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Key factors of therapeutic effects for surgery in patients with cirrhotic portal hypertension

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Abstract. – OBJECTIVE: In the clinical management of cirrhotic portal hypertension, surgery is often necessary; however, the operative mortality rate is high.

PATIENTS AND METHODS: Data from 161 patients, who underwent surgery for cirrhotic portal hypertension, were analyzed, and 24 potential predictors of surgical outcome were assessed. A Kruskal-Wallis rank sum test was used for single-factor comparisons, and multivariate logistic regression for multifactor comparisons to identify key factors for poor surgical outcomes and calculate their scores.

RESULTS: Six predictors of poor surgical outcomes were identified: postoperative bleeding within 30 h of > 2 L, with a score of 3; severe liver atrophy (an anteroposterior diameter of the left lobe of ≤ 55 mm and an oblique diameter of the right lobe ≤ 110 mm), with a score of 3; a base excess of < –3 mmol/L, with a score of 3; a platelet count of < 3 T/L, with a score of 2; an amount of intraoperative bleeding of > 2 L, with a score of 2; and a red blood cell count of < 3 G/L, with a score of 1. For patients with good outcome (n = 147), all patients had a score of ≤ 3, except one patient who had a score of 4. With respect to patients who died (n = 14), all had a score of ≥ 5, except one patient who had a score of 4. A significant difference was observed between the two groups ($p < 0.05$). The mortality was 100% in patients with a score of ≥ 7.

CONCLUSIONS: Six key factors for poor surgical outcomes were identified in this study. Operative mortality appears to be significantly increased in patients with a score of 5-6. Surgery should be contraindicated in patients with a score of ≥ 7. To reduce mortality, close attention should be paid to preoperative and intraoperative treatment and prevention to achieve a score of < 4.

Key Words:
Cirrhotic portal hypertension, Surgical prognosis, Key factors.

Introduction

In patients with cirrhotic portal hypertension, 35% of cases have ≤ 50,000 platelets (PLTs) in blood circulation, 40% of cases have a history of upper gastrointestinal hemorrhage[1], and 18-23% of cases are complicated by liver cancer[2,3]. The majority of these patients requires surgery, with a goal of staunching bleeding, eliminating splenomegaly and severe hypersplenism (hereinafter referred to as hypersplenism), and resecting liver tumors. However, the surgical risks are great and the mortality rates are high. To investigate the reasons for this, a prospective study was performed to identify risk factors prognostic of surgical outcome in 161 patients with cirrhotic portal hypertension admitted and treated by the authors' hospital from January 2000 to June 2012. The risk factors were scored and the scores were used to evaluate their effects on surgical prognosis.

Patients and Methods

Patients with portal hypertension due to cirrhosis were included, as were patients with splenomegaly complicated by hematocytopenia of one or multiple cell lines in the circulatory blood. The protocol required that patients enrolled had already undergone surgery, and required complete clinical data for all patients.

This study excluded patients with noncirrhotic portal hypertension such as regional portal hypertension, patients with no evidence of splenomegaly, or hematocytopenia of one or multiple cell lines in the circulatory blood.

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Clinical Data

Of the 161 patients enrolled, 97 were male and 64 female (males:females 1.5:1). The ages of patients ranged from 10 to 64 years and averaged 42 years. One hundred twenty-two patients had liver cirrhosis secondary to HBV-hepatitis, Twenty-six patients had liver cirrhosis secondary to HCV-hepatitis, 5 had biliary cirrhosis, 3 had alcoholic cirrhosis, 2 had schistosomial cirrhosis, 2 had autoimmune cirrhosis, and 1 had drug cirrhosis. Endoscopy or upper gastroenterography indicated moderate or severe varices in both the lower esophagus and stomach fundus. The entire group suffered with splenomegaly, under the left rib arch can be obviously hit (not to be hit if the normal spleen), spleen is located in the left rib arch under the < 5 cm (for I degree splenomegaly) 70 cases, > 5 cm to the navel (for II degree splenomegaly) 60 cases, below the umbilicus, or more than belly line (splenomegaly III degrees) 31 cases. Average spleen size of 224 mm × 159 mm × 95 mm as measured by ultrasonography or computerized tomography (CT). Eighty-five cases mainly because of the digestive tract hemorrhage (≥ 500 ml), the bleeding or greater, 45 cases mainly because of PLT < 5 × 10^9/L, 31 cases are mainly due to the huge spleen and underwent splenectomy plus extensive devascularization around the cardia, and an additional splenorenal shunt in 16 cases, mesocaval shunt in 10 cases, and portacaval shunt in 4 cases. Postoperatively, 32 patients (19.9%) were clinically recovered, 115 (71.4%) had improved, and 14 (8.7%) had died.

