Imaging in HPB Tumors: A guide to RT planning

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Disclaimer- Purely from a radiation oncologist's perspective

Introduction

Hepatobiliary pancreas system consists of

- Liver
- Intrahepatic bile ducts (IHBDs)
- Extrahepatic bile ducts (EHBDs) including the gallbladder.
- Pancreas

- Radiological modalities used in imaging HBPS.
- Normal Radiologic anatomy of HBP system
- Tips for radiation planning scan
- Tumour identification

Requirement of Imaging for Radiation Therapy

- For tumour staging /work up
- For RT Planning
- For tumour mapping /contouring
- For response evaluation

Radiological modalities used in imaging HBS – is there a one stop shop ?

1.X Ray.

- Used but it is limited to **metastatic work up**

▪Can detect radiopaque stones depending on its composition size and location
▪Can detect enlargement in the liver and calcifications in the gallbladder wall.

2. Ultrasound.

First imaging in investigative.
Work up
EUS
B Mode and Doppler are additional tools

3. Computed tomography (CT) scan.

-**Underestimates tumour volume**
-Sensitivity in differentiating HCC from obstructive jaundice & determining level of obstruction parallels USG.
Reserved to evaluate cause of obstruction & for staging biliary tumours

4. Magnetic resonance imaging (MRI)

Provides higher contrast ratios & allows superior lesion detection & characterization-better spatial resolution

ERCP,PTC,HIDA

5. PET scan.

- Useful in target delineation in previously treated liver tumours as it can distinguish active tumour from fibrosis
- Metastatic Work up

All are usable -Most imaging compliment each other

Ultrasound

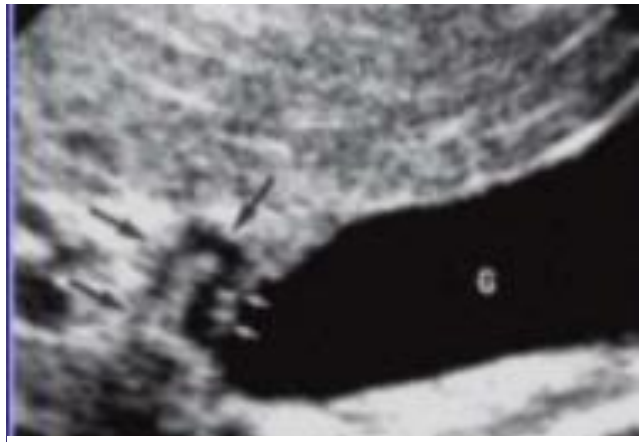
- Modality of choice to start with in HBS for diagnostic work up
- **Echo patterns:**

➢ Hyper-echoic = White (bones)

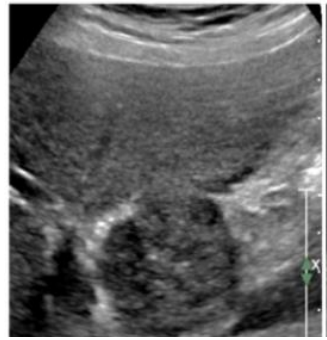
➢ Hypo-echoic = Light Grey

➢ An-echoic = Black (fluid)

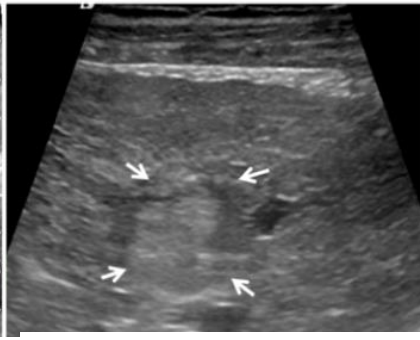
- Intrahepatic Cholangio-ca. has variable echogenicity
- Internal architecture is usually homogeneous, but it can be heterogeneous, depending on amount of fibrous tissue, mucin & calcification.



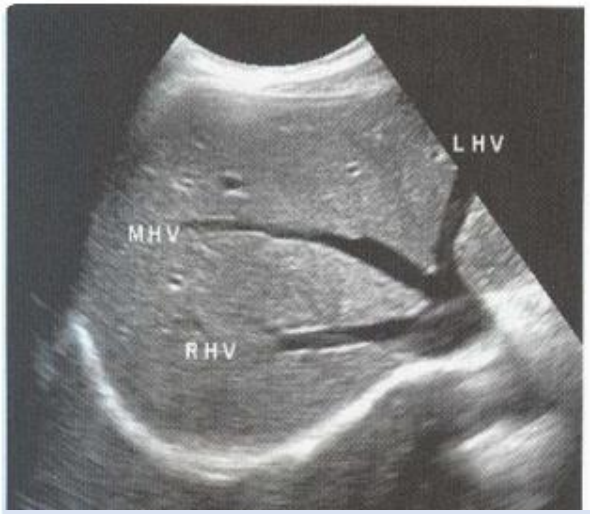
Longitudinal view of GB neck and proximal cystic duct- Serrations=valves of Heister

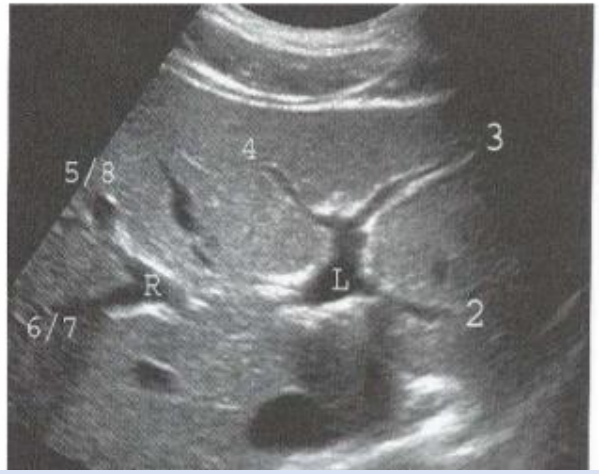


Well defined hypoechoic mass



Ill defined Heterogenous isoechoic mass





- Signs of biliary dilatation- parallel Channel Sign- IHBD >2mm ,CBD >6mm
- Post fatty meal CBD size increase of 2mm
- Post cholecystectomy-no compensatory dilatation of CBD

Endoscopic ultrasound

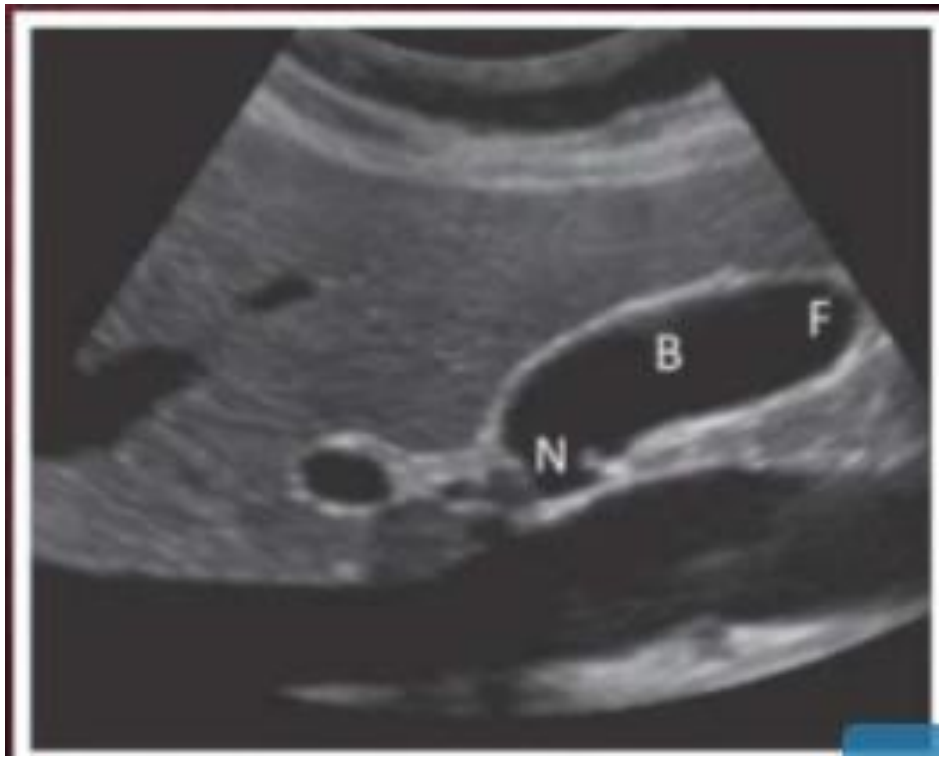
- **As sensitive as ERCP & superior to CT for detection of small ampullary tumors**
- **Accurate for depth of tumor invasion duodenum & local extension to adjacent structures**
- **Most accurate modality to assess local staging of ampullary tumors (accuracy of 70–90%)**

- Provides high frequency grey scale imaging (+/- color doppler) for evaluation of extrahepatic biliary tree pancreas & duodenum
- Important modality in diagnosis of CCA

Ultrasound and EUS

- **First imaging modality**
- Detect late stage tumour with high sensitivity -use limited in early lesion
- **EUS-Assessment of depth of tumor & presence of LAP at porta hepatis & peripancreatic regions**
- Obtaining bile for cytological analysis (73% sensitivity for diagnosis of GbCA)

- **Discontinuous thickening of GB mucosa**
- **Diffuse thickening of GB wall (>12 mm)**
- **Mural calcification**
- **Mass protruding into lumen**
- **Fixed mass in GB & loss of interface between liver & GB are common signs**



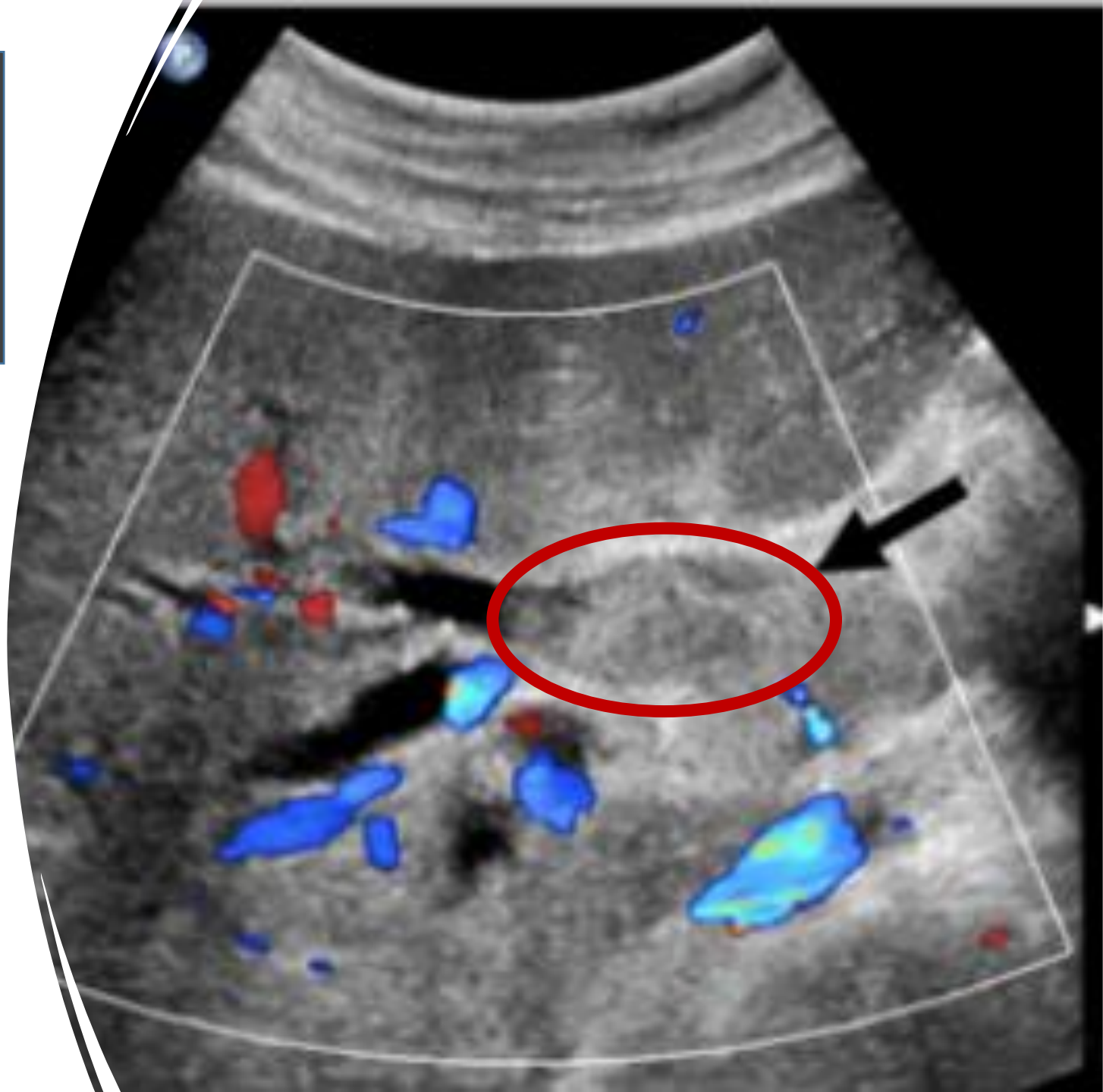
GB wall ≤ 3 mm

Anterior wall
Long-axis
Perpendicular

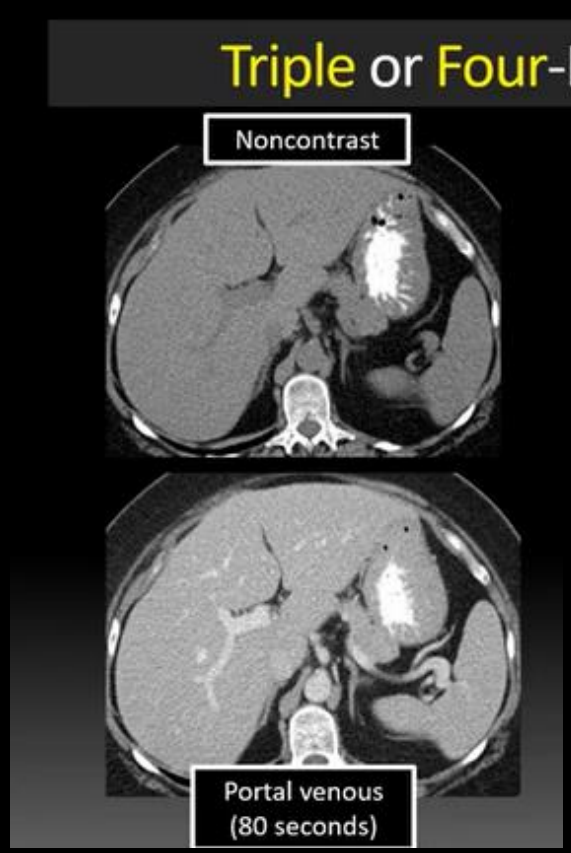
Transverse diameter < 4 cm

EUS-guided FNA (EUSFNA)

- Used for assessing nature of biliary strictures & for providing information on extent of periductal disease & presence of LN mets
- **Specificity -100%**
- **Sensitivity- 43-86%** (depending upon location of CCA)
- Also avoids contamination of biliary tree



CT scan

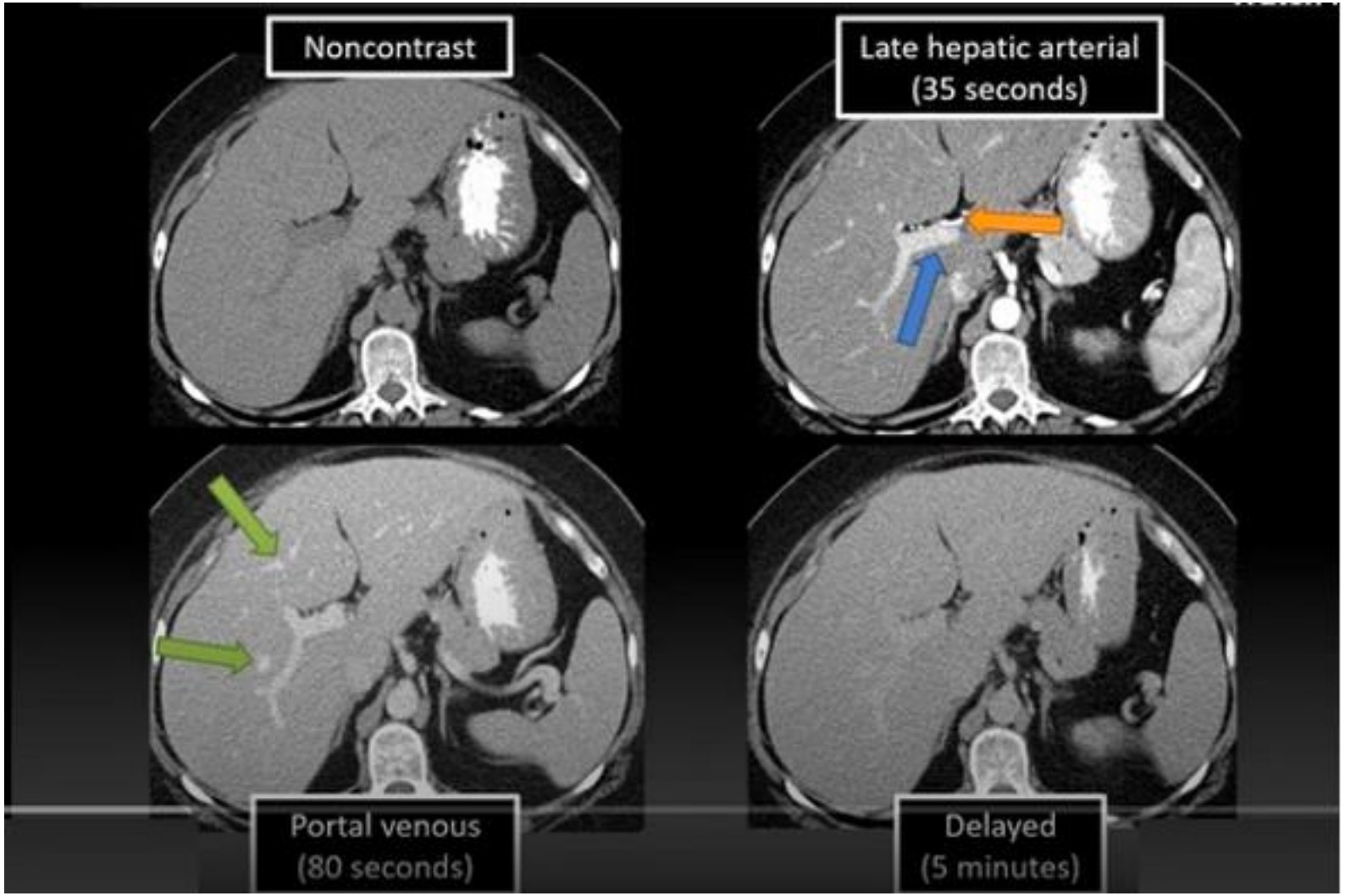


CT language:

- ➢ Hypo-dense = black to grey
- ➢ Hyper-dense = white
- Bones are more hyper-dense when compared to the aorta or liver

Multiphase CT scan= Series of images taken

- ❖ Prior to administration of contrast
- ❖ After administration of contrast
  - Late Hepatic- Arterial Phase
  - Delayed- Portal Venous Phase



Late Hepatic Arterial Phase

- **If no portal Vein – too early**
- **Hepatic veins seen- too late**
- **Best phase to detect hyper vascular lesions**

Triple phase CT interpretation

Multidetector CT

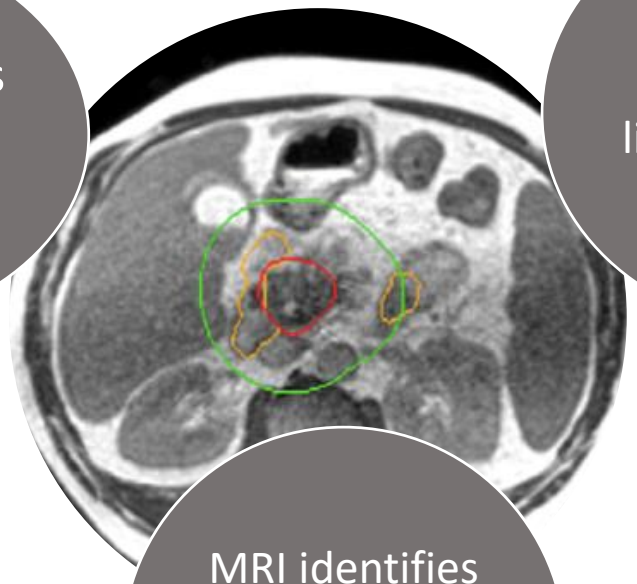
Parameter	Accuracy	
Diagnosis	78.6%-92.3% accuracy	strong tendency to underestimate the longitudinal extension of the tumor
Portal vein involvement	87%	
Arterial involvement	93%	
Assessment of resectability	- 60-88%	negative predictive values of 85-100%
Detection of regional lymphadenopathy	54%	

- Streak artifacts' & secondary inflammatory changes --occur when a stent is placed limits evaluation with CT
- A potential limitation of CT cholangiography is dependence on secretory function of biliary system that may be compromised in pts with high-grade obstruction or significantly elevated bilirubin levels

Role of MRI

Image acquisition using a specific protocol with appropriate slices provides precise visualization of tumor in relation to vasculature, luminal structures, especially with multi-planar reconstruction.

Helpful in delineation of ds due to superior soft tissue contrast



Also helpful for indeterminate liver lesions seen on CT

MRI identifies tumors which are difficult to visualize on CT

MRI language :

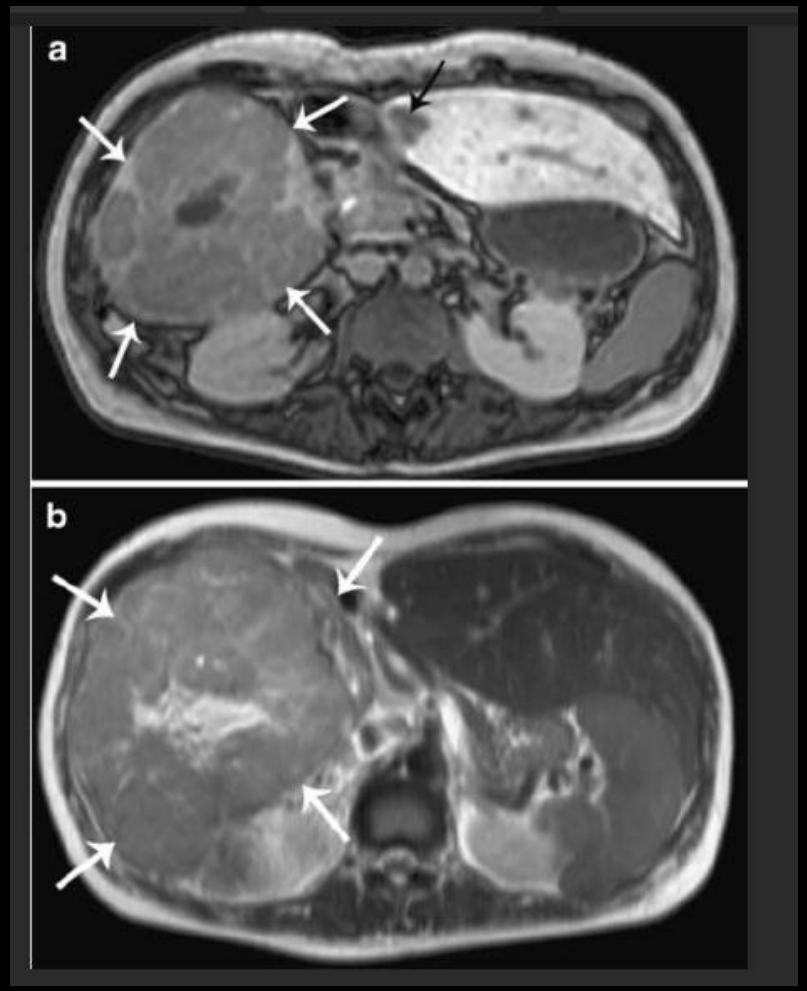
- - Hyper-intense signal= more white
  - Hypo-intense signal = more grey/black

➢T1: Fluid will appear black

➢T2: Fluid will appear white

- Gadolinium-Enhanced MRI typically demonstrates that HCCs densely enhance, usually in arterial phase, particularly if they are small.

MRI



MRI can help differentiate cirrhotic nodules from HCC as follows:

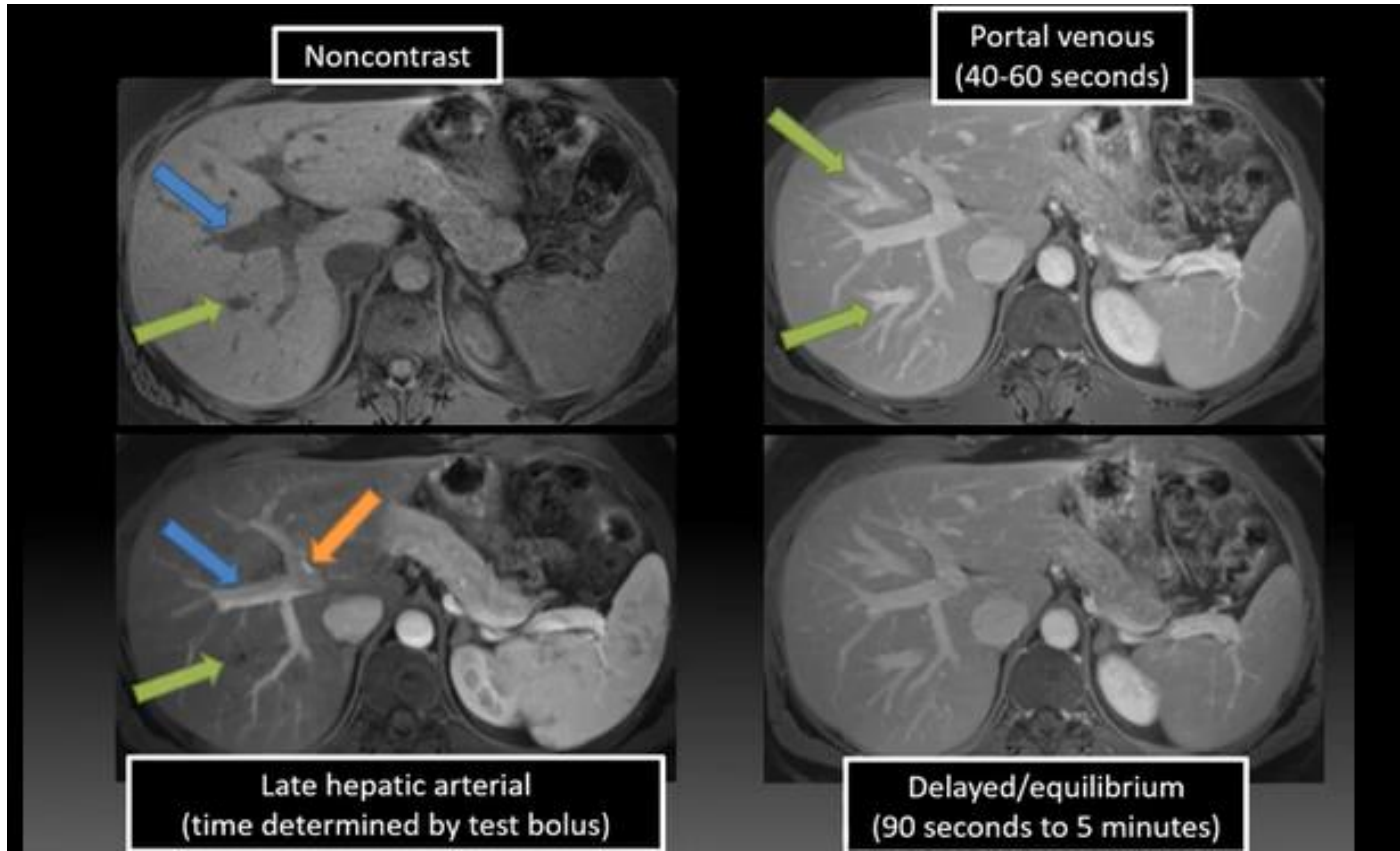
- If **mass is bright** on T2-weighted images, **it is HCC** until proven otherwise.
- If **mass is dark on T1- and T2-weighted** images, it is **a siderotic regenerative nodule or siderotic dysplastic nodule.**
- If mass is bright on T1-weighted images and dark or isointense on T2-weighted images, it is a dysplastic nodule or low-grade HCC.

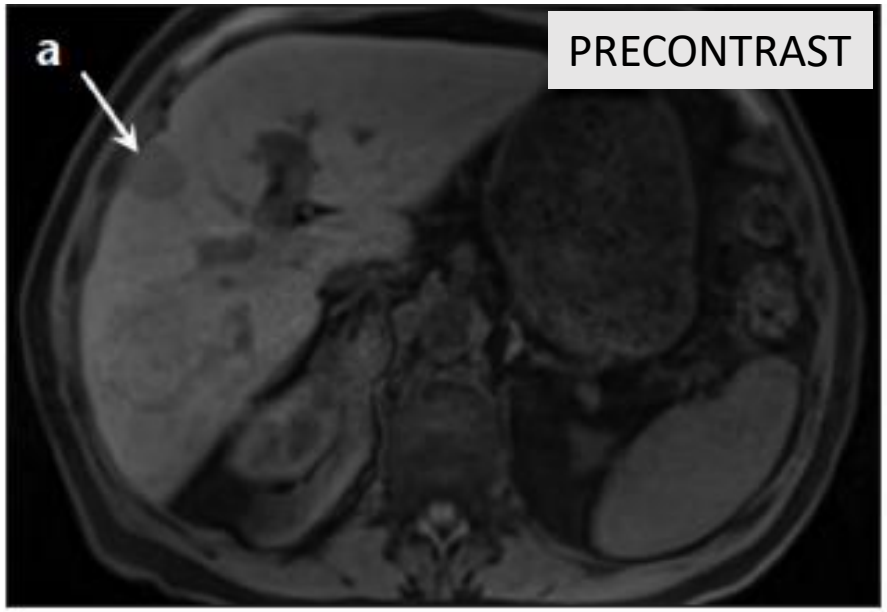
- MRI is superior to CT scan in identifying liver masses due to contrast resolution
- On T2-weighted images, HCC generally demonstrates high signal intensity.

