

Tumor in vein and Liver Imaging Reporting and Data System (LI-RADS) v2018: diagnostic features, pitfalls, prognostic and management implications

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Disclosures

- **Roberta Catania:**
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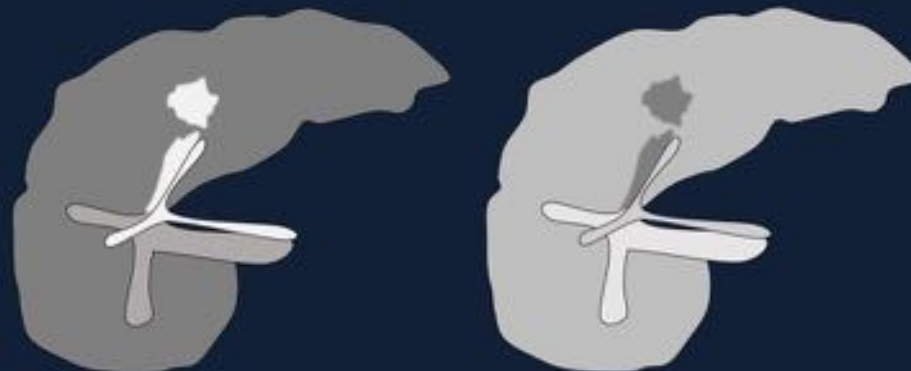
Educational Goals & Objectives

- To understand the clinical and prognostic implications of tumor in vein (TIV) in Patients with HCC
- To review the imaging features of TIV on CT/MRI according to LI-RADS v2018
- To analyze diagnostic pitfalls that may confound the interpretation of CT and MRI in the diagnosis of LR-TIV
- To provide suggestions on how to manage indeterminate cases

TARGET AUDIENCE: radiology residents, general radiologists, abdominal fellows and radiologists

Tumor in vein & HCC: overview

Venous invasion by hepatocellular carcinoma



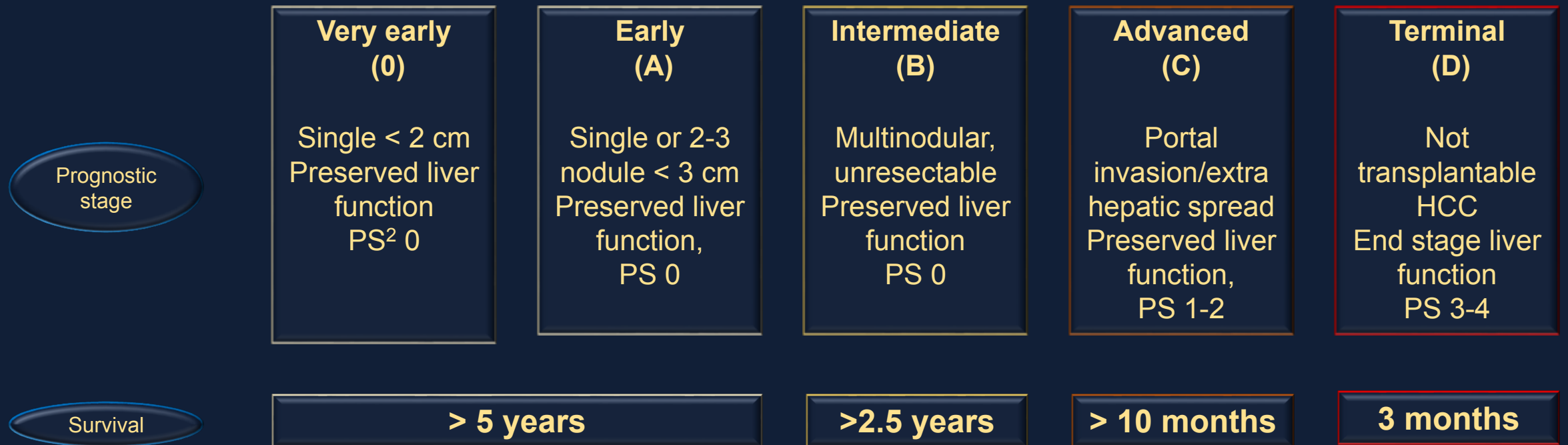
Arterial phase

Portal venous phase

- Portal vein invasion occurs more commonly than hepatic vein invasion, due to tumor blood drainage into sinusoids and portal venules.
- Incidence of TIV ranges between 6.5-44% of patients with HCC.
- Survival rate is reduced in patients with TIV. Main portal vein involvement has a worse prognosis compared to segmental or subsegmental involvement.

Tumor in vein & HCC: staging

TIV classifies HCC as advanced (stage C, BCLC¹)

