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EASL Clinical Practice Guidelines on extrahepatic abdominal surgery in patients with cirrhosis and advanced chronic liver disease☆

European Association for the Study of the Liver*

Summary

Extrahepatic abdominal surgery in patients with cirrhosis of the liver represents a growing clinical challenge due to the increasing prevalence of chronic liver disease and improved long-term survival of these patients. The presence of cirrhosis significantly increases the risk of perioperative morbidity and mortality following abdominal surgery. Advances in preoperative risk stratification, surgical techniques, and perioperative care have led to better outcomes, yet integration of these improvements into routine clinical practice is needed. These clinical practice guidelines provide comprehensive recommendations for the assessment and perioperative management of patients with cirrhosis undergoing extrahepatic abdominal surgery. An individualised patient-centred risk assessment by a multidisciplinary team including hepatologists, surgeons, anaesthesiologists, and other support teams is essential.

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Introduction

Managing extrahepatic abdominal surgery in patients with cirrhosis presents unique challenges, requiring a nuanced, multidisciplinary approach to optimise outcomes. Cirrhosis increases the risk of acute-on-chronic liver failure (ACLF) – defined by organ failure(s) in the context of decompensated cirrhosis[1] – which is associated with higher mortality, particularly in the perioperative setting. As a result, surgical interventions demand careful risk assessment and individualised treatment strategies.

These guidelines emphasise the importance of distinguishing between urgent and non-urgent surgeries in patients with cirrhosis. Urgent procedures require a specific risk-benefit evaluation**,** while non-urgent surgeries necessitate a thorough preoperative assessment, optimisation, and selection of the most appropriate surgical technique (Fig. 1). Multidisciplinary team discussions involving hepatology, surgery, radiology, anaesthesiology, and nutrition specialists are essential for coordinated planning and optimal perioperative management, whether for elective or emergency procedures. Furthermore, the guidelines advocate for differentiating surgical centres based on expertise rather than surgical volume. Prioritising expert teams over case numbers ensures that patients receive specialised care tailored to their complex needs**.** While the definition of an "expert centre" remains somewhat subjective, the primary goal is to enhance patient safety and surgical outcomes by ensuring that surgeries are performed in facilities with the necessary expertise and resources. Given the high risk of postoperative decompensation, mainly represented by intra- and postoperative mortality, a forward-looking approach is recommended, including early consideration of liver transplantation (LT) for eligible patients. This proactive strategy helps manage complications and facilitates access to LT if needed postoperatively. However, LT-specific considerations are beyond the scope of these guidelines, as they have been addressed separately in the LT guidelines.[2]

In summary, the EASL Clinical Practice Guidelines (CPGs) on extrahepatic abdominal surgery in patients with cirrhosis provide evidence-based recommendations on the risks, preoperative workup, and perioperative management of patients requiring surgery. These guidelines address both elective and emergency surgical scenarios in patients with compensated and decompensated liver disease. However, they do not cover hepatic surgery for primary liver cancers in patients with cirrhosis, as dedicated EASL guidelines on hepatocellular carcinoma[3] and intrahepatic cholangiocarcinoma[4] have been published recently.

Methodology used for the development of the present CPG

The EASL Governing Board has selected a multidisciplinary panel of experts to prepare these CPGs to provide the best evidence on extrahepatic abdominal surgery in patients with

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☆ Clinical Practice Guideline Panel: Chairs: Dominique Thabut, Bobby VM Dasari; Secretary to the Chair: Manon Allaire; Panel members: Annalisa Berzigotti, Annabel Blasi, Pål-Dag Line, Mattias Mandorfer, Vincenzo Mazzaferro; EASL Governing Board representative: Virginia Hernandez-Gea.

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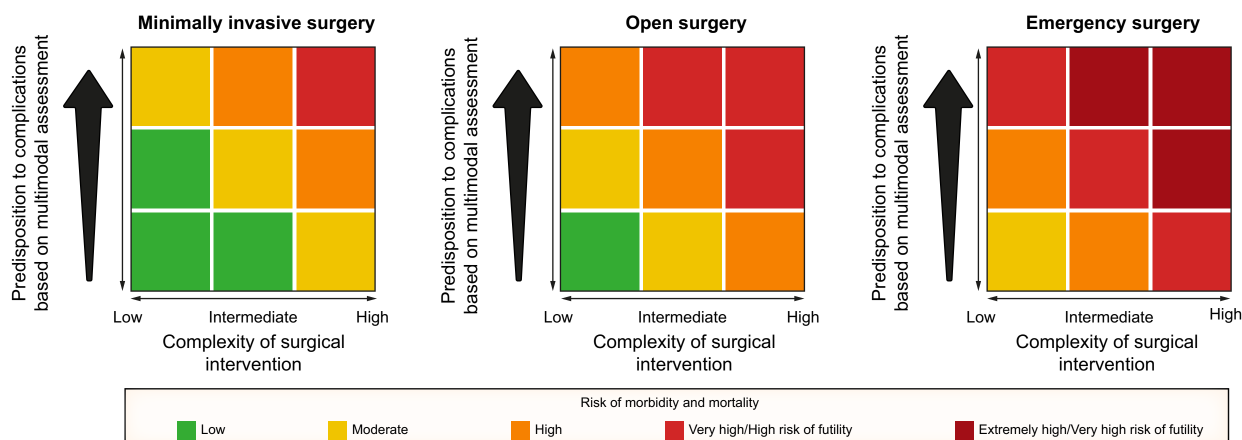

Fig. 1. Evaluation of the morbidity and mortality according to the type of surgery.

cirrhosis. The panel's first task was to identify the most relevant topics and those for which a substantial need for guidance existed. The identified themes were a) to define the risk according to the type of extrahepatic abdominal surgery considered, b) to define adequate assessment of the patients before extrahepatic abdominal surgery to reduce the risk of post-operative complications, c) to propose adequate management of the patient in the perioperative period.

EASL CPGs are based on questions developed according to the PICO format (P – Patient, Population, or Problem; I – Intervention, Prognostic Factor, or Exposure; C – Comparison or Intervention (if appropriate), O – Outcome). The panel agreed to use the PICO format, although the panel noted that for most of the topics, high-quality evidence was scarce. Overall, 21 questions were identified. The PICO questions were sent to a Delphi panel comprising 48 international experts in hepatology, anaesthesiology, surgery, radiology, and patient representatives from Europe interested in liver disease and abdominal surgery. The Delphi panel agreed or disagreed on the questions and provided inputs to the CPG panel to optimise them.

After revision of the questions, the multidisciplinary panel of experts assessed the available literature and provided answers to the questions and recommendations or statements. Each panellist was responsible for a group of questions. Meetings were held in person or by teleconference. An extensive literature search was performed using PubMed, Embase, Scopus, and Google Scholar. The initial keywords were: "abdominal surgery" AND "portal hypertension" AND "cirrhosis" OR "compensated advanced chronic liver disease-cACLD-". Additionally, references to relevant articles were manually reviewed. The selection of references was based on the appropriateness of the study design, the number of patients, and publication in peer-reviewed journals. Whenever available, meta-analyses were used; otherwise, original data were considered. The quality of evidence was scored according to the OCEBM (Oxford Centre for Evidence-based Medicine) (adapted from The Oxford 2011 Levels of Evidence) (Table 1). All panellists read the retrieved literature and searched for further literature where appropriate.

The panel formulated statements when insufficient evidence for a recommendation was available. The strength of the recommendations in this CPG has been graded according to the OCEBM into two categories: strong or weak. All final recommendations/statements were discussed and approved by all panellists. The evidence was evaluated and scored, and the guidance was produced following EASL's methodological recommendations for CPGs (Tables 1 and 2); definitions and statements were not graded.

The Delphi panel then examined and voted on the answers to the questions, recommendations, and statements. Returning scores were graded as follows: <50% consensus: re-write recommendation and resubmit to the Delphi panel; ≥50% to <75% consensus: re-write/improve the recommendation, but no resubmission to the Delphi panel; ≥75% to <95% consensus: no need to re-write the recommendation but the document will take into account comments; ≥95% consensus: considered strong consensus, no change needed but minor corrections possible. An agreement from at least 75% of Delphi panel members was required to consider a question approved. As mentioned above, the final version of the CPG, with marginal corrections, was finally sent for approval to the EASL Governing Board.

Preoperative assessment

In patients with cirrhosis with an indication for elective extrahepatic abdominal surgery, which models/scores based on clinical/laboratory information should be used to predict surgical risk and prevent post-operative complications?

Recommendation

- The VOCAL-Penn cirrhosis surgical risk score (online calculator: http://www.vocalpennscore.com) should be calculated as part of a multimodal risk assessment **(LoE 3, strong recommendation, strong consensus).**

A plethora of prognostic models have been applied (*e.g.* Child-Turcotte-Pugh [CTP] and model for end-stage liver disease [MELD] score) or specifically developed (Mayo risk score[5]) to predict surgical risk, primarily represented by intra- and

Table 1. Level of evidence based on the Oxford Centre for Evidence-based Medicine.

Level	Criteria	Simple model for high, intermediate and low evidence
1	Systematic reviews (SR) (with homogeneity) of randomised-controlled trials (RCT)	Further research is unlikely to change our confidence in the estimate of benefit and risk
2	RCT or observational studies with dramatic effects; SR of lower quality studies (*i.e.* non-randomised, retrospective)	
3	Non-randomised-controlled cohort/follow-up study/control arm of randomised trial (systematic review is generally better than an individual study)	Further research (if performed) is likely to have an impact on our confidence in the estimate of benefit and risk and may change the estimate
4	Case-series, case-control, or historically controlled studies (systematic review is generally better than an individual study)	
5	Expert opinion (mechanism-based reasoning)	Any estimate of effect is uncertain

Table 2. Grades of recommendation.

Grade	Wording	Criteria
Strong	Shall, should, is recommended. Shall not, should not, is not recommended.	Evidence, consistency of studies, risk-benefit ratio, patient preferences, ethical obligations, feasibility
Weak or open	Can, may, is suggested. May not, is not suggested.	

postoperative mortality. Importantly, most of these studies are based on outdated information, given the advances in surgical technique, perioperative care, and cirrhosis management. Thus, in addition to varying discriminative ability, these prognostic models/scores are miscalibrated (*i.e.* predicted risks do not accurately capture event rates) if applied in contemporary patients.[6]

The VOCAL-Penn cirrhosis surgical risk score (online calculator: http://www.vocalpennscore.com) comprising information on age, serum albumin and bilirubin, platelet count [PLT], obesity, metabolic dysfunction associated steatotic liver disease (MASLD), ASA (American Surgical Association) score, and emergency status has been developed[6] and externally validated[7] in contemporary cohorts of patients undergoing major surgery. Its C-statistic for 30-day postoperative mortality ranged around 0.85,[7] while the C-statistic for 90-day decompensation was 0.762.[6] However, the accuracy of the latter estimate could be better due to the chosen outcome definition/ ascertainment strategy, which is not in line with the current understanding of first/further hepatic decompensation.[8] One of the limitations of the VOCAL-Penn cirrhosis surgical risk score is that it has been derived nearly exclusively in males,[6] and although it has been externally validated in mixed cohorts, its performance in females has yet to be thoroughly evaluated.[7] Additionally, it does not include sarcopenia assessment, even if one must acknowledge that none of the available tools until now can be substituted for clinical judgment. Further validation in diverse geographical populations is also needed, and it remains unclear how the increasing use of extensive laparoscopic surgery will impact its discrimination and calibration. In addition, the incremental prognostic value of more accurate indicators of portal hypertension (PHT) (*vs.* PLT), as reflected by non-invasive tests (NITs) and hepatic venous pressure gradient (HVPG) measurement, over the VOCAL-Penn cirrhosis surgical risk score has yet to be evaluated. Notably, while recommending the VOCAL-Penn score, several sections continue to rely on CTP and MELD due to the lack of studies applying alternative models (Fig. 2). As a result, CTP and MELD may still have a role in multimodal risk assessment for specific clinical scenarios.

In patients with suspected cirrhosis with an indication for elective extrahepatic abdominal surgery, should NITs of PHT be used to predict surgical risk and prevent postoperative complications?

Recommendations

- NITs should be used to rule out cACLD/cirrhosis in patients with chronic liver disease and may be applied to rule out clinically significant portal hypertension in patients with cACLD, although their accuracy to predict surgical risk and prevent postoperative complications has not been adequately evaluated **(LoE 3, strong recommendation, strong consensus).**
- In patients with suspected cACLD/cirrhosis with an indication for elective extrahepatic abdominal surgery, further evaluation by minimally invasive HVPG measurement may be considered **(LoE 3, weak recommendation, consensus).**

NITs have largely replaced minimally invasive methods for staging liver fibrosis,[9] diagnosing cACLD/cirrhosis, and ruling in or ruling out clinically significant portal hypertension (CSPH).[8] The presence and severity of PHT is one of the critical predictors of outcomes in patients with cirrhosis undergoing surgery and, as such, NITs used as surrogates of PHT are expected to be capable of stratifying surgical risk by identifying patients with CSPH (Fig. 2).

Liver stiffness measurement (LSM) by transient elastography plays a central role in this process. LSM values below 10 kPa effectively rule out cACLD, identifying patients with chronic liver disease (CLD) without significantly increased surgical risk. In patients with cACLD, CSPH can be ruled out with high sensitivity and negative predictive value (>90%) when LSM is ≤15 kPa and PLT is ≥150×10^9/L. Conversely, CSPH is highly likely (specificity and positive predictive value >90%) in non-obese patients with LSM ≥25 kPa. In obese patients with MASLD, the ANTICIPATE-NASH

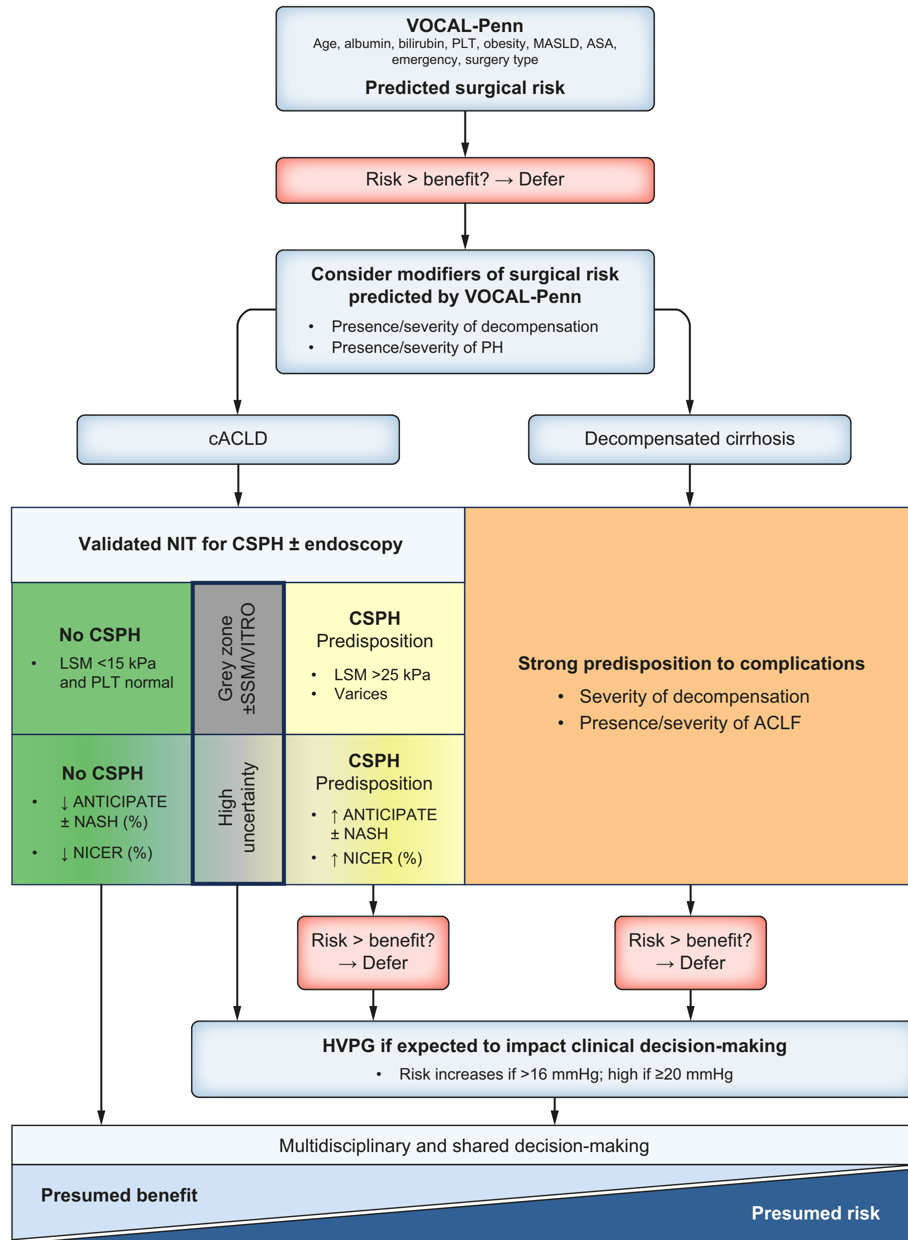

Fig. 2. Multimodal risk assessment in patients with advanced chronic liver disease/cirrhosis evaluated for elective extrahepatic abdominal surgery. As an initial step, the VOCAL-Penn cirrhosis surgical risk score should be calculated. If surgical risk clearly exceeds the presumed benefit, no further steps are needed. Notably, VOCAL-Penn lacks granularity regarding the presence/severity of PH and does not capture the presence/severity of decompensation. In cACLD (*i.e.* compensated cirrhosis), the patient's predisposition to complications should be evaluated by NITs for CSPH; while the presence of CSPH (yellow) predisposes patients to complications, patients without CSPH are expected to have favourable outcomes that may approximate those of patients without cirrhosis. Varices indicate CSPH, but their absence does not rule-out CSPH. LSM and PLT are the most broadly used NITs for PHT. In patients who are unclassifiable according to the LSM & PLT-based Baveno VII criteria (grey zone), SSM (<25 or >55 kPa) or VITRO may be applied (VITRO; <1.5 or >25 kPa) to rule-out or rule-in CSPH. In contrast, ANTICIPATE±NASH (LSM, PLT, and body mass index) and the NICER (additionally considering SSM) models provide an individual's predicted probability of CSPH (%), and thus, more granular information. Patients with decompensated cirrhosis have the strongest predisposition for complications, which may be determined by the severity of decompensation and the presence of ACLF. Patients with cACLD who cannot be classified by NITs (grey zone/high uncertainty) as well as patients with cACLD with CSPH or decompensated cirrhosis may undergo HVPG measurement, if HVPG is expected to impact clinical decision-making. Based on the risk predicted by VOCAL-Penn as well as the mentioned risk-modifying factors, a multidisciplinary and shared decision should be made. ACLF, acute-on-chronic liver failure; cACLD, compensated advanced chronic liver disease; CSPH, clinically significant portal hypertension; HVPG, hepatic venous pressure gradient; LSM, liver stiffness measurement; NICER, Non-Invasive CSPH Estimated Risk; NIT, non-invasive test; PHT, portal hypertension; SSM, spleen stiffness measurement; VITRO, von Willebrand factor-to-PLT ratio.

