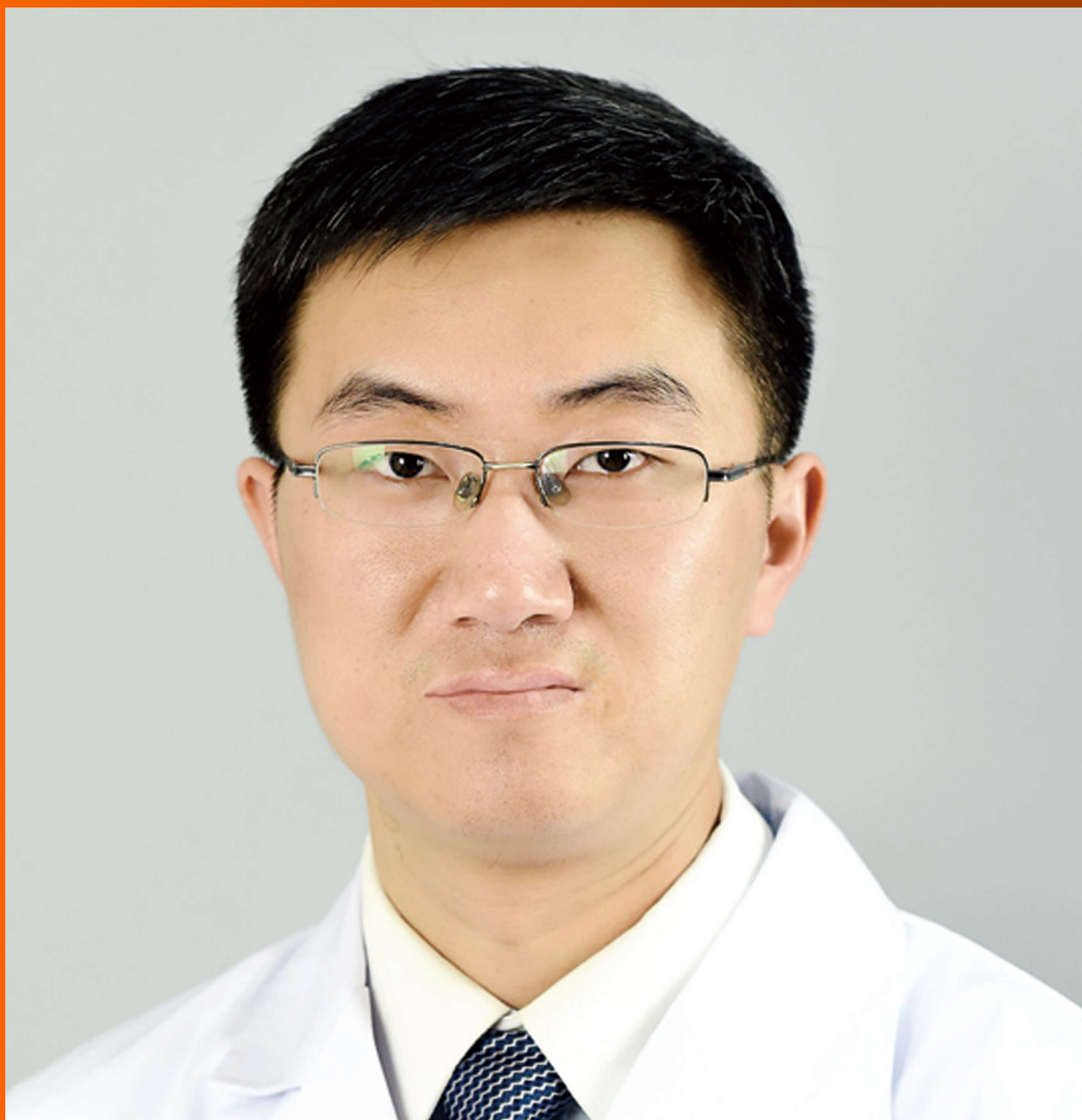


# World Journal of *Clinical Cases*

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### ABOUT COVER

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## Retrospective Cohort Study

**Comparison of simplified and traditional pericardial devascularisation combined with splenectomy for the treatment of portal hypertension**

Ya-Fei Zhang, Hong Ji, Hong-Wei Lu, Le Lu, Lei Wang, Jin-Long Wang, Yi-Ming Li

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**Author contributions:** Li YM conceived the research and critically reviewed and revised the paper; Zhang YF, Ji H, Lu HW and Lu L designed the research and analysed the data; Zhang YF and Li YM performed the research; all authors participated in the operations; Zhang YF drafted the paper.

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**Abstract****AIM**

To compare the clinical outcomes of patients with portal hypertension (PH) who underwent treatment with splenectomy plus simplified pericardial devascularisation (SSPD) or splenectomy plus traditional pericardial devascularisation (STPD).

**METHODS**

We conducted a single-centre retrospective study of 1045 PH patients treated with either SSPD (S Group, 357 patients) or STPD (T Group, 688 patients) between January 2002 and February 2017. In all, 37 clinical indicators were compared to evaluate the efficacy of SSPD.

**RESULTS**

Perioperative indicators in the S Group were significantly better than those in the T Group ( $P < 0.05$ ). In both groups, the postoperative long-term portal vein diameter and Model for End-Stage Liver Disease score were significantly lower than those in the preoperative and postoperative short-term groups ( $P$

< 0.05). The incidence of complications in the S Group was significantly lower than that in the T Group ( $P < 0.05$ ). Compared to the T Group, postoperative short-term WBC (white blood cell) and platelet counts were significantly lower and the short-term Hb (haemoglobin) level was significantly higher in the S Group ( $P < 0.05$ ). In the S Group, postoperative long-term total bilirubin, direct bilirubin, alanine transaminase, and aspartate transaminase and postoperative serum creatinine and cystatin C levels were significantly lower than those in the T Group ( $P < 0.05$ ), and postoperative albumin was significantly higher than that in the T Group ( $P < 0.05$ ).

### CONCLUSION

Compared to STPD, SSPD is a simple and easy procedure resulting in less tissue damage. Patients recovered smoothly and steadily with fewer complications. Short-term liver and kidney function damage was less severe, and long-term liver function recovery was better. Therefore, SSPD is worthy of clinical promotion and application for the treatment of PH.

