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# NCSCG 6<sup>TH</sup> ANNUAL **VIRTUAL** LIVER SYMPOSIUM

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# Management of Portal Hypertension in Patients With and Without Acute Variceal Hemorrhage

DANIEL SZE, MD, PHD

INTERVENTIONAL RADIOLOGY

STANFORD UNIVERSITY

# Disclosures Active and *Inactive*: (past 36 months)

- ▶ Consultant to:

- ▶ Artio Medical, *Astra-Zeneca*, *Bayer*, BlackSwan Vascular, Boston Scientific, *Bristol Myers Squibb*, *Eisai*, FluidX, W. L. Gore, *Guerbet*, *Koli*, Replimune, Sirtex, Terumo, TriSalus Life Sciences, Varian

- ▶ Institutional Research Support:

- ▶ Boston Scientific, *W. L. Gore*, Merit Medical, Sirtex

- ▶ Equity

- ▶ BlackSwan Vascular, *Confluent Medical*, *Koli*, *Proteus Digital Health*, RadiAction Medical, TriSalus Life Sciences

- ▶ I always try to discuss off-label use



# Complications of Portal Hypertension

- ▶ Why does PH need to be managed?

- ▶ Hemorrhage
- ▶ Ascites / hydrothorax
- ▶ *Encephalopathy*
- ▶ *Hepatorenal syndrome*
- ▶ *Hepatopulmonary syndrome*





# Ascites / Hydrothorax

- ▶ Transudative, hydrostatic, high SAAG
- ▶ Contributes to morbidity, mortality
- ▶ Severe, refractory:
  - ▶ AASLD: fluid overload that is unresponsive to Na-restricted diet and high dose diuretics (400 mg/d spironolactone, 160 mg/d furosemide) OR recurs rapidly after therapeutic paracentesis.
  - ▶ Not standardized:  $\geq 6$  large volume paracentesis/y ( $\geq 5$  liters)



# Ascites : treatment options

## ► Drainage

- Large volume paracentesis (LVP)
- Tunneled drain
- Peritoneo-cystic shunt (Europe)
- Peritoneo-venous shunt (Denver shunt)

Loss of  
protein,  
electrolytes

DIC

## ► Inflow pressure reduction

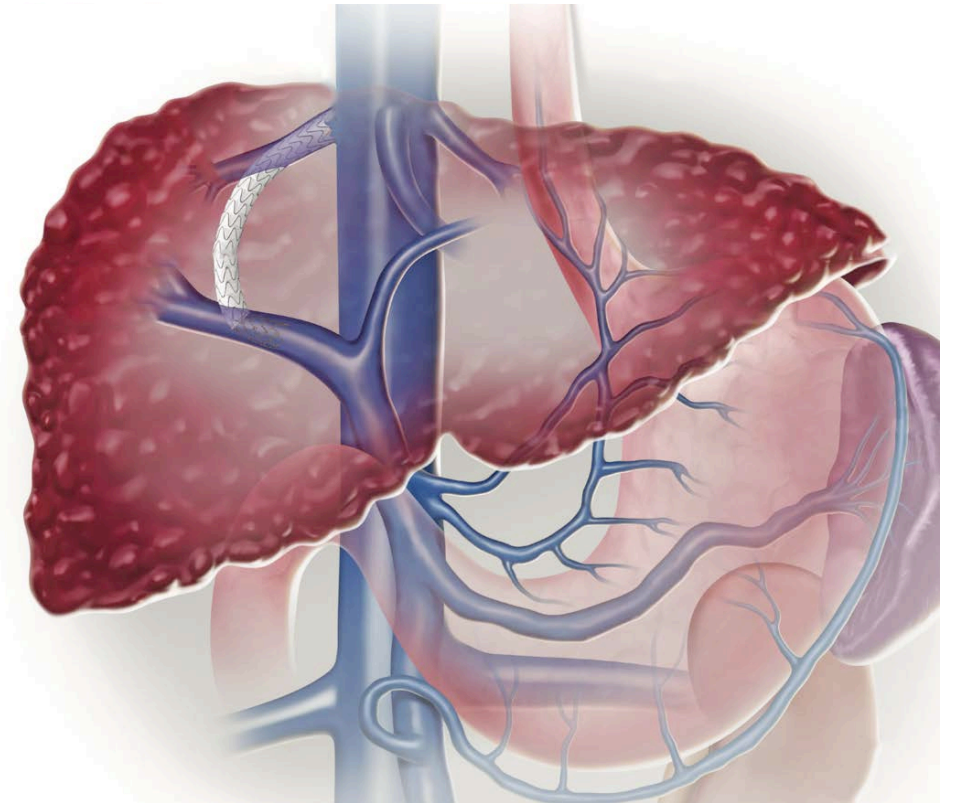
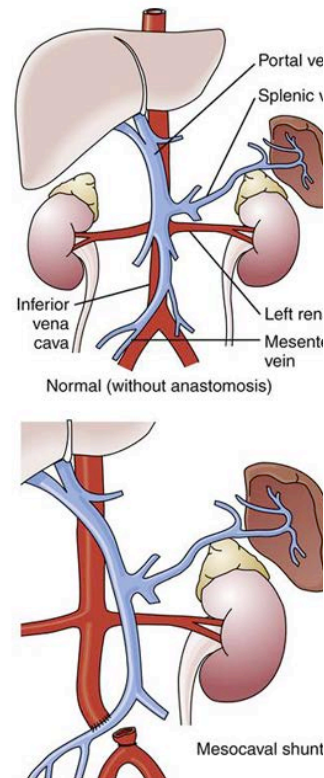
- Partial splenic embolization (PSE)

Hurts, PVT



# Ascites : treatment options

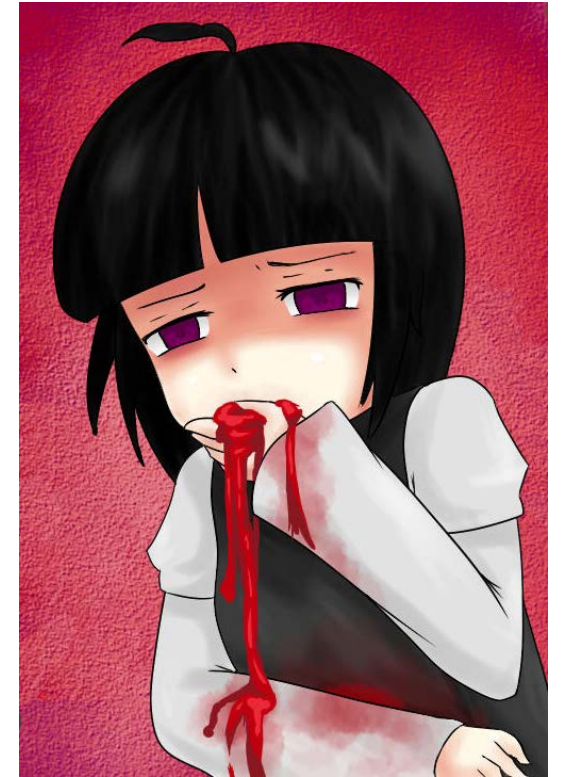
- ▶ Portosystemic shunt for decompression
  - ▶ Surgical shunts (splenorenal, mesocaval, portocaval)
  - ▶ Transjugular intrahepatic portosystemic shunt (TIPS)





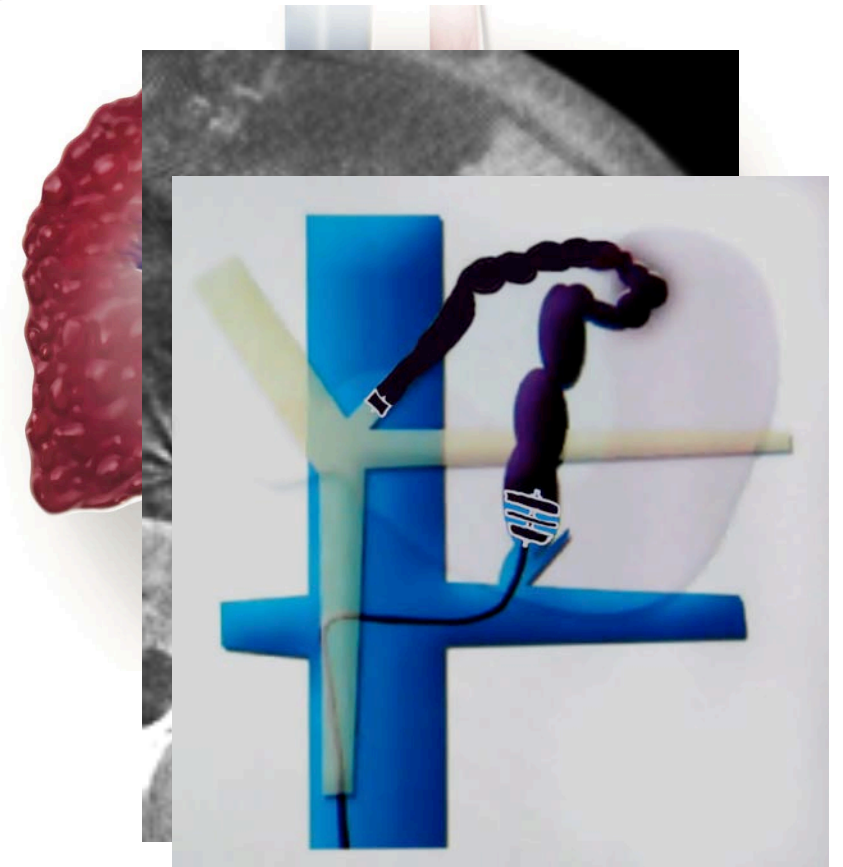
# Portal hypertensive hemorrhage

- ▶ Cause of death in ~1/3 of cirrhotic patients
- ▶ Mortality at 1 month ~20%, 1 year ~40%
  - ▶ Statistics have improved with improved endoscopic methods, pharmacologic prophylaxis, interventional techniques
  - ▶ Higher mortality and rebleed rates for gastric varices compared with esophageal varices, gastropathy, other (ectopic) varices