model, which incorporates body mass index (BMI), should be used for more accurate CSPH prediction.[10] Adding von Willebrand factor antigen-to-PLT ratio (VITRO) and spleen stiffness measurement (SSM) further reduces the proportion of patients for whom CSPH status would otherwise remain uncertain (approximately 50%).[11,12]

Spleen stiffness measurement (SSM) has emerged as a particularly accurate NIT for CSPH.[12,13] However, repurposing 50 Hz transient elastography for SSM led to a substantial technical failure rate (16%) in a meta-analysis of individual patient data, limiting its clinical applicability.[12] The development of a 100 Hz version (SSM-100 Hz) significantly reduced the failure rate to approximately 7%.[14] The aetiology-agnostic NICER model (Non-Invasive CSPH Estimated Risk), which combines SSM-100 Hz, LSM, PLT, and BMI, outperforms ANTICIPATE±NASH in contemporary cACLD cohorts, achieving an AUROC exceeding 0.9 with excellent calibration. The strength of models like NICER and ANTICIPATE±NASH lies in their ability to estimate an individual patient's CSPH risk – or conversely, the probability of missing a CSPH diagnosis – thereby refining surgical risk stratification. For detailed implications of CSPH presence/absence in extrahepatic abdominal surgery risk assessment, please refer to the next PICO question.

Despite the advantages of NITs in reducing the need for minimally invasive evaluation, several limitations must be considered in the context of risk stratification for extrahepatic abdominal surgery. First, the available evidence is largely indirect, extrapolated from studies on diagnostic and prognostic performance in non-surgical patients. Second, while NITs perform well in ruling out cACLD and in ruling in or out CSPH, their correlation with HVPG diminishes at higher values. As a result, they provide less granular information than HVPG and cannot reliably identify patients with HVPG >16 mmHg or ≥20 mmHg[13] – thresholds associated with increased or particularly high surgical risk (see the next PICO question). Given the potentially life-threatening complications of extrahepatic abdominal surgery, and since NITs have not been shown to reliably assess surgical risk or provide a clear cut-off for individual risk stratification, HVPG may be used whenever available, as it remains the most predictive tool for surgical risk assessment.

Additionally, portal venous thrombosis significantly impacts abdominal surgery outcomes and should be systematically evaluated through imaging as part of the preoperative workup.

In patients with cirrhosis with an indication for elective extrahepatic abdominal surgery, should invasive methods to assess the degree of PHT be used to predict surgical risk and prevent postoperative complications?

Recommendations

- HVPG measurement should be performed as part of a multimodal risk assessment, in particular, if NITs cannot rule out CSPH and information on HVPG is expected to impact clinical decision-making **(LoE 3, strong recommendation, consensus).**
- Patients should undergo preoperative oesophagogastroduodenoscopy, except for patients with cACLD in whom CSPH has been excluded with NIT/HVPG, as well as those who are already on adequate prophylaxis for hepatic decompensation and/or variceal (re-)bleeding **(LoE 3, strong recommendation, consensus).**

PHT is a key driver of both initial and recurrent hepatic decompensation[8] and is a strong predictor of postoperative mortality in patients with cirrhosis, as shown in registry-based studies.[15] The severity of sinusoidal PHT can be evaluated invasively by measuring HVPG.[8] HVPG values ≥10 mmHg denote CSPH, *i.e.* the haemodynamic threshold for developing oesophageal varices and other portosystemic collaterals, as well as complications (in particular, ascites and variceal bleeding), while such clinical findings imply the presence of CSPH. Indirectly measured (*i.e.* via a balloon catheter) HVPG values closely correspond to portal pressure gradient (*i.e.* the directly measured pressure gradient between the portal vein and the post-hepatic circulation) in most aetiologies of cirrhosis, while they are inaccurate in porto-sinusoidal vascular disorder[16] (*i.e.* a vascular liver disease that mimics cirrhosis) and less accurate in cholestatic liver disease and MASLD.[17–19] However, even in the latter context, the HVPG/CSPH maintained its prognostic value.[20] Notably, the utility of portal pressure gradient obtained via endoscopic ultrasound-guided puncture and the respective haemodynamic thresholds for diagnosis and risk prediction have yet to be established.[21] The predictive value of HVPG for postoperative mortality was assessed in a prospective multicentre Spanish study of 140 patients (60% with decompensated cirrhosis; 41% Child-Pugh B/C; median HVPG: 15 mmHg), including 121 who underwent abdominal surgery.[22] In patients who were operated on, ASA class, open surgery, and HVPG ≥20 mmHg were independent predictors of 1-year mortality, with the multivariate model achieving a C-statistic of approximately 0.85 for 30-day, 90-day, and 1-year mortality. An HVPG ≥20 mmHg was associated with a more than sixfold increased risk of postoperative mortality, though risk appeared to increase from HVPG >16 mmHg.[22] While HVPG's individual C-statistic was not reported, it is typically used as part of multimodal risk assessment. Moreover, due to the limited number of events at 30 days post-surgery (*i.e.* 8% 30-day mortality), it is difficult to discriminate whether HVPG was a determinant of surgical risk *per se*, or rather a strong prognostic indicator, as observed in other patients with cirrhosis. Finally, the ability of an HVPG-based risk assessment strategy over a conventional strategy (*e.g.* VOCAL-Penn cirrhosis surgical risk score ±NIT) to improve outcomes in patients considered for surgery has never been evaluated. Notably, the indication for HVPG measurement and other invasive investigations should be scrutinised in patients deemed unfit for surgery due to other findings in the multimodal risk assessment (*e.g.* unacceptably high predicted risk by VOCAL-Penn cirrhosis surgical risk score) (Fig. 2).

Oesophagogastroduodenoscopy (EGD) confirms CSPH when varices are present but cannot exclude CSPH when they are absent,[23] making it a limited tool for assessing PHT severity.[24] The indications for EGD in patients with cirrhosis undergoing elective extrahepatic abdominal surgery remain the same as for those not undergoing surgery.[8] Given that effective prophylaxis of variceal bleeding is expected to reduce postoperative morbidity and mortality, preoperative EGD should be performed unless its findings are unlikely to alter management – for instance, in patients with cACLD in whom CSPH has been ruled out via NITs or HVPG, or in those already receiving appropriate prophylaxis for hepatic decompensation and/or variceal bleeding (Fig. 2).

In patients with cirrhosis with an indication for major elective extrahepatic abdominal surgery, should specific cardiopulmonary assessment be performed to predict surgical risk and prevent postoperative complications?

Recommendation

- Preoperative assessment should include electrocardiogram, transthoracic echocardiography and pulse oximetry, and ideally, functional capacity and frailty assessment **(LoE 3, strong recommendation, consensus).**

Patients with cirrhosis often have comorbidities such as cardiovascular and pulmonary diseases, particularly in the context of alcohol-related and metabolic dysfunction-associated liver disease. These conditions are well-established risk factors for poor surgical outcomes in the general population. However, except in the setting of LT, no studies have specifically evaluated the additional surgical risks posed by comorbidities in patients with cirrhosis. A thorough preoperative assessment should include a detailed clinical history and physical examination to identify cardiovascular risk factors such as obesity, diabetes mellitus, hypertension, hyperlipidaemia, smoking history, and a family history of early cardiovascular disease. In addition, simple tests such as an electrocardiogram, transthoracic echocardiography, and pulse oximetry should be part of the standard preoperative workup. In patients with abnormal findings or increased cardiovascular risk, further diagnostic testing is necessary to refine risk stratification and weigh surgical risks against potential benefits. In patients presenting with hypoxia, contrast echocardiography using agitated saline can be used to diagnose hepatopulmonary syndrome (Fig. 3).[25,26]

Indication and type of surgery

Can bariatric surgery be considered in patients with cirrhosis?

Recommendation

- Bariatric surgery can be considered in patients with CTP A cirrhosis without CSPH in experienced centres, after careful risk assessment **(LoE 3, weak recommendation, consensus).**

The prevalence of MASLD is increasing and it is now a leading cause of cirrhosis. Consequently, the number of patients with cirrhosis meeting criteria for bariatric surgery due to elevated BMI and metabolic comorbidities is also increasing. Bariatric surgery has been shown to improve steatosis[27] and fibrosis, with fibrosis resolution observed in up to 45% of patients 5 years after surgery.[28] Additionally, it benefits other metabolic dysfunction-related conditions and overall health.[29,30] While data remain limited, these benefits are likely more pronounced in patients without other fibrosis-inducing factors. It is reasonable to expect that outcomes may differ between patients with MASLD and those with MetALD (concurrent metabolic dysfunction and alcohol-associated liver disease). However, multiple studies and meta-analyses indicate that bariatric surgery in patients with cirrhosis is associated with increased postoperative hepatic decompensation, morbidity, and mortality.[31,32] Nevertheless, in a recent study with a 15-year follow-up, bariatric surgery was shown to improve major liver-related adverse outcomes and decrease the transition to decompensated cirrhosis in patients with cirrhosis.[33] Therefore, it is crucial to restrict bariatric surgery to carefully selected patients in whom the benefit outweighs the risk. A comprehensive preoperative evaluation is essential, with decompensation status being a key determinant.[31,34] In general, limiting bariatric surgery to patients with CTP A cirrhosis seems reasonable.

Sleeve gastrectomy is the most commonly performed bariatric procedure in patients with cirrhosis, followed by Roux-en-Y gastric bypass. Although no consensus exists on the optimal approach,[35] sleeve gastrectomy may be associated with lower morbidity.[29,34] As with other surgeries in patients with cirrhosis, a laparoscopic approach is preferred to minimise the risk of postoperative hepatic decompensation and complications. Given the higher complication rate in this population, bariatric surgery should be performed in specialised centres with expertise in both bariatric surgery and cirrhosis management.[34]

Bariatric surgery has also been explored in the setting of LT, either before, during, or after the procedure. Systematic reviews suggest that it is feasible in LT recipients, though available series remain limited.[36–38]

Can surgery for symptomatic gallstone disease be considered in patients with cirrhosis?

Recommendations

- Surgery for symptomatic gallstone disease should be considered in patients with CTP A and B cirrhosis in experienced centres after careful risk assessment **(LoE 3, strong recommendation, strong consensus).**
- Minimally invasive approaches should be preferred to open surgery for symptomatic gallstone disease in patients with cirrhosis in experienced centres **(LoE 1, strong recommendation, strong consensus).**
- Non-surgical alternative procedures such as percutaneous cholecystostomy as well as endoscopic transpapillary or endoscopic ultrasound-guided gallbladder drainage may be considered for selected patients in experienced centres **(LoE 4, weak recommendation, consensus).**

Patients with cirrhosis have a 3- to 4-fold higher incidence of gallbladder stones compared to the general population. This increased prevalence is attributed to factors such as hypersplenism, increased haemolysis, elevated blood oestrogen levels, and impaired gallbladder motility and emptying.[39,40] However, the progression of asymptomatic gallstones to symptomatic or complicated gallstone disease (*e.g.* choledocholithiasis, biliary colic, cholangitis, cholecystitis, or pancreatitis) is not significantly higher than in the general population. Importantly, routine abdominal imaging may reveal gallbladder wall thickening in patients with cirrhosis, particularly those with ascites, even in the absence of cholecystitis. Therefore, clinical symptoms such as fever, pain, and

Fig. 3. Suggested cardiovascular work-up before major elective extrahepatic abdominal surgery in patients with cirrhosis. * In selected cases other anatomical and functional imaging modalities can be considered: *e.g.* consider performing Coronary Artery Calcium Scoring CT (CAC scan) in patients without previous quantification and contraindications to i.v. iodine contrast; consider stress MRI in patients with obesity or chronic lung disease preventing an appropriate acoustic window for echocardiography. AHA, American Heart Association; CAD, coronary artery disease; CHD, coronary heart disease; HPS, hepatopulmonary syndrome; mPAP, mean pulmonary arterial pressure; PVR, pulmonary vascular resistance; WU, Wood units.

tenderness should always be used to confirm cholecystitis and avoid unnecessary surgical interventions.

When symptomatic, gallstone disease in patients with cirrhosis carries higher morbidity and mortality risks than in individuals without cirrhosis. Similarly, cholecystectomy in this population is associated with increased surgical risk,[15,40] with worse outcomes linked to higher CTP and MELD scores, as well as the presence of ascites.[41,42] Laparoscopic cholecystectomy is generally preferred over open surgery, as meta-analyses of randomised-controlled trials have demonstrated lower postoperative complication rates (risk ratio 0.52, 95% CI 0.29–0.92), shorter hospital stays (mean difference: –3.05 days, 95% CI –4.09 to –2.01; p <0.001), and faster resumption of a regular diet (mean difference: –27.48 hours, 95% CI –30.96 to –23.99; p <0.001). Notably, approximately 97% of patients in these studies had CTP A/B liver function.[43,44] For patients with CTP C cirrhosis, smaller case series have raised concerns about cholecystectomy and instead support alternative non-surgical options. These include endoscopic ultrasound-guided placement of a lumen-apposing metal stent from the duodenum to the gallbladder, which has shown efficacy in non-operative candidates, and endoscopic transpapillary gallbladder drainage.[40,41,45–48] In cases of severe acute cholecystitis, percutaneous gallbladder drainage may serve as an effective, less invasive option for controlling sepsis.[49]

Can surgery for symptomatic hernia be considered in patients with cirrhosis?

Recommendations

- Surgery for symptomatic hernia may be considered in experienced centres after careful risk assessment **(LoE 3, strong recommendation, strong consensus).**
- Elective surgery in experienced centres should be preferred, as emergency surgery for symptomatic hernia is associated with worse outcomes **(LoE 3, strong recommendation, strong consensus).**

Abdominal wall hernias, particularly umbilical hernias, are common in cirrhosis, with an incidence of up to 20%, increasing to 40% in patients with ascites.[50,51] Contributing factors include increased intra-abdominal pressure from ascites, as well as malnutrition and sarcopenia leading to muscle wasting. Clinical manifestations range from skin ulcerations and leakage with peritonitis to incarceration with the risk of bowel necrosis.

Morbidity following elective umbilical hernia repair varies between 7% and 20%, with reported mortality rates ranging from 0% to 5.5%.[52] Due to the heightened risk in

decompensated cirrhosis, some advocate for non-surgical management. However, a prospective observational study found that conservative treatment or a "wait-and-see" approach was associated with higher mortality, likely due to an increased risk of incarceration.[53–56] Emergency umbilical hernia repair, particularly in cases of incarceration, carries significantly higher complication rates and up to a 7-fold increase in mortality compared to elective surgery.[50,57,58] Consequently, a "fix it while you can" strategy has been proposed for patients with cirrhosis with umbilical hernias.[59,60] Poor surgical outcomes are associated with MELD scores >15, CTP class C, poorly controlled ascites, symptomatic hernias, and emergent presentations.[55,61,62] Moreover, uncontrolled ascites significantly increases the risk of hernia recurrence (relative risk 8.51)[63] and impairs wound healing. Thus, preoperative measures to manage portal hypertension and ascites, such as transjugular intrahepatic portosystemic shunt (TIPS) placement, may be considered. In addition, mesh repair is preferred over suture repair, as it significantly reduces the risk of recurrence (2.7% *vs.* 14.2%).[64]

Can colorectal surgery be considered in patients with cirrhosis?

