

## Clinical analysis of surgical treatment of portal hypertension

Xin-Bao Xu, Jing-Xiu Cai, Xi-Sheng Leng, Jia-Hong Dong, Ji-Ye Zhu, Zhen-Ping He, Fu-Shun Wang, Ji-Run Peng, Ben-Li Han, Ru-Yu Du

Xin-Bao Xu, Xi-Sheng Leng, Ji-Ye Zhu, Fu-Shun Wang, Ji-Run Peng, Ru-Yu Du, Department of Hepatobiliary Surgery, People's Hospital, Peking University, Beijing 100044, China  
Xin-Bao Xu, Department of Hepatobiliary Surgery, Airforce General Hospital, Beijing 100036, China  
Jing-Xiu Cai, Zheng-Ping He, Jia-Hong Dong, Ben-Li Han, Center of Hepatobiliary Surgery, Southwest Hospital, The Third Military Medical University, Chongqing 400038, China  
Correspondence to: Xin-Bao Xu, Department of Hepatobiliary Surgery, People's Hospital, Peking University, Beijing 100044, China. x\_xb@163.net  
Telephone: +86-10-68792703  
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### Abstract

**AIM:** To review the experience in surgery for 508 patients with portal hypertension and to explore the selection of reasonable operation under different conditions.

**METHODS:** The data of 508 patients with portal hypertension treated surgically in 1991-2001 in our centers were analyzed. Of the 508 patients, 256 were treated with portaazygous devascularization (PAD), 167 with portasystemic shunt (PSS), 62 with selective shunt (SS), 11 with combined portasystemic shunt and portaazygous devascularization (PSS+PAD), 9 with liver transplantation (LT), 3 with union operation for hepatic carcinoma and portal hypertension (HCC+PH).

**RESULTS:** In the 167 patients treated with PSS, free portal pressure (FPP) was significantly higher in the patients with a longer diameter of the anastomotic stoma than in those with a shorter diameter before the operation ( $P<0.01$ ). After the operation, FPP in the former patients markedly decreased compared to the latter ones ( $P<0.01$ ). The incidence rate of hemorrhage in patients treated with PAD, PSS, SS, PSS+PAD, and HCC+PH was 21.09% (54/256), 13.77 (23/167), 11.29 (7/62), 36.36% (4/11), and 100% (3/3), respectively. The incidence rate of hepatic encephalopathy was 3.91% (10/256), 9.58% (16/167), 4.84% (3/62), 9.09% (1/11), and 100% (3/3), respectively while the operative mortality was 5.49% (15/256), 4.22% (7/167), 4.84% (3/62), 9.09% (1/11), and 66.67% (2/3) respectively. The operative mortality of liver transplantation was 22.22% (2/9).

**CONCLUSION:** Five kinds of operation in surgical treatment of portal hypertension have their advantages and disadvantages. Therefore, the selection of operation should be based on the actual needs of the patients.

**Key words:** Portal hypertension; Surgical operation; Shunt

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### INTRODUCTION

In order to discuss operation indications, the data of 508 patients with portal hypertension treated surgically with portaazygous disconnection (PD), portasystemic shunt (PSS), selective shunt (SS), combined portasystemic shunt and portaazygous devascularization (PSS+PAD), liver transplantation (LT), and union operation for hepatic carcinoma and portal hypertension (HCC+PH) in 1991-2002 in our centers were analyzed.

### MATERIALS AND METHODS

#### General data

Of the 508 patients, 425 were males and 83 females, aged 3-71 years (average 40.8 years). Three hundred and fifty-eight patients (70.47%) had a history of bleeding from the upper digestive tract, 150 patients (37.24%) had esophageal varices in different degrees with no history of bleeding from the upper digestive tract. Child-Pugh classification of liver function showed grade I in 260 patients, grade II in 164, grade III in 84. Etiology was posthepatic cirrhosis in 468 patients, biliary cirrhosis with biliary tract stenosis in 22, extrahepatic portal obstruction in 6, alcoholic cirrhosis in 8, schistosomiasis cirrhosis in 3, and idiopathic portal hypertension in 1.