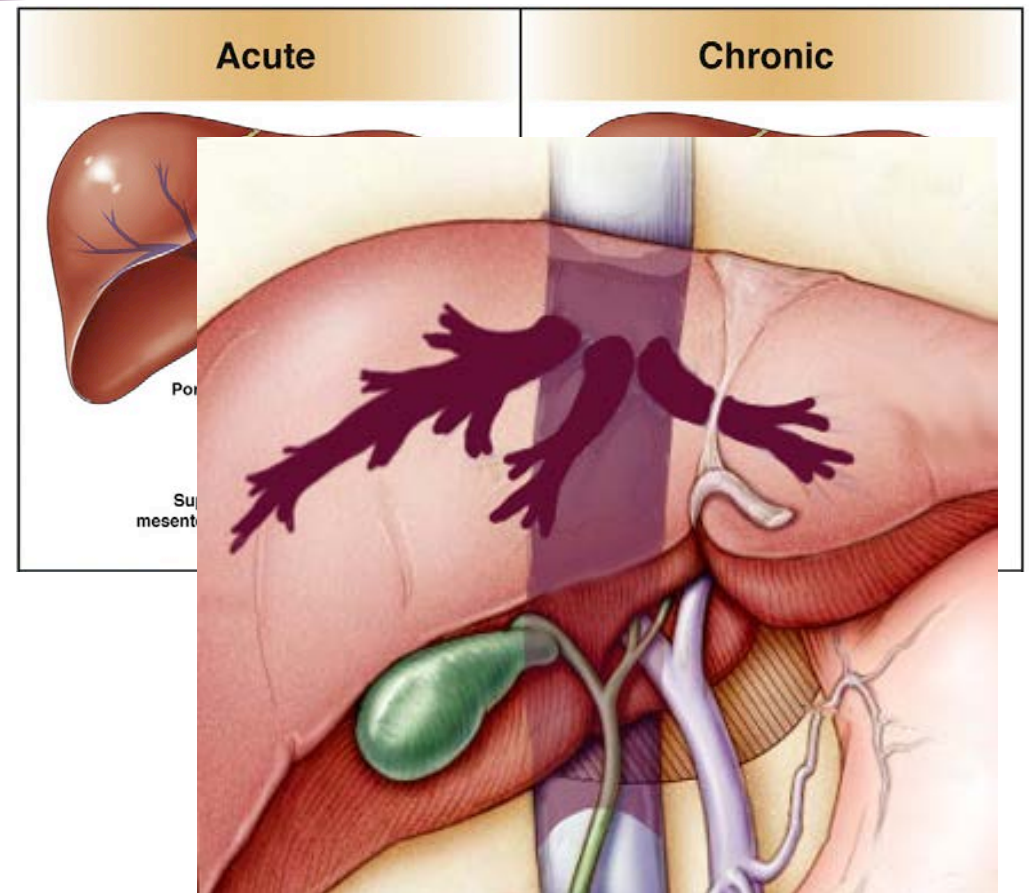
# Hemorrhage : treatment options

- ▶ Portosystemic shunt (TIPS, etc.)
- ▶ Inflow pressure reduction (PSE)
- ▶ Embolization / sclerotherapy
  - ▶ Balloon-occluded retrograde transvenous obliteration of varices (BRTO)
  - ▶ Variations, some in conjunction with TIPS



# Portal hypertension : treatment options

- ▶ Special circumstances
  - ▶ Acute portal venous thrombosis (PVT)
  - ▶ Chronic portal venous thrombosis
  - ▶ Budd-Chiari syndrome (BCS, hepatic venous outflow obstruction)





# TIPS developments

# TIPS developments : stentgrafts

- ▶ Since 2002, standard of care is to use PTFE-covered stents (Gore Viatorr)
- ▶ Primary patency improved from ~50% @ 1 y to 90+%
- ▶ New device is “variable expansion” from 8-10 mm diameter to allow for customization by gradient
- ▶ Some previous contraindications are not as valid



Sze et al., JVIR 2006;17:711

# TIPS developments : IVUS

- ▶ Intravascular ultrasound guidance
  - ▶ Improved safety (one pass)
  - ▶ Alternative paths
    - ▶ DIPS (Direct intrahepatic portosystemic shunt, IVC to MPV, less likely to traverse HA, biliary)

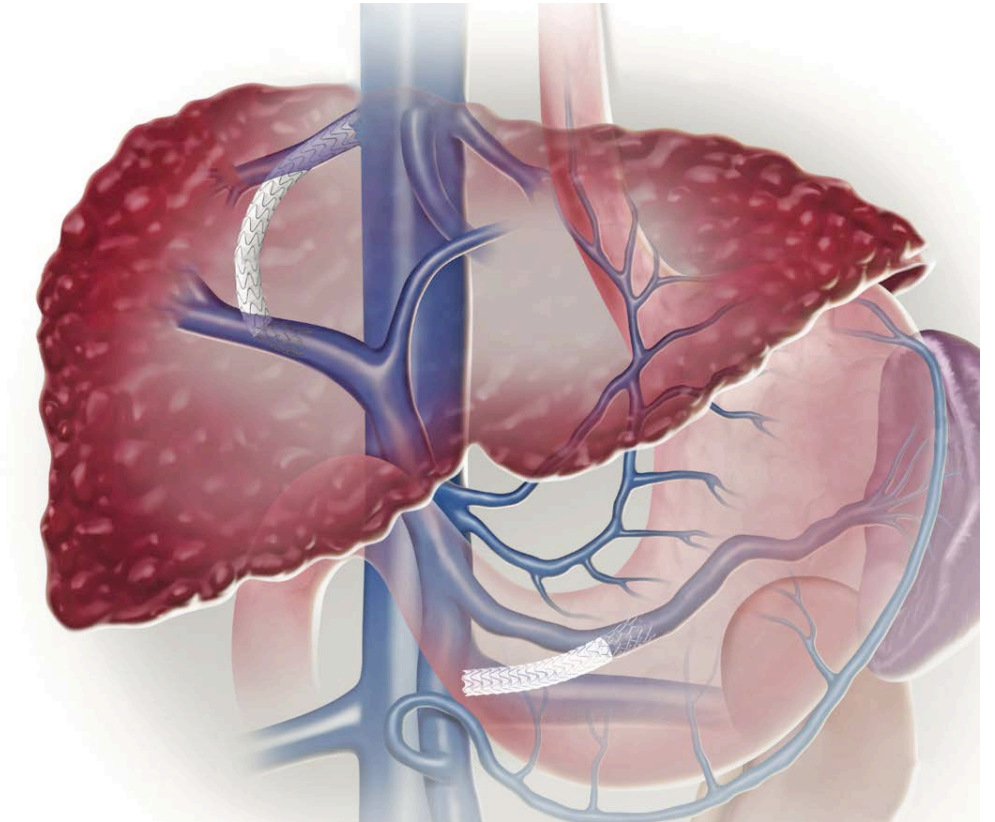


Hoppe, Wang, Petersen. Radiology 2008; 246:306



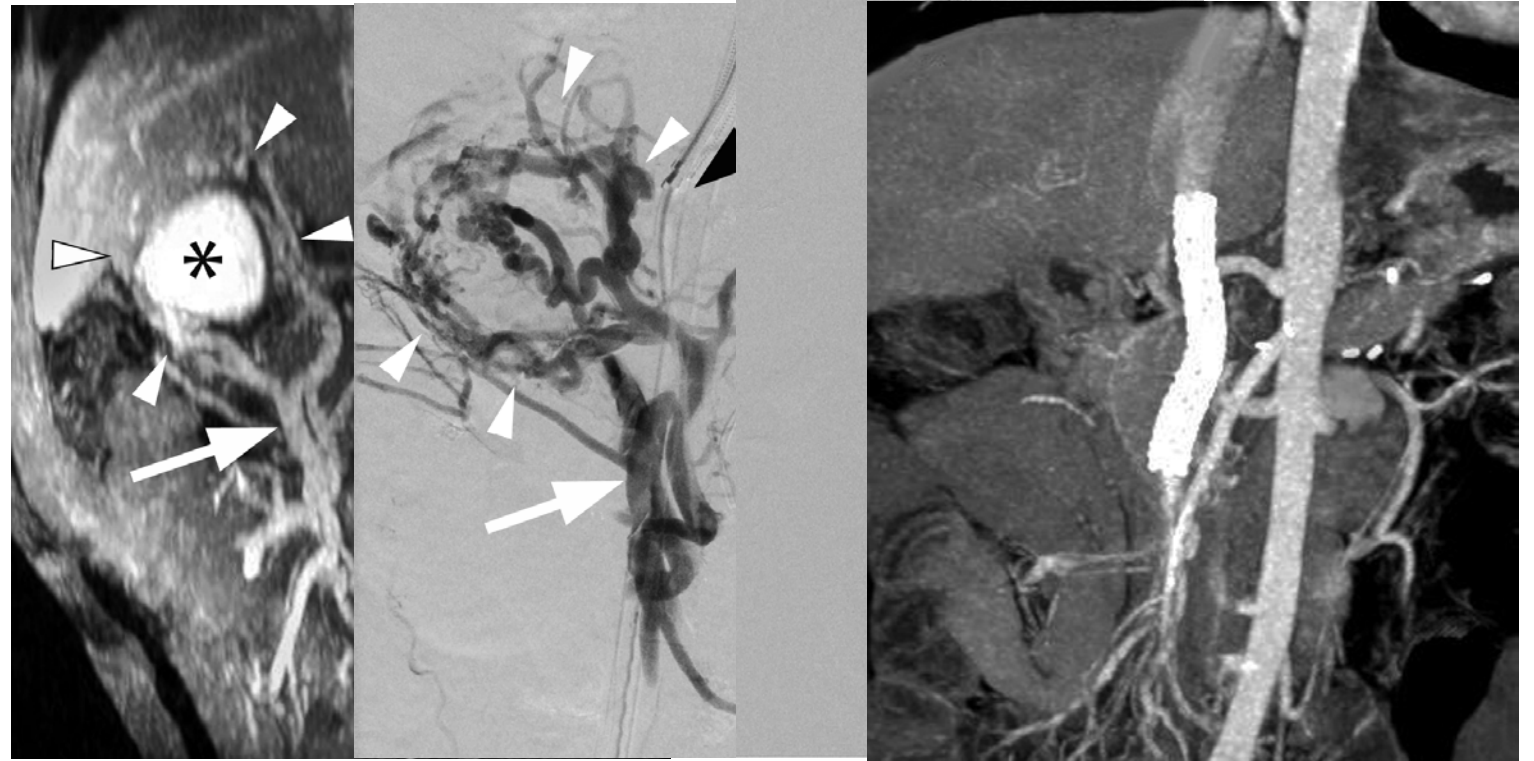
# TIPS developments : alternative shunts

- ▶ Transvenous Extrahepatic Portosystemic Shunts (TEPS)
  - ▶ Portocaval, Mesocaval, Splenocaval, Splenorenal
  - ▶ Possibility of selective shunting, preserving SMV flow into liver for first pass hepatic metabolism (↓encephalopathy, ↑trophic flow)



# TIPS developments : alternative shunts

- ▶ TEPS (transjugular extrahepatic portosystemic shunt)
  - ▶ Mesocaval shunt



# TIPS developments : Chronic PVT



## Pretransplantation Portal Vein Recanalization and Transjugular Intrahepatic Portosystemic Shunt Creation for Chronic Portal Vein Thrombosis: Final Analysis of a 61-Patient Cohort

Bartley Thornburg, MD, Kush Desai, MD, Ryan Hickey, MD, Elias Hohlastos, MD, Laura Kulik, MD, Daniel Ganger, MD, Talia Baker, MD, Michael Abecassis, MD, MBA, Juan C. Caicedo, MD, Daniela Ladner, MD, Jonathan Fryer, MD, Ahsun Riaz, MD, Robert J. Lewandowski, MD, and Riad Salem, MD, MBA

### ABSTRACT

**Purpose:** To report the final analysis of the safety and efficacy of portal vein (PV) recanalization (PVR) and transjugular intrahepatic portosystemic shunt (TIPS) creation (PVR-TIPS) in patients with PV thrombosis (PVT) in need of liver transplantation.

