Original Article

Effectiveness of anatomic reconstruction of the middle hepatic vein in right lobe graft living donor liver transplantation using natural portal vein graft and synthetic graft

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ABSTRACT

Background: Living donor liver transplantation (LDLT) using the right lobe is now a standard method for adults to alleviate the problem of graft size insufficiency. Without including middle hepatic vein (MHV) in right lobe graft (RLG) may cause severe congestion in segments V and VIII, which leads to graft dysfunction and septic complications.

Objective: This study was conducted to evaluate the efficacy of reconstructing the MHV in RLG LDLT with native portal vein (PV) graft versus synthetic graft.

Patients and Methods: This study involved 40 patients eligible for LDLT and was divided into group A, which had synthetic graft reconstruction, and group B, which had native PV graft reconstruction, while controlling for patient characteristics.

Results: In our study, 13 (32.5%) cases of postoperative venous graft thrombosis were recorded, with a higher incidence in the synthetic graft group (45.0%) compared with the native PV graft group (20.0%). However, the trend was not statistically significant. Timing-wise, thrombosis was observed earlier in the synthetic graft group. The existence of reconstructed veins V5 and V8 was associated with a higher incidence of thrombosis in the synthetic graft group. Sepsis was also found to be a potential risk factor but with no statistical significance.

Conclusion: In adult LDLT with right lobe graft, the native PV graft should be the first choice for MHV reconstruction. The patency rate of the native PV graft was higher than the synthetic graft, especially in cases with multiple veins requiring multiple venous anastomosis, which led to a decreased incidence of thrombosis.

Key Words: Liver transplantation, living donor, native graft, reconstructed middle hepatic vein, synthetic graft.

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INTRODUCTION

Living donor liver transplantation (LDLT) using the right lobe is now a standard method for adult patients to alleviate the problem of graft size insufficiency[1]. The hepatic venous outflow of the median sector (corresponding to the Couinaud segment V, VIII, and IV) is drained mainly into the middle hepatic vein (MHV)[2]. A right liver graft with an MHV trunk often provides an adequate graft volume for recipients, but it also adds more risk to the donor operation and therefore raises an important ethical issue in LDLT[3]. Without including MHV in the right-lobe graft may cause various degrees of congestion in the anterior segment (segments V and VIII), which leads to severe graft dysfunction and septic complications[4]. In such cases, reconstruction of the MHV tributaries with venous grafts is recommended, because this method could obviate the potential congestion in the anterior segment and provide a functioning liver comparable to an extended right liver graft[5].

For a right liver graft with MHV, there would be another technical difficulty in case additional reconstruction of the MHV tributaries is necessary, and for that, an issue concerns the source of optimal vessel graft for reconstruction, whether by a synthetic graft or a native graft[6]. There are many variations in MHV tributaries, and no single reconstruction method can be applied for all patients. As a result, many different methods have been reported[1]. The grafts for MHV tributary reconstruction can be divided into three types: synthetic vein graft, homologous (cryopreserved) cadaveric graft, and autologous vein graft[7].

The portal vein (PV) graft is one of the autologous vein graft types, and it is the most popular graft for MHV tributary reconstruction. The biggest demerit of this graft is that the length may not be adequate[8].

In this study, we assess the effectiveness of anatomic reconstruction of the middle hepatic vein tributaries in

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the right lobe graft living donor liver transplantation using native portal vein graft compared with the synthetic polytetrafluoroethylene (PTFE) graft.

PATIENTS AND METHODS:

Study design

The current study was a randomized controlled study. During this study, LDLTs that were performed at the Liver Transplantation Unit in Air Forces Specialized Hospital and Nasser Institute for Treatment and Research Hospital, Cairo, Egypt, between March 2022 and March 2023 were evaluated and included in the study.

All patients over 18 years old eligible for LDLT fulfilling the criteria of transplantation and requiring the reconstruction of the MHV tributaries according to the center protocol and approved by the transplantation multidisciplinary committee were included. The type of donor hepatectomy (right lobe without MHV) was determined according to the recipient's body weight, and graft volume by preoperative computed tomographic volumetry. Donors with thrombophilia FVLM hetero were accepted after a hematology consultation.

Our center started the LDLT program in 2015. So, we had sufficient data to analyze the risks and benefits of reconstruction of the MHV using a synthetic PTFE graft vs native portal vein graft. Accordingly, we designed this study. From the beginning of March 2022 till the end of March 2023, we had performed 82 LDLT cases. We excluded 42 recipients for the study due to the following: 19 pediatric cases, 4 cases of HCC, 7 cases with PVT, a single case of Budd-Chiari, a single case of retransplant, 2 cases with acute cellular rejection, 4 cases with no accessory veins to be reconstructed, i.e. only single venous outflow and one case with small for size. Three patients with early mortality (30 days' mortality) were also excluded from our study (two patients in the synthetic group and one patient in the natural group). All patients completed at least 1-month follow-up.

During this study, 40 patients candidate for LDLT were divided into two groups according to the type of the graft used in MHV tributary reconstruction. Group A included 20 recipients who had reconstruction of MHV tributaries with a synthetic PTFE graft compared with group B, which included 20 recipients who underwent reconstruction of MHV tributaries with a native PV graft.

All patients underwent evaluation and preparation for the surgery according to the center protocol. Anatomy of the vessels of the liver, including the number of MHV tributaries draining the right paramedian sector, and the biliary tract were confirmed using noninvasive contrast□ enhanced CT angiography. Biliary anatomy was assessed using MRCP.

