Role of Interventional Radiology in management of GI cancers

Lei Yu, MD

Assistant Professor

Associate IR residency program director

Interventional Radiology

University of Nebraska Medical Center

Disclosure

- None

From diagnosis to treatment

Intervention Oncology

- Percutaneous biopsy of primary lesion or metastasis for tissue diagnosis
- IV access: port, PICC
- Arterial embolization
  - Cancer treatment
  - Tumor hemorrhage
  - Preoperative embolization to decrease blood loss during surgery
- Percutaneous ablation
  - RFA, cryoablation, MWA
- Portal vein embolization to assist future surgical resection

Cancer related complication management

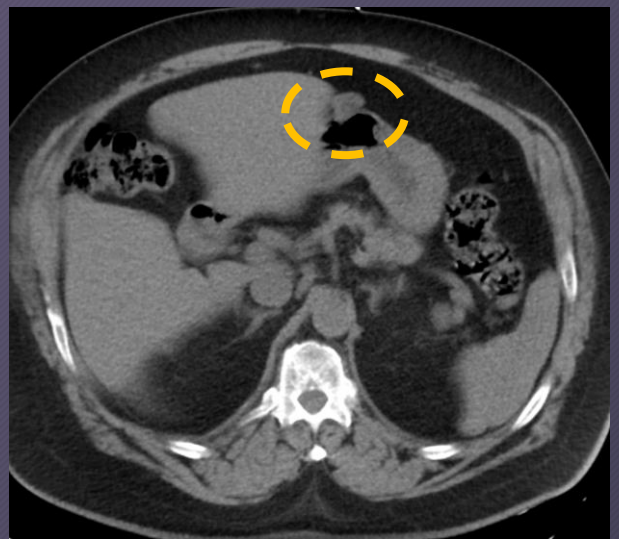
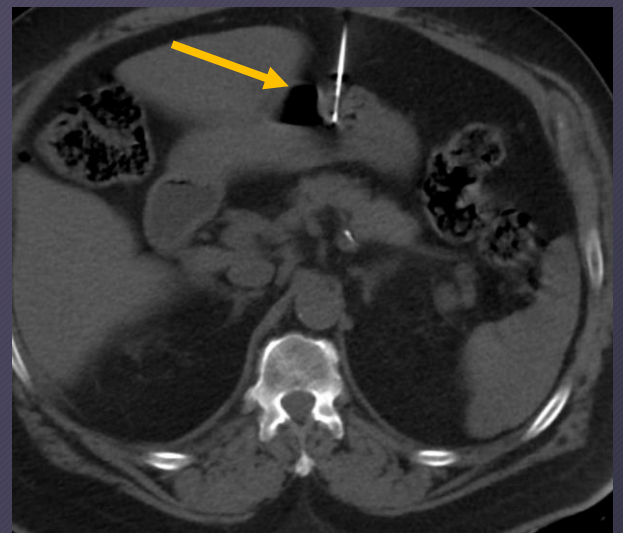
- Percutaneous transhepatic cholangiogram with drain placement for malignancy biliary obstruction
- Gastrostomy tube placement for malignancy gastric outlet obstruction or nutrition support
- Nerve block for intractable cancer related pain

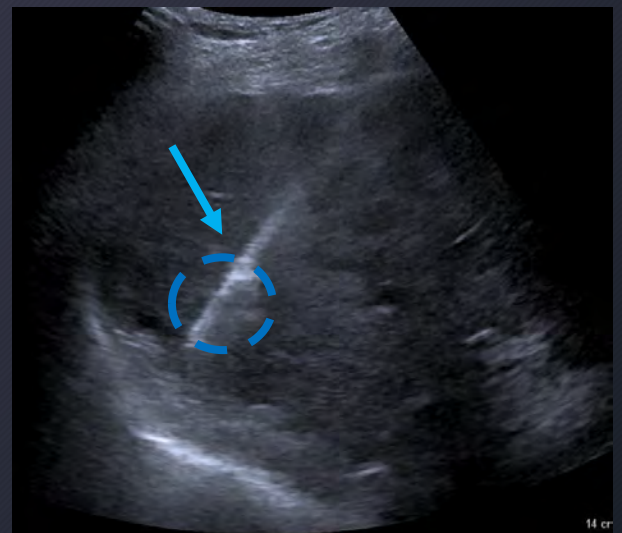
Post-operative complication management

- Embolization or stent grafting for postoperative hemorrhage
- Abscess drainage
- PTC for post-operative bile leak
- G-tube placement for delayed gastric emptying or anastomotic stricture

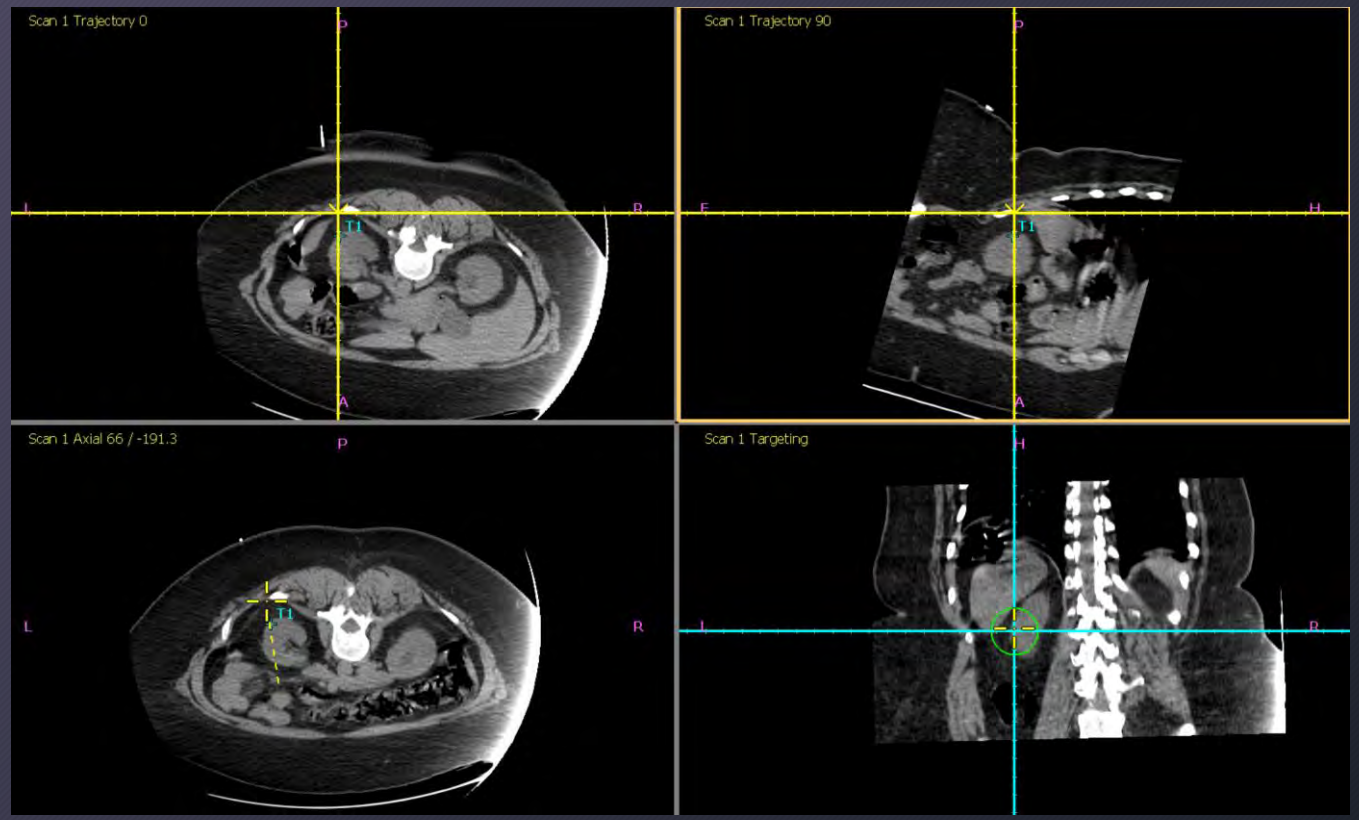
Percutaneous biopsy

- Biopsy samples are required for initial diagnosis, evaluate progression, predict prognosis and guide next-line treatment
- For GI cancer that can not be reached endoscopically, percutaneous biopsy can be obtained via directly visualization with image guidance
- Lesion location and accessibility determine imaging modality used for biopsy



Multimodality Image Fusion for Image-guided Percutaneous Interventions



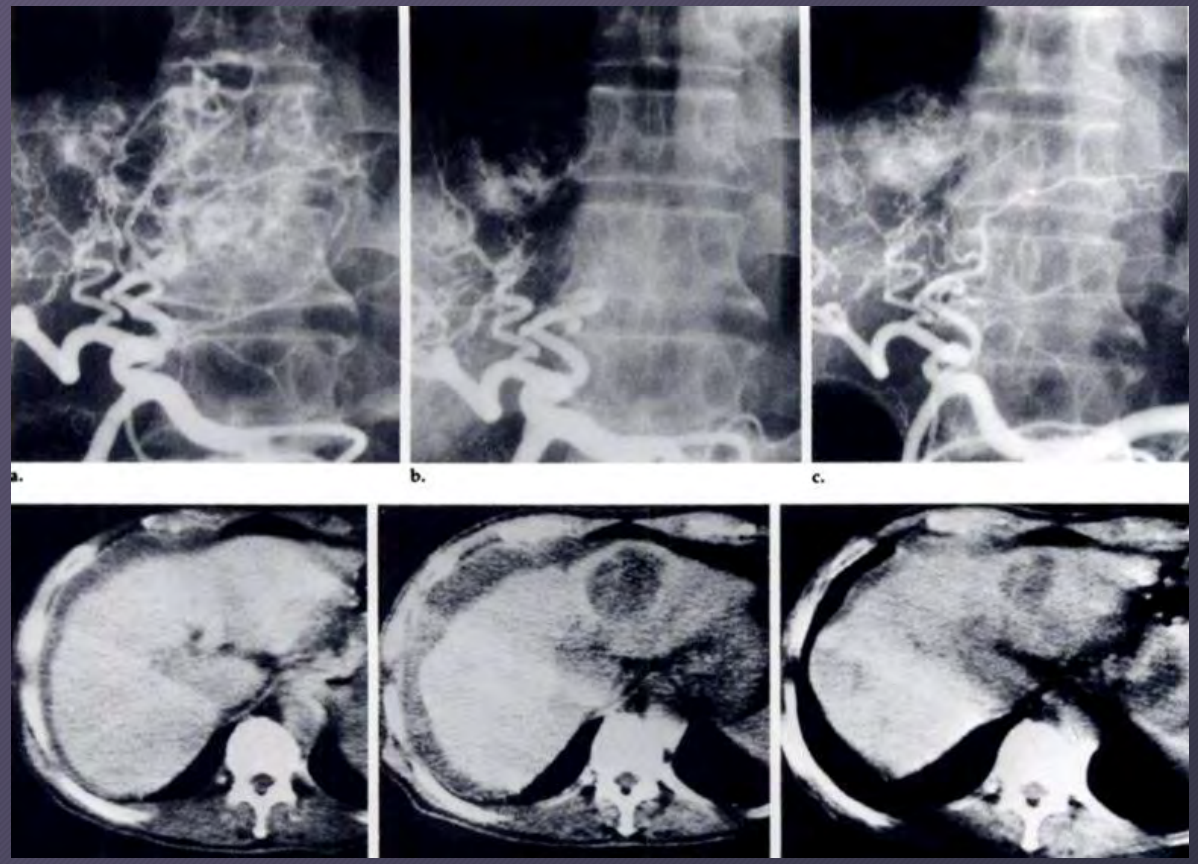
Loco-regional treatment of GI tumor liver metastases

- Transarterial Embolization
  - TAE: Transarterial Embolization
  - cTACE: Conventional Transarterial Chemoembolization
  - DEB-TACE: Drug-eluting beads TACE
  - TARE: Transarterial (Y-90) Radioembolization
- Percutaneous Ablation
  - PEI: Percutaneous Ethanol injection (non-thermal)
  - RFA: Radiofrequency Ablation
  - MWA: Microwave Ablation
  - Cryoablation

* Gene therapy: selective injection of genetic agents into hepatic arteries followed by vessel embolization (limited research but promising)

History of Hepatic Artery Embolization

- Dr. Yamada from Japan performed the first TAE in 1977



Ryusaku Yamada, M.D.
Morio Sato, M.D.
Mamoru Kawabata, M.D.
Haruki Nakatsuka, M.D.
Kenji Nakamura, M.D.
Sumio Takashima, M.D.

