

Autologous Recipient Portal Vein Segment For Middle and Right Or Left Hepatic Vein Reconstruction in Living Donor Liver Transplantation: Experience From Erbil, Iraq

Dilshad Abdulkarem M Shareef*, Assad Abidon Hassoun**, Abdullah Saeed Abdullah***

* Trainee at KHCMS Intra-Abdominal Solid Organ Transplantation, KHCMS, HD-General Surgery, Email: dr.dilshadshekhani@gmail.com

** Consultant General Surgeon, Organ Transplant Surgeon, Email, M.D., FACS, American Board-General Surgery, email: hassoua@sutterhealth.org

***Consultant General Surgeon, Organ Transplant Surgeon.

Corresponding author: Dilshad Abdulkarem M Shareef

Abstract

Background: Adequate hepatic venous outflow is essential for successful living donor liver transplantation (LDLT). Reconstruction of the middle hepatic vein (MHV) and right hepatic vein (RHV) may be required to prevent graft congestion, but the optimal vascular conduit remains uncertain. This study evaluated the feasibility, safety, and clinical outcomes of using an autologous recipient portal vein for hepatic venous reconstruction during LDLT.

Methods: This retrospective observational study included 39 patients who underwent LDLT at Zheen International Hospital, Erbil, Kurdistan Region, Iraq, between January 2012 and March 2026, in whom an autologous recipient portal vein segment was used for MHV and/or RHV reconstruction. Venous graft patency was assessed mainly by Doppler ultrasonography from postoperative Day 1 through 1 year. Early graft function was evaluated using AST, ALT, total bilirubin, INR, and serum creatinine. Early allograft dysfunction (EAD) was defined according to the Olthoff criteria. Vascular complications and patient survival were also assessed.

Results: The mean recipient age was 38.95 ± 16.12 years, and the mean graft-to-recipient weight ratio was $0.89 \pm 0.21\%$. Venous graft patency was 84.6% on Day 1, 91.9% on Day 7, 97.2% at 1 and 3 months, 94.4% at 6 months, and 100% among the 34 patients evaluated at 1 year. AST, ALT, total bilirubin, and INR decreased significantly during the first postoperative week (all $P < 0.001$), while serum creatinine also decreased significantly ($P = 0.007$). EAD occurred in 17 patients (43.6%). Vascular complications occurred in four patients (10.3%), including hepatic vein thrombosis in two (5.1%), hepatic vein stenosis in one (2.6%), and hepatic artery thrombosis in one (2.6%); no portal vein thrombosis was observed. Kaplan-Meier patient survival was 89.7% at 30 days, 90 days, and 1 year.

Conclusion: Autologous recipient portal vein grafts provided high venous patency with acceptable vascular complication rates and favorable short-term patient survival. The technique appears to be a feasible option for MHV and RHV reconstruction in carefully selected LDLT recipients.

Keywords: autologous portal vein; hepatic vein reconstruction; living donor liver transplantation; middle hepatic vein; vascular graft patency.

Introduction

Living donor liver transplantation (LDLT) has become an important treatment option for patients with end-stage liver disease, especially in countries where deceased-donor organs are limited. It allows transplantation to be performed without waiting for a deceased donor and has therefore helped reduce the effect of organ shortage. However, LDLT is technically demanding because an adequate graft must be provided for the recipient while maintaining donor safety. Careful evaluation of graft size, vascular anatomy, and the expected functional liver volume is therefore essential before surgery. Recent reports also stress the need to balance the recipient's need for sufficient liver tissue with the risk to a healthy donor. [1-2]

In adult LDLT, the right lobe is frequently selected because it usually provides enough liver volume for the recipient. One of the main technical difficulties with a right-lobe graft is maintaining adequate hepatic venous outflow. The right hepatic vein (RHV) drains most of the right lobe, whereas much of the anterior sector drains through tributaries of the middle hepatic vein (MHV). Removing the MHV with the right lobe may improve graft drainage, but it can compromise the venous drainage of the donor's remaining liver, particularly segment IV. For this reason, many centers preserve the donor MHV and reconstruct the important MHV tributaries of the graft during back-table preparation. [3-4]

Adequate venous drainage is important for maintaining graft function after transplantation. Poor outflow from the MHV or RHV territory can lead to venous congestion, reducing the effective functional volume of the transplanted liver and increasing the risk of postoperative graft dysfunction. Reconstruction of significant venous branches is

therefore performed to maintain drainage from the graft, particularly from segments V and VIII. The clinical importance of maintaining patency was demonstrated by Durairaj et al., who found that neo-MHV thrombosis was associated with higher 90-day all-cause and sepsis-related mortality, regardless of whether the reconstruction used recipient portal vein or a synthetic graft. [3]