Patients who underwent double-organ transplant (liver and kidney), retransplant, and patients with portal vein thrombosis or with Budd-Chiari syndrome or hepatocellular carcinoma (HCC) were also excluded. In addition, selected cases with small–for-size grafts of less than 0.7, postoperative vascular insult (arterial or portal), and patients who developed rejection that is proved by liver biopsy and received pulse steroid therapy were also excluded. Patients who died before the completion of the follow-up posttransplant at the time of data analysis were excluded from this study.

The recipients' age, sex, blood type, hepatopathy, preoperative laboratory and imaging test results, diagnosis of hepatopathy, model for end-stage liver disease (MELD) score, Child–Pugh score, BMI, previous biliary tract surgeries, type and weight of liver graft, graft to recipient weight ratio (GRWR), and date of transplant were abstracted.

Intraoperatively variables and reports of surgical procedures included the following: warm ischemia time, cold ischemia time and operative time, intraoperative blood loss, number of bile ducts and hepatic veins, method of hepatic veins tributaries reconstruction, and intraoperative duplex reading were recorded.

Postoperatively outcome included the following: postoperative duplex reading, morbidity, e.g. (sepsis, hepatic artery thrombosis, PVT), biliary leak or biliary anastomotic stricture (BAS), and the time elapsed from the date of transplantation to the diagnosis of reconstructed MHV graft thrombosis were recorded for each patient and mortality. Postoperative complications experienced by each patient were recorded.

Surgical procedures

Donor operation

Intraoperative Evaluation of Hepatic Venous Congestion: A J-shaped incision was made and the abdominal cavity was entered. Hepatectomy was started after a careful hilar dissection. An intraoperative ultrasound was then performed to confirm the hepatic vein anatomy and to verify the transection plane. The accessory right inferior hepatic vein, V5 or V8, if present and greater than 5 mm, was isolated and preserved. Parenchymal transection 1 cm to the right of the MHV was performed using a Cavitron Ultrasonic Surgical Aspirator (CUSA System 200; Valleylab Inc., Boulder, CO) with a standard tip was used for parenchymal transection with the following settings; 23 kHz, 70 Watt, and continuous irrigation at a rate of 4–6 ml/min with normal saline, and the vessel coagulation was performed by the bipolar sealer (Valleylab force FX electrosurgical generator, Medtronic, Minneapolis, USA); the power was used at 50. All sizable vascular and biliary structures were divided between ligatures. Hepatic venous

congestion in the right paramedian sector was observed intraoperatively after parenchyma transection.

Back-table surgery

The harvested liver graft was flushed with 3 liter of HTK (Histidine-Tryptophan-Ketoglutarate) solution through a cannula inserted into the right portal vein (Fig. 1).

In group A: A PTFE graft with suitable size (6 or 8 mm) was used in anastomosis with V5 or V8 using a nonabsorbable 6-0 polypropylene continuous suture (Fig. 2). In the single V5 or V8 settings, the synthetic graft was fashioned by initial end-to-end anastomosis.

In harvested grafts with V5 and V8 together, the synthetic graft was fashioned by initially performing end-to-end anastomosis to the V5 vein, followed by an end-to-side anastomosis of the V8 vein or anastomosing V5 and V8 individually using two separate synthetic grafts.

In group B: Native PV grafts for interposition were harvested from the recipients by elongation of both the right and left portal branches to the level of the second order with ligation of the side branches, and the main PV was at a level that would not jeopardize the reconstruction of the PV during implantation (Fig. 3). Anastomosis between V5 or V8 and autogenous PV grafts were carried out using a nonabsorbable 6-0 polypropylene continuous suture (Fig. 4).

In harvested grafts with V5 and V8 together, the native graft was fashioned by initial end-to-end anastomosis to the V5, followed by end-to-end anastomosis of the V8 in a Y-shaped manner or anastomosing V5 and V8 individually using two separate grafts.

Recipient operation

In the synthetic graft group, for MHV reconstruction, the stumps of the LHV and MHV of the recipients were preserved and served as anastomotic sites with the synthetic graft. The anastomosis was made with a nonabsorbable 6-0 polypropylene continuous suture. Graft MHV tributaries were anastomosed with a single synthetic graft when possible. The distal end of the graft was anastomosed by a common stump to LHV and MHV (Fig. 5).

In the native PV graft group, the anastomosis was made with a nonabsorbable suture using a 6-0 polypropylene continuous suture material to the nearest point of IVC due to the restricted length of graft (Figs. 6, 7).

All interventions were done by the same team of surgeons. Back-table preparation and vascular anastomosis were done by the senior surgeons throughout the study. Surgery in recipients and donors was standardized across the entire study.

Vascular flow in the graft or interposition vein patency was checked by Doppler ultrasound every day until the postoperative day 14 and once a week thereafter until hospital discharge. Results of postoperative Doppler at D0, D14, and D30 were recorded.

Prophylactic antibiotics were routinely used. The postoperative immunosuppressive regimen consisted of the tacrolimus, mycophenolate mofetil, and steroids. All patients received the same antiplatelet protocol (acetylsalicylic acid 100 mg once daily); anticoagulation was not given as a routine in our protocol only for special cases like patients with PV thrombosis.

All patients were followed-up for at least 1 month; during the hospital stay daily laboratory and radiological assessment was done during the first 2 weeks and then twice weekly until discharge. After discharge, follow-up was scheduled once weekly for the first month. Patients were asked every visit postoperatively for abdominal ultrasound and duplex together with routine laboratory data and immunosuppressive drug level. The day of the final follow-up was the end of March 2023.

