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Surgical Treatment Strategies for Cirrhosis and Its Complications

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Abstract: Cirrhosis is a complex chronic liver disease resulting in severe structural and functional damage to the liver, which is often accompanied by complications such as portal hypertension, ascites, spontaneous bacterial peritonitis, hepatic encephalopathy, hepatorenal syndrome and hepatocellular carcinoma. Surgical treatments play a key role in the treatment of these complications and include liver transplantation, splenectomy, transjugular intrahepatic portosystemic shunt (TIPS) and ascites drainage. Each treatment has its own indications and risks, and an individualized plan needs to be developed based on the patient's overall status and specific condition. The challenges for surgical treatment include surgery-related complications, postoperative liver failure, and long-term complications. Treatment effect and patient survival can be effectively improved through accurate preoperative evaluation, intraoperative monitoring, and postoperative management. In-depth study and optimization of surgical treatment strategies are essential to improve the prognosis of patients with cirrhosis.

Keywords: Cirrhosis; Complications; Surgical Treatment.

1. Introduction

Cirrhosis is a severe abnormality of liver structure and function due to fibrosis and nodule formation in the liver caused by chronic injury. Its major pathophysiologic changes include extensive necrosis of hepatocytes, hyperplasia of connective tissue, destruction of hepatic lobular structure and formation of regenerative nodules. These changes not only cause the liver to lose its normal function, but also lead to a series of complex complications, such as portal hypertension, hepatic encephalopathy, and hepatocellular carcinoma. Common causes of cirrhosis include viral hepatitis, alcoholic liver disease due to chronic alcohol abuse, and non-alcoholic fatty liver disease, which has been on the rise in recent years. The common feature of these causes is persistent liver damage and chronic inflammation, which eventually leads to cirrhosis. Cirrhosis is a severe chronic liver disease with a complex pathophysiologic process and many complications. Surgical treatment plays an important role in the management of cirrhosis, but there are many challenges. In-depth study on the pathogenesis and treatment strategies of cirrhosis is of great significance in improving the prognosis of patients with cirrhosis.

2. Main Complications of Cirrhosis

2.1. Portal Hypertension

Portal hypertension, one of the most common and serious complications of cirrhosis, it is elevated pressure in the portal venous system, usually caused by increased intrahepatic resistance. The mechanism of its occurrence is mainly related to hepatic fibrosis, nodular regeneration, and vascular structural abnormalities, resulting in obstruction of portal blood flow. Portal hypertension triggers a series of complications, including esophagogastric fundal varices, splenomegaly, hypersplenism, and ascites. Among them, rupture, and hemorrhage of the esophagogastric varices is the most fatal complication, with a high recurrence rate and a high mortality rate. In addition, portal hypertension can aggravate hepatic failure and hepatic encephalopathy by affecting hepatic hemodynamics. Therefore, the treatment of portal hypertension is crucial to the prognosis of cirrhotic patients.

2.2. Ascites and Spontaneous Bacterial Peritonitis

Cirrhosis is a common chronic liver disease that may lead to various complications as the disease progresses, among which spontaneous bacterial peritonitis (SBP) is one of the most serious and common complications. SBP is a symptom of acute peritonitis caused by bacterial infection of the intra-abdominal fluid accumulation in the absence of obvious intra-abdominal sources of infection. Usually, SBP is caused by portal hypertension and hepatic decompensation, which leads to impaired immune function in cirrhotic patients, and intestinal bacteria enter the abdominal cavity through the intestinal wall. Patients often have fever, abdominal pain, abdominal distension, and even unconsciousness[1]. The occurrence of SBP is closely associated with a high morbidity and mortality rate, so early diagnosis and prompt treatment are particularly important. Treatment usually consists of broad-spectrum antibiotics and, in some cases, prophylactic antibiotics to minimize the risk of recurrence. In patients with cirrhosis, regular monitoring of the peritoneal fluid is a key measure in the prevention of SBP.

