Synthetic Graft for Reconstruction of Middle Hepatic Vein Tributaries in Living-Donor Liver Transplant

Refaat Kamel,[1] Yasser Hatata,[2] Karim Hosny,[3] Khaled Amer,[4] Mohamed Taha[5]

Abstract

Objectives: **In middle hepatic vein dominant livers, the anterior segment of the right lobe of the liver (segments V and VIII) drains mainly into the middle hepatic vein. In these donors, when right lobe grafts are procured without the middle hepatic vein, the graft may harbor large segment V and/or VIII veins that need reconstruction to avoid graft congestion and subsequent graft dysfunction. Draining these middle hepatic vein tributaries using autologous or cryopreserved vessels is a solution, despite the possible difficulties of their preparation. However, these vessels are not always available. Our objective was to evaluate the effectiveness and safety of using a synthetic vascular graft.**

Materials and Methods: **Between January 2012 and October 2013, eighteen adult recipients underwent living-donor liver transplant using right lobe grafts without the middle hepatic vein at Dar Al Fouad Hospital, 6th of October City, Egypt. All grafts had a large tributary of the middle hepatic vein. Eight-mm ringed expanded polytetrafluoroethylene vascular grafts were used to drain 15 segment V vein tributaries and 3 segment VIII vein tributaries directly to the inferior vena cava. Follow-up was done using duplex ultrasound to evaluate the patency of the vascular graft and the liver congestion and the liver function tests including liver enzymes.**

Results: **Intraoperative Duplex ultrasound confirmed patency and absent segmental congestion in all 18 recipients. The vascular graft patency was 17/18 at 1 week (94.4%) and 15/18 at 1 month (83.3%). No recipients developed graft infection at 1 month.**

Conclusions: **Synthetic vascular expanded polytetrafluoroethylene grafts could be used effectively and safely in middle hepatic vein tributary reconstruction to overcome the unavailability of autologous or cryopreserved vessel grafts or just to avoid the additional burden of recovering autologous grafts thus simplifying the procedure.**

Key words: *Segment V, Segment VIII, Expanded polytetrafluoroethylene, Venous congestion, Venous outflow*

From the [1]Department of Surgery, Ein Shams University, Cairo; the [2]Department of Surgery, Fayoum University, Fayoum; the [3]Department of Surgery, Cairo University, Cairo; the [4]Department of Surgery, Military Medical Academy, Cairo; and the [5]Department of Surgery, Liver Institute Menoufia, Menoufia, Egypt

Acknowledgements: *The authors declare that they have no sources of funding for this study, and they have no conflicts of interest to declare.*

Corresponding author: *Karim Hosny, the Department of Surgery, Kasr Alainy Faculty of Medicine, Manial, Cairo, Egypt*

Phone: *+20 11 1568 5683* ***Fax:*** *+20 2 358 8008* ***E-mail:*** *karimhosny@hotmail.com*

Experimental and Clinical Transplantation (2015) Suppl 1: 318-322

Introduction

Living-donor liver transplant (LDLT) was first reported in 1989.[1,2] Living-donor liver transplant has become common at many transplant centers worldwide. Right lobe (RL) grafts provide more liver volume; thus, providing an adequate graft-to-recipient weight ratio (GRWR) to match the recipient's metabolic needs. However, to preserve a satisfactory liver remnant to the donor, the middle hepatic vein (MHV) may often not be included in RL grafts. In donors with MHV dominant livers, a RL graft without a MHV will harbor the ostia of large venous tributaries of the anterior segment (segments V and VIII). Anterior segment venous congestion will occur if the venous outflow from these veins is not restored, which may lead to early graft dysfunction, sepsis, and mortality.[3] To avoid this anterior segment congestion, various types of drainage options have been reported. One option is

DOI: 10.6002/ect.mesot2014.P159

a RL graft including MHV if the donor remnant allows.[4] The use of interposition vessels for reconstruction of MHV tributaries avoids jeopardizing donor safety.[3,5] However, cryopreserved vessels are not always available and autologous vessels preparation can sometimes be complicated and time consuming.[5-10] Thus, synthetic vessel grafts could be used to overcome the unavailability of vessel grafts and to simplify the procedure. We report our experience for drainage of anterior segment tributaries using synthetic expanded polytetrafluoroethylene (ePTFE) grafts in right lobe liver grafts.