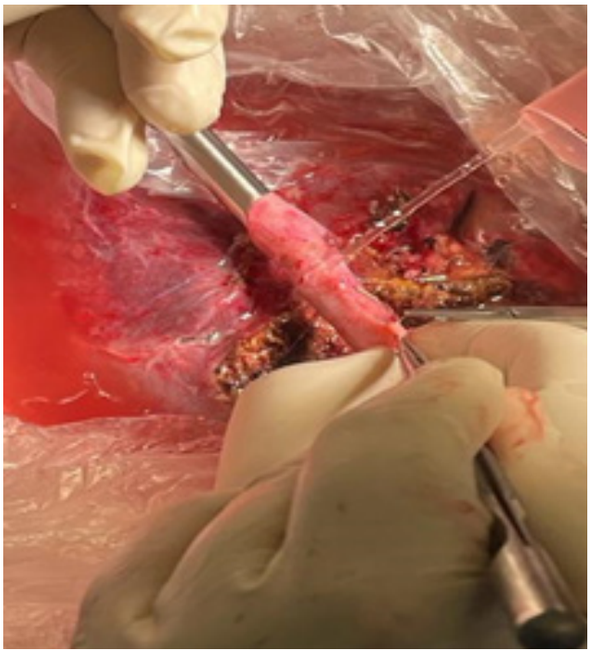

Fig. 1: Preparation of graft on the back table and washing with HTK solution

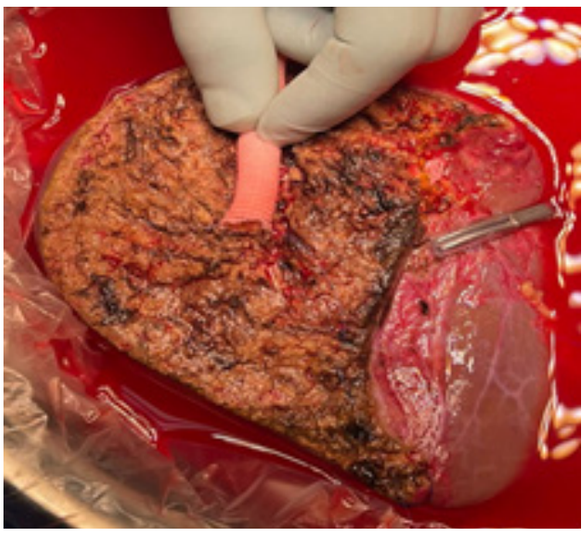

Fig. 2: Preparation of the synthetic graft on the back table.

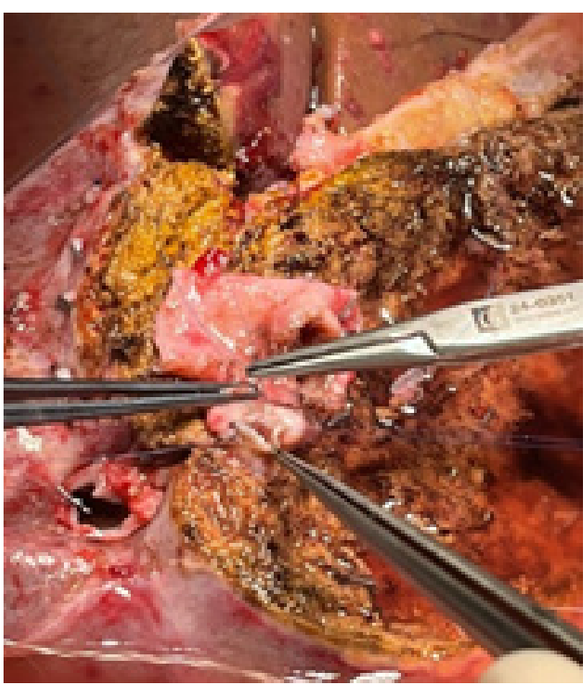

Fig. 3: Preparation of native portal vein graft on the back table.

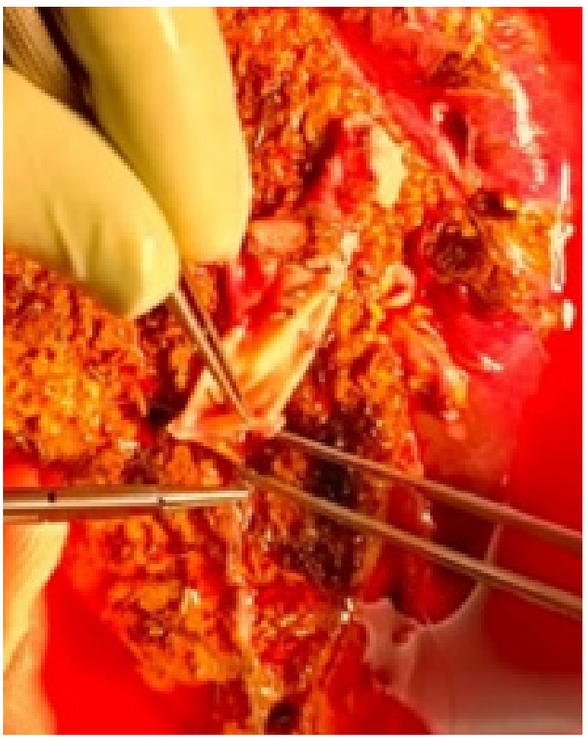

Fig. 4: Reconstruction using the native portal vein graft on the back table.

