

Liver Transplantation

ANESTHETIC CONSIDERATIONS:

- End-stage hepatic failure with systemic complications
 - Encephalopathy and cerebral edema
 - Restrictive lung disease, hepatopulmonary syndrome
 - Hyperdynamic circulation (distributive shock), risk of pulmonary HTN, cardiomyopathy
 - Delayed gastric emptying, ascites
 - Hepatorenal syndrome
 - Coagulopathy ± low grade DIC
 - Metabolic: ↓Na, ↑↓K, ↓Mg, ↑↓glucose, metabolic acidosis and/or respiratory alkalosis
 - Altered pharmacology: ↑volume of distribution, ↓protein binding
- Intraoperative hemodynamic instability
 - Preanhepatic stage: fluid loss with drainage of ascites, potential for major blood loss
 - Anhepatic stage: ↓↓CO
 - Neohepatic stage: washout of K, acids etc from liver, ↓↓BP, arrhythmias
- Potential for major blood loss: iv access, hemodynamic monitors, massive transfusion
- Universal precautions: potential Hep B/C, HIV

ANESTHETIC GOALS:

- Rapid sequence induction
- Maintain stable hemodynamics with volume replacement, blood product transfusion and vasopressors/inotropes
- Correct electrolyte and acid-base abnormalities
- Correct coagulopathy if clinical bleeding
- Prepare for each stage of the operation: *preanhepatic, anhepatic, neohepatic*

HISTORY

- AMPLE Hx
- Etiology of hepatic failure
- Systemic complications of hepatic failure (see Pathophysiology section)
- Screen for new infections
- Medications

PHYSICAL

- Vital signs – HR, BP (wide pulse pressure), RR, T (infection)
- CNS – altered LOC, cranial nerve exam, neurologic deficits
- AW – standard airway exam
- CVS – pulmonary HTN, CHF
- RESP – hypoxemia, respiratory distress, pleural effusions
- GI – ascites, splenomegaly
- MSK – muscle wasting, weakness

INVESTIGATIONS

- Labs
 - CBC/D, lytes, Ca, Mg, PO₄, urea, Cr, glucose, INR, PTT, fibrinogen, x-match
 - Bilirubin, albumin
 - +/- Blood cultures
- EKG – RV strain, ischemia
- Radiology
 - CXR – pleural effusions, atelectasis, pneumonia
 - CT head if altered LOC (bleeding, edema, metastatic tumors)
- Review investigations from liver Tx evaluation
 - Stress echo, cardiac catheterization, PFTs, UGI endoscopy, renal function

OPTIMIZATION

- Minimal time for optimization preop
- Management of CHF
- Dialysis if renal failure
- Transfusion if clinically oozy and lab evidence of coagulopathy
- Infections treated with broad-spectrum antibiotics
- Aspiration prophylaxis
- Consults from pre-transplant evaluation
 - Cardiology, Pulmonary, Nephrology, ID depending on comorbidities
 - ICU for postop disposition

ANESTHETIC OPTIONS

- Regional anesthesia
 - Epidural catheter discouraged due to prolonged perioperative coagulopathy
 - May consider TAP catheter
- General anesthesia

ANESTHETIC SETUP

- **Drugs**
 - For hemodynamic instability – lidocaine, atropine, NEpi, vasopressin, other resusc drugs, methylene blue
 - For hyperK and hypoCa
 - Preoperative antibiotics and immunosuppressive agents
- **Equipment**
 - Standard CAS with 5 lead EKG, temperature probe
 - Lines – extra caution (Hep B/C, HIV)
 - Large bore iv's
 - Arterial lines (radial and femoral), central line (consider U/S guidance with coagulopathy)
 - Consider PAC, TEE (risk with varices)
 - Forced air warmer, fluid warmer
 - Rapid infusion device, cell saver
 - Foley catheter
 - OG tube to decompress stomach/improve surgical exposure (avoid NGT with coagulopathy)
 - Consider preoperative placement of defibrillation pads in preparation for reperfusion phase
 - Consider ICP monitor (controversial, high risk bleeding; require INR < 1.5 prior to insertion)
 - Consider venovenous bypass (if severe pulmonary HTN, severe hemodynamic instability)
- **Other**
 - Notify blood bank and ensure blood product availability
 - 10U PC + 10U FFP in OR, 4U plt + additional blood products in blood bank

