

ESGAR Liver Imaging Workshop
Cluj-Napoca, June 27-28, 2024



Liver metastases detection and staging prior to surgery: methods and problems

Joanna Podgórska

Dept. of Radiology 1 Maria Skłodowska-Curie National Research Institute of Oncology, Warsaw, Poland

Key points

Pre-surgical staging with focus on detection and false positive rate of different imaging modalities (CT, PET-CT, MR with conventional and hepatobiliary contrast media)

Role of diffusion weighted imaging (**DWI**) and of the **hepatobiliary** phase in the diagnosis of metastases.

Differential diagnosis of liver metastases – especially to solid benign lesions.

Distinguishing slow-filling **haemangiomas** from metastases.

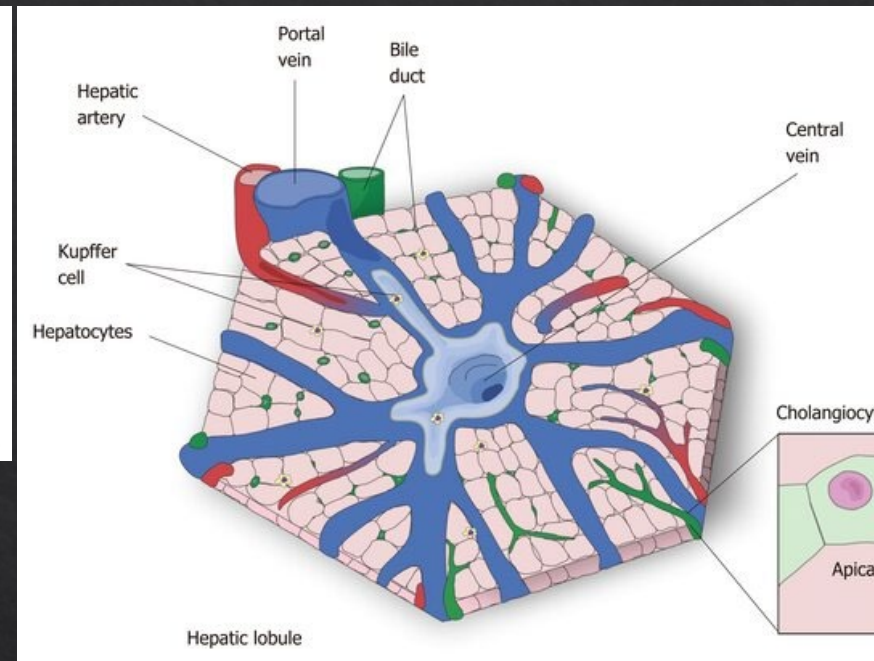
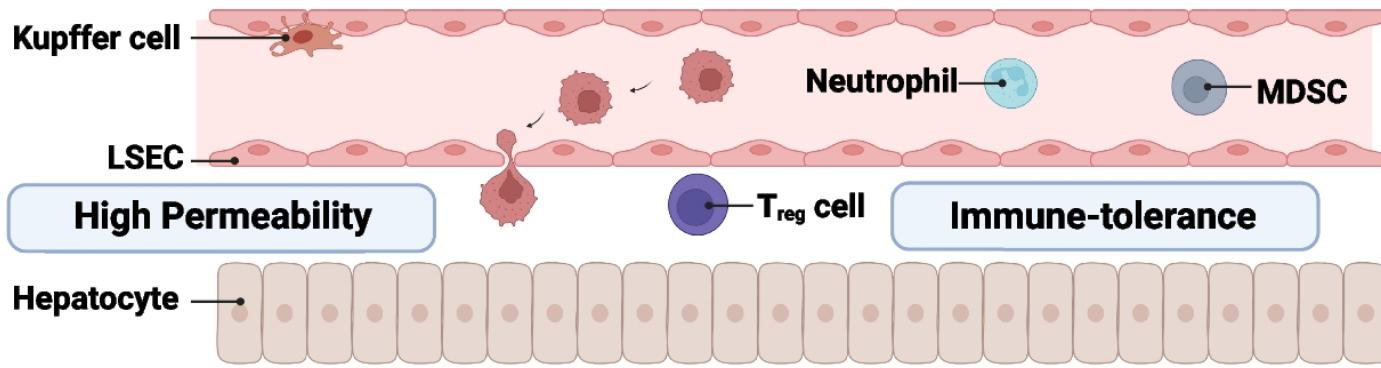
Oncologic patient

About 25% oncologic patients have liver metastases

About 20% of population have benign liver lesions

Small lesions <15mm

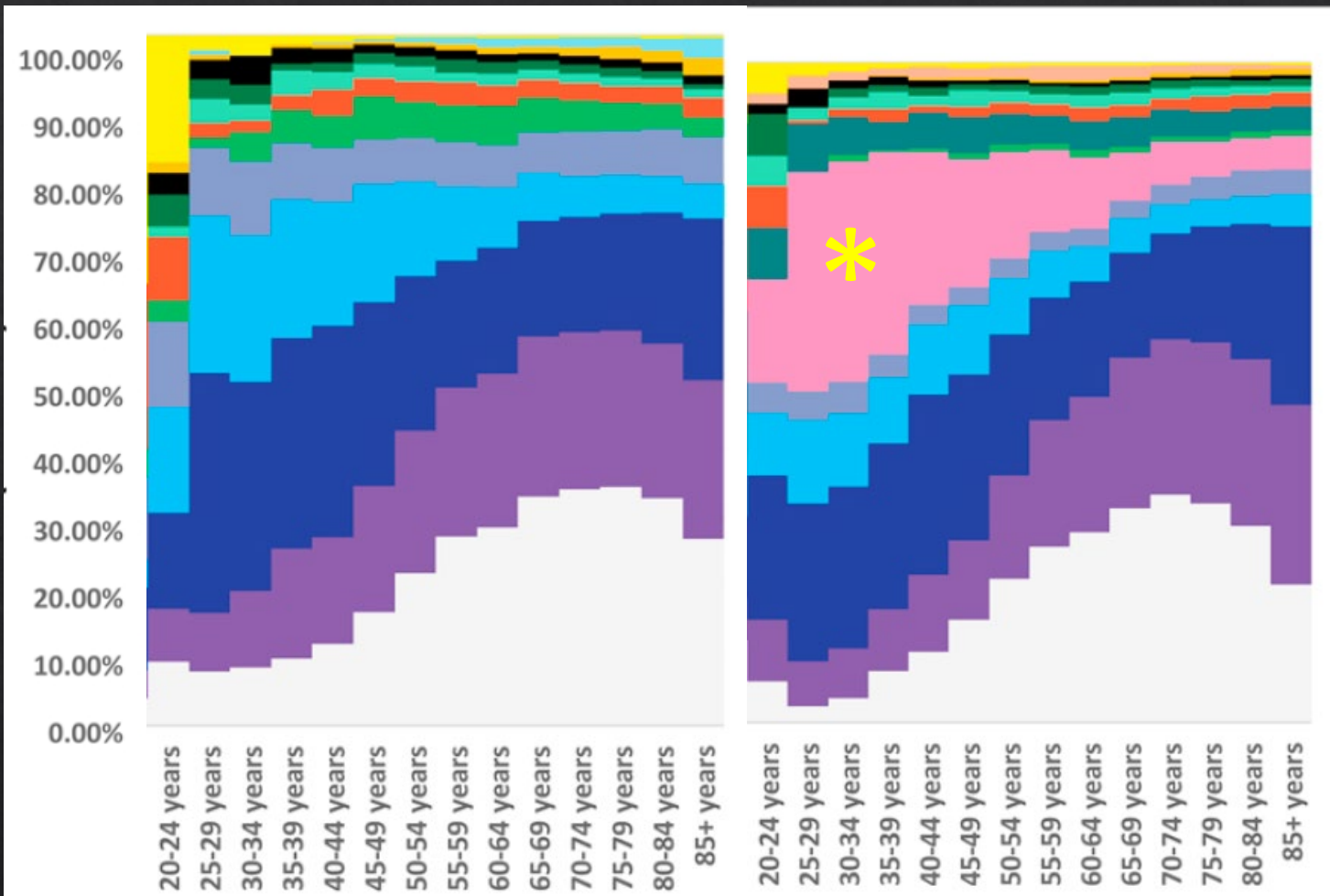
Pseudolesions



- Dual blood supply
- Slow blood flow through liver sinusoids
- Permeability of sinusoidal endothelium
- Immunosuppressive (tolerant) microenvironment

Inositol 1,4,5-trisphosphate receptor in the liver: Expression and function November 2019 World Journal of Gastroenterology 25(44):6483-6494

Wang, Y. et al. Liver metastasis from colorectal cancer: pathogenetic development, immune landscape of the tumour microenvironment and therapeutic approaches. J Exp Clin Cancer Res 42, 177 (2023)

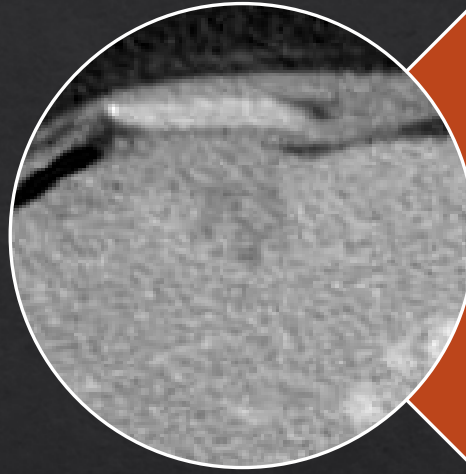
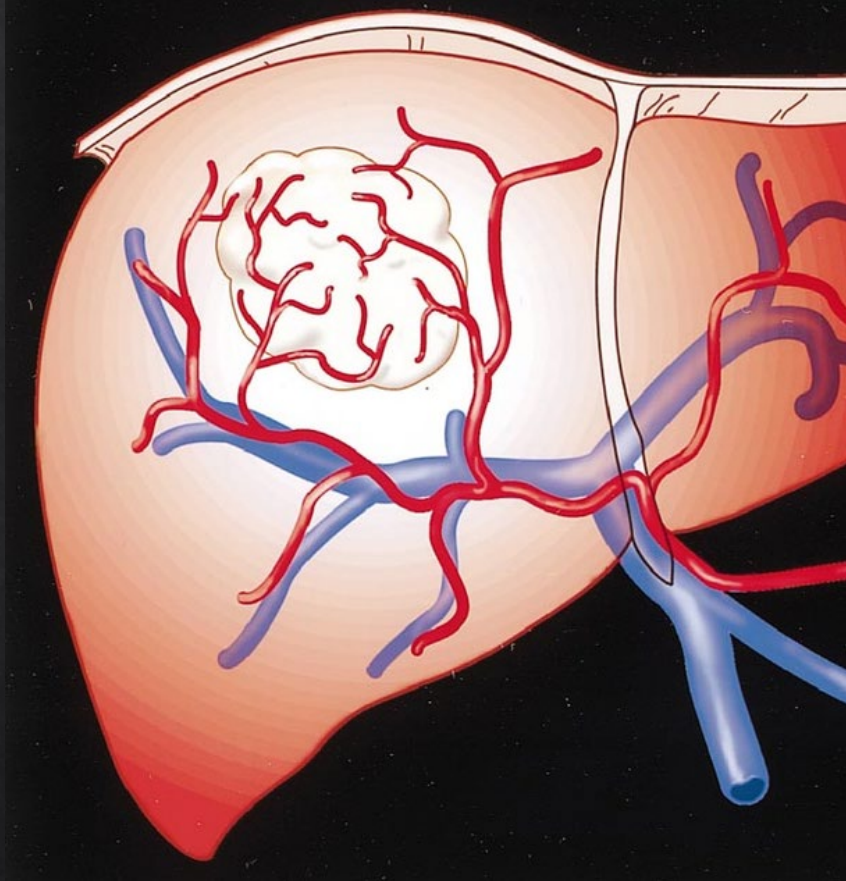


Male

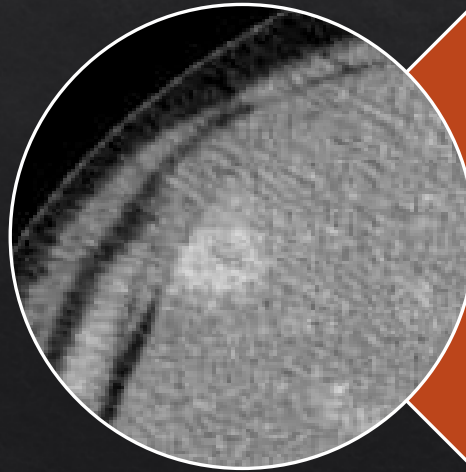
Female

- Soft Tissue including Heart
- Corpus Uteri
- Urinary Bladder
- Melanoma of the Skin
- Liver and Intrahepatic Bile Duct
- Small Intestine
- Kidney and Renal Pelvis
- Ovary
- Esophagus
- Breast
- Stomach
- Rectum and Rectosigmoid Junction
- Colon excluding Rectum
- Pancreas
- Lung and Bronchus

Arterial blood supply

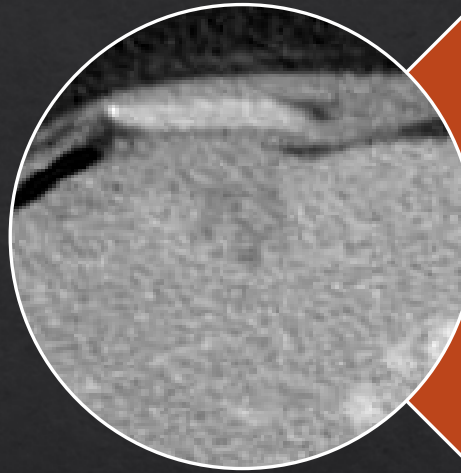
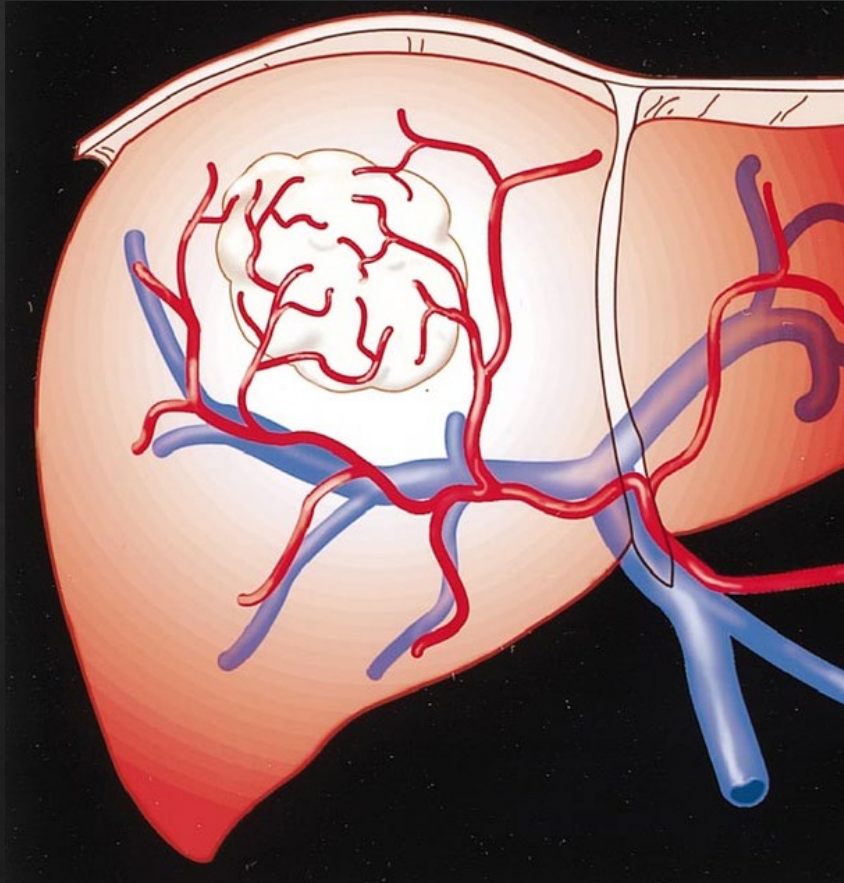


Hypovascular



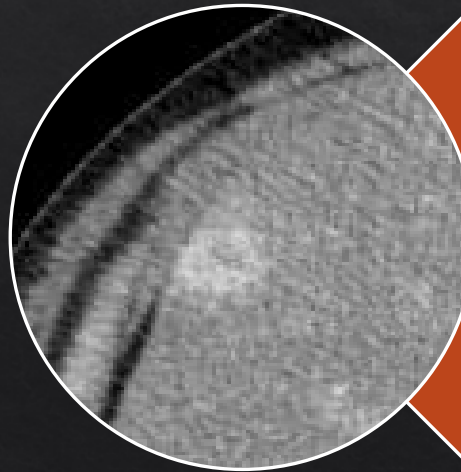
Hypervascular

Arterial blood supply



Hypovascular

Digestive tract
Pancreatic
Lung
Ovarian
Breast



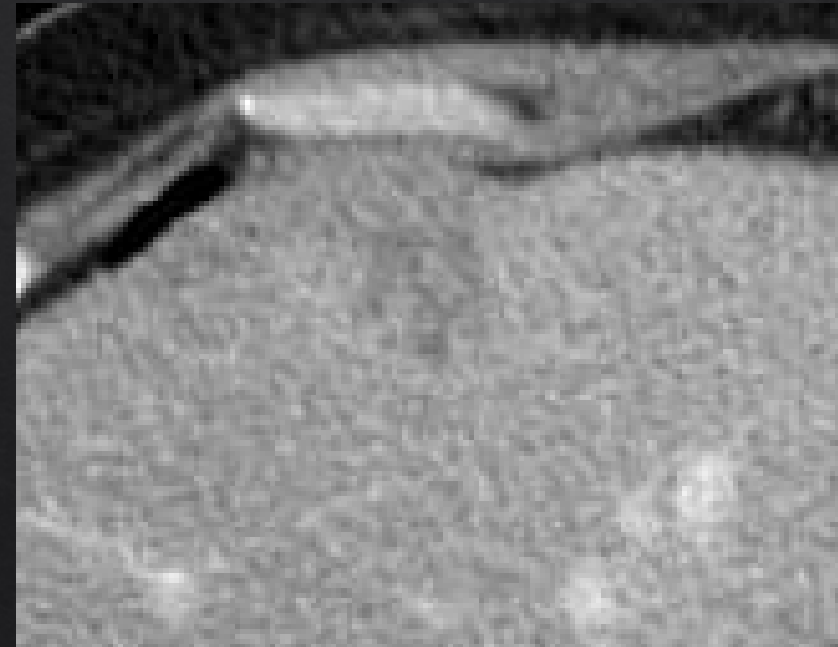
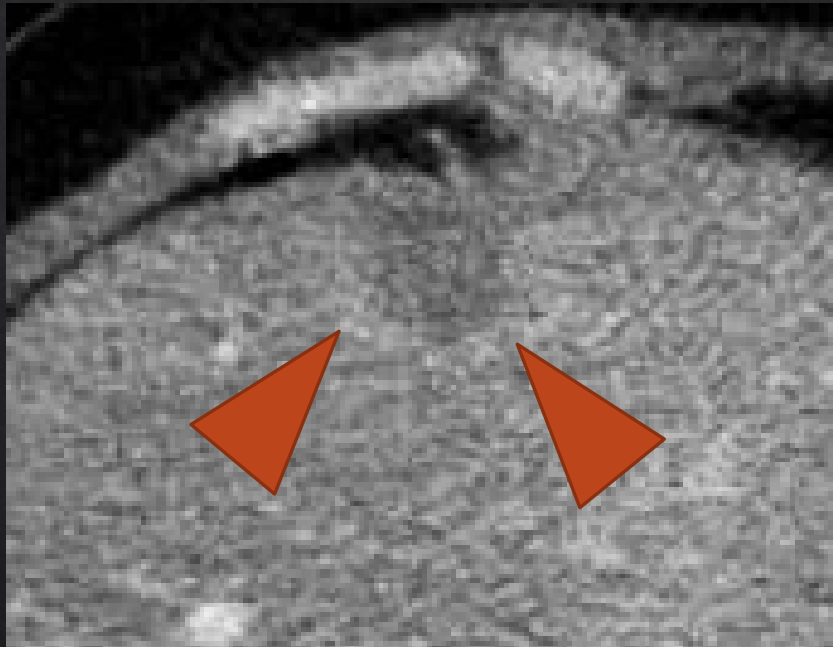
Hypervascular

RCC
Melanoma
Thyroid
NET
GIST
Breast

Classic appearance

Rim enhancement

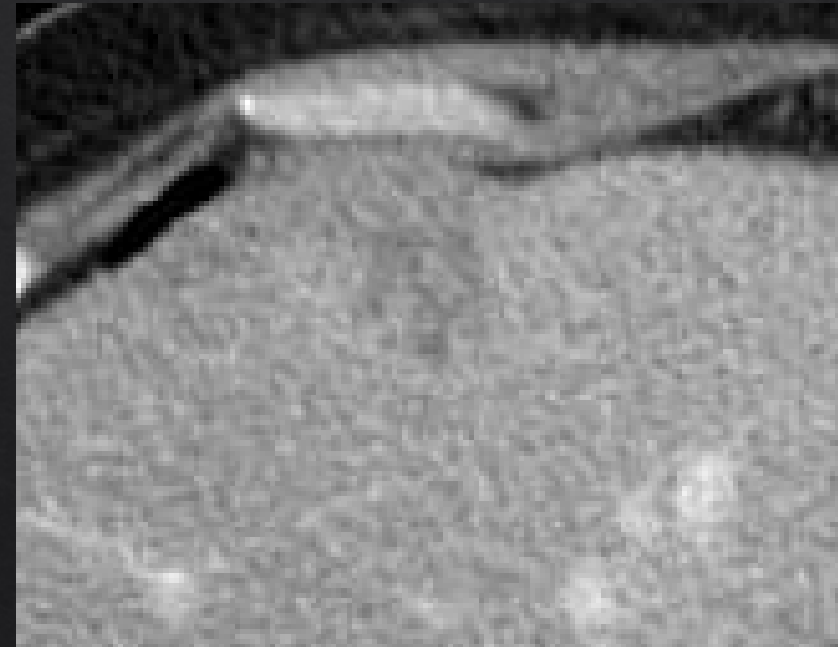
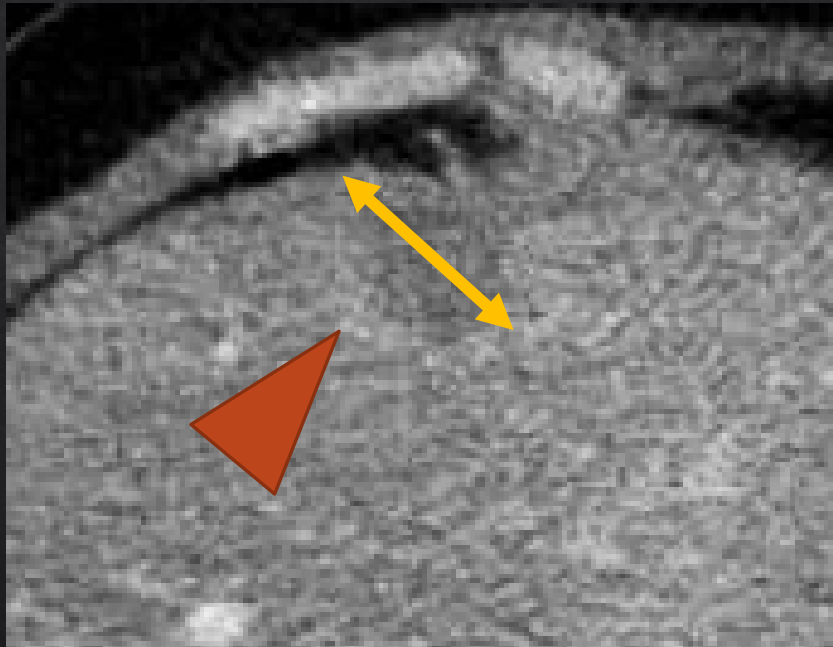
Diffusion of the contrast into the centre of the lesion



Classic appearance

Rim enhancement

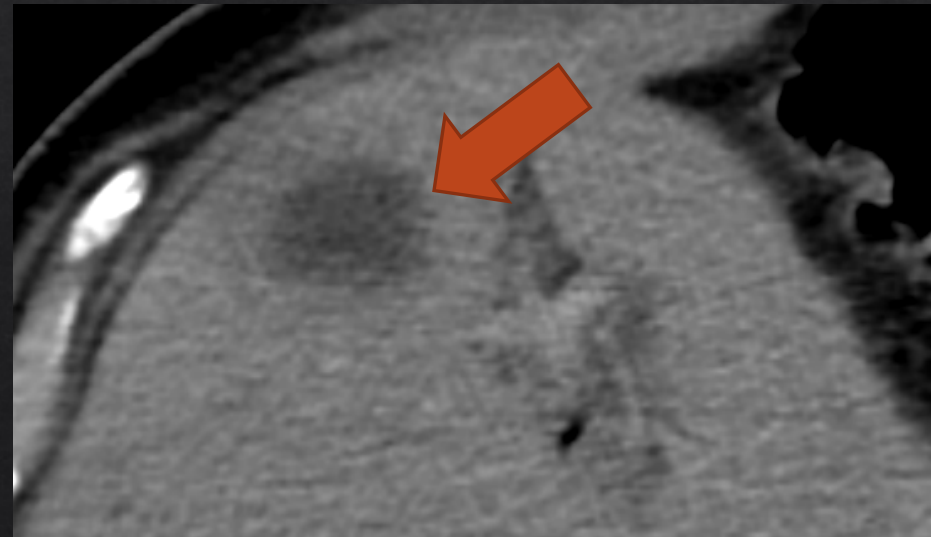
Diffusion of the contrast into the centre of the lesion



“Peripheral washout sign”

Portal venous or equilibrium phase

Both: hyper- and hypovascularized metastases



Perilesional enhancement

Arterial phase (CT / MR)

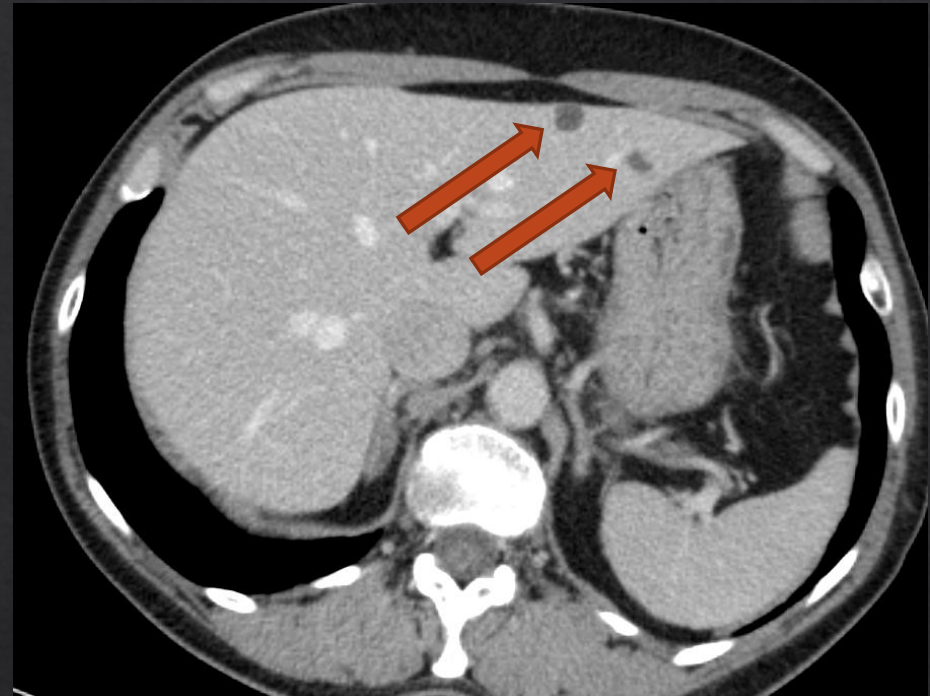
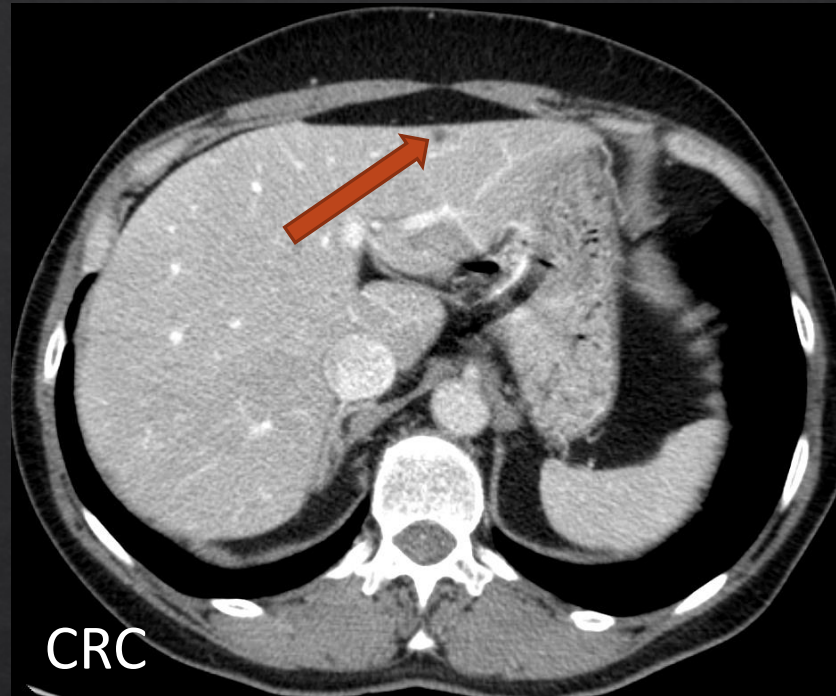
Arterioportal shunts due to increased sinusoidal pressure



