



Nasjonalt Senter for Gastroenterologisk Ultrasonografi

National Centre for Ultrasound in Gastroenterology
Haukeland University Hospital, Bergen, Norway

Ultrasound of diffuse and focal liver diseases

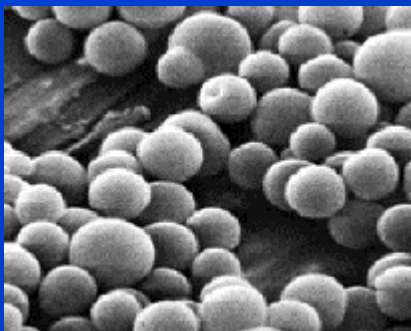
Odd Helge Gilja, MD, PhD

Professor

Department of Medicine

Haukeland University Hospital

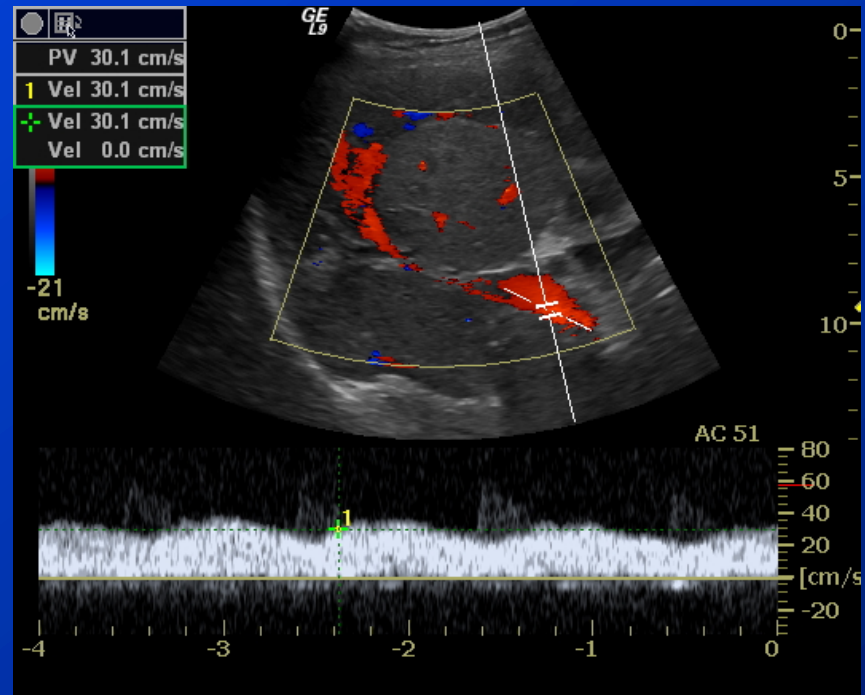
Bergen, Norway





The Ultrasound Tool-box

- Ultrasound of liver
 - B mode
 - B-Flow
 - Doppler
 - Color Doppler
 - Pulsed Doppler
 - Elastography
 - Strain imaging
 - Shear wave
 - Contrast-US (CEUS)
- US-guided liver biopsy (Menghini and Pistol)
- US-guided ablation techniques
- Sonoporation therapy

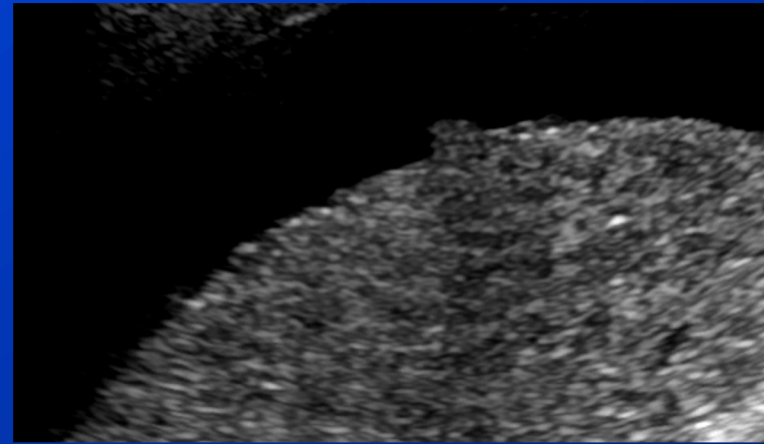




Ultrasound of the Liver

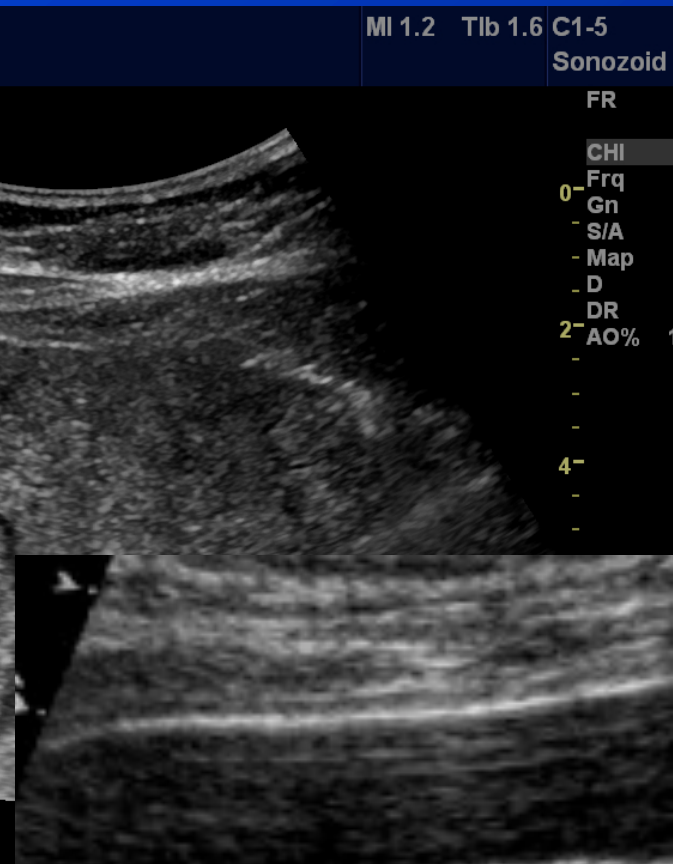
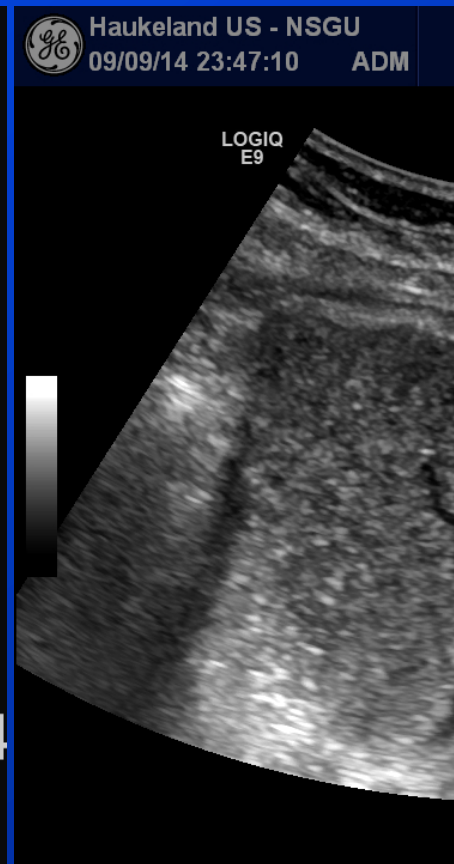
-What do we look for ?

- Echogenicity
- Size, capsule and form
- Any lesions?
- Liver veins
- Portal vein
- Arteria hepatica
- Intrahepatic bile ducts





The Liver capsule



Normal

Cirrhosis

Use high frequency (9-12 MHz)



Vena Porta

GE Haukeland US 09/29/10 09:20:35 ADM MI 1.2 Tls 1.7 C1-5 GASTRO

FR 24

CHI

0-Frq 5.0

Gn 64

-S/A 1/1

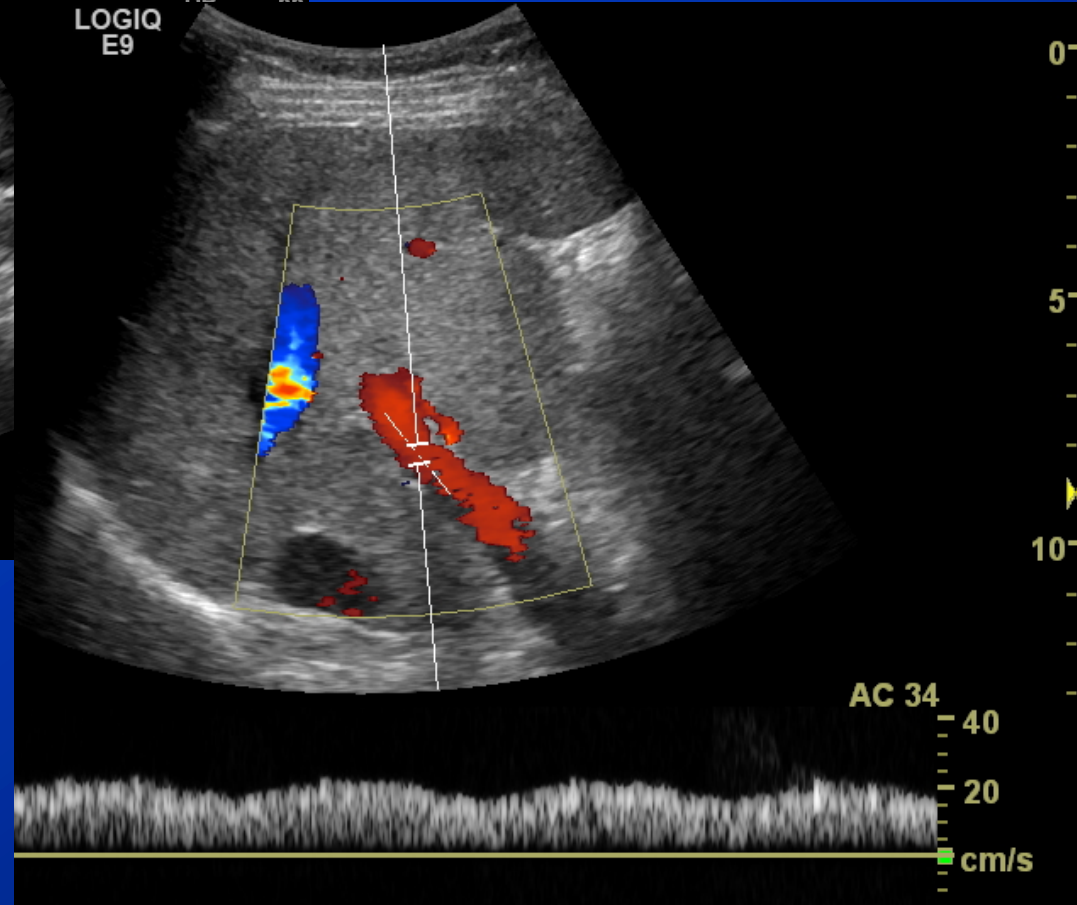
Map F/1

-D 12.0

DP 66

LOGIQ
E9

LOGIQ
E9



AC 34

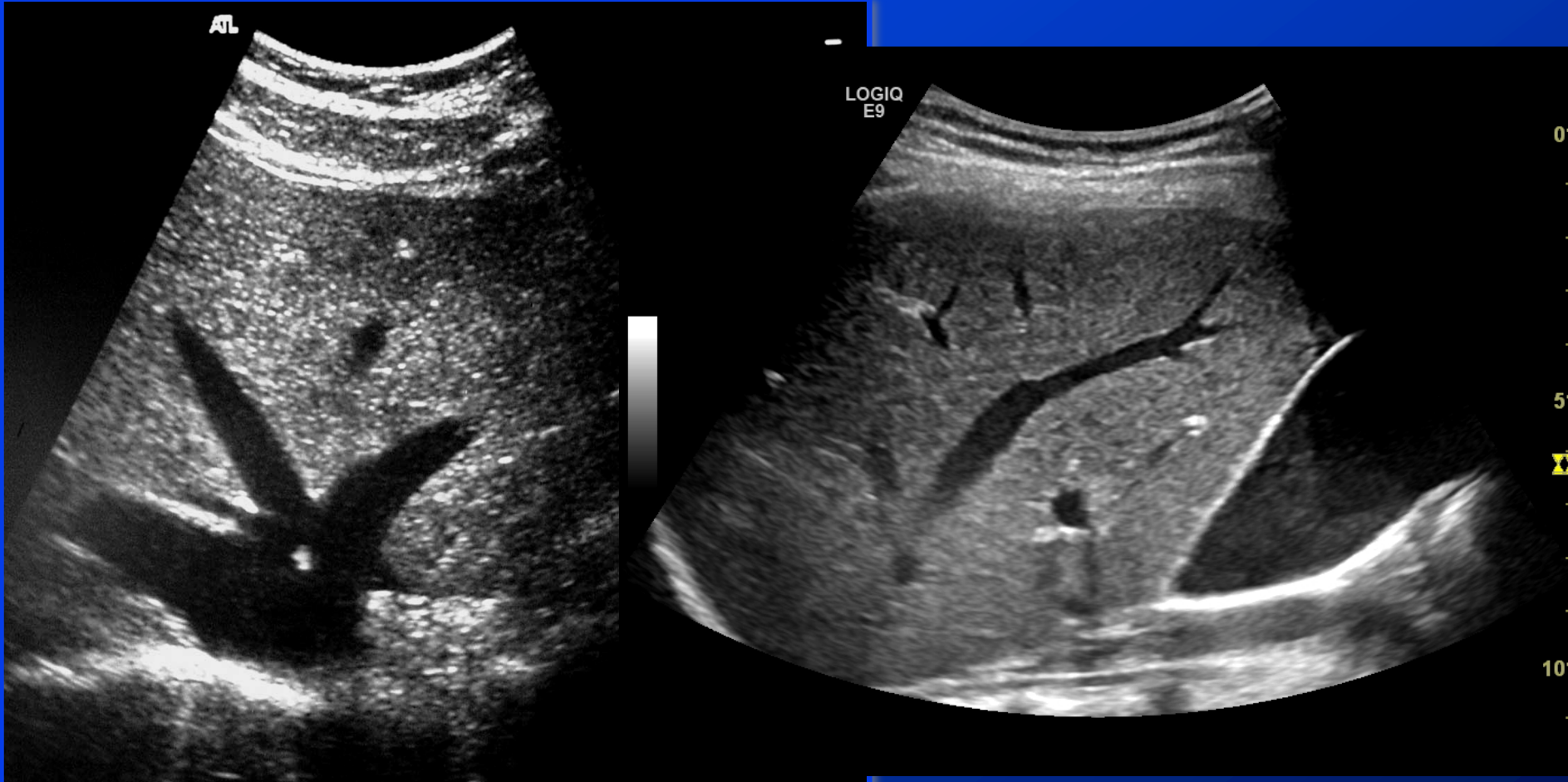
40

20

cm/s

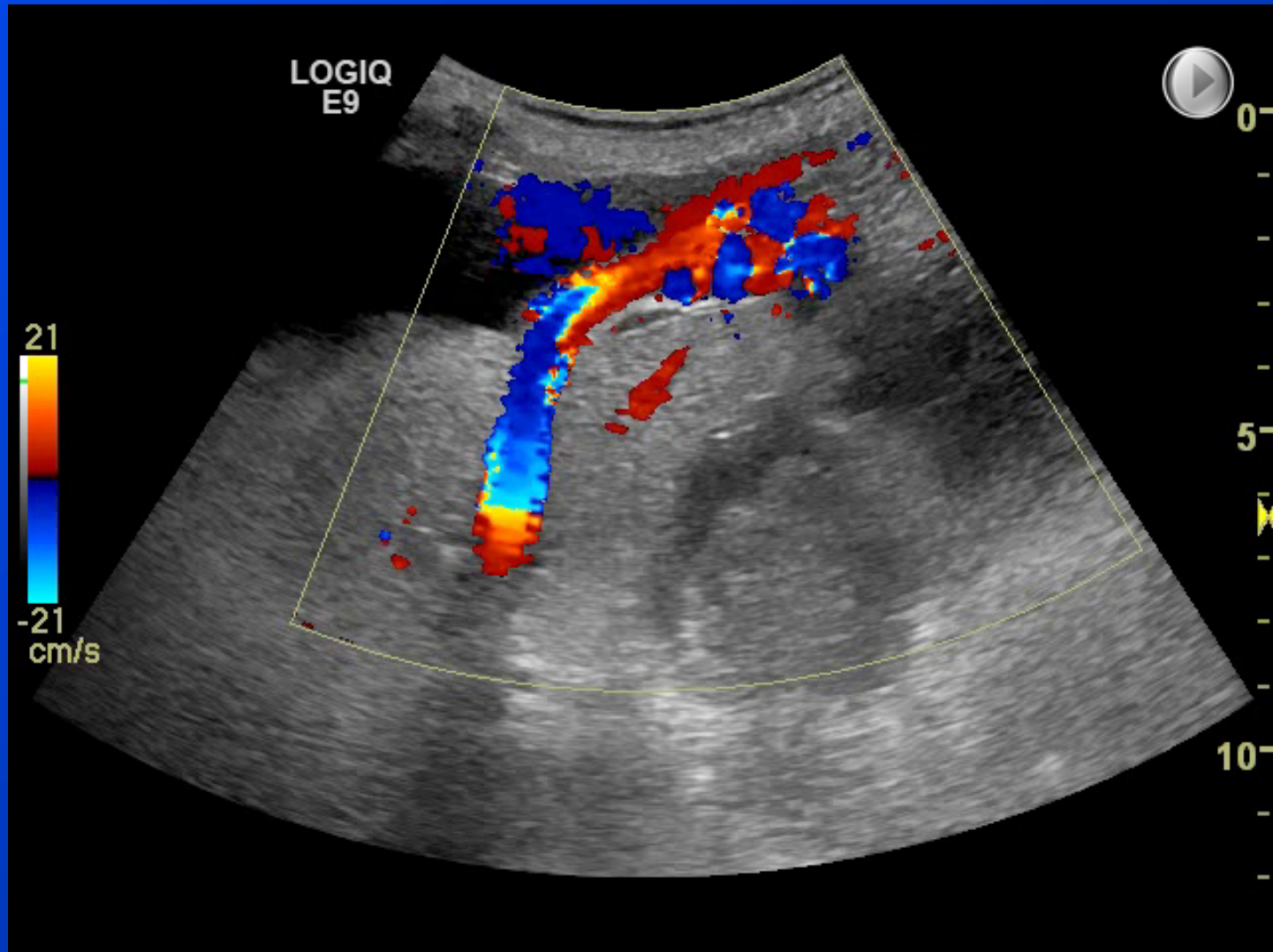


The hepatic veins





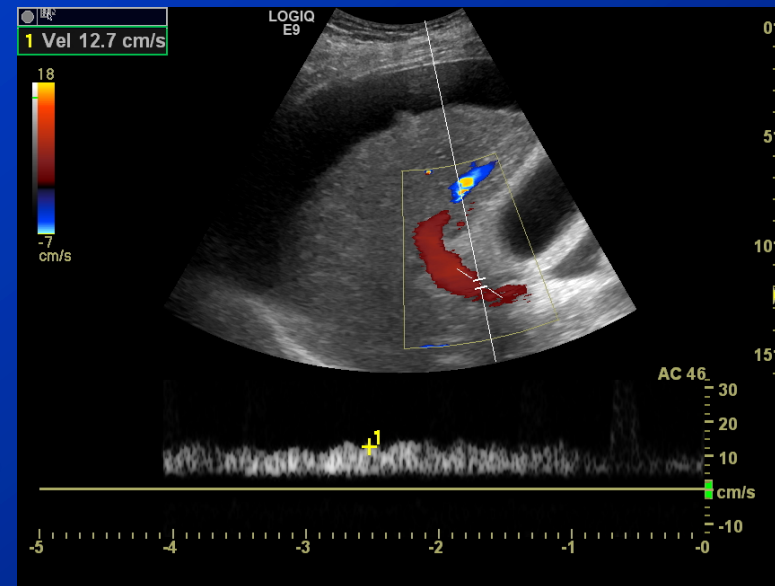
Doppler is useful !





US better than CT

- Small and complex cysts
- Flow evaluation
 - Portal vein thrombosis
 - Budd-Chiari
- Cirrhosis evaluation
 - Global liver assessment
 - Portal HT
 - TIPS





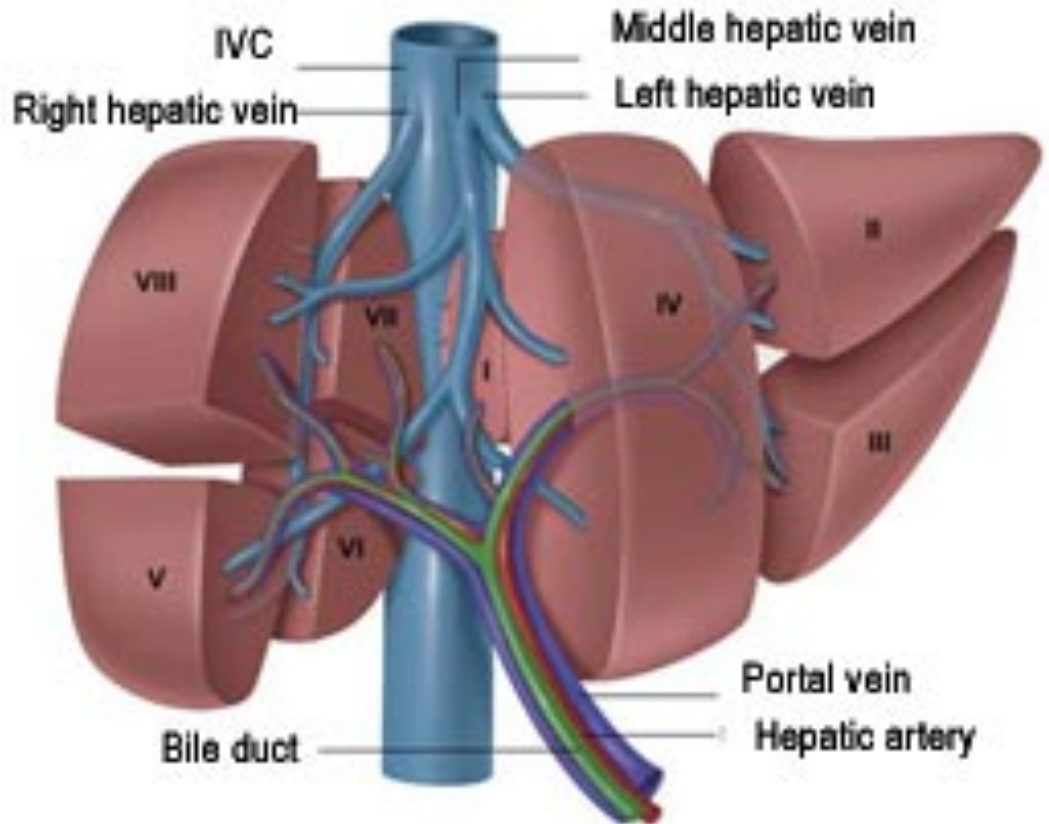
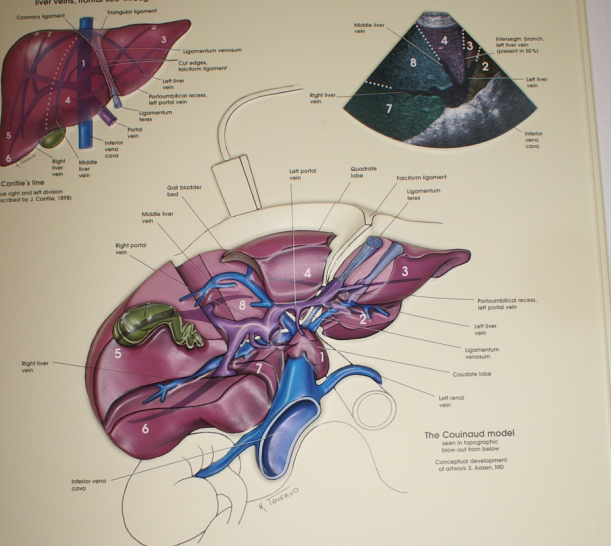
Segmentation of the liver

THE LIVER SEGMENTS

Defined by the portal branching and the liver veins

Interdigitation between portal branches and liver veins, frontal view-through

Transverse ultrasound scan, segment borders defined by the liver veins



The liver's eight-segment division. Patients undergoing surgery for liver cancer will have a section(s) of their liver removed in which the tumor(s) resides. Following surgery, this section grows back.



