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Full Length Research Paper

Value of Adequate Venous Outflow Reconstruction in Survival of Right Lobe Graft of Adult Living Donor Liver Transplantation

Abdelrahman M Elghandour MD[1]; Ahmed Mohamed ElGhandour MD;[2], Rasha O Refaie MD [3], Dalia Fahmy Emam MD [4] and Mohamed Ahmed Rady MD[1]

[1]- *General Surgery Department, Ain Shams University, Egypt.*
[2]- *Internal Medicine Department, Ain Shams University, Egypt.*
[3]-*Internal Medicine Department, Helwan University, Egypt.*
[4]-*Anasthesia, Intensive care and Pain Management Department, Ain Shams University, Egypt.*

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Corresponding Author:
Abdelrahman M E
General Surgery Department, Ain Shams University, Egypt.

Abstract
Background: Liver transplantation is now the first choice for treatment of patients with end staged liver disease and hepatocellular carcinoma. In Egypt, due to absence of cadaveric program living donor liver transplantation LDLT is the only available option for transplantation. The difficulty and challenges of getting a right lobe graft without middle hepatic vein is insurance of adequate venous drainage of the graft. This ensures better donor outcome when excluding MHV middle hepatic vein from the graft and avoiding right lobe graft venous congestion which is associated with impaired graft regeneration and function of recipients' right lobe graft by reconstruction of adequate accessory venous drainage. Objectives : Our aim is to clarify the importance of adequate venous drainage reconstruction of right lobe grafts in living donor liver transplantation and to determine its impact on the graft survival and avoidance of small for size syndrome as regard operative time, normalization of liver functions and survivalrates. Study design: Retrospective cohort study. Patients and methods: Between June 2014 and january 2018, 85 cases underwent right lobe graft LDLT at Ain Shams center for organ transplantation (ASCOT) and Wadi Elnile hospital by the same surgical team. Those 85 cases were further classified into two groups. (Group A) included 42 cases for whom we performed a single venous anastomosis which is the right hepatic vein. The second group (group B) included 43 cases for whom we performed multiple outflow venous anastomoses whether an additional single or double or triple anastomoses. We retrospectively compared groups as regards operative time, operative mortality rates (throughout the first month), normalization of liver functions and 6 months, 1-year survival rates of the patients. Results: There is significant increase in operative time in Group B. but when we compare between complications and outcomes in terms of laboratory findings and overall hospital stay, there were no significant differences. Six-month and one-year survival were better in Group B. Conclusion: Adult LDLT is safely achieved by harvesting the right lobe without MHV with better outcome to recipients and donors, provided that any significant MHV tributaries (segment V and/or VIII more than 4 mm) should be reconstructed, as well as any accessory considerable inferior right hepatic veins (IRHVs) named Makuuchi (MAK) to maintain adequate right lobe graft venous drainage.

Keywords: *Venous, Donor, Transplant, Liver*

Introduction

Chronic liver diseases and cirrhosis are common causes of morbidity and mortality all over the world. Liver transplantation is the best treatment for end-stage liver disease, including early HCC associated with advanced cirrhosis. However, the application of liver transplantation is limited by the shortage of deceased donor grafts; thus, many patients die while waiting for an available graft (1). The shortage of cadaveric livers has evolved an interest in living donor liver transplantation (LDLT). LDLT increased the liver graft pool and reduced waiting list mortality (2) The selection of the graft type represents a complex process with several variables to minimize the incidence of morbidity and mortality for both donors and recipients.(3,4). Right lobe grafts (RLGs) have become a standardized choice to meet the metabolic demand of adult recipients due to the advantage of a large graft volume (1,5)

The MHV carries out important venous drainage for the right anterior segment and is essential for perfect graft function in nearly more than 85% of right lobe LDLTs. (6) In the absence of the MHV, the right anterior segment of the liver graft may suffer from congestion and damage with subsequent diffuse injury to the right posterior segment, and the liver graft becomes effectively of small size. With the inclusion or the reconstruction of the MHV, early graft function is satisfactory. The inclusion of the MHV or

not in the donor's right lobectomy should be based on sound criteria to provide adequate functional liver mass for the recipient, while keeping the risk to the donor to the minimum. [7]. However, the management of anterior sector (segment 5 and segment 8) outflow remains an unresolved issue. Available alternatives are inclusion of the middle hepatic vein (MHV) in the RLG, reconstruction of the MHV tributary branches for segment 5 and 8 (V5, V8), and no outflow restoration. The target is to minimize the grade of hepatic venous congestion in the graft while maintaining adequate safety for the living donor. [3,4,5,8]. In this study our aim was to clarify the importance of adequate venous drainage of right lobe grafts in living donor liver transplantation and to determine its importance on the graft survival and avoidance of small for size graft syndrome (SSS). also, we analyzed and compared in this retrospective study the operative time, operative mortality rates (throughout the first month), normalization of liver functions and 6 month and 1 year survival rates in both groups.