Recommendations

- Surgery for emergency bowel diversion should be considered in patients with cirrhosis, even in patients with decompensated cirrhosis, in experienced centres after careful risk assessment **(LoE 4, strong recommendation, consensus).**
- A minimally invasive approach should be preferred to open surgery **(LoE 4, strong recommendation, strong consensus).**
- Colorectal surgery should be considered in experienced centres after careful risk assessment **(LoE 4, strong recommendation, strong consensus).**

Colorectal surgery in patients with cirrhosis is associated with higher early- and long-term mortality compared to in the general population, particularly in patients with decompensated cirrhosis undergoing emergency appendicectomy/colectomy.[65,66] However, decisions to withhold surgery should be made cautiously and on a case-by-case basis, considering individualised risk assessment tools (*e.g.* VOCAL-PENN score), the specific indication, and alternative treatment options. Preoperative TIPS placement may be considered in select cases.

The two primary indications for colorectal surgery in adults are colorectal cancer and diverticular disease. Surgery for colorectal cancer is associated with higher postoperative morbidity, mortality, and lower long-term survival in patients with cirrhosis,[67] with cirrhosis being a known risk factor for anastomotic leakage.[68] When feasible, less invasive alternatives, such as endoscopic resection, should be prioritised.[69] However, for surgically fit patients with compensated cirrhosis, curative surgery should not be withheld. A laparoscopic approach is preferred, as it reduces blood loss, postoperative complications, recovery time, and hospital stay.[70,71]

Diverticular disease can be classified into complicated diverticular disease (including diverticulitis, complicated diverticulitis, and diverticular bleeding) and symptomatic uncomplicated or asymptomatic diverticulosis. Surgery for diverticulitis is associated with increased postoperative mortality, morbidity, and prolonged hospitalisation in patients with cirrhosis,[72,73] particularly in decompensated cirrhosis, where emergency surgery further amplifies these risks.[74] As with colorectal cancer, laparoscopic surgery improves postoperative outcomes, including in decompensated cirrhosis.[73] In high-risk patients, conservative management may be preferred, though the potential need for emergency surgery in the setting of sepsis must be weighed carefully. Elective colectomy may be considered in patients with compensated cirrhosis with prior complicated diverticulitis and progressive liver disease to minimise the risk of decompensation with future acute episodes. Given the elevated risk of anastomotic leakage and failure to rescue, bowel diversion is often recommended.[73]

In patients with primary sclerosing cholangitis-related cirrhosis who require partial or total proctocolectomy due to inflammatory bowel disease complications, intestinal resections are associated with high postoperative morbidity and mortality.[75,76] Restorative proctocolectomy with pelvic pouch creation may be feasible, but pelvic sepsis poses a significant mortality risk. These complex cases should be managed in specialised referral centres.

Can pancreatic surgery be considered in patients with cirrhosis?

Recommendations

- Pancreatic resectional surgery for malignancy or premalignant lesions can be considered in patients with CTP A cirrhosis without CSPH in experienced centres, after careful risk assessment **(LoE 3, strong recommendation, strong consensus).**
- Pancreatic resectional surgery for malignancy or premalignant lesions should be discouraged in patients with CTP B and C cirrhosis, even in experienced centres **(LoE 4, strong recommendation, consensus).**
- Pancreatic resectional surgery should not be performed for benign pancreatic disease in patients with cirrhosis regardless of CTP score **(LoE 4, strong recommendation, consensus).**

Pancreatic resection is associated with significant postoperative morbidity (approximately 30%), primarily due to complications such as pancreatic fistula, haemorrhage, and sepsis from anastomotic leakage. Evidence on pancreatectomy in patients with cirrhosis is scarce, with only a few small case series available, likely reflecting the reluctance to perform these high-risk surgeries in this population. Additional risks of pancreatic surgery in patients with cirrhosis are attributed to the complications of PHT such as variceal bleeding, portal venous thrombosis, and impaired coagulation. Among pancreatic procedures, pancreaticoduodenectomy carries a higher risk than distal pancreatectomy. In patients undergoing

pancreaticoduodenectomy, Teraoku *et al.* reported significantly increased 90-day mortality in patients with *vs.* without cirrhosis (40% *vs.* 2.9%; p <0.01), whereas no statistically significant difference in mortality was observed for distal pancreatectomy (14% *vs.* 3%; p = 0.18).[77] A multicentre study from France reported similar postoperative mortality (4% *vs.* 5%; p = 0.94), and 3-year overall survival (44% *vs.* 50%; p = 0.46) following pancreaticoduodenectomy between patients with CTP A cirrhosis and those without cirrhosis (n = 35) but complication rates were higher in patients with cirrhosis (79% *vs.* 43%; p = 0.002).[78] Survival rates and complication rates vary in other reports, owing to the heterogeneity of patient populations, severity of cirrhosis, and probably to centre experience (with some advocating pancreatic surgery even in the presence of PHT).[79–82]

Mariette *et al.* (1993) examined outcomes of pancreatic surgery for benign indications: 17 patients underwent surgery for chronic pancreatitis, three for acute pancreatitis, one for a benign tumour, and 14 for malignant tumours. The overall morbidity rate was 51%, and the mortality rate was 20%. All three patients who underwent emergency pancreatic surgery died (unpublished data). However, advances in surgical techniques and perioperative management have improved outcomes since then. Additionally, non-operative strategies for benign pancreatic disease have evolved and should be the preferred option in patients with cirrhosis whenever feasible.

Currently, there is insufficient data to recommend a minimally invasive approach for pancreatic resection in patients with cirrhosis. Further studies are needed to establish the safety and efficacy of laparoscopic or robotic techniques in this high-risk population.

Can abdominal aortic surgery for abdominal aortic aneurysm be considered in patients with cirrhosis?

Recommendations

- Aortic surgery for abdominal aortic aneurysm should be considered in patients with CTP A cirrhosis in experienced centres after careful risk assessment **(LoE 3, strong recommendation, strong consensus).**
- Aortic surgery should be discouraged in patients with CTP B and C cirrhosis **(LoE 3, strong recommendation, strong consensus).**
- Endovascular repair may be preferred to open surgery **(LoE 3, weak recommendation, strong consensus).**

Aortic vascular disease and liver disease share common risk factors, *i.e.* features of the metabolic syndrome.[83] An abdominal aortic aneurysm (AAA) is a potentially life-threatening condition where the risk of rupture is related to the diameter of the aneurysm. The indication for intervention is, therefore, mandated by the risk of acute rupture. Surgery for AAA can be performed as open reconstruction or endovascular repair (EVAR). In a study of 2,115 patients (5,308 open repair and 15,807 EVAR), the perioperative (30 days) mortality in the open repair group was 3.7% compared to 1.3% after EVAR.[84] Chronic liver disease is a significant risk factor for adverse outcomes after surgical procedures,[85] and aortic surgery in patients with chronic liver disease represents a major challenge. There are few reports on aortic surgery in patients with cirrhosis. In a study of 1,189 patients with AAA who underwent open repair, 24 were found to have biopsy-proven cirrhosis, of whom 22 were classified as CTP A and two as CTP B. Operative time and intraoperative blood transfusion requirements were significantly higher in patients with cirrhosis compared to controls. However, there were no significant differences in terms of major perioperative complications. During follow-up, both patients with CTP B cirrhosis died within 6 months. The survival rate at 2 years was 77.4% in patients with cirrhosis and 97.8% in matched controls. A MELD score >10 was associated with reduced midterm survival.[86]

EVAR reduces surgical trauma and might be a better alternative in the presence of serious comorbidity. A population-based study compared 146 patients with cirrhosis and 730 matched controls treated by EVAR or thoracic EVAR. The article did not classify the patients according to MELD or CTP score but describes 54.9% of the patients as having early cirrhosis and 45.1% as having late cirrhosis. The difference between the rates of in-hospital mortality and perioperative complications were not statistically significant between the two groups. Still, the patients with cirrhosis had an increased transfusion volume, a trend toward a lower survival rate, and a higher risk of liver-related death (4.1% *vs.* 0.7%; p <0.001) and liver-related readmission (6.2% *vs.* 0.3%; p <0.001).[87]

How should the futility of emergency extrahepatic abdominal surgery be determined in patients with cirrhosis?

Recommendation

- In patients with compensated cirrhosis, the futility of emergency surgery may be decided in analogy to the general population **(LoE 5, weak recommendation, consensus).**

Emergency surgery poses a substantial risk for poor outcomes in patients with cirrhosis. When a patient presents with an emergent, terminal condition or a disease with no curative options, surgical intervention may provide little to no therapeutic benefit. In such cases, proceeding with surgery could not only expose the patient to unnecessary risks but also create unrealistic expectations regarding survival and quality of life. The term futility in this context refers to without benefit or "overtreatment" and raises ethical questions and resource allocation issues. Futility in emergency surgery remains controversial. According to Sokol,[88] critical dimensions of futility as a concept are:

- Futility is goal-specific.
- Physiological futility is when the proposed intervention cannot physiologically achieve the desired effect (the most objective type of futility judgment).
- Quantitative futility is when the proposed intervention is unlikely to achieve the desired effect.
- Qualitative futility is when the proposed intervention, if successful, will probably produce such a poor outcome that it is deemed best not to attempt it.

There are few reports or guidelines on the question of futility in emergency extrahepatic abdominal surgery, specifically for patients with chronic liver disease. Therefore, it is plausible to use the general literature on emergency surgery and futility to explore physiological futility that may also be valid in patients with cirrhosis. In a study of 890 emergency laparotomies, the records of 50 patients with a mortality risk ≥75%, according to the ACS NSQIP Surgical Risk Calculator, were identified. The median age was 82.5 years and 66% were male. The mean APACHE II score (Acute Physiology And Chronic Health Evaluation) was 31.5 in the 46 patients dying within 30 days compared to 14.5 in the four surviving patients. Additionally, higher BMI, preoperative vasopressor support, mechanical ventilation requirement, lower Glasgow scale, and fragility index scores were linked to mortality.[89] Similar findings have been reported in a study of 74 deaths (13.9%) after 534 emergency laparotomies. Death occurred early (≤72 hours) after surgery in 28 (37.8%) and late (>72 hours) in 46 (62.2%) of the patients. A risk score (the CELIOtomy score) was constructed using age, Glasgow coma scale, lactate, creatinine, and pH. A CELIOtomy score ≥13 was associated with a >50% risk of early mortality after surgery.[90] Similar findings have been reported in a large audit of a national emergency laparotomy audit.[91] The results from the above studies are most likely also valid for patients with cirrhosis since they are based on physiological data.

Discussions regarding the futility of emergency surgery in patients with cirrhosis are mostly centred around decompensated patients with organ failures. ACLF is defined by the occurrence of organ failure(s) in the context of decompensated cirrhosis and is diagnosed/graded by the EF-CLIF criteria.[1] The sequential application of the CLIF-C ACLF score should determine the prognosis of ACLF. However, the latter is expected to underestimate the risk of mortality, as the adverse physiological effects of surgery may further worsen organ function while deferring emergency surgery denotes a shift to palliative care. Even without emergency surgery, ACLF-1, -2, and -3 are associated with 3-month mortality rates of roughly 25%, 50%, and 75%, respectively. Given the poor short-term prognosis, emergency surgery is increasingly likely to be futile in those with ACLF-2 and -3, if the indication for surgery is not the precipitating factor underlying ACLF and timely LT is not envisioned. Notably, criteria for withdrawal of organ support and palliative care are provided in the EASL CPG on ACLF.[1] However, performing emergency surgery in patients with cirrhosis requires careful case-by-case assessment and should be conducted in experienced centres.

Perioperative management

In patients with cirrhosis and CSPH with an indication for extrahepatic abdominal surgery, should preoperative TIPS placement be performed to reduce postoperative complications?

Recommendations

- Owing to insufficient data, preoperatory TIPS placement is not recommended before extrahepatic abdominal surgery in patients with CTP A cirrhosis and CSPH **(LoE 5, strong recommendation, strong consensus).**
- The placement of a preparatory TIPS before extrahepatic abdominal surgery can be considered by expert teams to improve postoperative outcomes in patients with CTP B and C cirrhosis **(LoE 5, weak recommendation, consensus).**

As previously discussed, the presence of PHT significantly increases the risk of morbidity and mortality following both hepatic and extrahepatic abdominal surgeries. HVPG >10 mmHg and liver surface nodularity are associated with worse outcomes in hepatic surgery,[92,93] while thresholds of >16 mmHg or ≥20 mmHg correlate with higher postoperative complication rates in extrahepatic abdominal surgery.[22] Given these risks, preoperative TIPS placement in patients with CSPH has been proposed to improve perioperative outcomes and reduce postoperative mortality. However, most supporting evidence comes from non-randomised studies and case reports, limiting the strength of conclusions.[94–98] These studies primarily involve non-hepatic surgeries, with heterogeneous patient populations, cirrhosis severity, and outcome measures, making direct comparisons challenging. Furthermore, some studies include TIPS placement for non-surgical indications (*e.g.* refractory ascites or variceal bleeding), further complicating interpretation.

This section focuses on elective surgeries, as emergency settings generally preclude TIPS placement due to clinical instability, time constraints, and logistical challenges. Only one study has included TIPS in an emergency surgery context, with TIPS performed postoperatively in three patients, except for one who received it preoperatively.[40] To date, three retrospective case-control studies with relatively small sample sizes have examined TIPS before elective extrahepatic abdominal surgery.[96,99,100]

One study comparing patients with and without preoperative TIPS (54% undergoing colorectal surgery) found that while TIPS reduced postoperative ascites, it did not decrease overall morbidity or mortality. Additionally, half of the patients experienced hepatic encephalopathy or hepatic function deterioration post-TIPS.[96] Another study focused on patients with decompensated cirrhosis (ascites or variceal bleeding) undergoing either elective or emergency abdominal surgery. Among the 28 patients who received TIPS, seven had it placed postoperatively. The TIPS-treated group exhibited improved outcomes, including

lower rates of postoperative ascites (33% *vs.* 54%), infections (18% *vs.* 54%), and acute renal failure (14% *vs.* 46%), with similar 90-day mortality (4% *vs.* 8%).[99] In a propensity-matched study, TIPS placement was associated with significantly lower rates of ACLF at 1 and 3 months (9% *vs.* 29% and 13% *vs.* 33%, respectively) and improved 1-year survival (8% *vs.* 38%), without an increased risk of hepatic encephalopathy.[100] More recently, a retrospective study of 195 patients with mostly CTP B cirrhosis found greater transplant-free survival in those who underwent surgery within 3 months after TIPS.[101] In summary, these findings suggest that preparatory TIPS may have a role before extrahepatic abdominal surgery in reducing postoperative complications associated with PHT, including ascites, infections, and acute kidney injury.

Thus, TIPS placement before extrahepatic abdominal surgery can be considered. The risk of hepatic encephalopathy warrants a case-by-case discussion, including the therapies envisioned for the patient, especially weighting the indications and contra-indications for LT. It must be kept in mind in this discussion that post-TIPS encephalopathy can be managed by medical therapy, revision/obturation of TIPS and even prophylaxis of hepatic encephalopathy, even though no studies are available in this particular setting.[102] The experts call for devoted randomised-controlled trials assessing the benefits of preoperative TIPS placement in patients with PHT. Similarly, the literature is scarce regarding patients who undergo TIPS placement for a PHT complication and then require surgery. In such patients, although no evidence is available, it seems reasonable to check for TIPS permeability before surgery.

In patients with cirrhosis on antiplatelet and/or anticoagulant treatment with an indication for extrahepatic abdominal surgery, should management follow the same guidelines as in the general population to reduce postoperative bleeding and thrombotic complications?

Recommendation

- Antiplatelet and/or anticoagulant agents should be managed following the same guidelines as in patients without cirrhosis before extrahepatic abdominal surgery **(LoE 5, strong recommendation, strong consensus).**

Acknowledging the risk of bleeding complications in patients with cirrhosis, it is crucial to understand that many of these instances are not attributed to haemostatic failure but rather to PHT or mechanical vessel injury, often resulting from inadvertent vessel punctures during invasive procedures. Notably, the effective management of haemostatic irregularities before such procedures remains largely unexplored in adequately powered randomised studies, mainly due to the relatively low incidence of bleeding, typically below 1.5%, following standard invasive procedures. No specific guidelines regarding the management of antiplatelets and anticoagulants in extrahepatic abdominal surgery are available for patients with cirrhosis and similar protocols to those used in patients without cirrhosis are likely to be appropriate.[103–107] However, due to hepatic function impairment and coagulation factor alterations observed in patients with cirrhosis,[108] some uncertainties persist, particularly regarding the timing of treatment discontinuation. This uncertainty arises from the potential delays in the clearance of anticoagulants, often metabolised by the liver and/or kidneys, and potential alterations in their efficacy in patients with cirrhosis.[109,110]

In patients with cirrhosis with an indication for elective abdominal surgery, should specific perioperative medications (antibiotics, somatostatin, statins, postoperative anticoagulants) or aetiological treatments be used to reduce postoperative complications?

Recommendations

- It is recommended to treat the cause of liver disease wherever possible to avoid hepatic decompensation and ACLF **(LoE 5, strong recommendation, strong consensus).**
- It is recommended to follow the local practices applied to all patients with cirrhosis regarding antibiotics, somatostatin, statins, and postoperative antiplatelets and/or anticoagulants **(LoE 5, strong recommendation, strong consensus).**

The degree of PHT can accurately predict post-surgical outcomes in cirrhosis. However, despite identified cut-offs beyond which postoperative complications are significantly higher (>16 mmHg for extrahepatic abdominal surgery), there is no specific study addressing the use of PHT-lowering drugs before abdominal surgery in patients with cirrhosis. Carvedilol significantly decreases PHT in patients with cirrhosis, with greater haemodynamic effects than propranolol,[111] and prevents hepatic decompensation in patients with CSPH.[112,113] When it comes to statins, the available data are controversial, and there is no conclusive evidence supporting their blood pressure-lowering effects, particularly in conjunction with carvedilol.[114,115,116,117] Somatostatin has a more profound portal pressure-lowering effect in an acute setting and may also be an option to ameliorate PHT during surgery and reduce ascites occurrence after liver resection.[118] However, there is no evidence to recommend the use of any of these drugs to date outside of their established indications.