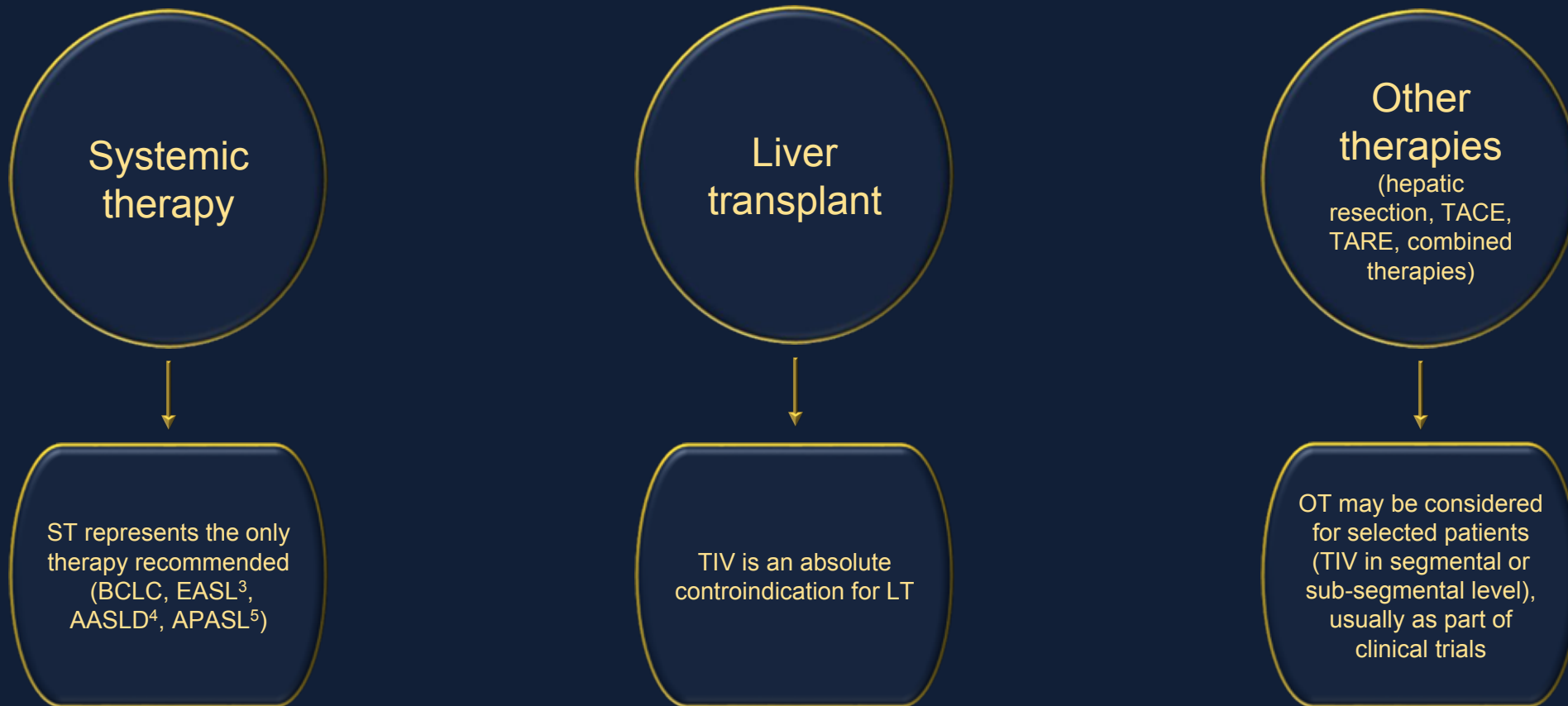


¹BCLC: Barcelona-Clinic Liver Cancer

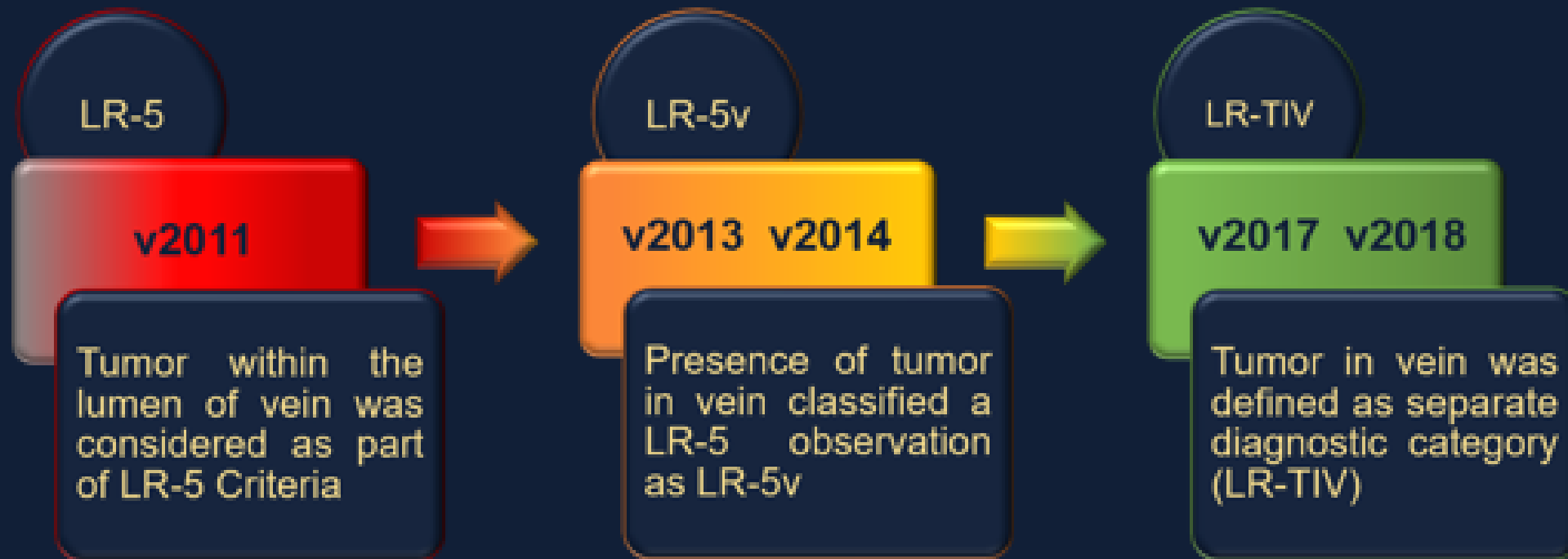
²PS: Performance Status

Tumor in vein & HCC: which treatment?

TIV indicates poor prognosis, usually related to poor liver function, high tumor aggressiveness, decreased chemotherapy tolerance and high risk of complications related to surgery

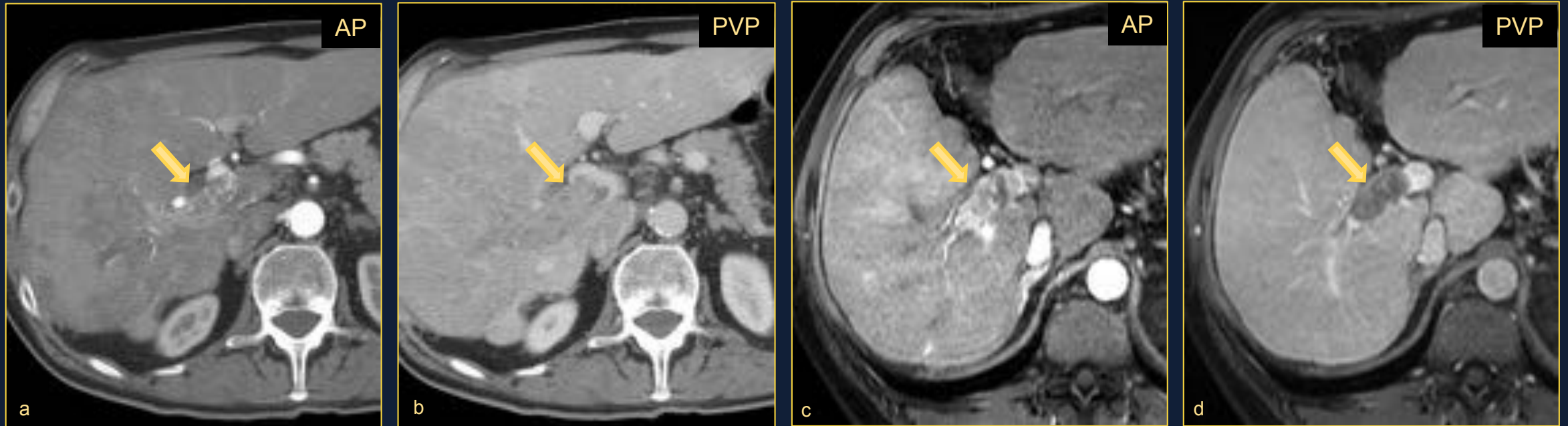


Tumor in Vein & LI-RADS[®] CT/MRI



LR-TIV: features diagnostic of TIV

Unequivocal enhancing soft tissue in vein, regardless of visualization of parenchymal mass

