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Contents

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MINIREVIEWS

- 1559 Impact of tumour rupture risk on the oncological rationale for the surgical treatment choice of gastrointestinal stromal tumours
Peparini N
- 1564 Prevention and treatment of hepatic encephalopathy during the perioperative period of transjugular intrahepatic portosystemic shunt
Wang LJ, Yao X, Qi Q, Qin JP
- 1574 Vascular complications of chronic pancreatitis and its management
Walia D, Saraya A, Gunjan D
- 1591 Historical changes in surgical strategy and complication management for hepatic cystic echinococcosis
A JD, Chai JP, Jia SL, A XR

ORIGINAL ARTICLE

Basic Study

- 1600 High spindle and kinetochore-associated complex subunit-3 expression predicts poor prognosis and correlates with adverse immune infiltration in hepatocellular carcinoma
Zheng LL, Wang YR, Liu ZR, Wang ZH, Tao CC, Xiao YG, Zhang K, Wu AK, Li HY, Wu JX, Xiao T, Rong WQ

Case Control Study

- 1615 Post-transplant biliary complications using liver grafts from deceased donors older than 70 years: Retrospective case-control study
Jimenez-Romero C, Justo-Alonso I, del Pozo-Elso P, Marcacuzco-Quinto A, Martín-Arriscado-Arroba C, Manrique-Municio A, Calvo-Pulido J, García-Sesma A, San Román R, Caso-Maestro O
- 1629 Goldilocks principle of minimally invasive surgery for gastric subepithelial tumors
Chang WJ, Tsao LC, Yen HH, Yang CW, Chang HC, Kor CT, Wu SC, Lin KH

Retrospective Cohort Study

- 1641 Prognosis after splenectomy plus pericardial devascularization *vs* transjugular intrahepatic portosystemic shunt for esophagogastric variceal bleeding
Qi WL, Wen J, Wen TF, Peng W, Zhang XY, Shen JY, Li X, Li C
- 1652 Initial suction drainage decreases severe postoperative complications after pancreatic trauma: A cohort study
Li KW, Wang K, Hu YP, Yang C, Deng YX, Wang XY, Liu YX, Li WQ, Ding WW

Retrospective Study

- 1663** Radiation therapy prior to a pancreaticoduodenectomy for adenocarcinoma is associated with longer operative times and higher blood loss
Aploks K, Kim M, Stroeve S, Ostapenko A, Sim YB, Sooriyakumar A, Rahimi-Ardabili A, Seshadri R, Dong XD
- 1673** Prognostic significance of preoperative lymphocyte to monocyte ratio in patients with signet ring gastric cancer
Liu HL, Feng X, Tang MM, Zhou HY, Peng H, Ge J, Liu T
- 1684** Clinical efficacy of total laparoscopic splenectomy for portal hypertension and its influence on hepatic hemodynamics and liver function
Qi RZ, Li ZW, Chang ZY, Chang WH, Zhao WL, Pang C, Zhang Y, Hu XL, Liang F
- 1693** Accurate resection of hilar cholangiocarcinoma using eOrganmap 3D reconstruction and full quantization technique
Cui DP, Fan S, Guo YX, Zhao QW, Qiao YX, Fei JD
- 1703** Regional differences in islet amyloid deposition in the residual pancreas with new-onset diabetes secondary to pancreatic ductal adenocarcinoma
Wang R, Liu Y, Liang Y, Zhou L, Chen MJ, Liu XB, Tan CL, Chen YH
- 1712** Risk factors and their interactive effects on severe acute pancreatitis complicated with acute gastrointestinal injury
Chen JH, Zhang MF, Du WC, Zhang YA
- 1719** Effects of ultrasound monitoring of gastric residual volume on feeding complications, caloric intake and prognosis of patients with severe mechanical ventilation
Xu XY, Xue HP, Yuan MJ, Jin YR, Huang CX
- 1728** Enhanced recovery nursing and mental health education on postoperative recovery and mental health of laparoscopic liver resection
Li DX, Ye W, Yang YL, Zhang L, Qian XJ, Jiang PH
- 1739** Changing trends in gastric and colorectal cancer among surgical patients over 85 years old: A multicenter retrospective study, 2001–2021
Chen K, Li M, Xu R, Zheng PP, Chen MD, Zhu L, Wang WB, Wang ZG

Observational Study

- 1751** Knowledge, attitude, and practice of monitoring early gastric cancer after endoscopic submucosal dissection
Yang XY, Wang C, Hong YP, Zhu TT, Qian LJ, Hu YB, Teng LH, Ding J
- 1761** Anti-reflux effects of a novel esophagogastric asymmetric anastomosis technique after laparoscopic proximal gastrectomy
Pang LQ, Zhang J, Shi F, Pang C, Zhang CW, Liu YL, Zhao Y, Qian Y, Li XW, Kong D, Wu SN, Zhou JF, Xie CX, Chen S
- 1774** Prognostic scores in primary biliary cholangitis patients with advanced disease
Feng J, Xu JM, Fu HY, Xie N, Bao WM, Tang YM

SYSTEMATIC REVIEWS

- 1784** Maternal choledochal cysts in pregnancy: A systematic review of case reports and case series
Augustin G, Romic I, Miličić I, Mikuš M, Herman M
- 1799** Intraoperative pancreas stump perfusion assessment during pancreaticoduodenectomy: A systematic scoping review
Robertson FP, Spiers HVM, Lim WB, Loveday B, Roberts K, Pandanaboyana S
- 1808** Comparison between upfront surgery and neoadjuvant chemotherapy in patients with locally advanced gastric cancer: A systematic review
Fiflis S, Papakonstantinou M, Giakoustidis A, Christodoulidis G, Louri E, Papadopoulos VN, Giakoustidis D

CASE REPORT

- 1819** Long-term survival of patients with hepatocellular carcinoma with hepatic, pulmonary, peritoneal and rare colon metastasis: A case report
Gong YQ, Lu TL, Chen CW
- 1825** Donor hepatic artery reconstruction based on human embryology: A case report
Zhang HZ, Lu JH, Shi ZY, Guo YR, Shao WH, Meng FX, Zhang R, Zhang AH, Xu J
- 1831** Outpatient hybrid endoscopic submucosal dissection with SOUTEN for early gastric cancer, followed by endoscopic suturing of the mucosal defect: A case report
Ito R, Miwa K, Matano Y

LETTER TO THE EDITOR

- 1838** Is endoscopic mucosal resection-precutting superior to conventional methods for removing sessile colorectal polyps?
Yang QY, Zhao Q, Hu JW

ABOUT COVER

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The primary aim of *World Journal of Gastrointestinal Surgery* (WJGS, *World J Gastrointest Surg*) is to provide scholars and readers from various fields of gastrointestinal surgery with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJGS mainly publishes articles reporting research results and findings obtained in the field of gastrointestinal surgery and covering a wide range of topics including biliary tract surgical procedures, biliopancreatic diversion, colectomy, esophagectomy, esophagostomy, pancreas transplantation, and pancreatectomy, etc.

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Prevention and treatment of hepatic encephalopathy during the perioperative period of transjugular intrahepatic portosystemic shunt

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Abstract

Transjugular intrahepatic portosystemic shunt (TIPS) is an established procedure for treating the complications of portal hypertension in liver cirrhosis. While the pathogenesis of postoperative TIPS-related hepatic encephalopathy (HE) has yet to be fully understood, intraoperative portosystemic shunts may provide a pathological basis for the occurrence of postoperative HE in patients with liver cirrhosis. Studies at home and abroad have expressed mixed opinions about TIPS-related HE. This study presents a literature review on the risk factors for and prevention and treatment of perioperative TIPS-related HE in patients with liver cirrhosis, aiming to optimize the procedure and reduce the incidence of postoperative HE.

Key Words: Portosystemic shunt; Transjugular intrahepatic; Hepatic encephalopathy; Liver cirrhosis; Hypertension; Portal; Therapeutics

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Core tip: Transjugular intrahepatic portosystemic shunt (TIPS) is a minimally invasive interventional procedure used to treat the complications of portal hypertension in patients with liver cirrhosis of different origins. As the exact pathogenesis of postoperative TIPS-related hepatic encephalopathy (HE) remains unclear, domestic and foreign studies have expressed mixed opinions about TIPS-related HE. This study provides a literature review on the risk factors for and the prevention and treatment of perioperative TIPS-related HE.

