of portal venoplasty have been reported for the treatment of PV stenosis using percutaneous transhepatic, transjugular intrahepatic, transfemoral venous, or transileocolic venous approaches. Stent placement has also been widely accepted as a treatment of choice for the management of venous obstruction after LT. Metallic stents have been used to treat recurrent and elastic stenosis.

Thus, the aim of this study was to evaluate retrospectively the management and outcome of HV and PV stenosis after LDLT in one single center.

**MATERIALS AND METHODS**

**Patients**

Between February 1999 and May 2009, 223 cases of LDLT were performed in West China Hospital. A total of 7 male recipients developed postoperative hepatic and/or PV obstruction/stenosis (Table 1). Patients ranged in age from 9 to 56 years (median, 44 years). HV obstruction/stenosis was diagnosed in 6 adult male patients after LDLT, including 1 intraoperative HV tension, 3 early-onset HV-vena cava anastomosis stenosis, and 2 late-onset HV-vena cava anastomosis stenosis after LDLT. One intraoperative HV tension was suggested by hepatic congestion and confirmed at the same time during LDLT. HV tension was induced by the small right lobe liver graft falling into the deep right upper abdomen. Three early-onset HV stenosis was confirmed 3, 14 and 15 d post LDLT, respectively. Two late-onset HV-vena cava anastomosis stenosis was diagnosed 51 and 180 d after LDLT, respectively. Extrahepatic PV anastomotic stenosis was diagnosed in 1 male pediatric patient who was treated with left lobe LDLT 140 d post LDLT.

Postoperative HV and PV stenosis was suggested by intractable ascites and confirmed by means of Doppler ultrasonography (HV flow velocity < 10 cm/s; PV flow velocity < 12 cm/s) and percutaneous portography followed by interventional procedures.

**Management of HV obstruction**

The treatment procedures were shown in Table 1. One intraoperative HV obstruction was corrected with a balloon filled with 75 mL air during LDLT; the balloon was placed under the liver to underlay the graft. Emergent laparotomy was performed for 1 patient with abdominal bleeding 3 d post LDLT, and HV stenosis was diagnosed during the operation. Abdominal bleeding came from liver incision rupture, which was the result of severe hepatic congestion induced by HV stenosis. Liver rupture repair and HV-vena cava re-anastomosis were performed. Transjugular HV balloon dilatation and metallic stent placement were performed for the other two early-onset HV stenosis on the 15th and 50th d post LDLT, respectively. Transfemoral venous balloon dilatation was performed for the two late-onset HV stenosis on the 55th and 270th d post LDLT, respectively.

**Management of PV stenosis**

As shown in Table 1, the pediatric patient with PV anastomotic stenosis received PV balloon dilatation and plastic stent placement 168 d post LDLT. All procedures were performed under general anesthesia. A new approach was employed for balloon dilatation and stent placement: the approach via the superior mesenteric vein. A small incision was made in the middle upper abdomen. Balloon dilatation and a 10 mm × 30 mm intravascular plastic stent placement were performed via superior mesenteric venous puncture. The diameter of the venous stent was about 1.0 cm. Immediately after the procedure, the patient underwent systemic anticoagulation with heparin-sodium for 7 consecutive days to maintain a partial thromboplastin time and INR of 1.5 times higher than normal levels. Follow-up data were obtained with routine clinical examination and Doppler sonography surveillance on days 1, 2, 3, and 7, at 2 wk and at 1 and 2 mo post procedure.

**RESULTS**

The results are shown in Table 1. The balloon underlying the liver graft during LDLT eliminated postoperative HV tension induced venous obstruction, and the balloon was removed on the 12th postoperative day. There was no outflow obstruction detected by ultrasonography before and after removal of the balloon. This patient has survived for 1.5 mo without ascites and hepatic congestion now.

