Percutaneous Intervention in Patients with Acute and Chronic Portal Hypertension

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Total hepatic blood flow

- 75-80% of total hepatic blood flow is supplied by the portal vein:
  - Fasting portal flow 1,100 ml/min
  - Hepatic arterial flow 350 ml/min

- Postprandial portal flow can increase 8 fold
Total hepatic blood flow

- Determinants of hepatic blood flow:
  - Hepatic artery resistance
  - Intrahepatic portal resistance
  - Splanchnic resistance
- Influenced by sympathetic activity and vasoactive substances
  - Most pharmacologic therapies to control portal hypertension target the alpha and beta II sympathetic fibers of the splanchnic circulation
Pathophysiology of portal hypertension

- Backward Flow theory: increased portal resistance
  - Swelling of the hepatocyte; sinusoidal capillary formation; and collagenization of the space of Disse combine to impede portal flow at the hepatic sinusoidal level and fibrosis obliterates the hepatic microcirculation
Pathophysiology of portal hypertension

- Forward Flow theory: increased splanchnic inflow resulting from a blunted response of mesenteric vessels to circulating vasoconstrictors and elevated levels of circulating vasodilators combined with increased portal resistance
Hemodynamic assessment

- WHP = Wedged hepatic vein pressure
  - Reflects the hepatic sinusoidal pressure in the absence of portal vein occlusion
  - Sum of the portal pressure and the intra-abdominal pressure
- FHP = Free hepatic vein pressure
  - Reflects the intra-abdominal pressure
  - Interchangeable with the IVC pressure
- CSP = Corrected sinusoidal pressure
  - CSP=WHP - FHP
Hemodynamic assessment

- Normal CSP is less than 5 mm Hg
- In presinusoidal obstruction the CSP is normal
- In sinusoidal, postsinusoidal, and mixed patterns of obstruction the CSP is elevated
Imaging findings

- Presinusoidal obstruction
  - Portal-portal collaterals develop to bypass the site of obstruction
  - The high resistance of these collateral pathways results in portal hypertension that ultimately may lead to portosystemic collaterals
  - Portal flow is diminished and the liver may be small
  - Hepatic arterial flow increases
Imaging findings

- Postsinusoidal portal hypertension
  - Increased liver resistance results in portal hypertension which initially maintains liver perfusion; liver size is normal or enlarged
  - When hepatic resistance approaches systemic resistance portosystemic collaterals develop and portal flow decreases
  - Hepatopetal portal flow is maintained up to CSP of 12 mm Hg; Hepatofugal flow and portosystemic varices develop thereafter. (petal=to seek; fugal=to flee)
  - Hepatic arterial flow increases to maintain perfusion and the arteries become enlarged, tortuous, and eventually “corkscrew” in appearance
Corkscrew vessels of cirrhosis
Portosystemic collaterals (varices)

- Portosystemic collaterals allow portal decompression
  - Esophageal and gastric to azygos and hemiazygos
  - Inferior mesenteric to superior hemorrhoidal to iliac
  - Left portal to umbilical to epigastric
  - Splenic and mesenteric to retoperitoneal veins to IVC
  - Splenic to retroperitoneal to left renal
Etiology of pre-sinusoidal obstruction

- Extrahepatic obstruction
  - Portal vein thrombosis
    - Inflammatory – pancreatitis, intraabdominal infections,
    - Neoplastic
    - Coagulopathy
    - Trauma
    - Idiopathic
  - Intrahepatic obstruction
    - Congenital hepatic fibrosis
    - Infectious/inflammatory conditions – Schistosomiasis
    - Chronic malaria
    - Viral hepatitis
    - Infiltrative conditions
Etiology of pre-sinusoidal obstruction

- Overcirculation
  - Arterial portal fistula
    - Iatrogenic
    - Posttraumatic
    - Neoplastic
    - Congenital
  - Arteriovenous malformation
  - Banti’s syndrome—portal hypertension associated with splenomegaly
Etiology of sinusoidal, post-sinusoidal, and mixed obstruction

- Cirrhosis
- Budd-Chiari syndrome
- Tricuspid incompetence
- Congestive heart failure
- Constrictive pericarditis
45 yo M with ESLD secondary to Hepatitis C, listed for transplantation. Past history of banding for esophageal varices, no recent bleeding episodes. Moderate ascites. Medically controlled encephalopathy
Portal vein thrombosis in ESLD

- PVT may complicate transplantation in 2 – 26% of patients
- PVT can exclude patients from transplantation when thrombus occupies > 25% of PV lumen
- PVT increases postoperative complications and mortality, especially with splanchnic extension
- Several small series suggest TIPS can improve or maintain PV patency
  - Technical difficulty higher
  - Complications of TIPS may be higher
Portal vein thrombosis

- Three populations:
  - Hypercoagulable - presenting with acute mesenteric venous thrombosis or Budd-Chiari
  - ESLD without hepatoma
  - Hepatoma

- Three situations:
  - Dilated veins suggesting acuity
  - Identifiable thrombus but maintained hepatopetal flow
  - Cavernous transformation suggesting chronicity
Possible next steps

- TPA
- Mechanical thrombectomy
- Power pulse thrombectomy
- Balloon thrombectomy
51 y M with Wilson’s disease diagnosed in 1963. Two months ago he suddenly developed weakness, ascites, confusion and shortness of breath. This was attributed to portal hypertension from worsening cirrhosis.