MANAGEMENT OF ANESTHESIA

- **Induction**
 - RSI (emergency surgery/full stomach, gastroparesis, ascites)
 - Avoid ↑ICP during intubation
 - Monitor for postinduction hypotension (baseline low SVR and relative hypovolemia)
- **Maintenance**
 - Volatile agent + opioid
 - Avoid halothane (splanchnic vasoconstriction) and N2O (bowel distention)
 - If cerebral edema: minimize volatile agents, monitor ICP, osmotherapy
 - If hemodynamic instability: minimize volatile agent concentrations; midazolam useful during these periods
 - Cisatracurium advantageous: organ-independent elimination, no histamine release
 - Frequent intraoperative laboratory tests (ABG with lactate, glucose, Na, K, iCa, Hb; coagulation parameters including INR, PTT, fibrinogen, plts, +/- TEG)
 - Manage blood loss and coagulopathy
 - Avoid hypothermia
 - Transfuse PRBCs, FFP, plts, cryoppt as indicated
 - Antifibrinolytics to reduce blood loss (? risk hepatic artery and portal vein thrombosis)
 - rFv VIIa
- **Preanhepatic/dissection phase**
 - Mobilizing and removing native liver; hypotension with drainage of ascites drained; risk of hemorrhage with dissection, impaired venous return due to retraction; risk of ↓Ca, ↑K, metabolic acidosis; oliguria common, maintain urine output
- **Anhepatic phase**
 - Blood supply to native liver clamped resulting in ↓venous return and hypotension; may use venovenous bypass to avoid ↓↓venous return and venous congestion; ↓cardiac output may require inotropes; retraction for placement of new liver may compromise ventilation; risk of hypoCa with absent hepatic function (citrate toxicity); donor liver flushed prior to implantation; venous anastomoses
- **Neohepatic phase**
 - Begins with venous x-clamp release with reperfusion syndrome (acidosis and ↑K, with severe hypotension and arrhythmias); anastomosis of hepatic artery and bile duct; once allograft functioning expect slow improvement in lactate, bilirubin, coags, urine output, electrolytes
- **Emergence**
 - Immediate vs delayed extubation
 - Standard extubation criteria
 - 75% of patients may be eligible for fast-track
 - Delay extubation if significant preop hepatic encephalopathy or fulminant hepatic failure
- **Anesthesia for patients after liver transplantation**
 - Reasons for exploration
 - Bleeding, biliary leak, bowel obstruction, abscess, unrelated procedures
 - Liver function may not have returned to baseline
 - Immunosuppressant therapy
 - Assess for infectious complications and maintain strict aseptic techniques
 - Drug toxicity, drug interactions

DISPOSITION & MONITORING

- **Disposition**
 - ICU for close monitoring and routine supportive care
- **Analgesia**
 - IV opioids, TAP catheter
 - Typically lower analgesic requirements than other major abdominal surgery

- **Oxygenation**
 - Routine
- **Monitoring**
 - Frequent assessment of cardiac and pulmonary function, serum glucose and electrolytes, hepatic and renal function, and coagulation
 - Graft dysfunction: coagulopathy, CV instability, hypoCa, hypoglycemia, ↑lactate
 - Low threshold for surgical re-exploration

COMPLICATIONS

- Hemodynamic instability
- Massive hemorrhage
- Hyperkalemia
- Rejection
- Vascular thrombosis
- Anastomotic leak
- Infection