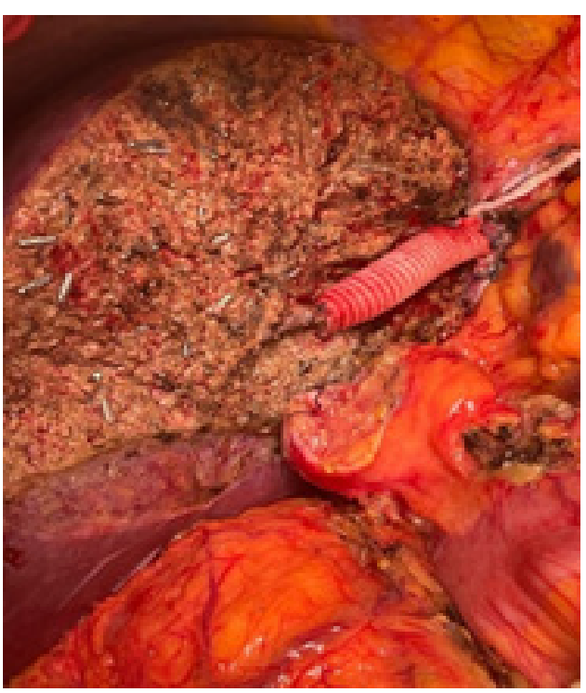

Fig. 5: Reconstruction using a synthetic polytetrafluoroethylene graft.

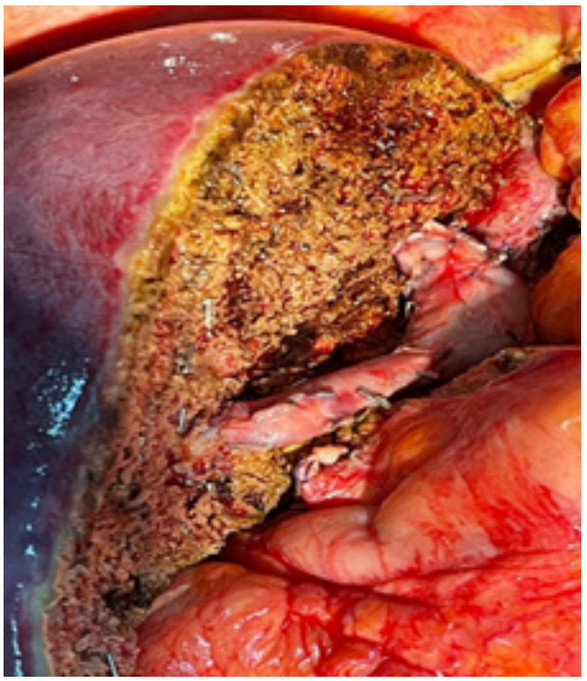

Fig. 6: Reconstruction using a native portal vein graft.

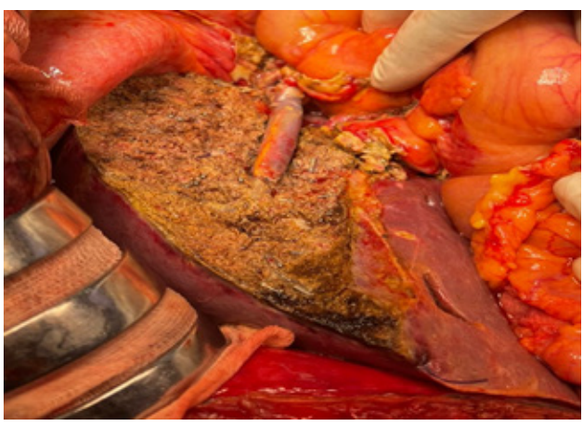

Fig. 7: Reconstruction using a native portal vein graft.

Ethics

Informed consent was obtained from every recipient before recruitment in the study, and after explaining the purpose and procedures and use of anonymized patient data for scientific purposes were taken. The approval from the ethics committees of both institutes as well as the approval of the supreme committee of organ transplant, MOH, Egypt was taken case by case.

The study was approved by the Research Ethics Committee at Faculty of Medicine, Ain Shams University, and the General Surgery Department has approved our study protocol from an ethical point of view. The Faculty of Ain Shams University, General Surgery Department Research Ethics Committee is organized and operated according to guidelines of the International council on Harmonization (ICH) and Islamic Organization for Medical Sciences (TOMS). The United States Office for Human Research Protection and the United States Code of Federal Regulations and operates under federal-wide assurance No.IRB-0006379.

Before LDLTs, all patients were informed at local transplant boards that the technique of middle hepatic vein reconstruction can be changed intraoperatively according to the intraoperative finding and consent for randomization was taken.

Patients who consented and fulfilled the inclusion criteria were randomized into two groups (1 : 1 allocation ratio), based on a computer-generated simple randomization sequence, with the name of the group enclosed in opaque, sealed envelopes, which were opened just before back-table preparation of the graft by the trial coordinator (a trained nurse) after confirming the need of MHV tributary reconstruction either for V5 or V8 or both to determine which technique would be done. Blinding of the operators was not possible.

Definition

The tributaries of MHV are classified as V8, which drains the cranial part of the portal trunk of the right paramedian sector and V5, which drains the corresponding caudal part[9].