Hepatic Artery Embolization in 120 Patients with Unresectable Hepatoma[1]

Transcatheter hepatic artery embolization was performed in 120 patients with unresectable hepatoma. The cumulative one-year survival rate was 44%. In most cases follow-up angiography revealed the selective disappearance of tumor vessels, and computed tomography demonstrated a marked decrease in tumor density without any changes in the surrounding liver parenchyma. Histologic examination in 14 cases confirmed these findings.

Index terms: Arteries, therapeutic blockade, 9.129 • (Hepatic artery, therapeutic embolization, 9[52].129) • (Liver, malignant hepatoma, 7[61].329) • Liver neoplasms, blood supply • Liver neoplasms, therapy

Radiology 148: 397–401, August 1983

HEPATOMA is a relatively common malignant tumor in Japan, and patients with this neoplasm have a poor prognosis. The first choice of treatment is hepatectomy, but most cases are considered inoperable due to extreme tumor extension at the time of diagnosis and accompanying advanced cirrhosis. According to the 1979 report of the Liver Cancer Study Group of Japan (1), only 9% of hepatoma patients underwent hepatectomy. The report also concluded that the one-year survival rate after surgery was only 28%. Chemotherapy produced even worse results: the survival rate one year after treatment was 7%, and the mean length of survival was 3 to 6 months.

Since 1977 we have performed transcatheter arterial embolization in 120 cases of unresectable hepatoma. This report describes our experience with embolization, which demonstrates far more satisfactory results than other existing treatments.

MATERIALS AND METHODS

Two hundred thirty-five embolization procedures were performed in 120 patients with unresectable hepatoma from June 1977 to May 1982. Repeat embolizations (2 to 7 procedures) were performed in 45% of cases. The patients were 103 men and 17 women who ranged in age from 25 to 78 years. All of them were unable to undergo surgery for reasons including tumor size, extension, metastasis, and advanced liver cirrhosis. The diagnosis in these cases was made by biopsy, autopsy, or clinical examinations such as angiography and serum α-fetoprotein (AFP) assays.

Prior to embolization, hepatic arteriography was performed to obtain information about the size, type, location, and feeding artery of the tumor, and portography was performed to confirm that the main portal vein was not obstructed by tumor. Following this, a vascular catheter was inserted superselectively into the hepatic artery that fed the tumor. A gelatin sponge block was cut into 1- to 2-mm pieces and permeated with an antineoplastic agent (10 mg of mitomycin C or 20 mg of adriamycin) and a contrast material (76% Urografin [meglumine and sodium diatrizoate]). Under fluoroscopic guidance, these embolic materials were infused into the feeding artery through the catheter, with care being taken not to allow backflow of the pieces into proximal arteries. Since the catheter must be inserted distally to the proper hepatic artery, it should be small and soft. We usually use a Formocath 7644 catheter (Becton-Dickinson) (0.055-in [0.14-cm] inner diameter, 0.075-in [0.19-cm] outer diameter).

The results of this therapy were investigated by biopsy, autopsy, angiography, computed tomography (CT), and serum AFP determinations, and evaluated according to Karnofsky's criteria (2).

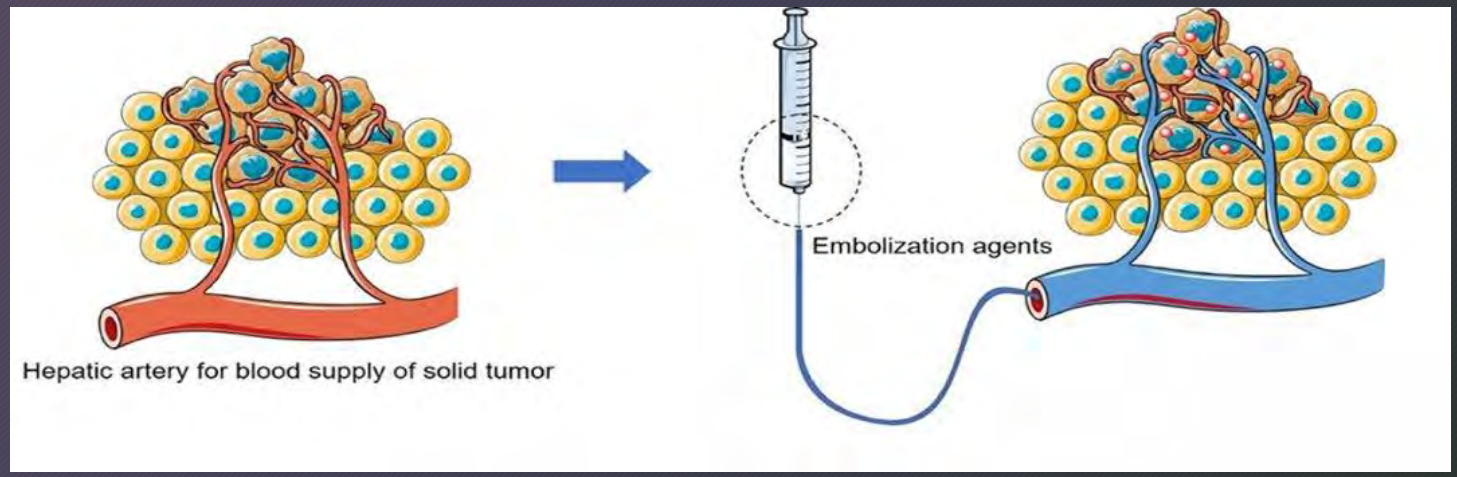
RESULTS

According to Karnofsky's criteria, the therapeutic effect of hepatic artery embolization was rated as 0–B or better in 96% of the total cases

[1] From the Department of Radiology, Wakayama Medical College, Wakayama City (R.Y., M.S., M.K.), and the Department of Radiology, Osaka City University Medical School, Osaka (H.N., K.N., S.T.), Japan. Presented at the Sixty-eighth Scientific Assembly and Annual Meeting of the Radiological Society of North America, Chicago, IL, Nov. 28–Dec. 3, 1982. Received Dec. 10, 1982; accepted and revision requested Jan. 11, 1983; revision received April 4. cg

Hepatic artery embolization

- Unique dual blood supply in the liver:
  - 75% liver's blood supply is via the portal vein
  - 25% coming from the hepatic artery
- Tumors (especially hypervascular ones) will predominantly derive their blood supply from the hepatic artery (well-oxygenated blood)
- Transarterial embolization: selectively injure the tumors, while the portal vein supplies surrounding healthy parenchyma.

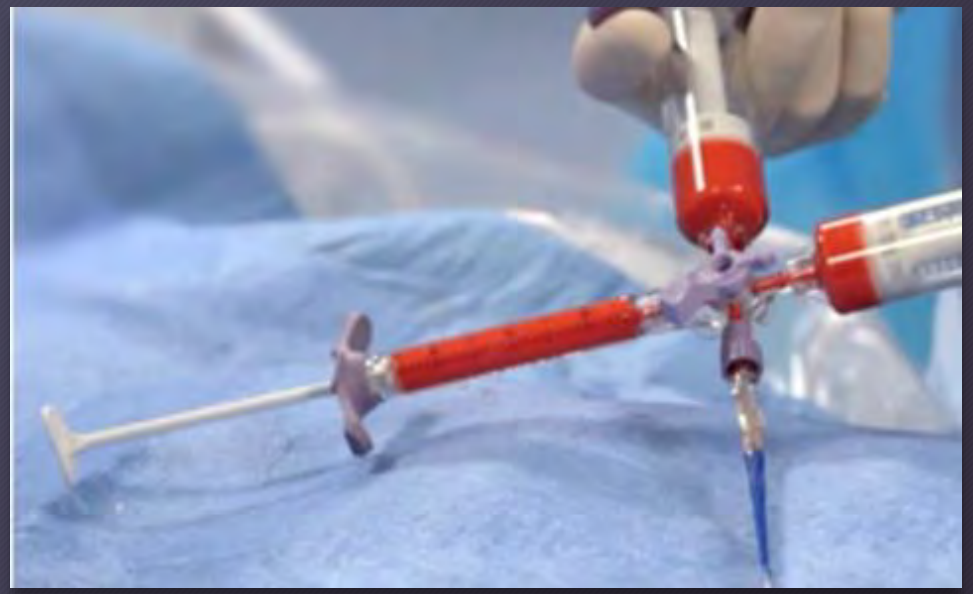


TAE vs cTACE vs DEB TACE

- TAE: occlusion of arterial supply to the tumor with embolic material such as polyvinyl alcohol particles or microspheres without the addition of chemotherapy or radiation by embolic materials

cTACE: Conventional Trans arterial Chemoembolization

- Direct injection of chemotherapeutic agents mixed with lipiodol into the feeding hepatic artery branch
- Three components
  - Chemo regimen
  - Oil: Lipiodol (poppy seed oil, radiopaque)
  - Embolic (PVA) particles 150-250 um, Gelfoam, Embospheres



DEB-TACE or DEBIRI-TACE

- DEBIRI-TACE:
  - Drug-eluting beads (irinotecan) Transarterial Chemoembolization
  - Used for Colorectal Cancer Liver Metastases (CRLM)