Methods

According to the regularly accessed common clinical indicators and the contents of preregistration forms, information regarding 24 predictors including age, gender, degree of liver atrophy, Child-Pugh classification, coagulation profile, spleen size, renal function, blood pH value, base excess (BE), operative time, ascites volume, and intraoperative and postoperative hemorrhaging volume was collected and statistically summarized. For each of the predictors, 2-3 different quantitative subgroups were set up to carry out comparisons.

Statistical Analisys

The software package SPSS 18.0 of IBM (International Business Machines Corporation) was used for statistical analysis. Single factors were compared using the *T* rank sum test to filter statistically significant ($p < 0.05$) predictors, followed by an integrated multiple logistic regression analysis, to filter risk factors impacting surgical prognosis. Furthermore, according to the proportion of these prognosis factors using the multiple regression equation $\hat{Y} = b_0 + b_1 X_1 + b_2 X_2 \ldots$, their impacts on surgery were sorted, rated, and investigated.

Results

Single-Factor Analysis

After undergoing the Kruskal–Wallis rank sum test, age, sex, blood urea, serum creatinine, fibrinogen (Fib), oxygen partial pressure (PO_2), total bilirubin, and free portal venous pressure were observed to have no significant correlation with prognosis ($p > 0.05$). Sixteen factors, including liver volume, Child-Pugh classification, prothrombin time (PT), serum albumin, degree of esophageal varices, spleen size, PLT count, white blood cell (WBC) count, red blood cell (RBC) count, hemoglobin (Hb), blood pH, base excess (BE), ascites volume, operative time, and intraoperative and postoperative wound bleeding volume within 30 h, had a significant correlation with prognosis ($p < 0.05$), as shown in Tables I and II.

Multifactor Analysis

Using the 16 single factors that were significantly correlated with prognosis, an integrated multiple logistic regression analysis was performed, and the 6 predictors that had a significant correlation ($p < 0.05$) with diagnosis were filtered as key factors (Table III).

Scoring of key Factors

The 6 key factors were scored based on sorting by the multiple regression equation and permissible clinical experience (Table IV), which were used to select surgery type and to assess prognosis, as well as to suggest preventive therapy for abnormal indexes prior to operation.

According to the scores in Table IV, of the 147 cases in the clinically recovered and improved group, 1 case had a total score of 4 points, 12 cases had 3 points, 17 had 2 points, 26 had 1 point, and 91 had 0 points. Of the 14 cases in the group that died, except for one who received 4 points, all had a total score of over 5 points, including 2 with 5 points, 4 with 6 points, 2 with 7 points, 2 with 8 points, and 3 with 9 points (Figure 1). The difference between the two groups was significant ($p < 0.05$).

Table I. Relationship between clinical predicators and prognosis

Predicators		Total case number	Recovered (%)	Improved (%)	Died (%)	Value of H	*p*
Sex	Male	131	24 (18.3)	94 (71.8)	13 (9.9)		
	Female	30	8 (26.7)	21 (70.0)	1 (3.3)	2.072	0.355
Age (y)	< 30	17	5 (29.4)	10 (58.8)	2 (11.8)		
	30-60	115	22 (19.1)	83 (72.1)	10 (8.8)	1.220	0.543
	> 60	29	5 (17.2)	22 (75.9)	2 (6.9)		
Liver volume (mm)	≤ 55-110	26	4 (15.4)	14 (53.8)	8 (30.8)		
	> 55-110	135	28 (20.7)	101 (74.8)	6 (4.4)	18.913	0.000
Esophageal varices (severity)	Minor	25	17 (68.0)	8 (32.0)	0 (0)		
	Medium	48	11 (22.9)	33 (68.8)	4 (8.3)	25.476	0.000
	Severe	88	6 (6.8)	72 (81.8)	10 (11.4)		
Degree of splenomegaly	I	78	20 (25.6)	56 (71.8)	2 (2.6)		
	II	63	11 (17.5)	46 (73.0)	6 (9.5)	12.947	0.002
	III	20	2 (10.0)	12 (60.0)	6 (30.0)		
Ascites volume (L)	< 0.5	127	27 (21.3)	96 (75.6)	4 (3.1)		
	0.5-1	18	5 (27.8)	9 (50.0)	4 (22.2)	24.741	0.000
	>1	16	0	10 (62.5)	6 (37.5)		
Child-Pugh classification	A	88	23 (26.1)	63 (71.6)	2 (2.3)	20.453	0.000
	B	63	9 (14.3)	48 (76.2)	6 (9.5)		
	C	10	0	4 (40.0)	6 (60.0)		
Intraoperative bleeding (L)	< 1	105	27 (25.7)	70 (66.7)	8 (7.6)		
	1-2	46	5 (10.9)	39 (84.8)	2 (4.3)	7.619	0.022
	> 2	10	0	6 (60.0)	4 (40.0)		
Portal venous pressure (cmH_2O)	< 24	3	3 (100)	0	0		
	24-30	40	9 (22.5)	29 (72.5)	2 (5.0)	3.922	0.141
	> 30	118	20 (16.9)	86 (72.9)	12 (10.2)		
Operative time (h)	< 2	17	11 (64.7)	6 (35.3)	0		
	2-4	106	16 (15.1)	82 (77.4)	8 (7.5)	13.324	0.001
	> 4	38	5 (13.2)	27 (71.0)	6 (15.8)		
Postoperative wound bleeding (L)	1	147	32 (21.8)	11 (76.8)	2 (1.4)		
	1-2	8	0	2 (25.0)	6 (75.0)	115.282	0.000
	> 2 6	0	0	6 (100)			