#### Types of operation

Portaazygous disconnection (PAD) was performed in 256 patients (50.39%); portasystemic shunt (PSS) in 167 patients (32.87%, Table 1); selective shunt (SS) including distal splenorenal shunt (DSRS), distal splenocaval shunt (DSCS), coronary vein-left renal vein shunt and coronary vein-caval shunt in 62 patients (12.20%, Table 2).

#### Statistical analysis

The data were expressed as mean $\pm$ SD, and analyzed with SPSS 10.0 for Windows.  $P<0.05$  was considered statistically significant.

### RESULTS

#### Free portal pressure (FPP)

The changes of free portal pressure (FPP) in 215 cases

**Table 1** Patients treated with PSS

Types of operation	Cases
Portacaval shunt (PCS)	14
Portacaval shunt with prosthetic H-graft (PCS-H)	25
Mesocaval shunt (MCS)	66
Inferior mesocaval shunt (IMCS)	26
Splenorenal shunt (SRS)	12
Juxtal splenocaval shunt (SCS)	16
Branch of mesenterico-caval shunt (BMCS)	5
Inferior meso-left renal vein shunt	2
Colonic media vein-caval shunt	1
Total	167

**Table 2** Patients treated with selective shunt (SS)

Types of operation	Cases
Distal splenocaval shunt (DSCS)	42
Distal splenorenal shunt (DSRS)	16
Coronary vein-caval shunt	4
Total	62

were observed before and after operation. The results are summarized in Table 3.

The results showed that FPP in the four groups of operation showed a marked post-operative decrease, especially in the PSS group with a diameter of anastomotic stoma in 8-12 mm compared to pre-operation ( $P < 0.01$ ). The pre-operation FPP in the PSS (diameter 8-12 mm) group was notably higher than that in other groups ( $P < 0.01$ ). The decreased absolute value of post-operation FPP in the PSS (diameter 8-12 mm) group ( $1.23 \pm 0.5$  kPa) was also much higher than that in the PAD group ( $0.5 \pm 0.47$  kPa) and SS group ( $0.51 \pm 0.46$  kPa,  $P < 0.01$ ). No significant difference was found in the post-operation FPP of the above-mentioned four groups ( $P > 0.05$ ).

The FPP in 9 of 11 patients who underwent combined PSS+PAD decreased 0.79 kPa (81 cm H<sub>2</sub>O) averagely after operation with no change of FPP in the other 2 patients. The degrees of esophageal varices in 7 of the 11 patients were alleviated with no change in the other 4 patients after operation as confirmed by barium meal.

**Table 3** Changes of free portal pressure (FPP) in three types of operation (mean±SD)

Types of operation	Cases	Pre-operation (kPa)	Post-operation (kPa)
Portaazygous disconnection (PAD)	81	3.78±0.50	3.26±0.57
PSS (diameter of anastomotic stoma in 8-12 mm)	52	4.29±0.80	3.11±0.63
PSS (diameter of anastomotic stoma in 6-8 mm)	42	3.91±0.48	3.12±0.46
Selective shunt (SS)	62	3.85±0.59	3.26±0.45

**Rehemorrhage**

Ninety-one of the five hundred and eight cases (16.8%) had rehemorrhage. The incidence rate of hemorrhage in patients treated with PAD, PSS, SS, and PSS+PAD was

21.09% (54/256), 13.77 (23/167), 11.29 (7/62), and 36.36% (4/11), respectively. Twenty-four (44.44%) of the fifty-four rebleeding patients treated with PAD had rebleeding within a year after operation, the incidence rate of rehemorrhage was 9.38% (24/256). Fourteen cases had rebleeding 5 years after PAD. Hepatectomy combined with splenic artery ligation, coronary vein and cardia and fundus varix ligation, or portacaval shunt with H-grafts (8 mm in diameter) was performed in three patients with hepatocellular carcinoma complicated by portal hypertension. The incidence rate of rebleeding was 100% (3/3).

**Hepatic encephalopathy**

The total incidence rate of hepatic encephalopathy was 6.50% (33/508). The incidence rate of hepatic encephalopathy in patients treated with PAD, PSS, SS, PSS+PAD, and HCC+PH was 3.91% (10/256), 9.58% (16/167), 4.84% (3/62), 9.09% (1/11), and 100% (3/3), respectively.

