CT findings of splanchnic venous thrombosis (SVT)

On Koo Cho MD, Yongsoo Kim, MD, PhD,
Young Seo Cho MD, Sang hyeok Lim MD.

Dept. of Radiology, Hanyang Univ. Guri Hospital,
SOUTH KOREA

Learning objectives

- Discuss the pathophysiologic mechanism of splanchnic venous thrombosis (SVT).
- Describe the causes of SVT
- Describe the CT features according to underlying diseases.

Background

- Splanchnic vein include the portal vein, splenic vein , superior mesenteric vein, inferior mesenteric vein and additional small tributaries drain the stomach, pancreas and gallbladder.
- SVT is a critical but not infrequent occurrence in patients with liver cirrhosis. Decreased portal blood flow velocity and hypercoagulable state caused by cirrhosis constitutes the main risk factors for portal vein thrombosis.
- In this review, we provide an overview of the diverse causes of splanchnic venous thrombosis (portal vein, superior and inferior mesenteric vein and splenic vein), subdividing them into well defined categories to facilitate comprehension, discuss the underlying pathogenic mechanisms, and correlate these features with the underlying disease entities.

Classification of causes of SVT

Benign

Hypercoagulable state

- Liver cirrhosis
- Myeloproliferative disorders

Inflammatory state

- Liver abscess
- Appendicitis
- Pancreatitis
- Sigmoid colon diverticulitis

Malignant

- Hepatocellular carcinoma
- Pancreas cancer
- Stomach cancer
- Colon cancer
- Bile duct cancer
- Metastatic tumor or LN metastases

SVT : CT finding

- Non enhancing filling defect within the lumen with luminal dilatation
- Rim enhancement :
  - flow through vasa vasorum
  - increased flow around periphery of clot
- Complete or partial non-opacification of the lumen
- Involve part of, or the whole portal vein and its branches
- Enhanced thrombus represents tumor thrombus
- Cavernous transformation in chronic longstanding SVT
- Increased hepatic parenchymal enhancement during arterial phase or decreased attenuation during portal phase (THAD)

Liver cirrhosis

- Cirrhosis is one of the most common causes of PVT from decreased portal flow due to the increased hepatic resistance .
- In cirrhotic patients, the prevalence of bland PVT ranges between 0.6% and 26%. Likelihood of developing thrombus is associated with severity of disease.
- PVT can develop in the intra- or extrahepatic segments of the portal vein and may extend to the superior mesenteric vein and/or the splenic vein.
- Sites of portal vein thrombosis is frequently located within the main trunk of the portal vein in the majority of patients (71%). Left hepatic branch is more frequently involved than right branch.
- Incomplete luminal obstructing mural thrombus is more frequent than complete luminal obstruction.

Hypercoagulable state

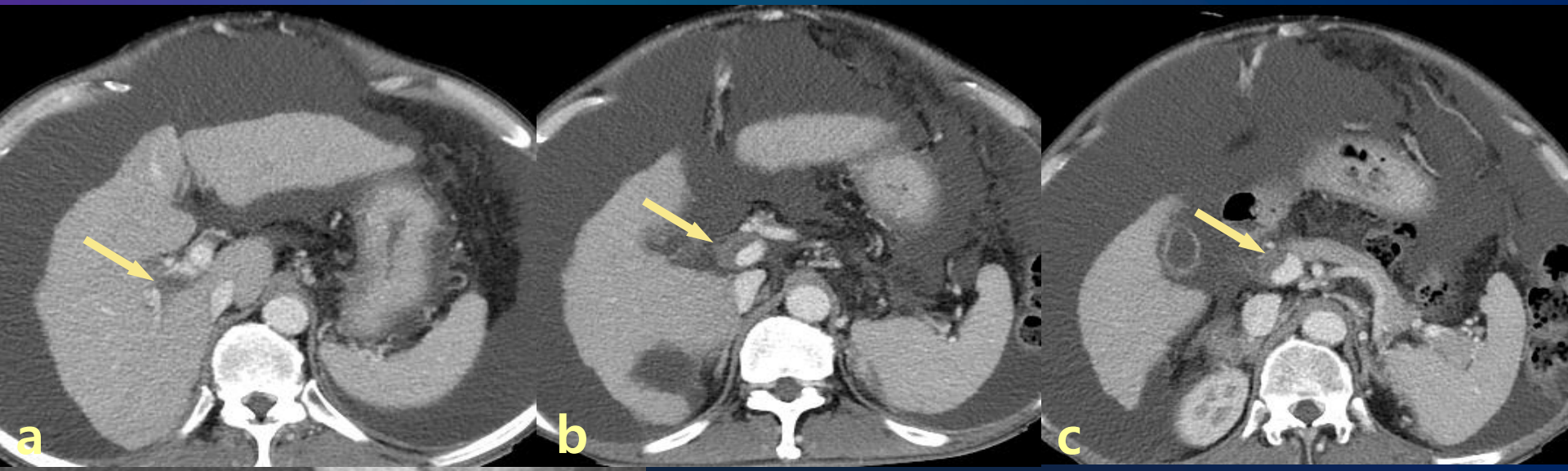


Fig. 1 55 years old male with liver cirrhosis.
Incomplete luminal obstructive nonenhancing mural thrombus within the main extrahepatic portal vein (b, c, d, arrow) and right portal vein (a, arrow).

Hypercoagulable state

Fig. 2 56 years old male with liver cirrhosis. Incomplete luminal obstructive nonenhancing thrombus within the main extrahepatic portal vein (a, d, arrow) and Rt and left portal vein (b, c, arrow).

Hypercoagulable state

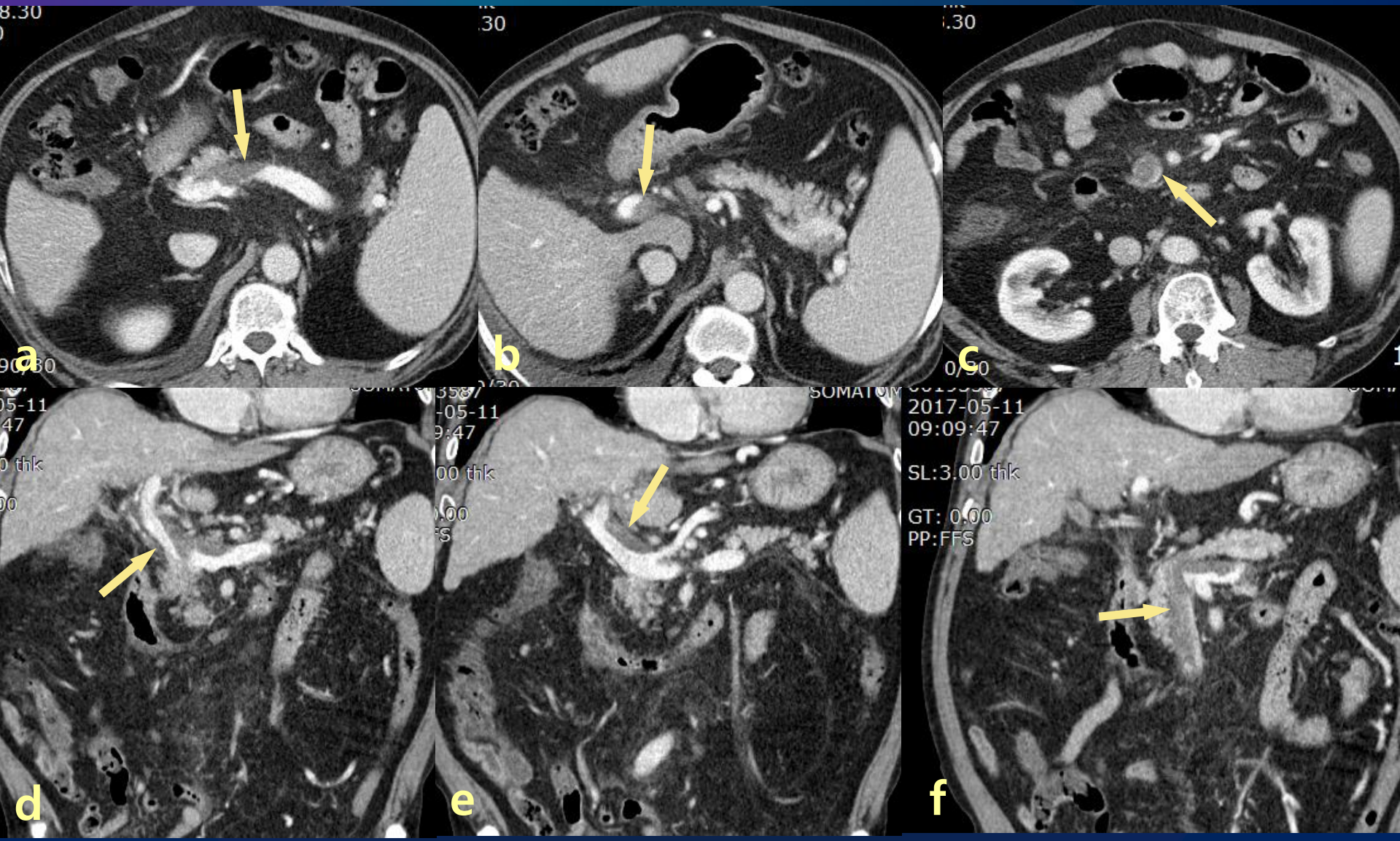


Fig. 3. 67 years old male with liver cirrhosis.
Bland portal vein thrombus within the extrahepatic portal vein (b, d, e arrow) and extending thrombus distribution within the splenic vein and superior mesenteric vein(a, c, f, arrow) .

Hypercoagulable state

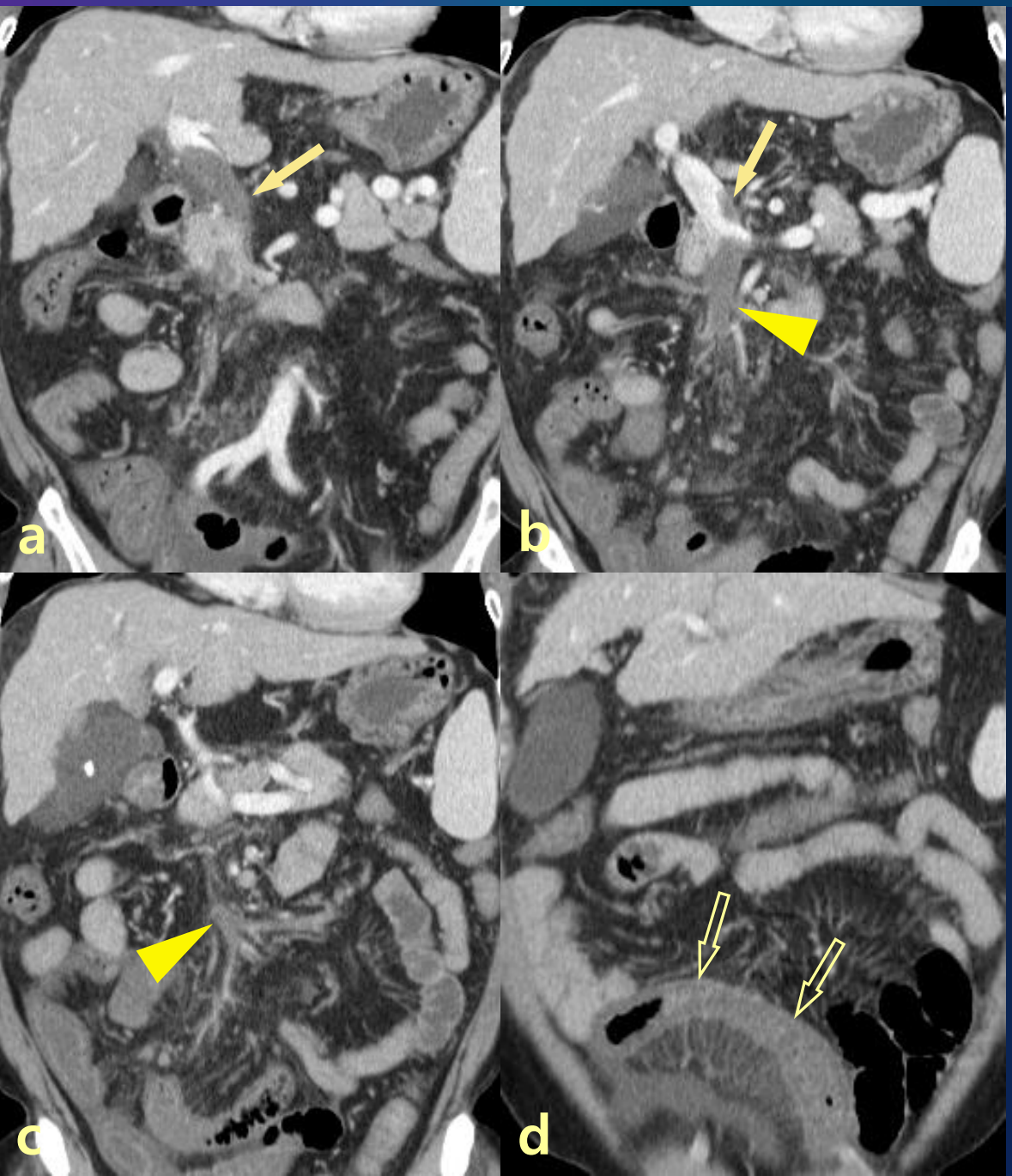


Fig. 4 50 years old male with liver cirrhosis.
Nonenhancing bland thrombus within the extrahepatic portal vein (a, b, arrow) and superior mesenteric vein (b, arrow head) . Poorly enhanced thickened wall of the ileal loop and mesenteric edematous change (d, open arrows) is seen with thrombus within the ileal branch (c, arrow head). Ischemic small bowel loop from SMV thrombosis finding in liver cirrhosis.