Patients with cirrhosis carry a high infection risk. No studies have assessed the potential benefit of antibiotic prophylaxis before/during extrahepatic abdominal surgery in patients with cirrhosis. However, it seems reasonable to follow the indications already validated for antibiotic prophylaxis, *i.e.* secondary prophylaxis after spontaneous bacterial peritonitis, and primary prophylaxis in patients with CTP score ≥9 and serum bilirubin level ≥3 mg/dl, with either impaired renal function or hyponatremia, and ascitic fluid protein lower than 15 g/L.[119] In these settings, if oral medications are tolerated, the use of daily oral norfloxacin at the dosage of 400 mg/day is suggested. In patients who cannot take oral medications, third-generation cephalosporins, like ceftriaxone, can be administered prophylactically at a dose of 1 g every 24 hours intravenously until oral intake is possible again.[119]

Outside this particular setting, there is no data to recommend the use of antibiotic prophylaxis in patients with cirrhosis undergoing elective extrahepatic abdominal surgery, and decisions regarding its use can follow guidelines for the general population.

Prophylaxis of postoperative venous thromboembolism is an issue as patients with cirrhosis have a high thrombotic risk.[120] There are no specific studies in the setting of surgery. Outside the surgical setting, current evidence is insufficient to advise for or against using venous thromboembolism prophylaxis, but its use does not appear to be associated with a significant bleeding risk.[121] In the setting of surgery, decisions regarding the use of thromboprophylaxis can follow guidelines for the general population.[122]

Some patients may require non-selective beta-blockers due to CSPH or oesophageal varices. However, there is concern regarding the use of selective beta-blockers in patients without cirrhosis undergoing non-cardiac surgery who are at risk of atherosclerotic disease. Specifically, the Poise trial, which included over 8,000 patients, showed that while the incidence of cardiac infarction was lower in the beta-blocker group, there was a noted increase in overall mortality.[123] These findings cannot be directly applied to patients with cirrhosis, who should resume non-selective beta-blocker therapy after surgery. We recommend discussing the timing of restarting non-selective beta-blockers with the anaesthesiologist on a case-by-case basis.

Surgery is an insult in patients with cirrhosis, often precipitating decompensation and ACLF in the postoperative period.[124] Treatment of the cause of cirrhosis is associated with a decrease in PHT and an improvement in hepatic function. Hence, in the setting of elective surgery, it is important to try to minimise the risk of decompensation by treating the cause of chronic liver disease wherever possible, *e.g.* alcohol abstinence in alcohol-related liver disease and antiviral drugs in viral cirrhosis. One important consideration is whether to prioritise treating the underlying cause of liver disease and to postpone elective surgery; however, unfortunately, there is insufficient data in the literature to guide this decision (Fig. 4).

In patients with cirrhosis with an indication for elective abdominal surgery and a high risk of bleeding, should perioperative haemostatic measures and monitoring be used to reduce postoperative complications?

Recommendations

- Preoperative coagulation test abnormalities should not be systematically corrected to reduce postoperative complications **(LoE 3, strong recommendation, strong consensus).**
- Viscoelastic tests should be used to monitor coagulation and guide blood product administration in case of active bleeding before and during the procedure **(LoE 2, strong recommendation, strong consensus).**

Anaemia is a frequent complication observed in patients with cirrhosis, occurring at a prevalence of about 60%, and may represent a marker of the severity of chronic liver disease. Its aetiology is usually multifactorial: gastrointestinal haemorrhage, hypersplenism, chronic haemolysis, spur-cell anaemia, hypocellular bone marrow, alcohol abuse, and folic acid, vitamin B12 and B6 deficiencies, which could be related to inadequate food intake or intestinal malabsorption.[125–127]

Erythrocytes contribute to primary haemostasis both through rheological effects and by enhancing platelet activation

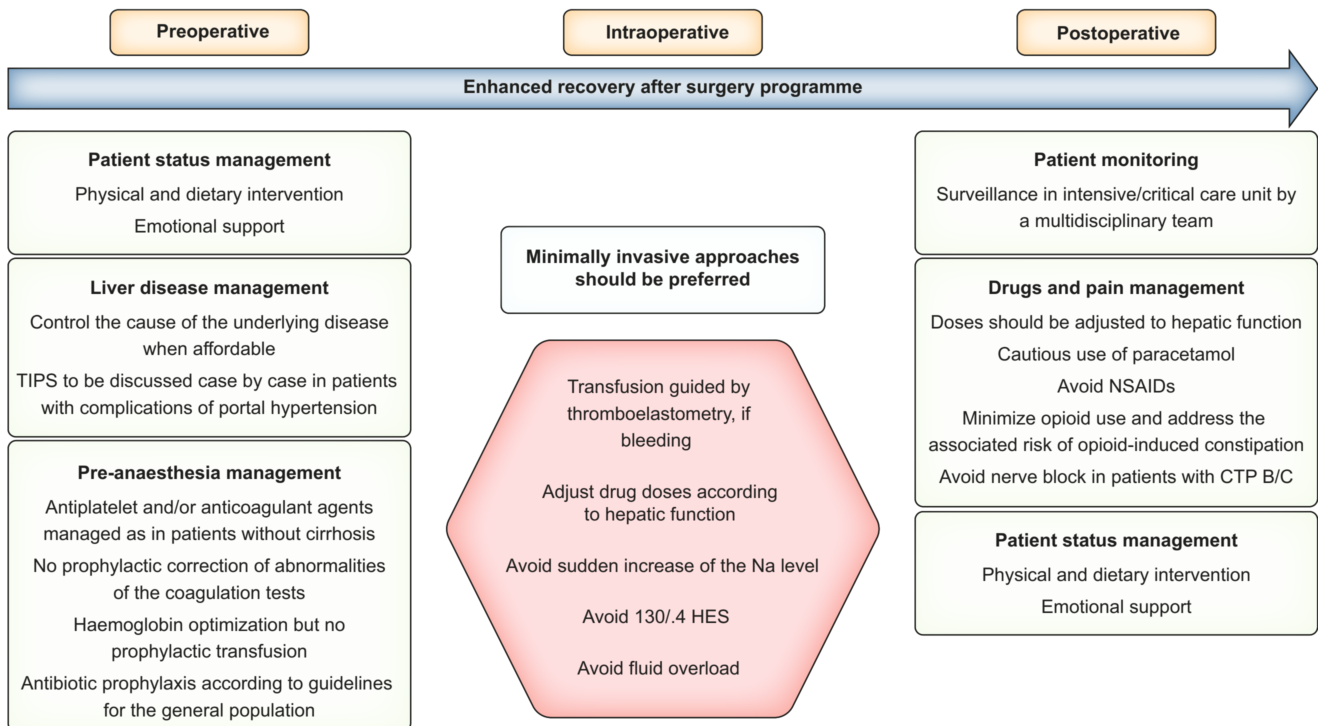

Fig. 4. Perioperative management for elective extrahepatic abdominal surgery in patients with cirrhosis. CSPH, clinically significant portal hypertension; CTP, Child-Turcotte-Pugh; HES, hydroxyethyl starch; NSAIDs, non-steroidal anti-inflammatory.

and promoting platelet adhesion to von Willebrand factor.[128] *In vivo* correction of anaemia has been reported to correct bleeding times and to reduce bleeding complications.[129] The limited available data suggest that anaemia in patients with cirrhosis could be associated with an increased risk of bleeding.[130] However, no data are available on the effect of correcting anaemia on post-procedure bleeding rates.

Preoperative anaemia has been also associated with higher rates of intraoperative transfusion because haemoglobin is the main determinant of red blood cell transfusion. Anaemia has been associated with increased transfusion requirements, need for postoperative ventilation, increased risk of post-operative acute kidney injury and prolonged intensive care unit stay.[131–134] Preoperative transfusion was found to be associated with increased 5-year mortality in liver transplantation, with a hazard ratio of 4.8.[135] Hence, prophylactic red blood cell transfusion with the aim of decreasing the risk of procedural bleeding is not recommended in this setting.[103]

Preoperative haemoglobin optimisation is a WHO recommendation. Haemoglobin optimisation is the first pillar of Patient Blood Management programmes, which must be followed for surgeries with a high risk of bleeding. Patient Blood Management guidelines recommend optimising haemoglobin with iron, with or without erythropoiesis-stimulating agents. Haemoglobin optimisation before surgery is a major challenge in patients with cirrhosis for several reasons: 1) multifactorial origin of anaemia, 2) proteins involved in iron metabolism are difficult to interpret in these patients, 3) onset of concurrent haemorrhagic episodes that may preclude the effectiveness of any treatment. From a practical standpoint, iron, folic acid, vitamin B12, and endoscopic treatment of gastrointestinal bleeding lesions are the only therapeutic options to date. A recent systematic review and meta-analysis, with no studies performed in LT candidates, found significant improvements in preoperative haemoglobin concentration and reduced requirements for blood transfusion, with no increase in adverse events, in patients receiving intravenous iron prior to major surgery.[103] The benefit of this strategy in other contexts is probable but not confirmed.

Darbepoetin has been used in centres were Jehovah's witnesses undergo LT, showing an effective and safe profile.[136,137] The role of erythropoietin-stimulating agents in improving haemoglobin levels in patients with chronic liver disease needs to be addressed in randomised-controlled trials.

Due to the lack of specific data on extrahepatic abdominal surgery in patients with chronic liver disease, perioperative haemostasis management is largely extrapolated from LT. While general guidelines recommend preoperative laboratory tests for haemostasis, their utility in chronic liver disease is limited, as these tests do not accurately reflect the complex balance between pro- and anticoagulant factors.[138] As evidence of this imbalance, transfusion-free LT is feasible even in patients with significantly prolonged prothrombin time and activated partial thromboplastin time at baseline or intraoperatively.[139–141] Similarly, in patients with cirrhosis undergoing invasive procedures, correction of an elevated international normalised ratio with fresh frozen plasma is not recommended, as it does not improve haemostasis.[85,103] Current data do not allow for any recommendation about prothrombin complex. The role of prothrombin complex concentrates remains uncertain, although they effectively reduce international normalised ratio, there is no clear evidence that this translates into reduced bleeding.[142] Recombinant activated factor VII is also not recommended, as it has been shown to increase thrombotic risk[143,144] without reducing blood loss or transfusion requirements during LT.[140] Thrombocytopenia in chronic liver disease should be assessed in the context of elevated von Willebrand factor levels and should not be interpreted in the same manner as isolated thrombocytopenia in individuals with normal hepatic function.[145] Similarly, while plasma fibrinogen levels may be reduced in chronic liver disease, the fibrin structure is more thrombogenic, potentially balancing the haemostatic effect.[146] There is no established threshold for platelet transfusion, or a definitive fibrinogen concentration required for adequate haemostasis in these patients. However, expert consensus suggests considering transfusion at platelet counts below $50x10^9$/L or fibrinogen levels below 1.5 g/L in cases of high bleeding risk.[147–149] The prophylactic use of tranexamic acid has been shown to reduce blood loss and transfusion requirements in urgent surgery, LT, and hepatic surgery, without increasing thrombotic risk.[150–152] Viscoelastic testing (VET), a point-of-care functional assay that allows for rapid assessment of coagulation and fibrinolysis, has demonstrated a statistically significant reduction in overall blood product transfusion compared to standard coagulation testing, without affecting mortality.[153,154–159] VET is recommended to guide transfusion during LT and in other high-risk surgical scenarios.[149,160] However, prophylactic transfusion based on VET alone is not justified, and its use should primarily guide blood product administration in active bleeding. A current limitation of VET is the absence of well-defined transfusion thresholds (Fig. 4).

In patients with cirrhosis with an indication for elective abdominal surgery, should specific fluid management during the perioperative period be used to reduce post-operative complications?

Recommendations

- Avoiding fluid overload is recommended to reduce post-operative complications **(LoE 5, strong recommendation, consensus).**
- The use of 130/.4 hydroxyethyl starch may be avoided due to its association with higher acute kidney injury risk **(LoE 4, weak recommendation, strong consensus).**

In surgical patients, fluid therapy aims to replace blood and electrolyte losses, ensuring adequate tissue perfusion, oxygenation, and fluid-electrolyte balance. In the absence of significant bleeding, crystalloids are the preferred choice, while for substantial blood loss, initial resuscitation with crystalloids is recommended, followed by colloid administration if necessary.[161] Patients with chronic liver disease and PHT have a relative pooling of blood in the splanchnic circulation, and excessive fluid administration can exacerbate venous overload. Despite this, no specific perioperative fluid therapy guidelines exist for patients with cirrhosis undergoing surgery. Clinical practice is largely extrapolated from LT and critical care management. A key intraoperative strategy to minimise bleeding in

these patients is maintaining a low circulating volume and, consequently, low portal pressure.[162,163] Monitoring total circulating volume is more accurately achieved using trans-oesophageal echocardiography (*e.g.* respiratory variability of the superior vena cava) rather than central venous pressure or pulmonary artery pressure measurements.[164–166] Fluid restriction and diuretics can help maintain lower portal pressure, while vasoconstrictors should be used to ensure a mean arterial pressure of at least 60–65 mmHg.[167] However, this approach must be carefully balanced to avoid compromising tissue perfusion, particularly renal perfusion.[168–170] Sustained hypervolemia should be avoided in patients showing no fluid responsiveness, high filling pressures, or echocardiographic signs of volume overload.[170]

The electrolyte composition and total daily ion intake in administered fluids should be carefully considered. Hydroxyethyl starch (HES) 130/.4 is not recommended due to its association with acute kidney injury in this population.[171] While no specific colloid or crystalloid is universally preferred for routine volume replacement in patients with cirrhosis,[170] balanced electrolyte solutions are generally favoured over 0.9% sodium chloride and colloids with high chloride content to prevent hyperchloremic acidosis and sudden increases in sodium levels.[172] Based on evidence from patients with trauma and sepsis, albumin may offer advantages over crystalloids for intraoperative volume replacement[173,174] (Fig. 4).

In patients with cirrhosis with an indication for elective extrahepatic abdominal surgery, should specific perioperative anaesthetic management be used to reduce postoperative complications?

Recommendations

- Doses of perioperative drugs should be adjusted based on hepatic function **(LoE 3, strong recommendation, strong consensus).**
- The placement of nerve block should be avoided in patients with CTP B and C cirrhosis due to the risk of haematoma **(LoE 4, strong recommendation, consensus).**

The aim of intraoperative management in patients with chronic liver disease is to preserve hepatic blood flow and oxygen supply to prevent more liver harm. Hepatic blood flow decreases by 35% to 42% in the first 30 minutes of anaesthesia induction. In cirrhosis, the compensatory mechanisms increasing hepatic artery tone to keep perfusion to the liver are compromised.[161] General recommendations on tissue perfusion (mean arterial pressure >65 mmHg) need to be followed in these patients. Given the risk of neurological complications, rapid correction of hyponatremia should be avoided.

Perioperative monitoring will usually depend on the type of intervention and the severity of the patient's condition. Discrepancy between peripheral and central arterial blood pressure in these patients should be considered. Trans-oesophageal echocardiography is safe in patients with oesophageal varices and is an effective diagnostic tool for haemodynamic instability.[175,176] Continuous cardiac output monitoring by pulse contour analysis becomes less reliable for monitoring as the disease progresses from CTP A to CTP B and C cirrhosis.[177] Since the dose of anaesthetic is mostly overestimated in patients with pre-existing encephalopathy, bispectral index monitoring may help to guide the depth of anaesthesia.[178] General ventilatory strategies recommended in abdominal surgery also apply in this population.[179]

Hepatic dysfunction can affect the pharmacokinetics of various anaesthetic drugs, resulting in a prolonged elimination half-life and lower anaesthetic requirements. As a general rule, dose reduction and increased dosing interval are needed.[161,180]

Benzodiazepines should be avoided in patients with current hepatic encephalopathy.[161]

Propofol displays no significant pharmacokinetic alteration in cirrhosis, a normal recovery time, and minimal effects on pre-existing encephalopathy.[181,182] Even so, based on their low hepatic metabolism, volatile anaesthetics isoflurane, sevoflurane, and desflurane are weakly recommended over propofol for maintenance of anaesthesia, except for in patients at risk of increased intracranial pressure.[161,183]

Ketamine has a vasoconstrictor action on systemic circulation with minimal or no effect on splanchnic circulation. It can be considered for anaesthetic induction but not maintained in the long term[184]

Long-acting opioids like morphine should be avoided because their elimination is delayed. Fentanyl is the safest drug because it does not have a toxic metabolite, and it does not usually need dosage changes. Tramadol can be used with caution at lower doses and longer dosing times.[185,186]

Atracurium and cisatracurium are suitable neuromuscular blockers as they do not rely on hepatic excretion. Sugammadex rapidly antagonises moderate residual rocuronium-induced neuromuscular block in patients with CTP A undergoing hepatic resection. Monitoring of neuromuscular block is recommended.[187]

Regional anaesthesia, including both neuraxial and peripheral techniques, can be considered in patients with hepatic dysfunction as it reduces the risk of delayed recovery associated with impaired drug metabolism. However, the placement of epidural catheters in patients with CTP B or C cirrhosis is generally discouraged due to the increased risk of epidural haematoma. While spinal or epidural anaesthesia can enhance postoperative pain management, the benefits must be carefully weighed against the potential risks. Additionally, the intraoperative advantages of regional anaesthesia on hepatic blood flow remain inconclusive.[188–190]

The choice of analgesic agent in patients with cirrhosis should take into account the severity of liver disease. The therapeutic approach includes dose up-titration, increased administration interval, and careful monitoring to minimise side effects or hepatic decompensation. Co-prescription of laxatives is mandatory to avoid constipation and encephalopathy.

