

# World Journal of *Gastroenterology*

*World J Gastroenterol* 2018 July 28; 24(28): 3055-3200



**REVIEW**

- 3055** Non-pharmacological therapies for inflammatory bowel disease: Recommendations for self-care and physician guidance

*Duff W, Haskey N, Potter G, Alcorn J, Hunter P, Fowler S*

- 3071** *Helicobacter pylori* in human health and disease: Mechanisms for local gastric and systemic effects

*Bravo D, Hoare A, Soto C, Valenzuela MA, Quest AF*

- 3090** Proton therapy for hepatocellular carcinoma: Current knowledge and future perspectives

*Yoo GS, Yu JI, Park HC*

**MINIREVIEWS**

- 3101** Encapsulating peritoneal sclerosis

*Danford CJ, Lin SC, Smith MP, Wolf JL*

- 3112** Considerations for bariatric surgery in patients with cirrhosis

*Goh GB, Schauer PR, McCullough AJ*

**ORIGINAL ARTICLE****Basic Study**

- 3120** Impact of hyperglycemia on autoimmune pancreatitis and regulatory T-cells

*Müller-Graff FT, Fitzner B, Jaster R, Vollmar B, Zechner D*

- 3130** Moxibustion treatment modulates the gut microbiota and immune function in a dextran sulphate sodium-induced colitis rat model

*Qi Q, Liu YN, Jin XM, Zhang LS, Wang C, Bao CH, Liu HR, Wu HG, Wang XM*

- 3145** Integrated genomic analysis for prediction of survival for patients with liver cancer using The Cancer Genome Atlas

*Song YZ, Li X, Li W, Wang Z, Li K, Xie FL, Zhang F*

**Retrospective Study**

- 3155** Multikinase inhibitor-associated hand-foot skin reaction as a predictor of outcomes in patients with hepatocellular carcinoma treated with sorafenib

*Ochi M, Kamoshida T, Ohkawara A, Ohkawara H, Kakinoki N, Hirai S, Yanaka A*

**Observational Study**

- 3163** Health behaviors of Korean adults with hepatitis B: Findings of the 2016 Korean National Health and Nutrition Examination Survey

*Yi YH, Kim YJ, Lee SY, Cho BM, Cho YH, Lee JG*

**SYSTEMATIC REVIEWS**

- 3171** Role of colectomy in preventing recurrent primary sclerosing cholangitis in liver transplant recipients  
*Buchholz BM, Lykoudis PM, Ravikumar R, Pollok JM, Fusai GK*

**META-ANALYSIS**

- 3181** Hepatitis B reactivation in patients receiving direct-acting antiviral therapy or interferon-based therapy for hepatitis C: A systematic review and meta-analysis  
*Jiang XW, Ye JZ, Li YT, Li LJ*

**CASE REPORT**

- 3192** Regulating migration of esophageal stents - management using a Sengstaken-Blakemore tube: A case report and review of literature  
*Sato H, Ishida K, Sasaki S, Kojika M, Endo S, Inoue Y, Sasaki A*

**LETTERS TO THE EDITOR**

- 3198** Genetic analysis is helpful for the diagnosis of small bowel ulceration  
*Umeno J, Matsumoto T, Hirano A, Fuyuno Y, Esaki M*

## ABOUT COVER

Editorial board member of *World Journal of Gastroenterology*, Nobuhiro Ohkohchi, MD, PhD, Professor, Department of Surgery, Division of Gastroenterology and Hepatobiliary Surgery and Organ Transplantation, University of Tsukuba, Tsukuba 305-8575, Japan

## AIMS AND SCOPE

*World Journal of Gastroenterology* (*World J Gastroenterol*, *WJG*, print ISSN 1007-9327, online ISSN 2219-2840, DOI: 10.3748) is a peer-reviewed open access journal. *WJG* was established on October 1, 1995. It is published weekly on the 7<sup>th</sup>, 14<sup>th</sup>, 21<sup>st</sup>, and 28<sup>th</sup> each month. The *WJG* Editorial Board consists of 642 experts in gastroenterology and hepatology from 59 countries.

The primary task of *WJG* is to rapidly publish high-quality original articles, reviews, and commentaries in the fields of gastroenterology, hepatology, gastrointestinal endoscopy, gastrointestinal surgery, hepatobiliary surgery, gastrointestinal oncology, gastrointestinal radiation oncology, gastrointestinal imaging, gastrointestinal interventional therapy, gastrointestinal infectious diseases, gastrointestinal pharmacology, gastrointestinal pathophysiology, gastrointestinal pathology, evidence-based medicine in gastroenterology, pancreatology, gastrointestinal laboratory medicine, gastrointestinal molecular biology, gastrointestinal immunology, gastrointestinal microbiology, gastrointestinal genetics, gastrointestinal translational medicine, gastrointestinal diagnostics, and gastrointestinal therapeutics. *WJG* is dedicated to become an influential and prestigious journal in gastroenterology and hepatology, to promote the development of above disciplines, and to improve the diagnostic and therapeutic skill and expertise of clinicians.

## INDEXING/ABSTRACTING

*World Journal of Gastroenterology* (*WJG*) is now indexed in Current Contents®/Clinical Medicine, Science Citation Index Expanded (also known as SciSearch®), Journal Citation Reports®, Index Medicus, MEDLINE, PubMed, PubMed Central and Directory of Open Access Journals. The 2018 edition of Journal Citation Reports® cites the 2017 impact factor for *WJG* as 3.300 (5-year impact factor: 3.387), ranking *WJG* as 35<sup>th</sup> among 80 journals in gastroenterology and hepatology (quartile in category Q2).

## EDITORS FOR THIS ISSUE

Responsible Assistant Editor: *Xiang Li*  
Responsible Electronic Editor: *Shu-Yu Yin*  
Proofing Editor-in-Chief: *Lian-Sheng Ma*

Responsible Science Editor: *Xue-Jiao Wang*  
Proofing Editorial Office Director: *Ze-Mao Gong*

NAME OF JOURNAL  
*World Journal of Gastroenterology*

ISSN  
ISSN 1007-9327 (print)  
ISSN 2219-2840 (online)

LAUNCH DATE  
October 1, 1995

FREQUENCY  
Weekly

EDITORS-IN-CHIEF  
**Damian Garcia-Olmo, MD, PhD, Doctor, Professor, Surgeon**, Department of Surgery, Universidad Autonoma de Madrid; Department of General Surgery, Fundacion Jimenez Diaz University Hospital, Madrid 28040, Spain

**Stephen C Strom, PhD, Professor**, Department of Laboratory Medicine, Division of Pathology, Karolinska Institutet, Stockholm 141-86, Sweden

**Andrzej S Tarnawski, MD, PhD, DSc (Med), Professor of Medicine, Chief Gastroenterology**, VA Long Beach Health Care System, University of California, Irvine, CA, 5901 E. Seventh Str., Long Beach,

CA 90822, United States

EDITORIAL BOARD MEMBERS  
All editorial board members resources online at <http://www.wjgnet.com/1007-9327/editorialboard.htm>