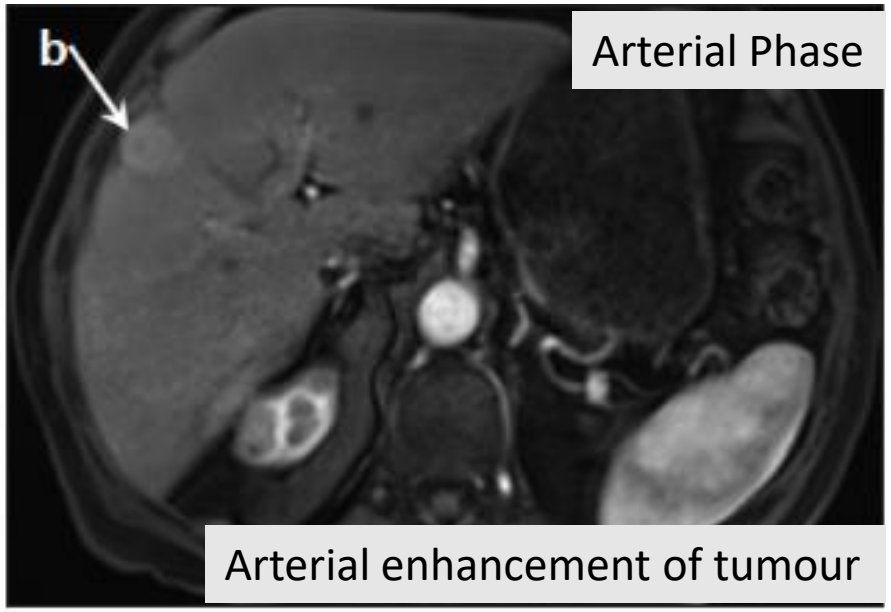
Multiphasic MRI

- IV contrast contraindicated-multiphase MR
- MRI also is better in delineation of infiltrative lesions
- MR contrast contraindicated-non-contrast T1 weighted images(7mm)

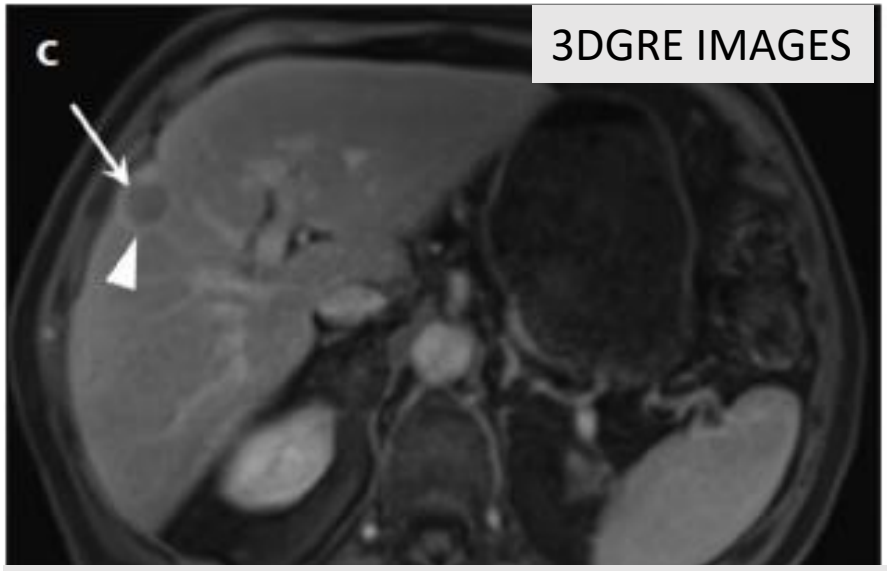
- Noncontrast images
  - T1 in-phase, opposed-phase: Identify intracellular fat
  - T2: Compare liver lesion intensity relative to spleen
  - DWI/ADC: Detects restricted diffusion often seen with abscess and malignancy
- Post-contrast images
  - Can obtain at more time points compared to CT without ionizing radiation (e.g., immediate post-contrast, 1 minute, 3 minute, 4 minute, 5 minute)
  - Subtraction imaging

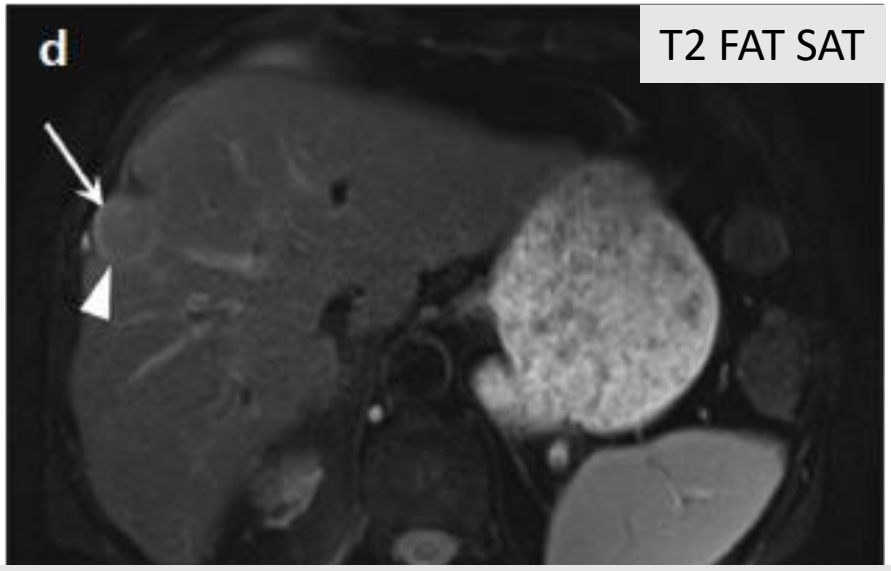






Arterial enhancement of tumour

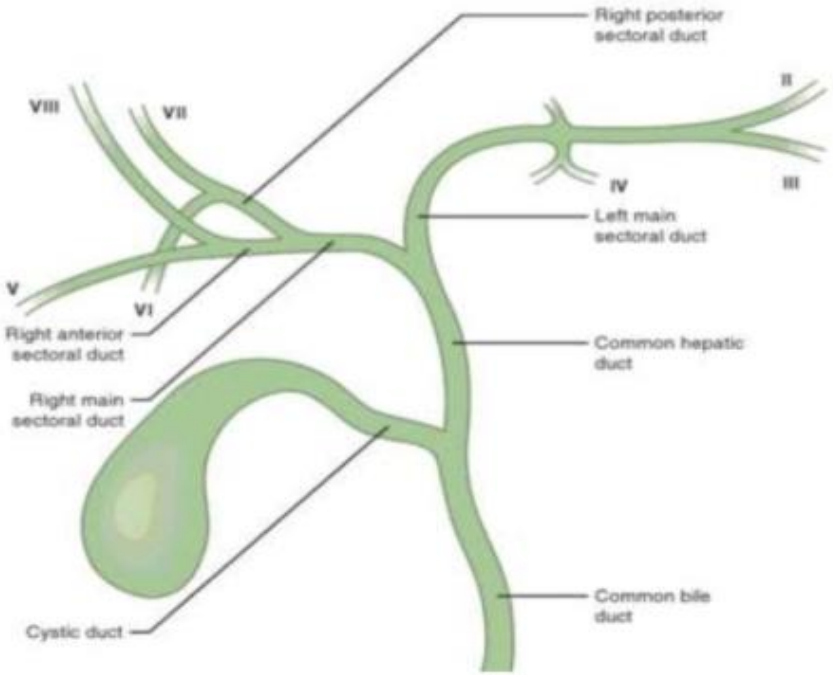


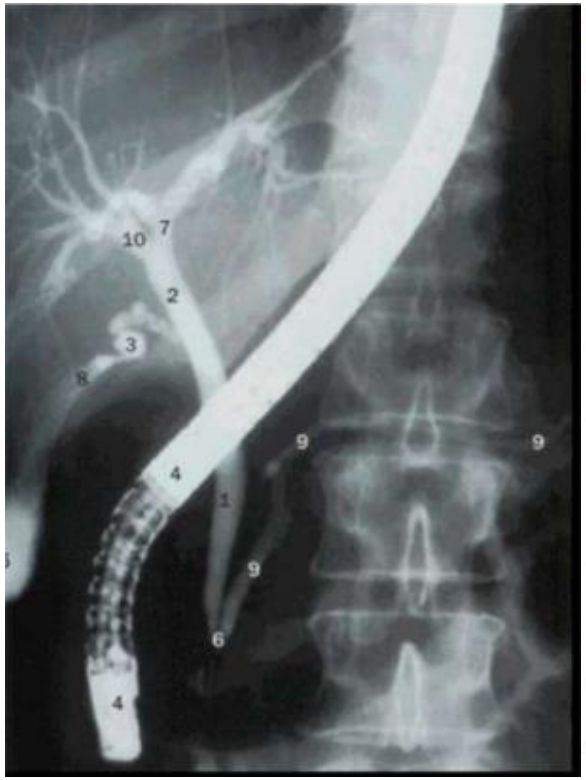


Washout & capsule enhancement Elevated T2 signal intensity within tumor & tumor capsule

Endoscopic Retrograde Cholangiopancreatography(ERCP)

- Allows direct bile & pancreatic duct opacification ,as well as visual assessment of duodenum & ampulla of Vater
- Allows biopsy /brushings / sphincterotomy /stenting /stricture dilatation
- **Complication- Pancreatitis**

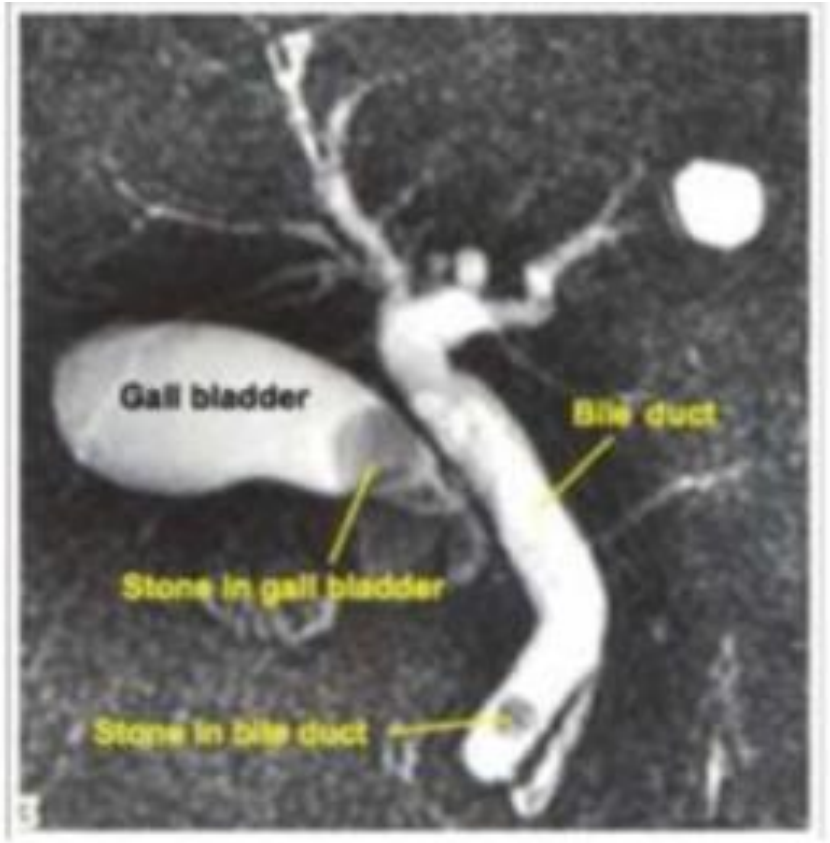


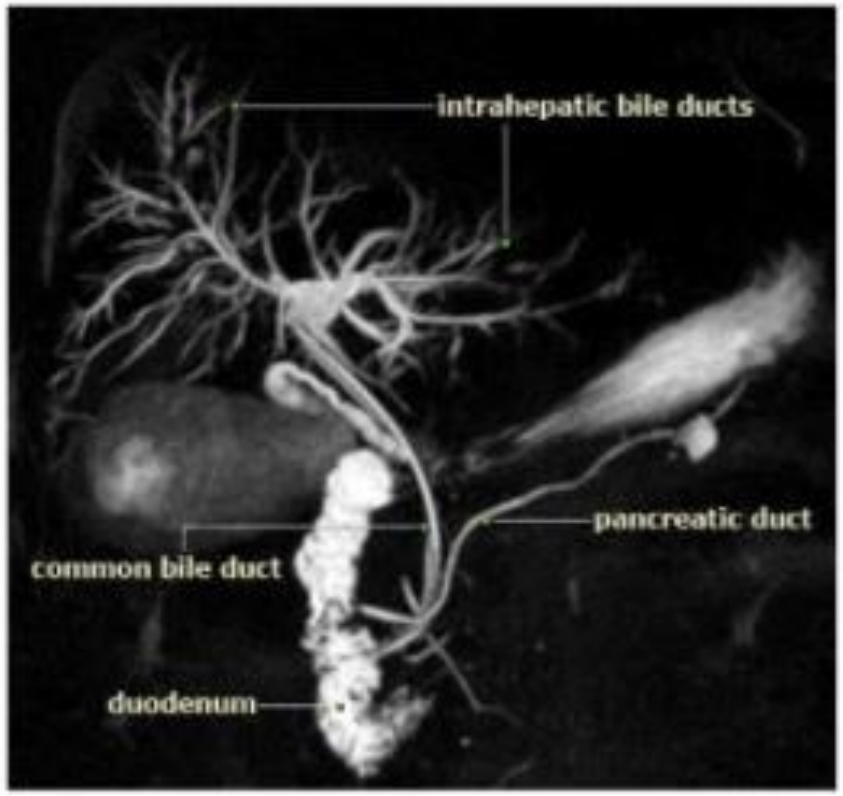


1	Common bile duct
2	Common hepatic duct
3	Cystic duct
4	Endoscope in duodenom
5	Gallbladder
6	Amper´s ampulla
7	Left hepatic duct
8	Neck of gallbladder
9	Pancreatic duct
10	Right hepatic duct

Percutaneous Cholangiography(PTC)

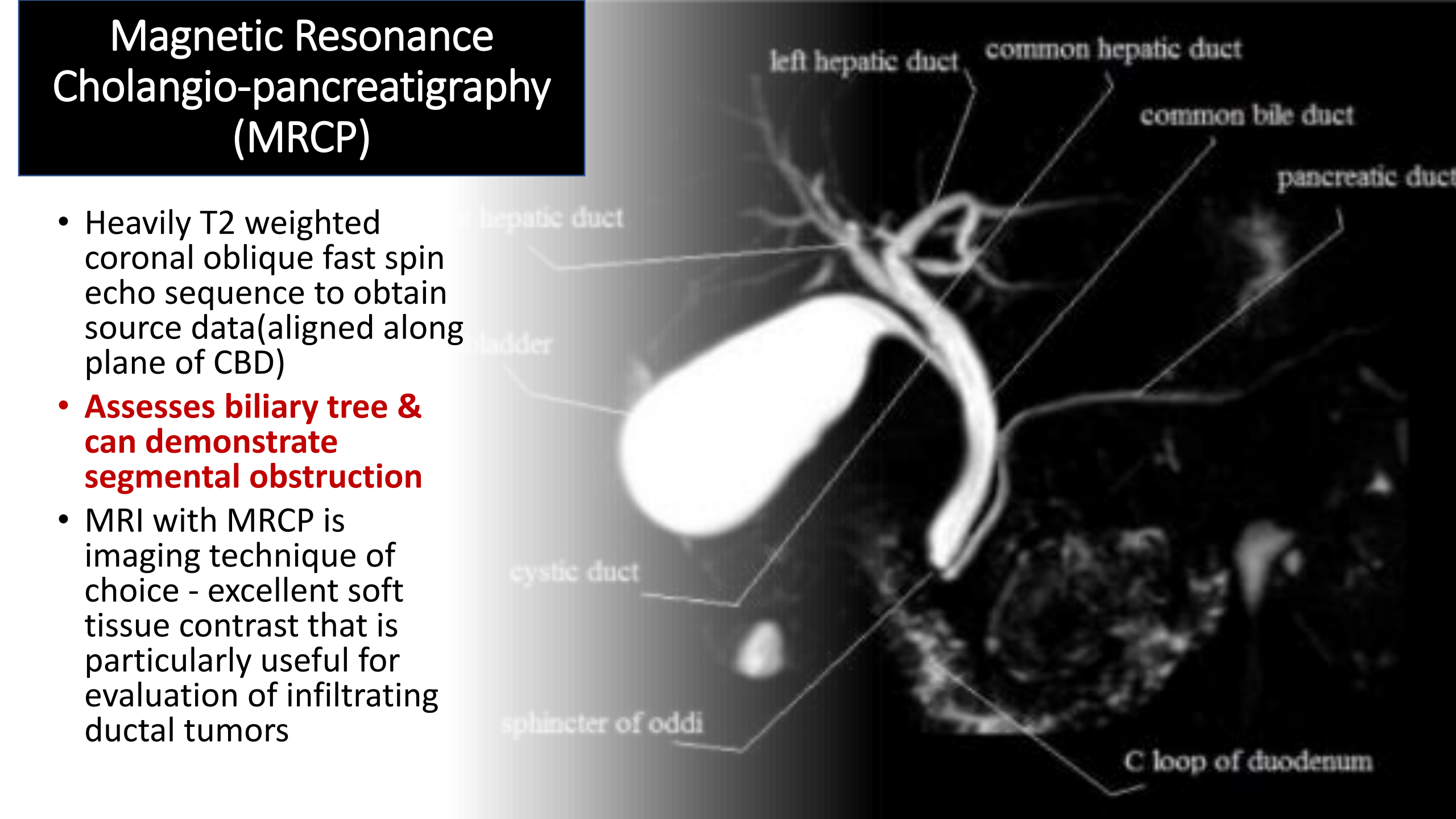
Direct Puncture of the intrahepatic ducts using a fine guage Chiba needle – allows demonstration of biliary tree
Used in obstructed jaundice with or without duct dilatation





Magnetic Resonance Cholangio-pancreatigraphy (MRCP)

- Heavily T2 weighted coronal oblique fast spin echo sequence to obtain source data(aligned along plane of CBD)
- **Assesses biliary tree & can demonstrate segmental obstruction**
- MRI with MRCP is imaging technique of choice - excellent soft tissue contrast that is particularly useful for evaluation of infiltrating ductal tumors



MRI and MRCP

- **N**on-invasive method of imaging pancreaticobiliary tree & is used in those who either cannot tolerate more invasive ERCP or in whom a large tumor occludes orifice of duct
- Neoplasm appears as a filling defect within duodenal lumen with characteristic delayed enhancement

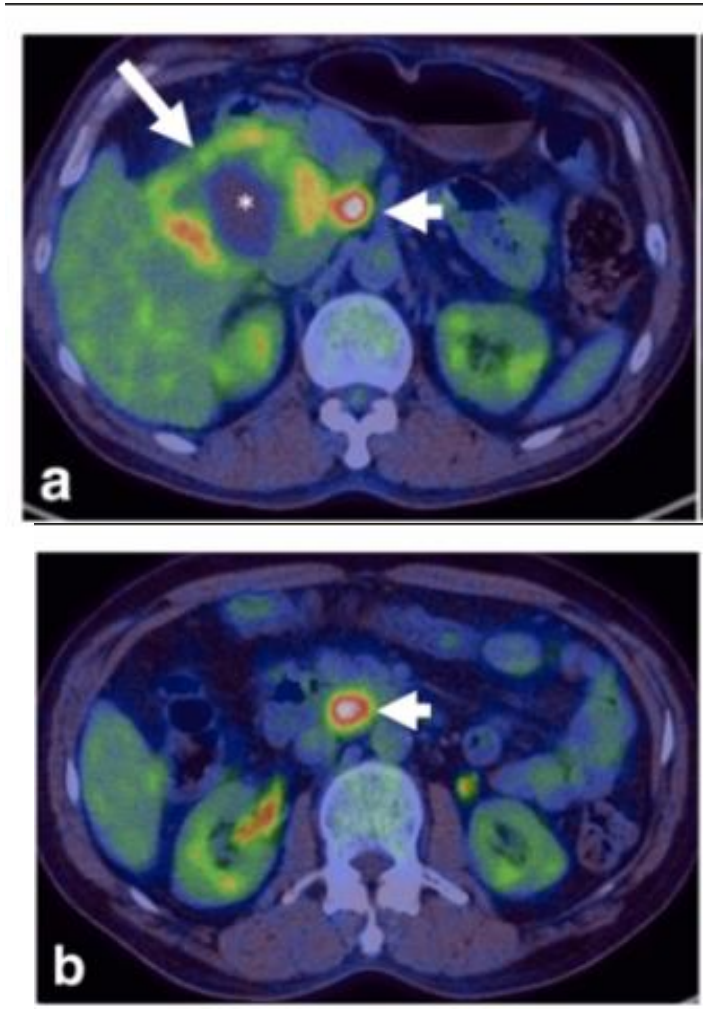
Parameter	Accuracy
Accuracy for LN mets detection-	66%
Portal vein involvement	78% Sensitivity 91% Specificity
Hepatic Arterial involvement	93% Specificity 58-73% Sensitivity
Extent of bile duct involvement	71-96%
Detection of regional lymphadenopathy	54%

PET

- Metabolic information on tumors--detection of tumors as small as 1 cm
- **Less helpful for infiltrative periductal tumours**
- Detection of mass forming IHCCA >1 cm in diameter

➢ **Specificity 85-95% & sensitivity of 100%**

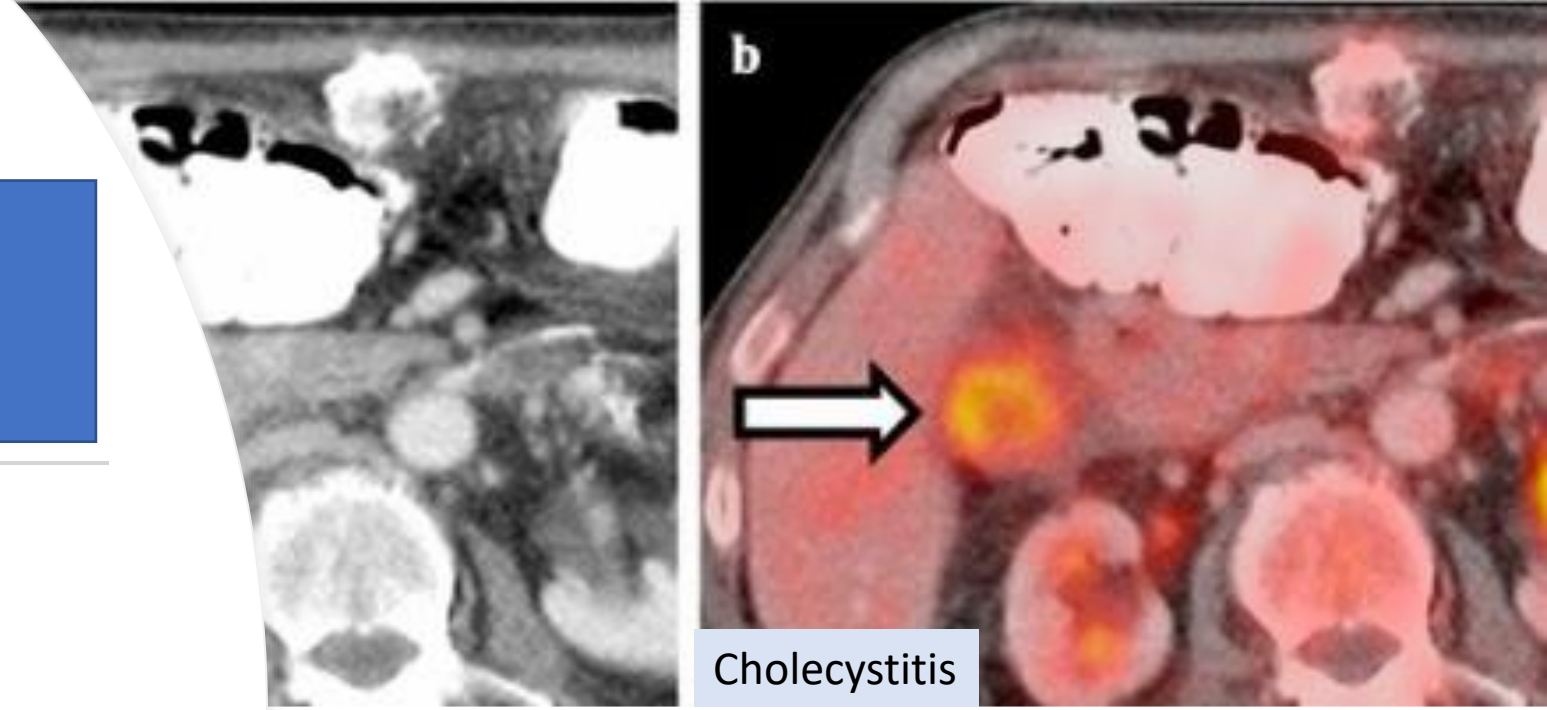
- **Drawback** -inability to differentiate malignant from benign lesions
- Complement in identifying occult distant mets &recurrence with previously treated/ resected CCA.
- **For Perihilar lesions-** Interpretation can be difficult as areas of inflammation may have increased uptake and desmoplastic areas of low cellularity may lead to possible false negatives.

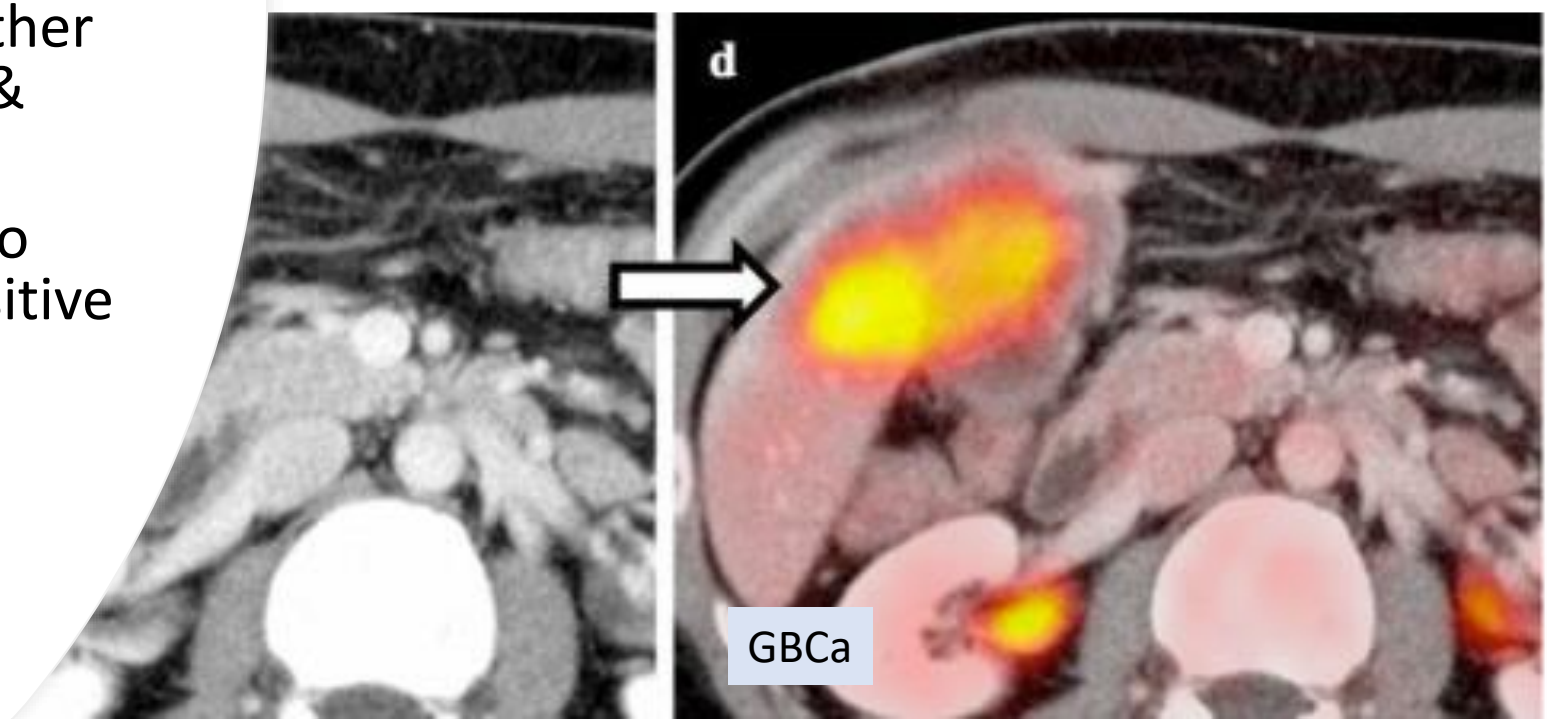


FDG-avid iCCA with central photopenia (*) indicating necrosis/fibrosis with FDG-avid portal LN (a,) & aortocaval LN (b,) metastases.

