Vascular complications after living-donor liver transplantation: Assiut University Hospitals' experience

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Background
Posttransplant vascular complications (PTVCs) have a significant effect on graft and patient after living-donor liver transplantation. We aim to determine the incidence of these complications, focusing on the effects of using synthetic venous grafts in vascular reconstruction, versus performing nongraft primary anastomosis. We did not use natural grafts in this study.
Settings and design
We collected the preoperative/intraoperative and postoperative data prospectively from 39 recipients/donors who underwent living-donor liver transplantation from November 2014 to August 2019 at the department of surgery in Al-Rajehy Liver Hospital, Assiut University.
Patients and methods
The vascular reconstruction of hepatic veins (HVs) in all patients was performed using synthetic vascular grafts, anastomosing the grafts' HVs (V5 and V8) to the recipients' inferior vena cava, whereas portal veins were reconstructed without grafts. PTVCs were analyzed over 3 months to determine their effect on recipients' morbidity and mortality, and their relation to the use of synthetic grafts in vascular reconstruction.
Statistical analysis
Data were analyzed via Statistical Package for the Social Science, version 22. We used Student *t* test or Mann–Whitney test for quantitative data, and χ^2 test for qualitative data.
Results
Among 39 recipients, four (10.26%) died during the follow-up period. Vascular complications were the leading cause of death in three patients. Portal vein thrombosis had the highest incidence rates among the seven recipients having PTVCs, being developed in three (7.69%) of them. It represented the leading cause of death in one patient, whereas HVs thrombosis developed in one (2.56%) recipient, leading to his death on the seventh postoperative day.
Conclusion
PTVCs have significant effect on graft durability, as well as recipient's morbidity and mortality. The use of synthetic grafting in vascular reconstruction has shown particularly a significant negative effect.

Keywords:
graft vascular reconstruction, hepatic vein thrombosis, living-donor liver transplantation, portal thrombosis, posttransplant hepatic vascular complications, vascular graft

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Introduction

The endless number of hepatic vascular anatomical variations represents one of the major challenges concerning living-donor liver transplantation (LDLT) [1,2], rendering the posttransplant vascular complications (PTVCs) as one of the most common causes of recipients' morbidity or death [3–5].

Hepatic vessel reconstruction can be performed with or without using synthetic vascular grafts [6–8]. In this study, we performed graft reconstruction for hepatic veins (HVs), and primary anastomosis – without using any grafts – for portal veins (PV).

As a new transplant center experience, we conducted this study to determine the incidence rates of PTVCs, comparing our recent results with those in the literature.

Patients and methods

Study population

After approval of Assiut University ethical committee regarding our 'prospective' study, 39 patients with

end-stage liver disease – together with their related donors – were recruited for LDLT from November 2014 to August 2019 at the Department of Surgery in Al-Rajehy Liver Hospital, Assiut University.

The included donors in our series were evaluated following strict criteria: (a) any donor should be related to the recipient, up to the fourth degree; (b) he/she should have an age ranging from 21 to 45 years old; (c) the donor's BMI should be less than 28; (d) he/she has to be serologically negative for hepatitis B virus (HBV), hepatitis C virus (HCV), and HIV as well as being free from any hepatic dysfunction; (e) the donor should be ABO compatible with recipient, (f) he/she should not have a history of chronic medical disease, bleeding tendencies, or major upper abdominal operations, or previous hepatobiliary surgery (with the exception of cholecystectomy); (g) any donor has to be psychologically stable and nonsmoker, nor drug or alcohol abuser; (h) female donors should not be pregnant or on hormonal therapy; (i) concerning the transplanted grafts, the graft-to-recipient weight ratio has to be more than or equal to 0.8%, with functional liver volume more than or equal to 35%, and remaining liver left for the donor should be more than or equal to 30% of total liver volume; and (j) concerning the vascular anatomical criteria of the graft, the following should be satisfied:

(a) All included grafts should contain two HVs: V5 and V8.
(b) The grafts included should have no accessory veins.
(c) Patients who had been assessed preoperatively to have PV trifurcation were not included.
(d) Number of hepatic artery (HA) branches was one branch in 36 grafts and two in the remaining three grafts.