EDITORIAL OFFICE  
Ze-Mao Gong, Director  
*World Journal of Gastroenterology*  
Baishideng Publishing Group Inc  
7901 Stoneridge Drive, Suite 501,  
Pleasanton, CA 94588, USA  
Telephone: +1-925-2238242  
Fax: +1-925-2238243  
E-mail: [editorialoffice@wjgnet.com](mailto:editorialoffice@wjgnet.com)  
Help Desk: <http://www.f6publishing.com/helpdesk>  
<http://www.wjgnet.com>

PUBLISHER  
Baishideng Publishing Group Inc  
7901 Stoneridge Drive, Suite 501,  
Pleasanton, CA 94588, USA  
Telephone: +1-925-2238242  
Fax: +1-925-2238243  
E-mail: [bpgoffice@wjgnet.com](mailto:bpgoffice@wjgnet.com)  
Help Desk: <http://www.f6publishing.com/helpdesk>  
<http://www.wjgnet.com>

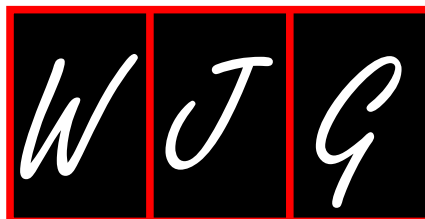
PUBLICATION DATE  
July 28, 2018

COPYRIGHT  
© 2018 Baishideng Publishing Group Inc. Articles published by this Open-Access journal are distributed under the terms of the Creative Commons Attribution Non-commercial License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non commercial and is otherwise in compliance with the license.

SPECIAL STATEMENT  
All articles published in journals owned by the Baishideng Publishing Group (BPG) represent the views and opinions of their authors, and not the views, opinions or policies of the BPG, except where otherwise explicitly indicated.

INSTRUCTIONS TO AUTHORS  
Full instructions are available online at <http://www.wjgnet.com/bpg/gerinfo/204>

ONLINE SUBMISSION  
<http://www.f6publishing.com>



## Considerations for bariatric surgery in patients with cirrhosis

George Boon-Bee Goh, Philip R Schauer, Arthur J McCullough

George Boon-Bee Goh, Department of Gastroenterology and Hepatology, Singapore General Hospital, Singapore 169608, Singapore

George Boon-Bee Goh, Duke-NUS Graduate Medical School, Singapore 169608, Singapore

Philip R Schauer, Bariatric and Metabolic Institute, Cleveland Clinic, Cleveland, OH 44195, United States

Arthur J McCullough, Department of Gastroenterology, Cleveland Clinic, Cleveland, OH 44195, United States

Arthur J McCullough, Department of Pathobiology, Cleveland Clinic, Cleveland, OH 44195, United States

ORCID number: George Boon-Bee Goh (0000-0001-8221-5299); Philip R Schauer (0000-0001-6258-5604); Arthur J McCullough (0000-0002-4906-0034).

Author contributions: All the authors contributed to the writing of this review.

Conflict-of-interest statement: All Authors declare no conflict of interest for this manuscript.

Open-Access: This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

Manuscript source: Invited manuscript

Correspondence to: George Boon-Bee Goh, MBBS, MRCP, Adjunct Professor, Department of Gastroenterology and Hepatology, Singapore General Hospital, 20 College Road, Academia, Singapore 169856, Singapore. [goh.boon.bee@singhealth.com.sg](mailto:goh.boon.bee@singhealth.com.sg)  
Telephone: +65-63266137

Received: April 5, 2018

Peer-review started: April 5, 2018

First decision: May 9, 2018

Revised: May 17, 2018

Accepted: June 25, 2018

Article in press: June 25, 2018

Published online: July 28, 2018

### Abstract

With the ever increasing global obesity pandemic, clinical burden from obesity related complications are anticipated in parallel. Bariatric surgery, a treatment approved for weight loss in morbidly obese patients, has reported to be associated with good outcomes, such as reversal of type two diabetes mellitus and reducing all-cause mortality on a long term basis. However, complications from bariatric surgery have similarly been reported. In particular, with the onslaught of non-alcoholic fatty liver disease (NAFLD) epidemic, in associated with obesity and metabolic syndrome, there is increasing prevalence of NAFLD related liver cirrhosis, which potentially connotes more risk of specific complications for surgery. Bariatric surgeons may encounter, either expectedly or unexpectedly, patients with non-alcoholic steatohepatitis (NASH) and NASH related cirrhosis more frequently. As such, the issues and considerations surrounding their medical care/surgery warrant careful deliberation to ensure the best outcomes. These considerations include severity of cirrhosis, liver synthetic function, portal hypertension and the impact of surgical factors. This review explores these considerations comprehensively and emphasizes the best approach to managing cirrhotic patients in the context of bariatric surgery.

**Key words:** Cirrhosis; Portal hypertension; Non-alcoholic fatty liver disease; Bariatric surgery; Complications

© The Author(s) 2018. Published by Baishideng Publishing Group Inc. All rights reserved.



**Core tip:** Bariatric surgery can be performed in patients with well compensated cirrhosis, typically of Child's A status, with minimal complication risks from surgical or hepatic factors. Patients need to be carefully selected and optimised, while surgical technique and modality also play equally important roles. With the onslaught of the non-alcoholic fatty liver disease epidemic and anticipated increase in patients with non-alcoholic steatohepatitis cirrhosis, bariatric surgery may provide an elixir as part of the armamentarium of therapeutic options.

Goh GB, Schauer PR, McCullough AJ. Considerations for bariatric surgery in patients with cirrhosis. *World J Gastroenterol* 2018; 24(28): 3112-3119 Available from: URL: <http://www.wjgnet.com/1007-9327/full/v24/i28/3112.htm> DOI: <http://dx.doi.org/10.3748/wjg.v24.i28.3112>

## INTRODUCTION

The global obesity pandemic continues unabated, accompanied with increasing healthcare and economic burden<sup>[1]</sup>. In 2005, 23.2% of the world's adult population were overweight and 9.8% were considered obese, translating to 937 million and 396 million overweight and obese adults, respectively. Projections have estimated the prevalence of overweight and obese adults to increase to 1.35 billion and 573 million adults by 2030 respectively<sup>[2]</sup>. Obesity is commonly associated with a plethora of chronic diseases, among them being non-alcoholic fatty liver disease (NAFLD), the most common chronic liver diseases seen in gastroenterology clinics<sup>[3]</sup>. NAFLD represents a spectrum of disease, of which a subset with more severe liver disease; namely non-alcoholic steatohepatitis (NASH) may progress to cirrhosis<sup>[4]</sup>. Cirrhosis represents advanced stage liver disease where cumulative liver injury and necroinflammation result in fibrogenesis of the liver. This fibrogenesis is characterised by diffuse nodular regeneration, surrounded by dense fibrous septa, leading to parenchymal loss and collapse/distortion of normal liver architecture. Clinically, this correlates with the development of portal hypertension and hepatic synthetic dysfunction<sup>[5]</sup>.

With increasing recognition of efficacy in treating obesity and obesity related diseases, bariatric surgery has been increasingly performed worldwide. Not unexpectedly, bariatric surgeons may encounter patients with NASH and NASH related cirrhosis, especially with the rising prevalence of obesity. A survey of bariatric surgeons found that 39% of them had unexpected discovery of cirrhosis during bariatric surgery, accounting for an incidence rate of 0.14%<sup>[6]</sup>. More importantly, the presence of cirrhosis often presents a vexing dilemma whether to proceed with surgery or not. This review explores the various important considerations in this context and suggests the best approaches to managing such patients.

