



## Original research

# Effects of surgical procedures on the occurrence and development of postoperative portal vein thrombosis in patients with cirrhosis complicated by portal hypertension



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## HIGHLIGHTS

- Incidence of postoperative portal vein thrombosis (PVT) was compared.
- Total 116 liver cirrhosis patients with portal hypertension were analyzed.
- Surgeries were SRS combined with PCDV, PCDV with splenectomy and selective PCDV.
- SRS combined with PCDV had lower incidence of postoperative PVT than others.
- SRS combined with PCDV significantly improved liver function compared with others.

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## ABSTRACT

**Objective:** We have compared the influences of three surgical strategies on the occurrence and development of portal vein thrombosis (PVT) in patients with liver cirrhosis complicated by portal hypertension (PHT) in this study.

**Methods:** Total 116 patients who respectively underwent pericardial devascularization (PCDV) with splenectomy (PDS group: n = 50), selective PCDV (SPD group: n = 28) and splenorenal shunt (SRS) combined with PCDV (combined group: n = 38) were investigated in this study. The incidence of PVT before and after operation was monitored. The incidence of Grade II-IV PVT was used to assess the severity of PVT. The liver function was assessed according to the Child-Pugh classification.

**Results:** The incidence and severity of PVT and live function were similar among the three groups before operation ( $P > 0.05$ ). The incidence of PVT was significantly increased after surgery in each group ( $P < 0.001$ ), but recovered to the baseline level at six months in combined group ( $P = 0.629$ ). Besides, the severity of PVT was significantly aggravated in PDS ( $P < 0.001$ ) and SPD ( $P = 0.026$ ) groups after operation, but not in combined group ( $P = 0.525$ ). Patients in combined group showed significantly lower incidence and severity of PVT than those in the other two groups at each follow-up time point ( $P < 0.05$ ). In addition, the liver function in the combined group was significantly improved compared with the other two groups.

**Conclusions:** SRS combined with PCDV is superior to PCDV with splenectomy and selective PCDV for PHT in liver cirrhotic patients in inhibiting the occurrence and development of postoperative PVT and improving liver function.

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*Abbreviation:* PV, portal vein; PVT, portal vein thrombosis; PHT, portal hypertension; PCDV, pericardial devascularization; SRS, splenorenal shunt; SMV, superior mesenteric vein.

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## 1. Introduction

Portal vein thrombosis (PVT) is defined as a partial or complete occlusion of the lumen of the portal vein (PV) or its tributaries by thrombus formation [1]. It frequently occurred in cirrhosis and hepatocellular carcinoma [2,3]. Also, it is a cause of significant morbidity amongst patients with endstage liver disease/

hepatocellular carcinoma [4,5]. Incomplete PVT leads to extensive hepatic portal venous collaterals, and then cavernous transformation of the portal vein (CTPV) would be formed, while complete PVT may develop and lead to liver failure, refractory ascites, hematochezia, intestinal obstruction, and even intestinal ischemic necrosis, which threatened the life of patients [6–8].

In addition, portal hypertension (PHT) is a commonly clinical syndrome, which is defined as a pathological increase of portal pressure gradient resulting in the formation of portal-systemic collaterals that shunt part of the portal blood flow to the systemic circulation bypassing the liver [9]. As a common complication of liver cirrhosis and a major cause of morbidity and mortality in cirrhotic patients [10–12], it is one of the factors contributing to the risk of PVT in liver cirrhosis patients [13,14]. Surgical procedures for PHT were also associated with the incidence and development of PVT [15,16]. Among the surgical procedures, pericardial devascularization (PCDV) with splenectomy, selective PCDV, and splenorenal shunt (SRS) combined with PCDV are the most widely used therapeutic tools for PHT in China, except liver transplantation [17–19]. The incidences of postoperative PVT in these surgeries were difference among the previous studies [20–22]. Therefore, it is necessary to find a surgery procedure which had less incidence of postoperative PVT.

However, few reports focused on the selection of appropriate surgical procedures to reduce the incidence of postoperative PVT, currently. Hence, we performed this study to compare the incidence and severity of postoperative PVT and improvement of liver function among the three commonly surgeries (PCDV with splenectomy, selective PCDV, and SRS combined with PCDV) in 116 patients with liver cirrhosis complicated by PHT.