SCHERING

Ultravist

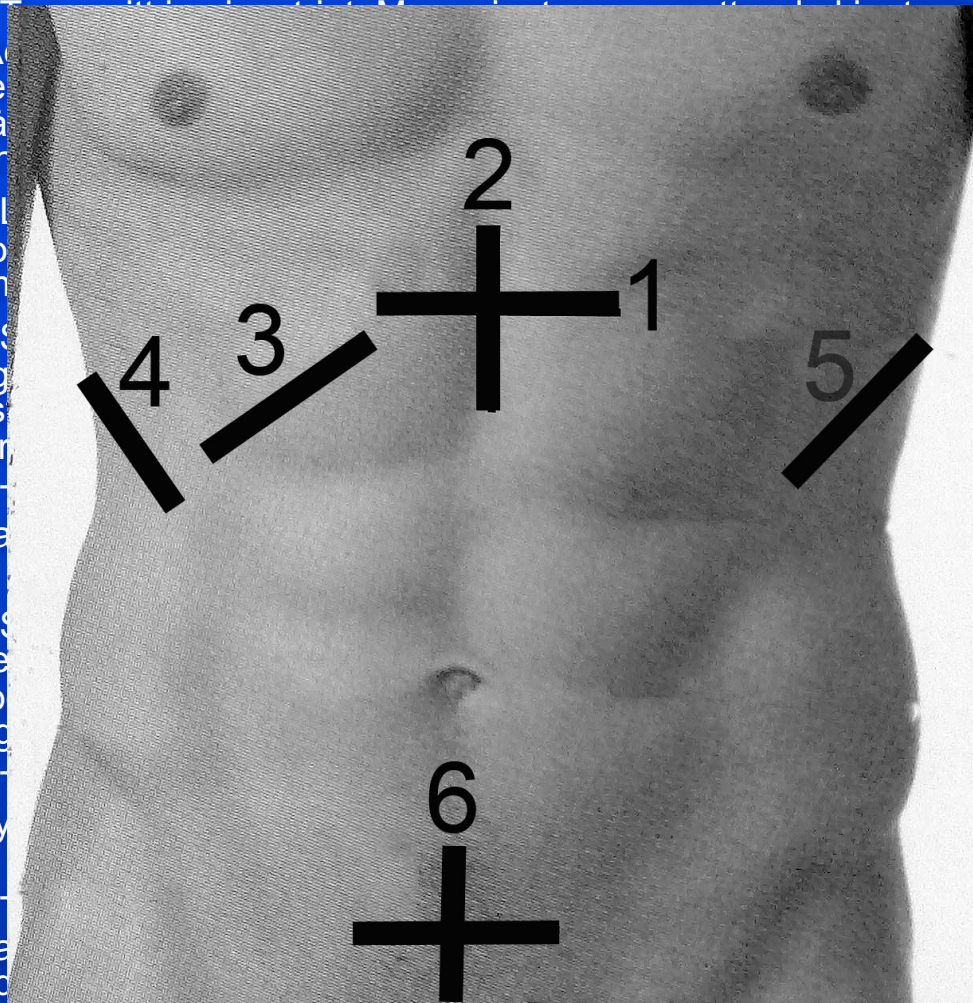
Levovist



6+

A systematic examination of abdominal organs

- **Stasjon 1** Tilstedeværelse av anatomiske landemerker: Areolarer, navel, etc. Man skanner systematisk gjennom hele buken til å puste dypt inn for å få en god oversikt. 2 glass vann å drikke kan noen ganger være nyttig.
 - **Stasjon 2** I lengderetning og i tværretning (antrum) i sammenheng med den avgående kar i mesenteriet og mesosekken.
 - **Stasjon 3** Som gjør at man noen ganger undersøkelse fast vinkling og interkostalt.
 - **Stasjon 4** Lydhodet og skalleintercostalt.
 - **Stasjon 5** Slik lokaliserer milten, nyre fra pol til pol, venstre flanke og høyre flanke.
 - **Stasjon 6** Urinblæren er fylt og sees.
 - **Stasjon +** for å se etter "tarm" og identifisere og retning ned til sigmoideum.
- atomiske
er. Man skanner
ten til å puste
2 glass vann å
avgående kar i
gesekken
som gjør at
tilfelle
subcostal
on og grep om
lflaten samt
venstre flanke og
n fremstilling av
te kunne sees fra
økes best når
a som regel
ning av tarmer
øyre fossa iliaca
becum og i distal





Stasjon 2 – Ve. lobe



Haukeland US / NSGU
01/17/18 10:58:06

ADM

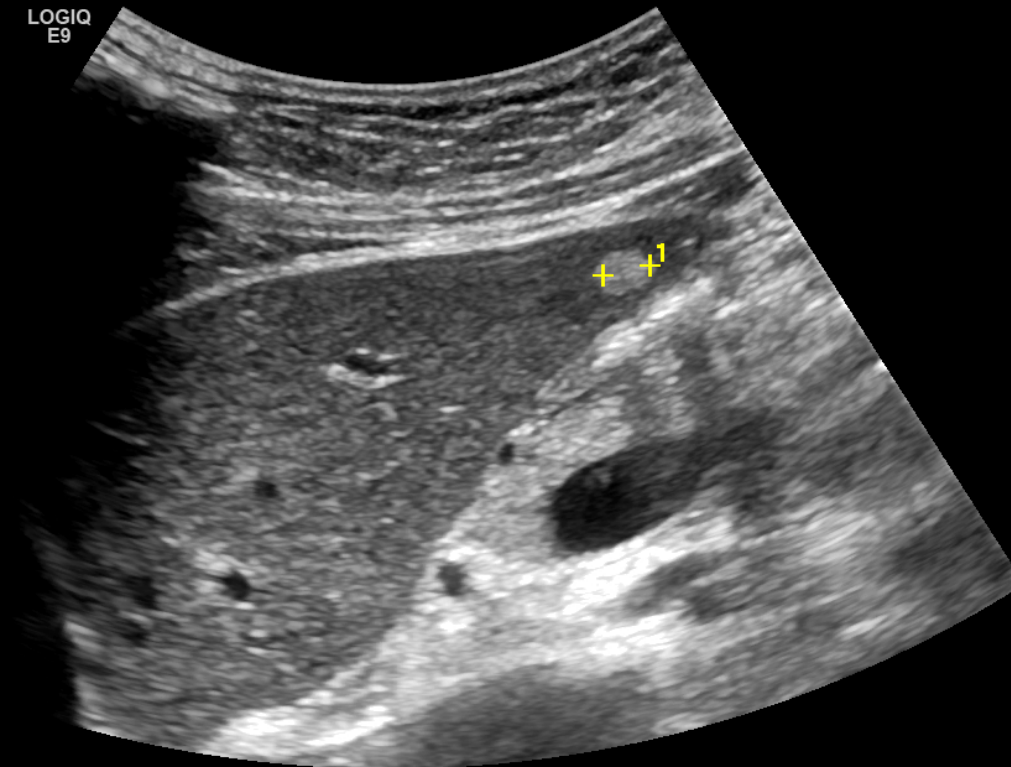
MI 1.2

TIs 0.6

C1-6
Abdomen

FR 28

LOGIQ
E9



CHI

Frq 4.0

Gn 59

0 S/A 2/1

- Map A/1

- D 8.0

- DR 72

- AO% 100

2

-

-

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-

4

-

-

-

-

6

-

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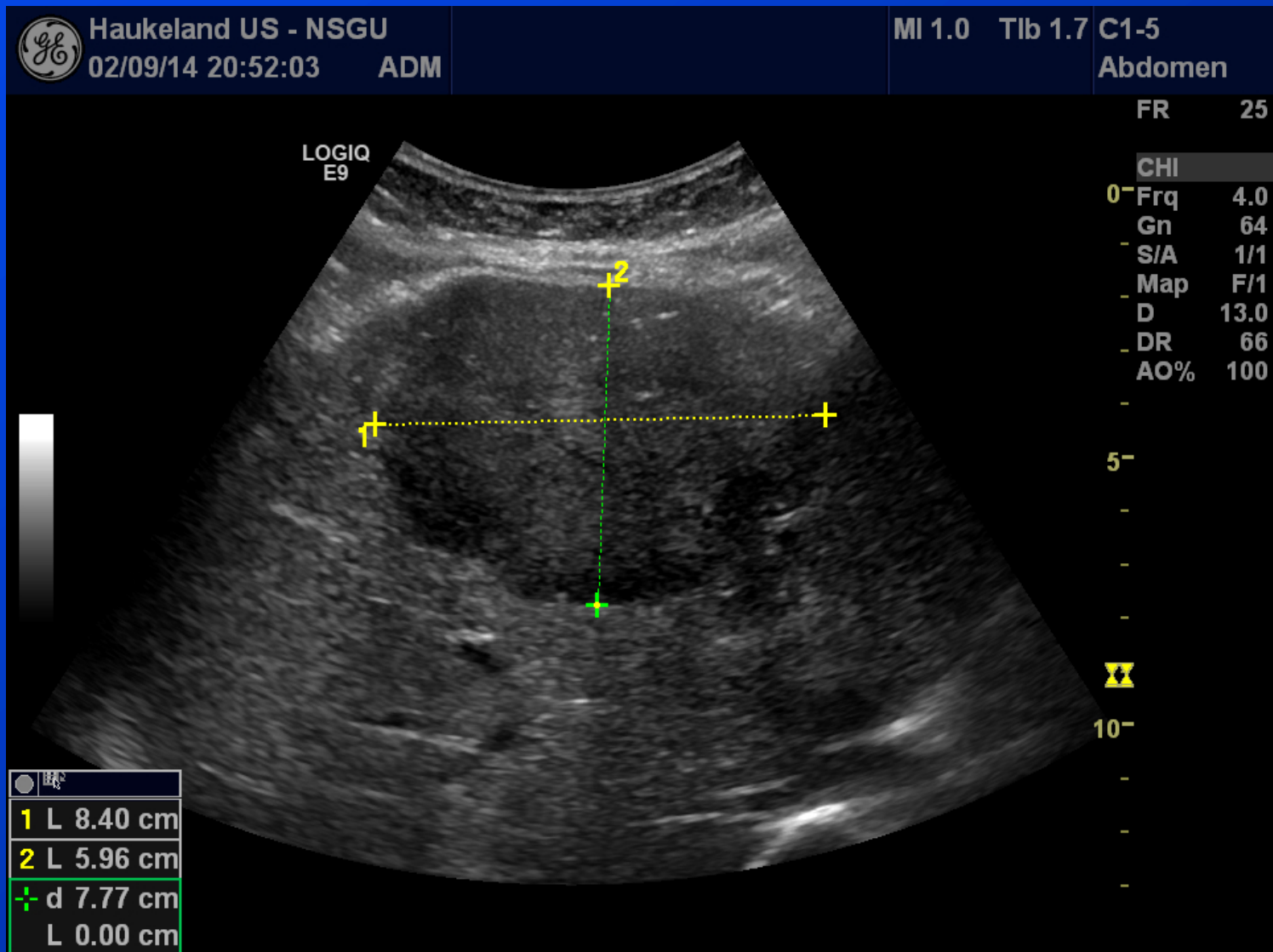
8

-

1 L 0.56 cm

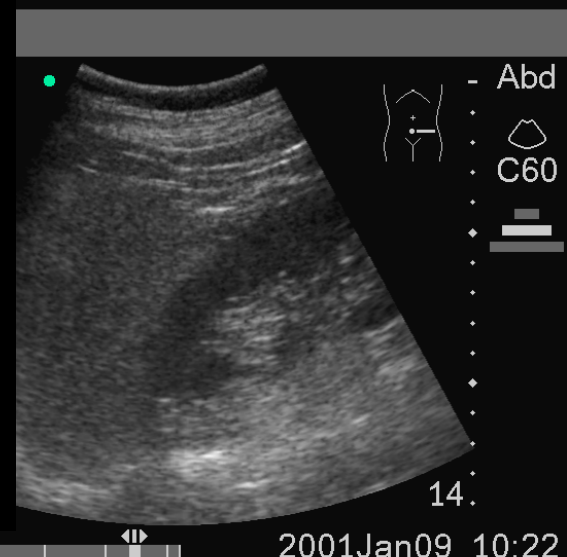
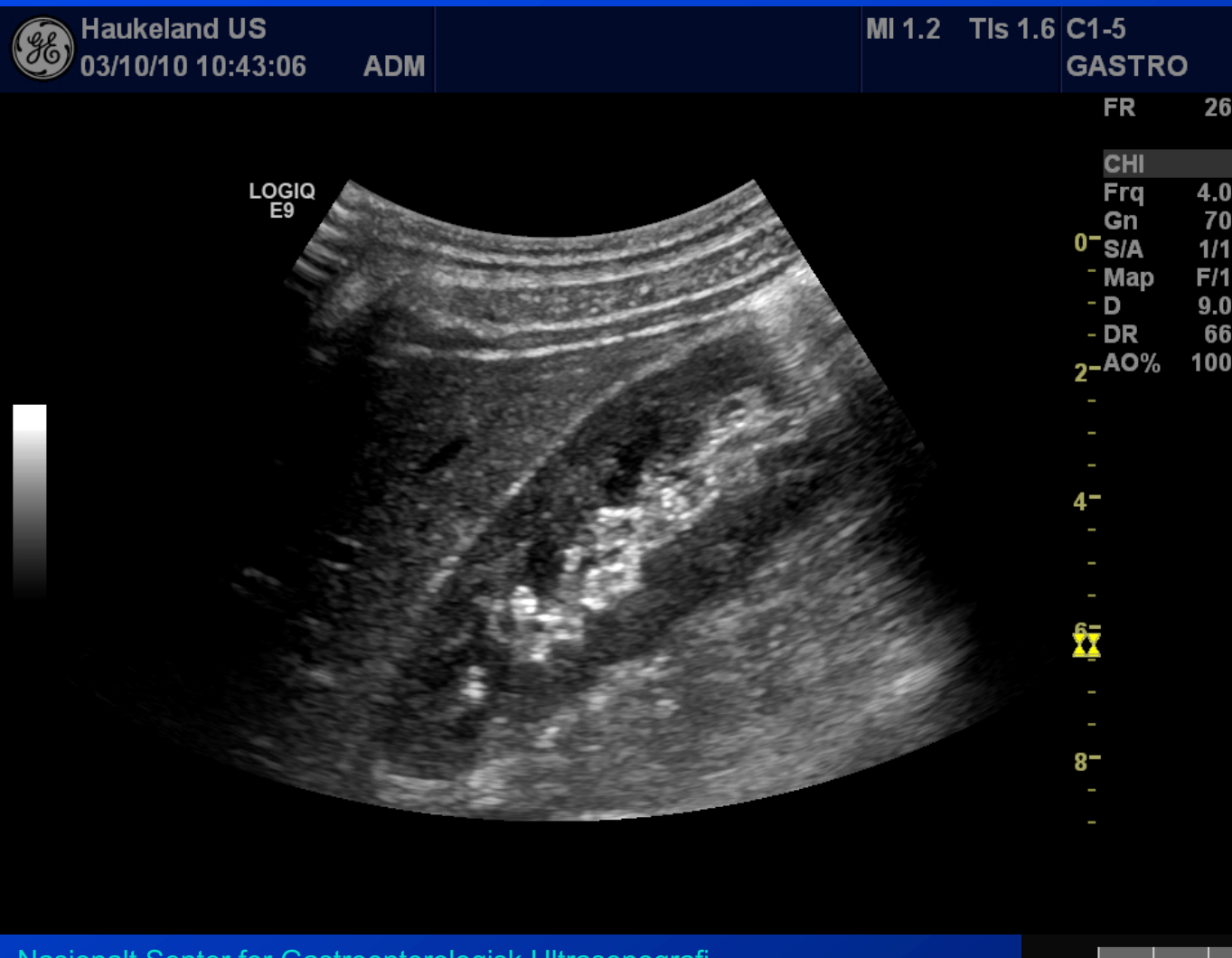


Stasjon 3 – Scanne for FLLs





Sammenlignende ekkogenisitet lever-nyre





Alkoholiske leversykdommer

- Generell parenchymaffeksjon
 - Steatose
 - Hepatitter
 - Fibrose – Cirrhose
- Fokale lesjoner
 - Regenerasjonsknuter - DN
 - HCC

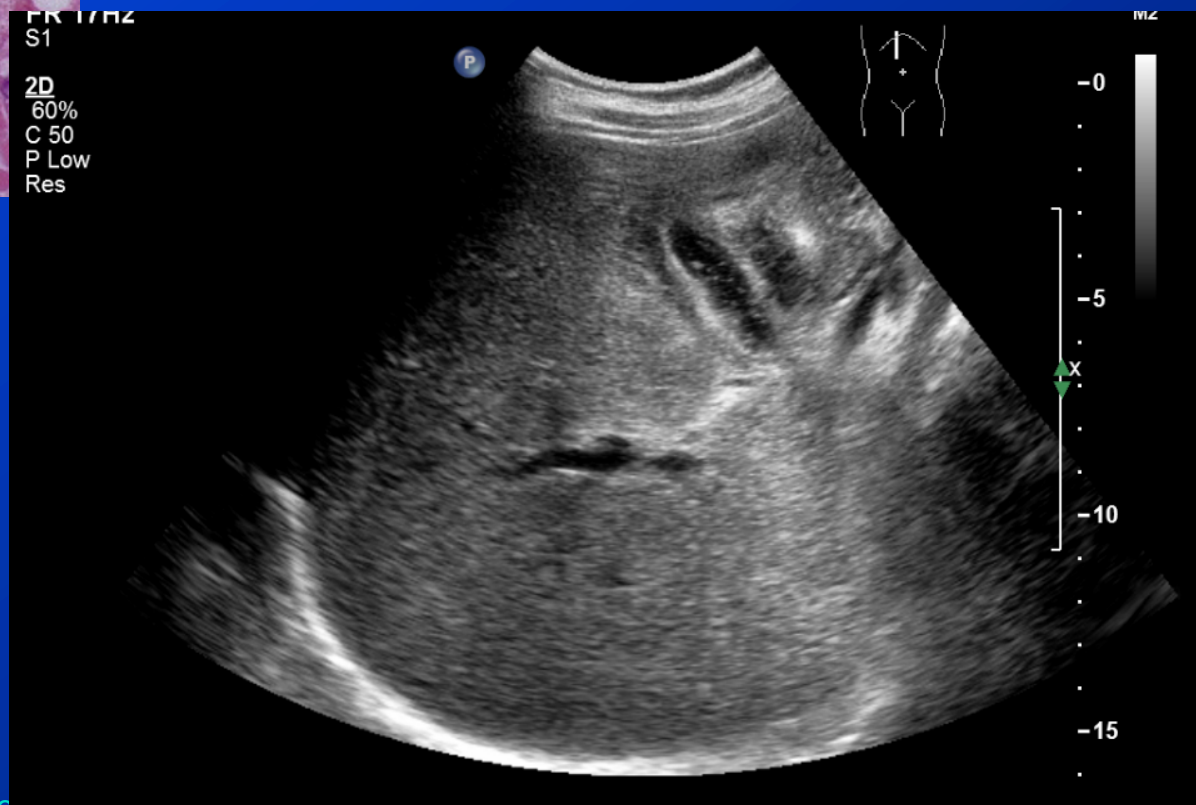




Alkoholisk Hepatitt



Hvordan spørre om
Alkoholvaner?



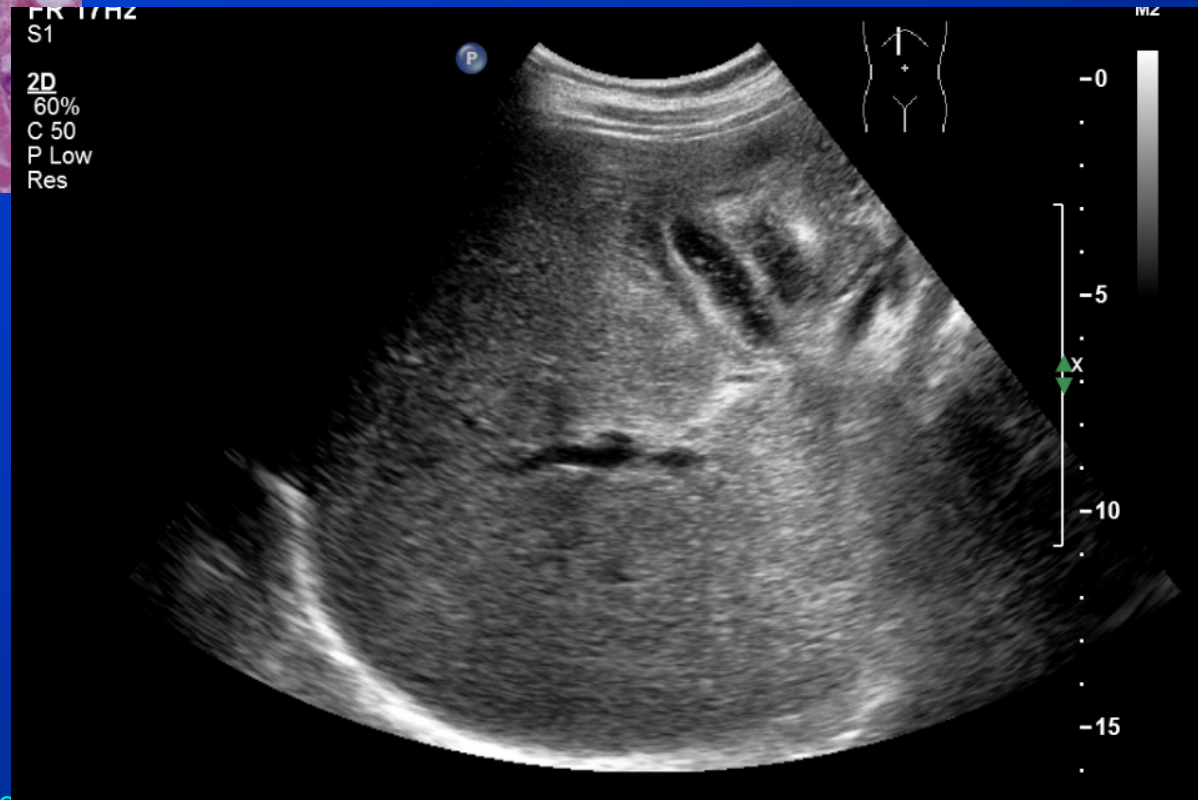


"Jeg drikker bare et glass om dagen, doktor !"



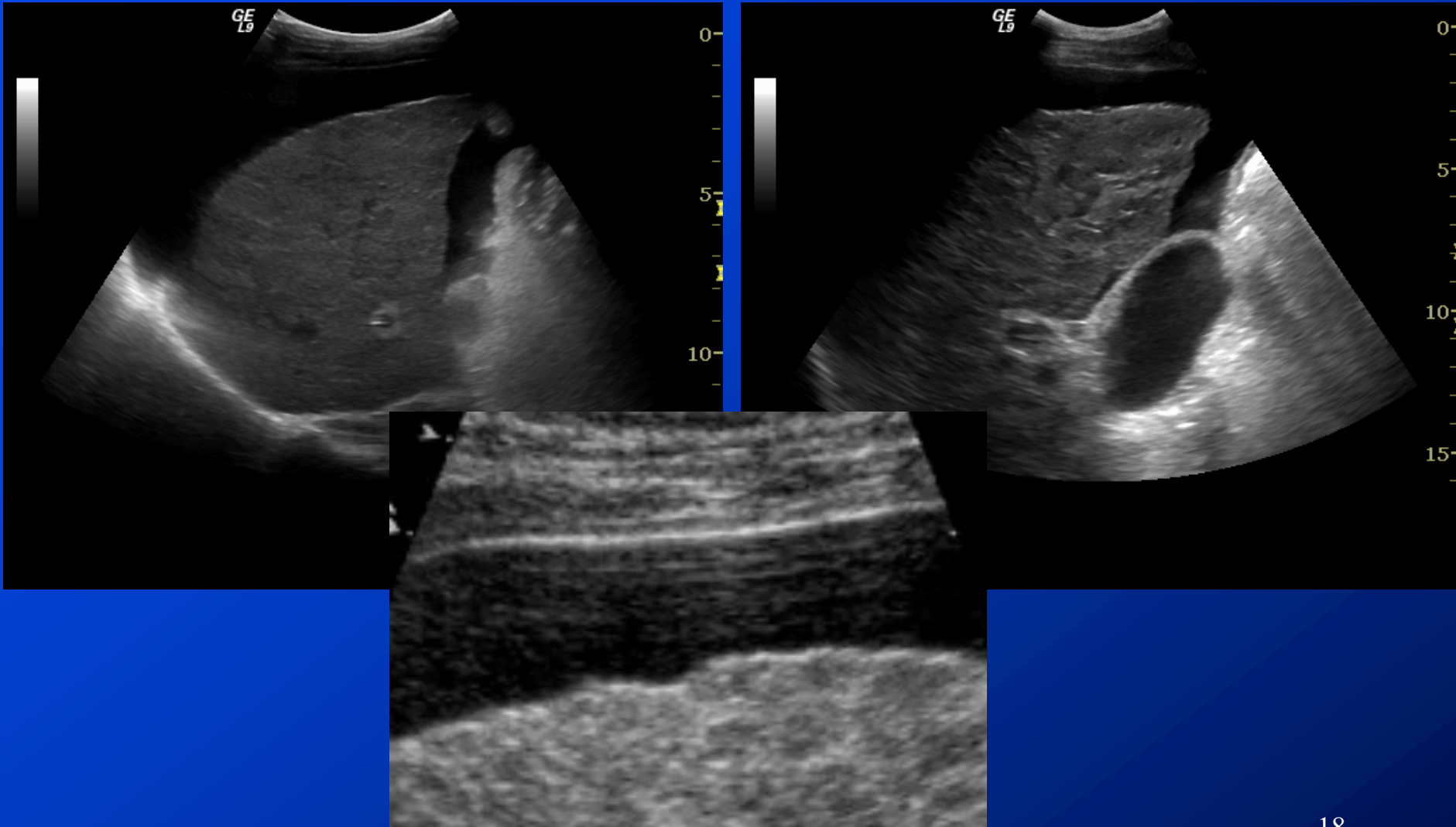


Alcoholic Hepatitis





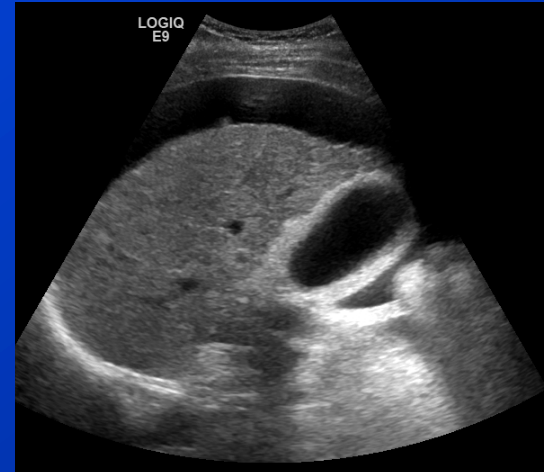
Liver cirrhosis





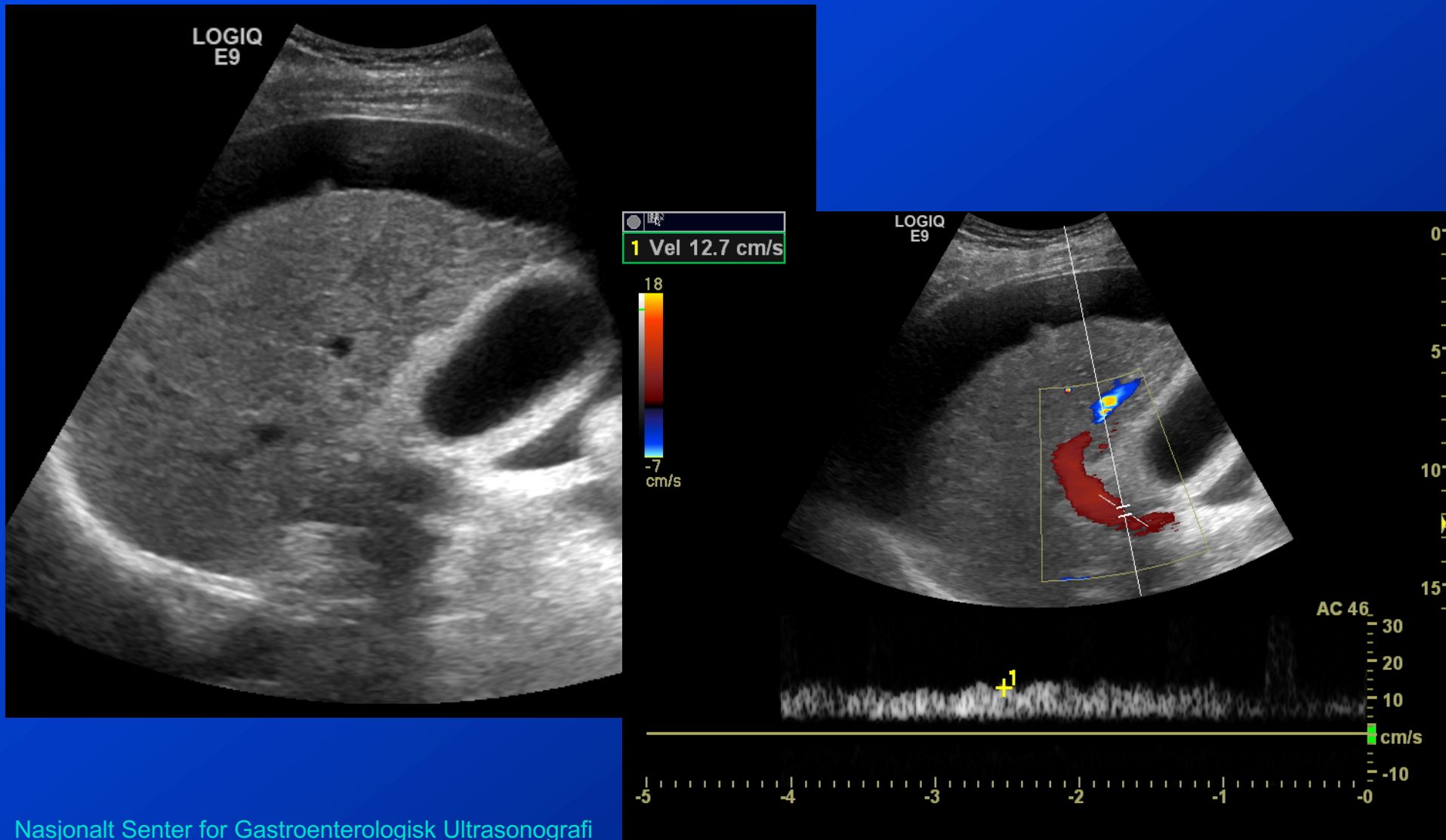
Ultrasound in the evaluation of cirrhotic livers