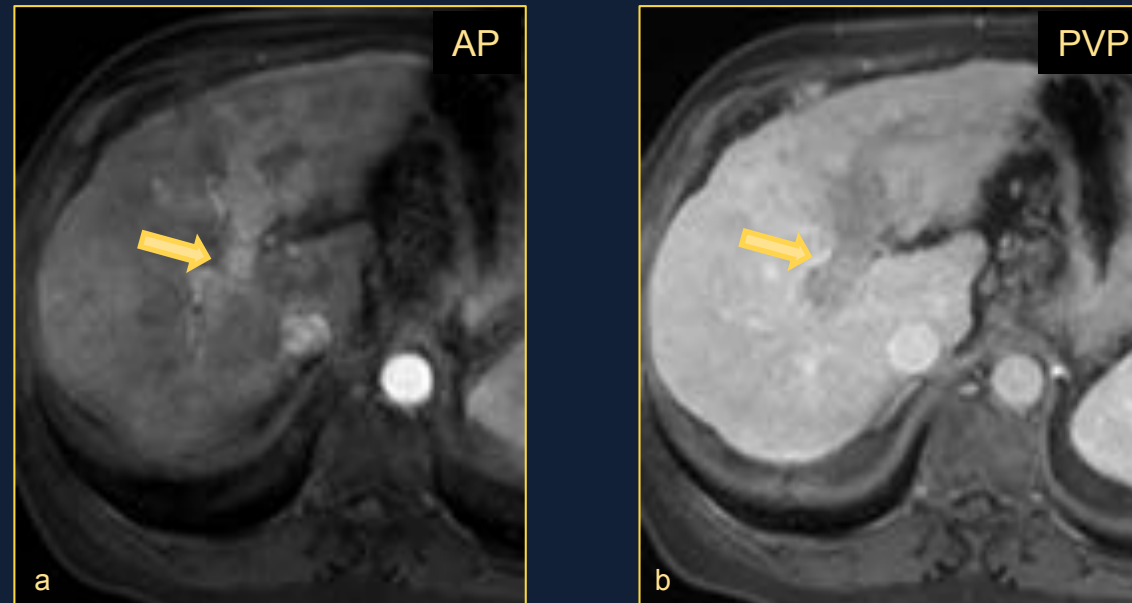


Axial contrast enhanced CT (a, b) and MRI (c, d) images in a cirrhotic patient show a filling defect in the right portal vein (arrows), with heterogeneous arterial phase hyperenhancement (APHE) (arrow, a and c) and washout on portal-venous phases (arrow, b and d). Imaging features diagnostic for tumor in vein (LR-TIV).

LR-TIV: features diagnostic of TIV

Unequivocal *enhancing soft tissue in vein*, regardless of visualization of parenchymal mass

TIV can be present without a visible parenchymal mass



Axial contrast enhanced MRI (a, b) images in a cirrhotic patient show a filling defect in the portal vein (arrows), with heterogeneous APHE (arrow, a) and washout on PVP (arrow, b). No evidence of parenchymal mass is detected.

LR-TIV: features diagnostic of TIV

Unequivocal *enhancing soft tissue in vein*, regardless of visualization of parenchymal mass



Only observations that can be diagnosed as TIV with **100% certainty** can be classified as LR-TIV

To achieve such high specificity, modest sensitivity is unavoidable:

- not all cases of tumor in vein can be categorized as LR-TIV
- a category other than LR-TIV doesn't exclude tumor in vein



LR-TIV: pitfalls on CT/MRI

1. Bland thrombus misdiagnosed as TIV

- Inherent hyperintensity of thrombus on unenhanced T1w
- Expansive thrombus without enhancement
- Peri-portal collaterals

2. TIV not showing enhancement

- Infiltrative HCC
- Necrotic thrombus

LR-TIV: pitfalls on CT/MRI

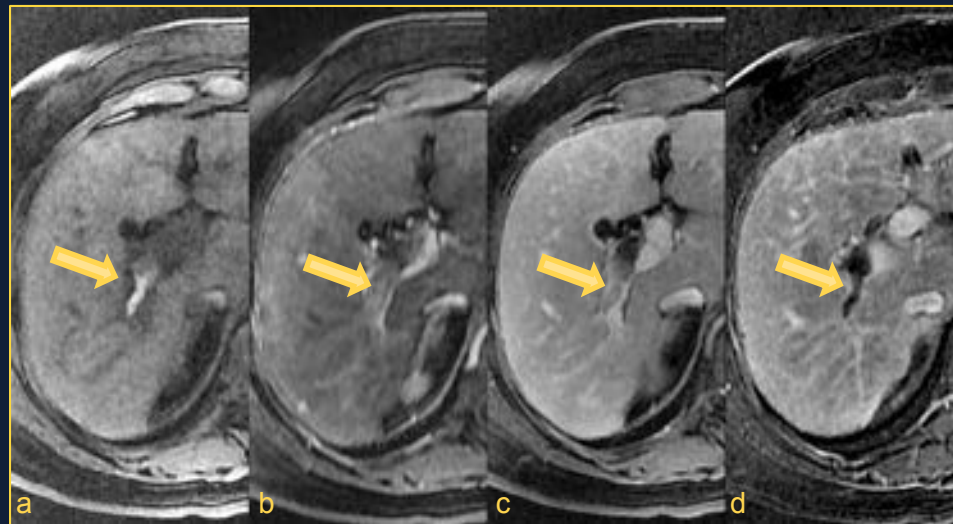
1. Bland thrombus misdiagnosed as TIV

25% of Patients with Cirrhosis may develop bland venous thrombus which can be secondary to

- portal hypertension in the setting of chronic liver disease
- malignancy-associated thrombophilia