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INTRODUCTION

Transjugular intrahepatic portosystemic shunt (TIPS) is a minimally invasive interventional procedure for treating the complications of portal hypertension in liver cirrhosis of various origins. By creating a shunt between the hepatic and portal veins, TIPS is widely used in clinical settings to alleviate variceal bleeding, refractory pleural effusion and ascites, and other complications associated with portal hypertension[1-3]. Hepatic encephalopathy (HE), one of the most common postoperative TIPS-related complications[4], often occurs within the first 1-3 mo after the procedure[5]. With an incidence rate of 25%-50%[6-9], HE has a profound impact on the prognosis and quality of life of patients with liver cirrhosis[10]. According to the "2021 North American Practice-Based Recommendations for Trans-jugular Intrahepatic Portosystemic Shunts in Portal Hypertension"[3], intraoperative embolization of spontaneous portosystemic shunts and the narrowing of the stent diameter may reduce the risk of postoperative TIPS-related HE. The 2019 Clinical Practice Guidelines: Management of TIPS for Portal Hypertension by the Chinese College of Interventionalists (CCI)[11] recommend using stents particularly designed for TIPS to create a shunt from the left branch of the portal vein to reduce the risk of postoperative TIPS-related HE. "The 2023 French Recommendations for the Diagnosis and Management of Hepatic Encephalopathy"[12] viewed that the postoperative use of rifaximin can prevent postoperative TIPS-related HE. Although these recommendations have reached some levels of consensus, some have been debated. This study reviewed the risk factors for and the prevention and treatment of perioperative TIPS-related HE, thereby providing a reference to optimize TIPS and minimize the risk of postoperative HE.

DEFINITION AND CLASSIFICATION OF TIPS-RELATED HE

TIPS-related HE refers to a spectrum of central nervous system dysfunctions caused by metabolic disorders following the creation of a shunt between the portal vein and systemic circulation during TIPS after excluding other known brain diseases[13]. The 11th World Congress of Gastroenterology[14] classified HE into three types (A, B and C) based on etiological factors, with type C being the most common form of HE occurring in patients with chronic liver disease or cirrhosis and a portosystemic shunt. The Practice Parameters Committee of the American College of Gastroenterology[15] further graded HE into 0-4 according to the severity of symptoms based on the widely accepted West Haven Criteria. Seeing the difficulty in distinguishing between grades 0 and 1 in the West Haven Criteria, the International Society for HE and Nitrogen Metabolism[16] introduced an alternative grading system, called the spectrum of neurocognitive impairment in cirrhosis, to differentiate covert HE (CHE) from overt HE (OHE) based on the diagnosis of orientation disorders and asterixis. CHE is defined as a neuropsychiatric disorder without orientation disorders or asterixis in patients with liver cirrhosis. The pathogenesis of postoperative TIPS-related HE is not fully understood. Most patients undergoing TIPS due to portal hypertension have varying degrees of liver dysfunction. This undermines the liver's ability to detoxify ammonia produced by the intestines. Toxins enter the central nervous system through the blood-brain barrier, interfering with brain energy metabolism and eventually causing HE. Natural and artificial shunts play an important role in HE development as they allow toxins in the visceral blood to bypass the liver and enter systemic circulation. Moreover, these shunts can reduce liver perfusion and further exacerbate liver dysfunction. Studies[17-19] have revealed the close associations between the diameter of an intraoperative portosystemic shunt and HE incidence. This may explain the occurrence of postoperative HE in patients with portal hypertension[13]. Nevertheless, HE has other contributory causes, such as liver cell dysfunction, natural collateral circulation, increased production of intestinal neurotoxins, and increased blood-brain barrier permeability[20].

RISK FACTORS FOR POSTOPERATIVE TIPS-RELATED HE

Numerous risk factors are closely associated with the development of HE, which should be carefully considered to optimize preoperative patient selection. A meta-analysis[21] has shown that prior HE is one of the key independent predictors of postoperative TIPS-related HE [odds ratio (OR): 3.07, 95% confidence interval (CI): 1.75-5.40]. The 2020 TIPS guidelines jointly developed by the British Society of Gastroenterology, the British Society of Interventional Radiology, and the British Association for the Study of the Liver (BASL)[22] highlighted that TIPS can aggravate or induce HE; thus, patients should undergo preoperative screening for CHE and OHE before nonemergency TIPS. The latest guidelines for preventing and treating HE[12] and the European Association for the Study of the Liver (EASL) guidelines[10] have suggested that a single episode of OHE is not an absolute contraindication for nonemergency TIPS. Most studies[23-26] have not excluded patients with a history of HE or have merely excluded those with a history of recurrent OHE. As a result, the reported incidence of postoperative TIPS-related HE was not higher than the HE incidence following standard modalities, such as endoscopic treatment plus drug therapy and large-volume paracentesis plus albumin infusion. Many

studies[7,27,28] have addressed the relationship between CHE and an increased risk of postoperative TIPS-related HE. However, no preoperative medication (*e.g.*, lactulose or rifaximin) is recommended for patients diagnosed with CHE and scheduled for TIPS. Therefore, the 2021 North American Practice-Based Recommendations[3] considered whether preoperative medication for CHE and cirrhosis can minimize the risk of OHE after TIPS an emerging research interest. A recent study[29] has indicated that HE is not a contraindication for early TIPS for acute variceal bleeding. Several studies [25,30,31] have suggested that early TIPS does not necessarily entail an increased risk of postoperative HE. Therefore, the 2023 French recommendations[12] state that prior HE is not a contraindication for early TIPS.

The severity of liver disease is closely associated with the occurrence of postoperative TIPS-related HE[21,23,32,33]. The aforementioned meta-analysis[21] has suggested that Child–Turcotte–Pugh class C liver function is the most robust independent predictor of postoperative TIPS-related HE (OR: 4.0, 95%CI: 1.4–11.1). A single-center retrospective study [33] has shown that according to the Model for End-Stage Liver Disease scoring system, > 18 is independently associated with the occurrence of postoperative TIPS-related HE (58% *vs* 37%, $P = 0.009$). Advanced age[33,34], elevated creatinine levels[34], and hyponatremia[35,36] have also been reported to be closely related to the occurrence of postoperative TIPS-related HE. Nutritional status is potentially associated with postoperative TIPS-related HE. The BASL[22] has suggested that cachexia is associated with more postoperative TIPS-related HE. In two recent prospective studies[35,36], sarcopenia has been reported to have a strong association with the occurrence of HE. Nardelli *et al*[36] suggested that sarcopenia is independently associated with the development of postoperative TIPS-related HE (subdistribution hazard ratio: 31.3, 95%CI: 4.5–218.07; $P < 0.001$). They reported that the relationship between sarcopenia and HE contributed to decreased ammonia clearance and highlighted the importance of considering sarcopenia during patient selection for TIPS. Two prospective studies by Tapper *et al*[37,38] have demonstrated a close association between the development of OHE and frailty in patients with cirrhosis, as evaluated by the chair stand, grip strength, and walking speed tests. Ney *et al*[39] have found that based on the Montreal Cognitive Assessment (MoCA) and the Clinical Frailty Scale (CFS), the complex MoCA–CFS scoring system has a predictive value for readmission due to HE within 6 mo postoperatively in liver cirrhosis cases without prior HE. These findings show that in patients with liver cirrhosis, frailty is a risk factor for HE. However, no research has discussed the effect of frailty on the occurrence of postoperative TIPS-related HE. Even if patients were carefully selected by considering all aforementioned factors, there is no guarantee that these patients will not have postoperative TIPS-related HE. The 2021 North American Practice-Based Recommendations[3] consider TIPS unsuitable for patients with cognitive impairment and inadequate family or social support because they are at a higher risk of developing HE after the procedure. In nonspecific cases, informing patients and their families that postoperative HE may unavoidably occur and that they should be aware of possible signs and symptoms to identify the condition as early as possible is necessary for the surgeon and attending physician. According to the risk of postoperative TIPS-related HE, the relative contraindications for nonemergency TIPS are shown in Table 1.