Small-for-size graft dysfunction (SFSS) is defined as a dysfunction of a partial liver graft based on the presence of two of the following three criteria on 3 consecutive days during the first postoperative week, after exclusion of other causes: total bilirubin greater than 5.8 mg/dl, PT INR greater than 2, and encephalopathy[10,11].

Early allograft dysfunction, when one or more of the following variables are present: total serum bilirubin greater than 10 mg/dl on postoperative day 7, prothrombin time (PT)/international normalized ratio (INR) greater than 1.6 on postoperative day 7, and aspartate aminotransferase (AST) or alanine aminotransferase (ALT) greater than 2000 IU/ml up to day 7[12].

Statistical analysis

Recorded data were analyzed using the Statistical Package for the Social Sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). The quantitative data were presented as mean±standard deviation and ranges when their distribution was parametric (normal), while non-normally distributed variables (nonparametric data) were presented as median with interquartile range (IQR). Also, qualitative variables were presented as numbers and percentages. Data were explored for normality using Kolmogorov–Smirnov and Shapiro–Wilk tests.

The following tests were done:

Independent-samples t-test of significance was used when comparing between two means. The comparison between groups with qualitative data was done by using the χ^2 test and Fisher's exact test instead of the χ^2 test only when the expected count in any cell was less than 5. The confidence interval was set to 95%, and the margin of error accepted was set to 5%. So, the *P value* was considered significant as the following: *P value* less than 0.05 was considered significant. *P value* less than 0.001 was considered as highly significant. *P value* greater than 0.05 was considered insignificant.

RESULTS:

This study included 40 patients who are candidates for LDLT and were divided equally into two groups. The synthetic graft group and native PV graft group were compared while controlling for patient characteristics.

The two groups were comparable in age with the mean±SD in each of the synthetic graft groups, and the native PV graft group was 54.05±10.09 compared with 47.25±15.76, respectively (Table 1), as there was no statistically significant difference between the groups with *P value* (*P=0.112*).

Despite that the male-to-female ratio was disproportionate within the same group, it did not reach a statistical significance. Sex description also showed comparability (Table 1). In the synthetic graft group, there were 16 (80.0%) male patients and four (20.2%) female patients compared with the native PV graft group, where 11 (55.0%) patients and nine (45.0%) patients were male and female, respectively. There was no statistically significant difference between the groups with *P value* (*P=0.186*). However, there was no statistically significant difference between groups according to MELD and Child score with *P value* (*P>0.05*).

The majority of patients were HCV (45.0%) in the synthetic graft group (n=9) compared with 25.0% in the native PV graft group (n=5), followed by cryptogenic cirrhosis (30.0%) in the synthetic graft group (n=6) compared with15.0% in the native PV graft group (n=3). There was no statistically significant difference between groups, with *P value* (*P>0.05* NS) (Table 1). However, in the native PV graft group the most common etiology was autoimmune hepatitis (AIH) (n=9, 45.0%) compared with a single case (5.0%) in the synthetic graft group, with a significant *P value* (*P=0.004*) (Table 1).

According to operative characteristics shown in (Table 2), the operative duration in the native PV graft group was significantly longer than that of the other group by an average of 1.15 h. Table 2 shows that in the synthetic graft group, the GRWR was 1.0275±0.3083, the intraoperative blood loss was 1676.35±390.51, and intraoperative blood transfusion was required in 70.0% of patients in this group (n=14). However, in the native PV graft group, GRWR was 1.0855±0.3257;, the intraoperative blood loss was 1715.00±455.62; and intraoperative blood transfusion was required in 75.0% of patients in this group (n=15) and it showed no statistically significant difference on the previous operative data (*P>0.05*). As for the outflow and biliary reconstruction, the patency of the venous graft intraoperatively was comparable in both groups, and there was no statistically significant difference between groups, with *P value* (*P>0.05*).

On stratifying MHV tributary reconstruction techniques of the synthetic graft group and native graft group (Table 3), V5 and V8 were similarly represented in both groups. Also the liver grafts that harbor both V5 and V8 that required to be reconstructed were also equally distributed in both groups. All liver grafts with V5 and V8 were reconstructed using a single venous graft, a straight graft with end-to-end and side-to-end anastomoses in the synthetic graft group and a Y-shaped graft with two end-to-end anastomoses in the native PV graft group. It is worth mentioning that no conversion from one technique of reconstruction to the other was needed or recorded in the whole study.

The highest postoperative complications (Table 4) recorded in both groups were biliary leakage and sepsis, 40.0% (n=8) and 35.0% (n=7), respectively. Regarding the synthetic graft group, eight patients had postoperative complications; two patients had sepsis, two patients had biliary leakage, and three patients had both and a single patient developed renal impairment. However, five patients in the native PV graft group had complications; two patients had biliary leakage, one patient had biliary leakage and sepsis, another patient had a chest infection and sepsis and one patient had head trauma.

On comparing the above-mentioned complications in the two groups, no statistical significance was observed. We did not face any case of postoperative SFS or allograft dysfunction in the study group. As the postoperative complications were not significant between the two groups, both the ICU and hospital stay, were comparable and statistically insignificant (Table 4) with a *P value* of 0.844 and 1.227, respectively.

In our study (N=40), postoperative venous graft thrombosis was recorded in 13 (32.5%) cases (Table 5). Nine cases in the synthetic graft group versus four cases in the native PV graft group, 45.0% and 20.0%, respectively. Although the trend of thrombosis was toward the synthetic graft, it failed to show statistical significance. When observing the timing of thrombosis, no cases were recorded by the end of the second week in the native PV group. Only one (25.0%) case was on the postoperative day 0, and the other three (75.0%) cases were on the postoperative day 14. However, in the synthetic graft group, 11.1% of cases

(n=1) were recorded on the postoperative day 30, two (22.2%) cases were on the postoperative day 0, and the other six (66.7%) cases were on postoperative day 14.