Patients and methods

In this retrospective cohort study, the study population included all the patients who performed right lobe living donor liver transplantation from June 2014 till January 2018 at Ain Shams center for organ transplantation (ASCOT) and Wadi Elnile hospital. Our study included 85 cases who performed right lobe LDLT in that time interval and fulfilled the required data and time interval follow up. Those 85 cases were further classified into 2 groups:

Group A: Patients for whom we performed a single venous anastomosis including 42 cases i.e. only right hepatic vein anastomosis (RHV).

Group B: Patients for whom we performed multiple venous anastomoses whether an additional single or double or triple anastomoses including 43 cases **i.e.** in addition to RHV anastomosis, V5 or V8 or both were anastomosed. V5 was anastomosed to inferior vena cava (IVC) using synthetic Dacron graft while V8 was anastomosed to MHV using synthetic Dacron graft (ePTFE) as well, also an inferior right hepatic vein (IRHVs) or Makuuchi (Mak) with a considerable diameter was anastomosed directly to IVC.

Study Procedures

All donors and recipients passed into the following preoperative preparation:

Preoperative workup

Clinical evaluation and following labs: ALT, AST, blood group, Rh type, HCV Ab, HBV sAg, HIV Ab and HBcAb IgG, CBC with differential count, ESR, CRP, liver functions (total bilirubin, direct bilirubin, albumin, total protein, ALP, GGT, amylase), renal profile (BUN, creatinine, uric acid, Na, K), lipid profile (cholesterol, HDL, LDL and Triglycerides), bleeding profile (PT, PTT, INR, Prothrombin concentration, factor V concentration, protein C, protein S, antithrombin III), serum ferritin, Fasting and 2 hours postprandial blood sugar, Chloride, Calcium, Glucose, Phosphorus, viral markers (HAV Ab IgM, HAV Ab IgG, HBsAb titre, HBeAb, HBeAg, HBcIgM), Urine for drug abuse for (Cocaine, Cannabis, Barbiturates, Benzodiazepines, Opiates, Amphetamines), complete urine analysis, complete stool analysis, Bilharzial Ab titre, factor V Leiden gene mutation, CRP quantitative. Viral markers (HBV PCR qualitative, HCV PCR qualitative, EBV lgM, EBV IgG, CMV IgG, CMV IgM, HSV type 1 IgM, HSV type 1 IgG), coagulation profile (antithrombin III, protein C, protein S, anticardiolipin Ab IgM, anticardiolipin Ab Ig G, lupus anticoagulant), tumor markers (CEA, CA 19-9, PSA, CA125, CA 15-3, α-FP) and circulating BilharzialAg if needed.

Pre-operative imaging procedures

Abdominal duplex ultrasonography, Spiral CT scan of the abdomen for exclusion of any unrecognized diseases (for both donors and recipients), CT arteriography, portography and venography to assess arterial and venous anatomy. This was done mainly in the donor to assess if there is an extra venous anastomosis beyond the RHV by detecting any venous abnormality in the hepatic vasculature such as large V5, V8, single or double inferior right hepatic veins, CT volumetry was done in the donor to estimate the whole liver volume, right lobe volume (to be compared to the weight of the recipient to get a satisfactory graft weight recipient weight ratio (GRWR) more than 0.8, the remaining liver volume (which is called the residual liver volume and it is one of the most important factors that affects the donor safety and should be more than 35% of the total liver volume), MRCP was done to delineate the biliary anatomy and was compared with intraoperative cholangiography and finally liver biopsy was routinely done for all donors for evaluation.

Donor Surgical procedure

The selected donors were admitted to the hospital one day before the operation and underwent right formal hepatectomy through a (J shaped) hockey stick incision including a right subcostal incision with small midline extension was used to enter the abdomen. First, we mobilized the liver, piggyback for identification and preservation of makuuchi vein if present. Cholecystectomy then cholangiography through the cystic duct stump for biliary tree evaluation. Identifying the right portal vein and right hepatic artery at the liver hilum was done and the line of transection was determined by using intraoperative ultrasound. A harmonic scalpel (J&J, USA) and cavitron ultrasonic surgical aspirator (CUSA System 200 macrodissector; Cavitron Surgical Systems, Stamford, CT) were used for parenchymal division after identifying and preserving V5 and V8 if they are of significant diameter (>4 mm). The graft was flushed after harvesting through right portal vein by about 3 liters of HTK (histidine- tryptophan-ketoglutarate) solution on the backtable.