PETCT for GBCa

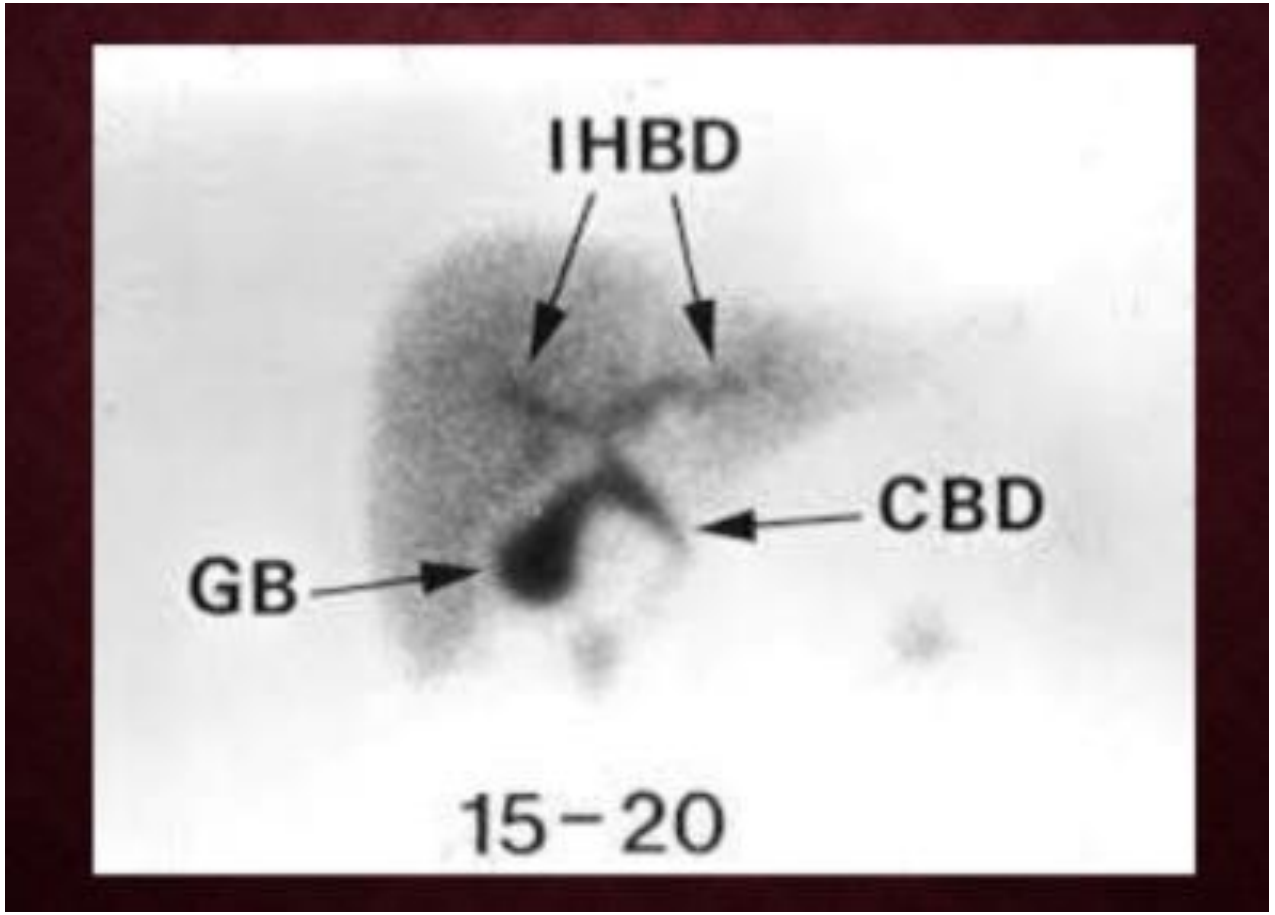
- Intense accumulation of 18 F-FDG in region of GB suggests malignancy although it lacks specificity in differentiating primary GBCa from other malignant lesions such as HCC, CCA & metastatic disease
- Benign inflammatory lesions can also accumulate FDG & result in false positive interpretations.
- Role in detection of unsuspected metastases





Hepatobilary Scintigraphy

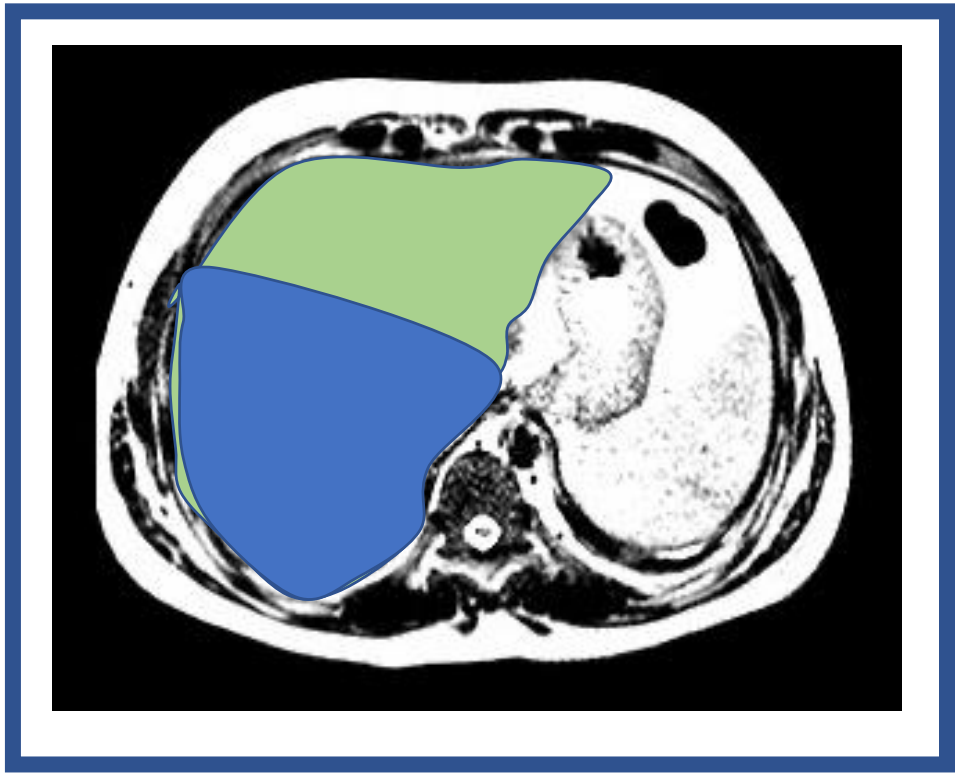
- Hepatobiliary iminodiacetic acid (HIDA) scintigraphy (bilirubin analogue labelled with 99mTc) Serial images obtained 2-4 hours after Iv injection
- Delayed Hepatic activity- HCC
- Non demonstration of gall bladder – acute cholecystitis /contracted gall bladder



Good at assessing function (physiology), but poor at assessing anatomy

Preplanning Exercise

- Contouring on the diagnostic scan
- Volumetric assessment in the diagnostic scan
- Feasibility
- Technical Challenges
- Requirement of additional imaging



Diagnostic MRI

Liver Volumetry

Liver Volumetry:

Hepatic volume was determined by manually tracing the contours of both the entire liver and the graft, excluding the inferior vena cava and gall bladder fossa.

The volumes are as follows:

REGION	Volume (grams)
Whole liver	1405
Left lateral segment	446 (32 %)
Left lobe of liver (including the MHV)	668 (48 %)
Right lobe of liver (excluding the MHV)	637 (46.6 %)

RT Planning Imaging

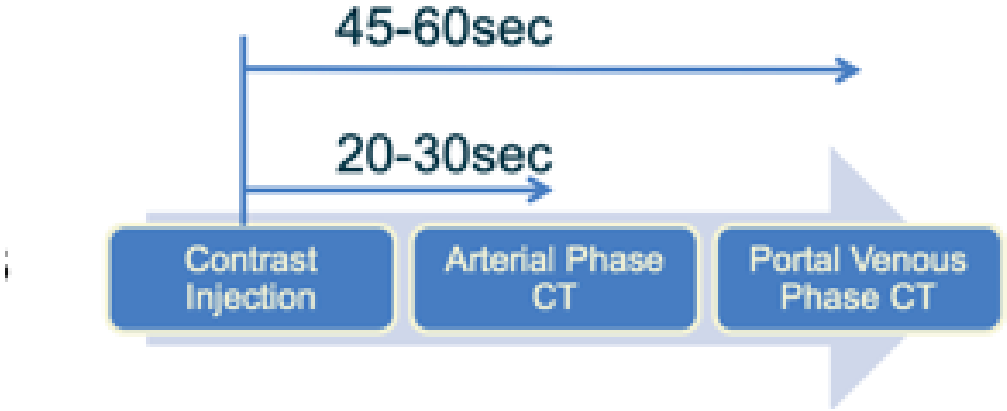
Simulation

- There are multiple luminal bowel structures in the upper abdomen so **fasting (2 to 4 hours) to be performed**
- For SBRT with internal fiducials – fiducials placed prior to the CT simulation.
- Administrationof 8 ounces of water just prior to simulation & each treatment to better delineate the duodenum and stomach.
- For postoperative treatment, scars or drains may be wired to help identify them on scan.
- Arms are placed above head so that they are not in the path of the radiation beams.

SIMULATION

CT scans used for target delineation - multi-phase IV contrast scans

- Head-first-supine position
- Arterial imaging is important;-patients undergo both an early arterial-phase CT scan acquired **at end-expiration breath-hold** and a venous-phase CT scan also acquired at end expiration.
- **Slice thickness is generally 1.25-3 mm.**
- **Levels should be 5cm above and below ROI**
- 4D CT scan obtained to capture respiratory motion as well as to serve as a delayed-phase scan especially for intrahepatic lesions
- Oral contrast/water for delineation of duodenum



Planning MRI

- Ideally be performed on same day as CT in treatment position
- Acquisition of an MRI in trt. position enables normal organ & tumour delineation in exact position in which a pt will be treated with RT with same immobilization devices

MR sequences that will typically be utilized for contouring the radiation targets are

T2 (duodenal wall delineation)

Fat-suppressed T1 (normal gland delineation)

Late arterial phase post-contrast fat-suppressed T1 (tumor & LN delineation)

Tumor appears dark, LNs appear bright) because these sequences offer best contrast resolution between tumor & normal tissues

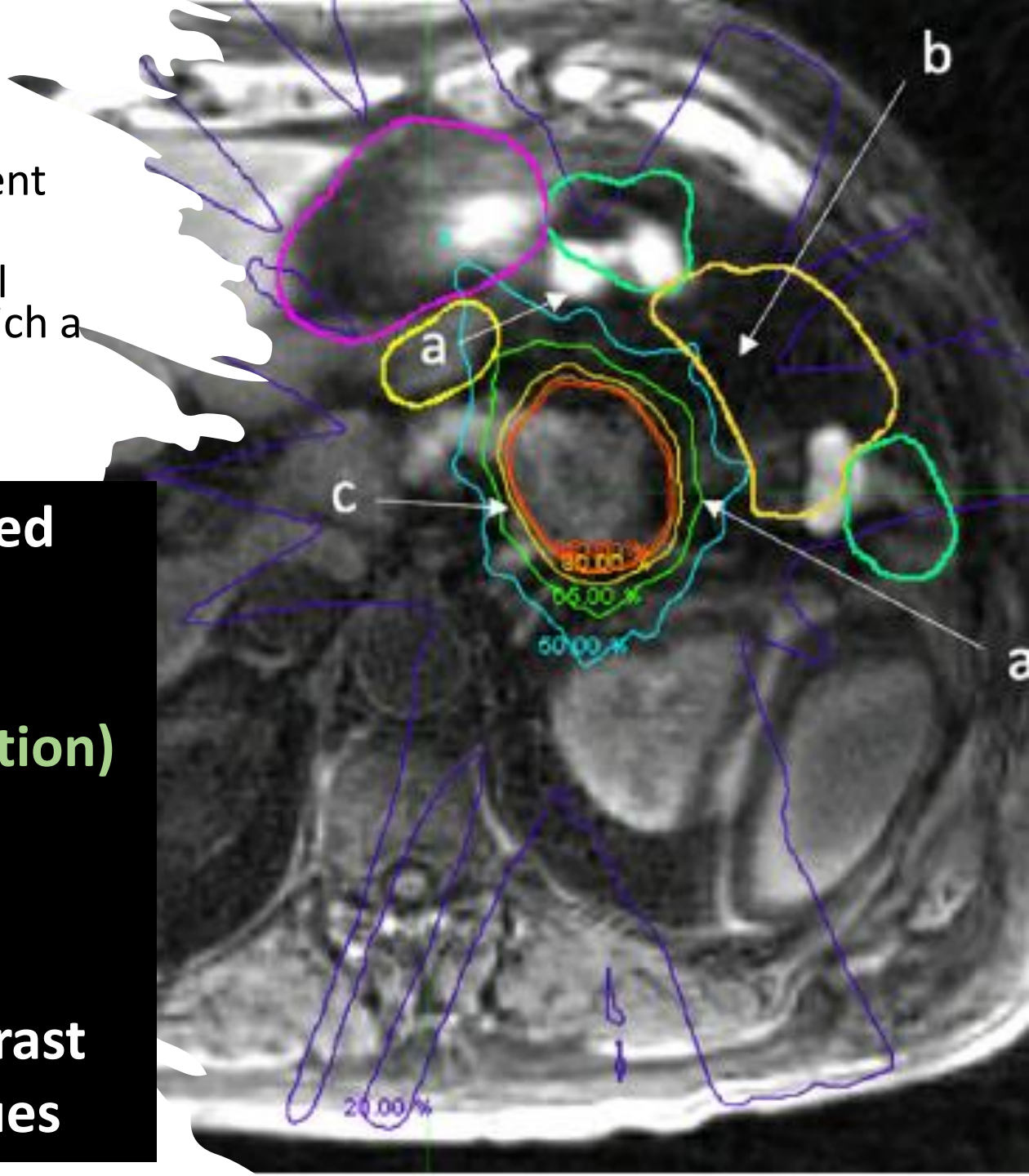
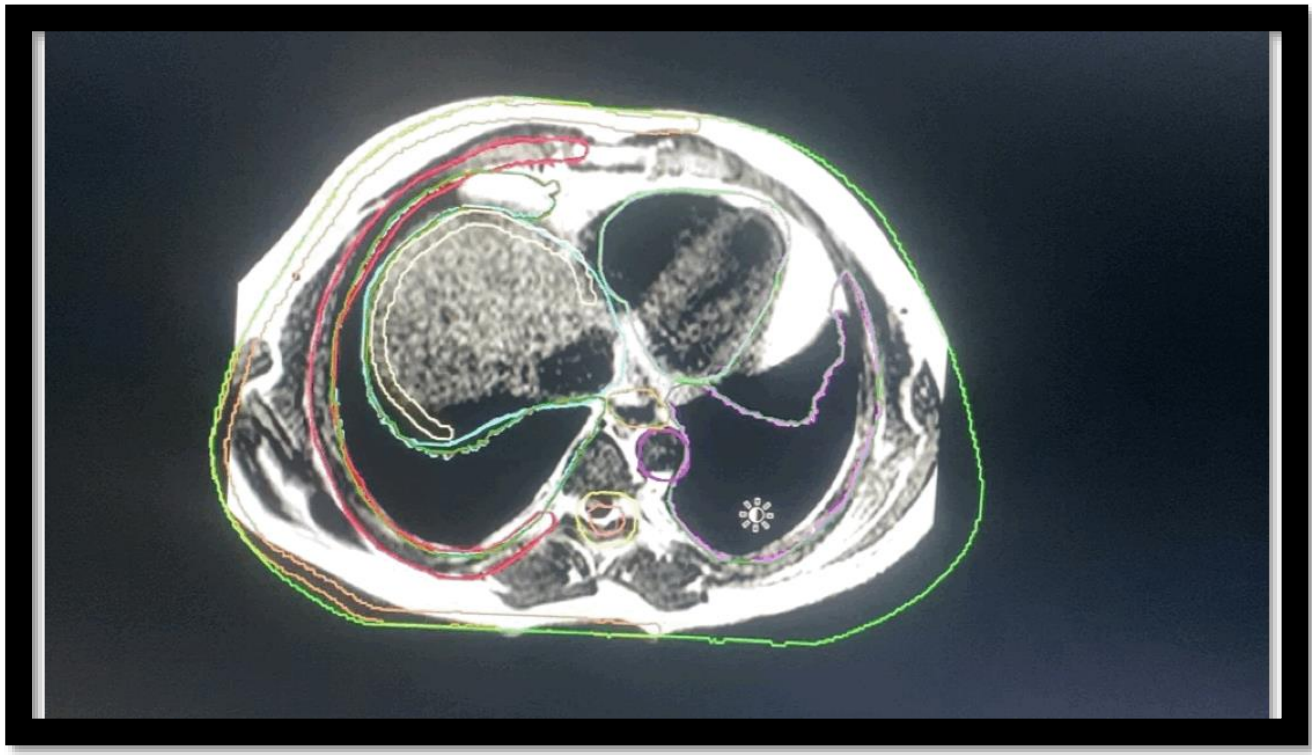
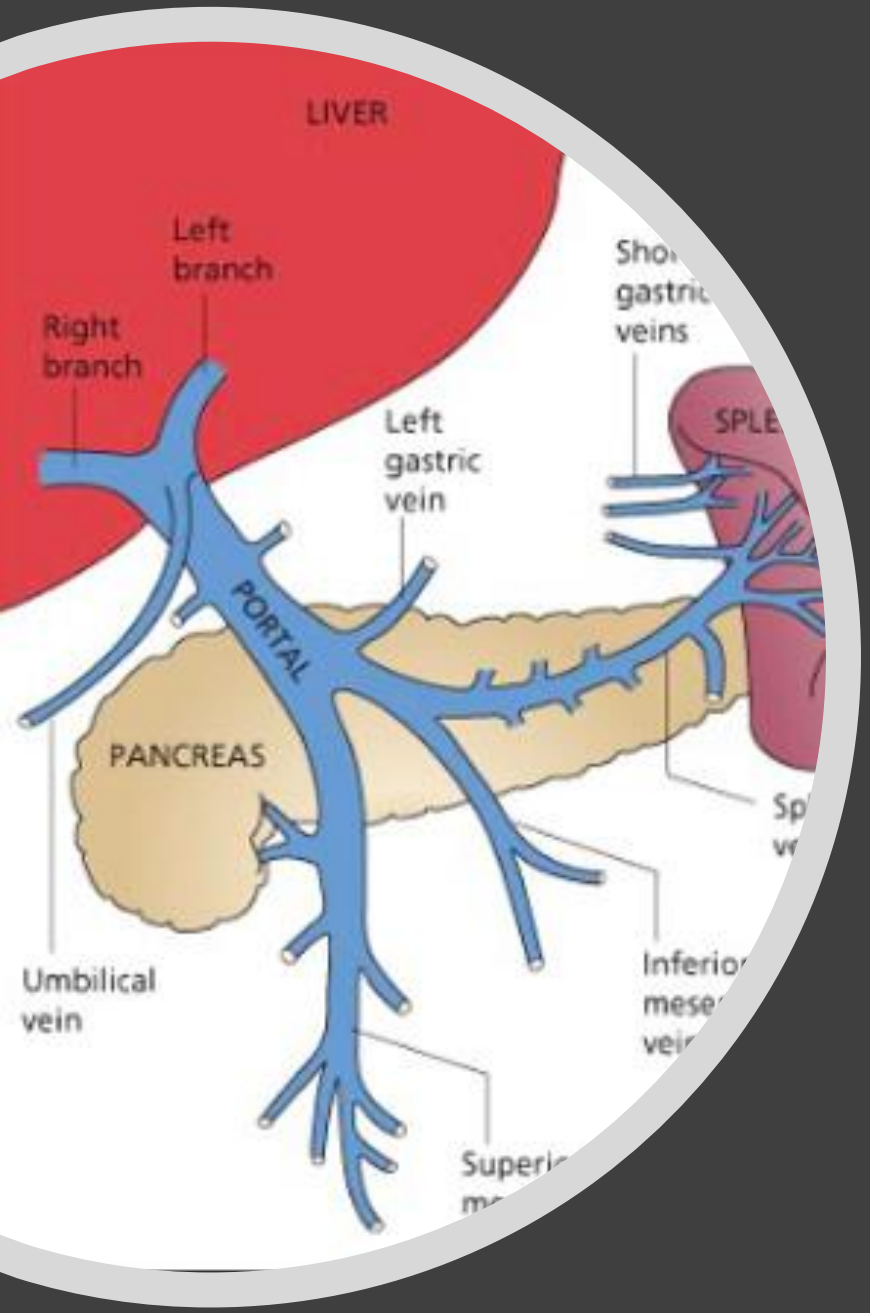
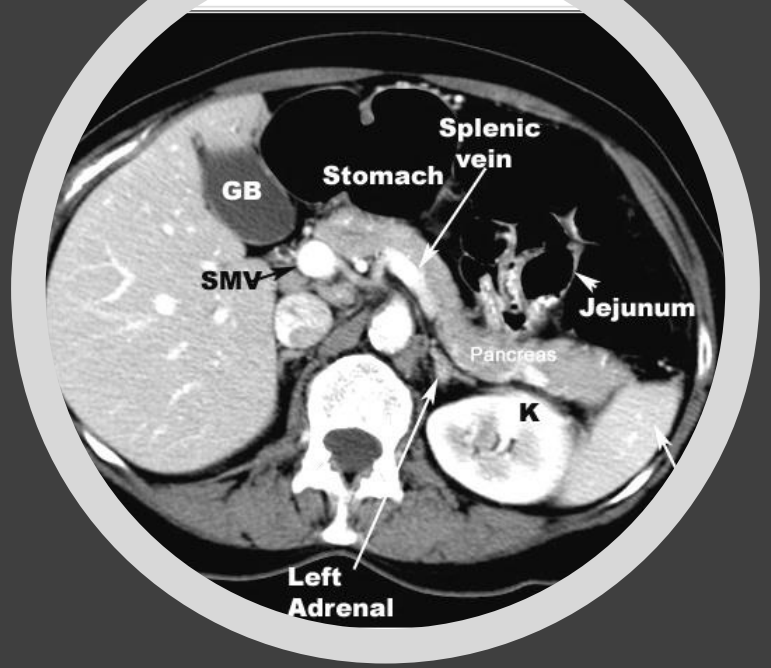


Image Registration

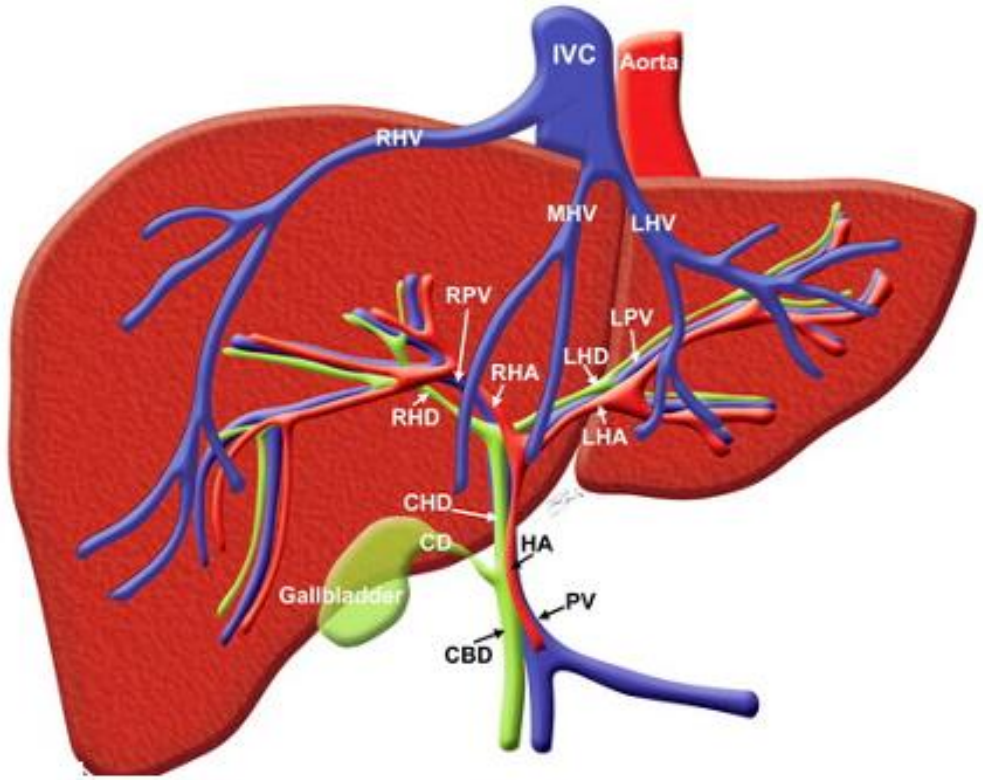
- **Multiple registrations permitted in new TPS**
- **Register with best fit liver- to-liver image registration, focusing on region of PTVs if deformation or rotation occurs between scans for- Liver tumours**
- **For LN delineation – Bony Match**





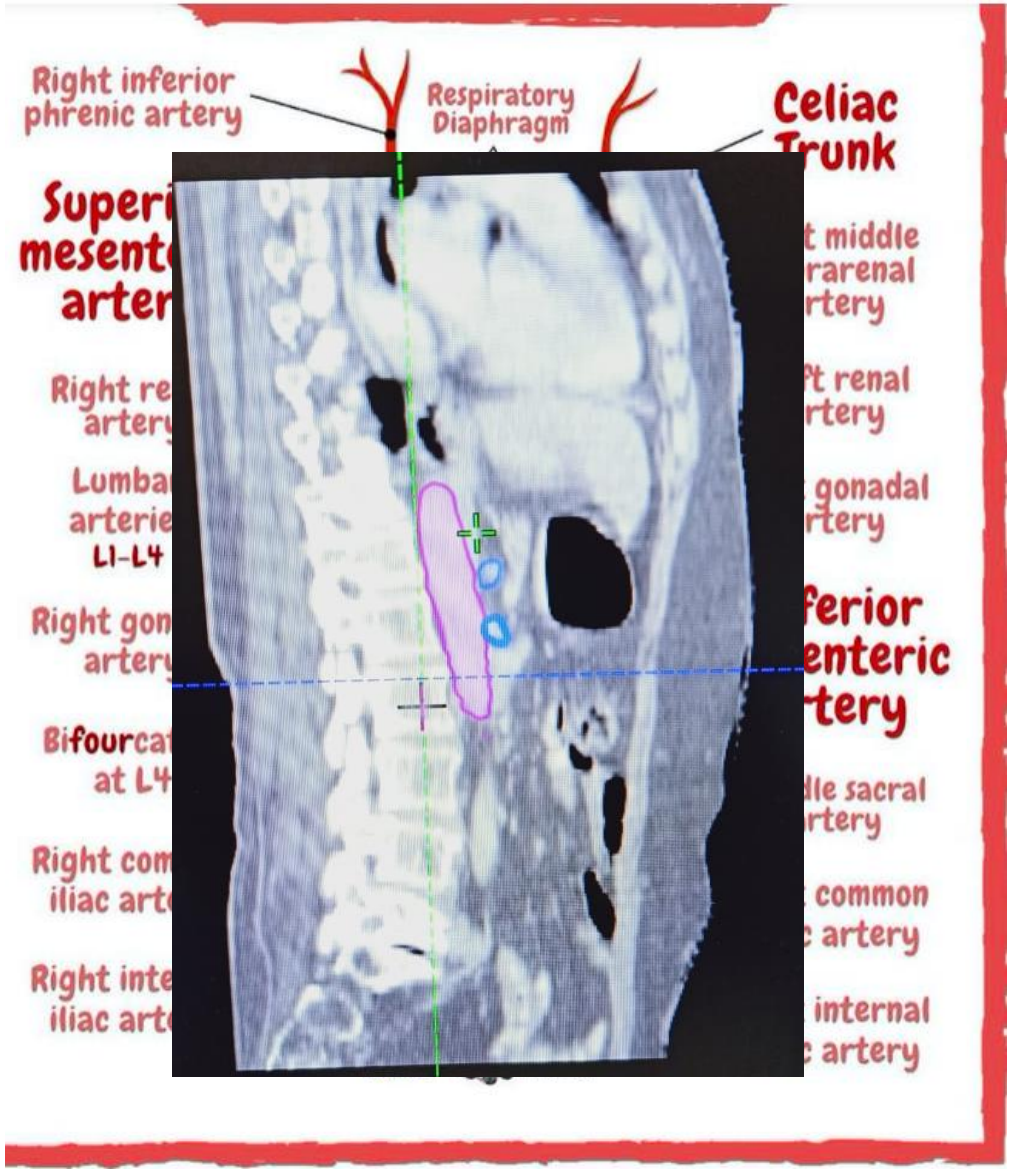


Radiologic Anatomy of HBP system/ OARS

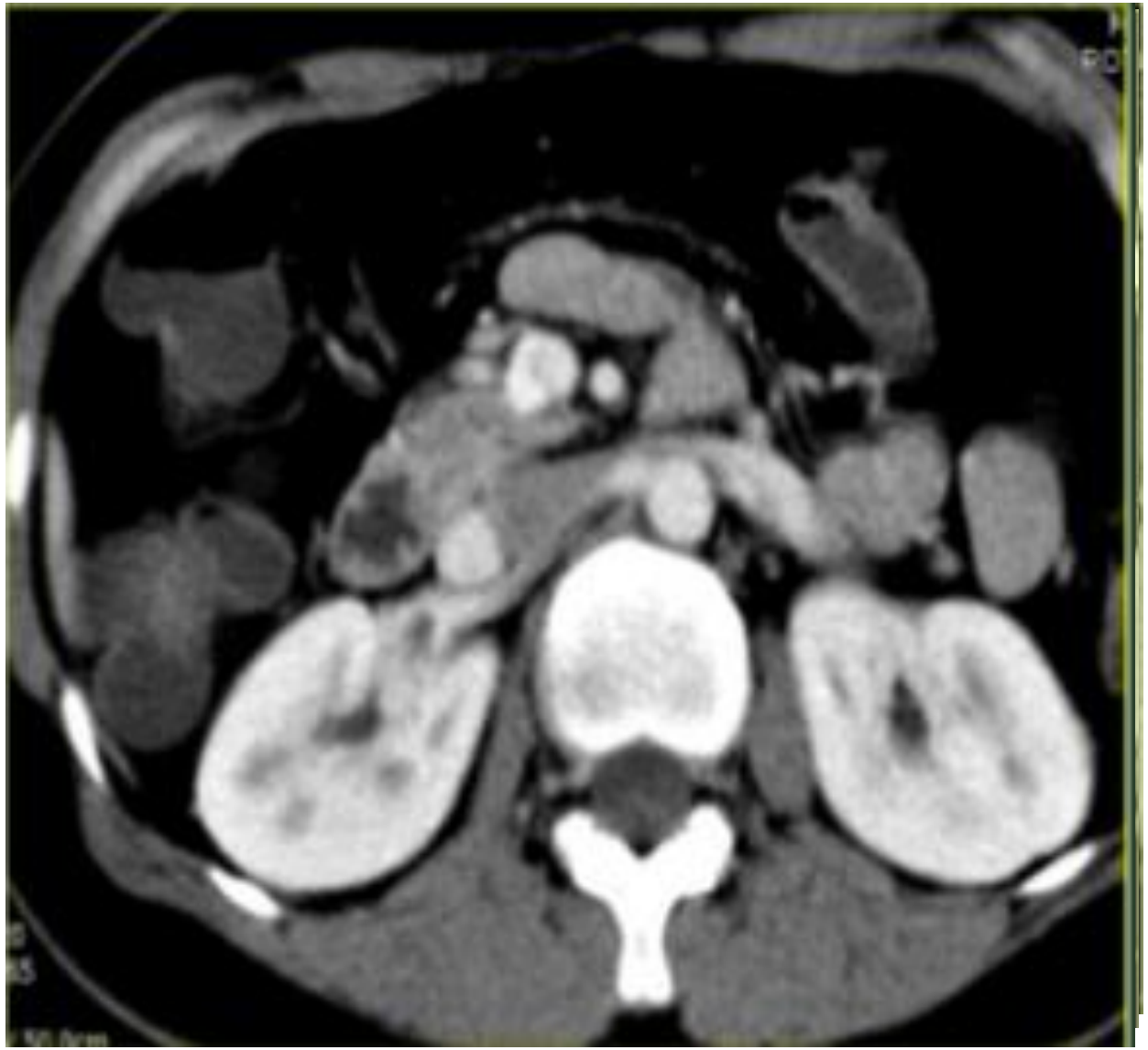


Portal Vein is formed behind pancreatic neck by intersection of SMV & SV

- PV is located posterior to CBD & hepatic artery
- PV bifurcates into RPPV, RTAPV and LPV
- Left gastric vein enters the PV near its SV/PV confluence