In a trial to understand the relationship between the number of reconstructed veins and the risk for venous graft thrombosis (Table 6), we found that the existence of two veins, i.e. V5 and V8 is associated with a higher incidence of thrombosis (66.7%, n=6/9) in the synthetic graft group; on the other side, it represented only in 25.0% (n=1/4) of cases with thrombosed native PV graft.

There was a remarked incidence of venous graft thrombosis (Table 6) in patients with sepsis reaching 55.6% in the synthetic graft group and 50.0% in the native PV graft group, respectively. Similarly, biliary leakage was present in one-third of patients in the synthetic graft group and one-fourth of patients in the other group. However, the previous factors could not be considered risk factors in our study as they showed insignificant statistical values (0.676 and 0.726, respectively). Finally, on analyzing the different etiologies diagnosed in patients with venous graft thrombosis, we did not find a relationship between the underlying disease and the incidence of thrombosis in the study group of patients.

Table 1: Preoperative patients' demographic data of the synthetic graft group and native graft group according to demographic data

Demographic data	Synthetic graft (*N*=20) [n (%)]	Native graft (*N*=20) [n (%)]	Test value	*P* value	Significance
Age 'years'					
Mean±SD	54.05±10.09	47.25±15.76	1.625	0.112	NS
Range	20–65	17–67			
Sex					
Female n, ٪	4 (20.0)	9 (45.0)	2.849	0.091	NS
Male n, ٪	16 (80.0)	11 (55.0)			
Child Score					
Mean±SD	4.95±2.01	4.40±2.01	0.865	0.393	NS
Range	1–8	1–7			
MELD					
Mean±SD	17.60±5.87	16.30±4.05	0.815	0.42	NS
Range	9–30	9–22			
Hepatopathy					
HCV	9 (45.0)	5 (25.0)	1.714	0.190	NS
NASH	1 (5.0)	2 (10.0)	0.351	0.553	NS
Cryptogenic	6 (30.0)	3 (15.0	1.258	0.262	NS
Autoimmune	1 (5.0)	9 (45.0%)	8.320	0.004	S
HBV	1 (5.0)	0	1.000	0.317	NS
Hemochromatosis	1 (5.0)	0	1.000	0.317	NS
Wilson	0	1 (5.0)	1.000	0.317	NS
Congenital hepatic fibrosis	1 (5.0)	0	1.000	0.317	NS

Using: t-Independent sample t-test for Mean±SD.
Using: χ^2: Chi-square test for number (%) or Fisher's exact test, when appropriate.
HS, highly significant; NS, nonsignificant; S, significant.

Table 2: Operative characteristics and outcomes of the synthetic graft group and the native graft group

Operative characteristics	Synthetic graft (*N*=20)	Native graft (*N*=20)	Test value	*P* value	Significance
GRWR					
Mean±SD	1.0275±0.3083	1.0855±0.3257	0.578	0.566	NS
Range	0.8–1.32	0.8–1.4			
Operative duration (h)					
Mean±SD	8.26±1.59	9.41±1.93	−2.058	0.047	S
Range	5.8–12	6–13			
Intraoperative blood loss (ml)					
Mean±SD	1676.35±390.51	1715.00±455.62	−0.179	0.859	NS
Range	127–3000	1000–3000			
Intraoperative blood transfusion (n,%)					
PRBCs	14 (70.0)	15 (75.0)	0.125	0.723	NS
Outflow reconstruction (n,%)					
RHV	16 (80.0)	15 (75.0)	0.140	0.709	NS
RHV + MAK	4 (20.0)	5 (25.0)	0.140	0.709	NS
Intraoperative graft Doppler (n,%)					
Patent	20 (100.0)	20 (100.0)	0.000	1.000	NS
Biliary reconstruction (n,%)					
1×1	9 (45.0)	7 (35.0)	0.406	0.524	NS
2×1	8 (40.0)	5 (25.0)	1.000	0.317	NS
2×2	3 (15.0)	7 (35.0)	2.080	0.149	NS
3×3	0	1 (5.0)	1.000	0.317	NS

Using: t-Independent sample t-test for mean±SD.
Using: χ^2: Chi-square test for number (%) or Fisher's exact test, when appropriate.
HS, highly significant; NS, nonsignificant; S, significant.

Table 3: MHV tributary reconstruction techniques of the synthetic graft group and the native graft group

	Synthetic graft (*N*=20) [n (%)]	Native graft (*N*=20) [n (%)]	Test value	*P* value	Significance
Number of veins					
V5	13 (65.0)	13 (65.0)	0.000	1.000	NS
V8	2 (10.0)	2 (10.0)	0.000	1.000	NS
V5 and V8	5 (25.0)	5 (25.0)	0.000	1.000	NS
Type of reconstruction					
V5 alone	13/20	13/20	0.000	1.000	NS
V8 alone	2/20	2/20	0.000	1.000	NS
V5+V8 with Y-shaped graft	0/20	5/20	5.571	0.018	S
V5+V8 with straight graft	5/20	0/20	5.571	0.018	S

Using: t-Independent sample t-test for mean±SD.
HS, highly significant; NS, nonsignificant; S, significant.

