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Wenyue Hu, Zhaojin Wang, Shuangmei Xi, Shuna Zhang, Yuanyuan Zhang, Yanmei Gu

Department of Nursing. Beijing Youan Hospital. Capital Medical University. Beijing, Peoples's Republic of China

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Correspondence: Yanmei Gu. Department of Nursing. Beijing Youan Hospital. Capital Medical University. 8 West Toutiao, Youanmenwai, Fengtai District. Beijing 100069, People's Republic of China
e-mail: yanmei2023gu@163.com

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ABSTRACT

Objective: this study aimed to explore the preoperative and intraoperative factors that influence the complete recovery of gastrointestinal function after liver transplantation and provide a reference for early enteral nutrition care assessment, care and intervention.

Methods: a retrospective analysis of 254 patients with first-time liver transplants (January 2022 to March 2023) was conducted. Patients were categorised into two groups based on the duration of gastrointestinal function recovery: ≤ 7 days and > 7 days. Clinical parameters were compared, and multi-factor logistic regression was used to analyse influencing factors.

Results: the increase in the model for end-stage liver disease score, ascites volume, intraoperative bleeding and hepatic portal blockage time were preoperative and intraoperative risk factors for the delayed recovery of gastrointestinal function after liver transplantation.

Conclusion: if preoperative liver function is improved sufficiently, intraoperative bleeding minimised and haemodynamic stability maintained, the occurrence of delayed recovery in gastrointestinal function early after liver transplantation may be effectively reduced.

Keywords: Liver transplantation. Recovery of gastrointestinal function. Risk factors. Prognosis.

RESUMEN

Objetivo: explorar los factores preoperatorios e intraoperatorios que influyen en la recuperación completa de la función gastrointestinal después del trasplante de hígado y proporcionar una referencia para la evaluación, el cuidado y la intervención temprana del cuidado de la nutrición enteral después del trasplante de hígado.

Métodos: se realizó un análisis retrospectivo de 254 pacientes con trasplante de hígado por primera vez (enero de 2022 a marzo de 2023). Los pacientes se clasificaron en dos grupos según la duración de la recuperación de la función gastrointestinal: ≤ 7 días y > 7 días. Se compararon los parámetros clínicos y se utilizó regresión logística multifactorial para analizar los factores influyentes.

Resultados: el aumento del puntaje MELD, el volumen de ascitis, el sangrado intraoperatorio y el tiempo de bloqueo del portal hepático fueron factores de riesgo preoperatorios e intraoperatorios para el retraso en la recuperación de la función gastrointestinal después del trasplante de hígado.

Conclusión: si la función hepática preoperatoria mejora lo suficiente, se minimiza el sangrado intraoperatorio y se mantiene la estabilidad hemodinámica, se puede reducir eficazmente la aparición de un retraso en la recuperación de la función gastrointestinal poco después del trasplante de hígado.

Palabras clave: Trasplante de hígado. Recuperación de la función gastrointestinal. Factores de riesgo. Pronóstico.

INTRODUCTION

Patients undergoing liver transplantation, especially those with benign end-stage liver disease, often experience severe malnutrition caused by reduced preoperative long-term energy intake, impaired glycogen stores and increased protein requirements. Even patients with stable cirrhosis with a Child-Pugh class A liver function have nearly 20 % increased protein consumption compared with healthy individuals (1). McCullough et al. demonstrated that the prevalence of hepatic-derived protein-energy malnutrition in patients with advanced liver disease is 18 %-65 % (2). The challenges encountered in post-transplant recovery are intricately linked to malnutrition in liver disease, as the pre-existing nutritional status of patients significantly influences the recovery trajectory after liver transplantation. Malnutrition can exacerbate gastrointestinal dysfunction, prolonging the recovery process and potentially leading to complications, such as extended intensive care unit (ICU) stays and increased susceptibility to infections. Addressing malnutrition through targeted nutritional interventions is crucial for optimising post-transplant outcomes and enhancing overall patient well-being.