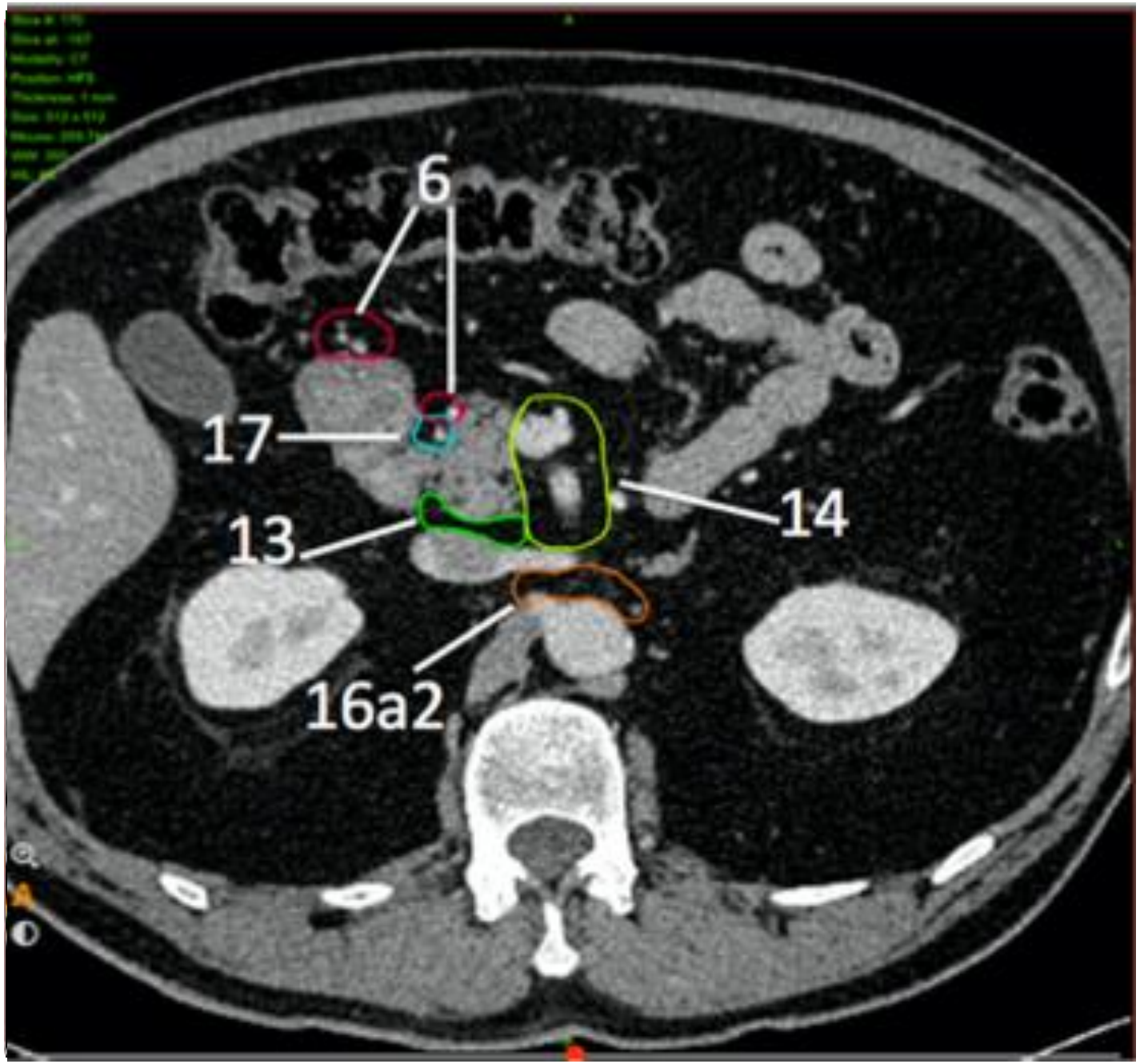
Vascular anatomy



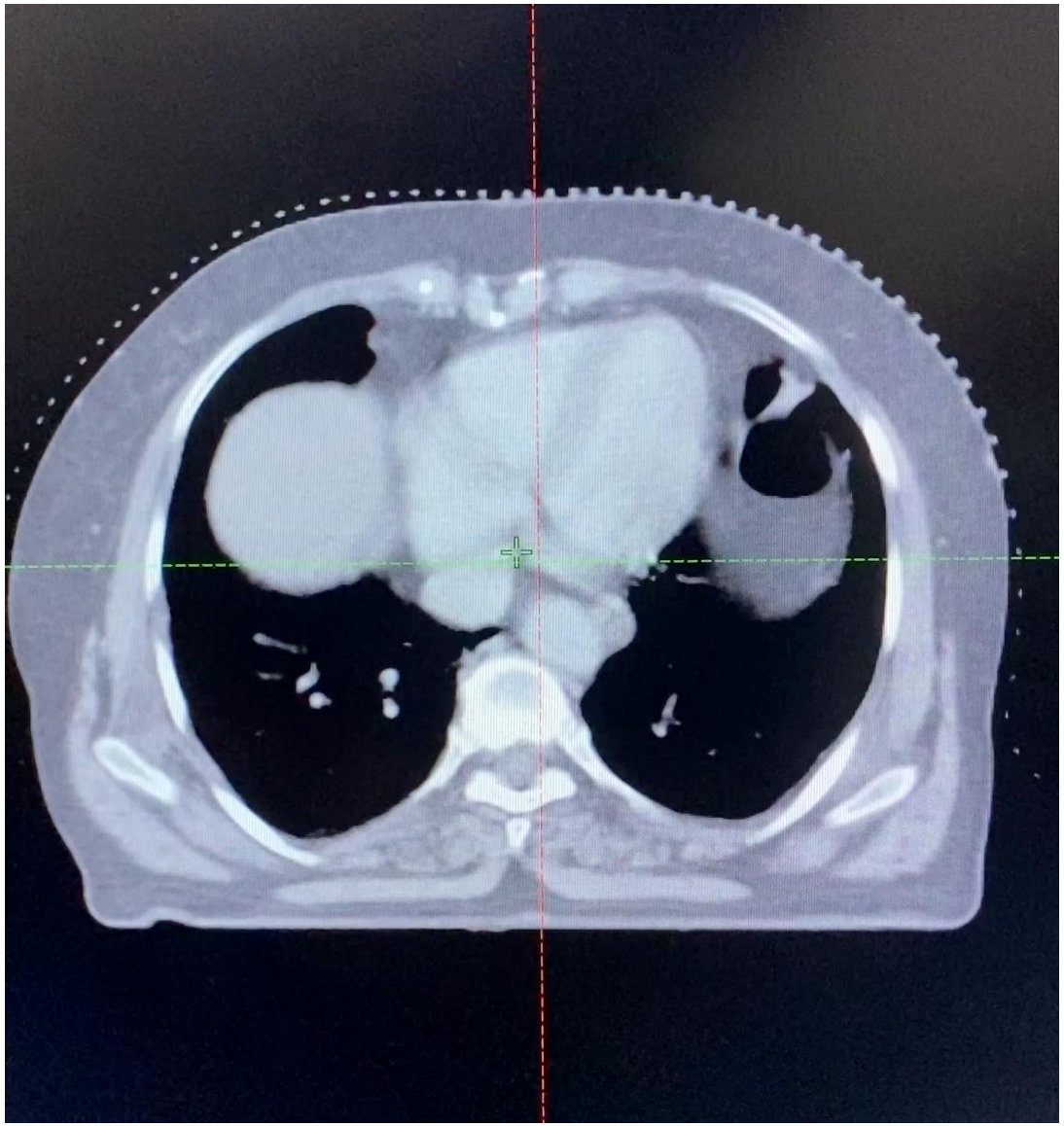
SMV
SMA
Uncinate process

Lymph Node delineation

Vessel Based



ESTRO ACROP guidelines for the delineation of lymph nodal areas in upper gastrointestinal malignancies Radiotherapy and Oncology 164 (2021) 92–97



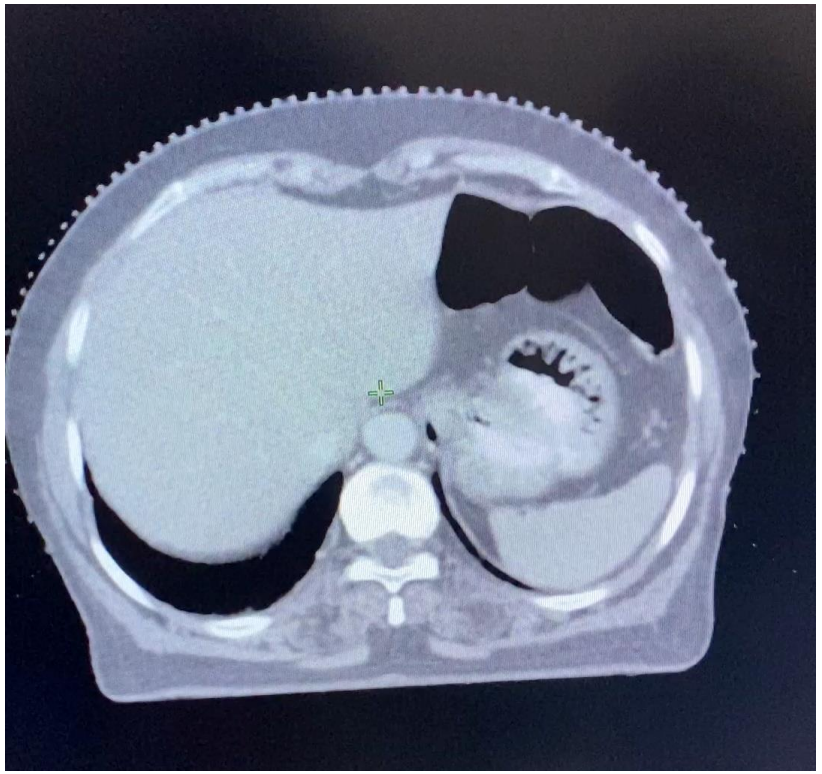
Portal Vein

Splenic V

Hepatic

Aorta

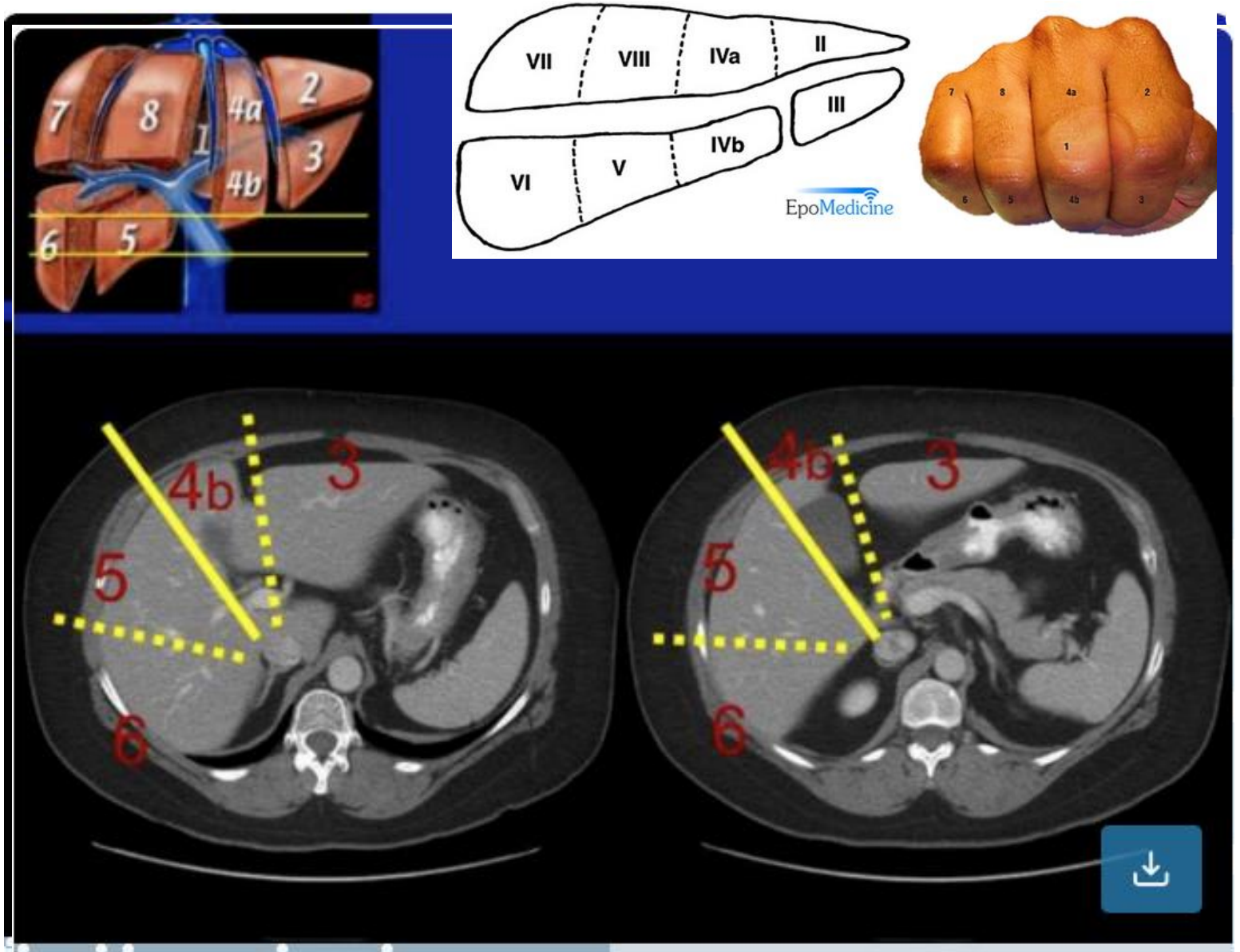
IVC

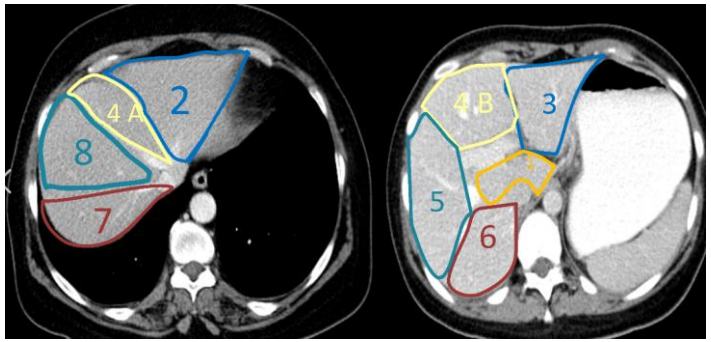


Vascular Delineation

Lymph node delineation

Segments of Liver

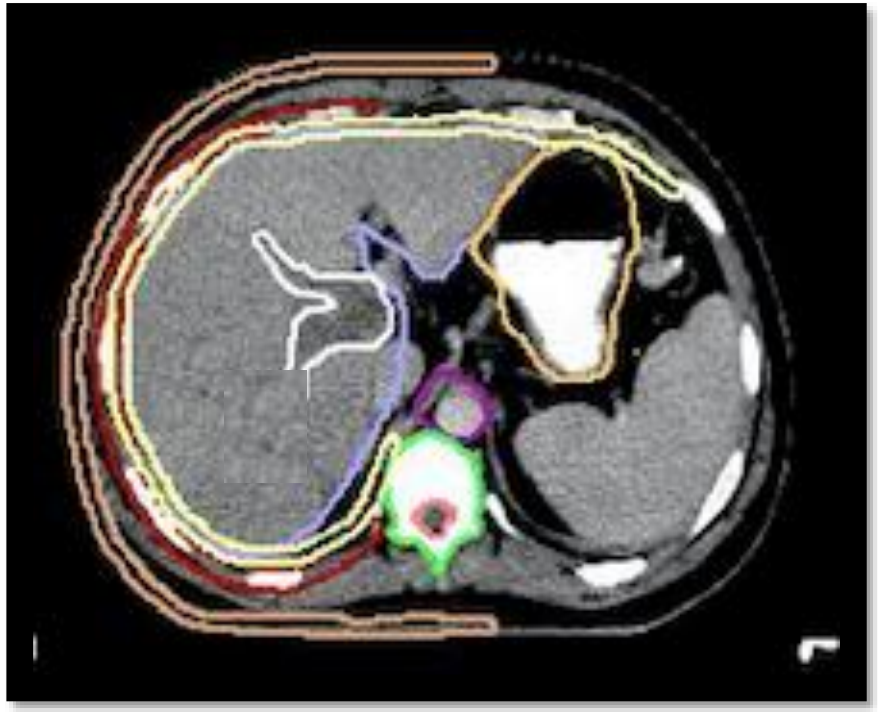


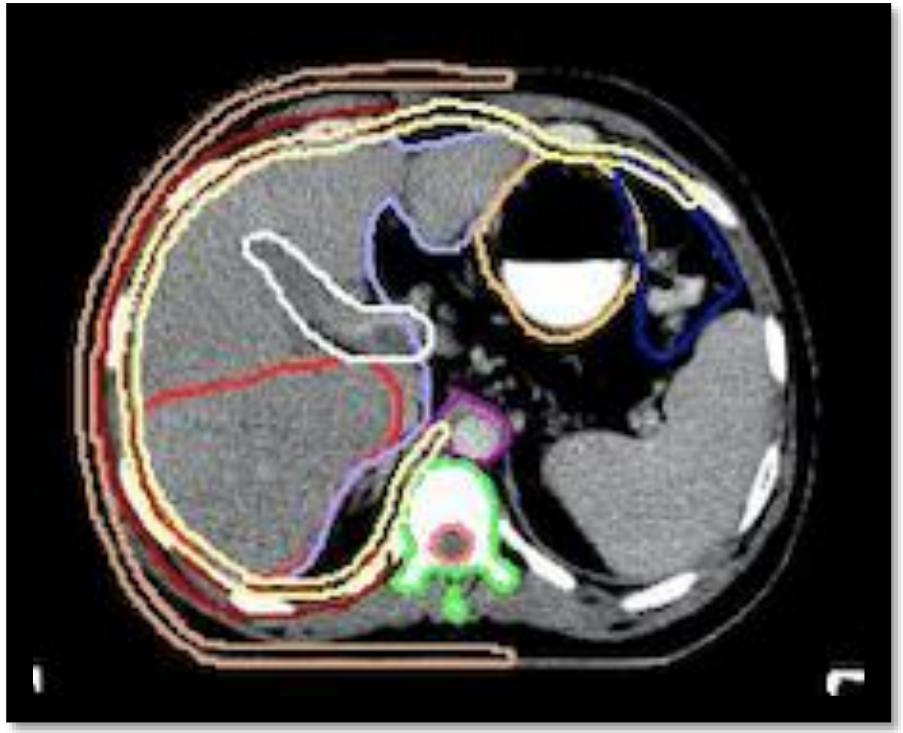


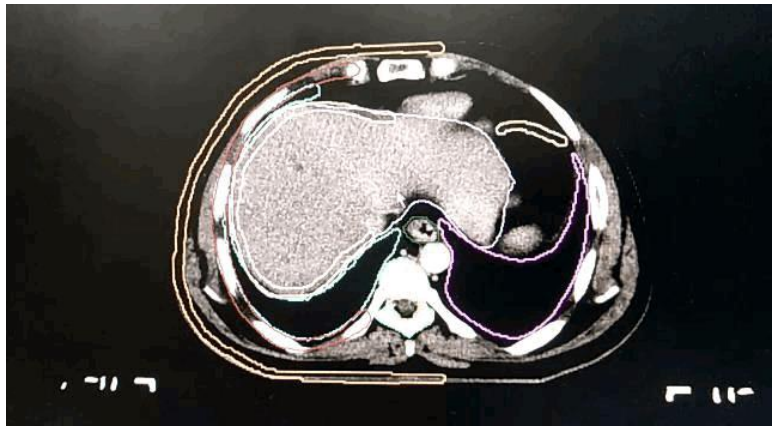
Left liver: lateral(II/III) vs medial segment (IVA/B)
Extrapolate a line along the falciform ligament superiorly to the confluence of the left and middle hepatic veins at the IVC

Left vs Right liver: IVA/B vs V/VIII
Extrapolate a line from the gallbladder fossa superiorly along the middle hepatic vein to the IVC

Right liver: anterior (V/VIII) vs posterior segment (VI/VII)
Extrapolate a line along the right hepatic vein from the IVC inferiorly to the lateral liver margin







Central hepatobiliary tract

Defined by a 15-mm expansion of the portal vein from the splenic confluence to the first bifurcation of left and right portal veins

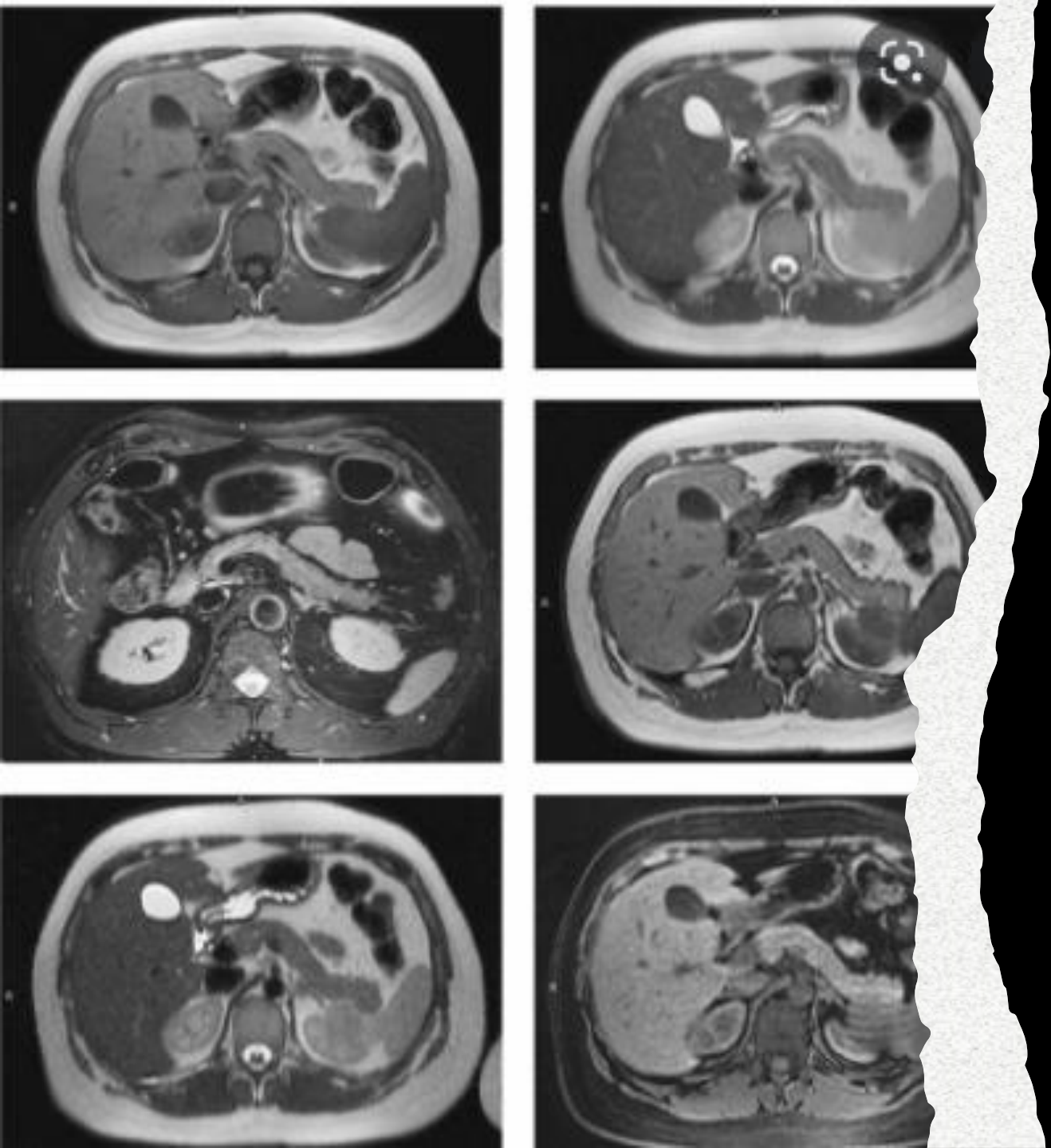
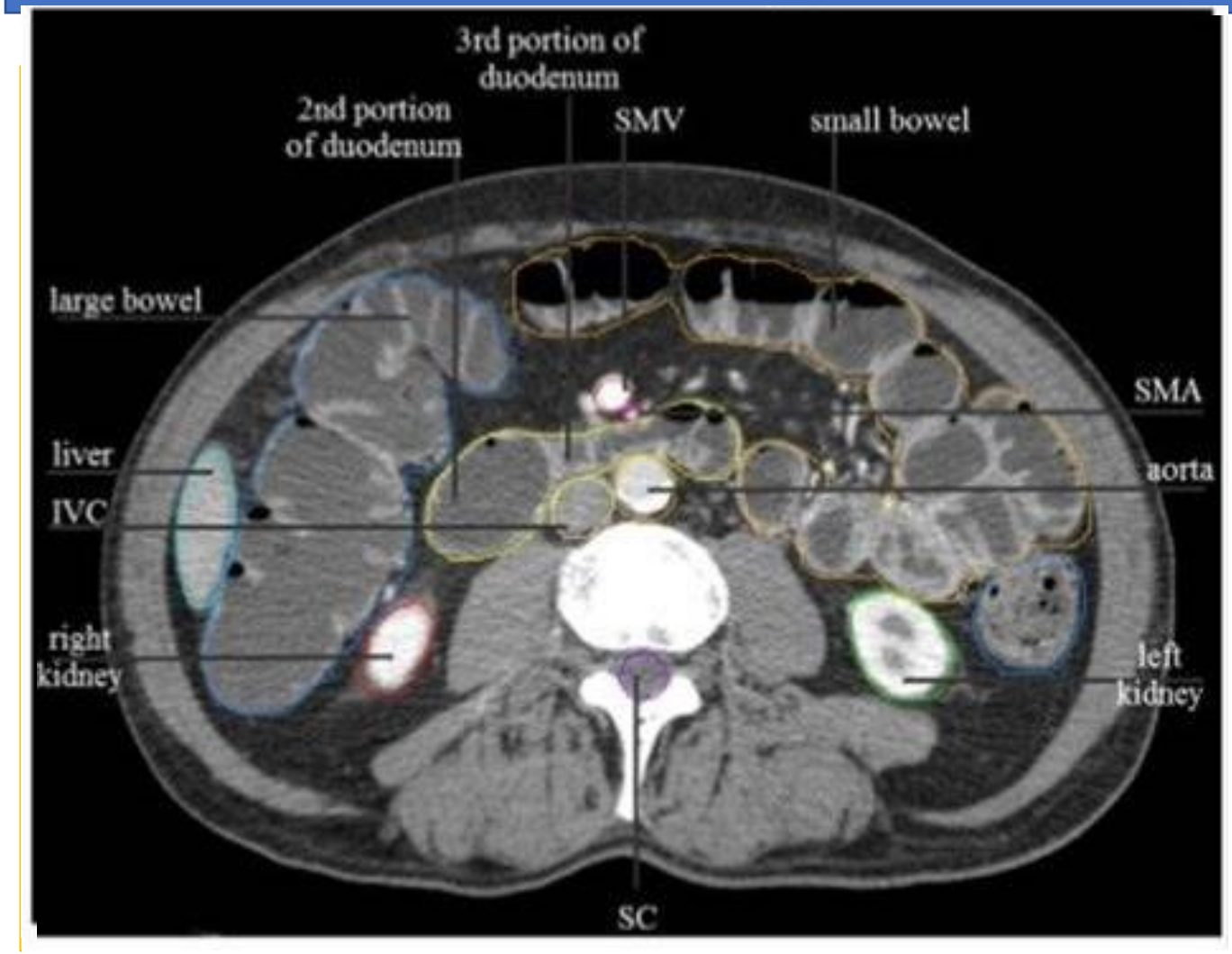


Table 1. Scanning parameters for CT using 16- and 64-slice MDCT

	16-MDCT	64-MDCT
Detector Configuration	16 x 1.25	64 x 0.625
Rotation time (s)	0.5	0.5
Pitch	0.9-1.375	0.9-1
Table speed (mm/rotation)	27.5	40
kVp	120-140	120-140
MA	ATCM	ATCM
Reconstruction Algorithm	Standard	Standard
Slice thickness		
1. Arterial phase	2.5	2.5
2. Pancreatic phase	2.5	2.5
3. Porto venous	5	5
IV contrast (mg/ml)	370	370
IV contrast volume	100-150	100-150
Contrast injection rate (cc/s)	4	4
Oral contrast	Neutral oral contrast	Neutral oral contrast
Scan delay (fixed)	40s (PP), 60s (PVP)	45s, 65s (PVP)
Reconstructions	1. Sagittal and coronal reformations 2. MIP reconstruction of arterial and venous phase 3. CT pancreatography for abnormal pancreas	