EFFECTS OF PORTAL VEIN BRANCHES ON HE

According to the 2019 CCI Clinical Practice Guidelines[11], establishing a shunt from the left portal vein branch can reduce the incidence of postoperative TIPS-related HE. A study[40] has proposed that the reflux from the splenic and superior mesenteric veins reaches the left and right portal vein branches, respectively, before being thoroughly mixed. Specifically, the blood from the superior mesenteric vein mainly goes to the right branch, whereas that from the splenic vein enters the left branch. Therefore, the blood ammonia level in the systemic circulation after puncturing the left portal vein branch is lower than that of the right branch. In another study[41], based on CO₂ venography, an iodinated contrast was used to replace traditional imaging methods to treat patients with chronic liver disease who underwent percutaneous transhepatic puncture of the portal vein and splenic vein catheterization. The study has reported a difference in the imaging of the blood flow in the left and right portal vein branches by injecting 30 mL of the contrast at a rate of 5 mL/s *via* a mechanical injection system. In 2009, a randomized controlled study[42] assigned 72 patients to two groups and found that the incidence rates of HE and newly occurring HE were both lower when the shunt was established from the left portal vein branch than when the shunt was established from the right branch ($P = 0.036$ and 0.012 , respectively). A similar conclusion was reached in a 2014 retrospective study[43]. Based on these findings, some interventional physicians in China now prefer the left portal vein branch when creating a shunt by puncture. However, before the Viatorr stent, particularly designed for TIPS, was released in the Chinese market in October 2015, Fluency covered stents were the most frequently used stents for TIPS. Characterized by strong support and robust axial elastic tension, these stents can malfunction due to occlusion as they are released at a position too low in the hepatic vein, or the portion in the portal vein is too short. With the shunt receiving blood from the main portal vein, whether postoperative HE is associated with the choice of puncture site (at either the left or right portal vein branch) is debatable. Whether there is blood flow into the left and right portal vein branches following the convergence of the splenic and mesenteric blood into the main portal vein in patients with liver-cirrhosis-induced portal hypertension remains controversial[44]. In China, a 2020 study[45] collected data from 120 patients with liver-cirrhosis-induced portal hypertension who underwent TIPS with the Viatorr stent. The study results have shown that in 52 patients, the shunt was created at the left portal vein branch, whereas the remaining 68 patients had a shunt established at the right branch, and the two groups had no significant difference in the incidence of postoperative HE ($\chi^2 = 0.159$, $P = 0.69$). Another domestic study in 2020[46] included 15 patients with hepatitis-B-related cirrhosis and upper gastrointestinal bleeding who underwent TIPS. Blood samples were collected from the left and right branches and the main trunk of the portal vein during the procedure and were found to have similar plasma ammonia levels (left branch: $96.4 \pm 17.6 \mu\text{mol/L}$, right branch: $113.5 \pm 18.4 \mu\text{mol/L}$, main trunk: $106.9 \pm 38.7 \mu\text{mol/L}$; all $P > 0.05$). A recent retrospective cohort study[47] has reported that the incidence of postoperative TIPS-related HE did not

Table 1 Relative contraindications for nonemergency transjugular intrahepatic portosystemic shunt (based on the risk of postoperative-transjugular intrahepatic portosystemic shunt related hepatic encephalopathy)**Relative contraindications for nonemergency transjugular intrahepatic portosystemic shunt**

Prior HE episodes
Serious liver dysfunction (Child-Pugh ≥ 12 or MELD ≥ 18)
Advanced age (> 70 yr)
High creatinine (serum creatinine > 1.1 mg/dL)
Cachexia
Cognitive impairment
Lack of social and family support

HE: Hepatic encephalopathy; MELD: Model for End-Stage Liver Disease.

differ between patients with a shunt created at the left portal vein branch and those with a shunt created at the right branch (13% *vs* 24%) ($P = 0.177$). More multicenter prospective randomized controlled studies are needed to clarify whether the occurrence of postoperative TIPS-related HE is related to the choice of shunting branch.

EFFECTS OF SPONTANEOUS PORTOSYSTEMIC SHUNTS ON HE

As the resistance to the blood flow in the portal vein increases, a compensatory network of blood vessels will take form between the portal vein and systemic circulation to achieve partial diversion of the portal venous flow. As portal hypertension deteriorates, some branches gradually become enlarged, leading to the formation of vascular shunts, termed spontaneous portosystemic shunts (SPSS)[48]. Theoretically, the formation of SPSS and the post-TIPS shunting increase the risk of HE by further diversion of portal blood from the liver. A multicenter study by Laleman *et al*[49] has demonstrated that SPSS occurs in 46%–70% of patients with refractory HE. A large-scale multicenter retrospective study [50] has found that an SPSS with a diameter > 8 mm is associated with an increased risk of OHE and death in patients with liver cirrhosis. Likewise, a recent study[51] has reported that an SPSS with a total cross-sectional area > 83 mm² implies an increased risk of OHE and death in patients with liver cirrhosis. In a comparative analysis of unembolized and embolized SPSS by He *et al*[52], patients with unembolized SPSS are at a higher risk of developing postoperative TIPS-related OHE. In contrast, a meta-analysis[53] has shown that SPSS embolization plus TIPS can reduce the risk of recurrent bleeding compared with TIPS alone, and yet, the two surgical approaches lack significant differences in the incidence of HE. A retrospective study[54] has compared TIPS with and without SPSS embolization and reported no significant difference in the incidence of postoperative TIPS-related HE. The 2021 North American Practice-Based Recommendations [3] has suggested that in patients with refractory pleural effusion and ascites, the embolization of SPSS with a diameter > 6 mm during TIPS can be considered to reduce the risk of postoperative HE. The 2020 TIPS guidelines[22] have recommended the embolization of SPSS when a patient is at a high risk of postoperative TIPS-related HE. However, large-scale, multicenter prospective studies are needed to address whether SPSS should be embolized during TIPS, a much debated question.

EFFECTS OF THE PORTAL VENOUS PRESSURE GRADIENT ON HE AFTER SHUNT PLACEMENT

Studies have shown that a greater decrease in portal venous pressure (PVP) after TIPS is associated with better outcomes and an increased risk of postoperative TIPS-related HE in patients with liver cirrhosis and complications of portal hypertension[55]. At present, it is believed that PVP should be reduced to at least 12 mmHg or 50% of the initial baseline level to effectively prevent or treat the complications of portal hypertension[19]. In contrast, some researchers[56] have argued that a decrease in PVP to below 10 mmHg can significantly increase the incidence of postoperative TIPS-related HE. The 2020 TIPS guidelines[22] have suggested that patients with variceal bleeding are at a higher risk when PVP is reduced to < 12 mmHg and that a safer option is maintaining PVP at 20% below baseline. In the face of refractory ascites and other indications, the PVP level should be managed through individualized assessment of therapeutic effects and the risk of HE. In our recent study[44], a Viatorr stent with 8 mm inner diameter was used for shunting. With all included patients having consistent baseline characteristics, PVP was reduced to 12 mmHg or below 50% of the initial baseline level. The study results have shown that the incidence of HE differed among patients with liver cirrhosis of different origins, with the incidence of postoperative HE in patients with hepatitis-B-related liver cirrhosis lower than in those with alcoholic or primary biliary cirrhosis. It is believed that the development of HE is somehow associated with post-TIPS liver reserve function, which can be explained by subsequent etiological treatment and patient management in addition to perioperative treatment. There is no clear consensus over the treatment protocol for PVP in

TIPS. Therefore, the appropriate PVPG level should be determined based on individual conditions, such as the cause of liver cirrhosis and symptoms of portal hypertension, which proposes a direction for future studies.

EFFECTS OF THE CHOICE OF STENT ON HE

A randomized controlled trial[57] has revealed that using a covered stent for TIPS can significantly reduce the risk of malfunction, despite the negligible benefits for HE development and survival. The aforementioned meta-analysis[9] has shown that compared with bare stents, covered stents can improve stent patency and survival; however, these devices have no obvious advantage for minimizing the risk of HE. In a direct comparison between bare and covered stents[8], the study results have shown a lack of significant difference in the incidence of OHE. Therefore, the 2021 North American Practice-Based Recommendations[3] have considered discussing the difference in the incidence of OHE between bare and covered stents. Despite their history, bare stents are virtually obsolete in TIPS because of low survival rates and limited therapeutic effects.

PVPG plays a significant role in the development of postoperative TIPS-related HE, and according to Poiseuille's law ($r = 8L \times \eta / r^4$), stent diameter is essentially associated with PVPG[19]. Both the North American and British TIPS guidelines[3,22] have proposed that a smaller stent diameter can reduce the risk of HE but has little effect on reducing PVPG. A prospective, nonrandomized controlled study by Schepis *et al*[58] has shown that as far as covered stents are concerned, a smaller diameter (6–7 mm) can significantly reduce the incidence of HE at 1 year postoperative compared with standard diameters (≥ 8 mm). Several studies[17–19] have reported that the incidence of OHE was significantly lower in patients using an 8-mm-diameter stent than in those using a 10-mm-diameter stent. In the study using a 6-mm-diameter covered stent[59], the efficacy profile was satisfactory, with propranolol compensating for the limited decrease in PVPG and reducing the risk of HE. On this basis, researchers[19] have introduced the use of TIPS-dedicated stents with smaller diameters (6–8 mm) and medication or other treatment methods as combined modalities can effectively treat and prevent the complications of portal hypertension while reducing the risk of HE. Notably, a prospective study on expandable stents[60] has introduced a promising modality of placing an expandable stent into the body during the procedure and adjusting the stent diameter between 8 and 10 mm according to the response to the treatment until satisfactory outcomes are achieved. The study results have shown effective control of variceal bleeding and a reduced risk of HE in patients with portal hypertension following the placement of the expandable stent.

