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Operative risks of digestive surgery in cirrhotic patients

Risque opératoire du patient cirrhotique en chirurgie digestive

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Summary Digestive surgery in cirrhotic patients has long been limited to the treatment of disorders related to the liver disease (portal hypertension, hepatocellular carcinoma and umbilical hernia). The improvement in cirrhotic patient management has allowed an increase in surgical procedures for extrahepatic indications. The aim of this study was to evaluate the operative risks of such surgical procedures. Extrahepatic surgery in cirrhotic patients is associated with high mortality and morbidity. Emergency surgery, gastrointestinal tract opening (esophagus, stomach and colon), < 30 g/L serum albumin, transaminase levels more than three times the upper limit of normal, ascites, and intraoperative transfusions are the main risk factors for postoperative death. In Child A patients, the operative risk of elective surgery is moderate and surgical indications are not altered by the presence of cirrhosis. The laparoscopic approach should be recommended because of the potentially lower morbidity. In Child C patients, operative mortality is often higher than 40%; surgical indications must remain exceptional and non operative management has to be preferred. In Child B patients, preoperative improvement of liver function is mandatory for lower risk surgery.

Résumé La chirurgie digestive chez le cirrhotique a longtemps été limitée au traitement des conséquences de la maladie hépatique (hypertension portale, carcinome hépatocellulaire, hernie ombilicale). L'amélioration de la prise en charge des cirrhotiques a permis une augmentation du nombre d'interventions réalisées pour des indications extrahépatiques. Le but de ce travail a été de faire le point sur le risque opératoire du cirrhotique dans ces indications chirurgicales. La chirurgie extrahépatique chez le patient cirrhotique est associée à des taux élevés de mortalité et de morbidité élevés. Une intervention en urgence, une intervention portant sur le tube digestif (œsophage, estomac, côlon), une hypoalbuminémie inférieure à 30 g/L, des transaminases supérieures à trois fois la limite supérieure de la normale, la présence

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d'une ascite et l'existence de transfusions peropératoires sont les principaux facteurs de risque de mortalité postopératoire. Chez les malades Child A, le risque opératoire en chirurgie élective est modéré et les indications chirurgicales ne sont pas modifiées par la cirrhose. La voie d'abord laparoscopique doit être privilégiée car elle pourrait diminuer la morbidité. Chez les malades Child C, la mortalité opératoire dépasse souvent 40 %; les indications chirurgicales doivent rester exceptionnelles et il faut privilégier les traitements non opératoires. Pour les malades Child B, il faut différer l'intervention et améliorer la fonction hépatique pour diminuer le risque opératoire.

Introduction

Digestive surgery in cirrhotic patients has long been limited to the treatment of disorders related to the liver disease; portal hypertension, hepatocellular carcinoma and umbilical hernia. Improvement in cirrhotic patient management has improved patient survival and so more and more cirrhotic patients are proposed for surgery. In this population, the number of surgical procedures for extrahepatic disease has consequently increased in a similar proportion. Although postoperative morbidity and mortality are higher than generally observed, few studies have examined the specific risks of digestive surgery in the cirrhotic patient. The purpose of this study was to review our knowledge of the operative risk of digestive surgery in the cirrhotic patient. The operative risk related to hepatic surgery and portal hypertension will not be discussed in this review because they are directly related to the liver disease and its consequences. We will first discuss the overall operative risk in the cirrhotic patient and then examine the specific consequences of surgery in this population before analyzing the different types of surgery individually.

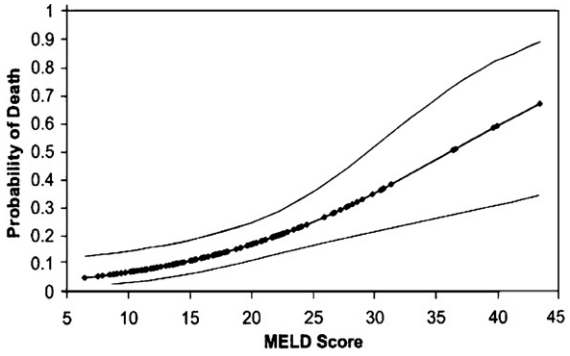
Surgical risk in the cirrhotic patient

Operative mortality in the cirrhotic patient is correlated with the severity of liver failure, irrespective of the score used to assess surgical risk [1,2]. The Child-Pugh (Table 1) and model for end-stage liver disease (MELD) (Fig. 1) scores initially correlated with operative mortality for portal caval anastomosis, can be transposed to general operative risk for cirrhotic patients. More recently, Ziser et al. confirmed these data and identified eight factors significantly correlated with postoperative morbidity and mortality in the cirrhotic patient undergoing general surgery procedures (Table 2) [3]. Operative risk is higher in patients with several factors [3]. The risk of postoperative death, even for a major operation, in cirrhotic patients free of ascites, liver failure and acute alcoholic hepatitis, and who have a normal prothrombin level, is the same as observed in noncirrhotic patients with the same pathological condition [4].