SMV thrombosis with ischemic bowel

- Spontaneous idiopathic thrombosis, not associated with any predisposing conditions has been termed primary mesenteric venous thrombosis
- The location and extent of venous thrombosis and the status of collateral circulation are important predictors of bowel ischemia. Patients with thrombosis of the venae rectae and venous arcades are at greater risk of developing bowel abnormalities than with thrombosis confined to the SMV close to the splenoportal confluence.
- The anatomic site of involvement in acute mesenteric venous thrombosis is most often ileum or jejunum, followed by colon and duodenum .
- Associated bowel abnormalities most commonly manifests as mural thickening. Wall thickening may result from intramural edema which appears as hypoattenuating bowel wall or intramural hemorrhage which causes increased attenuation of the affected bowel wall.
- Due to the underlying venous congestion and/or superimposed inflammatory process, mesenteric fat stranding is frequently seen.

Hypercoagulable state

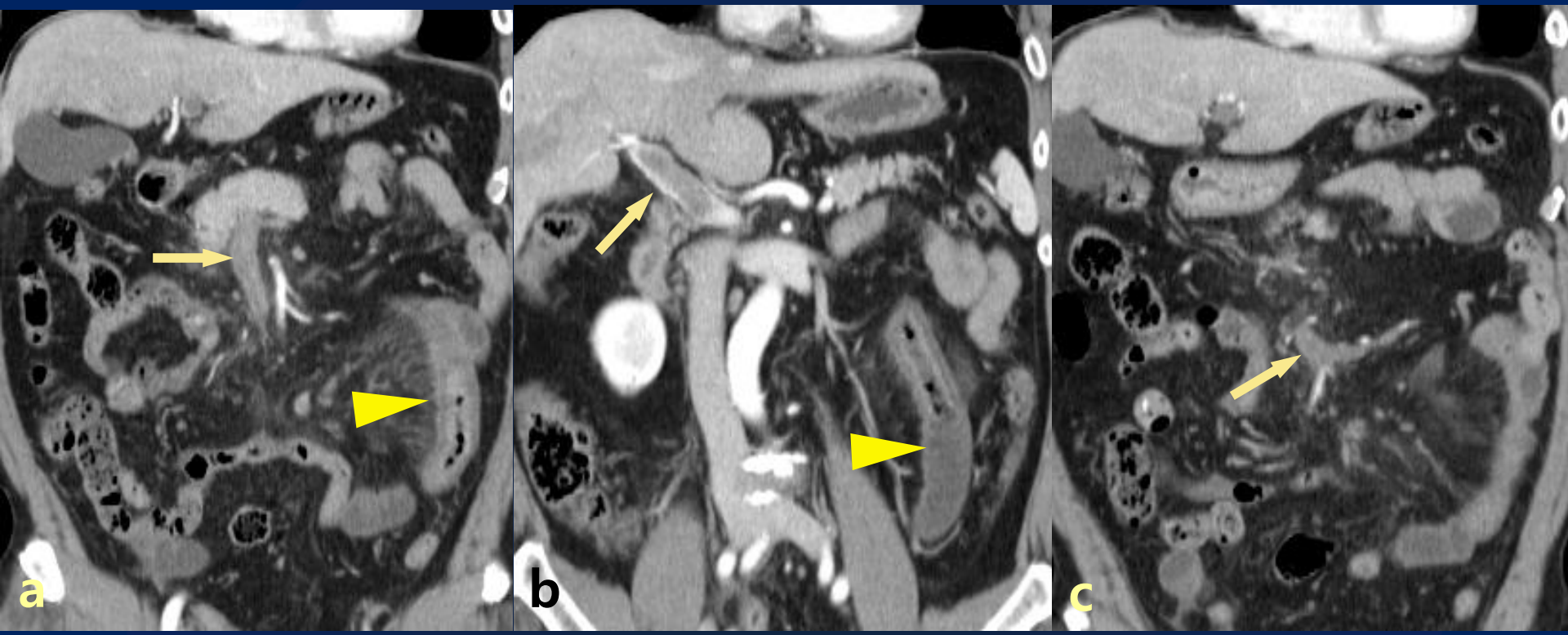
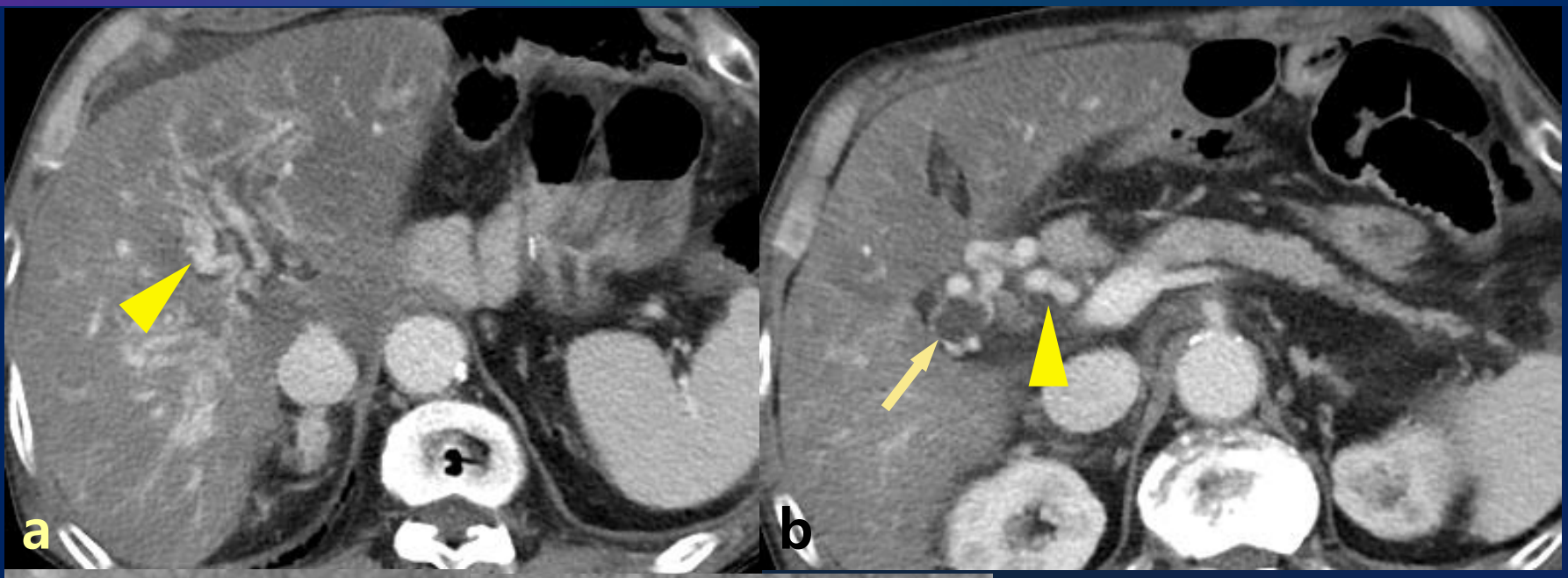


Fig. 5 69 years old male with bowel infarction from primary SMV thrombosis .
Idiopathic SMV thrombosis, not associated with any predisposing conditions. Thrombus is distributed within the SMV, jejunal branch and portal vein (a, b, c, arrow).
Diffuse thickened jejunal small bowel wall with diminished contrast enhancement and mesenteric edematous infiltration finding is seen (a, b, arrow head).

Cavernous transformation of PV

- In the setting of long-standing portal vein thrombosis, a collateral hepatopetal venous circulation develops in the hepatic hilum.
- This phenomenon is known as cavernous transformation of the portal vein, which is necessary to drain tributaries of portal and maintain adequate hepatic perfusion .
- On image finding, it manifests as numerous serpiginous vessels in the periportal region and nonvisualization of the main portal trunk.
- Possible linear areas of calcification within the previously thrombosed portal vein indicating chronic venous thrombosis
- Can produce compression and deformation of the biliary tract.

Hypercoagulable state



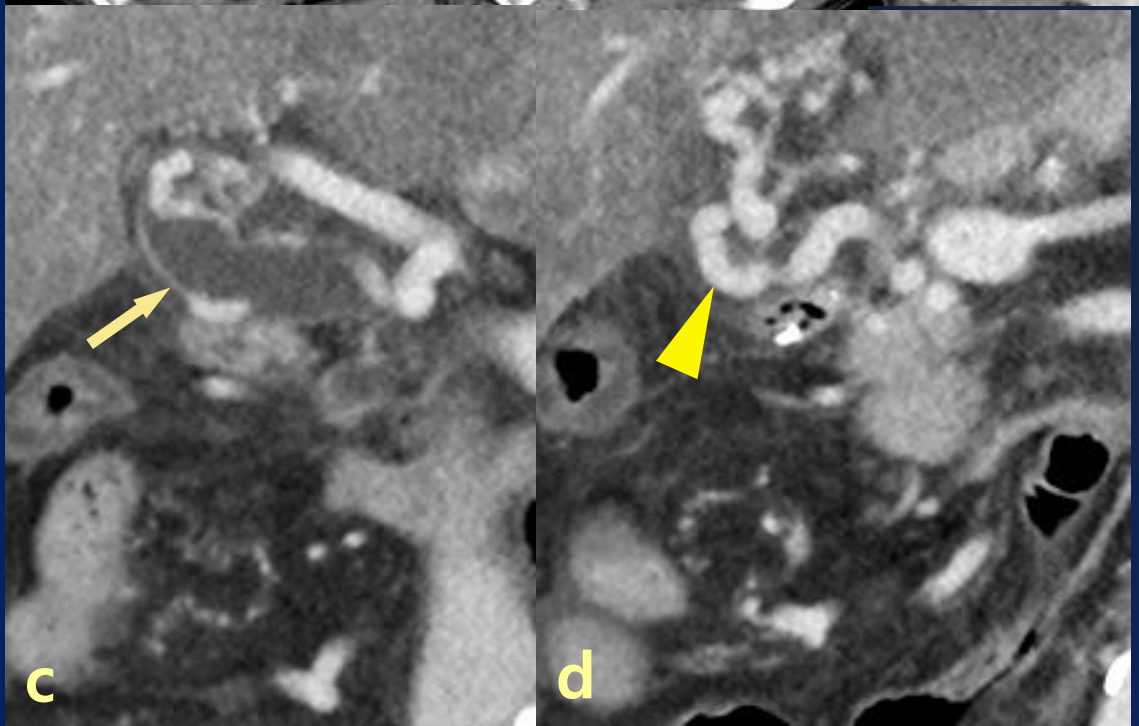


Fig. 6 56 years old male with alcoholic liver cirrhosis.
Diffuse severe fatty liver with thrombosis of the main portal vein (b, c, arrow). Numerous serpiginous collateral vessels (cavernous transformation) in the periportal region (a, b, d, arrow head) .

Myeloproliferative disorders

Myeloproliferative disorders are often associated with thrombosis, and PVT may be the first sign of the disease due to the masking of the typical blood characteristics (polyglobuly, leukocytosis, thrombocytosis) caused by the hemodilution and hypersplenism.