PREVENTION AND TREATMENT OF POSTOPERATIVE TIPS-RELATED HE

While lactulose and rifaximin are recommended medications for HE, their benefits for HE prevention after TIPS remain a controversial and much disputed subject. Two randomized controlled trials[61,62] on secondary prevention of OHE have shown that nonabsorbable disaccharides can significantly reduce the risk of developing recurrent HE. The French guidelines[12] have recommended using lactulose or lactitol as a first-line treatment to prevent recurrent OHE. A randomized controlled trial on bare stents[63] has reported a lack of significant difference in the incidence of postoperative TIPS-related OHE between patients using lactulose, rifaximin and placebo. A large-scale randomized controlled trial[64] in 2021 highlighted that the experimental group using prophylactic rifaximin before TIPS had a lower incidence of postoperative TIPS-related HE than the placebo control group (34% *vs* 53%; OR: 0.48, 95%CI: 0.27–0.87). Based on this study, the latest HE prevention and treatment guidelines[12] have recommended using rifaximin to prevent postoperative TIPS-related HE. Despite the notable findings, this trial has not considered prior OHE because lactulose was merely administered to prevent postoperative TIPS-related HE instead of as preoperative prophylaxis. The latest EASL HE guidelines[10] and the Baveno VII consensus[65] have only recommended the prophylactic use of rifaximin before TIPS in patients with prior HE. A recent prospective study[66] has shown that postoperative infusion of human albumin has no clear association with the incidence of postoperative TIPS-related HE.

Although careful patient selection and perioperative measures can lower the risk of TIPS-related HE, achieving effective management of postoperative TIPS-related HE remains challenging. In addition to standard management and pertinent medication therapy, interventional stent restriction is required in the case of refractory HE. As described by the BASL[22], standard HE management is to correct and restore biochemical parameters to normal levels, withdraw nocturnal sedation, stop using proton pump inhibitors (PPIs), and ensure regular bowel movements using lactulose. The 2021 North American Practice-Based Recommendations[3] have recommended administering lactulose for the first episode of OHE after TIPS and lactulose plus rifaximin for recurrent HE. Several studies[67,68] have shown that decreased tissue zinc levels are observed in patients with liver cirrhosis and are related to the pathogenesis of HE. In contrast, these findings are the opposite of the reported effects of zinc supplementation on HE[69–71]. EASL[10] does not recommend HE management through zinc supplementation. The incidence of refractory HE after TIPS is 3%–8%[72–75]. Although there is no standard definition for refractory HE, the 2021 North American Practice-Based Recommendations[3] have recommended shunt flow restriction if patients with persistent HE do not respond to medication therapy or need readmission due to at least three episodes of HE in the past 3 mo. Most patients show improvement in symptoms through shunt flow restriction[76]; however, they are at risk of the recurrence of complications associated with portal hypertension. In a retrospective study[77], 20 patients with postoperative TIPS-related HE underwent shunt flow restriction ($n = 18$) or TIPS occlusion ($n = 2$). Of these patients, HE was responsive in 11 (55%) cases and unresponsive in nine (45%), and the responsive cases showed an improvement in HE grades and did not have refractory ascites or recurrent variceal bleeding. This provides supportive evidence for the safety of shunt flow restriction in treating

Table 2 Modalities for preventing and treating postoperative transjugular intrahepatic portosystemic shunt-related hepatic encephalopathy

Prevention	Treatment
Lactulose	Lactulose
Rifaximin	Rifaximin
Albumin (potential)	Correction of biochemical parameters
	Withdrawal of nocturnal sedation
	Discontinued use of PPIs
	Stent flow restriction
	Liver transplantation

PPIs: Proton pump inhibitors.

postoperative TIPS-related HE, particularly in patients with OHE. However, no response to shunt flow restriction usually indicates a poor prognosis[78]. Finally, liver transplantation remains the last resort for patients with portal hypertension and liver cirrhosis. Modalities for preventing and treating postoperative TIPS-related HE are listed in Table 2.

CONCLUSION

As the TIPS technique and related materials, particularly stents, continue to evolve, the incidence of postoperative TIPS-related HE and related symptoms is expected to decrease. At present, whether the occurrence of postoperative TIPS-related HE is associated with the choice of portal vein branch shunting remains unclear. Given the lack of evidence, the invariable use of the left portal vein branch as the puncture site not only makes the procedure even more challenging but hinders the promotion and application of this technique. Patients with liver cirrhosis largely have widened liver fissures, which could expose the bifurcation of the left portal vein branch and carry an increased risk of intraperitoneal hemorrhage during intraoperative puncture of the left portal vein branch. Currently, it is believed that in patients with liver cirrhosis and portal hypertension, using an 8-mm-inner-diameter stent is associated with satisfactory shunting performance and a significantly reduced incidence of postoperative HE compared with using a 10-mm-inner-diameter product. However, further studies are needed to determine the ideal size of a stent and evaluate the clinical use of the emerging expandable stents with a controllable inner diameter in treating elderly patients with liver cirrhosis and those with poor liver reserve function. Considering the wide spectrum of etiologies causing liver cirrhosis in different countries and regions, it is an intriguing research interest to tailor post-TIPS PVPG management for the Chinese population and develop individualized treatment plans for patients with liver cirrhosis. Proactive etiological treatment can reduce the risk of postoperative TIPS-related HE. In China, post-TIPS etiological treatment has produced favorable outcomes in patients with liver cirrhosis and portal hypertension caused by the most commonly occurring hepatitis B virus[79]. Based on etiological treatment, future studies can hopefully benefit more patients with hepatitis-B-induced liver cirrhosis by achieving recompensated cirrhosis, as defined by the Baveno VII consensus[65]. Considering the complex pathogenesis of HE associated with clinical operations, postoperative patient management, and many other factors, future research requires larger sample sizes and should adopt a multicenter randomized controlled study design.