Table 1 Child-Pugh classification [1].

	1 point	2 points	3 points
Encephalopathy	Absent	Confusion	Coma
Ascites	Absent	Discrete	Moderate
Serum bilirubin (μmol/L)	<35	35—50	>50
Serum albumin (g/L)	>35	28—35	<35
Prothrombin (%)	>50	40—50	<40

The Child-Pugh score is the sum of points (5—15). The Child-Pugh stage is established from the Child-Pugh score: A: 5 or 6 points; B: 7—9 points; C: 10—15 points. For primary biliary cirrhosis, the points for serum bilirubin are as follows: 1 point for <70 μmol/L, 2 points for 70 to 170 μmol/L and 3 points for >170 μmol/L.



MELD score	5	10	15	20	25	30	35	40	45
Prob of death (%)	5	7	11	17	26	36	50	59	67
95% CI	2-13	3-15	6-19	11-25	17-38	21-53	27-73	31-82	34-89

* Predicted probabilities derived from regression model with c-statistic = 0.72 and 71.6% concordance rate.

Figure 1 From Northup et al. [2], mortality rate in the 140 study cirrhotic patients at 30-day follow-up after general surgery according to the model for end-stage liver disease (MELD) score. The MELD score takes into account the international normalized ratio, total bilirubin and serum creatinine level.

Organ failure in the operated cirrhotic patient

Hemodynamics

Irrespective of the etiology, cirrhotic patients present a hyperkinetic hemodynamic situation associating elevated heart flow rate, low systemic blood pressure and low left ventricle afterload associated with splanchnic vasodilatation [5]. This splanchnic vasodilation ''steals'' vascular flow from other vital territories such as the renal circulation [5,6]. Perioperative infusion of vasopressive amines may be necessary to counterbalance the loss of volumetric control triggered by the surgery. Perioperative hemodynamic variations may disclose an alcohol-related dilated cardiomyopathy (low cardiac output and/or rythm disorders) or

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Table 2 Factors associated with postoperative complication in cirrhotic patients [3].

Risk factors	Morbidity (%)	Mortality at 30 days (%)	Mortality at 6 months (%)
Child-Pugh score: 7—10	42	15	31
Ascites	48	20	39
Elevated serum creatinine	42	21	36
Chronic respiratory disease	41	18	29
Preoperative infection	74	49	60
Upper digestive bleeding	70	12	23
ASA 4—5	68	32	52
Major surgery	39	12	23
Low interoperative blood pressure	45	15	26
Cryptogenetic cirrhosis	33	14	24

cirrhotic cardiomyopathy (left ventricular dysfunction) [7]. Pulmonary artery hypertension, defined as a mean pulmonary arterial pressure $\geq$25 mmHg, associated with a normal wedge pressure can coexist with cirrhosis. The risk is severe intra- and postoperative heart failure due to right ventricle failure. The prevalence of coronary artery disease is high in the cirrhotic population, where diabetes, alcohol abuse and smoking are common [7].

Respiratory function

Hypoxemia has been noted in 15 to 45% of cirrhotic patients [6,8], generally related to pleural effusion associated with ascites [6]. The hepatopulmonary syndrome is defined by hypoxemia associated with an oxygen alveolar-arterial gradient without cardiac anomalies. The causal mechanism is the shunt provoked by the dilation of the pulmonary precapillary arterioles. A spontaneous ventilation hyperoxemia test can be used to assess the correction of the hypoxemia and quantify the shunt, predictive of postventilatory weaning and postoperative respiratory tolerance [8].

Renal function and ascites

Renal blood flow declines proportionally with the severity of the cirrhosis-related hyperkinetic syndrome [5—7]. In patients with liver failure, lean body mass is often diminished and glomerular filtation can be greatly reduced despite a normal serum creatinine level [6]. Serum levels must be assayed repeatedly in cirrhotic patients receiving nephrotoxic drugs [6,9]. In a surgery context, blood or digestive fluid losses, constitution of a third sector, evacuation of abundant ascites, aggressive diuretic treatment and inappropriate fluid and electrolyte restriction may aggravate the impact of the hyperkinetic syndrome on the kidneys inducing functional renal failure [6]. Ascites is a frequent complication of abdominal surgery in the cirrhotic patient [10]. The ascitic fluid arises via a diminution of the circulating volume [6]. There is no evidence supporting the hypothesis that postoperative restriction of fluid intake prevents postoperative ascites [5,6]. There is no evidence that exsudative effusion associated with digestive resection and postoperative chylous ascites are specific for this population [11].

Hemostasis disorders

Splenic sequestration of platelets leads to various degrees of thrombopenia. Circulating platelets are functionally effective [12]. A deficit in factors I, II, V, VII, IX, X due to defective hepatic synthesis is correlated with the severity of liver failure. Apparently primary fibrinolysis is usually a complication, especially of infection. Hypercoagulation markers are common in patients with cirrhosis, who are susceptible to thromboembolic complications [12].