Different vascular materials have been used for hepatic venous reconstruction, including cryopreserved allografts, synthetic grafts, and autologous vessels. Synthetic materials such as polytetrafluoroethylene (PTFE) and Hemashield grafts have the advantage of immediate availability and can be prepared according to the required size and length. However, their use introduces foreign material into an immunosuppressed patient and may be associated with thrombosis, infection, or other graft-related complications. Recent studies have evaluated the effect of reconstruction material on MHV patency and have shown that the choice of conduit remains an important technical issue in LDLT. [3,5-6]

The recipient's own portal vein offers an alternative autologous conduit for hepatic vein reconstruction. Once the diseased liver has been removed, an appropriate segment of the native portal vein may be harvested from the explanted liver and used for reconstruction. Because the vessel belongs to the recipient, it avoids the introduction of synthetic material and has the advantages of good tissue compatibility, low risk of graft-related infection, and suitable handling characteristics. Autologous portal vein tissue has been used for MHV reconstruction, vascular patching, venoplasty, and other complex vascular reconstructions in LDLT. [3,7-8]

Clinical experience has shown that the recipient portal vein can also be useful when complex vascular anatomy requires modification. Feng et al. described the use of an autogenous portal vein patch for portal vein venoplasty in pediatric LDLT, while Song et al. reported successful use of the recipient's portal vein confluence as a Y-graft to reconstruct separate portal branches. These reports show that recipient portal venous tissue can be adapted for different types of vascular reconstruction and may provide a practical option when a suitable autologous vessel is available. [8-9]

Evidence specifically examining the recipient portal vein for MHV reconstruction has also been encouraging. Borle et al. evaluated the explanted portal vein for reconstruction of the MHV in right-lobe LDLT, while Lee et al. studied the effect of reconstruction material on MHV patency. More recently, Durairaj et al. directly compared the recipient portal vein with PTFE in a randomized clinical trial. They found no significant difference in neo-MHV thrombosis between the two groups at either 14 or 90 days, suggesting that the recipient portal vein can provide early patency comparable with a synthetic graft. [3,6-7]

Despite these potential advantages, the recipient portal vein is not suitable in every case. Its use depends on adequate length, diameter, and vessel-wall quality. Portal vein thrombosis may make the vessel unusable, and possible malignant vascular involvement must also be considered in patients transplanted for hepatocellular carcinoma or other liver tumors. Therefore, the decision to use the recipient portal vein should be based on individual vascular anatomy, the condition of the vessel, and the requirements of the hepatic venous reconstruction. [3,7]

Although several studies have described recipient portal vein grafts and compared them with other materials, data on their longer-term performance remain limited. Important outcomes include graft patency, early graft function, postoperative venous complications such as thrombosis and stenosis, and short-term patient and graft survival. Evaluation of these outcomes is especially relevant in transplant centers where cryopreserved allografts are not readily available and the choice is often between an autologous recipient vein and a synthetic conduit. Further clinical evidence may therefore help clarify the safety and usefulness of the recipient portal vein for MHV and RHV reconstruction in LDLT. [3,5-7]

Aim and Objectives of the Study

This study aimed to evaluate the feasibility, safety, and clinical outcomes of using the autologous recipient portal vein for reconstruction of the middle and right hepatic veins during living donor liver transplantation. The primary objective was to assess venous graft patency following reconstruction with the recipient portal vein. The secondary objectives were to evaluate early graft function, determine the incidence of venous complications, particularly thrombosis and stenosis, assess short-term patient and graft survival, and compare the observed outcomes with those reported for other hepatic venous reconstruction techniques

Methodology

This retrospective observational study was conducted to evaluate the clinical outcomes of using an autologous recipient portal vein segment for hepatic venous reconstruction during living donor liver transplantation (LDLT). The study was carried out at the Liver Transplant Center of Zheen International Hospital, Erbil, Kurdistan Region, Iraq. All patients who underwent LDLT between January 2012 and March 2026 were reviewed for eligibility. The study specifically included patients in whom a segment of the recipient portal vein was used as an interposition graft for reconstruction of the middle hepatic vein (MHV), right hepatic vein (RHV), or both.

All eligible patients who underwent LDLT using an autologous recipient portal vein graft for MHV and/or RHV reconstruction and had adequate perioperative and follow-up data were included. Patients were excluded if portal vein thrombosis prevented graft use, essential records were incomplete, or hepatic malignancy involved portal vascular invasion.

Data were collected retrospectively from medical records, operative and anesthesia records, laboratory results, follow-up records, and vascular imaging. Variables included recipient characteristics (age, sex, body weight, MELD and MELD-Na scores), donor age and sex, graft weight and GRWR, and operative factors including ischemia times, anhepatic phase, blood loss, and packed red blood cell transfusion.