**Key words:** Simplified pericardial devascularisation; Clinical outcome; Splenectomy; Portal hypertension

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**Core tip:** We performed the use of splenectomy plus simplified pericardial devascularisation (SSPD) in 2002. In this study, we compared the clinical data of patients treated with SSPD or splenectomy plus traditional pericardial devascularisation to evaluate the efficacy of SSPD. A total of 1045 portal hypertension patients were included, and the results suggest that SSPD is simple and easy to perform, resulting in less tissue damage and a reduced inflammatory reaction. Patients recovered smoothly and steadily after SSPD, with lower rates of thrombosis and other complications. Liver and kidney function damage are less severe and long-term liver function recovery is better.

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### INTRODUCTION

Due to the high incidence of hepatitis B and hepatitis C in Asia, especially in China, an increasing number of patients suffer from portal hypertension (PH) secondary to cirrhosis. Oesophagogastric varices and hypersplenism are the main clinical manifestations of PH. The incidence and mortality of severe oesophagogastric variceal haemorrhage are extremely high and seriously threaten patients' lives and health<sup>[1,2]</sup>. Currently, the

main purpose of surgical treatment for PH is to address the bleeding caused by oesophagogastric variceal rupture, followed by the resolution of splenomegaly and hypersplenism<sup>[3,4]</sup>.

The surgical treatment of PH mainly consists of shunt and devascularisation. Although a shunt may reduce portal vein pressure, liver function may be compromised due to decreased hepatic blood flow from the portal vein, potentially resulting in hepatic encephalopathy, and patients may ultimately die from liver failure. Compared with a shunt, the greatest advantage of devascularisation is that it does not reduce portal vein blood flow to the liver, does not affect liver nutrition, does not compromise liver function, and is associated with a lower likelihood of hepatic encephalopathy. Therefore, patient survival after the operation is better<sup>[5]</sup>. Due to the difference of etiology, the treatment of PH in western countries is mainly shunt, while in Asian countries, especially in China, are mainly devascularization. Splenectomy plus pericardial devascularisation (SPD) can simultaneously address the problems of bleeding, thrombocytopenia and leukocyte reduction and has therefore become the most effective surgical treatment for PH<sup>[5]</sup>. This method has been continuously improved and has achieved excellent clinical effects<sup>[6-8]</sup>. However, splenectomy plus traditional pericardial devascularisation (STPD) needs to cut the serous layer and damage the seromuscular layer of the stomach and the esophagus. The high postoperative rebleeding rate, the complexity of the procedure and severe resultant tissue damage can cause extensive liver and renal function injury, which affect many patients and seriously threaten people's lives.

Based on the experiences of domestic and foreign experts, we simplified the traditional pericardial devascularisation method and developed a splenectomy plus simplified pericardial devascularisation (SSPD) technique, which achieved good initial treatment effects<sup>[9]</sup>. In this study, we retrospectively analysed the short-term and long-term clinical efficacy of SSPD vs STPD from 2002 to the present.

### MATERIALS AND METHODS

#### Study objective

PH patients with oesophagogastric varices and hypersplenism who were seen in our department from January 2002 to February 2017 were screened for this single-centre retrospective cohort study. According to the patients' and their relatives' choices of surgical method, the patients were divided into an S Group and a T Group. The patients in the S Group were treated with SSPD, and the patients in the T Group were treated with STPD. The two surgical methods were performed by the same group of doctors. In this study, clinical indicators of the two groups were compared and analysed to evaluate the efficacy of SSPD. This research was approved by the Ethical Committee of the Second Affiliated Hospital of Xi'an Jiaotong University. All procedures were conducted in accordance with the

Helsinki Declaration of the World Medical Association and with the ethical standards of the committee responsible for human experimentation (institutional and national). The requirement for written informed patient consent was waived due to the retrospective and anonymous nature of this study; all data were used only for statistical analysis.

### **Inclusion and exclusion criteria**

The inclusion criteria were as follows: (1) PH patients diagnosed with oesophagogastric varices and hypersplenism based on clinical symptoms combined with laboratory, digestive endoscopy or image examinations; (2) PH patients classified as grade A or B according to the Child-Pugh grading criteria or Child-Pugh grade C at admission assigned a reduced classification to preoperative Child-Pugh grade A or B after liver preservation therapy to attain appropriate surgical indications; and (3) patients who could tolerate general anaesthesia and had no surgical contraindications. The exclusion criteria were as follows: (1) patients with acute heart failure, shock, or other vital organ diseases; (2) patients in an acute haemorrhagic state with unstable vital signs; and (3) patients with poor function of the heart, lung, liver or kidney.

### **Operative procedures**

An arc-shaped incision was made in the left ribs with the patient under general anaesthesia. The abdominal cavity was explored, and the spleen was removed. The short gastric and posterior gastric vessels were cut, and the left diaphragmatic blood vessel was sutured and ligated. The venae coronariae ventriculi and arteriae gastricae sinistrae were sutured and ligated from the roots. The vessels from the arteriovenous gastrica sinistra to the tributaries of the stomach were sutured and ligated one by one. The rami oesophagei and high rami oesophagei were sutured and ligated. The peritoneal cavity was routinely closed (Figure 1). The patients underwent traditional STPD surgery, as described previously<sup>[9]</sup>.

### **Investigation indices**

The perioperative indicators were postoperative hospital stay, operation fee, total hospitalisation cost, operative time, intraoperative blood loss, intraoperative transfusion, time to first flatus, mortality and reoperation for rebleeding. The short-term and long-term recovery indicators and complications after the operation were portal vein diameter, Model for End-Stage Liver Disease (MELD) score and complications. The short-term and long-term postoperative routine blood tests were white blood cell (WBC), haemoglobin (Hb), and platelets. The short-term and long-term postoperative liver function tests were total bilirubin (TBIL), DBIL (direct bilirubin), alanine transaminase (ALT), aspartate transaminase (AST), albumin (ALB), and globulin (GLB). The short-term and long-term postoperative renal function tests

were serum creatinine (Scr) and cystatin C (Cys C). Short-term refers to within one month after the operation, and long-term refers to more than one month after the operation.

### **Statistical analysis**

Continuous variables are presented as the mean  $\pm$  SD and were evaluated using an independent samples *t* test or the Wilcoxon rank test. Categorical variables are expressed as the frequencies and percentages and were compared *via* the  $\chi^2$  test or Fisher's exact test (in cases of small numbers, indicated by  $n \leq 5$ ). A *P*-value  $< 0.05$  was considered statistically significant. The statistical analysis was performed with SPSS software (version 22.0, SPSS Inc., Chicago, IL, United States).

## **RESULTS**

### **Patient demographics and characteristics**

A total of 1045 PH patients were included, with 357 in the S Group and 688 in the T Group. No significant differences were observed in the clinical parameters, including gender, age, aetiology of disease, history of abdominal surgery, history of variceal bleeding, ascites, oesophageal varices grade, MELD score at admission, and preoperative portal vein diameter, between the two groups ( $P > 0.05$ ). However, significant differences were identified between the two groups in Child-Pugh grade and the incidence of portal hypertensive gastropathy (PHG) at admission ( $P < 0.05$ ). In the S Group, the proportions of patients with Child grades A, B and C disease were 42.86%, 52.66% and 4.48%, respectively. In the T Group, the proportions were 52.18%, 43.60% and 4.22%, respectively. The incidence of PHG was 33.05% in the S Group and 25.0% in the T Group (Table 1).

### **Comparison of perioperative indicators**

Statistically significant differences were observed in postoperative hospital stay, operation fee, total hospitalisation cost, operative time, intraoperative blood loss, intraoperative transfusion, and time to first flatus between the two groups ( $P < 0.05$ ); the S Group exhibited significantly better results compared to the T Group. In the T Group, 4 patients died due to rebleeding or liver and renal failure during the perioperative period (3 in Child B, 1 in Child C), and 1 patient underwent reoperation for rebleeding. No perioperative death or rebleeding occurred in the S Group (Table 2).

### **Comparison of short-term and long-term recovery indicators and complications after the operation**

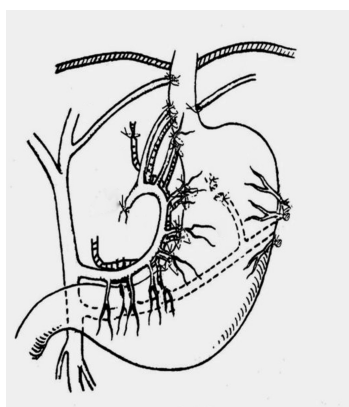
No significant differences in the short-term and long-term portal vein diameters or MELD scores were observed between the two groups after surgery ( $P > 0.05$ ), but the postoperative long-term indicators were significantly lower than the preoperative and postoperative short-term indicators ( $P < 0.05$ ). The incidence rates of short-term ascites, portal vein thrombosis and pleural effusion



**Table 1** Comparison of clinical characteristics *n* (%)

Parameters	S Group ( <i>n</i> = 357)	T Group ( <i>n</i> = 688)	Statistic	<i>P</i> -value
Gender, male	196 (54.90)	368/320 (53.49)	$\chi^2 = 0.19$	0.66
Age (yr)	47.68 ± 11.71	47.13 ± 11.98	<i>t</i> = 0.71	0.48
Aetiology			$\chi^2 = 7.52$	0.11
Hepatitis B	261 (73.11)	454 (65.99)		
Hepatitis C	39 (10.92)	82 (11.92)		
Autoimmune hepatitis	9 (2.52)	33 (4.80)		
Nonspecific hepatitis	40 (11.20)	94 (13.66)		
Others	8 (2.24)	25 (3.63)		
History of abdominal surgery	81 (22.69)	183 (26.60)	$\chi^2 = 1.90$	0.17
History of variceal bleeding	181 (50.70)	388 (56.40)	$\chi^2 = 3.07$	0.08
Ascites	268 (75.07)	490 (71.22)	$\chi^2 = 1.75$	0.19
Child-Pugh grade at admission			$\chi^2 = 8.60$	0.01
A	153 (42.86)	359 (52.18)		
B	188 (52.66)	300 (43.60)		
C	16 (4.48)	29 (4.22)		
Oesophageal varices grade			$\chi^2 = 0.30$	0.86
Mild	44 (12.32)	93 (13.52)		
Moderate	114 (31.93)	219 (31.83)		
Severe	199 (55.74)	376 (54.65)		
PHG at admission	118 (33.05)	172 (25.00)	$\chi^2 = 7.60$	< 0.05
Preoperative MELD score	5.97 ± 0.40	5.95 ± 0.40	<i>t</i> = 0.61	0.54
Preoperative portal vein diameter (cm)	1.53 ± 1.52	1.39 ± 0.43	<i>t</i> = 0.86	0.4

MELD: Model for end-stage liver disease.



**Figure 1** Schematic diagram of splenectomy plus simplified pericardial devascularisation.

in the S Group were significantly lower than those in the T Group ( $P < 0.05$ ). Moreover, the incidence rates of long-term ascites, portal vein thrombosis and rebleeding in the S Group were significantly lower than those in the T Group ( $P < 0.05$ ) (Table 3). The number of rebleeding patients was 21 (5.88%) for S group (rebleeding site: 13 in esophageal and gastric vein, 8 in gastric mucosa) and 89 (12.94%) for T group (rebleeding site: 52 in esophageal and gastric vein, 37 in gastric mucosa). For rebleeding patients, we performed drug hemostasis (vasopressin, somatostatin, etc.) or endoscopic ligation. While for severe bleeding patients, surgical treatment was chosen.

#### Comparison of short-term and long-term routine blood tests after the operation

Within 2 d after the operation, the number of WBCs peaked rapidly in the two groups and then gradually decreased. The short-term WBC count in the S Group

was lower than that in the T Group, and the difference was statistically significant on the second, ninth, thirteenth, fifteenth, and eighteenth days ( $P < 0.05$ ). However, no significant difference was found between the two groups in the long-term WBC count ( $P > 0.05$ ), which was within the normal reference range in both groups. The short-term Hb level was decreased in both groups, but the level in the T Group was lower than the normal reference range. The short-term Hb level in the S Group was higher than that in the T Group, and the difference was statistically significant on the first, third, fourth, seventh, ninth, eleventh, thirteenth, fourteenth, and sixteenth days ( $P < 0.05$ ). No significant difference between the two groups was observed in the long-term Hb level ( $P > 0.05$ ), which was within the normal reference range. The platelet number in the two groups gradually increased and peaked on approximately the fifteenth day after the operation, and then gradually decreased to a normal value. The short-term platelet number in the S Group was lower than that in the T Group, and the difference was statistically significant on the second, fifth, tenth, and seventeenth days ( $P < 0.05$ ). However, no significant difference was found between the two groups in the long-term number of platelets ( $P > 0.05$ ) (Figure 2).

#### Comparison of short-term and long-term liver function after the operation

No significant differences in the short-term TBIL and DBIL levels were observed between the two groups ( $P > 0.05$ ). The long-term TBIL and DBIL levels in the S Group were lower than those in the T Group, and the differences were statistically significant at the twelfth, twenty-second, thirty-fourth, thirty-eighth, and forty-fourth months for TBIL ( $P < 0.05$ ) and at the twelfth,

**Table 2** Comparison of perioperative indicators

Parameters	S Group (n = 357)	T Group (n = 688)	Statistic	P-value
Postoperative hospital stay (d)	10.70 ± 5.35	14.96 ± 5.66	<i>t</i> = -3.64	< 0.05
Operation fee (Yuan)	3638.85 ± 1144.17	4168.06 ± 960.53	<i>t</i> = 3.60	< 0.05
Total hospitalisation cost (Yuan)	29654.60 ± 17475.10	35331.13 ± 18165.41	<i>t</i> = 2.67	0.01
Operative time (min)	125.60 ± 46.08	144.83 ± 54.06	<i>t</i> = 3.96	< 0.05
Intraoperative blood loss (mL)	291.46 ± 208.86	573.42 ± 409.38	<i>t</i> = 4.76	< 0.05
Intraoperative transfusion (mL)	700.82 ± 541.92	986.60 ± 627.75	<i>t</i> = 5.30	< 0.05
Time to first flatus (d)	3.74 ± 1.21	4.61 ± 1.60	<i>t</i> = -7.83	< 0.05
Mortality	0	4		
Reoperation	0	1		

**Table 3** Comparison of short-term and long-term recovery indicators and complications after the operation *n* (%)

Parameters	S Group (n = 357)	T Group (n = 688)	Statistic	P-value
Short-term portal vein diameter (cm)	1.27 ± 0.18	1.28 ± 0.20	<i>t</i> = -0.07	0.94
Long-term portal vein diameter (cm)	1.13 ± 0.14 <sup>1</sup>	1.16 ± 0.17 <sup>1</sup>	<i>t</i> = -1.16	0.25
Short-term MELD score	5.88 ± 0.54	5.97 ± 0.48	<i>t</i> = -1.39	0.16
Long-term MELD score	5.79 ± 0.50 <sup>1</sup>	5.78 ± 0.42 <sup>1</sup>	<i>t</i> = 0.27	0.79
Short-term complications				
Ascites	105 (29.41)	298 (43.31)	$\chi^2 = 19.17$	< 0.05
Portal vein thrombosis	49 (13.73)	153 (22.24)	$\chi^2 = 10.92$	< 0.05
Pleural effusion	66 (18.49)	271 (39.39)	$\chi^2 = 47.00$	< 0.05
Wound infections	10 (2.80)	37 (5.38)	$\chi^2 = 3.63$	0.06
Hepatic encephalopathy	3 (0.84)	5 (0.73)	$\chi^2 = 0.04$	1
Rebleeding	0 (0.00)	3 (0.44)	$\chi^2 = 1.56$	0.56
Long-term complications				
Ascites	36 (10.08)	122 (17.73)	$\chi^2 = 10.71$	< 0.05
Portal vein thrombosis	25 (7.00)	78 (11.34)	$\chi^2 = 4.97$	0.03
Pleural effusion	57 (15.97)	95 (13.81)	$\chi^2 = 0.88$	0.35
Hepatic encephalopathy	3 (0.84)	7 (1.02)	$\chi^2 = 0.08$	1
Rebleeding	21 (5.88)	89 (12.94)	$\chi^2 = 12.42$	< 0.05

<sup>1</sup>A significant difference compared with the preoperative and short-term parameters. MELD: Model for end-stage liver disease.

twenty-second, thirty-eighth, and forty-fourth months for DBIL ( $P < 0.05$ ). ALT and AST levels in the S Group were lower than those in the T Group one week after the operation, but the difference was not statistically significant ( $P > 0.05$ ). The short-term ALT and AST levels in the S Group were significantly lower than those in the T Group only on the twelfth day after the operation ( $P < 0.05$ ). The long-term ALT and AST levels in the S Group were lower than those in the T Group, with a significant difference at the forty-fourth month ( $P < 0.05$ ). The short-term and long-term levels of ALB in the S Group were higher than those in the T Group, and the difference was statistically significant on the sixth, seventh, ninth, tenth, eleventh, and seventeenth days and at the seventh and fifty-fourth months after the operation ( $P < 0.05$ ). The short-term and long-term levels of GLB in the S Group were significantly lower than those in the T Group only at the thirtieth and fortieth months after the operation ( $P < 0.05$ ) (Figure 3).

#### Comparison of short-term and long-term renal function after the operation

The short-term Scr and Cys C levels in the S Group were lower than those in the T Group; the difference was statistically significant for Scr on the first and eighth

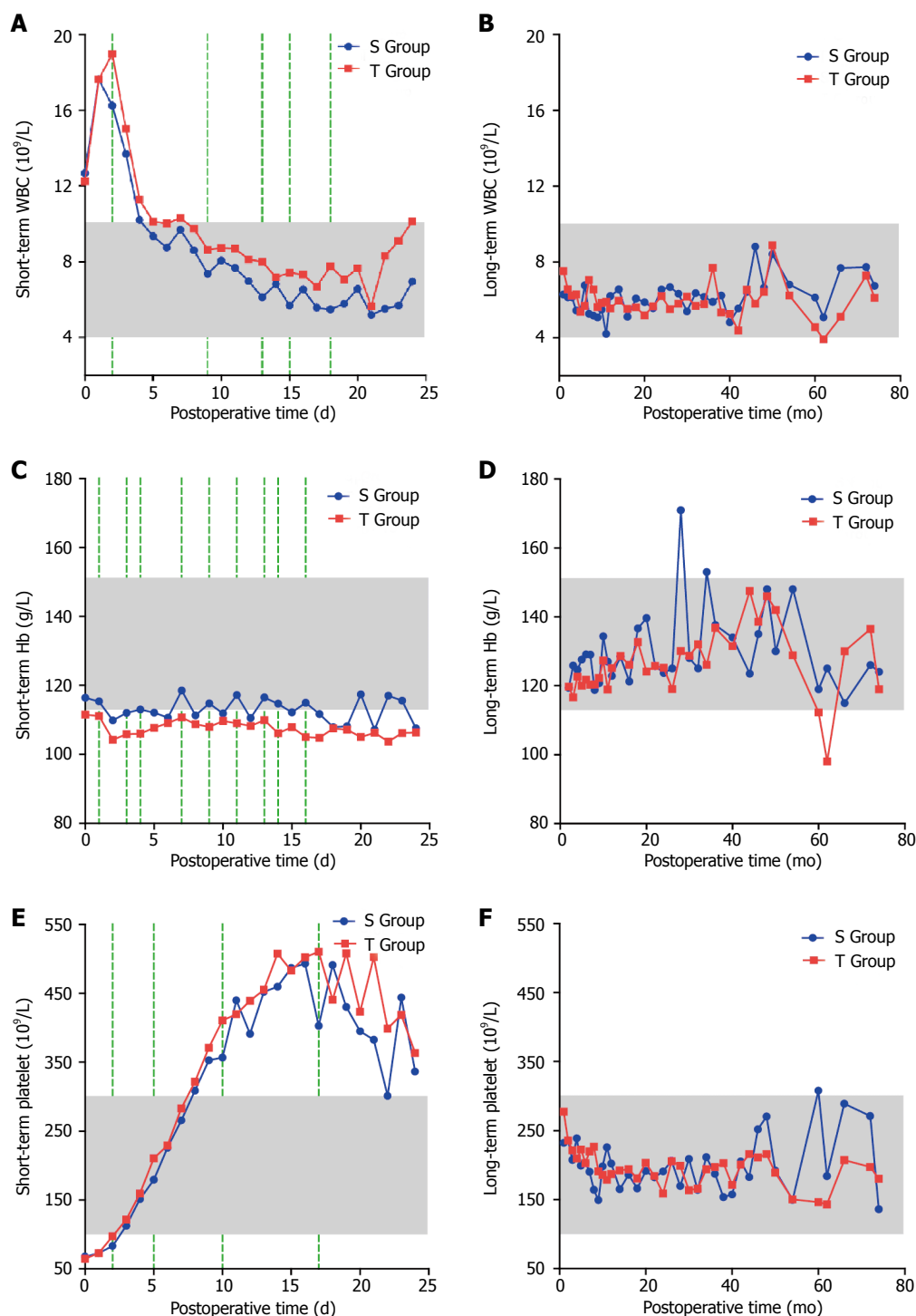
days, and Cys C was significantly different on the third, fifth, eighth, eleventh and fifteenth days ( $P < 0.05$ ). The long-term Scr level in the S Group was lower than that in the T Group, and the difference was statistically significant at the tenth and fourteenth months ( $P < 0.05$ ). However, no significant difference was found between the two groups in the long-term Cys C level ( $P > 0.05$ ) (Figure 4).

## DISCUSSION

The pathogenesis and mechanism of PH are varied and complicated and are associated with haemodynamic and mechanical dynamic changes in the liver and circulatory system. PH develops due to increased portal resistance and prograde portal flow. Blood flows through the collateral circulation from the high-pressure portal vein system to the relatively low-pressure systemic venous system, resulting in corresponding complications<sup>[10,11]</sup>. After the formation of PH, the rami anastomaticus opens, the collateral circulation expands, and haemorrhage occurs; the most important clinical complication is the formation of oesophagogastric varices<sup>[12,13]</sup>.

Surgery is the main treatment for PH in patients with cirrhosis<sup>[14]</sup>. Liver transplantation appears to be the most

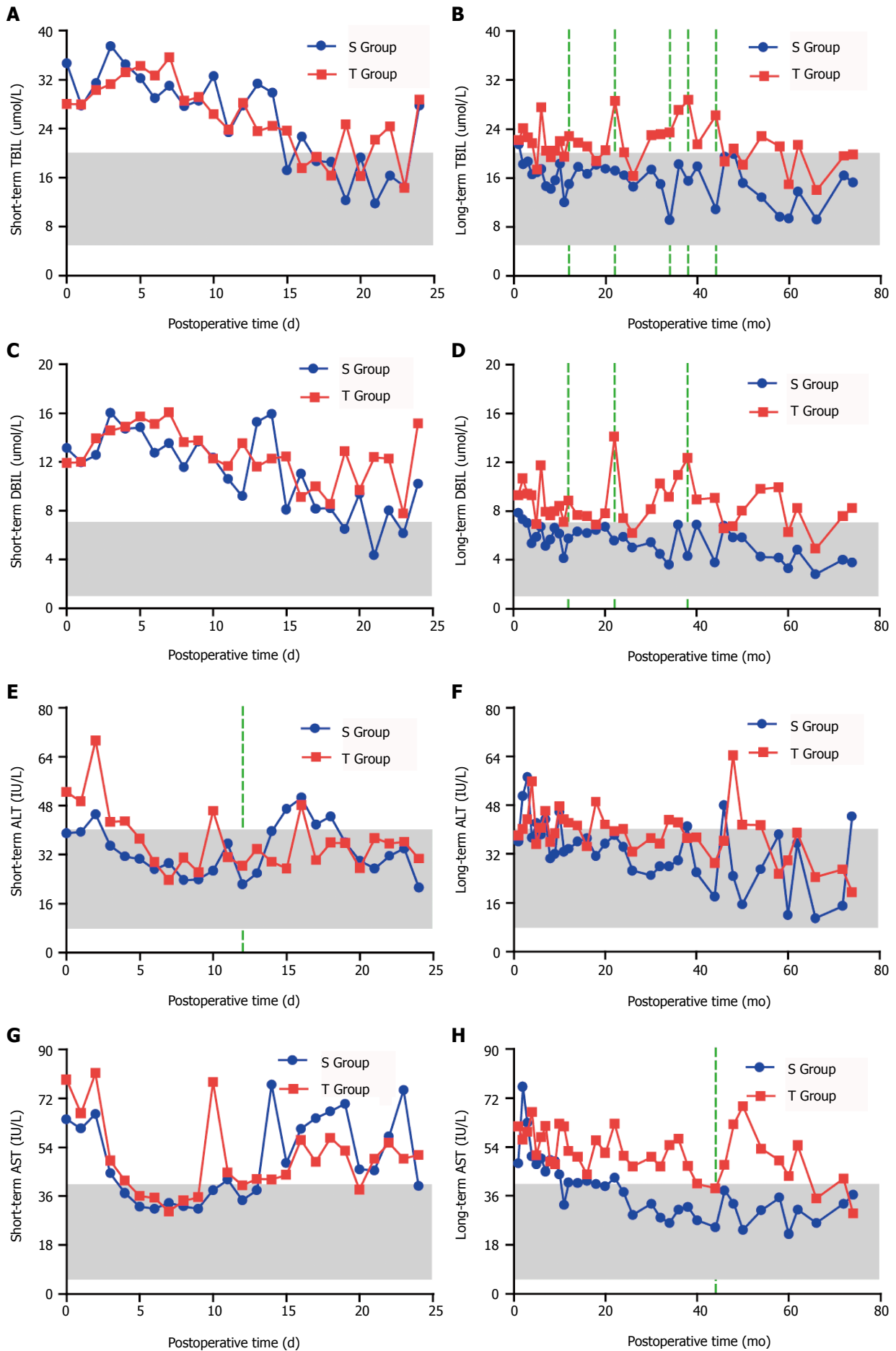


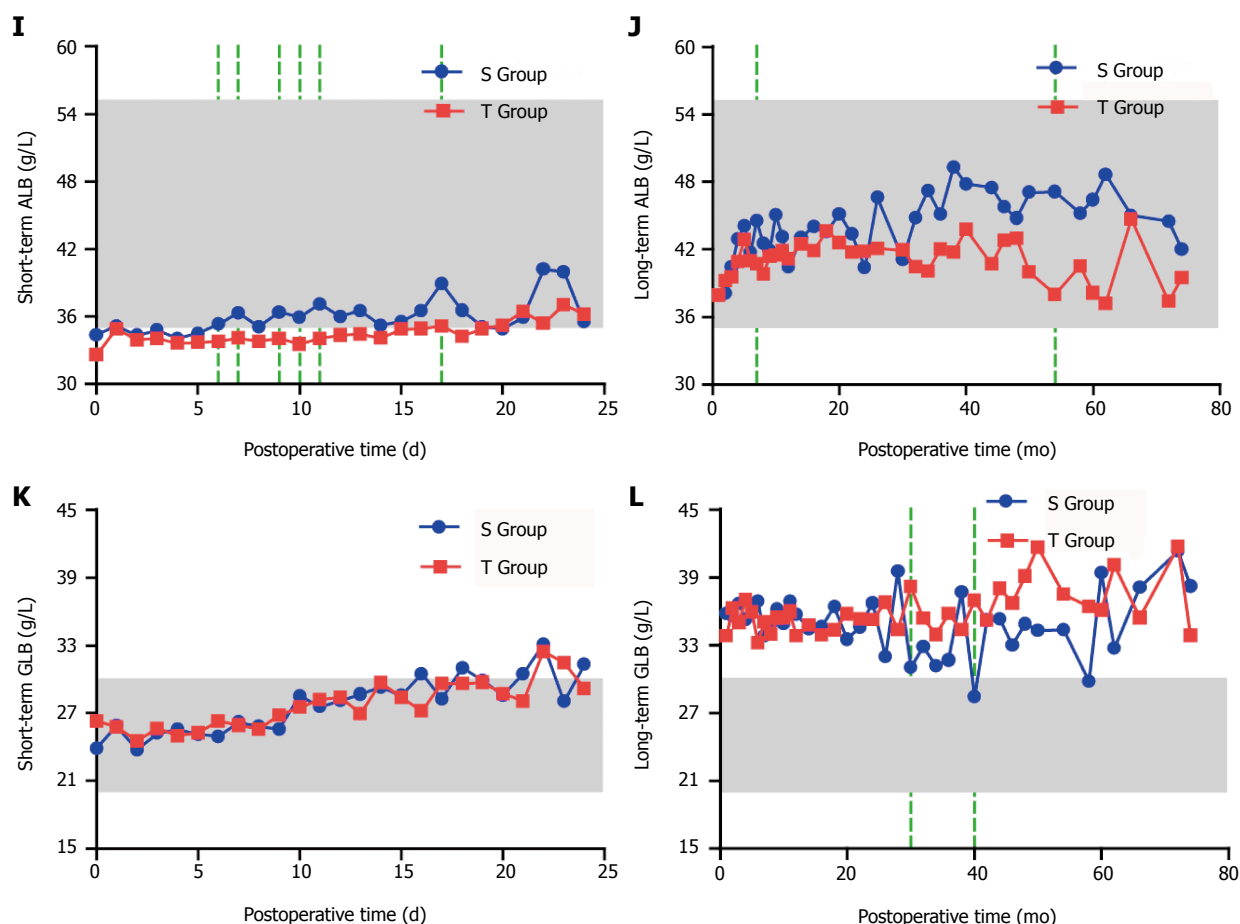


**Figure 2 Comparison of short-term and long-term routine blood tests after the operation.** A: Comparison of short-term white blood cell after the operation; B: Comparison of long-term white blood cell after the operation; C: Comparison of short-term haemoglobin after the operation; D: Comparison of long-term haemoglobin after the operation; E: Comparison of short-term platelet after the operation; F: Comparison of long-term platelet after the operation. Shadow: Normal range of reference values; Green dotted line: Time points with statistically significant differences ( $P < 0.05$ ). WBC: White blood cell; Hb: Haemoglobin.

effective treatment for PH. However, the considerable lack of liver donors and high medical costs limit its broad clinical application. Therefore, SPD has become the most commonly used method to treat PH<sup>[15,16]</sup>. STPD can achieve a remarkable curative effect by maintaining prograde portal flow and protecting liver function and haemostasis<sup>[17]</sup>. However, STPD is complex and can

lead to severe tissue damage and many complications. For PH patients with poor liver function, STPD increases the burden of the liver and increases the risk of complications such as hepatic coma and hepatorenal syndrome<sup>[3]</sup>. Therefore, we simplified STPD and introduced SSPD, which includes cutting and ligating the pericardial vessels to the posterior gastric vessels and suturing



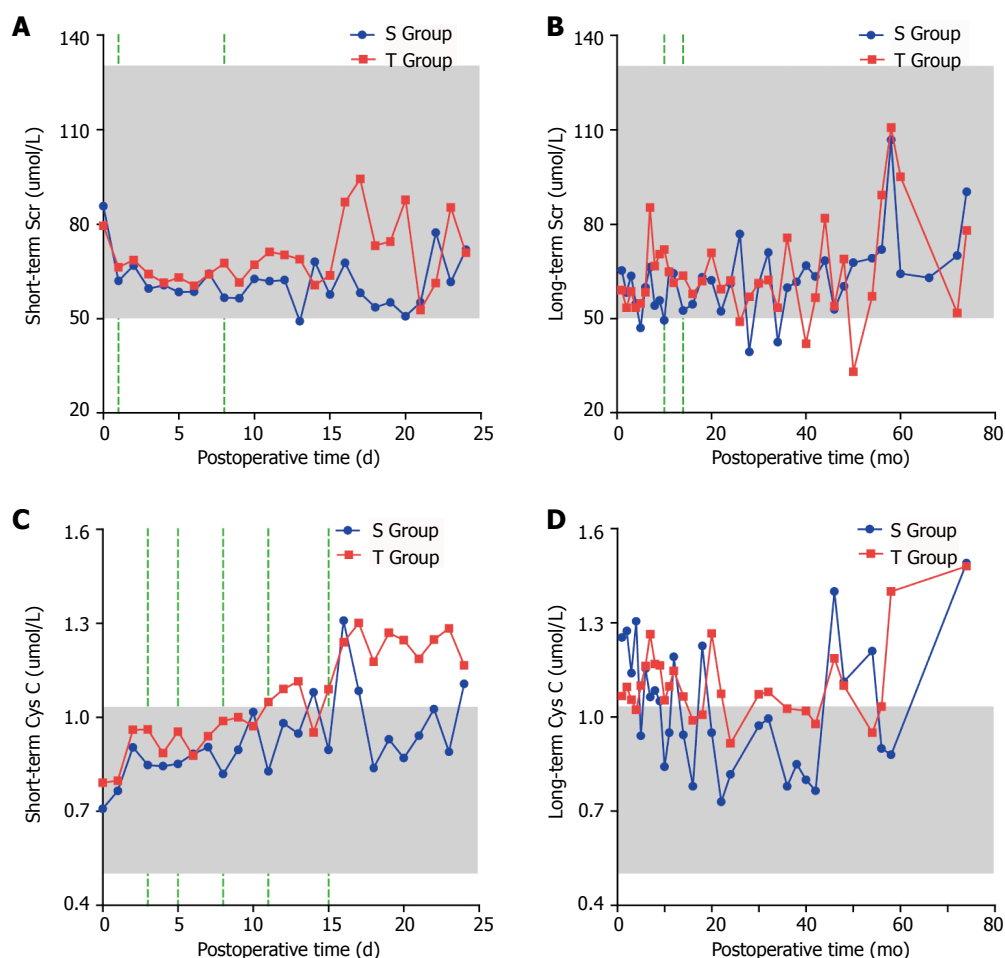


**Figure 3 Comparison of short-term and long-term liver function after the operation.** A: Comparison of short-term total bilirubin after the operation; B: Comparison of long-term total bilirubin after the operation; C: Comparison of short-term direct bilirubin after the operation; D: Comparison of long-term direct bilirubin after the operation; E: Comparison of short-term alanine transaminase after the operation; F: Comparison of long-term alanine transaminase after the operation; G: Comparison of short-term aspartate transaminase after the operation; H: Comparison of long-term aspartate transaminase after the operation; I: Comparison of short-term albumin after the operation; J: Comparison of long-term albumin after the operation; K: Comparison of short-term globulin after the operation; L: Comparison of long-term globulin after the operation. Shadow: Normal range of reference values; Green dotted line: Time points with statistically significant differences ( $P < 0.05$ ); TBIL: Total bilirubin; DBIL: Direct bilirubin; ALT: Alanine transaminase; AST: Aspartate transaminase; ALB: Albumin; GLB: Globulin.

the left gastric vessels along the lesser curvature of the stomach to the lower oesophageal vessels. Preserving the paraoesophageal vein and severing only the perforating vein can block reflux of the abdominal oesophagus, lower the portal vein pressure and ensure thorough haemostasis, thus reducing congestion of the gastric mucosa and reducing the occurrence of PHG and then reducing the postoperative rebleeding. Using a suture and not cutting the muscle layer minimise injury to the wound and reduce blood oozing during the operation. Additionally, the operative time is shortened significantly by simplifying the operation, thereby reducing the liver burden caused by the procedure. In the dynamic balance of two systems of coagulation and anticoagulation, liver plays an important regulatory role<sup>[18]</sup>. Therefore, better liver function can reduce portal vein thrombosis. The patients recovered well, with a low incidence of complications such as bleeding, liver and kidney dysfunction and jaundice. In this study, the clinical efficacy and safety of SSPD were retrospectively compared and evaluated.

The results of this study showed that the S Group

exhibited significantly better outcomes compared to the T Group in terms of postoperative hospital stay, operation fee, total hospitalisation cost, operative time, intraoperative blood loss, intraoperative transfusion, and time to first flatus. When cutting and ligating blood vessels, STPD includes cutting the serosa, which will cause additional wounds, increase intraoperative bleeding and prolong the operation<sup>[8,19]</sup>. This study also found no significant differences in short-term and long-term portal vein diameters or MELD scores between the two groups after the operation, while the long-term postoperative indicators of the two groups were significantly lower than the preoperative and postoperative short-term indicators, demonstrating that both surgical methods have good long-term effects and that SSPD is superior to STPD in reducing portal vein pressure and improving the long-term prognosis. The incidence rates of short-term and long-term ascites, portal vein thrombosis and pleural effusion and long-term rebleeding in the S Group were significantly lower, indicating that SSPD is significantly better than STPD in reducing long-term and short-term postoperative



**Figure 4** Comparison of short-term and long-term renal function after the operation. A: Comparison of short-term serum creatinine after the operation; B: Comparison of long-term serum creatinine after the operation; C: Comparison of short-term cystatin C after the operation; D: Comparison of long-term cystatin C after the operation. Shadow: Normal range of reference values; Green dotted line: Time points with statistically significant differences ( $P < 0.05$ ); Scr: Serum creatinine; Cys C: Cystatin C.

complications. Ascites, portal vein thrombosis and rebleeding are the most serious and most common complications after pericardial devascularisation, seriously affecting patients' prognoses and threatening PH patients' lives<sup>[8]</sup>. SSPD has a better clinical effect compared to STPD.

WBC elevation after the operation is related to severe tissue injury and an intense inflammatory reaction<sup>[20]</sup>. Our results showed that fewer WBCs were detected in the short term in the S Group compared to the T Group, illustrating that SSPD is simpler and easier than STPD, causes less tissue damage, and minimises inflammatory reactions. The short-term Hb levels in both groups were decreased, and the levels in the T Group were lower than the normal reference range. The short-term Hb level in the S Group was higher. This was related to less tissue injury, a reduced stress response and less bleeding with SSPD vs STPD. The platelet count in the S Group was lower in the short term. Greater thrombocytopenia corresponds to a higher risk of thrombosis<sup>[21]</sup>. Thrombosis is a common, serious complication after pericardial devascularisation that substantially affects the prognosis of the patients.

This study shows that SSPD has a certain advantage in reducing the number of platelets and decreasing the risk of thrombosis postoperatively in the short term.

In the T Group, 4 participants died due to rebleeding or liver and renal failure during the perioperative period, and 1 patient underwent reoperation for rebleeding; no death or rebleeding occurred in the S Group. STPD requires carving of the serosa, which causes significant damage to the tissue and increases intraoperative bleeding, prolongs the operation, and increases the burden on the liver, thereby increasing the risk of complications such as hepatic coma and hepatorenal syndrome. The long-term TBIL and DBIL levels in the S Group were lower than those in the T Group. SSPD is a simplified version of STPD that can relieve the liver burden due to the operation. The patients recovered smoothly after SSPD, especially in terms of long-term liver function recovery. The short-term and long-term ALT and AST levels in the S Group were significantly lower than those in the T Group. ALT is a sensitive marker of acute hepatocyte damage<sup>[22]</sup>. The results showed that short-term liver injury was mild and that long-term liver function was significantly better in the

S Group compared to that in the T Group. The short-term and long-term ALB levels were higher in the S Group. The short-term and long-term GLB levels were significantly lower in the S Group, indicating that SSPD has significant advantages for protecting liver function. The short-term and long-term Scr and Cys C levels were lower in the S Group than those the T Group, suggesting that the S Group experienced a significant advantage of reduced renal function injury, especially in the short term. Notably, significant differences in Child-Pugh grade and the incidence of PHG at admission were observed between the two groups. Patients' conditions in the S Group were more serious compared to those in the T Group, and the indicators in the S Group were better than those in the T Group, reflecting the advantages of SSPD.

Our study has some limitations. First, it was a retrospective cohort study. Because it was not a randomised research study, we cannot exclude a residual selection bias, which may have affected our results<sup>[23]</sup>. However, due to pragmatic and ethical reasons, a randomised clinical trial would be difficult to perform. Second, because we do not have complete follow-up data, such as survival, haemodynamics, and others (this is the focus of our next study), we were only able to evaluate in-hospital indicators. Third, the study was limited to Chinese patients, and due to differences in aetiology and other factors, our results may not be directly applicable to other ethnic groups. In Western countries, for example, PH is mainly caused by alcoholic cirrhosis, and shunting surgery may therefore have a better effect. In addition, this study is a single-centre study, and due to differences in treatments and national conditions, some of the results may not be generalisable to other institutions. For example, some hospitals tend to prolong the postoperative hospital stay to reduce complications, while hospitals in some other countries try to shorten the hospitalisation time to lower hospital expenses. A randomised, controlled multi-centre study with larger samples and long-term follow-up data are still needed to evaluate SSPD. Despite the above limitations, we believe that our study contributes evidence in support of SSPD for the treatment of PH.

In summary, SSPD is simple and easy to perform, resulting in less tissue damage and minimising inflammatory reactions. Operative time, intraoperative blood loss, postoperative hospital stay and expenses are all lower for SSPD compared with those for STPD. After SSPD, patients recovered smoothly and steadily, which effectively reduced the risk of thrombosis and the incidence of complications in the short term and long term. Short-term liver and kidney function damage was mild, and long-term liver function recovery was better. Therefore, SSPD is an excellent surgical method for the treatment of PH patients and is worthy of clinical promotion and application, especially in primary hospitals. Additional long-term follow-up data are still needed.

## ARTICLE HIGHLIGHTS

### Research background

Splenectomy plus pericardial devascularisation is the main surgical treatment for portal hypertension (PH) caused by virus hepatitis. However, the procedure of splenectomy plus traditional pericardial devascularisation (STPD) is complex with high rates of postoperative rebleeding and complications. A simplified pericardial devascularisation was extremely needed. We developed a splenectomy plus simplified pericardial devascularisation (SSPD), whose better short-term and long-term prognosis compared to STPD were reported in the present study.

### Research motivation

The procedure of SSPD is simple and easy to perform resulting in less tissue damage and less liver and kidney function injury, which is worthy of clinical promotion and application.

### Research objectives

The main objectives of this retrospective study were to evaluate the short-term and long-term clinical efficacy of SSPD vs STPD.

### Research methods

We retrospectively analyzed the perioperative indicators, short-term and long-term prognosis indicators and complications and short-term and long-term blood biochemical indexes of 1045 PH patients who underwent SSPD or STPD. The patients were divided into an S Group (underwent SSPD) and a T Group (underwent STPD). We analyzed the short-term and long-term clinical efficacy of SSPD vs STPD.

### Research results

Perioperative indicators in the S Group (underwent SSPD) were significantly better than those in the T Group (underwent STPD). In both groups, the postoperative long-term portal vein diameter and MELD score were significantly lower than those in the preoperative and postoperative short-term groups. The incidence of complications in the S Group was significantly lower than that in the T Group. Compared to the T Group, postoperative short-term white blood cell and platelet counts were significantly lower and the short-term haemoglobin level was significantly higher in the S Group. In the S Group, postoperative long-term total bilirubin, direct bilirubin, alanine transaminase, and aspartate transaminase and postoperative serum creatinine and cystatin C levels were significantly lower than those in the T Group, and postoperative albumin was significantly higher than that in the T Group.

### Research conclusions

SSPD is a simple and easy procedure resulting in less tissue damage and less liver and kidney function injury, which is worthy of clinical promotion and application, especially in primary hospitals.

### Research perspectives

Long-term survival and hemodynamic indexes should be further studied between the two operation types in the future research.

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