## CONSIDERATION OF LIVER FACTORS: SEVERITY OF CIRRHOSIS

Traditionally, surgical procedures in cirrhotic patients have been recognised to confer significant morbidity and mortality. Compared to non-cirrhotic patients undergoing surgery, patients with cirrhosis were reported to have longer length of hospital stay and higher hospitalisation charges<sup>[7]</sup>. Early studies report an overall 30% postoperative mortality and 11.6% thirty day postoperative mortality after various surgical procedures<sup>[8]</sup>. Further characterisation of surgical risk has identified severity of liver disease, nature and type of surgery to be important dependant factors. The Child-Turcotte-Pugh (CTP) score based on a combination of 5 clinical and laboratory parameters, correlates well with surgical risk and has been validated in several studies; in general, patients with Child's A cirrhosis have postoperative mortality rates of 10%, rising to 30% and 80% with Child's B and C, respectively<sup>[9-11]</sup>. One criticism of the CTP score is the subjective nature of assessing two components of the CTP score; ascites and encephalopathy, which may lead clinicians to under or over-estimate actual liver function<sup>[12]</sup>. The model for end stage liver disease (MELD) score, a more recently developed score, has also been shown to effectively predict postoperative mortality, in particular 30-d mortality, where a linear relationship is observed, with mortality rising 1% for each MELD point below 20 and 2% thereafter<sup>[13]</sup>. In general, a MELD score above 8 predicts a poor outcome<sup>[12]</sup>. The advantage of the MELD score is that it is less subjective than the CTP score as it utilises only objective laboratory parameters (serum bilirubin, international normalised ratio and creatinine). However, based on current literature, the superiority of one score over the other has not been clearly established<sup>[14]</sup>. In the setting of NASH, lifestyle modifications including sustained weight loss form the cornerstone of treatment. In this respect, bariatric surgery may provide the most consistent and effective method of achieving and maintaining adequate weight loss, as compared to exercise/diet and other lifestyle measures. In addition, the benefits of bariatric surgery in NASH may extend from direct effects of weight loss to indirect effects of improved insulin resistance and pro-inflammatory state<sup>[15]</sup>. Pooled data from a meta-analysis of 15 studies demonstrated improvement/resolution in steatosis (91.6%), steatohepatitis (81.3%) and fibrosis (65.5%)<sup>[16]</sup>. However, the current literature available consists only of data from cohort studies and not randomised controlled trials. Furthermore, most of the data pertained to subjects without advanced fibrosis/cirrhosis. As such, a 2010 Cochrane review was unable to provide any recommendations in this aspect<sup>[17]</sup>. Moreover, considering the invasive nature of bariatric surgery, there is an urgent need for well-designed randomised controlled studies to clarify the efficacy of such interventions in the treatment of NASH and specifically NASH cirrhosis.

## CONSIDERATION OF LIVER FACTORS: PORTAL HYPERTENSION

Portal hypertension is another important factor to consider while assessing surgical risk. Portal hypertension is a frequent sequelae of cirrhosis, where fibrosis, scarring and the presence of regenerating nodules result in architectural distortion of the liver and in turn increased portal pressures<sup>[18]</sup>. Increased portal pressures contribute to the pathogenesis of many complications seen in cirrhosis, such as splenomegaly with thrombocytopenia, hyperkinetic circulatory state with ascites/unstable hemodynamics, gastro-esophageal varices, hepatorenal syndrome and portopulmonary syndrome<sup>[19]</sup>. Intuitively, in the context of surgery, the thrombocytopenia connotes increased bleeding risk, presence of ascites may impact on healing and wound complications particularly in abdominal surgery, while also promoting atelectasis and pulmonary complications through reduced lung expansion. Perioperative hemodynamics and fluid balance may be difficult to manage. Perioperative developments of hepatorenal or portopulmonary syndromes compromise the renal and respiratory systems, making surgery all the more difficult and complicated.

The gold standard technique of assessing portal hypertension is using hepatic venous pressure gradient measurement (HVPG), which is a strong prognostic factor in cirrhosis. Clinically significant portal hypertension is observed when HVPG increased above 10 mmHg<sup>[18,20,21]</sup>. Other signs to suggest significant portal hypertension would include presence of gastro-oesophageal varices, splenomegaly with thrombocytopenia and presence of ascites. With respect to hepatic resection for hepatocellular carcinoma in cirrhotic patients, both European (European Association for the Study of the Liver) and American (American Association for the Study of Liver Diseases) liver society guidelines consider portal hypertension to be a relative contraindication for surgery<sup>[22,23]</sup>, based on clinical studies observing increased risk of postoperative liver failure, complications and mortality in patients with portal hypertension compared to those without portal hypertension<sup>[24-26]</sup>. Similarly, in a nationwide population based American study on mortality following colorectal surgery, patients with cirrhosis and portal hypertension had significantly higher in-patient mortality compared to patients with cirrhosis but without portal hypertension (29% vs 14% mortality rate)<sup>[27]</sup>. This was consistent with a separate study exploring the impact of cirrhosis and portal hypertension on inpatient mortality across four specific types of surgery; cholecystectomy, colectomy, abdominal aortic aneurysm repair and coronary artery bypass grafting). Patients with cirrhosis and portal hypertension were at higher risk of mortality (Hazard ratio 7.8 to 22.7) compared to patients with cirrhosis alone (Hazard ratio 3.4 to 8) and patients without cirrhosis<sup>[7]</sup>. One method of addressing the issue of portal hypertension is through portal decompression using Transjugular Intrahepatic Portosystemic Shunt (TIPS) placement, which has been used to treat complications

such as bleeding varices, refractory ascites, hepatic hydrothorax and hepatorenal syndromes<sup>[28]</sup>. Several small case series have suggested the potential role and benefits of TIPS placement in reducing perioperative complications and mortality rates across a variety of surgical procedures, showing one year survival ranging between 56% and 100%<sup>[29-32]</sup>. Having said that, the potential benefits of preoperative TIPS must be weighed against the risk of TIPS placement. Progressive hepatic failure is a rare but most feared complication post TIPS placement. It is often the reflection of decreased liver blood perfusion due to shunting of blood away from the liver, culminating in hepatic ischemia and progressive dysfunction in an already poorly functioning liver<sup>[33]</sup>. In addition, the incidence of new or worsening hepatic encephalopathy following TIPS is 20%-31%, which may limit the enthusiasm for this procedure<sup>[34,35]</sup>. Increasing age, liver dysfunction and shunt diameter are important risk factors associated with hepatic encephalopathy post-TIPS placement<sup>[36]</sup>. Hence, caution must be exercised when selecting appropriate patients to undergo a TIPS procedure<sup>[28]</sup>.

In summary, common cirrhosis (including portal hypertension driven) related complications to be vigilant about in the post-operative setting would include worsening or new onset ascites, worsening or new onset hepatic encephalopathy, coagulopathy, fluid overload, renal failure or liver failure.