Materials and Methods

Between January 2012 and October 2013, eighteen adult recipients underwent LDLT and received a RL graft with a large MHV tributary at Dar Al Fouad Hospital in 6th of October City, Egypt. Fifteen patients required reconstruction of a segment V vein (V5) and 3 patients required reconstruction of a segment VIII vein (V8). All veins were reconstructed using ringed synthetic ePTFE grafts of 8 mm diameter. The use of these grafts was approved by the ethics committee before this work began, and the protocols conformed to the ethical guidelines of the 1975 Helsinki Declaration. Written informed consent was obtained from patients or their guardians including approval of the protocol of treatment and the anonymous use of the data for research purposes.

Pretransplant evaluation

Pretransplant data of the recipients and donors is shown in Table 1. Preoperative assessment of MHV tributaries involved multislice computed tomographic (CT) angiography with 3-dimensional reconstructions in all patients as well as MeVis imaging (MeVis Medical Solutions AG, Bremen, Germany) which additionally provided detailed information about the percentage of liver volume drained by each tributary, thus knowing the significance of each MHV tributary (Figure 1).

Donor surgery

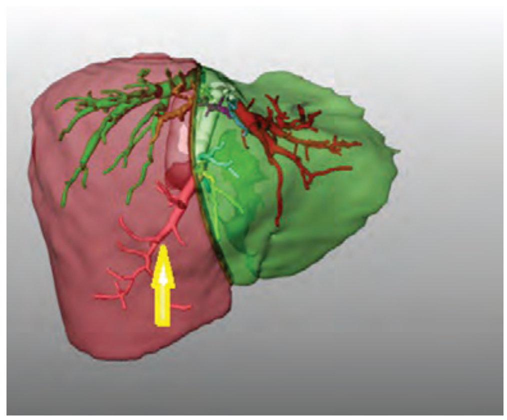
During parenchymal transection in the donor hepatectomy any major MHV branches greater than 5 mm in diameter were identified and tied with silk ligature. This allowed quantification of the purple discoloration that occurred because of congestion of the draining segment.

Table 1. Demographic Data of the 18 Recipients Who Received LDLT With Synthetic Grafts and Their Donors

Recipient Information		
Recipient gender		18:0 (male: female)
Recipient age (y)		51.8 ± 11.2†
Recipient body weight (kg)		71.2 ± 9.8†
Original liver disease	Viral hepatitis	18/18 (100%)
	Others	0/18 (0%)
MELD score		20.1 ± 8.7†
Donor Information		
Donor gender		16:2 (male: female)
Donor age (y)		26.8 ± 9.8†

Abbreviations: MELD, model for end stage liver disease
†mean ± standard deviation.

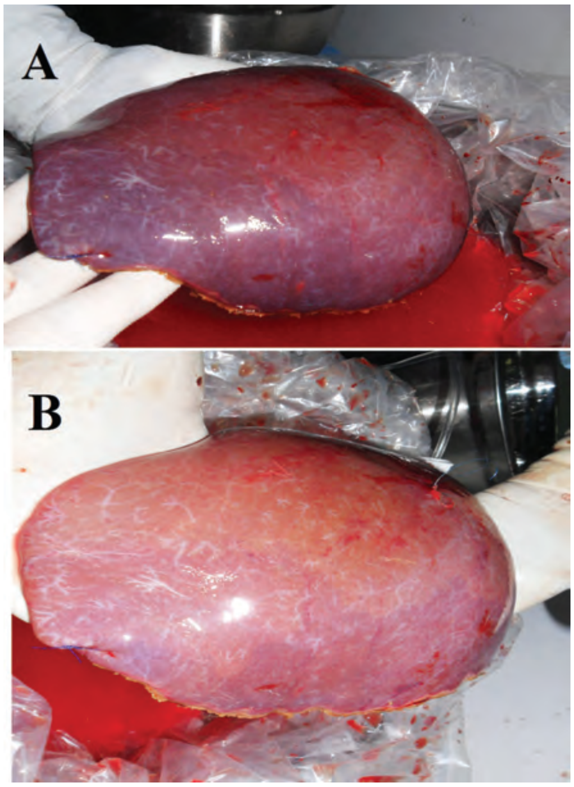
Figure 1. Three Dimensional MeVis Reconstruction Showing a Potential Right Lobe Graft Without the Middle Hepatic Vein With a Large Segment V Vein (Arrow) Draining Into the Middle Hepatic Vein