Imaging of the pancreas: Part 1

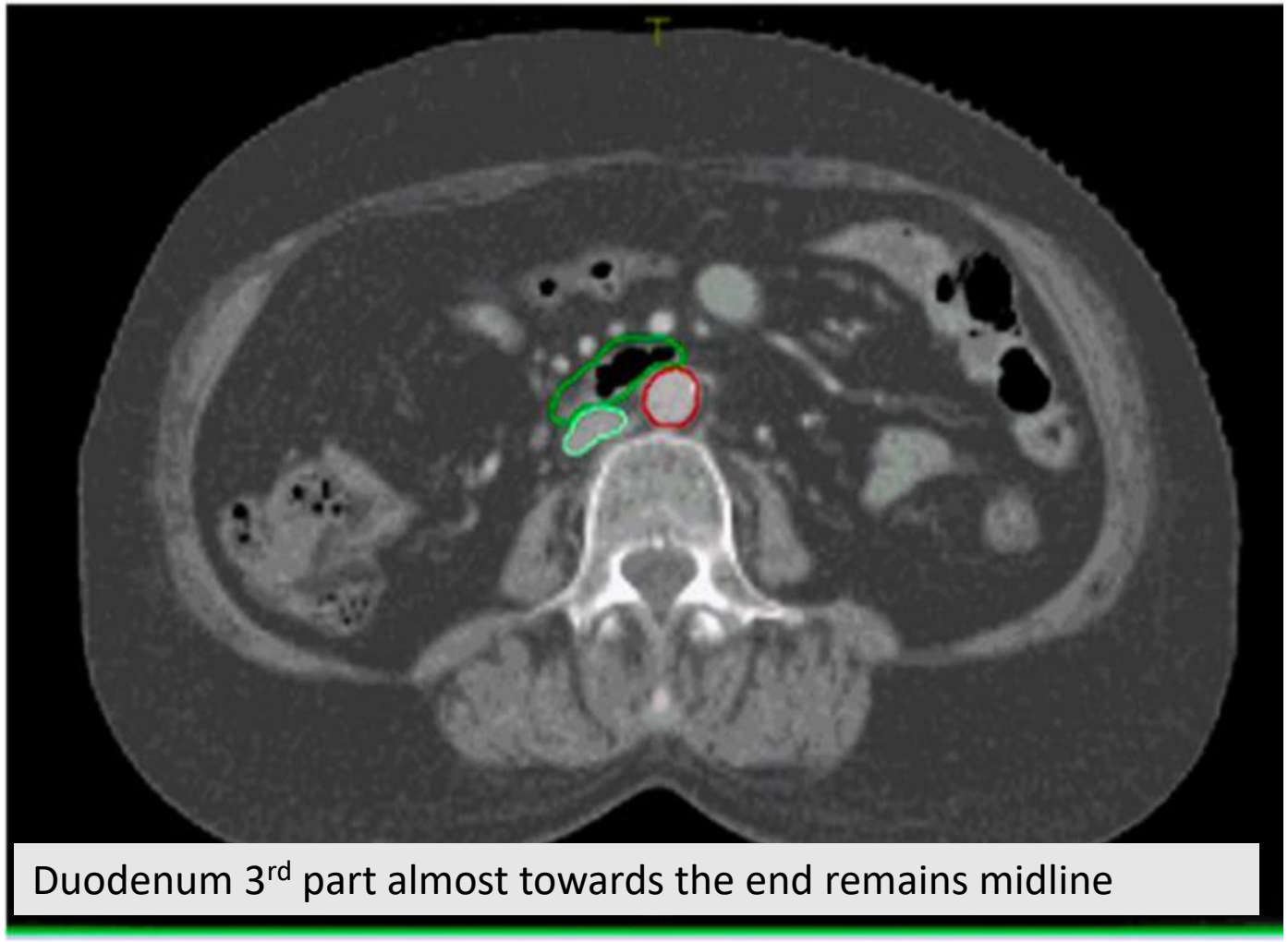
Organs at Risk



D duodenum
SV-Splenic vein
PV-portal vein
CBD-common bile duct
IVC- inferior vena cava
SMA- superior mesenteric artery
SMV -Superior mesenteric vein
SC -spinal canal
IMV- inferior mesenteric vein,
RAPV- Right anterior portal vein
MHV-Middle hepatic vein
LPV Left portal vein
H Heart
S stomach
LB, large bowel
SB Small bowel
GB, gallbladder
P pancreas
PV portal vein,
CA celiac artery

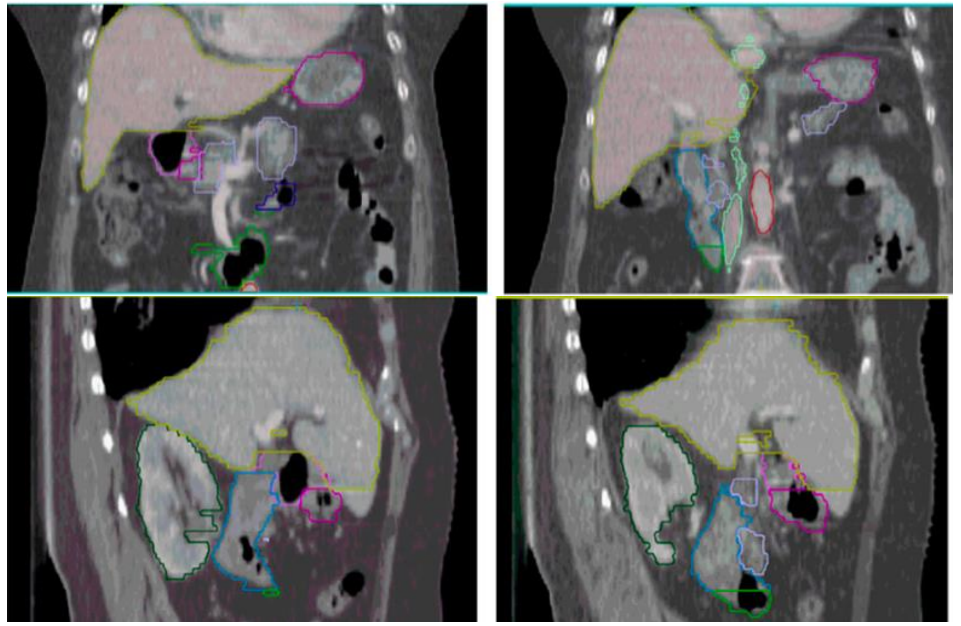
Pract Radiat Oncol. 2014 Mar-Apr; 4(2): 82–89.

Duodenum



Duodenum 3rd part almost towards the end remains midline

T Kataria et al



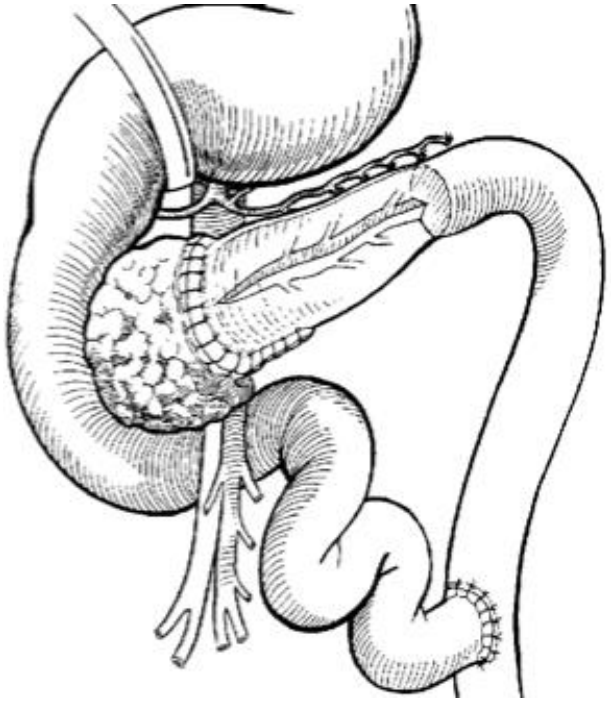
1st portion: begins after pylorus, is retroperitoneal after 1st approximate 5 cm

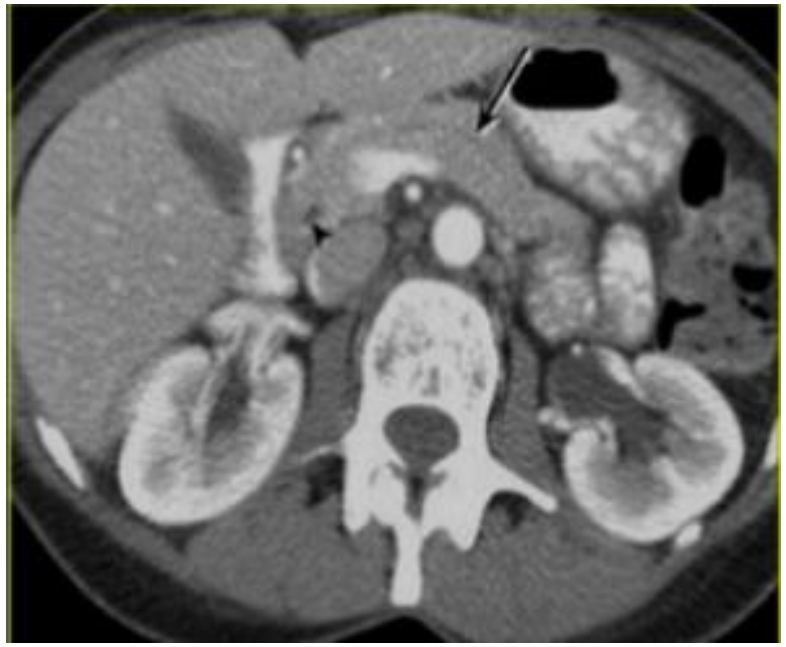
2nd (descending) portion: starts at superior duodenal flexure, is attached to head of pancreas, is about 7.5 cm long, located to rt of IVC at levels L1 to L3.

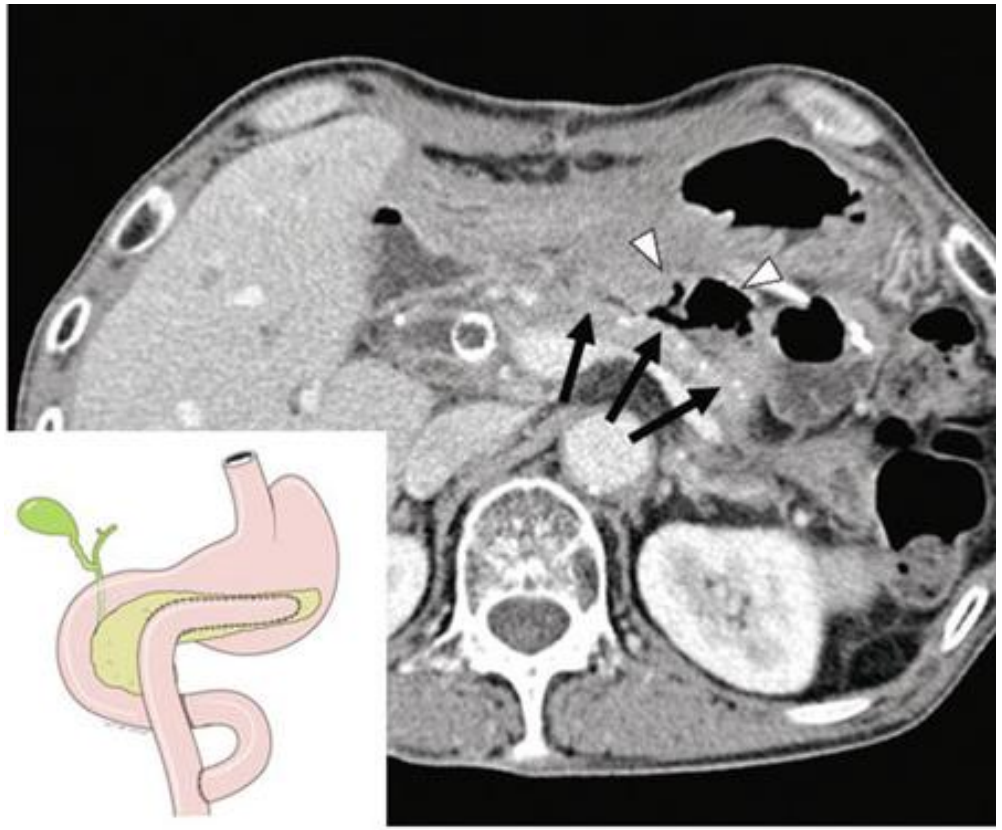
3rd (transverse) portion: crosses in front of aorta & IVC & is posterior to SMA & SMV, is about 10 cm& marks end of C-loop of duodenum.

4th (ascending) portion: travels superiorly until it is adjacent to inferior pancreatic body, is about 2.5 cm long, lies anteriorly to IMV until IMV moves medially at transition to jejunum.

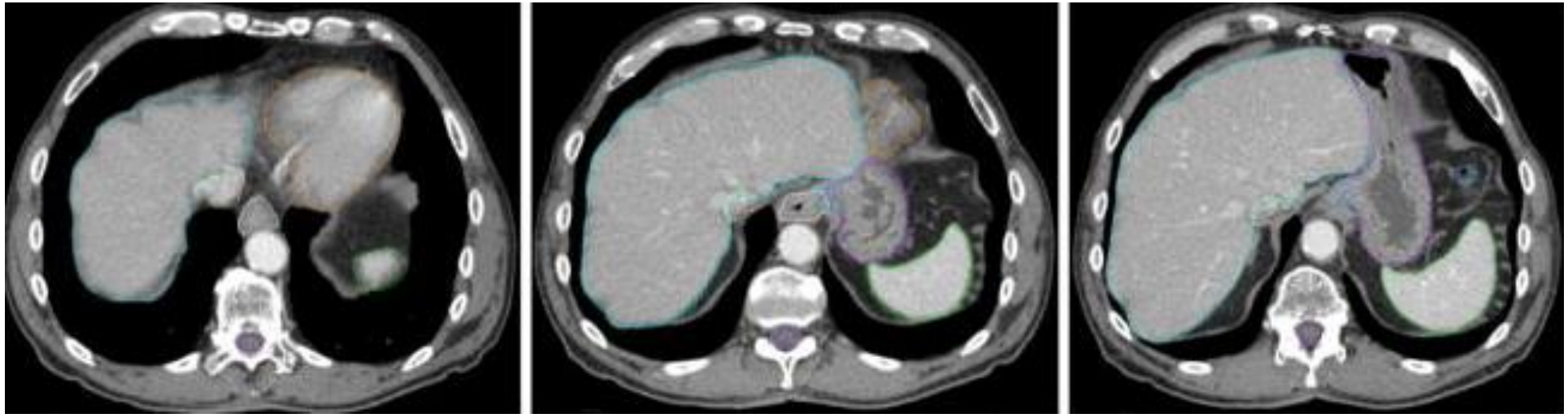
Pancreatico-jejunostomy





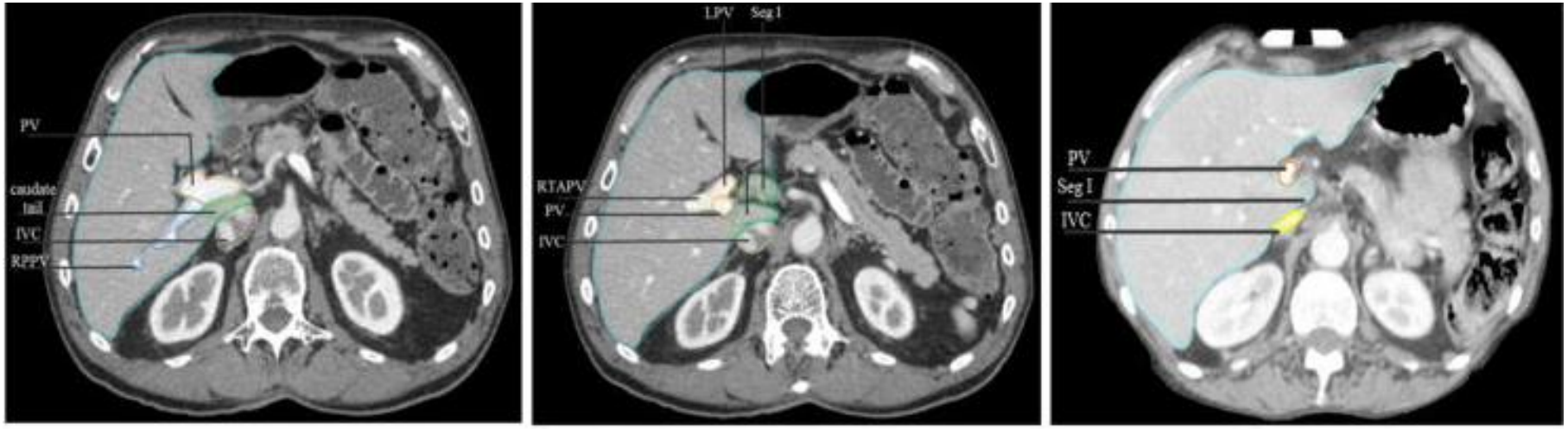


PJ is identified by following pancreatic remnant medially & anteriorly until junction with jejunal loop is noted.
PJ should be expanded 0.5 -1.0 cm in all directions



liver
IVC
esophagus
heart
spleen
stomach .
spinal canal
gastroesophageal junction
large bowel
segment (Seg) I (caudate lobe)
portal vein

Whole liver should be contoured for dose calculation with volume minus PTV



- When Segment I, "caudate tail," posterior to the PV liver contour should exclude the PV
- When Segment I to left of PV Liver contour should include segment I & PV.

Liver Contouring

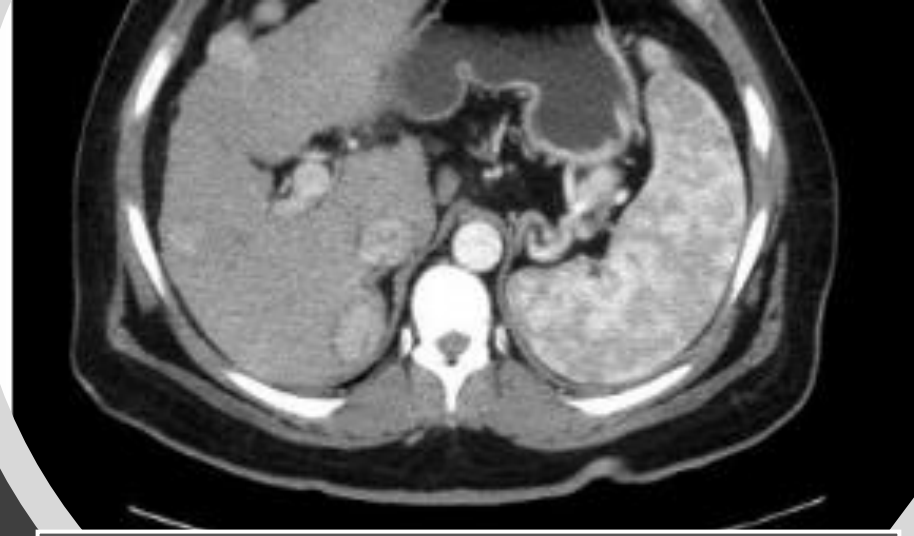
Gallbladder should be excluded
•IVC should be excluded when it is discrete from liver

Consensus contours of liver *Pract Radiat Oncol*. 2014 ; 4(2): 82–89. doi:10.1016/j.prro.2013.06.004.

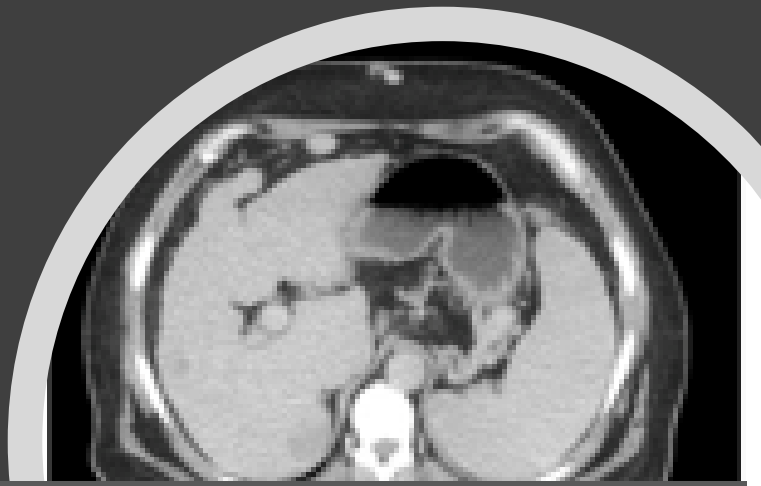
Radiologic features of HPB tumours
(for GTV delineation)

HCC

- **Lesion showing arterial enhancement - most likely HCC**
- Dysplastic nodules & regenerative nodules can show similar enhancement
- Enhancement varies with the degree of necrosis
- Administration of superparamagnetic iron oxide demonstrate HCC(contain fewer or no Kupffer cells)
- **Mangafodipir trisodium** can evaluate questionable Liver lesions -taken up by normal hepatocytes & masses that contain hepatocytes--- increased signal intensity on T1-weighted images.
- Helps differentiate a tumor of hepatocellular origin from secondary hepatic masses.

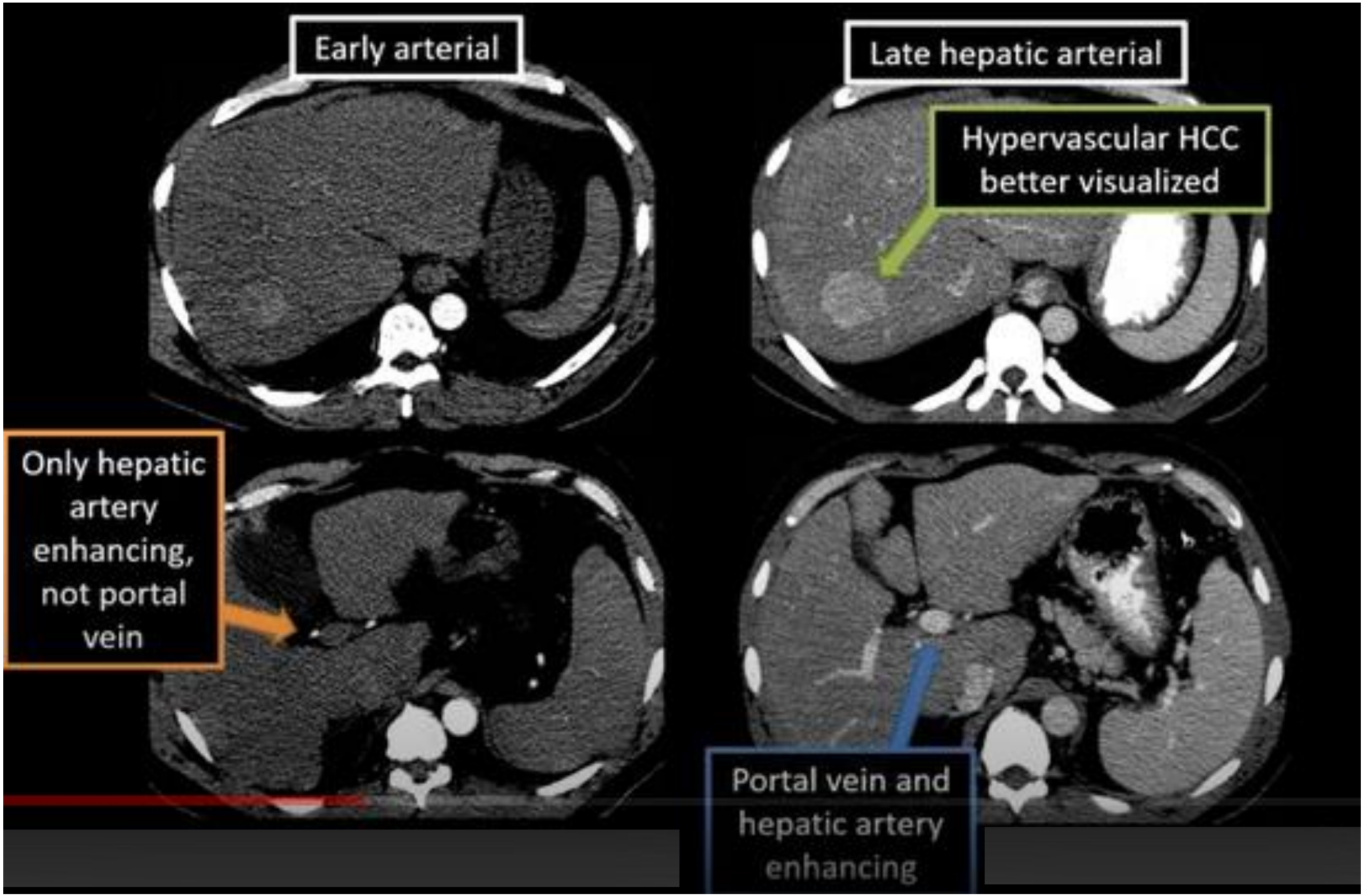


Arterial phase CT scan demonstrating enhancement of HCC



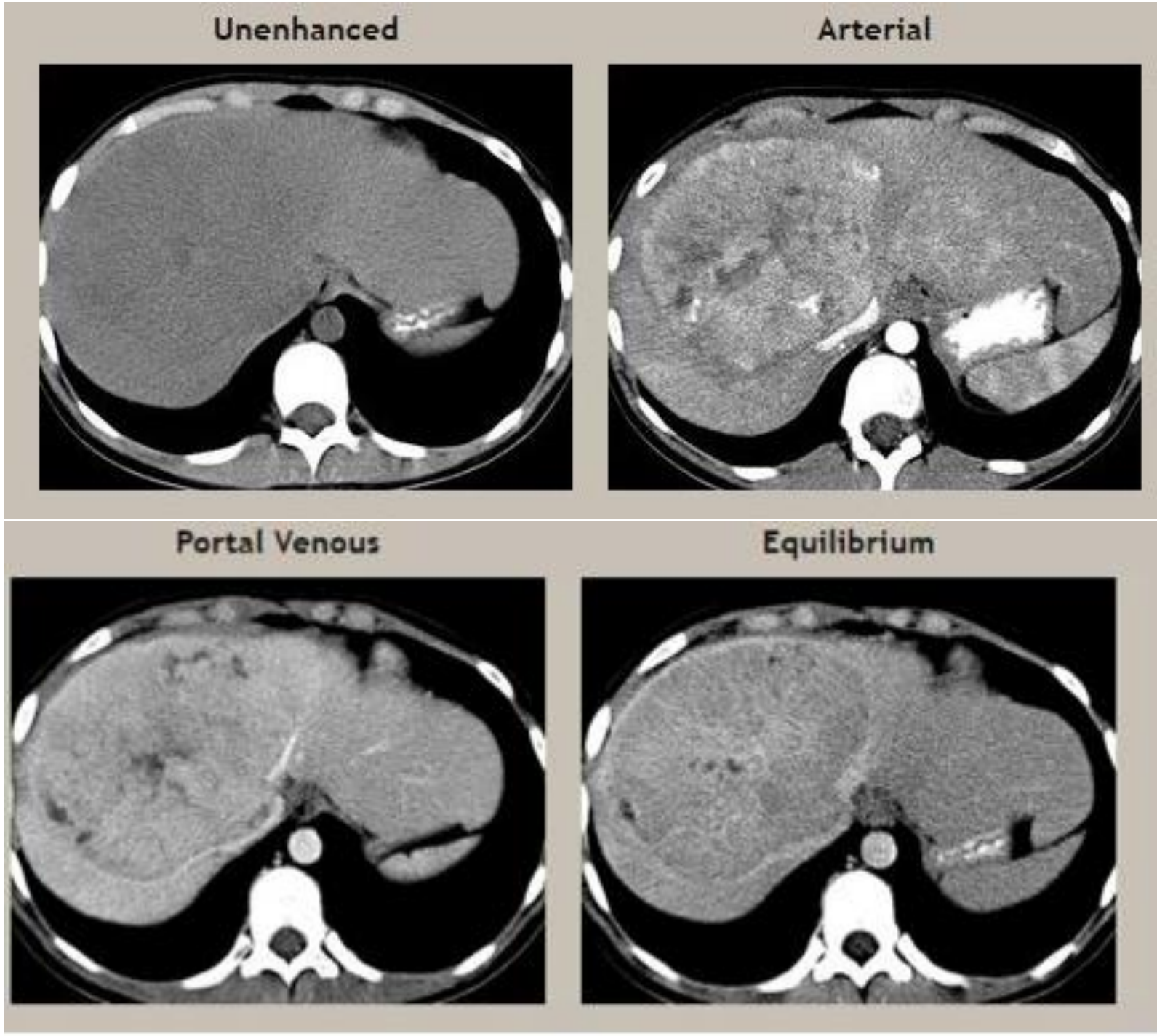
Portal Venous phase CT –Washout of HCC

https://liveratlas.org/diagnosis/14/


Early arterial
Late hepatic arterial
Hypervascular HCC better visualized
Only hepatic artery enhancing, not portal vein
Portal vein and hepatic artery enhancing

Fibrolamellar with central scar and no calcification

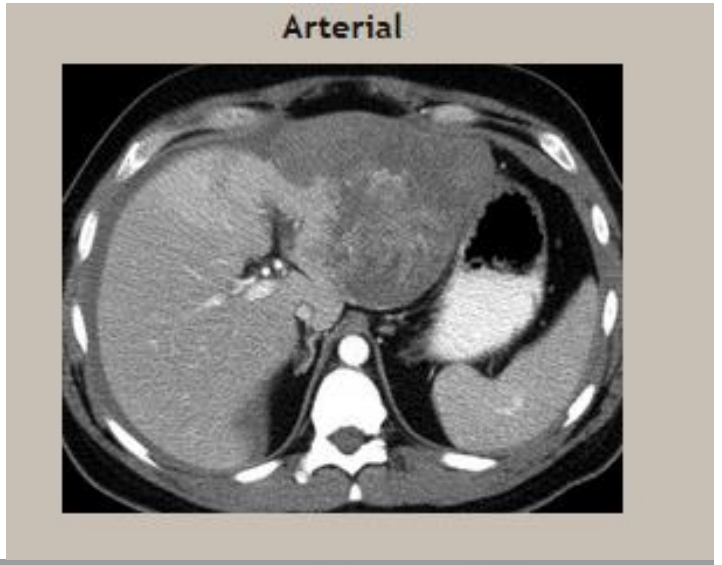
- Large well circumscribed hypervascular fibrolamellar type HCC with washout in equilibrium phase.
- Central irregular scar shows typical delayed enhancement(in 25% HCC)