Back table procedure

Flushing of the graft was maintained until the effluent became clear, the graft was weighted and, then kept immersed in the

HTK solution inside a plastic bag with underlying sterilized ice prepared in advance. The graft is assessed at the back table considering the right portal vein stump, the right hepatic artery stump, the right hepatic bile duct, the right hepatic vein stump, and number of veins to be anastomosed in the recipient according to diameter (more than 4 mm), thickness of the wall, flow of the solution and depth inside the graft. If V5 and/or V8 were significant after the assessment, we begin reconstruction using an ePTFE synthetic grafts. If both veins were for reconstruction in the same graft, it can be done either by 2 separate grafts for each vein through end to end anastomosis or with a single common graft for both veins through end to side anastomosis using prolene 6/0.

Recipient Surgical procedure

A (J shaped) hockey stick incision including a right subcostal incision with small midline extension was used to enter the abdomen. A left subcostal extension may be done for obese patients to improve exposure. Standard piggyback technique was used to mobilize the liver. Hilum dissection with section of right and left branches of HA, then dissection and section of bile duct. The whole liver was removed with preservation of the RHV stump and MHV and LHV through their common stump. First step in graft implantation was anastomosis of the right hepatic vein to the RHV stump in the IVC with prolene 4/0 and the inferior right hepatic vein (Mak) was anastomosed to IVC directly using prolene 5/0 if preserved. Then anastomosis of the portal vein was done using prolene 6/0 and at this step venous declamping was done where the graft was flushed with the portal blood. V5, if present, was anastomosed to IVC via synthetic graft, while V8 if present was anastomosed to MHV of the recipient via synthetic graft with prolene 5/0 as shown in figure (3). The next step was the anastomosis of the hepatic artery using prolene 8/0 under 4.5x loupe magnification. Then anastomosis of the bile duct was done using 6/0 PDS with or without stent applied and at this step intraoperative cholangiography was done to assess patency of the biliary tree.

- **Intraoperative data were recorded**

Operative time, cold ischemia and warm ischemia times, graft weight to asses graft GWRW ratio (actual graft weight rather than that calculated through the CT volumetry for better and more accurate value for the GWRW ratio), number of veins that need to be anastomosed in the recipient (RHV, V5, V8 and IRHV) and intraoperative duplex after complete vascular anastomosis to assess vascular anastomosis.

- **Postoperative management (Intensive Care Unit and Ward)**

All patients were transferred postoperatively to the ICU and stayed from 7-10 days, where the following management was done: Continuous monitoring of ECG, SpO2 and arterial blood pressure by electronic monitors. Body temperature, central venous pressure and urine output were checked every two hours, daily abdominal duplex ultrasonography to assess portal venous inflow, hepatic venous outflow, hepatic artery inflow (for the first week) and if any radiological and/or laboratory evidence of graft congestion developed during the period of ICU stay continuous infusion of terlipressin was administered at rate of 2ug/kg/h for 72 hours. After ICU discharge: Full labs and abdominal ultrasound are repeated every other day in the second week, then twice weekly till discharge, then weekly in the second and third month then once per month for the next 9 months. Triphasic CT scan abdomen with portography, venograghy and arteriography is done in some cases when there is a doubt of venous outflow obstruction (elevated bilirubin, liver enzymes, prolonged prothrombin time, ascites and/or congested segment inultrasonography).

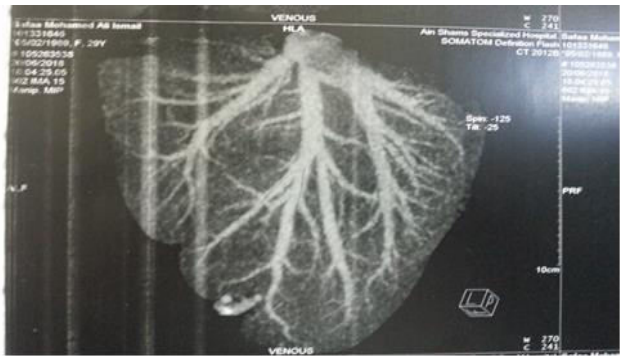

Fig (1): CT volumetry of a donor showing a significant area drained through V5.