Note: *55 mm refers to the longitudinal diameter of the left liver lobe, and 110 mm diameter refers to the oblique diameter of the right lobes. H: is the boundary value of the rank sum test.

Discussion

Using a logistic regression analysis, 6 key factors closely related to operative prognosis were identified. Of the 6 key factors, intraoperative and postoperative wound hemorrhage volumes were not predictive, while for 4 factors other factors were determined to be predictive and evaluable, and could be added for a total score. A total score of 4 points was the shared central area for the recovered and improved group and the death group (one patient in each). To reduce mortality, patients should be actively treated preoperatively to maintain the total score within 4 points or less.

Table II. Relationship between clinical predicators and prognosis

Predicators		Total case number	Recovered (%)	Improved (%)	Died (%)	Value of H	*p*
	> 4	100	19 (19.0)	81 (81.0)	0		
WBC (T/L)	3-4	47	9 (19.1)	34 (72.4)	4 (8.5)	32.527	0.000
	< 3	14	4 (28.6)	0	10 (71.4)		
	> 4	111	22 (19.8)	89 (80.2)	0		
RBC (G/L)	3-4	36	10 (27.8)	22 (61.1)	4 (11.1)	37.556	0.000
	< 3	14	0	4 (28.6)	10 (71.4)		
	> 50	102	24(23.5)	76 (74.5)	2 (2.0)		
PLT (T/L)	50-30	49	6 (12.2)	39 (79.6)	4 (8.2)	27.050	0.000
	< 30	10	2 (20.0)	0	8 (80.0)		
	> 60	103	20 (19.4)	80 (77.7)	3 (2.9)		
Hb (g/L)	59-30	43	8 (18.6)	33 (76.7)	2 (4.7)	23.604	0.000
	< 30	15	4 (26.7)	2 (13.3)	9 (60.0)		
	> 35	95	23 (24.2)	66 (69.5)	6 (6.3)		
Albumin (g/L)	35-30	42	9 (21.4)	31 (73.8)	2 (4.8)	7.142	0.028
	< 30	24	0	18 (75.0)	6 (25.0)		
	< 34.2	122	28 (22.9)	87 (71.3)	7 (5.7)		
Total bilirubin (μmol/L)	34.2-51.3	31	4 (12.9)	22 (71.0)	5 (16.1)	7.966	0.099
	> 51.3	8	0	6 (75.0)	2 (25.0)		
	< 44	12	5 (41.7)	5 (41.7)	2 (16.7)		
Serum creatinine (μmol/L)	44-115	141	27 (19.1)	104 (73.8)	10 (7.1)	5.566	0.062
	> 115	8	0	6 (75.0)	2 (25.0)		
	< 2.8	15	3 (20.0)	8 (53.3)	4 (26.7)		
Blood urea (mmol/L)	2.8-8.2	138	29 (21.0)	101 (73.2)	8 (5.8)	2.199	0.333
	> 8.2	8	0	6 (75.0)	2 (25.0)		
	< 20	90	22 (24.4)	66 (73.3)	2 (2.2)		
PT (s)	20-30	69	11 (15.9)	47 (68.1)	11 (15.9)	13.026	0.001
	> 30	2	0	1 (50.0)	1 (50.0)		
	> 2.0	94	23 (24.5)	63 (67.0)	8 (8.5)		
FIB (g/L)	1.5-2.0	41	9 (21.9)	30 (73.2)	2 (4.9)	4.980	0.083
	< 1.5	26	0	22 (84.6)	4 (15.4)		
	< 7.35	15	2 (13.3)	5 (33.3)	8 (53.3)		
Blood pH	7.35-7.35	121	23 (19.0)	96 (79.3)	2 (1.7)	7.212	0.027
	>7.45	25	7 (28.0)	14 (60.0)	4 (16.0)		
	< -3	46	3 (6.5)	33 (71.7)	10 (21.7)		
BE (mmol/L)	-3-3	97	21 (21.6)	74 (76.3)	2 (2.1)	16.672	0.000
	> 3	18	8 (44.4)	8 (44.4)	2 (11.2)		
	> 3	18	8 (44.4)	8 (44.4)	2 (11.2)		
Oxygen partial pressure	> 60	159	32 (20.1)	113 (71.1)	14 (8.8)		
(mmHg)	40-60	2	0	2 (100)	0	0.850	0.669
	< 40	0	0	0	0		