Bland thrombus never shows enhancement

However, sometimes it may resemble TIV



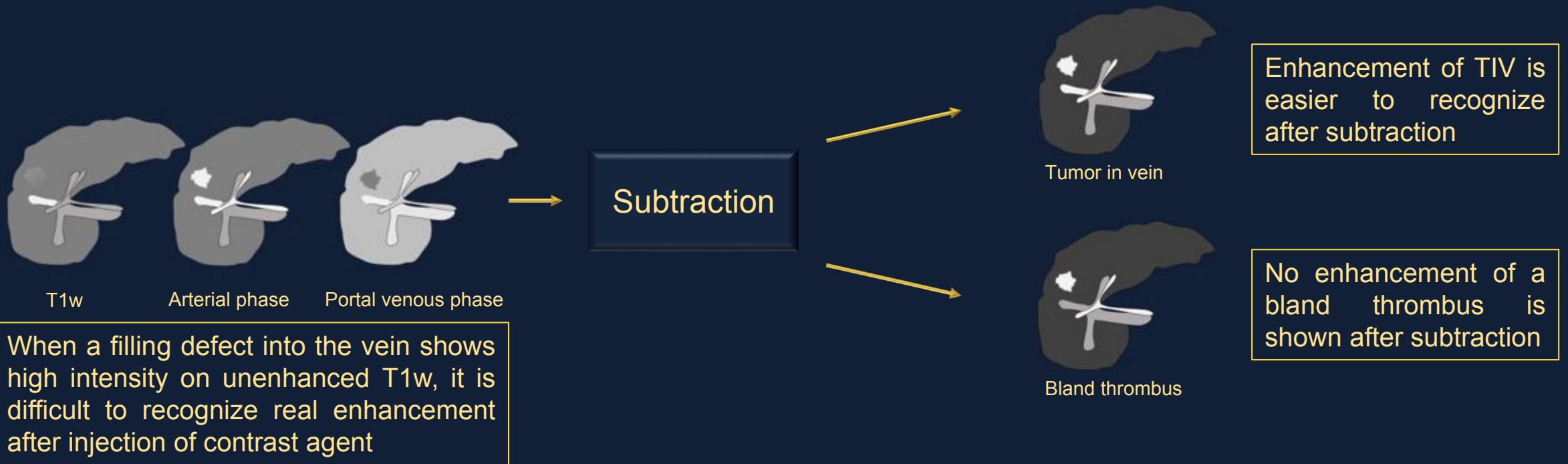
Axial T1 image (a) shows a hyperintense thrombus within the portal vein (arrow), which may be considered enhancing on arterial phase (arrow, b), with wash-out on portal venous phase (arrow, c). However, subtraction image (d), clearly shows absence of contrast enhancement within the thrombus (arrow, d).

LR-TIV: pitfalls on CT/MRI

➤ Inherent hyperintensity of thrombus on unenhanced T1w

Both acute bland thrombus and tumor in vein may have hemorrhagic components which can show high signal intensity on unenhanced T1w images

Need subtraction imaging to assess real enhancement



LR-TIV: pitfalls on CT/MRI

➤ Peri-portal collaterals

Collateral vessels around a bland thrombus can mimic enhancing soft tissue in a vein



Don't call enhancing soft tissue in vein if it may represent collateral vessels around a thrombus

➤ Expansive thrombus without enhancement

Expansion of vessel is commonly considered one of the main features of tumor in vein. However, radiologists should always be aware that acute bland thrombus can expand the vein mimicking soft tissue



Call TIV only when there is unequivocal enhancement

LR-TIV: pitfalls on CT/MRI

1. Bland thrombus misdiagnosed as TIV

- Thrombus hyperintense on unenhanced T1-weighted images
- Expansive thrombus without enhancement
- Peri-portal collaterals

2. TIV not showing enhancement

- Infiltrative HCC
- Necrotic thrombus

LR-TIV: pitfalls on CT/MRI

2. TIV not showing enhancement

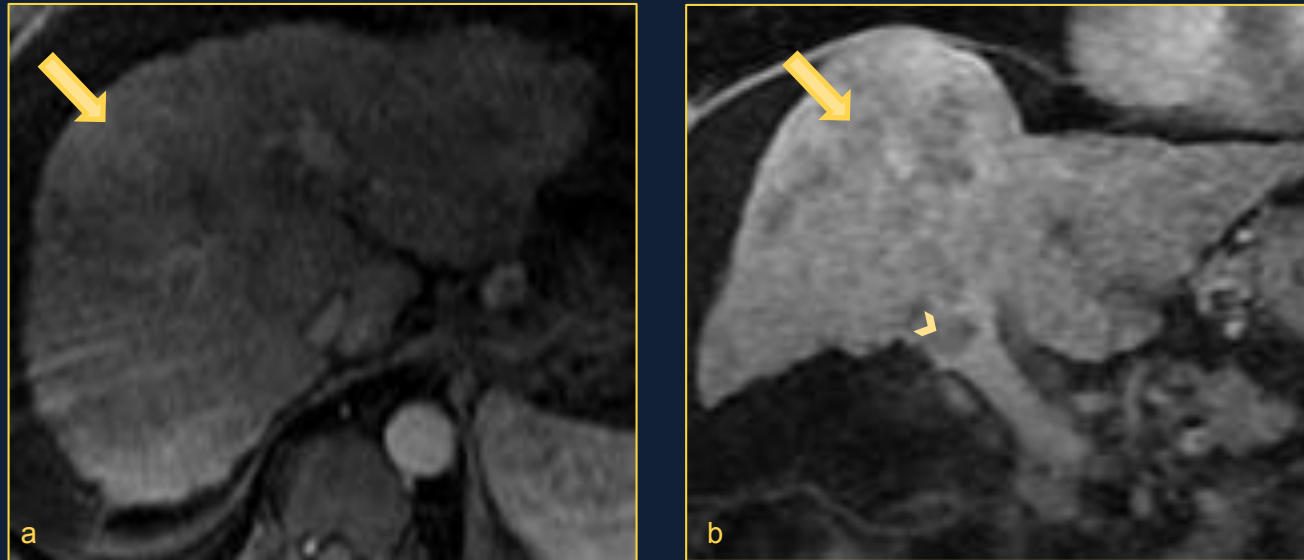
➤ Infiltrative-appearance HCC

- Permeative-growing HCC
- The APHE-criteria is highly variable, often referred as minimal, patchy or miliary
- Washout is highly heterogeneous, difficult to recognize in the setting of fibrosis
- TIV almost always associated (68-100%): it represents a helpful diagnostic clue, but it may show poor enhancement as the infiltrative HCC
- Subtraction may be helpful to characterize subtle enhancement of TIV

➤ Necrotic thrombus

LR-TIV: pitfalls on CT/MRI

2. TIV not showing enhancement



62 year-old male with history of cirrhosis secondary to NASH. Gd-EOB-DTPA enhanced axial MRI obtained during the arterial phase (a) shows an ill-defined area with very subtle arterial phase hyperenhancement in segment 8 (arrow). Wash-out is evident on coronal MRI image (arrow in b) which also appears in contiguity with a filling defect within the right portal vein (arrowhead). IHCC with TIV was pathologically proven.