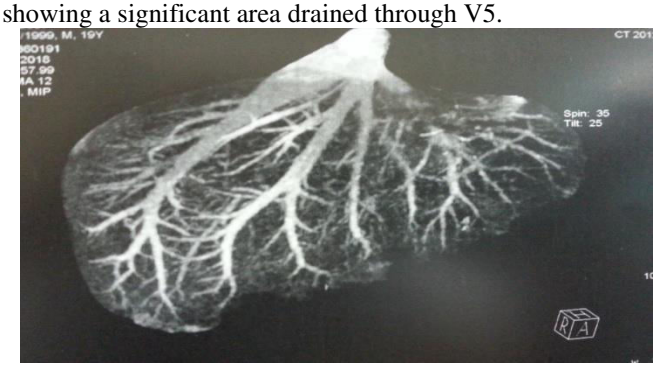

Fig (2): CT volumtry in a donor showing areas of drainage for V5 and V8

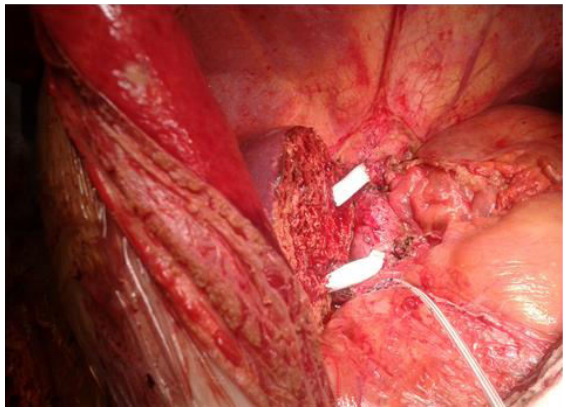

Fig (3): It shows V5 anastmosis to IVC and V8 anastmosis to MHV stump with 2 separate grafts through an end to end anastmosis.

Statistical analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations and ranges when their distribution found parametric and median with inter-quartile range (IQR) when their distribution found nonparametric. Also, qualitative variables were presented as number and percentages. The comparison between two groups regarding qualitative data were done by using *Chi-square test* and *Fisher exact test*. The comparison between two independent groups with quantitative data and parametric distribution were done by using*Independent t-test.* The comparison between two independent groups with quantitative data and non-parametric distribution were done by using *Mann-Whitney test.*

Results

Between June 2014 and January 2018, 85 cases underwent right lobe graft LDLT at Ain Shams center for organ transplantation (ASCOT) and Wadi Elnile hospital. We compared between patients with single venous anastomosis group A (n=42) and patients with multiple venous anastomoses group B (n=43). Demographic data of both groups were compared and showed no statistical difference.

Table (1): Demographic data of both groups.

		Group A	Group B	P-value	Sig.
		No. = 42	No. = 43		
Age	Mean ± SD	49.48 ± 8.26	51.4 ± 10.57	0.354	NS
	Range	21 – 61	30 – 69		
Weight	Mean ± SD	71.4 ± 5.36	72.63 ± 6.65	0.354	NS
	Range	60 – 88	60 – 88		
CHILD	Mean ± SD	11.05 ± 1.51	11.02 ± 1.65	0.944	NS
	Range	8 – 14	7 – 14		
MELD	Mean ± SD	15.36 ± 3.41	16.67 ± 3.67	0.090	NS
	Range	**10 – 26**	**10 – 24**		

Table (2): The etiology of liver diseases and indications for liver transplantation:

Diagnosis	Group A No. = 42	Group B No. = 43	Test value	P-value	Sig.
HCV + cirrhosis	35 (83.3%)	38 (88.4%)	0.445*	0.505	NS
HCV+HCC	28 (66.7%)	30 (69.8%)	0.094*	0.759	NS
Cryptogenic cirrhosis	0 (0.0%)	1 (2.3%)	0.988*	0.320	NS
Bilharzias	**1 (2.4%)**	**0 (0.0%)**	**1.036***	**0.309**	**NS**

Table (3): Types of anastomoses in our study.

	No	Percentage
Single	42	**49.4%**
Multiple	43	**50.6%**
V5 to IVC	33	**38.8%**
V8 to MHV	10	**11.8%**
MAK to IVC	15	**17.6%**
v5andv8	6	**7.1%**
V5andMAK	8	**9.4%**
V8andMak	1	**1.2%**
V5,V8, Mak	**1**	**1.2%**

Table (3) shows different types of anastmoses in our study groups and as we stated before group A (single anastomosis) was 42 cases (49.4%) and group B (multiple anastomoses) was 43 cases (50.6%). V5 only was done in 33 cases (38.8%) while V8 anastomosis only was done in 10 cases (11.8%), Mak anastomosis in 15 cases (17.6%), V5 and V8 together in 6 cases (7.1%), V5 and Mak together in 8 cases (9.4%), V8 and Mak together in one case (1.2%) and finally V5 with V8 and Mak were done only in one case (1.2%) .