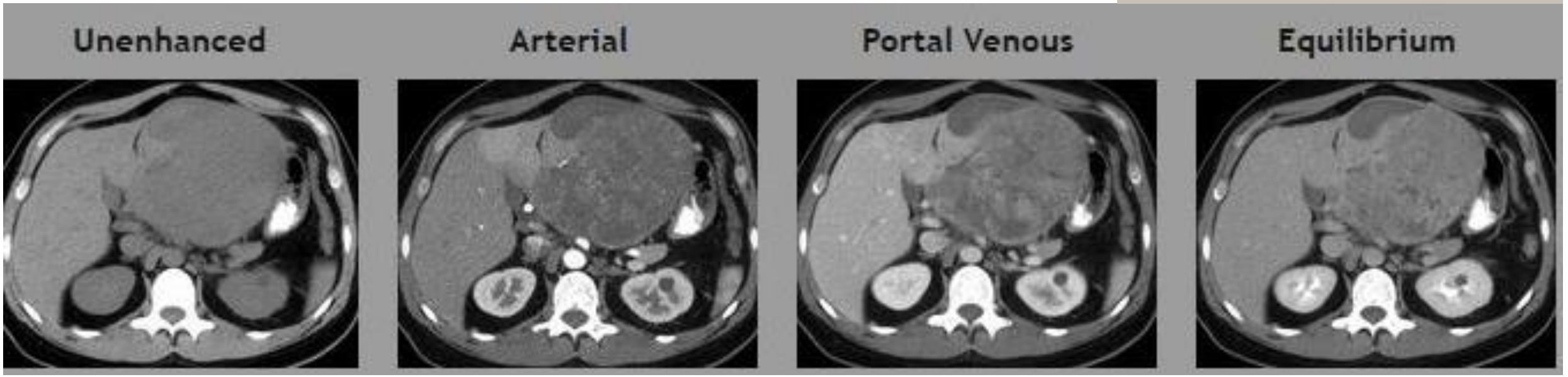


Teaching Atlas of Hepatobiliary and Pancreatic Imaging
A Collection of Clinical Cases

Hemorrhagic HCC

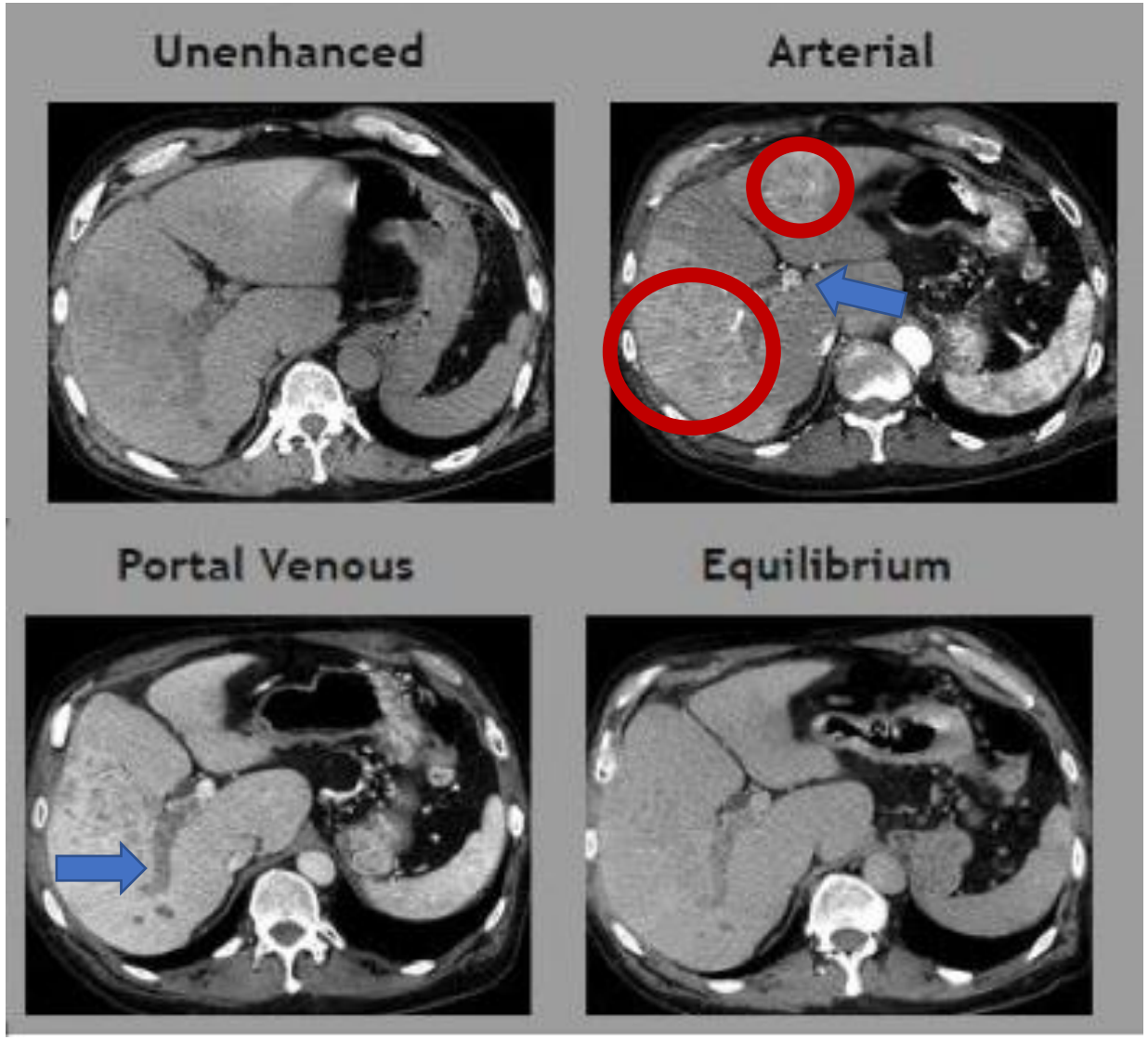
Image of mass at initial diagnosis with perihepatic fluid due to intraperitoneal heamorrhage





Large HCC in left lobe. One month after rupture with hypervascular components,necrosis and subcapsular residual hrg anteriorly and posteriorly.

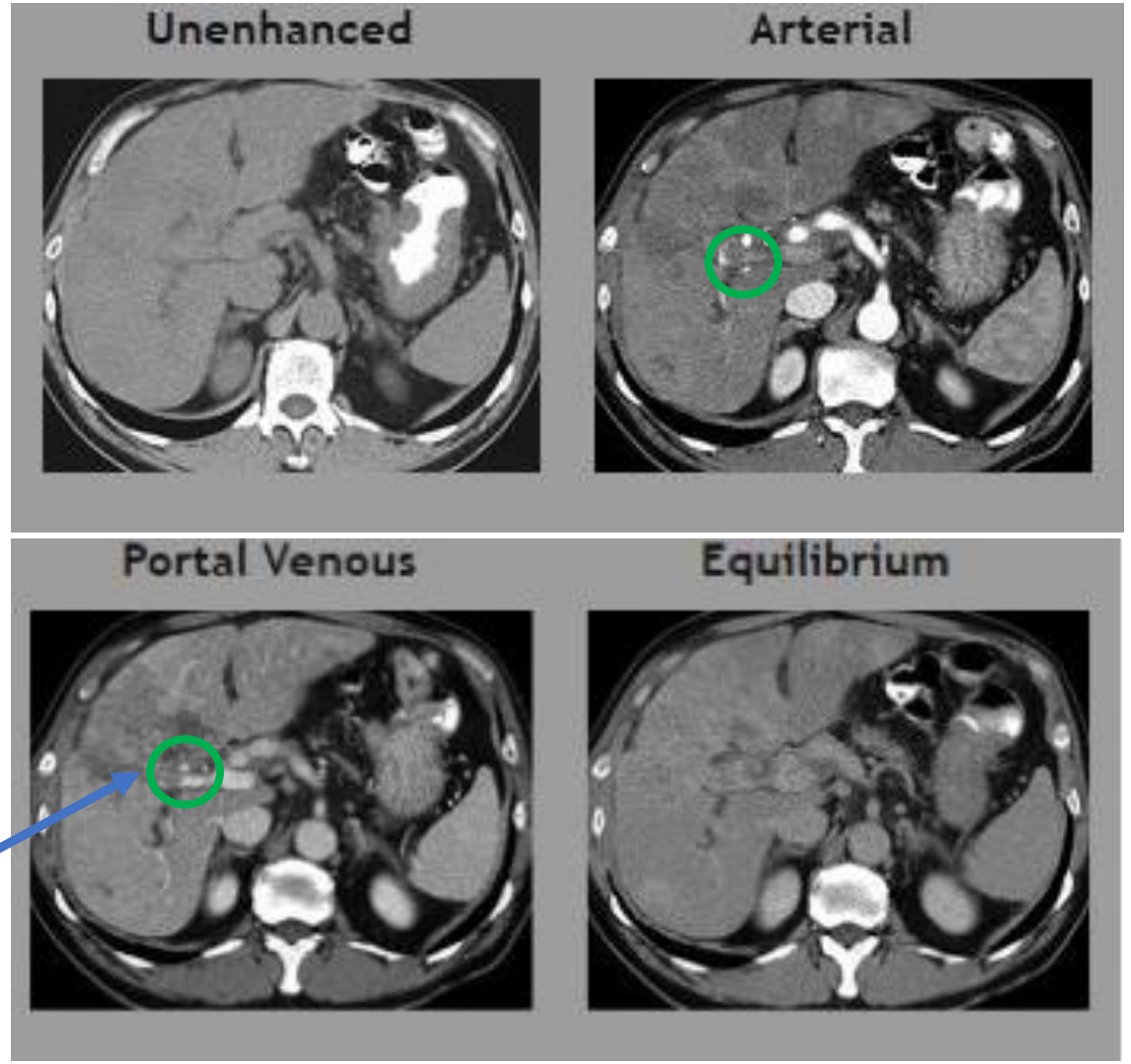
Infiltrative HCC with portal vein invasion & reactive perfusion anomaly



Infilterative HCC in right & left lobe liver. Masses are hypovascular but involved areas show hypervascularity with washout due to concomitant portal vein invasion

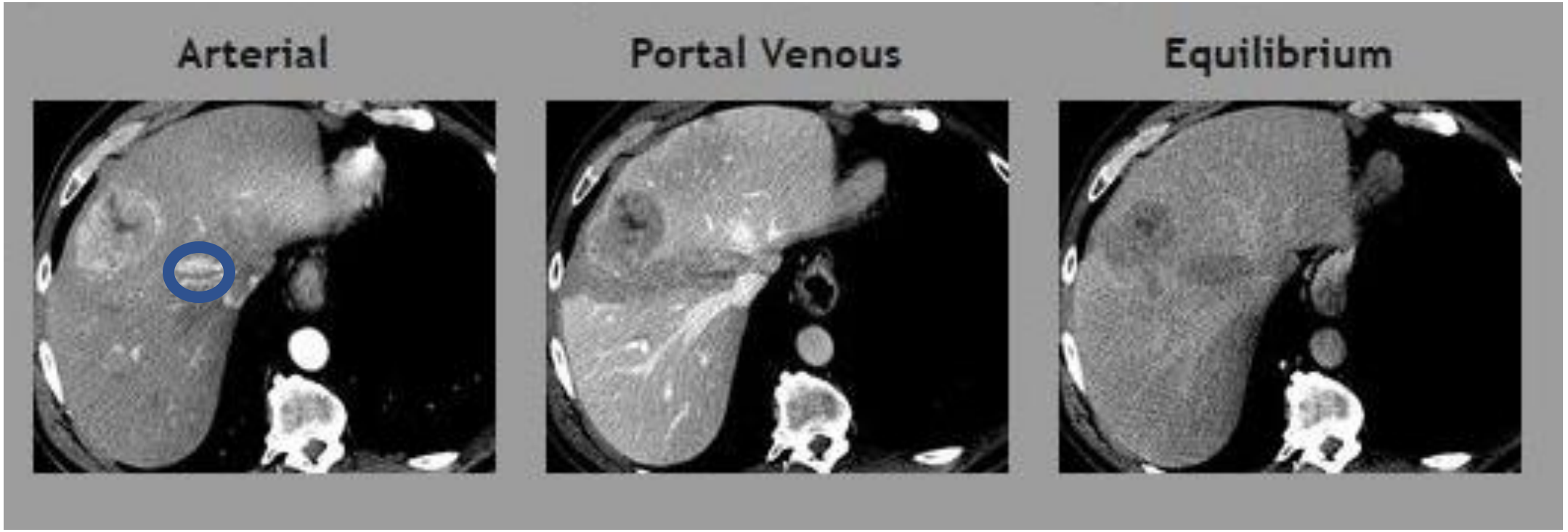
Fibrotic HCC with portal venous thrombus and bland thrombus

Vascular HCC thrombi are best seen on venous phase imaging as hypointensity relative to the contrast in the vessel



Enhancing thrombus in rt portal vein representing tumour thrombus.
Non enhancing thrombus in ant & post segmental branches representing bland thrombus.
Reactive perfusion anomalies on arterial phase obscure parenchymal portion of HCC.
Delayed enjhancement of larger portions of HCC on equilibrium phase(typical of fibrotic components)

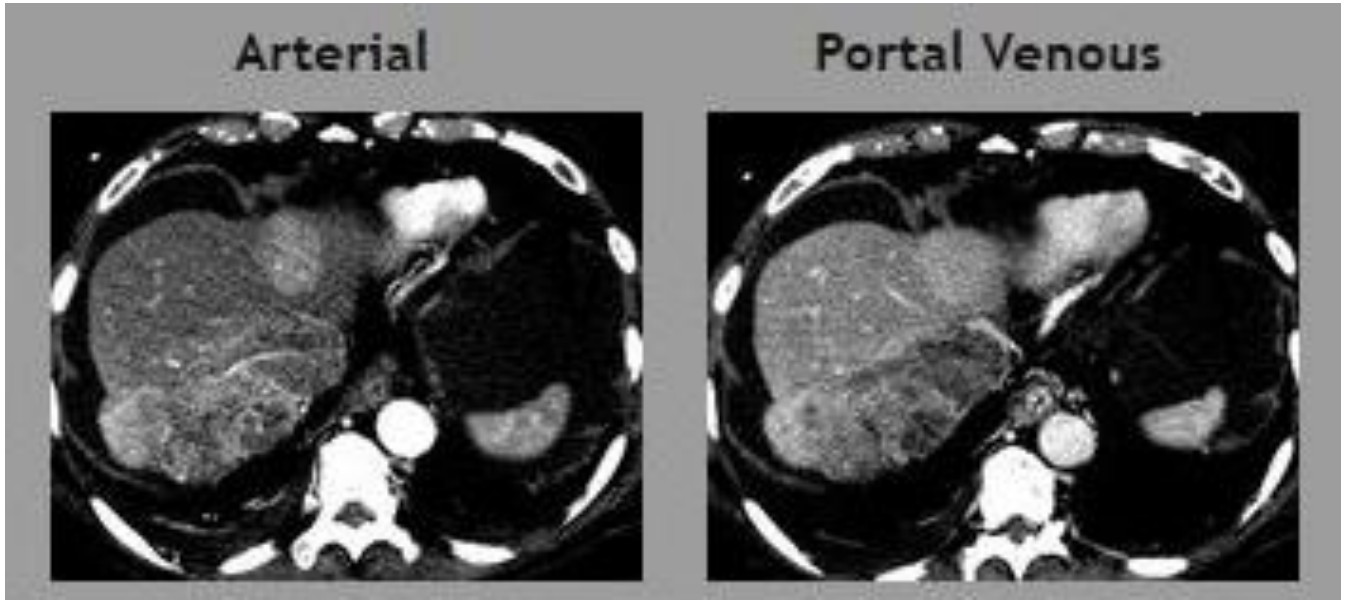
Right hepatic vein invasion with hypovascular transient hepatic attenuation difference

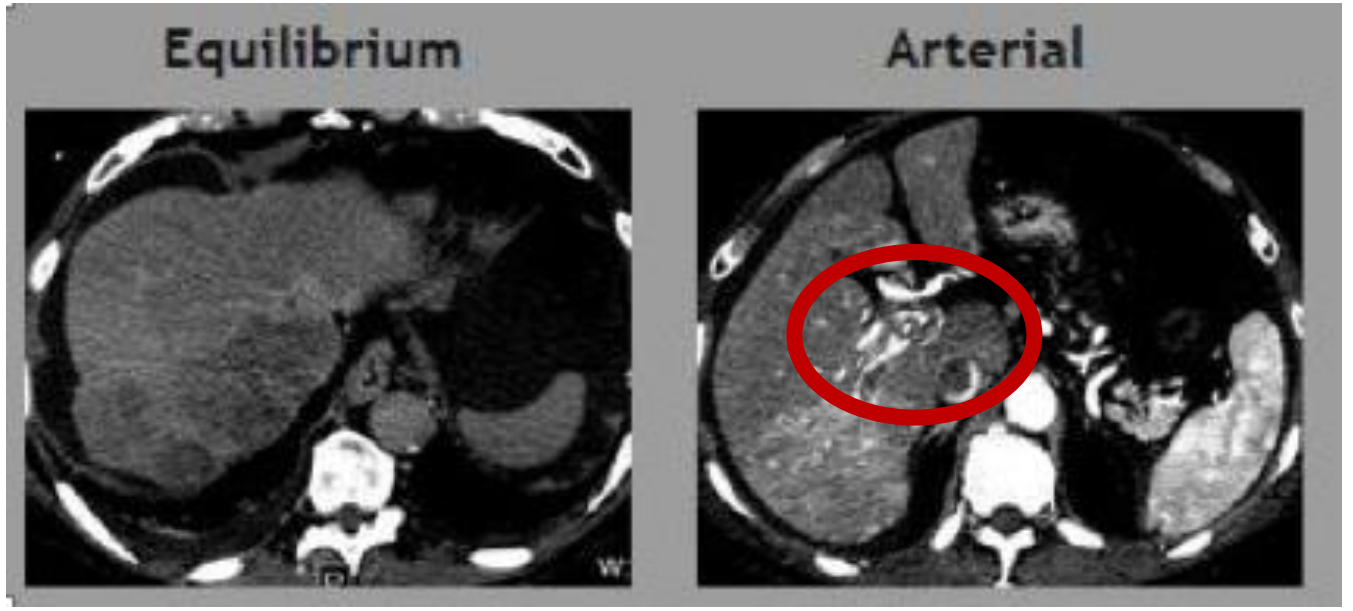


Hypervascular HCC in segment 8 with washout on equilibrium phase and invasion into right hepatic vein
Equilibrium images show posteriorly oriented tumour finger invading the hepatic vein
Hypovascular THAD is uncommon. Tumour thrombus obliterated right hepatic vein causing delayed sinusoidal opacification of the hepatic vascular territory which drains into the vein due to local congestion

Multicentric HCC withvascular invasion of portal hepatic veins ,IVC and right Atrium

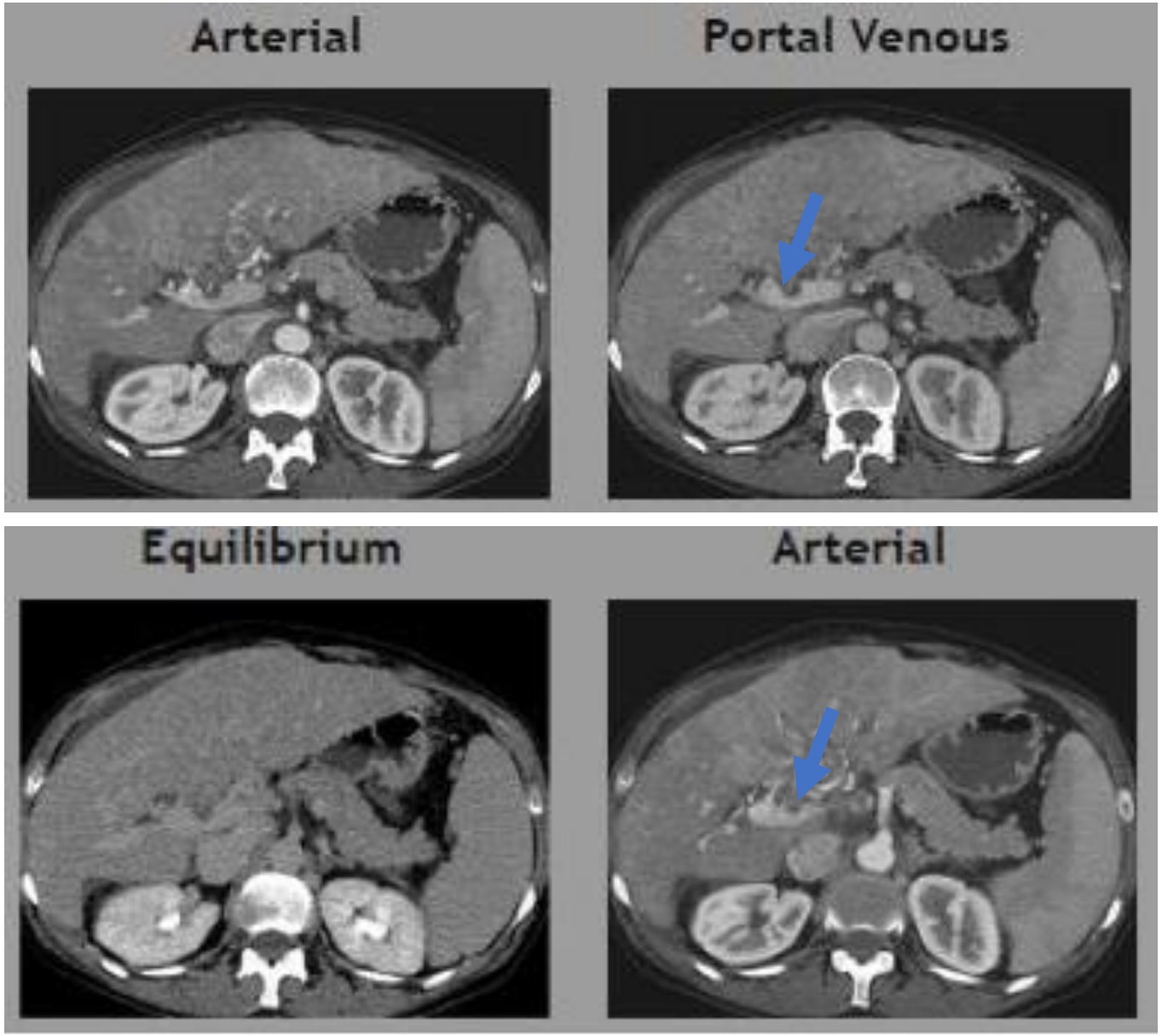
- Invasion of the main portal vein,portal branches,rt hepatic vein,IVC and right atrium.
- Tumour thrombus shows hypervascularity and washout **(Thread & Streak sign).**
- Right lobe demonstrates arterial phase hypervascularity as an arterial buffer response to occlusion ot the right portal vein.



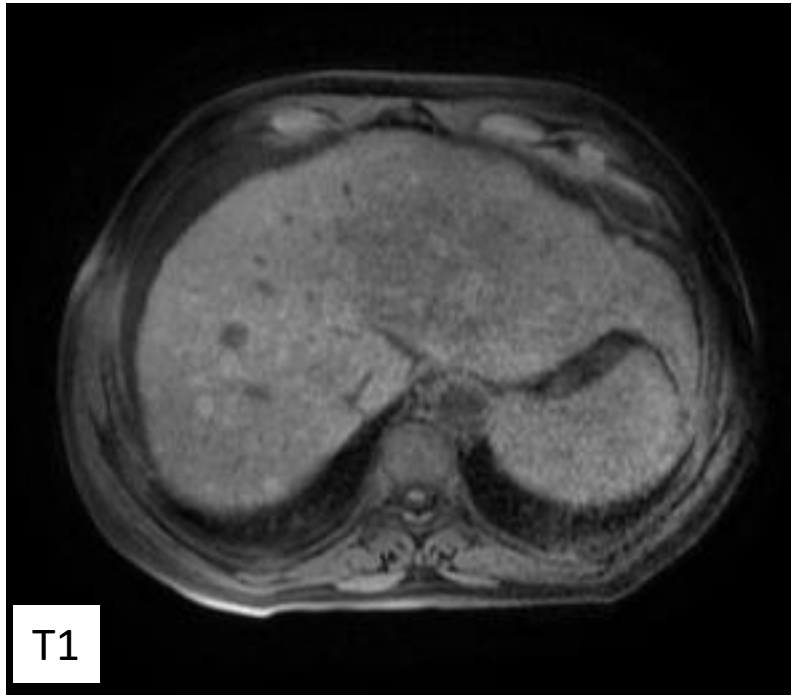


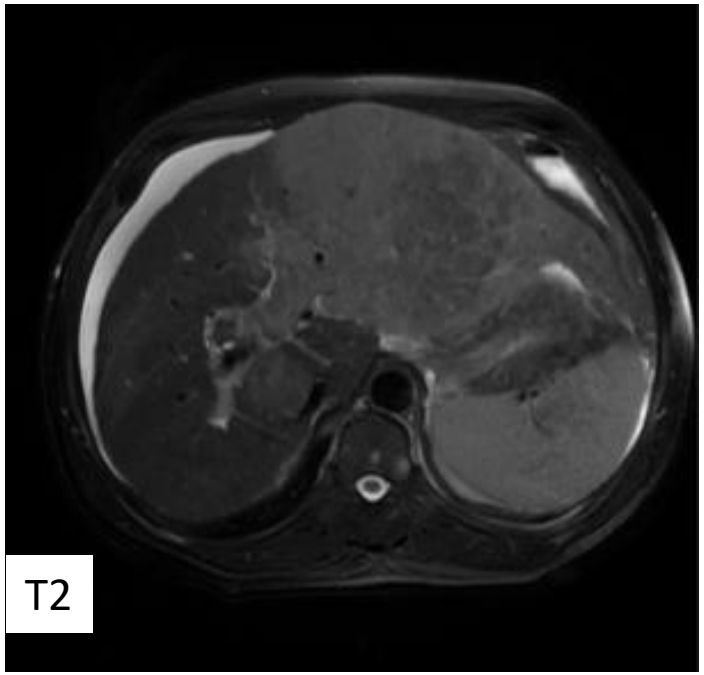
Infilterative HC in cirrhohsis with left portal venous thrombus

Ill defined HCC in segment 4 with portal venuos invasion. Mass and tumour thrombus are inseparable.
Entire left lobe is hypervascular secondary tp occluded left portal vein



Diffuse HCC MRI findings

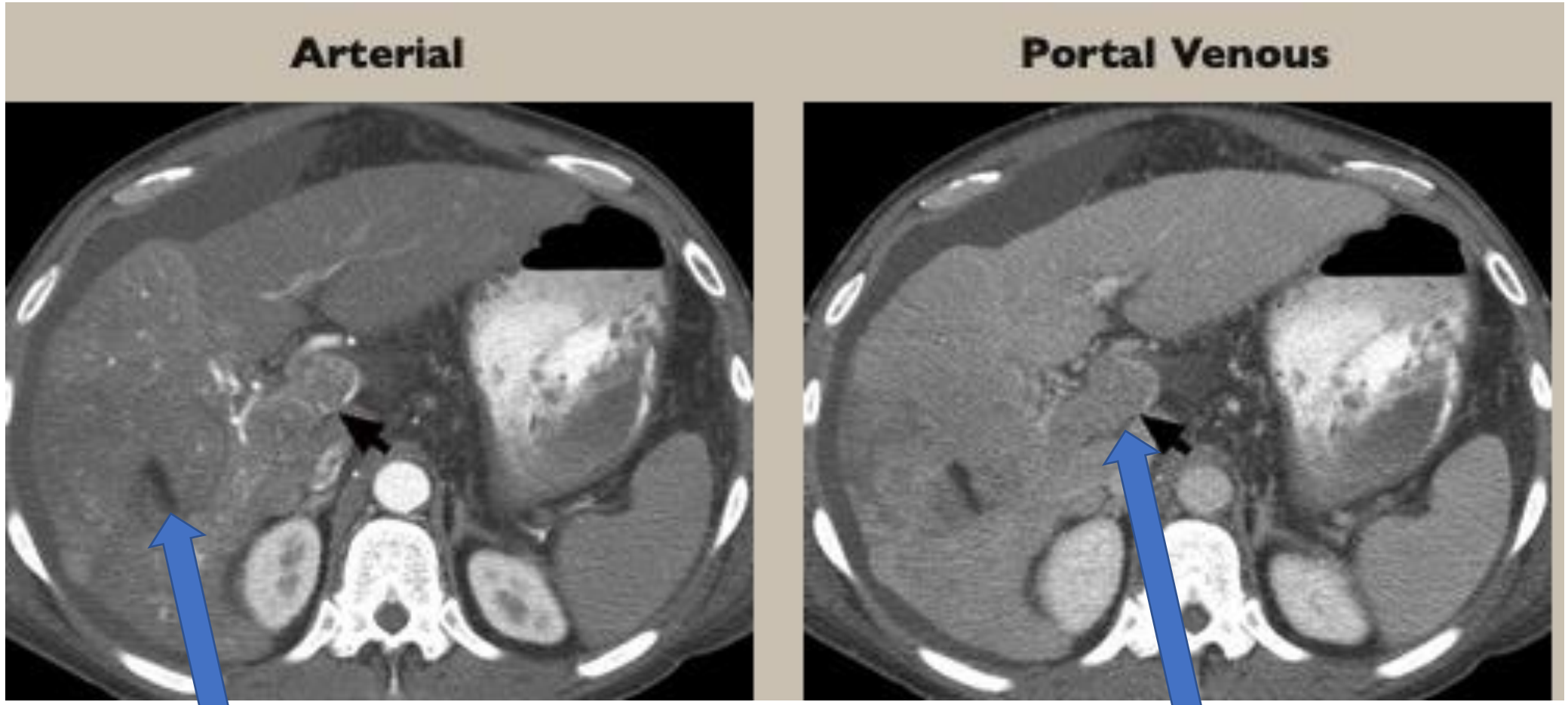




Slightly hyperintense in comparison to normal surrounding liver

- Shows minimal arterial enhancement, hypoenhancement or isoenhancement
- Miliary pattern of enhancement

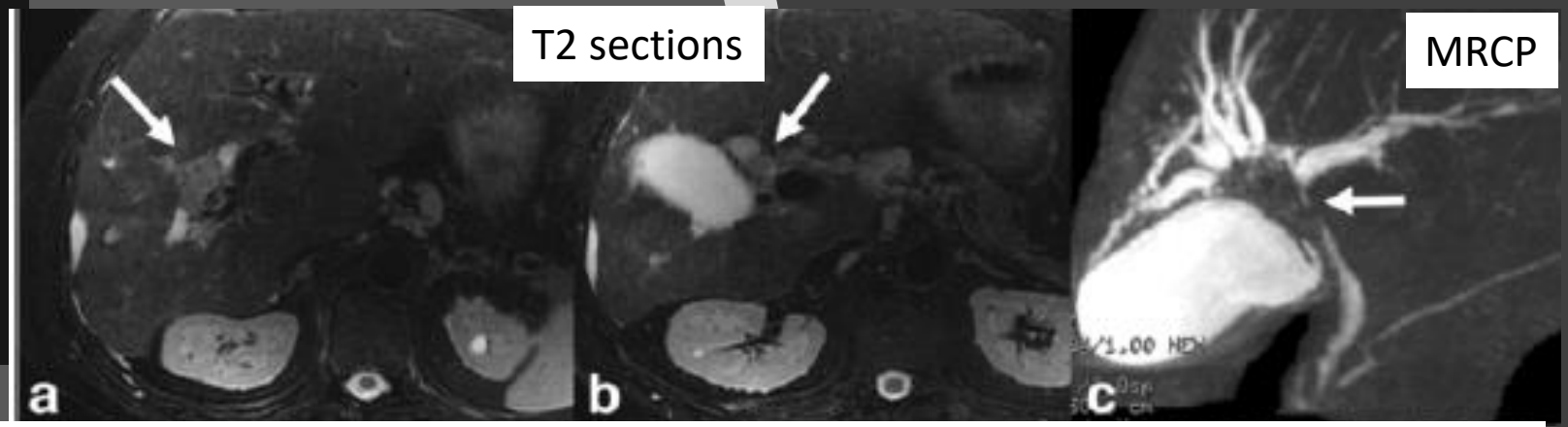
Diagn Interv Radiol 2014; 20:209-221



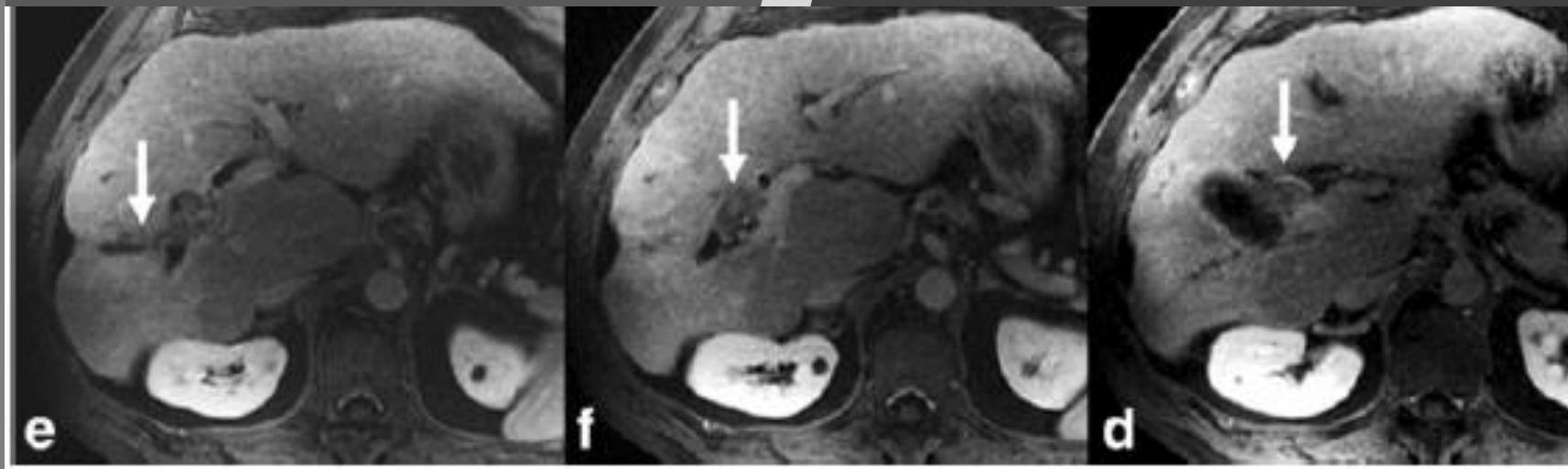
Fatty variant with portal venous thrombosis

Imaging features of Intrahepatic Cholangiocarcinoma

- Dependent on size & proportion of fibrosis, necrosis &mucin content.
- Well defined or infiltrative - lack fibrous capsules
- Hypo- or iso-attenuating on unenhanced CT with most remaining hypoattenuating during arterial & portal venous phases with **enhancement only in delayed phase**



Isointense filling defect (white arrow) in RHD & extending into CHD with dilation of intrahepatic ducts



Post CET1-weighted images show mildly enhancing filling defect representing intraductal papillary neoplasm which extended from just under hepatic capsule filling right hepatic ducts to 3 cm below confluence of right & LHD.

MRI features of Intrahepatic Cholangiocarcinoma

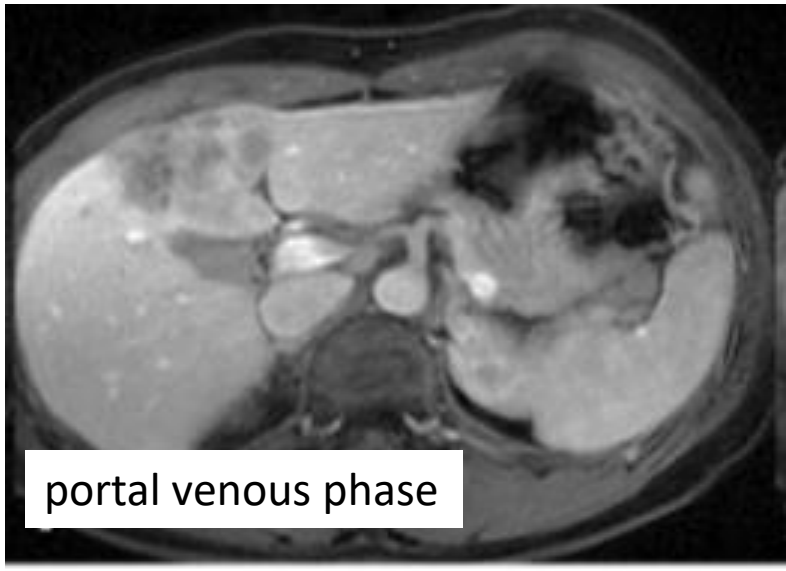
- **Hypo to isointense onT1W & variably hyperintense on T2W imaging**.
- Amount of T2W hyperintensity is determined by pathological subtype

❖ **Scirrhous subtype** - relatively lower signal intensity compared to a WD Adenoca

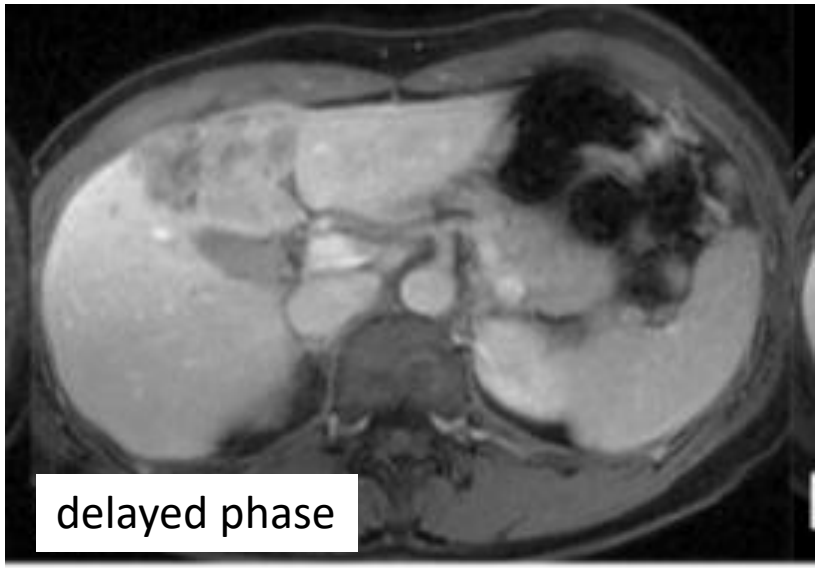
❖ After Gad administration CCA show minimal or heterogeneous enhancement at tumor periphery on early images, with progressive central enhancement on subsequent delayed images due to fibrous composition

❖ **In hepatobiliary phase -no uptake of Gd-EOB-DTPA by the mass suggests a non-hepatocellular tumor.**

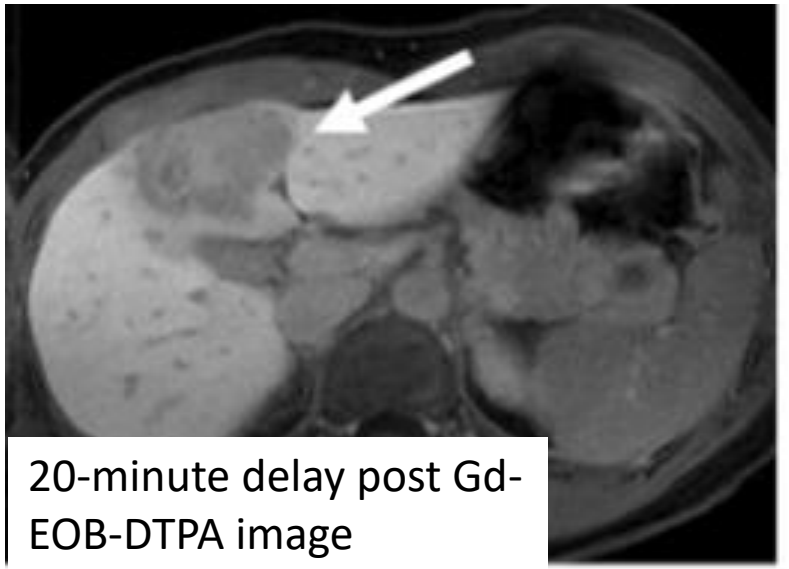
CEMRI images in arterial phase



portal venous phase



delayed phase



20-minute delay post Gd-EOB-DTPA image

Mass-forming ICC - irregularly marginated & demonstrates signal intensity

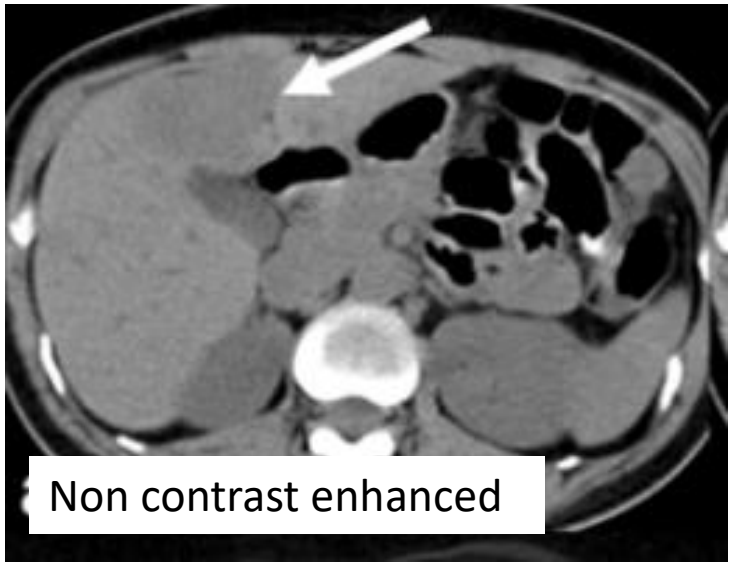
CT Scan

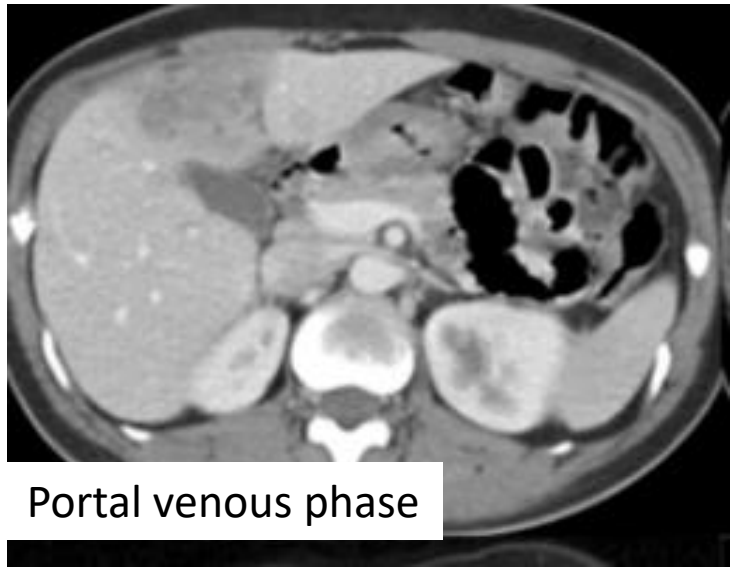
Periphery of malignant mass enhances rapidly after contrast enhancement & becomes isodense or hypodense during portal phase

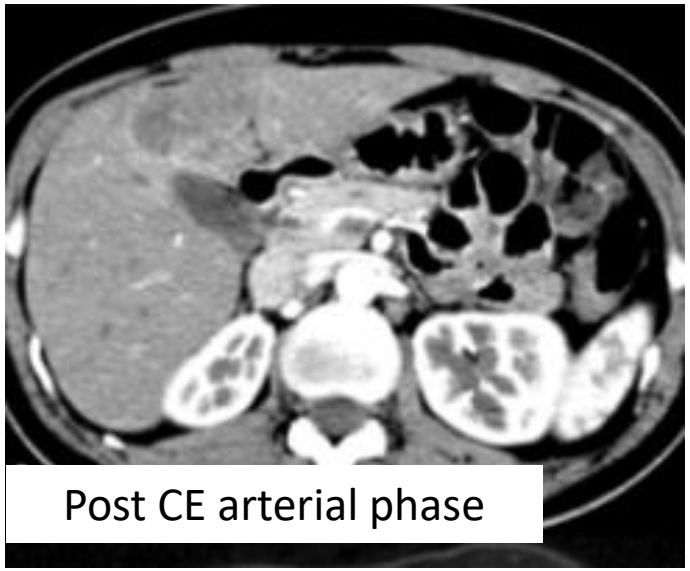
Central Fibrous tissue does not enhance in early phase - hyperdense in delayed phase (20 mins)-remains hypodense with necrotic or mucin-producing tumors.

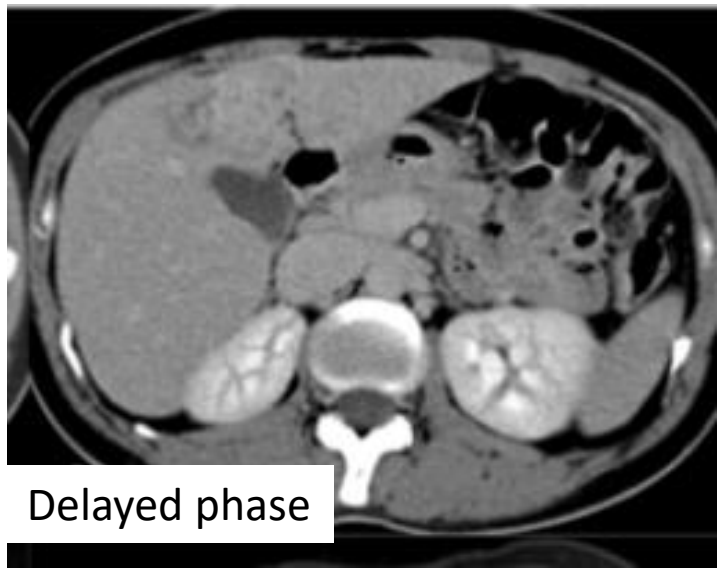
Degree of enhancement varies among tumors & some small mass-forming intrahepatic CCA are arterially enhancing, mimicking HCC.

Use of delayed phase increases diagnostic confidence .


Non contrast enhanced


Portal venous phase


Post CE arterial phase


Delayed phase

Perihilar CCA

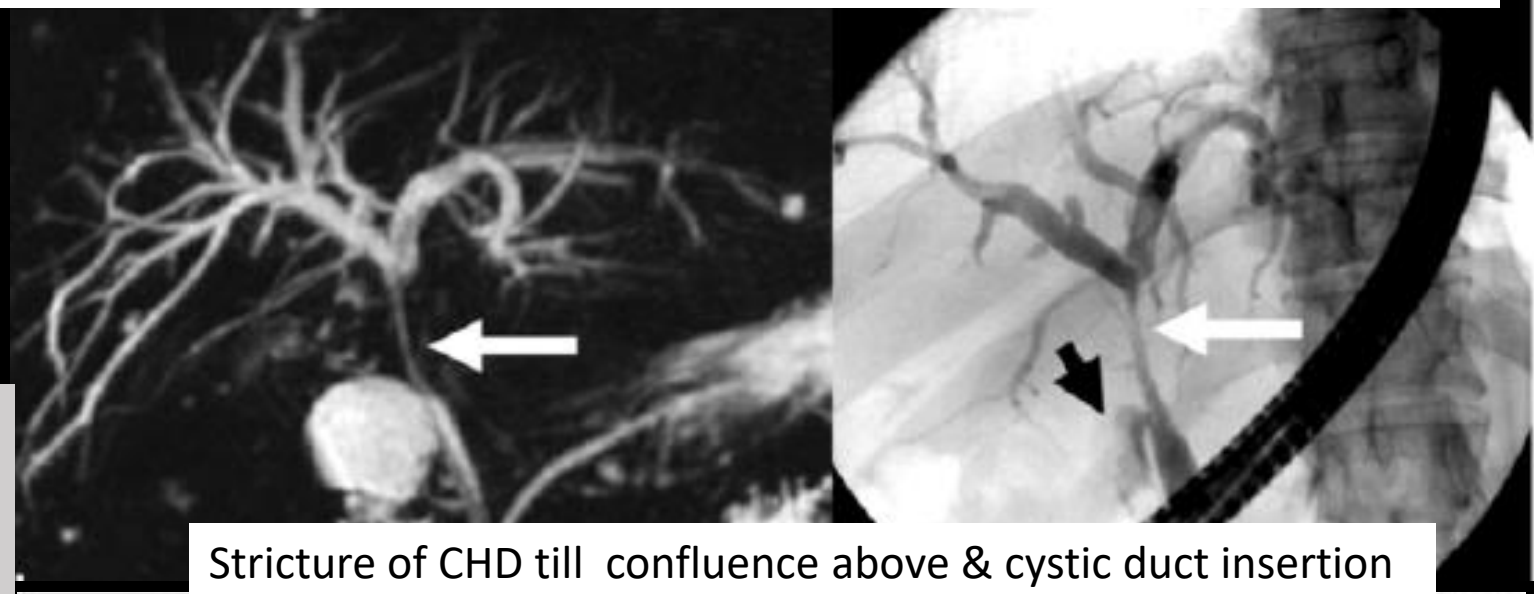
Develops anywhere from second order biliary ducts to CBD above & at site of cystic duct origin

CT hepatic arteriography, portography & venographic images provide a detailed pre-operative vascular roadmap

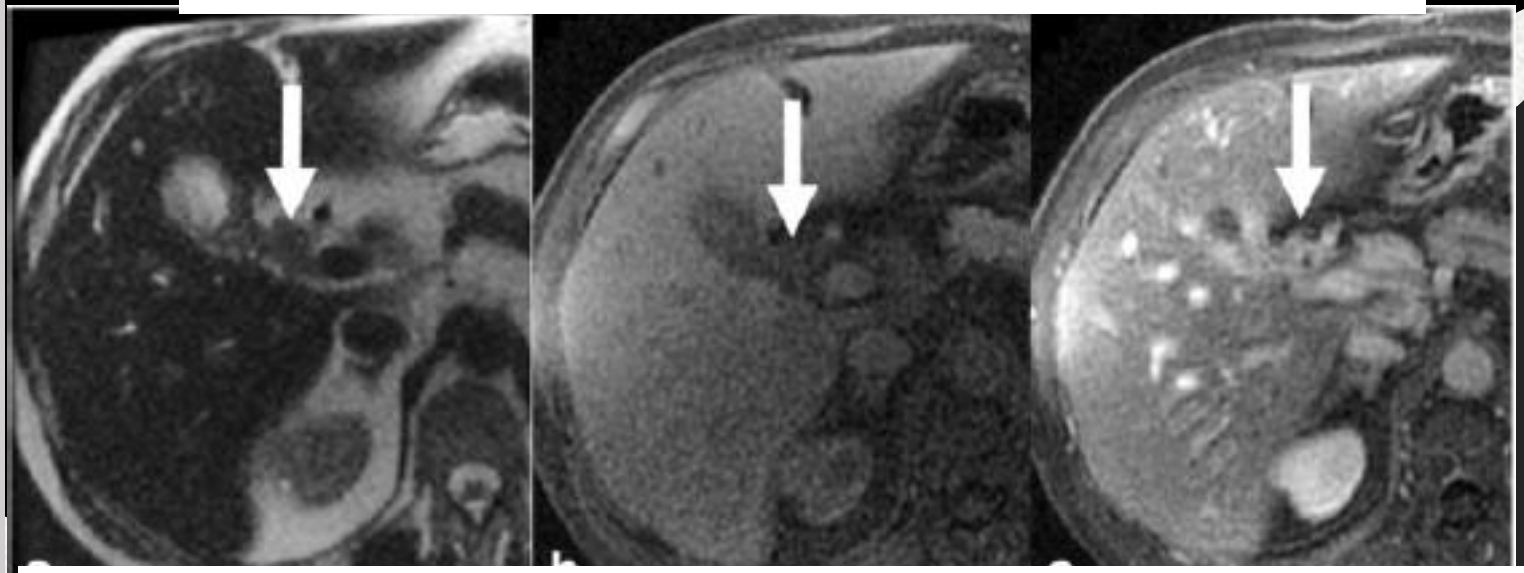
CT cholangiography provide details of biliary anatomy & where MRI is contraindicated or unavailable.

Limitation of CT cholangiography - dependence on secretory function of biliary system

GB not visualized on ERCP & irregularity of proximal cystic duct due to tumor.

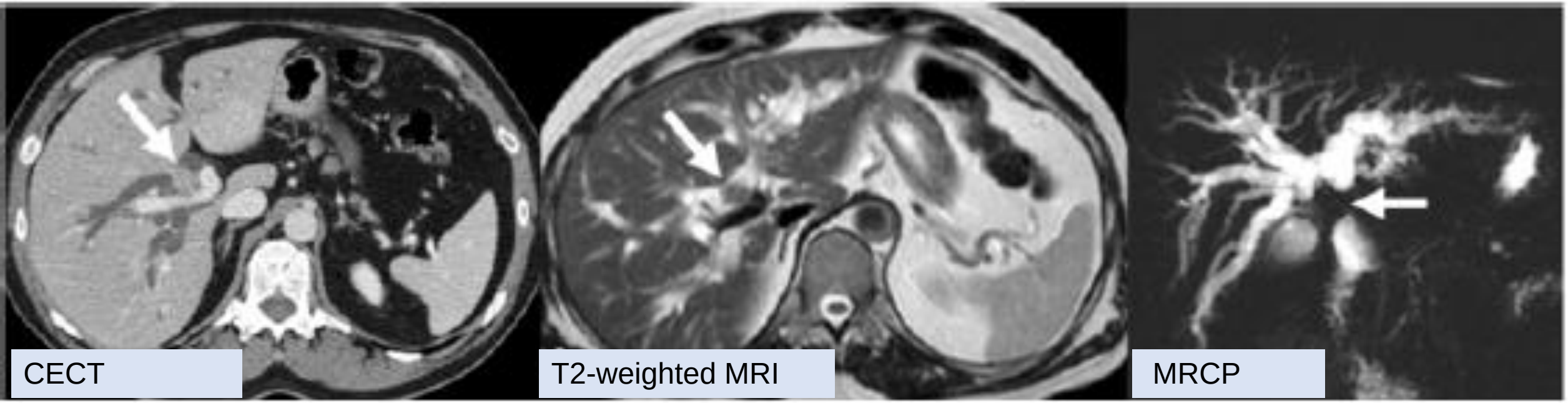


Stricture of CHD till confluence above & cystic duct insertion



pCCA arising from cystic duct & proximal GB with invasion of CHD .pCCA is mildly hyperintense on T2-weighted image (a), hypointense on T1-weighted image (b) and shows post contrast enhancement

CCA of CHD with involvement of Confluence

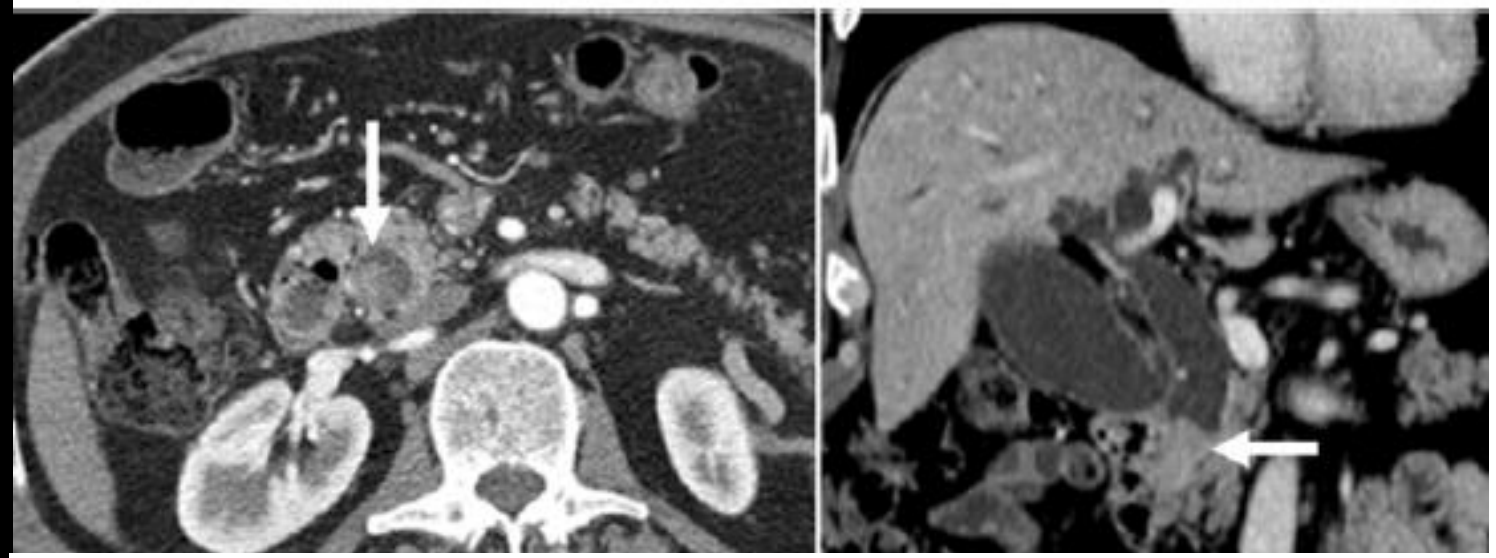


- Thickened & enhancing CHD with involvement of confluence & upstream dilatation of intrahepatic ducts.
- Ductal thickening appears hypointense to surrounding dilated bile ducts on MRI .
- Involvement of confluence is demonstrated better on MRCP.

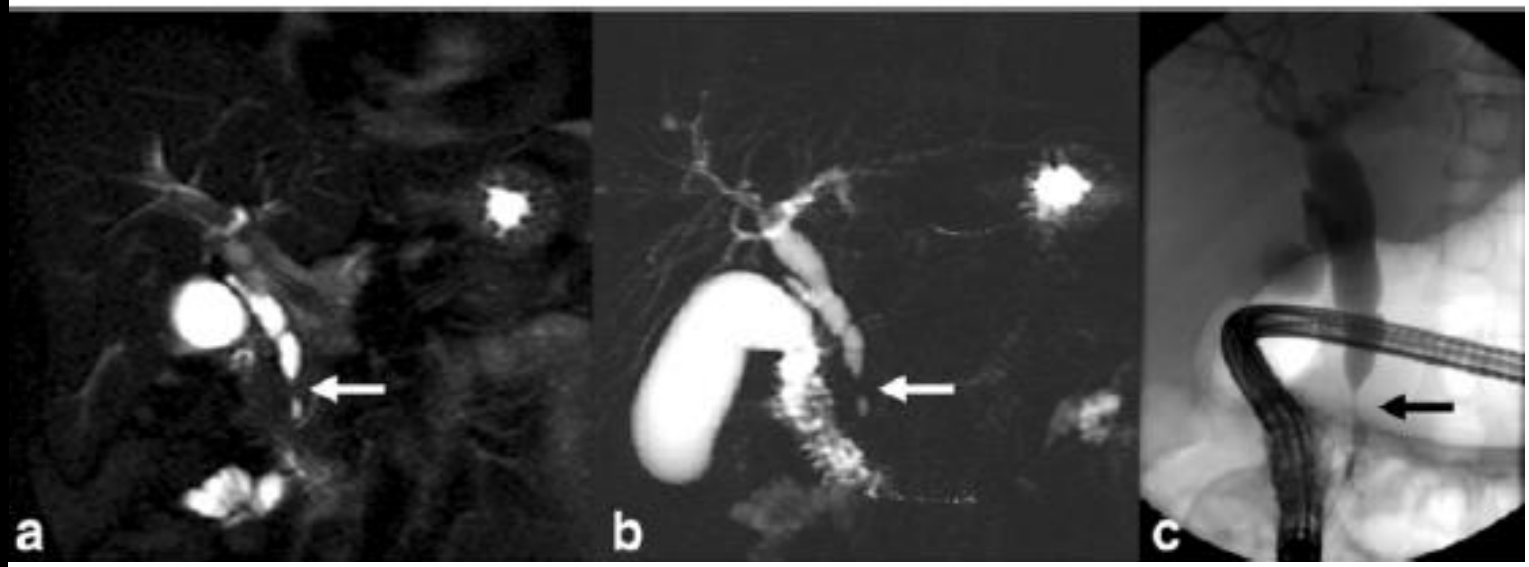
Distal CCA (d CCA)

CT & MRI with MRCP demonstrate thickening and/or stricturing of bile duct with proximal duct dilatation & sometimes a mass

- Imaging delineates invasion of vessels & pancreas.
- ERCP is specific & has high positive predictive for d CCA .
- EUS is important in preoperative evaluation of d CCA & EUS-FNA is very specific for predicting un-resectability .