The patient who underwent emergent operation for liver graft fracture bleeding induced by severe hepatic congestion died of hemorrhagic shock and renal failure 2 d later. Transjugular and transfemoral venous HV balloon dilatation was technically successful in each of 2 patients. In these 4 patients, the patient receiving...
### Table 1  Management and outcome of HV and PV obstruction/stenosis during and post LDLT

| Case | V-O | LDLT | Age (yr) | Diagnosis and management time | Management | Survival | Complication |
|------|-----|------|---------|--------------------------------|------------|----------|--------------|
| 1    | HV T | RL   | 46      | Intraoperative                  | Balloon underlaying | > 1.5 mo, alive | -            |
| 2    | HV S | RL   | 45      | 3, 3 d post LDLT                | Re-anastomosis    | 2 d, dead | H-S, RF      |
| 3    | HV S | RL   | 44      | 14, 15 d post LDLT              | Transjugular BD + stent | off the trail | Bloody ascites |
| 4    | HV S | RL   | 56      | 14, 50 d post LDLT              | Transjugular BD + stent | 2 wk, dead | LF, RF       |
| 5    | HV S | RL   | 43      | 51, 55 d post LDLT              | Transmeporal vein BD | > 8 mo, alive | -            |
| 6    | HV S | RL   | 39      | 180, 270 d post LDLT            | Transmeporal vein BD | > 4 mo, alive | -            |
| 7    | PV S | LL   | 9       | 140, 168 d post LDLT            | trans-superior mesenteric venous BD + stent | > 9 mo, alive | -            |

BD: Balloon dilatation; H-S: Hemorrhagic shock; HV-H: Hepatic vein hemorrhage; HVS: HV stenosis; HV T: HV tension; LF: Liver failure; LL: Left lobe; PVS: Portal vein stenosis; RF: Renal failure; RL: Right lobe; V-O: Venous obstruction. LDLT: Living donor liver transplantation.

### Discussion

Although it is a relatively uncommon complication, venous obstruction after LT, including HV and PV stenosis, can induce severe complications such as hepatic congestion, portal hypertension, massive ascites, hepatic necrosis and hemorrhage, hepatic dysfunction, and even liver failure and death. Thus venous obstruction after LT is a critical problem for the recipient. Intraoperative HV or PV obstruction can be corrected with re-anastomosis. Tissue expanders or Foley catheters can also be employed to reposition the graft to improve HV and PV outflows induced by graft malposition during LT. Key points in HV and PV outflow reconstruction include: (i) size of anastomotic orifice, (ii) length and orientation of vessels, and (iii) position of the graft. Excluding vessel anastomotic techniques, the main factor in intraoperative venous outflow blockade is graft malposition. Severe HV obstruction shortly after transplantation is a surgical emergency, and reoperation is usually necessary for correction. On the other hand, because of fibrotic changes around the anastomotic site, surgical correction is usually difficult for the late-onset HV outflow obstruction and PV stenosis. Thus interventional procedures were a treatment of choice for the management of venous stenosis after LT. The reported initial technical success rate was between 76% and 100%.

In our study, the incidence rates of HV and PV stenosis was 2.7% and 0.04%, respectively. Several types of modified vascular reconstruction technology were used to avoid HV anastomotic stenosis: (1) the HV-HV anastomosis should be performed by a triangular opening of the inferior vena cava (IVC); (2) size matching of the donor HV to that of the recipient. If the donor HV is smaller than that of the recipient, patching of the great saphenous vein (GSV) graft could be used for the donor HV plastic; (3) a technique of “end-to-side vertical anastomosis” between the right HV or the inferior right HV (IRHV). The triangle-shaped hole has better stability, so the rate of stenosis and obstruction was very low. This also ensured the long-term patency of the anastomotic stoma. However, 7 patients with venous obstruction occurred at different phases: during the LDLT operation, in the early post-LDLT period (< 1 mo) and the late post-LDLT period (> 1 mo), respectively. One intraoperative HV obstruction was corrected with a balloon filled with air during LDLT, and the balloon was removed 12 d later without recurrent obstruction and any complications. One HV obstruction occurred 3 d after LDLT induced liver graft incision fracture and massive bleeding; although emergent hepatic rupture mending and HV-vena cava re-anastomosis were performed, this patient died of hemorrhagic shock and renal failure 2 d later. Both transjugular HV balloon dilatation and stent placement procedures for HV stenosis occurring in early phase were technically successful. Although balloon angioplasty has been accepted as the safe and effective initial treatment to manage HV outflow abnormalities, it may induce rupture of the fresh anastomosis and may be ineffective for eliminating various etiologies of venous outflow obstruction in the early post-transplant period. Thus, the outcome of balloon dilatation and stent placement for the 2 early-onset HV stenosis were good in our study. The early (15 d post LDLT) transjugular balloon dilatation and stent placement induced massive bloody ascites 1 wk later, and the HV anastomosis bleeding may have been the cause of bleeding ascites. This patient left hospital and disappeared. Although the transjugular balloon dilatation and stent placement on the 50th postoperative day...
in the other one patient prevented HV anastomosis bleeding, the preexistence of massive asciites, liver injury and renal dysfunction induced by the early-onset HV stenosis eventually resulted in the patient’s death 2 wk later. However, the outcome of balloon dilatation for the two late-onset HV stenosis patients was good. These 2 patients have survived for more than 8 and 4 mo without recurrent stenosis and venous anastomosis bleeding, respectively.