- Size of liver
- Size of left lobe and caudate lobe
- Capsule smoothness
- Ascites
- Echogenicity, homogeneity, nodularity, focal lesions
- Bile ducts and gallbladder
- Diameter of portal vein (+ splenic vein and spleen)
- Doppler measurements:
 - Color and pulsed Doppler of portal and hepatic veins
 - Doppler of hepatic artery (TX)
- Elastography, mainly right lobe
- CEUS
- US-guided biopsy and ablation procedures



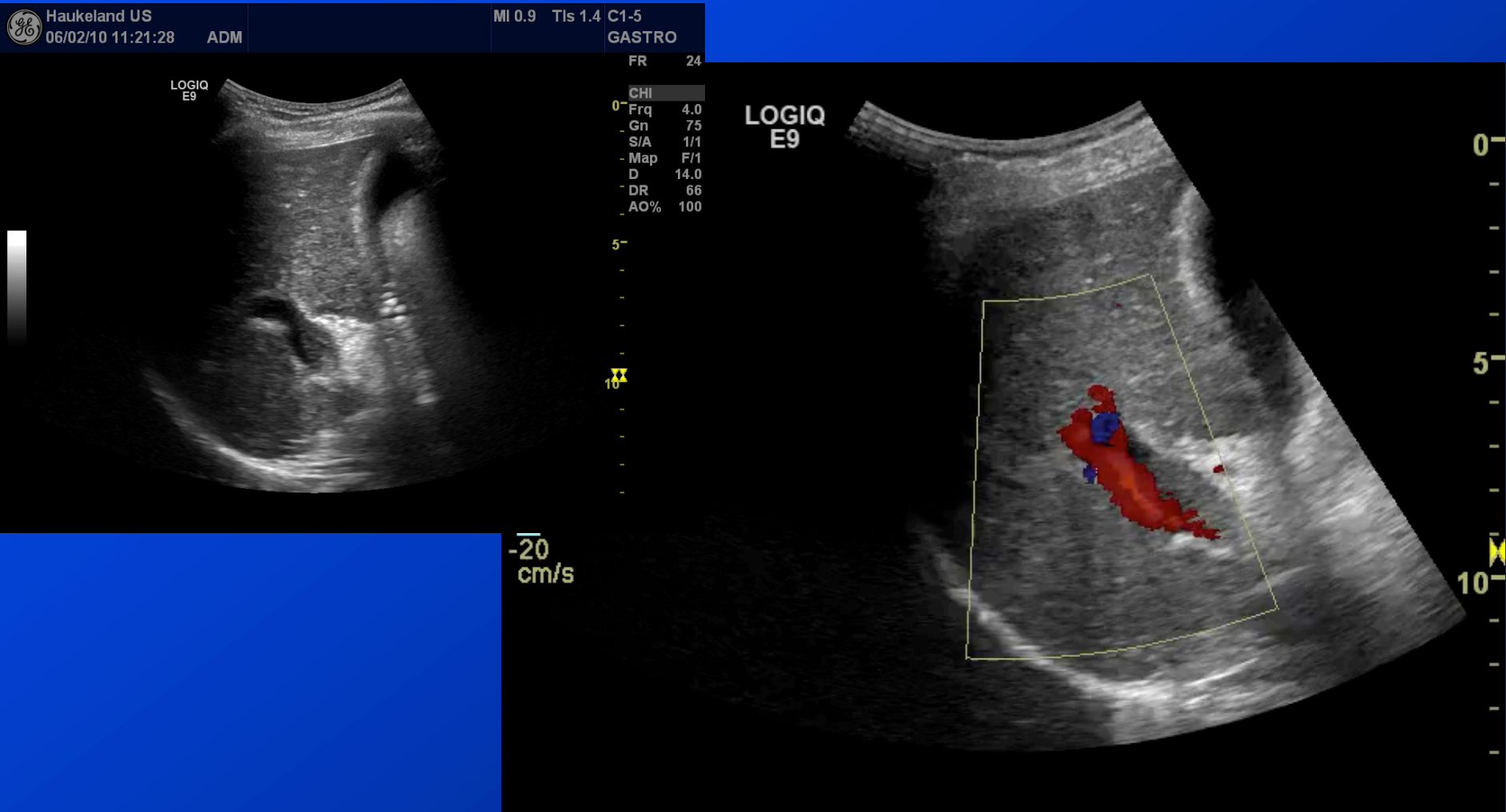


Lever Cirrhose



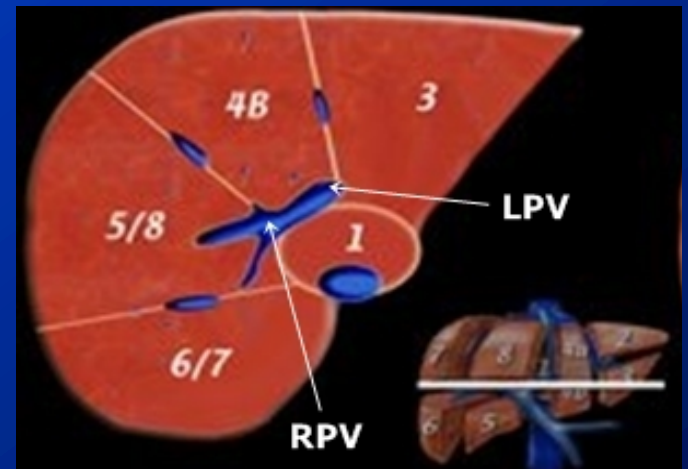
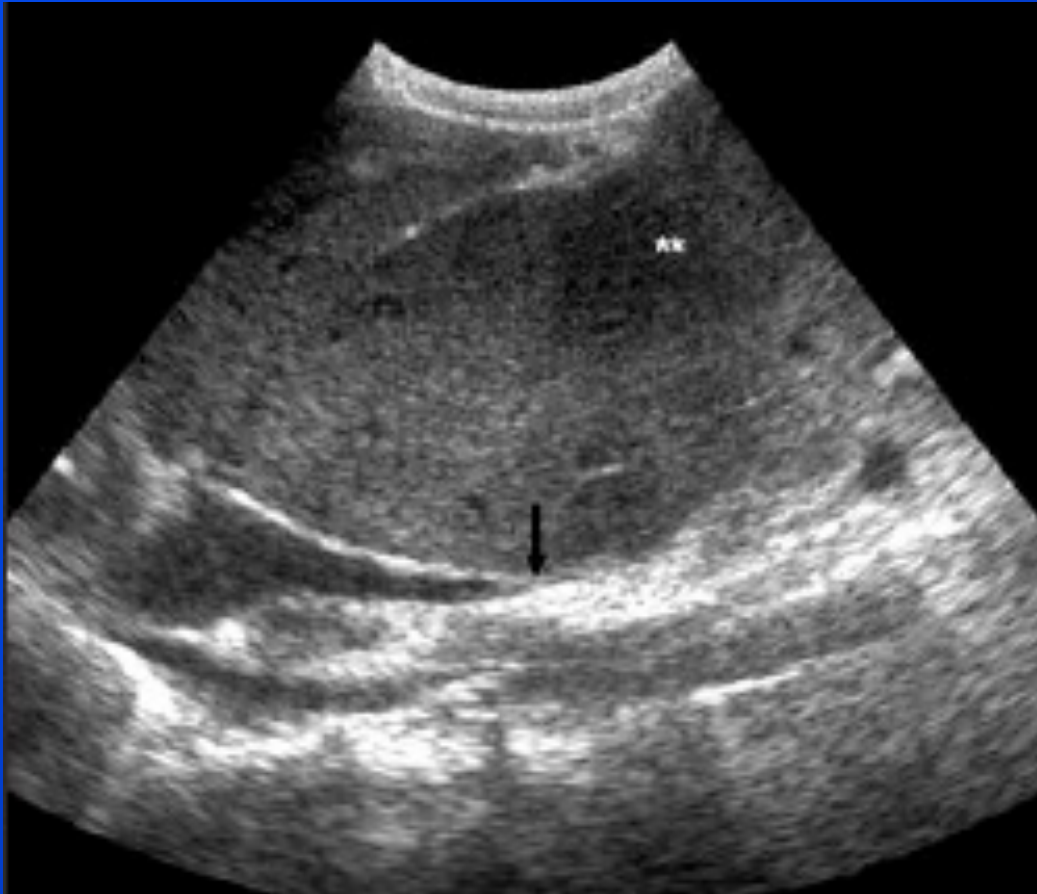


Color Doppler flow in real-time



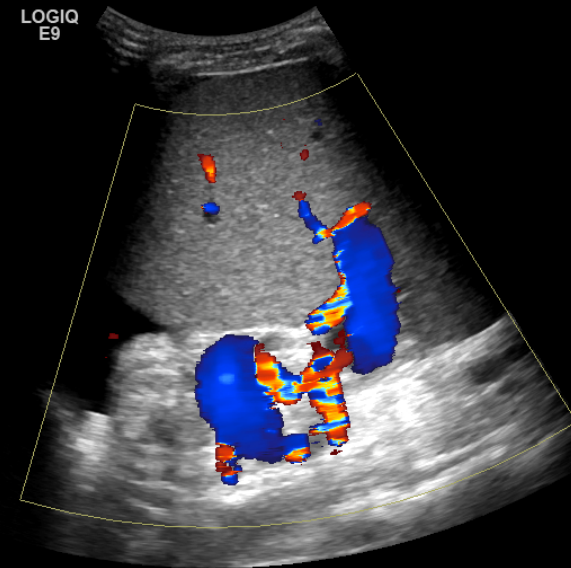
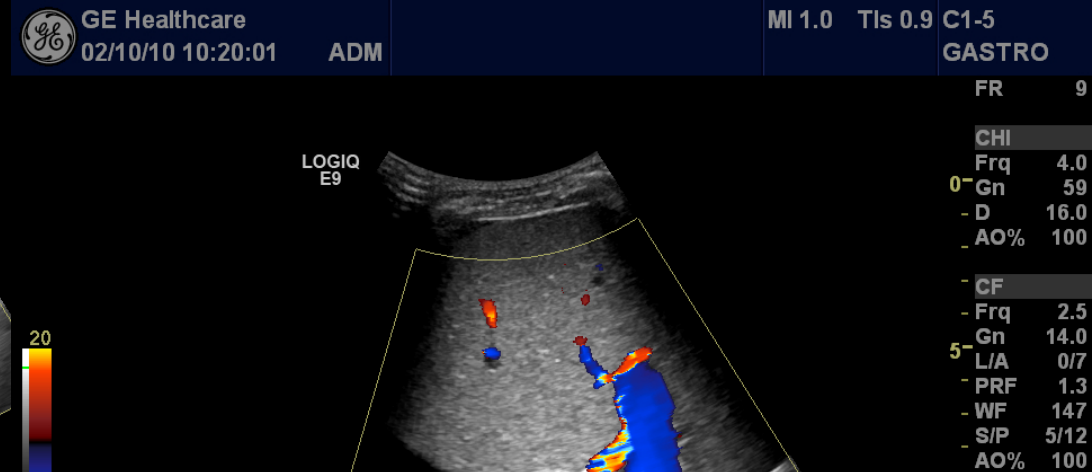
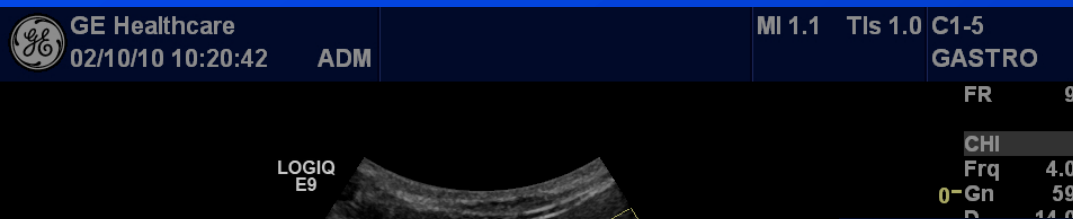


Enlarged caudate lobe





Dilated splenic vein in Portal HT



10-

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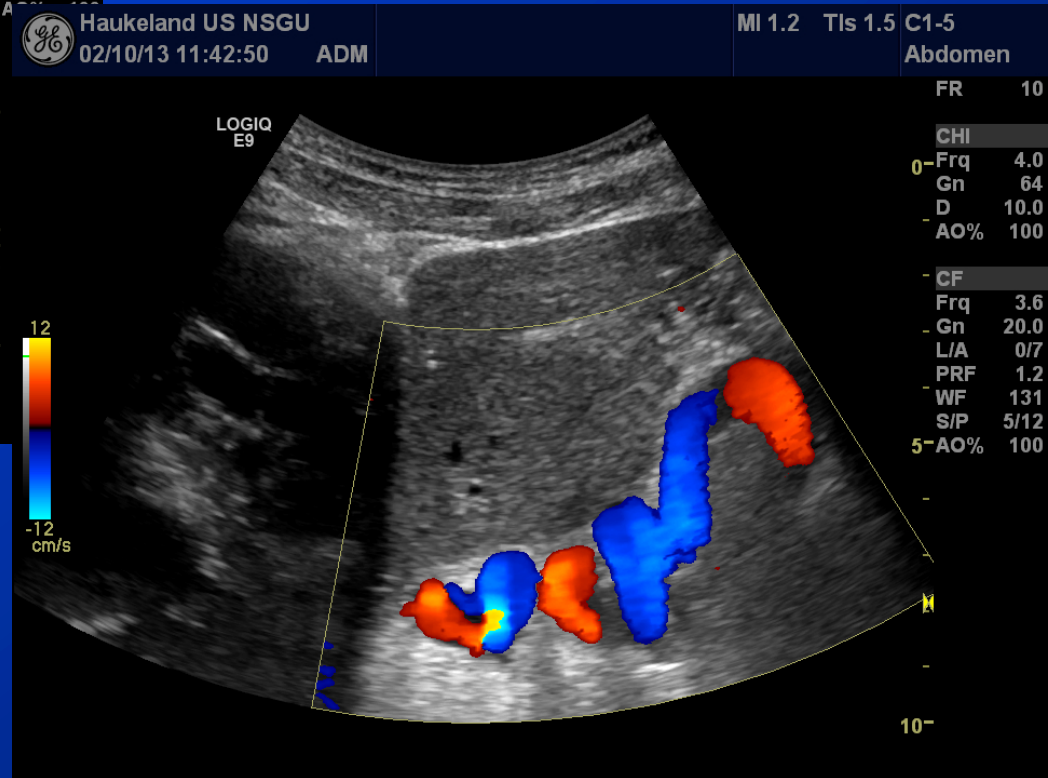
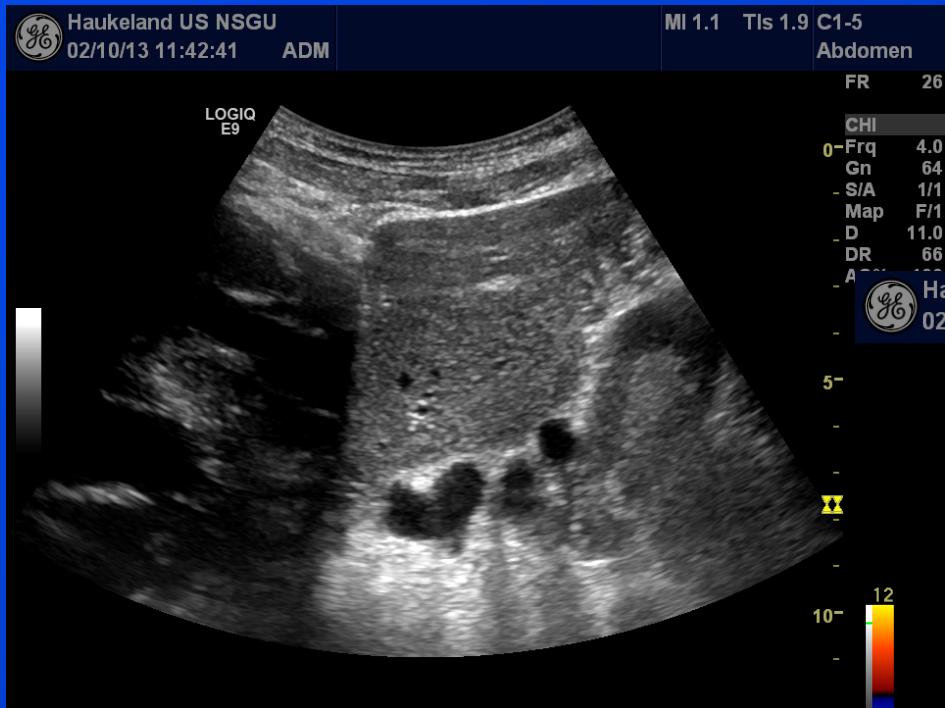
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15-

-



Esophageal Varices



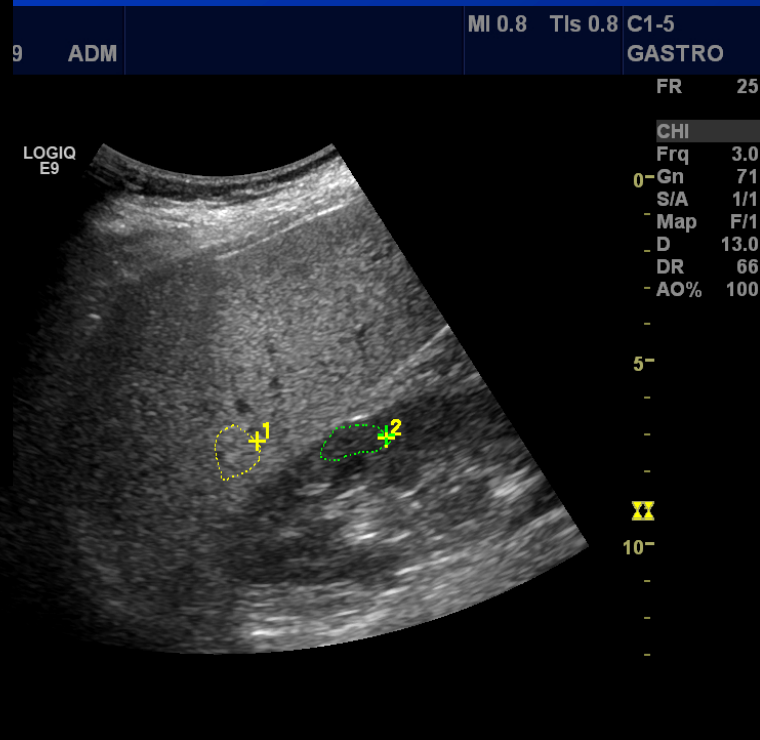
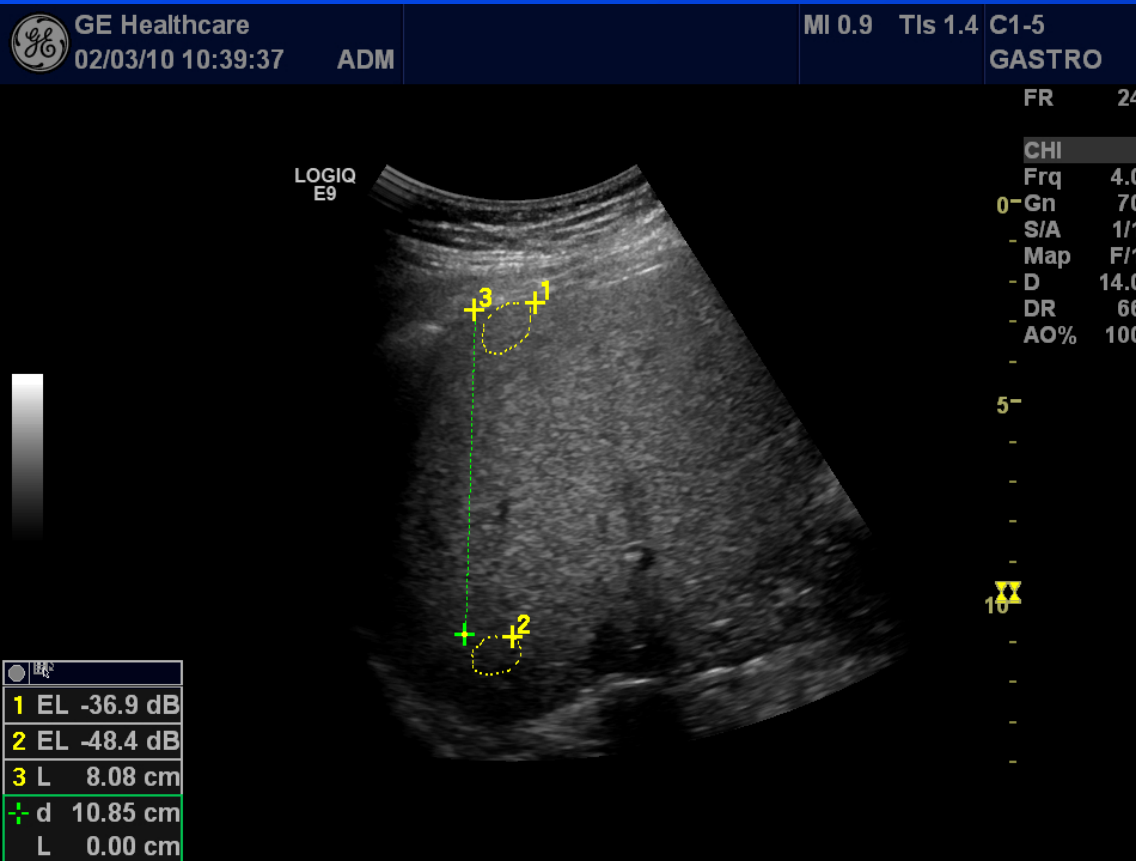


Fatty liver – Dangerous !