In addition, some patients have a combination of intestinal endotoxaemia, hypoproteinaemia and massive ascites, which are very likely to be complicated by intestinal dysfunction or even intestinal failure (3). Patients undergoing liver transplantation experience major intraoperative trauma, which often aggravates their intestinal dysfunction. Postoperatively, the body exhibits disorders in glucose metabolism, decreased hepatic protein synthesis, increased catabolism and impairment of mucosal barrier function (4). The identified factors frequently contribute to the protracted recuperation of gastrointestinal function in individuals undergoing liver transplantation. Despite this, there is a paucity of comprehensive investigations into the determinants impacting the recuperative trajectory of gastrointestinal function post-surgery. While the literature has expounded upon the risk factors associated with gastroparesis and postoperative gastrointestinal dysfunction in critically ill patients, there remains a noticeable dearth of dedicated studies on the multifaceted aspects influencing the recovery of gastrointestinal function following liver transplantation (5,6).

Research on recovery disorders related to postoperative gastrointestinal function in critically ill patients has increased in recent years, and researchers generally agree that the delayed recovery of gastrointestinal function seriously affects the prognosis of critically ill patients. The complete recovery of gastrointestinal function includes the recovery of digestive and absorption function, which enables improvements in the patient's abdominal distension, ability to experience hunger, defecation and stool patting, mucosal barrier function, endocrine function and immune function. Many factors may affect the complete recovery of gastrointestinal function after liver transplantation, among which the preoperative status and surgery-related factors have been the focus of attention; however, there is a lack of specific studies focusing on both preoperative and intraoperative factors in the context of liver transplantation, and no definite conclusion on the key risk factors has been reached. Given this, our study seeks to provide valuable insights for early enteral nutrition care assessment, intervention and overall post-transplantation care strategies.

PARTICIPANTS AND METHODS

Research participants

This study retrospectively collected the medical records of all patients who underwent liver transplantation for the first time at our hospital between January 2022 and March 2023. During the study period, the hospital completed 285 liver transplants. The inclusion criteria were as follows: (1) patients with complete medical records, such as laboratory tests, surgical records, anaesthesia record sheets, intensive care records and medical course records; (2) patients who survived for > 15 days after surgery. The exclusion criteria were as follows: 1) patients with a second liver transplantation, combined liver and kidney transplantation or combined hepatopancreas and kidney transplantation; 2) patients with incomplete medical records; 3) patients who died within 15 days of surgery; 4) patients with acute liver failure (to maintain a more homogeneous study population).

According to the inclusion and exclusion criteria, excluding 1 case of secondary liver transplantation, 3 cases of combined liver and kidney transplantation, 6 cases of patients with incomplete medical records and 21 patients who died within 15 days of surgery, a total of 254 patients were involved in this study.

Data collection

In this study, the date of complete recovery of gastrointestinal function was defined as the first day when patients experienced 3 consecutive days without discomfort, postoperative abdominal distension, deflation of the anus and a total intake of transoral and nutritional tube supplementation diet reaching 30 $mL.kg^{-1}.d^{-1}$. A prior study (7) noted that delayed recovery of gastrointestinal function in critically ill ICU patients occurs when the recovery time is > 6 days. Achieving 60 % of the target nutritional volume through enteral nutrition within approximately 3 days is crucial for improving patient prognosis. However, in this retrospective study, meeting this criterion was challenging, as only 55.4 % of cases achieved 60 % of the target nutritional volume within 7 days. Given these challenges, two groups were established based on recovery time: a ≤ 7-day group (considered normal), with 142 cases, and a > 7-day group (indicating delayed recovery), with 112 cases.