Back table

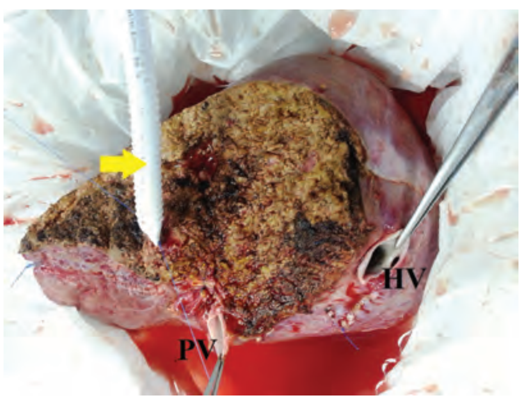
At the back table, the graft was perfused with a histidine-tryptophan-ketoglutarate solution via the portal vein. Congested segments retained their blood content despite clear fluid draining from the right hepatic vein orifice, and thus appeared as patches of dark discoloration. If the congested area was more than 20% of the anterior segment then the temporary ligature on the V5 or V8 was removed, which was followed by a gush of blood. Perfusion via the portal vein was continued until the segmental vein fluid was clear (Figure 2). The size of the vein was measured along with weighing the liver to calculate the GRWR, which along with the recipient Model for End stage Liver Disease (MELD) score aided in deciding whether venous drainage was needed. High MELD score and low GRWR favored venous reconstruction. Then, an end-to-end anastomosis was performed between the V5 or V8 hepatic vein and 1 end of a synthetic 8 mm ePTFE vascular graft using 6-0 polypropylene continuous sutures (Figure 3).

Figure 2. Back Table Liver Graft Perfusion



(A) Shows a congested segment V retaining blood despite portal perfusion. **(B)** After removal of the ligature on segment V vein and perfusion, the retained blood cleared.

Figure 3. Back Table Anastomosis of a Ringed ePTFE Graft (Arrow) to a Segment V Vein



Hepatic vein (HV) and portal vein (PV) are held with forceps.

Recipient surgery

In the recipient the usual steps were performed. The diseased liver was removed, and MHV and left hepatic vein orifices were closed. Then, the inferior vena cava (IVC) was nearly totally clamped with a Satinski double angled partial side-occluding clamp. The recipient right hepatic vein (RHV) orifice was divided caudally to create a larger opening that fits the longitudinal dimension of the graft RHV. Anastomosis of the RHV to the IVC was done using 5-0 polypropylene continuous sutures. The portal vein anastomoses was done using 6-0 polypropylene continuous sutures. Then, reperfusion was done before the ePTFE to IVC anastomosis.

Synthetic graft

At this point, there was a clamp occluding the ePTFE graft. We could visualize the size of the congested segment (Figure 4). A partial side occluding vascular clamp was applied to the IVC caudal to the RHV anastomosis. Then a longitudinal venotomy on the anterior wall of the IVC at least 1.3 cm long matching the 26 mm circumference of the 8 mm ePTFE graft was made, to which the ePTFE synthetic graft was anastomosed. The anastomosis was completed with 5-0 polypropylene continuous sutures (Figure 5). Intra-operative resolution of congestion of the segment drained was immediately noticed after anastomosis declamping (Figure 6). Intraoperative duplex ultrasonography was performed to immediately assess the patency of the MHV branches after the hepatic artery anastomosis was completed (Figure 7). No additional anticoagulant therapy was administered during or after the operation.