Table 4: Postoperative outcome and complications of the synthetic graft group and the native graft group

Post-operative	Synthetic graft (*N*=20)	Native graft (*N*=20)	Test value	*P* value	Significance
ICU stay					
Mean±SD	6.95±2.02	6.70±2.20	0.198	0.844	NS
Range	3–13	4–28			
Hospital stay					
Mean±SD	20.75±5.71	18.30±5.87	1.227	0.228	NS
Range	15–37	10–30			
Postoperative complications					
Biliary leakage	5/8 (62.5)	3/5 (60.0)	0.625	0.429	NS
Sepsis	5/8 (62.5)	2/5 (60.0)	1.558	0.212	NS
Others	1/8 (5.0)	2/5 (10.0)	0.360	0.548	NS

Using: t-Independent sample t-test for mean±SD.
HS, highly significant; NS, nonsignificant; S, significant.

Table 5: Comparison between the synthetic graft group and the native graft group regarding graft thrombosis and its timing

	Synthetic graft (*N*=20) [n (%)]	Native graft (*N*=20) [n (%)]	Test value	*P* value	Significance
Thrombosed graft	9/20 (45.0)	4/20 (20.0)	2.778	0.096	NS
Timing of diagnosis					
D0	2/9 (22.2)	1/4 (25.0)	0.042	0.837	NS
D14	6/9 (66.7)	3/4 (75.0)	0.325	0.568	NS
D30	1/9 (11.1)	0/4	2.292	0.130	NS

Using: t-independent sample t-test for mean±SD.
HS, highly significant; NS, nonsignificant; S, significant.

Table 6: Comparison between the synthetic graft group and native graft group in relation to other studied parameters

	Synthetic graft (*n*=9) [n (%)]	Native graft (*n*=4) [n (%)]	Test value	*P* value	Significance
No. of veins					
V5	2/9 (22.2)	3/4 (75.0)	3.011	0.083	NS
V8	1/9 (11.1)	0/4	0.444	0.505	NS
V5 and V8	6/9 (66.7)	1/4 (25.0)	4.435	0.035	S
Type of reconstruction					
V5 alone	2/9 (22.2)	¾ (75)	3.011	0.083	NS
V8 alone	1/9 (11.1)	0/4	0.444	0.505	NS
V5+v8 with Y-shaped graft	0/9	¼ (25)	2.250	0.134	NS
V5+V8 with straight graft	6/9 (66.7)	0/4	4.576	0.032	S
Hepatopathy					
HCV	3/9 (33.3)	0/4	1.598	0.206	NS
Cryptogenic	4/9 (44.4)	2/4 (50.0)	0.032	0.857	NS
Autoimmune	1/9 (11.1)	2/4 (50.0)	2.180	0.139	NS
Hemochromatosis	1/9 (11.1%)	0/4 (0.0%)	0.444	0.505	NS
Sepsis	5/9 (55.6)	2/4 (50.0)	0.174	0.676	NS
Bile leakage	3/9 (33.3)	1/4 (25.0)	0.123	0.726	NS

DISCUSSION

In this randomized study of adults LDLT using the right liver graft, we found a higher patency of the native PV graft when used for reconstruction of MHV tributaries over the synthetic graft in the first month postoperatively.

It can be difficult to ensure sufficient venous outflow in the right lobe of LDLT. When doing LDLT, the majority of high-volume transplant centers use a right lobe graft with interposition vascular grafts for back-table reconstruction of the MHV tributaries. This would resemble an extended right lobe graft physiologically and functionally[13,14]. It is still unclear which conduit would be best for reconstructing MHV tributaries.

It seems that the problem of liver transplants will always be the rarity of resources. The shortage of donors is still the main problem facing DDLT programs. In Egypt, cryopreserved veins are a major difficulty in LDLT programs owing to the inactive deceased donor program. The reconstruction of the MHV tributaries using venous grafts is needed in certain cases, the optimal vessel for interposition has emerged as a new problem.

Many types of vein grafts have been used for the reconstruction of MHV tributaries; cryopreserved veins have the problem of vein graft obstruction in the long-term observation period[15]. The inferior mesenteric vein (IMV), umbilical vein, and saphenous vein are too small to maintain flow for a long time and usually need venoplasty to increase its diameter. The iliac vein, which has a similar size to the MHV, requires extensive dissection[16-18]. From here comes the idea of using the native PV interposition vein graft in the reconstruction of MHV tributaries.

The immunological safety of the RPV and the intrinsic benefits of an autologous vein, such as improved patency and a decreased risk of infection, were highlighted by Borle *et al*. However, the quality of the vessel wall, caliber of the original portal vein, and existence of hepatocellular carcinoma (HCC) in the explanted liver can all impact its utility[9]. The advantages of synthetic grafts include their readily available nature, their ease of handling, and their ability to precisely match the graft's existing venous drainage. However, with an immunocompromised recipient, the potential of infection from synthetic grafts is a constant concern.

In our study, in addition to the above-mentioned precautions, we had chosen to exclude all patients with preoperatively diagnosed preexisting PVT that may affect the quality of the harvested PV in addition to HCC patients so that not to affect the radicality.

Jian Wu and his coworker adopted the idea of using the portal vein graft and mentioned several advantages as it is always available and easy to expose after the resection of the liver, the suitable caliber, thick wall, and natural curvature of the PV can reduce the risk of thrombosis after transplantation[18]. In his study, he used this technique as the main interpositional vein grafts in 13 patients and showed successful results[19].

