Transjugular Intrahepatic Portosystemic Shunt: Decoding the TIPS Procedure, Appearance, and Complications for the Diagnostic Radiologist

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Disclosures: None
Learning Objectives

• Target audience: Diagnostic radiologists interpreting imaging on patients post-TIPS

• Understand the clinical indications for TIPS
• Identify the appearance of a typical TIPS procedure
• Learn the appropriate follow-up findings
• Identify variations of a normal TIPS
• Identify alternatives to a TIPS
What is a TIPS?

- **Transjugular Intrahepatic Portosystemic Shunt (TIPS)**
  - Endovascular creation of a low-resistance tract through the liver
  - Connects the portal and hepatic venous systems

- TIPS decompresses the portal venous system reducing portal hypertension
<table>
<thead>
<tr>
<th>Indications</th>
<th>Contraindications</th>
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<tbody>
<tr>
<td>• Acute hemorrhage from varices not responsive to medical therapy</td>
<td>• Severe hepatic failure</td>
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<td>• Recurrent variceal hemorrhage not responsive to medical therapy (Child’s B and C)</td>
<td>• Sepsis</td>
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<td>• Refractory ascites</td>
<td>• Right-sided heart failure</td>
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<td>• Refractory hepatic hydrothorax</td>
<td>• Pulmonary hypertension</td>
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<td>• Budd-Chiari syndrome</td>
<td>• Portal vein cavernous transform</td>
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<td>• Severe hepatic encephalopathy</td>
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*All contraindications are relative.*
Stents Used for TIPS

• Viatorr®:
  • Polytetrafluoroethylene (PTFE) covered self-expanding nitinol stent
  • Uncovered segment anchors device in portal vein allowing portal flow past TIPS
    • PTFE graft lining reduces bile/mucin permeation and tissue ingrowth thus improving patency
  • Radiopaque band between uncovered and covered portions

![Diagram of Viatorr® stent](image)
Complications of TIPS

• Major intraprocedural:
  • Hepatic laceration/hemorrhage
  • Failure to create shunt
  • Cardiac failure

• Major acute post-procedural:
  • Cardiac decompensation
  • Liver failure
  • Worsening of hepatic encephalopathy
  • Portal vein thrombosis or TIPS occlusion

• Late:
  • TIPS stenosis or eventually occlusion
Typical TIPS Placement

• Ideal/most common approach:
  • Right hepatic vein to right portal vein

• Portal end should be at least 1 cm from main PV bifurcation

• Anatomic variants/hepatic or portal vein occlusion may require alternatives:
  • Middle hepatic to left or right portal vein
  • Left hepatic to left portal vein
Alternative TIPS courses

- MHV to RPV
- MHV to LPV
Malpositioned TIPS

- Too deep in the right atrium
  - May lead to arrhythmia or intracardiac thrombosis

- Too deep in the portal vein
  - Covered portion of the Viatorr® stent extends too proxial into the portal system
  - Can cause portal vein narrowing, thrombosis or occlusion
  - May lead to early stenosis
Malposition – Too deep in the atrium

• Proximal TIPS terminating in the right atrium on non-subtracted (1) and subtracted (2) angiography

• No flow was seen in the TIPS on ultrasound in this case prior to TIPS revision
Malposition – Too deep in the portal vein

- Ultrasound showing no flow (1) near the origin of the TIPS in the portal vein
- Coronal CT showing thrombus extending from the main portal vein into the distal aspect of the TIPS (2)
- Axial CT view of the thrombus (3)

*TIPS extends greater than 1 cm into the main portal vein, predisposing to portal vein thrombosis
Post-procedure Follow-up

- Doppler ultrasound
  - Air trapped within the expanded PTFE layers of the Viatorr® can cause shadowing
    - Can take a week to dissipate
  - Baseline exam around 1 week after placement
  - CT with contrast:
    - Can show shunt patency, insensitive for stenosis

- Repeat ultrasound at 3 month, then 6 month intervals
TIPS ultrasound evaluation

• Normal:
  • Pulsatile flow in shunt
  • Peak systolic shunt velocities: 90-190 cm per second
  • Velocity at portal and hepatic ends of shunt similar
  • Hepatofugal flow in the nonshunted PV branch
  • Hepatopedal flow in portal and splenic
  • Portal vein velocity: At least 40 cm/sec
TIPS ultrasound evaluation

- **Abnormal:**
  - Abnormal shunt peak systolic velocities: $<90 \text{ cm/sec}$ or $>190 \text{ cm/sec}$
  - Change from baseline post-TIPS shunt velocities ($>40 \text{ cm/sec}$ decrease or $>60 \text{ cm/sec}$ increase in fasting patient)
  - Increase in velocity from one point to another in the shunt of $>100 \text{ cm/sec}$
  - Visible shunt narrowing
  - Non-pulsatile shunt flow
  - Decrease in portal vein velocity from post-procedure baseline
  - Portal vein velocity less than 30 cm/sec
  - Hepatofugal or to-and-fro main portal or splenic vein flow
  - Change from hepatofugal to hepatopedal flow in the non-shunted portal vein
  - Absence of flow in shunt
TIPS Occlusion