CT/MRI LI-RADS[®] v2018

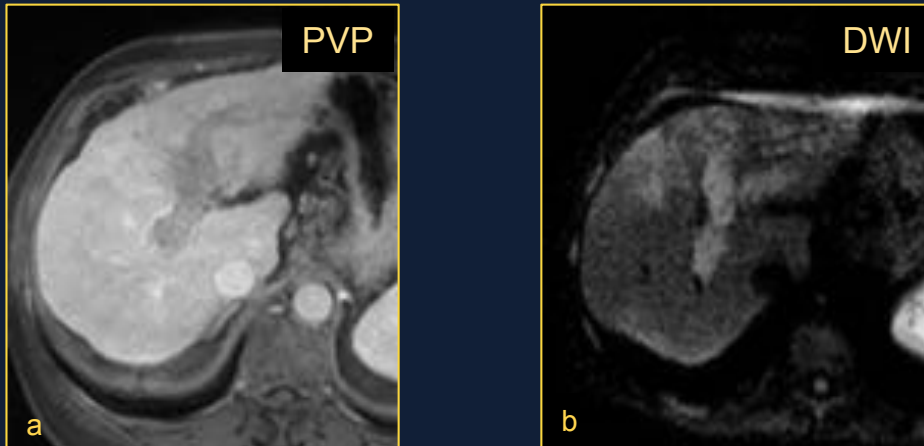
Imaging features suggestive of TIV:

- Occluded vein with ill-defined walls
- Occluded vein with restricted diffusion
- Occluded or obscured vein in contiguity with malignant parenchymal mass
- Heterogeneous vein enhancement not attributable to artifact

CT/MRI LI-RADS[®] v2018

Imaging features suggestive of TIV:

- Occluded vein with ill-defined walls
- **Occluded vein with restricted diffusion**
- Occluded or obscured vein in contiguity with malignant parenchymal mass
- Heterogeneous vein enhancement not attributable to artifact



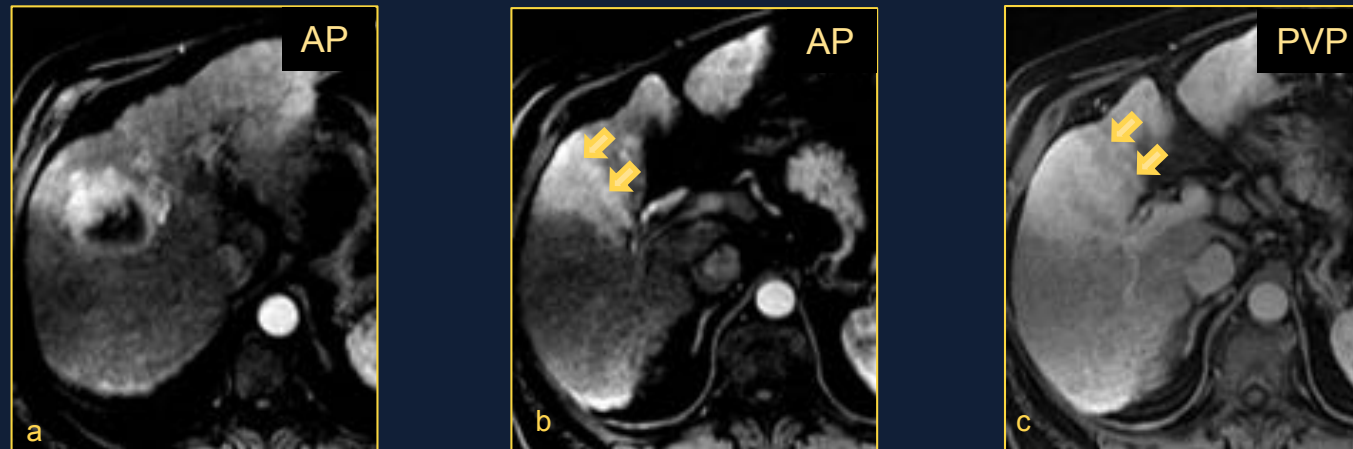
Portal venous phase (a) image shows a filling defect within the portal vein. High signal intensity is demonstrated on DWI with high b-value (b)

Author	Sensitivity	Specificity	ADC (TIV)	ADC (benign)
Catalano 2010	79%	100%	0.88	2.9
Sandrasegaran 2013	84%	59%	1.03	1.37
Kim 2016	76-83%	94-98%	-	-

CT/MRI LI-RADS[®] v2018

Imaging features suggestive of TIV:

- Occluded vein with ill-defined walls
- Occluded vein with restricted diffusion
- **Occluded or obscured vein in contiguity with malignant parenchymal mass**
- Heterogeneous vein enhancement not attributable to artifact



Arterial phase (a) image shows a parenchymal mass with APHE. Arterial phase (b) and portal venous phase (c) images show linear hypointensity right below the mass suspicious for tumor in vein

CT/MRI LI-RADS[®] v2018

Imaging features suggestive of TIV:

- Occluded vein with ill-defined walls
- Occluded vein with restricted diffusion
- Occluded or obscured vein in contiguity with malignant parenchymal mass
- Heterogeneous vein enhancement not attributable to artifact

If any of these features are present, **scrutinize** vein for enhancing soft tissue

But

Classify as LR-TIV only with features diagnostic of TIV (=only if unequivocal enhancing soft tissue is present)

Why LR-TIV as separate category?