The pretransplant MELD score was calculated using the most recent serum creatinine, total bilirubin, and INR values according to the conventional formula: $MELD = 9.57 \times \ln(\text{creatinine [mg/dL]}) + 3.78 \times \ln(\text{total bilirubin [mg/dL]}) + 11.20 \times \ln(INR) + 6.43$. Values below 1.0 were set to 1.0, while creatinine was capped at 4.0 mg/dL, including patients receiving two or more dialysis treatments during the preceding week [10-12].

The MELD-Na score was calculated using laboratory values closest to transplantation to account for the prognostic effect of serum sodium, using the formula: $MELD-Na = MELD + [1.32 \times (137 - Na)] - [0.033 \times MELD \times (137 - Na)]$, with serum sodium limited to 125–137 mmol/L. The score incorporates bilirubin, INR, creatinine, and serum sodium to better reflect liver disease severity [10-12].

Venous graft patency was assessed mainly by Doppler ultrasonography on postoperative Days 1, 3, and 7 and at 1, 3, 6, and 12 months. A graft was considered patent when continuous blood flow was present without complete thrombosis or occlusion. Patency rates were calculated among patients evaluated at each follow-up point.

Early graft function was assessed using AST, ALT, total bilirubin, INR, and serum creatinine on postoperative Days 1, 3, and 7. Early allograft dysfunction (EAD) was defined according to the Olthoff criteria as the presence of at least one of the following: bilirubin ≥ 10 mg/dL on Day 7, INR ≥ 1.6 on Day 7, or AST/ALT $> 2,000$ IU/L within the first 7 postoperative days. Patients meeting none of these criteria were classified as having no EAD [13].

Postoperative vascular complications, including hepatic vein thrombosis or stenosis, portal vein thrombosis, and hepatic artery thrombosis, were identified from clinical and imaging records and reported as frequencies, percentages, and 95% confidence intervals. Their management and outcomes were also recorded when available.

Patient survival was calculated from transplantation to death from any cause, while graft survival was calculated from transplantation to graft failure or loss. Patients without an event were censored at their last follow-up. Kaplan–Meier analysis was used to estimate patient and graft survival at 30 days, 90 days, and 1 year.[14,15]

Statistical analysis was performed using SPSS Statistics version 29. Continuous variables were presented as mean $\pm$ SD or median (IQR), as appropriate, while categorical variables were summarized as frequencies and percentages. Changes in laboratory values across postoperative Days 1, 3, and 7 were assessed using the Friedman test. Graft patency and vascular complications were reported as proportions with 95% confidence intervals, and patient and graft survival were estimated using Kaplan–Meier analysis. A two-sided P value < 0.05 was considered statistically significant.

The study was conducted after obtaining ethical approval for Kurdistan Higher Council for Medical specialties (meeting code: 1466 granted on 14/06/2026) and permission to access the relevant hospital records. As this was a retrospective study based on existing clinical data, no additional intervention or radiological investigation was performed for research purposes. Confidentiality was maintained throughout the study. Patient names and other direct identifiers were excluded from the research database, and all collected information was used only for the purposes of this study.

Results

The study included 39 liver transplant recipients. The mean recipient age was 38.95 ± 16.12 years, with a 95% confidence interval (CI) of 33.73–44.17 years. The mean recipient weight was 70.92 ± 19.18 kg (95% CI: 64.70–77.14 kg). The donors had a mean age of 31.03 ± 8.09 years, with a 95% CI of 28.40–33.65 years.

The mean graft weight was 599.54 ± 113.79 g (95% CI: 562.66–636.42 g), while the mean graft-to-recipient weight ratio (GRWR) was 0.89 ± 0.21 (95% CI: 0.82–0.96%). Regarding the operation, the mean cold ischemia time was 191.41 ± 36.16 minutes (95% CI: 179.69–203.13 minutes), the mean warm ischemia time was 49.92 ± 10.30 minutes (95% CI: 46.58–53.26 minutes), and the mean anhepatic phase was 81.03 ± 9.88 minutes (95% CI: 77.83–84.23 minutes).

Table1. Continuous Demographic, Clinical, Graft, and Operative Characteristics

	Variable	Mean $\pm$ SD	95% CI
Recipient characteristics	Recipient age (years)	38.95 ± 16.12	33.73–44.17
Recipient characteristics	Recipient weight (kg)	70.92 ± 19.18	64.70–77.14
Donor characteristics	Donor age (years)	31.03 ± 8.09	28.40–33.65
Graft characteristics	Graft weight (g)	599.54 ± 113.79	562.66–636.42
Graft characteristics	Graft-to-recipient weight ratio (GRWR)	0.89 ± 0.21	0.82–0.96
Operative characteristics	Cold ischemia time (min)	191.41 ± 36.16	179.69–203.13
Operative characteristics	Warm ischemia time (min)	49.92 ± 10.30	46.58–53.26
Operative characteristics	Anhepatic phase (min)	81.03 ± 9.88	77.83–84.23

Recipient age: 38.95 ± 16.12 (range: 3–68) years.