**Materials and Methods:** Sixty-one patients with cirrhosis and PVT underwent PVR-TIPS to improve transplantation candidacy. Median patient age was 58 years (range, 22–75 y), and median pre-TIPS Model for End-Stage Liver Disease score was 14 (range, 7–42). The most common etiologies of cirrhosis were nonalcoholic fatty liver disease in 18 patients (30%) and hepatitis C in 13 patients (21%). Twenty-seven patients (44%) had partial PVT, and 34 patients (56%) had complete thrombosis. Forty-nine patients (80%) had Yerdel grade 2 PVT, and 12 (20%) had Yerdel grade 3 PVT. Twenty-nine patients (48%) had cavernous transformation of the PV.

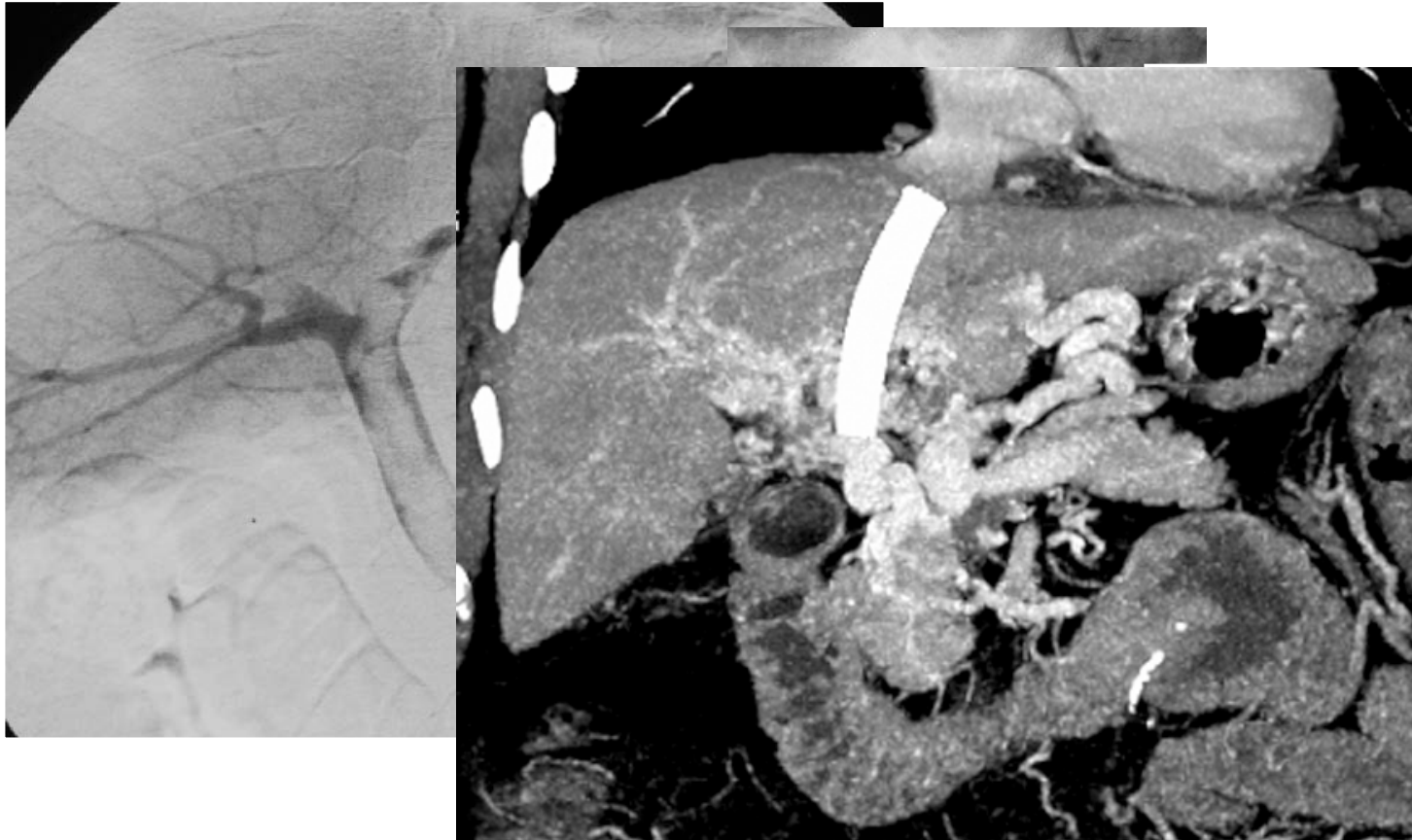
**Results:** PVR-TIPS was technically successful in 60 of 61 patients (98%). PV/TIPS patency was maintained in 55 patients (92%) at a median follow-up of 19.2 months (range, 0–105.9 mo). Recurrent PV/TIPS thrombosis occurred in 5 patients (8%), all of whom initially presented with complete PVT. The most common adverse events were TIPS stenosis in 13 patients (22%) and transient encephalopathy in 11 patients (18%). Twenty-four patients (39%) underwent transplantation, 23 of whom (96%) received an end-to-end anastomosis. There were no cases of recurrent PVT following transplantation, with a median imaging follow-up of 32.5 months (range, 0.4–75.4 mo). Five-year overall survival rate was 82%.

**Conclusions:** PVR-TIPS is a safe, effective, and durable treatment option for patients with chronic PVT who need liver transplantation.





# TIPS developments : Acute PVT



## Technical Innovation

### Mesenteric and Portal Venous Thrombosis Treated by Transjugular Mechanical Thrombolysis

Daniel Y. Sze<sup>1</sup>, Gerard J. O'Sullivan<sup>1,2</sup>, Denise L. Johnson<sup>3</sup>, Michael D. Dake<sup>1</sup>

**A**cute mesenteric ischemia from venous thrombosis is rare, and even when recognized, carries a grim prognosis. Improved imaging of the portal and splanchnic venous systems has increased clinical awareness, yet treatment remains problematic. Resection of infarcted bowel and aggressive anticoagulation continue to be the standard of care although the mortality rate in patients with extensive thrombosis remains as high as 76% [1, 2]. Case reports have described successful catheter-directed or systemic thrombolysis [3–7], but these techniques greatly magnify the already high risk of gastrointestinal hemorrhage. We report a case of massive thrombosis of the portal, superior mesenteric, and splenic veins. An attempt at intraarterial thrombolysis resulted in substantial gastrointestinal hemorrhage. A new method of treatment—transjugular portal access and mechanical thrombolysis—proved to be a safe and effective alternative.

#### Subject and Methods

A 37-year-old man with a history of hepatitis B presented to a community hospital with severe abdominal pain, vomiting, and anorexia. CT of the abdomen identified thrombosis of the portal and superior mesenteric veins (Fig. 1A). Angiography revealed patent superior mesenteric and splenic arteries. Venous phase images confirmed complete

thrombosis of the superior mesenteric vein with partially occlusive thrombus in the splenic and portal veins (Fig. 1B). Intraarterial thrombolysis via the superior mesenteric artery was commenced with urokinase (Abbokinase, Abbott Laboratories, North Chicago, IL) at 100,000 U/hr and systemic IV heparin. After 16 hr, the patient developed hematochezia and coffee-ground emesis, and the infusions were discontinued. The patient's hematocrit fell from 48% to 25% over 2 days.

On transfer to our institution, the patient was acidotic and hemodynamically unstable. Imaging to assess the effect of urokinase was not pursued. The patient underwent exploratory laparotomy, and 1.4 m of necrotic jejunum was resected. A small amount of thrombus was successfully expressed from the divided branches of the superior mesenteric vein. The liver did not appear cirrhotic, and no portosystemic collateral vessels were identified. A primary duodenoileal anastomosis was performed, and IV heparin was restarted. Pathologic examination of the resected specimen confirmed transmural infarction, vascular congestion, and extravasation of RBC.

Although improved, the patient remained acidotic and produced copious ascites. Because of this evidence of persistent ischemia, mechanical thrombolysis was proposed to improve splanchnic venous outflow. Because the transhepatic route is associated with a greater risk of hemorrhage, particularly in the presence of ascites and anticoagulation, a transjugular approach was used [3]. With the patient still under general anesthesia, a wedged carbon dioxide portogram was obtained, opacify-

ing only the left portal vein. A Rosch-Uchida set (Cook, Bloomington, IN) was used to gain access to the left portal vein, and the tract was dilated to 6 mm in diameter with an angioplasty balloon (Marshall, Boston Scientific, Watertown, MA). A 10-French sheath (Cook) was passed through the tract and into the portal vein. The portosystemic gradient could not be measured because of the extensive thrombosis.

Over a 0.018-inch guidewire (Hi-Torque Flex-T; Mallinckrodt, St. Louis, MO), an AngioJet device (AV-60 catheter; Possis Medical, Minneapolis, MN) was used to aspirate as much thrombus as possible from the main portal vein. To remove residual mural thrombus, a 12 × 60 mm Wallstent (Boston Scientific) was then deployed in the tract and portal vein to provide a conduit into which the residual thrombus was swept with an angioplasty balloon.

Venography of the superior mesenteric and splenic veins confirmed thrombosis in both veins, with poorly formed collateral drainage (Fig. 1C). The AngioJet device was reintroduced through a 6-French angled guide-catheter (Cordis/Johanson & Johnson, Miami, FL), and thrombus in these large-caliber veins was aspirated using a helical sweeping pattern. In addition, the device was used in four tributaries of the superior mesenteric vein. A total of 1000 mL of effluent was collected. Antegrade flow was reestablished in the splenic vein, main trunk of the superior mesenteric vein, main portal vein, and left portal vein (Fig. 1D). The portosystemic gradient was 5 mm Hg after the thrombolysis, and the stent was intentionally left undilated to encourage flow into the left portal vein.

Received December 17, 1999; accepted after revision February 2, 2000.