Paracetamol is safe in these patients, but reduced doses of 2–3 grams daily are recommended for long-term use.[191]

Non-steroidal anti-inflammatory drugs are best avoided because of the risk of renal impairment, hepatorenal syndrome, and gastrointestinal haemorrhage.[192,193]

Opioids of immediate-release, as opposed to controlled-release formulations, are advised. Due to the risk of constipation with these drugs, prevention and treatment of hepatic encephalopathy is recommended when used.

Tramadol: is suitable for treating moderate to severe pain in patients with cirrhosis. It is effective in the postoperative setting in combination with cautious doses of paracetamol, especially in patients with alcohol consumption or anorexia/fasting (induction of cytochrome P450 isoenzymes or reduction of intrahepatic glutathione).[194] The daily dose should not exceed 400 mg and it should be decreased in the presence of renal impairment.[195] Tramadol, combined with paracetamol, is effective in treating acute pain. The daily dose should not exceed 300 mg and should be decreased in the presence of renal impairment.[196]

Morphine: It can accumulate in patients with impaired renal function. The doses should be spaced out and reduced.

Methadone: Some studies indicate it is safe in hepatic dysfunction, although the half-life is longer in this population. It does not accumulate in the presence of renal insufficiency. As a drawback, it has a significant inter-individual variability.[196]

In patients with cirrhosis with an indication for elective extrahepatic abdominal surgery, should a preoperative nutritional programme and enhanced recovery after surgery be used to reduce postoperative complications?

Recommendations

- Nutritional status should be assessed before surgery **(LoE 3, strong recommendation, strong consensus).**
- Prehabilitation 4-6 weeks before elective surgery and enhanced recovery after surgery are recommended **(LoE 3, strong recommendation, strong consensus).**

Both undernutrition (BMI <18.5 kg/m^2) and severe obesity (BMI >40 kg/m^2),[197] as well as sarcopenia, are associated with increased morbidity and mortality before and after major surgery, including LT and hepatic resection. Reduced functional capacity and frailty have also been consistently associated with worse postoperative outcomes in patients undergoing LT.[198–200] In addition, in geriatric individuals without cirrhosis, frailty is a strong risk factor for postoperative complications.[201] Hence, evaluation of functional capacity, using simple tests such as 6-minute walking distance and assessment of frailty by the liver frailty index,[200] could further improve risk assessment. In addition, identifying patients with preoperative frailty might enable them to be included in prehabilitation programmes (oral, enteral, or parenteral nutrition) to optimise postoperative outcomes.[202] Of course, as in any other field of medicine, the availability and costs of the proposed tests and delays resulting from such tests should be considered when prescribing preoperative work-up.

Prehabilitation, incorporating physical and dietary interventions, and anxiety reduction techniques, is recommended for high-risk patients (elderly, malnourished, obese, smokers, or those with psychological disorders) undergoing hepatic surgery, ideally starting 4-6 weeks before surgery, although the optimal approach is not fully defined.[203] However, the exact content (physical exercises, dietary interventions, or anxiety reduction exercises) and duration of the prehabilitation programme for hepatic surgery are not yet clearly established.

Enhanced recovery after surgery (ERAS) is a multimodal, evidence-based programme of care developed to minimise the response to surgical stress.[204,205] The concept is based on a multidisciplinary team working around the patient. It includes preoperative counselling, rehabilitation (physical exercises, dietary interventions, or anxiety reduction exercises), preoperative nutrition, pre-anaesthetic medication, prophylaxis (anti-thrombotic, antibiotics, steroids), choice of the type of anaesthesia, and postoperative management (glycaemic control, stimulation of bowel movements, vomiting prophylaxis, fluids). The implementation of ERAS recommendations in major surgery domains, including colorectal,[206] pancreatic,[207] and hepatic surgery,[208] is associated with improved recovery, with a reduction in postoperative complications and hospital length of stay but without an increase in readmission rates. In patients undergoing hepatic surgery, three recent meta-analyses showed that ERAS decreased postoperative complications, length of stay, and costs.[209–211] No study assessed the benefit of ERAS in elective abdominal surgery in patients with cirrhosis (Fig. 4).

Optimising nutrition after surgery seems to be mandatory, although no study was performed in the specific subset of patients with cirrhosis. The European Society for Clinical Nutrition & Metabolism guidelines on clinical nutrition in surgery published in 2017 recommend oral nutrition postoperatively.[212] In patients undergoing colorectal and gastrointestinal surgery, establishing early enteral nutrition is important; however, the ideal route of administration remains unclear.[213] In the setting of LT, normal oral food intake and/or enteral nutrition (nasogastric tube or jejunostomy) should be started 12–24 h after LT, according to the patient's tolerance.[214]

In patients with cirrhosis with an indication for elective extrahepatic abdominal surgery, should minimal invasive approaches be used to reduce postoperative complications?

Recommendation

- Minimally invasive approaches (laparoscopic or robotic) should be considered whenever feasible to reduce postoperative complications **(LoE 3, strong recommendation, strong consensus).**

The available literature on both hepatic and extrahepatic abdominal surgery shows a clear postoperative benefit of laparoscopic surgery compared to the open approach in patients with cirrhosis.[70,71,73,215–217] This is in line with the rationale that minimally invasive surgery leads to the highest benefit, in terms of postoperative complications and functional recovery, in patients with lower functional reserve, such as patients with cirrhosis. Indeed, in these patients, the reduction in surgical trauma appears to have the strongest impact on time to recovery and mitigation of postoperative morbidity. However, given the complexity of PHT and the elevated bleeding risks, especially with laparoscopic approaches near umbilical varices, surgeons should prioritise performing procedures within their areas of expertise to maximise patient safety and outcomes.

In patients with cirrhosis with an indication for elective extrahepatic abdominal surgery, should specific post-operative monitoring be used to reduce post-operative complications?

Recommendation

- Surveillance in an intensive/critical care unit by a multidisciplinary team following extrahepatic abdominal surgery may be considered to detect early complications **(LoE 5, weak recommendation, consensus).**

Postoperatively, it is crucial to maintain a vigilant watch over patients with cirrhosis, actively monitoring for signs of hepatic decompensation, including encephalopathy and ascites as well as coagulopathy, worsening jaundice, and renal dysfunction. No specific recommendations for patients with cirrhosis are available. However, post-surgery surveillance in an intensive care unit could be beneficial for close monitoring and in order to initiate adapted therapy when needed.[203]

A specific focus should be placed on assessing infections and intravascular volume, a task complicated by extravascular volume overload. Sustaining adequate intravascular volume helps mitigate the risk of hepatic and renal under-perfusion. Nevertheless, caution is warranted, as excessive crystalloid infusion may lead to pulmonary oedema and subsequent postoperative complications like ascites, peripheral oedema, and wound dehiscence. Meticulous attention to fluid balance becomes paramount in the postoperative management of patients with cirrhosis.[203]

Appendix. Delphi round agreement on the recommendations of the present clinical practice guidelines.

Recommendation/statement	Consensus
The VOCAL-Penn cirrhosis surgical risk score (online calculator: http://www.vocalpennscore.com) should be calculated as part of a multimodal risk assessment **(LoE 3, strong recommendation).**	97%
NITs should be used to rule out cACLD/cirrhosis in patients with chronic liver disease and may be applied to rule out clinically significant portal hypertension in patients with cACLD, although their accuracy to predict surgical risk and prevent postoperative complications has not been adequately evaluated **(LoE 3, strong recommendation).**	95%
In patients with suspected cACLD/cirrhosis with an indication for elective extrahepatic abdominal surgery, further evaluation by minimally invasive HVPG measurement may be considered **(LoE 3, weak recommendation).**	92%
HVPG measurement should be performed as part of a multimodal risk assessment, in particular, if NITs cannot rule out CSPH and information on HVPG is expected to impact clinical decision-making **(LoE 3, strong recommendation).**	90%
Patients should undergo preoperative oesophagogastroduodenoscopy, except for patients with cACLD in whom CSPH has been excluded with NIT/HVPG, as well as those who are already on adequate prophylaxis for hepatic decompensation and/or variceal (re-) bleeding **(LoE 3, strong recommendation).**	92%
Preoperative assessment should include electrocardiogram, transthoracic echocardiography and pulse oximetry, and ideally, functional capacity and frailty assessment **(LoE 3, strong recommendation).**	92%
Bariatric surgery can be considered in patients with CTP A cirrhosis without CSPH in experienced centres, after careful risk assessment **(LoE 3, weak recommendation).**	92%
Surgery for symptomatic gallstone disease should be considered in patients with CTP A and B cirrhosis in experienced centres after careful risk assessment **(LoE 3, strong recommendation).**	97%
Minimally invasive approaches should be preferred to open surgery for symptomatic gallstone disease in patients with cirrhosis in experienced centres **(LoE 1; strong recommendation).**	98%
Non-surgical alternative procedures such as percutaneous cholecystostomy as well as endoscopic transpapillary or endoscopic ultrasound-guided gallbladder drainage may be considered for selected patients in experienced centres **(LoE 4, weak recommendation).**	94%
Surgery for symptomatic hernia may be considered in experienced centres after careful risk assessment **(LoE 3, strong recommendation).**	95%
Elective surgery in experienced centres should be preferred, as emergency surgery for symptomatic hernia is associated with worse outcomes **(LoE 3, strong recommendation).**	100%
Surgery for emergency bowel diversion should be considered in patients with cirrhosis, even in patients with decompensated cirrhosis, in experienced centres after careful risk assessment **(LoE 4, strong recommendation).**	87%
A minimally invasive approach should be preferred to open surgery **(LoE 4, strong recommendation).**	97%
Colorectal surgery should be considered in experienced centres after careful risk assessment **(LoE 4, strong recommendation).**	97%
Pancreatic resectional surgery for malignancy or pre-malignant lesions can be considered in patients with CTP A cirrhosis and no CSPH in experienced centres, after careful risk assessment **(LoE 3, strong recommendation).**	97%
Pancreatic resectional surgery for malignancy or pre-malignant lesions should be discouraged in patients with CTP B and C cirrhosis, even in experienced centres **(LoE 4, strong recommendation).**	92%
Pancreatic resectional surgery should not be performed for benign pancreatic disease in patients with cirrhosis regardless of CTP score **(LoE 4, strong recommendation).**	85%
Aortic surgery for abdominal aortic aneurysm should be considered in patients with CTP A cirrhosis in experienced centres after careful risk assessment **(LoE 3, strong recommendation).**	100%

(*continued on next page*)

(*continued*)

Recommendation/statement	Consensus
Aortic surgery should be discouraged in patients with CTP B and C cirrhosis **(LoE 3, strong recommendation).**	97%
Endovascular repair may be preferred to open surgery **(LoE 3, weak recommendation).**	98%
In patients with compensated cirrhosis, the futility of emergency surgery may be decided in analogy to the general population **(LoE 5, weak recommendation).**	91%
Owing to insufficient data, preoperatory TIPS placement is not recommended before extrahepatic abdominal surgery in patients with CTP A cirrhosis and CSPH **(LoE 5, strong recommendation).**	97%
The placement of a preparatory TIPS before extrahepatic abdominal surgery can be considered by expert teams to improve post-operative outcomes in patients with CTP B and C cirrhosis **(LoE 5, weak recommendation).**	76%
Antiplatelet and/or anticoagulant agents should be managed following the same guidelines as in patients without cirrhosis before extrahepatic abdominal surgery **(LoE 5, strong recommendation).**	95%
It is recommended to treat the cause of liver disease wherever possible to avoid hepatic decompensation and ACLF **(LoE 5, strong recommendation).**	95%
It is recommended to follow the local practices applied to all patients with cirrhosis regarding antibiotics, somatostatin, statins, and post-operative antiplatelets and/or anticoagulants **(LoE 5, strong recommendation).**	95%
Preoperative coagulation test abnormalities should not be systematically corrected to reduce postoperative complications **(LoE 3, strong recommendation).**	95%
Viscoelastic tests should be used to monitor coagulation and guide blood product administration in case of active bleeding before and during the procedure **(LoE 2, strong recommendation).**	100%
Avoiding fluid overload is recommended to reduce postoperative complications **(LoE 5, strong recommendation).**	87%
The use of 130/.4 hydroxyethyl starch may be avoided due to its association with higher acute kidney injury risk **(LoE 4, weak recommendation).**	100%
Doses of perioperative drugs should be adjusted based on hepatic function **(LoE 3, strong recommendation).**	98%
The placement of nerve block should be avoided in patients with CTP B and C cirrhosis due to the risk of haematoma **(LoE 4, strong recommendation).**	87%
Nutritional status should be assessed before surgery **(LoE 3, strong recommendation).**	100%
Prehabilitation 4-6 weeks before elective surgery and enhanced recovery after surgery are recommended **(LoE 3, strong recommendation).**	97%
Minimally invasive approaches (laparoscopic or robotic) should be considered whenever feasible to reduce postoperative complications **(LoE 3, strong recommendation).**	95%
Surveillance in an intensive/critical care unit by a multidisciplinary team following extrahepatic abdominal surgery may be considered to detect early complications **(LoE 5, weak recommendation).**	82%

Affiliations

European Association for the Study of the Liver (EASL). The EASL Building - Home of Hepatology, 7 rue Daubin, 1203 Geneva, Switzerland

Abbreviations

AAA, abdominal aortic aneurysm; ACLF, acute-on-chronic liver failure; BMI, body mass index; cACLD, compensated advanced chronic liver disease; CLD, chronic liver disease; CPG, clinical practice guidelines; CSPH, clinically significant portal hypertension; CTP, Child-Turcotte-Pugh; EGD, oesophagogastroduodenoscopy; ERAS, enhanced recovery after surgery; EVAR, endovascular aneurysm repair; HVPG, hepatic venous pressure gradient; LSM, liver stiffness measurement; LT, liver transplant; MASLD, metabolic dysfunction associated liver disease; MELD, model for end-stage liver disease; NITs, non-invasive tests; PHT, portal hypertension; PLT, platelet count; PT, prothrombin time; SSM, spleen stiffness measurement; TIPS, transjugular intrahepatic portosystemic shunt; VET, viscoelastic test.

Conflict of interest

DM served as an advisory board member for Alfasigma and Satellite Bio, and received lecture fees from AbbVie, Gilead, W. L. Gore & Associates, Lucane Pharma, and Pfizer. MM served as a speaker, consultant, and/or advisory board member for AbbVie, AstraZeneca, Echosens, Eli Lilly, Gilead, Ipsen, Takeda, and W. L. Gore & Associates, and received grant support from Echosens as well as travel support from AbbVie and Gilead. VHG received lecture fees from W. L. Gore & Associates and Cook Medical. AB served as a consultant to Boehringer-Ingelheim, advisory board member for Astellas, and received lecture fees from GE Healthcare and Hologic. VM, PDL, BD, AB, and MA have no potential financial or non-financial conflicts of interest regarding this study. Please refer to the accompanying ICMJE disclosure forms for further details.

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Supplementary data

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References

[1] European Association for the Study of the Liver. EASL Clinical Practice Guidelines on acute-on-chronic liver failure. J Hepatol 2023;79(2):461–491.

[2] European Association for. the Study of the Liver. EASL clinical practice guidelines on liver transplantation. J Hepatol 2024;81(6):1040–1086.

[3] European Association for the Study of the Liver. EASL Clinical Practice Guidelines on the management of hepatocellular carcinoma. J Hepatol 2024 [doi.org/10.1016/j.jhep.2024.08.028.

[4] European Association for the Study of the Liver. EASL-ILCA Clinical Practice Guidelines on the management of intrahepatic cholangiocarcinoma. J Hepatol 2023;79(1):181–208.

[5] Teh SH, Nagorney DM, Stevens SR, et al. Risk factors for mortality after surgery in patients with cirrhosis. Gastroenterology 2007;132(4):1261–1269.

[6] Mahmud N, Fricker Z, Hubbard RA, et al. Risk prediction models for post-operative mortality in patients with cirrhosis. Hepatology 2021;73(1):204–218.

[7] Mahmud N, Fricker Z, Panchal S, et al. External validation of the VOCAL-Penn cirrhosis surgical risk score in 2 large, independent health Systems. Liver Transplant 2021;27(7):961–970.

[8] Franchis R de, Bosch J, Garcia-Tsao G, et al. Baveno VII – Renewing consensus in portal hypertension. J Hepatol 2022;76(4):959–974.