**Operative mortality and its causes**

The total operative mortality was 5.91% (30/508).

**PAD** The operative mortality was 5.86% (15/256). The cause of death was rebleeding. The high mortality was associated with severe disease. After being discharged from hospital, 21 cases died of rebleeding (10 cases), primary hepatocellular carcinoma (5 cases), liver function failure (5 cases) and malignant lymphoma (1 case).

**PSS** The operative mortality was 4.19% (7/167). Three patients died of severe hepatorenal syndrome, two died of rebleeding after operation, two underwent emergency MCS (12 mm in diameter of the anastomotic stoma), and died of hepatic encephalopathy 5 d after operation due to the improper operation method and large diameter of the anastomotic stoma. After being discharged from hospital, 16 cases died of primary hepatocellular carcinoma (5 cases), liver function failure (7 cases) and of rebleeding (4 cases).

**SS** The operative mortality was 4.84% (3/62). Three patients died of cerebral hemorrhage 5 d after operation, hepatorenal syndrome, and, rehemorrhage and infection in the subphrenic area and left lung. After discharge, two patients died of primary peritonitis, one of severe hepatitis, one of rebleeding.

**PSS+PAD** The operative mortality was 9.09% (1/11), this patient died of persistent deterioration of hepatic function and renal failure.

**HCC+PH** The operative mortality was 66.67% (2/3). One patient died of postoperative hemorrhage, the other died of hepatic failure. The last one succumbed to hepatic function failure 10 mo later after operation.

**Liver transplantation** We performed liver transplantation in 9 (1.77%) cases. The operative mortality was 2/9 (22.22%). The major reason of death was liver failure and infection after operation.

**Portacaval shunt for patients with portal hypertension combining ascites**

Nineteen patients with ascites before operation underwent portacaval shunt. They all had hematemesis, dark stools, moderate and severe esophageal varices, ascites, and no hypertension and kidney disease. The liver function of all

the patients was Child's grade B, and their HBsAg was positive. Eleven patients underwent portacaval shunt with H-graft, and eight patients, portacaval side-to-side anastomosis. No ascites were found by B-type ultrasound reexamination in the abdominal cavity before discharge. Hepatic tissue biopsy showed liver cirrhosis. But mild and moderate hepatic coma occurred in three patients with diameter of anastomotic stoma of 8-10 mm after operation.

### **Emergency operation for massive hemorrhage of gastrointestinal tract due to portal hypertension**

Twenty (3.94%) of the above-mentioned patients underwent emergency operation. Ten of the patients (50%) had massive hemorrhage in gastrointestinal tract for the first time, the other 10 patients had a past medical history of massive hemorrhage in the gastrointestinal tract. They received endoscopic sclerotherapy (four cases) and loop ligation of varices (two cases), TIPSS (one case), balloon tamponade compression by a four-lumen tube (three cases). The causes of portal hypertension were cavernous transformation of portal vein, idiopathic portal hypertension, and posthepatic cirrhosis. Liver function was Child's grade A (2 cases), Child's grade B (7 cases), Child's grade C (11 cases). Of the 20 cases, 12 cases received emergency PSS, 8 emergency PAD (gastroesophageal devascularization, 4 cases had ligation of splenic artery without splenectomy). The ratio of preoperative liver function as Child's grade C was 58.33% (7/12) in the PSS group and 50% (4/8) in the PAD group. Postoperative mean loss of FFP was 9.6 cm H<sub>2</sub>O in the PSS group and 1.8 cm H<sub>2</sub>O in the PAD group. Surgical hemostasis had an effect on all the patients. Of the eight patients who underwent PAD, none had hepatic encephalopathy, five recovered smoothly, three (37.5%) had rehemorrhage within 2 wk after operation. We could not determine whether rupture of varices or hemorrhagic gastritis was the cause of postoperative bleeding. Of 12 patients who received PSS, 3 (25%) had hepatic encephalopathy, 2 (16.67%) rehemorrhagia, 4 died of liver failure. The total operative mortality was 25%. The operative mortality was 33.33% in the PSS group and 12.5% in the PAD group.

