



## TRANSJUGULAR INTRAHEPATIC PORTOSYSTEMIC SHUNTS (TIPS)

<b>Surgical Specialty:</b>	Interventional Radiology
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### Background:

- General Considerations
  - The transjugular intrahepatic portosystemic shunt (TIPS) procedure involves the placement of a shunt with an expandable stent that connects the hepatic vein with an intrahepatic branch of the portal vein through percutaneous angiography to result in decreased portal pressures<sup>1</sup>.
    - TIPS is indicated in several conditions, including:
      - Portal hypertension resulting in variceal bleeding (failed initial hemostasis therapy or rebleed after 120+ hours)
      - Refractory ascites
      - Hepatic hydrothorax
      - Budd-chiari syndrome
      - Veno-occlusive disease
      - Portal hypertensive gastropathy
      - Hepatorenal syndrome
      - Hepatopulmonary syndrome<sup>1</sup>.
    - The TIPS procedure is not a first-line treatment option for either ascites or variceal bleeding and is typically reserved for refractory/recurrent cases.
    - TIPS has been thought of as a “bridge to transplant” as it decompresses the portal circulation but does not definitely treat portal hypertension.
- Patient Considerations
  - Disease Specific Considerations
    - Patients with ascites and hepatic hydrothorax present with reduced functional residual capacity.
      - A supine position may further exacerbate this condition<sup>2</sup>.
    - In the case of variceal bleeding, patients taken back to the interventional radiology suite may not be fully optimized for anesthesia.
      - Patients presenting with gastrointestinal bleed secondary to varices may present with large quantities of blood in their upper GI tract, making them high risk for aspiration.

- Associated Comorbidities/Syndromes<sup>3</sup>
  - Patients with liver disease are at risk for multiple other conditions that may affect the anesthetic plan, as liver disease can affect multiple other systems.
  - **Neurologic:** Patients may present with some degree of hepatic encephalopathy, making them more sensitive to sedatives and hypnotics.
    - These patients are also at higher risk for aspiration.
  - **Cardiovascular:** Patients are at risk of cirrhotic cardiomyopathy, resulting in increased cardiac output along with decreased response to pharmacologic, physiologic, or pathologic stress, which places them at risk of heart failure.
    - Careful administration of IV fluids should be performed to avoid volume overload.
    - Patients with portal hypertension are also at risk for portopulmonary hypertension and thus are at risk for right heart failure.
  - **Pulmonary:** See discussion of ascites above. Patients with hepatopulmonary syndrome may require supplemental oxygen.
  - **FEN/GI:** Patients with liver disease are at risk for electrolyte derangements, which should be corrected as able.
    - Hyponatremia should not be corrected unless acute or the patient displays neurologic symptoms.<sup>3</sup>
  - **Renal:** Patients with liver disease are also at risk of renal dysfunction, which may lead to hepatorenal syndrome.
    - Urine output and electrolyte status should be carefully monitored, and nephrotoxins should be avoided.
  - **Hematologic:** Patients with decreased liver synthetic function are at risk of coagulopathy and thus may require correction prior to the procedure
    - Platelet goal  $\geq 50,000/\text{microL}$  or  $>100,000/\text{microL}$  for active bleeding and fibrinogen levels  $\geq 200 \text{ mg/dL}$ .
    - INR correlates poorly with hemostasis in cirrhosis.<sup>3</sup>
- Contraindications to the TIPS procedure
  - Absolute contraindications: CHF, severe tricuspid regurgitation, severe pulmonary hypertension (MPP  $>45 \text{ mmHg}$ ), polycystic liver disease, sepsis/active systemic infection, and unrelieved biliary obstruction<sup>1</sup>.
  - Relative contraindications: liver tumors, obstruction of all hepatic veins, hepatic encephalopathy, portal vein thrombosis, thrombocytopenia ( $<20,000$ ), and moderate pulmonary hypertension<sup>1</sup>.

### Anesthetic Planning:

- Pre-Anesthetic Evaluation
  - Additional labs/tests indicated during work-up
    - A full history and physical should be performed with a focus on ensuring that the patient's comorbidities are investigated.
    - Labs: CBC, CMP, coagulation studies (aPTT, PT/INR, fibrinogen), type and cross (with blood readily available). Consider TEG/ROTEM if significant coagulopathy is present.
    - Imaging: Liver imaging should be obtained to assess for patency of the portal and hepatic veins, spleen size, ascites, and presence and extent of portosystemic collaterals. Chest radiograph is performed to assess for cardiomegaly and fluid overload.

- A cardiac evaluation should be performed to look for signs and symptoms of heart failure, cardiomyopathy, or pulmonary hypertension. This frequently includes an echocardiogram.
    - Model for End-Stage Liver Disease (MELD) scores are highly predictive of post-TIPS mortality at three months<sup>1</sup>.
    - Correct abnormal lab results as needed/able prior to procedure except those noted above (Na, INR, etc).
  - Discussions to have with the surgeon/family
    - Code Status
    - Patient's renal function should be discussed prior to the administration of any contrast load.
    - Consider paracentesis prior to the TIPS procedure to decrease the risk of aspiration.
      - For patients who receive large volume paracentesis (>50 mL/kg), albumin infusion should be performed to decrease the risk of post-paracentesis circulatory dysfunction<sup>4</sup>.
- Specific or Unique Room Set-Up Requirements
  - Airway
    - Consider risks/benefits/alternatives of monitored anesthesia care (MAC) vs general endotracheal anesthesia (GETA).
      - This procedure is typically performed in an angiography suite where access to the airway may be limited.
      - A secure airway with endotracheal intubation is typically preferred.
    - Consider risks/benefits/alternatives of rapid sequence induction (RSI), especially in patients presenting for emergent procedures, GI bleeding, severe ascites, and hepatic encephalopathy, as they are at increased risk of aspiration.
  - Drugs/Infusions<sup>3</sup>
    - Many options/combinations for maintenance and institutional practices may vary.
      - Benzodiazepines
        - These medications have low extraction ratios, and both the elimination half-life and free drug are increased. Enhanced sedation and longer duration of action should be anticipated. Reduced doses should be titrated to effect.
      - Sevoflurane
        - May result in a small reduction of hepatic blood flow, but has no association with hepatic toxicity.
      - Induction Agents
        - Propofol and etomidate can be used.
          - Titrate to clinical effect, as patients with liver failure can have varying tolerances for medications.
      - Muscle relaxants
        - Succinylcholine and cisatracurium are the safest agents to use since they undergo no hepatic metabolism<sup>5</sup>.
        - Both rocuronium and vecuronium are metabolized by the liver. Clearance, elimination, and duration of neuromuscular block are prolonged. Despite these, the initial dose should be increased due to elevated gamma-globulin concentrations and an increase in volume of distribution (edema/ascites).

