Surgical Risk in Patients with Advanced Liver Disease Undergoing Elective Surgery

Objectives

- Effects of anesthesia and surgery on the liver
- Estimation of operative risk
- Risks associated with specific types of surgery
- Choice of sedatives for endoscopy and surgery
Estimated Hepatic Blood Flow (EHBF) During Anesthesia


Postoperative Liver Dysfunction

Common, mild, transient
All anesthetics
Risk of decompensation with pre-existing liver disease:
  Susceptibility to hypoxemia and hypotension
  Hyperdynamic circulation
  Reduced portal blood flow
  Impaired hepatic arterial autoregulation
Postoperative Hepatic Dysfunction

Cholestasis ← Ischemic Hepatitis

Zone 3
Zone 3 necrosis
Zone 2 cholestasis

Reduced Hepatic Oxygenation During Surgery

Decreased hepatic blood flow or mesenteric vasoconstriction

Hypotension, shock
Hemorrhage
Hypoxemia
Hypercapnia
Heart failure

Vasoconstrictive drugs
Intermittent positive pressure breathing
Traction on abdominal viscera
**Intraoperative Hypoxemia**

**Risk Factors**

- Ascites
- Hepatic hydrothorax
- Hepatopulmonary syndrome
- Hypoalbuminemia
- Pulmonary hypertension
- Aspiration

**Surgery in Liver Disease**

**Absolute Contraindications**

- Acute liver failure
- Acute viral hepatitis
- Alcoholic hepatitis
Cirrhosis and Surgery: Study Design Flaws

Mostly small studies
Retrospective
Examination of selected, arbitrary parameters

Cirrhosis and Surgery: Some Identified Risk Factors

Emergency
Biliary surgery
COPD
Malnutrition
Low albumin
Prolonged PT
Prolonged PTT
Elevated bilirubin

Anemia
Ascites
Encephalopathy
Postoperative bleeding
↓ Aminopyrine clearance
↓ AA clearance
Child-Pugh class
MELD score
Cirrhosis and Surgery

100 cirrhotics, >95% alcoholic
Mortality 30%, morbidity 30%
Retrospective: 52 parameters assessed

Risk factors
- ascites
- malnutrition
- emergency
- infection
- WBC > 10,000
- bilirubin ≥ 3
- albumin ≤ 3
- PT 1.5 sec ↑
- PTT ↑
- Child’s class

Multivariate analysis

Child’s class: Excluded Included
- albumin
- infection
- PT/PTT ↑
- Child’s class

Surgical Mortality in Cirrhosis

N = 92
50% alcoholic/50% nonalcoholic
Abdominal surgery


Surgical Morbidity and Mortality in Cirrhosis

N = 100
Abdominal surgery

Child-Pugh Class
Correlations in Postoperative Period

- Mortality: Infection and sepsis
- Liver failure: Renal failure
- Encephalopathy: Hypoxia
- Bleeding: Intractable ascites

Cirrhosis Operative Guidelines

<table>
<thead>
<tr>
<th>Child’s Class</th>
<th>Operability</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Good</td>
</tr>
<tr>
<td>B</td>
<td>Tolerable with preoperative preparation</td>
</tr>
<tr>
<td>C</td>
<td>Poor</td>
</tr>
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</table>
Child’s Class A Cirrhosis
Predictive Value of HVPG* in Patients Undergoing Hepatic Resection

Role of preoperative TIPS? Uncertain

* Hepatic venous pressure gradient

Risk Factors for Postoperative Mortality in 772 Patients with Cirrhosis

Mayo Clinic
1980-1990
1994-2004

Age

ASA class (first 7 days)

MELD score

MELD Score and Postoperative Mortality in 772 Patients with Cirrhosis

1980-1990
1994-2004

30 Days
90 Days


Postoperative Mortality Risk in Patients with Cirrhosis

What is the age?
What is the ASA score?
What is the bilirubin?
What is the creatinine?
What is the INR?
What is the etiology of cirrhosis?