All patients had a Model for End-stage Liver Disease (MELD) score more than 15. Only four patients with MELD score less than 15 were included in our study – as an exception – owing to the development of (a) life-threatening portal hypertension and recurrent variceal bleeding (in three patients), and (b) uncontrollable liver failure in the fourth one.

Any recipient who presented with disseminated hepatocellular carcinoma (following Milan's criteria), alpha fetoprotein more than 1000 ng/ml, or presence of another malignancy such as cholangiocarcinoma were excluded from surgery. Patients with uncontrolled systemic sepsis or HIV were also excluded. Clinically unfit patients or those with advanced cardio/pulmonary disease, total occlusion of splanchnic venous inflow, or patients with grades 2, 3, and 4 portal vein thrombosis (PVT) were excluded (grade 1: <50% PVT +/– minimal SMV obstruction; grade 2: >50% PVT +/– minimal SMV obstruction; grade 3: complete PVT and proximal SMV thrombosis; and grade 4: complete PVT and entire SMV thrombosis). Concerning the grafts, we have excluded any one with macrosteatosis more than or equal to 15% or microsteatosis more than or equal to 30% on liver biopsy.

Data collection

The age, sex, BMI (weight/height^2, kg/m^2), inclusion and exclusion criteria for liver transplantation, preoperative/postoperative and operative variables, together with short-term follow-up of survivors (3 months posttransplant) were retrospectively collected. All data were collected from clinical files of the operative theater, ICU, and ward sectors at Al-Rajehy Liver Hospital. Written informed consents were obtained from all recipients and donors before transplantation, and also for the use of their demographic and operative data in our study, according to a protocol approved by the institutional review and ethics committee of Assiut University (code 17200407).

Preoperative evaluation

All donors and recipients were evaluated via three phases: the phase I included detailed history analysis and physical examination. Blood testing was carried out, including ABO blood grouping, Rhesus factor, complete blood count, erythrocyte sedimentation rate, C-reactive protein, HCV (Ab/PCR), HBV (sAb/Ag/cAb), and HIV. Liver function tests (prothrombin time, PTT, INR, protein C and S, Factor V, total and direct bilirubin levels, aspartate transaminase, alanine transaminase, albumin, total protein, alkaline phosphatase, and gamma-glutamyl transferase), renal profile (creatinine, urea, and uric acid), bleeding profile, and lipid profile (LDH, cholesterol and triglycerides) were measured to assess the clinical fitness. The serum levels of different electrolytes such as Na, K, CL, PO^4, and Ca were also evaluated. All recipients and donors had a preoperative abdominal ultrasound (US) Duplex to evaluate the liver echogenicity and to exclude steatosis or any focal parenchymal lesions.

Phase II included the viral testing of herpes simplex, varicella zoster, Epstein-Barr, and cytomegalovirus. Assessment of tumor markers, including alpha fetoprotein, carcinoembryonic antigen, and CA 19-9 were done. CA 125 and CA 15-3 were measured for

female donors, whereas PSA was evaluated for male donors more than 40 years.

Phase III followed with computed tomographic (CT) scan volumetry for donors to assess the desired liver graft weight for each patient. Vascular anatomy of HVs, HA, and PV and biliary anatomy were assessed by triphasic CT angiography to exclude any possible intrahepatic anomalies, and MRCP to exclude significant biliary anomalies that may affect the transplantation surgery passively. Liver biopsy was taken to assess any liver pathology, or to detect liver macrosteatosis or microsteatosis, if present.

Operative steps

The surgery of LDLT includes two main operations, namely, graft-harvesting from the donor, and graft-transplantation into the recipient (after total hepatectomy), with a transitional back-table preparation of the harvested graft to be ready for implantation into the recipient.