## CONSIDERATION OF SURGICAL FACTORS

The nature and type of surgery impacts on the morbidity and mortality in cirrhotic patients. While postop mortality and morbidity rates have been high historically, better identification/awareness, preoperative assessment/optimisation, newer anaesthetics and surgical techniques have mitigated such risks. Overall, better outcomes are observed with laparoscopic surgery over open surgery. In a small case series of 50 predominantly mild to moderately cirrhotic patients undergoing a variety of laparoscopic surgical procedures, Cobb *et al*<sup>[37]</sup> found an overall morbidity rate of 16% with no incidence of hepatic decompensation or mortality. A separate population-based study advocated the preference of laparoscopic cholecystectomy over open cholecystectomy in cirrhotic patients, with improved mortality (1.3% vs 8.3%), less post-operative infection (0.7% vs 3.5%) and lower requirement for blood transfusion (14.4% vs 19.2%)<sup>[38]</sup>. In general, laparoscopic techniques have improved outcomes over a range of surgical procedures in patients with mild to moderate cirrhosis<sup>[37]</sup>.

Separately, emergency surgery is generally regarded to have higher associated morbidity and mortality compared to elective surgery<sup>[39,40]</sup>. In addition, the surgical procedure itself has important implications and considerations in cirrhotic patients. Cardiac and major abdominal surgeries are considered high-risk surgeries in cirrhotic patients<sup>[14]</sup>. Assessing nationwide mortality rates

post elective surgery in cirrhotic patients, Csikesz *et al*<sup>[7]</sup> found disparate mortality rates among different surgical procedures (Hazard ratio 3.4, 3.7, 5.0 and 8.0 for cholecystectomy, colectomy, abdominal aortic aneurysm repair and coronary artery bypass grafting, respectively).

In summary, common surgical related complications among patients with cirrhosis would include sepsis, wound infection/dehiscence/impaired healing and bleeding.

## IMPACT OF BARIATRIC SURGERY ON THE LIVER

There have been several case series on the impact of bariatric surgery on the liver. In the 1960s to early 1980s, the jejunoileal bypass (JIB) was among the first bariatric surgical procedures used to treat morbid obesity. However, this procedure has since been abandoned due to multiple side effects of this procedure, including the development of hepatic failure<sup>[41]</sup>. In a longitudinal follow up study of patients who had undergone JIB, the risk of development of hepatic fibrosis and cirrhosis at 15 years post JIB was 45% and 8%, respectively<sup>[42]</sup>. Several other studies have confirmed the risk of progressive liver dysfunction following JIB, where rapid weight loss, protein-caloric malnutrition, global malabsorption and endotoxin effects have all been implicated<sup>[43-45]</sup>. Hepatic decompensation (albeit inconsistent evidence) has also been reported following biliary pancreatic diversion and long limb Roux en Y gastric bypass<sup>[46-48]</sup>. There has been less evidence of detrimental effects on the liver following the other bariatric surgical procedures. As such, in a survey of 126 bariatric surgeon responders, 59% would perform banded gastroplasty, 39% standard Roux en Y gastric bypass and only 5% biliary pancreatic diversion in patients with cirrhosis<sup>[6]</sup>. Bariatric surgery may also be associated with nutritional deficiencies, depending on the type of procedure performed. In particular, protein deficiency remains a significant concern which can manifest as oedema, loss of lean muscle mass, as well as biochemical features of anaemia and hypoalbuminemia. Changes in taste/food preference, potential macronutrient mal-digestion or absorption contribute to reduced protein intake, coupled with the generally higher protein demand following surgery, leads to a compromised nitrogen balance and connotes an important problem<sup>[49,50]</sup>. This takes on even more consequence in the setting of cirrhosis, where pre-existing malnutrition, sarcopenia and impaired protein metabolism are prevalent<sup>[51]</sup>. Hence, the predicament being that cirrhotic patients may not be able to achieve adequate protein intake with the pre-existing cirrhosis and additional demands placed by the bariatric surgery.

## REPORTED COMPLICATIONS OF BARIATRIC SURGERY IN PATIENTS WITH CIRRHOSIS

There have been relatively few studies describing com-

plications of bariatric surgery in patients with cirrhosis (Table 1). In an early survey of 126 bariatric surgeons worldwide who had collectively performed almost 87000 bariatric surgeries, 125 cases of cirrhosis with overall incidence of 0.14% were unexpectedly encountered. While there was no intraoperative mortality observed, 4 deaths perioperatively (within 30 d) were related to overwhelming sepsis or fulminant hepatic failure. In addition, a further 7 late deaths were accounted for predominantly from liver failure. Separately, within the same paper, Brolin reported on 8 of his own patients with cirrhosis out of an overall series of 580 patients; hepatic failure accounted for 1 perioperative and 1 late mortality<sup>[6]</sup>. With the advent of laparoscopic approaches to bariatric surgery, surgical outcomes have improved further. Dallal *et al*<sup>[52]</sup> performed a retrospective review of 2119 patients who had undergone laparoscopic bariatric surgery and identified 30 patients with cirrhosis (1.4%), the majority of which were discovered intraoperatively. While there were no perioperative deaths, need for conversion to open laparotomy or liver related complications, early postoperative complications occurred in 9 of the cirrhotic patients, including anastomotic leak, acute tubular necrosis, prolonged intubation, ileus and blood transfusion. In addition, there were no major late complications other than 1 unrelated death from esophageal cancer one year post gastric bypass<sup>[52]</sup>. A subsequent case series of 23 cirrhotic patients who had undergone a combination of laparoscopic bariatric procedures (RYGB, sleeve gastrectomy, adjustable gastric banding) reported complications in 8 patients including anastomotic leak, structuring, infected hematoma, pneumonia and bleeding requiring blood transfusion. However, there was no liver decompensation after surgery and no perioperative mortality was reported. Of note, 2 of the cirrhotic patients successfully underwent laparoscopic sleeve gastrectomy after TIPS procedure to control their portal hypertension<sup>[53]</sup>. Takata *et al*<sup>[54]</sup> also advocated the safety and benefits of laparoscopic bariatric surgery in patients with cirrhosis; 2 out of 6 patients with cirrhosis who underwent laparoscopic sleeve gastrectomy had only minor complications (1 patient developed ascites that responded to medical therapy while the other patient developed hepatic encephalopathy secondary to urinary tract infection that also responded to standard therapy)<sup>[54]</sup>. Additional support for laparoscopic sleeve gastrectomy in cirrhotic patients was provided by Rebibo and colleagues, who reviewed 13 patients with Child's A cirrhosis and observed no postoperative mortality or cirrhosis specific complications<sup>[55]</sup>. A unique complication of portal vein thrombosis with associated mesenteric ischaemia was described by Hughes and colleagues in a cirrhotic patient two weeks post laparoscopic sleeve gastrectomy. However, the patient recovered well post resection of her ischaemic bowel<sup>[56]</sup>. Further experiences of bariatric surgery in the context of cirrhosis patients were reported by Woodford *et al*<sup>[57]</sup>, who reported two surgical complications, but no operative mortality in their series of 14 patients with compensated cirrhosis that underwent