PATHOPHYSIOLOGY

- Systemic complications of end-stage liver failure

Table 54-5 Multisystem Complications of End-Stage Liver Disease

| SYSTEM | CONSEQUENCE |
|---|--|
| Central nervous system | Fatigue |
| Encephalopathy (confusion to coma) | Blood–brain barrier disruption and intracranial hypertension (acute liver failure) |
| Pulmonary | Hypoxemia/hepatopulmonary syndrome |
| Respiratory alkalosis | |
| Pulmonary hypertension | Reduced right heart function |
| Cardiovascular | |
| Reduced systemic vascular resistance Diastolic dysfunction Prolonged QT interval Blunted responses to inotropes Blunted responses to vasopressors Diabetes | Hyperdynamic circulation |
| Gastrointestinal | |
| Gastrointestinal bleeding from varices Ascites Delayed gastric emptying | |

| | |
|--|-----------------------------------|
| Hematologic | |
| Decreased synthesis of clotting factors | Risk of massive surgical bleeding |
| Hypersplenism (pancytopenia) Impaired fibrinolytic mechanisms | |
| Renal | |
| Hepatorenal syndrome | Impaired renal excretion of drugs |
| Hyponatremia | |
| Endocrine | |
| Glucose intolerance | |
| Osteoporosis | Fracture susceptibility |
| Nutritional/metabolic | Muscle wasting and weakness |
| Other | |

| | |
|---|---|
| Poor skin integrity Increased volume of distribution for drugs | |
| Decreased citrate metabolism | Calcium requirement with rapid FFP infusion |

From Barash (p. 1402)

- Indications for liver transplant
 - Chronic
 - Non-cholestatic (HepB, HepC, EtOH, NASH, autoimmune)
 - Cholestatic (PBC, PSC)
 - Metabolic (Wilson’s disease, hemochromatosis, inherited metabolic disorders)
 - Hepatocellular carcinoma
 - Acute
 - Toxin-induced (drugs (acetaminophen, CCl4, Reye’s syndrome), mushrooms)
 - Viral (HepA, HepB, HepC)
 - Ischemia/hypoperfusion (shock-liver)
 - Acute fatty liver of pregnancy
- Contraindications to liver Tx
 - Active sepsis (HIV *not* a contraindication)
 - Advanced cardiac disease (severe CAD)
 - Advanced pulmonary disease (severe hepatopulmonary syndrome, severe pulmonary HTN)
 - Extrahepatic malignancy
 - Cholangiocarcinoma
 - Active alcoholism/substance abuse
- Extended criteria donor grafts
 - Major classes of donor include advanced age, NASH, DCD, split grafts, extended hospital LOS
 - Need to limit cold ischemia time, postop delayed graft function
- Organ allocation
 - Child-Turcotte-Pugh classification
 - Based on encephalopathy, ascites, INR, albumin, bilirubin
 - Was used to determine organ allocation for liver transplant until 2002

Pugh’s modification of the Child-Turcotte classification

| Variable | <Points scored> | | |
|---|-----------------|---------|----------|
| | <1> | <2> | <3> |
| Encephalopathy | None | 1–2 | 3–4 |
| Ascites | Absent | Slight | Moderate |
| Prothrombin time (sec prolonged) | <4 | 4–6 | >6 |
| Albumin (g/dL) | >3.5 | 2.8–3.5 | <2.8 |
| Bilirubin (mg/dL) for cholestatic disease | <2 | 2–3 | >3 |
| | <4 | 4–10 | >10 |

Child-Pugh class A, 5–6; class B, 7–9, class C, 10–15.

- MELD score
 - Based on bilirubin, INR, Cr; modified for HCC
 - MELD Score = $0.957 \times \text{Log}_e(\text{creatinine in mg/dL}) + 0.378 \times \text{Log}_e(\text{total bilirubin in mg/dL}) + 1.12 \times \text{Log}_e(\text{INR}) + 0.643$
 - Used to allocate donor liver on basis of medical urgency

REFERENCES

- Miller p. 2169-76, Barash p. 1401-05
- Anesthesia Coexisting Disease p. 273-73
- Anesthesia for liver transplant surgery. *Anesth Clin N Am* 2004;22:687-711