## 2. Materials and methods

This is a retrospective study. Written informed consent was obtained from all patients and the protocol was approved by the Institutional ethics committee of the Shanghai Renji Hospital based on the Helsinki Declaration.

### 2.1. Patients

The clinical data were collected from 116 patients with liver cirrhosis complicated by PHT (56 males; median age, 56.2 years), who were treated with surgical procedures at the Renji Hospital (Shanghai, China) from January 2008 to July 2010. According to the Child-Pugh classification for cirrhosis of the liver, 45 patients were in class A, 58 patients in class B and 13 patients in class C.

Of the 116 patients, they were divided into three groups according to the surgery types: PDS group (50 patients who underwent PCDV with splenectomy; 24 males; median age, 53.5 years), SPD group (28 patients who treated with selective PCDV; 14 males; median age, 62.2 years) and combined group (38 patients who received SRS combined with PCDV; 18 males; median age, 50.7 years). The choice of surgery type depends on the severity of the disease (the number and size of the cysts, severity of symptoms, degree of PHT, and underlying hepatic function) and experience of the surgeon in an attempt to reduce PHT. All surgical operations were conducted by an experienced surgeon. To avoid the influence of anticoagulant drugs on PVT, no anticoagulant drugs were used before and after operation. Postoperative PVT was treated by thrombectomy.

### 2.2. Surgical methods

PCDV with splenectomy was performed according to the previously reported studies [17,23]. Briefly, after the routine

splenectomy, the gastric branch and esophageal branch of the gastric coronary vein were disconnected. The esophageal branch was disconnected and ligated. Then gastric posterior vein and left subphrenic vein were ligated. Finally, arteries accompanied by the veins (including the left gastric artery, left gastroepiploic artery, gastric posterior artery and left subphrenic artery) were disconnected.

Selective PCDV is a modified procedure of PCDV, in which the trunk of left gastric vein and paraesophageal veins were completely preserved in order to achieve self-shunt and reduce the PV pressure [24,25].

A splenorenal end-to-side shunt was performed after splenectomy in combined group. The anastomotic stoma was controlled within 0.8–1.0 cm. Then the devascularization was performed after completion of splenorenal vein anastomosis [26,27].

### 2.3. Thrombus classification

All patients with confirmed PVT were classified into four grades according to the extent of thrombosis, as described by Yerdel et al. [28]. Briefly, Grade I PVT (Fig. 1A) represents minimally or partially thrombosed PV, in which the thrombus is confined to <50% of the vessel lumen with or without minimal extension into the SMV. Grade II PVT (Fig. 1B) is defined as >50% occlusion of the PV, including total occlusion with or without minimal extension into the SMV. Grade III PTV (Fig. 1C) is defined as complete thrombosis of both PV and proximal SMV with an open distal SMV. Grade IV PTV is confirmed with complete thrombosis of the PV and the proximal and distal SMV.

As thrombus in Grade II-IV PVT occurs in more than 50% occlusion of PV diameter and can extend to the SMV, the liver blood perfusion and intestinal blood backflow may be affected. Hence, the incidence of Grade II-IV PVT was used to assess the severity of thrombosis in this study.

### 2.4. Data collection

The incidence and severity of PVT and liver function was monitored at 1 week before operation, the first month after operation once a week and once a month later. Thrombosis was assessed by abdominal CT angiography (CTA) with a Siemens Somatom Definition AS 128 slice scanner (Siemens AG, Erlangen, Germany) at the PV phase [29,30]. Liver function was determined according to the Child-Pugh classification (Class A, B and C) [31]. The overall median time of follow up was 14.7 months (PDS group: 12.3 months; SPD group: 15.0 months; combined group: 15.6 months).

### 2.5. Statistical analysis

SPSS 19.0 software (SPSS, Chicago, IL, USA) was used for all statistical analyses including Chi-square test and non-parametric test. *P* values of less than 0.05 were considered statistically significant.

## 3. Results

In order to compare the effect of three surgical methods (PCDV with splenectomy, selective PCDV, and SRS combined with PCDV) on the occurrence and development of postoperative PVT in liver cirrhotic patients with PHT, we compared the incidence and severity of PVT among the three groups before and after treatments.

### 3.1. Comparison of the incidence of PVT

As shown in Table 1, all the surgical procedures sharply

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