Donor's operation

The donor's operation began with a right subcostal incision and midline extension. Right hepatic lobe was the transplanted graft to all recipients in our study. After mobilization of the donor's liver, the right branch of PV and then right branch of HA were identified and temporarily occluded to determine line of transection. Intraoperative US was done to identify middle hepatic vein, V8, V5, and V6 (if present), in addition to identify the line of resection 1 cm to the right of middle hepatic vein. Hepatectomy was performed using harmonic scalpel and ultrasonic scalpel [Cavitron Ultrasonic Surgical Aspirator (CUSA) 200 CEM, Stanford, California, USA] after hanging the liver to avoid the intraoperative blood loss. Finally, HA, PV, and HVs were clamped, then the donor's graft was harvested, waiting for the recipient to be ready. We performed routine intraoperative cholangiography after cholecystectomy to delineate the biliary tree and the point of right bile duct division, avoiding any affection of biliary drainage concerning the remaining liver.

Back-table preparation

After obtaining the liver graft, it was weighted to calculate the actual graft-to-recipient weight ratio, with all were more than or equal to 0.8%. The graft then was prepared on the back-table by cold Ringer's solution at 4°C, and then perfused with Custodiol (histidine tryptophan ketoglutarate) through PV stump. HV reconstruction began on the back-table using synthetic vascular graft, which one of its ends would be sutured to the end of V5 or V8, using 4/0 prolene continuous sutures (Ethicon, Inc., Johnson & Johnson Company, Edinburgh, Scotland). The other end of the graft was lately sutured to the recipient's inferior vena cava (IVC) via an end-to-side fashion.

Recipient's operation

The recipient operation began with recipient total hepatectomy via a right subcostal incision and midline extension, followed by a high hilar dissection, preserving the right and left hepatic pedicle branches. The posterior surface of the liver was then dissected off the IVC by ligation division of all small accessory HVs (piggy-back technique). Total hepatectomy was done followed by preserving the IVC, RHV, common trunk of middle/left HVs, main PV, hepatic artery proper, and common bile duct. All dissections were done with pinch-burn-cut technique to decrease blood loss.

Graft implantation then followed, with the graft HVs (V5 and V8) anastomosed to the recipient IVC by synthetic vascular grafts, using prolene 4/0 continuous sutures (Ethicon). The graft was routinely flushed with 500 ml Esteril (Essential Pharmaceuticals, LLC, Durham, North Carolina, USA) via the PV during construction of the anterior wall of the HV anastomosis. An end-to-end porto-portal anastomosis was then performed using continuous prolene 5/0 suture (Ethicon), with seven (17.9%) cases had been presented with grade 1 PVT (<50% PVT +/– minimal obstruction of SMV) to which eversion thrombectomy was done. The HA anastomosis was done using end-to-end anastomosis with prolene 8/0 interrupted sutures. A duct-to-duct biliary anastomosis was performed in all cases.

Postoperative follow-up

All donors were managed in the ICU for 2–4 days postoperatively, with total hospital stay of 6–10 days, whereas recipients were admitted to the ICU for 4–8 days, with total hospital stay of 18–36 days.

Laboratory investigations and abdominal imaging were performed every day for all donors in their hospital stay to detect any postoperative complications, particularly the vascular ones. Additionally, recipients had a vascular follow-up by Doppler US twice daily until 1 week, once daily until 2 weeks, and twice a week during the rest of hospital stay. After discharge, patients were followed up once every 3 months, and when clinically deemed necessary. If any vascular complications were suspected at any time, more advanced tests, such as angiography, were performed.

Statistical analysis

Statistical analysis was carried out using the Statistical Package for the Social Sciences (IBM-SPSS, Bristol University, UK), version 22, under Microsoft Windows (Microsoft Corporation, Redmond, Washington, USA). The description of data was in the form of mean±SD for quantitative data. Patient and graft survivals were measured as the interval between transplantation and death or last follow-up (90 days). A P value of less than 0.05 is considered significant. The Student t test or Mann–Whitney U test were used to compare quantitative data, whereas χ^2 test was used to compare qualitative data.

Results

Demographic data

All donors were of first to fourth degree relation with recipient. Of all of them, 18 (46.15%) candidates were sons, nine (23.07%) daughters, four (10.26%) wives, three (7.69%) sisters, two (5.13%) mothers, and two (5.13%) brothers. The mean±SD age and BMI, as well as sex distribution of both donors and recipients are shown in Tables 1 and 2.