**Table 1** Study characteristics of bariatric surgery in patients with cirrhosis

Author, year	Number. cirrhotics	Childs status	Procedure	Average op time	Average blood loss	LOS	Complication	Mortality	Comments
Brolin 1998	8	NR	7 RYGB, 1 JIB reversal	NR	543 mL	NR	Ascitic fluid leak, marginal ulcer, amputation	1 periop death, 2 late deaths	
Dallal 2004	30	A	27 lap RYGB, 3 lap SG	4 h	290 mL	4	ATN, anastomotic leak, blood transfusion, prolonged ileus, prolonged intubation	1 late unrelated death	%EWL at 12 mo 63%
Takata 2008	6	4 A, 2B	6 Lap SG	141 min	58 mL	4.2	2 pts, development of ascites, HE post UTI	Nil	%EWL at 9 mo 33%
Shimizu 2013	23	22 A, 1B	14 lap RYGB, 8 lap SG, 1 LAGB	NR	NR	4.3	8 pts, anastomotic leak, stricture, infected hematoma, pneumonia	1 death 9 months postop of unknown cause	
Lin 2013	20	NR	Lap SG	151 min	NR	4.2	2 wound infections, 1 transient HE, 1 transient renal insufficiency, 1 bleeding, 1 staple line leak	1 death 4 years postop, 2 deaths on liver tx waiting list	
Rebibo 2014	13	13 A	13 lap SG	75 min	NR	3	1 postop intra-abdo hematoma	Nil	%EWL at 6 mo 61.9%
Hughes 2014	1	A	Lap SG	NR	NR	NR	Portal vein thrombosis with mesenteric ischaemia	Nil	
Woodford 2015	14	NR	14 LAGB	NR	NR	NR	1 postop surgical site infection, 1 revision of malpositioned band	1 unrelated death 11 yr post surg	%EWL at 12 mo 61.3%
Pestana 2015	14	A	11 SG, 3 RYGB	NR	NR	NR	1 unrelated HE 2 yr post-surgery	Nil	%Total weight loss at 24 mo 25.6%
Wolter 2016	12	NR	12 lap procedures	NR	NR	NR	1 staple line leak, 1 intra-abdominal abscess, 1 intraluminal bleed, 1 dysrhythmia	Nil	No significant association betw cirrhosis and periop events

NR: Not recorded; JIB: Jejunioileal bypass; SG: Sleeve gastrectomy; RYGB: Roux-en-Y gastric bypass; LAGB: Laparoscopic adjustable gastric banding; BPD: Biliopancreatic diversion; lap: Laparoscopic; %EWL: Percentage excess weight loss.

laparoscopic adjustable gastric banding. Comparable accounts were corroborated by a separate series of 14 cirrhotic patients that underwent sleeve gastrectomy or gastric bypass<sup>[58]</sup>. Along similar lines, Wolter *et al*<sup>[59]</sup> described 302 patients who had laparoscopic gastric bypass or sleeve gastrectomy performed, of which 12 patients had cirrhosis; there were no significant association between perioperative complications and liver cirrhosis. Nevertheless, in a large scale population based study of bariatric surgery patients, presence of compensated cirrhosis was associated with increased length of hospital stay (4.4 d vs 3.2 d,  $P = 0.03$ ) and increased mortality rates (OR: 2.17, 95%CI: 1.03-4.55). Not unexpectedly, patients with decompensated cirrhosis had even worse outcomes. The combined in hospital mortality rate for both compensated and decompensated cirrhotics was 1.2%, with mortality rates lower at high volume centres (> 100 procedures per year) compared to lower volume centres<sup>[60]</sup>. More recently, in a retrospective study of 297 patients with NAFLD who had undergone bariatric surgery, while the median length of hospital stay was higher in patients with advanced liver fibrosis (4 d vs 3 d,  $P = 0.002$ ) compared to those without advanced fibrosis,

there was no significant difference in the proportion of patients with complications over 1 year post operation (36.4% vs 32.8%,  $P = 0.54$ )<sup>[61]</sup>.

## APPROACH TO BARIATRIC SURGERY IN PATIENTS WITH CIRRHOSIS

While the few case series on bariatric surgery in patients with cirrhosis do suggest that bariatric surgery can be performed safely in carefully selected patients without prohibitive complication rates, the majority of the studies were based on patients with well compensated cirrhosis. Therefore, it remains to be seen if such surgeries can be similarly performed successfully in patients with poorer hepatic reserves. Preferably, cirrhotic patients should undergo bariatric surgery in high volume centres

The first step is to recognise and diagnose patients with cirrhosis. This is usually based on biochemical and imaging features. Surgical risk can be further stratified using CTP or MELD score to estimate liver reserve. In addition, HVPG to assess degree of portal hypertension would be useful in further management. In the event of

significant portal hypertension, TIPS can be considered to reduce risk of perioperative complications<sup>[32]</sup>. Input from a hepatologist to optimise cirrhotic patients perioperatively would be valuable.

There remains no consensus on which bariatric modality is best suited for the patient with cirrhosis<sup>[62]</sup>. Current available data suggest that the less invasive laparoscopic approach would be safer to perform in cirrhotics. The bariatric procedures that can be performed laparoscopically would include the RYGB, sleeve gastrectomy and gastric banding, each representing their own distinct advantages and disadvantages.

In general, RYGP provides the most potential for weight loss, but may have a greater risk of vitamin deficiencies compared to sleeve gastrectomy that may further lead to progressive hepatic dysfunction. In addition, due to altered anatomy surgically, the stomach remnant and biliary tree would be inaccessible endoscopically in the event of a gastrointestinal bleed or biliary obstruction. Furthermore, the altered anatomy may render future orthotopic liver transplantation more challenging.

Gastric banding would be the least invasive procedure, but the potential risk of infection with placement of a foreign device in cirrhotic patients already at increased risk of infections would limit the enthusiasm of such a procedure.

Sleeve gastrectomy reduces the risk of malabsorption or placement of a foreign body, but may predispose to bleeding risk in the setting of gastric varices. Increasingly, laparoscopic sleeve gastrectomy has been advocated as the bariatric modality of choice in patients with cirrhosis<sup>[53-55]</sup>. Sleeve gastrectomy is well tolerated, technically less challenging with a relatively short learning curve and operating time<sup>[63]</sup>. Relative to gastric bypass, sleeve gastrectomy has been shown to be associated with fewer complications overall<sup>[64]</sup>. Furthermore, access to the stomach remnants and biliary system would remain possible with sleeve gastrectomy. With respect to liver transplantation, laparoscopic sleeve gastrectomy was observed to be well tolerated while improving candidacy for liver transplantation<sup>[54]</sup>. In addition, sleeve gastrectomy has been shown to be safe and feasible in combination with liver transplantation at a single setting or as a staged procedure post liver transplantation<sup>[65, 66]</sup>.

Nevertheless, there remains important information gaps with regards to bariatric surgery in patients with cirrhosis. More studies are needed to assess the long term outcomes of patients with cirrhosis post bariatric surgery. In addition, more data is required in patients with more advanced cirrhosis. Better characterisation in terms of surgical candidacy, differentiating those who would derive benefit and those who would not, are imperative to develop strategies and recommendations for the improvement of bariatric surgical outcomes in patients with cirrhosis.

## CONCLUSION

Bariatric surgery can be performed in patients with

well compensated cirrhosis, typically of Child's A status, with minimal complication risks from surgical or hepatic factors. Patients need to be carefully selected and optimised, while surgical technique and modality also play equally important roles. With the onslaught of the NAFLD epidemic and anticipated increase in patients with NASH cirrhosis, bariatric surgery may provide an elixir as part of the armamentarium of therapeutic options.