Probability of Mortality (%)
7 days 30 days 90 days 1 year 5 years


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Postoperative Mortality Risk in Patients with Cirrhosis

What is the age? 55
What is the ASA score? 3
What is the bilirubin? 2.6
What is the creatinine? 1.1
What is the INR? 1.5
What is the etiology of cirrhosis? Alcoholic or Cholestatic
Viral/Other

Probability of Mortality (%)

<table>
<thead>
<tr>
<th>Time</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 days</td>
<td>3.277</td>
</tr>
<tr>
<td>30 days</td>
<td>12.778</td>
</tr>
<tr>
<td>90 days</td>
<td>19.813</td>
</tr>
<tr>
<td>1 year</td>
<td>33.025</td>
</tr>
<tr>
<td>5 years</td>
<td>67.044</td>
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</table>

One-Year Survival after Surgery in Patients with Cirrhosis

Survival, %

Time after surgery or diagnosis, months

Outpatient controls (n = 562)
Minor surgery controls (n = 303)
Major surgery patients (n = 772)

Surgical Morbidity and Mortality in Cirrhosis

Mt. Sinai, New York
N = 100, Abdominal Surgery

Surgical Mortality in Cirrhosis
≤2.5: 60%
>2.5: 14%


MELD ≥15
N = 33

Serum Albumin (mg/dL)  |  Mortality (%)
-----------------------|---------------
≤2.5                  | 60
>2.5                  | 14

Surgical Mortality in Cirrhosis

Drexel
2007-2014

N = 368, Non-Laparoscopic Surgery

Mortality (%)

<table>
<thead>
<tr>
<th>MELD Score</th>
<th>7-Day</th>
<th>30-Day</th>
<th>90-Day</th>
<th>1-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>D=Drexel; M=Mayo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-7</td>
<td>D</td>
<td>M</td>
<td>D</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>0.0</td>
<td>1.9</td>
<td>1.4</td>
<td>5.7</td>
</tr>
<tr>
<td>8-11</td>
<td>2.2</td>
<td>3.3</td>
<td>4.8</td>
<td>10.3</td>
</tr>
<tr>
<td>12-15</td>
<td>0.0</td>
<td>7.7</td>
<td>0.0</td>
<td>25.4</td>
</tr>
<tr>
<td>16-20</td>
<td>0.0</td>
<td>14.6</td>
<td>15.7</td>
<td>44.0</td>
</tr>
<tr>
<td>21-25</td>
<td>15.0</td>
<td>23.0</td>
<td>15.0</td>
<td>53.8</td>
</tr>
<tr>
<td>26+</td>
<td>30.0</td>
<td>30.0</td>
<td>30.0</td>
<td>90.0</td>
</tr>
</tbody>
</table>

Emergency General Surgery in Patients with Chronic Liver Disease

N = 707, retrospective

Median MELD score: 14

90-day mortality rate: 30.1%

↑ odds ratio of mortality 1.63 for each ↑ MELD score of 10

↓ mortality 2.2 fold with ↓ MELD score of 3 in the 48 hours following ICU admission
Hepatic Resection

Residual Volume Needed

Normal Liver  25%
Cirrhotic Liver  40%

Hepatic Resection of Hepatocellular Carcinoma in Patients with Cirrhosis

N = 82
Retrospective, 1993-2003

<table>
<thead>
<tr>
<th>Child Class</th>
<th>N</th>
<th>Perioperative Mortality, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>80</td>
<td>13 (16)</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>0 (0)</td>
</tr>
<tr>
<td>MELD Score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤8</td>
<td>37</td>
<td>0 (0)</td>
</tr>
<tr>
<td>≥9</td>
<td>45</td>
<td>13 (29)</td>
</tr>
</tbody>
</table>

Other predictors: tumor symptoms, ASA score

Cirrhotic patient eligible for liver resection

MELD score

<9

9-10

≥140 mEq/L

<140 mEq/L

Serum sodium level

Segmentectomy or bisegmentectomy

Segmentectomy or limited resection

Risk of irreversible liver failure >15% in all types of hepatectomies

Major hepatectomy

Post-Resectional Liver Failure Risk Factors

Surgical

Small remnant
Prolonged surgery

Patient

Cirrhosis
Steatosis
Cholestasis
Males
Age >65
Comorbidities

Other

Hepatic congestion
Ischemia-reperfusion injury
Infection
### Post-Resectional Liver Failure

**“50-50” Criteria**

- PT index <50% (INR >1.7)
- Bilirubin >50 µmol/L (2.9 mg/dL)*

**Frequency**

0.7-9.1%

**Mortality**

59% (vs. 1.2%)

* In noncirrhotic patients, a peak bilirubin level >7 mg/dL predicts post-resectional liver failure

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### Cardiac Surgery in Patients with Liver Disease