[9] European Association for the Study of the Liver. EASL Clinical Practice Guidelines on non-invasive tests for evaluation of liver disease severity and prognosis - 2021 update. J Hepatol 2021;75(3):659–689.
[10] Pons M, Augustin S, Scheiner B, et al. Noninvasive diagnosis of portal hypertension in patients with compensated advanced chronic liver disease. Am J Gastroenterol 2021;116(4):723–732.
[11] Jachs M, Hartl L, Simbrunner B, et al. The sequential application of Baveno VII criteria and VITRO score improves diagnosis of clinically significant portal hypertension. Clin Gastroenterol Hepatol 2023;21(7):1854–1863.e10.
[12] Dajti E, Ravaioli F, Zykus R, et al. Accuracy of spleen stiffness measurement for the diagnosis of clinically significant portal hypertension in patients with compensated advanced chronic liver disease: a systematic review and individual patient data meta-analysis. Lancet Gastroenterol Hepatol 2023;8(9):816–828.
[13] Mandorfer M, Hernández-Gea V, García-Pagán JC, Reiberger T. Noninvasive diagnostics for portal hypertension: a comprehensive review. Semin Liver Dis 2020;40(3):240–255.
[14] Jachs M, Odriozola A, Turon F, et al. Spleen stiffness measurement by vibration-controlled transient elastography at 100 Hz for non-invasive predicted diagnosis of clinically significant portal hypertension in patients with compensated advanced chronic liver disease: a modelling study. Lancet Gastroenterol Hepatol 2024;9(12):1111–1120.
[15] Csikesz NG, Nguyen LN, Tseng JF, Shah SA. Nationwide volume and mortality after elective surgery in cirrhotic patients. J Am Coll Surg 2009;208(1):96–103.
[16] De Gottardi A, Sempoux C, Berzigotti A. Porto-sinusoidal vascular disorder. J Hepatol 2022;77(4):1124–1135.
[17] Ferrusquía-Acosta J, Bassegoda O, Turco L, et al. Agreement between wedged hepatic venous pressure and portal pressure in non-alcoholic steatohepatitis-related cirrhosis. J Hepatol 2021;74(4):811–818.
[18] Rinella ME, Lazarus JV, Ratziu V, et al. A multi-society Delphi consensus statement on new fatty liver disease nomenclature. J Hepatol 2023;79(6):1542–1556.
[19] Bassegoda O, Olivas P, Turco L, et al. Decompensation in advanced Nonalcoholic fatty liver disease may Occur at lower hepatic venous pressure gradient levels than in patients with viral disease. Clin Gastroenterol Hepatol 2022;20(10):2276–2286.e6.
[20] Paternostro R, Kwanten WJ, Hofer BS, et al. Hepatic venous pressure gradient predicts risk of hepatic decompensation and liver-related mortality in patients with MASLD. J Hepatol 2024;81(5):827–836.
[21] Laleman W, Mertens J, Vanderschueren E, Praktiknjo M, Trebicka J. Advances in Endohepatology. Am J Gastroenterol 2023;118(10):1756–1767.
[22] Reverter E, Cirera I, Albillos A, et al. The prognostic role of hepatic venous pressure gradient in cirrhotic patients undergoing elective extrahepatic surgery. J Hepatol 2019;71(5):942–950.
[23] Berzigotti A, Reig M, Abraldes JG, Bosch J, Bruix J. Portal hypertension and the outcome of surgery for hepatocellular carcinoma in compensated cirrhosis: a systematic review and meta-analysis. Hepatology févr 2015;61(2):526–536.
[24] Berzigotti A, Seijo S, Arena U, Abraldes JG, Vizzutti F, García-Pagán JC, et al. Elastography, spleen size, and platelet count identify portal hypertension in patients with compensated cirrhosis. Gastroenterology janv 2013;144(1):102–111.e1.
[25] Hoeper MM, Krowka MJ, Strassburg CP. Portopulmonary hypertension and hepatopulmonary syndrome. Lancet 1 mai 2004;363(9419):1461–1468.
[26] Humbert M, Kovacs G, Hoeper MM, Badagliacca R, Berger RMF, Brida M, et al. 2022 ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension. Eur Respir J [Internet] 1 janv 2022 [cité 1 févr 2024]; Disponible sur: https://erj.ersjournals.com/content/early/2022/08/25/13993003.00879-2022.
[27] Singh T, Kochhar GS, Goh GB, Schauer P, Brethauer S, Kroh M, et al. Safety and efficacy of bariatric surgery in patients with advanced fibrosis. Int J Obes (Lond) mars 2017;41(3):443–449.
[28] Lassailly G, Caiazzo R, Ntandja-Wandji LC, Gnemmi V, Baud G, Verkindt H, et al. Bariatric surgery provides long-term resolution of Nonalcoholic steatohepatitis and Regression of fibrosis. Gastroenterology oct 2020;159(4):1290–1301.e5.
[29] Agarwal L, Sahu AK, Baksi A, Agarwal A, Aggarwal S. Safety of metabolic and bariatric surgery in obese patients with liver cirrhosis: a systematic review and meta-analysis. Surg Obes Relat Dis mars 2021;17(3):525–537.
[30] Vuppalanchi R, McCabe ME, Tandra SR, Parcha SP, Ghafoor A, Schuh L, et al. Safety and efficacy of bariatric surgery in cirrhosis patients with Extreme obesity. Ann Surg 1 janv 2022;275(1):e174–e180.
[31] Mosko JD, Nguyen GC. Increased perioperative mortality following bariatric surgery among patients with cirrhosis. Clin Gastroenterol Hepatol oct 2011;9(10):897–901.
[32] Ahmed S, Pouwels S, Parmar C, Kassir R, de Luca M, Graham Y, et al. Outcomes of bariatric surgery in patients with liver cirrhosis: a systematic review. Obes Surg mai 2021;31(5):2255–2267.
[33] Aminian A, Aljabri A, Wang S, et al. Long-term liver outcomes after metabolic surgery in compensated cirrhosis due to metabolic dysfunction-associated steatohepatitis. Nat Med 2025 Mar;31(3):988–995. https://doi.org/10.1038/s41591-024-03480-y.
[34] Mumtaz K, Lipshultz H, Jalil S, Porter K, Li N, Kelly SG, et al. Bariatric surgery in patients with cirrhosis: careful patient and surgery-type selection is key to improving outcomes. OBES SURG 1 sept 2020;30(9):3444–3452.
[35] Fernandes E de SM, de Mello FPT, Pimentel LS, Andrade R de O, Girão C, César C, et al. Combined liver transplantation with sleeve gastrectomy: a pioneer case series from Brazil. Updates Surg 1 févr 2022;74(1):81–86.
[36] Chierici A, Alromayan M, De Fatico S, Drai C, Vinci D, Anty R, et al. Is bariatric surgery safer before, during, or after liver transplantation? A systematic review and meta-analysis. J Liver Transplant 1 févr 2023;9:100139.
[37] de Barros F, Cardoso Faleiro Uba PH. Liver transplantation and bariatric surgery: a new surgical reality: a systematic review of the best time for bariatric surgery. Updates Surg oct 2021;73(5):1615–1622.
[38] Lopez-Lopez V, Ruiz-Manzanera JJ, Eshmuminov D, Lehmann K, Schneider M, von der Groeben M, et al. Are We Ready for bariatric surgery in a liver transplant program? A meta-analysis. Obes Surg mars 2021;31(3):1214–1222.
[39] Silva MA, Wong T. Gallstones in chronic liver disease. J Gastrointest Surg 2005;9(5):739–746.
[40] Wang SY, Yeh CN, Jan YY, Chen MF. Management of gallstones and acute cholecystitis in patients with liver cirrhosis: what should We consider when performing surgery? Gut Liver 15 juill 2021;15(4):517–527.
[41] Currò G, Iapichino G, Melita G, Lorenzini C, Cucinotta E. Laparoscopic cholecystectomy in Child-Pugh class C cirrhotic patients. JSLS 2005;9(3):311–315.
[42] Nguyen KT, Kitisin K, Steel J, Jeyabalan G, Aggarwal S, Geller DA, et al. Cirrhosis is not a contraindication to laparoscopic cholecystectomy: results and practical recommendations. HPB (Oxford) mars 2011;13(3):192–197.
[43] Laurence JM, Tran PD, Richardson AJ, Pleass HCC, Lam VWT. Laparoscopic or open cholecystectomy in cirrhosis: a systematic review of outcomes and meta-analysis of randomized trials. HPB (Oxford) mars 2012;14(3):153–161.
[44] de Goede B, Klitsie PJ, Hagen SM, van Kempen BJH, Spronk S, Metselaar HJ, et al. Meta-analysis of laparoscopic versus open cholecystectomy for patients with liver cirrhosis and symptomatic cholecystolithiasis. Br J Surg janv 2013;100(2):209–216.
[45] James TW, Krafft M, Croglio M, Nasr J, Baron T. EUS-guided gallbladder drainage in patients with cirrhosis: results of a multicenter retrospective study. Endosc Int Open sept 2019;7(9):E1099-104.
[46] Itoi T, Sofuni A, Itokawa F, Tsuchiya T, Kurihara T, Ishii K, et al. Endoscopic transpapillary gallbladder drainage in patients with acute cholecystitis in whom percutaneous transhepatic approach is contraindicated or anatomically impossible (with video). Gastrointest Endosc sept 2008;68(3):455–460.
[47] Okamuro K, Cui B, Moazzez A, Park H, Putnam B, de Virgilio C, et al. Laparoscopic cholecystectomy is safe in emergency general surgery patients with cirrhosis. Am Surg 1 oct 2019;85(10):1146–1149.
[48] Irani SS, Sharzehi K, Siddiqui UD. AGA clinical practice update on role of EUS-guided gallbladder drainage in acute cholecystitis: Commentary. Clin Gastroenterol Hepatol mai 2023;21(5):1141–1147.
[49] Currò G, Cucinotta E. Percutaneous gall bladder aspiration as an alternative to laparoscopic cholecystectomy in Child-Pugh C cirrhotic patients with acute cholecystitis. Gut juin 2006;55(6):898–899.
[50] Carbonell AM, Wolfe LG, DeMaria EJ. Poor outcomes in cirrhosis-associated hernia repair: a nationwide cohort study of 32,033 patients. Hernia déc 2005;9(4):353–357.
[51] Pipek LZ, Cortez VS, Taba JV, Suzuki MO, do Nascimento FS, de Mattos VC, et al. Cirrhosis and hernia repair in a cohort of 6352 patients in a tertiary hospital: risk assessment and survival analysis. Medicine (Baltimore) 11 nov 2022;101(45):e31506.
[52] Gray SH, Vick CC, Graham LA, Finan KR, Neumayer LA, Hawn MT. Umbilical herniorrhapy in cirrhosis: improved outcomes with elective repair. J Gastrointest Surg avr 2008;12(4):675–681.

[53] Eker HH, van Ramshorst GH, de Goede B, Tilanus HW, Metselaar HJ, de Man RA, et al. A prospective study on elective umbilical hernia repair in patients with liver cirrhosis and ascites. Surgery sept 2011;150(3):542–546.
[54] Marsman HA, Heisterkamp J, Halm JA, Tilanus HW, Metselaar HJ, Kazemier G. Management in patients with liver cirrhosis and an umbilical hernia. Surgery sept 2007;142(3):372–375.
[55] Pinheiro RS, Andraus W, Waisberg DR, Nacif LS, Ducatti L, Rocha-Santos V, et al. Abdominal hernias in cirrhotic patients: surgery or conservative treatment? Results of a prospective cohort study in a high volume center: cohort study. Ann Med Surg (Lond) 22 nov 2019;49:9–13.
[56] de Goede B, van Rooijen MMJ, van Kempen BJH, Polak WG, de Man RA, Taimr P, et al. Conservative treatment versus elective repair of umbilical hernia in patients with liver cirrhosis and ascites: results of a randomized controlled trial (CRUCIAL trial). Langenbecks Arch Surg févr 2021;406(1):219–225.
[57] Andraus W, Pinheiro RS, Lai Q, Haddad LBP, Nacif LS, D'Albuquerque LAC, et al. Abdominal wall hernia in cirrhotic patients: emergency surgery results in higher morbidity and mortality. BMC Surg 21 mai 2015;15:65.
[58] Johnson KM, Newman KL, Green PK, Berry K, Cornia PB, Wu P, et al. Incidence and risk factors of postoperative mortality and morbidity after elective versus emergent abdominal surgery in a national sample of 8193 patients with cirrhosis. Ann Surg 1 oct 2021;274(4):e345–e354.
[59] Odom SR, Gupta A, Talmor D, Novack V, Sagy I, Evenson AR. Emergency hernia repair in cirrhotic patients with ascites. J Trauma Acute Care Surg sept 2013;75(3):404–409.
[60] Hill CE, Olson KA, Roward S, Yan D, Cardenas T, Teixeira P, et al. Fix it while you can … Mortality after umbilical hernia repair in cirrhotic patients. Am J Surg déc 2020;220(6):1402–1404.
[61] Bhangui P, Laurent A, Amathieu R, Azoulay D. Assessment of risk for non-hepatic surgery in cirrhotic patients. J Hepatol oct 2012;57(4):874–884.
[62] Cho SW, Bhayani N, Newell P, Cassera MA, Hammill CW, Wolf RF, et al. Umbilical hernia repair in patients with signs of portal hypertension: surgical outcome and predictors of mortality. Arch Surg sept 2012;147(9):864–869.
[63] McKay A, Dixon E, Bathe O, Sutherland F. Umbilical hernia repair in the presence of cirrhosis and ascites: results of a survey and review of the literature. Hernia oct 2009;13(5):461–468.
[64] Ammar SA. Management of complicated umbilical hernias in cirrhotic patients using permanent mesh: randomized clinical trial. Hernia févr 2010;14(1):35–38.
[65] Rashid A, Gupta A, Adiamah A, West J, Grainge M, Humes DJ. Mortality following Appendicectomy in patients with liver cirrhosis: a systematic review and meta-analysis. World J Surg mars 2022;46(3):531–541.
[66] Shahait A, Pearl A, Saleh KJ. Outcomes of colectomy in United States Veterans with cirrhosis: Predicting outcomes using Nomogram. J Surg Res janv 2024;293:570–577.
[67] Cheng YX, Tao W, Zhang H, Peng D, Wei ZQ. Does liver cirrhosis affect the surgical outcome of primary colorectal cancer surgery? A meta-analysis. World J Surg Oncol 9 juin 2021;19:167.
[68] Käser SA, Hofmann I, Willi N, Stickel F, Maurer CA. Liver cirrhosis/severe fibrosis is a risk factor for anastomotic leakage after colorectal surgery. Gastroenterol Res Pract 2016;2016:1563037.
[69] Pimentel-Nunes P, Libânio D, Bastiaansen BAJ, Bhandari P, Bisschops R, Bourke MJ, et al. Endoscopic submucosal dissection for superficial gastrointestinal lesions: European society of gastrointestinal endoscopy (ESGE) guideline - update 2022. Endoscopy juin 2022;54(6):591–622.
[70] Pei KY, Asuzu DT, Davis KA. Laparoscopic colectomy reduces complications and hospital length of stay in colon cancer patients with liver disease and ascites. Surg Endosc mars 2018;32(3):1286–1292.
[71] Tokuhara K, Nakatani K, Ueyama Y, Yoshioka K, Kon M. Short- and long-term outcomes of laparoscopic surgery for colorectal cancer in the elderly: a prospective cohort study. Int J Surg 1 mars 2016;27:66–71.
[72] Montomoli J, Erichsen R, Strate LL, Pedersen L, Nilsson T, Sørensen HT. Coexisting liver disease is associated with increased mortality after surgery for diverticular disease. Dig Dis Sci juin 2015;60(6):1832–1840.
[73] Kazi A, Finco TB, Zakhary B, Firek M, Gerber A, Brenner M, et al. Acute Colonic diverticulitis and cirrhosis: outcomes of laparoscopic colectomy compared with an open approach. J Am Coll Surg juin 2020;230(6):1045–1053.
[74] Kruger AJ, Mumtaz K, Anaizi A, Modi RM, Hussan H, Zhang C, et al. Cirrhosis is associated with increased mortality in patients with diverticulitis: a nationwide Cross-Sectional study. Dig Dis Sci nov 2017;62(11):3149–3155.
[75] Lian L, Menon KVN, Shen B, Remzi F, Kiran RP. Inflammatory bowel disease complicated by primary sclerosing cholangitis and cirrhosis: is restorative proctocolectomy safe? Dis Colon Rectum janv 2012;55(1):79–84.
[76] Carbone M, Della Penna A, Mazzarelli C, De Martin E, Villard C, Bergquist A, et al. Liver transplantation for primary sclerosing cholangitis (PSC) with or without inflammatory bowel disease (IBD)-A European society of organ transplantation (ESOT) consensus statement. Transpl Int 2023;36:11729.
[77] Teraoku H, Morine Y, Ikemoto T, Saito Y, Yamada S, Waki Y, et al. Impact of pancreatic resection in patients with liver cirrhosis. J Med Invest 2023;70(1.2):189–194.
[78] Regimbeau JM, Rebibo L, Dokmak S, Boher JM, Sauvanet A, Chopin-Laly X, et al. The short- and long-term outcomes of pancreaticoduodenectomy for cancer in Child A patients are acceptable: a patient-control study from the Surgical French Association report for pancreatic surgery. J Surg Oncol mai 2015;111(6):776–783.
[79] Fuks D, Sabbagh C, Yzet T, Delcenserie R, Chatelain D, Regimbeau JM. Cirrhosis should not be considered as an absolute contraindication for pancreatoduodenectomy. Hepatogastroenterology mai 2012;59(115):881–883.
[80] Sethi H, Srinivasan P, Marangoni G, Prachalias A, Rela M, Heaton N. Pancreaticoduodenectomy with radical lymphadenectomy is not contra-indicated for patients with established chronic liver disease and portal hypertension. Hepatobiliary Pancreat Dis Int févr 2008;7(1):82–85.
[81] Futagawa Y, Yanaga K, Kosuge T, Suka M, Isaji S, Hirano S, et al. Outcomes of pancreaticoduodenectomy in patients with chronic hepatic dysfunction including liver cirrhosis: results of a retrospective multicenter study by the Japanese Society of Hepato-Biliary-Pancreatic Surgery. J Hepatobiliary Pancreat Sci juill 2019;26(7):310–324.
[82] Kang WH, Yu YD, Yoon KC, Jo HS, Kim DS. Should we be reluctant to perform pancreatectomy in patients with chronic liver disease? A single center 10-year experience. Acta Chir Belg avr 2023;123(2):156–162.
[83] Mahamid M, Khoury T, Mahamid B, Sbeit W, Mari A, Nseir W. The interplay between abdominal aortic aneurysm, metabolic syndrome and fatty liver disease: a retrospective case-control study. Diabetes Metab Syndr Obes 2019;12:1743–1749.
[84] Malas M, Arhuidese I, Qazi U, Black J, Perler B, Freischlag JA. Perioperative mortality following repair of abdominal aortic aneurysms: application of a randomized clinical trial to real-world practice using a validated nationwide data set. JAMA Surg déc 2014;149(12):1260–1265.
[85] Northup PG, Friedman LS, Kamath PS. AGA clinical practice update on surgical risk assessment and perioperative management in cirrhosis: expert review. Clin Gastroenterol Hepatol mars 2019;17(4):595–606.
[86] Marrocco-Trischitta MM, Kahlberg A, Astore D, Tshiombo G, Mascia D, Chiesa R. Outcome in cirrhotic patients after elective surgical repair of infrarenal aortic aneurysm. J Vasc Surg avr 2011;53(4):906–911.
[87] Chou AH, Chen CC, Lin YS, Lin MS, Wu VCC, Ting PC, et al. A population-based analysis of endovascular aortic stent graft therapy in patients with liver cirrhosis. J Vasc Surg mai 2019;69(5):1395–1404.e4.
[88] Sokol DK. The slipperiness of futility. BMJ 5 juin 2009;338:b2222.
[89] Ramírez-Giraldo C, Isaza-Restrepo A, García-Peralta JC, González-Tamayo J, Ibáñez-Pinilla M. Surgical mortality in patients in extremis: futility in emergency abdominal surgery. BMC Surg 27 janv 2023;23(1):21.
[90] Kao AM, Maloney SR, Prasad T, Reinke CE, May AK, Heniford BT, et al. The CELIOtomy Risk Score: an effort to minimize futile surgery with analysis of early postoperative mortality after emergency laparotomy. Surgery oct 2020;168(4):676–683.
[91] Javanmard-Emamghissi H, Doleman B, Lund JN, Frisby J, Lockwood S, Hare S, et al. Quantitative futility in emergency laparotomy: an exploration of early-postoperative death in the National Emergency Laparotomy Audit. Tech Coloproctol sept 2023;27(9):729–738.
[92] Hobeika C, Cauchy F, Sartoris R, Beaufrère A, Yoh T, Vilgrain V, et al. Relevance of liver surface nodularity for preoperative risk assessment in patients with resectable hepatocellular carcinoma. Br J Surg 2020;7:878–888.
[93] Seror M, Sartoris R, Hobeika C, Bouattour M, Paradis V, Rautou PE, et al. Computed Tomography-derived liver surface nodularity and sarcopenia as prognostic factors in patients with resectable metabolic syndrome-related hepatocellular carcinoma. Ann Surg Oncol janv 2021;28(1):405–416.
[94] Vinet E, Perreault P, Bouchard L, Bernard D, Wassef R, Richard C, et al. Transjugular intrahepatic portosystemic shunt before abdominal surgery in cirrhotic patients: a retrospective, comparative study. Can J Gastroenterol juin 2006;20(6):401–404.