FOOTNOTES

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REFERENCES

- de Franchis R; Baveno VI Faculty. Expanding consensus in portal hypertension: Report of the Baveno VI Consensus Workshop: Stratifying risk and individualizing care for portal hypertension. *J Hepatol* 2015; **63**: 743-752 [PMID: 26047908 DOI: 10.1016/j.jhep.2015.05.022]
- García-Pagán JC, Saffo S, Mandorfer M, Garcia-Tsao G. Where does TIPS fit in the management of patients with cirrhosis? *JHEP Rep* 2020; **2**: 100122 [PMID: 32671331 DOI: 10.1016/j.jhepr.2020.100122]
- Boike JR, Thornburg BG, Asrani SK, Fallon MB, Fortune BE, Izzy MJ, Verna EC, Abraldes JG, Allegretti AS, Bajaj JS, Biggins SW, Darcy MD, Farr MA, Farsad K, Garcia-Tsao G, Hall SA, Jadowiec CC, Krowka MJ, Laberge J, Lee EW, Mulligan DC, Nadim MK, Northup PG, Salem R, Shatzel JJ, Shaw CJ, Simonetto DA, Susman J, Kolli KP, VanWagner LB; Advancing Liver Therapeutic Approaches (ALTA) Consortium. North American Practice-Based Recommendations for Transjugular Intrahepatic Portosystemic Shunts in Portal Hypertension. *Clin Gastroenterol Hepatol* 2022; **20**: 1636-1662.e36 [PMID: 34274511 DOI: 10.1016/j.cgh.2021.07.018]
- Nardelli S, Bellafante D, Ridola L, Faccioli J, Riggio O, Gioia S. Prevention of post-tips hepatic encephalopathy: The search of the ideal candidate. *Metab Brain Dis* 2023; **38**: 1729-1736 [PMID: 36445629 DOI: 10.1007/s11011-022-01131-0]
- Rössle M. TIPS: 25 years later. *J Hepatol* 2013; **59**: 1081-1093 [PMID: 23811307 DOI: 10.1016/j.jhep.2013.06.014]
- Lv Y, Yang Z, Liu L, Li K, He C, Wang Z, Bai W, Guo W, Yu T, Yuan X, Zhang H, Xie H, Yao L, Wang J, Li T, Wang Q, Chen H, Wang E, Xia D, Luo B, Li X, Yuan J, Han N, Zhu Y, Niu J, Cai H, Xia J, Yin Z, Wu K, Fan D, Han G; AVB-TIPS Study Group. Early TIPS with covered stents versus standard treatment for acute variceal bleeding in patients with advanced cirrhosis: a randomised controlled trial. *Lancet Gastroenterol Hepatol* 2019; **4**: 587-598 [PMID: 31153882 DOI: 10.1016/S2468-1253(19)30090-1]
- Masson S, Mardini HA, Rose JD, Record CO. Hepatic encephalopathy after transjugular intrahepatic portosystemic shunt insertion: a decade of experience. *QJM* 2008; **101**: 493-501 [PMID: 18440957 DOI: 10.1093/qjmed/hcn037]
- Bureau C, Garcia-Pagan JC, Ota P, Pomier-Layrargues G, Chabbert V, Cortez C, Perreault P, Péron JM, Abraldes JG, Bouchard L, Bilbao JJ, Bosch J, Rousseau H, Vinel JP. Improved clinical outcome using polytetrafluoroethylene-coated stents for TIPS: results of a randomized study. *Gastroenterology* 2004; **126**: 469-475 [PMID: 14762784 DOI: 10.1053/j.gastro.2003.11.016]
- Yang Z, Han G, Wu Q, Ye X, Jin Z, Yin Z, Qi X, Bai M, Wu K, Fan D. Patency and clinical outcomes of transjugular intrahepatic portosystemic shunt with polytetrafluoroethylene-covered stents versus bare stents: a meta-analysis. *J Gastroenterol Hepatol* 2010; **25**: 1718-1725 [PMID: 21039832 DOI: 10.1111/j.1440-1746.2010.06400.x]
- European Association for the Study of the Liver. EASL Clinical Practice Guidelines on the management of hepatic encephalopathy. *J Hepatol* 2022; **77**: 807-824 [PMID: 35724930 DOI: 10.1016/j.jhep.2022.06.001]
- Chinese College of Interventionalists. [CCI clinical practice guidelines: management of TIPS for portal hypertension (2019 edition)]. *Zhonghua Gan Zang Bing Za Zhi* 2019; **27**: 582-593 [PMID: 31594075]
- Thabut D, Bouzib C, Meunier L, Haas M, Weiss N, Louvet A, Imbert-Bismut F, Mochel F, Nadjar Y, Santiago A, Thevenot T, Duhalde V, Oberti F, Francoz C, Coilly A, Hilleret MN, Lebray P, Liou-Schischmanoff A, Barbier L, Duvoux C, Pageaux GP, Bismuth M, Galanaud D, Broucker T, Cadranet JF, Leroy V, Di Martino V, Larrey D, Camus C, Scatton O, De Ledinghen V, Mallat A, Rudler M, Bureau C; Association Française pour l'Etude du Foie (AFEF) group of experts of HE recommendations. Diagnosis and management of hepatic encephalopathy: The French recommendations. *Liver Int* 2023; **43**: 750-762 [PMID: 36625084 DOI: 10.1111/liv.15510]
- Riggio O, Nardelli S, Moscucci F, Pasquale C, Ridola L, Merli M. Hepatic encephalopathy after transjugular intrahepatic portosystemic shunt. *Clin Liver Dis* 2012; **16**: 133-146 [PMID: 22321469 DOI: 10.1016/j.cld.2011.12.008]
- Ferenci P, Lockwood A, Mullen K, Tarter R, Weissenborn K, Blei AT. Hepatic encephalopathy--definition, nomenclature, diagnosis, and quantification: final report of the working party at the 11th World Congresses of Gastroenterology, Vienna, 1998. *Hepatology* 2002; **35**: 716-721 [PMID: 11870389 DOI: 10.1053/jhep.2002.31250]
- Blei AT, Córdoba J; Practice Parameters Committee of the American College of Gastroenterology. Hepatic Encephalopathy. *Am J Gastroenterol* 2001; **96**: 1968-1976 [PMID: 11467622 DOI: 10.1111/j.1572-0241.2001.03964.x]
- Bajaj JS, Cordoba J, Mullen KD, Amodio P, Shawcross DL, Butterworth RF, Morgan MY; International Society for Hepatic Encephalopathy and Nitrogen Metabolism (ISHEN). Review article: the design of clinical trials in hepatic encephalopathy--an International Society for Hepatic Encephalopathy and Nitrogen Metabolism (ISHEN) consensus statement. *Aliment Pharmacol Ther* 2011; **33**: 739-747 [PMID: 21306407 DOI: 10.1111/j.1365-2036.2011.04590.x]
- Wang Q, Lv Y, Bai M, Wang Z, Liu H, He C, Niu J, Guo W, Luo B, Yin Z, Bai W, Chen H, Wang E, Xia D, Li X, Yuan J, Han N, Cai H, Li T, Xie H, Xia J, Wang J, Zhang H, Wu K, Fan D, Han G. Eight millimetre covered TIPS does not compromise shunt function but reduces hepatic encephalopathy in preventing variceal rebleeding. *J Hepatol* 2017; **67**: 508-516 [PMID: 28506905 DOI: 10.1016/j.jhep.2017.05.006]
- Luo X, Wang X, Zhu Y, Xi X, Zhao Y, Yang J, Li X, Yang L. Clinical Efficacy of Transjugular Intrahepatic Portosystemic Shunt Created with Expanded Polytetrafluoroethylene-Covered Stent-Grafts: 8-mm Versus 10-mm. *Cardiovasc Intervent Radiol* 2019; **42**: 737-743 [PMID: 30643936 DOI: 10.1007/s00270-019-02162-4]
- Bosch J. Small diameter shunts should lead to safe expansion of the use of TIPS. *J Hepatol* 2021; **74**: 230-234 [PMID: 32987029 DOI: 10.1016/j.jhep.2020.09.018]
- Garcovich M, Zocco MA, Roccarina D, Ponziani FR, Gasbarrini A. Prevention and treatment of hepatic encephalopathy: focusing on gut microbiota. *World J Gastroenterol* 2012; **18**: 6693-6700 [PMID: 23239905 DOI: 10.3748/wjg.v18.i46.6693]
- Bai M, Qi X, Yang Z, Yin Z, Nie Y, Yuan S, Wu K, Han G, Fan D. Predictors of hepatic encephalopathy after transjugular intrahepatic portosystemic shunt in cirrhotic patients: a systematic review. *J Gastroenterol Hepatol* 2011; **26**: 943-951 [PMID: 21251067 DOI: 10.1111/j.1440-1746.2011.06663.x]

