

Venovenous bypass ahead of mobilization of the liver in orthotopic liver transplantation

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BACKGROUND: To evaluate feasibility and safety of venovenous bypass prior to mobilization of the liver during orthotopic liver transplantation (OLT).

METHODS: Fifty-four patients were classified into two groups. Group A consisted of 23 patients receiving OLT with classical venovenous bypass. Group B consisted of 31 patients who received a modified-procedure: venovenous bypass ahead of the mobilization of the liver during OLT. The blood loss, duration of venovenous bypass, cold ischemia time, anhepatic phase, and transfusion during operation in the two groups were compared. Complications after the operation were also compared between the two groups.

RESULTS: The duration of venovenous bypass and cold ischemia time in group A were longer than those in group B [(99.78 ± 21.36 min) vs (96.32 ± 22.25 min) and (484.78 ± 134.01 min) vs (443.15 ± 85.27 min)]. The anhepatic phase lasted for about 100 min averagely in the two groups. The volumes of blood loss and transfusion during the operation were larger in group A than in group B [(5096 ± 4243 ml) vs (1726 ± 1125 ml) and (3676 ± 2938.74 ml) vs (1217.69 ± 829.72 ml)]. Postoperative complications occurred in 26 patients of group A and in 19 patients of group B.

CONCLUSION: This modified-procedure or venovenous bypass ahead of mobilization of the liver in OLT can reduce the blood loss during OLT and the incidence of postoperative complications without prolongation of the anhepatic phase and duration of venovenous bypass.

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Key words: liver transplantation; venovenous bypass; coagulopathy; complication; anhepatic phase; cold ischemia

Introduction

Liver transplantation has been widely accepted in China in recent years. Up to present, several liver transplantation centers have adopted different procedures during OLT,^[1] including trans-

plantation with venovenous bypass, transplantation without venovenous bypass and piggyback liver transplantation.^[2,3] Operating style is dependent on the experience and preference of surgeons because each procedure has its merits and demerits. Generally, little interference on the systematic circulation but difficult resection is caused by piggyback liver transplantation. Time saving and fewer complications are always associated with classic liver transplantation without venovenous bypass, but unstable circulation and renal impairment may occur.^[4-6] Based on our experience in OLT with venovenous bypass, we advocate venovenous bypass ahead of the mobilization of the liver during

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OLT with satisfactory results.

Methods

From February 1992 through January 2002, 54 patients were subjected to OLT (44 men and 10 women, aged from 11 to 68 years) at the West China Hospital of Sichuan University, Chengdu, China. Cirrhosis after hepatitis B was noted in 29 patients, hepatocarcinoma with cirrhosis in 12, hepatolithiasis with cirrhosis in 1, alcoholic cirrhosis in 1, polycystic liver and kidney associated with cirrhosis in 2, Budd-Chiari syndrome in 2, congenital intrahepatic bile duct saccular dilatation in 3, sclerosing cholangitis in 1, and hepatic echinococcosis in 3, respectively. In all patients, 45 were complicated by cirrhosis. According the Child-Pugh's classification, 39 patients belonged to Child C, 2 Child B, and 13 Child A. Staging of UNOS revealed that 14 patients were of grade I and 40 grade II. Emergency liver transplantation was performed in 14 of the 54 patients because of acute hepatic failure. They were associated with serious jaundice (total bilirubin 129–676 nmol/L), moderate ascites (2500–11 000 ml), and coagulatory disorder. Hepatic coma was observed in 4 of the 14 patients.

All the patients were divided into two groups: 23 patients in group I who underwent OLT with classic venovenous bypass and 31 patients in group II who underwent OLT with a modified procedure. In group I, we segregated the perihepatic ligament, supra-hepatic vena cava, and infra-hepatic vena cava in order, dissected the hepatic artery and portal vein, and finally established venovenous bypass. After the establishment of venovenous bypass, the supra-hepatic vena cava and infra-hepatic vena cava were obstructed. At last, the liver was resected and donor liver implanted.^[7,8] In group II, however, the venovenous bypass was es-

tablished after transection of the choledochus, left and right branches of the hepatic artery and dissection of the portal vein. At this time, the supra-hepatic vena cava and infra-hepatic vena cava were blocked for subsequent mobilization of the liver under bloodless condition. Then, the liver was resected, the retroperitoneum hemostasized, and the donor liver implanted.

The sex, number of cirrhotics, UNOS grading, Child-Pugh's classification, and blood type coincidence in the two groups are shown in Table 1. All the donor livers were taken from brain death donors, with informed consent given by their relatives. The hepatic artery and portal vein were infused simultaneously with about 4000–5000 UW perfusate during the resection of donor livers. All but those with hepatocarcinoma received autoblood reinfusion. Operations lasted 7 to 10 hours, with a median of 8 hours and 28 minutes. The data were treated with the SPSS software statistical system.

Results

In this series, 49 (90.74%) patients survived the first month after operation, and 5 (9.25%) died. Of the 5 deaths, one was an 11-year-old girl with congenital intrahepatic bile duct saccular dilatation who had received reduced-size liver transplantation, resulting in stress ulceration, rebleeding and perforation after administration of steroid during the period of rejection. She eventually died of systemic infection and multiple organ failure on the 32nd postoperative day. Another one with liver cirrhosis associated with hepatic failure and serious coagulation disorder after transplantation had blood loss for 19 500 ml during the operation resulting in an awful general condition. This patient died of systemic mould infection on the 14th postoperative day. The third one who had hepatitis B associated with cirrhosis died from intracranial hemorrhage on

Table 1. Comparison of variables of patients between the two groups

Group	n	Sex (M/F)	Average age (range) (y)	Primary diseases			UNOS			Child-Pugh		Blood type	
				Cirrhosis	Hepatic carcinoma	Others	I	II	A	B	C	Match	Mismatch
I	23	16/7	38.76 (11–57)	16	2	5	8	15	3	0	20	18	5
II	31	28/3	39.16 (19–68)	17	10	4	7	14	10	2	19	19	12

Table 2. Comparison of blood loss and information of bypass between the two groups

Group	n	Duration of bypass (min)	Period of cold ischemia (min)	Anhepatic phase (min)	Blood loss in operation (ml)	Transfusion in operation (ml)
I	23	99.78 ± 21.6	484.78 ± 134.01	100.00 ± 21.19	5096.09 ± 4243.59	3676.0 ± 2938.74
II	31	96.32 ± 22.25	443.15 ± 85.27	102.00 ± 24.31	1726.23 ± 1125.29	1217.69 ± 829.72

$P < 0.01$.

Table 3. Comparison of postoperative complications between the two groups

Complications	Group I	Group II
Secondary intraabdominal hemorrhage	3	1
Infection of ascites	1	0
Gastrointestinal hemorrhage	3	1
Gastric ulcer perforation	1	0
Pulmonary infection	8	8
Left heart failure	2	2
Biliary leakage	2	2
Oral diffuse ulcer	3	2
Enteric fungal infection	2	1
Intracranial hemorrhage	1	2

the 11th postoperative day. The fourth and fifth deaths were due to pulmonary infection and MOF respectively after emergency liver transplantation.

In perioperative survivors, 6 patients died of recurrent hepatocarcinoma in the 4th and 5th month after transplantation (2), intractable infection from Budd-Chiari syndrome caused MOF 76 days after transplantation (1), pulmonary infection and MOF due to hepatitis B cirrhosis the second month after transplantation (1), cerebral haemorrhage the fifth month after transplantation (1), and heart failure the third month after operation (1). Up to now, 43 of the 54 have been surviving over 6 months (30), one year (17), and two years (7) respectively.

The duration of venovenous bypass, cold ischemia, anhepatic phase, blood loss during the operation, and volume of infusion are shown in Table 2. The duration of venovenous bypass and anhepatic phase was not significantly different between the two groups, but the volume of blood loss and infusion during the operation was lower in group II than in group I. Complications after the operation showed that the incidence of complications in group II was fewer than in group I (Table

3). Primary nonfunction (PNF) and venous or biliary duct complications in the later period were not observed in all patients.

Discussion

In our series, 45 (83.33%) of the 54 patients had portal cirrhosis, and 29 of them were related to hepatitis B. All the 45 patients showed symptoms of hepatic insufficiency, hypersplenism, splenomegaly, and coagulopathy disorder. In 39 of the 54 patients, their liver function belonged to Child C or UNOS degree I and II before operation. Of the 39 patients, 14 who were associated with serious jaundice, moderate ascites, and serious coagulopathy disorder underwent emergency liver transplantation because of acute hepatic failure. In dealing with such patients,^[9,10] the problem is extensive bleeding caused by coagulopathy disorder during the operation. Moreover, the establishment of collateral circulation around the porta hepatis and perihepatic region in patients with portal hypertension may injure the large collateral vein during the procedure and lead to massive bleeding. In our series, a total of 19 500 ml blood lost in group I, causing difficulty in recovery after operation and more complications. To solve this problem, we performed venovenous bypass ahead of the mobilization of the liver during the operation apart from intensive monitoring of coagulopathy function. First, the hepatoduodenal ligament was dissected carefully including cutting of the cystic duct and choledochus, followed by mobilization of the proper hepatic artery and the left and right branches of the hepatic artery and their subsequent transection. After dissection of the hepatoduodenal ligament, the portal vein was segregated from the hepatoduodenal ligament easily. It should be extremely careful to do this operation because there is abundant collateral

circulation. The breaking end of soft tissue must be ligated to decrease blood loss. Thus, venovenous bypass is established between the portal vein, superior vena cava, and inferior vena cava. The supra-hepatic inferior vena cava and infra-hepatic inferior vena cava is blocked after segregation. Subsequently, the diseased liver could be resected quickly without consideration of bleeding due to the establishment of venovenous bypass. The donor liver can be transplanted into the recipient after haemostasis of the retroperitoneum.

Using this method, we performed OLT for 32 patients with short segregation time for the liver. The blood loss was decreased more significantly in group II (median 1726 ml, and only 400–1000 ml in 18 of 31) than in group I (5096 ml). Because of retransfusion of autoblood, the volume of external transfusion averaged 1200 ml. The anhepatic phase and duration of venovenous bypass were not statistically different between the two groups. The data in Table 3 show that this method decreases the incidence of complications because of blood transfusion and that more expense was saved in group II than in group I.

Moreover, this method is also advantageous to patients with hepatocarcinoma. First, it is likely to decrease the chance of tumor cells spreading into the circulation due to crushing of tumor. Second, the porta hepatis is dissected immediately after opening of the abdominal cavity without exploration of the tumor. Hence the perihepatic ligament is cut and the diseased liver is resected without compression on the tumor. Third, thorough resection involving the posterior segment of the vena cava and chemotherapy prescribed before, during, and after operation can inhibit tumor recurrence. Our recent 10 recipients have been surviving without tumor for 5–10 months. They are still subjected to follow-up.

In summary, venovenous bypass ahead of the mobilization of the liver in OLT can reduce blood loss and postoperative complications without prolonging the duration of venovenous bypass and anhepatic phase. We think that this method can be adopted in patients with end-stage liver cirrhosis and hepatocarcinoma.

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Competing interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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