[95] Menahem B, Lubrano J, Desjouis A, Lepennec V, Lebreton G, Alves A. Transjugular intrahepatic portosystemic shunt placement increases feasibility of colorectal surgery in cirrhotic patients with severe portal hypertension. Dig Liver Dis janv 2015;47(1):81–84.
[96] Tabchouri N, Barbier L, Menahem B, Perarnau JM, Muscari F, Fares N, et al. Original study: transjugular intrahepatic portosystemic shunt as a bridge to abdominal surgery in cirrhotic patients. J Gastrointest Surg 1 déc 2019;23(12):2383–2390.
[97] Fares N, Robic MA, Péron JM, Muscari F, Otal P, Suc B, et al. Transjugular intrahepatic portosystemic shunt placement before abdominal intervention in cirrhotic patients with portal hypertension: lessons from a pilot study. Eur J Gastroenterol Hepatol janv 2018;30(1):21–26.
[98] Lahat E, Lim C, Bhangui P, Fuentes L, Osseis M, Moussallem T, et al. Transjugular intrahepatic portosystemic shunt as a bridge to non-hepatic surgery in cirrhotic patients with severe portal hypertension: a systematic review. HPB (Oxford) févr 2018;20(2):101–109.
[99] Aryan M, McPhail J, Ravi S, Harris P, Allamneni C, Shoreibah M. Perioperative transjugular intrahepatic portosystemic shunt is associated with decreased postoperative complications in decompensated Cirrhotics undergoing abdominal surgery. Am Surg juill 2022;88(7):1613–1620.
[100] Chang J, Höfer P, Böhling N, Lingohr P, Manekeller S, Kalff JC, et al. Preoperative TIPS prevents the development of postoperative acute-on-chronic liver failure in patients with high CLIF-C AD score. JHEP Rep mars 2022;4(3):100442.
[101] Piecha F, Vonderlin J, Frühhaber F, Graß JK, Ozga AK, Harberts A, et al. Preoperative TIPS and in-hospital mortality in patients with cirrhosis undergoing surgery. JHEP Rep janv 2024;6(1):100914.
[102] European Association for the Study of the Liver. EASL Clinical Practice Guidelines on the management of hepatic encephalopathy. J Hepatol sept 2022;77(3):807–824.
[103] European Association for the Study of the Liver. EASL Clinical Practice Guidelines on prevention and management of bleeding and thrombosis in patients with cirrhosis. J Hepatol mai 2022;76(5):1151–1184.
[104] Patel IJ, Rahim S, Davidson JC, Hanks SE, Tam AL, Walker TG, et al. Society of interventional radiology consensus guidelines for the Periprocedural management of thrombotic and bleeding risk in patients undergoing percutaneous Image-guided interventions-Part II: recommendations: Endorsed by the Canadian association for interventional radiology and the cardiovascular and interventional Radiological society of Europe. J Vasc Interv Radiol août 2019;30(8):1168–1184. e1.
[105] Hornor MA, Duane TM, Ehlers AP, Jensen EH, Brown PS, Pohl D, et al. American College of surgeons' guidelines for the perioperative management of antithrombotic medication. J Am Coll Surg nov 2018;227(5):521–536. e1.
[106] Douketis JD, Spyropoulos AC, Spencer FA, Mayr M, Jaffer AK, Eckman MH, et al. Perioperative management of antithrombotic therapy: Antithrombotic therapy and prevention of thrombosis, 9th ed: American College of chest Physicians evidence-based clinical practice guidelines. Chest févr 2012;141(2 Suppl):e326S–e350S.
[107] Narouze S, Benzon HT, Provenzano D, Buvanendran A, De Andres J, Deer T, et al. Interventional spine and pain procedures in patients on antiplatelet and anticoagulant medications (Second Edition): guidelines from the American society of regional anesthesia and pain medicine, the European society of regional anaesthesia and pain therapy, the American Academy of pain medicine, the international Neuromodulation society, the North American Neuromodulation society, and the world Institute of pain. Reg Anesth Pain Med avr 2018;43(3):225–262.
[108] Lisman T, Caldwell SH, Intagliata NM. Haemostatic alterations and management of haemostasis in patients with cirrhosis. J Hepatol juin 2022;76(6):1291–1305.
[109] Potze W, Arshad F, Adelmeijer J, Blokzijl H, van den Berg AP, Meijers JCM, et al. Decreased tissue factor pathway inhibitor (TFPI)-dependent anticoagulant capacity in patients with cirrhosis who have decreased protein S but normal TFPI plasma levels. Br J Haematol sept 2013;162(6):819–826.
[110] Potze W, Arshad F, Adelmeijer J, Blokzijl H, van den Berg AP, Porte RJ, et al. Routine coagulation assays underestimate levels of antithrombin-dependent drugs but not of direct anticoagulant drugs in plasma from patients with cirrhosis. Br J Haematol déc 2013;163(5):666–673.
[111] Sinagra E, Perricone G, D'Amico M, Tinè F, D'Amico G. Systematic review with meta-analysis: the haemodynamic effects of carvedilol compared with propranolol for portal hypertension in cirrhosis. Aliment Pharmacol Ther mars 2014;39(6):557–568.
[112] Villanueva C, Albillos A, Genescà J, et al. β blockers to prevent decompensation of cirrhosis in patients with clinically significant portal hypertension (PREDESCI): a randomised, double-blind, placebo-controlled, multicentre trial. Lancet 2019 Apr 20;393(10181):1597–1608. https://doi.org/10.1016/S0140-6736(18)31875-0.
[113] Villanueva C, Torres F, Sarin SK, Shah HA, Tripathi D, Brujats A, et al. Carvedilol reduces the risk of decompensation and mortality in patients with compensated cirrhosis in a competing-risk meta-analysis. J Hepatol 2022;77(4):1014–1025.
[114] Abraldes JG, Albillos A, Bañares R, Turnes J, González R, García-Pagán JC, et al. Simvastatin lowers portal pressure in patients with cirrhosis and portal hypertension: a randomized controlled trial. Gastroenterology mai 2009;136(5):1651–1658.
[115] Alvarado-Tapias E, Brujats A, Puente A, et al. Hemodynamic effects of carvedilol plus simvastatin in cirrhosis with severe portal hypertension and suboptimal response to β-blockers: a double-blind, placebo-controlled, randomized trial. Hepatology 2024. https://doi.org/10.1097/HEP.0000000000001148.
[116] Pollo-Flores P, Soldan M, Santos UC, et al. Three months of simvastatin therapy vs. placebo for severe portal hypertension in cirrhosis: A randomized controlled trial. Dig Liver Dis 2015;47:957–963.
[117] Pose E, Jiménez C, Zaccherini G, et al. LIVERHOPE Consortium. Simvastatin and Rifaximin in decompensated cirrhosis: A randomized clinical trial. JAMA 2025 Mar 11;333(10):864–874. https://doi.org/10.1001/jama.2024.27441.
[118] Mohkam K, Rayar M, Adam JP, Muscari F, Rode A, Merle P, et al. Evaluation of postoperative ascites after somatostatin infusion following hepatectomy for hepatocellular carcinoma by laparotomy: a multicenter randomized double-blind controlled trial (SOMAPROTECT). BMC Cancer 23 août 2018;18(1):844.
[119] European Association for the Study of the Liver. EASL Clinical Practice Guidelines for the management of patients with decompensated cirrhosis. J Hepatol 1 août 2018;69(2):406–460.
[120] Ambrosino P, Tarantino L, Di Minno G, Paternoster M, Graziano V, Petitto M, et al. The risk of venous thromboembolism in patients with cirrhosis. A systematic review and meta-analysis. Thromb Haemost 5 janv 2017;117(1):139–148.
[121] Pasta A, Calabrese F, Labanca S, Marenco S, Pieri G, Plaz Torres MC, et al. Safety and efficacy of venous thromboembolism prophylaxis in patients with cirrhosis: a systematic review and meta-analysis. Liver Int juill 2023;43(7):1399–1406.
[122] Douketis JD, Spyropoulos AC, Murad MH, Arcelus JI, Dager WE, Dunn AS, et al. Executive summary: perioperative management of antithrombotic therapy: an American College of chest Physicians clinical practice guideline. Chest nov 2022;162(5):1127–1139.
[123] Effects of extended-release metoprolol succinate in patients undergoing non-cardiac surgery (POISE trial): a randomised controlled trial. The Lancet 31 mai 2008;371(9627):1839–1847.
[124] Klein LM, Chang J, Gu W, Manekeller S, Jansen C, Lingohr P, et al. The development and outcome of acute-on-chronic liver failure after surgical interventions. Liver Transpl févr 2020;26(2):227–237.
[125] Gkamprela E, Deutsch M, Pectasides D. Iron deficiency anemia in chronic liver disease: etiopathogenesis, diagnosis and treatment. Ann Gastroenterol 2017;30(4):405–413.
[126] Gonzalez-Casas R, Jones EA, Moreno-Otero R. Spectrum of anemia associated with chronic liver disease. World J Gastroenterol 7 oct 2009;15(37):4653–4658.
[127] Qamar AA, Grace ND. Abnormal hematological indices in cirrhosis. Can J Gastroenterol juin 2009;23(6):441–445.
[128] Ruggeri ZM. Mechanisms initiating platelet thrombus formation. Thromb Haemost juill 1997;78(1):611–616.
[129] Uhl L, Assmann SF, Hamza TH, Harrison RW, Gernsheimer T, Slichter SJ. Laboratory predictors of bleeding and the effect of platelet and RBC transfusions on bleeding outcomes in the PLADO trial. Blood 7 sept 2017;130(10):1247–1258.
[130] Kundumadam S, Phatharacharukul P, Reinhart K, Yousef A, Shamseddeen H, Pike F, et al. Bleeding after elective interventional endoscopic procedures in a large cohort of patients with cirrhosis. Clin Transl Gastroenterol 17 déc 2020;11(12):e00288.
[131] Lichtenegger P, Schiefer J, Graf A, Berlakovich G, Faybik P, Baron DM, et al. The association of pre-operative anaemia with survival after orthotopic liver transplantation. Anaesthesia avr 2020;75(4):472–478.
[132] Collas O, Robertson FP, Fuller BJ, Davidson BR. Anaemia in patients with chronic liver disease and its association with morbidity and mortality following liver transplantation. Int J Surg mai 2018;53:48–52.

[133] Aydogan MS, Erdogan MA, Yucel A, Konur H, Bentli R, Toprak HI, et al. Effects of preoperative iron deficiency on transfusion requirements in liver transplantation recipients: a prospective observational study. Transpl Proc 2013;45(6):2277–2282.

[134] Aydogan MS, Ozgül U, Erdogan MA, Yucel A, Toprak HI, Durmus M, et al. Effect of preoperative iron deficiency in liver transplant recipients on length of intensive care unit stay. Transpl Proc avr 2013;45(3):978–981.

[135] Seong H, Jang Y, Ko E, Lee J, Kim T, Lim CH, et al. Impact of preoperative red blood cell transfusion on long-term mortality of liver transplantation: a retrospective cohort study. Medicine (Baltimore) 15 sept 2023;102(37):e34914.

[136] Jeong JY, Jee HS, Koo BS, Cho SH, Kim SH, Kim G. Liver transplantation in Jehovah's Witnesses: two cases report. Korean J Anesthesiol juin 2017;70(3):350–355.

[137] Darwish A. Liver transplant in Jehovah's Witnesses patients. Curr Opin Organ Transpl juin 2011;16(3):326–330.

[138] Tripodi A, Caldwell SH, Hoffman M, Trotter JF, Sanyal AJ. Review article: the prothrombin time test as a measure of bleeding risk and prognosis in liver disease. Aliment Pharmacol Ther 15 juill 2007;26(2):141–148.

[139] Lisman T, Bakhtiari K, Pereboom ITA, Hendriks HGD, Meijers JCM, Porte RJ. Normal to increased thrombin generation in patients undergoing liver transplantation despite prolonged conventional coagulation tests. J Hepatol mars 2010;52(3):355–361.

[140] Lisman T, Porte RJ. Rebalanced hemostasis in patients with liver disease: evidence and clinical consequences. Blood 12 août 2010;116(6):878–885.

[141] de Boer MT, Molenaar IQ, Hendriks HGD, Slooff MJH, Porte RJ. Minimizing blood loss in liver transplantation: progress through research and evolution of techniques. Dig Surg 2005;22(4):265–275.

[142] Pereira D, Liotta E, Mahmoud AA. The Use of Kcentra® in the Reversal of coagulopathy of chronic liver disease. J Pharm Pract févr 2018;31(1):120–125.

[143] Gurusamy KS, Pissanou T, Pikhart H, Vaughan J, Burroughs AK, Davidson BR. Methods to decrease blood loss and transfusion requirements for liver transplantation. Cochrane Database Syst Rev 7 déc 2011;2011(12):CD009052.

[144] Vincent JL, Rossaint R, Riou B, Ozier Y, Zideman D, Spahn DR. Recommendations on the use of recombinant activated factor VII as an adjunctive treatment for massive bleeding–a European perspective. Crit Care 2006;10(4):R120.

[145] Lisman T, Bongers TN, Adelmeijer J, Janssen HLA, de Maat MPM, de Groot PG, et al. Elevated levels of von Willebrand Factor in cirrhosis support platelet adhesion despite reduced functional capacity. Hepatology juill 2006;44(1):53–61.

[146] Hugenholtz GCG, Macrae F, Adelmeijer J, Dulfer S, Porte RJ, Lisman T, et al. Procoagulant changes in fibrin clot structure in patients with cirrhosis are associated with oxidative modifications of fibrinogen. J Thromb Haemost mai 2016;14(5):1054–1066.