Table (4): Comparison between the 2 groups concerning operation time, cold and warm ischemia times.

		Group A	Group B		
		No. = 42	**No. = 43**	**P-value**	**Sig.**
eration time (HR)	Mean ± SD	9.08 ± 1.47	9.52 ± 1.20		
	Range	6 – 12	7 – 12	0.131	**NS**
ischemia time (min)	Mean ± SD	29.64 ± 5.67	49.53 ± 14.18		
	Range	15 – 35	25 – 70	0.000	**S**
ı ischemia time (min)	Mean ± SD	35.29 ± 7.65	56.40 ± 22.34		
	Range	**15 – 45**	**20 – 90**	0.000	**HS**

There is no significant difference in operative time between both groups. Concerning the cold ischemia time (time from clamping the donor graft till removal from cold solution), *group A* ranged from (15-35 mins) with a (mean= 29.64 mins), while *group B* ranged from (25-70 mins) with a (mean= 49.53 mins) which was significant between the two groups. Pointing to the warm ischemia time (time taken for anastomosis of RHV and Mak if present and portal vein anastomosis while the hepatic artery anastomosis in not included in warm ischemia), *group A* ranged from (15-45 mins) with a (mean= 35.29 mins), while *group B* ranged of (20-90 mins) with a (mean= 56.40 mins) which was highly significant.

Table (5): Comparison between both groups as regard daily findings of pelvi-abdominal U/S within the first month.

		Group A	Group B		
		No. (%)	**No. (%)**	**P-value**	**Sig.**
	Normal	33 (78.6%)	31 (72.1%)		
Daily u/s	**Positive**	**9 (21.4%)**	**12 (27.9%)**	0.489	**NS**

Table (5) shows a comparison between both groups concerning the daily findings of pelvi-abdominal U/S, *group A* showed 21.4% (n=9) of cases had positive findings 7 cases of which developed congestion of segment 8, manifested by mild ascites and right hypochondrial dull pain with mild elevation in total bilirubin, INR and AST levels, while only 2 cases developed congestion of segment 5 with unremarkable elevation of total bilirubin, INR and ASTlevels.

While *group B* showed a 27.9% (n=12) cases have positive findings. V8 not visualized in 5 cases ranging from day 12-20 posttransplant with corresponding slight elevation in AST and ALT levels. Occluded Mak in one case at Day 7 with dull pain at left hypochondrial and remarkable elevation in AST and bilirubin levels. Hepatic artery thrombosis in one case at Day 35 due to sepsis and this patient showed a remarkable rise in AST, ALT, INR and total bilirubin levels. Occluded V5 in 3 cases ranging from day 2-10 post transplant with slight elevation in liver profile, mild congestion in segment 5 at Day 8. Congested segment 8 in one case has only V5 anastomosed at Day 7 with a slight rise in AST and ALT levels. Congested segment 5 and occluded V8 in one case with only V8anastomosed at Day 2 and this case showed marked ascites and lower limb edema whereas AST, ALT,INR, T. bilirubin were markedly elevated.

Table (6): Survival and mortality rates in the 2 groups within 1 year post LDLT.

		Group A	Group B		
		No. (%)	**No. (%)**	**P-value**	**Sig.**
Survival		35 (83.3%)	36 (83.7%)		
Mortality		7 (16.7%)	7 (16.3%)	0.106	**NS**
Cause of death	Brain infarction	0 (0.0%)	1 (16.7%)		
	Vascular complications (portal vein and hepatic artery)	2 (28.5%)	3 (42.8%)		
	Pneumonia	1 (14.2%)	1 (14.2%)		
	RTA	1 (14.2%)	0 (0.0%)		
	Septic shock	2 (28.5%)	0 (0.0%)		
	Small for size syndrome SSS	**1(14.2%)**	**2(28.5%)**		

Table (6) showed that Causes of deaths post LDLT are variable but mortality related to outflow obstruction in *group A* occurred in 1 patient due to congested segment 8 with subsequent SSS and on revision of operative data a significant V8 was injured and ligated during parenchymal dissection of the donor graft despite our plan for its reconstruction, while in *group B* 2 patients died of SSS due to Congested segment 5 and occluded V8 and the other one was due to mak occlusion despite our trial of reconstruction.

Table (7): Comparing first group labs throughout the first month post LDLT.