The following data were collected separately from the two groups: (i) preoperative data – age, sex, underlying disease, presence of combined hepatic encephalopathy, history of diabetes mellitus, history of upper abdominal surgery, presence of ascites, model for end-stage liver disease (MELD) score, serum albumin levels, serum sodium levels, platelet count and body mass index (BMI ($kg.m^{-2}$)). The MELD score is a numerical scale used to assess the severity of liver disease. It provides valuable information about a patient's likelihood of survival while waiting for a liver transplant (8), which includes the following: serum creatinine (Cr) and serum bilirubin (TB) levels, prothrombin time, international normalised ratio (INR) and aetiology; the regression coefficients of these indicators form the mortality risk prediction formula: $R = 9.6 \times \ln(\text{Cr mg.dl}^{-1}) + 3.8 \times \ln(\text{TB mg.dl}^{-1}) + 11.2 \times \ln(\text{INR}) + 6.4 \times$ (etiology (0 for alcoholic or cholestatic cirrhosis and 1 for the rest)). The higher its R-value is, the greater its risk and the lower its survival rate. Later, for ease of calculation, Kamath et al. (8) modified the formula to $R = 3.8 \times \ln(\text{TB mg.dl}^{-1}) + 11.2 \times \ln(\text{INR}) + 9.6 \times \ln(\text{Cr mg.dl}^{-1}) + 6.4 \times$ (etiology (0 for alcoholic or cholestatic cirrhosis and 1 for the rest)); (ii) intraoperative data – intraoperative bleeding during liver transplantation, rehydration volume, hepatic portal blockage time and operation time. In simpler terms, the MELD score helps doctors prioritise patients on the transplant waiting list based on the urgency of their needs. Higher scores indicate more severe liver dysfunction and a greater risk of mortality without transplantation. Therefore, patients with higher MELD scores are typically given priority for receiving a liver transplant.

Underlying diseases are divided into benign liver disease and malignant liver disease. Malignant liver diseases include primary liver cancer and cholangiocarcinoma; benign liver diseases include various types of cirrhosis, acute and chronic liver failure, hepatolenticular degeneration, Buga's syndrome and cholelithiasis.

The main diagnostic bases of hepatic encephalopathy are the following: (i) mental disturbance, lethargy or coma; (ii) severe liver disease and/or extensive portal collateral circulation; (iii) significant liver function impairment or increased blood ammonia; and (iv) causative factors of hepatic encephalopathy. Typical electroencephalogram-related changes and flutter-like tremors have important reference values.

Grouping and coding of influencing factors in logistic analysis

After reviewing the literature and guidelines related to postoperative liver transplantation, the MELD score was used as a reliable predictor of patient prognosis. Literature data (9) revealed that survival and quality of life in patients undergoing liver transplantation with a MELD score ≥ 15 was reduced compared with patients with a score < 15; survival time decreased as the score increased, with a MELD score ≥ 15 = 1 and a MELD score < 15 = 0.

One study (10) suggested that patients with an intraoperative bleeding volume > 3,000 mL are prone to impaired gastrointestinal recovery, increased infection-related complications, prolonged postoperative hospital stay and increased mortality. In the present study, patients undergoing liver transplantation with intraoperative bleeding ≥ 3,000 mL were selected as positive manifestations, with intraoperative bleeding ≥ 3,000 mL = 1 and intraoperative bleeding < 3,000 mL = 0.

A prolonged hepatic portal blockage time increased operative time, and extensive intraoperative fluid rehydration may affect patient prognosis. Grouping and coding were based on expertise and clinical experience, with an operative time ≥ 9 h = 1 and operative time < 9 h = 0, as shown in table I.

Statistical analysis

The SPSS 21.00 statistical package (IBM, Armonk, NY, USA) was used for analysis. Statistically significant factors were first derived using a chi-squared test or *t*-test and then incorporated into a dichotomous logistic regression analysis to identify significant suspected risk factors; these were grouped and coded for stepwise logistic regression analysis. A regression method with a partial maximum likelihood ratio estimation was used to derive risk factors for the delayed recovery of gastrointestinal function, and the difference was considered statistically significant at $p < 0.05$.