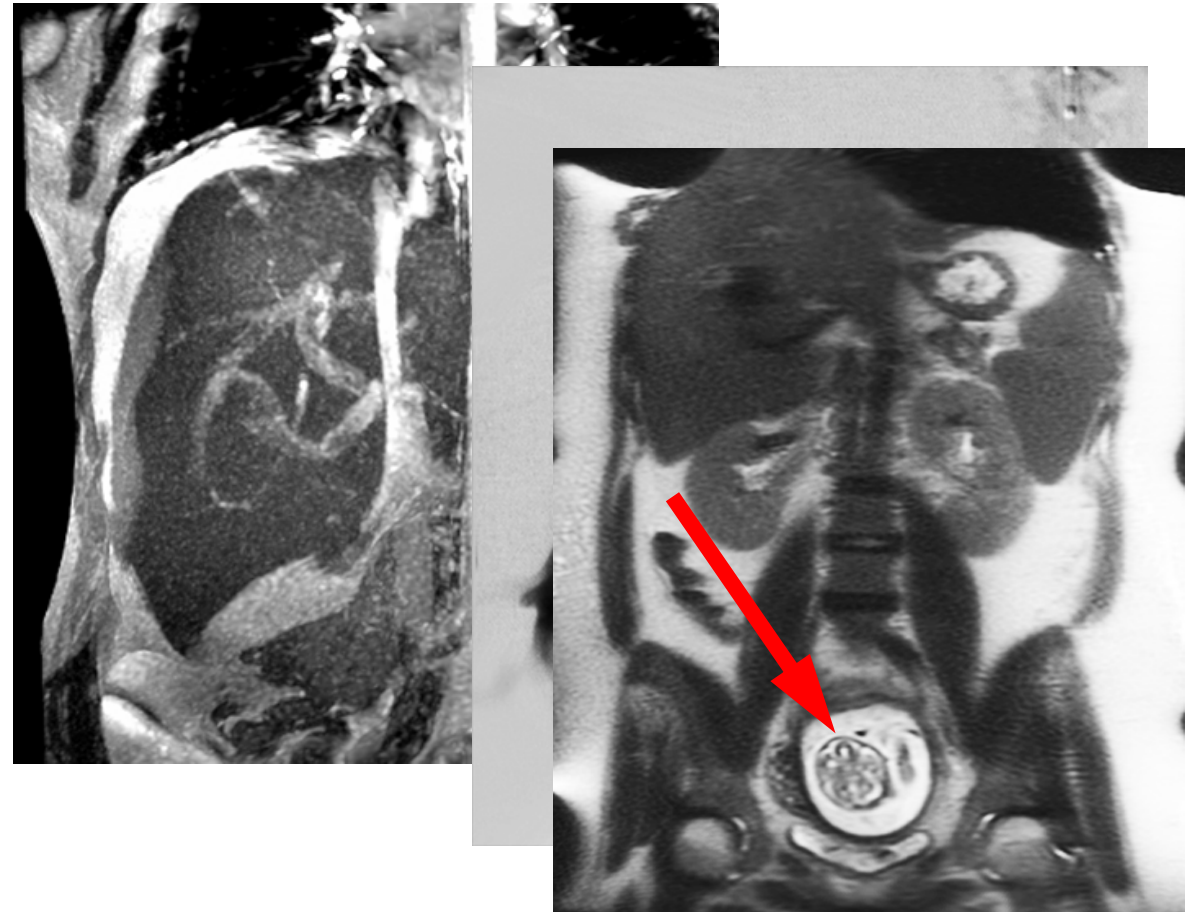
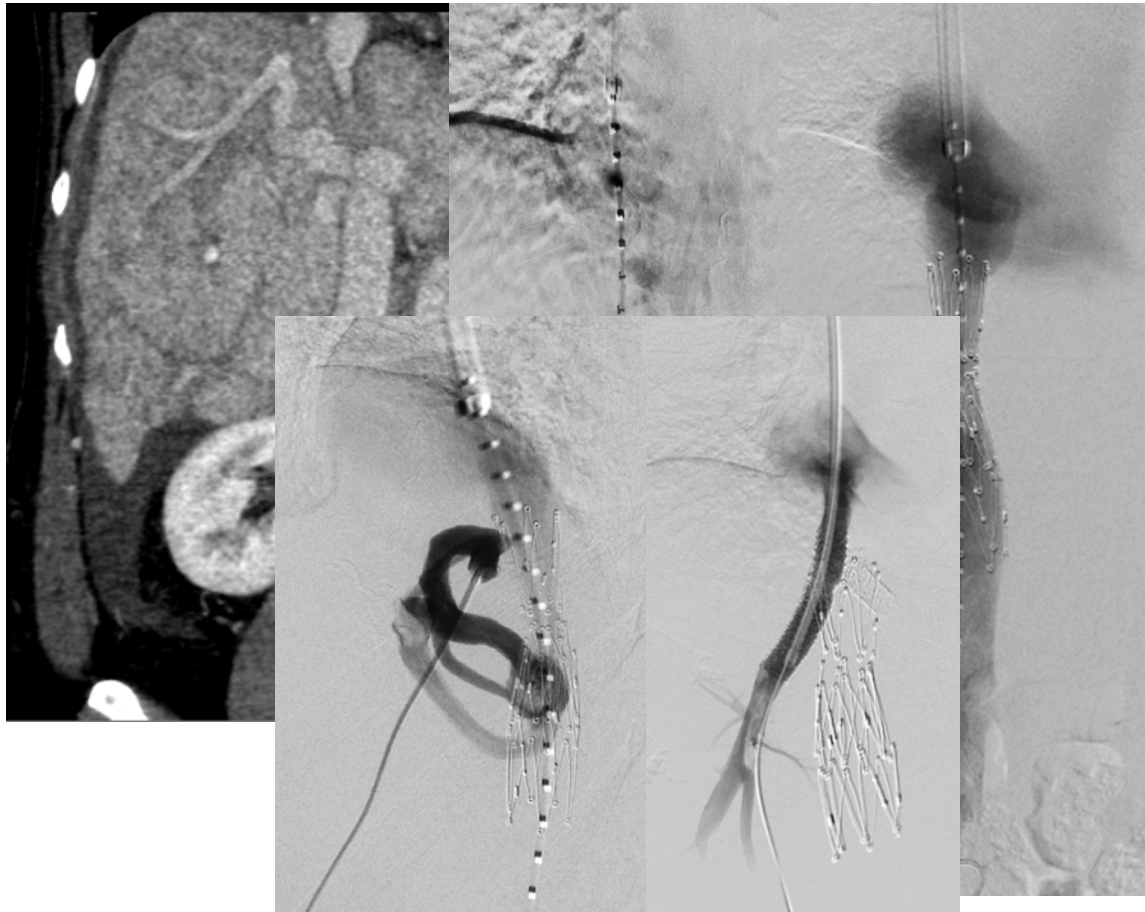
<sup>1</sup>Division of Cardiovascular and Interventional Radiology, Stanford University Medical Center, 300 Pasteur Dr., Ste. H3600, Stanford, CA 94305-5642. Address correspondence to D. Y. Sze.

<sup>2</sup>Present address: Division of Vascular and Interventional Radiology, Rush-Presbyterian-St. Luke's Medical Center, 1725 W. Harrison St., Ste. 400, Chicago, IL 60612.

<sup>3</sup>Department of General Surgery, Stanford University Medical Center, Stanford, CA 94305-5655.

AJR 2000;175:732–734 0361–803X/00/1753–732 © American Roentgen Ray Society

# TIPS developments : Budd Chiari

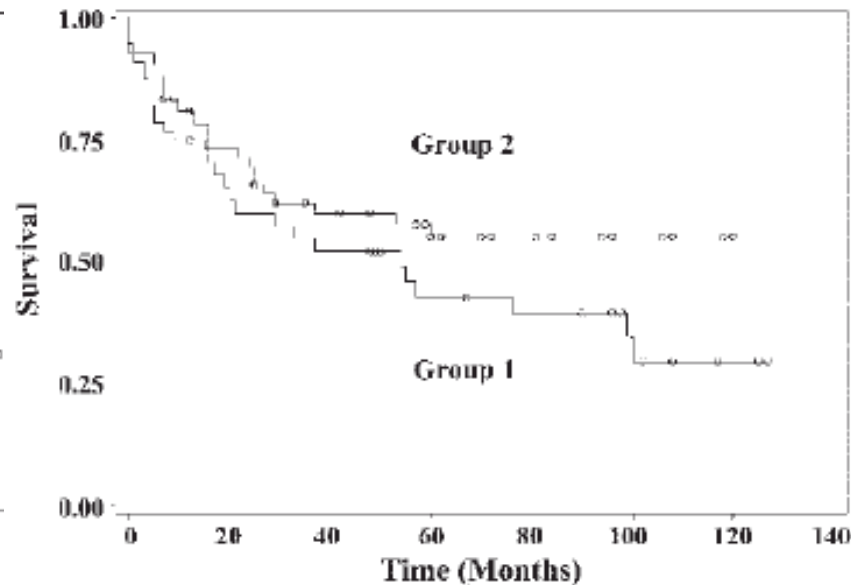
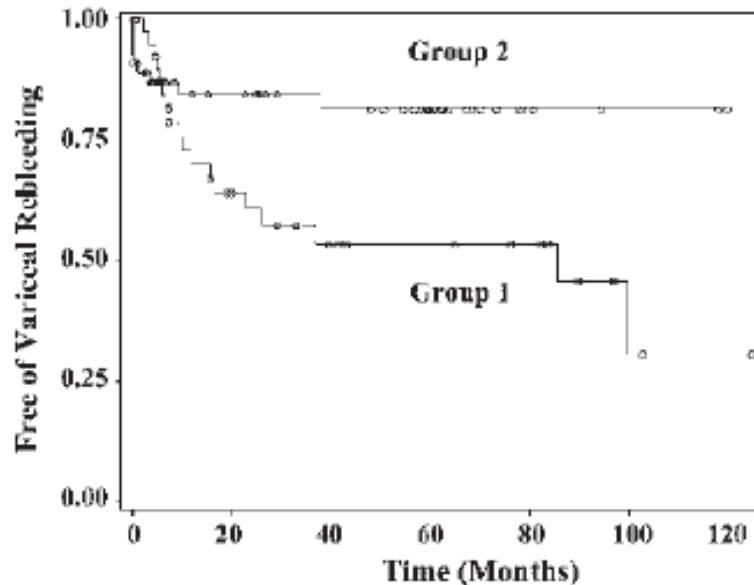


# TIPS developments : adjunctive embolization

radiology

I. Kaare Tesdal, MD  
Thomas Filser, MD  
Christel Weiss, Dr Sc Hum  
Eggert Holm, MD  
Christoph Dueber, MD  
Werner Jaschke, MD<sup>2</sup>

## Transjugular Intrahepatic Portosystemic Shunts: Adjunctive Embolotherapy of Gastroesophageal Collateral



- ▶ Bare stent TIPS
  - ▶ Technical failures underwent adjunctive embolization / sclerotherapy
  - ▶ Rebleed, survival benefits
  - ▶ Less obvious with stentgrafts, since rebleed rate lower

# Embolization developments

The header features a dark purple background with a wavy bottom edge. On the right side, there are decorative elements: a large light purple circle, a smaller light purple semi-circle below it, and a vertical pink rectangle at the top right corner.