The percutaneous transhepatic approach is the traditional method of PV stenosis interventional management. Our approach of preference was the trans-superior mesenteric venous approach. The first reason for this was the child's noncooperation for the percutaneous transhepatic approach under local anesthesia. The second reason was the risk of injury to the liver, the intrahepatic bile duct and artery, which could lead to liver damage, bile leakage, and hemorrhage, respectively. The good exposure of the superior mesenteric vein was the third cause, usually because of nonsevere adhesions or scar tissue surrounding the superior mesenteric vein after LT. As the PV is the linear prolongation of the superior mesenteric vein, superior mesenteric vein puncture, sheath intervention and placement of the guidewire into the PV, balloon dilatation and stent placement were easily performed. As the superior mesenteric vein puncture hole was sutured with 5-00 blood vessel suture (Proline), venous injury was not present. Postoperative paralytic ileus reported in the previous study[16] was not present in this child. This child has survived for 9 mo with normal liver function, without venous thrombosis and recurrent venous stenosis now. This effective result suggested that a plastic stent could be used to treat pediatric venous stenosis after LDLT.

In conclusion, the results in our study suggested that the use of balloon filled with air to improve HV tension in malposed liver allograft is a simple and effective method during LDLT. Although balloon dilatation and stent placement is a safe and effective treatment to manage HV stenosis in the late post-transplant period, it may induce rupture of the fresh anastomosis in the early post-transplant period. The trans-superior mesenteric venous approach is clinically feasible and it is a safe and effective approach for PV stenosis intervention management after LDLT in children unfit for percutaneous transhepatic approach.

**Research frontiers**

As there is a relatively high recurrence rate, i.e. 28.6%-36.8%, following balloon angioplasty, subsequent stent placement has been used to manage recurrent HV and PV stenosis after LT. However, some authors prefer to perform primary stent placement rather than balloon angioplasty in the early posttransplantation period (< 1 mo).

**Innovations and breakthroughs**

In this study, management and outcome of intraoperative HV obstruction induced by venous tension, as well as post-LDLT venous anastomotic stenosis in one single center were retrospectively analyzed. A balloon filled with air was employed for repositioning the graft to improve HV outflow obstruction induced by intraoperative graft malposition. Transjugular and transfemoral venous balloon dilatation were performed for treatment of 2 postoperative HV anastomotic stenosis, and immediately followed by stent placement via transjugular approach in 2 recipients. Plastic stent placement after balloon dilatation via the superior mesenteric venous approach was administered to manage a pediatric PV stenosis post living left lobe LT, and a good outcome was achieved.

**Applications**

A balloon filled with air could be used for repositioning the graft to improve HV outflow induced by intraoperative graft malposition. Emergent reoperation should be performed for HV obstruction shortly after LDLT. Proper interventional balloon dilatation and stent placement can be effective to manage HV and PV stenosis after LDLT. Balloon dilatation and stent placement via the superior mesenteric venous approach can be employed for treatment of PV stenosis after LDLT in children who do not cooperate with performance of the percutaneous transhepatic approach under local anesthesia.

**Peer review**

The single center study by the authors evaluated management and outcome of HV and PV obstruction after LDLT. Although venous obstruction post LDLT is a rare complication, choosing the ideal management is crucial since this complication can be life-threatening. Though the authors only report on 6 patients with venous obstruction following LDLT, the results and the conclusions drawn from their observations are quite interesting and important.

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S- Editor Tian L  L- Editor O’Neill M  E- Editor Ma WH