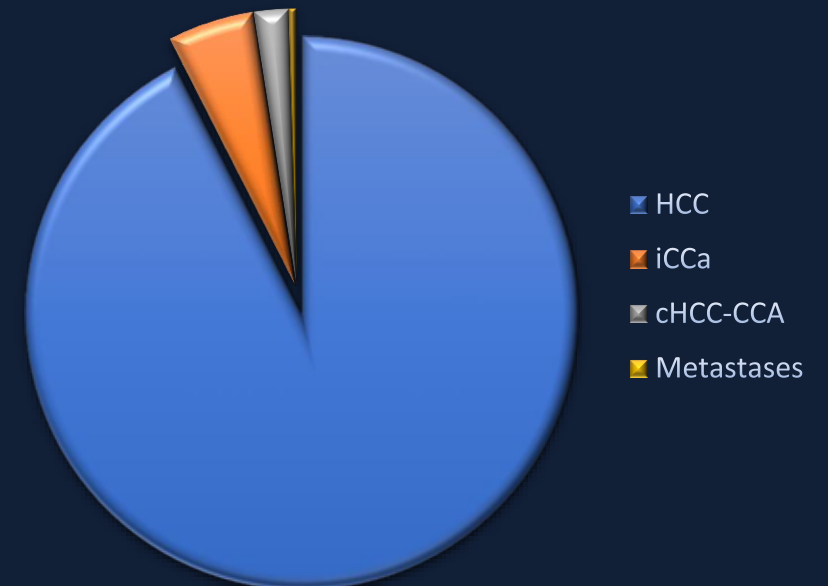


LR-TIV: not always HCC

TIV = malignancy but TIV \neq HCC

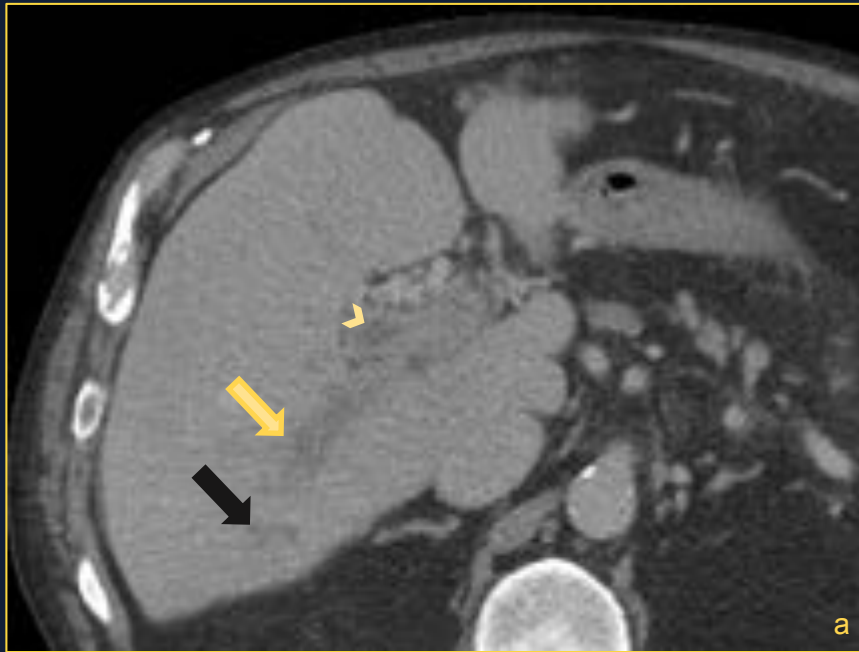
Although HCC is the most common liver malignancy associated with TIV, other tumors can have vascular invasion and occasionally occur in cirrhotic patients (LR-M):

- Intrahepatic cholangiocarcinoma (iCCA)
- Combined hepatocellular carcinoma – cholangiocarcinoma (cHCC-CCA)
- Metastases (rare):
 - Colorectal cancer
 - Melanoma
 - Germ cell tumor
 - Neuroendocrine tumors
 - Pancreatic adenocarcinoma



LR-TIV: not always HCC

TIV = malignancy but TIV \neq HCC

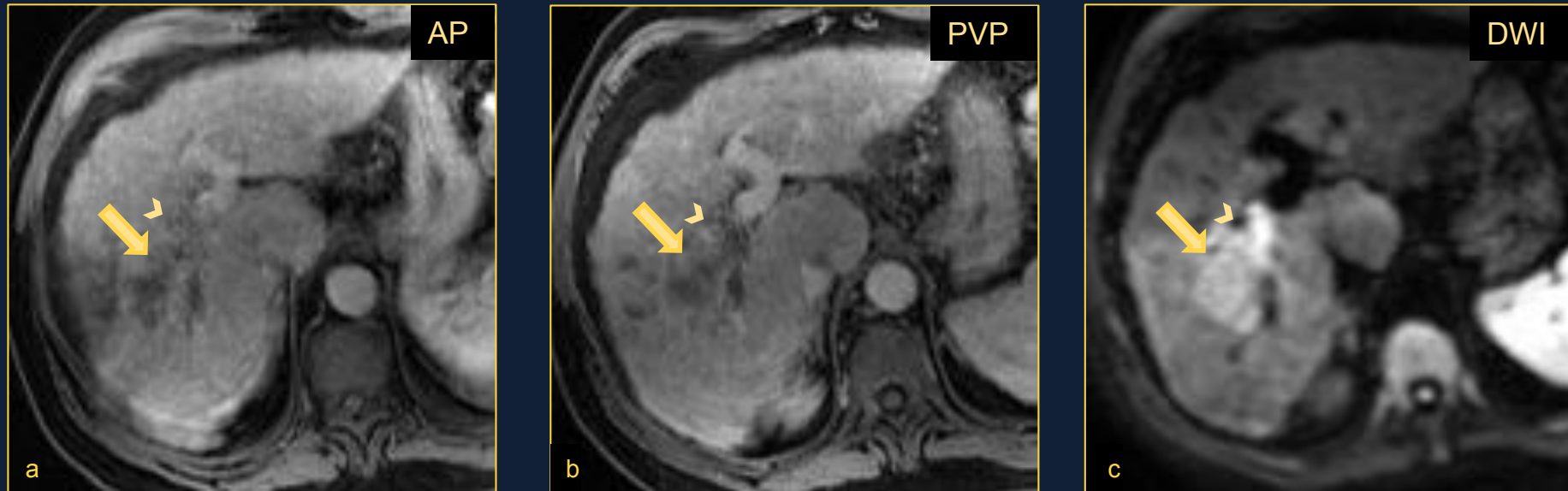


77 year-old male with chronic liver disease. Axial CT image obtained during portal venous phase (a) shows an occluded vein (arrow) in contiguity with a hypoenhancing mass (black arrow): Thrombosis of the main portal vein is also evident (arrowhead). An intrahepatic cholangiocarcinoma was pathologically proven after US-guided biopsy (b).