- 22 **Tripathi D**, Stanley AJ, Hayes PC, Travis S, Armstrong MJ, Tsochatzis EA, Rowe IA, Roslund N, Ireland H, Lomax M, Leithead JA, Mehrzad H, Aspinall RJ, McDonagh J, Patch D. Transjugular intrahepatic portosystemic stent-shunt in the management of portal hypertension. *Gut* 2020; **69**: 1173-1192 [PMID: [32114503](#) DOI: [10.1136/gutjnl-2019-320221](#)]
- 23 **Bureau C**, Thabut D, Oberti F, Dharancy S, Carbonell N, Bouvier A, Mathurin P, Otal P, Cabarro P, Péron JM, Vinel JP. Transjugular Intrahepatic Portosystemic Shunts With Covered Stents Increase Transplant-Free Survival of Patients With Cirrhosis and Recurrent Ascites. *Gastroenterology* 2017; **152**: 157-163 [PMID: [27663604](#) DOI: [10.1053/j.gastro.2016.09.016](#)]
- 24 **Lv Y**, Zuo L, Zhu X, Zhao J, Xue H, Jiang Z, Zhuge Y, Zhang C, Sun J, Ding P, Ren W, Li Y, Zhang K, Zhang W, He C, Zhong J, Peng Q, Ma F, Luo J, Zhang M, Wang G, Sun M, Dong J, Bai W, Guo W, Wang Q, Yuan X, Wang Z, Yu T, Luo B, Li X, Yuan J, Han N, Zhu Y, Niu J, Li K, Yin Z, Nie Y, Fan D, Han G. Identifying optimal candidates for early TIPS among patients with cirrhosis and acute variceal bleeding: a multicentre observational study. *Gut* 2019; **68**: 1297-1310 [PMID: [30415233](#) DOI: [10.1136/gutjnl-2018-317057](#)]
- 25 **García-Pagán JC**, Caca K, Bureau C, Laleman W, Appenrodt B, Luca A, Abrahales JG, Nevens F, Vinel JP, Mössner J, Bosch J; Early TIPS (Transjugular Intrahepatic Portosystemic Shunt) Cooperative Study Group. Early use of TIPS in patients with cirrhosis and variceal bleeding. *N Engl J Med* 2010; **362**: 2370-2379 [PMID: [20573925](#) DOI: [10.1056/NEJMoa0910102](#)]
- 26 **Bucsics T**, Hoffman S, Grünberger J, Schoder M, Matzek W, Stadlmann A, Mandorfer M, Schwabl P, Ferlitsch A, Peck-Radosavljevic M, Trauner M, Karner J, Karmel F, Reiberger T. ePTFE-TIPS vs repetitive LVP plus albumin for the treatment of refractory ascites in patients with cirrhosis. *Liver Int* 2018; **38**: 1036-1044 [PMID: [29091351](#) DOI: [10.1111/liv.13615](#)]
- 27 **Berlioux P**, Robic MA, Poirson H, Métivier S, Otal P, Barret C, Lopez F, Péron JM, Vinel JP, Bureau C. Pre-transjugular intrahepatic portosystemic shunts (TIPS) prediction of post-TIPS overt hepatic encephalopathy: the critical flicker frequency is more accurate than psychometric tests. *Hepatology* 2014; **59**: 622-629 [PMID: [24620380](#) DOI: [10.1002/hep.26684](#)]
- 28 **Nardelli S**, Gioia S, Pasquale C, Pentassuglio I, Farcomeni A, Merli M, Salvatori FM, Nikolli L, Torrisi S, Greco F, Nicoletti V, Riggio O. Cognitive Impairment Predicts The Occurrence Of Hepatic Encephalopathy After Transjugular Intrahepatic Portosystemic Shunt. *Am J Gastroenterol* 2016; **111**: 523-528 [PMID: [26925879](#) DOI: [10.1038/ajg.2016.29](#)]
- 29 **Rudler M**, Hernández-Gea V, Procopet BD, Giraldez A, Amitrano L, Villanueva C, Ibañez L, Silva-Junior G, Genesca J, Bureau C, Trebicka J, Bañares R, Krag A, Llop E, Laleman W, Palazon JM, Castellote J, Rodrigues S, Gluud LL, Noronha Ferreira C, Canete N, Rodríguez M, Ferlitsch A, Mundi JL, Gronbaek H, Hernandez-Guerra M, Sassatelli R, Dell'era A, Senzolo M, Abrahales JG, Romero-Gómez M, Zipprich A, Casas M, Masnou H, Larue H, Primignani M, Nevens F, Calleja JL, Schwarzer R, Jansen C, Robic MA, Conejo I, Martínez Gonzalez J, Catalina MV, Albillos A, Alvarado E, Guardascione MA, Mallet M, Tripon S, Casanovas G, Bosch J, Garcia-Pagan JC, Thabut D; for International Variceal Bleeding Observational Study Group: a Baveno Cooperation. Hepatic encephalopathy is not a contraindication to pre-emptive TIPS in high-risk patients with cirrhosis with variceal bleeding. *Gut* 2023; **72**: 749-758 [PMID: [36328772](#) DOI: [10.1136/gutjnl-2022-326975](#)]
- 30 **Rudler M**, Cluzel P, Corvec TL, Benosman H, Rousseau G, Poynard T, Thabut D. Early-TIPSS placement prevents rebleeding in high-risk patients with variceal bleeding, without improving survival. *Aliment Pharmacol Ther* 2014; **40**: 1074-1080 [PMID: [25230051](#) DOI: [10.1111/apt.12934](#)]
- 31 **Deltenre P**, Trépo E, Rudler M, Monescillo A, Fraga M, Denys A, Doerig C, Fournier N, Moreno C, Moradpour D, Bureau C, Thabut D. Early transjugular intrahepatic portosystemic shunt in cirrhotic patients with acute variceal bleeding: a systematic review and meta-analysis of controlled trials. *Eur J Gastroenterol Hepatol* 2015; **27**: e1-e9 [PMID: [26049710](#) DOI: [10.1097/MEG.0000000000000403](#)]
- 32 **García-Pagán JC**, Di Pascoli M, Caca K, Laleman W, Bureau C, Appenrodt B, Luca A, Zipprich A, Abrahales JG, Nevens F, Vinel JP, Sauerbruch T, Bosch J. Use of early-TIPS for high-risk variceal bleeding: results of a post-RCT surveillance study. *J Hepatol* 2013; **58**: 45-50 [PMID: [22940408](#) DOI: [10.1016/j.jhep.2012.08.020](#)]
- 33 **Casadaban LC**, Parvinian A, Minocha J, Lakshoo J, Grant CW, Ray CE Jr, Knuttinen MG, Bui JT, Gaba RC. Clearing the Confusion over Hepatic Encephalopathy After TIPS Creation: Incidence, Prognostic Factors, and Clinical Outcomes. *Dig Dis Sci* 2015; **60**: 1059-1066 [PMID: [25316553](#) DOI: [10.1007/s10620-014-3391-0](#)]
- 34 **Riggio O**, Angeloni S, Salvatori FM, De Santis A, Cerini F, Farcomeni A, Attili AF, Merli M. Incidence, natural history, and risk factors of hepatic encephalopathy after transjugular intrahepatic portosystemic shunt with polytetrafluoroethylene-covered stent grafts. *Am J Gastroenterol* 2008; **103**: 2738-2746 [PMID: [18775022](#) DOI: [10.1111/j.1572-0241.2008.02102.x](#)]
- 35 **Praktiknjo M**, Clees C, Pigliacelli A, Fischer S, Jansen C, Lehmann J, Pohlmann A, Lattanzi B, Krabbe VK, Strassburg CP, Arroyo V, Merli M, Meyer C, Trebicka J. Sarcopenia Is Associated With Development of Acute-on-Chronic Liver Failure in Decompensated Liver Cirrhosis Receiving Transjugular Intrahepatic Portosystemic Shunt. *Clin Transl Gastroenterol* 2019; **10**: e00025 [PMID: [30939488](#) DOI: [10.14309/ctg.0000000000000025](#)]
- 36 **Nardelli S**, Lattanzi B, Torrisi S, Greco F, Farcomeni A, Gioia S, Merli M, Riggio O. Sarcopenia Is Risk Factor for Development of Hepatic Encephalopathy After Transjugular Intrahepatic Portosystemic Shunt Placement. *Clin Gastroenterol Hepatol* 2017; **15**: 934-936 [PMID: [27816756](#) DOI: [10.1016/j.cgh.2016.10.028](#)]
- 37 **Tapper EB**, Zhao L, Nikirk S, Baki J, Parikh ND, Lok AS, Waljee AK. Incidence and Bedside Predictors of the First Episode of Overt Hepatic Encephalopathy in Patients With Cirrhosis. *Am J Gastroenterol* 2020; **115**: 2017-2025 [PMID: [32773463](#) DOI: [10.14309/ajg.0000000000000762](#)]
- 38 **Tapper EB**, Konerman M, Murphy S, Sonnenday CJ. Hepatic encephalopathy impacts the predictive value of the Fried Frailty Index. *Am J Transplant* 2018; **18**: 2566-2570 [PMID: [30019835](#) DOI: [10.1111/ajt.15020](#)]
- 39 **Ney M**, Tangri N, Dobbs B, Bajaj J, Rolfsen D, Ma M, Ferguson T, Bhardwaj P, Bailey RJ, Abrahales J, Tandon P. Predicting Hepatic Encephalopathy-Related Hospitalizations Using a Composite Assessment of Cognitive Impairment and Frailty in 355 Patients With Cirrhosis. *Am J Gastroenterol* 2018; **113**: 1506-1515 [PMID: [30267028](#) DOI: [10.1038/s41395-018-0243-0](#)]
- 40 **Luo SH**, Chu JG, Huang H, Zhao GR, Yao KC. Targeted puncture of left branch of intrahepatic portal vein in transjugular intrahepatic portosystemic shunt to reduce hepatic encephalopathy. *World J Gastroenterol* 2019; **25**: 1088-1099 [PMID: [30862997](#) DOI: [10.3748/wjg.v25.i9.1088](#)]
- 41 **Maruyama H**, Okugawa H, Ishibashi H, Takahashi M, Kobayashi S, Yoshizumi H, Yokosuka O. Carbon dioxide-based portography: an alternative to conventional imaging with the use of iodinated contrast medium. *J Gastroenterol Hepatol* 2010; **25**: 1111-1116 [PMID: [20594227](#) DOI: [10.1111/j.1440-1746.2010.06248.x](#)]
- 42 **Chen L**, Xiao T, Chen W, Long Q, Li R, Fang D, Wang R. Outcomes of transjugular intrahepatic portosystemic shunt through the left branch vs. the right branch of the portal vein in advanced cirrhosis: a randomized trial. *Liver Int* 2009; **29**: 1101-1109 [PMID: [19386025](#) DOI: [10.1111/j.1478-3231.2009.02016.x](#)]