2.3. Hepatic Encephalopathy

Hepatic encephalopathy (HE) is one of the major complications of cirrhosis and the dysfunction of the central nervous system due to severe impairment of liver function. Liver function deterioration prevents toxic substances (especially ammonia) from being effectively excreted from the body, and then enters the brain through blood circulation, resulting in neurotoxic effects. The clinical manifestations of hepatic encephalopathy are diverse, ranging from mild cognitive dysfunction and behavioral abnormalities to severe confusion and coma, and even life-threatening. Common triggers include infections, gastrointestinal bleeding,

electrolyte disturbances, and the use of sedative medications. The diagnosis of HE is usually based on clinical presentation and the exclusion of other causes of abnormal brain function. Treatment strategies include reducing ammonia production and absorption, such as oral lactulose and antibiotics, and aggressive treatment of triggers. In patients with cirrhosis, recurrent episodes of hepatic encephalopathy are an important marker of deterioration, and in severe cases, liver transplantation may be required as a radical treatment.

2.4. Hepatorenal Syndrome

Hepatorenal syndrome (HRS) is one of the serious complications of cirrhosis and usually occurs in patients with end-stage liver disease. HRS is a functional renal failure characterized by progressive deterioration of renal function in the presence of severe hepatic impairment without significant structural damage to the kidneys themselves. The pathological mechanism of HRS is complex and is mainly related to systemic hemodynamic changes induced by cirrhosis, endothelin, and abnormal activation of the renin-angiotensin system. According to the progression of the disease, HRS is divided into two types: acute type (HRS-1), characterized by rapid deterioration of renal function, which often develops within a few days; and chronic type (HRS-2), which is slower but still has a poor prognosis. Clinical manifestations include oliguria, anuria, and hyponatremia. Treatment of HRS consists primarily of improving liver function, vasodilator use, and possibly liver transplantation. Due to the high morbidity and mortality rate of HRS, early diagnosis and intervention are essential to improve the prognosis[2].

2.5. Hepatocellular Carcinoma

Hepatocellular carcinoma (HCC) is one of the most serious complications of cirrhosis and a common type of primary liver cancer worldwide. Cirrhosis is one of the most significant risk factors for HCC, resulting in mutation of hepatocytes and formation of malignant tumors due to prolonged chronic inflammation, fibrosis, and continuous regeneration of hepatocytes. The development of HCC is usually insidious, with no obvious symptoms in the early stages, and is often detected during regular screening of patients with cirrhosis. As the disease progresses, patients may experience weight loss, loss of appetite, right upper abdominal pain, and worsening jaundice and ascites, etc. Diagnosis of HCC relies on imaging tests and the detection of tumor markers such as alpha-fetoprotein. Treatment options include surgical resection, local ablation, transarterial chemoembolization (TACE), targeted drug therapy, and immunotherapy. For advanced HCC that is inoperable, liver transplantation is the only possible radical treatment. Due to the high recurrence rate and aggressiveness of HCC, regular surveillance and early intervention are crucial for patients with cirrhosis.

3. Indications and Contraindications for Surgical Treatment of Cirrhosis

3.1. Surgical Risk Assessment in Patients with Cirrhosis

Surgical risk assessment in cirrhotic patients is a critical step in deciding the surgical treatment plan. Due to the impaired liver function, abnormal coagulation function and portal hypertension in cirrhotic patients, they face a higher risk of complications during surgery. Therefore, a thorough preoperative evaluation is critical to the success of the surgery and the patient's prognosis. The evaluation usually includes assessment of liver function (e.g., Child-Pugh score or MELD score), portal pressure level, nutritional status, and cardiopulmonary function, etc. The Child-Pugh score can help predict the risk of surgery by initially grading the severity of cirrhosis, whereas the MELD score evaluates the patient's short-term risk of death after surgery by calculating the relevant indicators of liver function. In addition, comorbidities such as renal insufficiency, infection and severe anemia can increase the difficulty and risk of surgery. Based on the assessment results, the surgeon can decide whether to proceed with the surgery, choose the appropriate timing and mode of surgery, or adopt alternative therapies to reduce the risk of surgery.

