Letter to the Editor

Portal inflow reconstruction for liver transplantation with portal vein thrombosis

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Complex non-malignant portal vein thrombosis (PVT), defined as Yerdel grade 4, was previously considered as a contraindication for liver transplantation (LT) because of technical challenges followed by high morbidity and mortality (1). In complex PVT, Bhangui *et al.* proposed defining reconstruction of portal inflow as physiological when the splanchnic venous blood can be redirected to the graft, thus resolving the pre-existing portal hypertension (PHT) (2). Renoportal anastomosis (RPA) and coronary-portal anastomosis (CPA) are 2 main options (3). However, all reports were single case reports or small case series regarding physiological reconstruction for complex PVT, therefore, the postoperative outcomes were very heterogeneous. Herein, we introduced our experience of physiological portal inflow restoration for liver transplant in complex PVT patients, and outcomes were compared with those of patients with non-complex PVT.

This study enrolled 38 consecutive patients with PVT transplanted during the period of July 2017 to June 2020 in our center. This study was conducted with the approval of the institutional review board and ethics committee and conformed to the Declaration of Helsinki. Informed consent was obtained from each patient. Patients with Yerdel grade 4 PVT were grouped as "complex PVT" (n=16) and less severe PVT (Yerdel grade 1–3) were classified as "non-complex PVT" (n=22). Patient characteristics and correlation with grade of PVT were shown in *Table 1*. Compared with non-complex PVT group, complex PVT group had longer operative time (366.06 *vs.* 311.77 minutes, P=0.038), more red blood cell transfusion (8.97 *vs.* 3.93 unites, P=0.002), higher postoperative anastomotic stricture rates (25% *vs.* 4.5%, P=0.066) and lower overall survival (OS) rate (81.3% *vs.* 100%, P=0.034). Patient survival rates at 1 and 2 years in the complex PVT group and non-complex PVT group were 81.3%, 81.3% and 100%, 100%, respectively (P=0.036, Figure S1A). By excluding death not related to surgical complication, patient survival was both 100% of the 2 groups. Non-PHT related postoperative complication adversely affect patient survival. Patients with non-PHT related postoperative complication has significantly inferior 1, 2, and 3 years OS than those without (78.6%, 78.6%, 78.6% *vs.* 100%, 100%, 100%, P=0.018, Figure S1B). In addition, no significant difference was observed between complex and non-complex PVT patients in terms of liver function recovery, except for the change of alanine aminotransferase in the early phase after LT. No postoperative kidney injury was observed in patients with complex PVT (Figure S2).

Operative details and postoperative course of the patients with complex PVT are summarized in Table S1. Diffuse PVT and the presence of any patent collaterality were confirmed in all cases, and therefore physiological portal inflow to the graft was feasible. Among 16 patients, 7 patients had large left gastric vein (LGV) and CPA was performed. Three patients had significant splenorenal shunt (SRS) (>8 mm, 1 surgical and 2 spontaneous) and received RPA. Enlarged pericholedochal varix, splenic vein (SV) or distal superior mesenteric vein (DSMV) were observed in 3 patients, and thus pericholedochal varix to portal vein anastomosis, splenic-portal anastomosis (SPA) or DSMV-