Malnutrition

Malnutrition is a common finding in cirrhotic patients [13] and is correlated with the severity of liver failure. Dextrose infusions may reveal deficiency in trace elements and vitamins [13]. Today, clinicians consider that cirrhosis does not preclude renutrition but have been unable to formally demonstrate an advantage in terms of postoperative mortality [14,15].

Infections in the operated cirrhotic patient

Preexisting infection is an independent variable associated with postoperative morbidity (74%) and mortality at 30 days (49%) and 6 months (60%) in the operated cirrhotic patient [3]. Systematic search for infection and preoperative treatment are thus mandatory in the cirrhotic patient. Cirrhosis is not an independent factor for operative site infection, irrespective of the type of surgery (contaminated or not) [16]. It is, however, a risk factor for infections distant from the operative site [16]. Consequently, the same antibiotic prophylaxis must be scheduled for the cirrhotic patient as for the noncirrhotic patient with the same surgical risk [17]. The steady rise in medicalization of cirrhotic patients has led to a high prevalence of multiresistant germs, irrespective of the site of infection [18]. Nasal and rectal swabs might be helpful in detecting carriers of multiresistant bacteria among previously medicalized cirrhotic patients [17]. In the cirrhotic patient, the frequency of postoperative infections is associated with translocation of gastrointestinal tract bacteria into the general blood stream, blood transfusion, duration of surgery, severity of liver failure and insufficient antibiotic therapy [3,19,20]. Preoperative decontamination of the digestive tract has not been found to decrease the rate of postoperative infections [21].

Pharmacokinetic alterations

Quantitative changes in the synthesis of binding proteins circulating in the blood stream leads to an increase in the concentration of pharmacologically active free fraction of

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certain drugs, including antibiotics [9]. The distribution volume of certain drugs can be increased as a result of fluid and electrolyte retention [22]. Drug administration must be titrated.

Anesthesia and postoperative analgesia

No anesthesia protocol has been proven superior in the operated cirrhotic patient [22]. Locoregional and peridural anesthesia and analgesia should be discussed for patients with normal coagulation factors and a platelet count above 100,000/mm^3 who would not be expected to develop major fibrinolysis postoperatively. Acetaminophen should be used prudently [23]. Nefopam is not submitted to hepatic metabolism; its efficacy in relieving postoperative pain has been demonstrated for major digestive surgery [23]. Careful titration of analgesic and secondary effects is required for morphine prescription [22]. Inhibition of prostaglandin synthesis in the kidneys by administration of nonsteroidal anti-inflammatory drugs (NSAID) is a cause of renal ischemia by reduced blood flow [6]. NSAID should be proscribed for cirrhotic patients with ascites [6].

Chronic viral hepatitis B and C

Viral disease can be associated with renal failure, systemic hypertension, pulmonary vasculitis, cryoglobulinemia, peripheral neuropathy, thyroid dysfunction and thrombopenic purpura. The secondary effects of certain antiviral agents should be taken into account, e.g. epilepsia, depression, leukothrombopenia with infection and risk of hemolysis with ribavirin [24].

Specific postoperative complications

Ascites

Postoperative ascites is one of the main complications observed in cirrhotic patients undergoing abdominal surgery. The prevalence is greater than 20% [25]. The risk of postoperative ascites is significantly increased by the presence of intraoperative ascites and installation of drainage. The risk differs depending on the type of abdominal surgery; it is lower after parietal and biliary surgery. Postoperative ascites in a cirrhotic patient can be divided into three categories. Type I is correlated with liver failure. It is favored by postoperative fluid and electrolyte retention and readily responds to treatment. Type II ascites is defined as unremitting and difficult to treat. More commonly observed after supramesocolonic surgery (gastrectomy), this type of ascites would be related to section of the lymphatic vessels draining the liver and overloaded with interstitial fluid because of the portal hypertension [26]. This is a lymphatic ascites of hepatic origin producing a clear effusion with high protein content, high lymphocyte count and a normal triglyceride level, similar to the ascites observed after liver transplantation [10]. Type III postoperative ascites is a chylous effusion related to the extravasation of lymphatic fluid rich in triglycerides arising from the interruption of the mesenteric lymphatic flow because of the surgical section of the mesenteric or periaortic lymphatic vessels [11]. It can be observed after pancreatic, colonic or small bowel surgery. There is no relationship between the severity of the liver failure and the development of chylous ascites. Treatment is difficult; fat-free diet supplemented with medium chain triglycerides may be insufficient. Drainage (or iterative puncture) may be needed, combined with exclusive parenteral nutrition to halt the production of this chylous ascites in 4 to 6 weeks.

Renal failure

Renal failure is observed in nearly 10% of operated cirrhotic patients [25] who may present functional renal failure [3,26], a hepatorenal syndrome associated with severe liver failure [3,27] or renal failure subsequent to acute tubular necrosis related to severe infection or multiorgan failure. It is associated with ascites in 60% of patients and an infectious syndrome in 50%. These associations show that the renal failure is generally the consequence of other complications (dehydration, infection, multiorgan failure).