Liver cirrhosis on top of HCV represented the commonest indication for LDLT in our study. Figure 1 presents the contribution of each disease as an indication for transplantation.

Additionally, nine (23.07%) recipients had diabetes mellitus type 2, whereas two (5.13%) recipients had hypertension as a comorbid disease. The mean±SD MELD score was 6–26 (range, 15.1±4.2), with four (10.26%) males having MELD score less than 15, whereas the remaining 35 (89.74%) recipients presenting with MELD more than 15.

General operative data

The mean±SD values of both are shown in Table 2. Interestingly, we found that the harvested graft had one hepatic duct in 11 (28.2%) grafts, two ducts in 23 (58.97%) grafts, and they had three hepatic ducts in five (12.82%) grafts.

Operative time, cold/ischemia time, intraoperative blood loss, and the need for blood transfusion for both donors and recipients are shown in Tables 1 and 2. However, blood transfusion was not required

Table 1 Clinical profiles of liver transplant donors

Variants	Range	%	Mean±SD
Number of donors			
Male	21	53.85	
Female	18	46.15	
Total	39	100	
Age (years)	18–48		28.7±8.4
BMI (kg/m^2)	15–32		24.6±3.5
Operative time (h)	7–8		7.5±1
Blood transfusion (units)	No blood transfusion were required		
Blood loss (ml)	530–900		670±150
ICU admission (days)	2–4		3±1
Hospitalization (days)	6–10		8±2

Table 2 Clinical profiles of liver transplant recipients

Variants	Range	%	Mean±SD
Number of recipients			
Male	29	74.3	
Female	10	25.6	
Total	39	100	
Age (years)	15–63		50.9±2.1
BMI (kg/m^2)	16–37		26.9±4.7
MELD	6–26		15.1±4.2
GRWR (%)	0.7–1.5		1.1±0.2
RLV for donors (%)	36–60		35.1±5.5
Operative time (h)	8–16		12±3
Blood transfusion (units)	4–20		12±8 packed RBCs
Blood loss (ml)	1000–9600		3200±1500
ICU admission (days)	4–8		6±2
Hospitalization (days)	18–36		27±9

GRWR, graft-to-recipient weight ratio; MELD, model for end-stage liver disease; RBC, red blood cell; RLV, remnant liver volume.

for any of the donors in this study, whereas packed red blood cell units were required for 17 (43.6%) patients, with three cases of them additionally requiring PLT concentrate (12 U).

After surgery, all donors were admitted to ICU and were then transported to the ward to follow-up their functions before discharge. The period of recipients' admission was logically longer than those of the donors. All postoperative complications of both donors and recipients are recorded.

Donors' posttransplant complications and mortality

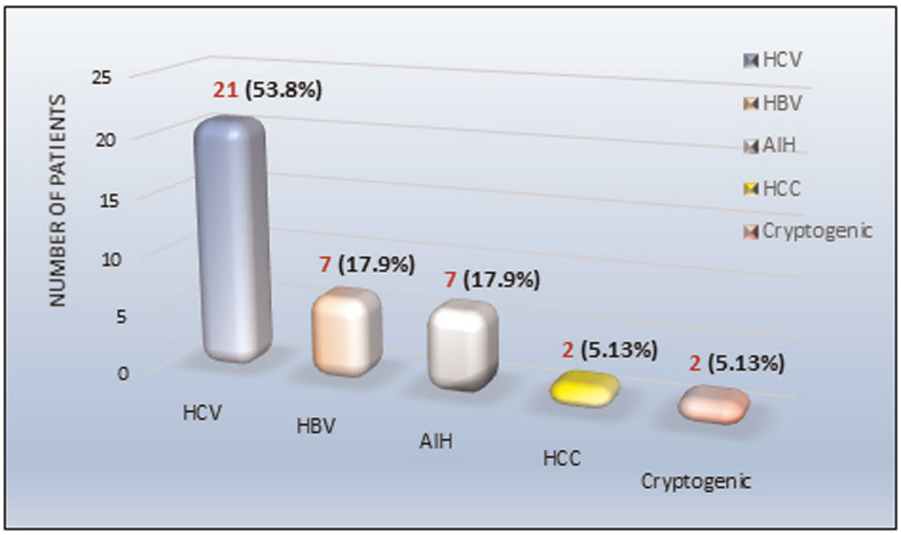
No donor mortality was encountered in our study. Of the 39 donors, 17 (43.58%) had controlled complications, with postoperative bleeding representing the most common (Fig. 2). However, it was conservatively managed and improved. No complications were encountered, concerning vascular or biliary ones. Table 3 shows the number and rate of postoperative donors' complications and deaths.