Results

Intraoperative recipient and graft data are shown in Table 2. Intraoperative Duplex ultrasonography confirmed patency of all ePTFE grafts and showed absent congestion in their corresponding drained segments. The ePTFE graft patency was assessed daily and monitored for 1 month. After 1 week 17/18 recipients (94.4%) had patent grafts. After 1 month graft patency was documented in 15/18 recipients (83.3%). One patient with no flow on the third postoperative day showed marked elevation of the liver enzymes with persistent high output ascites in the drains. The patient did not require any intervention and was managed conservatively and

Table 2. Intraoperative and Graft Information

Operative Information	
Graft weight (g)	730 ± 195†
GRWR (%)	0.93 ± 0.42†
Operative time (min)	520.8 ± 129.5†

Abbreviations: GRWR, graft-to-recipient weight ratio
†mean ± standard deviation.

Figure 4. Congested segments V and VIII After Reperfusion, But While the Synthetic Graft Was Clamped Before its Anastomosis to the Vena Cava

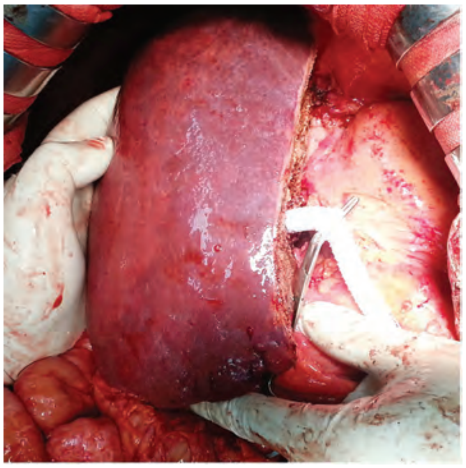
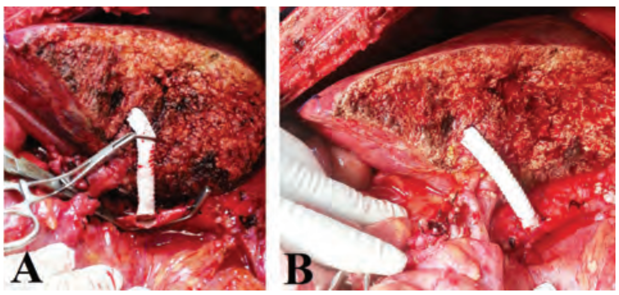
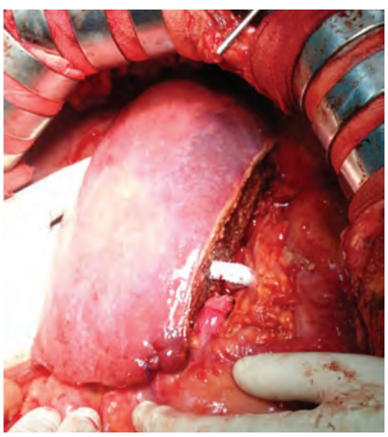


Figure 5. Final Anastomosis



(A) Inferior vena caval clamping and venotomy followed by anastomosis to synthetic graft.
(B) Declamping showing no twists or kinks in the synthetic graft.