TransArtery Radioembolization

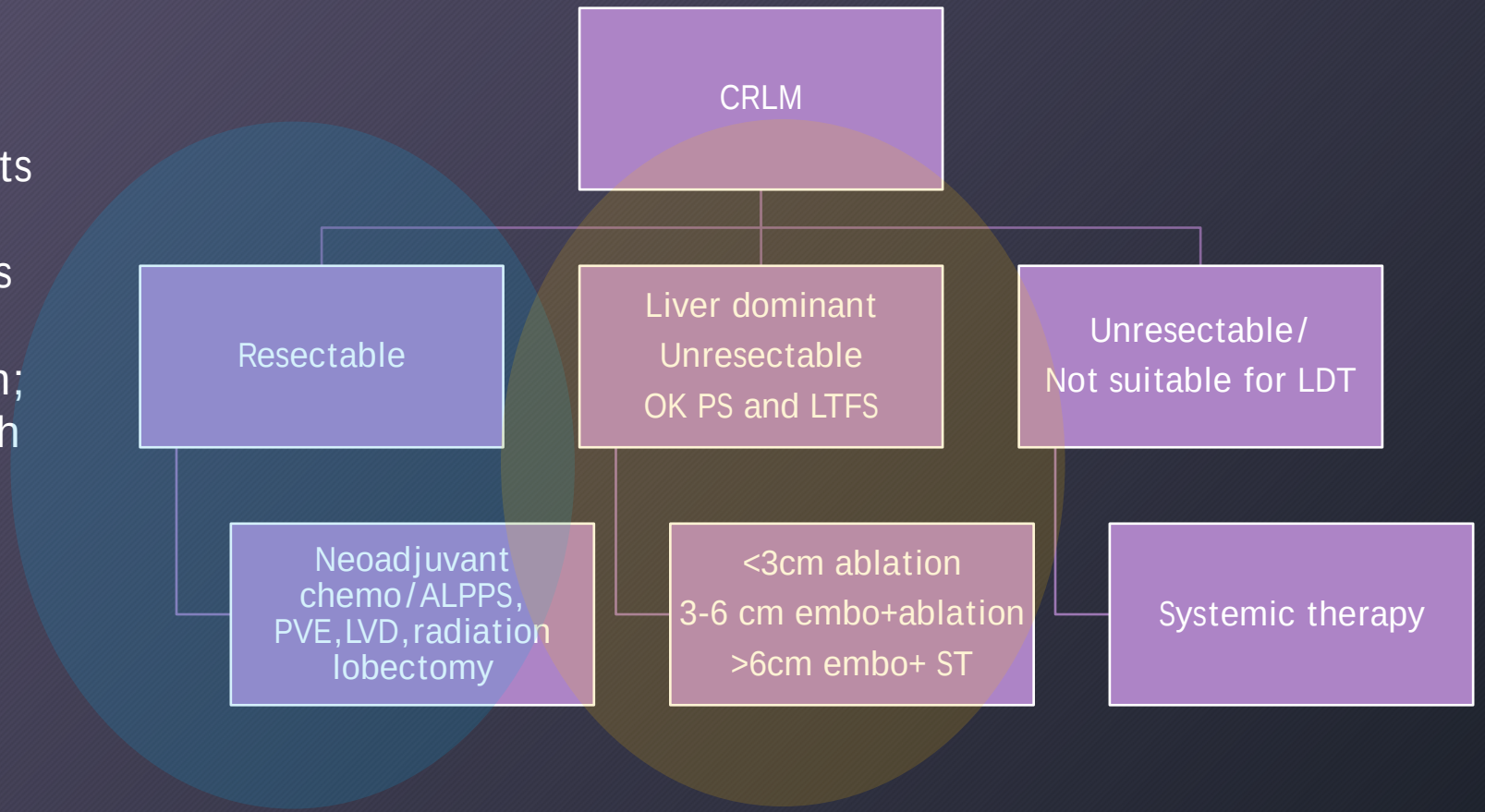
- Radioactive particles (commonly Yttrium-90 microspheres) are injected after selective cannulation of the target hepatic artery branch;
- Y90 microspheres achieve efficacy by providing microscopic brachytherapy and not by imparting a significant embolic effect;
- Require mapping prior to treatment
  - Technetium-99m labelled macroaggregated albumin is injected into the hepatic artery followed by single-photon emission computed tomography
  - Identify variant anatomy and intrahepatic portosystemic shunts
  - Calculate hepatopulmonary shunting (<20%) to avoid radiation pneumonitis

Yttrium-90

- Y-90 undergoes beta decay, thereby irradiating the tumor and causing cell death
- Half-life = 64.2 h
- Short tissue penetration: About two thirds of the β-particles will travel approximately 2.5 mm in liver tissue (90% of energy will be deposited within 5 mm) with a maximum penetration of 11 mm (high radiation dose is preferentially distributed in tumors compared to the adjacent healthy hepatocytes)

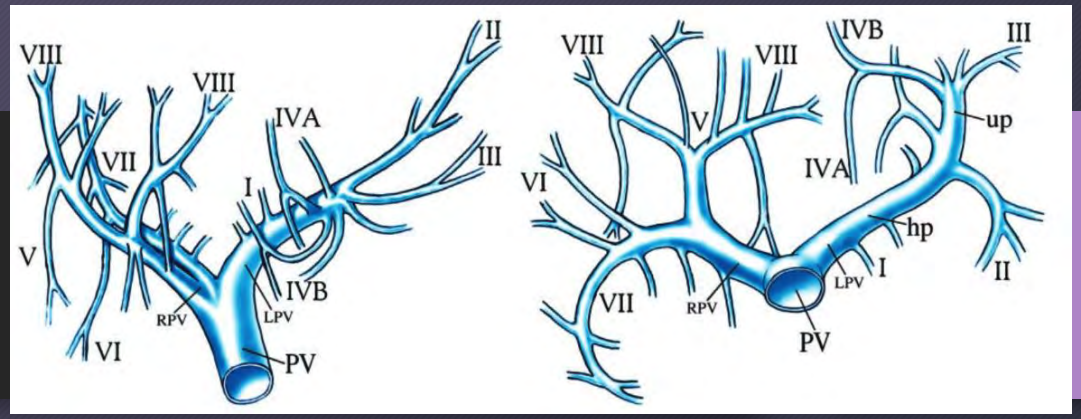
Colorectal liver metastases (CRLM)

- Most common death for patients with CRC is liver metastases;
- 13% 5-year survival for patients with mCRC; 35-40% 5-year survival after hepatic resection;
- However only 20% patients with CRLM are eligible for surgical resection.



https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/colorectal-cancer-facts-and-figures/colorectal-cancer-facts-and-figures-2020-2022.pdf

Portal vein embolization



- Future liver remnant(FLR) goal: minimal of 25% in normal underlying liver and 40% in underlying liver disease
- Need to have at least contagious liver segments which are cancer free

Madoff, David C., et al. "Transhepatic portal vein embolization: anatomy, indications, and technical considerations." *Radiographics* 22.5 (2002): 1063-1076.

FOLFOX+Bevacizumab alone vs FOLFOX+ DEBIRI +/-Bevacizumab

FOLFOX-DEBIRI arm versus the FOLFOX/bevacizumab arm:

- Significantly more downsizing to resection (35% vs 16%, *P* = .05)
- Improved median progression-free survival (15.3 vs 7.6 months).

Cancer

Original Article | Free Access

Randomized controlled trial of irinotecan drug-eluting beads with simultaneous FOLFOX and bevacizumab for patients with unresectable colorectal liver-limited metastasis

Robert C. G. Martin II MD, PhD, Charles R. Scoggins MD, MBA, Marshall Schreeder MD, William S. Rilling MD, Christopher J. Laing MD, Clifton M. Tatum MD ... See all authors

CONCLUSIONS

The simultaneous administration of mFOLFOX6 (with or without bevacizumab) and DEBIRI through the hepatic artery (FOLFOX-DEBIRI) is safe and does not cause treatment delays or increase the systemic toxicity of chemotherapy. This strategy leads to improved overall response rates, improved hepatic progression-free survival, and more durable overall progression-free survival in patients downsized to resection. ***Cancer* 2015.**

OXFORD

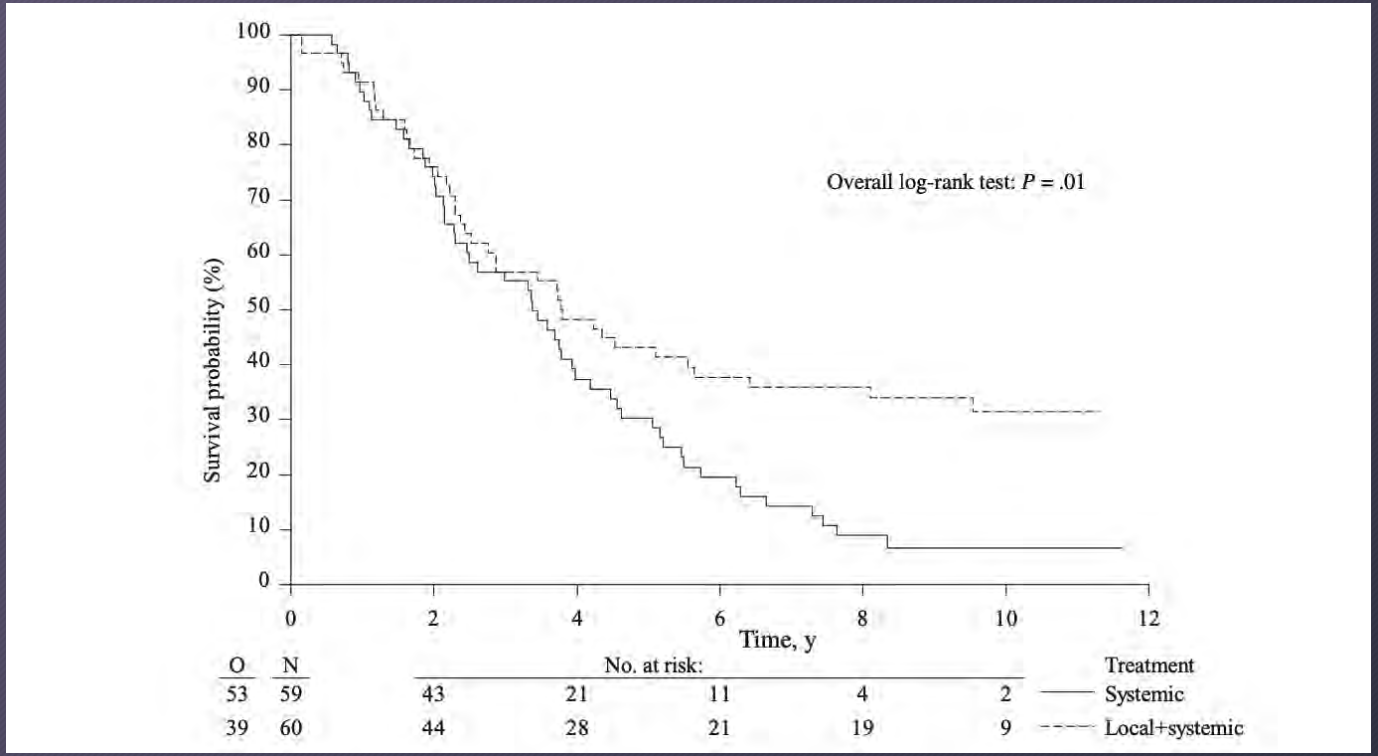
JNCI J Natl Cancer Inst (2017) 109(9): djx015

doi: 10.1093/jnci/djx015
First published online March 17, 2017
Article

ARTICLE

Local Treatment of Unresectable Colorectal Liver Metastases: Results of a Randomized Phase II Trial

EORTC-CLOCC Trial: ST alone vs ST+ local therapy (RFA)