3.2. Liver Transplantation as a Fundamental Treatment

Liver transplantation is the fundamental treatment for end-stage cirrhosis, and is applicable to cases of liver failure and liver cancer that cannot be cured by other methods [3]. Indications include: severe liver dysfunction (e.g. Child-Pugh score grade C), hepatocellular carcinoma but eligible for expanded indications, acute liver failure, chronic active hepatitis, and so on. However, liver transplantation is not indicated for all patients. Contraindications include severe cardiopulmonary insufficiency, active malignancy (except hepatocellular carcinoma), severe infections or comorbidities, and patients with cirrhosis of non-hepatic origin (e.g., drug-induced cirrhosis). Comprehensive preoperative evaluation and postoperative anti-rejection therapy are crucial to ensure the success of liver transplantation. Liver transplantation not only significantly improves the quality of patient's survival, but also significantly prolongs survival and brings new life to many patients with advanced cirrhosis.

3.3. Indications for Non-liver Transplantation: Splenectomy, Transjugular Intrahepatic Portosystemic Shunt (TIPS), Ascites Drainage, Etc.

Non-liver transplantation plays an important role in the surgical treatment of cirrhosis, mainly including splenectomy, transjugular intrahepatic portosystemic shunt (TIPS) and ascites drainage. Splenectomy is indicated for severe thrombocytopenia due to hypersplenism to improve blood parameters and relieve symptoms, but is not suitable for all patients and the risk of complications after splenectomy needs to be evaluated. TIPS is used to alleviate portal hypertension, especially when medical treatment is ineffective, and to reduce the risk of bleeding from esophagogastric fundal varices by establishing a portal vein shunt[4]. However, TIPS may cause complications such as hepatic encephalopathy and therefore needs to be chosen with caution. Ascites drainage is used to manage recalcitrant ascites and to reduce abdominal pressure and associated symptoms by draining the abdominal cavity through a peritoneal puncture. This procedure is indicated for patients with ascites who fail to respond to medication, but the risk of infection and bleeding need to be noted. Non-liver transplantation is not as fundamental as liver transplantation, but it is important in relieving symptoms and improving quality of life.

3.4. Contraindications to Surgery and Risk Management

Surgery in patients with cirrhosis has certain contraindications and risk management requirements. Contraindications include severe hepatic failure (e.g., Child-Pugh score grade C), combined severe cardiopulmonary insufficiency, active extrahepatic malignancy, uncontrollable infections, and other severe systemic diseases. As cirrhotic patients have reduced liver function and abnormal coagulation, complications such as bleeding and infection are likely to occur during surgery. Risk management includes comprehensive preoperative evaluation to ensure relatively stable liver function, as well as adequate preoperative preparation, such as correction of coagulation abnormalities and infection control. In addition, close postoperative monitoring of complications, such as hepatic encephalopathy, ascites, and infections, and timely management are critical to ensure the safety and success of the procedure. Comprehensive consideration of the patient's overall condition and individualized surgical plan can effectively reduce the risk and improve the treatment effect.

4. Surgical Treatment Strategies for Liver Cirrhosis and Complications

4.1. Surgical Intervention for Portal Hypertension

Portal hypertension is a common complication of cirrhosis, and surgical interventions usually include splenectomy, transjugular intrahepatic portosystemic shunt (TIPS) and partial hepatectomy. Splenectomy is used to ameliorate thrombocytopenia and leukopenia due to hypersplenism, but the risk of postoperative infection and splenectomy-related complications need to be evaluated. TIPS reduces portal pressure by creating a shunt between the portal vein and hepatic vein within the liver, relieving bleeding from esophagogastric fundal varices and ascites, but may cause complications such as hepatic encephalopathy[5]. Partial hepatectomy is indicated in cirrhosis with limited hepatic tumors to reduce portal pressure by reducing liver volume, but residual liver function needs to be assessed. All interventions need to be decided carefully after a comprehensive assessment of the patient's liver function, systemic status, and risk of complications to optimize effect and safety.