		Group A						
		Day 1	Day 7	Day 14	Day 21	Day 30	P-value	Sig.
Plt	Median (IQR)	73 (47 – 129)	84(39 – 148)	118.5(80 – 200)	165.5(112 –264)	186(132 –260)	0.000	H S
	Range	20 – 320	14 – 412	44 – 442	70 – 450	110 – 1111		
AS T	Median (IQR)	130.5 (117 –147)	35 (28 – 56)	34 (24 – 48)	39.5 (28 – 73)	31.5(25 – 41)	0.000	H S
	Range	17 – 400	10 – 474	15 – 450	10 – 290	15 – 210		
AL T	Median (IQR)	130 (120 – 157)	79.5 (39 –108)	42 (25 – 75)	49 (30 – 100)	41 (28 – 53)	0.000	H S
	Range	100 – 805	15 – 582	7 – 420	13 – 290	6 – 230		
T. bil.	Median (IQR)	3.75 (3.4 – 5.2)	2.85 (1.6 –3.9)	1.55 (0.9 – 3)	1.2 (0.8 – 2.5)	1 (0.8 – 1.5)	0.000	H S
	Range	3.1 – 16.6	0.4 – 8.7	0.5 – 7.9	0.4 – 8	0.4 – 7		
D. bil.	Median (IQR)	2 (1 – 2.7)	1.65 (0.8 –2.2)	0.75 (0.5 –1.5)	0.75 (0.4 – 1.5)	0.5 (0.3 – 0.9)	0.000	H S
	Range	0.4 – 8.6	0.2 – 5.9	0.2 – 5	0.1 – 4	0.1 – 4.5		
TL C	Median (IQR)	5.2 (4 – 10)	6.5 (4 – 9)	7 (5 – 10)	6.5 (6 – 8)	7 (6 – 8)	0.275	N S
	Range	2.7 – 164	2 – 16	4 – 20	4 – 20	3 – 12		
INR	Mean ± SD	2.10 ± 0.66	1.52 ± 0.35	1.42 ± 0.41	1.42 ± 0.32	1.34 ± 0.35		H S
	Range	**1.5 – 3.8**	**1 – 2.4**	**1 – 3.1**	**0.9 – 2.2**	**0.9 – 2.5**	0.000	

Table (7) shows the different variations and normalization in each single parameter in the follow up laboratory work up of *group A* throughout the first month post LDLT. From this table we concluded that: for *group A* platelets, AST, ALT, Total bilirubin, Direct bilirubin and INR are highly significant variants and reflects the success of a graft transplantation if they decline to the normal levels throughout our daily follow up.

Table (8): Comparing ***group B*** laboratory tests throughout the first month post LDLT**.**

		Group B						
		Day 1	Day 7	Day 14	Day 21	Day 30	P-value	Sig.
Plt	Median (IQR)	108 (73 – 132)	123 (70 – 179)	150 (86 – 240)	200 (119 – 256)	210 (180 – 241)	0.000	H S
	Range	19 – 310	21 – 366	38 – 350	63 – 445	90 – 450		
AST	Median (IQR)	86 (82 – 90)	41 (31 – 80)	32 (25 – 48)	38 (26 – 55)	38 (25 – 54)	0.000	H S
	Range	80 – 183	14 – 420	23 – 132	12 – 250	10 – 309		
ALT	Median (IQR)	122 (114 – 150)	68 (46 – 150)	50 (40 – 75)	40 (31 – 55)	55 (32 – 88)	0.000	H S
	Range	100 – 193	22 – 645	10 – 233	12 – 645	9 – 319		
T. bil.	Median (IQR)	3.7 (3.4 – 6)	2.2 (1.4 – 3.8)	1.6 (0.9 – 4)	1.6 (0.7 – 3)	1.1 (0.6 – 2)	0.000	H S
	Range	3 – 8.9	0.1 – 10	0.4 – 8	0.2 – 5	0.4 – 9.9		
D. bil.	Median (IQR)	2 (0.9 – 2.9)	1.1 (0.8 – 2.3)	0.7 (0.3 – 2.4)	0.9 (0.3 – 2)	0.7 (0.3 – 1.2)	0.000	H S
	Range	0.4 – 5.6	0.1 – 5	0.2 – 5	0.1 – 3	0.2 – 4.9		
TL C	Median (IQR)	6 (4 – 10)	5 (4 – 7)	6 (4 – 10)	7 (5 – 8)	7 (5 – 9)	0.142	N S
	Range	2 – 164	2 – 16	3 – 11	4 – 11	3 – 13		
INR	Mean ± SD	1.99 ± 0.66	1.53 ± 0.71	1.4 ± 0.37	1.35 ± 0.35	1.43 ± 0.52	0.000	H S
	Range	**1.4 – 3.8**	**0.9 – 4.7**	**1 – 3**	**0.9 – 2.5**	**0.9 – 4**		

Table (8) shows the different variations and normalization in each single parameter in the follow up laboratory work up of *group B* throughout the first month post LDLT. From this table we concluded that: *group B* platelets, AST, ALT, Total bilirubin, direct bilirubin and INR levels are highly significant variants and reflects the success of graft transplantation if they decline to the normal levels throughout our daily follow up.