LR-TIV: not always HCC

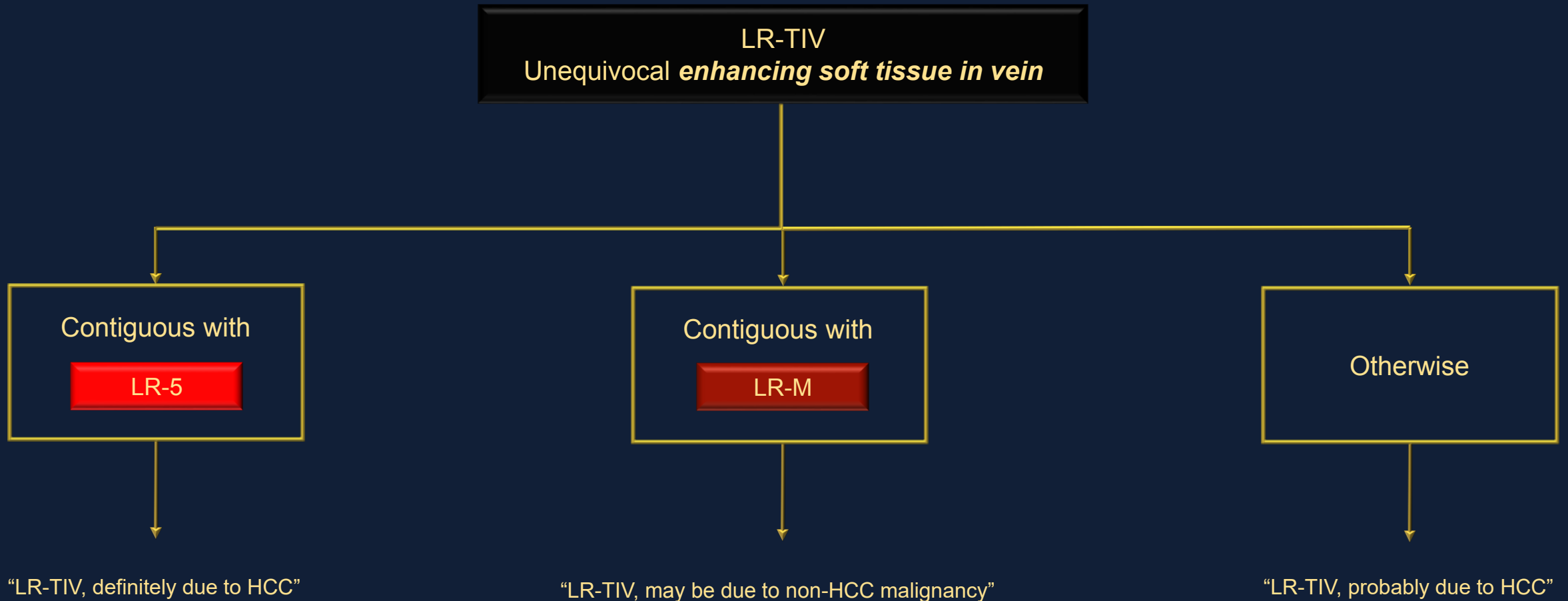
TIV = malignancy but TIV \neq HCC

Path-proven **cHCC-iCCA** with TIV (Ca19-9: 295 UI/mL ; AFP: 8 ng/mL)



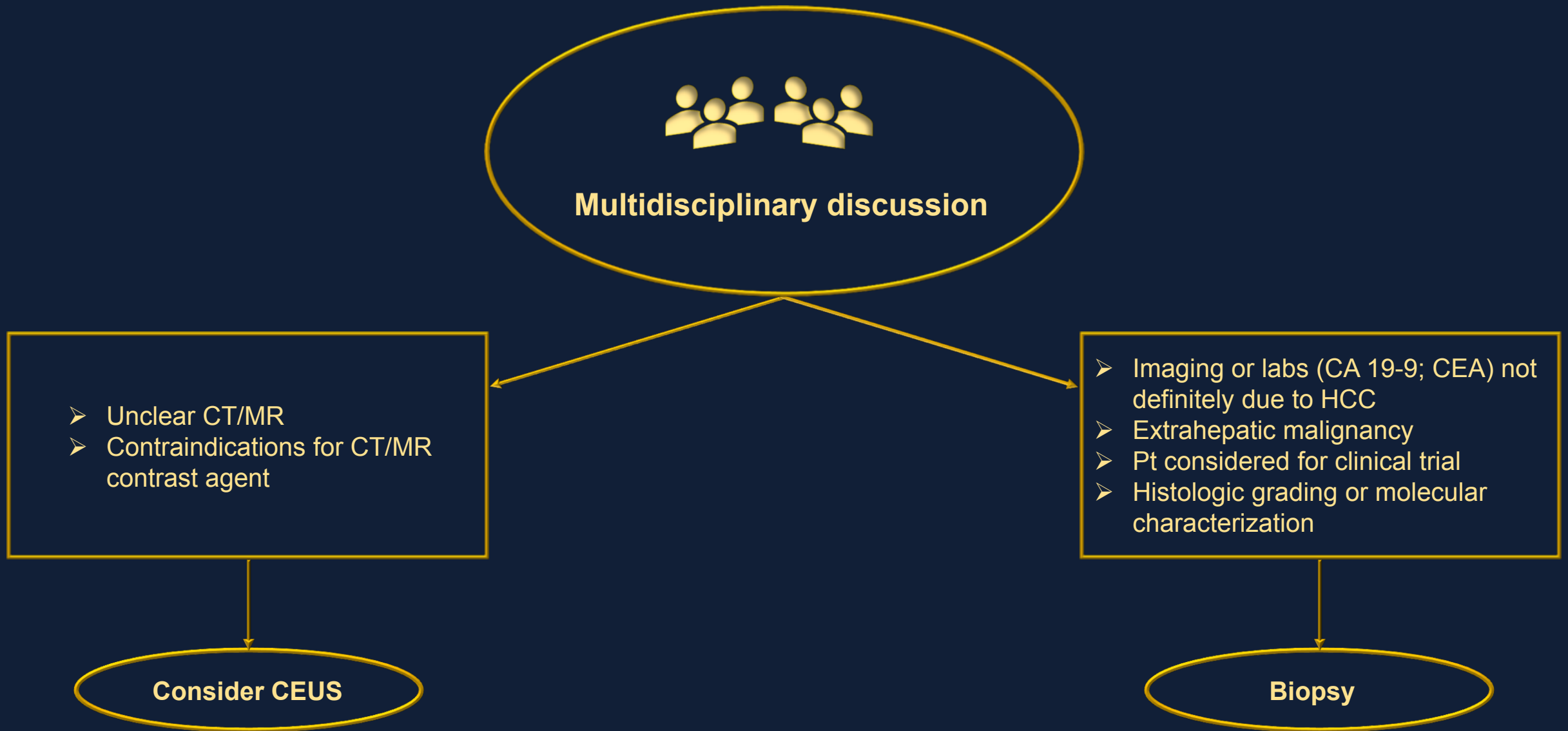
Gd-BOPTA enhanced MR images of a cirrhotic liver obtained during the arterial (a) and the portal venous (b) phases show an ill-defined mass in segment 5 (arrow in a and b). The presence of enhancing soft tissue within the portal vein (arrowhead in a and b) is compatible with tumor in vein (TIV). Note restricted diffusion of tumor (arrow, c) and TIV (arrowhead, c). A combined hepatocellular carcinoma-intrahepatic cholangiocarcinoma with TIV was pathologically proven at biopsy.