• Early occlusion
  • Technical failure
    • Acutely angled shunt trajectory
    • Inadequate stent length

• Late occlusion
  • In-stent pseudointimal hyperplasia
  • Hepatic vein intimal hyperplasia
  • Thrombosis

• 1-year patency rate:
  • Primary: Up to 66%
  • Secondary: Up to 85%
No Doppler flow: Total occlusion

- Doppler ultrasound (1) showing no flow in the TIPS

- Angiography (2) with contrast filling the portal vein but not the TIPS
No Doppler flow: Total occlusion

- Angioplasty of the occluded TIPS with a waist in the balloon at level of occlusion (1)

- Post-angioplasty evaluation of the TIPS demonstrates patency of the TIPS (2)
Elevated Doppler velocities: Stenosis

- Progressively decreased peak systolic velocities extending from the portal end (1) to the mid TIPS (2)

- Low (<90 cm/sec) velocities
Elevated Doppler velocities: Stenosis

- Increased peak systolic in the IVC end of the TIPS (1), consistent with stenosis near the IVC
- Angiography of the TIPS with focal stenosis (2) in the IVC end of the TIPS (top left image) with associated waist in the balloon on angioplasty (3)
Elevated Doppler velocities: Stenosis

- After angioplasty, previously seen waist is no longer apparent with decreased stenosis of the TIPS at the IVC end.
In-stent Stenosis

- Pseudointimal or hepatic vein intimal hyperplasia

- Most common ultrasound findings:
  - Abnormal shunt peak systolic velocities: <90 cm/sec or >220 cm/sec
  - Change from baseline post-TIPS shunt velocities (>40 cm/sec decrease or >60 cm/sec increase in fasting patient)
  - Increase in velocity from one point to another in the shunt of >100 cm/sec

- Less common findings:
  - Visible shunt narrowing
  - Non-pulsatile shunt flow
  - Decrease in portal vein velocity from post-procedure baseline
  - Portal vein velocity less than 30 cm/sec
  - Hepatofugal or to-and-fro main portal or splenic vein flow
  - Change from hepatofugal to hepatopedal flow in portal vein branches distal to shunt
  - Absence of flow in shunt
Treatment of Stenosis: Restenting

- Stenosis resistant to angioplasty
  - Elastic recoil of clot or hyperplasia
  - Requires opposing force to keep lumen open
  - Stent provides that force

- Note new radiopaque markers (blue arrows)
  - Not all stents have these
Alternatives to TIPS

• Direct Intrahepatic Portocaval Shunt (DIPS)
  • Requires IntraVascular US (IVUS)

• Balloon-occluded Retrograde Transvenous Obliteration (BRTO)
  • Only for gastric varices
  • Can increase portal hypertension
  • Also PARTO (Plug Assisted) and CARTO (Coil Assisted)

• Surgical Portosystemic Shunts (PSS)
  • Declining use
  • Consider use in PVT cases
  • Reported 5-year patency of 97%
Direct IVC to portal vein shunt (DIPS)

- Intravascular ultrasound-guided (IVUS) puncture from IVC to portal vein through caudate

- Advantages:
  - No hepatic vein stenosis
  - IVUS decreases procedural time and radiation dosage
  - May be only percutaneous shunt option in Budd-Chiari patients because of hepatic vein thrombosis
PARTO – Bleeding gastric varices

• Catheter in splenorenal shunt showing gastric varices (1)

• Amplatzer plug (2) occlusion of splenorenal shunt, embolization of varices performed

• Complete occlusion of the splenorenal shunt (3)

• Amplatzer plug (4) at the origin of the splenorenal shunt on CT
Congenital “TIPS”

- Congenital vascular malformation connecting the portal venous system to the systematic venous system
- Can cause progressively worsening hepatic encephalopathy later in life
- Situation may be complicated by the presence of portal hypertension, which may worsen if congenital shunt is occluded
Conclusions

• With increasing rates of chronic liver disease and portal hypertension, the incidence of TIPS placement will continue to increase.

• Accurate identification of normal versus abnormal TIPS can help guide patient care and allow for early intervention.

• Familiarity with the intraprocedural imaging and identification of technical variations can be helpful to correlate with follow-up imaging.
References


• Gur I, Diggs BS, Orloff SL. Surgical portosystemic shunts in the era of TIPS and liver transplantation are still relevant. HPB (Oxford). 2014;16(5):481-93.


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