Hypercoagulable state

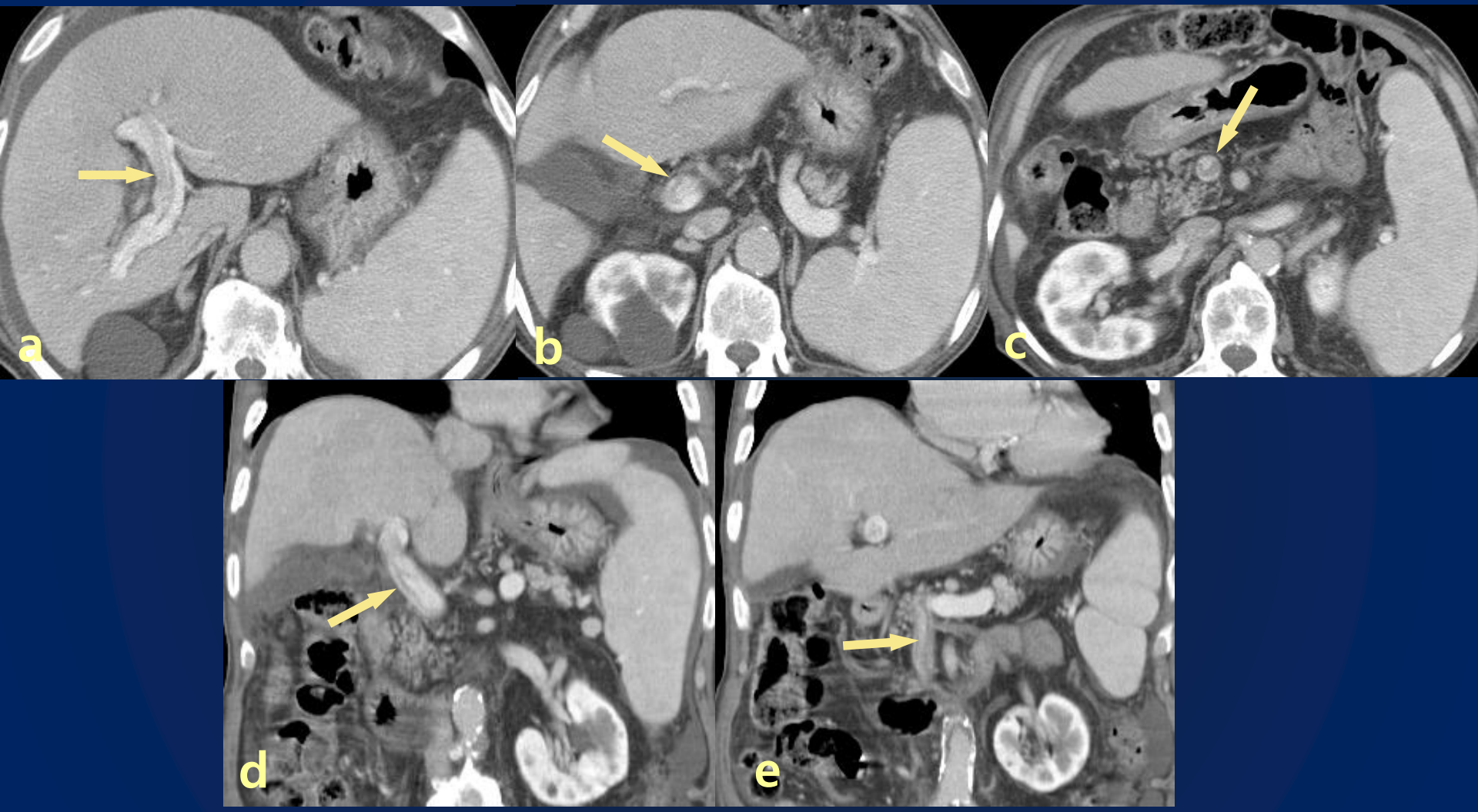


Fig.7 82 years old male with polycythemia vera.
Lineal low density thrombus within the superior mesenteric vein and portal vein (a-e, arrow)
Spleen is markedly enlarged.

Hypercoagulable state

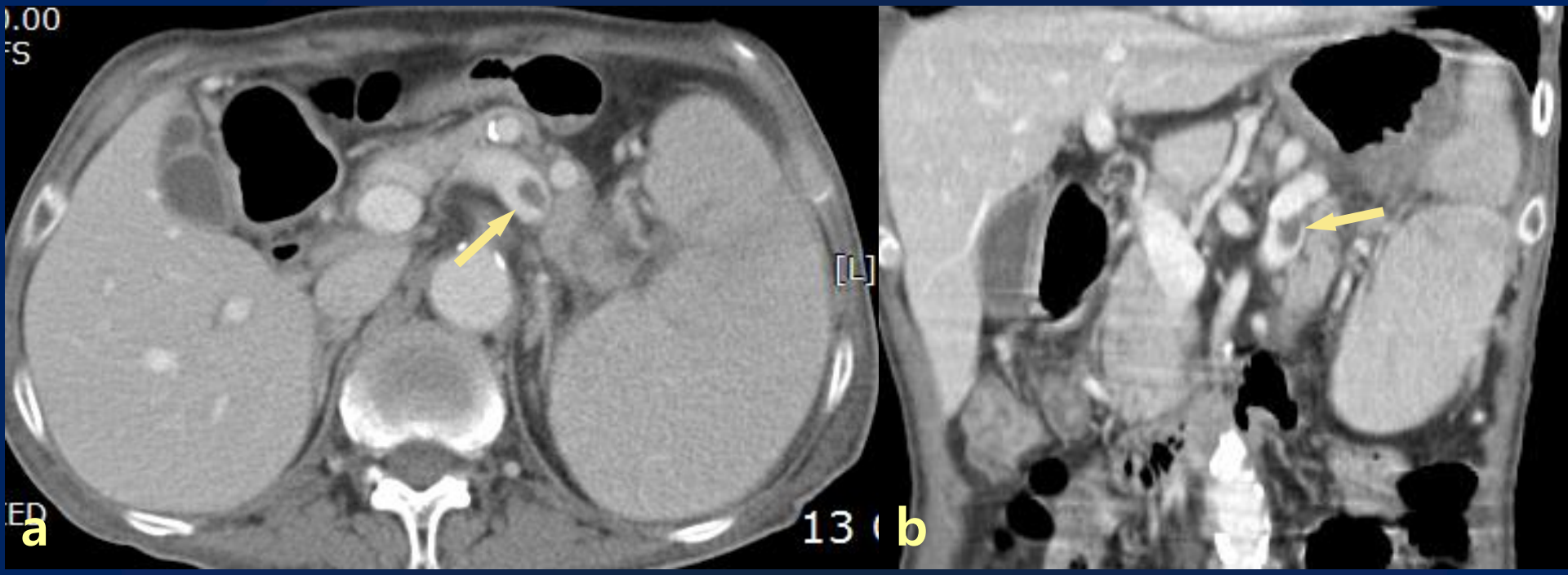


Fig. 8 77 years old male with myeloproliferative disorder.
Bland thrombus within the splenic vein (a, b, arrow). Marked splenomegaly

Pylephlebitis

- Pylephlebitis is a septic thrombophlebitis of the portal venous system.
- It is usually due to an infection in the region drained by the portal system or in the portal vein contiguous structures.
- Pylephlebitis begins with thrombophlebitis of the small veins that drain the infected area; subsequently, it extends to larger veins and it finally leads to septic thrombophlebitis of the mesenteric vein and it can even affect the portal vein, and can be associated with liver abscess
- Diverticulitis is the most common cause of pylephlebitis, but there are many others, including liver abscess, appendicitis, pelvic infections, biliary diseases, inflammatory bowel disease and necrotizing pancreatitis.

Inflammatory state

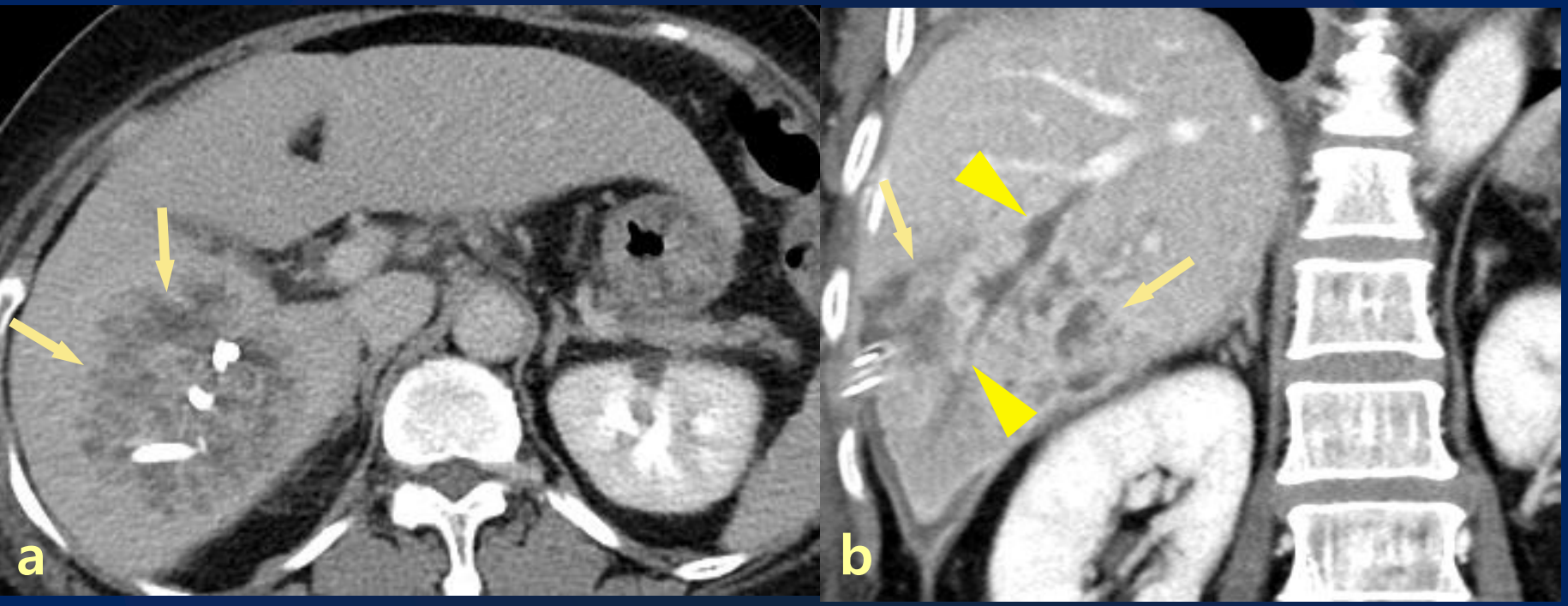


Fig. 9 65 years old female with liver abscess.
Low density multifocal clustered abscess in right lobe segment V and VI area (a, b, arrow) with drainage catheter within the abscess cavity. Low-density thrombosis present in the neighboring right portal vein without dilatation (b. arrowhead).