## **DISCUSSION**

Portal hypertension refers strictly to an increase in the portal venous pressure (>5 mm Hg or 7 cm H<sub>2</sub>O). Based on data in China, the normal portal venous pressure ranges from 13 to 24 cm H<sub>2</sub>O, its mean value is 18 cm H<sub>2</sub>O. Portal hypertension can be diagnosed when free portal venous pressure exceeds 25 cm H<sub>2</sub>O, but the term is used to the clinical syndrome associated with an increased portal venous pressure characterized by splenomegaly and the development of abnormal portalsystemic venous anastomosis. Increased resistance to blood flow in the portal venous system is the most important cause, though increased portal blood flow may contribute to it in a few cases. The causes of increased portal venous resistance may lie in the presinusoidal vessels outside the liver or in the intrahepatic vessels at pre-sinusoidal, sinusoidal or post-sinusoidal levels. No consistent therapeutic method has been successful due to its complex etiology, pathophysiology and hemodynamics. Which kind of surgical

treatment should be used depends on portal hemodynamics, etiology, age, liver pathology, liver function, bleeding history of upper digestive tract, size of spleen and hypersplenism.

### **PAD**

PAD has no significant effect on portal perfusion. Nutritional factors such as insulin and glucagons are favorable for maintaining normal liver function<sup>[1,2]</sup>. Portal hypertension is important in maintaining hepatopetal blood flow during liver cirrhosis<sup>[3-6]</sup>. The present study showed that FPP of the pre-PAD-operation decreased by 0.59 kPa averagely compared to that of post-PAD-operation ( $P<0.01$ ). In a small number of patients treated with PAD, the mean FPP decreased much more than 0.59 kPa, suggesting that PAD is an effective hemostatic method for patients with massive hemorrhage of the upper digestive tract<sup>[7]</sup>. A few of the patients with plentiful collateral circulation in gastric fundus and pericardia and recurrent upper gastrointestinal bleeding, had no change of FPP or a slightly elevated FPP after PAD and might have had rehemorrhage shortly after PAD operation.

One typical male patient had a massive hemorrhage of upper digestive tract combined with primary peritonitis, jaundice and ascites, and underwent emergency PAD. His hemorrhage ceased, and liver function and general state improved. Four years later, the patient had a massive rehemorrhage of upper digestive tract without jaundice and ascites, and received emergency MCS with a diameter of the anastomotic stoma in 10 mm. From then on, we followed him up continuously and found no rebleeding and hepatic encephalopathy. Animal experimental study showed that during cirrhotic portal hypertension, the defensive capacity of mucosa is progressively weakened, resulting in pathologic changes of the gastric mucosa<sup>[8]</sup>. After disconnection of portaazygous junction, desquamation of the epithelial cells of the gastric mucosa, edema and thickening of the submucosal layer, and narrowing of its capillaries occur<sup>[9]</sup>. The epithelium of the gastric mucosa is obviously ischemic and hypoxic, the defensive capability of the gastric mucosa is further deteriorated, indicating that it is one of the causes of high hemorrhage rate after disconnection<sup>[10,11]</sup>. A few patients may have rebleeding shortly after PAD<sup>[12,13]</sup>.

Another typical case, a female, had recurrent bleeding four times (hematemesis and hemafecia) accompanied with hydrothorax and ascites within 3 mo, underwent emergency PAD, then she could take food as her hydrothorax and ascites gradually receded. Seventeen days after operation, hematemesis occurred, she had a massive rehemorrhage of upper digestive tract the next day, balloon tamponade compression had no effect on hemostasis. Two days later, emergency MCS was performed, 1 000 mL ascites was found during operation, then rebleeding ceased. The rebleeding of this case was due to the pathologic changes of the gastric mucosa that resulted from PAD<sup>[14]</sup>.