Infections

Postoperative infection affects 13 to 40% of operated cirrhotic patients [25,28]. The rate is higher if the gastrointestinal tract has been opened [28,29]. In the cirrhotic patient, infections occur more readily late after surgery and generally do not involve the operative site. The most common localizations include the lung (8%) and the urinary tract or infected ascites, sometimes associated with septicemia [3,25,28,29]. The risk of spontaneous bacteriemia is higher in cirrhotic patients and increases further in the event of postoperative liver failure [30,31].

Complications involving the abdominal wall

Ascites leakage through the abdominal wall is observed in 2% of operated patients, even if abdominal drainage is installed. This leakage favors infections and evisceration. Abdominal drainage may be insufficient to avoid this leakage but significantly increases the risk of ascites infection [29]. Abdominal drainage can, however, avoid excessive accumulation of ascites which would exaggerate the leakage favoring the constitution of pseudocellulitis due to infiltration of the subcutaneous tissues and evisceration.

An expert consensus recommends a solid suture of the abdominal wall using a slow resorbing thread and tight closure of the teguments using a cutaneous overcast stitch. Depending on the procedure performed and the anticipated risk of postoperative ascites, it is recommended either to avoid drainage or to drain with a sterile aspiration system.

Digestive bleeding

This complication is observed in 10% of operated cirrhotic patients but in only 5% of those undergoing abdominal surgery [3,29]. Because of this high rate special pre- and postoperative measures are warranted to prevent digestive bleeding related to portal hypertension, i.e. betablockers and/or endoscopic treatment, depending on the size of the varices and the past history of rupture of esophageal varices [17]. In the cirrhotic patient, there is a higher risk of bleeding from gastroduodenal stress ulcers; favoring factors are severe sepsis, prolonged mechanical ventilation, liver failure and abdominal surgery [32]. Several studies have demonstrated an increased risk of nosocomial pneumopathy related to the use of antisecretory agents (compared with sucralfate) by alkalinization and colonization of the gastric contents [33].

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Severe liver failure

Severe liver failure is the most common complication, the cause of nearly 50% of postoperative deaths [25,28,34,35]. For the majority of patients, severe liver failure develops in a context of preoperative liver failure after an emergency intervention opening the gastrointestinal tract. Prothrombin below 50% and total serum bilirubin > 50 μmol/L on the 5th postoperative day would be the best sign of postoperative liver failure [36]. This 50-50 rule was defined for patients undergoing liver resection of healthy or pathological livers but not for patients undergoing extrahepatic surgery. It is difficult to differentiate liver failure from multiorgan failure, common in this context.

Surgery of the abdominal wall

Hernias and incisional hernias are more common in the cirrhotic patient than in the general population. Abdominal distention caused by the ascites and the loss of muscle mass secondary to the poor nutritional status are the main risk factors [37]. In the cirrhotic patient, the rate of abdominal wall hernia is 16% and reaches 24% in the presence of ascites [38,39]. More than half of all hernias are umbilical; the rate is 4-fold higher in patients with ascites. Umbilical hernias are also favored by Cruveilhier-Baumgarten syndrome (renewed patency of the umbilical vein). Treatments for inguinal hernia and incisional hernia must be distinguished from the treatment of umbilical hernia more specific to the cirrhotic patient.

Umbilical hernia

Indications retained for treating an umbilical hernia are functional impairment and presence of a complication: voluminous herniation, strangulation, rupture, cutaneous lesions. Strangulation, rare in patients with ascites, is favored by a sudden drop in the volume of the effusion due to an umbilical rupture, evacuating puncture, vigorous medical treatment or installation of a peritoneojugular shunt [40]. The goal is to treat the ascites before undertaking surgery. Specific complications after surgical treatment of an umbilical hernia are ascites, renal failure, wall infection, liver failure and recurrent hernia. Ascitis is the main cause of recurrent parietal deficiency; 71% versus 4% without ascites [41]. The predominant role of ascites in the development of postoperative complications explains why a simultaneous peritoneojugular shunt has been proposed in the event of refractory ascites or when an emergency treatment is required, despite the estimated 14% risk of infection [41]. More recently, a small series of three cirrhotic patients who underwent emergency surgery for a ruptured or strangulated umbilical hernia reported treatment by parietal repair and installation of a transjugular intrahepatic portosystemic shunt (TIPS) on days 2, 0 and 2 of the herniorrhaphy [42]. These data, based on the efficacy of TIPS for the treatment of refractory ascites [1], suggest that TIPS should be preferred over peritoneojugular shunt for the treatment of umbilical hernia in patients with refractory ascites.

In the series reported by the French Association of Surgery, which included 81 patients who underwent surgical treatment of an umbilical hernia, overall mortality was 5%: 11% after emergency surgery for ruptured or strangulated umbilical hernia and 2% after elective surgery [43]. Mortality was zero in the two most recent studies reported by expert centers and including 39 and 40 patients undergoing surgery for umbilical hernia [41,44].