Table (9): Comparison between the percent of change in each parameter in both groups throughout the first month.

% change		Group A No. = 42	Group B No. = 43	P-value	Sig.
Plt	Median (IQR)	161.1 (24.03 – 453.33)	106.44 (53.85 – 189.04)	0.238	N S
	Range	0 – 1421.92	0 – 979.31		
AST	Median (IQR)	-74.11 (-82.95 – -52.08)	-58.9 (-70.24 – -40)	0.029	S
	Range	-94.75 – 488.24	-89.25 – 276.83		
ALT	Median (IQR)	-73.02 (-84.19 – -56.67)	-61.22 (-70.68 – -41.06)	0.058	N S
	Range	-95.24 – 75.44	-93.08 – 115.54		

T.	Median (IQR)	-75 (-81.48 – -61.11)	-75.74 (-83.78 – -50)	0.989	**N**
bil.	Range	-92.86 – 51.61	-93.75 – 147.5		**S**
D.	Median (IQR)	-67.14 (-85 – -40)	-64.39 (-82.05 – -22.22)		**N S**
bil.	Range	-96.43 – 314.29	-94.29 – 188.89	0.633	
	Median (IQR)	17.29 (-25 – 77.78)	12.5 (-37.5 – 75)		**N S**
TLC	Range	-84.62 – 270.37	-96.95 – 333.33	0.962	
	Median (IQR)	-35.04 (-47.37 – -11.76)	-20 (-42.11 – 0)		**N S**
INR	**Range**	**-69.44 – 56.25**	**-73.68 – 53.85**	0.285	

This table showed that group B patients had more decline in blood level of AST, ALT, total bilirubin, direct bilirubin, total leucocytic count and INR although of no statistical significance of all but significant only in AST. This confirmed with the importance of anastomosing accessory hepatic veins when indicated.

Discussion

LDLT avoids the often-long waiting period of DDLT as the average waiting time for DDLT was about 169 days if compared to that for LDLT which was about only 68 days (9). In adult LDLT, right lobe grafts are used without the MHV for the sake of donor safety (10). However, a right lobe graft without MHV may be associated with graft congestion, which may result in liver dysfunction and serious complications, including graft failure and sepsis.
(11).

The reasons that anterior sector venous drainage is essential in right liver graft from living donors when the MHV is left in the donor are, first, when the graft volume is marginal and, second, because a visible congestion area is seen in the implanted liver graft and an outflow problem is detected with intraoperative Doppler US. Especially for the recipient, the importance of anterior sector drainage for small-for-size grafts is increasing. In these patients, adequate anterior sector venous drainage prevents graft congestion and hence resolves dysfunction and allows more reliable use of grafts with marginal volumes. In these critical situations, anterior sector venous drainage into the MHV ensures good drainage of the transplanted liver and allows more rapid regeneration of the graft in the critical early period after transplantation. (12, 13,14,15,16). The right liver graft with reconstructed anterior sector venous drainage provides a functioning liver mass comparable to an extended right liver graft. (17).

Many technical breakthroughs, modifications in donor hepatic transection and back table venoplasty procedures evolved over the last decade and led to a successful long-term outcome after transplantation in most of the LDLT centers. Thus, the venoplasty of MHV tributaries has been adapted as a standard procedure in liver transplantation. The venoplasty can be accomplished by using cryopreserved vascular grafts or synthetic polytetrafluoroethylene (PTFE) grafts. (18). Initial arguments against the venoplasty were the size and the number of venous tributaries that should be reconstructed. Venous branches > 4mm diameter require reconstruction. The back table procedure is also influenced by presence of graft venous variations that are found to be present in approximately 40% of donor livers and presence of a single or multiple IRHVs draining to inferior vena cava (IVC) is a common type of short hepatic vein in right liver. (19)

For all the liver allografts that are devoid of the MHV, the venous tributaries of segment 5 (V5) and 8 (V8) that are > 4 mm in diameter should be reconstructed. (20). Hepatic vein stenosis and occlusion may occur in the early posttransplant period for technical reasons, such as a tight suture line, torsion due to anastomotic kink, anastomotic level discrepancy, stretching, and graft regeneration and compression. It may also develop later in the posttransplant period due to intimal hyperplasia around the anastomotic sites. (21). The insufficiency of the simple end-to-end anastomosis between corresponding hepatic veins for securing an adequate and long-lasting outflow drainage in LDLT recipients, however, is widely accepted.Another important concern is the orthotopic position of the graft, and care should be taken regarding the graft position and anastomosis axis in outflow reconstruction to prevent obstruction of the outflow drainage. In this regard, it is important to achieve an anastomosis with an adequate reservoir capacity to withstand any type of axial kink or compression by graft regeneration or surrounding tissues, for which making the largest possible orifice in the IVC is of extreme importance in the recipient operation.(21). Previous reports have indicated a high incidence of occlusion of the MHV tributaries, V5 and V8, over the long-term period. (22).