Based on the above data about PAD, the operation indications for PAD include: massive bleeding of upper digestive tract which cannot be controlled by non-surgical methods; the FPP<3.92-4.41 kPa (40-45 cm H<sub>2</sub>O) after splenectomy; esophageal varicosis, splenomegaly, anteroposterior diameter of the spleen>7 cm and apparent hypersplenism; recurrent

bleeding of the upper digestive tract, debility or poor condition, and poor liver function; rebleeding after DSCS or DSRS, thrombosis of anastomotic stoma of splenic vein; regional portal hypertension.

### PSS

PAD combined with small stoma PSS is widely used in the therapy of portal hypertension<sup>[15,16]</sup>. The diameter of the anastomosis stoma of PSS mentioned in this paper was from 6 to 8 mm. Small-diameter portacaval shunt for patients is in favor of hepatic reserve<sup>[17,18]</sup>. After PSS, the FPP level was  $(3.15 \pm 0.39)$  kPa and the incidence rate of rehemorrhage of upper digestive tract reduced by alleviating pathological changes of gastric mucosa and prevented the formation of lateral branch circulation. In order to preserve hepatopetal perfusion to support and improve liver function, the FPP should be maintained at the level no more than  $(3.92-4.41)$  kPa. The FPP level was as high as 9.58% (16/167) in patients treated with PSS, which might be associated with improper selection of patients and large anastomotic stoma. In recent years, we have performed some kinds of PSS with small caliber and low blood flow discharge such as inferior mesocaval shunt (IMCS)<sup>[19]</sup>, inferior meso-left renal vein shunt<sup>[20,21]</sup> and branch of mesenterico-caval shunt (BMCS), which are technically easy to operate and popularize. Experimental animal study suggested that the portacaval shunt significantly improves the microcirculation of gastric mucosa<sup>[22]</sup> and can promote gastric mucosa to synthesize and secrete glycoprotein and prostaglandins, thus increasing the defensive capability of the gastric mucosa<sup>[23,24]</sup>. It was reported that the levels of plasma renin activity (PRA), angiotensin converting enzyme (ACE), angiotensin II and portal venous pressure (PVP) decrease significantly in cirrhotic patients with portal hypertension after portacaval shunts, which may be the major causes of ascites disappearance in cirrhotic patients after portacaval shunt<sup>[25]</sup>. Surgical PSS might be considered for acute or chronic portal bleeding if medical treatment fails<sup>[26]</sup>. Some kinds of diseases must be operated with PSS, such as extrahepatic portal vein obstruction and portal hypertension resulting from biliary cirrhosis of liver due to bile duct stenosis.

The operation indications for PSS include recurrent multiple bleeding of the upper digestive tract and liver function in Child's grades A and B status, no ascites, extrahepatic portal vein obstruction, portal hypertension resulting from biliary cirrhosis of liver due to hepatic duct stenosis, rebleeding after PAD, and rebleeding after PAD combined with PSS.

### Selective shunt (SS)

The theoretical bases for designing selective shunt (SS) are as follows<sup>[27,28]</sup>. PSS (unselective shunts) is effective in hemostasis of the upper digestive tract, but it decreases portal perfusion leading to deterioration of liver function<sup>[29,30]</sup>. PAD aggravates pathologic changes of gastric mucosa and has a high rate of rebleeding. The functional reserve of the liver depends on portal perfusion<sup>[17,31]</sup>. These thoughts have led to the development of selective portasystemic shunts. Warren first reported DSRS in 1967<sup>[32]</sup>, and Inokuchi

designed and reported coronary vein-caval shunt in 1968<sup>[33]</sup> and 1969<sup>[34]</sup>. Holmin *et al.*<sup>[35]</sup>, operated DSCS in rats in 1977, Bhalariao *et al.*<sup>[36]</sup>, firstly reported DSCS in patients in 1978. Since 1984, Cai *et al.*<sup>[37]</sup>, have begun to operate DSCS in patients in China. Preliminary data indicate that DSRS in a subgroup of patients with good liver function and a correct portaazygous disconnection, more effectively prevents variceal rebleeding than endoscopic sclerotherapy<sup>[38]</sup>. It was reported that DSCS selectively improves microcirculation and functions of the gastric mucosa<sup>[39]</sup>. DSCS and PAD are better than MCS and PCS (portacaval shunt) in protecting the hepatic reserve function in rats with cirrhotic portal hypertension<sup>[40-44]</sup>. Experimental study also revealed that the blood viscosity after DSCS is lower than that after PAD<sup>[45]</sup>. DSRS and DSCS have all the advantages of both PAD and PSS, but they are technically difficult. The incidence rates of rebleeding and hepatic encephalopathy in our patients treated with SS were lower compared to the patients treated with other kinds of operation, which might be partly associated with the different conditions of patients. Our results are in accord with other reports<sup>[46-48]</sup>.