H: is the boundary value of the rank sum test.

With a total score of 5-6 points, patients are at risk of surgical mortality, so special care should be taken when selecting the type of surgery. Total scores of ≥ 7 points should be classified as surgical contraindications. Such scoring not only avoids aimless operation, but also provides a the-

Table III. Results of the logistic regression analysis.

Items	Regression coefficients (b values)	*p* values
Postoperative wound bleeding	0.356	0.000
Degree of liver atrophy	-0.160	0.000
Base excess (BE)	-0.123	0.000
PLT	0.065	0.015
Intraoperative wound bleeding	0.062	0.014
RBC	0.053	0.024

Note: The 6key factors were sorted using the following multiple regression equation:
$Y = -0.360 + 0.356\ X_1 - 0.160X_2 - 0.123X_3 + 0.065\ X_4 + 0.062\ X_5 + 0.053\ X_6$
(X_1 represents postoperative wound bleeding, X_2 represents the degree of liver atrophy, X_3 represents BE, X_4 represents PLT count, X_5 represents intraoperative wound bleeding, and X_6 represents RBC count).

Table IV. Scores of the 6 key factors

Items	Severity	Scores
Postoperative major wound bleeding	> 2 L	3
Severe liver atrophy	≤ 55 and 110 mm*	3
BE	< -3	2
PLT	< 30,000	2
Intraoperative major wound bleeding	> 2 L	2
RBC	< 3 (G/L)	1
Total		14

Note: *55mm refers to the longitudinal diameter of the left liver lobe, and 110 mm diameter refers to the oblique diameter of the right lobes.

oretical basis for intensifying preoperative treatment.

Postoperative major wound bleeding refers to wound bleeding volumes of > 2 L within 30 h after surgery, and is the top key factor impacting surgical prognosis (which was awarded 3 points). Of the 14 deaths in this study, 3 died of postoperative major wound bleeding, while 0 of the 147

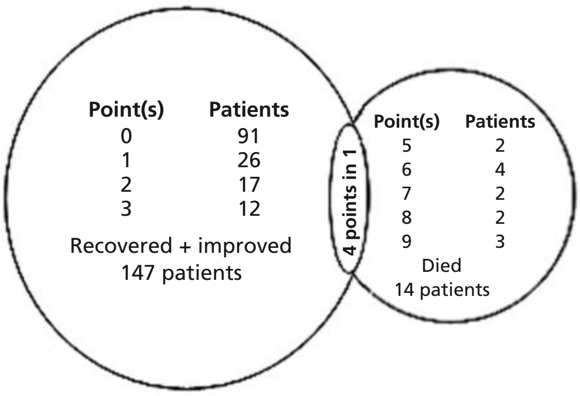

Figure 1. Group scores.