Among the 39 liver transplant recipients, the median MELD score was 16 (IQR: 12–22.5), while the median MELD-Na score was also 16 (IQR: 12–24). The median intraoperative blood loss was 1,800 mL (IQR: 1,100–3,600 mL), and the median number of PBCU used was 4 units (IQR:2–8).

Regarding sex distribution, 26 recipients (66.7%) were male, and 13 (33.3%) were female. Among the donors, 27 (69.2%) were male and 12 (30.8%) were female. Overall, both recipients and donors were predominantly male.

Table 2. Categorical and Non-Normally Distributed Characteristics of Recipients, Donors, and Operative Variables

Variable	Variable	n (%) / Median	IQR
Recipient characteristics	MELD score*	16.00	12.00–22.50
Recipient characteristics	MELD-Na score**	16.00	12.00–24.00
Operative characteristics	Intraoperative blood loss (mL) mean	1800	1100–3600
Operative characteristics	Packed red blood cells (units) mean	4	2–8
Recipient sex	Male	26 (66.7%)	
Recipient sex	Female	13 (33.3%)	
Donor sex	Male	27 (69.2%)	
Donor sex	Female	12 (30.8%)	

*Model for End-Stage Liver Disease

**Model for End-Stage Liver Disease sodium

During postoperative follow-up, 39 patients were evaluated on Day 1, of whom 33 had patent grafts, giving a patency rate of 84.6% (95% CI: 70.3–92.8). On Day 3, 38 patients were evaluated and 33 grafts remained patent, resulting in a patency rate of 86.8% (95% CI: 72.7–94.3). On Day 7, 37 patients were evaluated, with 34 patent grafts, giving a patency rate of 91.9% (95% CI: 78.7–97.2).

At 1 month, 36 patients were evaluated and 35 grafts were patent, corresponding to a patency rate of 97.2% (95% CI: 85.8–99.5). The same patency rate was observed at 3 months, with 35 of 36 evaluated grafts remaining patent. At 6 months, 34 of 36 evaluated grafts were patent, giving a patency rate of 94.4% (95% CI: 81.9–98.5). At 1 year, all 34 evaluated grafts were patent, resulting in a patency rate of 100.0% (95% CI: 89.8–100.0). Overall, the results showed high graft patency throughout follow-up, with the highest observed patency at 1 year.

Table 3. Vascular Graft Patency Rates at Different Postoperative Follow-up Time Points

Postoperative follow-up time	Evaluated patients (n)	Patent grafts (n)	Patency rate	95% CI
Day 1	39	33	84.6	70.3–92.8
Day 3	38	33	86.8	72.7–94.3
Day 7	37	34	91.9	78.7–97.2
1 month	36	35	97.2	85.8–99.5
3 months	36	35	97.2	85.8–99.5
6 months	36	34	94.4	81.9–98.5
1 year	34	34	100.0	89.8–100.0

Note: Patency rate was calculated as the number of patent grafts divided by the number of patients evaluated at each follow-up time point. CI = confidence interval. (4 deaths)

During the first postoperative week, all assessed laboratory parameters showed a significant change between Days 1, 3, and 7. The median AST level decreased from 518.45 U/L (IQR: 351.50–787.00) on Day 1 to 179.95 U/L (IQR: 125.08–352.00) on Day 3 and further to 55.20 U/L (IQR: 39.25–79.67) on Day 7 ($p < 0.001$).

Similarly, the median ALT level decreased from 480.45 U/L (IQR: 319.38–734.35) on Day 1 to 317.35 U/L (IQR: 251.55–781.25) on Day 3 and 146.60 U/L (IQR: 90.42–266.30) on Day 7 ($p < 0.001$).

The median total bilirubin also decreased from 5.32 mg/dL (IQR: 3.07–7.63) on Day 1 to 3.16 mg/dL (IQR: 2.16–5.25) on Day 3 and 2.63 mg/dL (IQR: 1.58–5.29) on Day 7 ($p < 0.001$).

The median INR decreased from 2.09 (IQR: 1.76–2.45) on Day 1 to 1.74 (IQR: 1.49–2.07) on Day 3 and 1.48 (IQR: 1.28–1.73) on Day 7 ($p < 0.001$).

For serum creatinine, the median value decreased from 0.85 mg/dL (IQR: 0.69–1.07) on Day 1 to 0.84 mg/dL (IQR: 0.61–1.19) on Day 3 and 0.73 mg/dL (IQR: 0.55–0.93) on Day 7. This change was also statistically significant ($p = 0.007$).