Median F/U: 9.7 ys
OS at 8 years:
ST:8.9%
ST+local: 35.8%

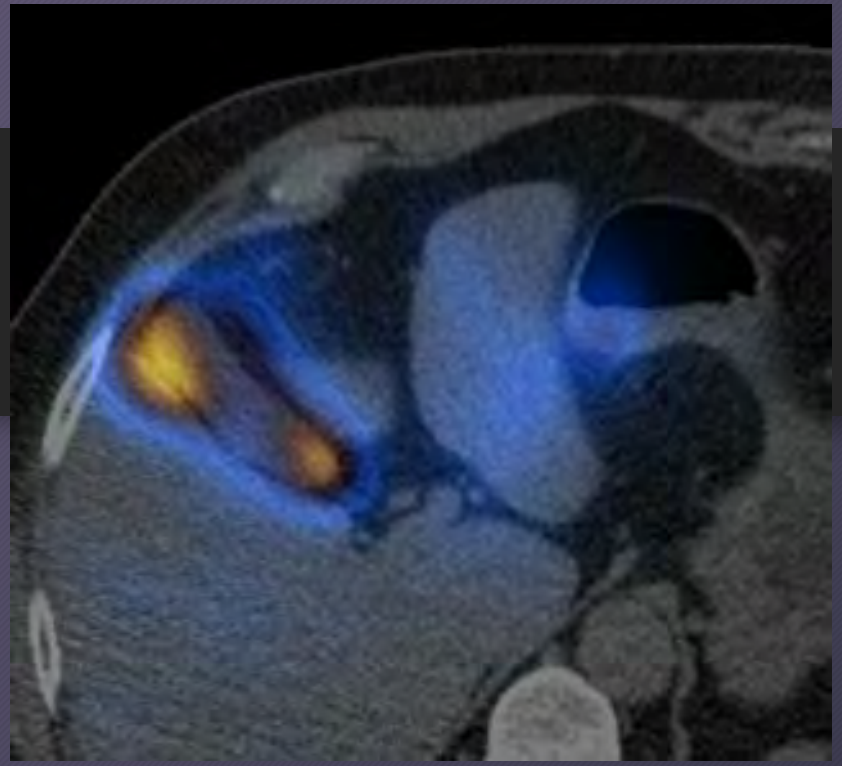
Neuroendocrine liver metastasis

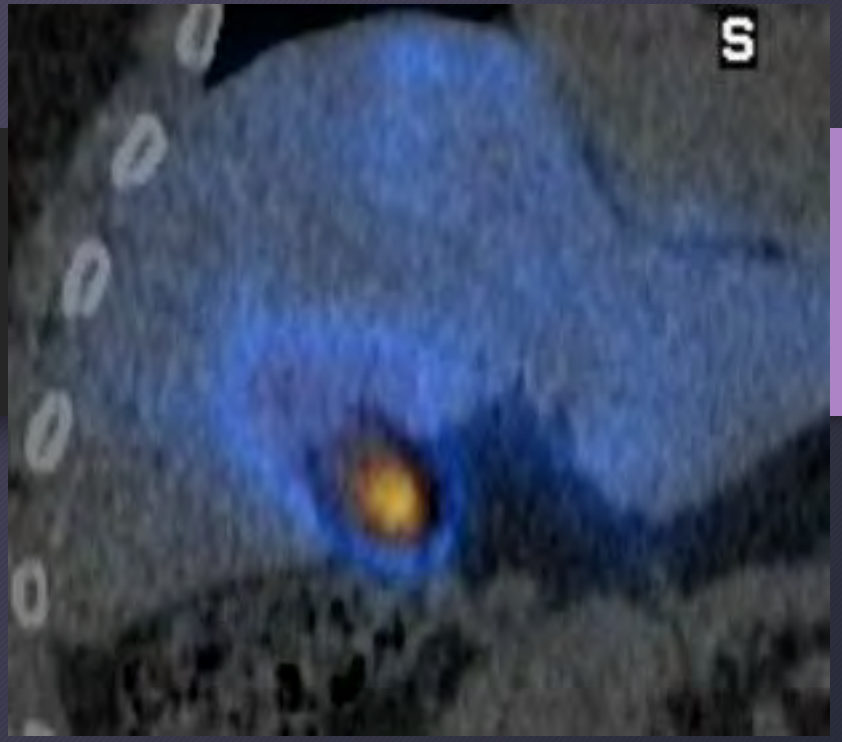
- Functional NETs metastases are associated with debilitation symptoms which impairs quality of life;
- 80-90% NETs with live metastases are inoperable and can benefits from locoregional treatment
- Hepatic artery embolization (bland embolization)
  - Stabilizing tumor growth-> longer progression-free survival (5yr survival rate- 30%)
  - Relief tumor related symptoms (severe diarrhea, flushing, electrolyte abnormalities ect)
  - Can safely repeat treatment if symptoms recur or disease progresses
  - No high-quality data to suggest TACE or TACE superior to bland embo

HAE complications

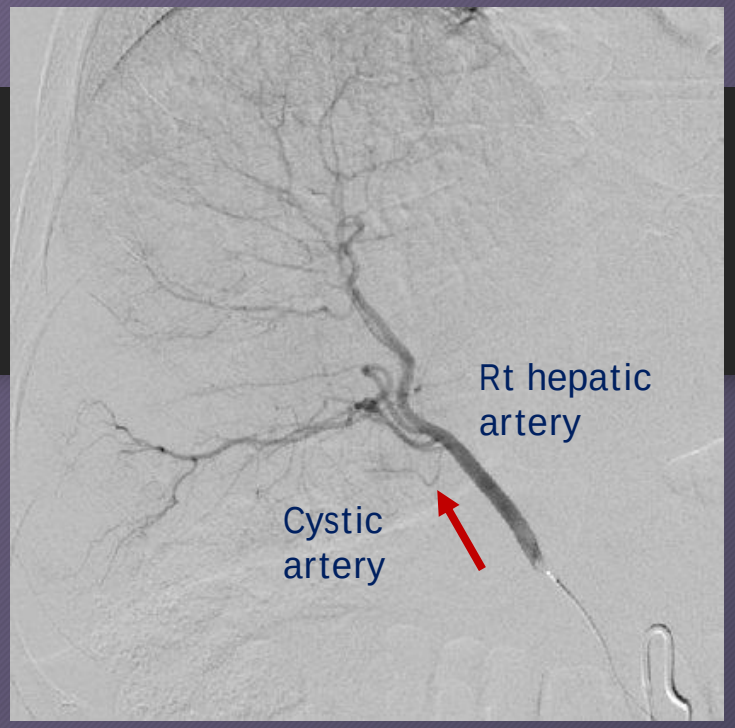
- The most common complication: post-embolization syndrome
  - constellation of non-specific symptoms including nausea, fatigue, fever and abdominal pain and can last for up to 10 days post-treatment
- The severity and duration might be associated with the extent of ischemia induced in normal parenchyma and the underlying liver function
- Other complications: liver decompensation, kidney injury, biliary injury, abscess formation, sepsis, GI bleeding and embolization of non-target extrahepatic arterial supply, i.e. cystic artery to the gallbladder leading to ischemic cholecystitis.
- Rarer complications: PE via undetected arteriovenous shunts within the tumor; tumor lysis syndrome

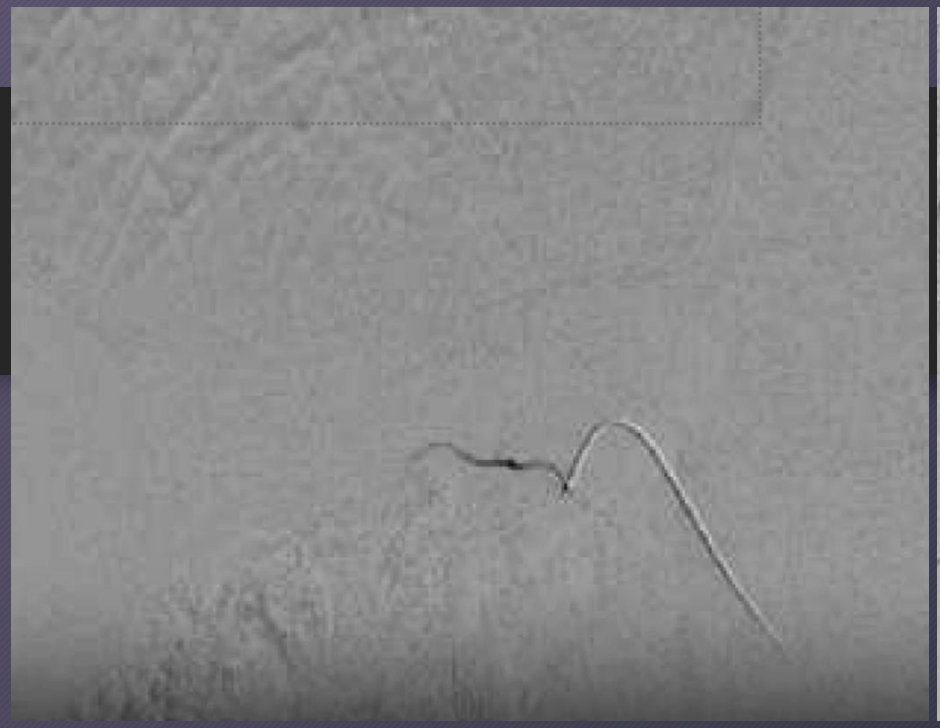
* Case report of carcinoid crisis after HAE of NETs.