RESULTS

Comparison of preoperative data between the two groups

This study cohort consisted of 178 men and 76 women aged 18-84 years, with a mean age of 45.58 ± 15.36 years. The primary disease was malignant liver tumour in 119 patients (46.85 %) and benign end-stage liver disease in 135 patients (53.15 %). The patients were divided into a complete recovery of intestinal function group (≤ 7-day group) and a delayed recovery of gastrointestinal function group (> 7-day group), based on the amount of time taken for the complete recovery of gastrointestinal function. The preoperative data of the two groups were compared, revealing that the mean age of the complete recovery group (105 men and 37 women) was 44.25 ± 12.15 years, the mean systolic blood pressure was 123.25 ± 9.57 mmHg and the mean diastolic blood pressure was 73.45 ± 7.53 mmHg. The mean age of the group with delayed recovery of gastrointestinal function (73 men and 39 women) was 46.23 ± 10.43 years, the mean systolic blood pressure was 124.42 ± 9.99 mmHg and the mean diastolic blood pressure was 72.40 ± 8.31 mmHg. Sex, age, height, systolic blood pressure, diastolic blood pressure, abdominal circumference, BMI and serum albumin levels indicating underlying lung disease were not different between the two groups ($p > 0.05$). The comparison of preoperative data between the two groups revealed statistically significant differences ($p < 0.05$) in eight factors: diabetes, liver cancer, preoperative combined hepatic encephalopathy, serum sodium levels, ascites volume, MELD score, preoperative PT, and platelet count. Diabetes mellitus, ascites, hepatic encephalopathy and MELD score were lower in the group with complete recovery of gastrointestinal function than in the group with delayed recovery of gastrointestinal function; the number of hepatocellular carcinoma cases, platelet count and serum sodium (mmol.L^{-1}) levels were higher in the group with complete recovery of gastrointestinal function than in the group with delayed recovery of gastrointestinal function (Table II).

Comparison of intraoperative data between the two groups

The comparison of intraoperative data between the two groups revealed statistically significant differences ($p < 0.05$): intraoperative bleeding volume, rehydration volume, intrahepatic portal blockage time and duration of surgery. Intraoperative rehydration volume, duration of surgery, intrahepatic portal blockage time (min) and intraoperative bleeding volume (mL) were lower in the group with complete recovery of gastrointestinal function than in the group with delayed recovery of gastrointestinal function (Table III).

Regression analysis of suspected factors affecting the time taken for the complete recovery of gastrointestinal function

Whether gastrointestinal function was fully recovered (> 7 days = 1, ≤ 7 days = 0) was used as the dependent variable and hepatic encephalopathy, platelet count, ascites volume, MELD score, intraoperative bleeding volume, intraoperative rehydration volume and duration of surgery were the independent variables, and the partial maximum likelihood estimation backward method (introduction of discriminant criterion $p \leq 0.05$ and exclusion criterion $p \geq 0.10$) was chosen to include and exclude these factors to construct a logistic regression analysis model. The results of the regression analysis removed hepatic encephalopathy, platelet count, ascites volume, intraoperative fluid volume, length of surgery and diabetes mellitus from the inclusion and exclusion process, indicating that these variables were not associated with the recovery of gastrointestinal function when other influencing factors were excluded. Factors influencing the delayed recovery of gastrointestinal function that were not removed, such as independent risk factors for hepatic portal blockage time, ascites volume, MELD score and intraoperative bleeding, are shown in table IV.

DISCUSSION

In this study, we found that an increase in MELD score, ascites volume, intraoperative bleeding and hepatic portal blockage time were preoperative and intraoperative risk factors for the delayed recovery of gastrointestinal function after liver transplantation. Liver transplantation is one of the most complex types of abdominal surgery and is highly traumatic, with a large amount of intraoperative bleeding and a long operation time. Because of the trauma of surgery and the existence of different degrees of malnutrition before transplantation, patients have certain barriers to the recovery of gastrointestinal function, and these barriers can lead to a longer stay in the ICU and an increased rate of infection, creating a vicious circle. Moreover, the surgical operation causes the activation of macrophages in the muscular layer, releasing nitric oxide, cytokines, defensins, prostaglandins and other substances (11). Simultaneously, because intraoperative stimulation increases the permeability of the mesentery, endogenous bacterial toxins have the opportunity to enter the intestinal wall and stimulate the release of pro-inflammatory cytokines along with inflammatory factors. The latter drives monocytes and neutrophils from the blood circulation into the muscular layer of the gastrointestinal tract, leading to a local inflammatory response, thus causing more inflammatory factors to be released.