## REFERENCES

- 1 **Wang YC**, McPherson K, Marsh T, Gortmaker SL, Brown M. Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet* 2011; **378**: 815-825 [PMID: 21872750 DOI: 10.1016/S0140-6736(11)60814-3]
- 2 **Kelly T**, Yang W, Chen CS, Reynolds K, He J. Global burden of obesity in 2005 and projections to 2030. *Int J Obes (Lond)* 2008; **32**: 1431-1437 [PMID: 18607383 DOI: 10.1038/ijo.2008.102]
- 3 **Younossi ZM**, Stepanova M, Afendy M, Fang Y, Younossi Y, Mir H, Srishord M. Changes in the prevalence of the most common causes of chronic liver diseases in the United States from 1988 to 2008. *Clin Gastroenterol Hepatol* 2011; **9**: 524-530.e1; quiz e60 [PMID: 21440669]
- 4 **Argo CK**, Caldwell SH. Epidemiology and natural history of non-alcoholic steatohepatitis. *Clin Liver Dis* 2009; **13**: 511-531 [PMID: 19818302 DOI: 10.1016/j.cld.2009.07.005]
- 5 **Tsochatzis EA**, Bosch J, Burroughs AK. Liver cirrhosis. *Lancet* 2014; **383**: 1749-1761 [PMID: 24480518 DOI: 10.1016/S0140-6736(14)60121-5]
- 6 **Brolin RE**, Bradley LJ, Taliwal RV. Unsuspected cirrhosis discovered during elective obesity operations. *Arch Surg* 1998; **133**: 84-88 [PMID: 9438765 DOI: 10.1001/archsurg.133.1.84]
- 7 **Csikesz NG**, Nguyen LN, Tseng JF, Shah SA. Nationwide volume and mortality after elective surgery in cirrhotic patients. *J Am Coll Surg* 2009; **208**: 96-103 [PMID: 19228510 DOI: 10.1016/j.jamcollsurg.2008.09.006]
- 8 **Ziser A**, Plevak DJ, Wiesner RH, Rakela J, Offord KP, Brown DL. Morbidity and mortality in cirrhotic patients undergoing anesthesia and surgery. *Anesthesiology* 1999; **90**: 42-53 [PMID: 9915311 DOI: 10.1097/00000542-199901000-00008]
- 9 **Garrison RN**, Cryer HM, Howard DA, Polk HC Jr. Clarification of risk factors for abdominal operations in patients with hepatic cirrhosis. *Ann Surg* 1984; **199**: 648-655 [PMID: 6732310 DOI: 10.1097/00000658-198406000-00003]
- 10 **Mansour A**, Watson W, Shayani V, Pickleman J. Abdominal operations in patients with cirrhosis: still a major surgical challenge. *Surgery* 1997; **122**: 730-5; discussion 735-6 [PMID: 9347849 DOI: 10.1016/S0039-6060(97)90080-5]
- 11 **Teh SH**, Nagorney DM, Stevens SR, Offord KP, Therneau TM, Plevak DJ, Talwalkar JA, Kim WR, Kamath PS. Risk factors for mortality after surgery in patients with cirrhosis. *Gastroenterology* 2007; **132**: 1261-1269 [PMID: 17408652 DOI: 10.1053/j.gastro.2007.01.040]
- 12 **Nicoll A**. Surgical risk in patients with cirrhosis. *J Gastroenterol Hepatol* 2012; **27**: 1569-1575 [PMID: 22694313 DOI: 10.1111/j.1440-1746.2012.07205.x]
- 13 **Northup PG**, Wanamaker RC, Lee VD, Adams RB, Berg CL. Model for End-Stage Liver Disease (MELD) predicts nontransplant surgical mortality in patients with cirrhosis. *Ann Surg* 2005; **242**: 244-251 [PMID: 16041215 DOI: 10.1097/01.sla.0000171327.29262.e0]
- 14 **Frye JW**, Perri RE. Perioperative risk assessment for patients with cirrhosis and liver disease. *Expert Rev Gastroenterol Hepatol* 2009; **3**: 65-75 [PMID: 19210114 DOI: 10.1586/17474124.3.1.65]
- 15 **Clanton J**, Subichin M. The Effects of Metabolic Surgery on Fatty Liver Disease and Nonalcoholic Steatohepatitis. *Surg Clin North Am* 2016; **96**: 703-715 [PMID: 27473796 DOI: 10.1016/j.suc.2016.03.008]
- 16 **Mummadi RR**, Kasturi KS, Chennareddygar S, Sood GK. Effect