Table 4. Biochemical Profiles and Early Allograft Function During the First Postoperative Week (N = 36)

Parameter	Day 1 Median (IQR)	Day 3 Median (IQR)	Day 7 Median (IQR)	p-value
AST (U/L)	518.45 (351.50–787.00)	179.95 (125.08–352.00)	55.20 (39.25–79.67)	<0.001
ALT (U/L)	480.45 (319.38–734.35)	317.35 (251.55–781.25)	146.60 (90.42–266.30)	<0.001
Total bilirubin (mg/dL)	5.32 (3.07–7.63)	3.16 (2.16–5.25)	2.63 (1.58–5.29)	<0.001
INR	2.09 (1.76–2.45)	1.74 (1.49–2.07)	1.48 (1.28–1.73)	<0.001
Serum creatinine (mg/dL)	0.85 (0.69–1.07)	0.84 (0.61–1.19)	0.73 (0.55–0.93)	0.007

Note: Data are presented as median [interquartile range (IQR)]. The Friedman test was used to compare repeated measurements across postoperative Days 1, 3, and 7.

Early allograft dysfunction (EAD) was assessed among the 39 liver transplant recipients using the Olthoff criteria. EAD was present in 17 patients (43.6%), while 22 patients (56.4%) did not meet the criteria for EAD. Thus, less than half of the recipients developed early allograft dysfunction during the early postoperative period.

Table 5. Early Allograft Dysfunction According to the Olthoff Criteria (N = 39)

EAD Status	N	%
EAD absent	22	56.4

EAD present	17	43.6
Total	39	100.0

Note: Early allograft dysfunction (EAD) was defined according to the Olthoff criteria as the presence of at least one of the following: total bilirubin ≥ 10 mg/dL on postoperative Day 7, INR ≥ 1.6 on postoperative Day 7, or AST/ALT $> 2,000$ IU/L during the first 7 postoperative days.

Statistical interpretation: all five biomarkers changed significantly across Days 1, 3, and 7, with AST, ALT, bilirubin, and INR showing marked postoperative decreases. Creatinine also showed a statistically significant change, although the magnitude appears smaller.

Postoperative vascular complications were recorded in 4 of the 39 liver transplant recipients (10.3%). Hepatic vein thrombosis was the most frequent complication, occurring in 2 patients (5.1%; 95% CI: 1.4–16.9), and these patients required re-intervention and thrombolysis. Hepatic vein stenosis occurred in 1 patient (2.6%; 95% CI: 0.5–13.2) and was managed with balloon angioplasty and stenting.

No cases of portal vein thrombosis were observed (0/39, 0.0%; 95% CI: 0.0–8.8). Hepatic artery thrombosis occurred in 1 patient (2.6%; 95% CI: 0.5–13.2) and was managed with early revascularization.

Overall, the rate of vascular complications was 10.3% (4/39; 95% CI: 4.1–23.6). These findings indicate that vascular complications were relatively uncommon, with hepatic vein thrombosis being the most frequent complication in this group.

Table 6. Postoperative Vascular Complications Among Liver Transplant Recipients (N = 39)

Vascular complication	N (%)	95% CI	Management/outcome
Hepatic vein thrombosis	2 (5.1)	1.4–16.9	Re-intervention / thrombolysis
Hepatic vein stenosis	1 (2.6)	0.5–13.2	Balloon angioplasty/stenting
Portal vein thrombosis	0 (0.0)	0.0–8.8	None
Hepatic artery thrombosis	1 (2.6)	0.5–13.2	Early revascularization
Total vascular complications	4 (10.3)	4.1–23.6	

Note: Percentages were calculated using the total study population (N = 39) as the denominator

Patient Survival

Kaplan–Meier analysis estimated patient survival at 89.7% at 30 days, 90 days, and 1 year. All recorded deaths occurred during the early postoperative period. Graft-survival estimates were not reported in the supplied Results file and therefore were not added.

Discussion

The present study evaluated the use of an autologous recipient portal vein for reconstruction of the middle and/or right hepatic veins during living donor liver transplantation (LDLT). Overall, the findings support the feasibility of this approach. The most important finding was the high patency of the reconstructed veins during follow-up, reaching 97.2% at 1 and 3 months and 100% among the 34 patients evaluated at 1 year. Early graft function also showed clear biochemical improvement during the first postoperative week. Vascular complications occurred in 10.3% of recipients, while hepatic vein thrombosis and stenosis occurred in 5.1% and 2.6%, respectively. These results suggest that the recipient portal vein can provide a useful autologous conduit for hepatic venous reconstruction, although early thrombosis remains an important complication that requires close postoperative surveillance.