Table 1 Patient characteristics and correlation with grade of non-malignant PVT

Variables	Grade of PVT		
	Non-complex PVT (n=22)	Complex PVT (n=16)	P value[a]
Pre-LT characteristics			
Male, gender, n (%)	17 (77.3)	11 (68.8)	0.556
Age, >50 years, n (%)	16 (72.7)	10 (62.5)	0.503
HBV etiology, n (%)	15 (68.2)	13 (81.3)	0.366
Child score at LT, C, n (%)	11 (50.0)	9 (56.3)	0.816
Pre-LT operation, n (%)	7 (31.8)	6 (37.5)	0.715
Pre-LT variceal bleeding, n (%)	11 (50.0)	5 (31.3)	0.248
Pre-LT ascites, n (%)	20 (90.9)	15 (93.8)	0.748
Pre-LT encephalopathy, n (%)	6 (27.3)	1 (6.3)	0.099
Splenorenal shunt, n (%)	0 (0.0)	6 (37.5)	0.002
Surgical characteristics			
Portal anastomosis, PPA, n (%)	22 (100.0)	0 (0.0)	<0.001
Interposed graft, n (%)	0 (0.0)	7 (43.8)	0.001
Operative time (min) (mean, SD)	311.77 (81.03)	366.06 (70.36)	0.038
Anhepatic time (min) (mean, SD)	73.36 (33.98)	85.31 (47.55)	0.372
Estimated blood loss (mL) (mean, SD)	1,769.55 (1430.29)	2,225 (870.63)	0.267
RBC transfusion (units) (mean, SD)	3.93 (3.82)	8.97 (5.63)	0.002
Fresh frozen plasma (ml) (mean, SD)	983.18 (376.2)	1,118.13 (330.62)	0.259
Post-LT complications			
Anastomotic thrombosis, n (%)	1 (4.5)	0 (6.3)	0.816
Anastomotic stricture, n (%)	1 (4.5)	4 (25)	0.066
Related to portal hypertension, n (%)	1 (4.5)	0 (0.0)	0.387
Not related to portal hypertension, n (%)	7 (31.8)	7 (43.8)	0.452
Survival after excluding death not related to surgical complication, n (%)	22 (100.0)	16 (100.0)	1.000
Overall Survival, n (%)	22 (100.0)	13 (81.3)	0.034

[a], Chi-square test. PVT, portal vein thrombosis; LT, liver transplantation; HBV, hepatitis B virus; PPA, porto-portal anastomosis; SD, standard deviation.

portal anastomosis was performed. One patient had patent SRS/SV and received RPA and SPA simultaneously (Figure S3). One patient had large SRS/LGV and received RPA and CPA (Figure S4). One patient had patent SRS/inferior mesenteric vein (IMV) and received RPA and IMV-portal anastomosis (IPA). A jump graft was used in 7 cases (43.8%). Portal anastomotic thrombosis and stricture was observed in 4 patients (25%), successfully resolved by percutaneous thrombolysis and stenting. No complications related to PHT occurred in the postoperative period. The most common non-PHT-related complication was biliary anastomotic stenosis (4/16 patients, 25%), and were improved with interventional therapy. One patient died at 29 days due to graft versus host disease (GVHD), 1 patient at 107 days due to pulmonary hypertension, and 1 patient at 57 days due to sepsis. There was no portal vein-related

morbidity. At last follow-up, 13 surviving patients had no signs of PHT and patent anastomoses on Doppler US and CT angiography.

The novel proposed classification of non-malignant PVT, incorporating functional/haemodynamic parameters, was directed towards surgical decision-making. We proposed flowchart for the management of complex portal vein thrombosis in LT as shown in Figure S5. In patients with complex PVT, a pre-existing patent portosystemic shunt (spontaneous or surgical) was mandatory to ameliorate PHT and achieve physiological reconstruction from a functional standpoint (4,5). Physiological RPAs could be considered as an option in case of extensive splanchnic vein thrombosis and large splenorenal shunt (6). Anastomosis of a large LGV to the graft portal vein was another optimal choice and 92% patients were well with a patent portal inflow (2). Other varices (such as pericholedochal varix, right superior colic vein, or ileocolic vein) also can be used to reconstruct the portal inflow to the graft (2). In line with our data, posttransplant anastomotic stenosis and thrombosis were the main concerns, however, over 80% were alive and well with patent portal inflow after medical or interventional therapy (7,8).

In conclusion, although technically demanding, tailored non-anatomical, physiological reconstructions can be performed safely and effectively as a life-saving procedure for patients with complex PVT, allowing similar outcomes as those patients without complex PVT.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by Institutional Ethics Committee of Shulan (Hangzhou) Hospital (NO.: 870) and individual consent for this retrospective analysis was waived.

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