Inflammatory state

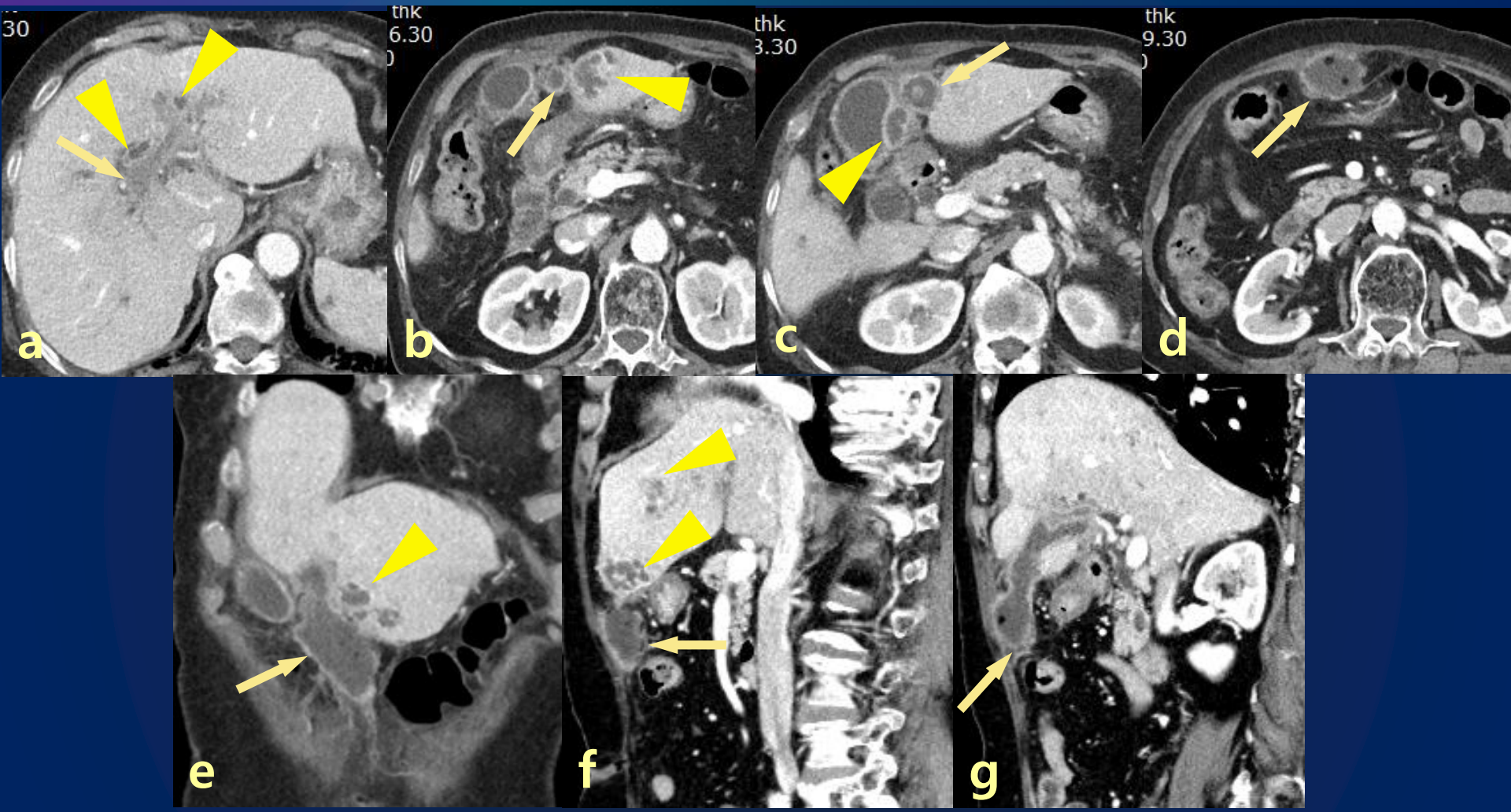


Fig. 10 88 years old female with clinically cholangitis finding with liver abscess.
Portal vein thrombosis is noted in both intrahepatic portal vein and it's tributaries (a, arrow). Minimally dilated IHD with enhanced wall suggesting cholangitis (a, arrow head). Multiple small liver abscess are (b, e, f, arrow head) noted and abscess in Seg. III extends to outside of the liver near GB fossa (c, arrow head) and extension along ligamentum teres (b, c, d, arrow) at the anterior peritoneal cavity. Abscess along lig. Teres is well defined on coronal and sagittal reconstruction image (e, f, g, arrow).

Inflammatory state

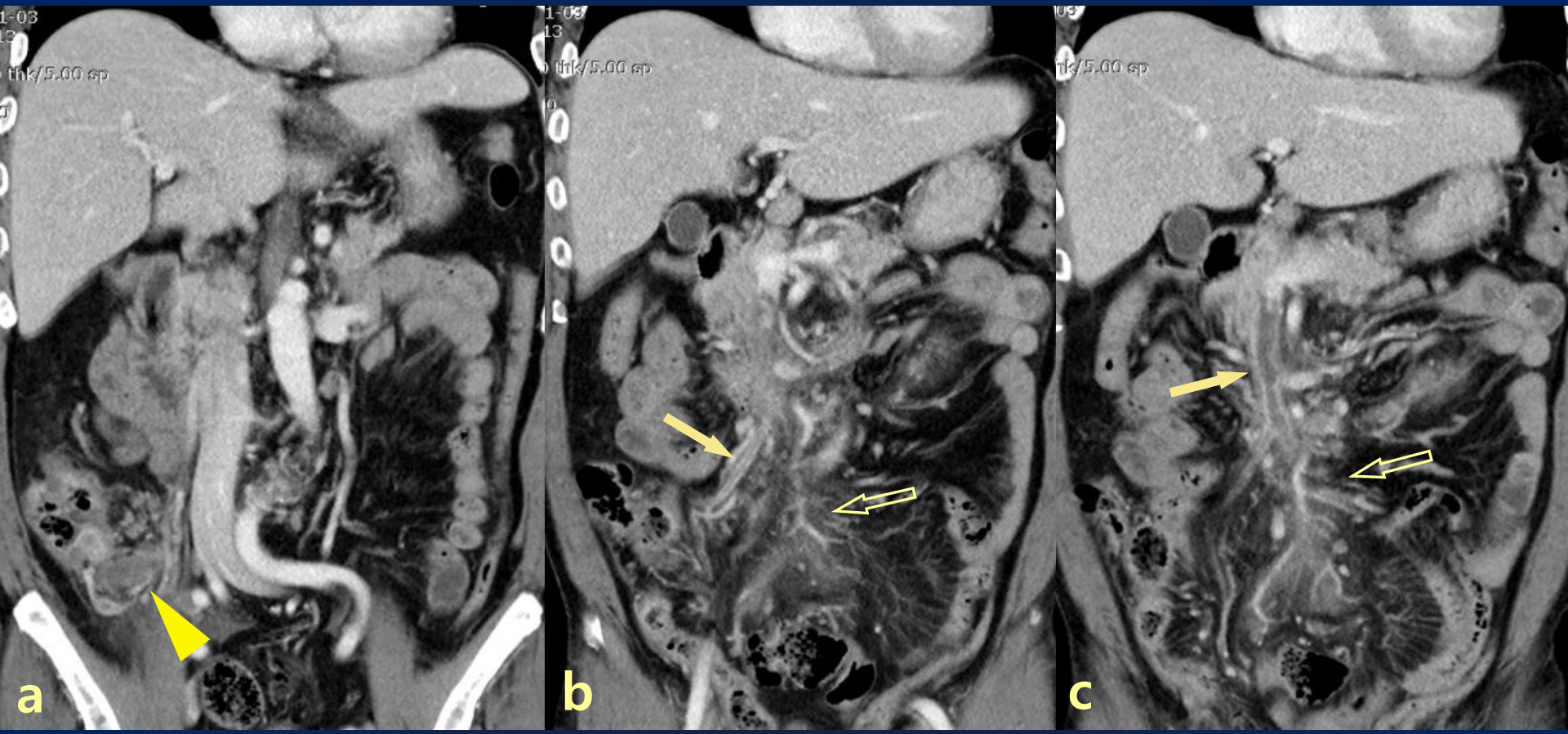


Fig. 11 74 year old female with complicated pylephlebitis in acute appendicitis.
Coronal CT images show an enlarged and thick-walled appendix (a, arrow head). Nonenhancing low-attenuation thrombi within the lumen of the ileal superior mesenteric vein tributaries (b, arrow) and superior mesenteric vein (c, arrow) with mesenteric infiltration (b, c, open arrow).

Pancreatitis with splanchnic vein thrombosis(SVT)

- Portal vein thrombosis is an unusual complication of acute pancreatitis. It occurs in some cases of severe acute pancreatitis particularly those associated with pancreatic necrosis.
- The splenic vein was the most commonly thrombosed vein, followed by the portal vein and the SMV.
- These vascular complications occurred significantly more frequently in alcohol-induced pancreatitis than in gallstone-induced pancreatitis.
- Venous thrombosis occurring with chronic pancreatitis is mainly due to the mass effect of pseudocysts .

Inflammatory state

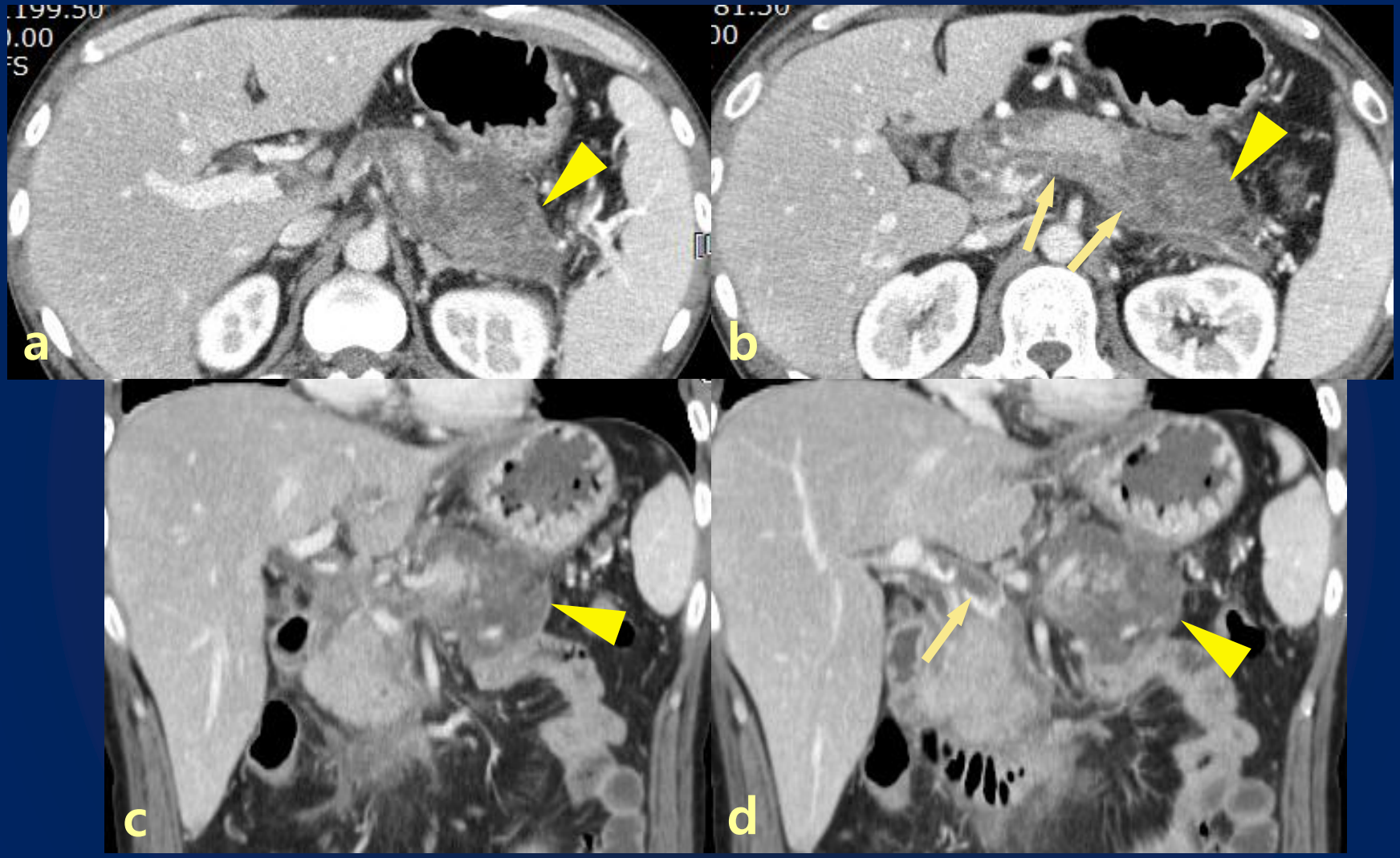


Fig. 12 49 years old male with acute necrotizing pancreatitis
CT demonstrates inhomogeneous non-enhancing low density of the pancreas body and tail area (a-d, arrow head) from necrotic pancreatic parenchyma. Splenic vein and portal vein thrombus is noted with enhanced wall (b, d, arrows). Alcoholic fatty liver disease with hepatomegaly is associated.