Recipients' posttransplant complications

From the 39 patients, 18 (46.15%) had postoperative complications in our study (Fig. 3 and Table 4):

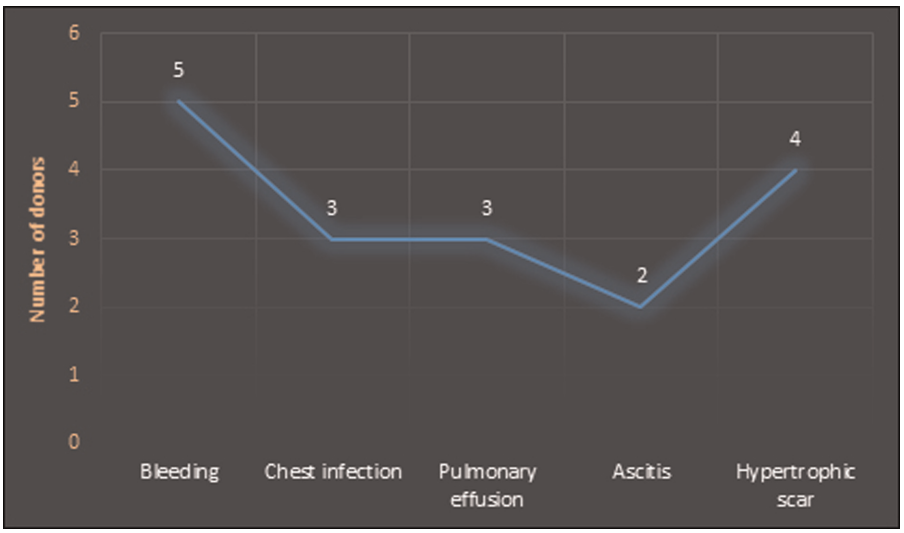
(1) Postoperative vascular complications were developed in seven recipients (Fig. 4 shows numbers/rates of each vascular complication, in relation to the total number of PTVCs). In this

Figure 1



Numbers and rates of patients according to the indications for transplantation. AIH, autoimmune hepatitis; HBV, hepatitis B virus; HCC, hepatocellular carcinoma; HCV, hepatitis C virus.

Figure 2



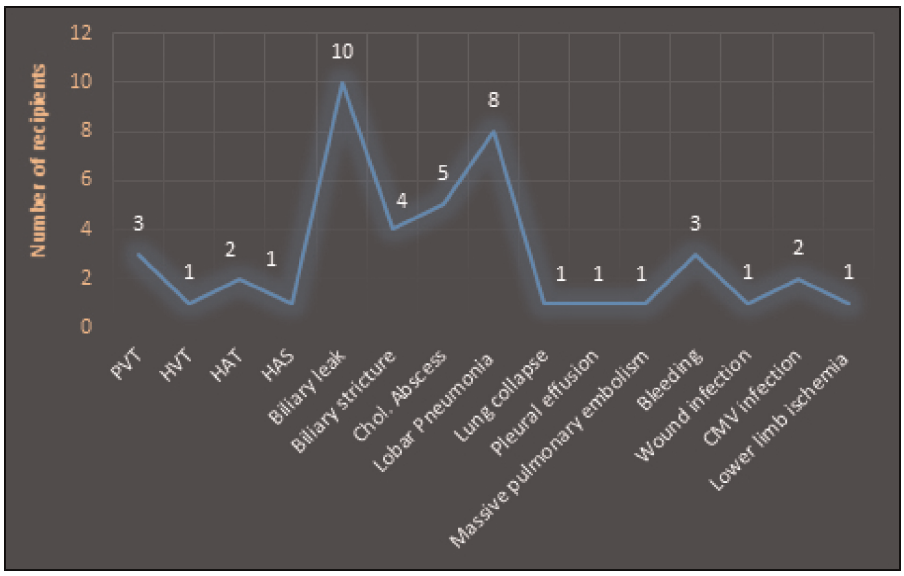
Donors' posttransplant complications, with the number of affected donor for each.