Gradual development of encephalopathy also exists after selective shunts, and is related with loss of hepatic perfusion of portal blood<sup>[49]</sup>. Based on other reports, portal blood flows to the liver in the early postoperative period in about 88% of patients but in about 42% after 3 years; no patient with a continuing flow of portal blood to the liver suffers from encephalopathy. Final loss of portal blood flow may be due to continuing superior mesenteric venous hypertension causing the development of collateral vessels which convert the selective shunt to an unselective shunt. The selective shunts have not yet been shown to improve long-term survival, which may in any case be limited by progressive liver disease, but their advantages in the shorter term may allow more patients a better survival.

The role of selective shunts in the treatment of gastrointestinal bleeding due to portal hypertension is still controversial. It has already established that it is not suitable to patients with ascites because it may become uncontrollable after the operation and cannot improve portal flow to the liver. It should never be done when there is centrifugal portal blood flow, as in the Budd-Chiari syndrome.

The operation indications for SS include liver function stabilized in Child's grade A or B, portal blood flow velocity higher than 8-10 cm/s, degree I or II of portal vein displaying during arterial portography<sup>[50]</sup>, more than 1.96 kPa (20 cm H<sub>2</sub>O) of the difference between splanchnic obstructive portal pressure (SOPP) and free portal pressure (FPP), no active hepatitis, esophageal varicosis with history of hemorrhage or severe esophageal varicosis without history of hemorrhage, splenomegaly and anteroposterior diameter of the spleen >7 cm and no apparent hypersplenism, no chronic pancreatitis and splenic phlebitis or periphlebitis, no ascites, no retro-peritoneal edema, no Budd-Chiari syndrome.

### Combined PSS+PAD

Compared to PAD, PSS+PAD had a higher operative mortality, but their postoperative hemorrhage incidence rates had no difference. The number of our cases that underwent

PSS+PAD was too small to induce a definite objective evaluation.

PSS+PAD was performed in the early 1980s. Huang Yaoquan<sup>[51]</sup> reported the experience of 33 cases operated with PSS+PAD. Then some similar reports showed that this type of operation cannot only decrease free portal pressure to achieve the goal of persistent hemostasis, but also not reduce excessive hepatopetal blood flow<sup>[16,52]</sup>. After PAD, spontaneous shunt will be gradually emerged. PSS+PAD, ahead of schedule replaces spontaneous shunt, which slowly occurs after PAD with artificial shunt in operation. Combined devascularization and splenorenal shunt (PAD+PSS) significantly decreases portal venous flow and portal pressure, as well as maintaining hepatopetal flow, thus entailing fewer complications compared to either PAD or PSS, some scholars even advocated that PSS+PAD could be a primary selection in the operations for portal hypertension<sup>[53,54]</sup>.

Compared to PSS or PAD, PSS+PAD prolongs operation time, aggravates surgical trauma, and damages liver function, which are the reasons why PSS+PAD cannot be generally performed. Based on the incomplete statistics of 24 famous Chinese hospitals in 1998, only 204 (only accounted for 1.7%) cases received PSS+PAD in more than 12 000 cases of operations for portal hypertension<sup>[55]</sup>.

Prognosis of the patients is mainly dependent on the condition of the whole body and hepatic function. We should select the operations which have minimal adverse effect on the whole condition and liver function in the patients. PSS has few advantages because of a negative effect on hepatic blood perfusion in contrast to PAD. In China, Yang Zhen and Qiu Fazu<sup>[6,56]</sup> reported that patients that underwent standard PAD have a postoperative rebleeding incidence rate lower than 10%. Thus, it should be emphasized that surgeons should be careful when choosing PSS+PAD as a treating method for the patients with portal hypertension.