4.2. Application of Splenectomy

Splenectomy is mainly used in the treatment of cirrhosis to alleviate complications caused by hypersplenism. Patients with cirrhosis often suffer from splenomegaly due to portal hypertension, which in turn triggers thrombocytopenia (hypersplenism) and the associated risk of bleeding. Splenectomy is effective in improving blood parameters and reducing spleen-related symptoms such as abdominal pain and the risk of splenic rupture due to splenomegaly. However, splenectomy also carries certain risks, including postoperative infections (especially bacterial infections), bleeding and thrombosis. Therefore, when deciding to perform splenectomy, the patient's general condition, liver function, severity of hypersplenism and potential complications need to be comprehensively evaluated. Postoperative infection and bleeding need to be closely monitored with necessary antibiotic prophylaxis and supportive therapy. Splenectomy can significantly improve the quality of life of patients with cirrhosis, but its risks and benefits must be weighed and an individualized treatment plan developed.

4.3. Surgical Strategies for the Treatment of Ascites

Ascites is a common complication in patients with cirrhosis, and surgical treatment strategies mainly include peritoneal puncture drainage and abdominal shunt. Peritoneal puncture drainage is a common approach for recalcitrant ascites, which is used to remove excess fluid and relieve symptoms such as abdominal distension and dyspnea through abdominal puncture. Although this method provides rapid symptomatic relief, it is important to be aware of the possible risks of infection, bleeding, and damage to intra-abdominal organs. Peritoneal shunts (e.g., TIPS) reduce portal vein pressure by creating a shunt between the portal and hepatic veins, which in turn reduces the formation of ascites. Peritoneal shunts are indicated in cases where medications and drainage by peritoneal puncture are ineffective, but may lead to complications such as hepatic encephalopathy. Therefore, when choosing a surgical treatment strategy for ascites, the patient's general health status, severity of ascites, and possible risks need to be considered, and an individualized treatment plan should be developed to optimize efficacy.

4.4. Surgical Management of Hepatic Encephalopathy

Hepatic encephalopathy is a serious complication of cirrhosis, mainly manifested by cognitive impairment, confusion, and behavioral abnormalities, for which surgical treatment strategies are relatively limited. Common surgical treatments include transjugular intrahepatic portosystemic shunt (TIPS) and liver transplantation. TIPS reduces portal pressure by creating a shunt between the portal vein and the hepatic vein, thereby reducing the abnormal distribution of hepatic blood flow, and alleviating the symptoms of hepatic encephalopathy. However, TIPS may lead to exacerbation of hepatic encephalopathy and other complications, and therefore needs to be performed with caution after full assessment of the patient's condition. Liver transplantation, on the other hand, is a radical measure to eradicate hepatic encephalopathy. By replacing the diseased liver and restoring normal liver function, the symptoms of hepatic encephalopathy can be significantly improved or reversed. Although liver transplantation can provide long-term improvement, the indications for surgery are strict, and long-term immunosuppressive therapy is required after surgery, which carries a high risk. Therefore, the choice of surgical treatment for hepatic encephalopathy needs to be weighed against the risks and benefits, and an individualized treatment plan should be developed.

4.5. Surgical Treatment of Hepatocellular Carcinoma

Surgical treatment of hepatocellular carcinoma (HCC) mainly includes hepatectomy and liver transplantation. Hepatic resection is indicated for patients with early-stage hepatocellular carcinoma and relatively normal liver function, aiming to eradicate the disease by removing the cancerous part of the liver. Conditions that make it suitable for surgery include having a confined tumor that meets liver function criteria (e.g., Child-Pugh score A or B) and no distant metastases. Although hepatectomy has a high cure rate, liver

insufficiency and risk of recurrence may occur after surgery. Liver transplantation, on the other hand, is a radical treatment that completely cures hepatocellular carcinoma by replacing the diseased liver, and is indicated for patients who meet the criteria for liver transplantation, such as having confined tumors and meeting the Milan criteria (i.e., tumors that are individually less than 5 centimeters or not more than three in multiples and all less than 3 centimeters in diameter). Although liver transplantation offers the possibility of long-term survival, the risk of postoperative immunosuppression and the challenge of obtaining a suitable donor need to be considered. Therefore, surgical management of hepatocellular carcinoma requires comprehensive evaluation and decision-making based on the patient's specific disease, liver function status, and postoperative management.