In critically ill patients, adaptive reactions occur in the form of a series of neuroendocrine events under stress, such as that caused by surgical trauma, resulting in physiological changes: severe metabolic reactions (such as high catabolism, high energy metabolism and hyperglycaemia); redistribution of blood to maintain blood supply to major vital organs, such as the heart, brain and kidney; ischaemia and hypoxia in the gastrointestinal tract; destruction of the mucosal barrier; and ulcers. The physiological functions of the gastrointestinal tract are also seriously affected. Therefore, the delayed recovery of gastrointestinal function after liver transplantation is common. This delayed recovery is the result of several factors. Tang et al. (12) concluded that gastric dysfunction in patients with cirrhosis is a multifactorial alteration, with an increase in gastrointestinal hormones, such as vasoactive intestinal peptide and ghrelin, and a decrease in gastric motility, leading to a significant decrease in the frequency and rhythm of gastric electrograms and a significant decrease in normal gastric electricity in patients with cirrhosis after meals compared with before meals. Researchers (13) analysed the preprandial and postprandial liver function of patients with Child-Pugh class B and C, determining that their rate of gastric disturbance was significantly higher than that of controls and the frequency and rhythm of gastric disturbance were significantly lower in patients before and after meals; however, the difference was not significant in patients with Child-Pugh class A scores compared with controls. Verne et al. (14) concluded that patients with cirrhosis with autonomic neuropathy are prone to gastrointestinal dysfunction and have a high incidence of delayed gastric emptying. Several studies have demonstrated that small bowel dysfunction is often identified in patients with cirrhosis, with significantly prolonged mouth-cecum transit times and more pronounced small bowel dysfunction with more severe hepatic encephalopathy (15,16). The possible mechanisms of gastrointestinal dysfunction in patients with cirrhosis are the following: 1) a water-electrolyte imbalance and impaired physiological function of the smooth muscle of the gastrointestinal tract; 2) impaired function of the smooth muscle interneurons of the gastrointestinal tract after portal hypertension, leading to long-term gastrointestinal hypoxia and stasis; 3) abnormal inactivation of various gastrointestinal hormones; 4) elevated serum endotoxin levels and nitric oxide concentrations, leading to impaired gastric emptying. Therefore, before liver transplantation, it is important to conduct a thorough assessment of the patient, including medical history, physical condition, comorbidities and liver function. A targeted plan for surgery and postoperative care can be developed through this assessment.

The results of this study revealed that the hepatic portal blockage time, ascites volume, MELD score and intraoperative bleeding volume were independent risk factors associated with the delayed recovery of gastrointestinal function. The preoperative MELD score and ascites volume are indicators that directly or indirectly reflect the preoperative liver function status of patients undergoing liver transplantation. The MELD score reflects the severity of liver disease and predicts short-term mortality. A higher MELD score indicates advanced liver dysfunction, affecting factors such as blood clotting, immune response and metabolic processes. In turn, this compromises the post-transplant recovery of gastrointestinal function due to impaired overall physiological homeostasis. Ascites formation is one of the manifestations of the decompensated stage of cirrhosis. After the formation of hepatic ascites, a large amount of fluid seeps into the abdominal cavity, resulting in blood concentration, reduced effective circulating blood volume, increased blood viscosity and slow blood flow, causing hypotension or shock; simultaneously, the liver blood flow decreases, exacerbating liver ischaemia and hypoxia and exacerbating hepatocyte necrosis. The accumulation of fluid in the abdominal cavity, which is conducive to bacterial growth, especially when laparotomy is performed to release ascites, may cause secondary infection to occur, leading to secondary or primary peritonitis. When the amount of ascites increases in the cirrhotic stage, gastrointestinal stasis is likely to occur, and gastrointestinal dysfunction is likely to occur when gastrointestinal motility is weakened. Studies have demonstrated that the mechanisms underlying gastrointestinal motility disorders in patients with cirrhosis include delayed gastric emptying time, disturbance of the basic electrical rhythm of the gastrointestinal tract, altered gastroduodenal motility, reduced transmission function of the small intestine and disturbance of the intestinal flora (17). In summary, preventing ascitic fluid leakage into the abdominal cavity during liver transplantation has practical implications that include reducing infection risks, maintaining surgical site cleanliness, lowering the incidence of complications, minimising inflammatory responses and improving overall surgical success.