**High mortality rate**

- Child’s A: 0-11%
- Child’s B: 18-50%
- Child’s C: 67-100%

**Morbidity (60-100%)**

- Infections
- Bleeding: platelet dysfunction, fibrinolysis, hypocalcemia

**Risk factors**

- Central venous pressure
- Cardiopulmonary bypass time
- Nonpulsatile bypass
- Need for pressor support
Biliary Surgery in Patients with Cirrhosis

Open cholecystectomy: mortality 25%

Laparoscopic cholecystectomy feasible with Child’s class A or B or MELD score <18

Cholecystostomy may be preferable in an emergency


Nonalcoholic Fatty Liver Disease and Surgery

Mortality rate following hepatic resection in patients with moderate-to-severe steatosis: 7-14%

Risk of hepatic decompensation after liver resection is greater with steatohepatitis than with simple steatosis

Additional risk factors: obesity and diabetes mellitus

Mortality rate of bariatric surgery (%):
- Decompensated cirrhosis 16.3
- Compensated cirrhosis 0.9
- Controls 0.3

Cirrhosis and Surgery: Major Predictors of Risk

MELD (and MELDNa) score (+ serum albumin)
Child’s class C > B
Emergency surgery
Hepatic resection
Cardiac surgery
Biliary tract and major abdominal surgery
Ascites: abdominal wall herniation, wound dehiscence

Obstructive Jaundice and Surgery: Risk Factors for Mortality

Hematocrit value <30%
Bilirubin >11 mg/dL
Malignant obstruction

<table>
<thead>
<tr>
<th>Mortality</th>
<th>All 3 +</th>
<th>60%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All 3 –</td>
<td>&lt;5%</td>
</tr>
</tbody>
</table>

Other risk factors: azotemia, hypoalbuminemia, cholangitis
Obstructive Jaundice: Preoperative Decompression

Retrospective studies: promising
Prospective studies: no benefit
Not demonstrated to improve survival
High rate of complications
Indicated for acute cholangitis or pruritus when surgery is delayed


Meta-Analysis of Randomized Controlled Trials of Moderate Sedation for Routine Endoscopy

36 Studies, 3,918 Patients

Propofol vs. Midazolam* ± Opioid:
Slightly greater patient satisfaction
No difference in adverse effects
Less frequent memory of procedure
Shorter sedation and recovery times

* Midazolam provided greater patient satisfaction and less frequent memory of procedure than diazepam

Propofol in Patients with Cirrhosis
Comparisons with Opioid and Benzodiazepine

- Improved induction
- Improved sedation efficacy
- Improved recovery
- Improved psychometric recovery
- No exacerbation of encephalopathy


Cirrhotic Patients with Subclinical Encephalopathy Before and After Endoscopy
Midazolam vs. Propofol
N = 61

* NCT, number connection test

Controls: from 25 ± 20 sec to 24 ± 20 sec
Cirrhosis+Midazolam: from 72.8 ± 62 sec to 85.6 ± 72 sec
Cirrhosis+Propofol: from 87.5 ± 62 sec to 74.2 ± 58 sec

Hepatic Metabolism of Anesthetic Agents

- Halothane 20%*
- Enflurane 3%*
- Isoflurane, desflurane, sevoflurane ≤1%

*Consequences
- Prolonged action in liver disease
- Formation of toxic metabolites

Anesthetics of Choice in Liver Disease

- Isoflurane
- Desflurane
- Sevoflurane
- Propofol
Preferred Agents in Liver Disease

Narcotic: Remifentanil

Benzodiazepine: Oxazepam or lorazepam

Muscle relaxant: Atracurium or cisatracurium

Induction agent: Etomidate, thiopental, or ketamine

Anesthetic Management in Patients with Liver Disease

Avoid hypercarbia
- Sympathetic stimulation
- Splanchnic vasoconstriction

Keep pCO₂ 35-40 mm Hg

Maintain adequate oxygenation
Surgery in Liver Disease
Preoperative Preparation and Postoperative Monitoring

Anesthesiology consultation
Fluid status
Ascites
Coagulopathy

Encephalopathy
Hypoxemia
Hypoglycemia
Varices
Jaundice

Take Home Points
Surgical mortality in patients with cirrhosis correlates with the MELD score and Child-Pugh class.

Additional risk factors for surgical mortality include age, ASA score, emergency surgery, hepatic resection, and low serum albumin.

In patients with obstructive jaundice, surgical outcome is not generally improved by preoperative decompression.

Anesthetic agents of choice in patients with cirrhosis are isoflurane, desflurane, sevoflurane, and propofol.