- 43 **Bai M**, He CY, Qi XS, Yin ZX, Wang JH, Guo WG, Niu J, Xia JL, Zhang ZL, Larson AC, Wu KC, Fan DM, Han GH. Shunting branch of portal vein and stent position predict survival after transjugular intrahepatic portosystemic shunt. *World J Gastroenterol* 2014; **20**: 774-785 [PMID: 24574750 DOI: 10.3748/wjg.v20.i3.774]
- 44 **Yao X**, He S, Wei M, Qin JP. Influence of different portal vein branches on hepatic encephalopathy during intrahepatic portal shunt via jugular vein. *World J Gastroenterol* 2022; **28**: 4467-4470 [PMID: 36159008 DOI: 10.3748/wjg.v28.i31.4467]
- 45 **Yao X**, Zhou H, Tang SH, Huang S, Chen XL, Qin JP. Effect of intraoperative Viatorr stent implantation for shunting of blood flow in the left or right branch of the portal vein and its effect on clinical outcome in patients with cirrhotic portal hypertension undergoing transjugular intrahepatic portosystemic shunt. *Linchuang Gandanbing Zazhi* 2020; **9**: 1970-1974
- 46 **Deng L**, Yan Y, Chen Y, Ye P, Miao HF, Zeng QY, Xie ZG. Preliminary analysis of liver-related blood components in portal vein system via TIPS approach. *Jieru Fangshexue Zazhi* 2020; **6**: 608-611
- 47 **Miraglia R**, Maruzzelli L, Mamone G, Petridis I, Tuzzolino F, Luca A. Right vs left portal branch puncture in TIPS creation with controlled expansion covered stent: comparison of hemodynamic and clinical outcomes. *Eur Radiol* 2023; **33**: 2647-2654 [PMID: 36454260 DOI: 10.1007/s00330-022-09280-7]
- 48 **Nardelli S**, Riggio O, Gioia S, Puzzono M, Pelle G, Ridola L. Spontaneous porto-systemic shunts in liver cirrhosis: Clinical and therapeutic aspects. *World J Gastroenterol* 2020; **26**: 1726-1732 [PMID: 32351289 DOI: 10.3748/wjg.v26.i15.1726]
- 49 **Laleman W**, Simon-Talero M, Maleux G, Perez M, Ameloot K, Soriano G, Villalba J, Garcia-Pagan JC, Barrufet M, Jalan R, Brookes J, Thalassinou E, Burroughs AK, Cordoba J, Nevens F; EASL-CLIF-Consortium. Embolization of large spontaneous portosystemic shunts for refractory hepatic encephalopathy: a multicenter survey on safety and efficacy. *Hepatology* 2013; **57**: 2448-2457 [PMID: 23401201 DOI: 10.1002/hep.26314]
- 50 **Simón-Talero M**, Roccarina D, Martínez J, Lampichler K, Baiges A, Low G, Llop E, Praktiknjo M, Maurer MH, Zipprich A, Triolo M, Vangrinsven G, Garcia-Martinez R, Dam A, Majumdar A, Picón C, Toth D, Darnell A, Abalde JG, López M, Kukuk G, Krag A, Bañares R, Laleman W, La Mura V, Ripoll C, Berzigotti A, Trebicka J, Calleja JL, Tandon P, Hernandez-Gea V, Reiberger T, Albillos A, Tsochatzis EA, Augustin S, Genesca J; Baveno VI-SPSS group from the Baveno Cooperation. Association Between Portosystemic Shunts and Increased Complications and Mortality in Patients With Cirrhosis. *Gastroenterology* 2018; **154**: 1694-1705.e4 [PMID: 29360462 DOI: 10.1053/j.gastro.2018.01.028]
- 51 **Praktiknjo M**, Simón-Talero M, Römer J, Roccarina D, Martínez J, Lampichler K, Baiges A, Low G, Llop E, Maurer MH, Zipprich A, Triolo M, Maleux G, Fialla AD, Dam C, Vidal-González J, Majumdar A, Picón C, Toth D, Darnell A, Abalde JG, López M, Jansen C, Chang J, Schierwagen R, Uschner F, Kukuk G, Meyer C, Thomas D, Wolter K, Strassburg CP, Laleman W, La Mura V, Ripoll C, Berzigotti A, Calleja JL, Tandon P, Hernandez-Gea V, Reiberger T, Albillos A, Tsochatzis EA, Krag A, Genesca J, Trebicka J; Baveno VI-SPSS group of the Baveno Cooperation. Total area of spontaneous portosystemic shunts independently predicts hepatic encephalopathy and mortality in liver cirrhosis. *J Hepatol* 2020; **72**: 1140-1150 [PMID: 31954206 DOI: 10.1016/j.jhep.2019.12.021]
- 52 **He C**, Lv Y, Wang Z, Guo W, Tie J, Li K, Niu J, Zuo L, Yu T, Yuan X, Chen H, Wang Q, Liu H, Bai W, Wang E, Xia D, Luo B, Li X, Yuan J, Han N, Zhu Y, Wang J, Yin Z, Fan D, Han G. Association between non-variceal spontaneous portosystemic shunt and outcomes after TIPS in cirrhosis. *Dig Liver Dis* 2018; **50**: 1315-1323 [PMID: 29960900 DOI: 10.1016/j.dld.2018.05.022]
- 53 **Qi X**, Liu L, Bai M, Chen H, Wang J, Yang Z, Han G, Fan D. Transjugular intrahepatic portosystemic shunt in combination with or without variceal embolization for the prevention of variceal rebleeding: a meta-analysis. *J Gastroenterol Hepatol* 2014; **29**: 688-696 [PMID: 24117967 DOI: 10.1111/jgh.12391]
- 54 **Leng X**, Zhang F, Zhang M, Guo H, Yin X, Xiao J, Wang Y, Zou X, Zhuge Y. Comparison of transjugular intrahepatic portosystemic shunt for treatment of variceal bleeding in patients with cirrhosis with or without spontaneous portosystemic shunt. *Eur J Gastroenterol Hepatol* 2019; **31**: 853-858 [PMID: 30633039 DOI: 10.1097/MEG.0000000000001349]
- 55 **Wan YM**, Li YH, Xu ZY, Wu HM, Wu XN, Xu Y, Guo T. Transjugular Intrahepatic Portosystemic Shunt: The Impact of Portal Venous Pressure Declines on Shunt Patency and Clinical Efficacy. *Acad Radiol* 2019; **26**: 188-195 [PMID: 29934023 DOI: 10.1016/j.acra.2018.05.015]
- 56 **Casado M**, Bosch J, García-Pagán JC, Bru C, Bañares R, Bandi JC, Escorsell A, Rodríguez-Láiz JM, Gilibert R, Feu F, Schorlemer C, Echenagusia A, Rodés J. Clinical events after transjugular intrahepatic portosystemic shunt: correlation with hemodynamic findings. *Gastroenterology* 1998; **114**: 1296-1303 [PMID: 9609767 DOI: 10.1016/s0016-5085(98)70436-6]
- 57 **Perarnau JM**, Le Gouge A, Nicolas C, d'Altoche L, Borentain P, Saliba F, Minello A, Anty R, Chagneau-Derrode C, Bernard PH, Abergel A, Ollivier-Hourmand I, Gournay J, Ayoub J, Gaborit C, Rusc E, Giraudeau B; STIC-TIPS group. Covered vs. uncovered stents for transjugular intrahepatic portosystemic shunt: a randomized controlled trial. *J Hepatol* 2014; **60**: 962-968 [PMID: 24480619 DOI: 10.1016/j.jhep.2014.01.015]
- 58 **Schepis F**, Vizzutti F, García-Tsao G, Marzocchi G, Rega L, De Maria N, Di Maira T, Gitto S, Caporali C, Colopi S, De Santis M, Arena U, Rampoldi A, Airolidi A, Cannavale A, Fanelli F, Mosconi C, Renzulli M, Agazzi R, Nani R, Quaretti P, Fiorina I, Moramarco L, Miraglia R, Luca A, Bruno R, Fagioli S, Golfieri R, Torricelli P, Di Benedetto F, Belli LS, Banchelli F, Laffi G, Marra F, Villa E. Under-dilated TIPS Associate With Efficacy and Reduced Encephalopathy in a Prospective, Non-randomized Study of Patients With Cirrhosis. *Clin Gastroenterol Hepatol* 2018; **16**: 1153-1162.e7 [PMID: 29378312 DOI: 10.1016/j.cgh.2018.01.029]
- 59 **Bellis L**, Moitinho E, Abalde JG, Graupera M, García-Pagán JC, Rodés J, Bosch J. Acute propranolol administration effectively decreases portal pressure in patients with TIPS dysfunction. Transjugular intrahepatic portosystemic shunt. *Gut* 2003; **52**: 130-133 [PMID: 12477774 DOI: 10.1136/gut.52.1.130]
- 60 **Miraglia R**, Maruzzelli L, Di Piazza A, Mamone G, Caruso S, Gentile G, Tuzzolino F, Floridia G, Petridis I, Volpes R, Luca A. Transjugular Intrahepatic Portosystemic Shunt Using the New Gore Viatorr Controlled Expansion Endoprosthesis: Prospective, Single-Center, Preliminary Experience. *Cardiovasc Intervent Radiol* 2019; **42**: 78-86 [PMID: 30073477 DOI: 10.1007/s00270-018-2040-y]
- 61 **Agrawal A**, Sharma BC, Sharma P, Sarin SK. Secondary prophylaxis of hepatic encephalopathy in cirrhosis: an open-label, randomized controlled trial of lactulose, probiotics, and no therapy. *Am J Gastroenterol* 2012; **107**: 1043-1050 [PMID: 22710579 DOI: 10.1038/ajg.2012.113]
- 62 **Sharma BC**, Sharma P, Agrawal A, Sarin SK. Secondary prophylaxis of hepatic encephalopathy: an open-label randomized controlled trial of lactulose versus placebo. *Gastroenterology* 2009; **137**: 885-891, 891.e1 [PMID: 19501587 DOI: 10.1053/j.gastro.2009.05.056]
- 63 **Riggio O**, Masini A, Efrati C, Nicolao F, Angeloni S, Salvatori FM, Bezzi M, Attili AF, Merli M. Pharmacological prophylaxis of hepatic encephalopathy after transjugular intrahepatic portosystemic shunt: a randomized controlled study. *J Hepatol* 2005; **42**: 674-679 [PMID: 15826716 DOI: 10.1016/j.jhep.2004.12.028]