Reconstructed V5 and V8 fully exposed on the cut surface of the graft might be vulnerable to extrinsic compression and inflammatory stimuli such as bile leakage and oozing blood, and the significantly impaired patency of V5 compared with V8 may be explained by the long venous pathway of V5, which is usually longer than that of V8. On the other hand, a reconstructed IRHV is shorter than V5 or V8, is isolated from the cut surface of the graft, and may be more tolerant to axial kinks or compression by graft regeneration or surrounding tissues, all of which may explain the better longterm patency of the IRHV.(23)

Xiao-Min Shi et al. (2011) between June 2007 and January 2008, 11 adult patients underwent LDLT using the modified right liver graft at Changzheng Hospital, Second Military Medical University, Shanghai, China. Anterior sector venous drainage was reconstructed in 9 recipients, who were all males, median age 46 (range 39-56) years. AST level shooted on postoperative day 1 and then decreased gradually. The total bilirubin level decreased rapidly after transplantation. One patient died day 9 after transplantation due to renal failure and severe pulmonary infection without any hemiliver venous outflow obstruction. The other 8 patients survived longer with a median follow-up of 30 months. In these 8 patients, Doppler ultrasonography showed no

thrombosis and blood flow was smooth within the first postoperative 30 days. This study was in agreement with our study concerning laboratory follow up in *group B*, mortality rates was 11.1% corresponding to 16.3% in our study. On contrary, this study stated that there are no cases of HVOO recorded throughout the first month while in our study *group B* some cases developed HVOO and other cases developed different U/S abnormality as previously mentioned.(24). *Ghazaly et al. (2013)* showed that the one-year survival rate was better for Group A (reconstruction patients with more than one HV anastomosis, n=16 (87.5%) with 87.5% versus 70.83% for Group B (patients with single HV anastomosis). All of the six patients with venous grafts are alive till that date and doing well, and those results were comparable to ours as we have better one year survival rates for patients with multiple venous anastomoses. (25).

In *Yu et al. (2007)* recipients' survival rate was 89.1% (49/55) with median follow-up of 10 months (range, 1 to 26 months). Six patients (10.9%) died of SSS , renal failure, multiple organ failure within 3 months after transplantation, and recurrent HCC within 13 months after transplantation. The overall graft survival rate was 90.9% (50/55). Causes of graft failure were hepatic vein stricture, small-for-size syndrome, vascular thrombosis, and sepsis. One late death caused by tumor recurrence was not considered graft failure, and those results were comparable to ours. (26) In our results, we compared a 6 month, 1 year survival rates of both groups and it showed that the second group has better survival rates (83.7% in second group and 83.3% in first group) and less mortality rates than the first group (16.3% in second group and 16.7% in first group) and this adds credits to the multiple venous reconstruction group.

For best meticulous follow up in our study we compared the daily full laboratories of each patient post LDLT and all data were driven in a common pool to get the most significant laboratory results for both study groups showing the different variations, till normalization in each single parameter throughout the first month post LDLT so as we can be able to highlight which group normalize their labs in a better course. As we discussed and explained the tables before in the results it was obvious that the second group is superior to the first group as it reached better platelets level at day 30. Concerning ALT, whereas from the first day the first group has higher values than the second group then slight rise at the end of the first week for both groups, then both decline during the second and third week with more normal values and better track for the second group. And in terms of direct bilirubin; whereas from the first day both groups have nearly the same levels and at the end of the first week the second group shows also a fast decline to normal levels when compared to the first group, then both groups continue with nearly similar normal levels throughout the third and fourth weeks.

Conclusion

According to our results, we declare that the second group in which we performed multiple venous anastomoses had better survival, less mortality rates, better graft survival and better postoperative course when daily follow up with full labs is done concerning platelets levels, ALT, direct bilirubin, INR and according to those results outflow reconstruction is highly recommended, if indicated, to achieve the best results in every single LDLT despite the longer cold and warm ischemic times.

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