- of bariatric surgery on nonalcoholic fatty liver disease: systematic review and meta-analysis. *Clin Gastroenterol Hepatol* 2008; **6**: 1396-1402 [PMID: 18986848 DOI: 10.1016/j.cgh.2008.08.012]
- 17 **Chavez-Tapia NC**, Tellez-Avila FI, Barrientos-Gutierrez T, Mendez-Sanchez N, Lizardi-Cervera J, Uribe M. Bariatric surgery for non-alcoholic steatohepatitis in obese patients. *Cochrane Database Syst Rev* 2010; CD007340 [PMID: 20091629 DOI: 10.1002/14651858.CD007340.pub2]
  - 18 **Berzigotti A**, Seijo S, Reverter E, Bosch J. Assessing portal hypertension in liver diseases. *Expert Rev Gastroenterol Hepatol* 2013; **7**: 141-155 [PMID: 23363263 DOI: 10.1586/egh.12.83]
  - 19 **Nusrat S**, Khan MS, Fazili J, Madhoun MF. Cirrhosis and its complications: evidence based treatment. *World J Gastroenterol* 2014; **20**: 5442-5460 [PMID: 24833875 DOI: 10.3748/wjg.v20.i18.5442]
  - 20 **Garcia-Tsao G**, Groszmann RJ, Fisher RL, Conn HO, Atterbury CE, Glickman M. Portal pressure, presence of gastroesophageal varices and variceal bleeding. *Hepatology* 1985; **5**: 419-424 [PMID: 3873388 DOI: 10.1002/hep.1840050313]
  - 21 **Stanley AJ**, Robinson I, Forrest EH, Jones AL, Hayes PC. Haemodynamic parameters predicting variceal haemorrhage and survival in alcoholic cirrhosis. *QJM* 1998; **91**: 19-25 [PMID: 9519209 DOI: 10.1093/qjmed/91.1.19]
  - 22 **Bruix J**, Sherman M; Practice Guidelines Committee, American Association for the Study of Liver Diseases. Management of hepatocellular carcinoma. *Hepatology* 2005; **42**: 1208-1236 [PMID: 16250051 DOI: 10.1002/hep.20933]
  - 23 **European Association For The Study Of The Liver**; European Organisation For Research And Treatment Of Cancer. EASL-EORTC clinical practice guidelines: management of hepatocellular carcinoma. *J Hepatol* 2012; **56**: 908-943 [PMID: 22424438 DOI: 10.1016/j.jhep.2011.12.001]
  - 24 **Bruix J**, Castells A, Bosch J, Feu F, Fuster J, Garcia-Pagan JC, Visa J, Bru C, Rodés J. Surgical resection of hepatocellular carcinoma in cirrhotic patients: prognostic value of preoperative portal pressure. *Gastroenterology* 1996; **111**: 1018-1022 [PMID: 8831597 DOI: 10.1016/S0016-5085(96)70070-7]
  - 25 **Llovet JM**, Fuster J, Bruix J. Intention-to-treat analysis of surgical treatment for early hepatocellular carcinoma: resection versus transplantation. *Hepatology* 1999; **30**: 1434-1440 [PMID: 10573522 DOI: 10.1002/hep.510300629]
  - 26 **Poon RT**, Fan ST, Lo CM, Liu CL, Lam CM, Yuen WK, Yeung C, Wong J. Improving perioperative outcome expands the role of hepatectomy in management of benign and malignant hepatobiliary diseases: analysis of 1222 consecutive patients from a prospective database. *Ann Surg* 2004; **240**: 698-708; discussion 708-10 [PMID: 15383797 DOI: 10.1097/01.sla.0000141195.66155.0c]
  - 27 **Nguyen GC**, Correia AJ, Thuluvath PJ. The impact of cirrhosis and portal hypertension on mortality following colorectal surgery: a nationwide, population-based study. *Dis Colon Rectum* 2009; **52**: 1367-1374 [PMID: 19617746 DOI: 10.1007/DCR.0b013e3181a80dca]
  - 28 **Boyer TD**, Haskal ZJ; American Association for the Study of Liver Diseases. The role of transjugular intrahepatic portosystemic shunt in the management of portal hypertension. *Hepatology* 2005; **41**: 386-400 [PMID: 15660434 DOI: 10.1002/hep.20559]
  - 29 **Schlenker C**, Johnson S, Trotter JF. Preoperative transjugular intrahepatic portosystemic shunt (TIPS) for cirrhotic patients undergoing abdominal and pelvic surgeries. *Surg Endosc* 2009; **23**: 1594-1598 [PMID: 19263108 DOI: 10.1007/s00464-009-0405-7]
  - 30 **Azoulay D**, Buabse F, Damiano I, Smail A, Ichai P, Dannaoui M, Castaing D, Bismuth H. Neoadjuvant transjugular intrahepatic portosystemic shunt: a solution for extrahepatic abdominal operation in cirrhotic patients with severe portal hypertension. *J Am Coll Surg* 2001; **193**: 46-51 [PMID: 11442253 DOI: 10.1016/S1072-7515(01)00911-5]
  - 31 **Gil A**, Martínez-Regueira F, Hernández-Lizoain JL, Pardo F, Olea JM, Bastarrika G, Cienfuegos JA, Bilbao JI. The role of transjugular intrahepatic portosystemic shunt prior to abdominal tumoral surgery in cirrhotic patients with portal hypertension. *Eur J Surg Oncol* 2004; **30**: 46-52 [PMID: 14736522 DOI: 10.1016/j.ejso.2003.10.014]
  - 32 **Kim JJ**, Dasika NL, Yu E, Fontana RJ. Cirrhotic patients with a transjugular intrahepatic portosystemic shunt undergoing major extrahepatic surgery. *J Clin Gastroenterol* 2009; **43**: 574-579 [PMID: 19169145 DOI: 10.1097/MCG.0b013e31818738ef]
  - 33 **Walser EM**, Nguyen M. Hepatic perfusion and hemodynamic effects of transjugular intrahepatic portosystemic shunts. *Semin Intervent Radiol* 2005; **22**: 271-277 [PMID: 21326705 DOI: 10.1055/s-2005-925553]
  - 34 **Sanyal AJ**, Freedman AM, Shiffman ML, Purdum PP 3rd, Luketic VA, Cheatham AK. Portosystemic encephalopathy after transjugular intrahepatic portosystemic shunt: results of a prospective controlled study. *Hepatology* 1994; **20**: 46-55 [PMID: 8020904]
  - 35 **Somberg KA**, Riegler JL, LaBerge JM, Doherty-Simor MM, Bachetti P, Roberts JP, Lake JR. Hepatic encephalopathy after transjugular intrahepatic portosystemic shunts: incidence and risk factors. *Am J Gastroenterol* 1995; **90**: 549-555 [PMID: 7717309]
  - 36 **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]
  - 37 **Cobb WS**, Heniford BT, Burns JM, Carbonell AM, Matthews BD, Kercher KW. Cirrhosis is not a contraindication to laparoscopic surgery. *Surg Endosc* 2005; **19**: 418-423 [PMID: 15624057 DOI: 10.1007/s00464-004-8722-3]
  - 38 **Chmielecki DK**, Hagopian EJ, Kuo YH, Kuo YL, Davis JM. Laparoscopic cholecystectomy is the preferred approach in cirrhosis: a nationwide, population-based study. *HPB (Oxford)* 2012; **14**: 848-853 [PMID: 23134187 DOI: 10.1111/j.1477-2574.2012.00562.x]
  - 39 **Millwala F**, Nguyen GC, Thuluvath PJ. Outcomes of patients with cirrhosis undergoing non-hepatic surgery: risk assessment and management. *World J Gastroenterol* 2007; **13**: 4056-4063 [PMID: 17696222 DOI: 10.3748/wjg.v13.i30.4056]
  - 40 **Carbonell AM**, Wolfe LG, DeMaria EJ. Poor outcomes in cirrhosis-associated hernia repair: a nationwide cohort study of 32,033 patients. *Hernia* 2005; **9**: 353-357 [PMID: 16132187 DOI: 10.1007/s10029-005-0022-x]
  - 41 **Hocking MP**, Duerson MC, O'Leary JP, Woodward ER. Jejunoileal bypass for morbid obesity. Late follow-up in 100 cases. *N Engl J Med* 1983; **308**: 995-999 [PMID: 6835318 DOI: 10.1056/NEJM198304283081703]
  - 42 **Hocking MP**, Davis GL, Franzini DA, Woodward ER. Long-term consequences after jejunoileal bypass for morbid obesity. *Dig Dis Sci* 1998; **43**: 2493-2499 [PMID: 9824141 DOI: 10.1023/A:1026698602714]
  - 43 **O'Leary JP**. Hepatic complications of jejunoileal bypass. *Semin Liver Dis* 1983; **3**: 203-215 [PMID: 6353595 DOI: 10.1055/s-2008-1040686]
  - 44 **Styblo T**, Martin S, Kaminski DL. The effects of reversal of jejunoileal bypass operations on hepatic triglyceride content and hepatic morphology. *Surgery* 1984; **96**: 632-641 [PMID: 6484807]
  - 45 **Vyberg M**, Ravn V, Andersen B. Pattern of progression in liver injury following jejunoileal bypass for morbid obesity. *Liver* 1987; **7**: 271-276 [PMID: 3695814 DOI: 10.1111/j.1600-0676.1987.tb00355.x]
  - 46 **Antal SC**. Prevention and Reversal of Liver Damage following Biliopancreatic Diversion for Obesity. *Obes Surg* 1994; **4**: 285-290 [PMID: 10742788 DOI: 10.1381/096089294765558520]
  - 47 **Castillo J**, Fábrega E, Escalante CF, Sanjuan JC, Herrera L, Hernáiz F, Martino E, Casafont F, Gómez Fleitas M. Liver transplantation in a case of steatohepatitis and subacute hepatic failure after biliopancreatic diversion for morbid obesity. *Obes Surg* 2001; **11**: 640-642 [PMID: 11594111 DOI: 10.1381/09608920160557174]
  - 48 **Cotler SJ**, Vitello JM, Guzman G, Testa G, Benedetti E, Layden TJ. Hepatic decompensation after gastric bypass surgery for severe obesity. *Dig Dis Sci* 2004; **49**: 1563-1568 [PMID: 15573905 DOI: 10.1023/B:DDAS.0000043364.75898.c8]
  - 49 **Moize V**, Geliebter A, Gluck ME, Yahav E, Lorence M, Colarusso T, Drake V, Flancbaum L. Obese patients have inadequate protein intake related to protein intolerance up to 1 year following Roux-

- en-Y gastric bypass. *Obes Surg* 2003; **13**: 23-28 [PMID: 12630609 DOI: 10.1381/096089203321136548]
- 50 **Odstreil EA**, Martinez JG, Santa Ana CA, Xue B, Schneider RE, Steffer KJ, Porter JL, Asplin J, Kuhn JA, Fordtran JS. The contribution of malabsorption to the reduction in net energy absorption after long-limb Roux-en-Y gastric bypass. *Am J Clin Nutr* 2010; **92**: 704-713 [PMID: 20739420 DOI: 10.3945/ajcn.2010.29870]
- 51 **Anand AC**. Nutrition and Muscle in Cirrhosis. *J Clin Exp Hepatol* 2017; **7**: 340-357 [PMID: 29234200 DOI: 10.1016/j.jceh.2017.11.001]
- 52 **Dallal RM**, Mattar SG, Lord JL, Watson AR, Cottam DR, Eid GM, Hamad G, Rabinovitz M, Schauer PR. Results of laparoscopic gastric bypass in patients with cirrhosis. *Obes Surg* 2004; **14**: 47-53 [PMID: 14980033 DOI: 10.1381/096089204772787284]
- 53 **Shimizu H**, Phuong V, Maia M, Kroh M, Chand B, Schauer PR, Brethauer SA. Bariatric surgery in patients with liver cirrhosis. *Surg Obes Relat Dis* 2013; **9**: 1-6 [PMID: 23201210 DOI: 10.1016/j.soard.2012.07.021]
- 54 **Takata MC**, Campos GM, Ciovia R, Rabl C, Rogers SJ, Cello JP, Ascher NL, Posselt AM. Laparoscopic bariatric surgery improves candidacy in morbidly obese patients awaiting transplantation. *Surg Obes Relat Dis* 2008; **4**: 159-164; discussion 164-165 [PMID: 18294923 DOI: 10.1016/j.soard.2007.12.009]
- 55 **Rebibo L**, Gerin O, Verhaeghe P, Dhahri A, Cosse C, Regimbeau JM. Laparoscopic sleeve gastrectomy in patients with NASH-related cirrhosis: a case-matched study. *Surg Obes Relat Dis* 2014; **10**: 405-410; quiz 565 [PMID: 24355322 DOI: 10.1016/j.soard.2013.09.015]
- 56 **Hughes DL**, Worrall SJ, Khan H, Cochrane R. Mesenteric ischaemia secondary to portomesenteric venous thrombosis, 2 weeks post laparoscopic sleeve gastrectomy in a cirrhotic patient. *BMJ Case Rep* 2014; **2014**: bcr2013202246 [PMID: 24618867]
- 57 **Woodford RM**, Burton PR, O'Brien PE, Laurie C, Brown WA. Laparoscopic Adjustable Gastric Banding In Patients with Unexpected Cirrhosis: Safety and Outcomes. *Obes Surg* 2015; **25**: 1858-1862 [PMID: 25708241 DOI: 10.1007/s11695-015-1623-9]
- 58 **Pestana L**, Swain J, Dierkhising R, Kendrick ML, Kamath PS, Watt KD. Bariatric surgery in patients with cirrhosis with and without portal hypertension: a single-center experience. *Mayo Clin Proc* 2015; **90**: 209-215 [PMID: 25659239 DOI: 10.1016/j.mayocp.2014.11.012]
- 59 **Wolter S**, Duprée A, Coelius C, El Gammal A, Kluwe J, Sauer N, Mann O. Influence of Liver Disease on Perioperative Outcome After Bariatric Surgery in a Northern German Cohort. *Obes Surg* 2017; **27**: 90-95 [PMID: 27272667 DOI: 10.1007/s11695-016-2253-6]
- 60 **Mosko JD**, Nguyen GC. Increased perioperative mortality following bariatric surgery among patients with cirrhosis. *Clin Gastroenterol Hepatol* 2011; **9**: 897-901 [PMID: 21782772 DOI: 10.1016/j.cgh.2011.07.007]
- 61 **Singh T**, Kochhar GS, Goh GB, Schauer P, Brethauer S, Kroh M, Aminian A, Lopez R, Dasarathy S, McCullough AJ. Safety and efficacy of bariatric surgery in patients with advanced fibrosis. *Int J Obes (Lond)* 2017; **41**: 443-449 [PMID: 27881858 DOI: 10.1038/ijo.2016.212]
- 62 **Wu R**, Ortiz J, Dallal R. Is bariatric surgery safe in cirrhotics? *Hepat Mon* 2013; **13**: e8536 [PMID: 23610589 DOI: 10.5812/hepatmon.8536]
- 63 **Trastulli S**, Desiderio J, Guarino S, Cirotchi R, Scalercio V, Noya G, Parisi A. Laparoscopic sleeve gastrectomy compared with other bariatric surgical procedures: a systematic review of randomized trials. *Surg Obes Relat Dis* 2013; **9**: 816-829 [PMID: 23993246 DOI: 10.1016/j.soard.2013.05.007]
- 64 **Li JF**, Lai DD, Ni B, Sun KX. Comparison of laparoscopic Roux-en-Y gastric bypass with laparoscopic sleeve gastrectomy for morbid obesity or type 2 diabetes mellitus: a meta-analysis of randomized controlled trials. *Can J Surg* 2013; **56**: E158-E164 [PMID: 24284156 DOI: 10.1503/cjs.026912]
- 65 **Heimbach JK**, Watt KD, Poterucha JJ, Ziller NF, Cecco SD, Charlton MR, Hay JE, Wiesner RH, Sanchez W, Rosen CB, Swain JM. Combined liver transplantation and gastric sleeve resection for patients with medically complicated obesity and end-stage liver disease. *Am J Transplant* 2013; **13**: 363-368 [PMID: 23137119 DOI: 10.1111/j.1600-6143.2012.04318.x]
- 66 **Lin MY**, Tavakol MM, Sarin A, Amirkiai SM, Rogers SJ, Carter JT, Posselt AM. Safety and feasibility of sleeve gastrectomy in morbidly obese patients following liver transplantation. *Surg Endosc* 2013; **27**: 81-85 [PMID: 22752278 DOI: 10.1007/s00464-012-2410-5]

**P- Reviewer:** Lenz K, Shimizu Y **S- Editor:** Wang JL **L- Editor:** A  
**E- Editor:** Yin SY





Published by **Baishideng Publishing Group Inc**  
7901 Stoneridge Drive, Suite 501, Pleasanton, CA 94588, USA  
Telephone: +1-925-223-8242  
Fax: +1-925-223-8243  
E-mail: [bpgoffice@wjgnet.com](mailto:bpgoffice@wjgnet.com)  
Help Desk: <http://www.f6publishing.com/helpdesk>  
<http://www.wjgnet.com>



ISSN 1007-9327