The study population had a mean graft weight of 599.54 ± 113.79 g and a mean graft-to-recipient weight ratio (GRWR) of $0.89 \pm 0.21\%$. The median MELD and MELD-Na scores were both 16, indicating a population with substantial but variable liver disease severity. The GRWR is particularly relevant because adequate graft volume and venous drainage work together to determine the effective functional mass of a partial liver graft. Qu et al. (2021, China) emphasized that graft selection in LDLT must provide adequate functional liver volume while

protecting donor safety. Their work also showed the importance of hepatic venous anatomy when selecting and reconstructing partial grafts [1].

The main finding of this study was the favorable patency of the reconstructed venous grafts. Patency increased from 84.6% on Day 1 to 91.9% on Day 7 and 97.2% at both 1 and 3 months. At 6 months, it was 94.4%, while all 34 grafts evaluated at 1 year were patent. These findings compare favorably with Durairaj et al. (2021, India), who conducted a randomized clinical trial comparing recipient portal vein (RPV) with polytetrafluoroethylene (PTFE) for neo-MHV reconstruction. They reported RPV thrombosis rates of 6.5% at 14 days and 14.5% at 90 days, compared with 10% and 18.3%, respectively, with PTFE. There was no significant difference between the two materials, leading the authors to conclude that RPV and PTFE provided similar early patency [3]. The high patency observed in the present study therefore provides further support for the recipient portal vein as a practical reconstruction material.

The present patency results also appear favorable when compared with some other reconstruction materials. Lee et al. (2019, South Korea) studied 521 right-lobe LDLT recipients and reported that patency varied according to reconstruction material. For recipient portal vein grafts, MHV patency was 62.5% on postoperative Day 7, 57.1% on Day 20, 48.8% on Day 90, and 45.2% at 1 year [6]. More recently, Won et al. (2026, South Korea) evaluated Hemashield prosthetic grafts and reported conduit occlusion-free rates of 81.0% at 3 months and 57.9% at 1 year [16]. Although direct comparison should be made cautiously because studies differ in surgical technique, imaging schedules, definitions of patency, and patient characteristics, the 100% patency among patients evaluated at 1 year in the present series is encouraging. Importantly, however, this value should not be interpreted as 100% patency for the original cohort because only 34 of the 39 recipients were evaluated at that time point.

One possible explanation for the favorable results is the biological nature of the recipient portal vein. Unlike PTFE or Dacron, the recipient portal vein is an autologous vessel and therefore avoids introducing permanent synthetic material. Durairaj et al. (2021, India) noted that RPV offers immunological safety, lower infection risk, and potentially favorable patency, while synthetic grafts offer easier availability and handling but raise concerns about infection in immunosuppressed recipients [3]. The recipient portal vein can also be adapted to complex vascular anatomy. Song et al. (2019, China) successfully used the recipient's own portal confluence as a Y-graft for vascular reconstruction, demonstrating the flexibility of autologous portal venous tissue [9]. These properties may partly explain why the recipient portal vein performed well in the current study.

Early graft function was another important outcome. AST decreased markedly from a median of 518.45 U/L on Day 1 to 55.20 U/L on Day 7, while ALT decreased from 480.45 to 146.60 U/L. Total bilirubin fell from 5.32 to 2.63 mg/dL and INR from 2.09 to 1.48, with all changes being statistically significant ($p < 0.001$). Serum creatinine also decreased significantly, although the change was smaller ($p = 0.007$). The rapid decline in aminotransferases together with improvement in bilirubin and INR suggests progressive recovery of hepatocellular injury and synthetic/excretory function during the first postoperative week. Adequate venous outflow may contribute to this recovery by reducing graft congestion. Recent work comparing different MHV reconstruction configurations has similarly shown that maintaining venous patency is an important technical goal, although differences in patency do not always translate into measurable differences in early biochemical graft recovery [17].

Despite this overall biochemical improvement, EAD according to the Olthoff criteria occurred in 17 of 39 recipients (43.6%). This proportion is higher than the 23.2% reported in the original Olthoff validation cohort, although that study included broader liver transplant populations rather than only LDLT recipients. More recent studies also demonstrate considerable variation in EAD frequency depending on the population and definition used. Wiemann et al. (2025, Germany) reported an EAD rate of 53.6% among 621 liver transplants and found that EAD was associated with poorer 1-year graft survival [13]. In contrast, a large multicenter LDLT study involving 2,944 recipients reported EAD in 10.9% and identified MELD score, hospitalization at transplantation, and graft weight as independent pretransplant predictors [18]. Therefore, the 43.6% rate in the present study should not necessarily be interpreted as evidence of poor performance of the portal vein conduit. EAD is multifactorial and can reflect recipient condition, graft size, ischemia-reperfusion injury, donor characteristics, operative factors, and vascular events.