Risk factors for the delayed recovery of gastrointestinal function early after liver transplantation are the amount of intraoperative bleeding and hepatic portal blockage time. This indicates that the intraoperative circulatory status during liver transplantation directly affects the occurrence of delayed gastrointestinal recovery early after surgery. Intraoperative bleeding of > 3,000 mL and a hepatic portal blockage time > 70 min significantly increase the chance of delayed early postoperative gastrointestinal recovery. The large intraoperative bleeding causes haemodynamic instability, which in turn leads to further disturbance of the intravascular coagulation system resulting from massive blood transfusion and fluid replacement, making it more difficult to stop the bleeding; a prolonged hepatic portal blockage prolongs the gastrointestinal stasis time, and the use of high-dose antihypertensive drugs for the rapid correction of hypotension can further aggravate pre-existing gastrointestinal functional impairment. High intraoperative bleeding is mainly associated with a history of upper abdominal surgery, significant abdominal adhesions, portal hypertension, hypersplenism and severe coagulation impairment. Therefore, intraoperative bleeding control and the maintenance of circulatory stability are crucial for preventing the delayed recovery of gastrointestinal function in the early postoperative period. The influence of these factors is contingent upon the patient's holistic health, procedural intricacies and the proficiency of the surgical team. Throughout the preoperative strategising and execution, the healthcare team endeavours to mitigate intraoperative haemorrhaging and fine-tune the duration of hepatic portal vein occlusion, aiming for both procedural efficacy and patient well-being. In the aftermath of the surgery, vigilant observation of the repercussions of these factors on postoperative recuperation and hepatic functionality is imperative. This facilitates the prompt implementation of requisite interventions for optimal patient care.

This study has some limitations. First, this is a single-centre study; it is difficult to ensure consistency at baseline when the cohort is compared in groups, and patients are likely to have other comorbidities that affect prognosis. This results in an association that can be masked between risk factors and the prognosis of gastrointestinal function in patients after liver transplantation. In addition, from a nutritional point of view, we did not include preoperative nutritional status as a predisposing variable, and we expect that future research should focus on prospective studies or multicentre trials to validate our results. Second, the small sample size included in this study caused by the specificity of the disease resulted in low test efficacy and should be followed up with further prospective studies. Third, postoperative patient management differs among patients, which can bias the results if its influence is not eliminated. Finally, when using the MELD scoring system, it is difficult to thoroughly assess the clinical condition of patients; thus, some aspects related to clinical status are not included. Moreover, the MELD scores overlap, leading to deviations between the real clinical status of patients and the scoring results.

In summary, the preoperative MELD score, ascites volume, intraoperative bleeding volume and hepatic portal blockage time are the main risk factors for the delayed recovery of gastrointestinal function early after liver transplantation. If preoperative liver function is improved sufficiently, intraoperative bleeding minimised and haemodynamic stability maintained, the occurrence of delayed gastrointestinal recovery early after liver transplantation may be effectively reduced.

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Table I. Grouping and coding of influencing factors

Doubtful influence factor	**Grouping**	**Coding**
Preoperative PT ≥ 15 s	Yes	1
	No	0
Abdominal water volume ≥ 1000 mL	Yes	1
	No	0
Hepatic encephalopathy	Yes	1
	No	0
MELD score ≥ 15 points	Yes	1
	No	0
Intraoperative blood loss ≥ 3000 mL	Yes	1
	No	0
Operation duration ≥ 9 h	Yes	1
	No	0
Hilar occlusion time ≥ 70 min	Yes	1
	No	0
Intraoperative fluid supply ≥ 8000 mL	Yes	1
	No	0

PT: prothrombin time; MELD: model for end-stage liver disease.

Table II. Comparison of preoperative data between the group with complete recovery of gastrointestinal function and the group with delayed recovery of gastrointestinal function

Baseline information	**≤ 7 days group** ***n* = 142**	**> 7 days group** ***n* = 112**	**Statistic**	***p*-value**
Gender (male/female)	105/37	73/39	χ^2 = 2.294	0.130
Basic lung diseases	11 cases	17 cases	χ^2 = 3.526	0.060
Age	44.25 ± 12.15	46.23 ± 10.43	t = 1.371	0.172
Height (cm)	159.32 ± 8.89	159.81 ± 11.94	t = 1.122	0.305
Body mass index	19.52 ± 7.63	20.32 ± 8.75	t = 0.778	0.440
Serum albumin (g/L)	34.23 ± 12.15	31.67 ± 15.31	t = 1.489	0.139
Systolic blood pressure (mmHg)	123.25 ± 9.57	124.42 ± 9.99	t = 1.076	0.283
Diastolic blood pressure (mmHg)	73.45 ± 7.53	72.4 ± 8.31	t = 1.187	0.236
Abdominal circumference (cm)	86.5 ± 10.17	87.43 ± 10.55	t = 0.803	0.423
Diabetes	17 cases	25 cases	χ^2 = 4.879	0.027
Ascites volume ≥ 1000 mL	15 cases	43 cases	χ^2 = 5.662	0.016
Hepatic encephalopathy	5 cases	16 cases	χ^2 = 8.420	0.004

Liver cancer	77 cases	39 cases	$\chi^2 = 9.853$	0.002
Platelet count	109.46 ± 25.01	93.24 ± 16.26	t = 4.447	< 0.001
Serum sodium (mmol/L)	131.35 ± 12.51	128.65 ± 20.33	t = 2.214	0.023
Preoperative PT	13.98 ± 6.02	18.23 ± 4.71	t = 6.135	< 0.001
MELD score	12.83 ± 2.16	18.79 ± 2.78	t = 19.211	< 0.001

Table III. Comparison of intraoperative data between the group with complete recovery of gastrointestinal function and the group with delayed recovery of gastrointestinal function

Baseline information	**≤ 7 days group *n* = 142**	**> 7 days group *n* = 112**	**Statistic**	***p*-value**
Intraoperative fluid Replacement volume (mL)	7531.27 ± 1291.31	8025.98 ± 1322.47	t = 2.322	0.021
Surgical duration (hours)	7.58 ± 0.84	8.11 ± 0.56	t = 5.636	< 0.001
Hepatic hilar occlusion time (minutes)	68.48 ± 11.21	74.79 ± 12.67	t = 4.198	< 0.001
Intraoperative bleeding volume (mL)	2896.55 ± 1243.20	4086.31 ± 1300.19	t = 7.332	< 0.001

PT: prothrombin time; MELD: model for end-stage liver disease.

Table IV. Regression analysis of factors affecting the time taken for the complete recovery of gastrointestinal function

Influence factor	**B**	**S.E**	**Wald**	***p*-value**	**OR**	**OR (95 % CI)**
Ascites volume	1.323	0.701	3.561	0.043	3.753	2.019-4.160
MELD score	1.712	0.526	10.593	0.000	5.541	3.880-5.700
Intraoperative bleeding volume	0.849	0.433	3.854	0.012	2.339	1.913-2.560
Hepatic hilar occlusion time (minutes)	1.418	0.615	5.316	0.024	4.130	3.430-4.542

MELD: model for end-stage liver disease.