Table 3 Incidence rates of posttransplant donors' complications and deaths

Complications	Number (patient)		Rate (%)	
Bleeding				
Cervical hematoma (at the site of CVP cannula),	1	5	2.56	12.8
Subcutaneous bleeding,	2		5.13	
Subcutaneous epigastric hematoma	2		5.13	
Chest infection	3		7.69	
Pleural effusion	3		7.69	
Chylous ascites	2		5.13	
Hypertrophic scar	4		10.2	
Deaths	0/39		0	

CVP, central venous pressure.

Figure 3



Recipients' posttransplant complications, with the number of affected recipient for each. HAS, hepatic artery stenosis; HAT, hepatic artery thrombosis; HVT, hepatic vein thrombosis; PVT, portal vein thrombosis.

series, we used synthetic vascular grafts only in HV reconstruction, with the development of only one case of HVT, presenting 14.29% of all patients with postoperative vascular complications (1/7 patients) and 2.56% of the total number of recipients in our study (1/39 patients). Unfortunately, the only patient who had developed HVT died only 1 week postoperative, after he had been managed with a medical conservative trial.

(2) On the contrary, other vascular reconstructions were performed without using synthetic vascular grafts, with six patients, out of seven, developing postoperative vascular complications, presenting 85.71% of the total patients who had developed postoperative vascular complications:
   (a) PVT developed within the first postoperative month, with multiple liver abscesses, sepsis, and liver failure, in one of the patients. Finally, he died after 40 days. The other two were managed medically with intravenous heparin then shifted to oral Warfarin at a dose of 3 mg/24 h, till INR=2.4.
   (b) Hepatic artery thrombosis (HAT) was developed in one recipient 2 h postoperative, and the patient was saved after urgent redo. The other who had recurrent HAT 3 days after surgery, had urgent redo for the first attack. All trials to obtain arterial signals in the second attack failed, and the patient died on the eighth postoperative day (POD).
   (c) Mild hepatic artery stenosis (HAS) developed in one patient 2 months postoperative and was managed medically by oral Warfarin for 3 months.

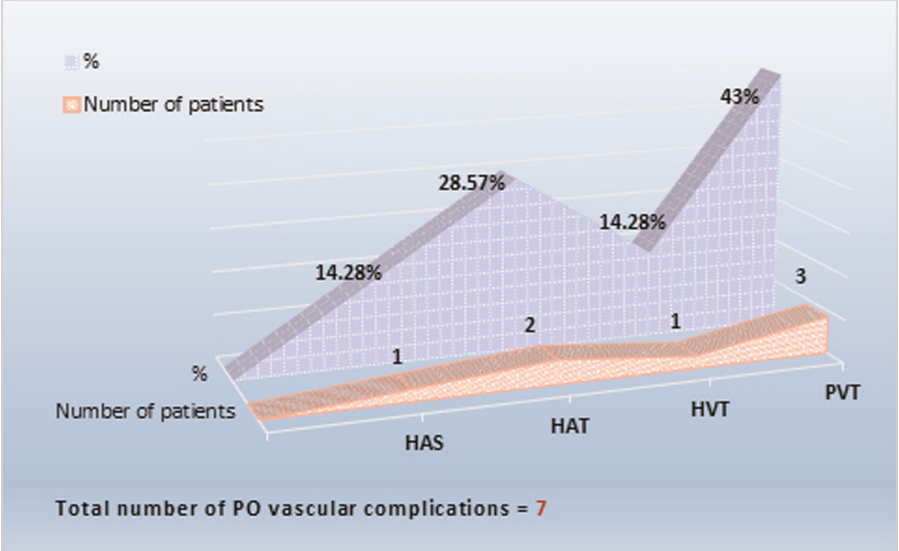
(3) Biliary complications were the most common postoperative morbidity in recipients, presenting as follows:
   (a) Patients who had biliary leakage were managed either conservatively, or by US-