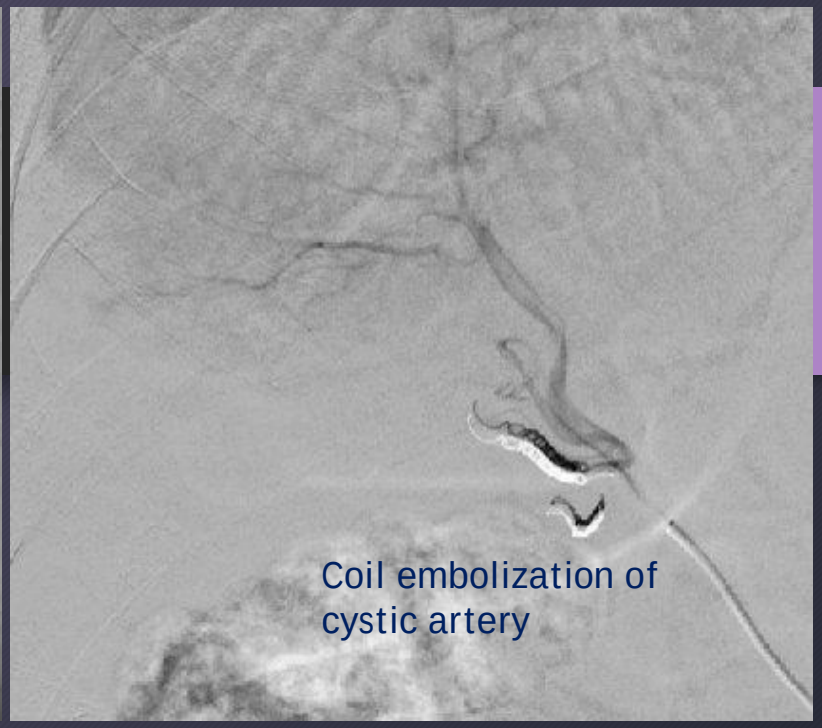


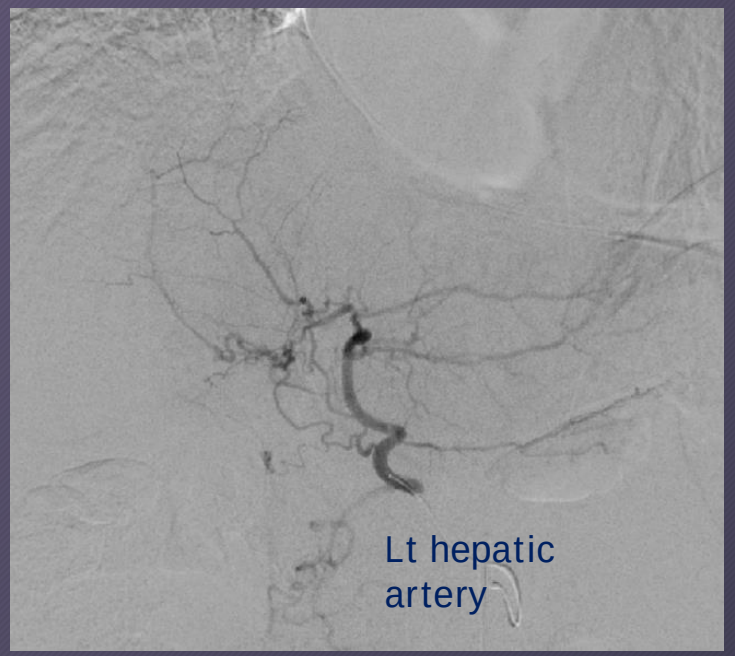


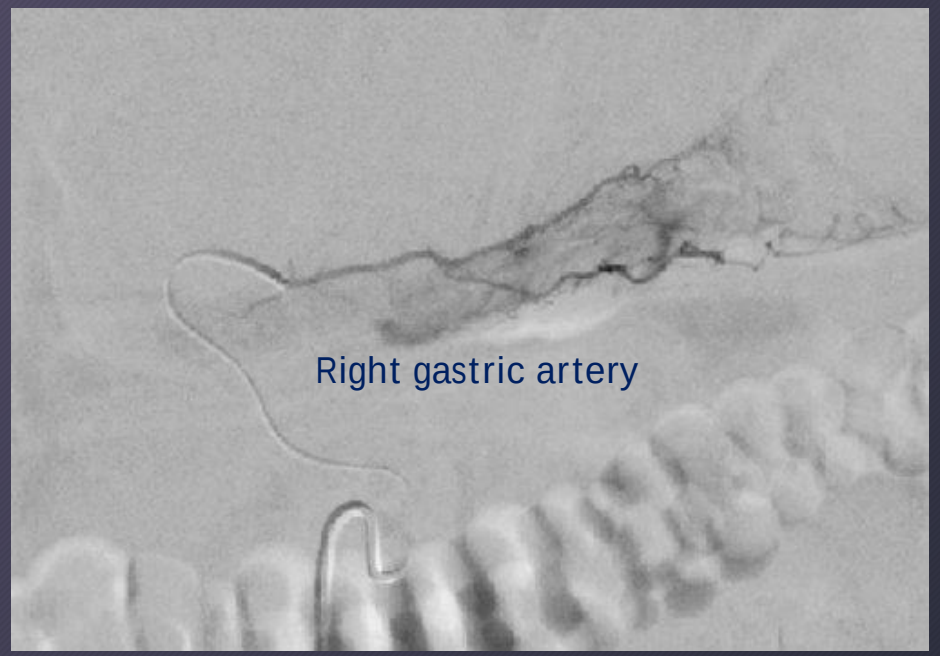
1. Hepatopulmonary shunt calculated at 0.97%.
2. Injected MAA radiotracer activity localizes to the right and left lobes with greatest radiotracer activity around the gallbladder and with focal activity also seen within the gallbladder. Otherwise, no intra-abdominal extrahepatic nontarget MAA
embolization identified.


Rt hepatic artery
Cystic artery




Coil embolization of cystic artery

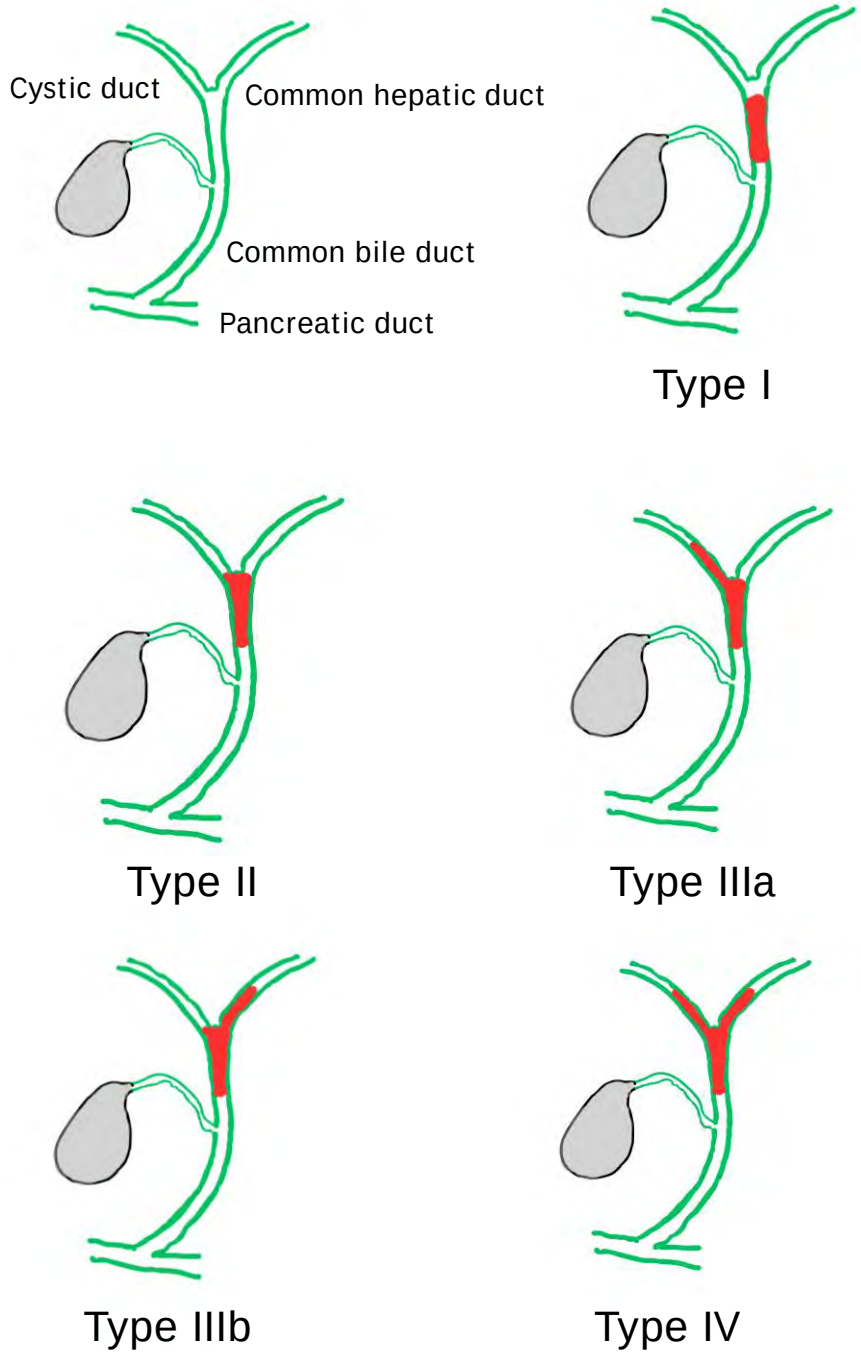

Lt hepatic artery


Right gastric artery


Coil embolization of right gastric artery

Malignancy biliary obstruction

- Accounts for 70-90% of biliary obstruction (mostly cholangiocarcinoma and pancreatic cancer)
- Often the initial presentation of malignancy
- Clinical presentation: painless jaundice, dark urine, pruritus
- Patient at risk for cholangitis due to bile stasis.
- 70% cholangiocarcinoma involves biliary confluence (Klastskin tumor)



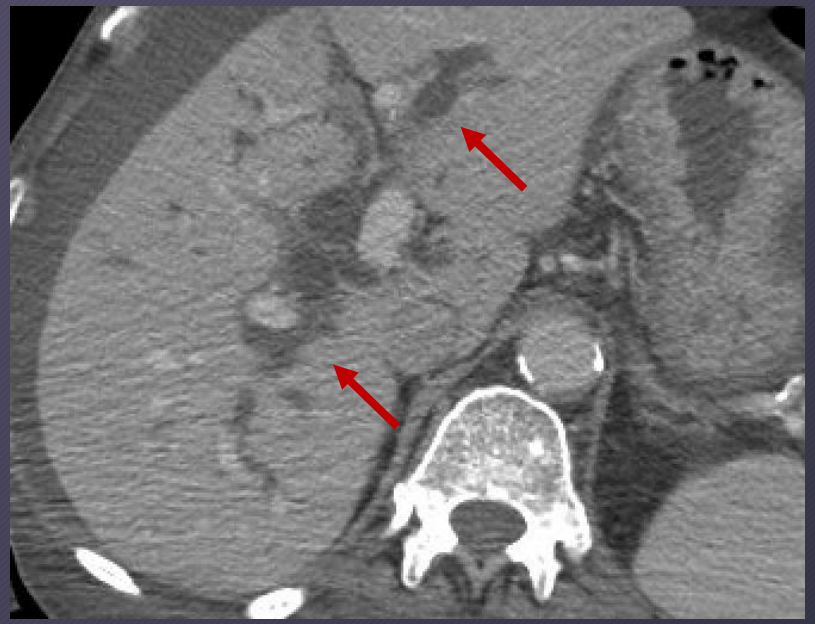
Percutaneous transhepatic cholangiography (PTC)

- Used to be the go-to diagnostic study before CT and MRI to delineate biliary anatomy;
- PTC with drain placement for decompression of malignancy biliary obstruction
- Can perform brush biopsy at the same time for histologic diagnosis

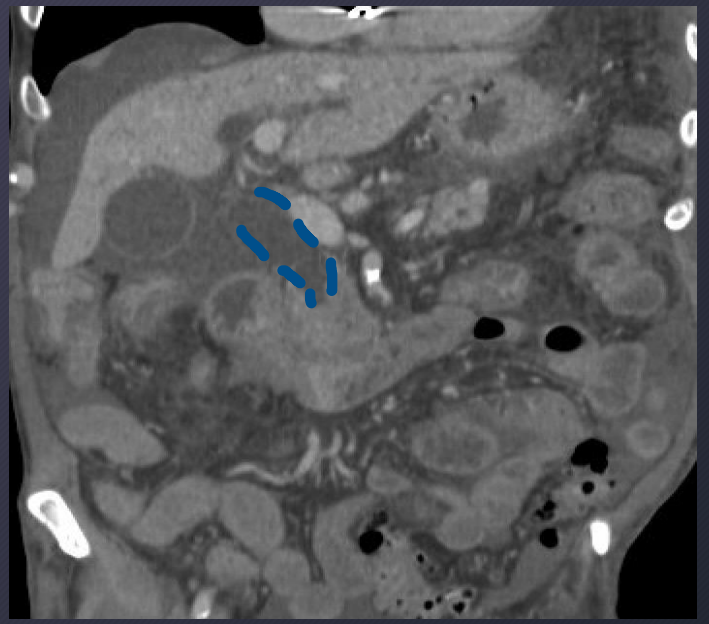
* Also performed in the setting of post-operative biliary injury->diverting flow to assist healing process

77 y/o male with malignancy biliary obstruction, unable to cannulize with ERCP

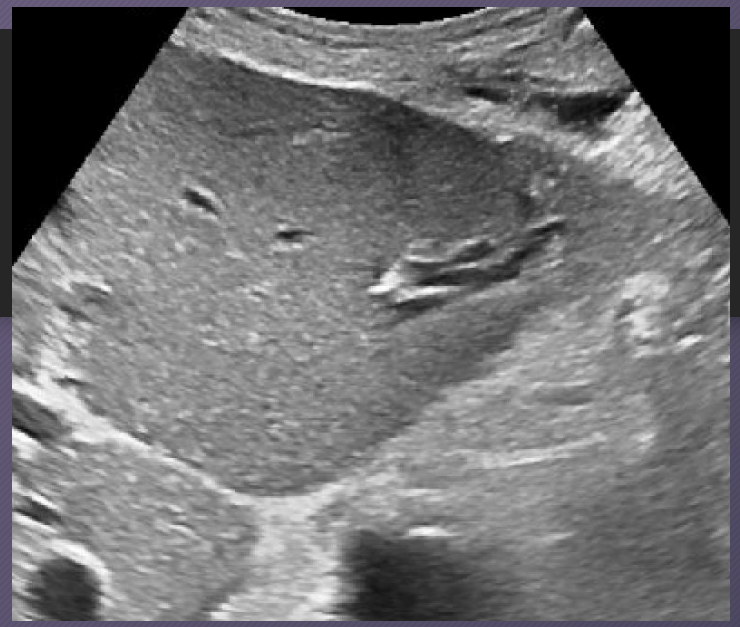
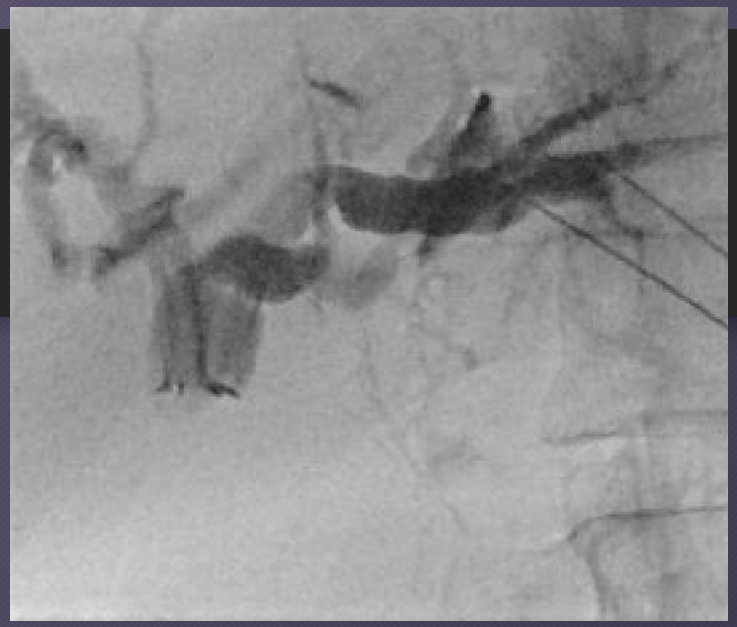
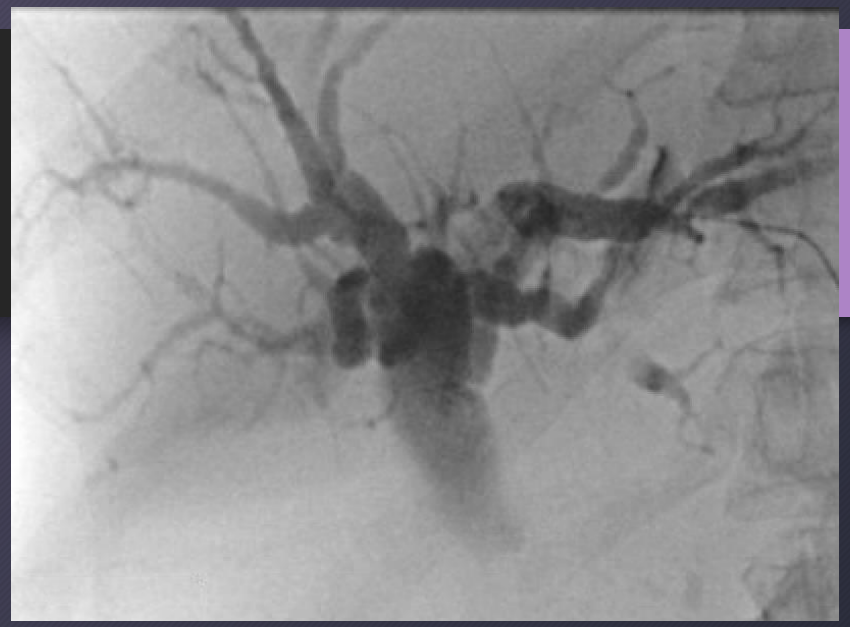
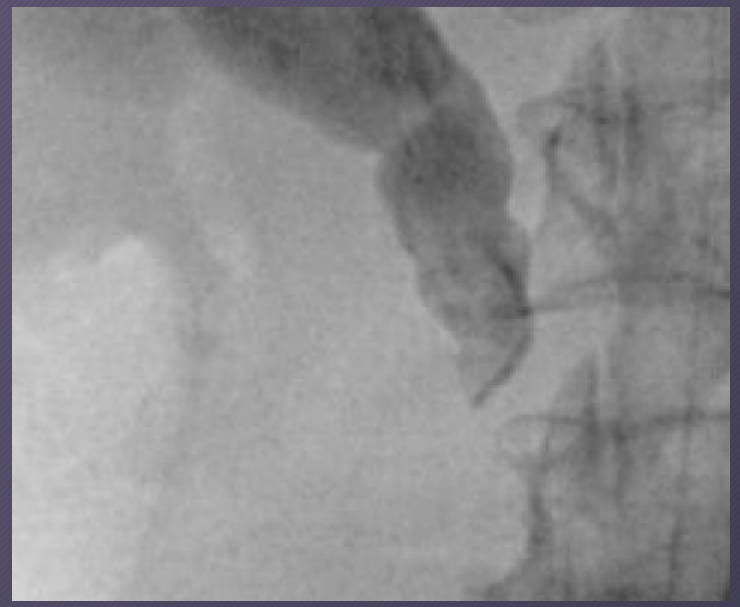
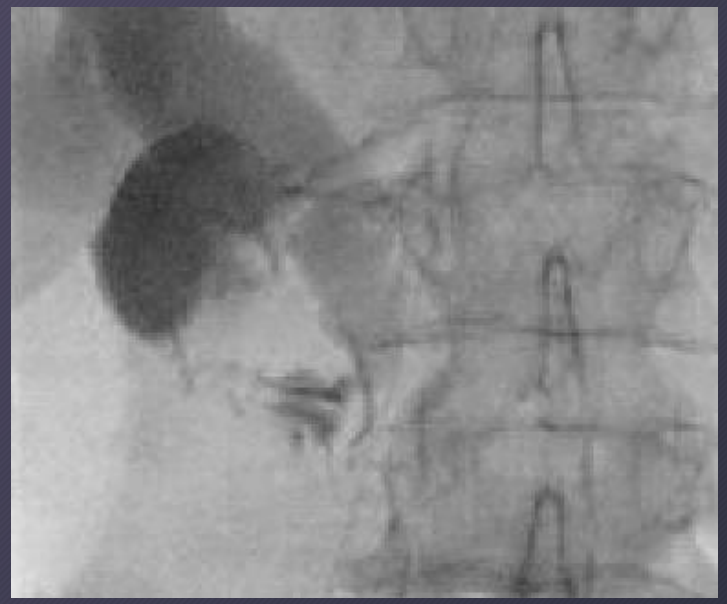
2nd and 3rd portion duodenal wall thickening/mass



Significant intrahepatic biliary dilatation



Dilated CBD with tapering at periampullary region

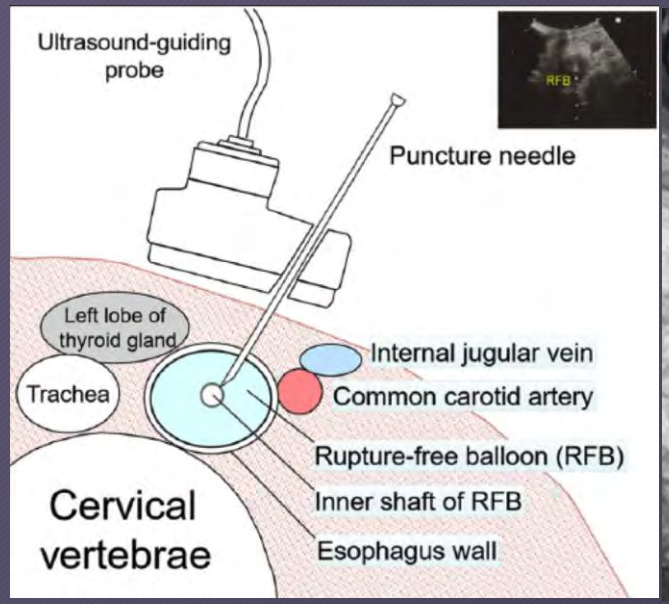






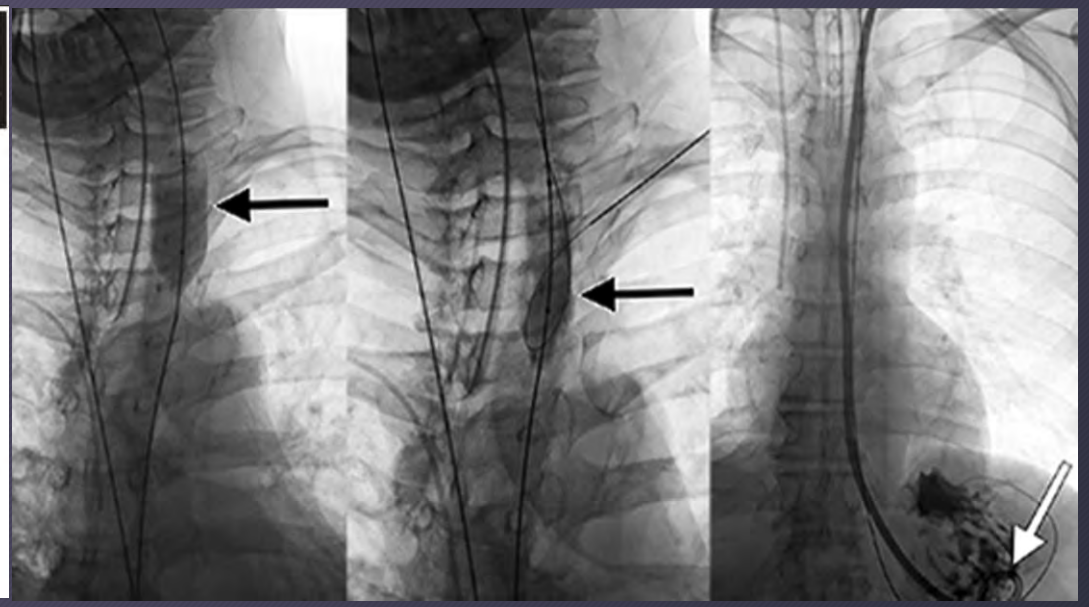

GI obstructions

- Small bowel or gastric outlet obstruction can be result of tumor luminal obstruction or postsurgical stricture ect.
- Gastrostomy tube can be used for decompression and nutrition support for patient with dysphasia or swallowing impairment.
- G-tube can be placement by IR, GI or surgery
- IR G-tube placement requires moderate sedation or sometimes local for patients cannot tolerate anesthesia,.
- Relative contraindication: coagulopathy, abdominal wall infection, ascites;
- Absolute contraindication: peritoneal carcinomatosis, significant ascites, and advanced gastric cancer involving anterior wall

Percutaneous transesophageal gastrostomy (PTEG)

- A novel procedure in patients with malignant bowel obstruction and transabdominal G-tube placement is not an option

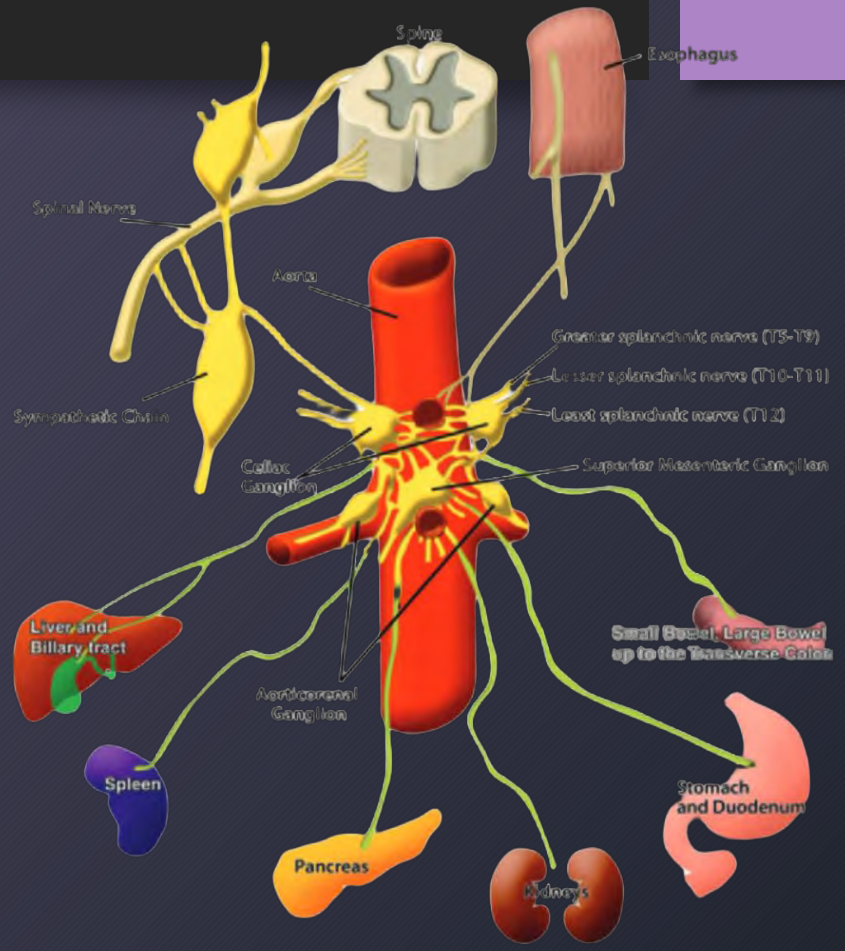


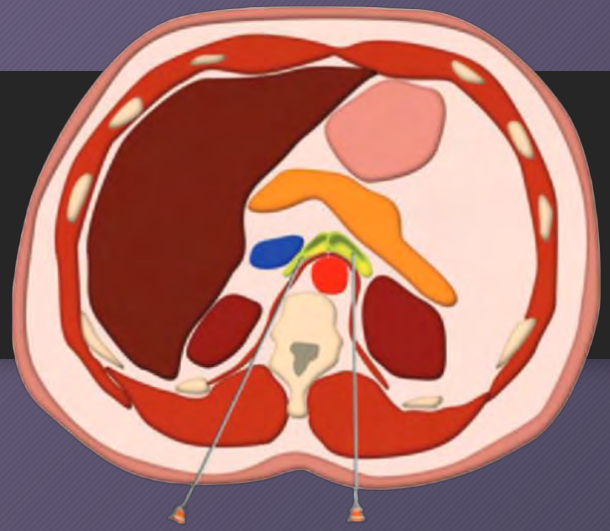


Selby, Debbie, et al. "Percutaneous transesophageal gastrostomy (PTEG): a safe and well-tolerated procedure for palliation of end-stage malignant bowel obstruction." *Journal of Pain and Symptom Management* 58.2 (2019): 306-310.
Toh Yoon, Ezekiel Wong, and Kazuki Nishihara. "Percutaneous transesophageal gastro-tubing (PTEG) as an alternative long-term tube feeding procedure when gastrostomy is not feasible." *Therapeutic Advances in Gastroenterology* 10.12 (2017): 911-917.
Rotellini-Coltvet, Lisa, et al. "Percutaneous transesophageal gastrostomy (PTEG): procedural technique and outcomes." *Journal of Vascular and Interventional Radiology* (2023).

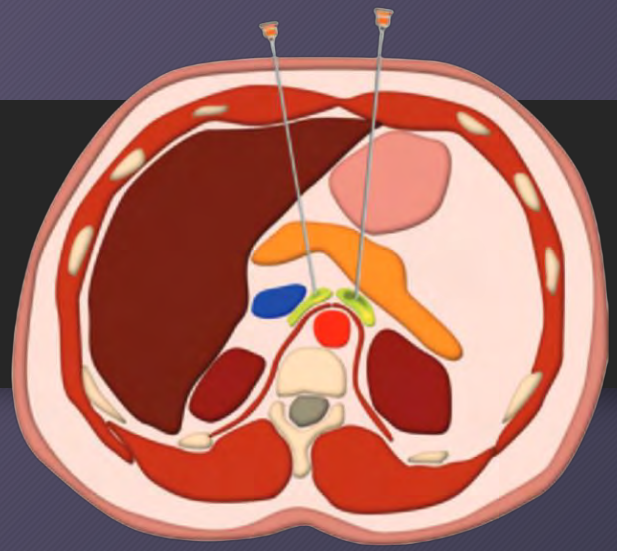
Palliative pain control: Celiac plexus neurolysis (CPB)

- CPB is used for intractable abdominal pain caused by pancreatic, gastric, esophageal, or biliary malignancy
- SPB also help manage severe nausea and vomiting in patients with pancreatic cancer
- Reduce narcotic use and associated complications
- Nerve block or celiac ganglion neurolysis can be performed with CT guidance for pain relieve
- Complication after celiac block- diarrhea(73%) and orthostatic hypotension (12%)
- Efficacy: long term pain control in 70%–90% of patients

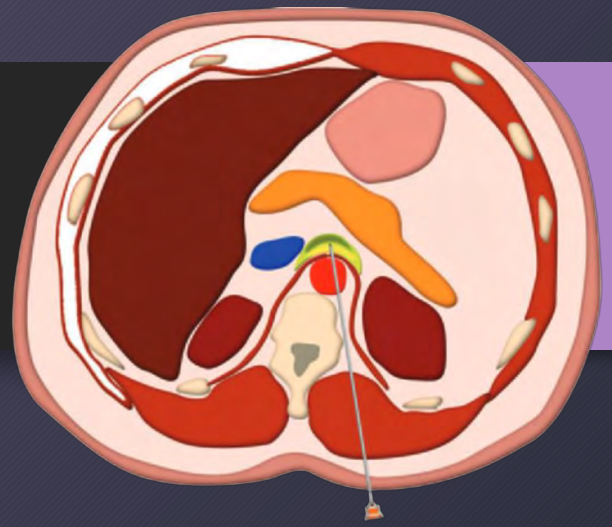




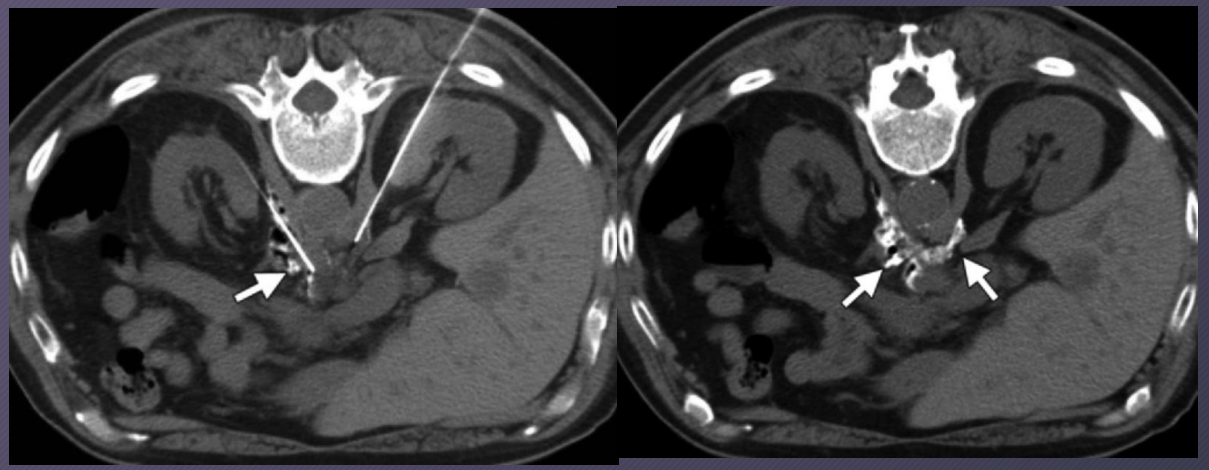
Bilateral Posterior Approach

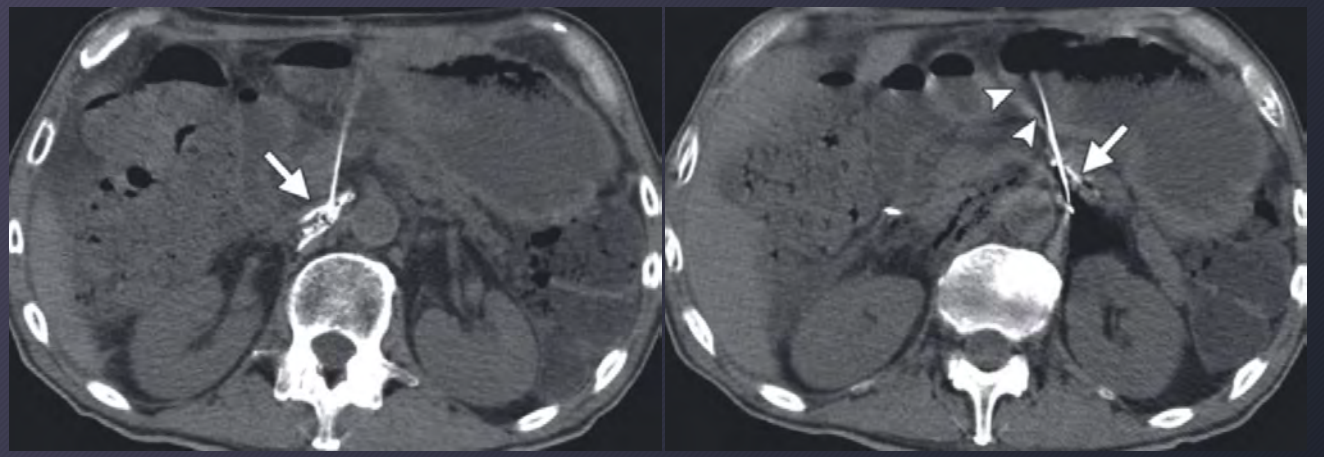


Anterior Approach



Transaortic Approach





Kambadakone A, Thabet A, Gervais DA, Mueller PR, Arellano RS. CT-guided celiac plexus neurolysis: a review of anatomy, indications, technique, and tips for successful treatment. *Radiographics*. 2011;31(6):1599-1621. doi:10.1148/rg.316115526