There is no consensus on when to reconstruct the MHV tributaries. Lee *et al*.[20] indicated that when the V5 or V8 during donor hepatectomy were larger than 5 mm in diameter, and Mizuno *et al*.[21] suggested 7 mm as the demarcation for the MHV tributary reconstruction. Sano and colleagues from Japan stated that the graft volume estimation excluding the discolored area during arterial clamping may cause insufficient postoperative metabolic demand and those recommending reconstruction of the hepatic vein or its tributaries[22]. The policy of our center for the right lobe LDLT without MHV is to reconstruct the tributaries of the MHV whatever their number or diameter as long as reconstruction is possible regardless of the GRWR.

Hwang and colleagues published a study recommending the use of ringed PTFE to attribute better patency rates due to the protective effect of the rings from extrinsic compression[23]. We did not use ringed PTFE because of a previous experience in our center before the start of this study with two patients where this type of PTFE grafts was used and eroded into the stomach and the duodenum on posttransplant follow-up accidentally discovered during ERCP.

Instead, a 10 mm nonringed PTFE graft is recommended by Durairaj and colleagues because it is thick, compressible, and malleable enough to conform to the curve of the right lobe graft. This guarantees that the sectoral veins' points of anastomosis rest pleasantly on the surface of the incision. It is still up for debate whether nonringed PTFE has a lower tendency for erosion[24]. Confirmation requires long-term monitoring.

We prefer to anastomose the V8 to the venous graft rather than doing a venoplasty between V8 and RHV as we think that this venoplasty may negatively affect the blood flow in V8 as the tension that may occur over the vein and the slit-shaped opening resulting from stretching the anastomosis, which may lead to vein obstruction.

Lo *et al*.[25] had an opposing opinion. He reported venoplasty between V8 and RHV as a standard

for all right lobe grafts. But in his study, he used a short interposition graft to indirectly anastomose the venoplasty to the IVC, gaining the benefit of reducing the possibility of obstruction because of kinking or misalignment. Wu *et al*.[19] also used this technique in reconstructing V8.

In 1 month, we were able to attain an 80% patency percentage in the native PV graft group and a 55.0% patency rate in the synthetic graft group. Yi *et al*.'s[26] nonrandomized investigation with PTFE for MHV reconstruction showed a patency rate of 81.0% at 1 month and 39.0% at 4 months; nevertheless, the PV graft was used in the study. Durairaj *et al*.[24] also attained greater than 80.0% patency rates in both arms at 3 months in a research that was comparable to the one under consideration. According to his explanation, this is because before anastomosing the RHV and the vein graft to the IVC, a single ostia is created for both. This procedure is similar to that of Yi *et al*. and may cause the neighboring MHV flow to drag along with the increased blood flow through the RHV ostium.

Despite the appealing concept, this theory cannot be verified. In our center, we recommend the use of separate anastomosis to protect the RHV from propagated thrombosis in case of graft thrombosis, and we believe that the higher flow of the blood in the RHV may cause a dynamic obstruction of the blood flow in the venous graft causing a sluggish stream leading to graft thrombosis.

However, Lee *et al*.[13] reported that several patients without MHV reconstruction suffered severe congestion of the right paramedian sector, resulting in progressive graft dysfunction and septic complication. Other research showed that the relatively poor regeneration of the anterior segment was associated with preoperatively dominant MHV tributaries, indicating that congestion could lead to inadequate regeneration of the affected area[27].

Out of the 40 recipients in the study, early graft thrombosis (i.e. POD 0) occurred in three patients due to graft thrombosis in POD 0 (7.5%). One patient in the native PV graft and two patients in the synthetic graft group. Liver congestion in the form of postoperative SFS or allograft dysfunction was not recorded. We assumed that this was due to the GRWR in both groups being above 1 on average and that the graft would tolerate the congestion caused by the insufficient reconstruction of the MHV tributaries during this early time.

Kaneko and colleagues. suggested that intrahepatic collateral could produce venous flow into the RHV after the occlusion of tributaries of the MHV. This kind of venous collateral developed within 10 days after transplantation[28] and the partial congestion in the anterior segment after occlusion could be tolerated by the liver[29].

Finally, it is worth mentioning that the only risk factor that showed significance in the multivariate analysis was multiple anastomosis for multiple veins reconstructed especially when the synthetic graft was used. Neither hepatopathy, biliary leakage nor sepsis seem to be an independent risk factor of graft thrombosis. However, there is a general worry that PTFE grafts in the presence of intra-abdominal infections, such as biliary peritonitis, can be more hazardous than native venous grafts.

CONCLUSION

Based on our study, in settings of adult LDLT with right lobe graft, we believe that the first choice for MHV reconstruction should be the native PV graft whenever available as its patency rate was higher than that of synthetic grafts especially on the contest of multiple veins that need multiple venous anastomosis showing a decreased incidence of thrombosis. Further multicentric studies are needed to overcome our limitations including a larger number of patients and other synthetic grafts such as the Dacron procedure.

LIMITATIONS

The current study has several limitations. First, the follow-up of neo-MHV patency was only for 1 month and, therefore, the issue of long-term patency rates is open to debate. Second, we followed-up the patency of the venous graft by Doppler US rather than a higher radiological assessment like CT. Third, we used only one type of the synthetic venous grafts. Besides this is a single-center study with a small sample size limiting the statistical capacity.

CONFLICT OF INTEREST

There are no conflicts of interest.

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