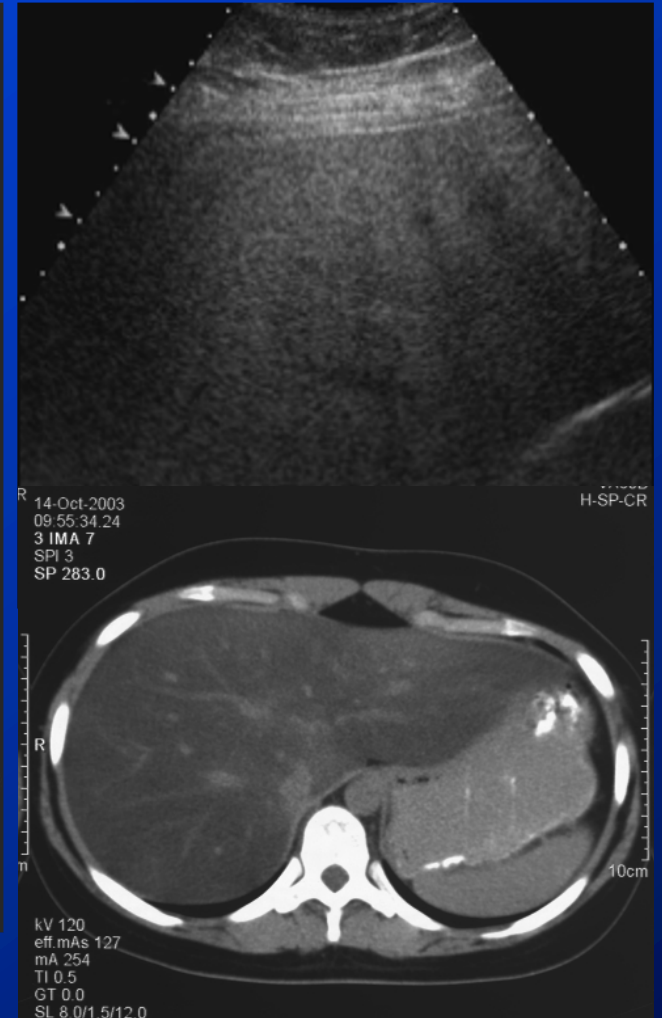
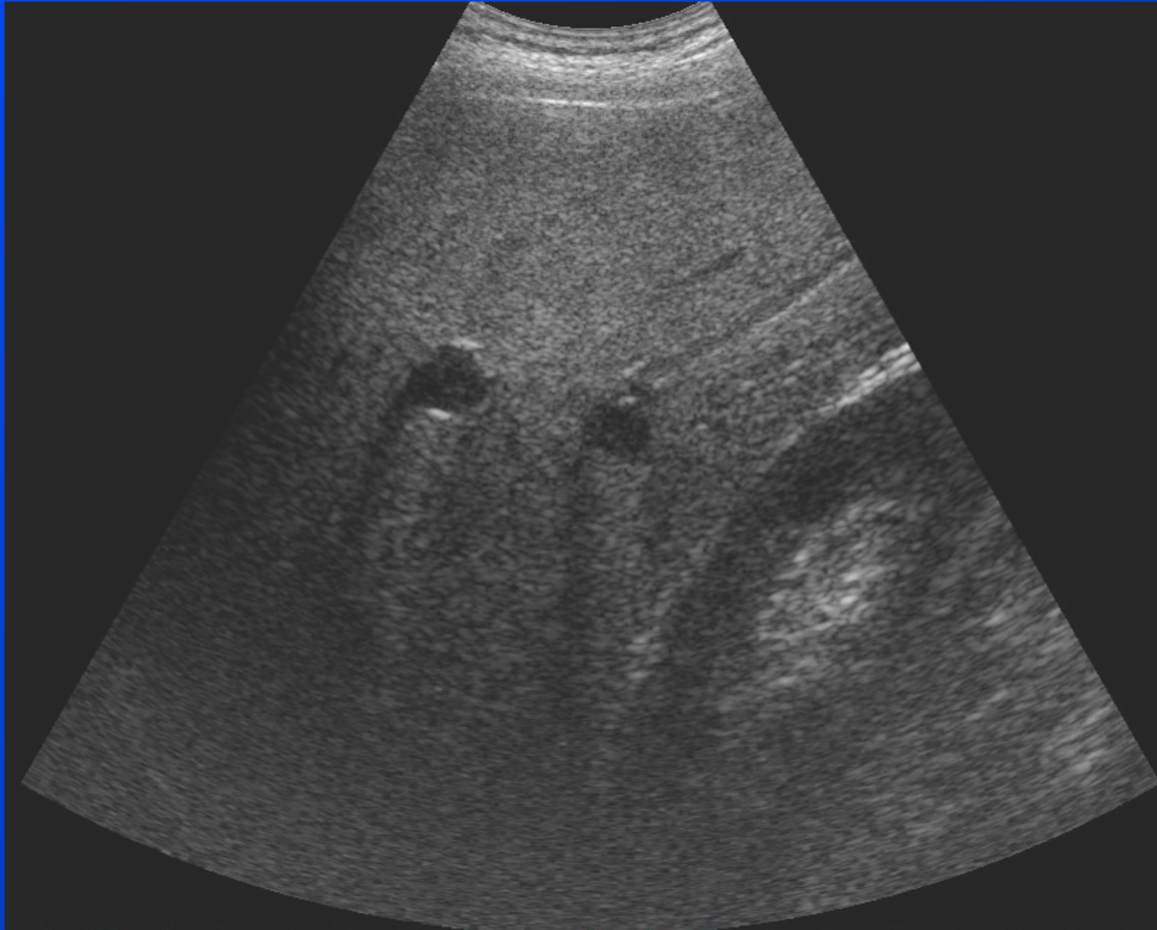


Steatose



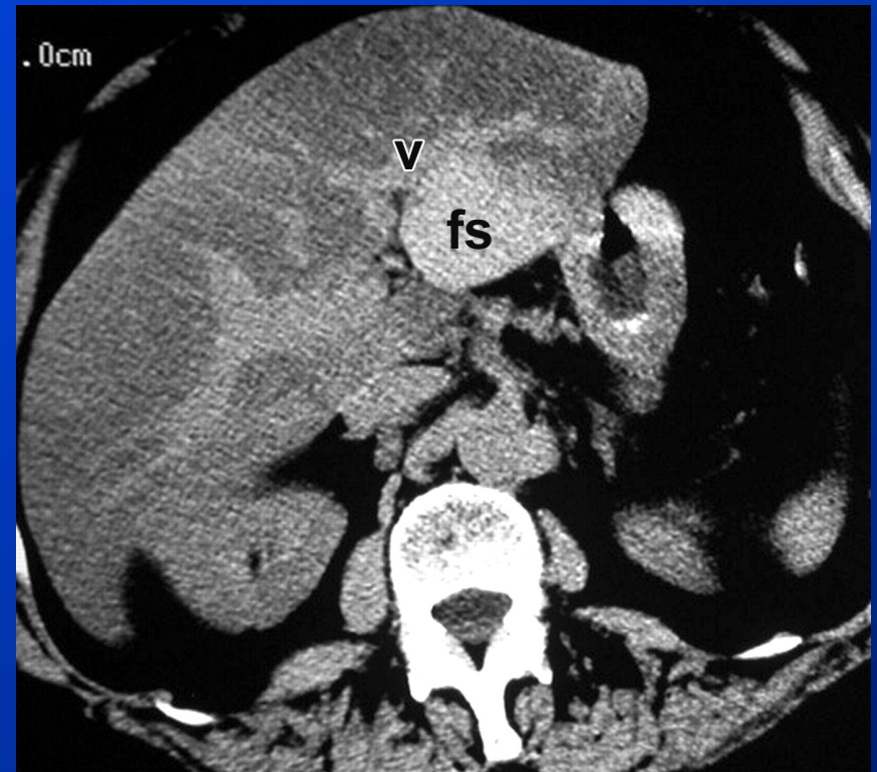
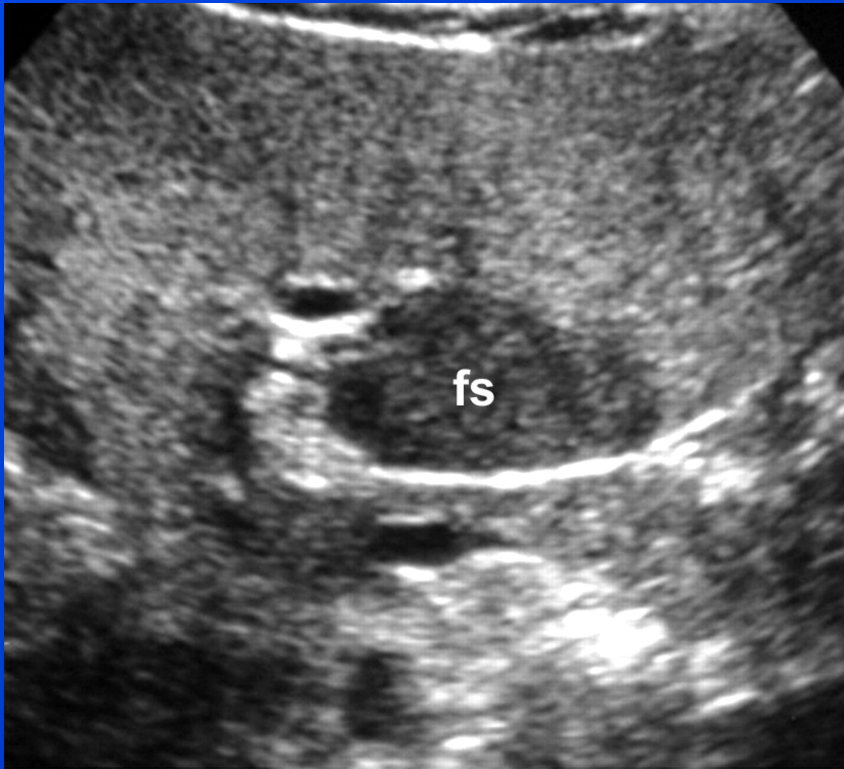


Steatosis



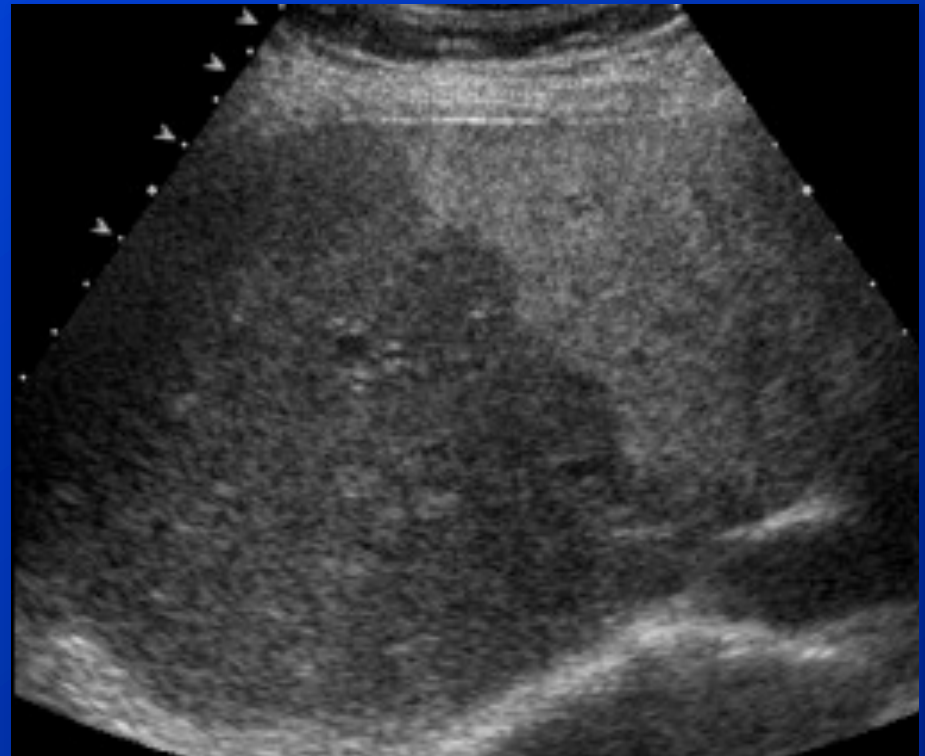
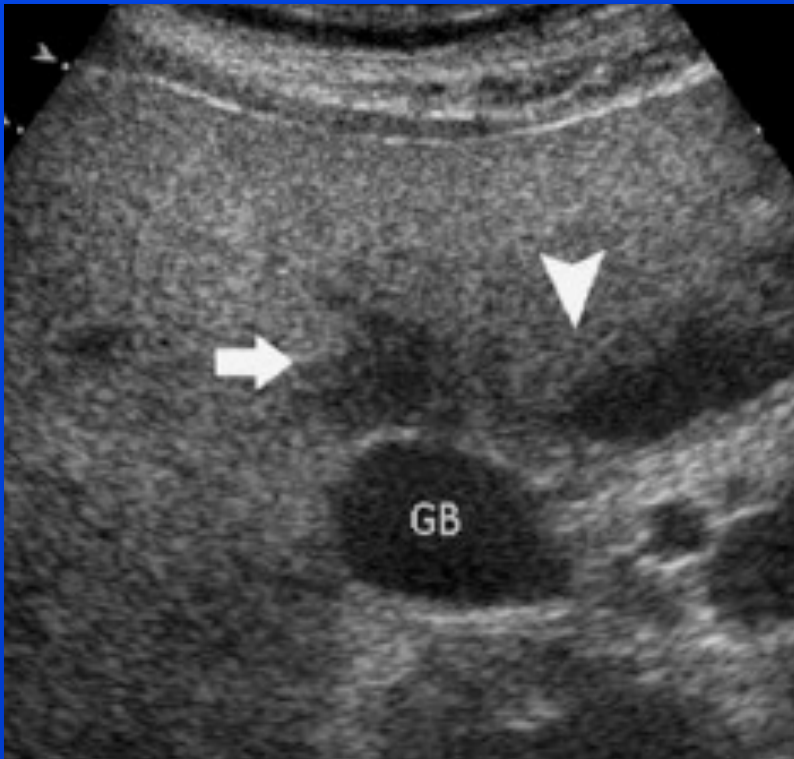


Fatty liver with "focal areas of sparing"



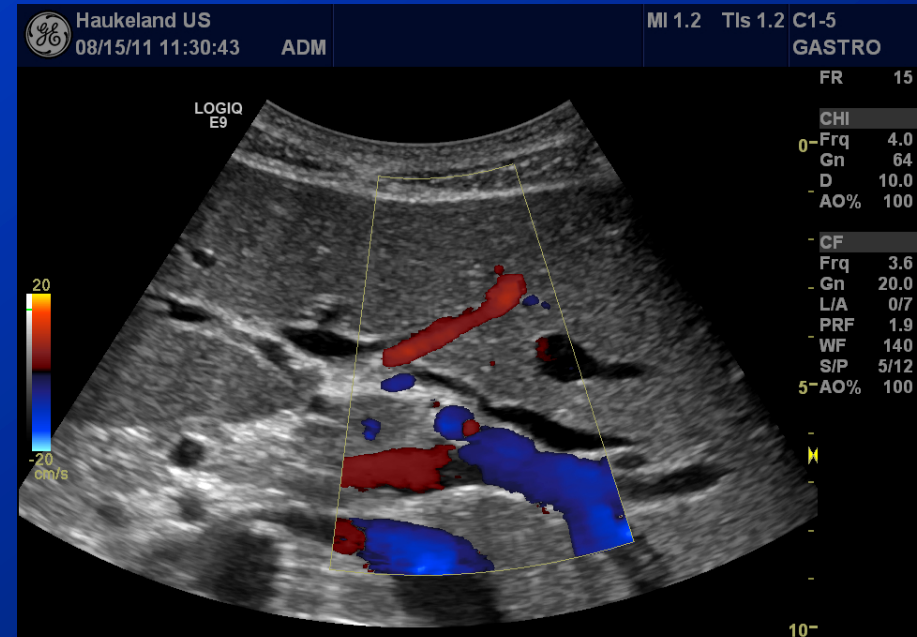
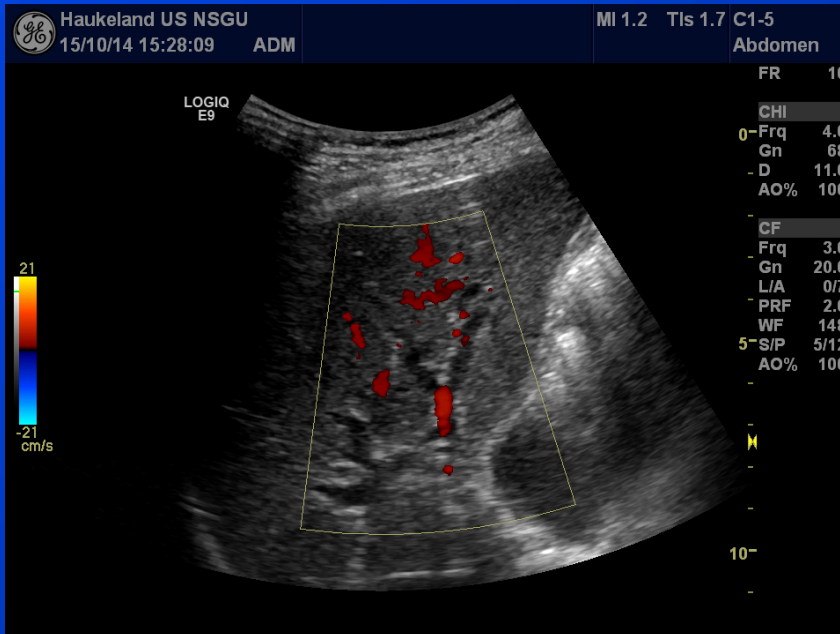
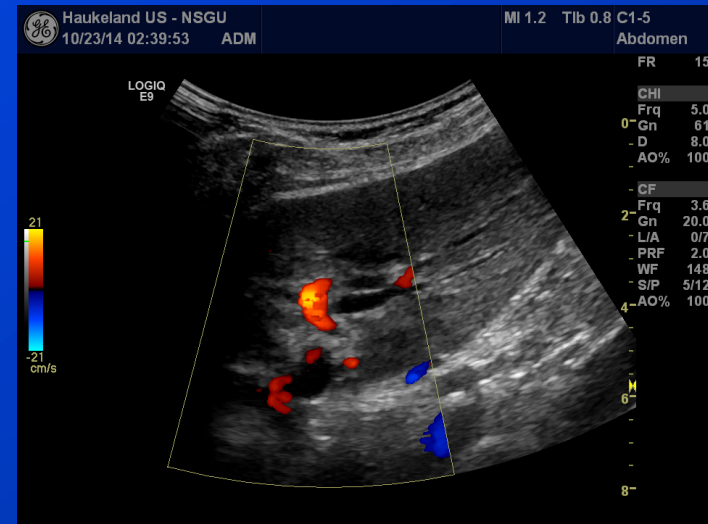
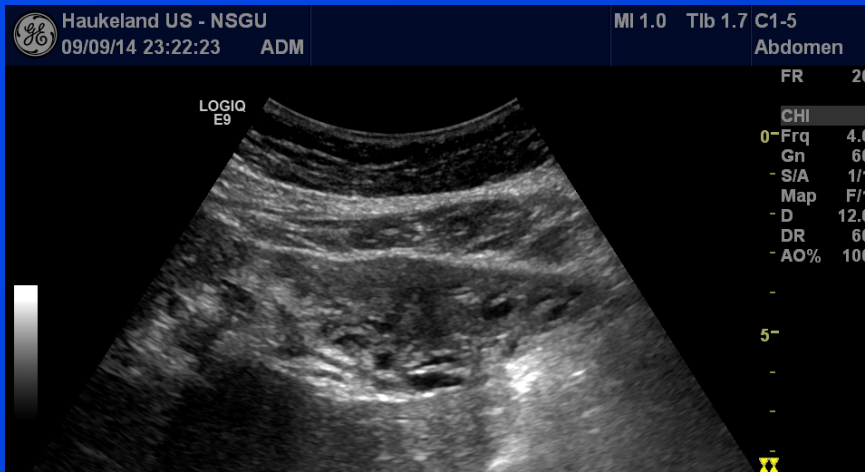


Fatty liver with "focal areas of sparing"





PSC: Primary Sclerosing Cholangitis



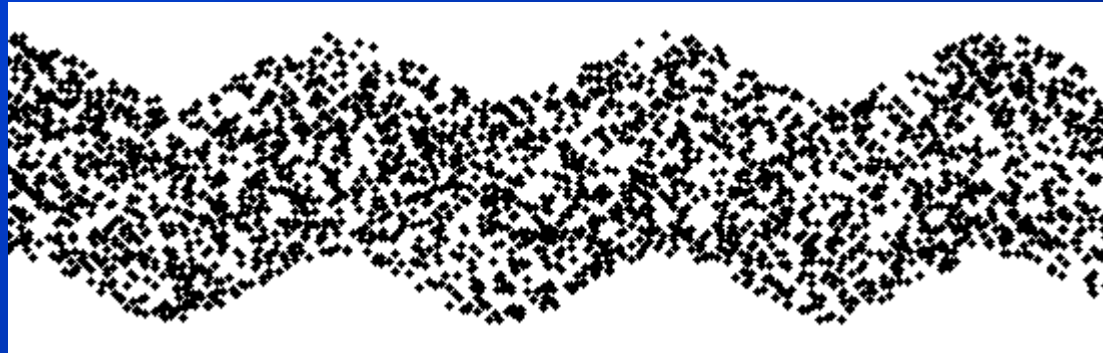
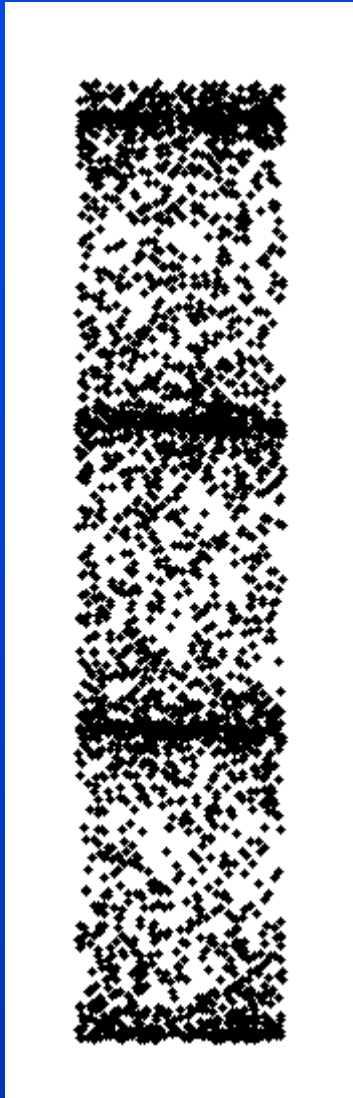


Longitudinal and Shear Waves

Ultrasound
Wave

$$c_l = \sqrt{\frac{K}{\rho}}$$

$c_l \sim 1540$ m/s
in tissue



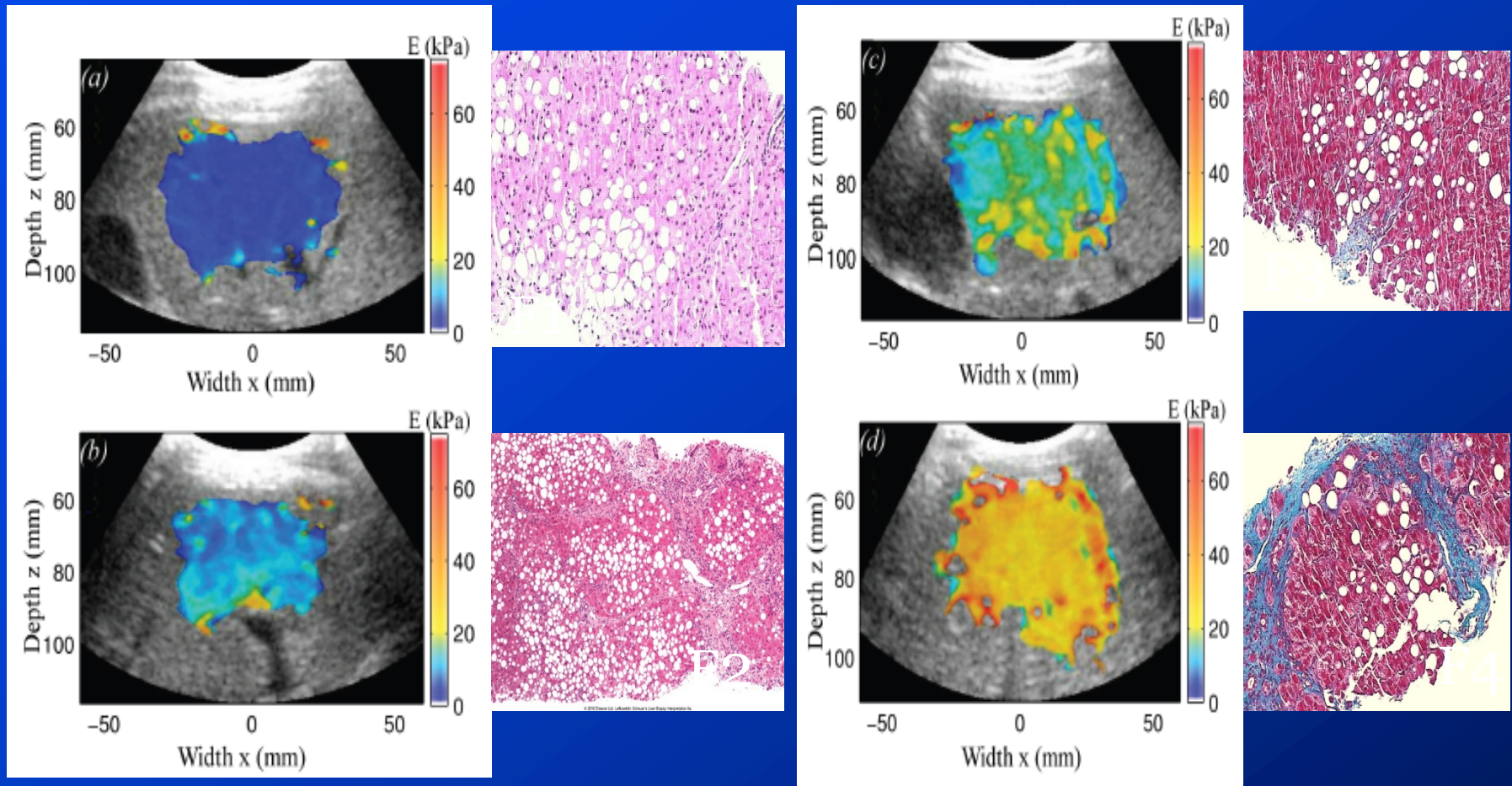
Shear Wave

$$c_t = \sqrt{\frac{E}{3\rho}}$$

$c_t = 1-10$ m/s in tissue



Shear Wave Elastography compared to histological findings and Liver Fibrosis



Ultrasound Med Biol. 2011 Sep;37(9):1361-73. Epub 2011 Jul 2011 Noninvasive in vivo liver fibrosis evaluation using supersonic shear imaging: a clinical study on 113 hepatitis C virus patients. Bava E, Gennisson JL, Couade M, Bercoff J, Mallet V, Fink M, Badel A, Vallet-Pichard



New Guidelines 2017

Guidelines & Recommendations

29 recommendations

Thieme

EFSUMB Guidelines and Recommendations on the Clinical Use of Liver Ultrasound Elastography, Update 2017 (Long Version)

EFSUMB-Leitlinien und Empfehlungen zur klinischen Anwendung der Leberelastographie, Update 2017 (Langversion)

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SWE in Hepatitis C and B

RECOMMENDATION 18

2D-SWE as demonstrated with SSI can be used as a first-line assessment for the severity of liver fibrosis in patients with chronic viral hepatitis C. It performs best with regard to the ruling out of cirrhosis (LoE 1b, GoR A) [139, 158, 159]. Broad consensus (17/0/1, 94%)

RECOMMENDATION 24

2D-SWE as demonstrated with SSI is useful in patients with CHB to identify those with cirrhosis (LoE 3a, GoR C) [196, 197]. Broad consensus (17/0/1, 94%)

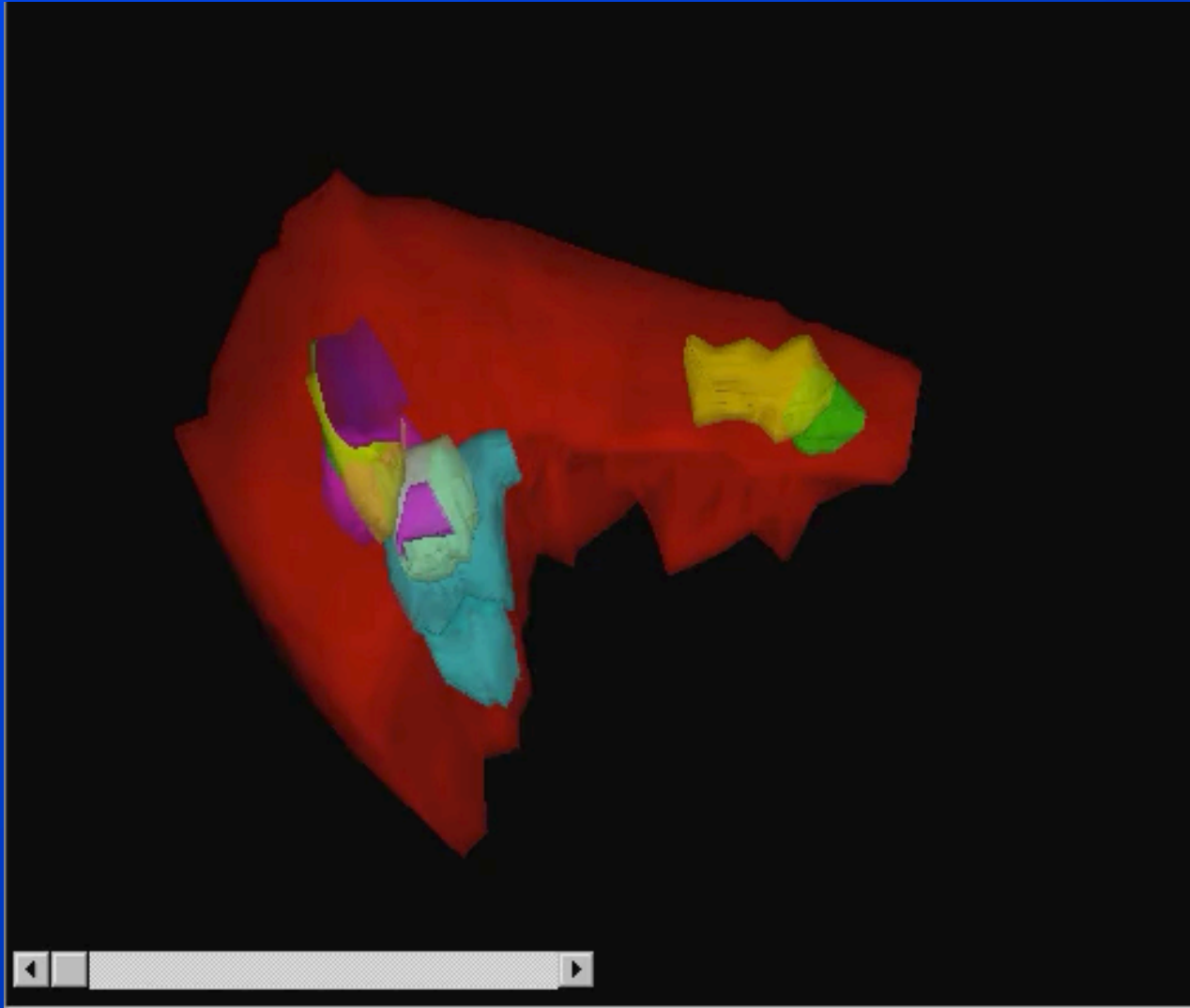


Ultrasound elastography

- Correlates well with histology regarding fibrosis
- Easy to perform
- Prolongs the US exam only with 2 min
- Provides valuable information to the clinician
- CT does not give data on liver stiffness
- MR elastography has low availability, is expensive and time consuming