# Embolization developments : BRTO

- ▶ 1970s: Transhepatic or transjugular embolization (w/o shunt)
  - ▶ Hypertonic glucose, thrombin, gelatin sponge
- ▶ 1980s: Sclerotherapy with EtOH, balloon occlusion

## TRANSHEPATIC CATHETERIZATION AND OBLITERATION OF THE CO PATIENTS WITH PORTAL HYPERTENSION AND ESOPHAGEAL

ANDERS LUNDERQUIST, M.D., AND JOHANNES VANG, M.D.

**Abstract** For the management of esophageal varices complicating portal hypertension, we have developed a method that consists of (1) percutaneous transhepatic portal venipuncture, (2) manipulation of a catheter via the portal vein into the coronary vein, and, (3) if injection of contrast medium demonstrates retrograde flow through that vein as well as esophageal varices, injection of 30 ml of 50

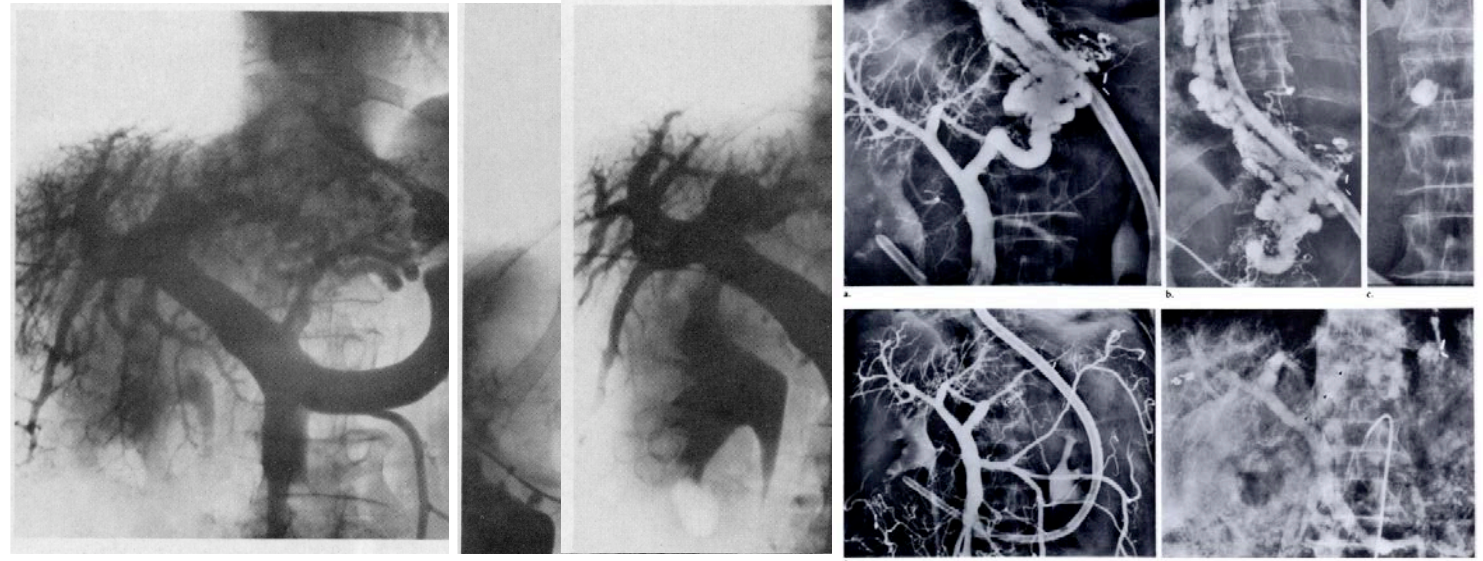
per cent glucose solution followed by a small amount of thrombin solution throughout to facilitate the procedure.

Four patients have been treated with this method with no variceal bleeding. In all four, portal vein by this method was successfully occluded (1974)

Frederick S. Keller, M.D.  
Josef Rösch, M.D.  
Charles T. Dotter, M.D.

Radiology 146: 615-619, March 1983

## Transhepatic Obliteration of Gastroesophageal Varices with Absolute Ethanol<sup>1</sup>



# Embolization developments : BRTO

- ▶ 1984 Olson et al.
- ▶ 20 ml EtOH, coils, balloon
- ▶ 1991 Kanagawa et al.
- ▶ 10% ethanolamine oleate

## Transrenal-Vein Reflux Ethanol Sclerosis of Gastroesophageal Varices

Eldon Olson,<sup>1</sup> Heun Y. Yune, and Eugene C. Klatte

AJR 143:627-628, September 1984 0361-803X/84/1433-0627

We describe a technique using transrenal-vein reflux of ethanol for the treatment of bleeding gastroesophageal varices in patients with spontaneous gastrosplenic shunts. Indications, procedure technique, results, and possible complications are discussed.

that the inflated balloon had forced the tip of the catheter into the vessel wall, thereby leading to the extravasation of ethanol. The balloon was then deflated and the catheter was repositioned to ensure an intravascular location, which was confirmed by contrast material injection. A third 8-mm coil was placed at the site of the extravasation. A final diagnostic injection with the catheter was performed.

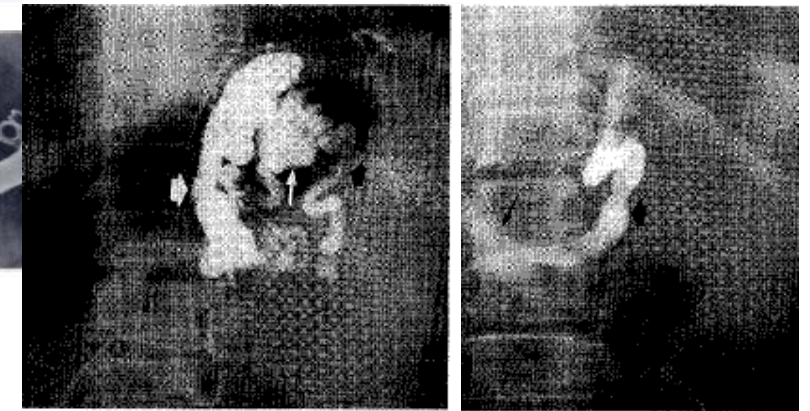
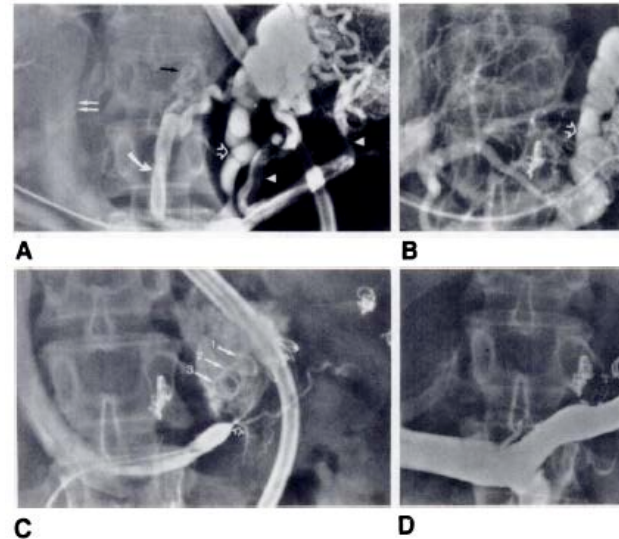
日消誌 88 (7) 1459-1462, 1991

### — 症例報告 —

バルーン下逆行性経静脈の塞栓術 (Balloon-occluded retrograde transvenous obliteration) による胃静脈瘤の1治験例

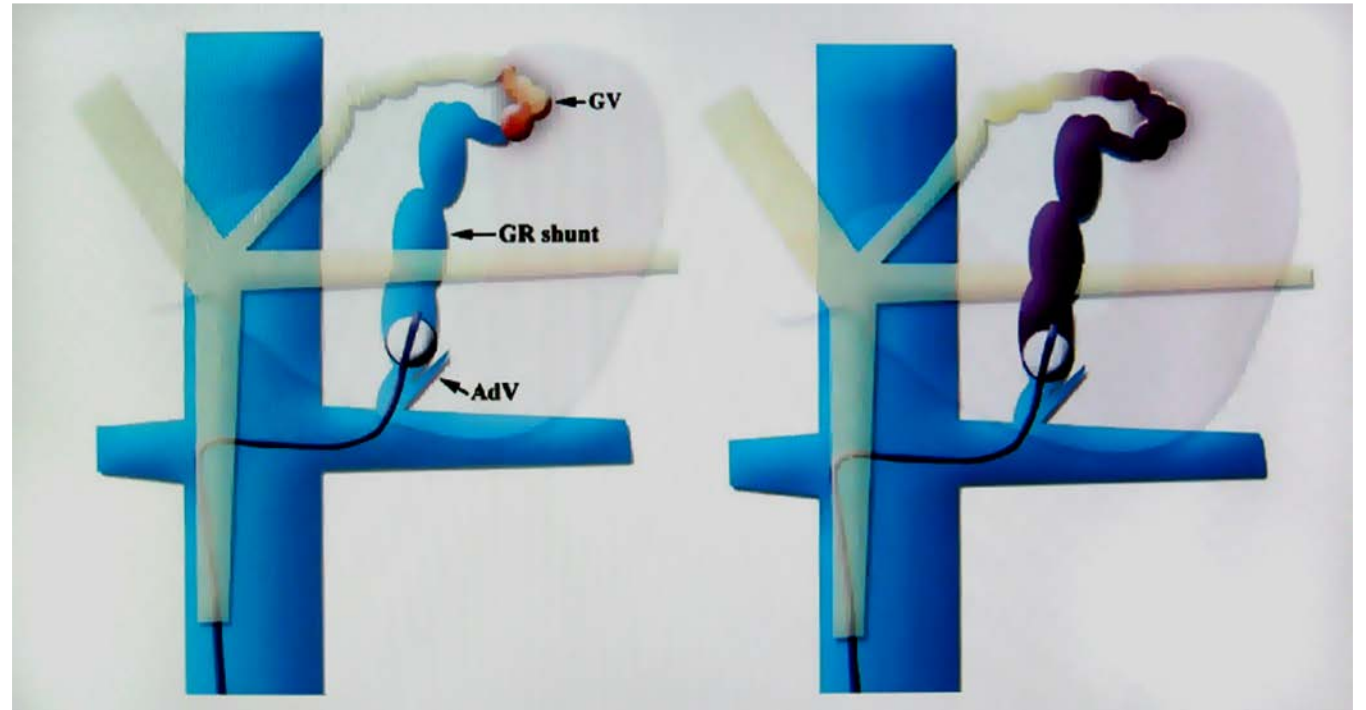
金川博史 美馬聰昭 香山明一  
水尾仁志 井尻正廣 田辺利男<sup>1)</sup>  
伊藤義雄<sup>2)</sup> 関谷千尋<sup>3)</sup>

索引用語：バルーン下逆行性経静脈の塞栓術，胃静脈瘤



# Embolization developments : BRTO

- ▶ Balloon-occlude renal/adrenal vein outflow
- ▶ Inject sclerosant to fill varices retrogradely
- ▶ Dwell 24 hours
- ▶ Aspirate, remove balloon



Kiyosue et al., Radiographics 2003; 23:911.