A trial of diuretics failed to improve his symptoms. He was referred to the hepatology service for evaluation for transplantation. An ultrasound of the liver was obtained.
Hepatic arterial portal fistula

- **Symptoms:**
  - Hemobilia
  - Abdominal pain
  - Diarrhea
  - Variceal bleeding
  - Ascites
  - Heart failure

- **Primary** - cogenital, Ehlers-Danlos syndrome, Osler-Weber Rendu
- **Secondary** - iatrogenic trauma, rupture of hepatic artery aneurysm, or a result of underlying parenchymal pathology
- Often small and close spontaneously or present years after injury
- Embolization can immediately resolve symptoms
  - Coils
  - Detachable balloons
  - Gelfoam
  - Isobutyl-2-acrylate
  - Alcohol

_Brophy DP. J Vasc Interv Radiol 2001;12:535_
Portal decompression in patients with post-sinusoidal obstruction
Optimum stent position

- No more than 2 cm into the portal vein
- Up to the IVC
- As straight as possible
Where should the TIPS end?

- 107 patients with TIPS analyzed for shunt position at the hepatic end.
- TIPS terminating in the HV (n= 47) vs. within 2 cm of the hepatocaval junction (n= 60)
- Mean patency 7.1 m vs. 16.8 m
- 1 Y patency 36% vs. 60% (p=.017)

Clark.J Vasc Inter Radiol 2004
For Tracheobronchial Obstructions and Fistulae
Viatorr stent graft

- Nitinol stent with 2 cm uncovered segment; and 4 - 8 cm covered segment.
- Internal porous ePTFE graft covering
- External non-porous bile resistant ePTFE film
- 8, 10, 12 diameter
100 patients had implantation of Viatorr TIPS stent-graft (84 primary) at one of three European hospital centers.

- TS: 100% with a decrease in PSG from a mean of 21 to 7 mm Hg
- 30 day re-intervention: 5%
- New or worsening encephalopathy: 14%
- 1 Y survival: 65%
- 1 Y primary patency: 84%

Charon. JVIR 2004
DIPS - direct intrahepatic inferior vena cava- to-portal-vein shunt

Petersen. JVIR 2001 & JVIR 2003
Indications for TIPS

- Refractory variceal bleeding
- Refractory ascites or hepatic hydrothorax
- Budd-Chiari syndrome
- Acute portal vein thrombosis pre-transplantation
- Portal vein thrombosis post-transplantation
Eleven prospective randomized trials compared TIPS to endoscopic therapy to prevent rebleeding.

- 811 patients were followed for 1 - 2.5 years.
- TIPS results:
  - 19% rebleeding rate after TIPS compared to 47%.
  - No statistical difference in mortality.
  - 34% post-treatment encephalopathy after TIPS compared to 19%.

Papatheodoridis. Hepatology 1999
Consensus

- No role for TIPS in acute bleeding
- No role for TIPS as prophylaxis for bleeding
- A lack of survival benefit when TIPS is used to prevent rebleeding and more frequent post treatment encephalopathy suggests TIPS should be reserved for salvage of patients following failed medical and endoscopic therapy
TIPS vs. surgical shunts

- 8mm prosthetic H-graft portacaval shunts vs. TIPS in 132 patients
  - 3% rebleeding rate after surgery vs. 16% with similar survival

- DSRS vs. TIPS in 67 patients
  - 6% rebleeding rate after surgery vs. 26% with similar survival and post-treatment encephalopathy of 19% vs. 43%

Rosemurgy. J Gastrointest Surg 2000
Khaitiyar. Hepato-Gastroenterology 2000
TIPS vs. surgical shunts in LT candidates

- Overall SPS have been shown to increase operative time and blood replacement requirements during LT
  - DSRS or MC with no or minimal hilar dissection are preferred
- Compared to TIPS, SPS increase blood loss, operative time, ICU stay, and LOS
  - DSRS decrease portal flow

Langnas. Am J Gastroenterol 1992
Abouljoud. West J Med 1995
Jaoude. Transplantation proceedings 2001
Post TIPS Mortality in 60 patients evaluated for transplantation with refractory bleeding or ascites

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<td>7 days</td>
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<td>Median survival</td>
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<td>2.6m</td>
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*older; higher CP; more co-morbidities; more emergency procedures

Spies. AJG 1995
Results of 100 Patients Undergoing TIPS for Refractory Ascites

Kaplan-Meier Survival Estimate

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<th>Listed (L)</th>
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<td>N</td>
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<tr>
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<td>165 days</td>
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Log-Rank test: Chisq = 19.69 df = 1  p<0.0001

UCHSC 2002
Does TIPS improve the results of transplantation operations?