CT/MRI LI-RADS[®] v2018 reporting



Specify the distribution and extent of TIV as well as change from prior examinations

TIV: how to manage indeterminate cases



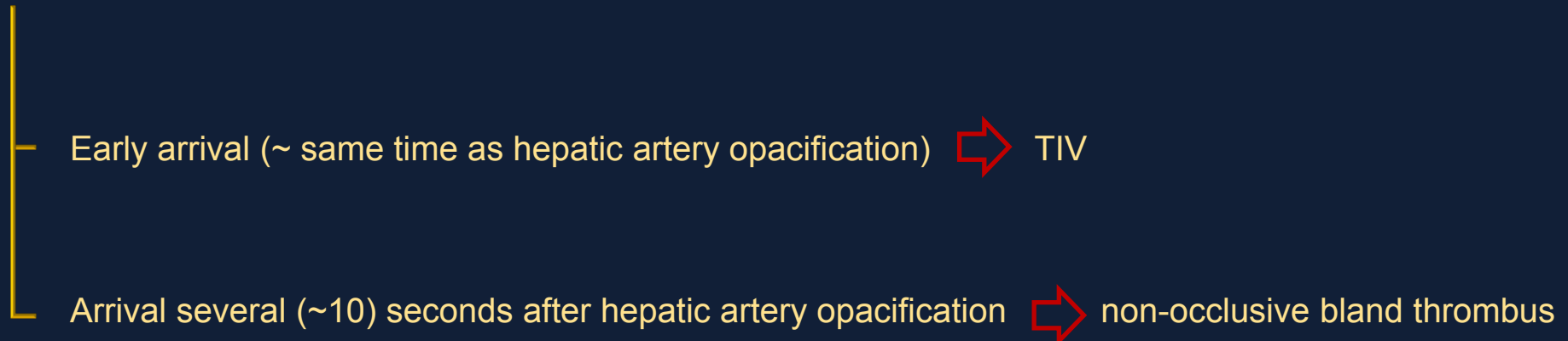
CEUS LI-RADS[®] v2017

CEUS LR-TIV

“Unequivocal ***enhancing soft tissue in vein***, regardless of visualization of parenchymal mass”

Because of the arterial flow resembling the vascular properties of primary HCC, malignant portal venous thrombi can be easily identified with CEUS

The arrival time helps to differentiate TIV from partially occlusive thrombus:



CEUS LI-RADS[®] v2017

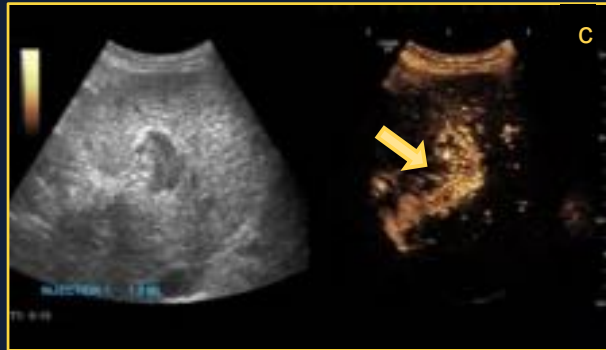
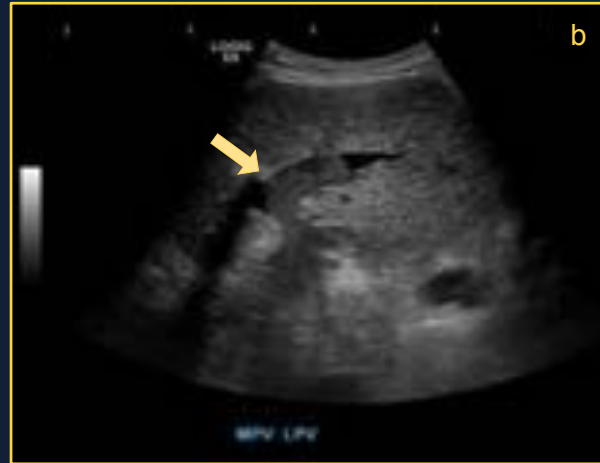
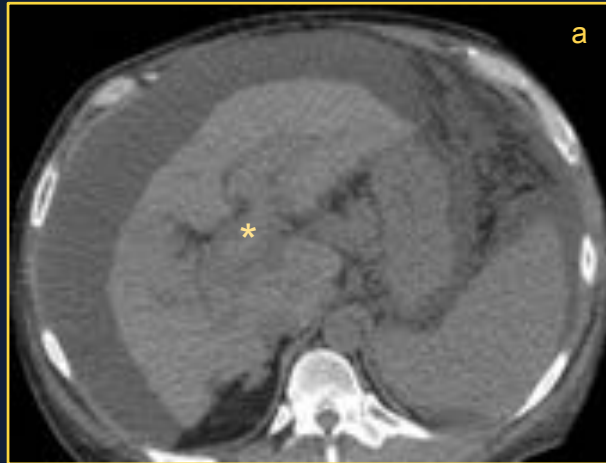
CEUS LR-TIV

“Unequivocal ***enhancing soft tissue in vein***, regardless of visualization of parenchymal mass”

CEUS offers high sensitivity in identifying TIV: sometimes malignant thrombi show only transient and very early enhancement after injection of US contrast agent. These cases may be easily missed, if CT and MR arterial phase scans are not taken at the time of maximum enhancement

Author	Sensitivity	Specificity
Tarantino et al. 2006	88%	100%
Rossi et al. 2008	98%	100%

CEUS LI-RADS[®] v2017



Unenhanced axial CT (a) in a patient with cirrhosis shows possible solid tissue within the portal vein (asterisk). Ultrasound of the same patient confirms the presence of undetermined thrombus within the lumen of portal vein (arrow).

CEUS images show hyperenhancement into the lumen of portal vein during the early arterial phase (arrow in c) and wash out during the portal venous phase (arrow in d) compatible with the presence of tumor in vein (LR-TIV).

TIV: take home points



- ➡ Presence of TIV classifies patients with HCC as advanced stage (C) indicating poor prognosis
- ➡ TIV represents a contraindication for liver transplant
- ➡ Classify as LR-TIV only if *unequivocal* enhancing soft tissue in vein
- ➡ The absence of visible malignant mass doesn't exclude the presence of TIV
- ➡ TIV doesn't mean HCC
- ➡ Consider CEUS for indeterminate/unclear cases on CT/MRI

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Thank you

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