Inguinal hernia

Incisional hernia. Surgery should be proposed solely for inguinal hernias and incisional hernia which become symptomatic or complicated. For patients with a moderately altered liver function (Child A or B), cure for inguinal hernia can be achieved with acceptable morbidity [43,45]. In the presence of ascites, the same precautions must be taken as for umbilical hernias. The French Association of Surgery reported a series of 38 inguinal hernias (one case of prosthesis interposition) and 23 incisional hernias (nine prosthesis interpositions and two peritoneojugular shunts) [43]. Mortality was 5.7% (91% elective surgery). The recurrence rate was 8 to 10% [43,45], recurrence being favored by weak wall structure and ascites.

Irrespective of the type of parietal hernia or evisceration, an extraperitoneal interposition prosthesis should be used in cirrhotic patients because of the higher risk of recurrence. Furthermore, prostheses with a very low infectious risk are available. This approach is however debatable if the patient presents a complication (strangulation, rupture), cutaneous lesions or an infected ascites. If the ascites proves to be unresponsive to treatment, a TIPS would probably be the best solution since indications for peritoneojugular shunt have disappeared. Should a cirrhotic patient on the liver transplantation list present a hernia or incisional hernia free of complications, treatment may be delayed until the transplantation procedure, although a TIPS while on the waiting list might be useful to prevent the development of parietal complications.

The operative technique should prefer oblique or transversal approaches, using a multilayer wall closure with slow resorption thread and overcast stitches to limit the risk of ascites leakage and evisceration. If possible, drainage should be avoided, but when necessary, using a minimally traumatic technique with sterile aspiration. There is no contraindication for laparoscopy in a cirrhotic patient [46].

Biliary surgery

Gallstones

Biliary surgery in cirrhotic patients is mainly represented by gallstone. Incidence is increased because of the hypersplenism and the subsequent hemolysis. Prevalence of gallstones in the cirrhotic patient is higher than in the general population, reaching 17 to 28% [47]. Cirrhosis, with cardiovascular disease, is the main risk factor for postcholecystectomy mortality. A recent meta-analysis demonstrated that, on average, cholecystectomy is performed in cirrhotic patients in more urgent situations and with higher morbidity [48]. Laparoscopic cholecystectomy is currently the preferred technique for cirrhotic patients [48]. Complications include ascites, liver failure, infection, kidney failure, digestive bleeding and operative site bleeding. Morbidity is related to the indication, the severity of the liver failure, blood transfusion and surgical approach. There were no deaths in a study comparing the results of laparoscopic

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cholecystectomy ($n = 26$) with open cholecystectomy ($n = 24$) in Child A or B patients [49]. The conversion rate for the laparoscopic procedures was 12%, with significantly decreased morbidity (19% versus 67%, $p = 0.001$) and lower risk of transfusion (0% versus 33%, $p = 0.008$) [50]. Laparoscopic cholecystectomy in Child A or B patients is feasible with a conversion rate of 5 to 9%, 5 to 10% morbidity and 0 to 1% mortality [51,52]. In the cirrhotic patient, laparoscopy is associated, as in the noncirrhotic patient, with less blood loss, shorter operative time and shorter hospital stay [48]. Some authors [53] have suggested that in the cirrhotic patient preoperative coagulation disorders would be more predictive of difficult operation and complications for laparoscopic cholecystectomy than the Child score. Others [54] have proposed subtotal cholecystectomy in this context of increased risk of hemorrhage, especially for acute or chronic cholecystitis. On the contrary, for the Child C patient, cholecystectomy is associated with a prohibitive death rate of 23 to 50% [55]; severe liver failure, acute cholecystitis and emergency surgery are common in this type of patient. Most authors agree that medical treatment should be proposed in this type of situation. If the medical approach is unsuccessful, or should pyocholecystitis develop, percutaneous cholecystostomy could be a solution [56]. The cholecystotomy should ideally be performed via a transhepatic approach after transfusion of platelets and coagulation factors; percutaneous drainage of the ascites may be associated or precede the operation.

Laparoscopic cholecystectomy is the procedure of choice for the Child A or B patient with symptomatic gallstones or acute cholecystitis [48]: morbidity is 10 to 15%, mortality 0 to 1% and conversion rate 5 to 9%. For the Child C patient, medical treatment should be proposed and, if necessary, combined with percutaneous cholecystostomy.