Table 4 Incidence rates of posttransplant recipients' complications and deaths

Complication	Number (patient)		Rate (%)	
Vascular complications				
PVT	3	7	7.69	17.95
HVT	1		2.56	
HAT	2		5.13	
HAS	1		2.56	
Biliary complications:				
Biliary leakage,	10	19	25.6	48.72
Biliary stricture,	4		10.2	
Multiple cholangitic abscesses.	5		12.8	
Lobar pneumonia		8	20.5	
Lung collapse		1	2.56	
Pleural effusion		1	2.56	
Massive pulmonary embolism		1	2.56	
Postoperative bleeding		3	7.69	
ACR (biopsy-proven)		2	5.13	
Lower limb ischemia		1	2.56	
Persistent ascites (6 months)		1	2.56	
Wound infection (*Staphylococcus aureus*)		1	2.56	
CMV infection		2	5.13	
Tacrolimus-induced DM		1	2.56	
Deaths, secondary to				
Vascular complication (PVT, HVT and HAT)		3 (1 for each)	7.69	
Massive pulmonary embolism		1	2.56	
Total		4/39	10.26	

ACR, acute cellular rejection; CMV, cytomegalovirus; DM, diabetes mellitus; HAS, hepatic vein stenosis; HAT, hepatic artery thrombosis; HVT, hepatic vein thrombosis; PVT, portal vein thrombosis.

Figure 4



Numbers/rates of each vascular complication, in relation to the total number of posttransplant vascular complications in recipients (seven patients). HAT, hepatic artery thrombosis; HAS, hepatic artery stenosis; HVT, hepatic vein thrombosis; PVT, portal vein thrombosis.

guided percutaneous Pigtail insertion for those with more severe leakage.

(b) Conservative management was done for recipients with anastomotic biliary stricture, whereas the patient who developed recurrent attacks of cholangitis and cholangitic abscesses were improved on ERCP double stenting.

(c) All cholangitic abscesses were managed by US-guided aspiration, with administration of IV Cipro (Ciprofloxacin) 400 mg/12 h plus IV Flazol (Flagyl) for 14 days.

(4) Severe lobar pneumonia developed at the fourth–sixth POD, with one of recipients had additionally pleural effusion, and another one came with lung collapse. They all were managed with intravenous Cipro 400 mg/8 h for 14 days.
(5) Massive pulmonary embolism was the leading cause of one recipient death at the third POD.
(6) The patient who had postoperative bleeding –with repaired huge para umbilical hernia – was re-explored to control subcutaneous bleeding, whereas the other recipients were managed conservatively.
(7) Recent-onset tacrolimus-induced diabetes mellitus developed after 1 month from surgery, and improved completely on stoppage of the drug.
(8) *Staphylococcus aureus* wound infection was improved after Augmentin 500 mg/12 h administration for 7 days.

Recipients' posttransplant mortality

Three-month posttransplant recipient survival rate was 89.74% (35/39 patient), as four (10.26%) patients died during the follow-up period. Three of four patients died secondary to vascular complications, representing 75% (3/4 death) of the total deaths and 7.69% (3/39 patient) of the total recipients in this series. Nonvascular complications were the leading cause of death in only one (25%) of four deaths and one (2.56%) of 39 patients. Three recipients died of the seven (42.85%) who presented with a vascular complication, with a vascular survival rate of 57.15%, whereas only one (2.70%) of 37 patients who presented with a nonvascular complication died, with a survival rate of 97.3%.

Discussion

PTVCs such as thrombosis and stenosis of the HA, HVs, and PV are serious complications [9,10], representing one of the most common problems after surgery [11]. They can lead to increased morbidity, graft loss, and patient death [9]. Various factors contributing to development of vascular thrombosis have been proposed: ABO incompatibility [11,12], multiple anastomoses [13,14], prolonged cold ischemic time [15], acute rejection [11,16,17], and previous vascular thrombosis [13]. In our study, two patients – out of the three who developed posttransplant PVT – presented preoperatively with grade 1 PVT that required intraoperative thrombectomy. Hence, previous PVT was an important factor of developing posttransplant PVT. Indeed, a total of seven patients had preoperative grade 1 PVT, with two of them (2/7 patients=28.57%) presented postoperatively with PVT, whereas five patients (5/7=71.43%) passed without having postoperative PVT.