- 64 **Bureau C**, Thabut D, Jezequel C, Archambeaud I, D'Alteroche L, Dharancy S, Borentain P, Oberti F, Plessier A, De Ledinghen V, Ganne-Carrié N, Carbonell N, Rousseau V, Sommet A, Péron JM, Vinel JP. The Use of Rifaximin in the Prevention of Overt Hepatic Encephalopathy After Transjugular Intrahepatic Portosystemic Shunt : A Randomized Controlled Trial. *Ann Intern Med* 2021; **174**: 633-640 [PMID: [33524293](#) DOI: [10.7326/M20-0202](#)]
- 65 **de Franchis R**, Bosch J, Garcia-Tsao G, Reiberger T, Ripoll C; Baveno VII Faculty. Baveno VII - Renewing consensus in portal hypertension. *J Hepatol* 2022; **76**: 959-974 [PMID: [35120736](#) DOI: [10.1016/j.jhep.2021.12.022](#)]
- 66 **Nardelli S**, Gioia S, Faccioli J, Riggio O, Ridola L. Albumin for cognitive impairment after TIPS: A road to be explored. *J Hepatol* 2023; **78**: e96-e97 [PMID: [36216135](#) DOI: [10.1016/j.jhep.2022.10.002](#)]
- 67 **Grüngreiff K**, Reinhold D, Wedemeyer H. The role of zinc in liver cirrhosis. *Ann Hepatol* 2016; **15**: 7-16 [PMID: [26626635](#) DOI: [10.5604/16652681.1184191](#)]
- 68 **Miwa T**, Hanai T, Toshihide M, Ogiso Y, Imai K, Suetsugu A, Takai K, Shiraki M, Katsumura N, Shimizu M. Zinc deficiency predicts overt hepatic encephalopathy and mortality in liver cirrhosis patients with minimal hepatic encephalopathy. *Hepatol Res* 2021; **51**: 662-673 [PMID: [33242359](#) DOI: [10.1111/hepr.13601](#)]
- 69 **Mousa N**, Abdel-Razik A, Zaher A, Hamed M, Shiha G, Effat N, Elbaz S, Elhelaly R, Hafez M, El-Wakeel N, Eldars W. The role of antioxidants and zinc in minimal hepatic encephalopathy: a randomized trial. *Therap Adv Gastroenterol* 2016; **9**: 684-691 [PMID: [27582881](#) DOI: [10.1177/1756283X16645049](#)]
- 70 **Katayama K**, Saito M, Kawaguchi T, Endo R, Sawara K, Nishiguchi S, Kato A, Kohgo H, Suzuki K, Sakaida I, Ueno Y, Habu D, Ito T, Moriawaki H. Effect of zinc on liver cirrhosis with hyperammonemia: a preliminary randomized, placebo-controlled double-blind trial. *Nutrition* 2014; **30**: 1409-1414 [PMID: [25280421](#) DOI: [10.1016/j.nut.2014.04.018](#)]
- 71 **Riggio O**, Ariosto F, Merli M, Caschera M, Zullo A, Balducci G, Ziparo V, Pedretti G, Fiaccadori F, Bottari E. Short-term oral zinc supplementation does not improve chronic hepatic encephalopathy. Results of a double-blind crossover trial. *Dig Dis Sci* 1991; **36**: 1204-1208 [PMID: [1893805](#) DOI: [10.1007/bf01307509](#)]
- 72 **Otal P**, Smayra T, Bureau C, Peron JM, Chabbert V, Chemla P, Joffe F, Vinel JP, Rousseau H. Preliminary results of a new expanded-polytetrafluoroethylene-covered stent-graft for transjugular intrahepatic portosystemic shunt procedures. *AJR Am J Roentgenol* 2002; **178**: 141-147 [PMID: [11756108](#) DOI: [10.2214/ajr.178.1.1780141](#)]
- 73 **Chung HH**, Razavi MK, Sze DY, Frisoli JK, Kee ST, Dake MD, Hellinger JC, Kang BC. Portosystemic pressure gradient during transjugular intrahepatic portosystemic shunt with Viatorr stent graft: what is the critical low threshold to avoid medically uncontrolled low pressure gradient related complications? *J Gastroenterol Hepatol* 2008; **23**: 95-101 [PMID: [18171347](#) DOI: [10.1111/j.1440-1746.2006.04697.x](#)]
- 74 **Fanelli F**, Salvatori FM, Rabuffi P, Boatta E, Riggio O, Lucatelli P, Passariello R. Management of refractory hepatic encephalopathy after insertion of TIPS: long-term results of shunt reduction with hourglass-shaped balloon-expandable stent-graft. *AJR Am J Roentgenol* 2009; **193**: 1696-1702 [PMID: [19933667](#) DOI: [10.2214/AJR.09.2968](#)]
- 75 **Pereira K**, Carrion AF, Salsamendi J, Doshi M, Baker R, Kably I. Endovascular Management of Refractory Hepatic Encephalopathy Complication of Transjugular Intrahepatic Portosystemic Shunt (TIPS): Comprehensive Review and Clinical Practice Algorithm. *Cardiovasc Intervent Radiol* 2016; **39**: 170-182 [PMID: [26285910](#) DOI: [10.1007/s00270-015-1197-x](#)]
- 76 **Rowley MW**, Choi M, Chen S, Hirsch K, Seetharam AB. Refractory Hepatic Encephalopathy After Elective Transjugular Intrahepatic Portosystemic Shunt: Risk Factors and Outcomes with Revision. *Cardiovasc Intervent Radiol* 2018; **41**: 1765-1772 [PMID: [29872892](#) DOI: [10.1007/s00270-018-1992-2](#)]
- 77 **Schindler P**, Seifert L, Masthoff M, Riegel A, Köhler M, Wilms C, Schmidt HH, Heinzow H, Wildgruber M. TIPS Modification in the Management of Shunt-Induced Hepatic Encephalopathy: Analysis of Predictive Factors and Outcome with Shunt Modification. *J Clin Med* 2020; **9** [PMID: [32092979](#) DOI: [10.3390/jcm9020567](#)]
- 78 **Kochar N**, Tripathi D, Ireland H, Redhead DN, Hayes PC. Transjugular intrahepatic portosystemic stent shunt (TIPSS) modification in the management of post-TIPSS refractory hepatic encephalopathy. *Gut* 2006; **55**: 1617-1623 [PMID: [16571635](#) DOI: [10.1136/gut.2005.089482](#)]
- 79 **Yao X**, Huang S, Zhou H, Tang SH, Qin JP. Clinical efficacy of antiviral therapy in patients with hepatitis B-related cirrhosis after transjugular intrahepatic portosystemic shunt. *World J Gastroenterol* 2021; **27**: 5088-5099 [PMID: [34497437](#) DOI: [10.3748/wjg.v27.i30.5088](#)]



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