Common bile duct stones

Treatment of stones in the common bile duct is more difficult in the cirrhotic patient because the procedure involves cholecystectomy and extraction of the stone from the bile duct. Stone extraction is difficult because of the portal hypertension and the risk of injuring neighboring varices or triggering hemobilia with the extraction instruments. In the series reported by the French Association of Surgery, morbidity in 31 patients undergoing surgery for a common bile duct stone was 29%, with 9.6% mortality. In a series of 87 cirrhotic patients who underwent surgery for gallstones ($n = 53$) or common bile duct stones ($n = 34$), morbidity was 15% and mortality 4.5%. Two factors had a significant impact on morbidity and mortality: Child-Pugh stage C (morbidity 32%, mortality 12%) and presence of a stone in the common duct (morbidity 24%, mortality 9%) [56]. Another team compared surgery ($n = 9$) versus endoscopic sphincterotomy ($n = 7$) for this indication. Mortality was 44% versus 14.3% ($p < 0.01$) and morbidity 66% versus 14% ($p < 0.01$) with a mean blood loss of 1576 mL after surgery highlighting the benefits for endoscopic sphincterotomy [57]. Another study confirmed these findings and reported 67% morbidity after surgery versus 22% after endoscopic sphincterotomy with no significant difference for mortality [58]. Endoscopic sphincterotomy has thus become the gold standard for common bile duct stones, followed by elective laparoscopic cholecystectomy. The risks must not however be overlooked; mortality was 7% in a series of 52 cirrhotic patients who underwent endoscopic sphincterotomy for common bile duct stones [59]. Considering this evidence, several teams have proposed balloon endoscopic sphincteroclasia to avoid the risk of bleeding in cirrhotic patients, particularly Child C patients [60].

For the Child A or B patient, stones in the common bile duct should be treated by endoscopic sphincterotomy followed by laparoscopic cholecystectomy. Endoscopic sphincteroclasia would appear to be the best alternative for Child C patients, without secondary cholecystectomy.

Pancreatic surgery

Excepting the survey published by the French Association of Surgery [61], data are lacking on the specificity of pancreatic surgery in the cirrhotic patient. In the published series, 35 patients underwent surgery for chronic ($n = 17$) or acute ($n = 3$) pancreatitis, a malignant tumor ($n = 14$) or a benign tumor ($n = 1$). The procedures were resection ($n = 9$; left pancreatectomy: 3, pancreaticoduodenectomy: 2, ampullectomy: 2, atypical resection for acute pancreatitis: 2) and derivations ($n = 26$; digestive = 7, biliodigestive: 13, pancreaticodigestive: 10). The transfusion rate was 44%, morbidity 51% and mortality 20%. All three patients who had an emergency procedure died. All deaths occurred in patients whose gastrointestinal tract was opened. The univariate analysis identified emergency procedure and elevated transaminase level as independently predictive of death.

The findings suggest endoscopic (stent, endoscopic cystogastrostomy, ampullectomy) and radiologic (percutaneous drainage of pancreatic abscesses) treatments should be preferred in cirrhotic patients with an inflammatory disease or tumor of the pancreas. The rare indications for resection should be reserved for elective procedures in Child-Pugh A patients without elevated transaminases.

Gastric surgery

Studies on gastric surgery in the cirrhotic patient have focused on the treatment of complications of peptic ulcers and gastric cancers.

Peptic ulcers appear to be more common in cirrhotic patients, affecting 8 to 20% of patients [62]. The proportion of cirrhotic patients among patients with peptic ulcer appears to be higher than the equivalent proportion in the general population: 9% among patients with hemorrhagic ulcer, 6% among patients with a perforated ulcer and 8% among patients aged 65 years-old and over with a symptomatic ulcer [63]. The mortality of emergency surgery for complicated peptic ulcer in the cirrhotic patient is very high, ranging from 23 to 64% [28,63,64]. Prognostic factors impacting mortality are severity of the liver failure and presence of ascitis [28,63,64]. With the advent of proton pump inhibitors, eradication of *Helicobacter pylori* and the development of endoscopic hemostasis techniques, the efficacy of simple suture of the perforation in a patient with peritonitis due to the perforated ulcer has been demonstrated, dramatically reducing the indications for surgery and gastric resections for hemorrhagic ulcers. Excepting rare cases, emergency surgery for complicated ulcers does not require resection, although the gastrointestinal tract must

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be opened. Two controlled studies have demonstrated the efficacy of laparoscopic suture of perforated ulcers [65,66]; by extrapolation, laparoscopic suture of perforated ulcers can be proposed for cirrhotic patients.

Two series from Japan have reported results of surgical treatment of gastric cancer in cirrhotic patients. The first was a series of 37 operated patients (24 superficial cancers); morbidity was 20%, mortality 0%, and 5-year actuarial survival 51% [67]. The second study included 39 operated patients (28 superficial cancers); morbidity was 26%, mortality 10.3% and 5-year acturarial survival 64% for superficial cancers and 14% for invasive cancers [68]. Causes of late death were mainly related to the liver disease.

The series of 66 operated cirrhotic patients with gastric disease reported by the French Association of Surgery included patients with a noncomplicated benign disease ($n = 12$), hemorrhagic or perforated ulcer ($n = 35$), malignant tumor ($n = 17$) or another disease ($n = 2$). Mortality was 23%, significantly higher in patients with ascites and low serum albumin; mortality was not affected by gastric disease or by type of surgery (simple suture, vagotomy, gastrectomy). Overall morbidity was 56%, most deaths related to ascites, infection, and renal failure [69].