# Embolization developments : BRTO

- ▶ No intrahepatic tract needed
  - ▶ Lower risk of hemorrhage, pain, anesthesia
- ▶ Portal flow and liver function may improve
  - ▶ Portal flow +50%, ICGC +20%, HE improved  
(Miyamoto 2003 J Gastroenterol Hepatol 18:934)
  - ▶ Decreased Child-Pugh score  
(Choi 2003 Korean J Radiol 4:109)

	TIPS	BRTO
Rebleed @ 1 year	20%	2%
Survival @ 1,3,5 years	81/64/40	96/83/76

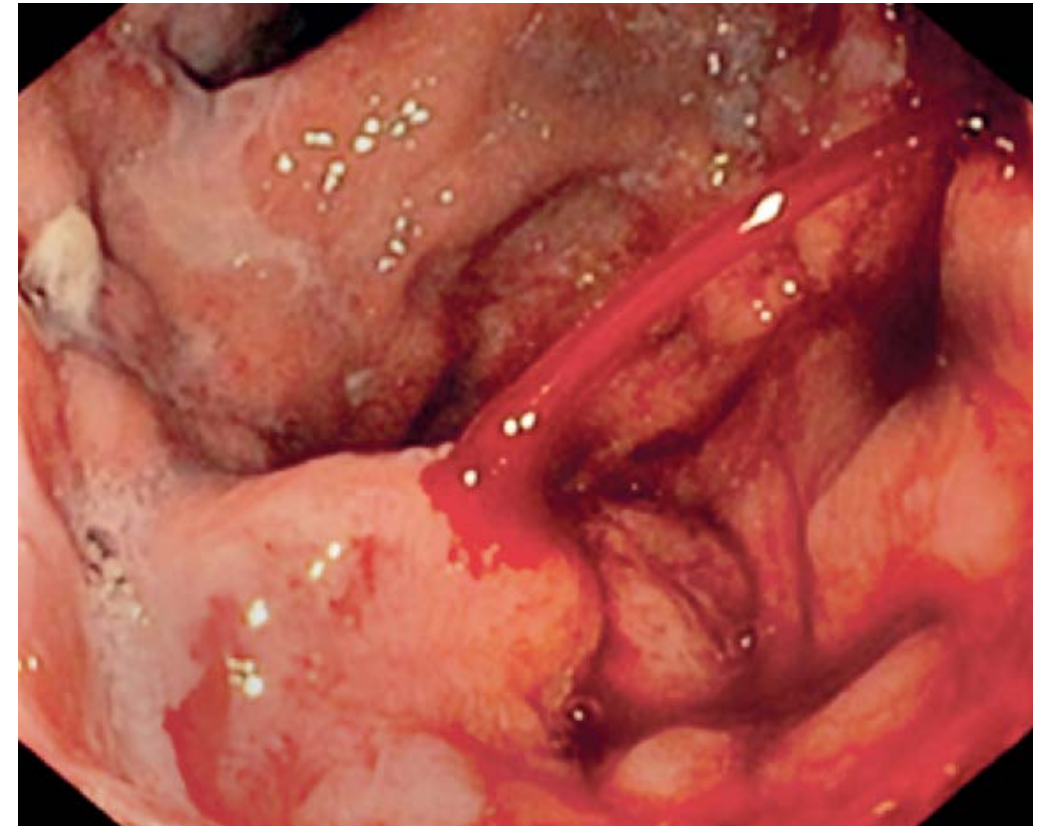
TIPS 1992-1998, BRTO 1996-2002

Ninoi, AJR 2004;183:369

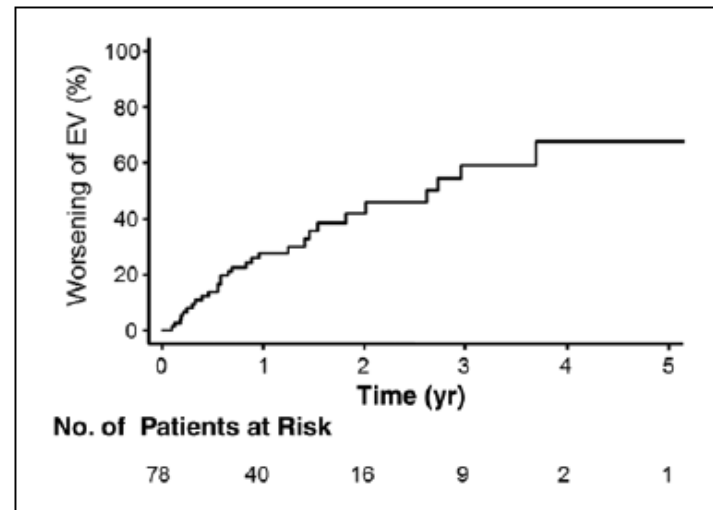
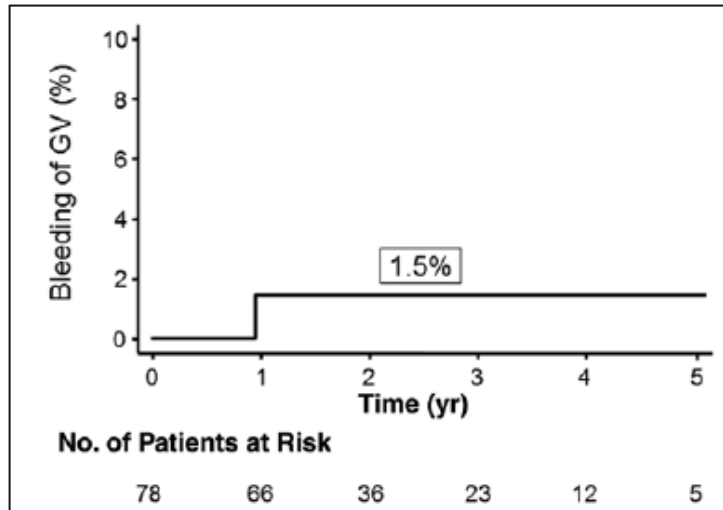


# Embolization developments : BRTO

- ▶ Active hemorrhage from gastric varices (GV) with GastroRenal Shunt (GRS)
- ▶ Bleeders, poor candidate for TIPS
  - ▶ CPT-C, MELD > ~18
  - ▶ HCC
  - ▶ Vascular occlusions
- ▶ Previous hemorrhage from GV with GRS
- ▶ High risk GV with GRS (submucosal)
- ▶ Refractory encephalopathy with GRS



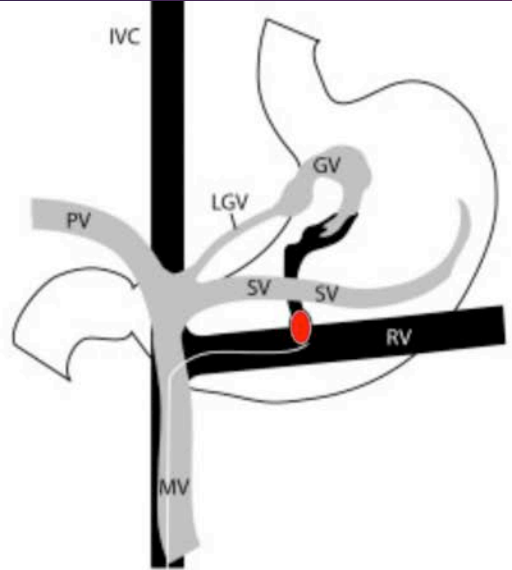
# Embolization developments : BRTO



- PHTN remains, actually increased
- Close endoscopic followup imperative
- Procedural complications

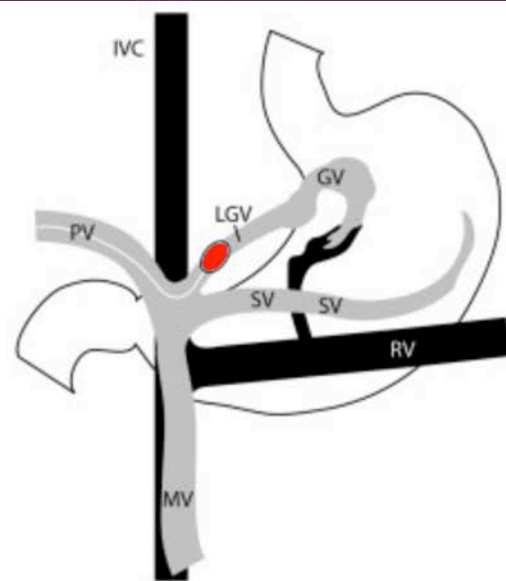
Complication Type	Incidence (%)
Procedural Complications	
Gross hematuria	15–100*
All pulmonary embolism	1.5–4.1
Symptomatic pulmonary embolism	1.4–2.5
Cardiac arrhythmia	1.5
Anaphylaxis	2.2–5.0
Rapid/Fulminant hepatic failure	4.8–7.0
Death within 30 days from fulminant hepatic failure	0.0–4.1
Renal failure	4.8
Long-Term Complications	
Encephalopathy	17.6**
Portal Hypertensive Gastropathy	5.3–13.2
Post-BRTO gastropathy (not to extent of portal hypertensive gastropathy)	56.5
Aggravation of esophageal varices	14–68***
Bleeding from esophageal varices	17–24***
Duodenal varices	Up to 3.2
Bleeding duodenal varices	Up to 2.3
Ascites	0–43.5
Spontaneous bacterial peritonitis	Up to 8.2
Pleural effusion (hydrothorax)	5.3–7.9
Portal vein thrombosis	Up to 4.7
Renal vein thrombosis (no clinical consequences)	Up to 5.0