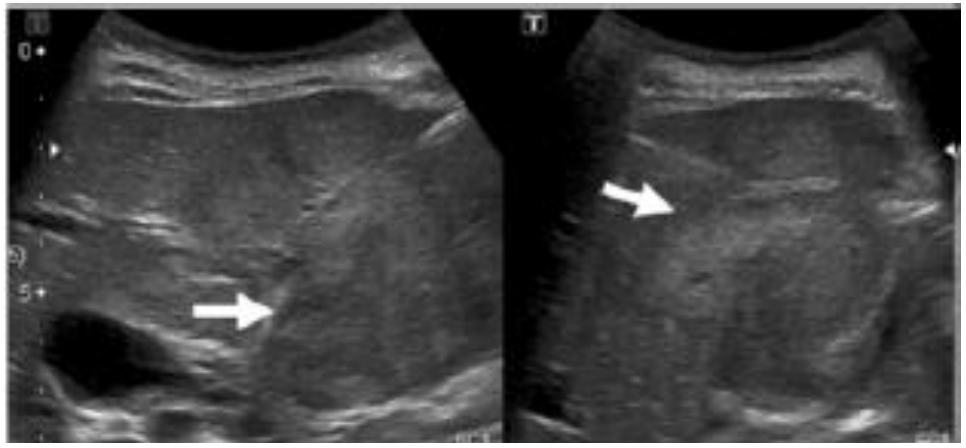
Distal CCA presenting as a polypoid mass with obstructive jaundice. CECT showing a soft tissue density filling defect in distal CBD(arrow) representing a carcinoma



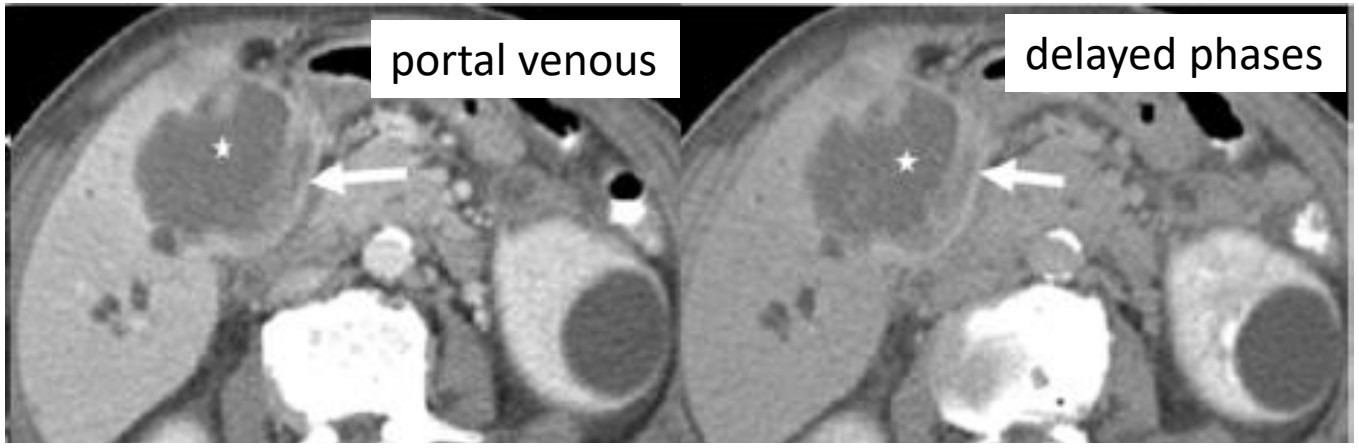
CBD stricture due to invasive ca. Images showing a short segmental narrowing with proximal dilatation.

Gallbladder carcinoma (GbCA)

- Mass replacing normal GB, diffuse or focal thickening of GB wall , polypoid mass within GB lumen or as a GB fossa mass . Mass replacing GB fossa -MC presentation



GB & GB fossa is replaced by a large heterogeneous mass of mixed echogenicity

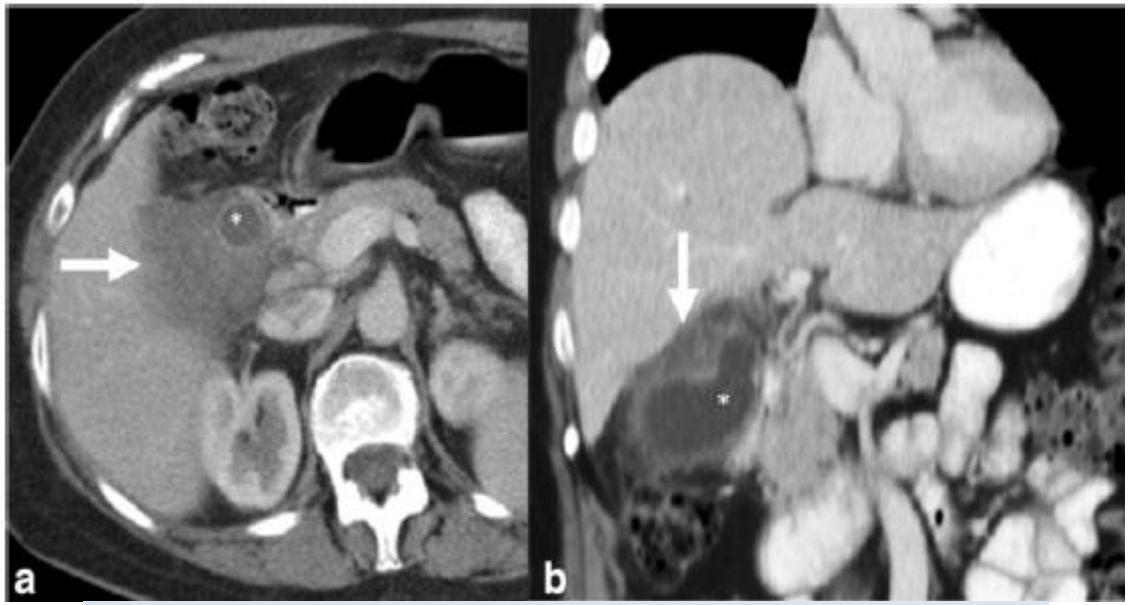


Heterogeneous hypodense mass on CECT with enhancement of fibrous stromal component (arrow)

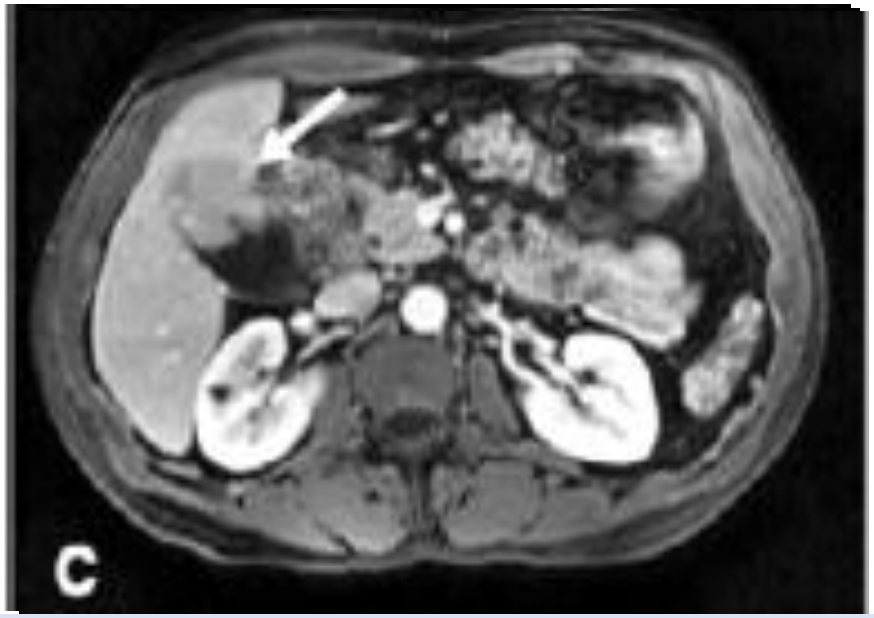
- Marked wall thickening (>1.0 cm) with mural irregularity or significant asymmetry
- Diffuse symmetric wall thickening - likely non-malignant
- GbCA are hypodense on unenhanced CT upto 40% showing hypervascular foci of enhancement =/> than adjacent liver parenchyma .
- Contrast enhancement may be retained in fibrous stromal components of GBCa during portal venous & delayed phases
- Sensitivity of CECT in detecting GBCa- 90% (particularly effective in detectingT2 or higher)
- On CECT - low-attenuation mass, enhancing mass with ill-defined borders, eccentric gallbladder wall thickening or a fungating mass.
- Valuable information on local & vascular invasion as well as hematogenous & LN metastases, although its reliability in staging LN disease is not always accurate.

Gallbladder carcinoma (GbCA)

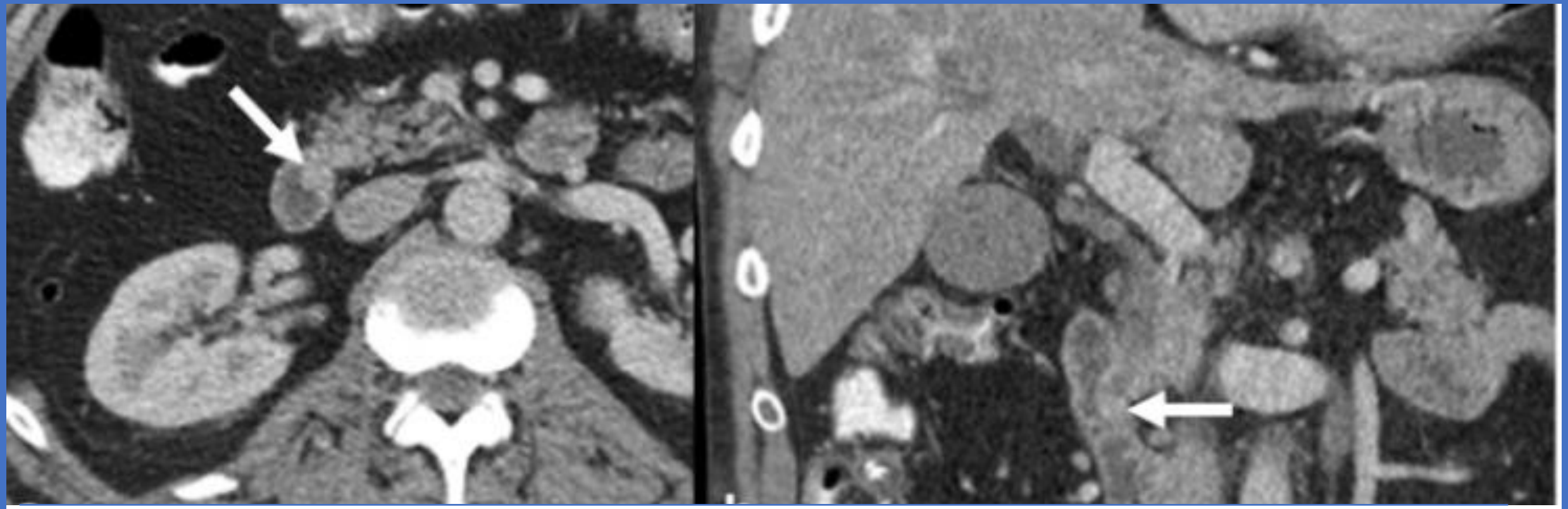
- About 25% of GbCA present as an intraluminal mass
- GbCA presenting as focal or diffuse mural thickening is least common & difficult to diagnose
- GbCA are hypo to iso-intense on T1W &moderately hyperintense on T2W sequences with enhancement
- MRI better for assessment of focal or diffuse mural thickening - able to distinguish GbCA from benign entities
- MR Angio & MRCP=Facilitate diagnosis of vascular & biliary infiltration
- Focal or eccentric stenosis, irregularity of lumen or abrupt amputation is suggestive of invasion.



CECT showing hypodense thickening of GB wall representing carcinoma with involvement of adjacent liver.



GbCA arising from fundus of GB seen as an iso to hyperintense mass onT2-weighted hypointense mass on T1-weighted images & shows enhancement on post gad image



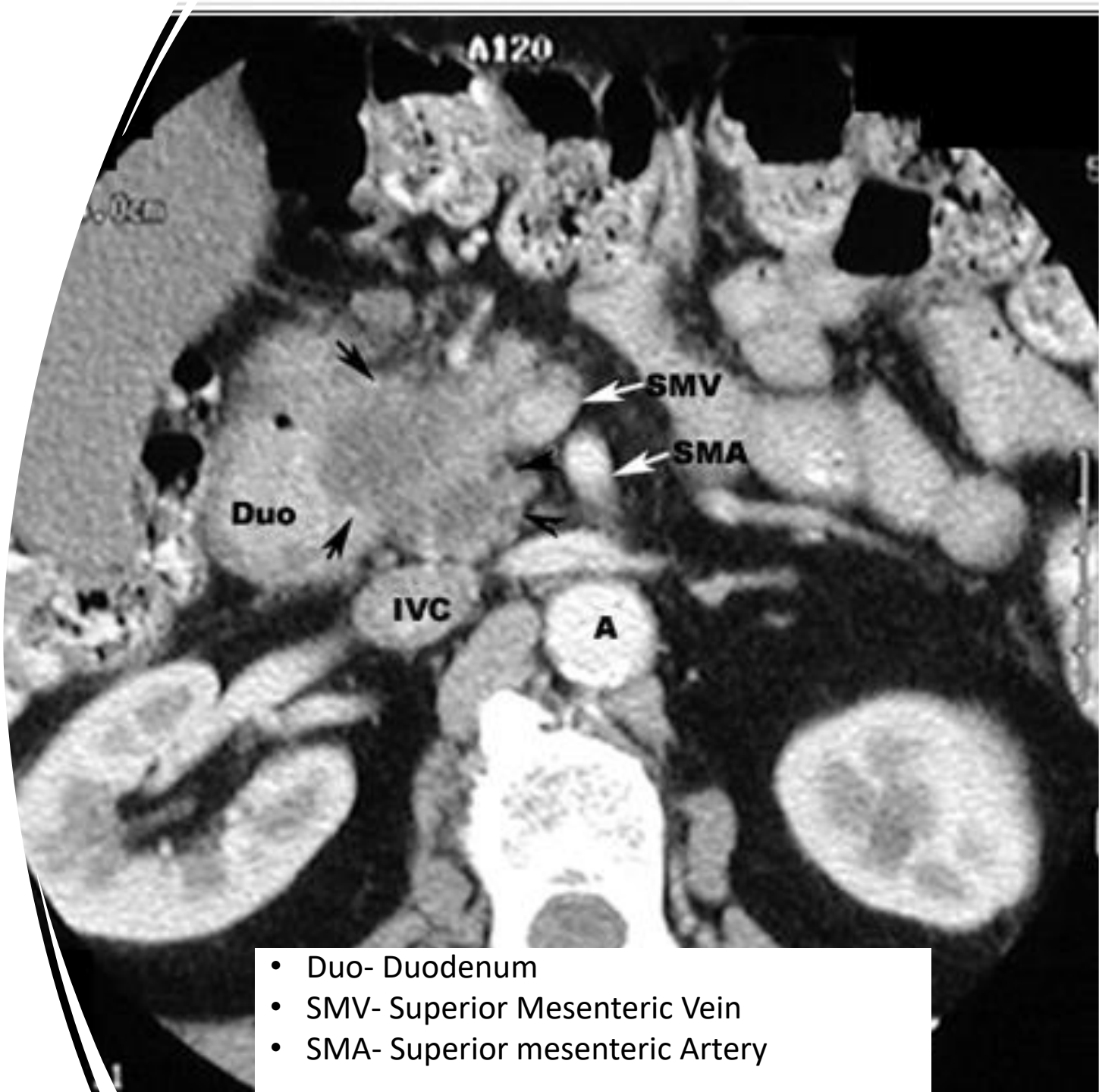
Ampullary carcinomas arise within ampullary complex, distal to bifurcation of distal CBD & pancreatic ducts

Marked & abrupt dilatation of distal bile duct or pancreatic duct in absence of stones or pancreatitis is highly suggestive of ampullary ca

Pancreatic carcinoma

Imaging for Ampullary carcinoma

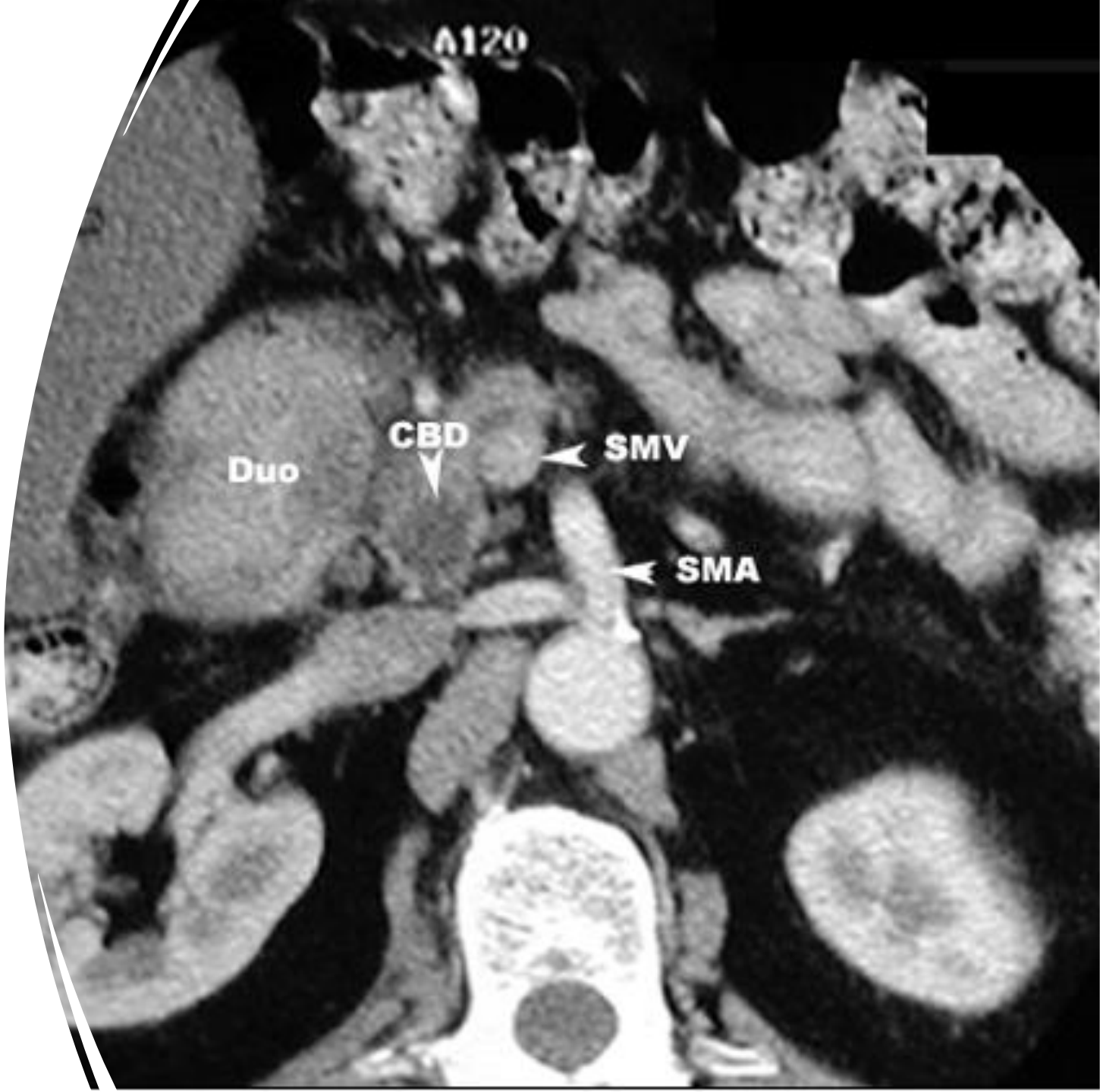
- **CT** detects masses obstructing distal CBD
- Not sensitive enough to allow visualization of small ampullary tumors within duodenal lumen.
- Lacks spatial resolution for extent of local invasion but useful for LAP & distant mets.
- On MRI-Appear as a discrete nodular mass at distal margin of pancreaticobiliary junction & are hypointense on T2W imaging
- Some appear as irregular periductal thickening around pancreaticobiliary junction or papillary bulging into duodenum



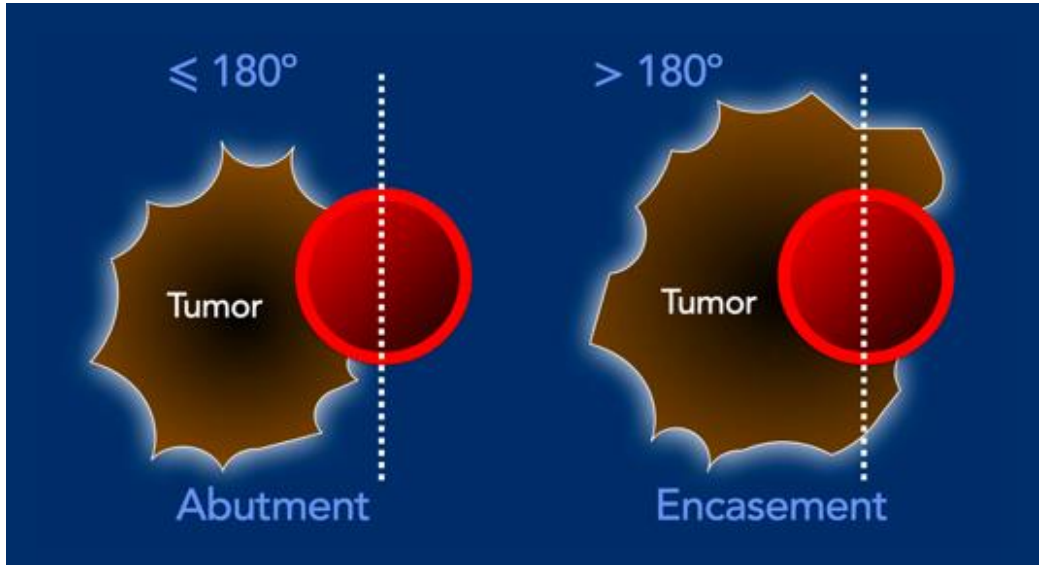
- Duo- Duodenum
- SMV- Superior Mesenteric Vein
- SMA- Superior mesenteric Artery

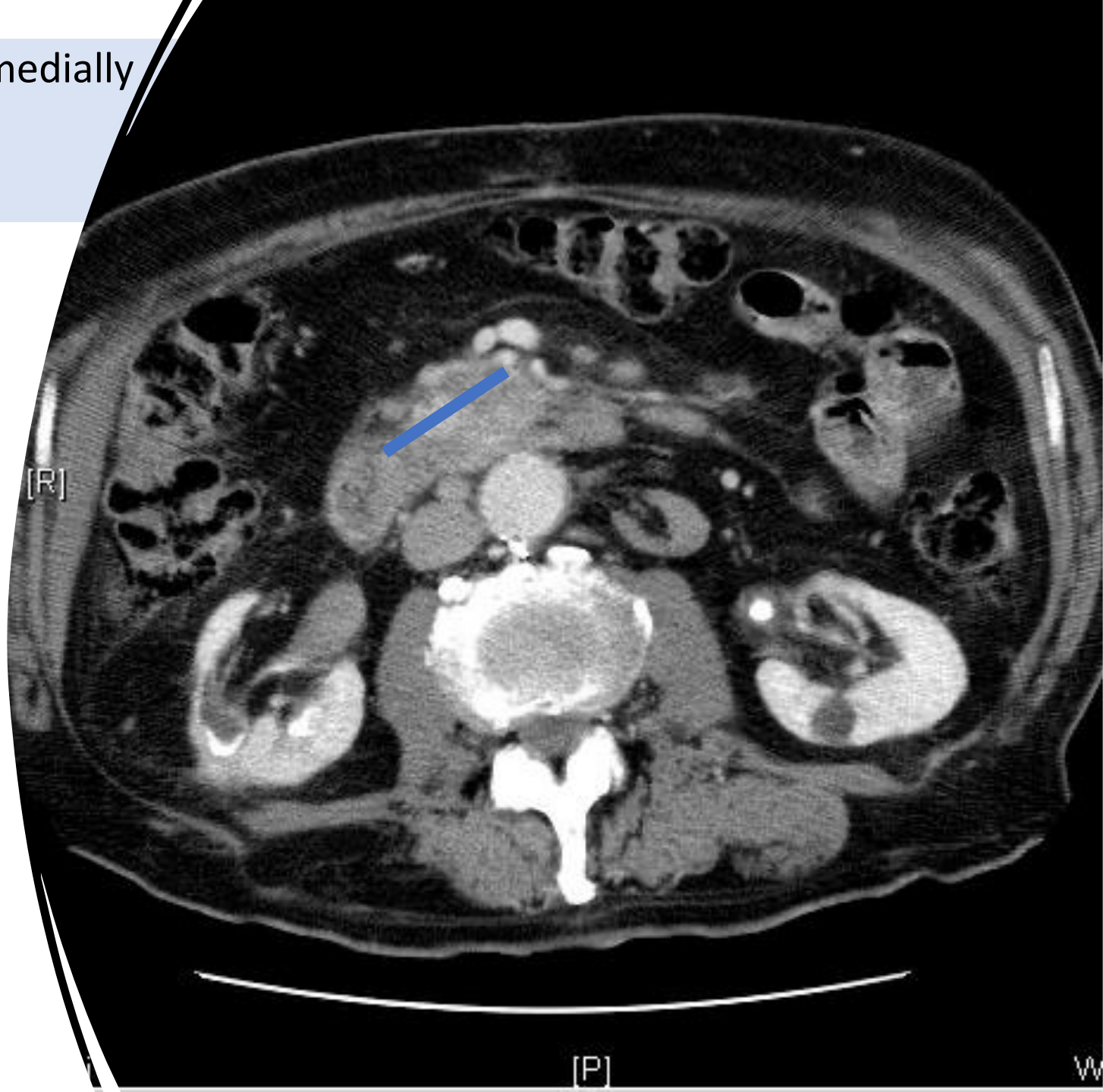
Obstructive Jaundice in Ca pancreas

- Duo- Duodenum
- SMV- Superior Mesentric Vein
- SMA- Superior mesenteric Artery
- CBD- Common Bile Duct

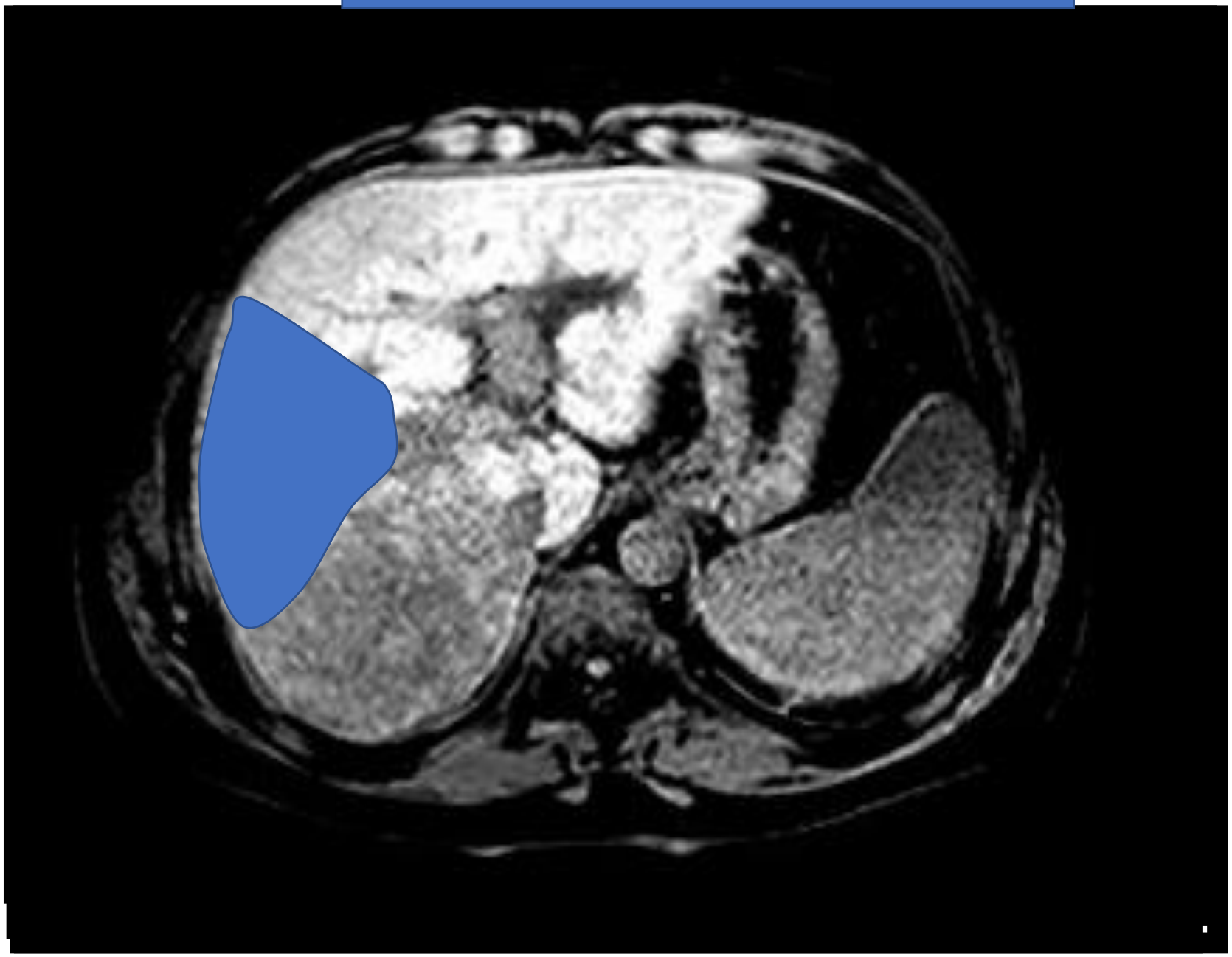


Enhancing mass head pancreas extending medially into the uncinate process





Word of Caution-Verify contours with radiologist



Conclusion

- High-quality imaging to delineate target lesions is a crucial first step in safely implementing RT.
- Conduct a triphasic CECT scan (hepatic arterial, portal venous, and delayed phases) or multiphase dynamic MRI
- Triphasic CECT scans are conducted with 1.25-mm slice thickness, as thinner slice thickness provides greater volumetric resolution of anatomy.
- MRI provides improved intra-hepatic soft tissue resolution & this complementary information may be especially useful for target delineation, especially with tumors that are difficult to visualize on CT, such as ICC.
- 18F-FDGPET may provide additional information in localizing existing metabolically active tumor as well as detecting occult or new tumors that have developed in interim between diagnostic imaging & treatment planning

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Thank You

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