For perforated ulcers in the cirrhotic patient, laparoscopic suture is the treatment of choice. In the event of a hemorrhagic ulcer, endoscopic hemostasis should be followed, if necessary, by surgery in order to maximize elective procedures. Direct hemostasis with arterial ligature and vagotomy should be preferred over vagotomy-antrectomy. In cirrhotic patients, who have a gastric cancer, surgery is a very high risk option in the presence of ascites, hypoalbuminemia, and Child-Pugh stage C. For stage A and B patients, it would be preferable to propose type D1 dissection and to avoid dissection of the hepatic pedicle because of the risk of type II lymphatic ascites.

Esophageal surgery

Seven percent of patients with cancer of the esophagus also have cirrhosis [16]. Overall morbidity after esophageal surgery in the operated cirrhotic patient is twice that observed in the noncirrhotic patient: 17 to 21% versus 3 to 8% [34,70]. Mortality does not appear to be affected by the type of operation; the rate of esophagogastric fistulization ranges from 9 to 11% [4]. Morbidity, especially lung disease, is significantly increased by cirrhosis [71]. Mortality is correlated with preoperative liver failure, prothrombin < 60%, presence of ascites and hypoalbuminemia [34,70]. The risk of postoperative liver failure is higher in the event of acute alcoholic hepatitis; it is recommended to wait until transaminase levels return to normal before attempting surgery. For most teams, the presence of Child B or C cirrhosis proscribes surgery [4]. The series of 53 patients undergoing esophageal surgery reported by the French Association of Surgery included 46 patients who had elective resections followed by esophagogastric anastomosis; 26% of the patients had ascites and 81% received a blood transfusion. Complications developed in 72% of patients:

- ascites (39%);
- pneumopathy (30%);
- pleural effusion (26%);
- anastomotic fistula (24%);
- infection (22%);
- renal failure (17%).

Twelve patients (26%) died. Factors predictive of fatal outcome included liver failure (prothombin < 60%, serum albumin < 30 g/L, serum bilirubin > 35 μmol/L), transfusion of more than three packed cell units and anastomotic fistula. These findings illustrate the risks of esophagectomy in the cirrhotic patient; mortality is greater than 20% and the rate of anastomotic leakage greater than 20%. This surgery should be reserved for Child-Pugh A5 patients with T1-T3 N0 tumors who are free of ascites and transaminase elevation. For all other patients, non-surgical treatment with exclusive chemoradiotherapy should be proposed [72].

Colorectal surgery

Particularities of colorectal cancer in the cirrhotic patient

Hepatic metastasis is less frequent in cirrhotic patients than non-cirrhotic patients [73,74]. For patients with chronic viral hepatitis B, colorectal cancer-related survival is longer than in noncirrhotic patients due to the lower rate of liver involvement [75]. Reporting experience of the Mayo clinic, Gervaz et al. [73] also observed a lower rate of hepatic metastasis in cirrhotic patients (10%) and noted that survival in these patients was long enough for hepatic metastases to develop. An alteration of the extracellular matrix [76], stimulation of the Kupffer cells [77], defective angiogenesis [78] and presence of spontaneous portalcaval shunts [79] have been proposed to explain this lower risk of hepatic metastasis. Because of the different prognostic course of colorectal cancer, Child-Pugh stage remains the main prognostic factor for long-term survival of these patients.

Indications for surgery in the cirrhotic patient

Two main series have reported results of colorectal cancer in cirrhotic patients: the Mayo clinic series [73] and the French Association of Surgery series [80]. The Mayo clinic reported 72 operated cirrhotic patients with colorectal cancer: Child A (43%), Child B (42%), Child C (15%). Mortality was 13% and morbidity 46%. Fistulae developed in 3%. Cirrhosis-related complications were mainly secondary to liver failure and included infection and digestive bleeding. Factors predictive of postoperative death were elevated serum bilirubin and low prothrombin level. Ten percent of the patients developed liver metastases. Overall 1, 2 and 3-year survivals were 69, 49 and 35%. Survival was better in Child A patients than Child B or C patients. Multivariate analysis identified serum albumin and prothormbin level as affecting survival. Conversely, Tumor Node Metastasis (TNM) staging had no impact on survival, suggesting that the prognosis in these patients depends mainly on liver function.

In the French Association of Surgery series, 54 cirrhotic patients underwent colorectal surgery: 11 for diverticular disease and 19 for other diseases. An emergency procedure was necessary for 17 patients for peritonitis ($n = 10$), obstruction ($n = 5$), hemorrhage ($n = 2$). Among the 56 patients who had a resection-anastomosis, 7% developed

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a fistula. Overall morbidity was 51%, mainly ascites and infection. Overall mortality was 23%. Emergency surgery and presence of intraoperative ascites were predictive of operative death. It should be remembered, however, that in the cirrhotic patient a protective stomy has specific complications including ascites leakage, ascites infection, stomial disinsertion, peristomial hernia, peristomial eviscer-ation and peristomial varices [81].