Inflammatory state

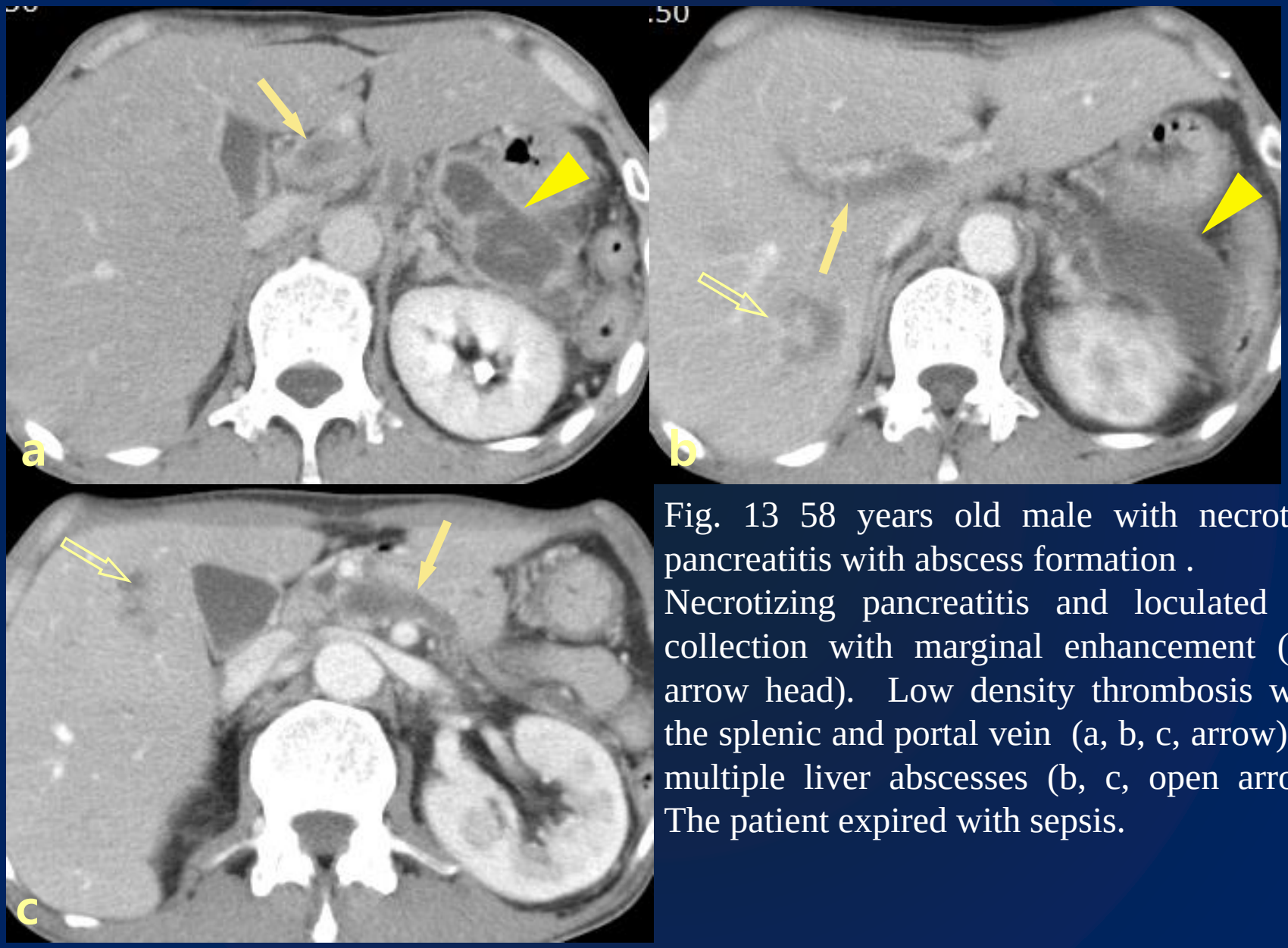
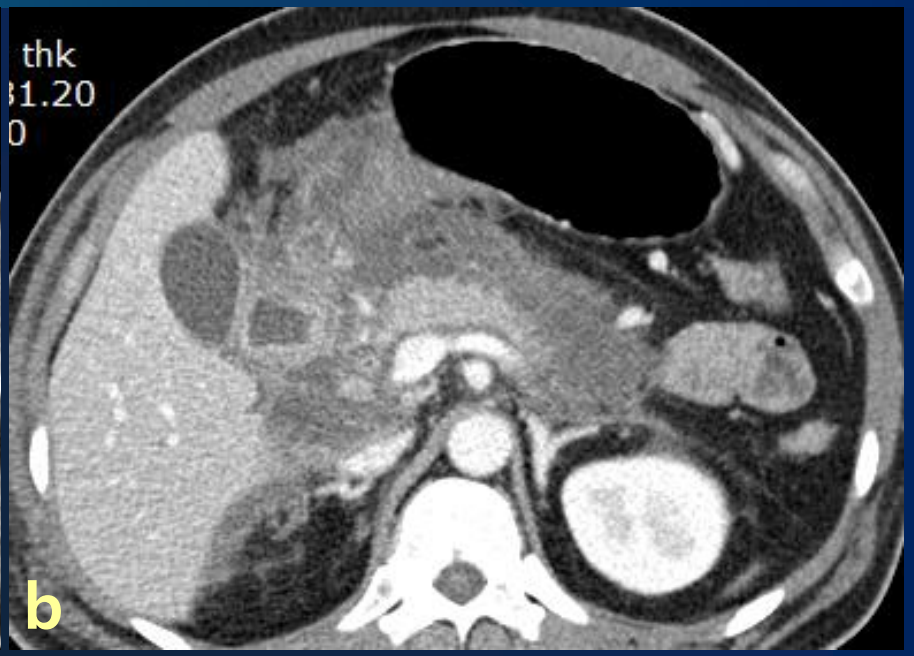


Fig. 13 58 years old male with necrotizing pancreatitis with abscess formation .
Necrotizing pancreatitis and loculated fluid collection with marginal enhancement (a, b, arrow head). Low density thrombosis within the splenic and portal vein (a, b, c, arrow) with multiple liver abscesses (b, c, open arrow) . The patient expired with sepsis.

Inflammatory state



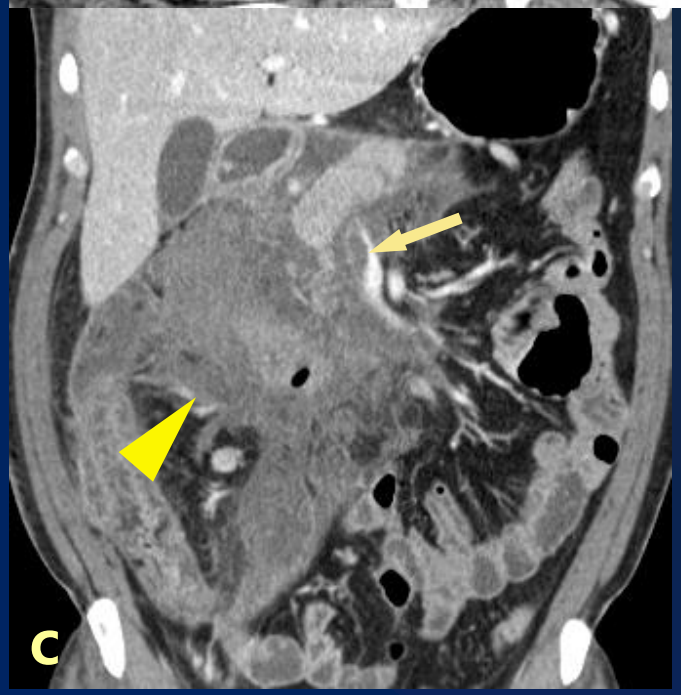


Fig. 14 33 years old male with severe degree acute pancreatitis with peripancreatic fluid collection in alcoholics.

More localized pancreatitis finding in pancreas head and associated extrapancreatic change on right side of mesentery (a, c, arrow heads).

Unusually superior mesenteric vein thrombosis develops in acute pancreatitis (a, c, arrow) due to neighboring prominent inflammatory change with normal splenic vein .

Inflammatory state

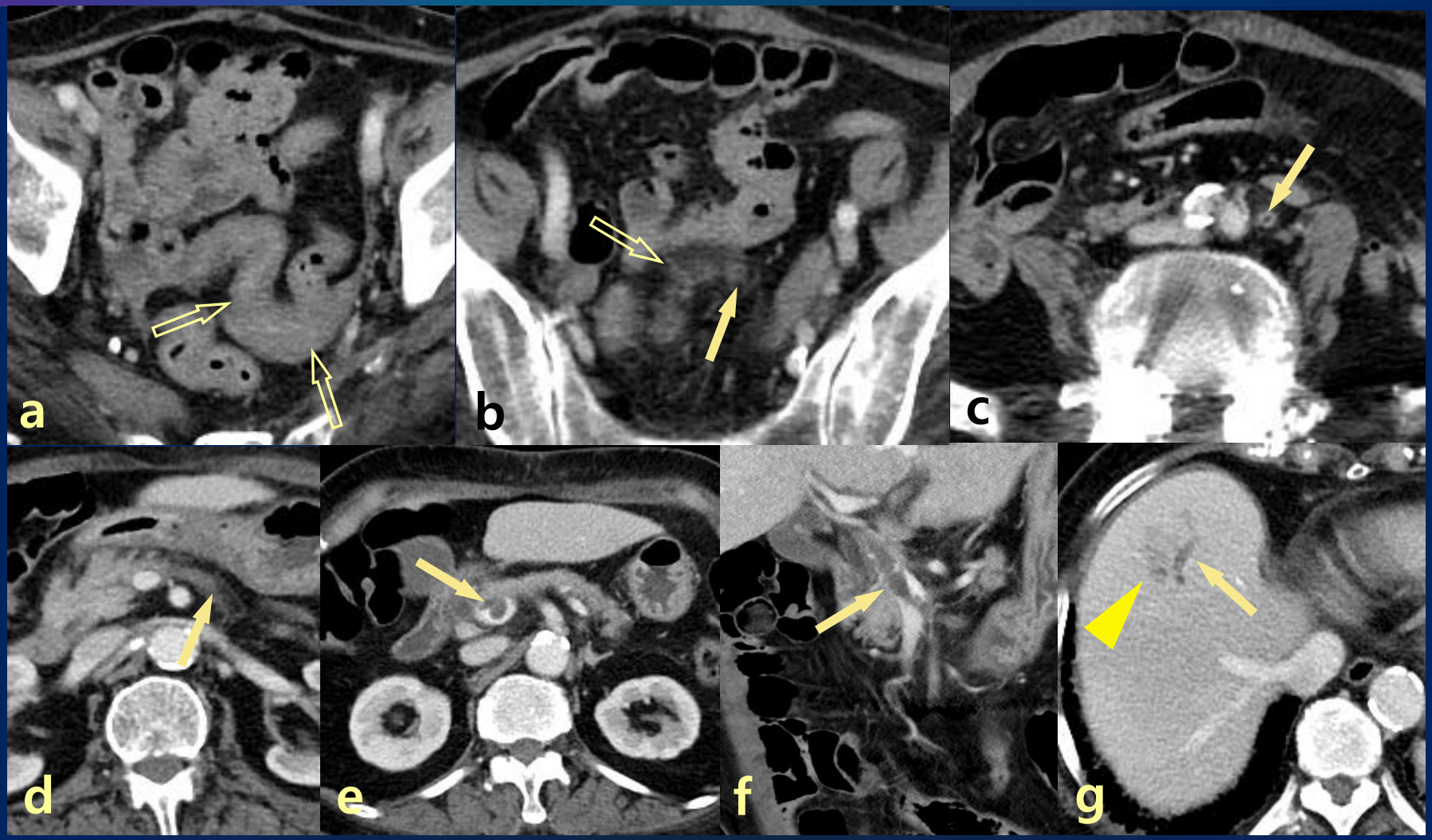


Fig. 15 66 years old female with acute diverticulitis of the sigmoid colon.
CT demonstrates edematous thickened sigmoid wall (a, open arrow) with mesenteric infiltration (b, open arrow). Thrombus within the inferior mesenteric vein with extending thrombus within the portal vein to hepatic branch (b-g, arrow). Associated small liver abscess in Seg. VIII of liver (g, arrow head).