# Embolization developments : BRTO variants



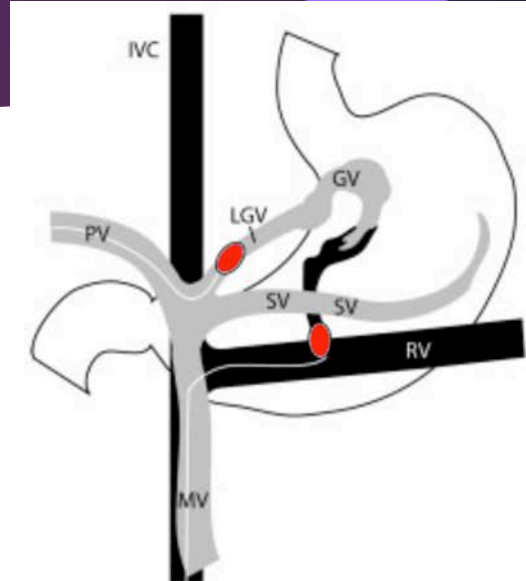
## ► BRTO:

- Poor TIPS candidate
- Poor liver function
- PV or SV occlusion



## ► BATO:

- With TIPS
- Problematic outflow(s)



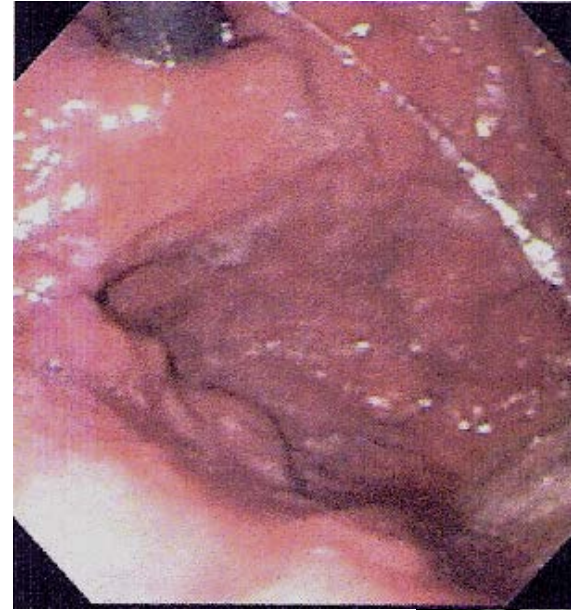
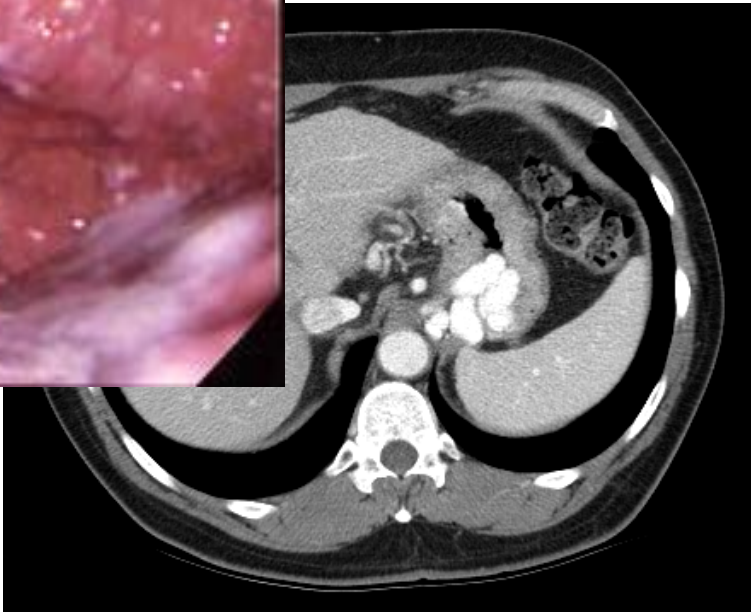
## ► Combination:

- Trap sclerosant
- Permanent coils, plugs (CARTO, PARTO, CAATO, PAATO)

# Embolization developments : BRTO variants



► GIB after OLT



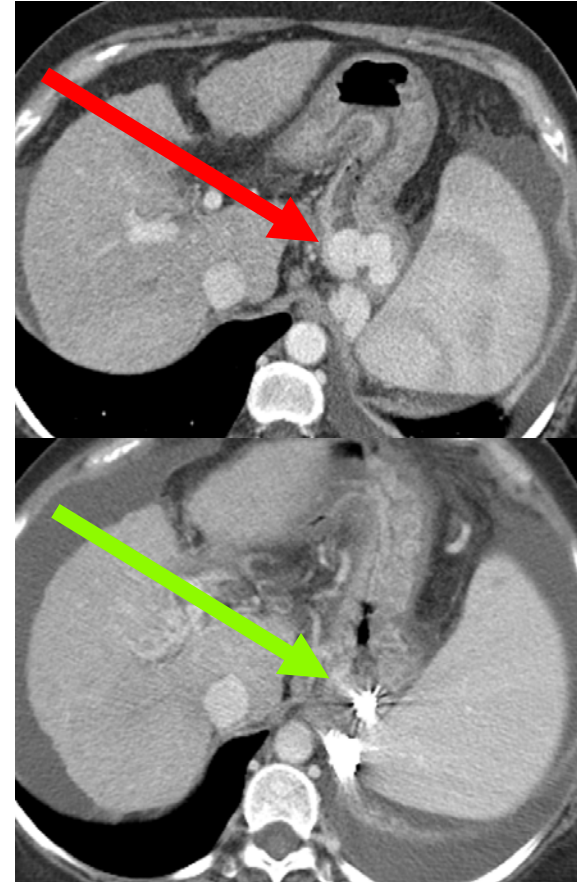
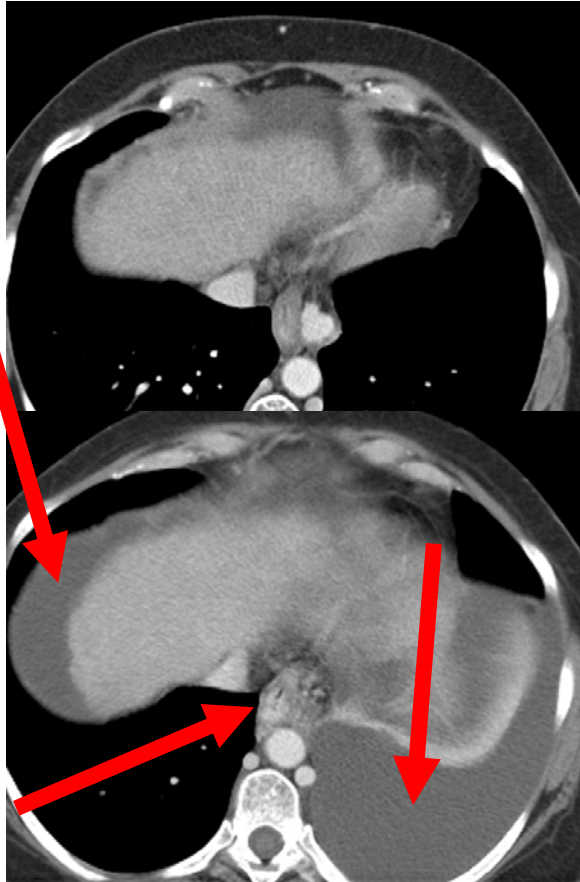
► EGD follow-up 1 month later

► CT follow-up 9 months later





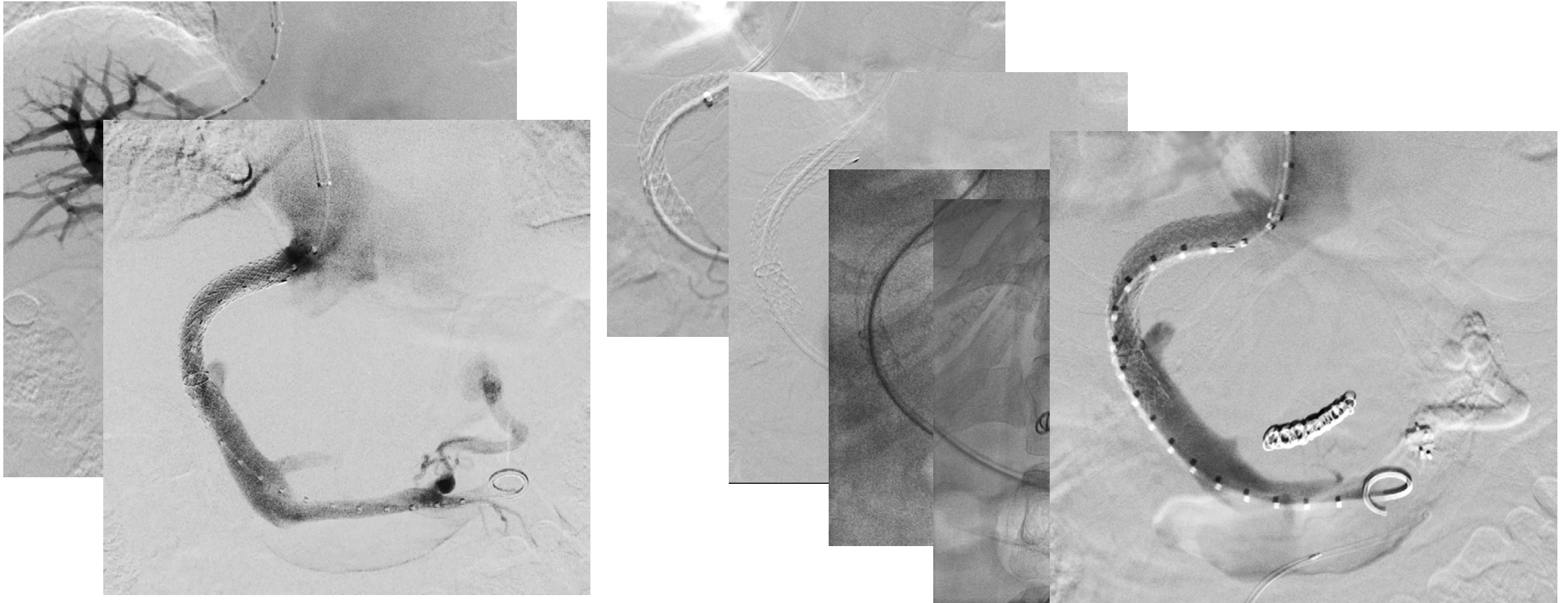
# Embolization developments : BRTO variants