- Retrospective study of 55 patients with TIPS matched to 55 controls undergoing LT
- No benefit in total operative time, blood product usage, renal function, liver function, LOS
- Less ascites in TIPS patients, decreased time from incision to cross-clamp
- Conclusions:
  - TIPS does not impact the course of LT
  - Pre-operative portal decompression solely to facilitate transplantation is not appropriate

Somberg. Transplantation 1997
Conclusions about salvage therapy with shunts

- TIPS should be used to bridge patients to transplantation in patients with refractory bleeding or ascites.
- In good risk, alcoholic cirrhotics surgical shunts appear to have lower rebleeding rates and similar mortality.
- Poor risk, non-transplantation candidates are poor candidates for TIPS.
When we intervene for bleeding

- Transplantation candidates and compliant, non-drinking, non-transplantation candidates with esophageal varices:
  - When endoscopic therapy fails
    - Uncontrolled bleeding after initiating ET
    - Second episode of bleeding in the hospital after initiating ET
    - Third out of hospital bleed after initiating ET
  - Gastric or stomal varices
Shunt malposition

- Shunt malposition requiring modification of the hepatic vascular anastomoses (7-30%)
- Shunt malposition requiring modification of the portal vein anastomoses (25-56%

Millis. Liver Transplantation and Surg 1995
Hutchins. Liver Transplantation 2000
Chui. Transplantation Proc 2000
Stent migration

- Shunt migrated into the left PA during LT performed 3 weeks post TIPS - snared
- Shunt migrated into the RV and lodged on the tricuspid valve - removed surgically at time of LT or post operatively with valve repair

Rumi. Transplantation 1999
Te. Transplantation 2001
Linka. Circulation 2001
How should TIPS candidates be selected?
Absolute Contraindications

- Insufficient hepatic reserve
- Refractory encephalopathy
- Refractory coagulopathy
- Severe cardiopulmonary disease
- Organic renal disease
- Prohibitive anatomy
Patient selection

- Child-Pugh classification
  - Non-discriminating - most patients are Class C
  - Subjective evaluation of ascites and encephalopathy
Predictors of mortality and stenosis after TIPS

- 90 TIPS for recurrent or uncontrolled bleeding, or refractory ascites
- Predictors of 30-day deaths:
  - uncontrolled variceal bleeding
  - serum creatinine > 1.7 mg/dL
  - PT > 17 s
- Coagulopathy and renal insufficiency combined yielded a 30-day mortality of 78%

Russo. Liver Transplantation 2002
Serum bilirubin and early mortality after TIPS: results of a multivariate analysis

- 220 patients undergoing TIPS for variceal bleeding
- Predictors of 30-day deaths:
  - serum bilirubin > 4 mg/dL
  - Child-Pugh class C
  - intubated
  - uncontrolled variceal bleeding*
- Each 1.0 mg/dL increase in total bilirubin was associated with a 40% greater odds of 30-day mortality

Rajan. JVIR 2002
A model to predict poor survival in patients undergoing TIPS (MELD)

- 231 patient undergoing elective TIPS for recurrent variceal bleeding or refractory ascites @ 4 centers
- Predictors of survival:
  - serum bilirubin
  - serum creatinine
  - INR
  - etiology of liver disease
- Risk score > 1.8 associated with a median survival of 3M or less

Malinchoc. Hepatology 2000
MELD as a predictor of mortality

- 72 patients with urgent or elective TIPS and creatinine < 3.0
- Predicted probability of death by MELD was compared to actual survival
- Meld predicted mortality higher than observed
- Meld risk score of > 18 associated with a 3-month survival of 55%
- Meld risk score of < 18 associated with a 3-month survival of 85%

Ferral. JVIR 2002
Just Say No!

- Creatinine > 2.0 mg/dL
- Bilirubin > 3.0 mg/dL
- INR > 2.0
- MELD > 18 – 25 LT
- Uncontrolled variceal bleeding
Ascites and hepatic hydrothorax

- Four single institution patient series of 50 patients and UCHSC series of 100 patients
- C-P C: 42 - 82%
- Technical success: 93 - 100%
- Response: 62 - 92%
- 30 mortality: 4 - 19%
- 1 Y survival: 28 - 66%

Crenshaw. Radiology 1996
Nazarian. Radiology 1997
Peron. JVIR 2000
TIPS vs. paracentesis for refractory ascites

- The probability of survival without liver transplantation was 69% at one year and 58% at two years in the TIPS group, compared with 52% and 32% in the paracentesis group.
- 61% complete ascites response.
- Similar encephalopathy.

TIPS vs. paracentesis for refractory ascites

- The probability of survival without liver transplantation was 77% at one year and 59% at two years in the TIPS group, compared with 52% and 29% in the paracentesis group.
- Higher encephalopathy rate 69% vs. 39%
Results of 100 Patients Undergoing TIPS for Refractory Ascites

Kaplan-Meier Survival Estimate

<table>
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Log-Rank test: Chisq = 19.69 df = 1  p<0.0001
When we intervene for ascites

- Carefully selected transplantation candidates and non-drinking non-transplantation candidates with refractory ascites and hepatic hydrothorax.