The operation indications for PAD combined with small stoma PSS (usually mesocaval shunt or portacaval shunt) include recurrent or massive bleeding of varices of esophagus and gastric fundus and stable liver function in Child's grades A and B, overt varices of esophagus and gastric fundus and Child's grade A status of hepatic function with FPPs more than 3.92-4.41 kPa (40-45 cm H<sub>2</sub>O) after splenectomy in operation and no ascites or small amounts of ascites, and a relatively younger age (generally less than 60 years).

### **Surgical treatment of primary hepatic carcinoma concurrent with portal hypertension**

Surgical treatment of primary hepatic carcinoma complicated by portal hypertension is based on appraisal of hepatosis and prediction of life expectancy of the patients with portal hypertension<sup>[57,58]</sup>. The 5-year survival rate of the patients with liver cirrhosis and hemorrhage of upper digestive tract is 25-35%. Pinto *et al*<sup>[59]</sup>, reported that 287 patients with hemorrhage of the upper digestive tract have a total 5-year survival rate of 26.2%, and that hepatic function condition of the patients exerts great effects upon their survival. Yang *et al*<sup>[60]</sup>, reported that poor liver

function increases postoperative rebleeding and mortality. Zhang *et al*<sup>[61]</sup>, showed that onestage hepatocellular carcinoma excision and splenectomy and portal azygous disconnection can be simultaneously performed for patients with good hepatic function. Our data showed that hepatectomy and portacaval shunt greatly exacerbate the hepatic function, if these two operations are performed simultaneously.

During the treatment of patients with hepatocellular carcinoma and portal hypertension, the following must be considered. Hepatic function of the patients is a fundamental factor in determining the prognosis and long-term survival. In recent years, many domestic hospitals have performed whole liver transplantation in order to treat the liver-function decompensation (Child's grade C or more serious) patients with hepatocellular carcinoma (mainly small HCC) and upper gastrointestinal hemorrhage due to portal hypertension, and have achieved good therapeutic effects. Prophylactic PAD and PSS should not be done for the patients with varices of esophagus and gastric fundus but without upper gastrointestinal hemorrhage. One-stage hepatectomy and PAD (splenectomy and pericardia disconnection) should be a better choice for patients with HCC and portal hypertension<sup>[62]</sup>. Interventional therapy (hepatic artery embolism) plus PAD and hepatectomy plus either sclerotherapy or loop ligation can reduce operational risk<sup>[63,64]</sup>.

### **Liver transplantation**

Liver transplantation can treat portal hypertension, and rehemorrhage, and encephalopathy do not occur in treated patients. Liver transplantation was carried out abroad much earlier. The domestic practice of liver transplantation in recent years indicates that liver transplantation is feasible not only in patients with chronic progressive hepatic failure, refractory ascites and jaundice, but also in patients with recurrent hemorrhage, especially with poor hepatic function, if they are not old and their other vital organs function well. For example, one patient with multiple upper gastrointestinal bleeding received repeated sclerotherapy and TIPS, but no effective results were achieved. He then underwent a whole liver transplantation because of carcinomatous changes in his liver, and his free portal pressure decreased to normal level and conditions were very satisfactory.

In China, most patients who underwent liver transplantation were those with advanced-stage hepatocellular carcinoma and malignant diseases of biliary tract, the few were those with benign irreversible liver diseases including liver failure and recurrent upper gastrointestinal hemorrhage.

The indication for liver transplantation is end-stage liver disease. Not all patients with variceal bleeding have end-stage liver disease, and not every patient with variceal bleeding needs a new liver. Although the availability and increasingly successful outcome of liver transplantation have significantly altered the management of patients with cirrhosis, the question "does this patient really need a transplant now, or is the patient likely to need a transplant in the future?" should always be asked.

We believe that the therapy of hepatic cirrhosis and portal hypertension complicated by upper digestive

hemorrhage will change greatly.

### **Portacaval shunt for patients with portal hypertension and ascites**

Many researches have confirmed that blood renin activity of the patients with liver cirrhosis and portal hypertension, especially those with ascites<sup>[25,65,66]</sup>, increases obviously. Vice versa, increased renin activity can raise portal vein pressure (PVP) via initiating renin-angiotensin-aldosterone system and plays an important role in ascites due to cirrhosis.