Detection of Focal Liver Lesions



Hausken, Gilja et al., 1999

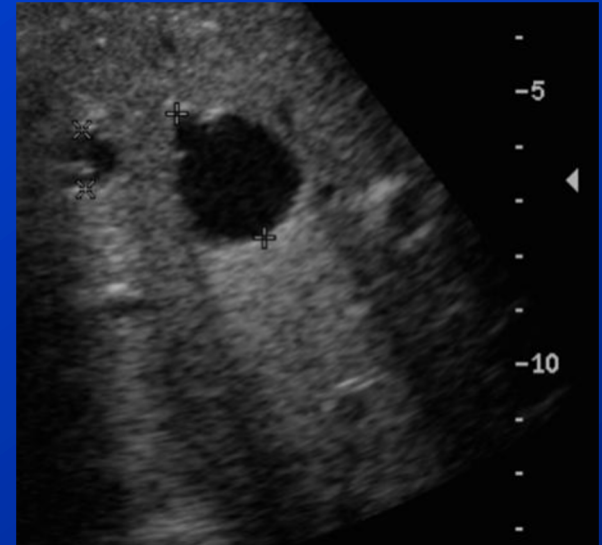
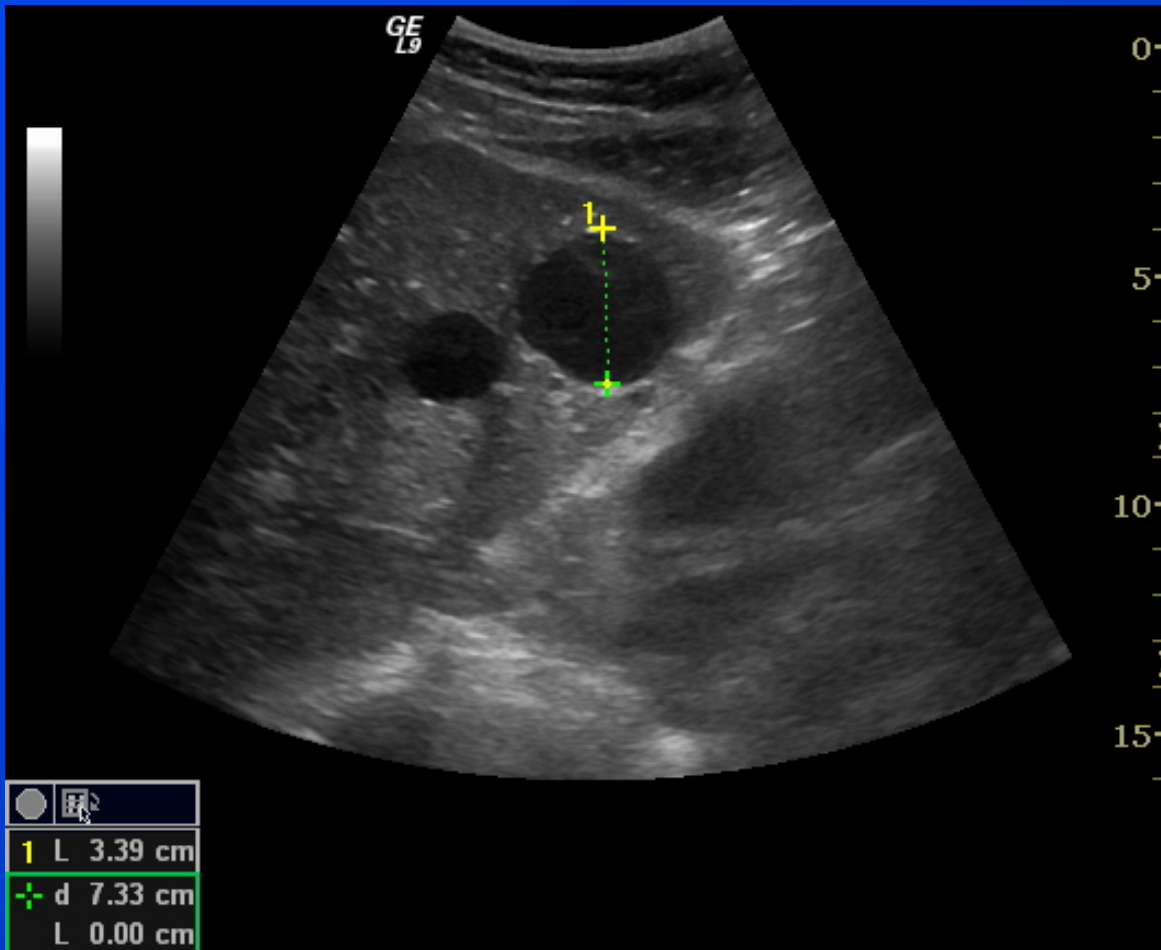


FLL Classification

Benign	Malignant
Hepatocellular	Hepatocellular
Adenoma	Hepatocellular Carcinoma
Focal Nodular Hyperplasia	(Hcc) and its variants
Diffuse Nodular Hyperplasia	Fibrolamellar Carcinoma
Macroregenerative Nodules	Hepatocholangiocarcinoma
Dysplastic Nodules	Hepatoblastoma
	Carcinosarcoma
Biliary Epithelium	Biliary Epithelium
Bile Duct Cyst	Cystadenocarcinoma
Biliary Duct -Adenoma	Cholangiocarcinoma
Mucinous Cystic Neoplasm	
Peribiliary Gland Hamartoma	
von Meyenburg Complex	
Biliary Cystadenoma	
Biliary Papillomatosis	
Vascular	Vascular
Cavernous Hemangioma	Angiosarcoma
Infantile Hemangioendothelioma	Epithelioid
	Hemangioendothelioma
Others	Others
Angiomyolipoma	Primary Lymphomas
Mesenchymal Hamartoma	Sarcomas
Solitary Fibrous Tumor	
Inflammatory Pseudotumor	

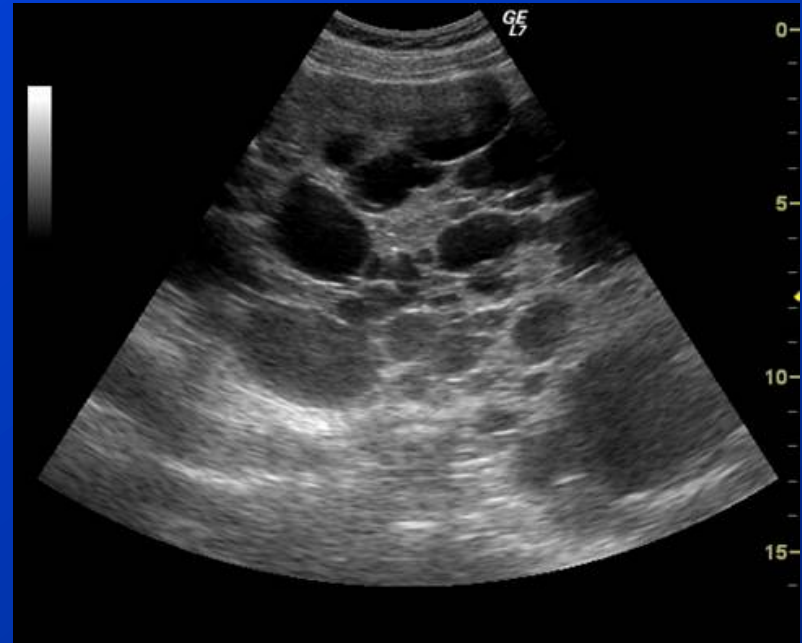
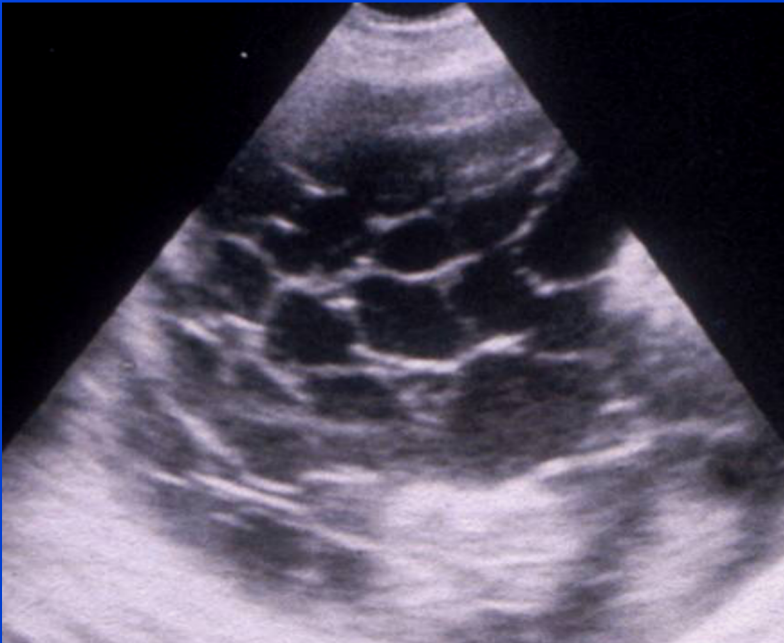


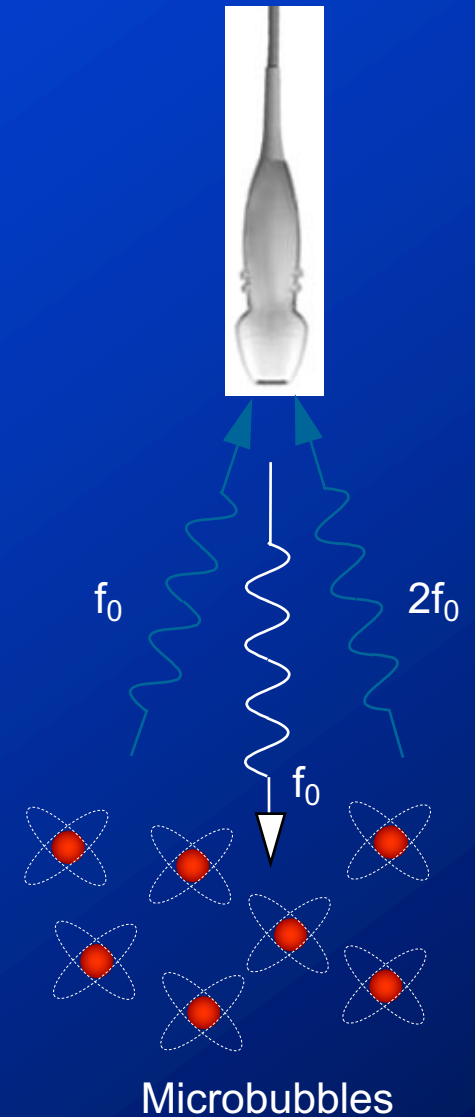
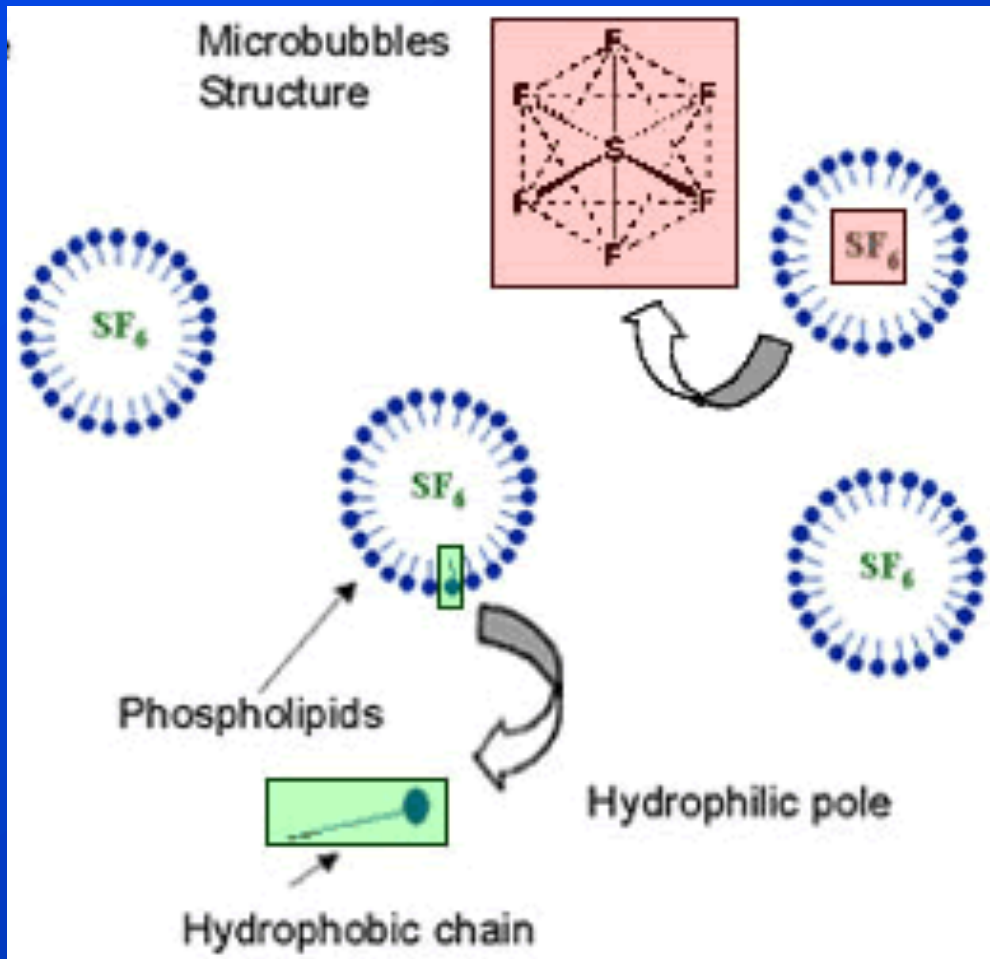
Liver cysts





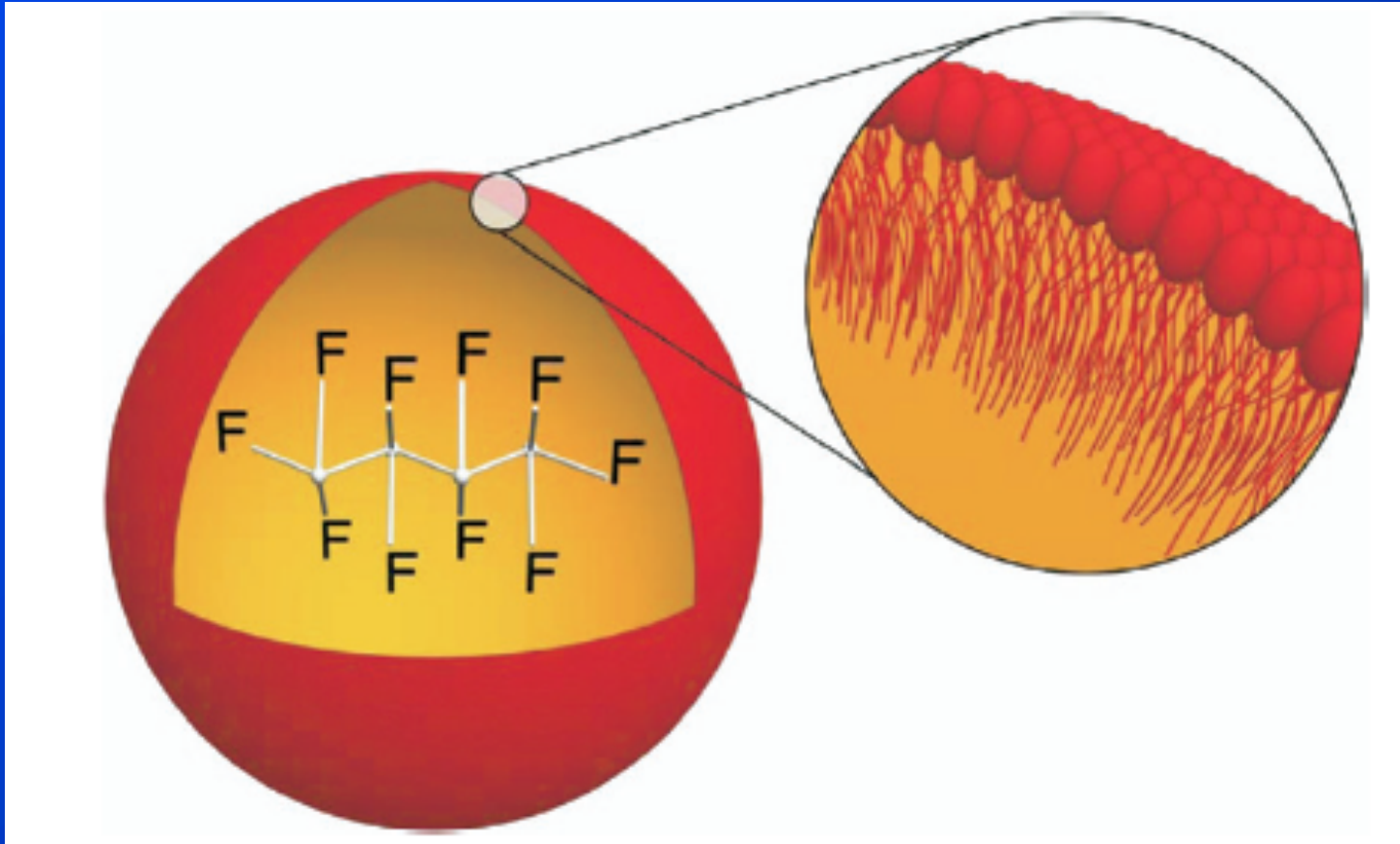
Polycystic liver disease







Sonazoid



- Membrane is hydrogenated egg phosphatidylserine sodium (HEPSNa)
- The gas is perfluorobutane (PFB)



New Guidelines for CEUS 2011

The EFSUMB Guidelines and Recommendations on the Clinical Practice of Contrast Enhanced Ultrasound (CEUS): Update 2011 on non-hepatic applications

Authors

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Bibliography

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New York · ISSN 0172-4614

Correspondence

Thematic sections

	Thematic Section	Chairperson
1	Introduction	F. Piscaglia – C. Nolsøe
2	Generalities	D. Cosgrove
3	Equipment	H. P. Weskott
4	Investigator's training	O. H. Gilja

List of Abbreviations

AAA=Abdominal Aortic Aneurysm
AUC=Area Under the Curve
CE=Contrast Enhanced
CECT=Contrast Enhanced Computed Tomography
CEMRI=Contrast Enhanced Magnetic Resonance Imaging

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Ultraschall Med / EJU Aug. 2011



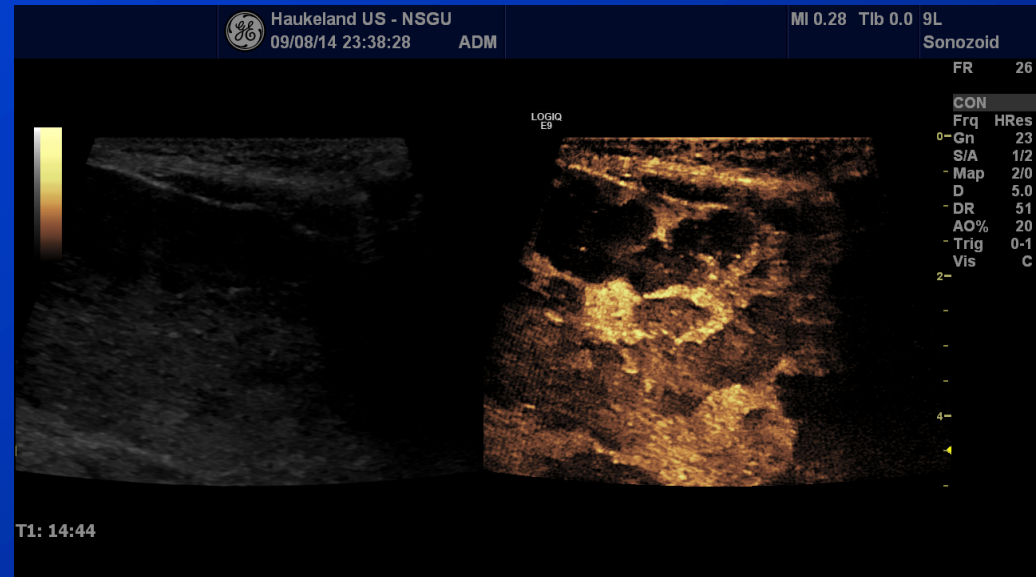
Indications - Liver

- Characterization of benign FLLs
 - FNH, hemangiomas, adenomas
- Detection of focal lesions
 - Metastasis
- Study FLL in cirrhosis
- Guiding of biopsies
- Guiding of intervention,- e.g. ablation



3 (4) Phases in liver perfusion

- Arterial phase
 - 0-30 sec.
- Portal phase
 - 30-120 sec.
- Sinusoidal phase
 - 2-4 min
- Post-vascular phase
 - 4-30 min



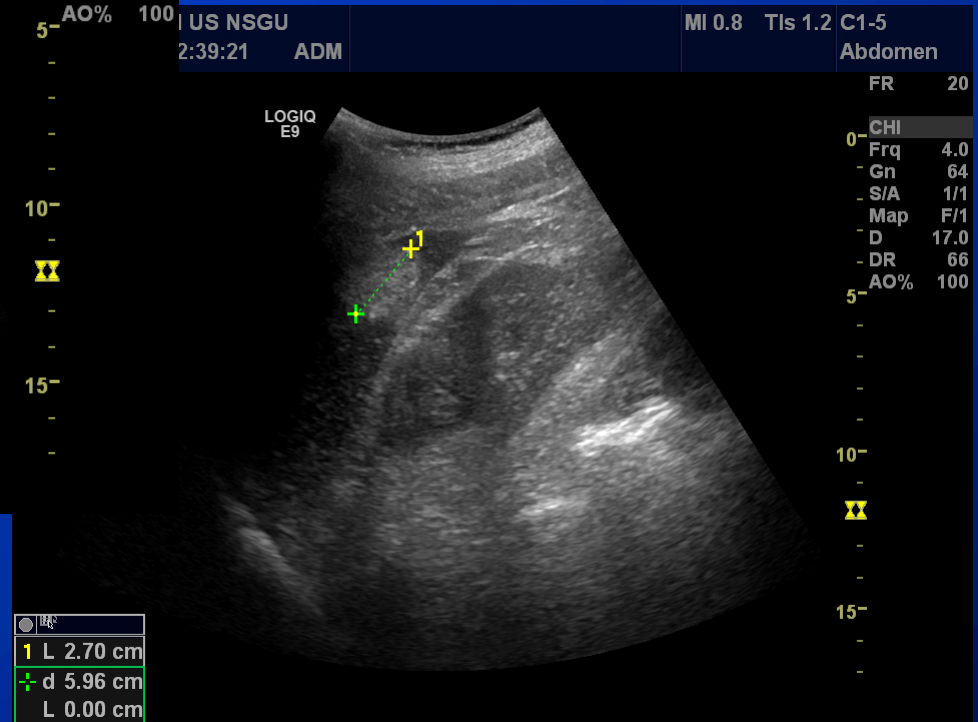
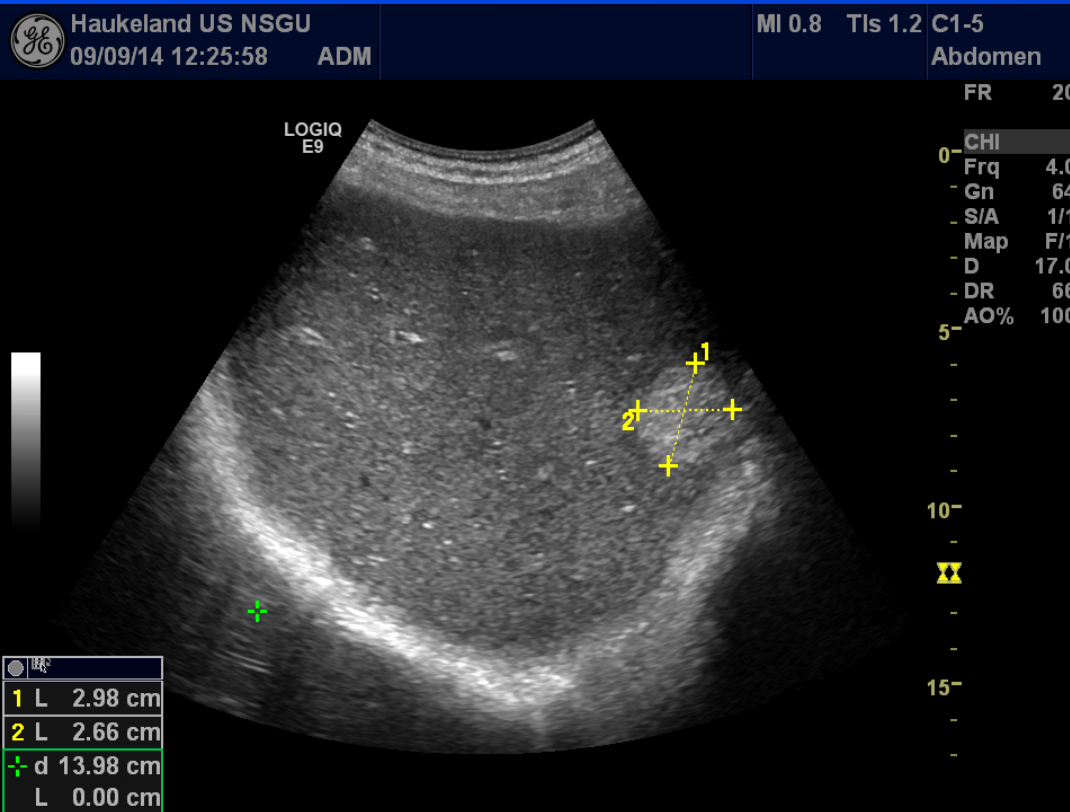


Focal Liver Lesions

	Type of lesion	Arterial phase	Portal phase	Sinusoidal phase (parenchymal)
Benign	Haemangioma	Globular enhancement from the periphery	Centripetal filling	Progressive enhancement (iso to hyperechoic)
	Focal Nodular Hyperplasia	1. Strongly hyperechoic 2. In 40% of cases spoke and wheel pattern	Moderately hyperechoic or Isoechoic	Moderately hyperechoic or Isoechoic (central scar visible in 40% of cases)
	Adenoma	Strong homogeneous enhancement of short duration (capsular vessels)	Isoechoic	Isoechoic
Malignant	Hepato-cellular Carcinoma	Enhancement 1.Homogeneous 2.Inhomogeneous	Slightly hypoechoic	Slightly or strongly hypoechoic
	Hypervascular Metastases	1. Hyperechoic 2. Possible central area of necrosis in large lesions	Slightly hypoechoic	Strongly hypoechoic
	Hypovascular Metastases	1.No enhancement 2.Peripheral rim	Slightly hypoechoic	Strongly hypoechoic

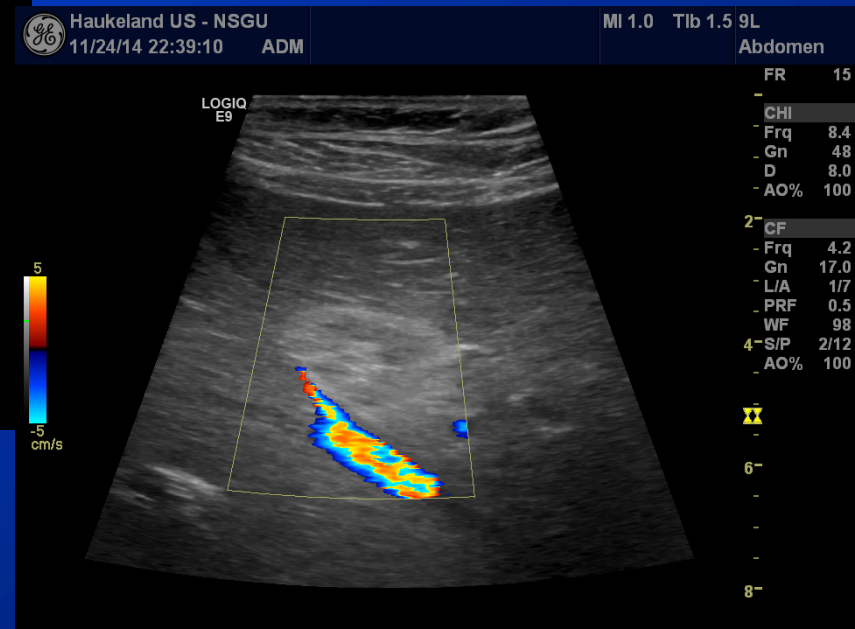
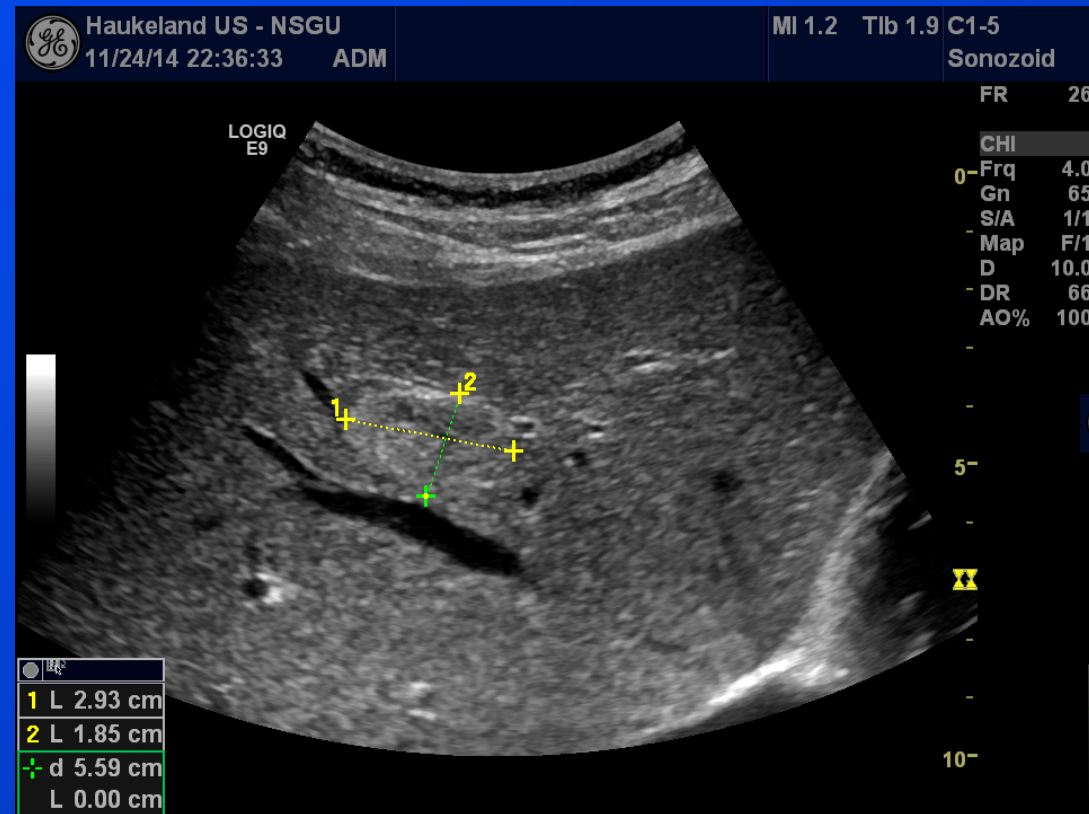


Lesion in Liver – S7



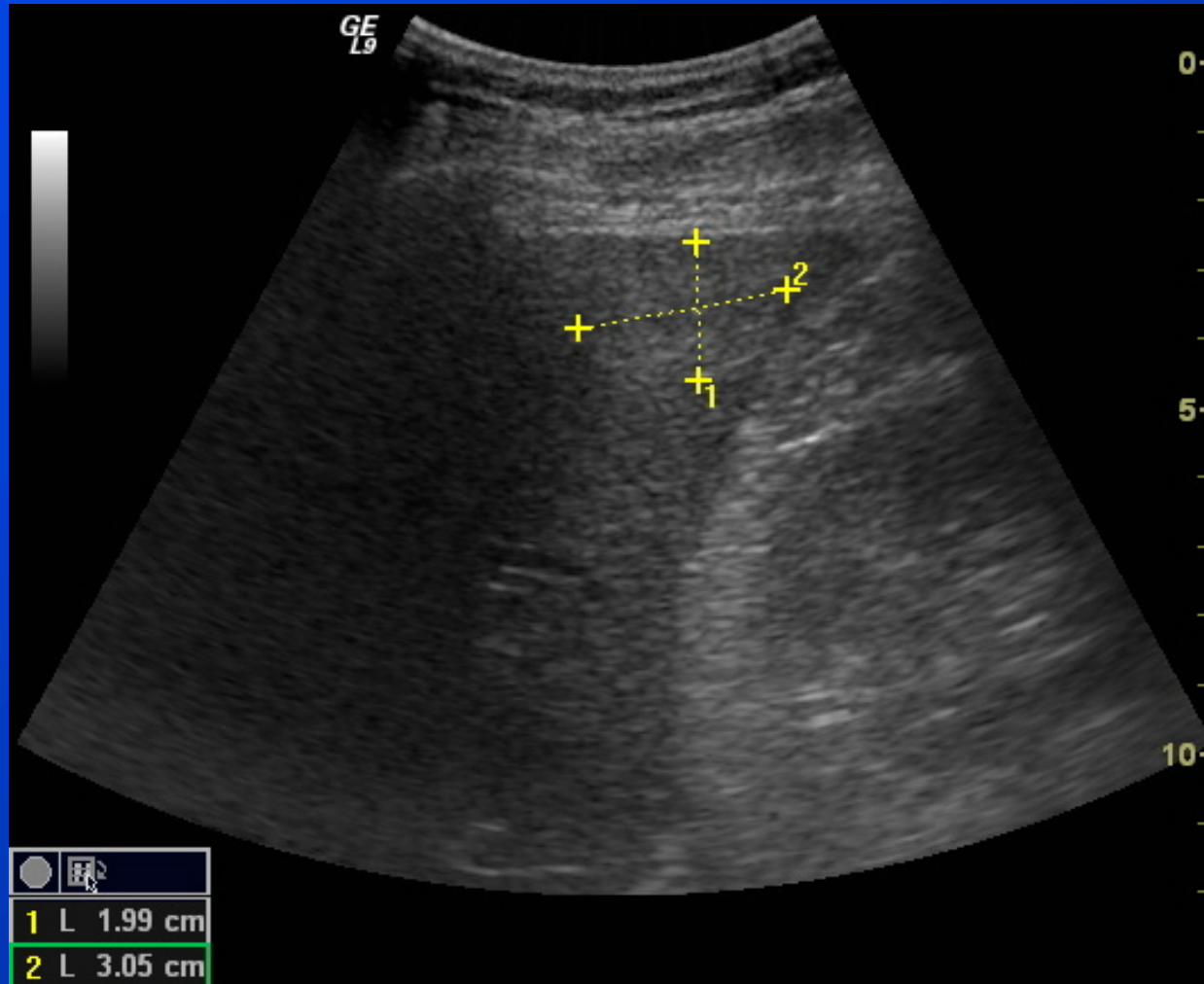


Hyper-echoic Tumor



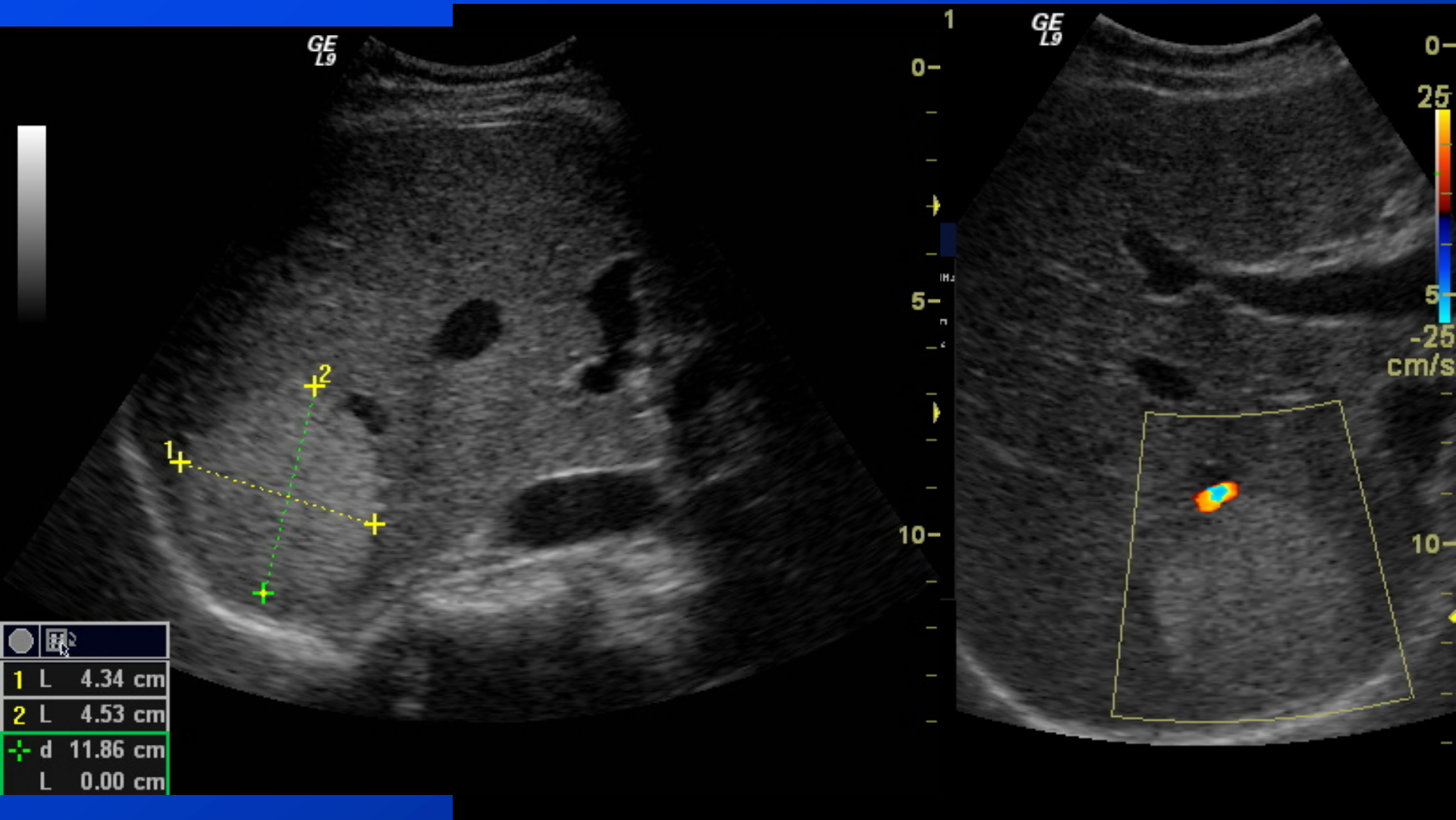


Typical location: By the capsule
or by an hepatic vein



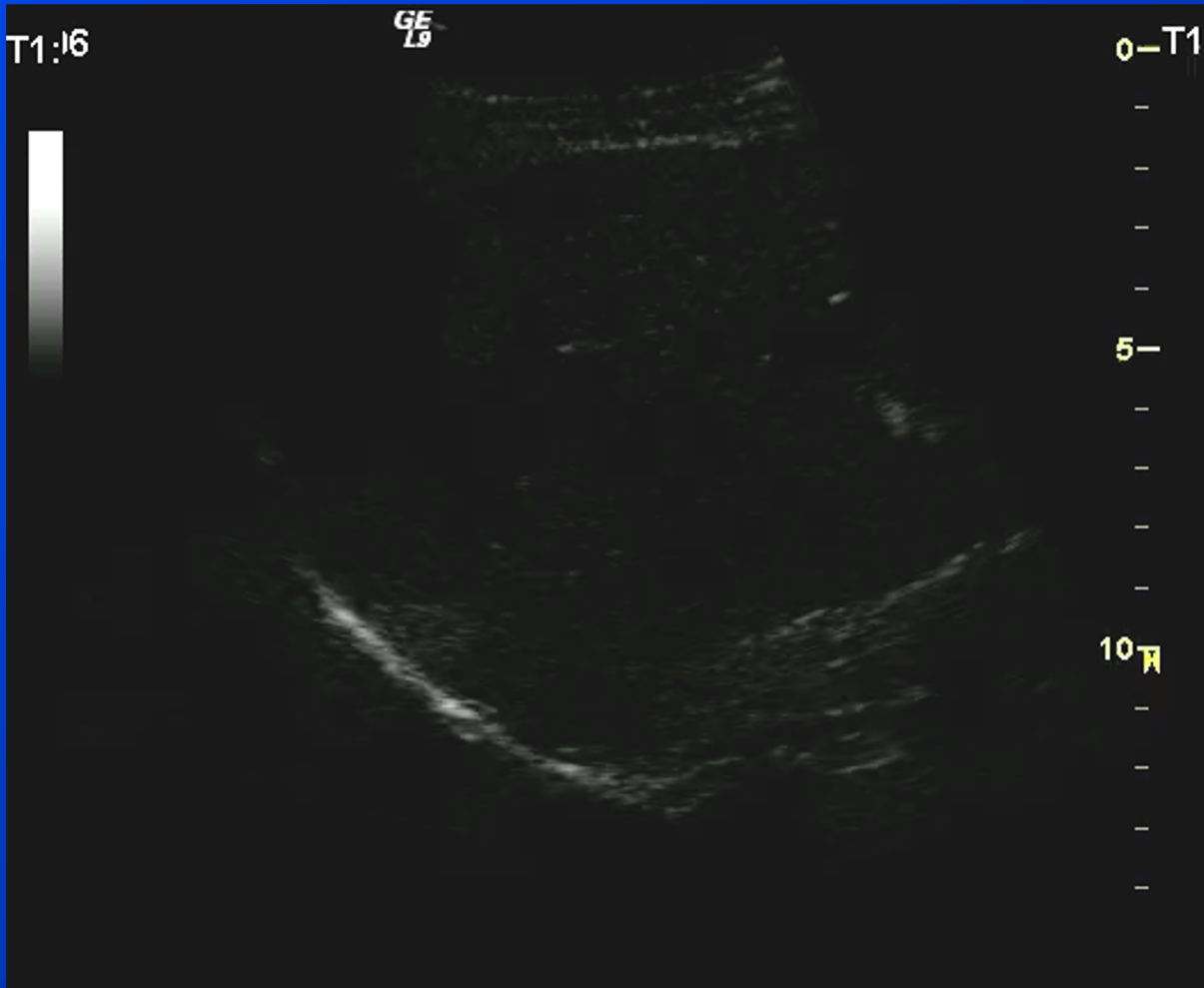


Referred from the CT-Lab Haemangioma ?





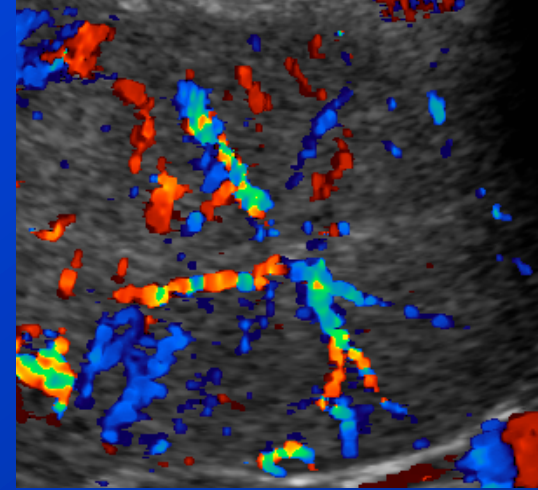
Peripheral Globular Enhancement



...with slow sentripetal filling



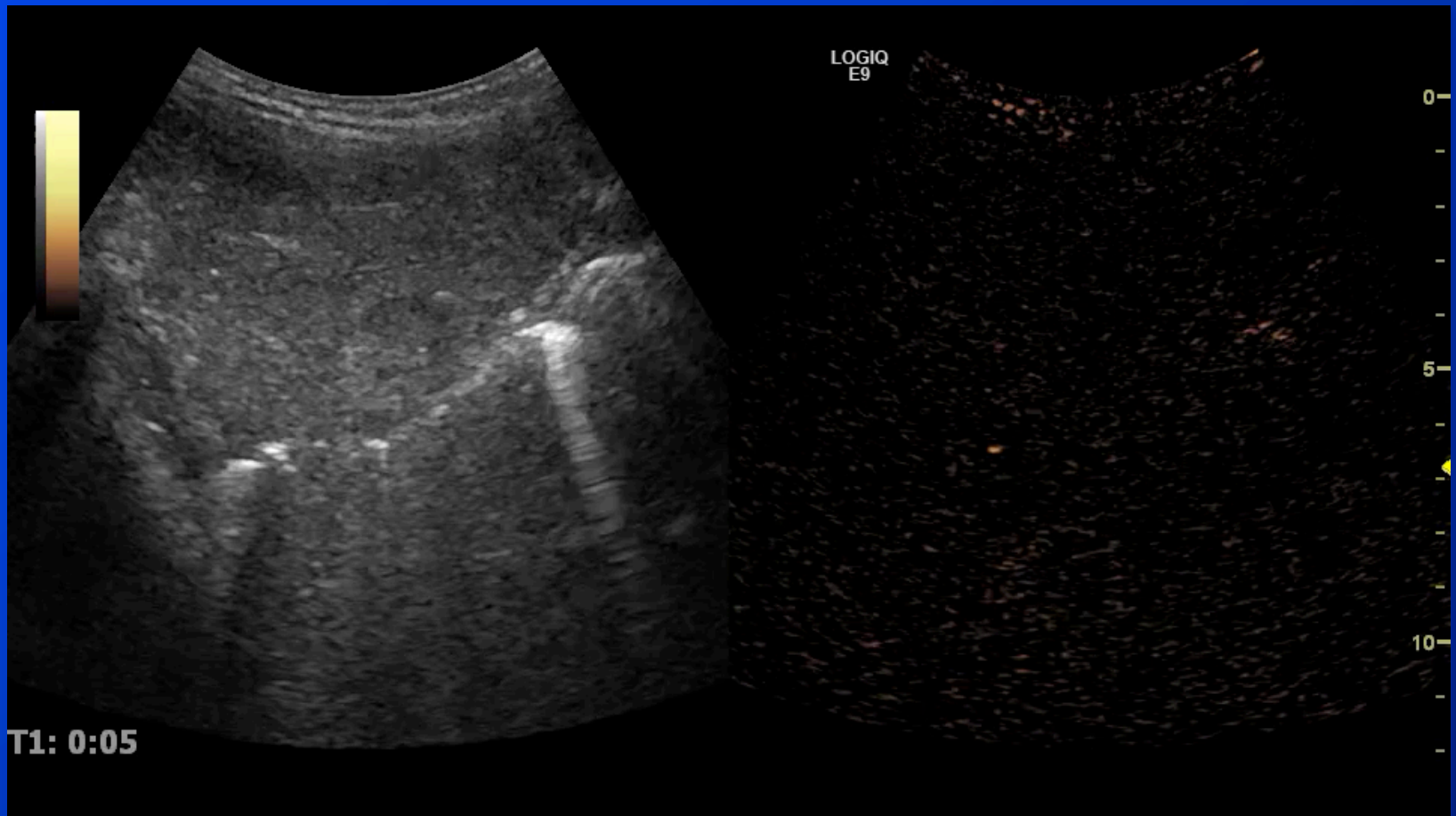
Focal Nodular Hyperplasia - FNH



- FNH- a centrifugal stellate branching in early arterial phase
- Spoke wheel pattern in approx 40%
- Intense homogenous uptake
- Iso- or hyperechoic lesion is seen in portal venous phase.
- With these characteristic features:
 - sensitivity and specificity of contrast-enhanced low MI real-time US are 87.6% and 94.5%, respectively
 - Di Stasi 1996

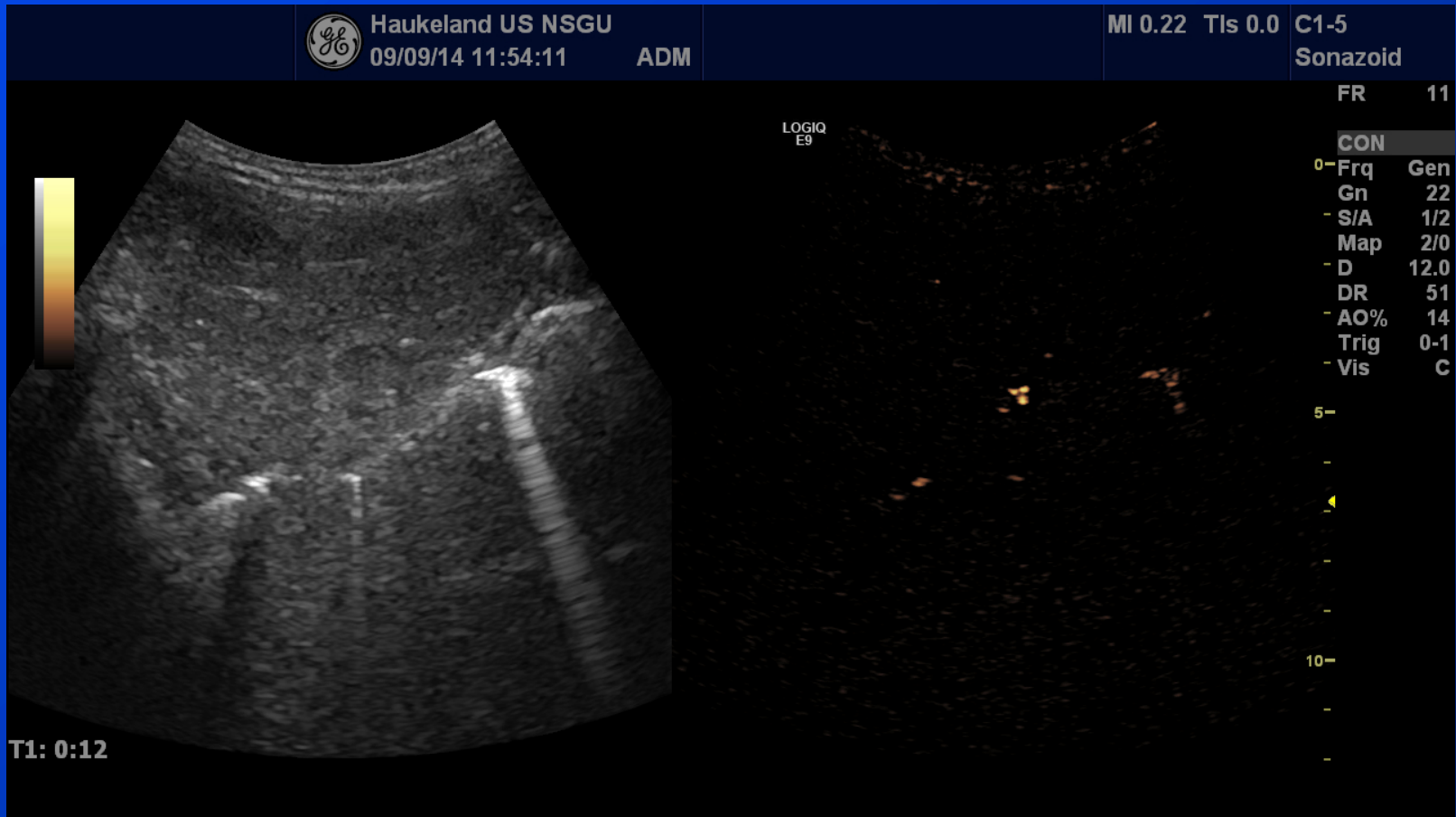


CEUS – Sonazoid - FNH





Arterial Phase: 12 sec.





Arterial Phase: 13 sec





Arterial Phase: 13 sec



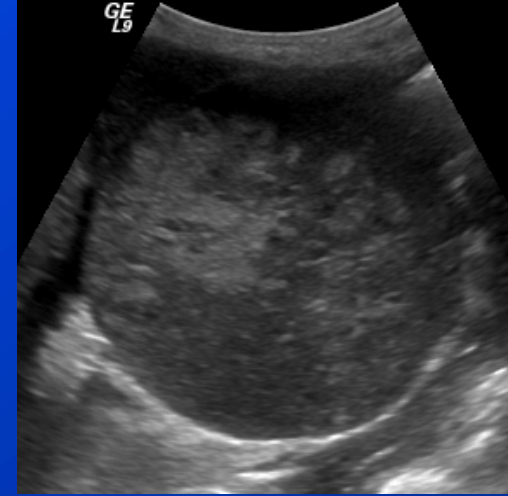


Arterial Phase: 15 sec





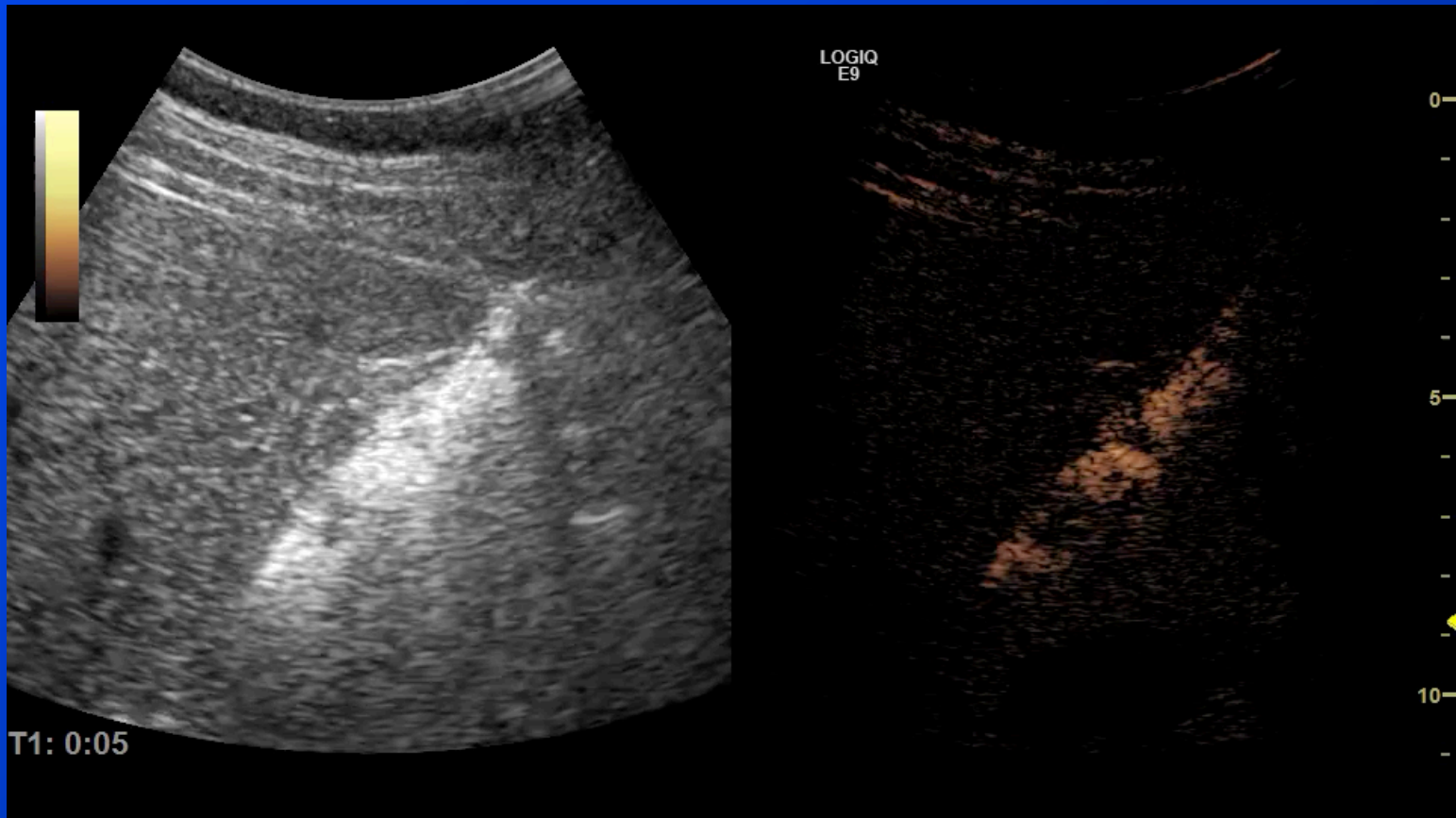
Liver cell adenoma



- Liver cell adenoma (LCA) is a rare primary benign neoplasm found mainly in young women with a history of oral contraceptive use
- The hypervascularity of adenomas can be demonstrated on Doppler,- sentripetal
- CEUS identification of the early and homogeneous hyperechoic enhancement in the periphery of the tumor, reflecting the presence of the subcapsular feeding arteries.
- The enhancement of LCA in the portal and late phases is nearly comparable with that of liver parenchyma, but LCA can remain slightly hypoechoic in relation to the adjacent liver



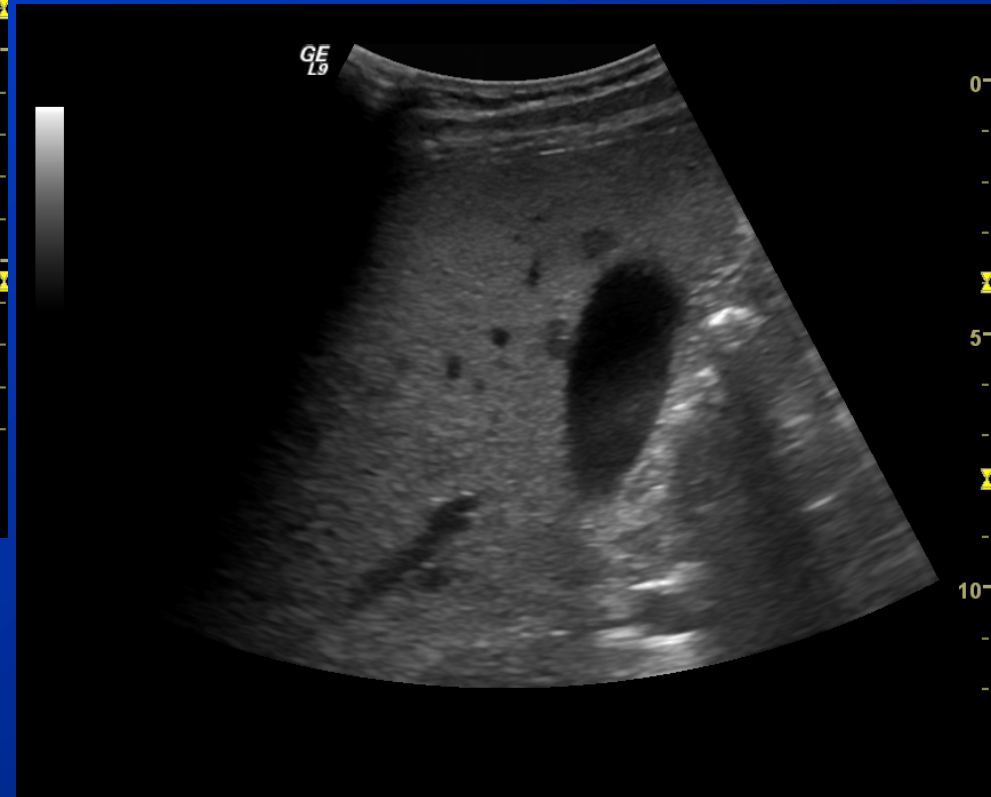
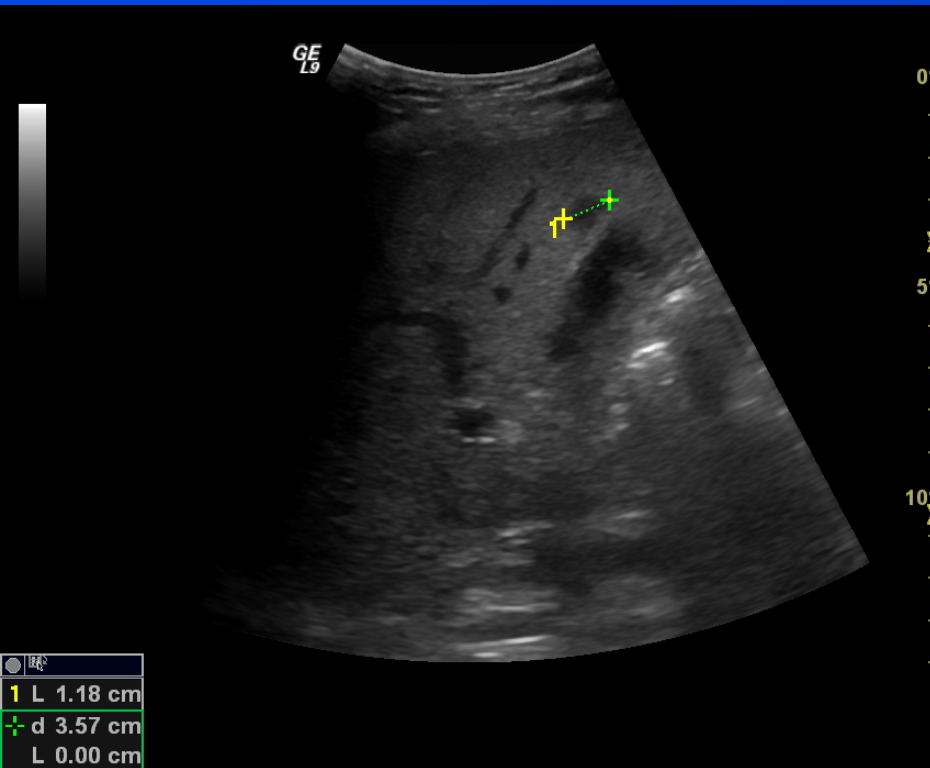
CEUS - Real-time Perfusion



Dynamic abilities outperforms CT and MR

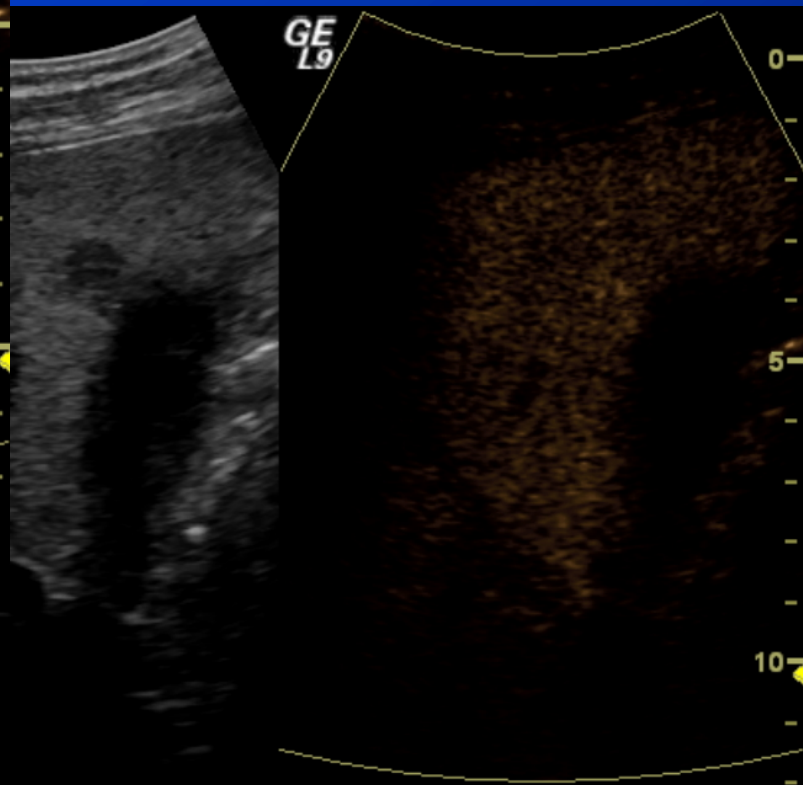
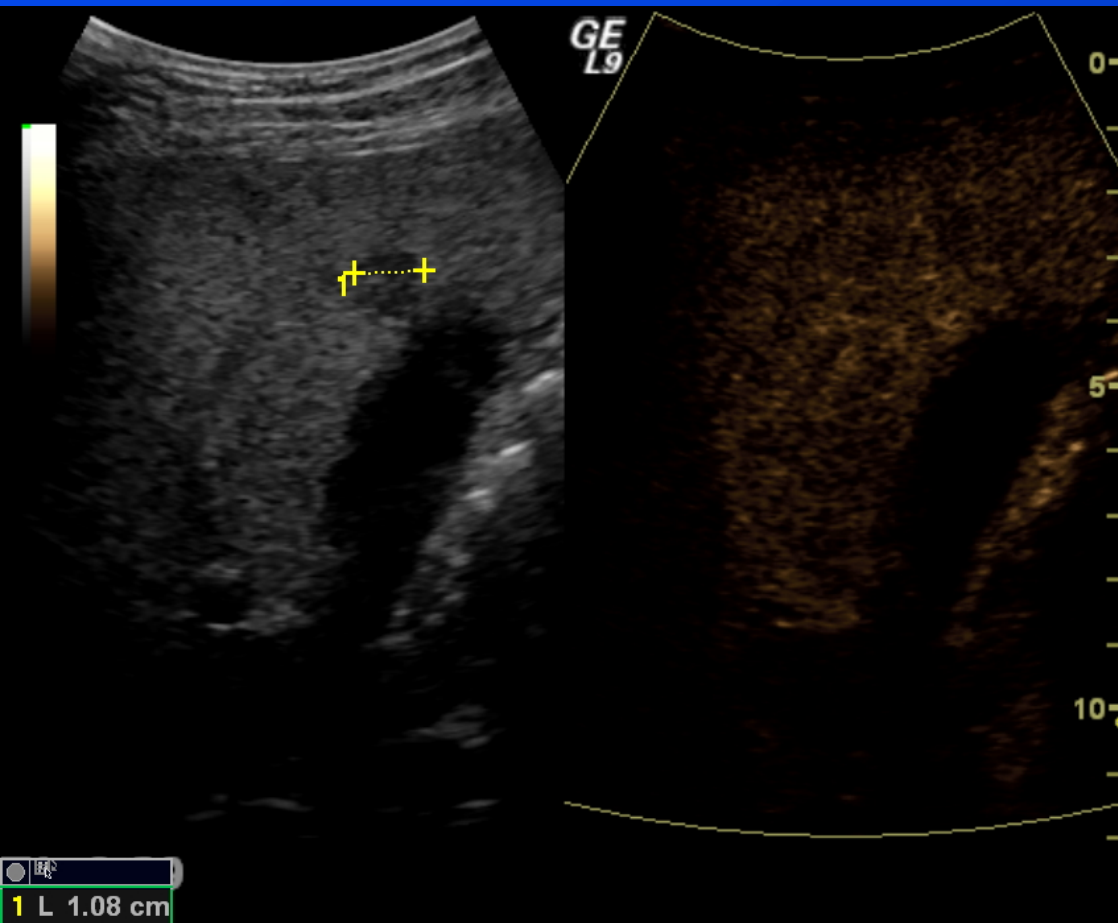


A common problem: Focal Lesions in Fatty Livers





CEUS in FLL

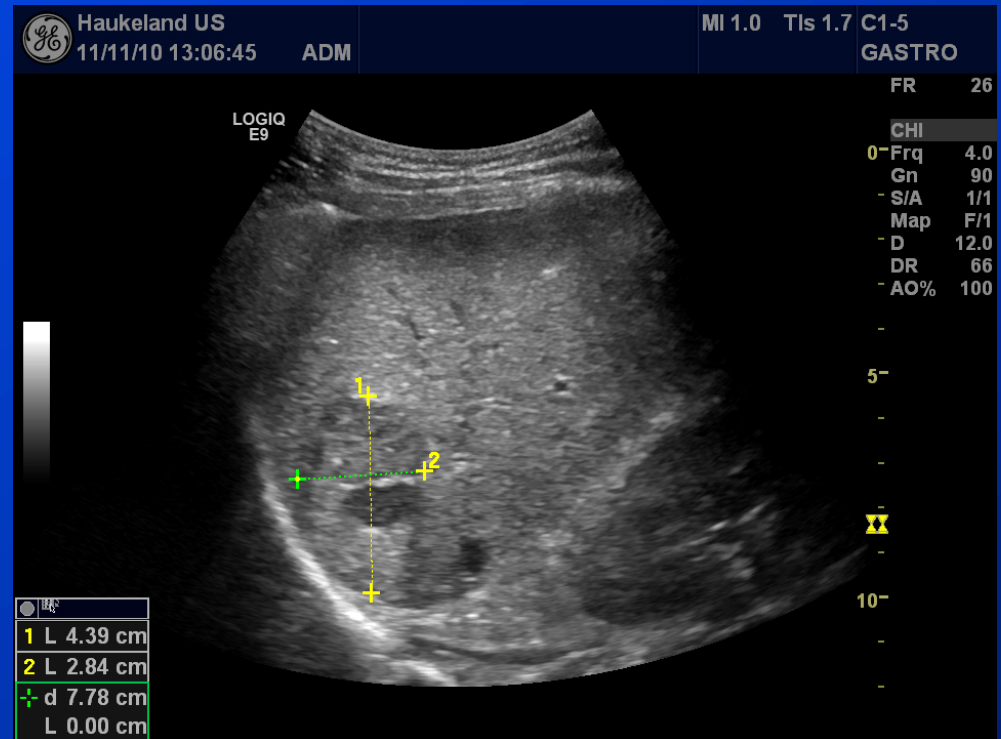


T1: 3:18



Ultrasound in HCC

- **Diagnosis**
 - B-mode
 - Doppler
 - CEUS
- US-guided biopsy
- Per-operative guiding of ablation
- Follow-up and monitoring of treatment
- **Surveillance / Screening**





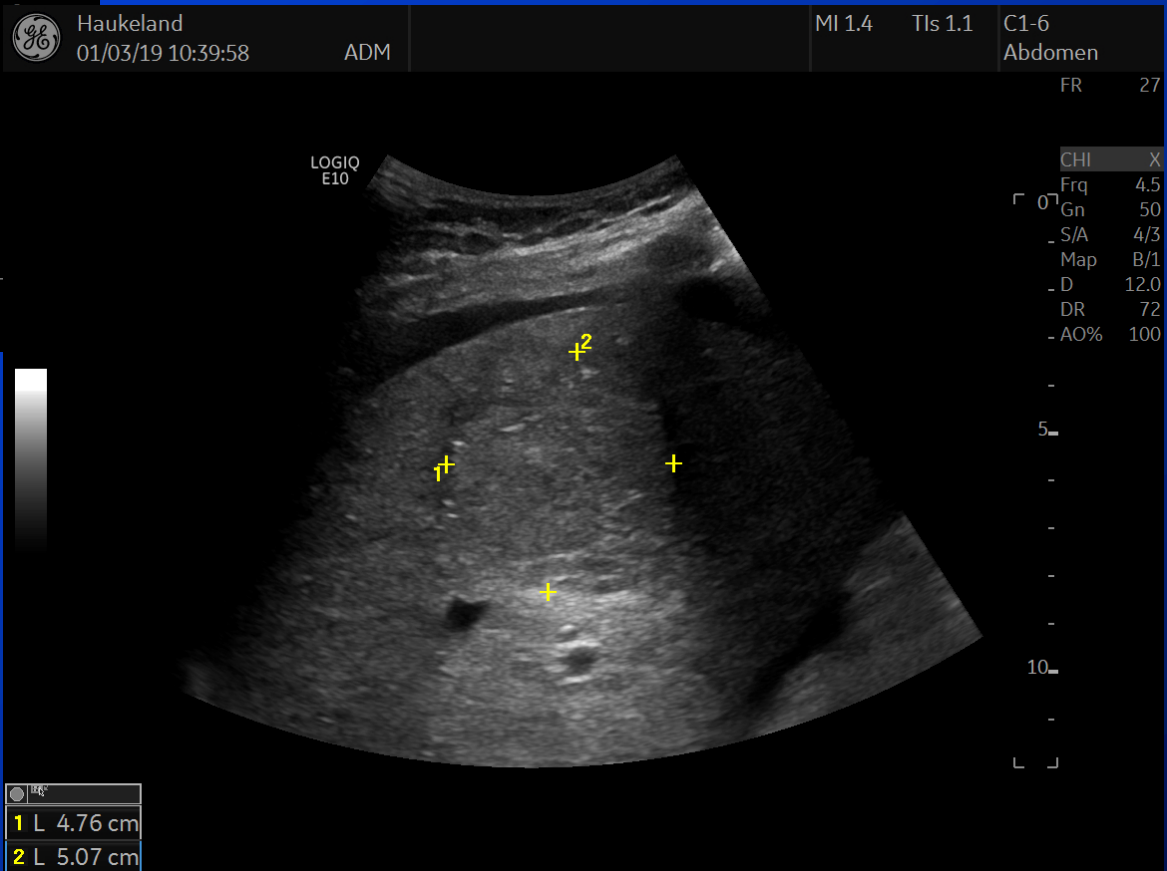
HCC facts

HCC – The great imitator

- Increasing incidence world-wide
- 90% has known ethiology
- AFP has limited sensitivity (approx. 60%)
- Most frequent: Alcohol (25%) and HCV
- NASH is increasing in incidence, thus feeding the HCC growth
- Barcelona criteria: 2 independant imaging methods are needed to avoid biopsy

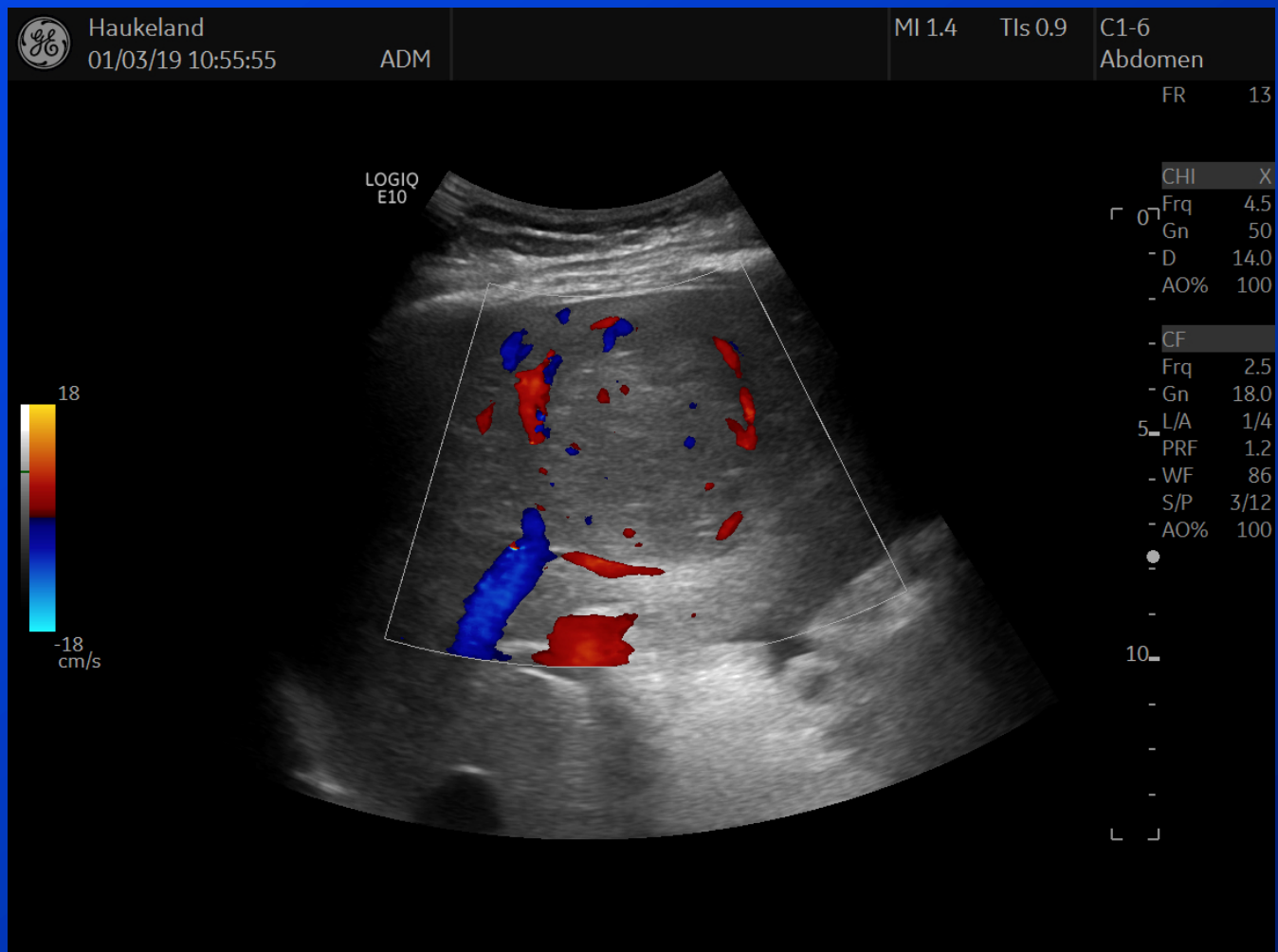


A patient with cirrhosis



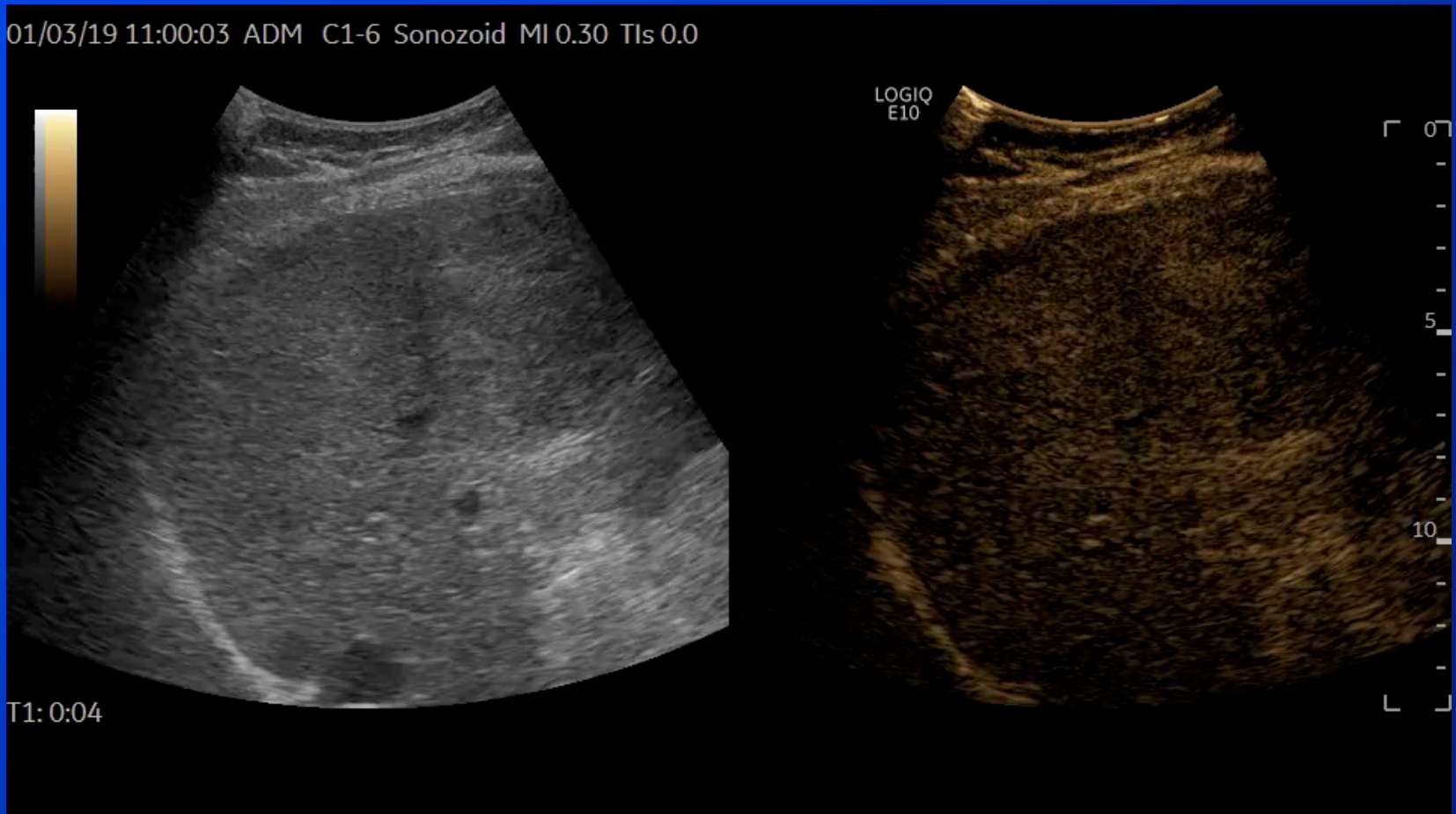


«The Basket Sign»



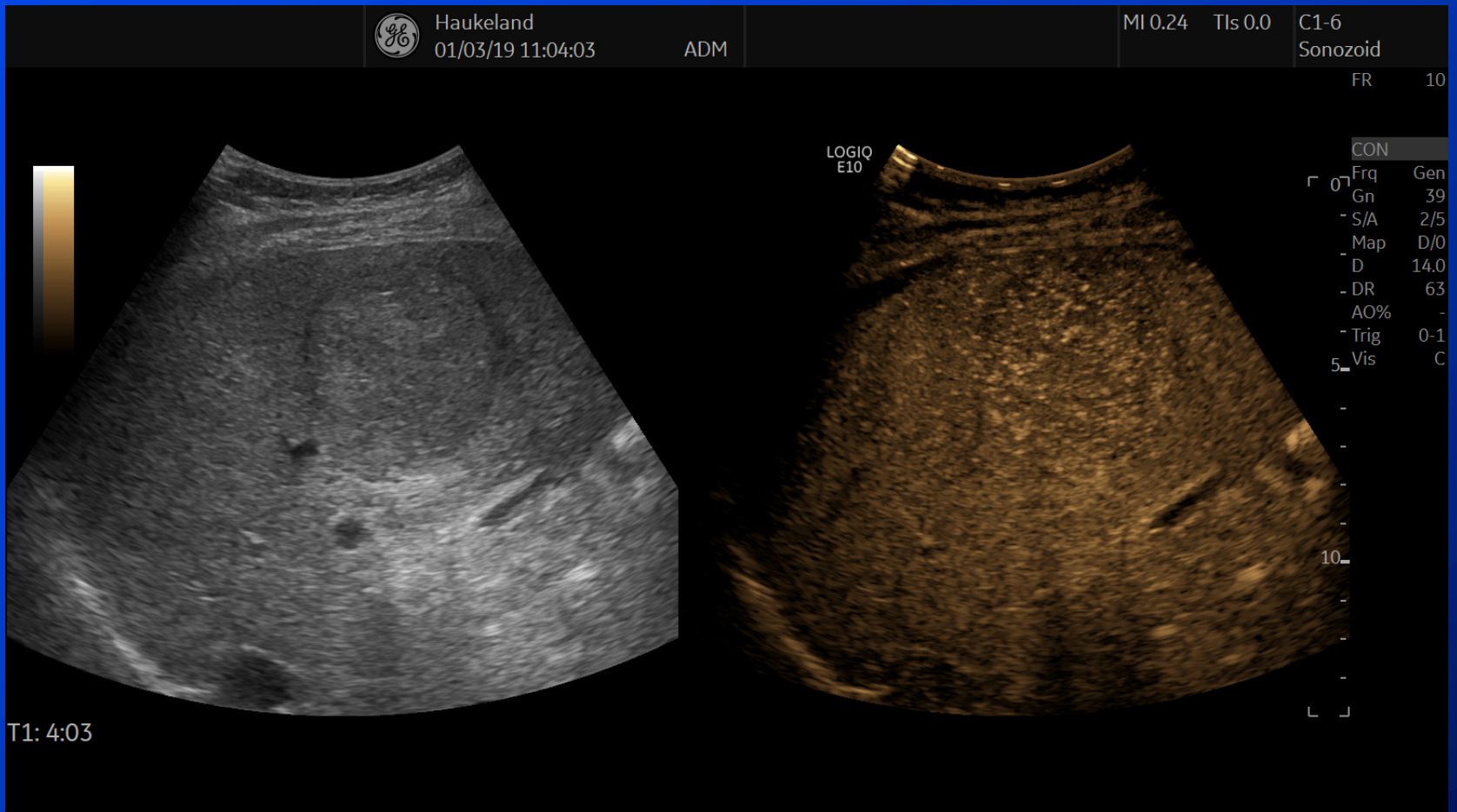


CEUS of tumor





Any wash-out in late phase ?





FNH versus HCC



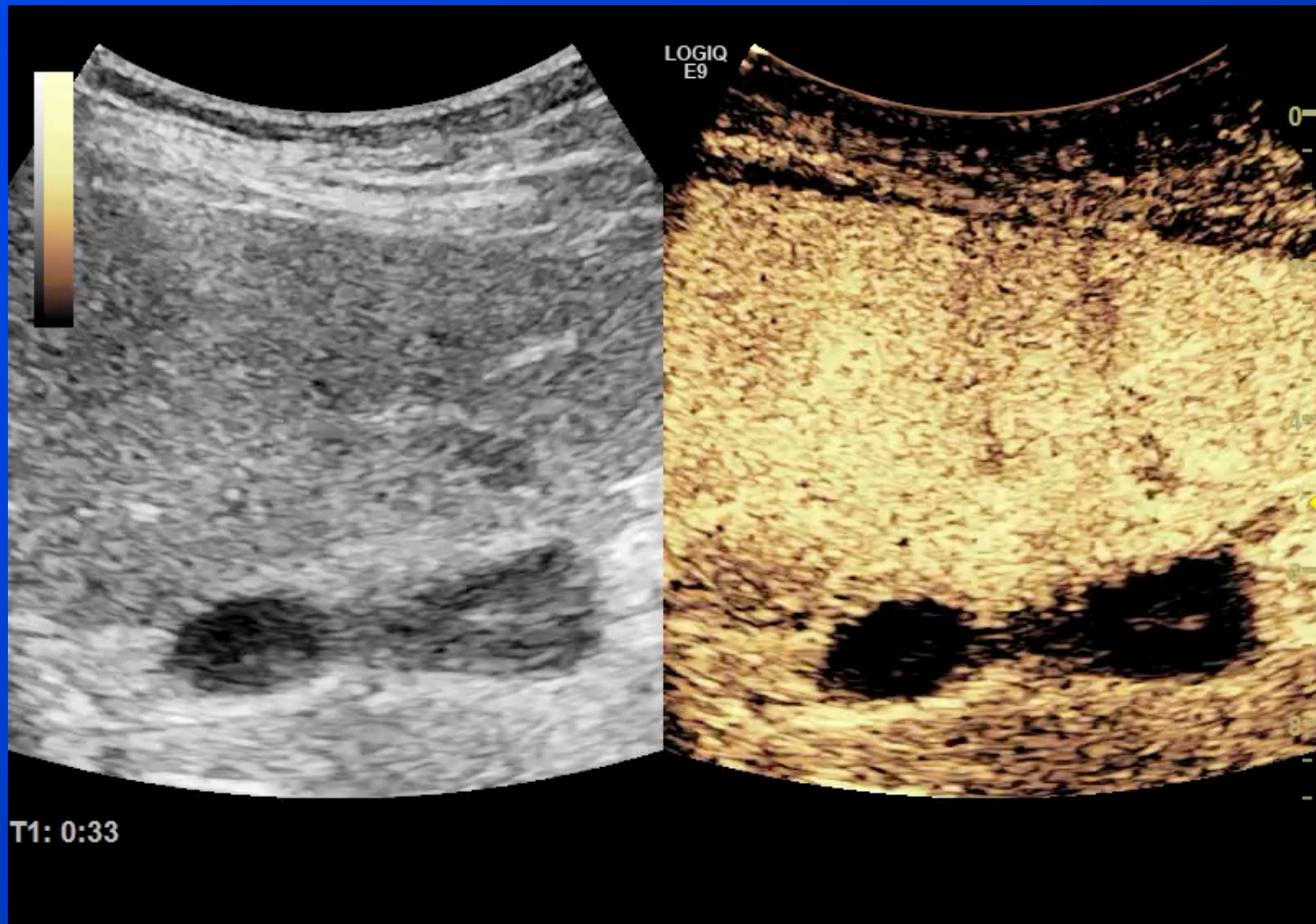
FNH



HCC



Early wash-out typical for mets

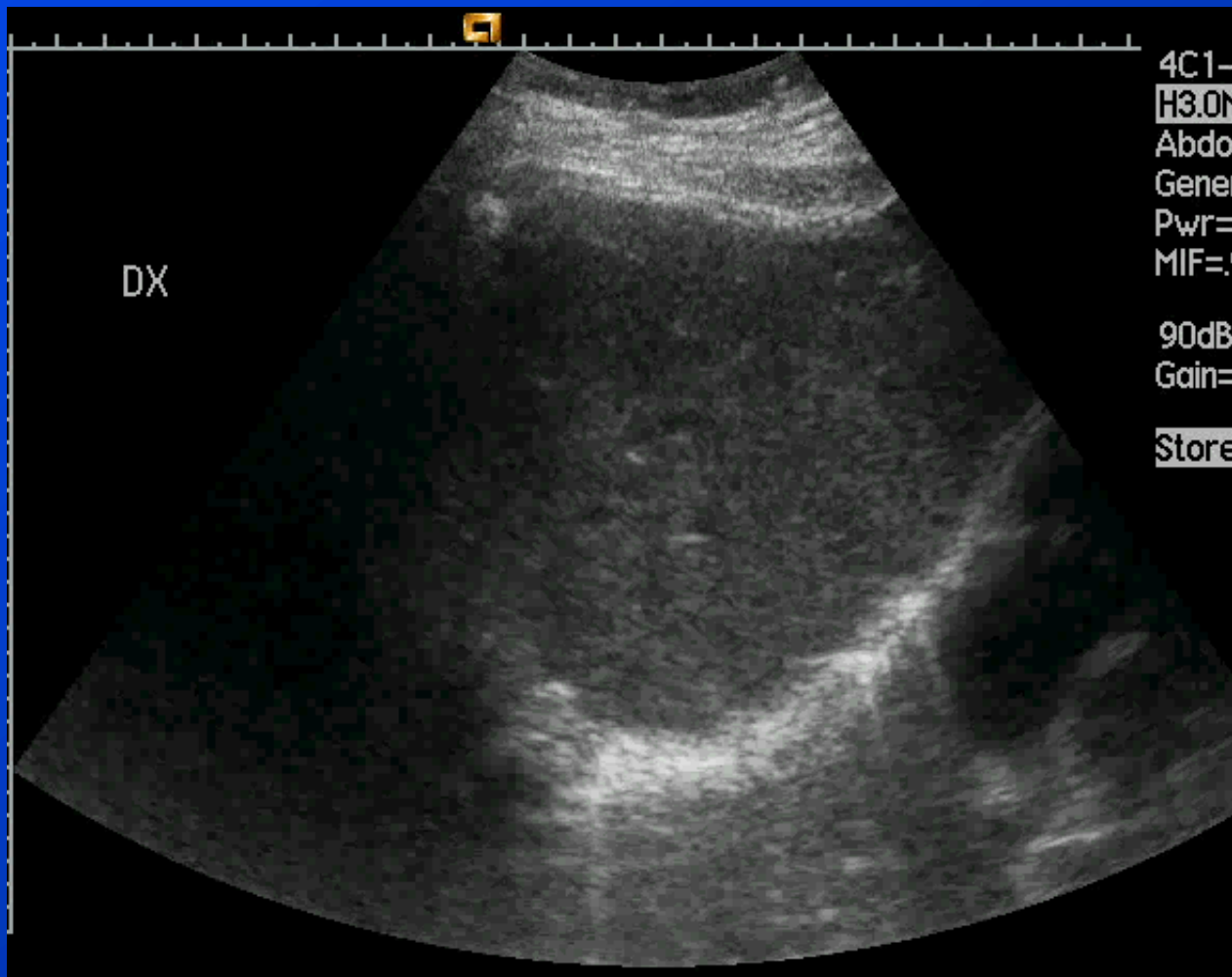


Not easily observed on CT and MRI



Liver Metastasis ?

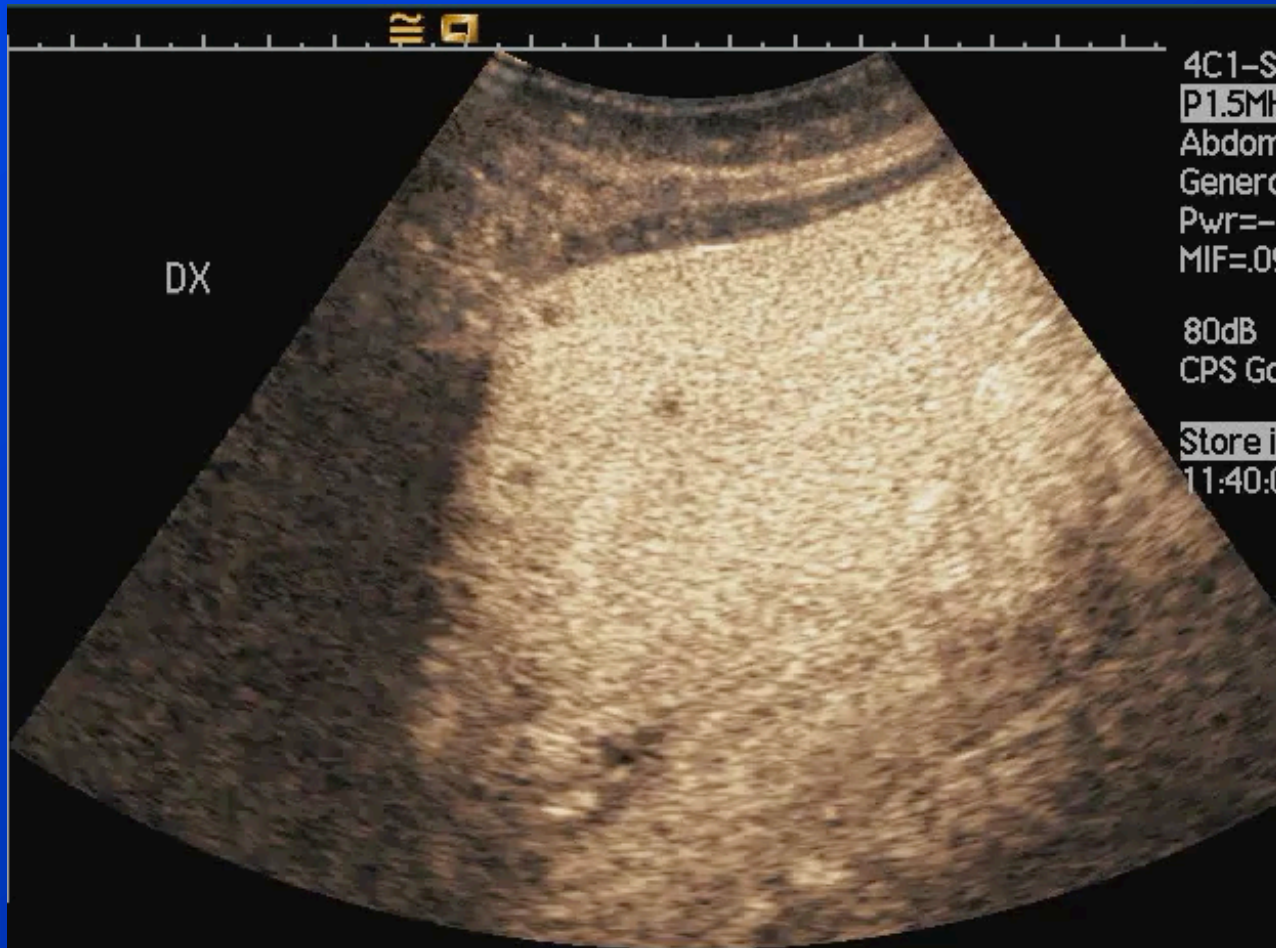
Before contrast injection





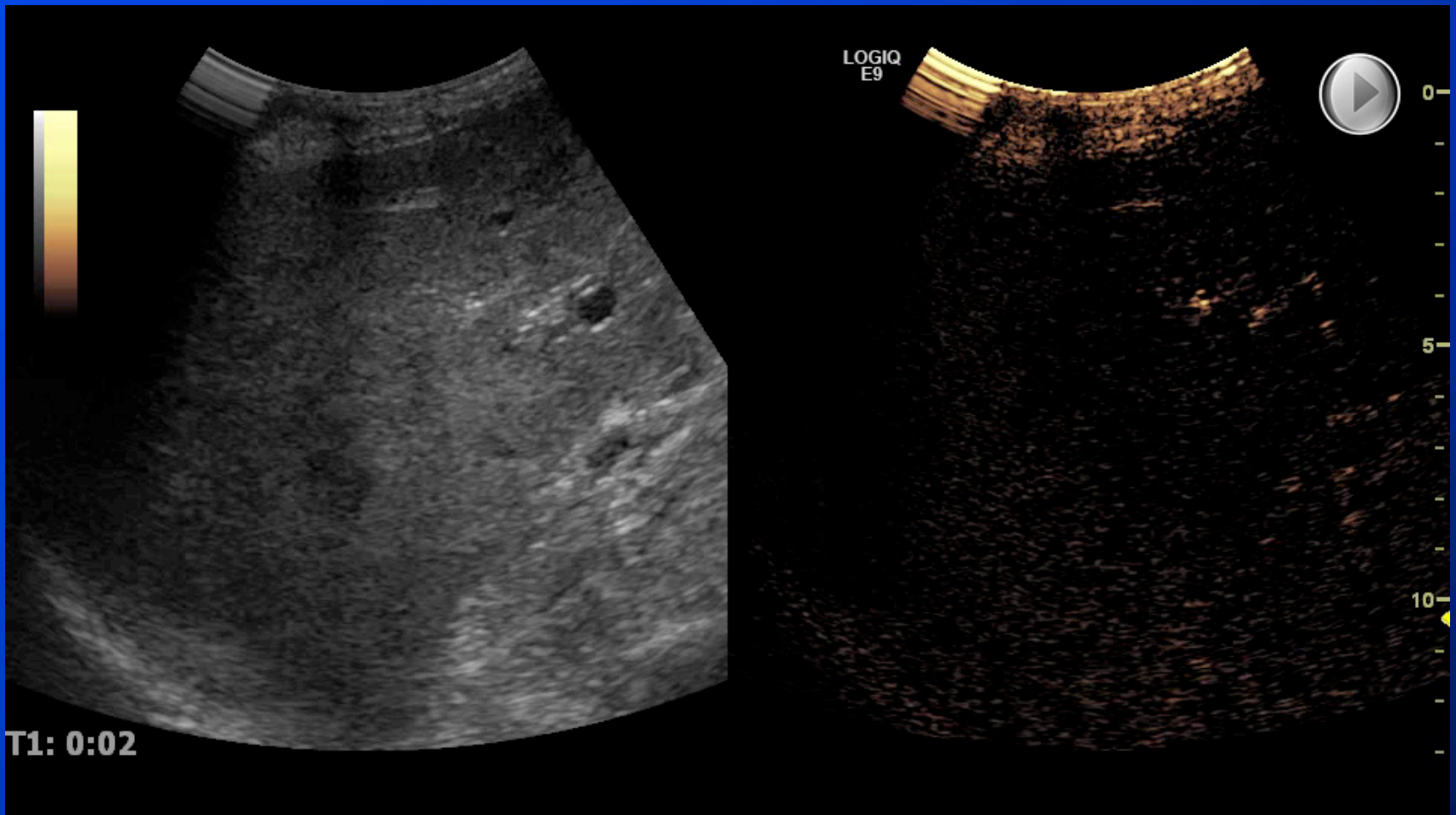
Liver Metastasis ?

After contrast injection in late phase





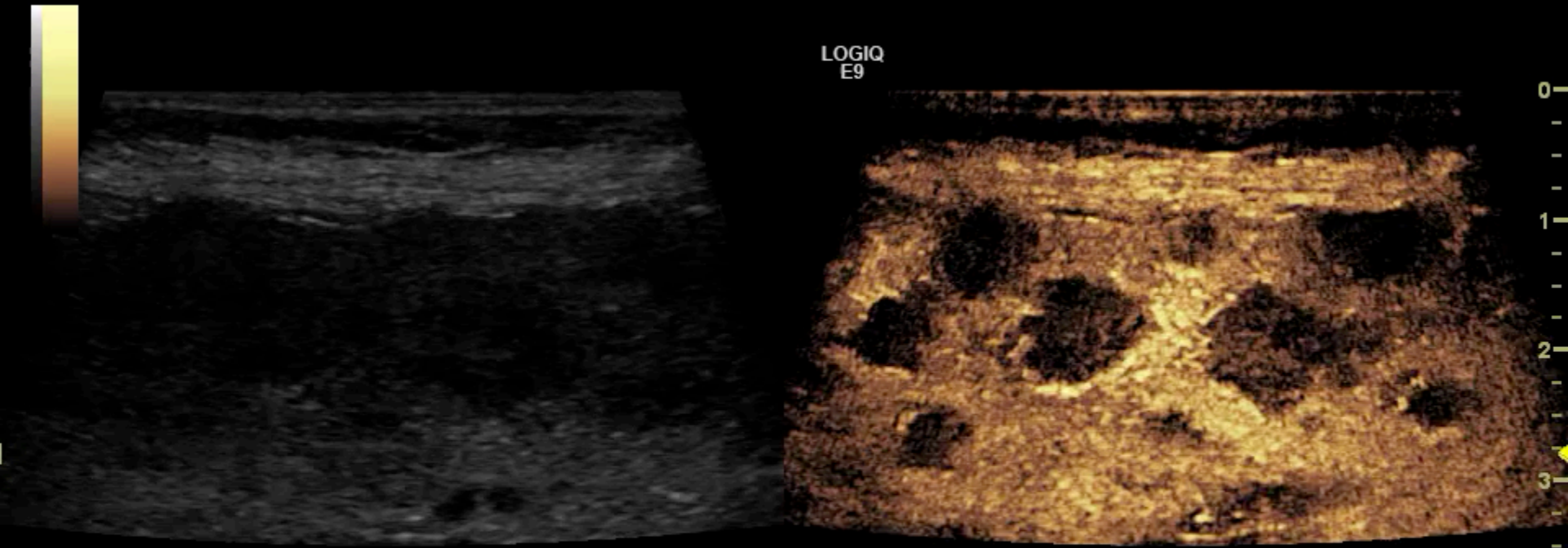
Mets from Rectal Cancer





High-Frequency 9 MHz LA probe

Post-vascular phase (Kupffer)

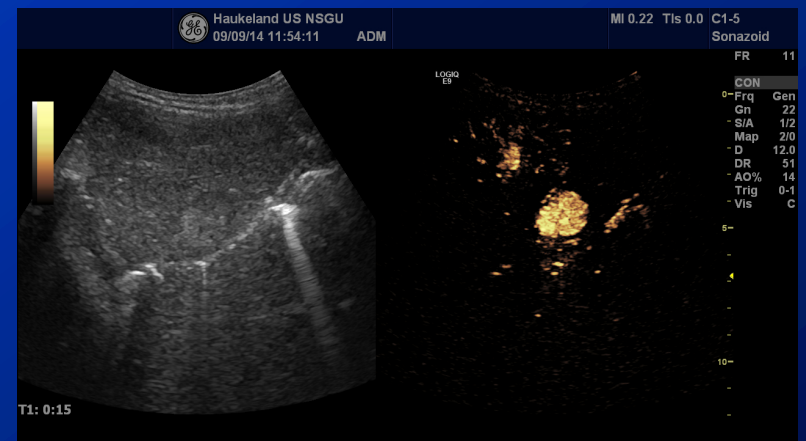
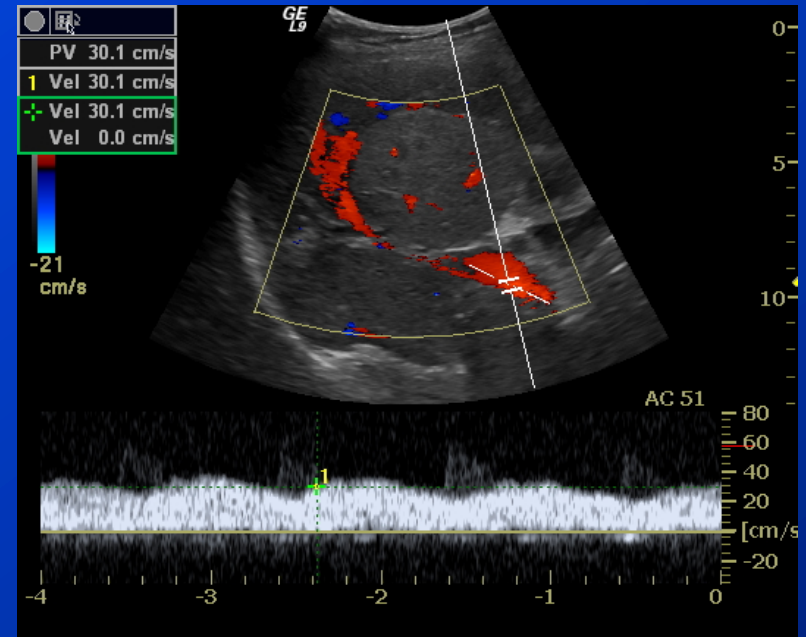


T1: 11:02



One stop shopping

- US B-mode
- Doppler
 - Color flow
 - Pulsed Doppler
- Elastography
 - Shear wave
 - Strain imaging
- CEUS
- US-guided biopsy





"Yes, we scan"





US first = Ultrasound first...



”This is NOT fake news !”