Cystic mets

Mucinous:

- colon cancer
- ovarian cancer



Necrosis, cystic degeneration

- SCC lung cancer
- Sarcomas
- Melanoma
- GIST
- NET/NEC



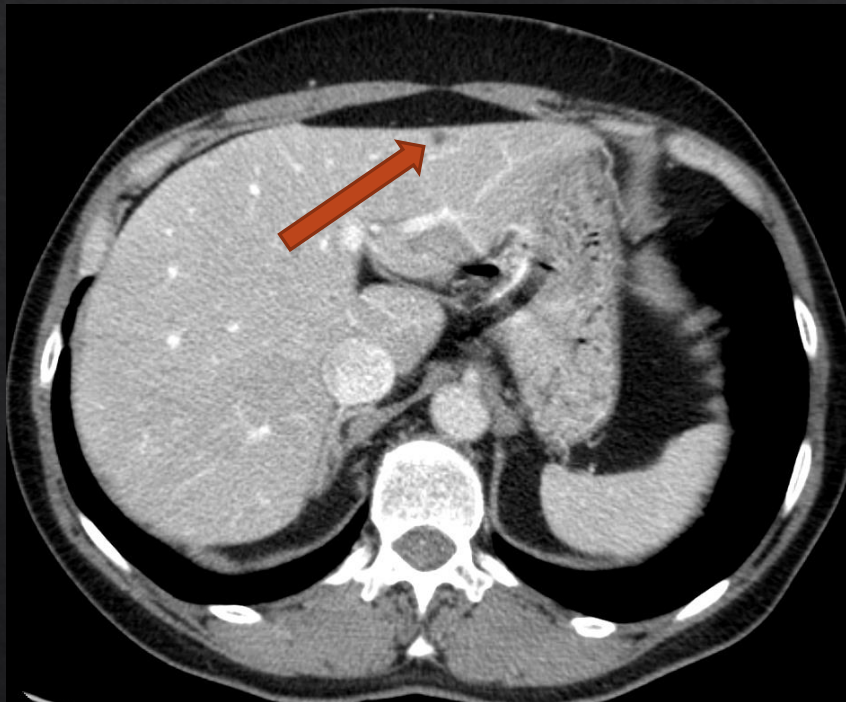
Bleeding - fluid-fluid level

- NET
- Melanoma

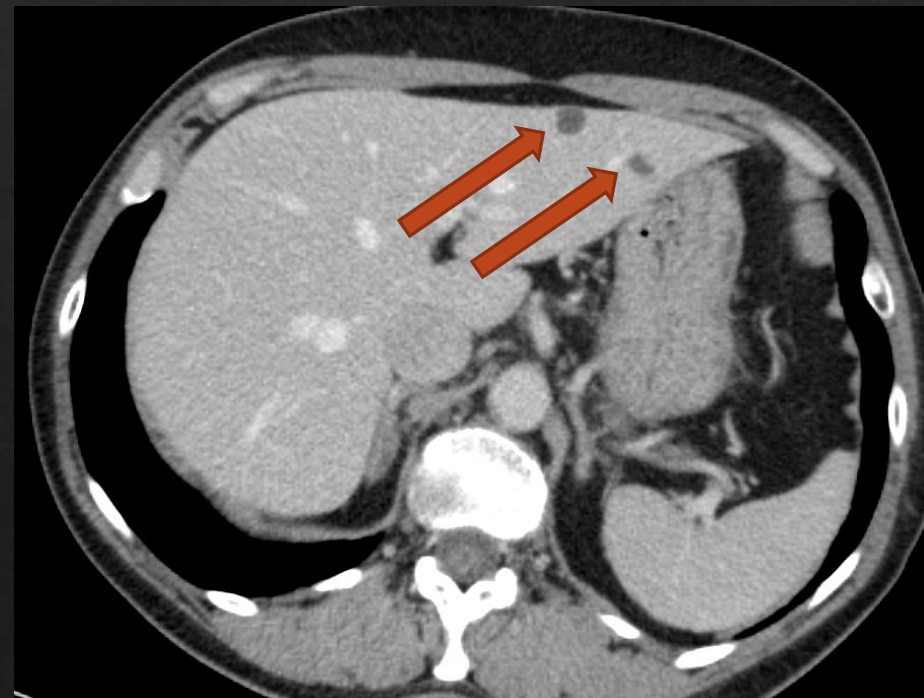
Cystic mets

Mucinous:

- colon cancer
- ovarian cancer



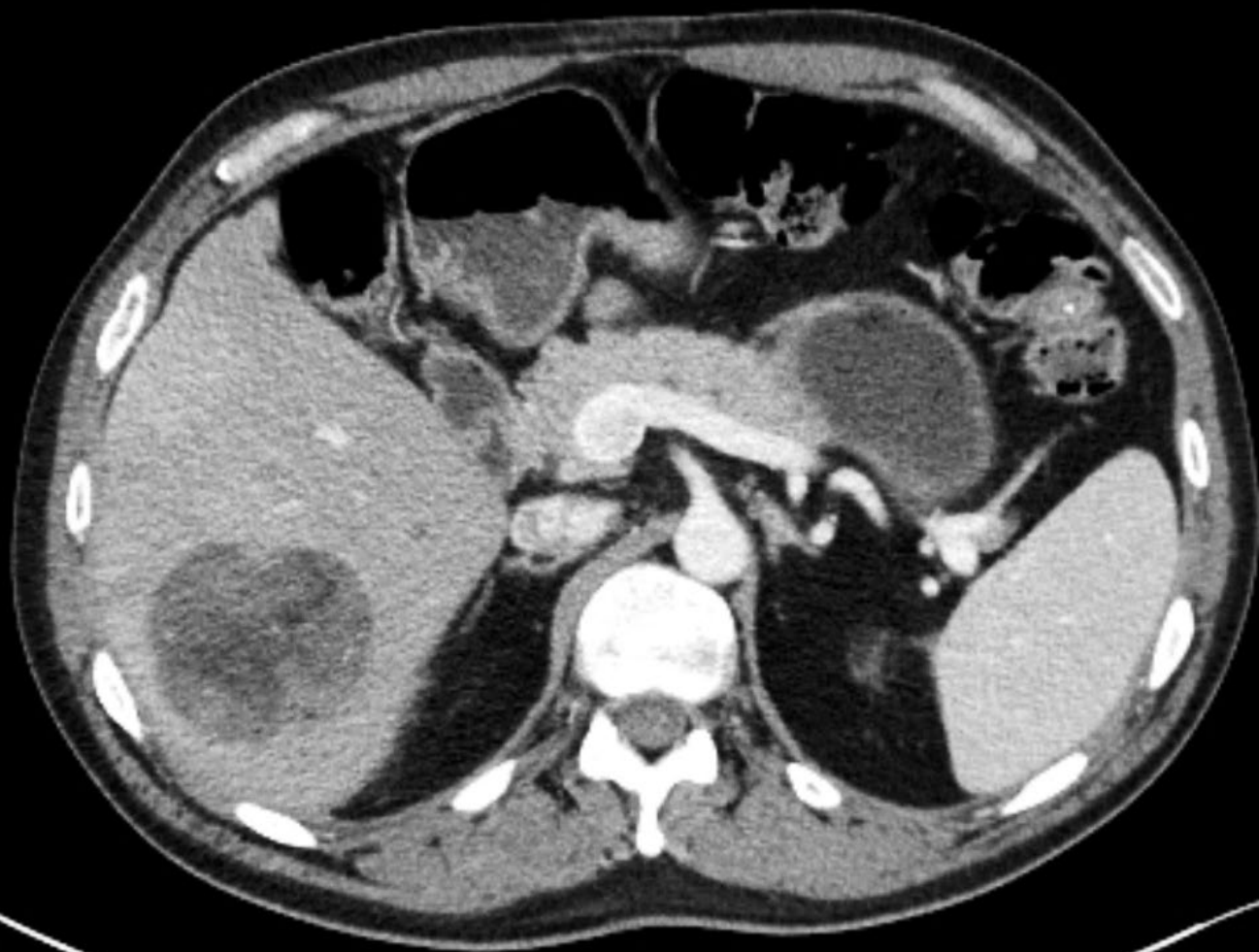
CRC



Fat containing

Liposarcoma

RCC (rare)



Metastases detection

	CE-CT	PET-CT	CE-MRI+DWI	CE-MRI+HBP	CE-MRI+DWI+HBP
sensitivity	51,8-84,6%	66-93%	87,1%	90,6%	95,5%
specificity	77,2-98%				80,2-98%



A meta-analysis of diffusion-weighted and gadoxetic acid-enhanced MR imaging for the detection of liver metastases

Valérie Vilgrain^{1,2,3} · Maxime Esvan^{4,5} · Maxime Ronot^{1,2,3} · Aurore Caumont-Prim^{4,5} ·
Christophe Aubé^{6,7} · Gilles Chatellier^{4,5,8}

Table 4 Sensitivity estimates for DW-MR imaging, gadoxetic acid-enhanced MR imaging, and combined MR techniques for each subgroup in all liver metastases

Subgroup	Number of articles (number of data sets)	DW-MRI Sensitivity	Gadoxetic acid sensitivity	Combined sensitivity	<i>p</i> value	<i>p</i> value	<i>p</i> value
					DW vs gadoxetic acid	DW vs Combined	gadoxetic acid vs combined
All lesions	39 (114)	87.1 (83.2;90.2) Cochran's Q = 60.2 (<i>p</i> value = 0.016); <i>I</i> ² = 35	90.6 (87.7;92.9) Cochran's Q = 21.6 (<i>p</i> value = 0.999); <i>I</i> ² = 0	95.5 (93.8;96.8) Cochran's Q = 16.6 (<i>p</i> value = 0.939); <i>I</i> ² = 0	0.0001	<0.0001	<0.0001
Small lesions (<10 mm)	15 (36)	68.9 (54.2;80.5) Cochran's Q = 38.1 (<i>p</i> value = 0); <i>I</i> ² = 82	83.0 (73.4;89.7) Cochran's Q = 22.1 (<i>p</i> value = 0.182); <i>I</i> ² = 23	90.9 (84.0;95.0) Cochran's Q = 2.4 (<i>p</i> value = 0.983); <i>I</i> ² = 0	0.0008	<0.0001	0.0054


ESMO consensus guidelines for the management of patients with metastatic colorectal cancer

E. Van Cutsem^{1*}, A. Cervantes², R. Adam³, A. Sobrero⁴, J. H. Van Krieken⁵, D. Aderka⁶, E. Aranda Aguilar⁷, A. Bardelli⁸, A. Benson⁹, G. Bodoky¹⁰, F. Ciardiello¹¹, A. D'Hoore¹², E. Diaz-Rubio¹³,

for lesions <10 mm in diameter, MRI is a more sensitive modality than CT

hepatobiliary MRI with specific contrast enhancers is associated with a higher accuracy of lesion detection

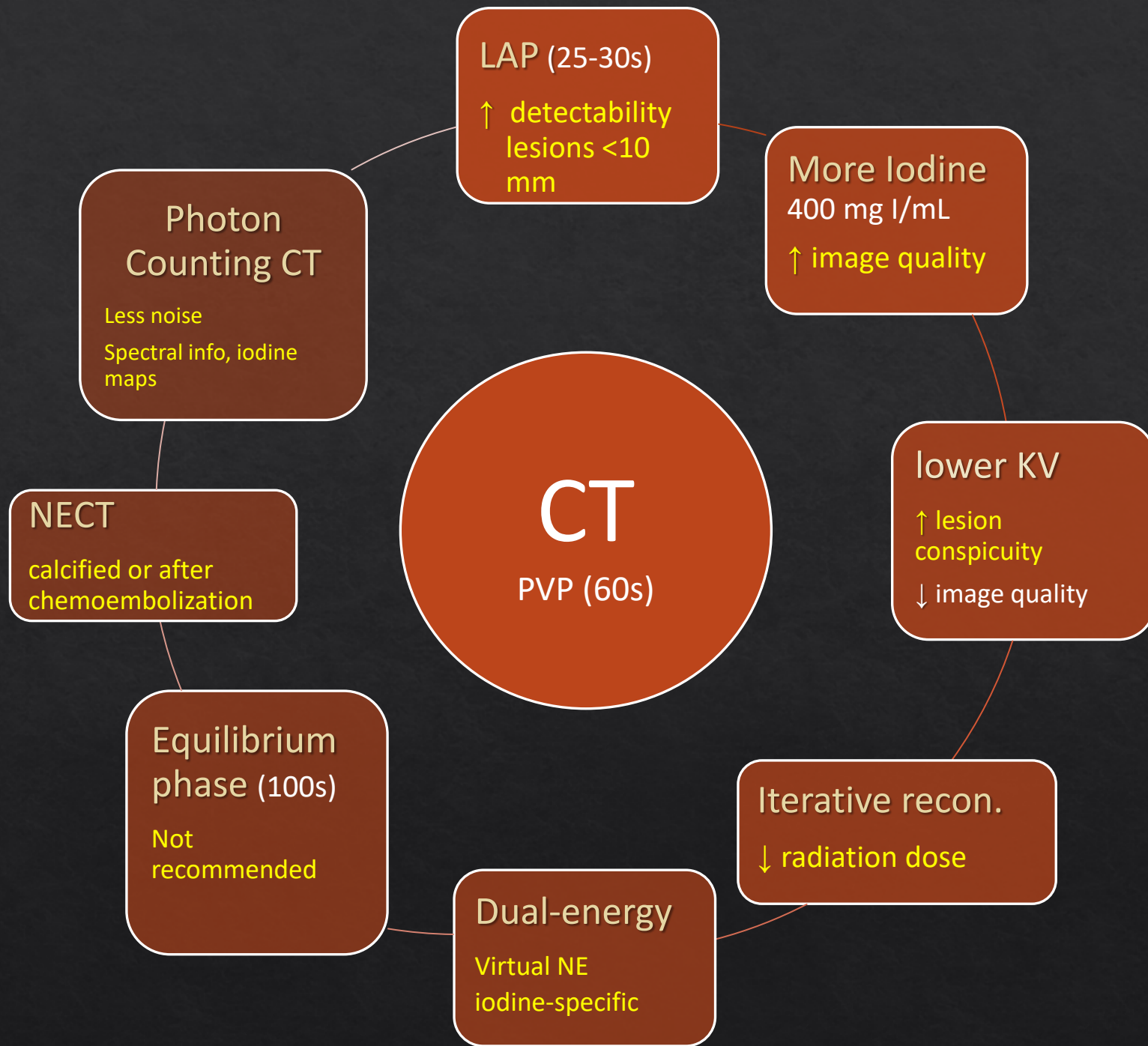
Randomized multicentre trial of gadoxetic acid-enhanced MRI versus conventional MRI or CT in the staging of colorectal cancer liver metastases

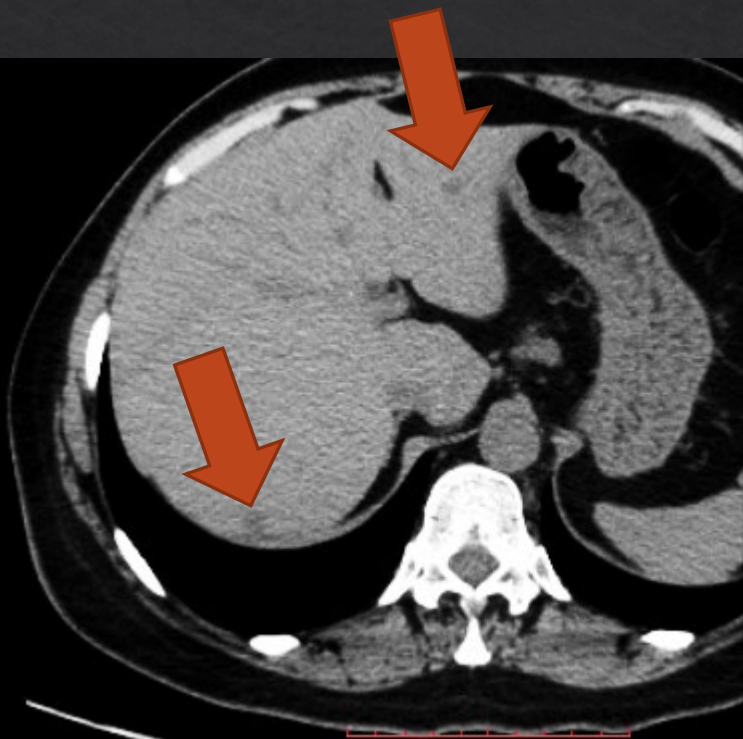
C J Zech , P Korpraphong, A Huppertz, T Denecke, M-J Kim, W Tanomkiat, E Jonas, A Ba-Ssalamah on behalf of the VALUE study group [Author Notes](#)

British Journal of Surgery, Volume 101, Issue 6, May 2014, Pages 613–621,

Table 2 Patients requiring further imaging to reach a diagnosis and therapy decision after initial imaging (efficacy population)

	No. of patients requiring further imaging	Test result	
		P^{\ddagger}	Rate difference (%) [†]
Gadoxetic acid-enhanced MRI	0 of 118 (0)		
ECCM-MRI	19 of 112 (17.0)	< 0.001 (H_03)	17.0 (11.4, 25.6)
CE-CT	44 of 112 (39.3)	< 0.001 (H_02)	39.3 (30.7, 49.8)
Pooled ECCM-MRI-CE-CT	63 of 224 (28.1)	< 0.001 (H_01)	28.1 (22.5, 34.6)





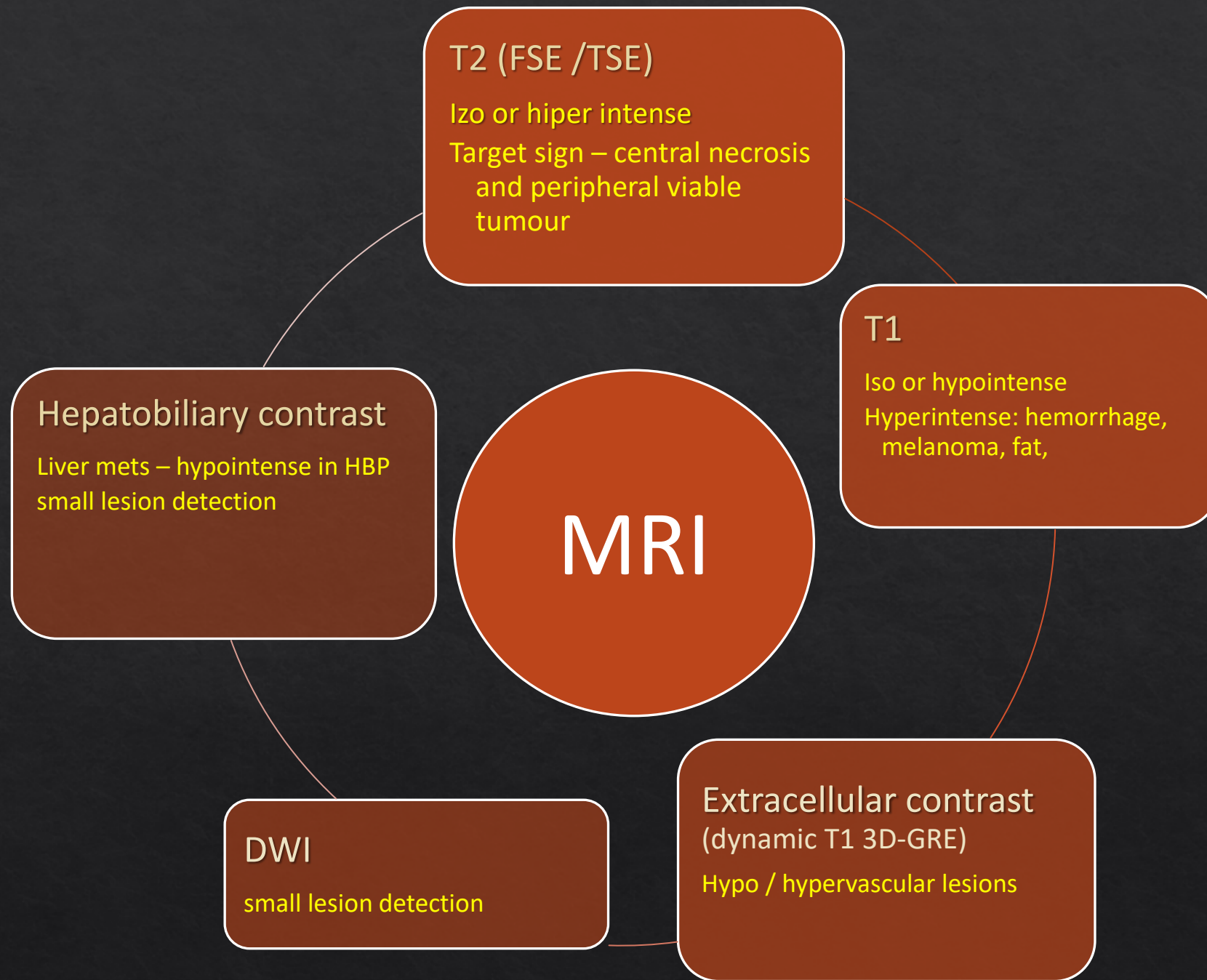
NECT



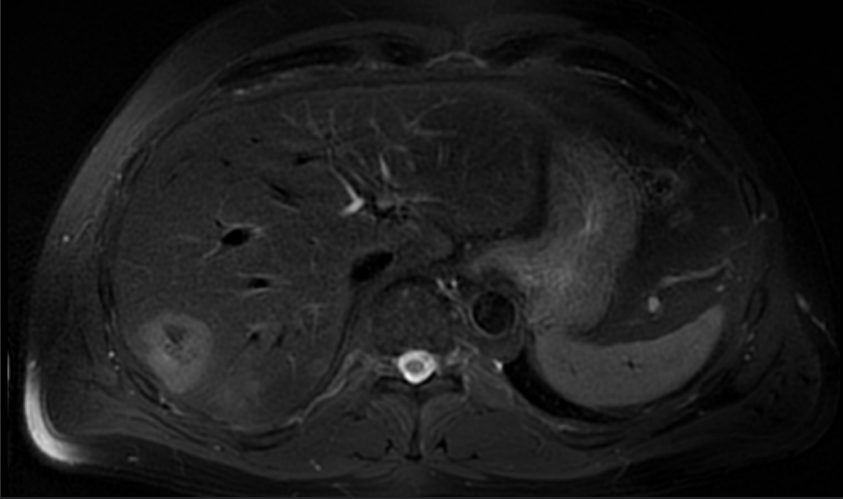
LAP



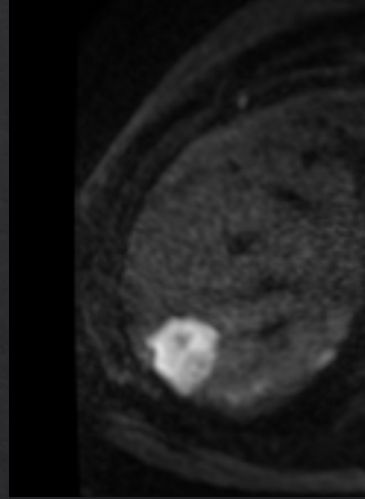
PVP



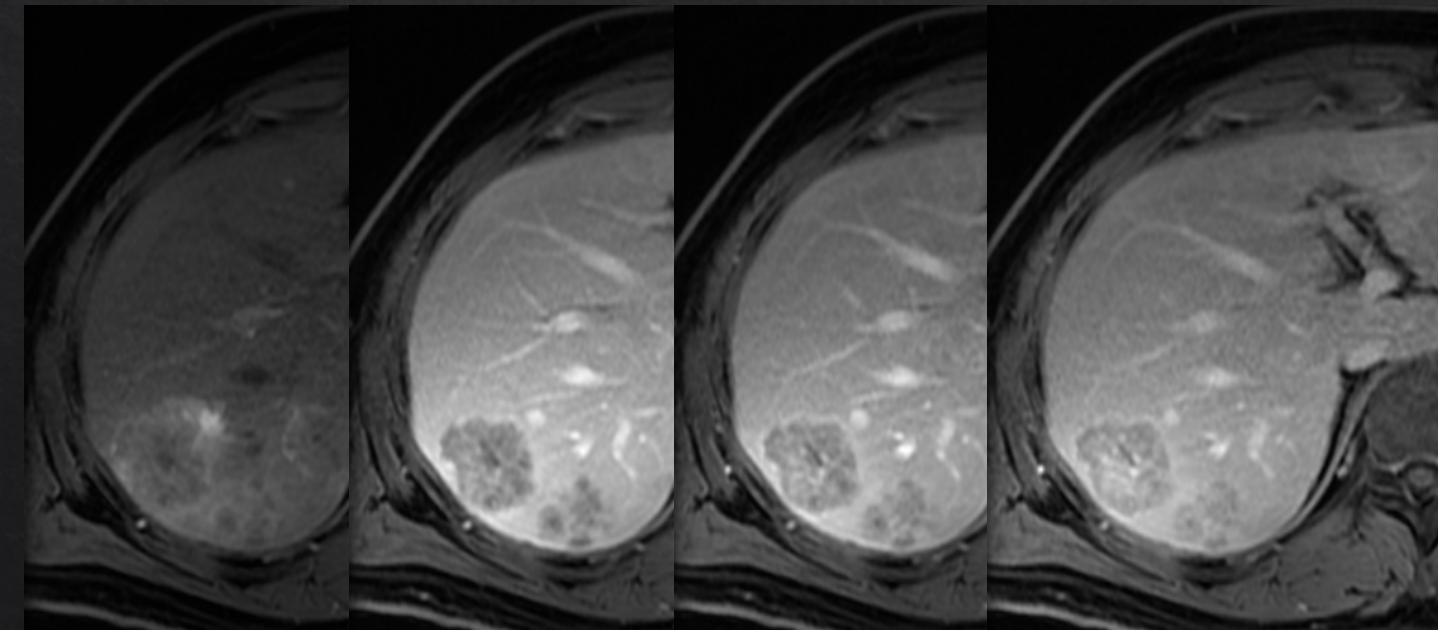
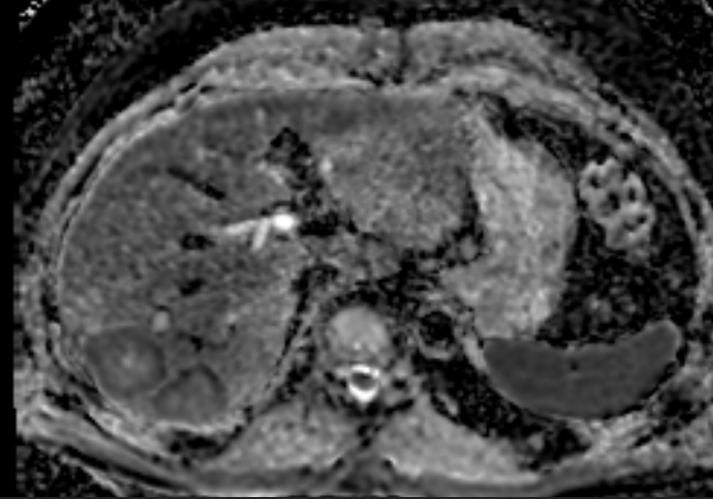
MRI



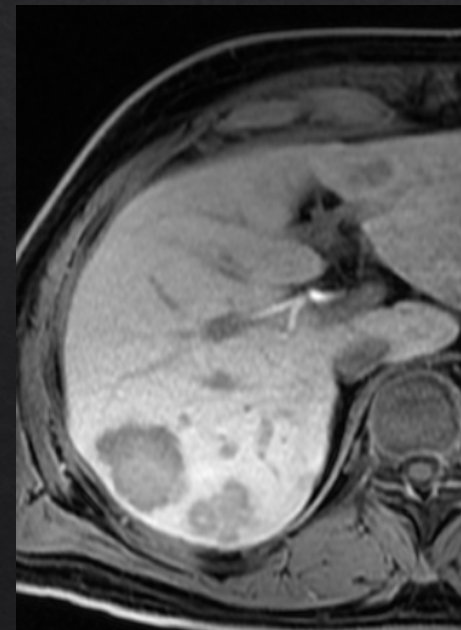
T2 Izo or hiper intense
Target sign



DWI +++



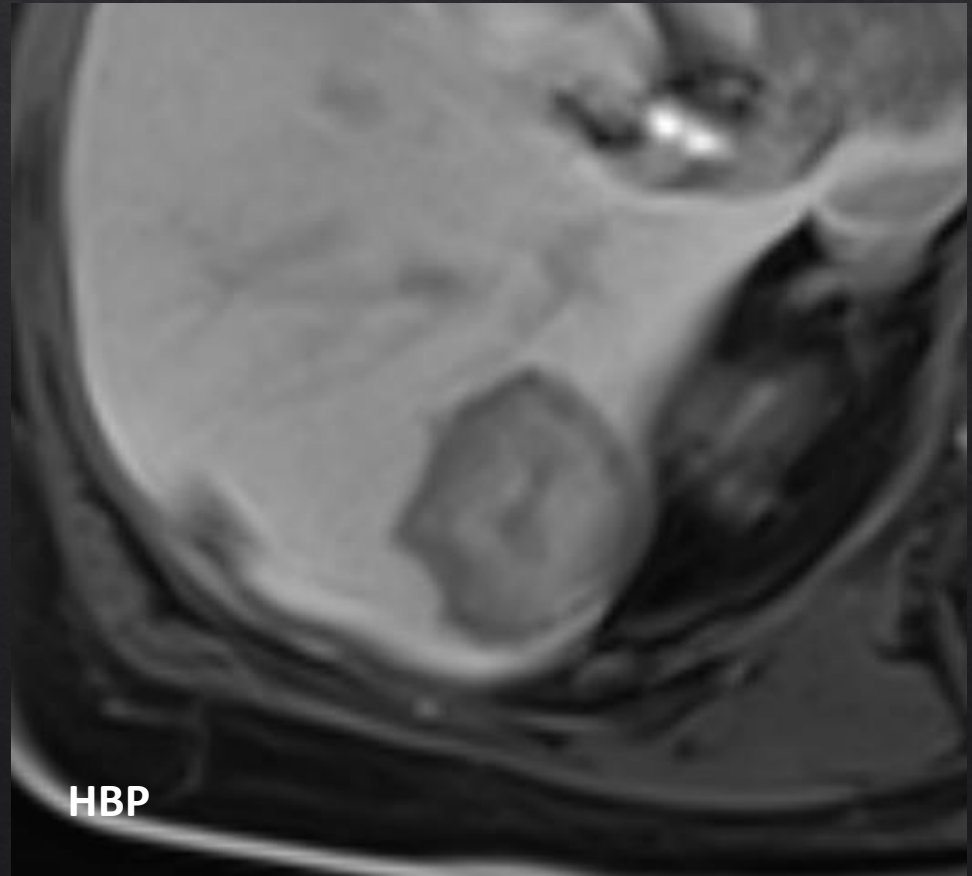
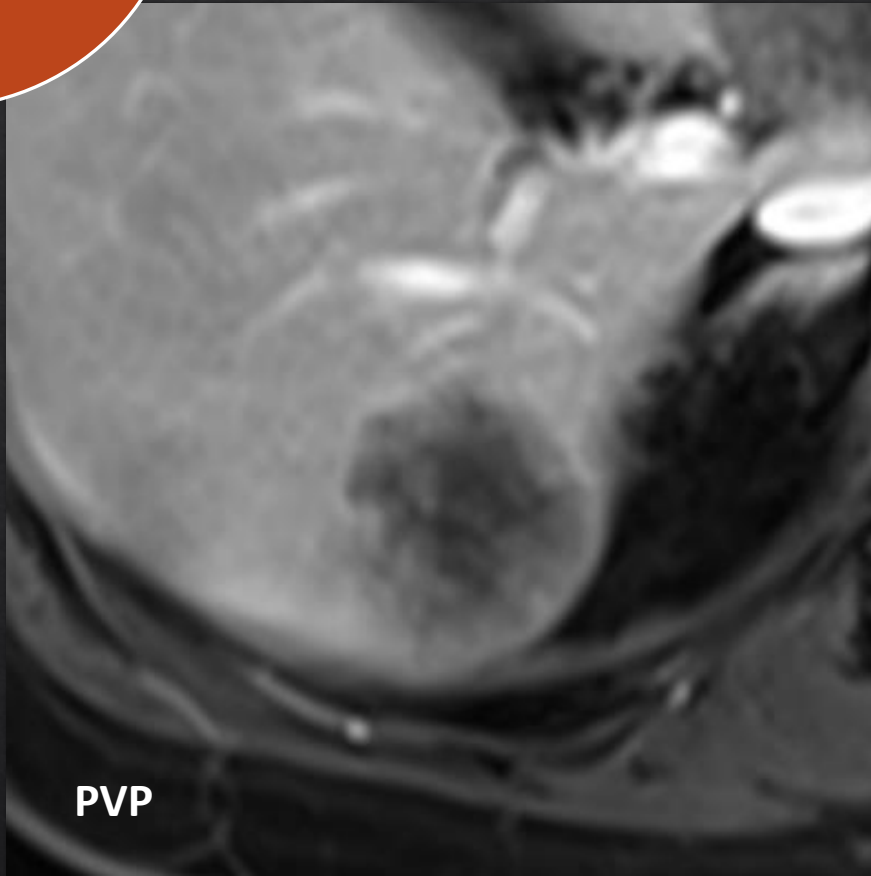
LAP



HBP hypo

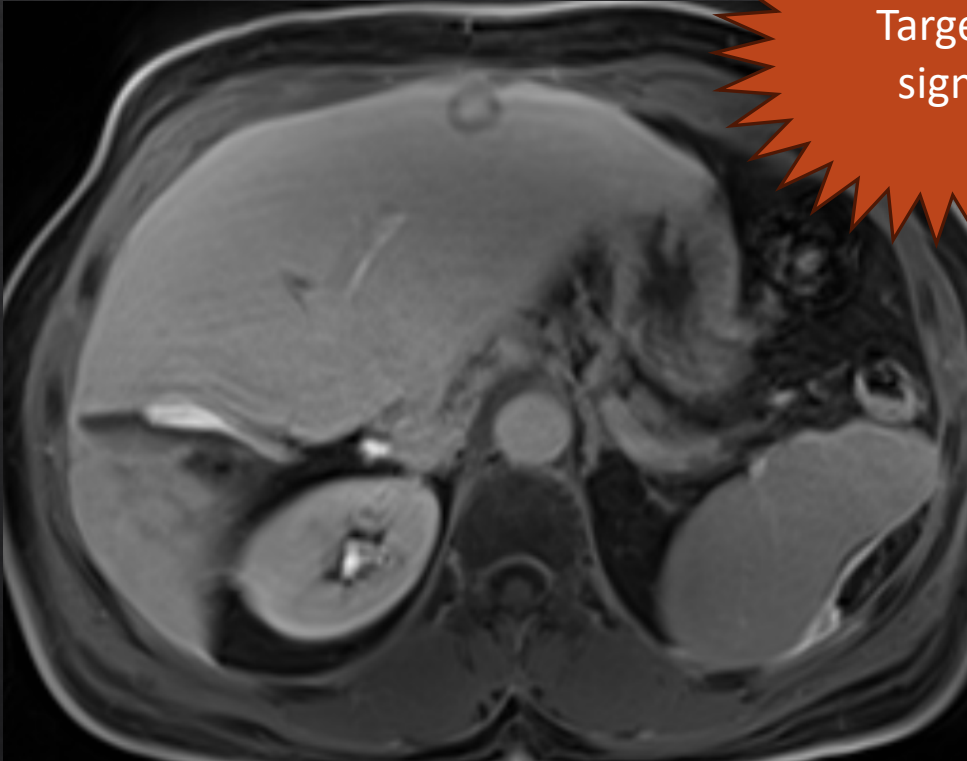
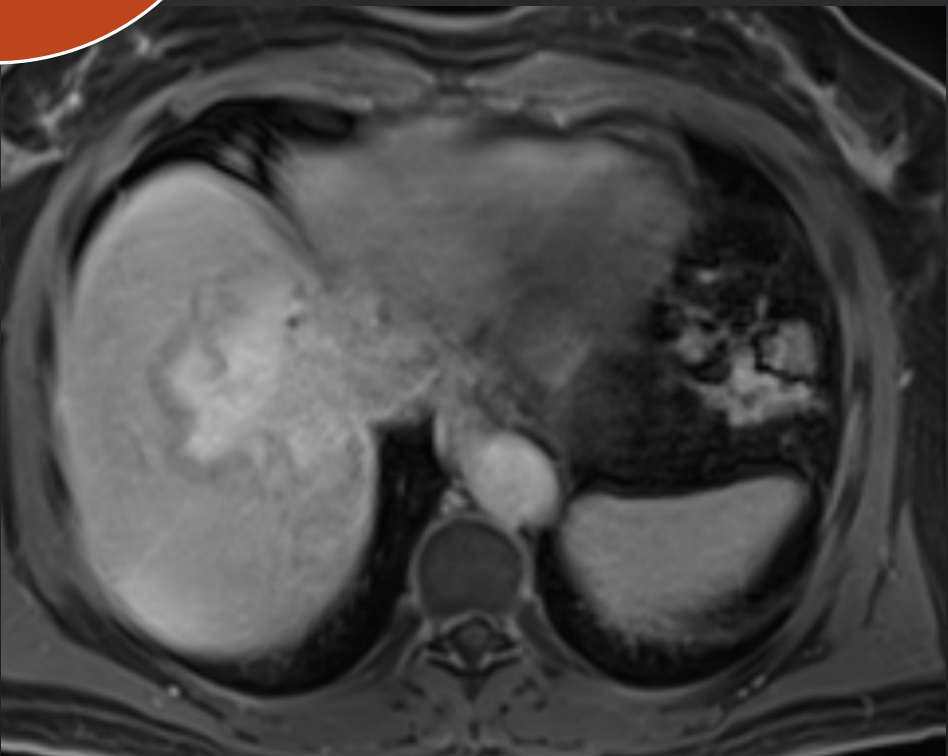
MRI

HBP



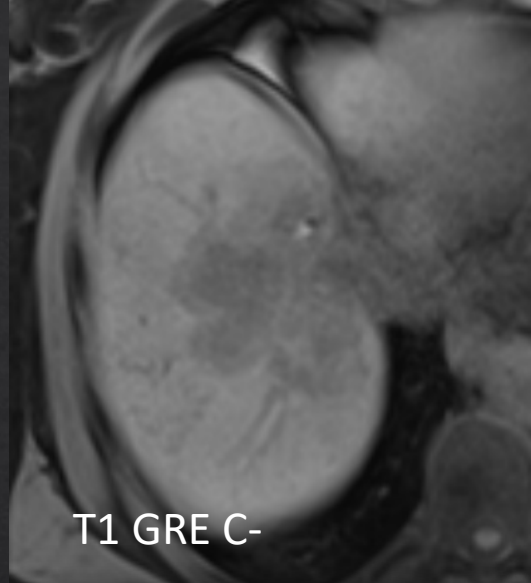
MRI

HBP

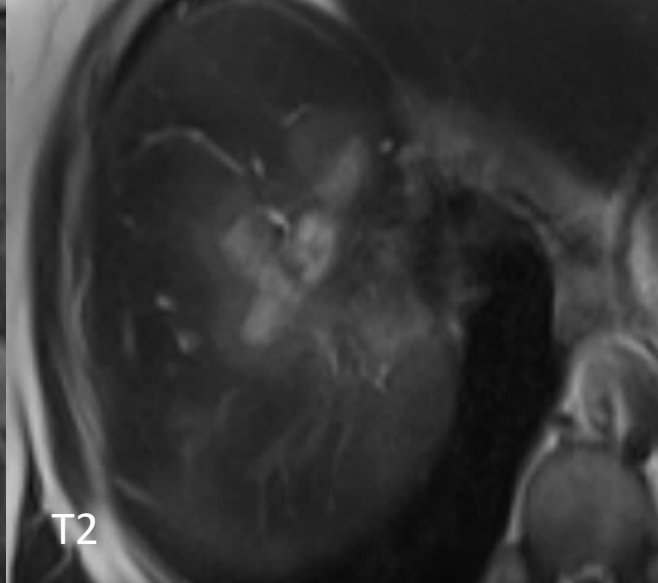


Target sign

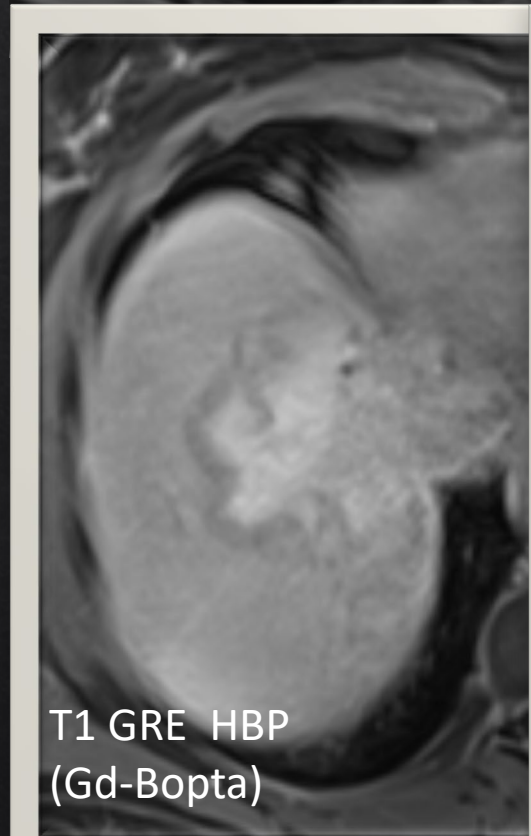
Melanoma



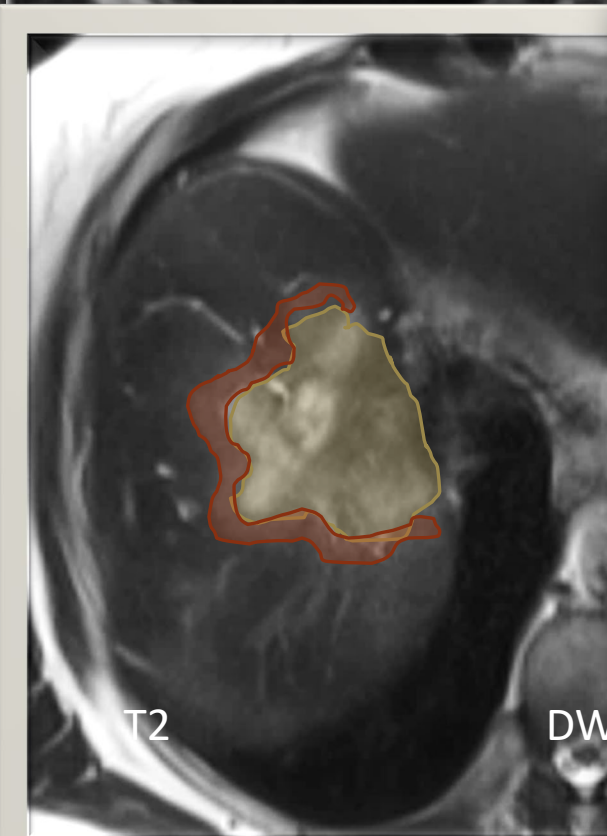
T1 GRE C-



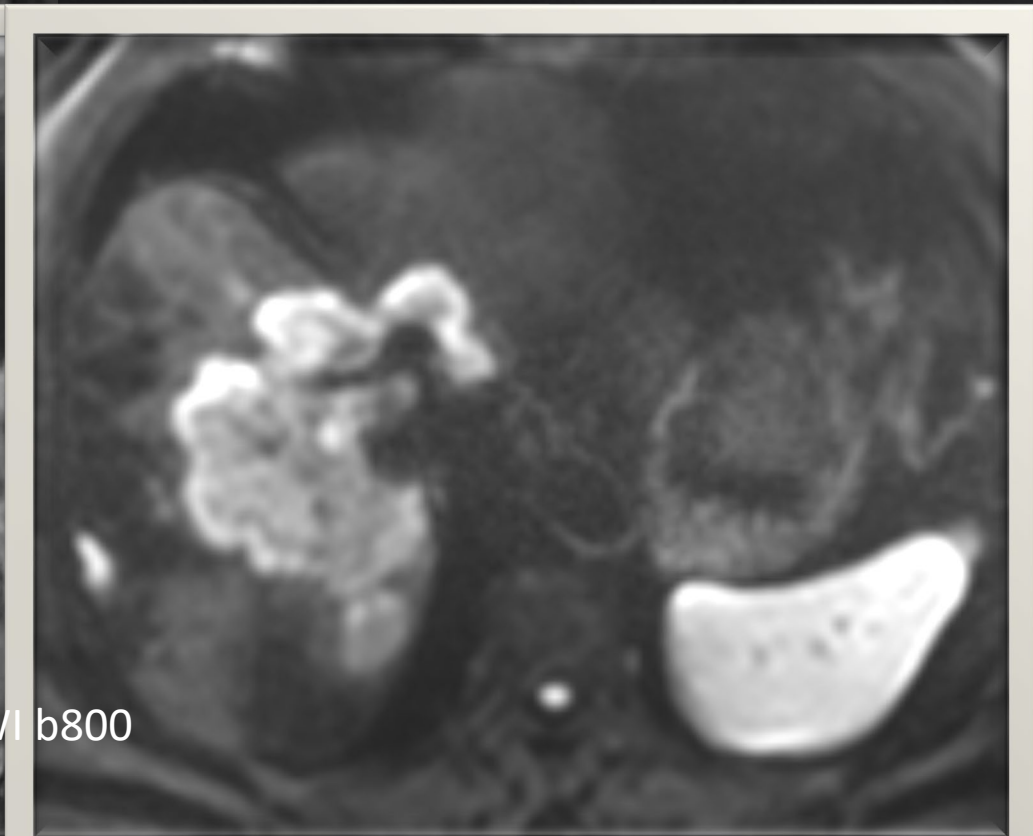
T2



T1 GRE HBP
(Gd-Bopta)



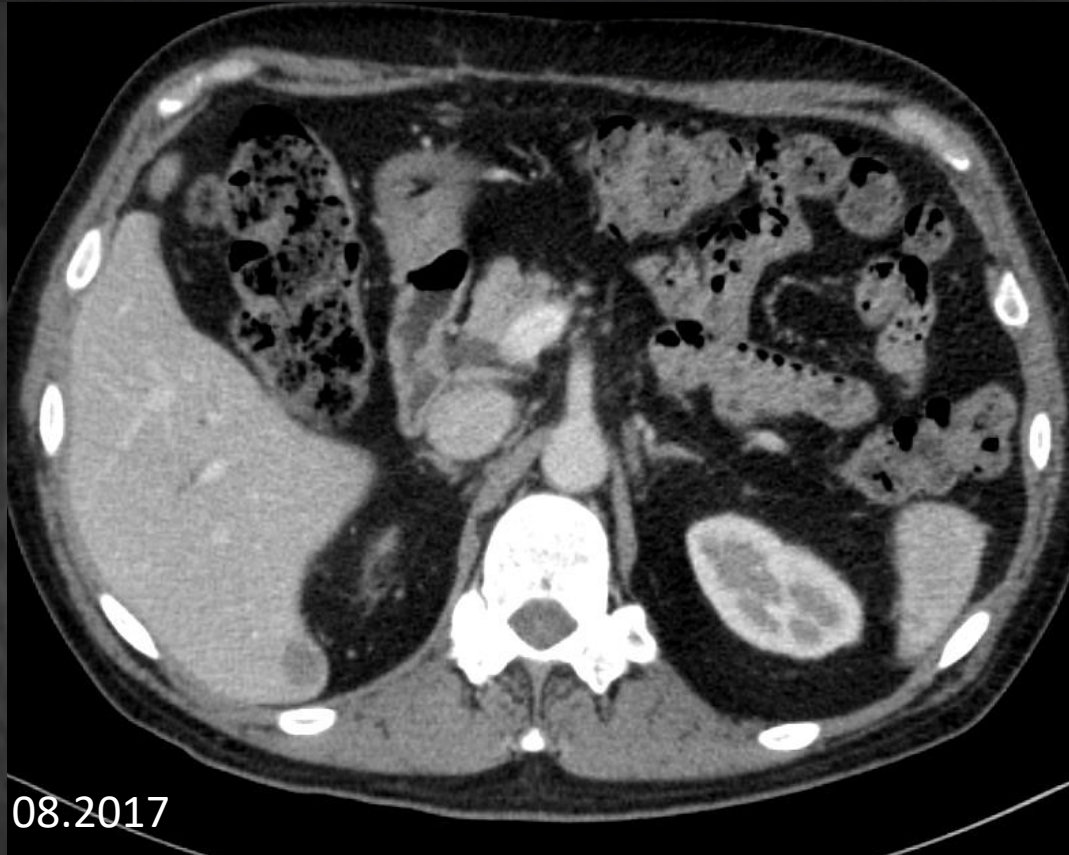
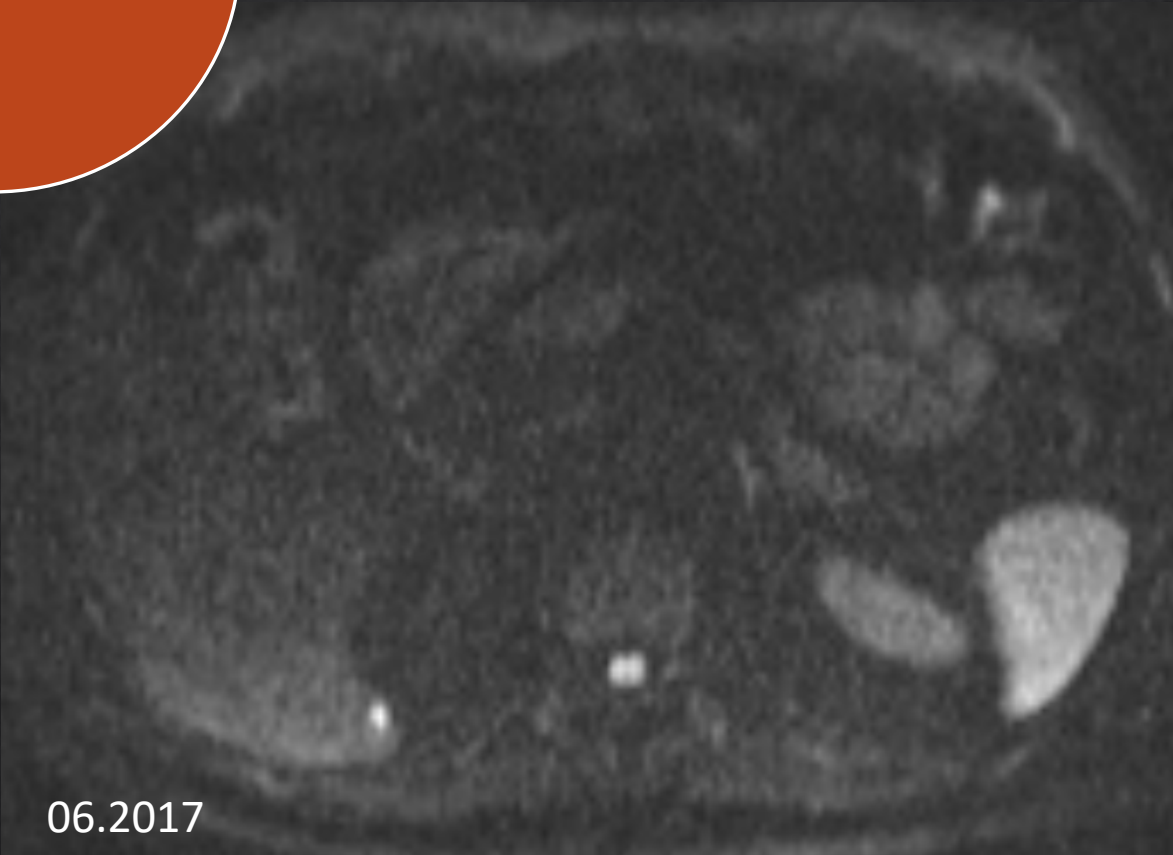
T2



DWI b800

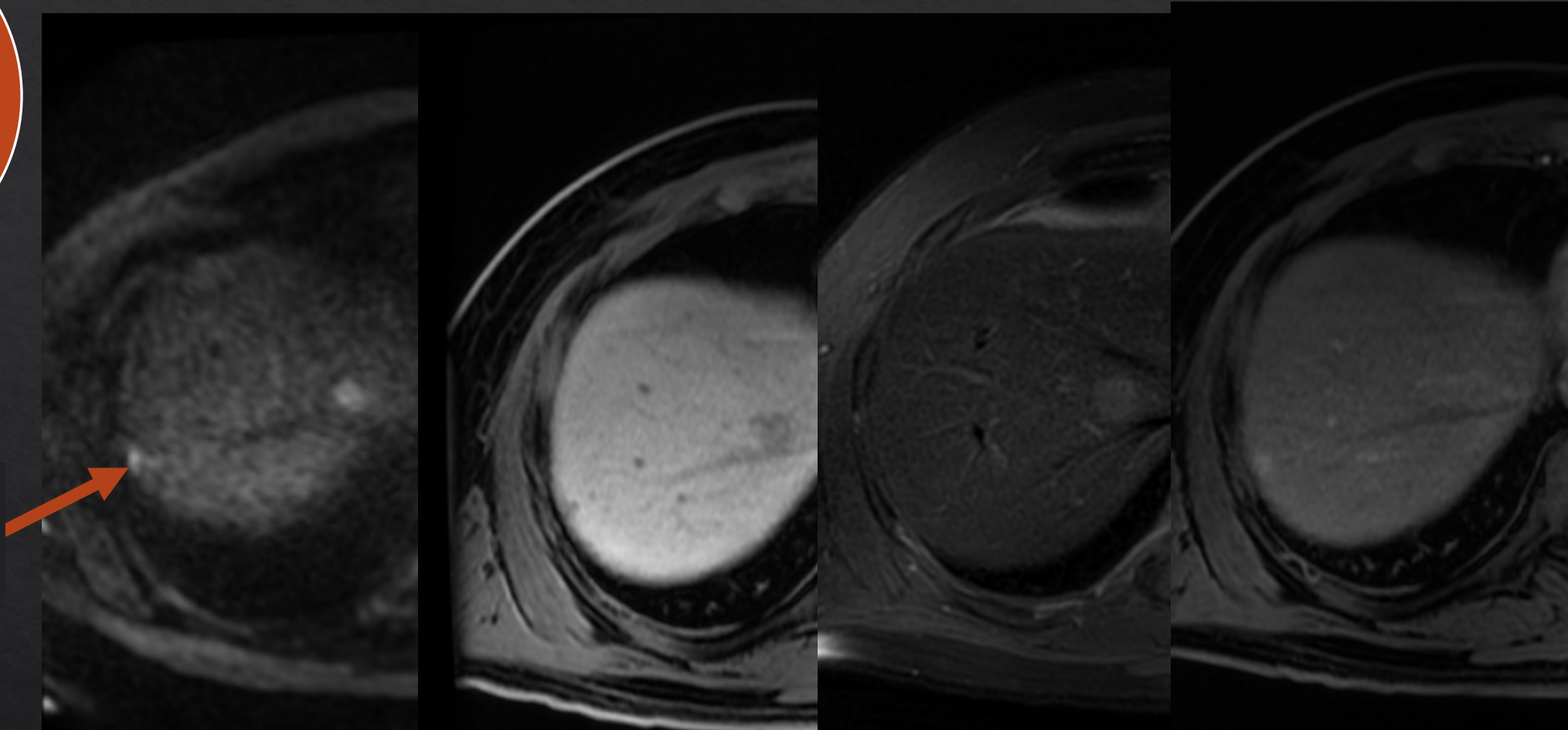
MRI

DWI



MRI

DWI + HBP – small lesion detection



DWI

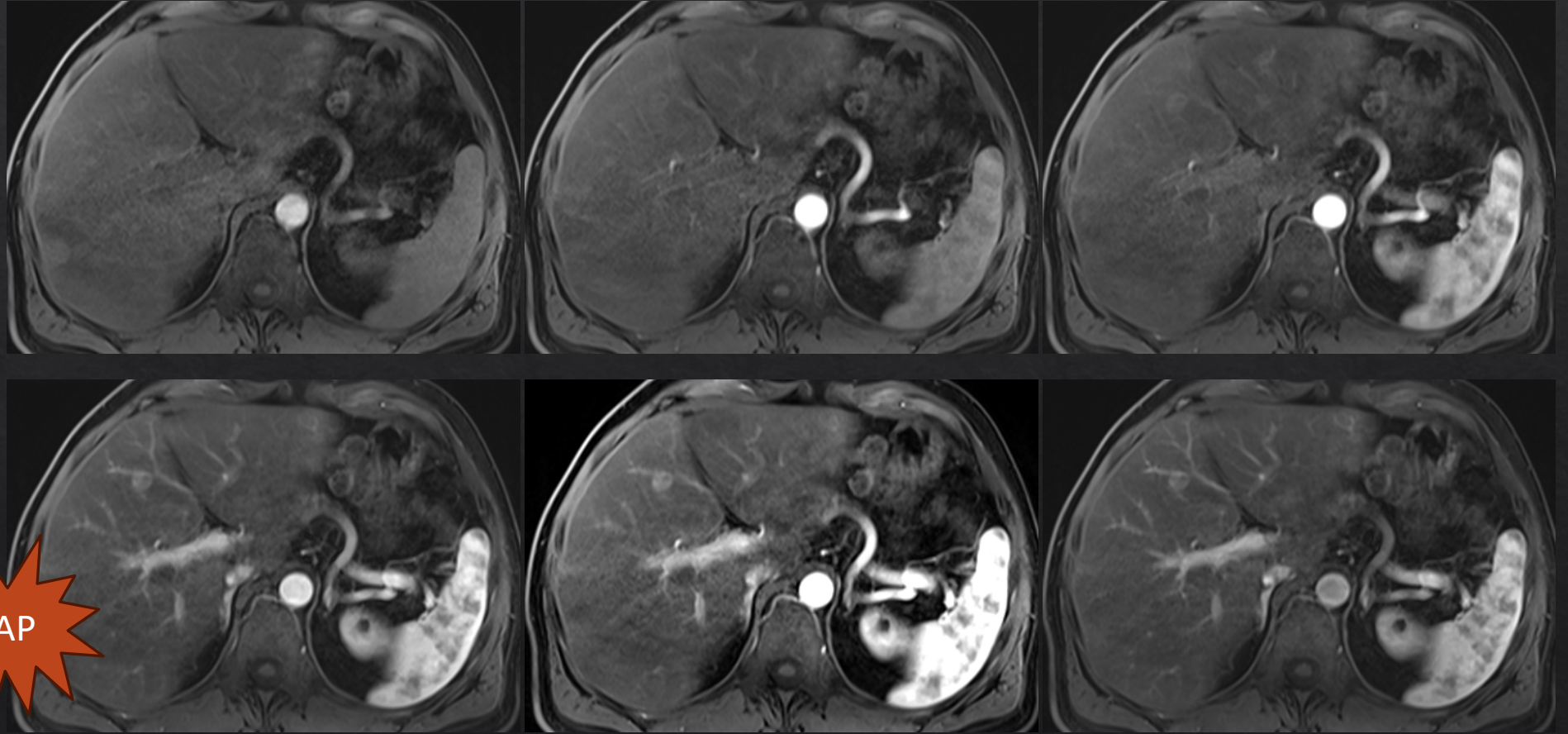
HBP

T2

LAP

MRI

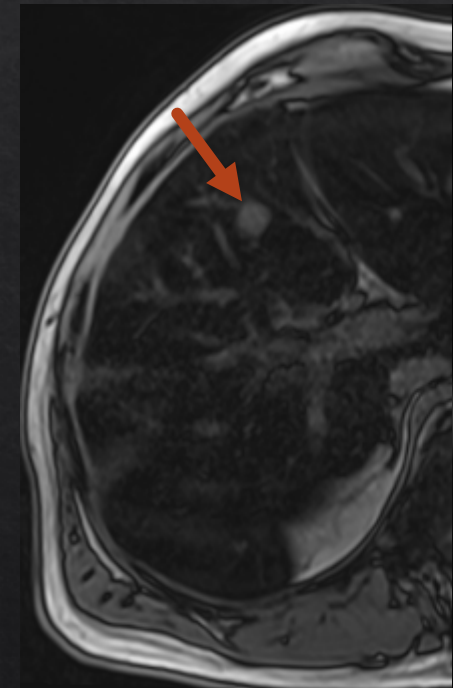
Multiarterial



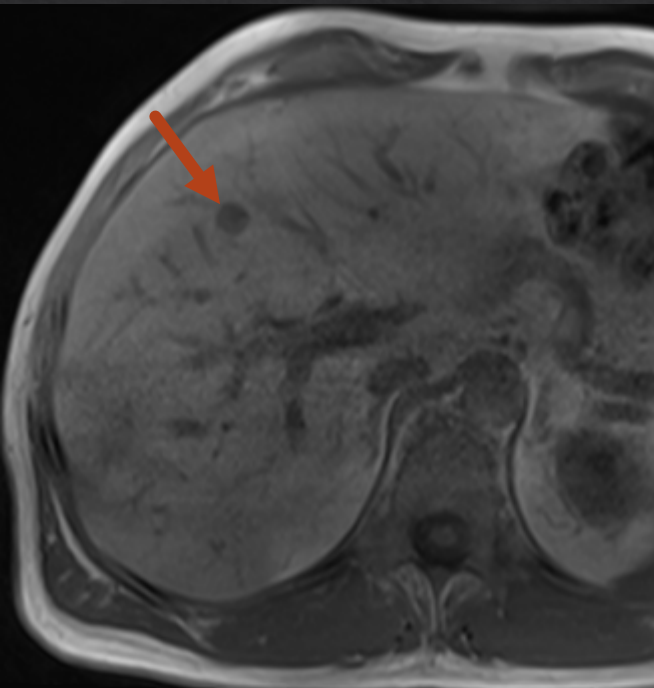
LAP

Liver steatosis

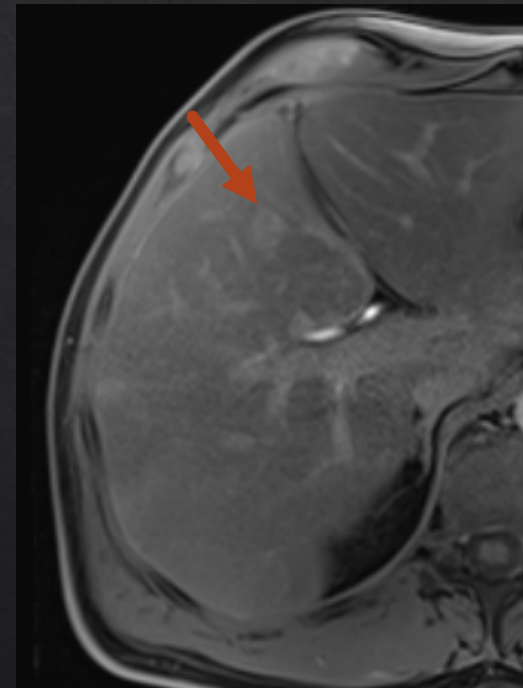
Problems with HBP



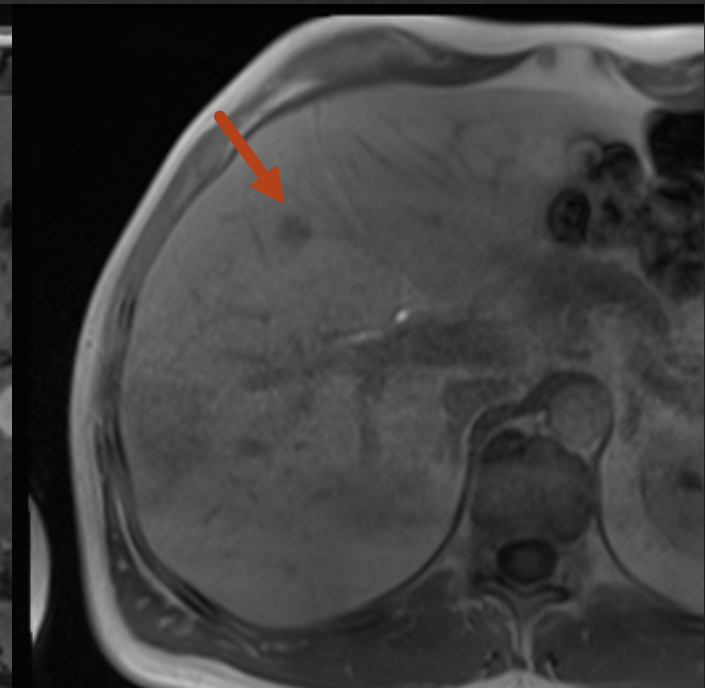
T1 out



T1 in



HBP (T1 DIXON Water)



HBP (T1 DIXON in)



PET-CT

- Mainly in doubtful cases
- Before complex surgery to exclude extrahepatic disease
- Tumours with dedicated tracers like NET (DOTA-TATE)

CRC

CRC metastases



15-30%

Synchronous ~15-30%

- detected at the time of diagnosis of the primary
- incidental liver metastases detected during surgery

20-50%

Early metachronous

- detected up to 12 months after diagnosis of the primary tumour

Late metachronous

- Detected more than 12 mths after diagnosis

Multisocietal European consensus on the terminology, diagnosis, and management of patients with synchronous colorectal cancer and liver metastases: an E-AHPBA consensus in partnership with ESSO, ESCP, ESGAR, and CIRSE

Ajith K. Siriwardena^{1,4}, Alejandro Serrablo², Åsmund Avdem Fretland³, Stephen J. Wigmore⁴, Jose Manuel Ramia-Angel⁵

CRC metastases



Collaborative Research

BJS, 2023, 110, 1161–117

<https://doi.org/10.1093/bjs/znad12>

Advance Access Publication Date: 13 July 2023

Consensus Statement

Multisocietal European consensus on the terminology, diagnosis, and management of patients with synchronous colorectal cancer and liver metastases: an E-AHPBA consensus in partnership with ESSO, ESCP, ESGAR, and CIRSE

Ajith K. Siriwardena^{1,4}, Alejandro Serrablo², Åsmund Avdem Fretland³, Stephen J. Wigmore⁴, Jose Manuel Ramia-Angel⁵

- Contrast-enhanced **CT of the thorax, abdomen and pelvis** should be undertaken at the **time of presentation**.
- Liver MRI with **hepatobiliary contrast** agents should be undertaken at the time of presentation (and before any chemotherapy). If hepatobiliary contrast agents are not available, standard liver agents (not hepatocyte-specific) may be used.
- Lesional liver **biopsy** may need to be considered in some specific settings, for example, if there is a **history of a different malignancy**.
- The consensus acknowledges the value of [18F] fluorodeoxyglucose **PET** in decision-making in patients with **stage IV** colorectal cancer, but does **not recommend** such imaging to be used **routinely** in the diagnosis of patients with synchronous colorectal cancer and liver metastases

MDT 😊

MDT should include the following core specialties:

- radiology (with expertise in gastrointestinal imaging),
- interventional radiology
- hepatobiliary (liver) surgery
- colorectal surgery
- gastrointestinal oncology
- radiation oncology
- histopathology
- cancer nurse specialist
- MDT coordinator (case manager)

\$\$\$

MDT process in a large teaching hospital/cancer centre:
- annual cost of MDTs in salaries alone is approximately £822,057.6
- each patient is £36.6
BMJ 2010;340:c951

CRC metastases

TAP
PVP
AP ?

Published Guidelines

Quantification of Liver Iron Overload with MRI (February 2023)
Review and Guidelines from the ESGAR and SAR

The guideline was published in Radiology.

[More Information](#)

Imaging standardisation in metastatic colorectal cancer (October 2022)
A joint EORTC-ESOI-ESGAR expert consensus recommendation

The guideline was published in the European Journal of Cancer.

[More Information](#)

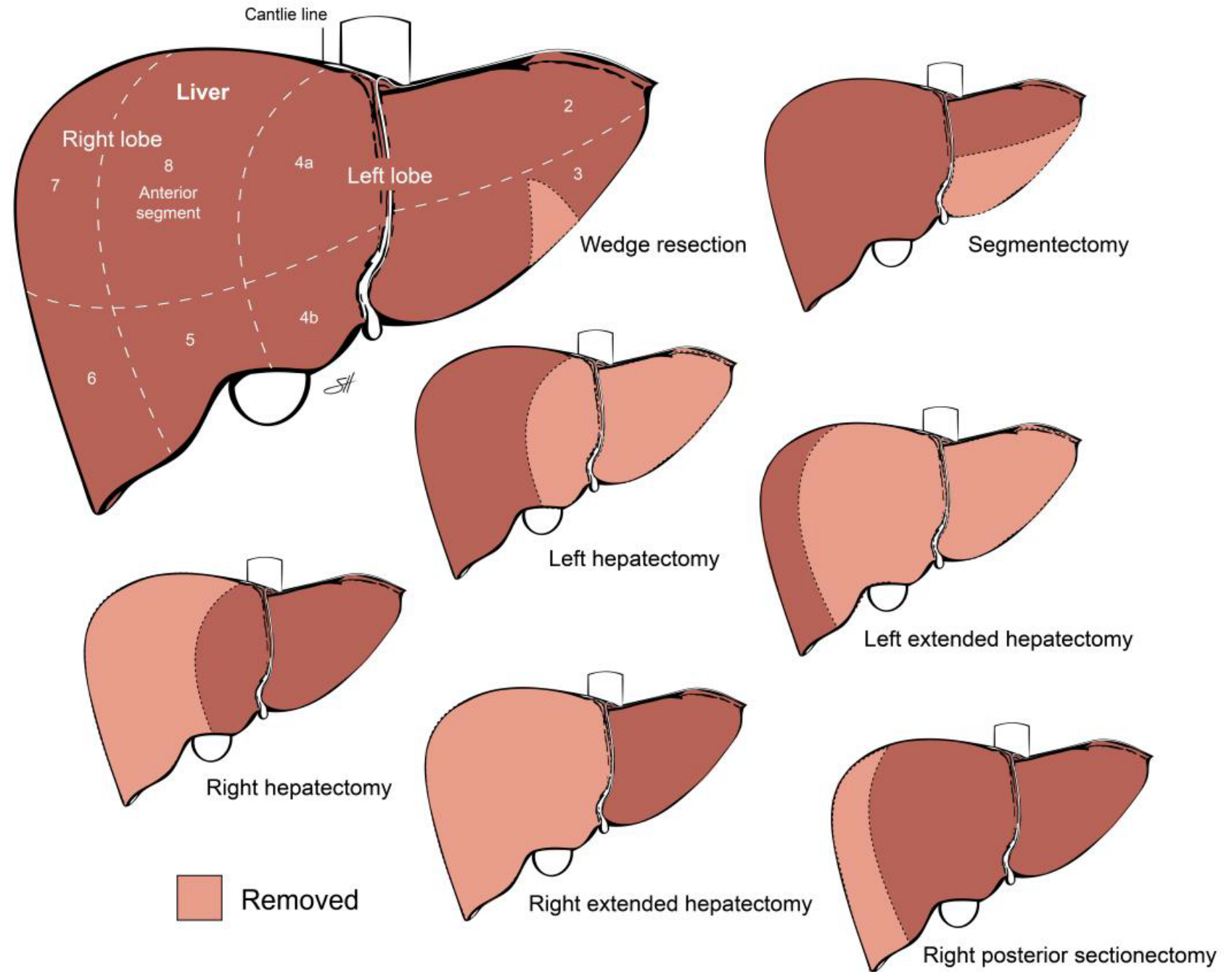
ECCO-ESGAR Topical Review on Optimizing Reporting for Cross-Sectional Imaging in IBD (October 2021)

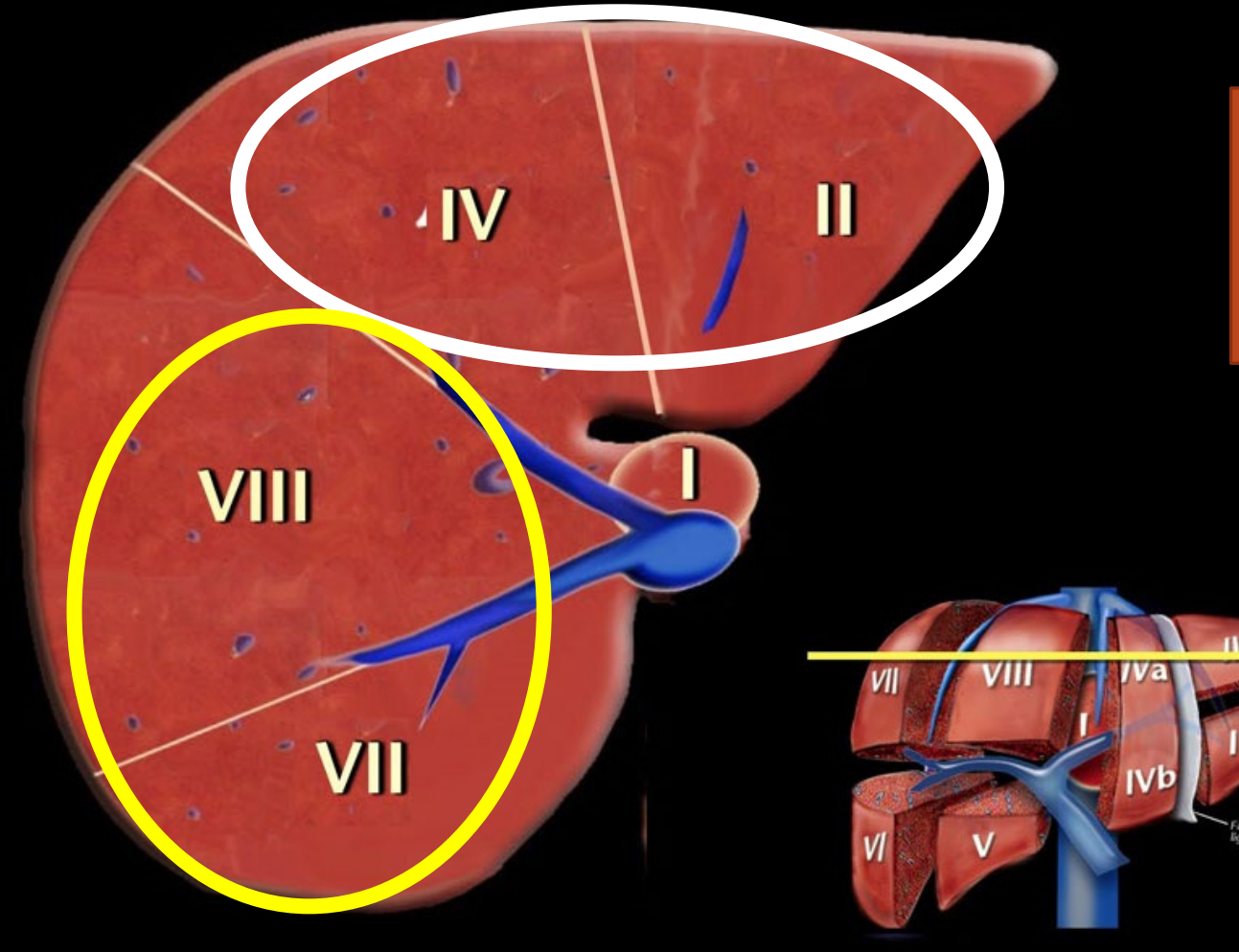
The guidelines were published in the Journal of Crohn's and Colitis.

[More Information](#)

Chest ST Window	Abdomen ST Window	Chest Lung Window	Protocol Parameters	Conformity
			Acquisition	Monophasic
			ST Slice Thickness	3 mm
			Lung Slice Thickness	1 mm
			Lung Kernel Available	Yes
			Oral Contrast	No

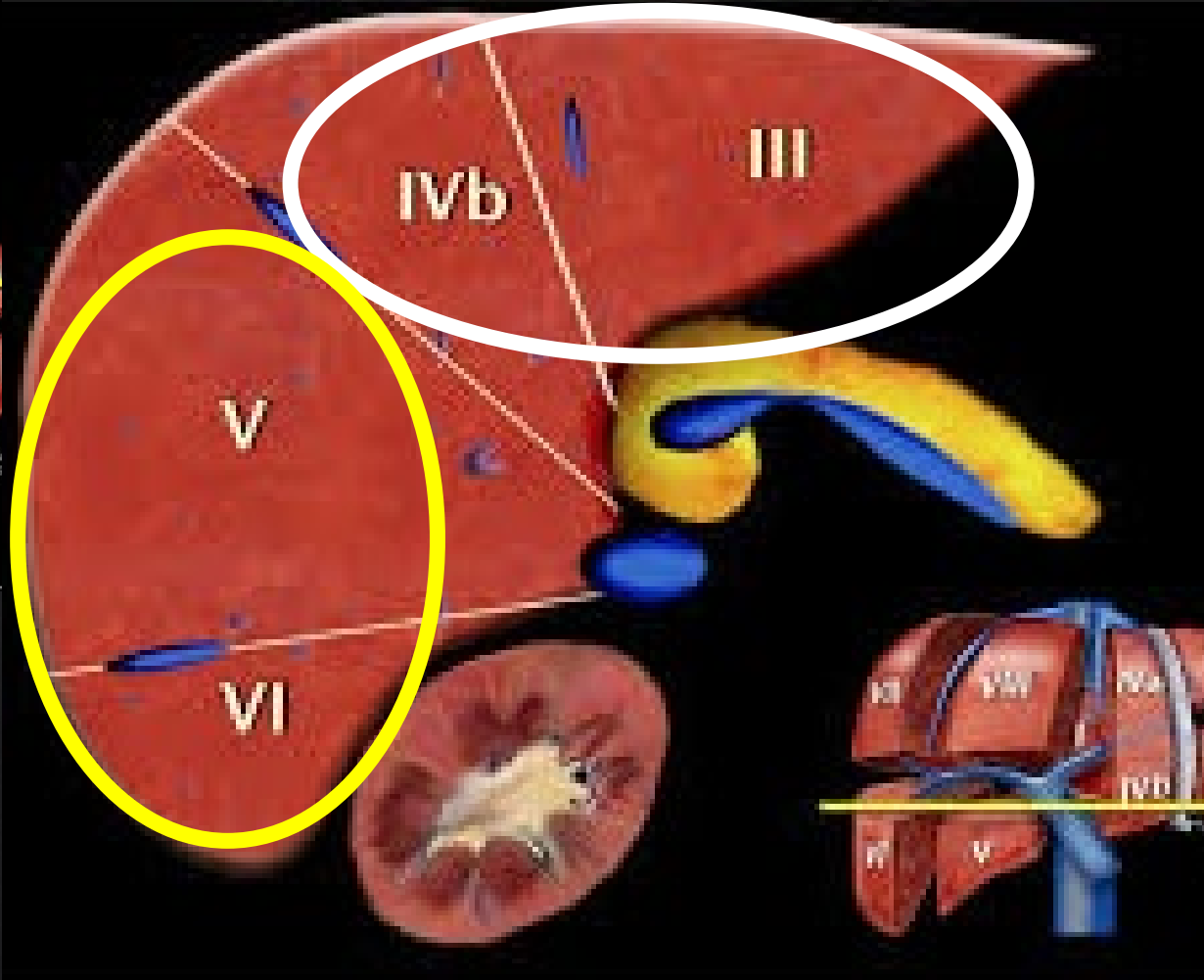
Presurgical staging

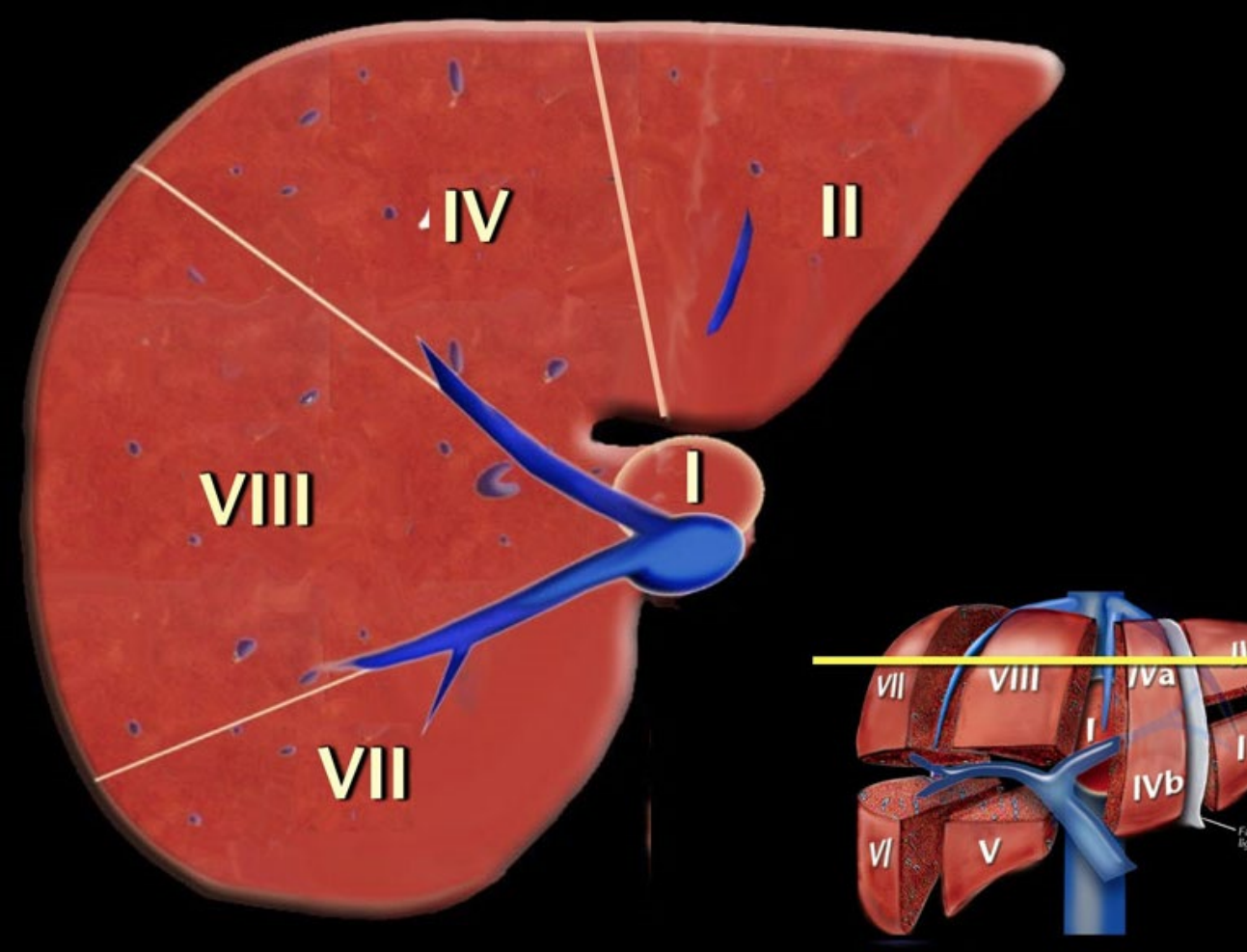




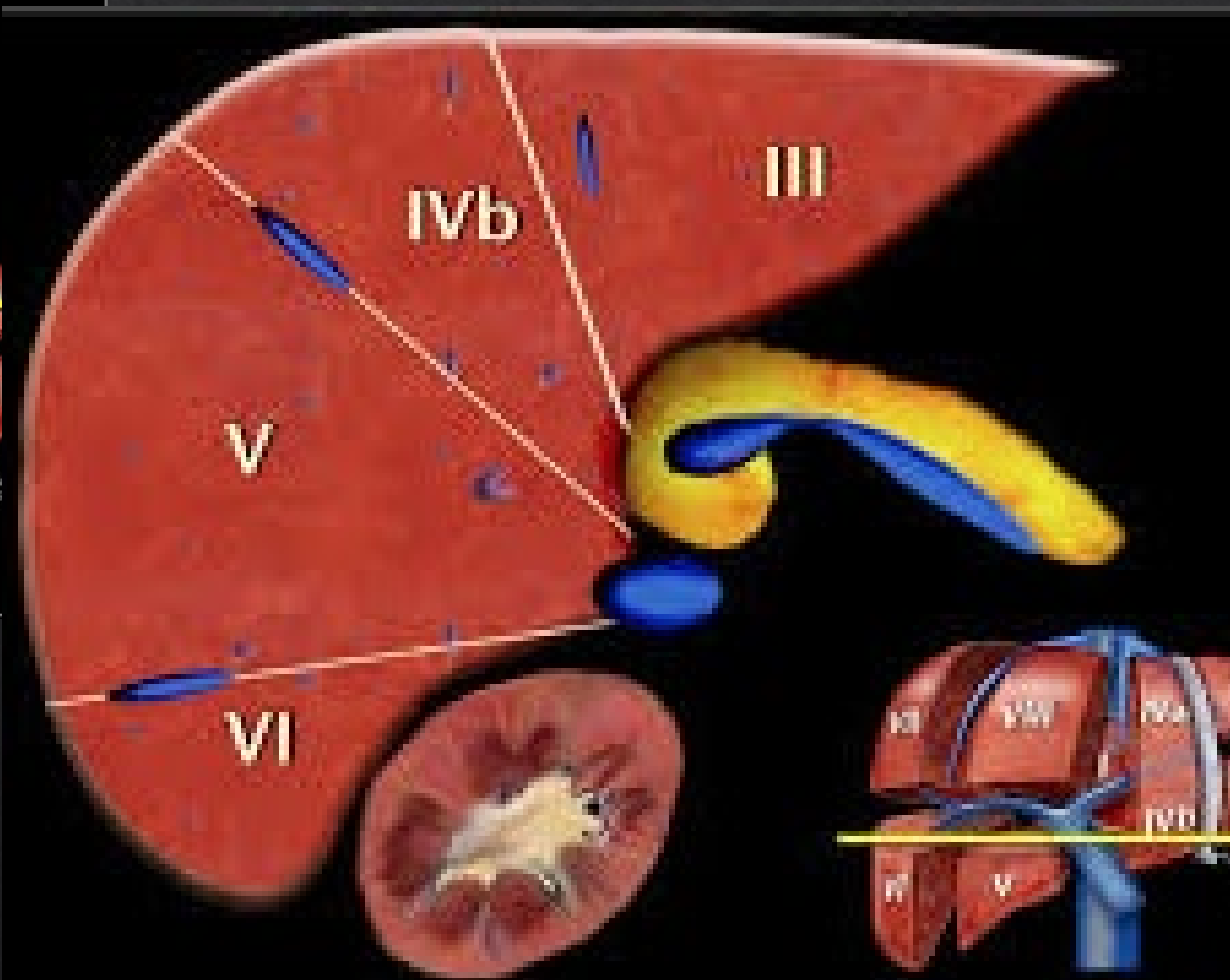
L

P



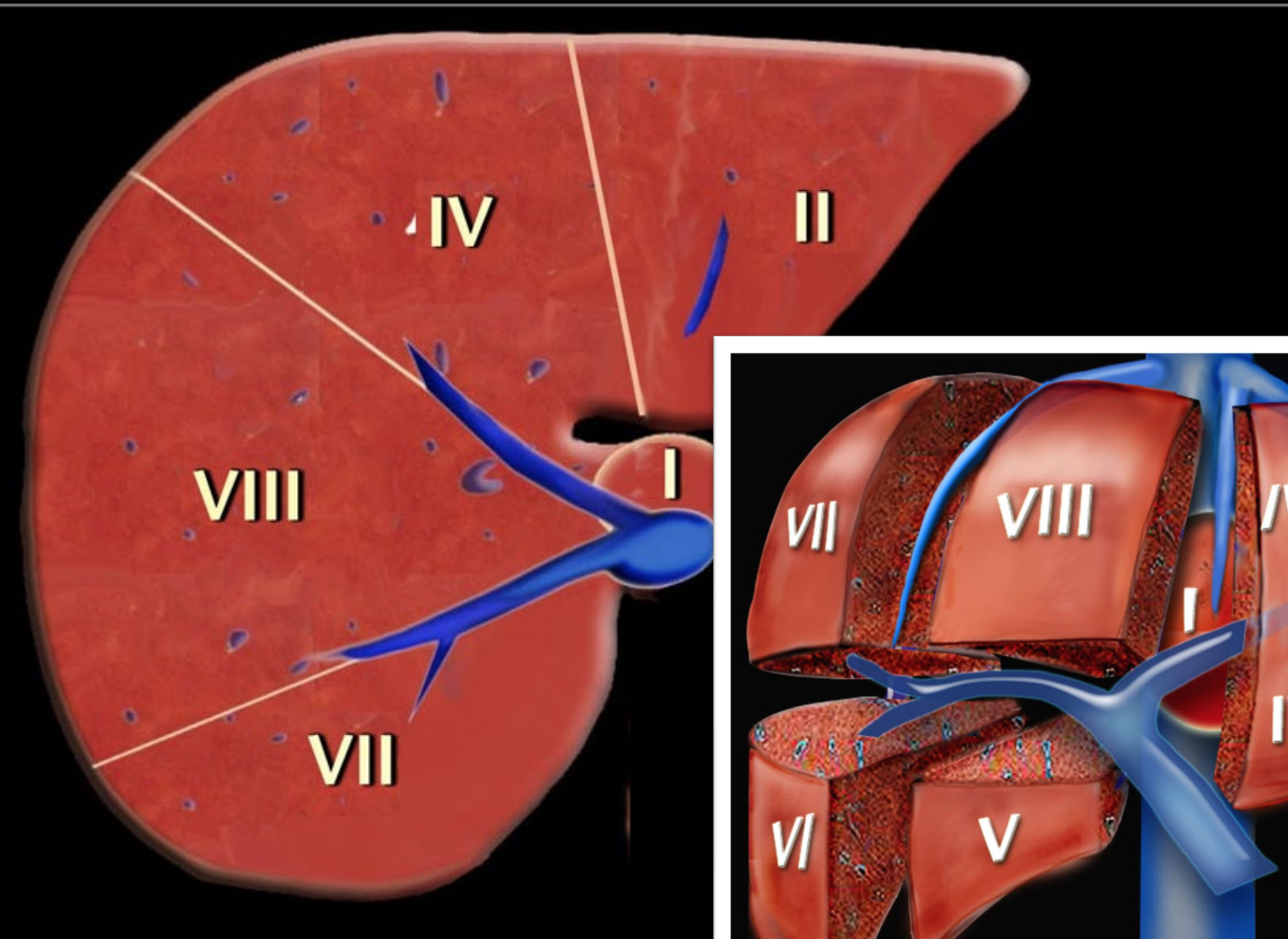


II, III – left lateral segments
 IVa, IVb – left medial segments

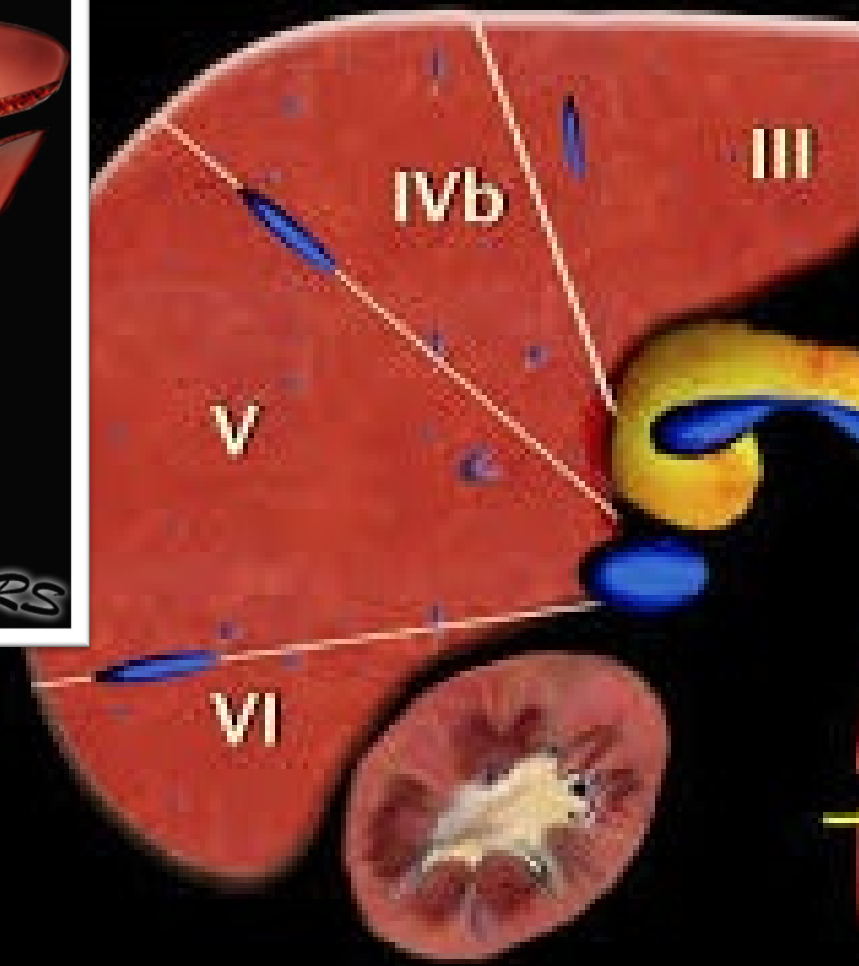
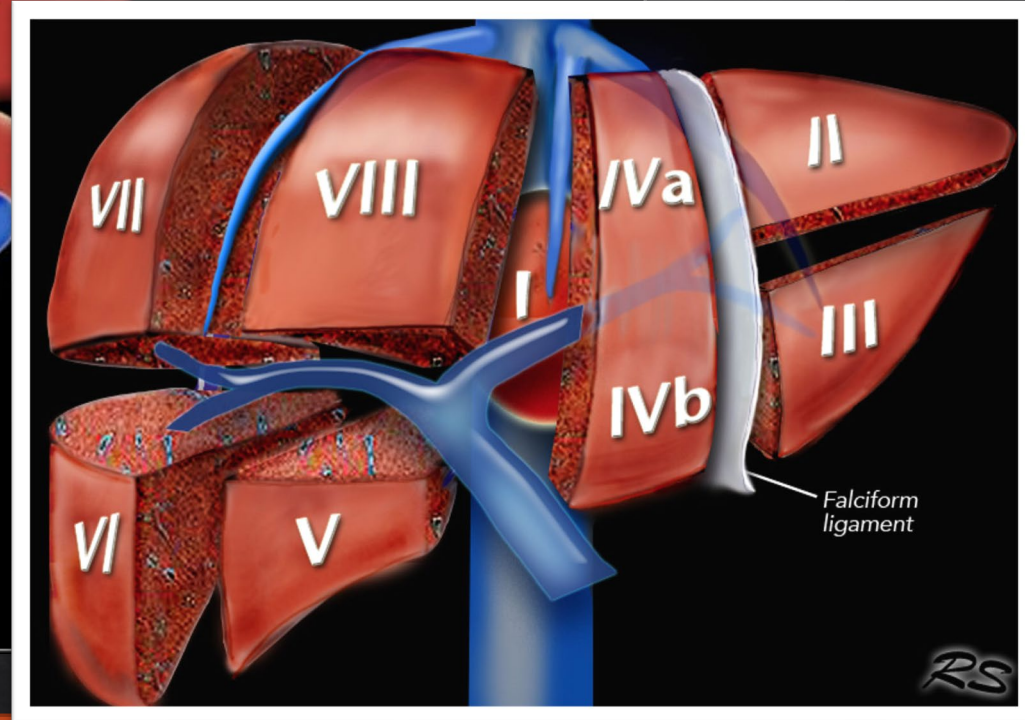


P

V, VIII – right anterior segments
 VI, VII – right posterior segments



II, III – left lateral segments
IVa, IVb – left medial segments

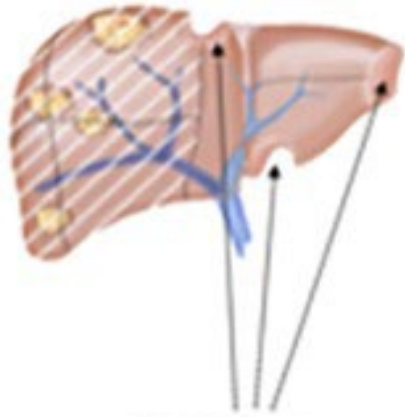


P

V, VIII – right anterior segments
VI, VII – right posterior segments

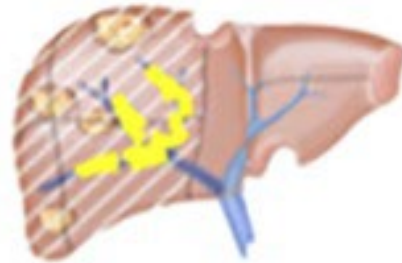
Portal Vein embolization (PVE)

Stage 1



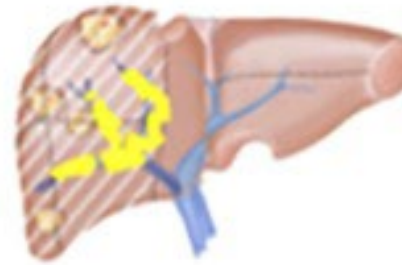
Surgery:
Parenchymal sparing
resections on the left

2-7
days



Interventional Radiology:
Embolization of the right
portal vein

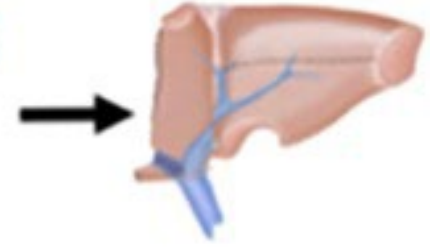
3-4
weeks



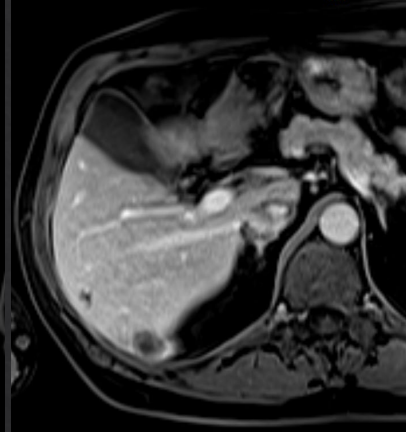
>30% of total liver

Volumetry

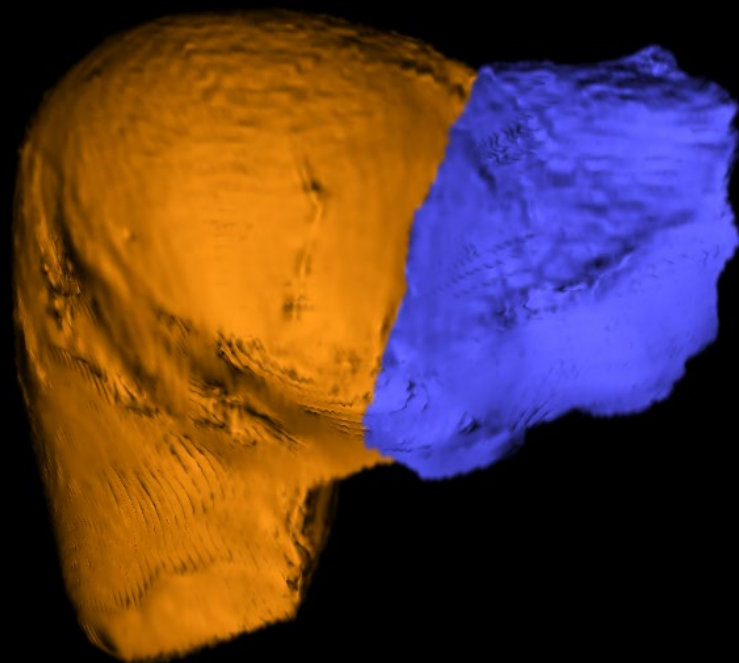
Stage 2



Surgery:
Removal of
the right lobe



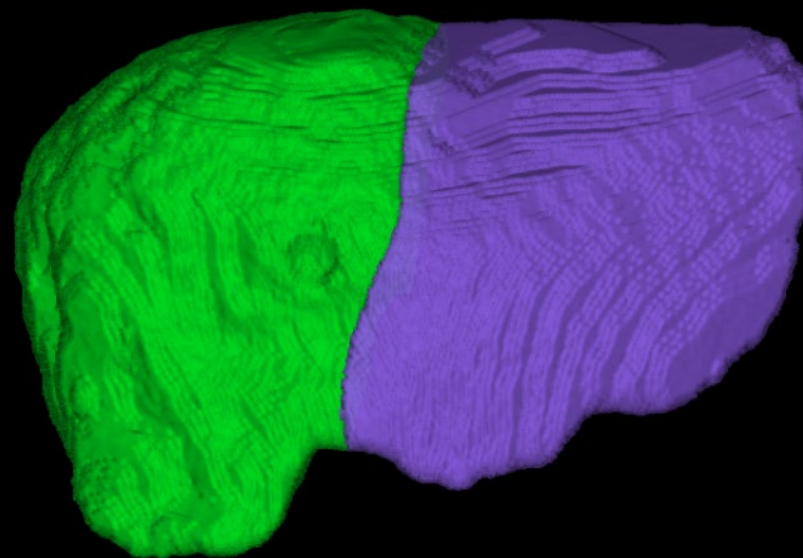
Region	Volume (ml)	Mean Value
seg. 1+2+3+4	284.73	313.3 ± 57.7
seg. 5+6+7+8	1046.61	388.8 ± 63.7
Total	1331.34	



DFOV 26.4 x 30.5 cm
STND/E/AR50 No Filter

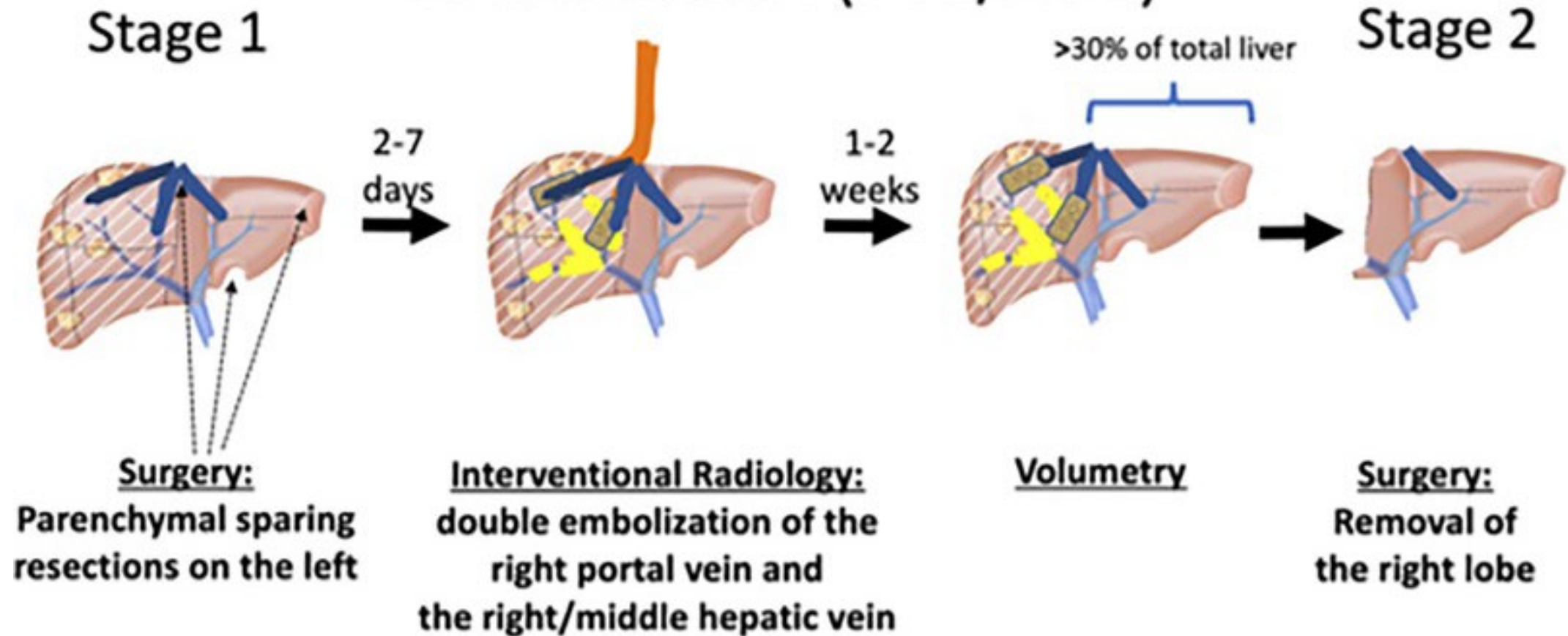
750/1
ROI 1 - Liver: 1232cm³
ROI 2 - seg. 1+2+3+4: 505cm³
ROI 3 - seg. 5+6+7+8: 727cm³

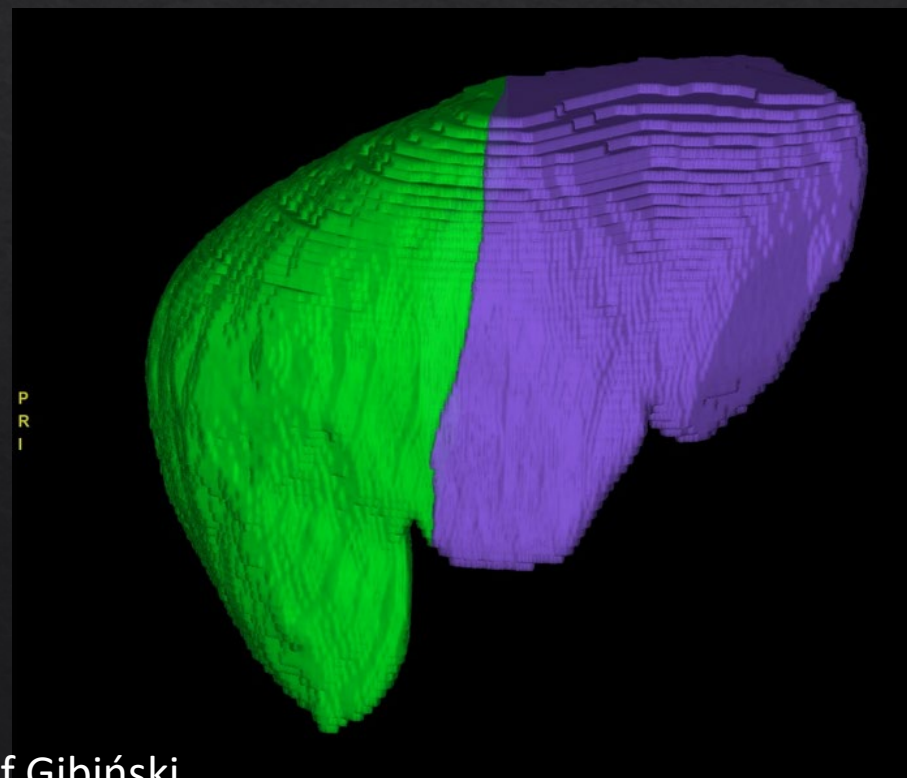
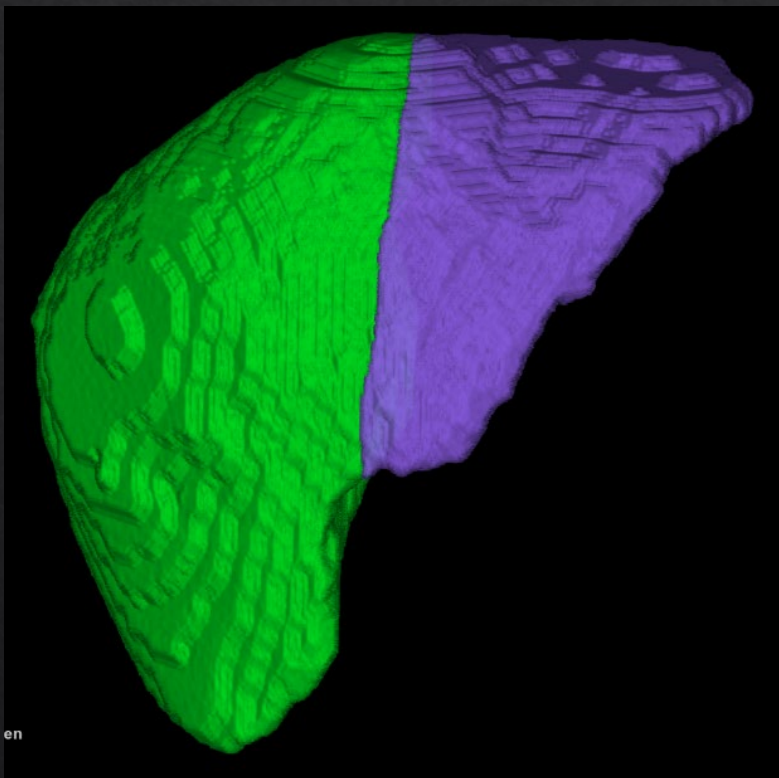
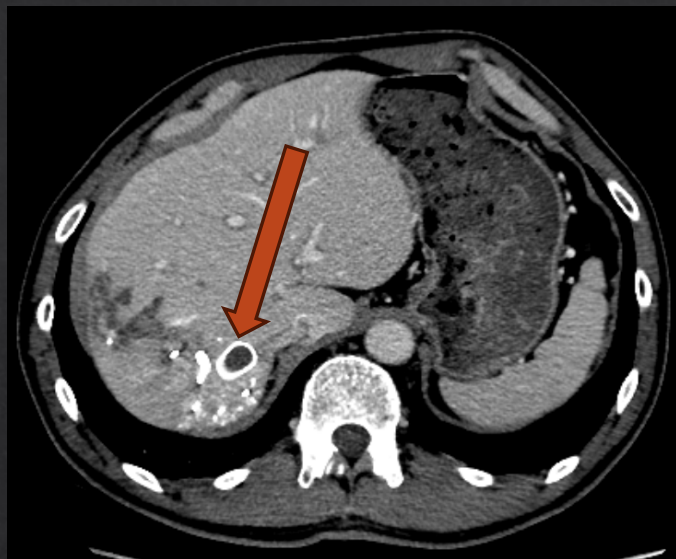
R
P
S



Courtesy of dr Krzysztof Gibiński

Simultaneous portal and hepatic vein embolization (PVE/HVE)

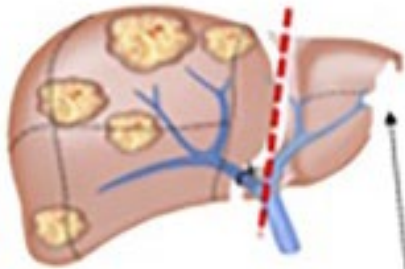




Courtesy of dr Krzysztof Gibiński

In-situ-split/ALPPS

Stage 1



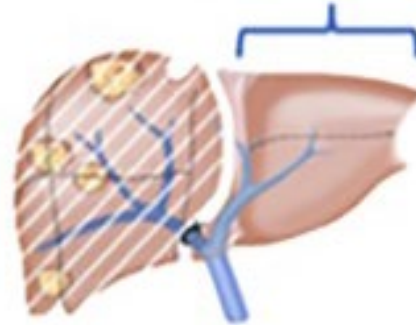
Surgery:
Ligation of the
portal vein

+ *in situ split*
+ parenchymal sparing
resections on the left

7-10 days



>30% of total liver



Volumetry:
Hypertrophy of the FLR



Stage 2



Surgery:
Removal of
the right liver

Presurgical staging

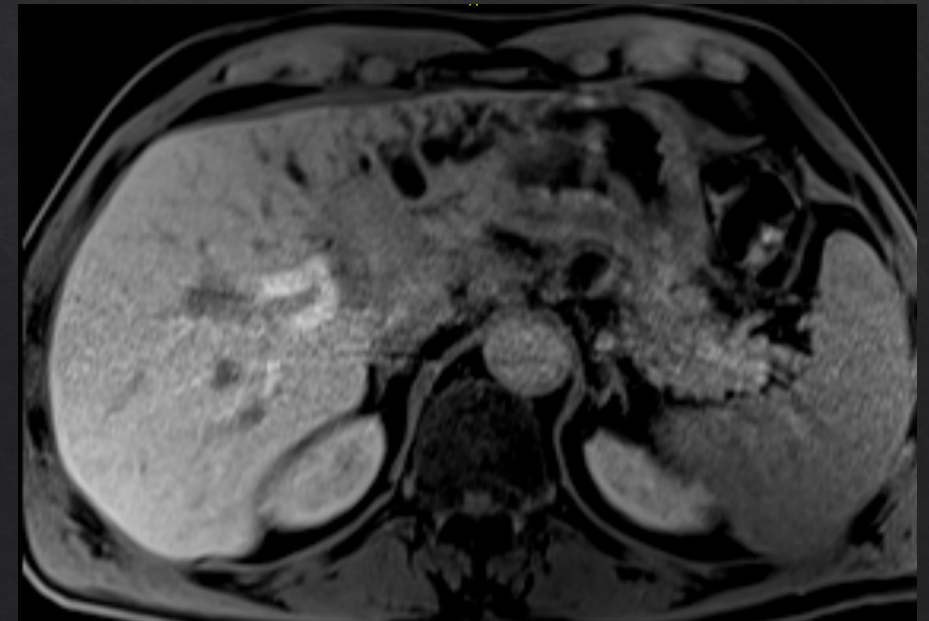
- Need for precise analysis (not the number of mets but the location is crucial)

- CT

- Better visualization of blood vessels
- Volumetry - counting the future liver remanent (**FLR**)

- MR

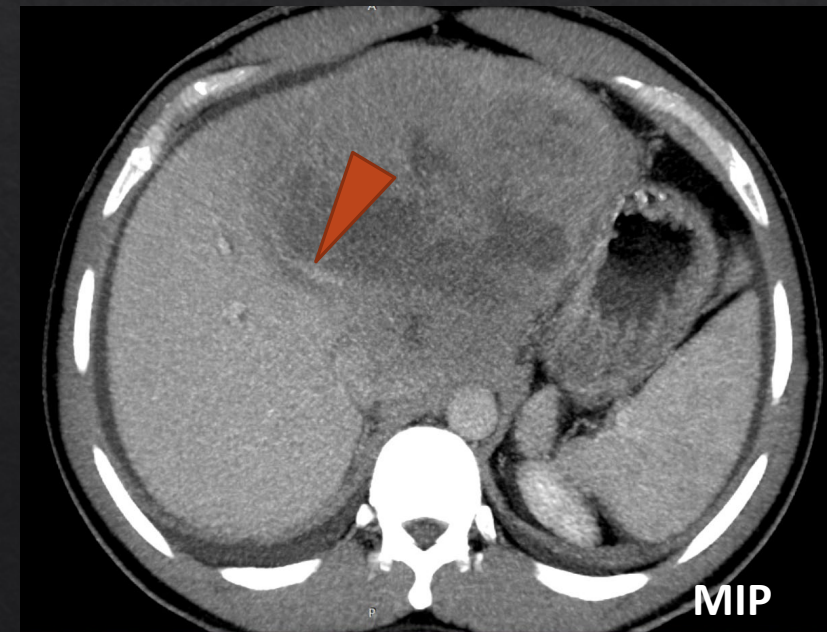
- Detection of small lesions
- Biliary anatomy
- HBP – lesion deliniation



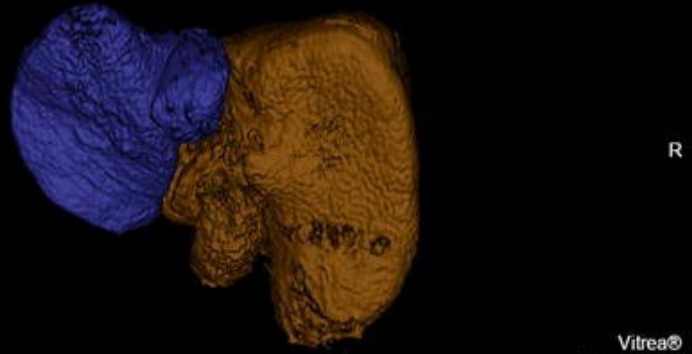
Presurgical staging

- IVC
- Hepatic veins
- Portal vein
- Hepatic arteries (variants!)
- Depth from the capsule
- Localization (precise – segmental anatomy)
- Liver volumetry – how much liver left?

- If post chemotherapy – must have baseline study for comparison



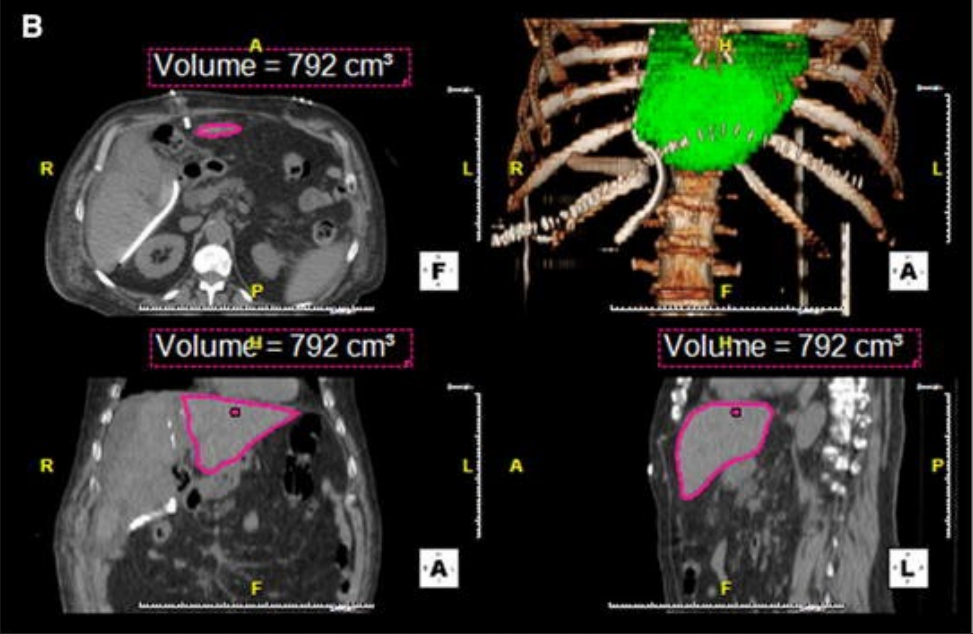
Region	Volume (ml)	Mean Value
Remaining Liver	1705.97	326.2 ± 117.5
Caudate	65.88	220.3 ± 42.8
Segments2&3	636.78	412.2 ± 169.5
Total	2408.63	



Vitrea®
 Zoom: 154%
 Phase %000
 WL: 1953/1002
 Segmented
 VR: All Anat I

FLR

- Healthy liver parenchyma >25%
- Post-chemotherapy >30%
- Chronic liver disease > 40 %



Disappearing metastasis



- The term ‘disappearing metastases’ is defined in this study as lesions present on baseline contrast **MRI*** which are no longer visible on hepatobiliary contrast MRI after systemic chemotherapy
- The presence of a scar on cross-sectional imaging is termed ‘evidence of treatment response’ but, if visible on hepatobiliary contrast MRI, the lesion is not regarded as disappearing

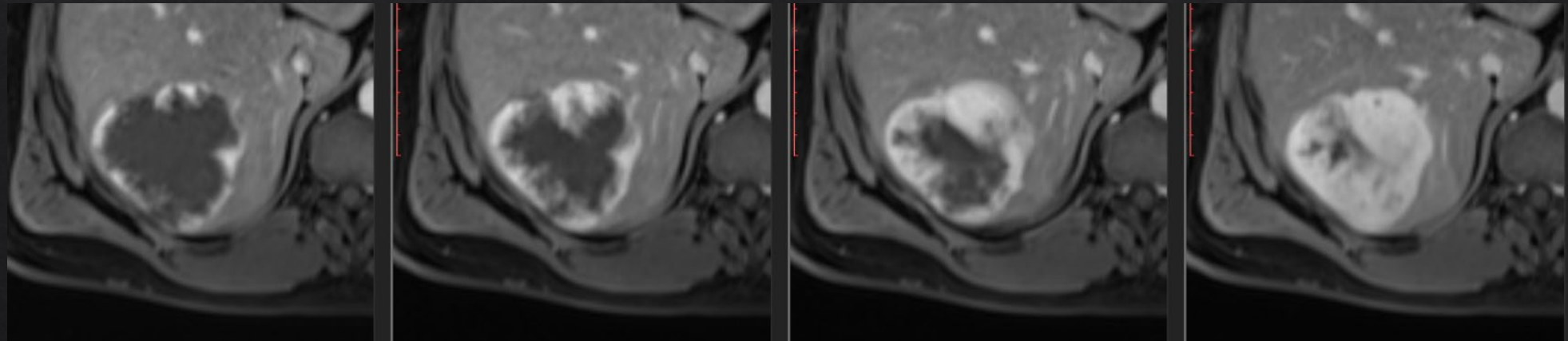
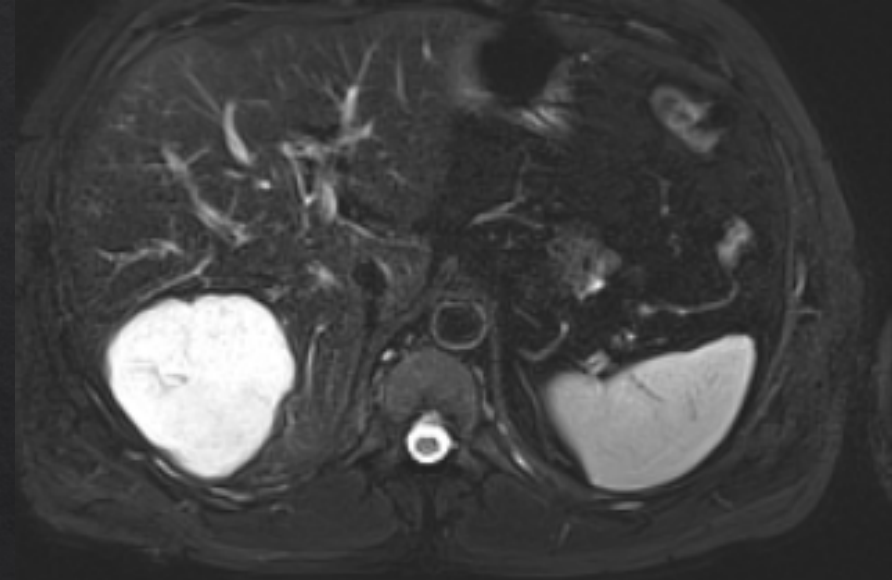
* There was no consensus to state that complete response on CT alone could justify the term ‘disappearing metastases’.

DDx

Haemangioma vs mets

Haemangioma classic appearance

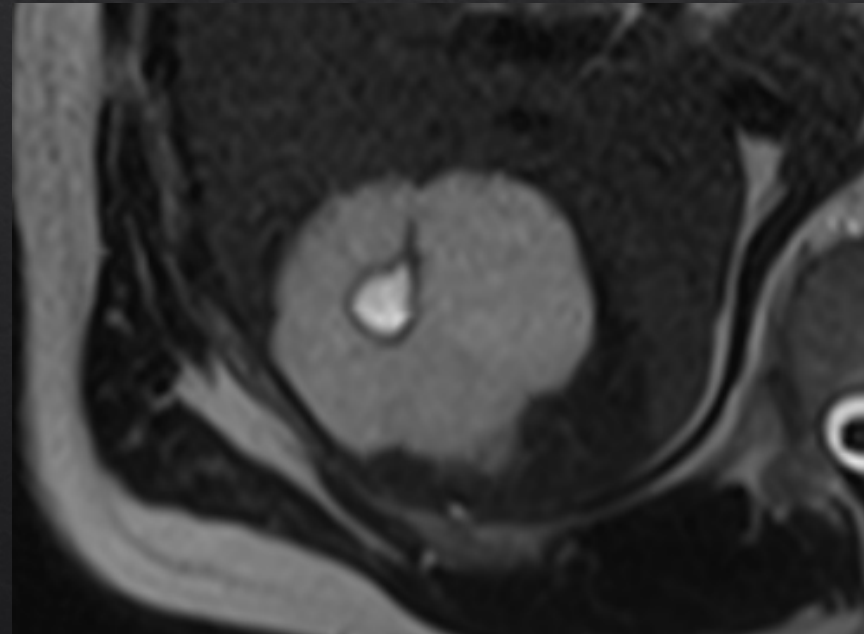
- **Well circumscribed** / no halo
- Geographic border / **lobulated**
- **Respect of liver contour**
- Classic gradual nodular enhancement (CT and MR)
- **T2 hyperintensity**
- Ultrasound - hyperechoic



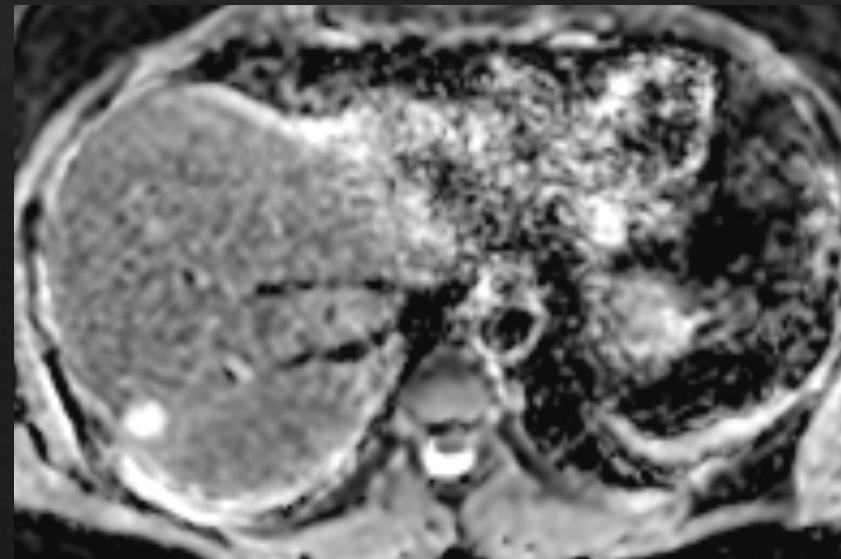
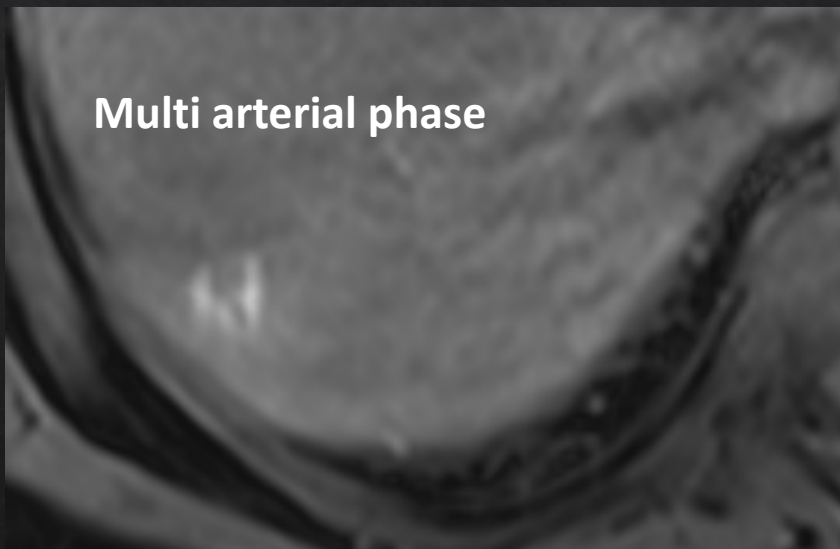
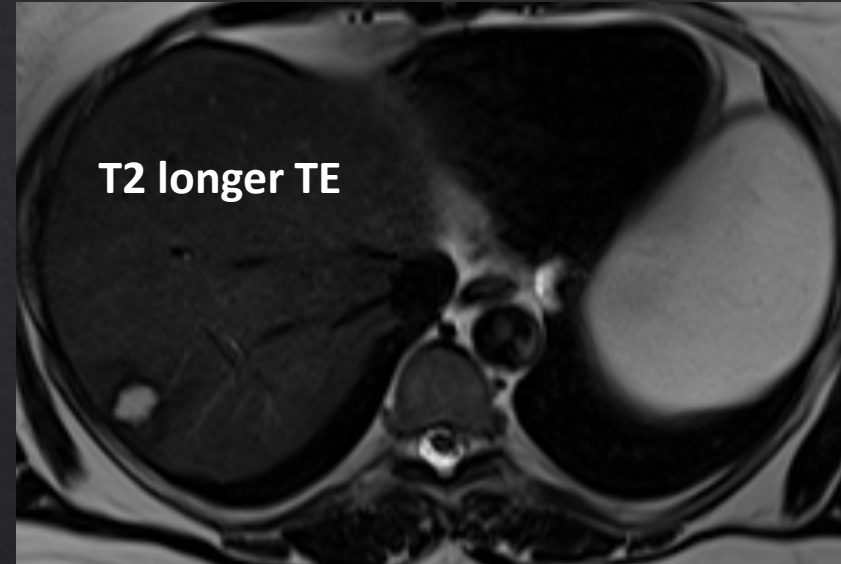
Haemangioma vs mets

Sometimes:

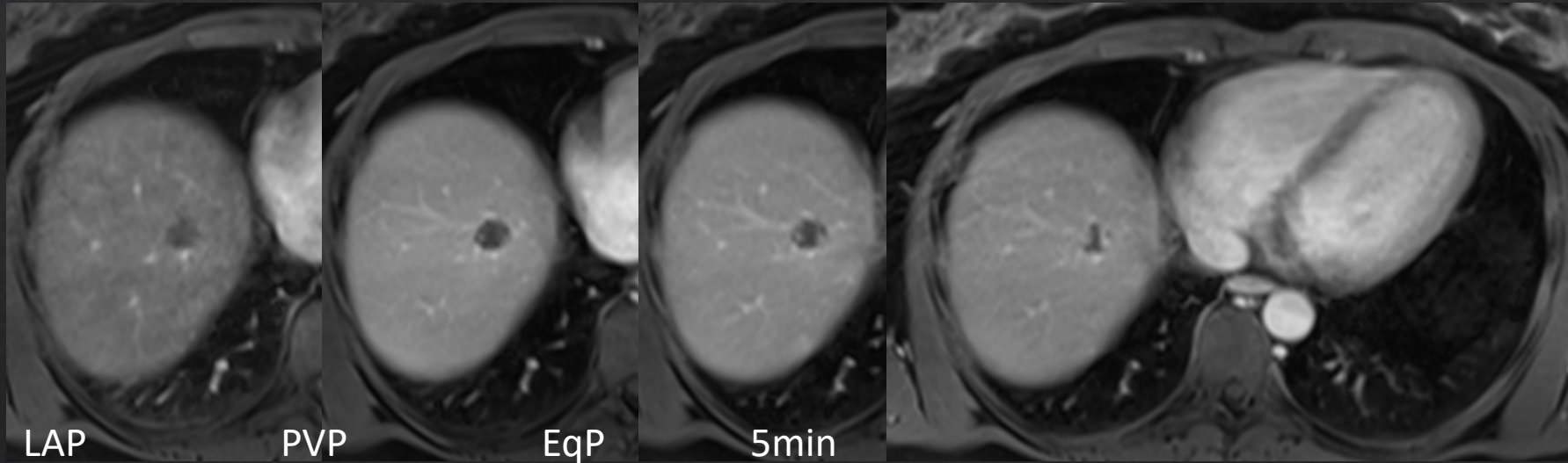
- **Fibrous scar** (heterogeneous T2)
- **Cystic** degeneration
- Pedunculated
- **Flash / slow enhancement**



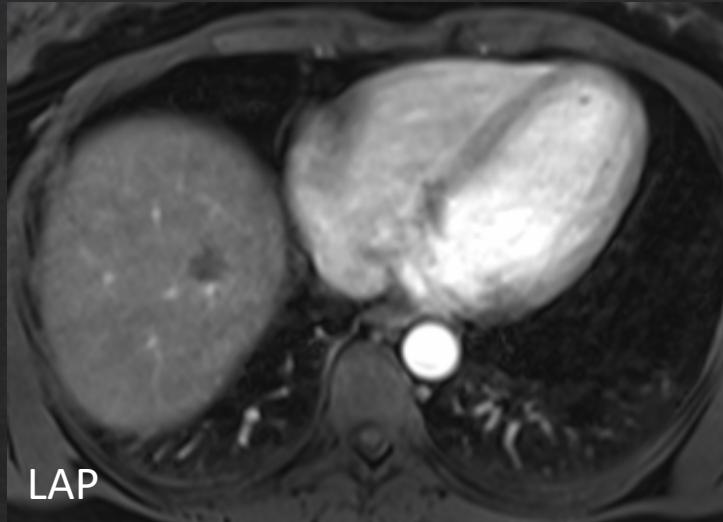
Flash filling haemangioma



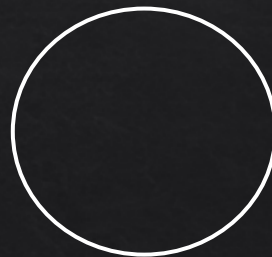
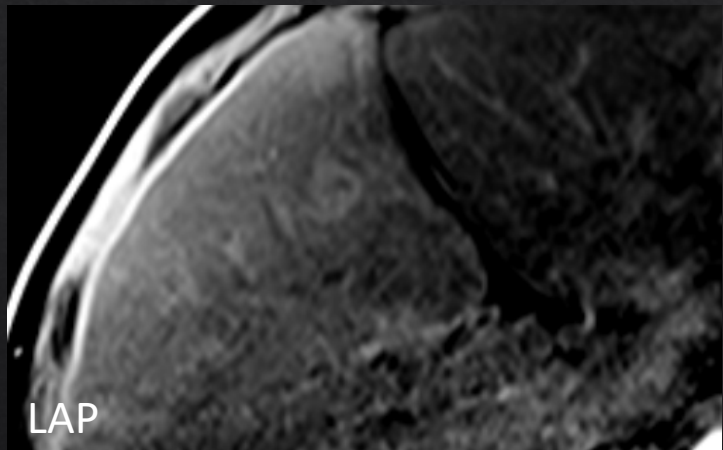
Slow filling haemangioma



Slow filling haemangioma

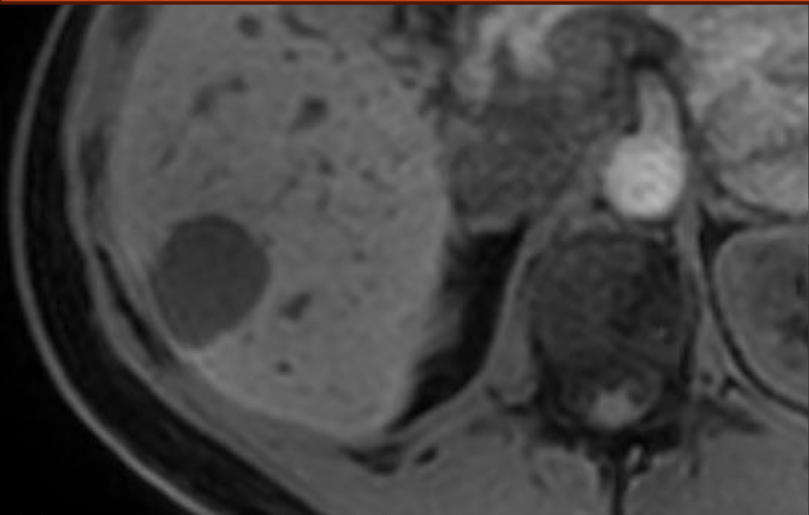


Discontinuous → haemangioma

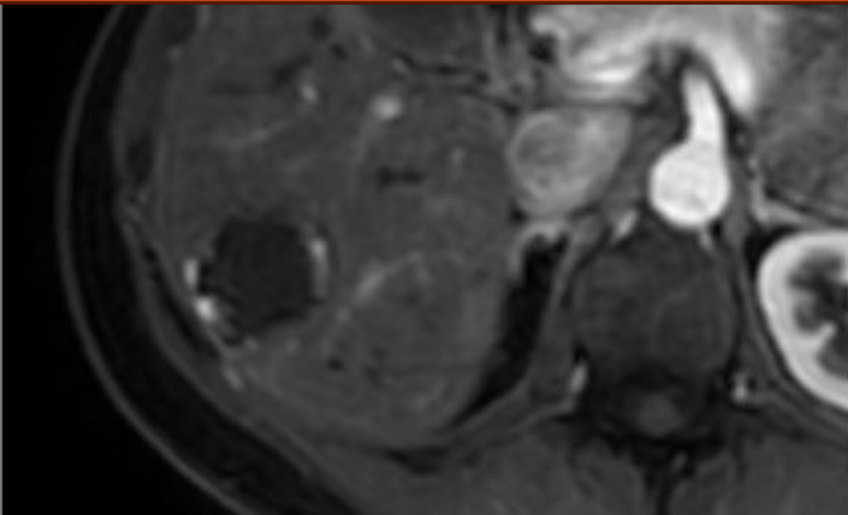


Ring → metastasis

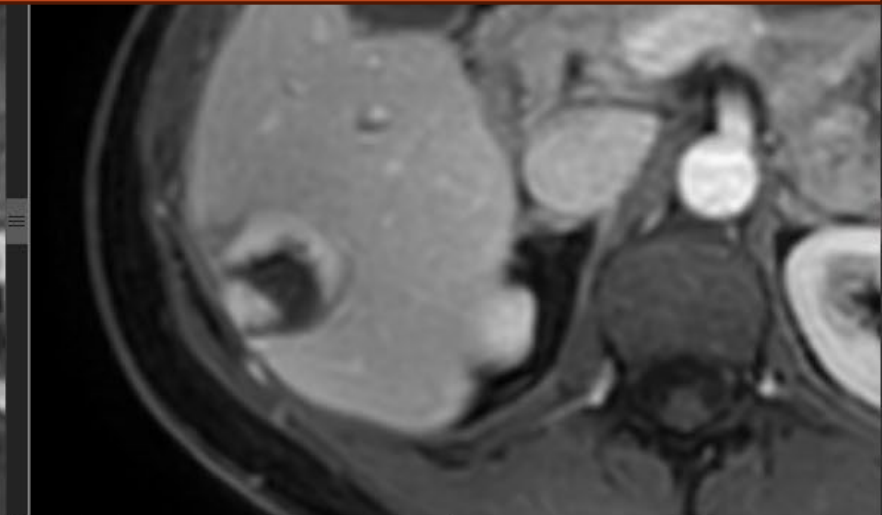
GD-EOB-DTPA - pseudo wash-out



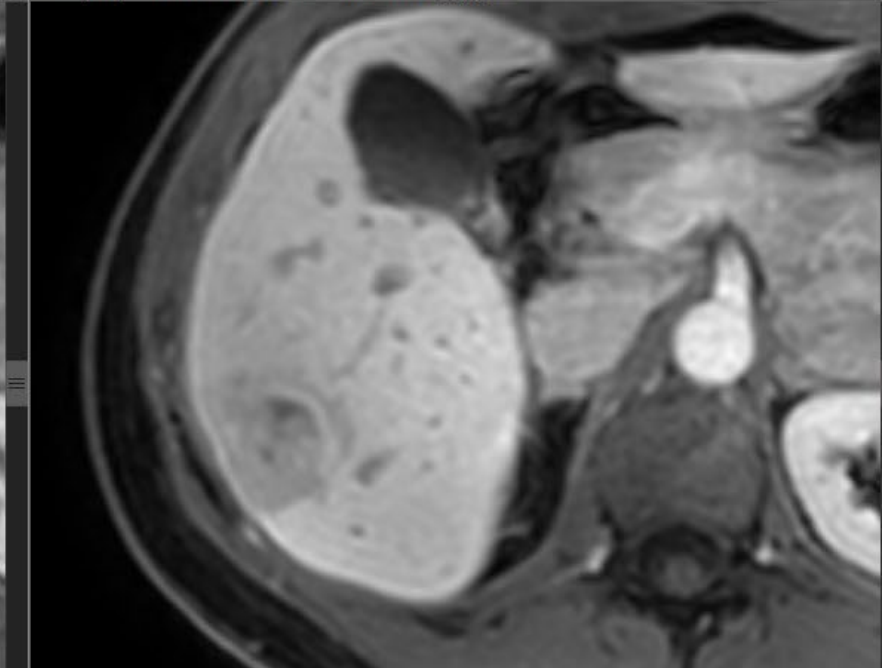
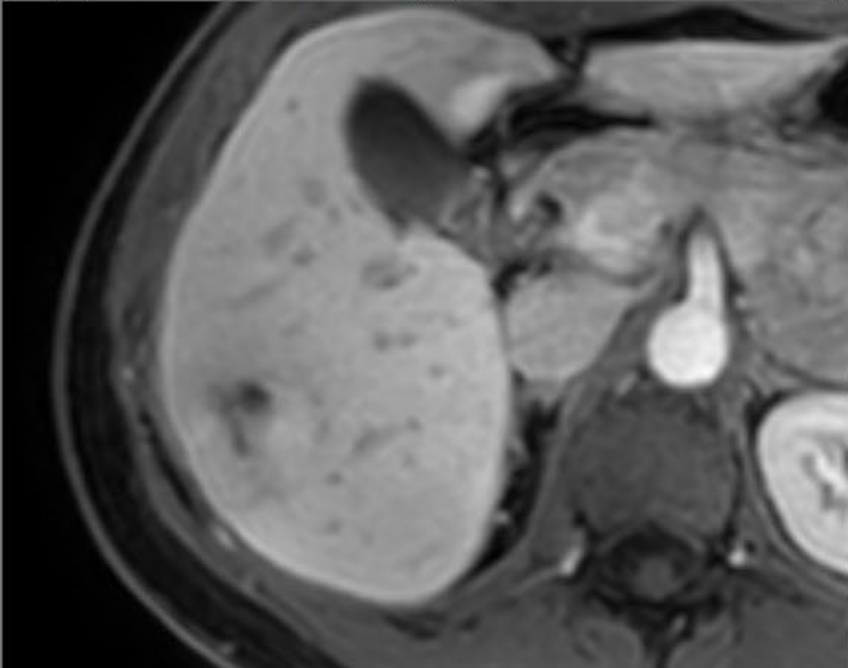
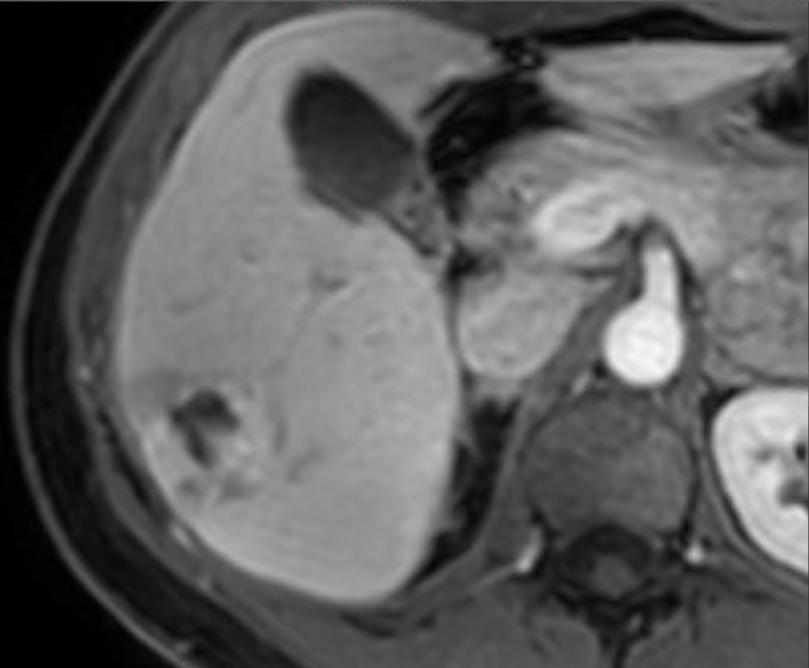
(1.39) - 07.09.2023 12:39:52 - mDIXON-W_dyn_BH



*** (1.39) - 07.09.2023 12:39:52 - mDIXON-W_dyn_BH



*** (1.39) - 07.09.2023 12:39:52 - mDIXON-W_dyn_BH



Haemangioma wash-out appearance

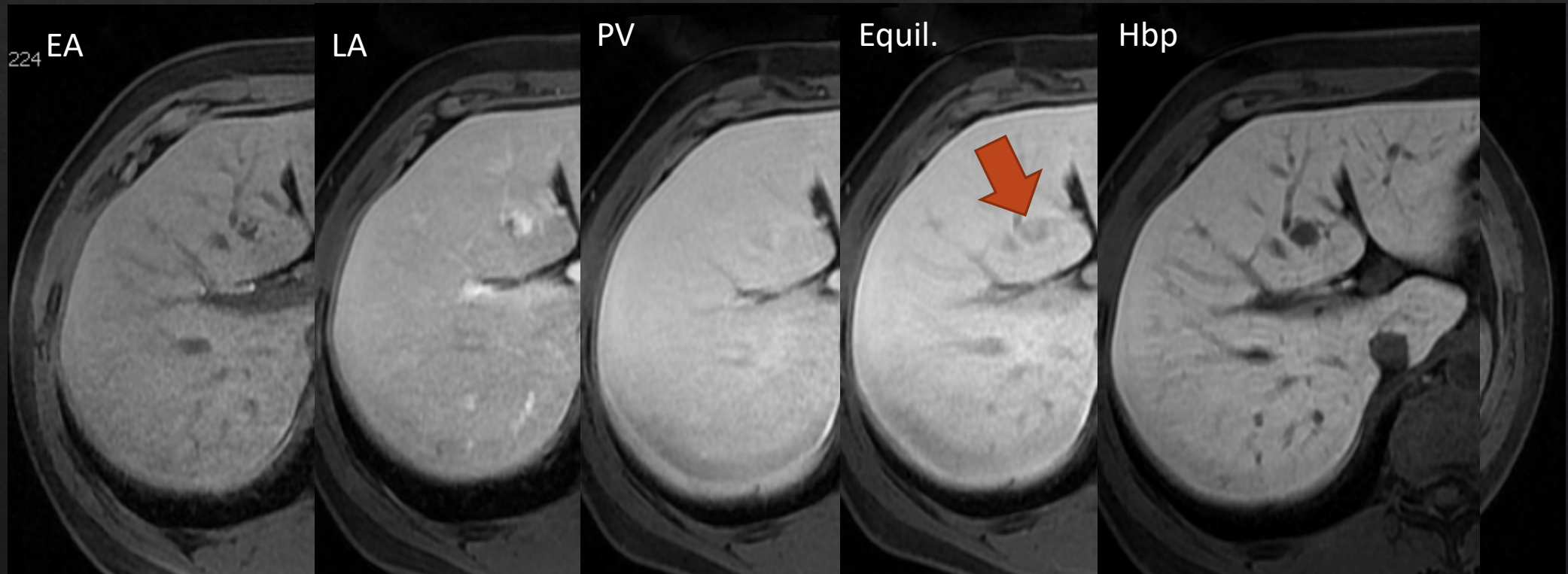
„extended washout sign”

haemangiomas vs metastases

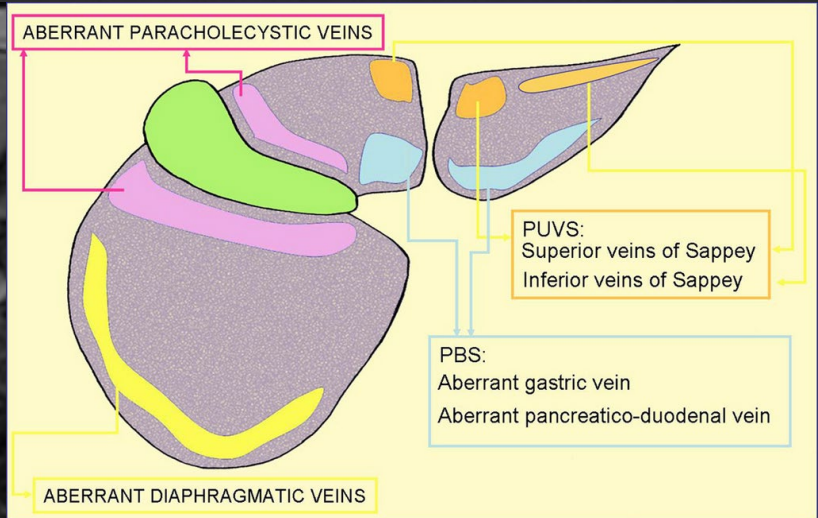
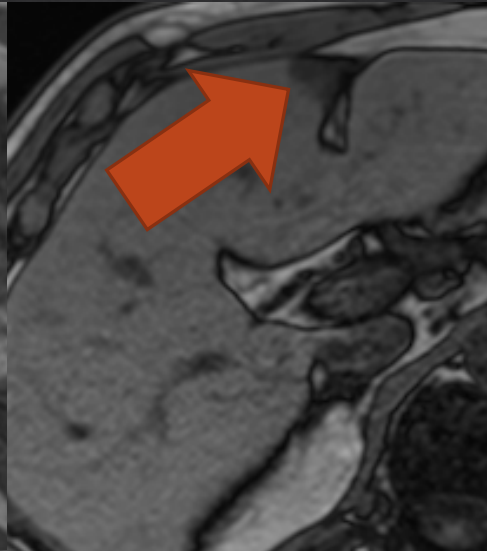
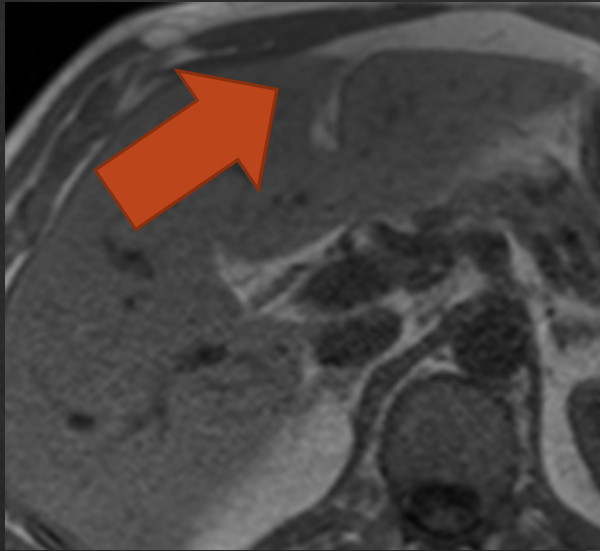
decrease of SI 8-20min over 10%

Agarwal S et al. Eur J Radiol. 2016 Mar;85(3):635-40.

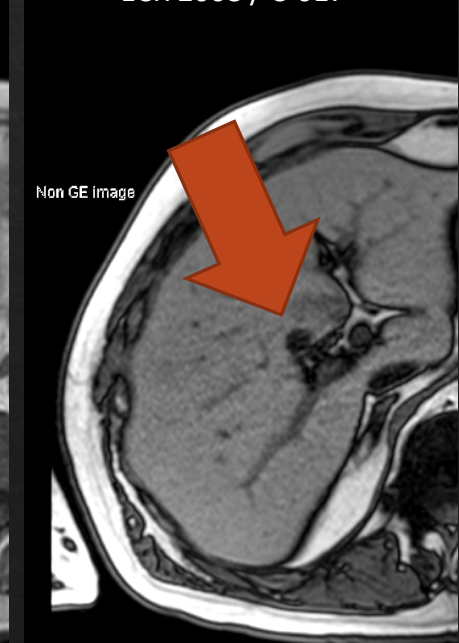
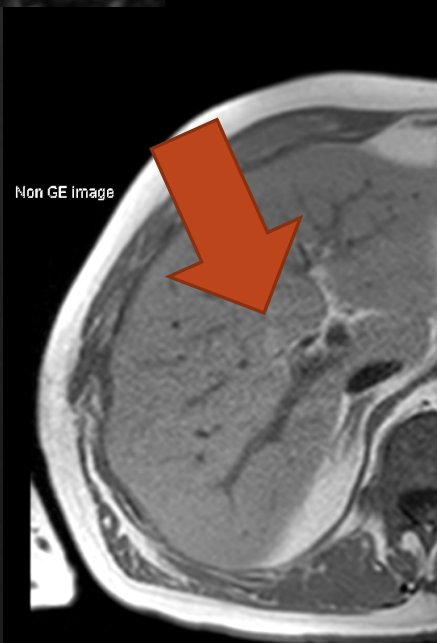
Gd-EOB-DTPA

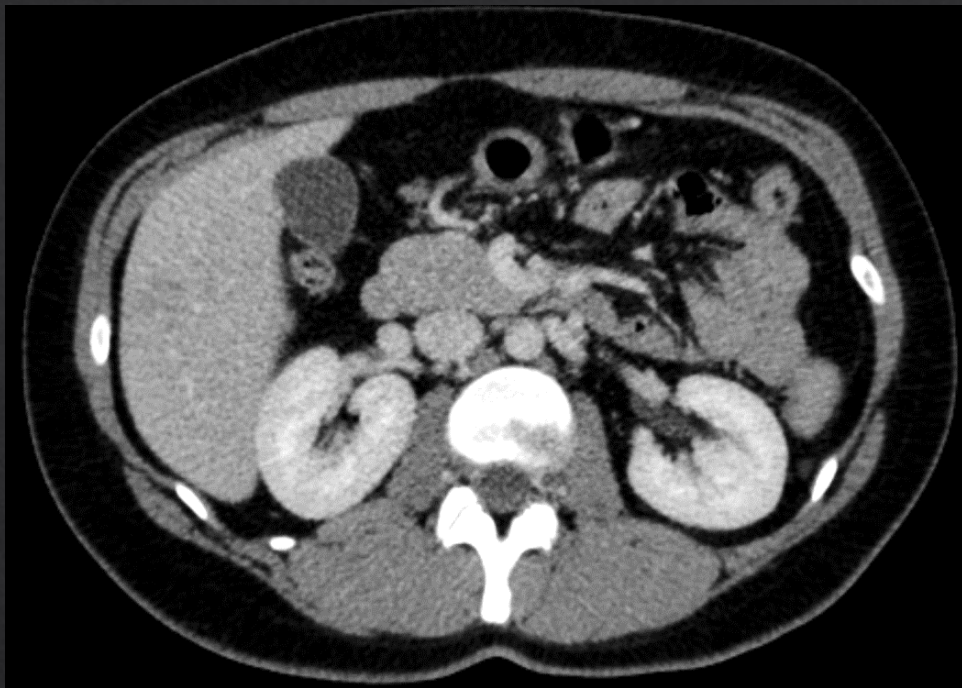


Focal steatosis

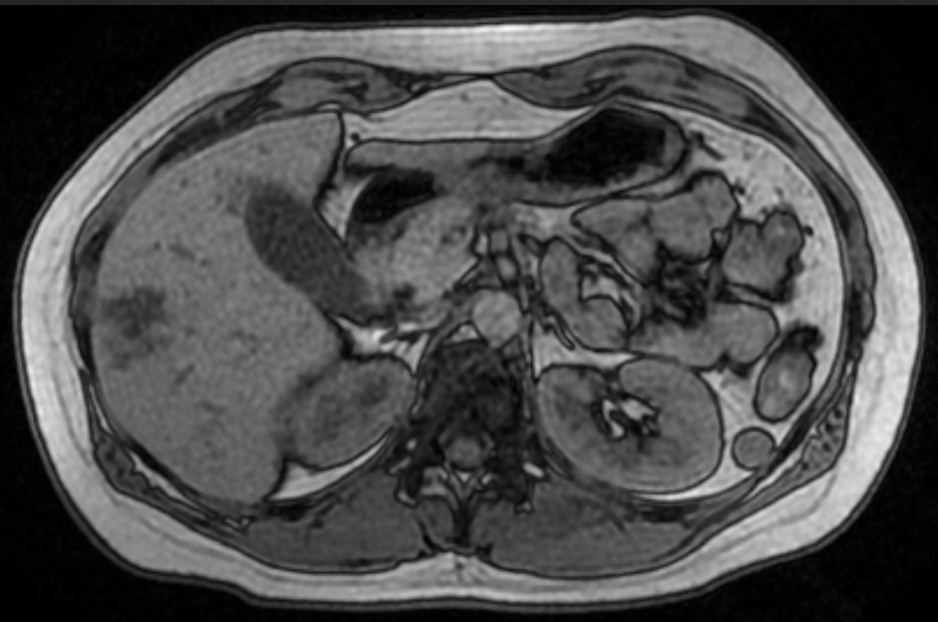
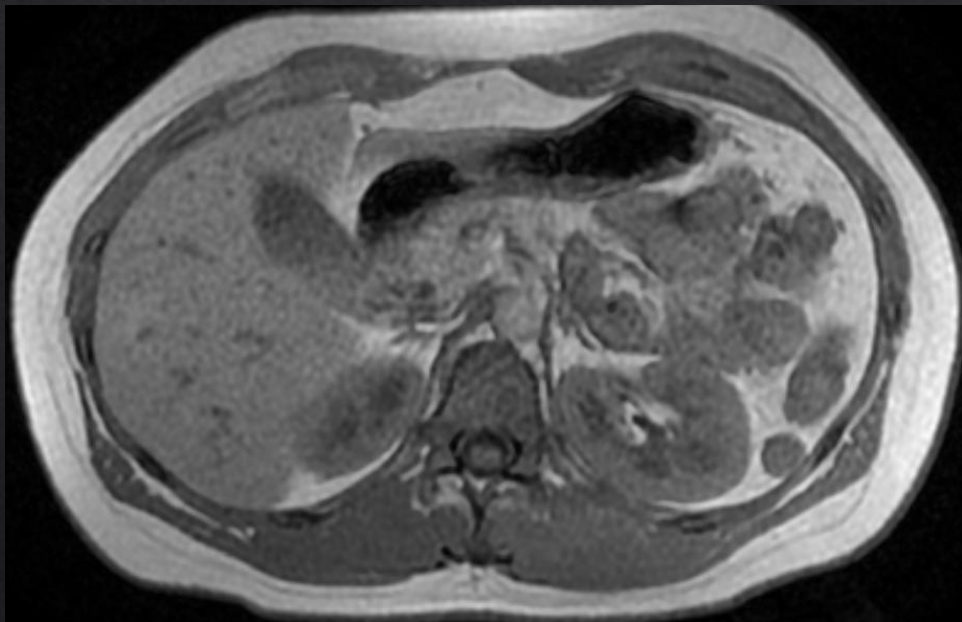


ECR 2008 / C-017

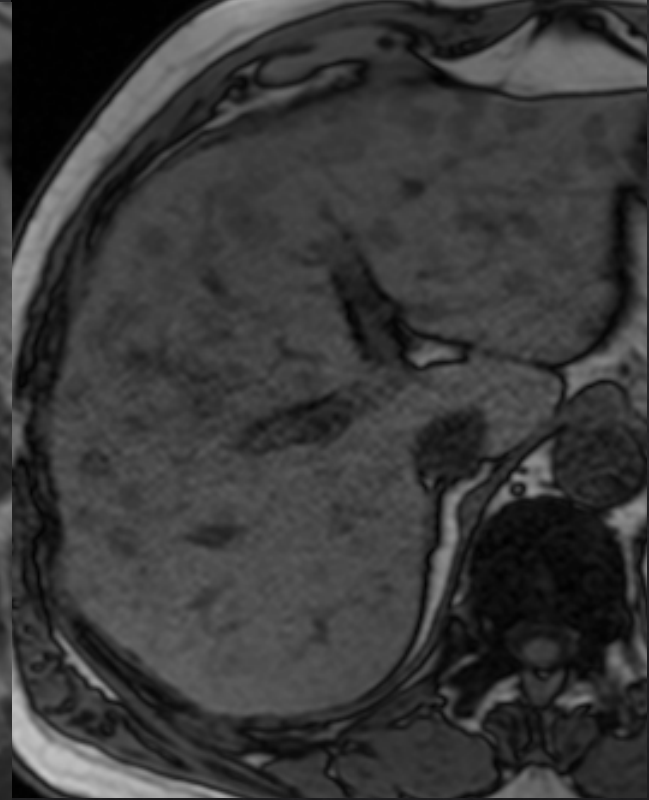
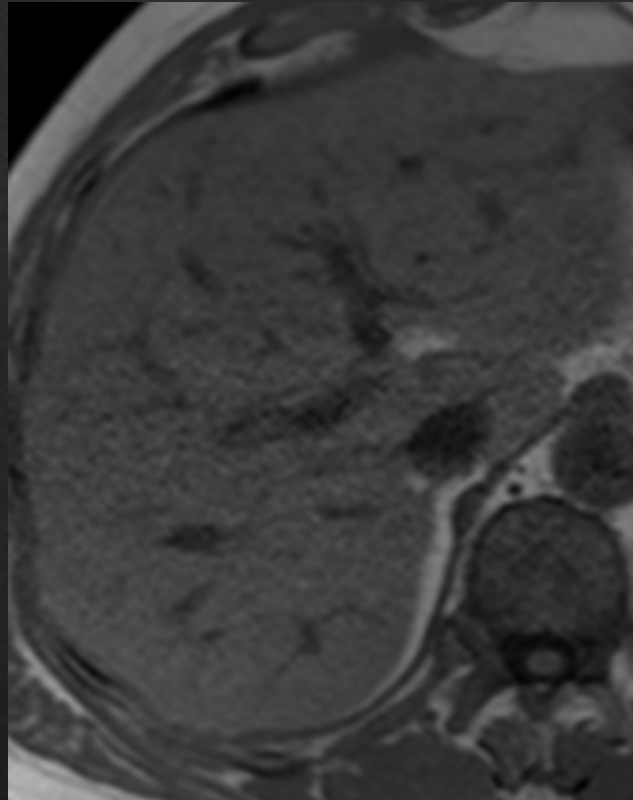




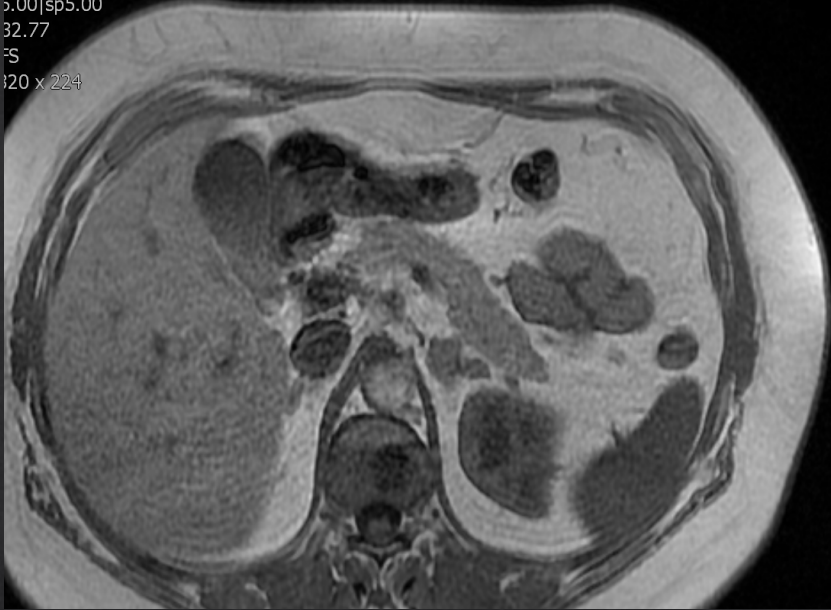
Focal steatosis



Focal steatosis

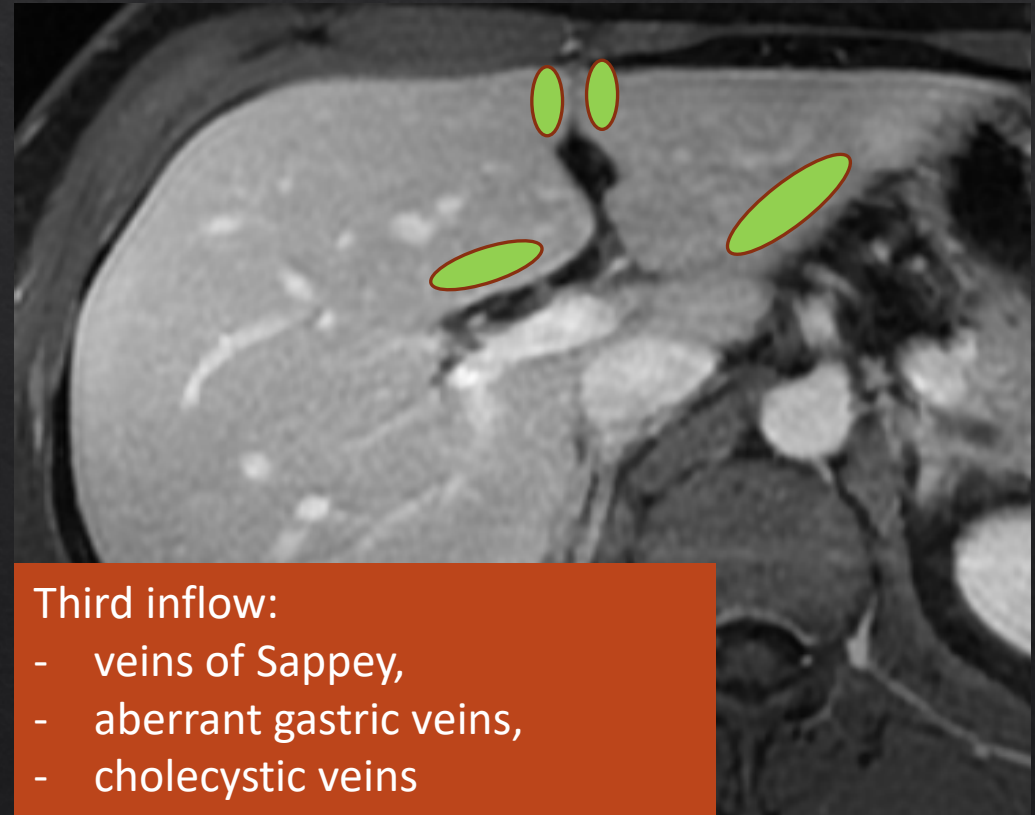
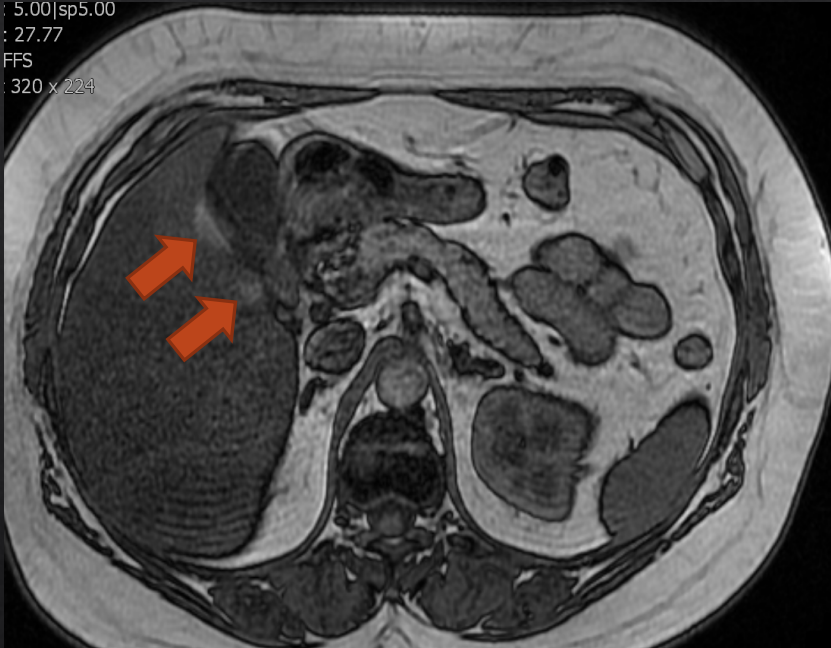