The reasons why their ascites disappear after portacaval shunt are as follows. Portal vein pressure (PVP) decreases significantly. After portacaval shunt, returned blood volume and effective blood volume increase, and then renal blood flow relatively raises, making the juxtaglomerular cells secrete less renin. The blood level of glucagons reduced by portacaval shunt also inhibits the secretion of renin<sup>[30,67]</sup>, that may weaken the role of renin-angiotensin-aldosterone system and reduce ascites.

It is well known that hepatic coma usually occurs in patients after portacaval shunt operation. We should use a small diameter (6-8 mm) of anastomosis stoma of portacaval shunt as best as we can.

### **Emergency operation for upper gastroesophageal massive hemorrhage due to portal hypertension**

The results in our study demonstrate that emergency operation rank non-negligible position in the treatment of portal hypertension.

Once the varices rupture, the chance of rehemorrhage is very high shortly after the first hemorrhage, and the mortality rate due to rehemorrhage is nearly twice that of the first hemorrhage. Thus, the indications of emergency surgery include massive hemorrhage which cannot be controlled within 12 h, recurrent massive upper gastrointestinal hemorrhage, and no obvious surgical contraindications.

Which surgical procedure should be adopted depends upon the condition of patients, liver function and findings in surgery. Generally, shunt operation can be performed in patients with relatively better condition and liver function, a great quantity of collateral vessels surrounding the spleen and higher portal pressure (>3.43 kPa or 35 cm H<sub>2</sub>O). On the contrary, patients with poor body condition and liver function, a few collateral vessels, obvious atrophy of liver volume and portal vein pressure less than 3.43 kPa (35 cm H<sub>2</sub>O), are fit for splenectomy and disconnection. Our data showed that only a slight difference in operative mortality between the two groups of patients was found, and that no operative mortality and encephalopathy occurred in the PAD group, suggesting that PAD can be performed when possible.

With regard to emergency operation, we should decide whether the spleen is resected according to the condition of patients. It was reported that splenic artery ligation in these patients achieves the same therapeutic effects as splenectomy<sup>[68]</sup>. Therefore, when the patients undergo disconnecting combined with shunting (except for splenorenal shunt), their spleen may not be excised, and splenic artery may be ligated.

It was considered previously that the patients with poor liver function should not be operated because of high operative

mortality. In the shunting group in this article, three of seven patients with Child's grade C died of surgical treatment. In the disconnecting group in this article, none of the three patients with Child's grade C died of PAD operation, suggesting that surgical therapy should be taken and PAD is the proper selection for patients with poor liver function<sup>[69]</sup>.

In regard to the surgical therapy of patients with portal hypertension, a suitable surgical procedure can achieve satisfactory therapeutic results. Different patients at different stages in their disease may require different therapies. An emphasis of this management is the full evaluation of the underlying liver disease. Our data showed that PAD as a major operation accounted for 50.39% of all the operations in this article. If the diameters of anastomotic stoma of PSS are restricted, favorable therapeutic effects can be achieved. When PSS needs to be conducted, the diameter of the anastomotic stoma should be 6-8 mm and the most usual operative approach is side-to-side meso-caval shunt. Selective shunt is a relatively ideal surgical procedure, but technically it is difficult. Although disconnection plus shunt seems to be a better procedure of choice because it can lower the portal pressure and maintain the portal flow, it will give the patient a big strike and should be carefully selected according to the liver function of patients. Liver transplantation can treat portal hypertension and achieve better long-term results, but it should not be the first choice in treating portal hypertension in China. Doctors should evaluate liver function comprehensively of patients with hepatocellular carcinoma and portal hypertension and carefully select combined operation in order to prolong their survival time. The cirrhotic patients with ascites can be treated with PSS with a small diameter (6-8 mm) of the stoma anastomosis. If acute continuous gastroesophageal variceal bleeding in cirrhotic patients cannot be controlled by medical treatment, and if no operational contraindication exists, emergency surgical treatment should be given immediately.

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