The occurrence of vascular complications provides a more direct assessment of reconstruction safety. Overall, four patients (10.3%) experienced a vascular complication. Hepatic vein thrombosis occurred in two patients (5.1%), hepatic vein stenosis in one (2.6%), and hepatic artery thrombosis in one (2.6%); importantly, no portal vein thrombosis was recorded. The hepatic vein thromboses were treated by re-intervention and thrombolysis, while stenosis was managed by balloon angioplasty and stenting. The 5.1% hepatic vein thrombosis rate compares

favorably with the RPV arm of Durairaj et al. (2021, India), in which neo-MHV thrombosis reached 6.5% at 14 days and 14.5% at 90 days [3]. This comparison is clinically important because that randomized trial also showed that neo-MHV thrombosis was associated with higher 90-day all-cause and sepsis-related mortality, regardless of the conduit used. Thus, the relatively low thrombosis rate in the present study supports the safety of the technique while also emphasizing the need for early Doppler surveillance.

The absence of portal vein thrombosis is also reassuring because the recipient portal vein is harvested and reused as a vascular conduit. It suggests that, in carefully selected recipients, use of part of the explanted portal vein for hepatic venous reconstruction does not necessarily create an additional portal venous problem. Nevertheless, recipient portal vein use requires appropriate vessel quality. Durairaj et al. noted that vessel caliber, wall quality, portal vein thrombosis, and possible malignant vascular involvement can limit its suitability [3]. Therefore, the favorable results of this study should be interpreted within the context of patient selection rather than suggesting that the technique is appropriate for every LDLT recipient.

Patient survival was estimated at 89.7% at 30 days, 90 days, and 1 year, with the recorded deaths occurring during the early postoperative period. This survival estimate is reasonably comparable with contemporary LDLT experience. A recent multicenter randomized trial by Reddy et al. (2025, India) involving 219 right-lobe LDLT recipients reported 1-year survival of 89% with single-outflow reconstruction and 85% with double-outflow reconstruction. The study also found that better early neo-MHV patency was associated with improved in-hospital survival, although the difference in 1-year survival was not significant [19]. These findings support the view that technically successful venous reconstruction is particularly important during the early postoperative period, when thrombosis, congestion, sepsis, and graft dysfunction can have their greatest clinical effect.

Taken together, the results indicate that the autologous recipient portal vein is a feasible option for MHV and RHV reconstruction during LDLT. Its main strengths are the use of native vascular tissue, avoidance of a synthetic foreign body, availability from the explanted liver in suitable patients, and the high observed patency in this cohort. The findings are consistent with the randomized evidence showing comparable early performance of RPV and PTFE [3], while the present study adds follow-up extending to 1 year. However, the results should be interpreted cautiously because the study included only 39 recipients, was retrospective and single-center, and the number of patients available for patency assessment decreased over time. In addition, without a concurrent PTFE, Dacron, or allograft control group, the present study cannot establish that the recipient portal vein is superior to other reconstruction materials. The findings instead support it as an effective option in appropriately selected patients.

Conclusion

The use of an autologous recipient portal vein for middle and right hepatic vein reconstruction during LDLT was feasible and showed favorable clinical outcomes. The technique achieved high venous graft patency, with improvement in early postoperative graft function and relatively low rates of venous thrombosis and stenosis. These findings support the recipient portal vein as a useful autologous conduit in appropriately selected patients.

Recommendations

The recipient portal vein may be considered for MHV and RHV reconstruction when the vessel has suitable length, caliber, and wall quality and is free from thrombosis or malignant involvement. Careful postoperative Doppler surveillance is recommended for early detection of thrombosis or stenosis. Larger prospective, multicenter studies comparing recipient portal vein grafts with synthetic and other vascular conduits are recommended to confirm long-term patency, safety, and survival outcomes.

References

1. Qu X, Wan P, Feng M, Qiu B, Luo Y, Zhou T, et al. Pediatric living-donor liver transplantation using right posterior segment grafts. *BMC Gastroenterol.* 2021;21(1):249. doi:10.1186/s12876-021-01835-0.
2. Song JL, Yang J, Wu H, Yan LN, Wen TF, Wei YG, et al. Pure laparoscopic right hepatectomy of living donor is feasible and safe: a preliminary comparative study in China. *Surg Endosc.* 2018;32(11):4614-4623. doi:10.1007/s00464-018-6214-0.

3. Durairaj MS, Mathew JS, Mallick S, Nair K, Manikandan K, Varghese CT, et al. Middle hepatic vein reconstruction in adult living donor liver transplantation: a randomized clinical trial. *Br J Surg*. 2021;108(12):1426-1432. doi:10.1093/bjs/znab346.
4. Varghese CT, Bharathan VK, Gopalakrishnan U, Balakrishnan D, Menon RN, Sudheer OV, et al. Randomized trial on extended versus modified right lobe grafts in living donor liver transplantation. *Liver Transpl*. 2018;24(7):888-896. doi:10.1002/lt.25014.
5. Park GC, Hwang S, Ha TY, Song GW, Jung DH, Ahn CS, et al. Hemashield vascular graft is a preferable prosthetic graft for middle hepatic vein reconstruction in living donor liver transplantation. *Ann Transplant*. 2019;24:639-646. doi:10.12659/AOT.919780.
6. Lee SH, Na GH, Choi HJ, Kim DG, You YK. Impact of the reconstruction material on the patency of middle hepatic vein in living donor liver transplantation using the right liver. *Transplant Proc*. 2019;51(8):2745-2749. doi:10.1016/j.transproceed.2019.03.075.
7. Borle DP, Pamecha V, Bharathy KGS, Sasturkar SV, Sinha PK, Patidar Y, et al. Explant portal vein for reconstructing middle hepatic vein in right lobe living donor liver transplantation-outcome analysis. *HPB (Oxford)*. 2018;20(12):1137-1144. doi:10.1016/j.hpb.2018.05.008.
8. Feng M, Wan P, Qiu B, Zhou T, Luo Y, Gu L, et al. Improved portal vein venoplasty with an autogenous patch in pediatric living donor liver transplantation. *Liver Transpl*. 2018;24(8):1084-1090. doi:10.1002/lt.25011.
9. Song JL, Wu H, Yang JY. Laparoscopic donor right hepatectomy in a donor with type III portal vein anomaly: a case report. *Medicine (Baltimore)*. 2019;98(32):e16736. doi:10.1097/MD.00000000000016736.
10. Kim JH, Cho YJ, Choe WH, Kwon SY, Yoo BC. Model for end-stage liver disease-3.0 vs. model for end-stage liver disease-sodium: mortality prediction in Korea. *Korean J Intern Med*. 2024;39(2):248-260. doi:10.3904/kjim.2023.005.
11. Lin HY, Loi PL, Ng J, Chung A, Raj P, Chang JPE, et al. MELD3.0 is superior to MELDNa and MELD for prediction of mortality in patients with cirrhosis: an external validation in a multi-ethnic population. *JGH Open*. 2024;8(6):e13098. doi:10.1002/jgh3.13098.
12. Mazumder NR, Fontana RJ. MELD 3.0 in advanced chronic liver disease. *Annu Rev Med*. 2024;75:233-245. doi:10.1146/annurev-med-051322-122539.
13. Wiemann BA, Beetz O, Weigle CA, Tessmer P, Störzer S, Kleine-Döpke D, et al. Early allograft dysfunction after liver transplantation: definition, incidence and relevance in a single-centre analysis. *Langenbecks Arch Surg*. 2025;410(1):76. doi:10.1007/s00423-025-03633-8.
14. Krendl F, Fodor M, Buch S, Singh DD, Esser H, Cardini B, et al. The BAR score predicts and stratifies outcomes following liver retransplantation: insights from a retrospective cohort study. *Transpl Int*. 2024;37:12104. doi:10.3389/ti.2024.12104.
15. Kwong AJ, Lake JR, Schladt DP, Martinez A, Weiss S, Handarova D, et al. OPTN/SRTR 2024 Annual Data Report: Liver. *Am J Transplant*. 2026;26(8 Suppl 1):S214-S320. doi:10.1016/j.ajt.2026.05.721.
16. Won DH, Hwang S, Ahn CS, Moon DB, Ha TY, Song GW, et al. Long-term patency of Hemashield vascular grafts used for middle hepatic vein reconstruction during living-donor liver transplantation: a single-center Korean experience. *Ann Transplant*. 2026;31:e951216. doi:10.12659/AOT.951216.
17. Taha AMI, Abdalla AM, Hassan RA, Elkhateb AI, Ali AM. Outflow reconstruction in right lobe living donor liver transplant: middle hepatic vein reconstruction versus separate tributaries to inferior vena cava anastomosis. *Exp Clin Transplant*. 2023;21(3):245-250. doi:10.6002/ect.2022.0417.
18. Li Z, Raptis D, Rammohan A, Gunasekaran V, Hong S, Chen ICY, et al. Validation of a pretransplant risk prediction model for early allograft dysfunction after living-donor liver transplantation. *Transplantation*. 2025;109(8):1383-1392. doi:10.1097/TP.0000000000005331.
19. Reddy MS, Koneti AJ, Chaudhary A, Rammohan A, Yalakanti RB, Mallick S, et al. Multicenter randomised controlled trial of single versus double venous outflow reconstruction in right lobe living donor liver transplantation: Venous Outflow in Liver Transplantation Trial. *Ann Surg*. 2025;281(6):911-920. doi:10.1097/SLA.0000000000006601.