5. Complications and Treatment of Surgical Treatment

5.1. Surgery-related Complications

Surgical treatment of patients with cirrhosis may result in various surgery-related complications. Common complications include bleeding, infection, hepatic encephalopathy, and postoperative hepatic insufficiency. Decreased liver function and coagulation abnormalities in patients with cirrhosis predispose them to intraoperative and postoperative bleeding, especially during major surgery or liver resection. In addition, there is an increased risk of postoperative infections, especially intra-abdominal infections, and postoperative wound infections. Hepatic encephalopathy may be exacerbated by surgery-induced stress or medication side effects, manifesting as blurred consciousness and cognitive decline. Postoperative hepatic insufficiency is also an important complication that may be caused by intraoperative hemodynamic changes or liver tissue injury. Effective risk management includes comprehensive preoperative evaluation, strict intraoperative monitoring, and close postoperative observation[6]. Symptomatic management, such as medication adjustment, anti-infective therapy, and supportive care, should be administered when necessary to minimize the complication rate and improve patient prognosis.

5.2. Prevention of Postoperative Liver Failure

Postoperative liver failure is one of the serious complications of surgical treatment for patients with cirrhosis, and its prevention is crucial. First, preoperative evaluation is the key, detailed examination of liver function, coagulation function and other related indexes are needed to assess the patient's liver tolerance ability. Intraoperatively, the use of minimally invasive techniques and reduction of liver trauma can reduce the risk of liver failure. Postoperatively, liver function indicators, such as liver enzymes, bilirubin, and coagulation function, should be closely monitored to detect abnormalities in time. Maintaining a good hemodynamic status and preventing hypotension and hepatic ischemia are important measures to prevent liver failure. In addition, hepatoprotective drugs should be used moderately in the postoperative period to avoid hepatotoxic drugs. Providing adequate nutritional support and performing appropriate fluid management can help liver recovery. Through these measures, the incidence of postoperative hepatic failure can be effectively reduced, and the postoperative recovery and overall prognosis of patients can be improved.

5.3. Long-Term Complications

Long-term complications after surgical treatment of cirrhosis include liver failure, infection, hepatic encephalopathy, and liver recurrence. Liver failure may occur as a result of progressive postoperative liver loss or progression of pre-existing cirrhosis, requiring long-term monitoring of liver function and appropriate intervention. The risk of infection is chronic, especially in liver transplant recipients on immunosuppressive therapy, and requires regular checkups and infection prevention. Hepatic encephalopathy may also be a long-term problem for patients, manifesting as cognitive deficits and behavioral changes that need to be managed with medication modification and lifestyle management. The issue of hepatic recurrence is particularly important for patients with hepatocellular carcinoma, in whom the liver may reoccur with tumors after surgery, and regular imaging and assessment of liver function are key. In addition, patients may face other complications associated with cirrhosis, such as portal hypertension and ascites, which require ongoing monitoring and management. Comprehensive treatment of these long-term complications can effectively improve patients' quality of life and long-term prognosis through multidisciplinary teamwork and individualized treatment plans.

6. Conclusion

Surgical treatment strategies for cirrhosis and its complications play a key role in improving patient survival and quality of life. Patients with cirrhosis face various complex complications, including portal hypertension, ascites, hepatic encephalopathy, and hepatocellular carcinoma. Effective treatment strategies include liver transplantation, splenectomy, transjugular intrahepatic portosystemic shunt (TIPS), and ascites drainage, these strategies have shown positive results in relieving symptoms and improving prognosis. However, surgical treatment is also accompanied by certain risks and complications, such as postoperative liver failure, infection, and long-term liver failure. In order to optimize treatment effect, comprehensive preoperative evaluation, meticulous intraoperative management, and close postoperative monitoring are necessary. Individualized treatment plans and multidisciplinary collaboration can effectively treat these complications and improve the prognosis of patients.

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