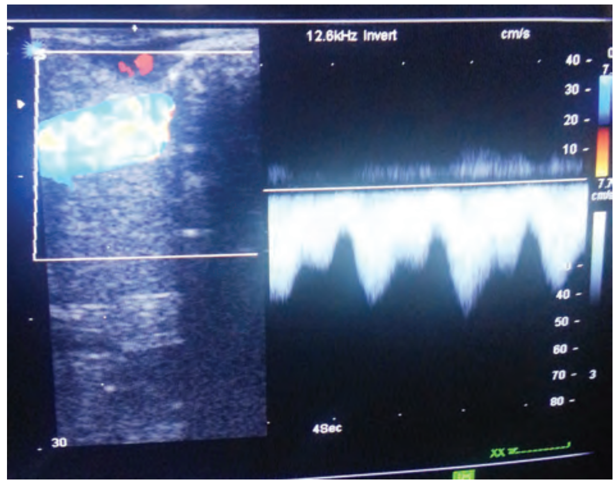
Figure 6. Resolution of Congestion of Segment V After Outflow Restoration Using a Synthetic Graft



Segment VIII Shows Minimal Residual Congestion.

had uneventful recovery. The 2 patients with no flow after 1 month had uneventful postoperative courses. No mortality or major morbidity including infections was documented in this group of patients.

Figure 7. Intraoperative Duplex Ultrasound Showing Nonresistance Flow in the Segment V Vein at the Anastomotic Site



Discussion

This study aimed at testing the patency of synthetic grafts in reconstruction of MHV tributaries in adult RL LDLT. In addition, the risk and incidence of infection was observed. Venous congestion due to MHV tributaries outflow obstruction in RL grafts can be prevented by a vascular graft between the MHV tributaries and the recipient's IVC.[11,12] This is more important when GRWR is below 1% as the liver graft regeneration is significantly lower when MHV tributary flow is not restored.[13,14]

In addition to the autologous vessels, which have complications during or after recovery,[15] other grafts such as cryopreserved veins and arteries have been used for this purpose.[5-10] Cryopreserved vessel grafts are associated with a good short-term outcome (2-3 mo) after transplant.[9,10] However, cryopreserved grafts are not available in many countries as Egypt.

Damaged sinusoids in congested areas of the right lobe will recover and function 1 week after transplant because intrahepatic venous collaterals develop.[5] Thus, the long-term patency of ePTFE grafts for MHV tributaries drainage may not be a crucial issue, as the liver graft recovers adequate graft function within 2 weeks. Also delayed occlusions of vascular grafts after 2 weeks did not cause any graft dysfunction or clinical problems during long-term follow-up. This observation was found in our study, as late occlusion of the ePTFE graft neither caused congestion in the liver graft nor any clinical abnormalities. In another study, although the 4-month patency rate was less than 50% none had complications related to graft congestion.[16]

Patency of cryopreserved vessels is thought to be higher than ePTFE grafts because a large percentage of luminal endothelial cells that remain viable at implantation are invaded with fibroblasts, making them less thrombogenic.[17] In a recent study, a composite graft using a synthetic graft and an artery patch to improve patency time was tried.[18]

Infection of synthetic grafts may be a concern; however, the recipient peritoneal cavity is not an infectious cavity, and contamination is uncommon because in all our cases we do duct-to-duct biliary anastomosis. While some studies show less infection with cryopreserved vessels versus ePTFE,[17] other studies had no incidence of infection in their group of ePTFE patients.[16,19]

Our technique in RL grafts with a main RHV and a right inferior hepatic vein is performing both these anastomoses before liver reperfusion. However, we perform the end-to-side anastomosis between the synthetic graft and the IVC after reperfusion of the liver. This allows us to see the congested segment size and to take a stitch in posterior anastomotic wall if needed and allows the liver to expand to estimate the IVC venotomy site and the graft length more accurately to avoid kinks and twists. It also decreases the warm ischaemia time. The use of ringed (reinforced) grafts versus nonringed grafts helps to avoid kinks and twists.

In conclusion, the patency rate in the early postoperative period of the ePTFE graft was satisfactory. Late obstruction of the ePTFE graft had no impact on congestion in the anterior segment or patient outcome. Therefore, the ePTFE grafts which are readily available and are easily handled may be useful for anterior segment vein drainage in living-donor liver transplant without serious complications.