- Opioids
  - Patients may require a smaller dose of opioids due to their hepatic metabolism.
  - Antibiotic prophylaxis (typically 3<sup>rd</sup> generation cephalosporins such as ceftriaxone to cover gram-negative bacteria or broad-spectrum antibiotics such as piperacillin-tazobactam in the case of an acute bleed)<sup>2</sup>.
- Standard ASA monitors
- IV access
  - 1 large bore IV for elective cases, as the risk of bleeding is low
  - 2 large bore IVs with consideration for the addition of a central line for cases with active bleeding
- Invasive arterial pressure monitoring may be indicated in hemodynamically unstable patients.
- Urinary catheter to monitor urine output (>0.5-1.0 mL/kg/h) if the case is expected to be long.
- Blood Availability (if indicated)
  - Patients presenting with active variceal bleeding will likely require blood intraoperatively or preoperatively.
- PICU Bed Availability (if indicated)
  - Patients are typically admitted to the PICU postoperatively.
- Other Indicated Resources
  - In the case of profuse bleeding, a rapid infuser may be necessary.

### Intraoperative Considerations:

- General
  - The TIPS procedure is minimally invasive and typically will not require heavy analgesia.
  - Complications intraoperatively that require additional blood products include liver capsule puncture and portal vein rupture; both are relatively rare.
- Induction
  - Consider risks/benefits/alternatives of MAC (only for elective procedures) vs. general anesthesia with or without RSI.
  - GETA is typically preferred for pediatric TIPS procedures.
- Positioning
  - Supine with head facing to the left (internal jugular access is typically achieved on the right side).
- Maintenance
  - Drugs and agents as mentioned above
  - Short-acting opiates for the stimulating parts of the procedure may be used.
    - Fentanyl 1-2 mcg/kg
- Hemodynamic/Physiologic goals
  - The goal blood pressure is to maintain the patient's baseline.
  - UOP >0.5-1.0 mL/kg/h
- Surgical Considerations
  - Patients presenting with acute variceal bleeding can be anticipated to have large volumes of blood loss, and blood availability in these situations is very important.
- Emergence/Disposition
  - Patients may be awakened in the OR prior to extubation.
- Post-op Care

- Patients usually do not present with much pain postoperatively as the TIPS procedure is minimally invasive and done through percutaneous angiography.
- Monitor for signs of new/worsening hepatic encephalopathy, as this is very common after the TIPS procedure.
- Patients should also be monitored for signs of new cardiac dysfunction.
- Patients should receive blood products as needed.

### Case-Specific Complications/Pitfalls

- Cardiac arrhythmias
  - The TIPS catheter passes through the SVC to the IVC and may come into contact with the right atrial wall or the right ventricular wall, resulting in arrhythmias.
  - Therefore, electrolyte abnormalities and acid-base status should be corrected prior to the procedure<sup>1</sup>.
- Cardiac failure
  - As the TIPS procedure results in the creation of a shunt from the splanchnic to the systemic circulation, the large fluid shift post-TIPS can increase venous return, cardiac output, and right heart pressures.
    - This can unmask underlying cirrhotic cardiomyopathy or portopulmonary hypertension.
  - Pre-TIPS cardiac evaluation can identify patients at risk for cardiac decompensation<sup>6</sup>.
- Puncture of the liver capsule
  - The liver capsule may be punctured as the TIPS catheter attempts to enter the portal vein.
  - The risk of clinically significant hemoperitoneum is low, and management includes balloon tamponade and coil embolization.
  - Additional blood products may be required<sup>1</sup>.
- Rupture of the portal vein
  - Extrahepatic puncture of the portal vein can result in severe bleeding.
  - Hemostasis may be achieved by placing the shunt over the site of injury.
  - Emergent surgery and additional blood products may be required<sup>1</sup>.
- Injury to the biliary tree
  - Puncture of the biliary tract can result in a biliary fistula.
- Post-operative hepatic encephalopathy
  - Signs of new/worsening hepatic encephalopathy usually arise 2-3 weeks after the TIPS procedure<sup>6</sup>.
- Infection/sepsis
  - Infection can result in increased risk of liver failure and should be treated with appropriate antibiotic coverage.
  - Antibiotic prophylaxis should be discussed prior to procedure<sup>6</sup>.
- Liver failure:
  - 20% of patients can have liver failure from either iatrogenic liver injury or the inability to maintain perfusion to the hepatic sinusoids<sup>6</sup>.
- TIPS dysfunction
  - This results in presentation of the initial complication (ascites, variceal bleeding, etc.).
  - In the case of thrombosis, prevention may occur with pharmacologic prophylaxis or treatment can be undergone with thrombolysis, anticoagulation, or thrombectomy<sup>6</sup>.

**References**

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