Of the 39 recipients in this series, 29 men were included, whereas only 10 women. This may be attributed to the higher incidence of HCV and HBV infections in men, secondary to their higher activity. On the contrary, the number of donor men was approximate to donor women, with 21 men and 18 women donors. The more dependence of family members on their father, brother, or husband may illustrate the increased number of donor women in our study (46.15%), compared with the lower number of female recipients (25.6%).

The incidence of vascular complications reported in the literature varies widely among centers [18]. Steinbrück *et al*. [19] showed in their study results the incidences as high as 23.7, 20.3, and 10.3% for HAT, PVT, and HAS, respectively, whereas our results showed 5.13, 7.69, and 2.56%, respectively. However, the mean rate of PVT in the literature – for example – is ∼3% in adults, which shows the wide variations among centers. HAT represented the most common PTVCs in the literature, whereas PVT was the commonest complication in ours [20–22]. The relatively low incidence rates of PTVCs in our study may be attributed to the low number of population size and the short posttransplant follow-up period. The overall incidence of vascular complications in our study was 17.94% (7/39 patient), whereas in the other studies was 21%, which may also be attributed to shorter period of follow-up in our study, and the lack of strict follow-up with some patients. However, it is clear that vascular complications have a high effect on the outcome of liver transplantation [20].

We find that patient survival rates after vascular complications (57.15%) are significantly less than those without vascular complications (97.3%) during the early posttransplant period. The only patient who presented with HVT died after surgery, whereas one patient died of three recipients with PVT. HA complications led to death of one recipient of the two patients who presented with it.

Differences in the diameters between the recipient's and donor's PVs, malrotation of the vessels or kinking of the PV, the use of vascular grafts in the venous reconstruction, and excessively long vessel stumps are common causes of PV complications [11,23]. However, PVT was the only portal complication in this series and was not caused by the use of venous grafting, as PV reconstructions were done in all

recipients without using any venous grafts. PVT is a serious complication necessitating immediate surgical intervention [23]. In the literature, the total rate of PVT in patients who have undergone liver transplant has been reported to be 3% in adults [11,24], compared with our study, which showed a rate of 7.69%. This may be attributed to the low number of LDLT patients in our recent institute, which was just beginning transplantation for not more 4 years. Because of the small number of patients with PVT (n=3), it is difficult to recommend which therapy is the most effective. However, in our study, one patient died out of the three patients who presented with PVT, clarifying the significant negative effect on graft and patient survival.The patency of reconstructed HVs depends largely on the size of the anastomotic orifice, the orientation of the vessels, and the position of the graft [25–28]. Balloon angioplasty efficacy in the treatment of hepatic veins outlet obstruction has been previously reported [29]. However, in our series, the only patient who developed HVT died 2 h postoperative, before giving a chance for any intervention.

Because of the relatively low number of vascular events in our series (7/39), risk factor analysis was of no significant value. However, risk factors for vascular complications have been drastically discussed in the literature [20].

Study limitations

The low flow of candidate patients for LDLT may be attributed to the high cost of surgery, the recent practice of such service in our liver institution, or to the difficulties of matching an appropriate related donor who accepts to donate a part of his liver. Long distance from home or high cost of follow-up may attribute to the low obedience with some patients.

Conclusion

Our study confirms the high incidence of vascular complications among the posttransplant ones and proves the significant effect they have on graft durability, as well as recipients' morbidity and mortality. However, the use of synthetic venous grafts for vascular reconstruction in LDLT could not be accurately evaluated, owing to the relatively low number of candidates in our study.

Recommendation

More studies with larger sample size and longer posttransplant follow-up period are recommended to reach more accurate results.

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Conflicts of interest

There are no conflicts of interest.

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