[147] British Committee for Standards in Haematology, Stainsby D, MacLennan S, Thomas D, Isaac J, Hamilton PJ. Guidelines on the management of massive blood loss. Br J Haematol déc 2006;135(5):634–641.

[148] Levy JH, Welsby I, Goodnough LT. Fibrinogen as a therapeutic target for bleeding: a review of critical levels and replacement therapy. Transfusion mai 2014;54(5):1389–1405. quiz 1388.

[149] Biancofiore G, Blasi A, De Boer MT, Franchini M, Hartmann M, Lisman T, et al. Perioperative hemostatic management in the cirrhotic patient: a position paper on behalf of the Liver Intensive Care Group of Europe (LICAGE). Minerva Anestesiol juill 2019;85(7):782–798.

[150] Moggia E, Rouse B, Simillis C, Li T, Vaughan J, Davidson BR, et al. Methods to decrease blood loss during liver resection: a network meta-analysis. Cochrane Database Syst Rev 31 oct 2016;10(10):CD010683.

[151] Liu P, Hum J, Jou J, Scanlan RM, Shatzel J. Transfusion strategies in patients with cirrhosis. Eur J Haematol janv 2020;104(1):15–25.

[152] Perel P, Ker K, Morales Uribe CH, Roberts I. Tranexamic acid for reducing mortality in emergency and urgent surgery. Cochrane Database Syst Rev 31 janv 2013;2013(1):CD010245.

[153] Kumar M, Ahmad J, Maiwall R, Choudhury A, Bajpai M, Mitra LG, et al. Thromboelastography-guided blood Component Use in patients with cirrhosis with Nonvariceal bleeding: a randomized controlled trial. Hepatology janv 2020;71(1):235–246.

[154] Bonnet A, Gilquin N, Steer N, Gazon M, Quattrone D, Pradat P, et al. The use of a thromboelastometry-based algorithm reduces the need for blood product transfusion during orthotopic liver transplantation: a randomised controlled study. Eur J Anaesthesiol nov 2019;36(11):825–833.

[155] Vuyyuru SK, Singh AD, Gamanagatti SR, Rout G, Gunjan D, null Shalimar. A randomized control trial of Thromboelastography-guided transfusion in cirrhosis for high-risk invasive liver-related procedures. Dig Dis Sci juill 2020;65(7):2104–2111.

[156] Wang SC, Shieh JF, Chang KY, Chu YC, Liu CS, Loong CC, et al. Thromboelastography-guided transfusion decreases intraoperative blood transfusion during orthotopic liver transplantation: randomized clinical trial. Transpl Proc sept 2010;42(7):2590–2593.

[157] Rout G, Shalimar Gunjan D, Mahapatra SJ, Kedia S, Garg PK, et al. Thromboelastography-guided blood product transfusion in cirrhosis patients with variceal bleeding : a randomized controlled trial. J Clin Gastroenterol 1 mars 2020;54(3):255–262.

[158] De Pietri L, Bianchini M, Montalti R, De Maria N, Di Maira T, Begliomini B, et al. Thrombelastography-guided blood product use before invasive procedures in cirrhosis with severe coagulopathy: a randomized, controlled trial. Hepatology févr 2016;63(2):566–573.

[159] Wei H, Child LJ. Clinical utility of viscoelastic testing in chronic liver disease: a systematic review. World J Hepatol 27 nov 2020;12(11):1115–1127.

[160] Kietaibl S, Ahmed A, Afshari A, Albaladejo P, Aldecoa C, Barauskas G, et al. Management of severe peri-operative bleeding: guidelines from the European society of anaesthesiology and intensive care: Second update 2022. Eur J Anaesthesiol 1 avr 2023;40(4):226–304.

[161] Hoetzel A, Ryan H, Schmidt R. Anesthetic considerations for the patient with liver disease. Curr Opin Anaesthesiol juin 2012;25(3):340–347.

[162] Jones RM, Moulton CE, Hardy KJ. Central venous pressure and its effect on blood loss during liver resection. Br J Surg août 1998;85(8):1058–1060.

[163] Massicotte L, Lenis S, Thibeault L, Sassine MP, Seal RF, Roy A. Effect of low central venous pressure and phlebotomy on blood product transfusion requirements during liver transplantations. Liver Transpl janv 2006;12(1):117–123.

[164] Vieillard-Baron A, Chergui K, Rabiller A, Peyrouset O, Page B, Beauchet A, et al. Superior vena caval collapsibility as a gauge of volume status in ventilated septic patients. Intensive Care Med sept 2004;30(9):1734–1739.

[165] Burtenshaw AJ, Isaac JL. The role of trans-oesophageal echocardiography for perioperative cardiovascular monitoring during orthotopic liver transplantation. Liver Transpl nov 2006;12(11):1577–1583.

[166] Cheung AT, Savino JS, Weiss SJ, Aukburg SJ, Berlin JA. Echocardiographic and hemodynamic indexes of left ventricular preload in patients with normal and abnormal ventricular function. Anesthesiology août 1994;81(2):376–387.

[167] Massicotte L, Perrault MA, Denault AY, Klinck JR, Beaulieu D, Roy JD, et al. Effects of phlebotomy and phenylephrine infusion on portal venous pressure and systemic hemodynamics during liver transplantation. Transplantation 27 avr 2010;89(8):920–927.

[168] Feng ZY, Xu X, Zhu SM, Bein B, Zheng SS. Effects of low central venous pressure during preanhepatic phase on blood loss and liver and renal function in liver transplantation. World J Surg août 2010;34(8):1864–1873.

[169] Schroeder RA, Collins BH, Tuttle-Newhall E, Robertson K, Plotkin J, Johnson LB, et al. Intraoperative fluid management during orthotopic liver transplantation. J Cardiothorac Vasc Anesth août 2004;18(4):438–441.

[170] Morkane CM, Sapisochin G, Mukhtar AM, Reyntjens KMEM, Wagener G, Spiro M, et al. Perioperative fluid management and outcomes in adult deceased donor liver transplantation - a systematic review of the literature and expert panel recommendations. Clin Transpl oct 2022;36(10):e14651.

[171] Hand WR, Whiteley JR, Epperson TI, Tam L, Crego H, Wolf B, et al. Hydroxyethyl starch and acute kidney injury in orthotopic liver transplantation: a single-center retrospective review. Anesth Analg mars 2015;120(3):619–626.

[172] Crivellin C, Cagnin A, Manara R, Boccagni P, Cillo U, Feltracco P, et al. Risk factors for central pontine and extrapontine myelinolysis after liver transplantation: a single-center study. Transplantation juin 2015;99(6):1257–1264.

[173] Nanchal R, Subramanian R, Alhazzani W, Dionne JC, Peppard WJ, Singbartl K, et al. Guidelines for the management of adult acute and acute-on-chronic liver failure in the ICU: Neurology, peri-transplant medicine, infectious disease, and Gastroenterology considerations. Crit Care Med 1 mai 2023;51(5):657–676.

[174] Perel P, Roberts I, Ker K. Colloids versus crystalloids for fluid resuscitation in critically ill patients. Cochrane Database Syst Rev 28 févr 2013;(2):CD000567.

[175] Markin NW, Sharma A, Grant W, Shillcutt SK. The safety of transesophageal echocardiography in patients undergoing orthotopic liver transplantation. J Cardiothorac Vasc Anesth 2015;29(3):588–593.

[176] De Marchi L, Wang CJ, Skubas NJ, Kothari R, Zerillo J, Subramaniam K, et al. Safety and benefit of transesophageal echocardiography in liver transplant surgery: a position paper from the society for the Advancement of transplant anesthesia (SATA). Liver Transpl août 2020;26(8):1019–1029.
[177] Naik BI, Durieux ME. Hemodynamic monitoring devices: putting it all together. Best Pract Res Clin Anaesthesiol déc 2014;28(4):477–488.
[178] Toprak Hİ, Sener A, Gedik E, Uçar M, Karahan K, Aydogan MS, et al. Bispectral index monitoring to guide end-tidal isoflurane concentration at three phases of operation in patients with end-stage liver disease undergoing orthotopic liver transplantation. Transpl Proc avr 2011;43(3):892–895.
[179] Chadha R, Patel D, Bhangui P, Blasi A, Xia V, Parotto M, et al. Optimal anesthetic conduct regarding immediate and short-term outcomes after liver transplantation - systematic review of the literature and expert panel recommendations. Clin Transpl oct 2022;36(10):e14613.
[180] Yang LQ, Song JC, Irwin MG, Song JG, Sun YM, Yu WF. A clinical prospective comparison of anesthetics sensitivity and hemodynamic effect among patients with or without obstructive jaundice. Acta Anaesthesiol Scand août 2010;54(7):871–877.
[181] Khamaysi I, William N, Olga A, Alex I, Vladimir M, Kamal D, et al. Subclinical hepatic encephalopathy in cirrhotic patients is not aggravated by sedation with propofol compared to midazolam: a randomized controlled study. J Hepatol janv 2011;54(1):72–77.
[182] Correia LM, Bonilha DQ, Gomes GF, Brito JR, Nakao FS, Lenz L, et al. Sedation during upper GI endoscopy in cirrhotic outpatients: a randomized, controlled trial comparing propofol and fentanyl with midazolam and fentanyl. Gastrointest Endosc janv 2011;73(1):45–51. 51.e1.
[183] Stravitz RT, Kramer AH, Davern T, Shaikh AOS, Caldwell SH, Mehta RL, et al. Intensive care of patients with acute liver failure: recommendations of the U.S. Acute Liver Failure Study Group. Crit Care Med nov 2007;35(11):2498–2508.
[184] Peltoniemi MA, Hagelberg NM, Olkkola KT, Saari TI. Ketamine: a review of clinical pharmacokinetics and Pharmacodynamics in anesthesia and pain therapy. Clin Pharmacokinet sept 2016;55(9):1059–1077.
[185] Hasselström J, Eriksson S, Persson A, Rane A, Svensson JO, Säwe J. The metabolism and bioavailability of morphine in patients with severe liver cirrhosis. Br J Clin Pharmacol mars 1990;29(3):289–297.
[186] Starczewska MH, Mon W, Shirley P. Anaesthesia in patients with liver disease. Curr Opin Anaesthesiol juin 2017;30(3):392–398.
[187] Abdulatif M, Lotfy M, Mousa M, Afifi MH, Yassen K. Sugammadex antagonism of rocuronium-induced neuromuscular blockade in patients with liver cirrhosis undergoing liver resection: a randomized controlled study. Minerva Anestesiol août 2018;84(8):929–937.
[188] Trepenaitis D, Pundzius J, Macas A. The influence of thoracic epidural anesthesia on liver hemodynamics in patients under general anesthesia. Medicina (Kaunas) 2010;46(7):465–471.
[189] Rahimzadeh P, Safari S, Faiz SHR, Alavian SM. Anesthesia for patients with liver disease. Hepat Mon juill 2014;14(7):e19881.
[190] Kortgen A, Silomon M, Pape-Becker C, Buchinger H, Grundmann U, Bauer M. Thoracic but not lumbar epidural anaesthesia increases liver blood flow after major abdominal surgery. Eur J Anaesthesiol févr 2009;26(2):111–116.
[191] Benson GD, Koff RS, Tolman KG. The therapeutic use of acetaminophen in patients with liver disease. Am J Ther 2005;12(2):133–141.
[192] Wong F, Massie D, Hsu P, Dudley F. Indomethacin-induced renal dysfunction in patients with well-compensated cirrhosis. Gastroenterology mars 1993;104(3):869–876.
[193] De Lédinghen V, Heresbach D, Fourdan O, Bernard P, Liebaert-Bories MP, Nousbaum JB, et al. Anti-inflammatory drugs and variceal bleeding: a case-control study. Gut Févr 1999;44(2):270–273.
[194] Louvet A, Ntandja Wandji LC, Lemaître E, Khaldi M, Lafforgue C, Artru F, et al. Acute liver injury with therapeutic doses of acetaminophen: a prospective study. Hepatology mai 2021;73(5):1945–1955.
[195] Chandok N, Watt KDS. Pain management in the cirrhotic patient: the clinical challenge. Mayo Clin Proc mai 2010;85(5):451–458.
[196] Bosilkovska M, Walder B, Besson M, Daali Y, Desmeules J. Analgesics in patients with hepatic impairment: pharmacology and clinical implications. Drugs 20 août 2012;72(12):1645–1669.
[197] Dick AAS, Spitzer AL, Seifert CF, Deckert A, Carithers RL, Reyes JD, et al. Liver transplantation at the extremes of the body mass index. Liver Transpl août 2009;15(8):968–977.
[198] European Association for the Study of the Liver. EASL Clinical Practice Guidelines on nutrition in chronic liver disease. J Hepatol janv 2019;70(1):172–193.
[199] Millwala F, Nguyen GC, Thuluvath PJ. Outcomes of patients with cirrhosis undergoing non-hepatic surgery: risk assessment and management. World J Gastroenterol 14 août 2007;13(30):4056–4063.
[200] Bhanji RA, Watt KD. Physiologic reserve assessment and application in clinical and research settings in liver transplantation. Liver Transpl juill 2021;27(7):1041–1053.
[201] Moreno-Carmona MR, Serra-Prat M, Riera SA, Estrada O, Ferro T, Querol R. Effect of frailty on postoperative complications, mortality, and survival in older patients with non-metastatic colon cancer: a systematic review and meta-analysis. J Geriatr Oncol 6 oct 2023:101639.
[202] Annema C, De Smet S, Castle EM, Overloop Y, Klaase JM, Janaudis-Ferreira T, et al. European society of organ transplantation (ESOT) consensus statement on prehabilitation for Solid organ transplantation candidates. Transpl Int 2023;36:11564.
[203] Joliat GR, Kobayashi K, Hasegawa K, Thomson JE, Padbury R, Scott M, et al. Guidelines for perioperative care for liver surgery: enhanced recovery after surgery (ERAS) society recommendations 2022. World J Surg janv 2023;47(1):11–34.
[204] Ljungqvist O, Scott M, Fearon KC. Enhanced recovery after surgery: a review. JAMA Surg 1 mars 2017;152(3):292–298.
[205] Kehlet H. Fast-track colorectal surgery. Lancet 8 mars 2008;371(9615):791–793.
[206] Greco M, Capretti G, Beretta L, Gemma M, Pecorelli N, Braga M. Enhanced recovery program in colorectal surgery: a meta-analysis of randomized controlled trials. World J Surg juin 2014;38(6):1531–1541.
[207] Coolsen MME, van Dam RM, van der Wilt AA, Slim K, Lassen K, Dejong CHC. Systematic review and meta-analysis of enhanced recovery after pancreatic surgery with particular emphasis on pancreaticoduodenectomies. World J Surg août 2013;37(8):1909–1918.
[208] Melloul E, Hübner M, Scott M, Snowden C, Prentis J, Dejong CHC, et al. Guidelines for perioperative care for liver surgery: enhanced recovery after surgery (ERAS) society recommendations. World J Surg oct 2016;40(10):2425–2440.
[209] Li L, Chen J, Liu Z, Li Q, Shi Y. Enhanced recovery program versus traditional care after hepatectomy: a meta-analysis. Medicine (Baltimore) sept 2017;96(38):e8052.
[210] Zhao Y, Qin H, Wu Y, Xiang B. Enhanced recovery after surgery program reduces length of hospital stay and complications in liver resection: a PRISMA-compliant systematic review and meta-analysis of randomized controlled trials. Medicine (Baltimore) août 2017;96(31):e7628.
[211] Noba L, Rodgers S, Chandler C, Balfour A, Hariharan D, Yip VS. Enhanced recovery after surgery (ERAS) reduces hospital costs and improve clinical outcomes in liver surgery: a systematic review and meta-analysis. J Gastrointest Surg avr 2020;24(4):918–932.
[212] Weimann A, Braga M, Carli F, Higashiguchi T, Hübner M, Klek S, et al. ESPEN practical guideline: clinical nutrition in surgery. Clin Nutr juill 2021;40(7):4745–4761.
[213] Gustafsson UO, Scott MJ, Hubner M, Nygren J, Demartines N, Francis N, et al. Guidelines for perioperative care in elective colorectal surgery: enhanced recovery after surgery (ERAS®) society recommendations: 2018. World J Surg 15 mars 2019;43(3):659–695.
[214] Brustia R, Monsel A, Skurzak S, Schiffer E, Carrier FM, Patrono D, et al. Guidelines for perioperative care for liver transplantation: enhanced recovery after surgery (ERAS) recommendations. Transplantation 1 mars 2022;106(3):552–561.
[215] Twaij A, Pucher PH, Sodergren MH, Gall T, Darzi A, Jiao LR. Laparoscopic vs open approach to resection of hepatocellular carcinoma in patients with known cirrhosis: systematic review and meta-analysis. World J Gastroenterol 7 juill 2014;20(25):8274–8281.
[216] Reis PCA, Bittar V, Almirón G, et al. Laparoscopic versus open pancreatoduodenectomy for periampullary tumors: a systematic review and meta-analysis of randomized controlled trials. J Gastrointest Cancer 2024 Sep;55(3):1058–1068. https://doi.org/10.1007/s12029-024-01091-x.
[217] Kabir T, Tan ZZ, Syn NL, Wu E, Lin JD, Zhao JJ, et al. Laparoscopic versus open resection of hepatocellular carcinoma in patients with cirrhosis: meta-analysis. Br J Surg 17 Déc 2021;109(1):21–29.

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