Colorectal surgery in the cirrhotic patient is associated with higher morbidity and mortality than in the noncirrhotic patient. Factors predictive of operative mortality are those of surgery in the cirrhotic patient: emergency procedure, serum albumin < 30 g/L, presence of ascites, low prothrom-bin [73,80]. These factors are included in Child-Pugh staging allowing the distinction of two categories of patients: Child A patients who can undergo elective surgery with an expected postoperative period comparable to noncirrhotic patients and Child C patients with a high operative mortality (40—50 %) for which surgery should be undertaken only exception-ally. For Child B patients, the degree of liver failure must be assessed carefully; correction of an ascites, with TIPS if necessary, may delay surgery.

Conclusions

In the cirrhotic patient, extrahepatic surgery is associ-ated with higher morbidity and mortality. In the series of the French Association of Surgery which collected data on 760 patients, including a very large majority of Child A patients, overall mortality was 14%. Factors predictive of operative mortality were emergency procedure, operation involving the digestive tract (esophagus, stomach, colon), serum albumin < 30 g/L, transaminase level more than three times above the upper limit of normal, presence of ascites and intraoperative blood transfusion [29].

Can the operative risk be reduced for the cirrhotic patient undergoing digestive surgery?

It is important to carefully search for cirrhosis before undertaking abdominal surgery. The problematic is sim-ple when the cirrhosis is known, for carriers of hepatitis C virus, or when chronic alcohol abuse is obvious. For approximately 20% of patients, however, cirrhosis may go unrecognized and be discovered intraoperatively. Focus should be placed on asymptomatic patients whose imag-ing work-up displays splenomegaly, hepatic dysmorphism or spontaneous portosystemic shunts as well as patients with an isolated thrombopenia, sometimes the inaugural sign of well-compensated cirrhosis [34]. A FibroScan can be useful before surgery; its contribution should be assessed [82].

Three factors known to aggravate the operative risk should be identified: ascites, serum albumin < 30 g/L, transaminase elevation. For Child A patients, the operative risk of elective surgery is acceptable and surgical indications need not be changed from those proposed for non-cirrhotic patients, if management is carefully adapted. The laparo-scopic approach should be preferred because it reduces the risk of bleeding, respiratory disorders, infection and abdom-inal wall defects as well as the prevalence of postoperative ascites.

For Child C patients, however, operative mortality is often 40%; indications for surgery should remain exceptional. Nonoperative endoscopic or percutaneous radi-ological treatments should be preferred.

For Child B patients, a precise assessment of the liver fail-ure and the operative risks as a function of the projected operation is required to adapt management practices. The operative risk may be reduced by improving liver function, reducing the ascites, improving the nutritional status and normalizing elevated transaminase levels; surgery may have to be delayed but not proscribed. The presence of por-tal hypertension with esophageal varices $\geq$ grade 2 warrants primary prophylaxis with betablockers. If the postopera-tive risk of hemorrhage is considered high, or if there is a contraindication for betablockers, prophylactic elas-tic ligation of the esophageal varices may be proposed. Persistence of refractory ascites or severe portal hyperten-sion (history of digestive bleeding by rupture of esophageal varices and $\geq$ grade 2 varices) despite well-conducted medi-cal treatment may require preoperative TIPS, which, in this indication, should replace the peritoneojugular shunt [83].

In emergency situations, it is best, whenever possi-ble, to defer surgery of the cirrhotic patient, preferring a semi-elective intervention. Intensive care and nonoper-ative treatments would be more advisable in these high-risk patients.

Regarding surgical technique for open procedures, oblique or transversal approaches are preferable. A multiple plane closure of the abdominal wall using slow absorption thread and overcast stitches is advisable to reduce the risk of ascites leakage, evisceration, incisional hernia and drainage should, whenever possible, be avoided. If necessary, non-traumatic minimal aspiration drainage can be used. Despite the lack of solid evidence, it is probably useful to pre-pare the colon to reduce the risk of bacterial contamination for esophageal, gastric or colorectal surgery. Rigorous sur-gical technique with special attention to hemostasis and lymphostasis is necessary; for cancer surgery, where the prognosis is probably more related to the cirrhosis than the cancer, there is evidence in the literature arguing against extensive nodal dissection.

Hepatotoxic and nephrotoxic agents should be avoided for anesthesia and perioperative intensive care; it is important to correct the baseline coagulation fac-tors (prothrombin level < 50%, fibrinogen < 1 g/L), schedule platelet transfusion when the platelet count is less than 50,000/mm^3, and maintain intra- and postoperative sys-temic, renal and hepatic hemodynamics, even at the cost of aggravating postoperative ascites if necessary. Intensive care must focus on nutritional status and identification and rapid treatment of infections, crucial challenges for the postoperative outcome of the cirrhotic patient.

Conflict of interests

None.

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