How to approach vascular complications: postoperative hemorrhage (PH) after Whipple

Time of onset

Early PH happens within 24 hours
- As a result of technique failure (inadequate ligation)
- Often at gastroduodenal artery (GDA) stump

Late PH happens usually after days or weeks
- GDA stump blowout, vascular erosion, pseudoaneurysm formation etc.
- Often associated with infection, pancreatic leak or anastomotic dehiscence

Location

Intraluminal:
- Typical presentation: hematemesis or melena
- Best diagnosed with endoscopy and/or computed tomography (CT)

Extraluminal
- Typical presentation: bloody output in abdominal drain
- Best diagnosed with CT imaging (in stable patients)
- Intraluminal bleeding can present as extraluminal due to anastomotic breakdown

Imaging diagnosis and endovascular intervention

CT (triple phase)

- Identify site and nature of vascular injury, could be in the forms of bleeding, pseudoaneurysm, thrombosis, luminal irregularity etc.
- Identify associated structural abnormality and other complications

Interventional Radiology: from diagnosis to intervention

In unstable situation, patient often directly proceed to angiography

- Active contrast extravasation
- Pseudoaneurysm
- Luminal irregularity or occlusion

Arterial embolization

- Great for small vessel or side branch to minimize distal flow sacrifices
- Complete embolization includes both inflow and outflow vessels

Stent grafting

- Preserves flow to distal organs
- Technically challenging in tortuous or small vessels
- Limited choice of size and length of stents

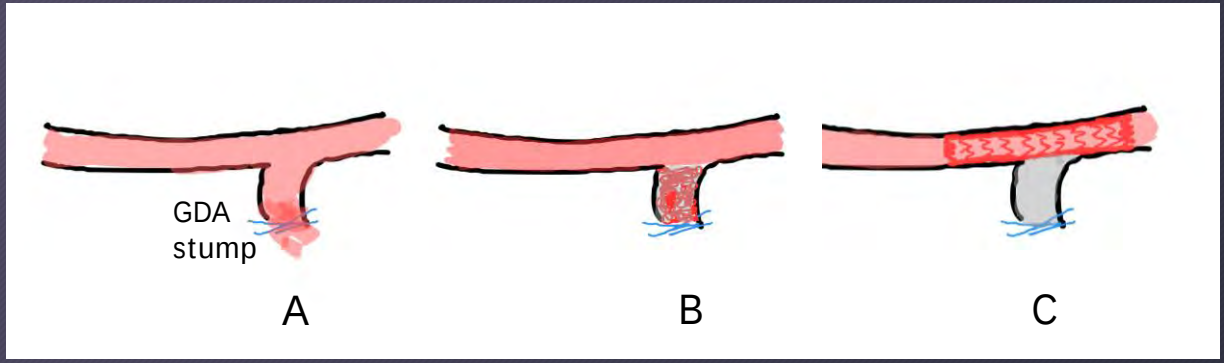
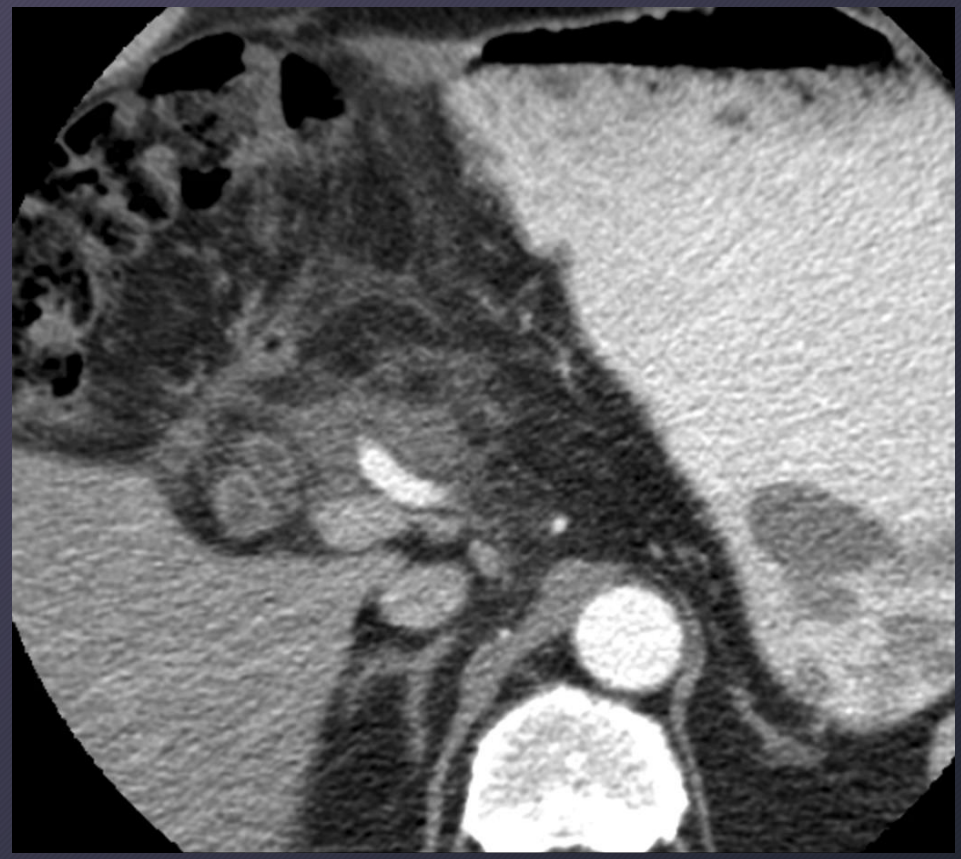


Illustration: (A) active bleeding at GDA stump; (B) coil embolization of stump; (C) covered stent graft placement cross the bleeding GDA stump

Case: 70-year-old male patient presented with massive hematemesis 3 weeks after Whipple procedure for ampullary adenocarcinoma

Case Summary:

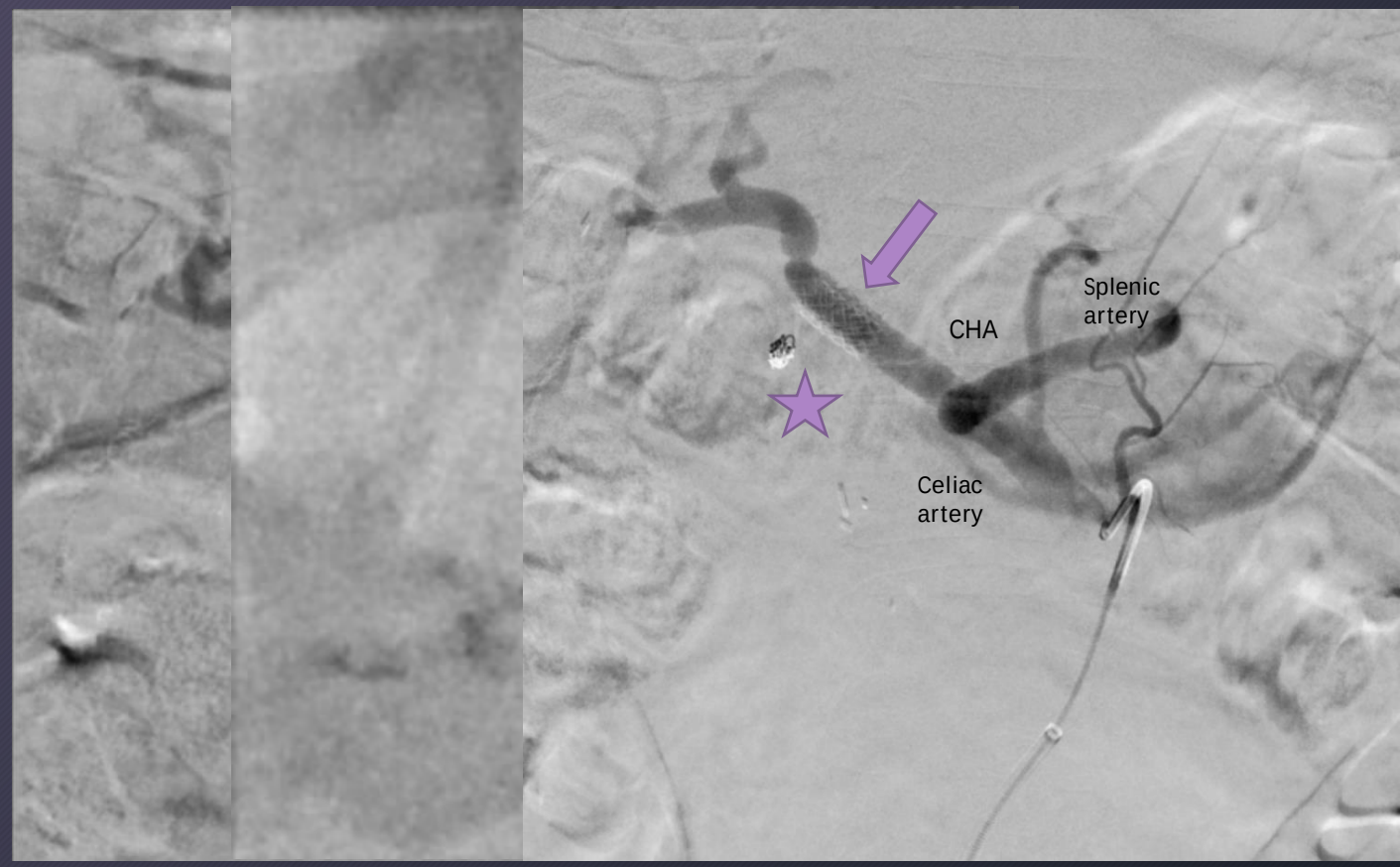
- CT abdomen with contrast showed active contrast extravasation in the region of GDA stump, concerning for GDA stump blowout
- IR was consulted for embolization
- Coil embolization of GDA stump was initially attempted, however continued bleeding seen on repeat angiogram
- Due to lack of sufficient landing space for additional coils, a 7mmx1.9cm covered stent was placed crossing the GDA
- Follow up celiac angiogram showed no further filling of GDA



Case: 70-year-old male patient presented with massive hematemesis 3 weeks after Whipple procedure for ampullary adenocarcinoma

Case Summary:

- CT abdomen with contrast showed active contrast extravasation in the region of GDA stump, concerning for GDA stump blowout
- IR was consulted for embolization
- Coil embolization of GDA stump was initially attempted, however continued bleeding seen on repeat angiogram
- Due to lack of sufficient landing space for additional coils, a 7mmx1.9cm covered stent was placed crossing the GDA
- Follow up celiac angiogram showed no further filling of GDA



Abscess drainage

- Could be presentation of cancer or postoperative complication;
- US guided drainage
  - Superficial/easily accessible collection;
  - Real time needle placement
  - No radiation exposure
- CT guided drainage
  - For deeper structure or abscess close to vital organs
  - Easy to evaluate abscess in relationship to surrounding organs
  - Radiation exposure to patients
- *Deep-seated abscess- transgastric/transhepatic/transrectal/transvaginal approach is necessary

References:

- Reitano, Elisa, et al. "Current trends and perspectives in interventional radiology for gastrointestinal cancers." *World Journal of Radiology* 13.10 (2021): 314.
- Raman, Siva P., et al. "CT after pancreaticoduodenectomy: spectrum of normal findings and complications." *American Journal of Roentgenology* 201.1 (2013): 2-13.

Thank you!

Contact:

Lei.yu@unmc.edu