5.00|sp5.00
32.77
FS
320 x 224



Focal fatty sparing

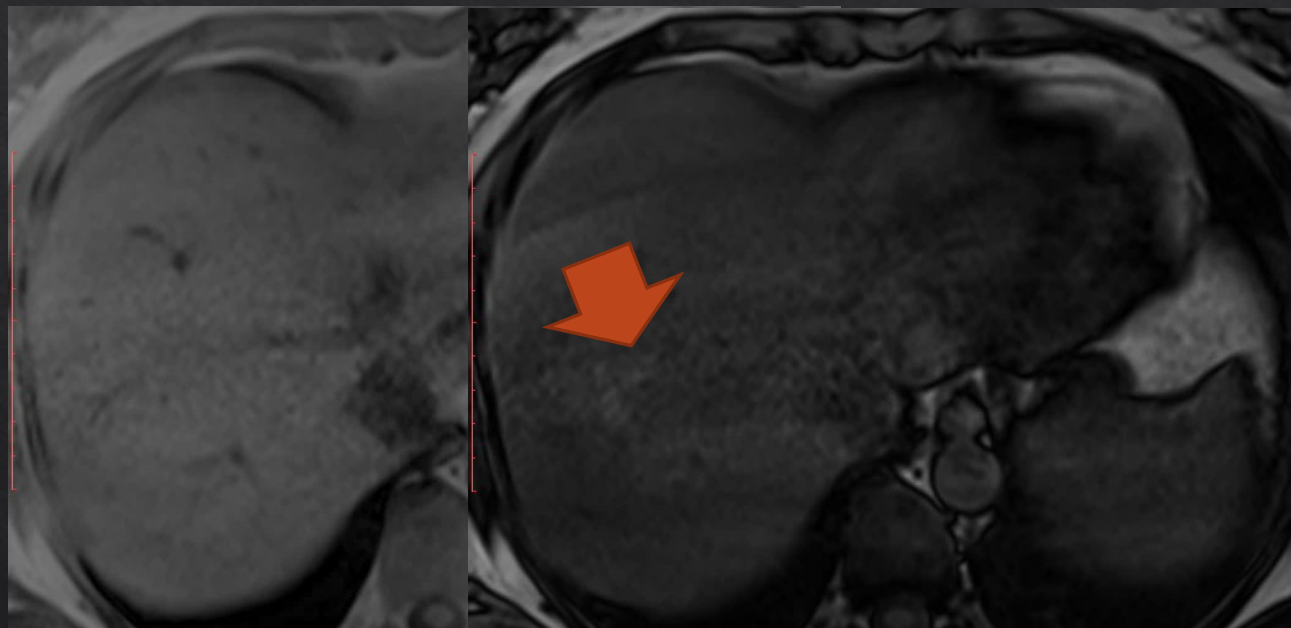
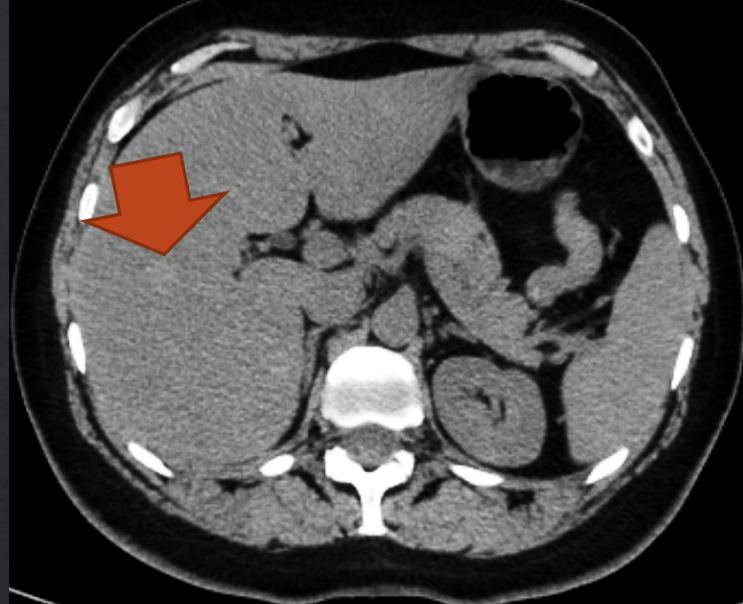
5.00|sp5.00
27.77
FFS
320 x 224



Third inflow:

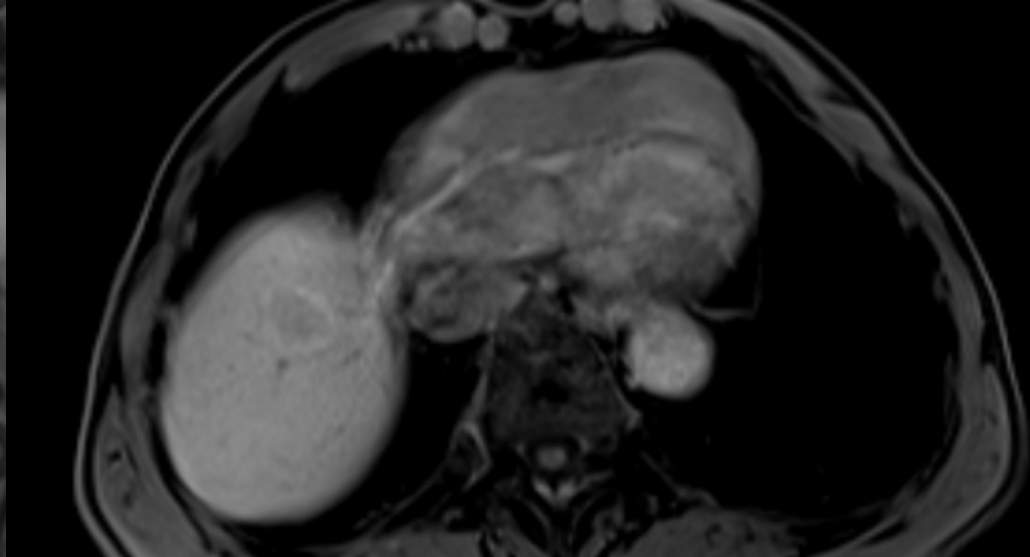
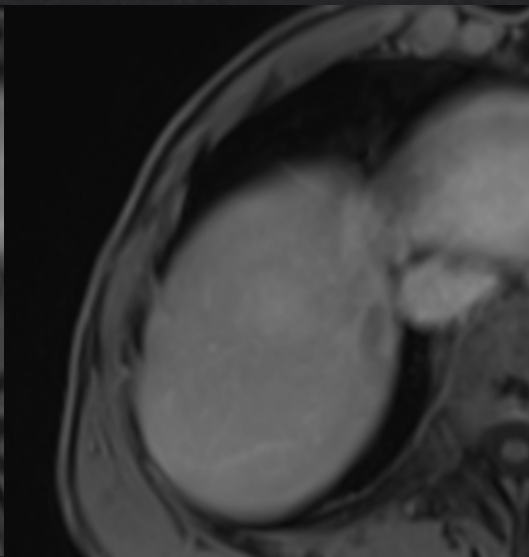
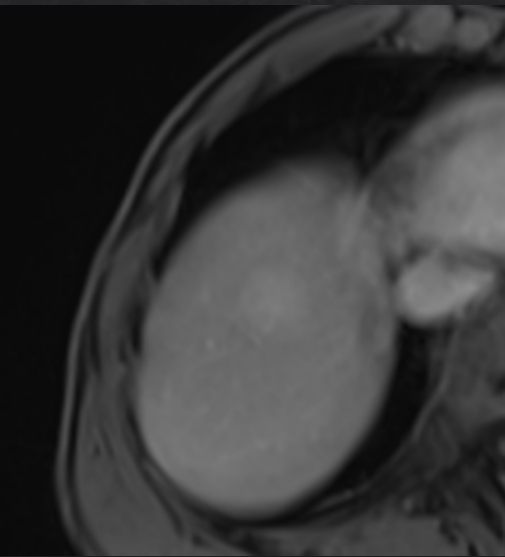
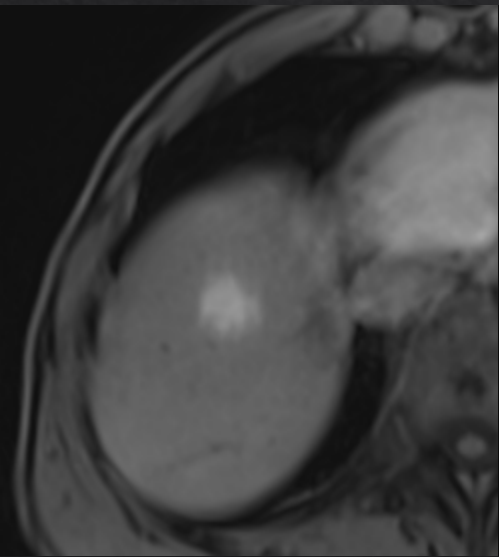
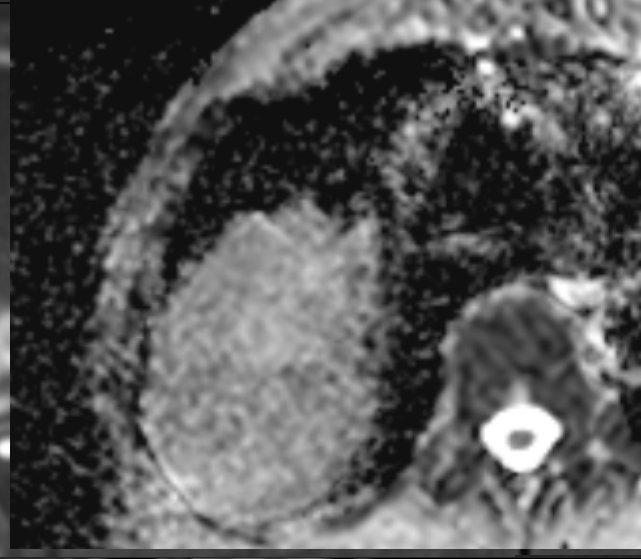
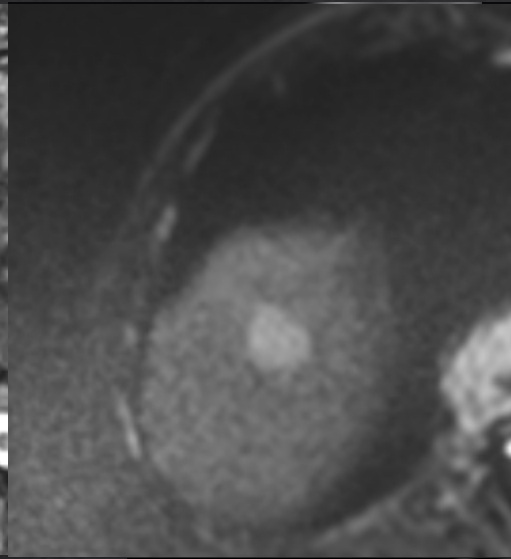
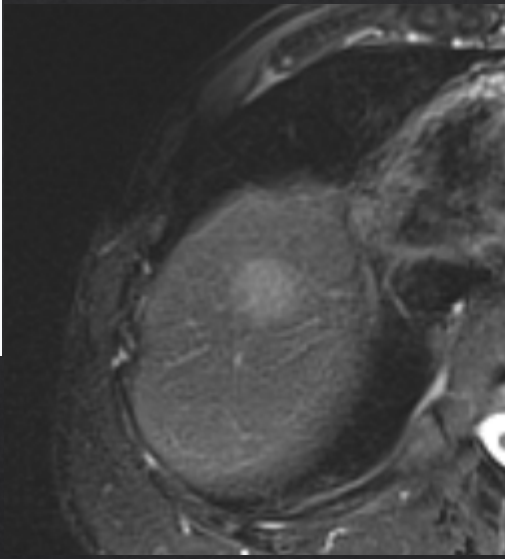
- veins of Sappey,
- aberrant gastric veins,
- cholecystic veins

Focal fatty sparing



27.05.2024

Two suspicious lesions in the liver, approximately 2 cm in diameter - segment 4b and 8/7, visible in CT and MRI. Please re-evaluate with hepatotropic contrast. In 2014, he underwent anterior resection of the rectum due to cancer, pT1N1B.

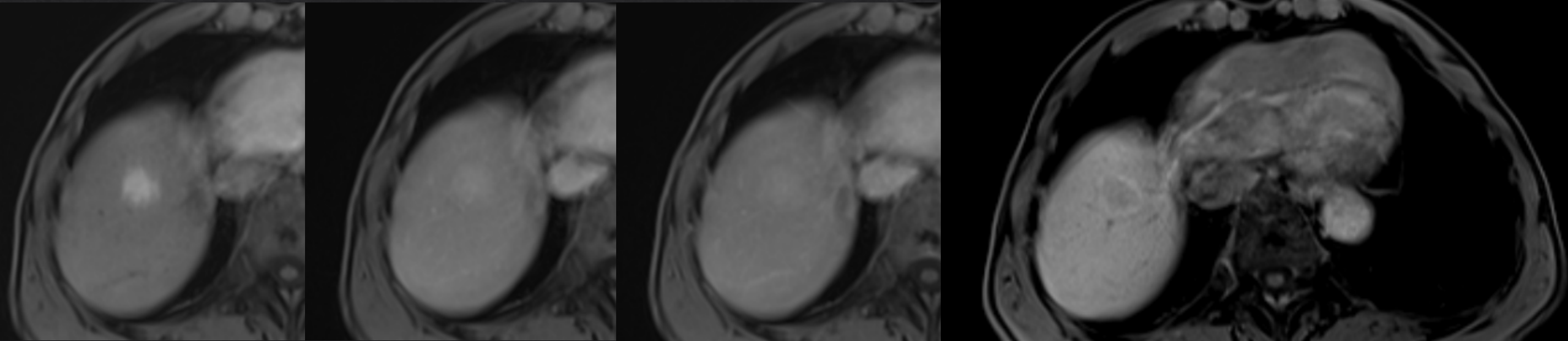
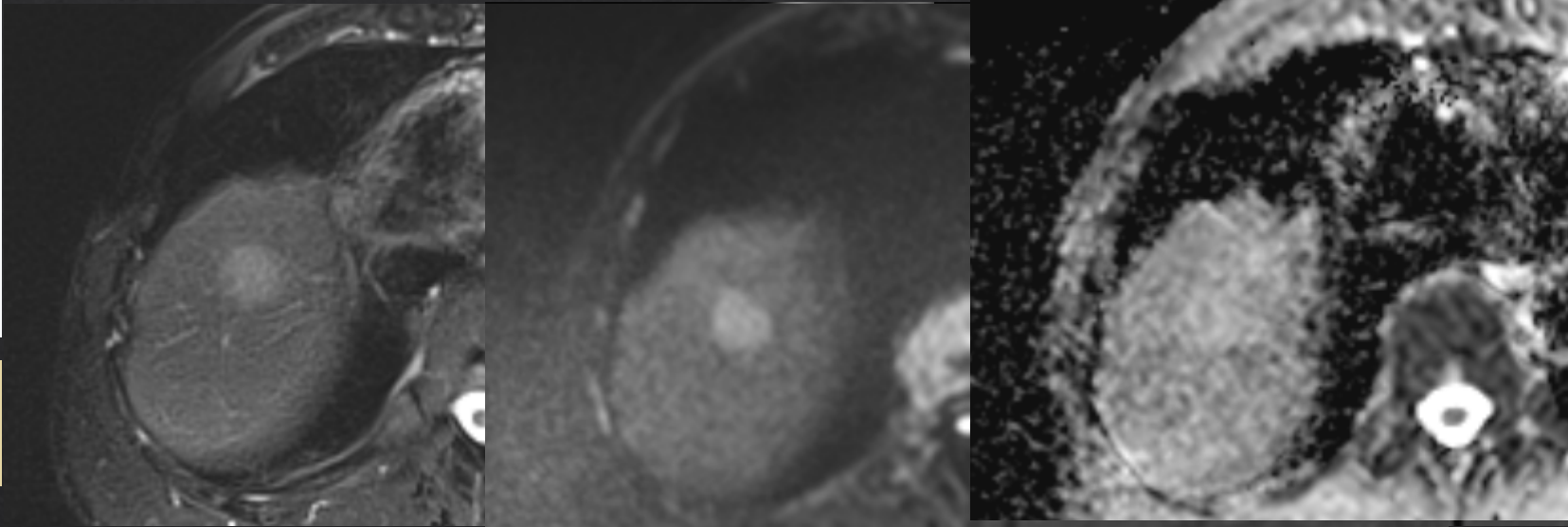


27.05.2024

Two suspicious lesions in the liver, approximately 2 cm in diameter - segment 4b and 8/7, visible in CT and MRI. Please re-evaluate with hepatotropic contrast. In 2014, he underwent anterior resection of the rectum due to cancer, pT1N1B.

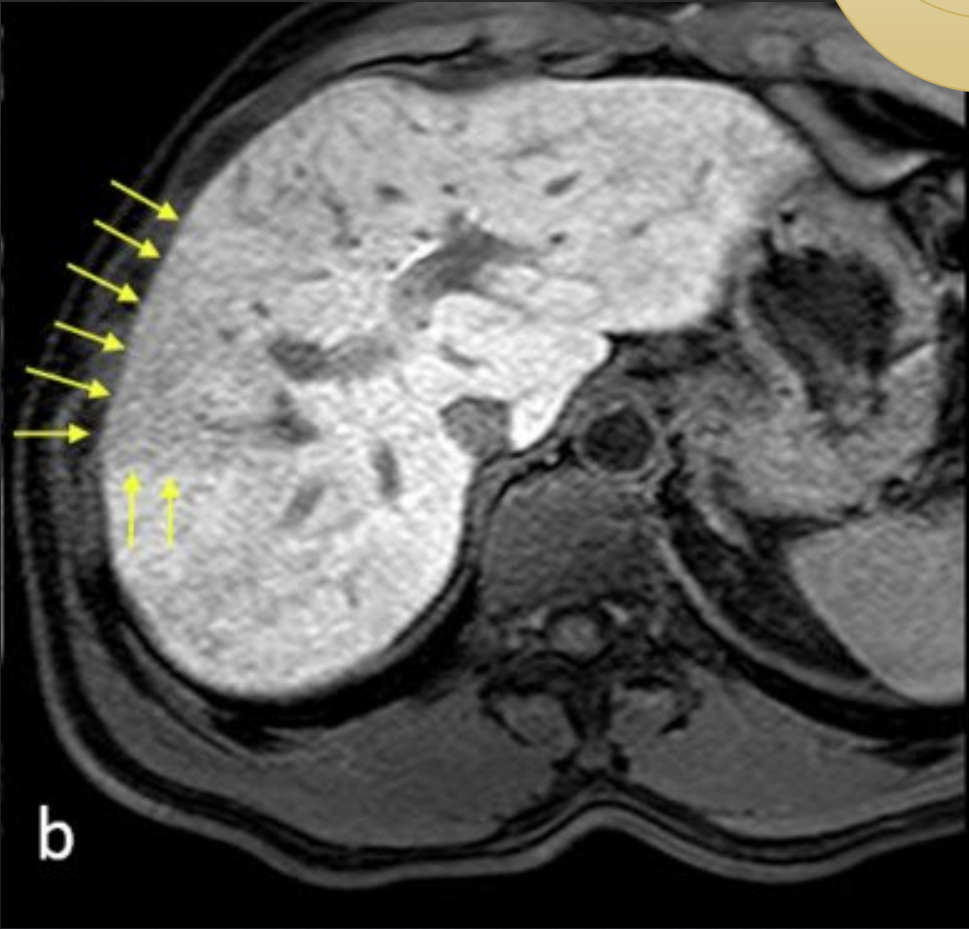
In 2015 chemo Folfox
After no recurrent disease

FNH-like lesion





Sinusoidal obstruction syndrome (SOS)

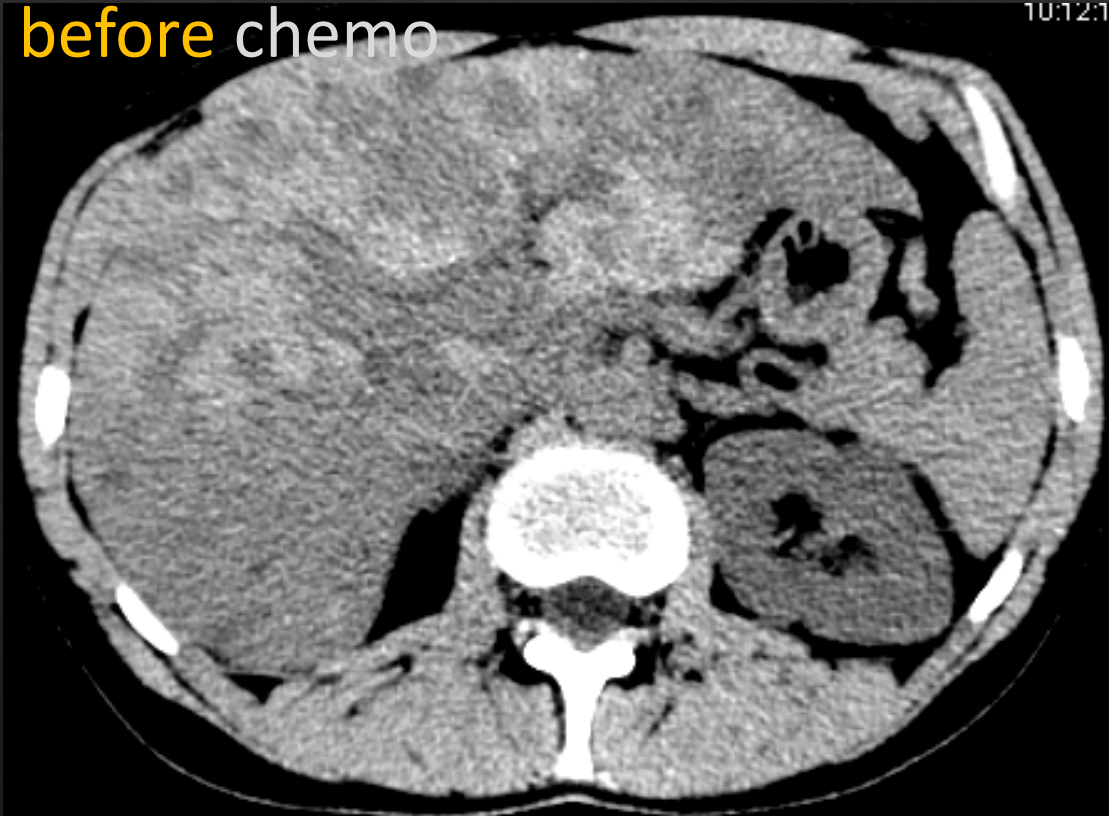


DOI: 10.1594/ecr2018/C-0327

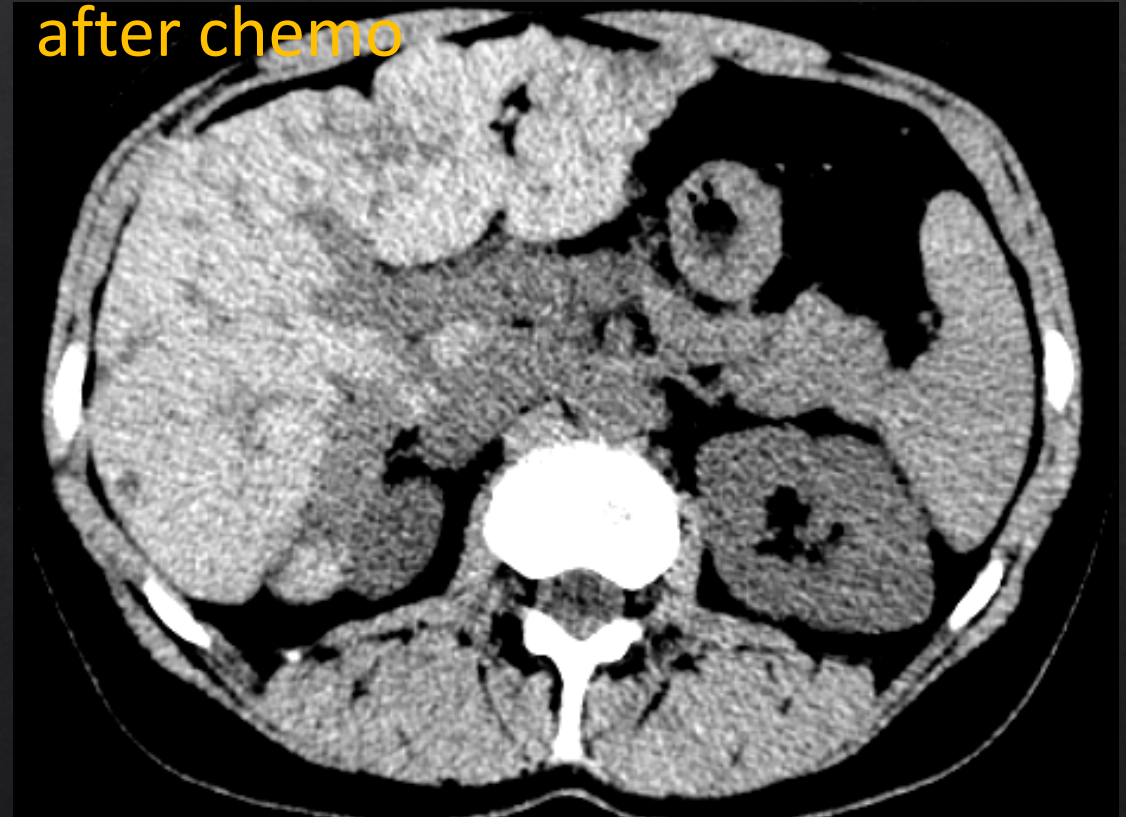
Pseudocirrhosis

Breast cancer mets

before chemo



after chemo



Curtesy of dr J Pałucki

Uncommon

- ◇ Solitary necrotic nodule
- ◇ Nodular elastosis
- ◇ Inflammatory pseudotumour
- ◇ Focal eosinophylic infiltration
- ◇ Granuloma

Thank you