Inflammatory state

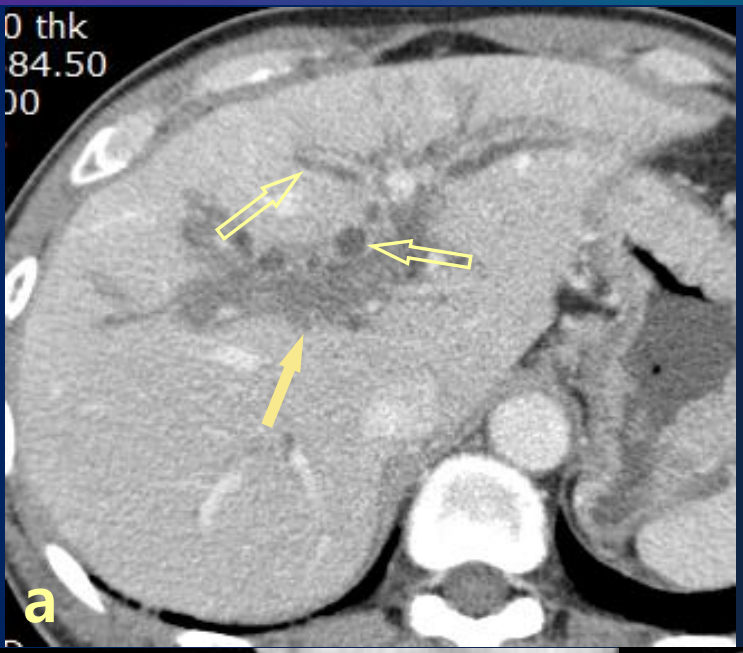
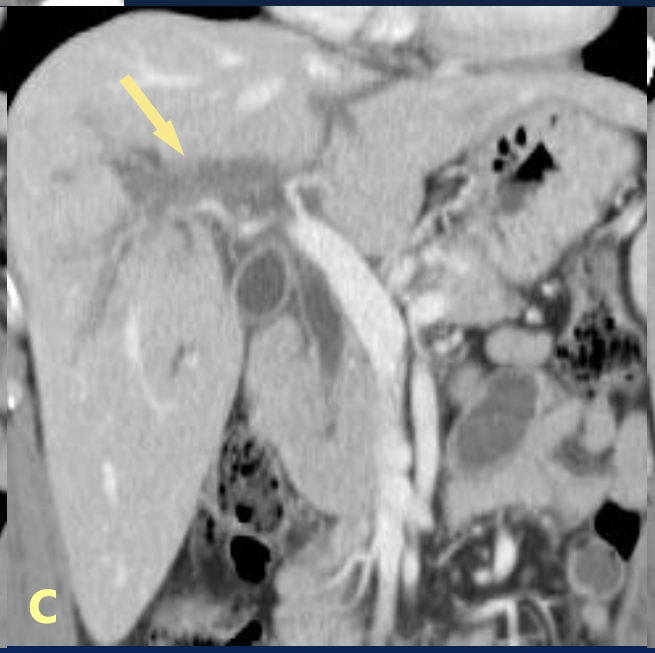
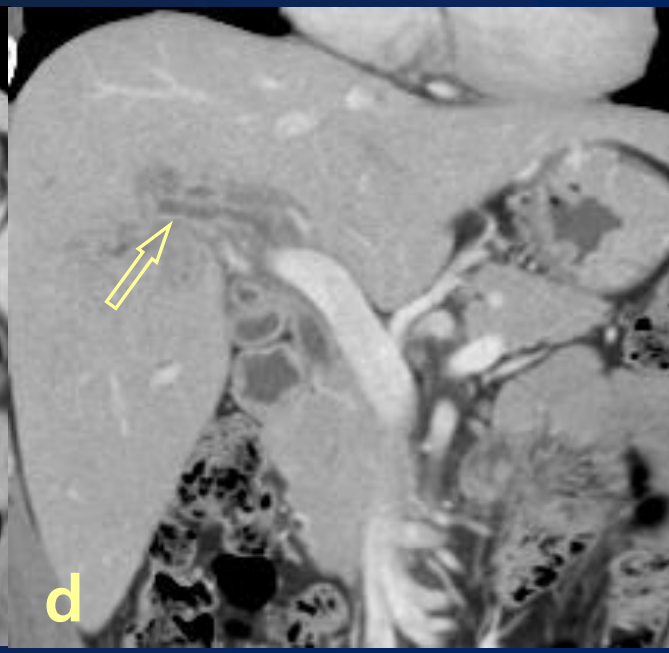


Fig. 16 45 years old male with cholangitis finding proven as IgG4-related sclerosing disease on periportal liver biopsy.
Minimally dilated bile duct with enhanced wall from cholangitis finding (a, b, d, open arrow). Associated thrombosis within the intrahepatic portal vein (a, c, arrow).





THAD

- Transient hepatic attenuation differences (THAD) lesions refer to areas of hyperintense parenchymal enhancement visible during the hepatic artery phase and revert to isointense in portal phase on enhanced CT. They are thought to be a physiological phenomenon , compensatory relationships between two liver sources of blood supply so that arterial flow increases when portal flow decreases.
- The central or hilar region of the liver has abundant collaterals, and in the event of portal vein thrombosis continues to receive portal blood supply via collaterals. The periphery of the liver has relatively fewer areas of communication and thus when the main portal vein flow decreases, there is decreased portal flow in the periphery of the liver, increased hepatic arterial flow, and a resultant THAD occurs.
- Hypovscular THAD may present, means geographic area of hypoattenuation on portal venous phase
- Usually the area show straight border representing vascular territory without mass effect, but sometimes it appears as round or geographic. Radiologists should be careful not to mistake the central low attenuation region for a hepatic tumor.

Inflammatory state

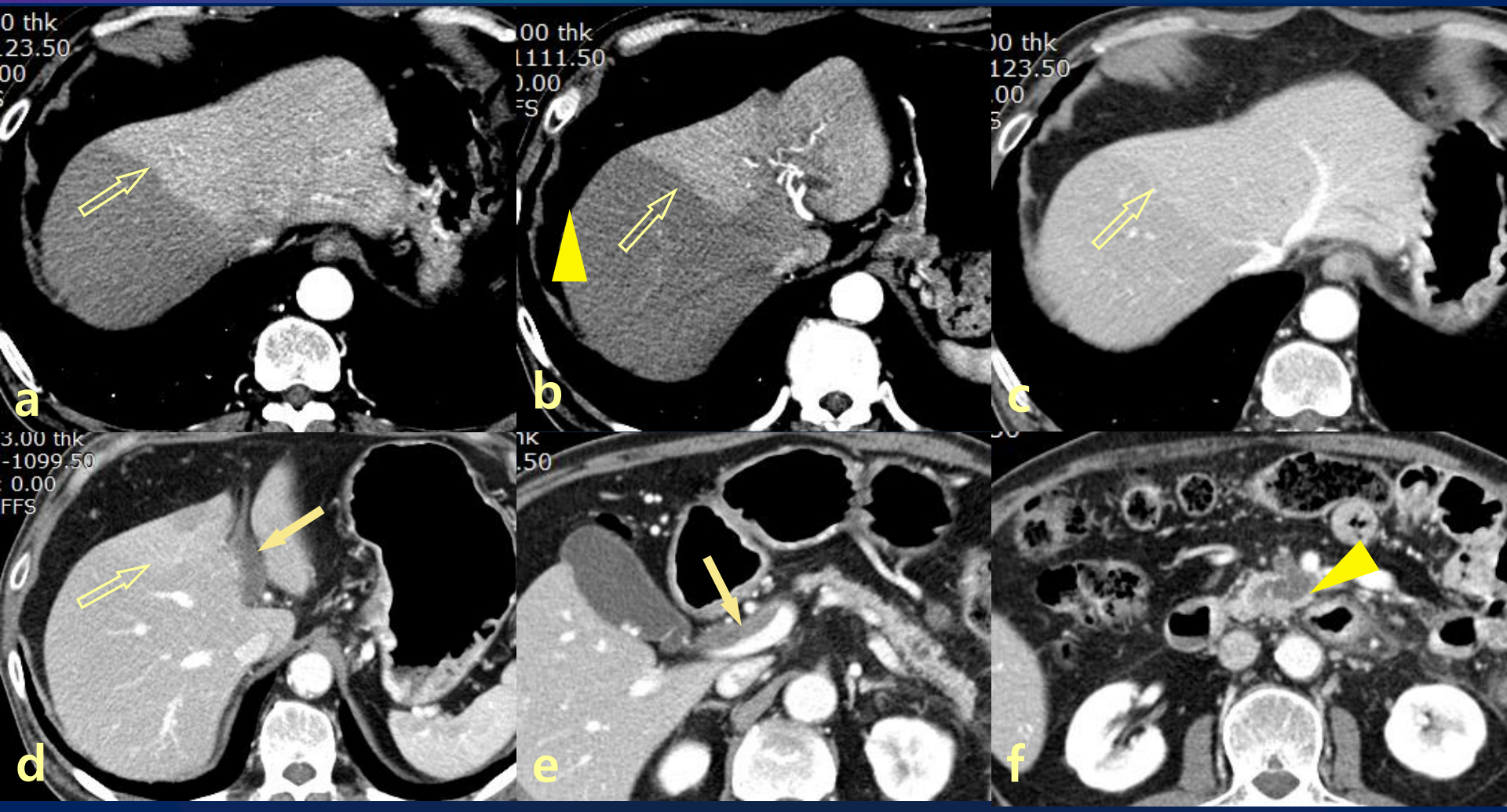


Fig. 17 63 years old male with acute pancreatitis and lobar distributed THAD.
CT demonstrates acute pancreatitis of the head with cystic lesion and peripancreatic infiltration (f, arrow head). Thrombosis within the main portal vein and left hepatic portal vein (d, e, arrow) . THAD with dilated left hepatic artery and clearly margined increased left lobe liver increased enhancement on arterial phase CT (a, b, open arrow) which reverts to nearly isodensity on portal (c, d open arrow).

Inflammatory state

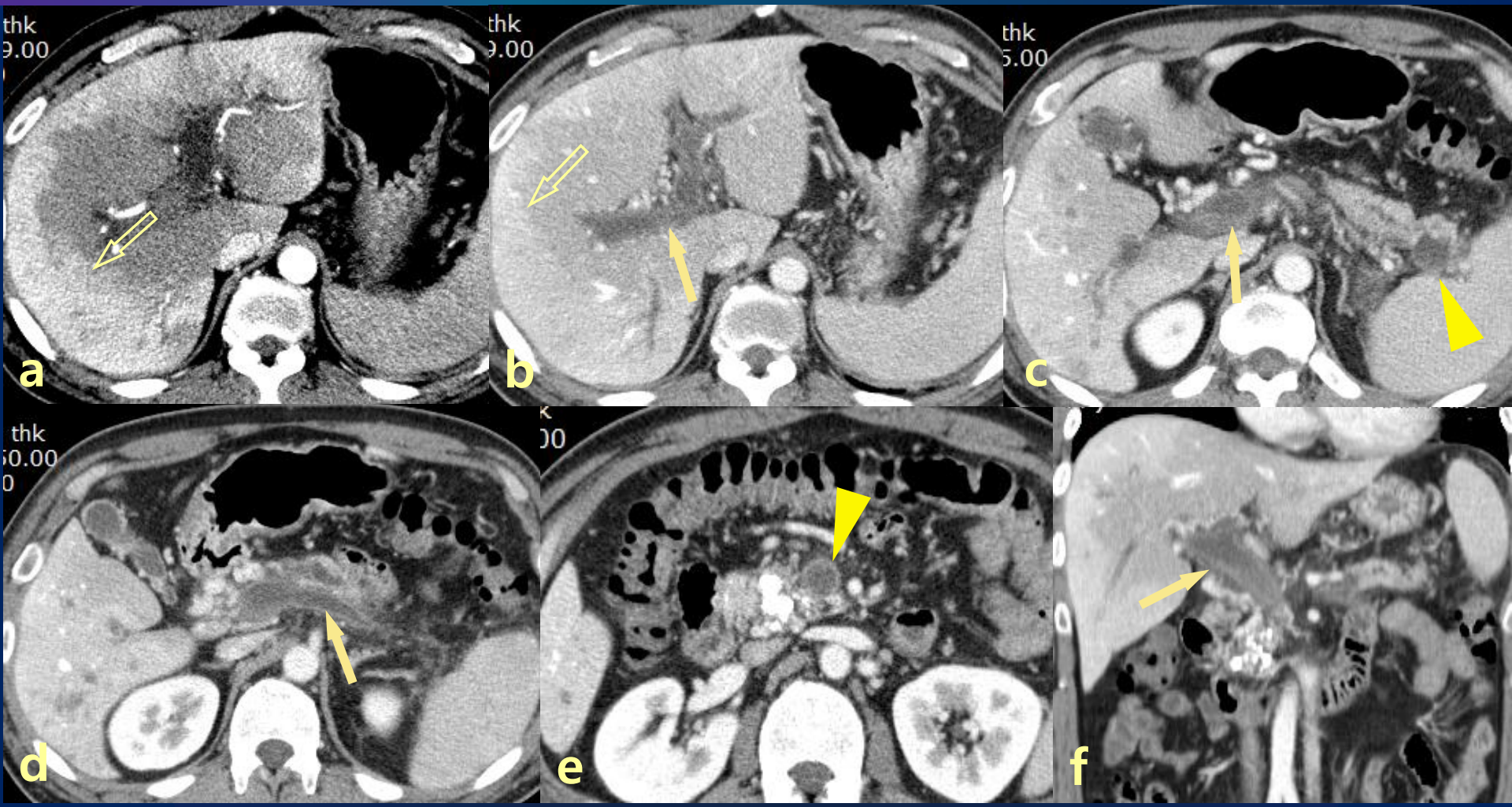


Fig. 18 45 years old male with chronic pancreatitis and peripheral distributed THAD.
CT demonstrates chronic pancreatitis with calcifications of the head and cystic lesion of the pancreas tail (c, e, arrow head). Thrombosis within the splenic vein, main portal vein and it's intrahepatic branches (b-d, f, arrow). Peripheral distributed THAD with dilated hepatic artery and peripheral increased liver attenuation on arterial phase CT (a, open arrow), which persists to portal phase with less prominent density difference (b, open arrow).

Splanchnic vein thrombosis in malignant tumor

- Neoplastic disease is, alongside liver cirrhosis, the most common disorder associated to PVT.
- HCC is the cancer most frequently associated with PVT and the portal thrombosis can be caused directly by the tumoral mass and indicative of an advanced tumoral stage.
- Tumoral PVT has also been reported to be associated with various other cancers such as pancreatic cancer, GB cancer, gastric cancer, colorectal cancer and cholangiocarcinoma, possibly by extrinsic vein occlusion by the primary mass or by enlarged metastatic lymph nodes.
- Differentiation between a bland thrombus and a tumoral thrombus is not always possible. However, enhancement within a thrombus during the hepatic arterial phase (thread and streak sign), disruption of the vessel wall and parenchymal infiltration suggests the presence of portal vein invasion and tumoral thrombosis. Another sign of malignant thrombosis is dilated portal vein greater than 23 mm in diameter due to distension of the venous lumen.