References

1. Raia S, Nery JR, Mies S. Liver transplantation from live donors. *Lancet*. 1989;2(8661):497.
2. Strong RW, Lynch SV, Ong TH, Matsunami H, Koido Y, Balderson GA. Successful liver transplantation from a living donor to her son. *N Engl J Med.* 1990;322(21):1505-1507.
3. Lee S, Park K, Hwang S, et al. Congestion of right liver graft in living donor liver transplantation. *Transplantation.* 2001;71(6):812-814.
4. Lo CM, Fan ST, Liu CL, et al. Extending the limit on the size of adult recipient in living donor liver transplantation using extended right lobe graft. *Transplantation*. 1997;63(10):1524-1528.
5. Gyu Lee S, Min Park K, Hwang S, et al. Modified right liver graft from a living donor to prevent congestion. *Transplantation.* 2002;74(1):54-59.
6. Cattral MS, Greig PD, Muradali D, Grant D. Reconstruction of middle hepatic vein of a living-donor right lobe liver graft with recipient left portal vein. *Transplantation.* 2001;71(12):1864-1866.
7. Lee KW, Lee DS, Lee HH, et al. Interpostion vein graft in living donor liver transplantation. *Transplant Proc*. 2004;36(8):2261-2262.
8. Dong G, Sankary HN, Malagò M, et al. Cadaver iliac vein outflow reconstruction in living donor right lobe liver transplantation. *J Am Coll Surg.* 2004;199(3):504-507.
9. Sugawara Y, Makuuchi M, Akamatsu N, et al. Refinement of venous reconstruction using cryopreserved veins in right liver grafts. *Liver Transpl.* 2004;10(4):541-547.
10. Hwang S, Lee SG, Ahn CS, et al. Cryopreserved iliac artery is indispensable interposition graft material for middle hepatic vein reconstruction of right liver grafts. *Liver Transpl*. 2005;11(6):644-649.
11. Yu PF, Wu J, Zheng SS. Management of the middle hepatic vein and its tributaries in right lobe living donor liver transplantation. *Hepatobiliary Pancreat Dis Int*. 2007;6(4):358-363.
12. Facciuto ME, Rodriguez-Davalos MI, Nagarajan S, Singh MK, Rocca JP, Sheiner PA. Preservation of recipient middle hepatic vein for drainage of anterior sector veins in adult-to-adult living-donor liver transplantation. *Transplant Proc*. 2009;41(5):1687-1690.
13. Karademir S, Astarcioglu H, Ozbilgin M, et al. Efficacy of right anterior sector drainage reconstruction in right-lobe live-donor transplantation. *Transplant Proc*. 2006;38(10):3582-3584.
14. Peng CJ, Wang XF, Li B, et al. Efficacy of middle hepatic vein reconstruction in adult right-lobe living donor liver transplantation. *Hepatobiliary Pancreat Dis Int*. 2010;9(2):135-138.
15. Kilic M, Aydin U, Sozbilen M, et al. Comparison between allogenic and autologous vascular conduits in the drainage of anterior sector in right living donor liver transplantation. *Transpl Int*. 2007;20(8):697-701.
16. Yi NJ, Suh KS, Lee HW, et al. An artificial vascular graft is a useful interpositional material for drainage of the right anterior section in living donor liver transplantation. *Liver Transpl.* 2007;13(8):1159-1167.
17. Madden RL, Lipkowitz GS, Browne BJ, Kurbanov A. A comparison of cryopreserved vein allografts and prosthetic grafts for hemodialysis access. *Ann Vasc Surg.* 2005;19(5):686-691.
18. Hwang S, Jung DH, Ha TY, et al. Usability of ringed polytetrafluoroethylene grafts for middle hepatic vein reconstruction during living donor liver transplantation. *Liver Transpl.* 2012;18(8):955-965.
19. Pomposelli JJ, Akoad M, Khwaja K, et al. Evolution of anterior segment reconstruction after live donor adult liver transplantation: a single-center experience. *Clin Transplant*. 2012;26(3):470-475.