patients in the recovered and improved group had postoperative major wound bleeding. Postoperative major wound bleeding is generally accompanied by intraoperative wound bleeding. In the single- and multifactor analyses, intraoperative major wound bleeding was significantly associated with prognosis ($p < 0.05$); it was awarded 2 points and ranked sixth in the overall group of key factors. In this group, 10 patients experienced intraoperative major wound bleeding and 3 died (33.3%). Several reasons for major wound bleeding exist. First, abnormal coagulation factors may play a role. In the single-factor analysis, a PT of > 30 seconds was significantly correlated with prognosis (H value of 13.026, $p = 0.001$). As such, a preoperative plasma transfusion is required to attempt to decrease PT to within 20 seconds. Fib, which is synthesized and secreted by liver cells, is an important physiological factor in physiological hemostasis. Although the effect of Fib was not obvious in the single-factor or multifactor analysis, Fib that is too low will extend PT, activated partial thromboplastin time, and thrombin time, resulting in extensive blood oozing from the wound surface. This is even more prominent when complicated by significantly prolonged PT. Two patients in this group with a Fib of ≤ 1.4 g/L and significantly prolonged PT experienced extensive exudation from the peritoneal-serosal surface and blood oozing from the wound surface immediately before the end of the splenectomy and portoazygous devascularization. These patients died despite resuscitation attempts. An effective way to elevate Fib is cryoprecipitate transfusion, and surgery is relatively safe when Fib levels are elevated to > 2 g/L. Second, thrombocytopenia impairs the important role of PLTs in physiological hemostasis. Third, after intraoperative wound bleeding, a large number of coagulation factors in the body are lost and PLTs are damaged. Despite a massive homologous blood and plasma transfusion, the transfused coagulation factors are wasted due to poor compatibility in the stressful situation, leading to coagulation dysfunction[4,5] and increased bleeding volume. Fourth, surgical procedures may be inappropriate and/or hemostasis is not complete after surgery. Fifth, if a surgical procedure takes too long, a relative increase in intraoperative blood loss can be exhibited. In the single-factor analysis, operative times of > 4 h exhibited significant correlation with prognosis (*H* value of 11.59, $p = 0.004$). Thus, surgeons and anesthetists should work closely together to perform surgeries under favorable anesthetic conditions to curtail surgery times as much as possible. Major wound bleeding leads to insufficient blood volume, causing ischemia and hypoxia of tissues and organs as well as cell damage, resulting in metabolic disorders and dysfunction of organs and systems.

Liver atrophy refers to a liver volume that is smaller than normal values due to inflammation, necrosis of liver tissues, liver fibrosis, or nodular regeneration of remnant liver cells caused by various reasons. Severe liver atrophy is the second major key factor affecting prognosis, and was awarded 3 points in this study. In this study, 26 patients had a longitudinal diameter of the left liver lobe of ≤ 55 mm and an oblique diameter of the right lobe of ≤ 110 mm; of these patients, 8 (30.8%) died, accounting for 57.1% of the total deaths. One hundred thirty-five patients had a longitudinal diameter of the left liver lobe of > 55 mm and an oblique diameter of the right lobe of > 110 mm; of these patients, 6 (4.4%) died. There was a significant difference between the two subgroups ($p < 0.00$). The superior-inferior diameter of the left hepatic lobe is the distance between the superior border and the inferior border of the left lobe, and the oblique diameter of the right lobe is the oblique distance between the most inferior point on the lateral border of the right lobe and the secondary portal of the liver. The normal oblique diameter is 120-140 mm. In our research, we found oblique diameters of ≤ 110 mm and > 110 mm, which were statistically significantly different ($p = 0.000$). Therefore, 110 mm was chosen as the criterion. Of course, other indexes to indicate the degree of hepatic cirrhosis exist, such as the size of the hepatic nodules, volume of ascitic fluid, and size of the spleen, but they are difficult to analyze due to the absence of unified objective standards. Multislice spiral CT scans may serve as a better method for measuring liver size[6,7], but CT scans have only recently begun to be performed on many of our patients, and most of the existing scans were not multislice spiral CT scans. In contrast, each enrolled patient had a B ultrasound examination. Therefore, we chose to use the results of the B ultrasound and CT examination for comparison, as such results had statistically significant differences. Due to poor liver reserve functions and compensatory functions after severe liver atrophy, postoperative prognosis is generally undesirable[8]. Generally, if a logistic regression coefficient of –0.160 indicates more severe liver atrophy; thus, patients are more prone to uncontrollable major bleeding and liver failure, which increases mortality[9]. The authors once personally encountered a single case of macronodular-type, hard texture, severe liver atrophy with pancytopenia, and a PLT of 15×10^9/L. Immediately upon removing the patient from the operating room following splenectomy and portoazygous devascularization, 600 mL of blood abruptly disgorged from the abdominal drainage tube. An abdominal exploration was immediately performed, which revealed "sweat-like" extensive oozing of blood from the serosa. There was no obvious bleeding from the surgical wound, and because it was unable to be treated, the patient died the next day. From the authors' understanding, a "sweat-like" extensive oozing of blood during surgery is a sign of poor prognosis. For patients with macronodular type (diameter > 10 mm) severe liver atrophy, remarkably abnormal coagulation factors and PLT < 20×10^9/L, surgery should be contraindicated.

BE level that is significantly lower than normal limits and falling into the acidemia category, was the third major key factors, and was awarded 3 points. Acidosis is a very serious complication that disturbs the metabolism of the body[10]. Acidemia or lactic acidosis may increase mortality owing to liver cirrhosis and blood loss during episodes of hepatic decompensation[11]. The logistic regression coefficient of BE was –0.123. A lower BE means more excessive acid, which results in acid-base imbalance, and is detrimental to the body[12], and it is a significant factor associated with death[13].

A low PLT count was the fifth key factor for prognosis, and was awarded 2 points. A PLT count of $< 30 \times 10^9$/L was clearly linked to prognosis ($p < 0.05$) both in the single-factor analysis (H value of 7.67, $p = 0.022$) and the multifactor logistic regression analysis. PLT count reduction is a common complication of liver cirrhosis and splenomegaly[14]. It is not only associated with the splenic retention theory, blood cell aggregation, enhanced phagocytosis, and destruction of macrophages[15], but also with bone marrow compensation and adjustment[16]. Thus, a low PLT count was the fifth risk factor associated with prognosis[17]. Preoperative PLT transfusion is required to elevate the PLT count to above 50×10^9/L. An increased postoperative PLT count has also been demonstrated to be a risk factor[18,19].

Low RBC count was the seventh key factor impacting prognosis, which was awarded 1 point. An RBC count of < 3 (G/L) was associated with prognosis in both the single-factor analysis (H value of 47.556, $p = 0.000$) and multifactor logistic regression analysis ($p = 0.015$). The main functions of the RBC are to transport O_2 and participate in CO_2 excretion[20] Transportation of O_2 by RBCs is accomplished by intracellular Hb. If the RBCs are reduced in number or ruptured, Hb will escape, and gas transportation functionality can be lost; this may cause ischemia and hypoxia of body tissues and result in multiple organ failure. Therefore, preoperative RBC transportation is required to elevate the RBC count to > 3 G/L.

In the single-factor analysis, prolonged PT was clearly associated with prognosis, but it was eliminated in the multifactor logistic regression analysis. This may have been related to strictly adhering to the principle of no surgery for cases with a prolonged PT of more than 30 seconds preoperatively. In this study, there were only 2 cases of prolonged PT greater than 30 seconds, which is too small for statistical analysis. In actuality, the normality of PT and Fib is more important than the decrease in the number of blood cells. Recently, a patient, aged 22 years, with a WBC of 1.35×10^9/L, an RBC of 2.42×10^{12}/L, a PLT of 27×10^9/L, and an Hb of 50 g/L, but normal PT, Fib, and liver function pre-operatively, recovered successfully after splenectomy with gastroesophageal devascularization.

Theoretically, an increase in portal vein pressure could increase the incidence of hemorrhage and death, but in this study, there were no statistically significant differences in the univariate or multivariate analyses ($p > 0.05$). This might be due to the small number of patients who underwent surgeries for massive gastrointestinal hemorrhage.

Even though patient nutrition, financial status, constitutional diathesis, psychological factors, and medical conditions may also be related to prognosis[21], the above mentioned 7 quantifiable risk factors cannot be ignored. They are critical factors affecting the surgical prognosis of cirrhotic portal hypertension**.** In order to verify the accuracy and operability of this model, data from 15 patients with portal hypertension admitted after January 2011 were analyzed directly using the 6 key factors for surgical outcome derived statistically (see the attached table). Of the 15 patients, only one patient, with a total score of 7 points, did not improve. The other 14 patients had total scores of less than 4 points and were discharged. Of the 14 patients, 9 were cured and 5 had improved. This verifies the contention proposed in this study that the total score must be controlled to be < 4 to improve the cure rate. The cross validation of the internal predicting model using the 15 external cases demonstrates the scientific and practical values of the 6 key factors affecting surgical outcome derived statistically in this study.

Conclusions

These results provide theoretical support for the selection of surgical indications, as well as perioperative treatment and prevention, thus, reducing operative mortality.

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Conflict of Interest

The Authors declare that they have no conflict of interests.

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