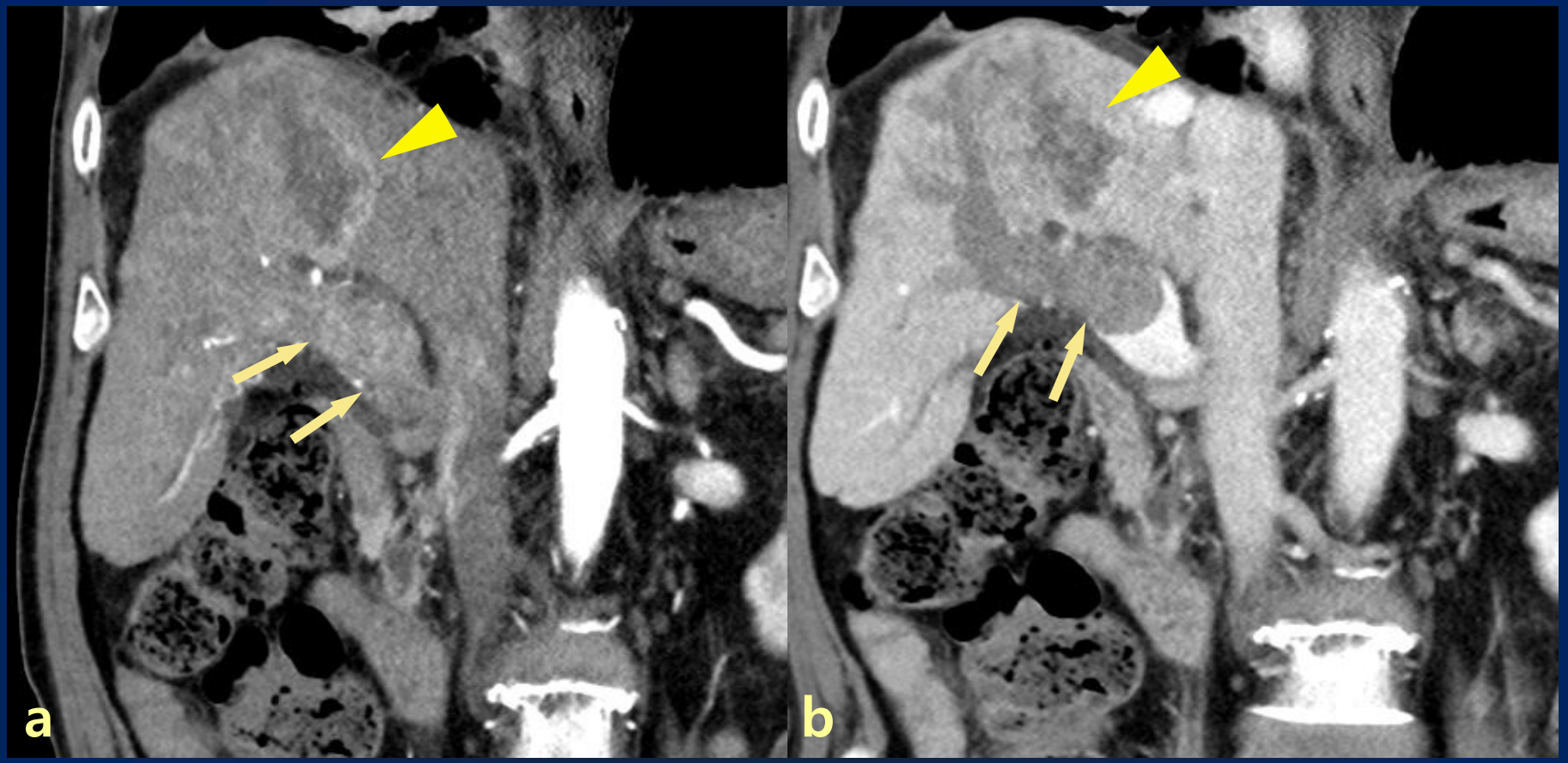


Fig. 19 84 years old male with hepatocellular carcinoma
Arterial phase CT (a) revealed heterogeneously enhanced hepatic focal lesion at the right hepatic lobe (arrow head) with enhanced right and main portal vein tumor thrombus (arrows) within the dilated portal vein . Portal phase CT (b) revealed wash-out of contrast from the right hepatic lobe focal lesion (arrow head), as well as the thrombus within the right and main portal vein (arrows).

Malignant diseases

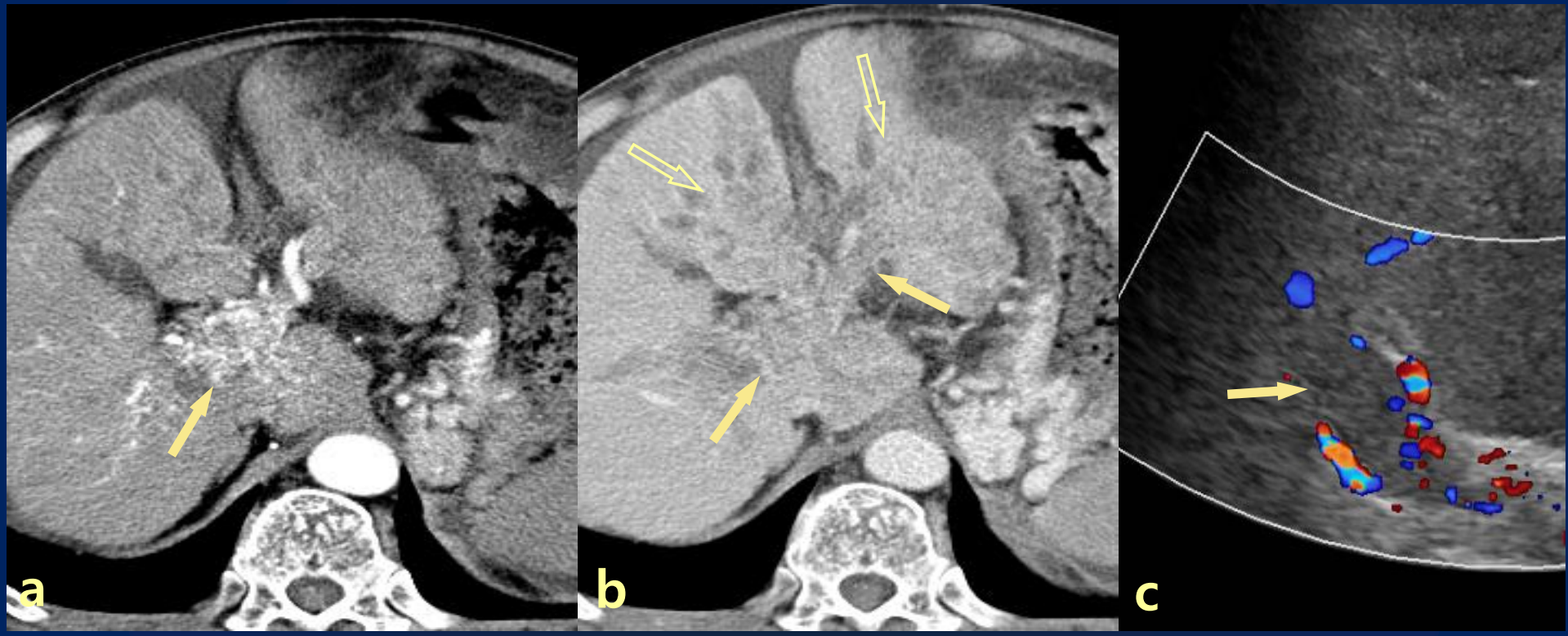


Fig. 20 70 years old male with diffuse infiltrating hepatocellular carcinoma
Arterial phase CT (a) revealed no definite enhancing mass lesion, however poorly outlined margin of low density infiltrating mass is seen in portal phase (b, open arrows). Rich enhanced networks of vessels (the thread and streak sign) are noted in and around a tumor cast that is growing in a large branch and trunk of the dilated portal vein (a, b, arrows).
On color doppler sonography, dilated hepatic artery and increased supply in and outside the tumor thrombus of the portal vein is noted (c, arrow) .

Malignant diseases

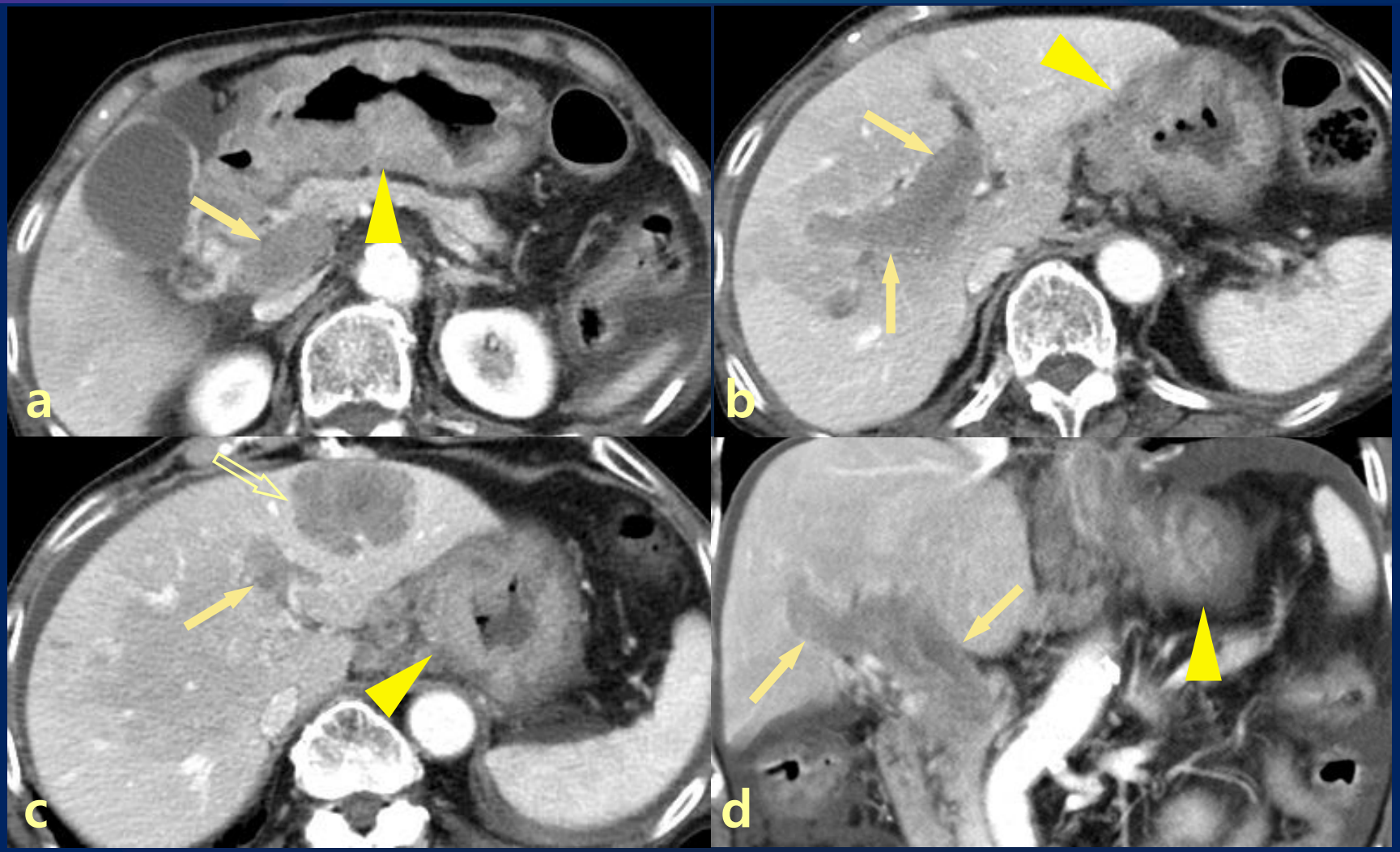


Fig. 21 78 years old female with gastric cancer
Irregular thickened gastric wall involving from fundus to distal antrum from diffuse infiltrating type gastric carcinoma (a-d, arrow head). Metastatic tumor within the left lobe liver is also noted (c, open arrow). Inhomogeneous density tumor thrombus is noted within the main and intrahepatic portal vein with markedly dilated venous lumen (a-d, arrows).