► Chronic PVT,  
cavernous  
transformation,  
refractory GIB

► 6 month  
follow-up

# Embolization developments : BRTO variants



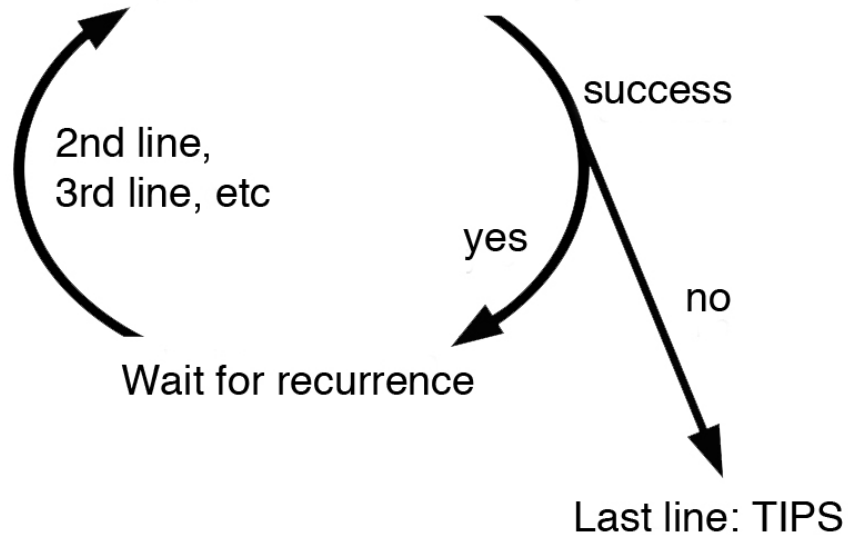
# Treatment algorithm developments



# Treatment algorithm developments

Variceal hemorrhage

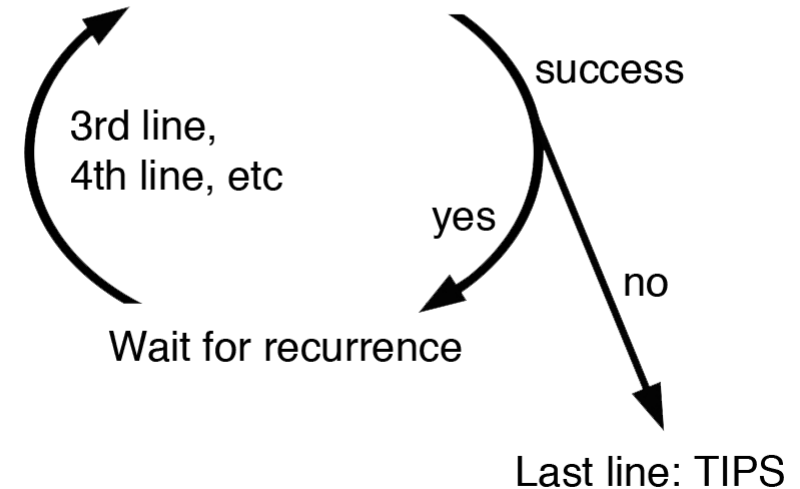
1st line: transfusion, balloon tamponade, octreotide, beta blockade, endoscopic treatment



Ascites

1st line: Diuretics, fluid/salt restriction

2nd line: paracentesis, diuretics

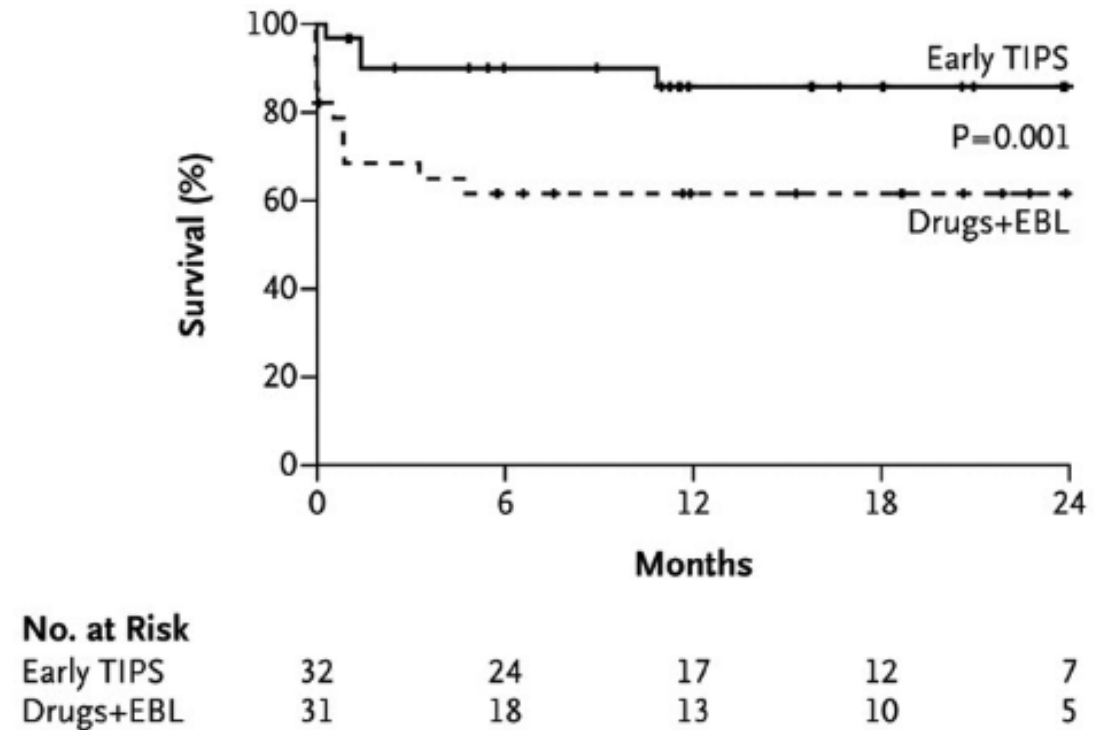




# Treatment algorithm developments : GIB

- ▶ 1<sup>st</sup> time acute variceal hemorrhage treated by endoscopy, vasoactive drugs
- ▶ Randomized to TIPS vs scheduled EBL

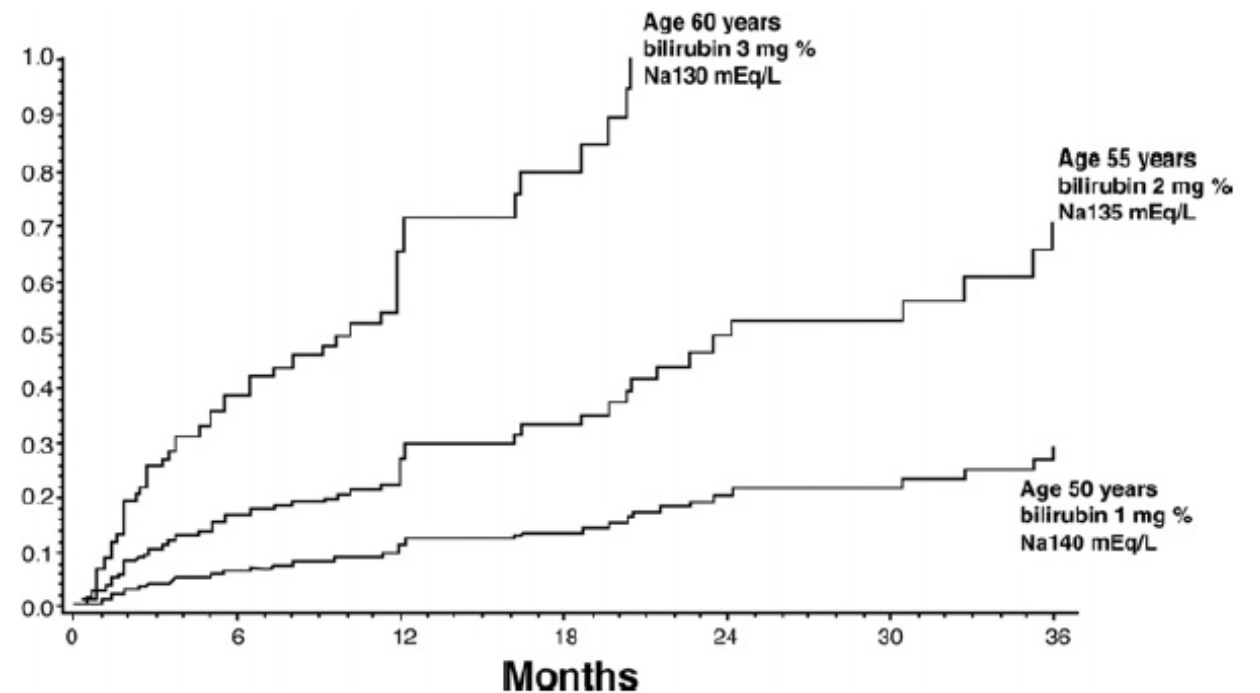
Garcia-Pagan et al. NEJM 2010;362:2370-9.



Don't wait!

# Treatment algorithm developments : Ascites

- ▶ Does this apply to ascites patients, too?
- ▶ Early TIPS for ascites trial (Gore), before refractory (6 times in 90 d, then 365 d), stopped for poor enrollment

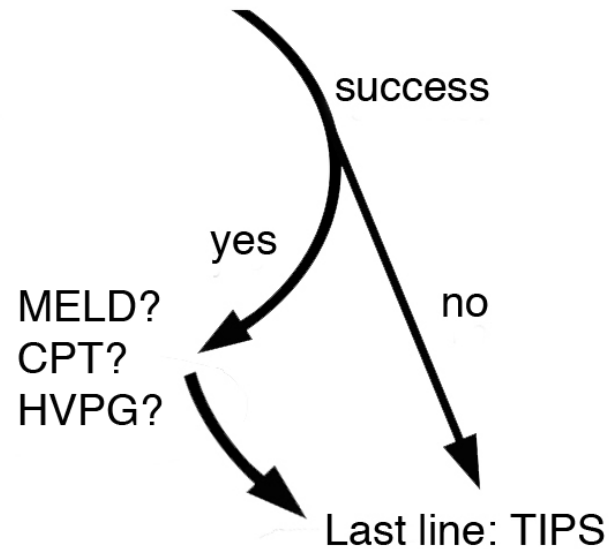


Salerno et al, Gastroenterology 2007;133:825  
Meta-analysis of 4 RCTs

# Treatment algorithm developments

Variceal hemorrhage

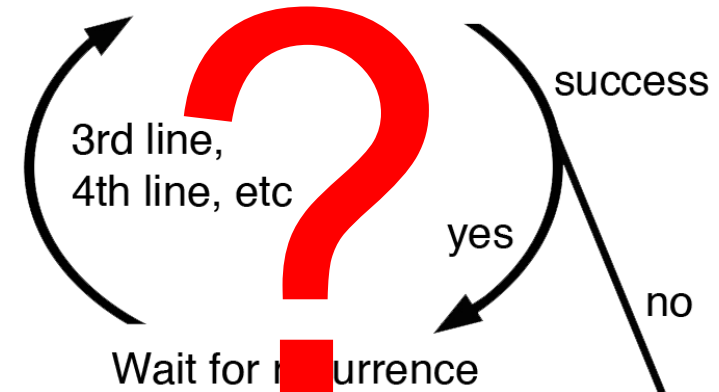
1st line: transfusion, balloon tamponade, octreotide, beta blockade, endoscopic treatment



Ascites

1st line: Diuretics, fluid/salt restriction

2nd line: paracentesis, diuretics



# Conclusions