Malignant diseases

Fig. 22 71 years old male with hepatic flexure colon cancer.
Thickened enhanced hepatic flexure colon cancer (a, open arrow) with lymph node metastases (a, arrow head) is noted. Inhomogeneous density tumor thrombus is noted within the main portal vein with markedly dilated venous lumen (b, c, arrow).

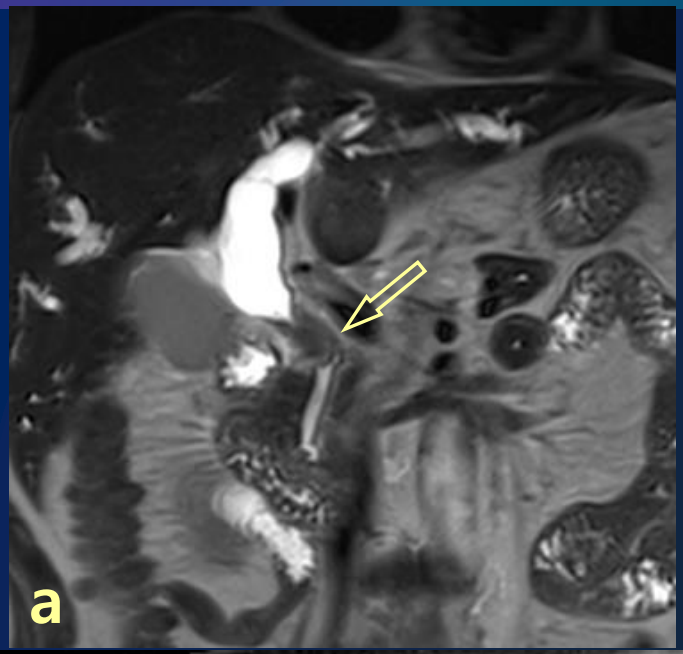
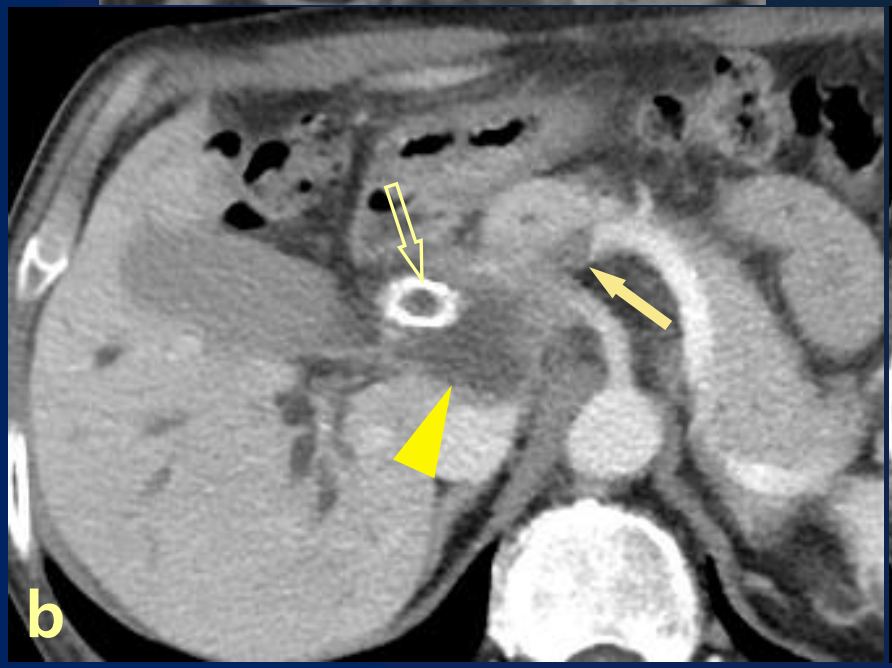
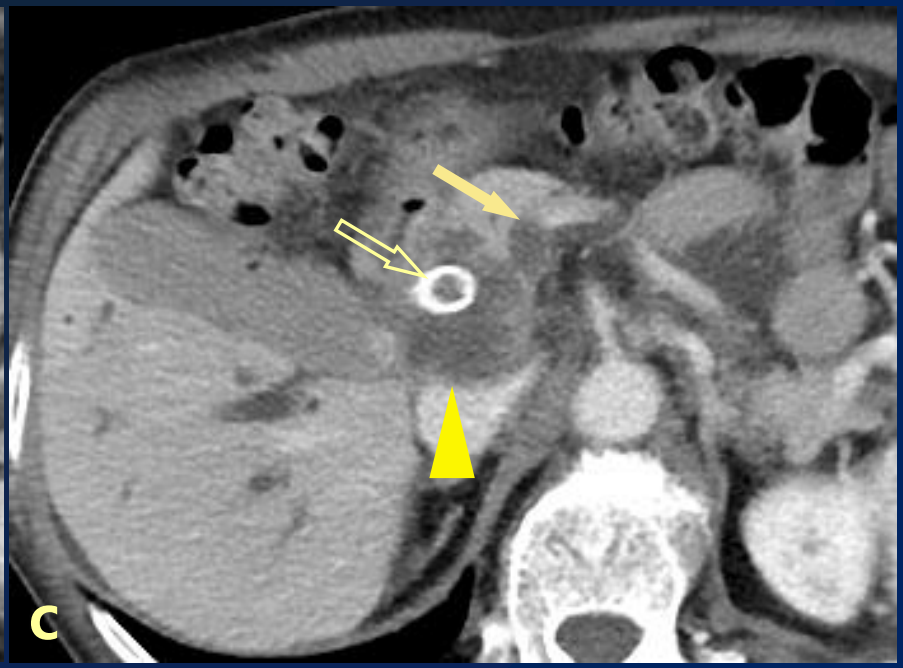


Fig. 23. 70 years old male with mid CBD cancer MRCP revealed abrupt narrowing and short segment thickened mid CBD wall from CBD cancer (a, open arrow).
4 months later CT with biliary stent insertion (b, c, open arrow), low density tumor extension outside of the bile duct lumen is noted (b, c, arrow head) and revealed direct invasion and thrombus within the splenic vein and portal vein (b, c, arrow).





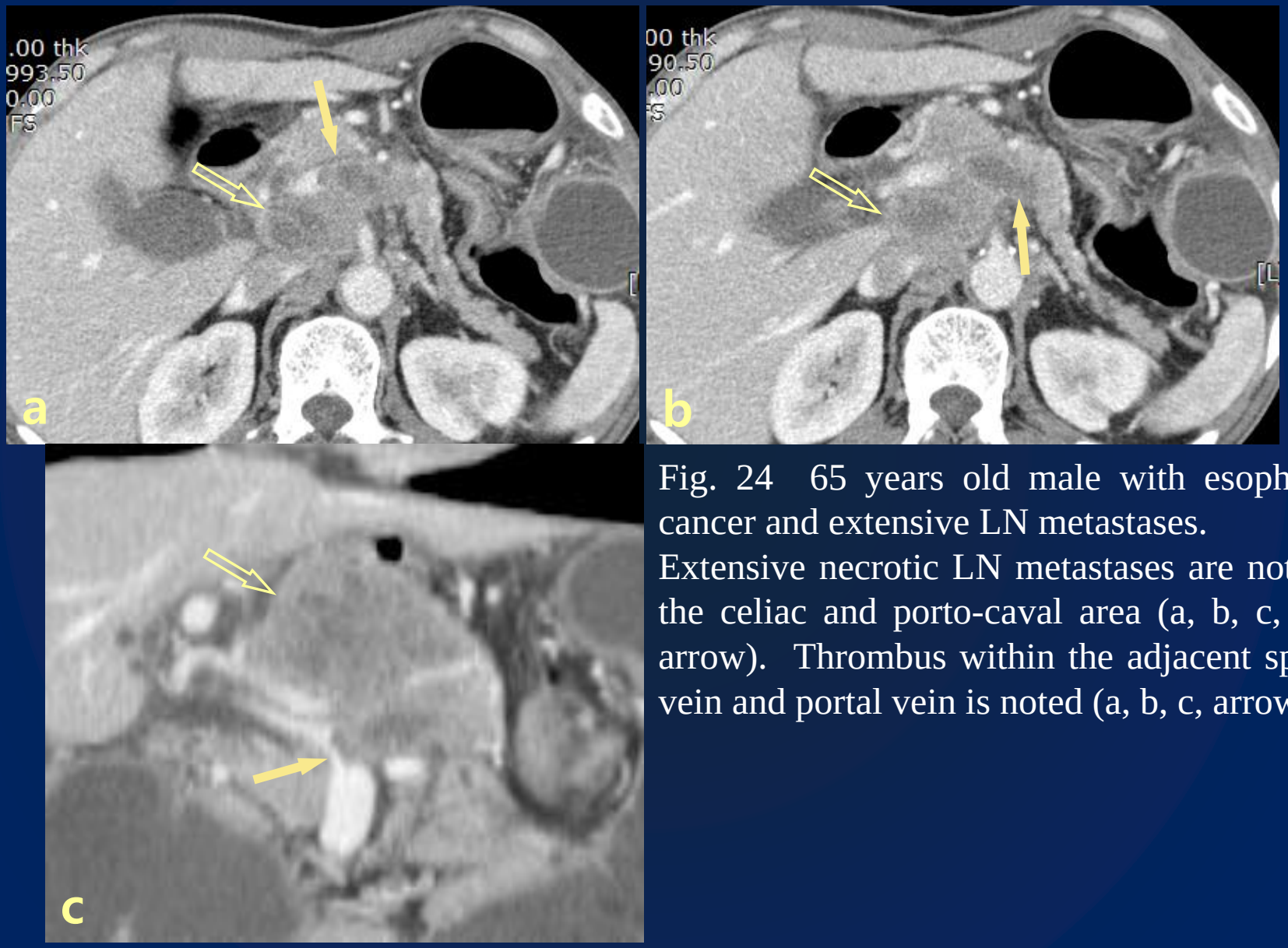


Fig. 24 65 years old male with esophageal cancer and extensive LN metastases.
Extensive necrotic LN metastases are noted at the celiac and porto-caval area (a, b, c, open arrow). Thrombus within the adjacent splenic vein and portal vein is noted (a, b, c, arrow).

Conclusion

- Portal venous thrombosis has many etiologies and may be complicated by mesenteric ischemia, splenic infarction and portal hypertension.
- Secondary to portal vein obstruction, liver attenuation abnormality may occur.
- Differentiation of bland thrombus from malignant tumor thrombus may possible with dynamic enhanced CT scan.
- Radiologists must not only recognize the appearance of portal vein thrombosis, but must vigilant in identifying theses additional findings, so that patients may receive prompt and appropriate treatment.

References

1. Rajesh S, Amar M and Ankur A Imaging Diagnosis of Splanchnic Venous Thrombosis Gastroenterology Research and Practice 2015(2):1-29 · November 2015
2. Novick SL, Fishman EK. Portal vein thrombosis: spectrum of helical CT and CT angiographic findings. Abdom Imaging. 1998 Sep-Oct. 23(5):505-10.
3. Haddad Mc, Clark DC, Sharif HS, Shahed MA, Aideyan O, Sammak BM MR, CT, and ultrasonography of splanchnic venous thrombosis. Gastrointes Radiol 17;1 34-40 1992
4. Cristina Margini, Annalisa Berzigotti Portal vein thrombosis: The role of imaging in the clinical setting international journal of gastroenterology and hepatology 49 :113-120 2017
5. R. Monreal, I. Rubio Marco, I. García de Eulate, J. et al Portal vein thrombosis: Imaging spectrum of etiologies in MDCT. Poster No.: C-0711Congress: ECR 2015 Type: Educational Exhibit
6. Qi X, Han G, He C, et al.. CT features of non-malignant portal vein thrombosis: a pictorial review. Clin Res Hepatol Gastroenterol 2012
7. Rafael D• Alban L. Denys, Letovanec I, Meuli RA, Schmidt S Multidetector CT Features of Mesenteric Vein Thrombosis Radiographics 32;5 1503-1522 2012
8. Gallego C, Velasco M, Marcuello P et-al. Congenital and acquired anomalies of the portal venous system. Radiographics. 2002;22 (1): 141-59. Radiographics (full text) - Pubmed citation
9. Balthazar EJ, Gollapudi P. Septic thrombophlebitis of the mesenteric and portal veins: CT imaging. J Comput Assist Tomogr. 2000;24 (5): 755-60.
10. J. Saraiva, C. Bilreiro, J. Brito, B. M. Q. Santos; Portimão PT Transient Hepatic Perfusion Differences (THAD/THID) What? When? Where? ECR 2017 Type: Educational Exhibit
11. Onofrio A. Catalano, MD, Garry Choy, MD, et al Differentiation of Malignant Thrombus from Bland Thrombus of the Portal Vein in Patients with Hepatocellular Carcinoma: