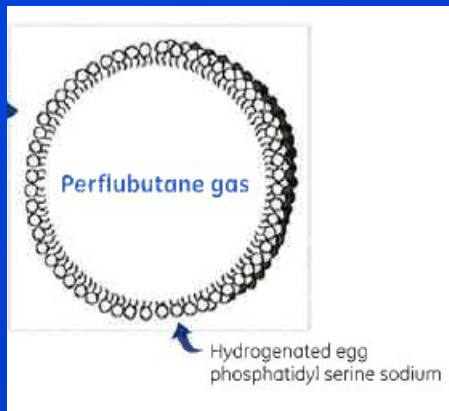




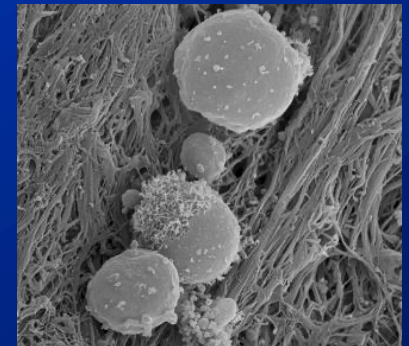
Nasjonalt Senter for Gastroenterologisk Ultrasonografi

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

Contrast-Enhanced Ultrasound CEUS



Odd Helge Gilja
Professor, MD, PhD
Department of Clinical Medicine
University of Bergen





The Ultrasound Tool-box

- Ultrasound of liver

- B mode

- B-Flow

- Doppler

- Color Doppler

- Pulsed Doppler

- Elastography

- Strain imaging

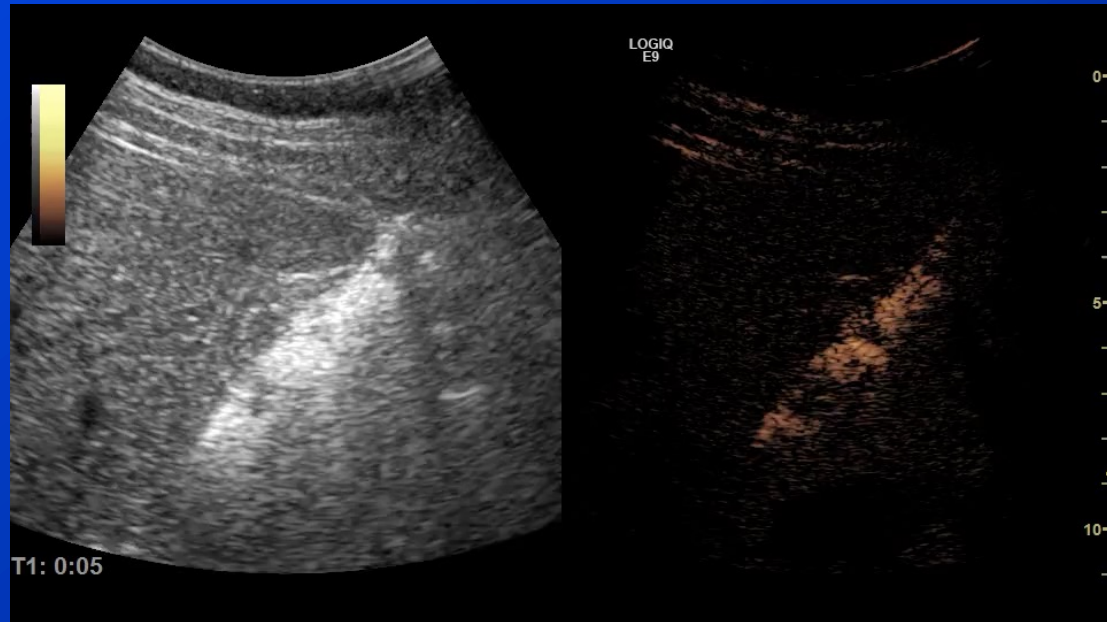
- Shear wave

- **Contrast-US (CEUS)**

- US-guided liver biopsy (Menghini and Pistol)

- US-guided ablation techniques

- Sonoporation therapy

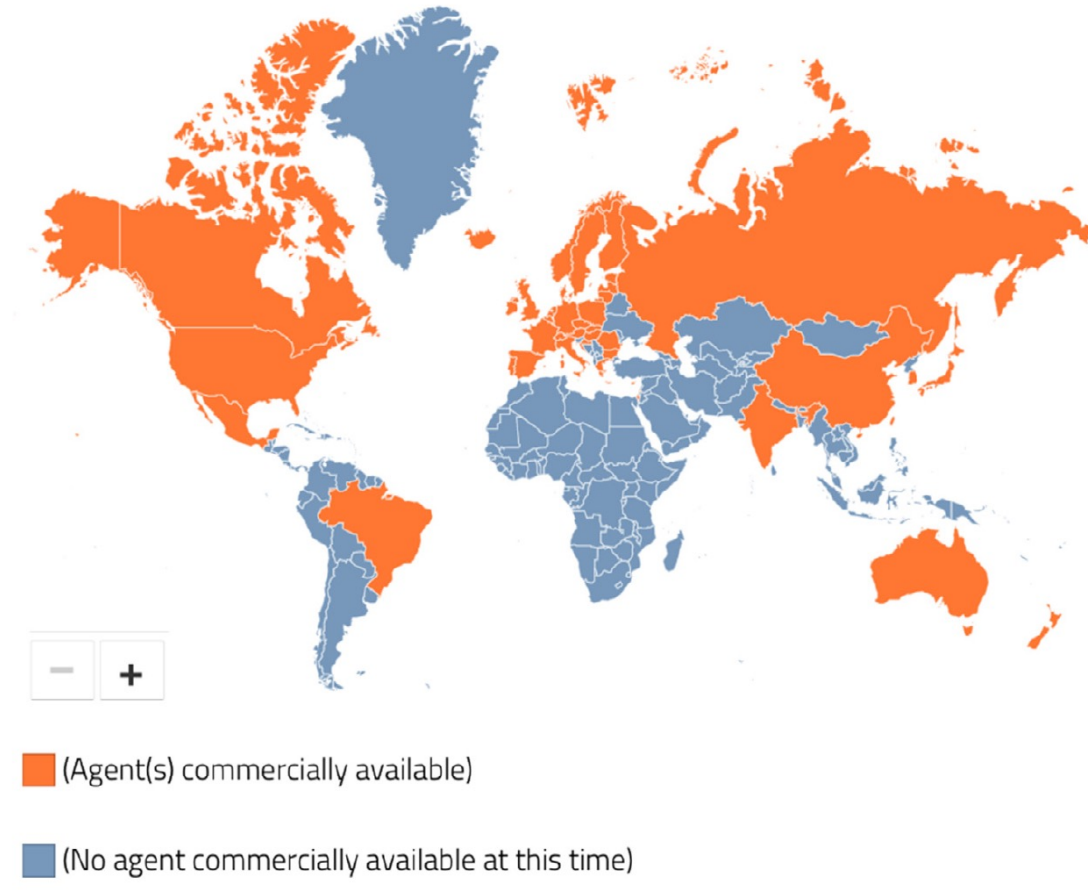




World map of CEUS

Global Contrast-Enhanced Ultrasound (CEUS)

Click on any country shaded in orange to see the commercially available agent(s).





Available agents for liver CEUS

- Definity/Luminality (Lantheus Medical Imaging, Inc., North Billerica, MA, USA)
- SonoVue/Lumason (Bracco Suisse SA, Geneva, Switzerland)
- Optison (GE Healthcare AS, Oslo, Norway)
- Sonazoid (GE Healthcare AS, Oslo, Norway)



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

F. Piscaglia¹, C. Nolsøe², C. F. Dietrich³, D. O. Cosgrove⁴, O. H. Gilja⁵, M. Bachmann Nielsen⁶, T. Albrecht⁷, L. Barozzi⁸, M. Bertolotto⁹, O. Catalano¹⁰, M. Claudon¹¹, D. A. Clevert¹², J. M. Correas¹³, M. D'Onofrio¹⁴, F. M. Drudi¹⁵, J. Eyding¹⁶, M. Giovannini¹⁷, M. Hocke¹⁸, A. Ignee¹⁹, E. M. Jung²⁰, A. S. Klauser²¹, N. Lassau²², E. Leen²³, G. Mathis²⁴, A. Saftoiu²⁵, G. Seidel²⁶, P. S. Sidhu²⁷, G. ter. Haar²⁸, D. Timmerman²⁹, H. P. Weskott³⁰

Affiliations

Affiliation addresses are listed at the end of the article.

Bibliography

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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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New CEUS guidelines 2020



ELSEVIER



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0301-5629/\$ - see front matter

<https://doi.org/10.1016/j.ultrasmedbio.2020.04.030>

● Review Article

GUIDELINES AND GOOD CLINICAL PRACTICE RECOMMENDATIONS FOR CONTRAST-ENHANCED ULTRASOUND (CEUS) IN THE LIVER—UPDATE 2020 WFUMB IN COOPERATION WITH EFSUMB, AFSUMB, AIUM, AND FLAUS

CHRISTOPH F. DIETRICH,^{*,†2} CHRISTIAN PÁLLSON NOLSØE,^{‡,2} RICHARD G. BARR,^{§,¶}
ANNALISA BERZIGOTTI,^{||} PETER N. BURNS,[#] VITO CANTISANI,^{**} MARIA CRISTINA CHAMMAS,^{††}
NITIN CHAUBAL,^{‡‡} BYUNG IHN CHOI,^{§§} DIRK-ANDRÉ CLEVERT,^{¶¶} XINWU CUI,^{|||} YI DONG,^{##}
MIRKO D’ONOFRIO,^{***} J. BRIAN FOWLKES,^{†††} ODD HELGE GILJA,^{‡‡‡} PINTONG HUANG,^{§§§}
ANDRE IGNEE,^{¶¶¶} CHRISTIAN JENSSEN,^{|||} YUKO KONO,^{###} MASATOSHI KUDO,^{****}
NATHALIE LASSAU,^{††††} WON JAE LEE,^{‡‡‡‡§§§§} JAE YOUNG LEE,^{¶¶¶¶} PING LIANG,^{|||} ADRIAN LIM,^{####}
ANDREJ LYSCHCHIK,^{*****} MARIA FRANCA MELONI,^{†††††} JEAN MICHEL CORREAS,^{‡‡‡‡‡}
YASUNORI MINAMI,^{§§§§§} FUMINORI MORIYASU,^{¶¶¶¶¶} CARLOS NICOLAU,^{|||} FABIO PISCAGLIA,^{#####}
ADRIAN SAFTOIU,^{*****} PAUL S. SIDHU,^{††††††} IOAN SPOREA,^{‡‡‡‡‡‡} GUIDO TORZILLI,^{§§§§§§}
XIAOYAN XIE,^{¶¶¶¶¶¶} and RONGQIN ZHENG^{|||}



Is CEUS safe?

RECOMMENDATION 1

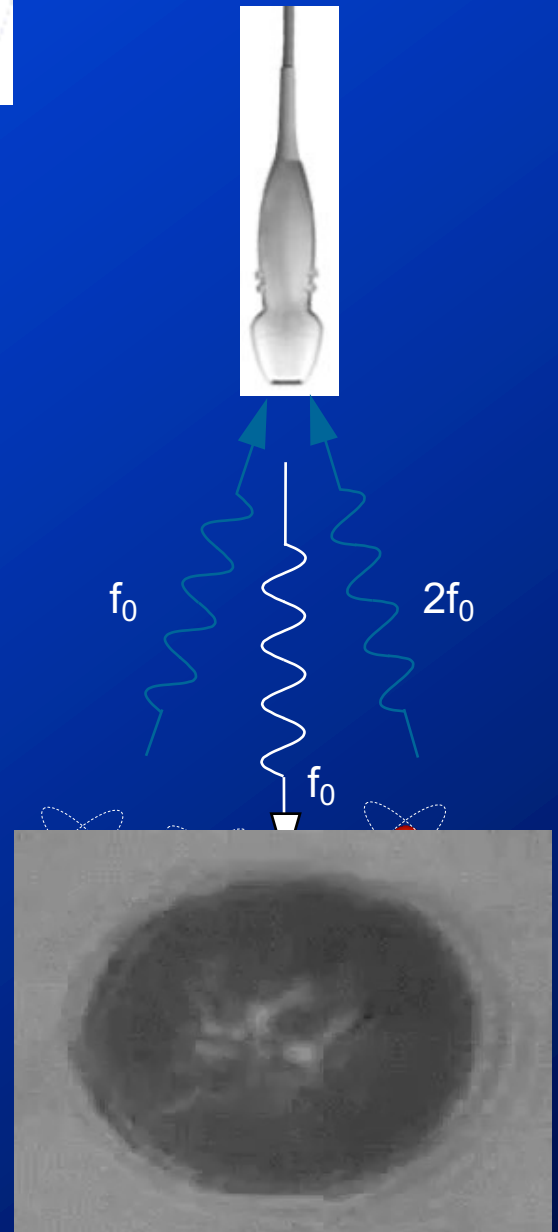
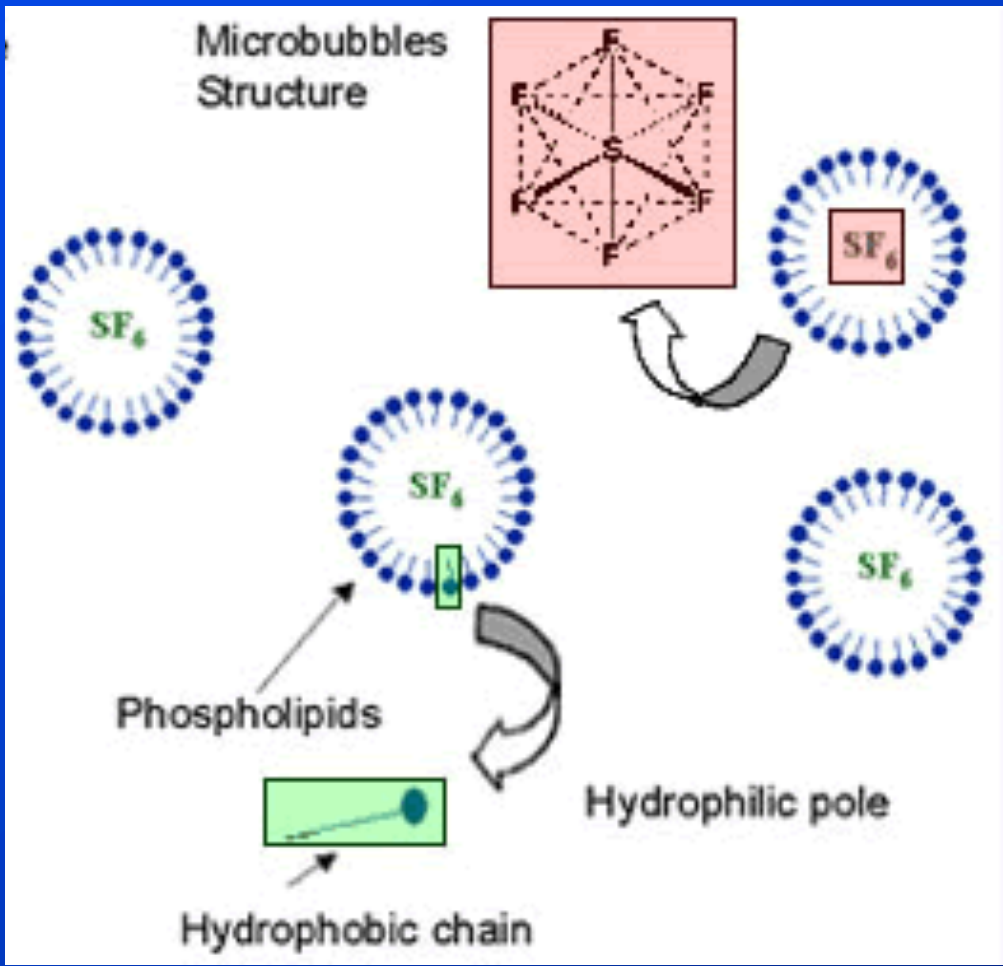
Intravenous use of UCAs in adult populations is safe (LoE 2) (Pro 28, Abs 0, Against 0).

RECOMMENDATION 2

Intravenous use of UCAs in pediatric populations is safe (LoE 3) (Pro 28, Abs 0, Against 0).

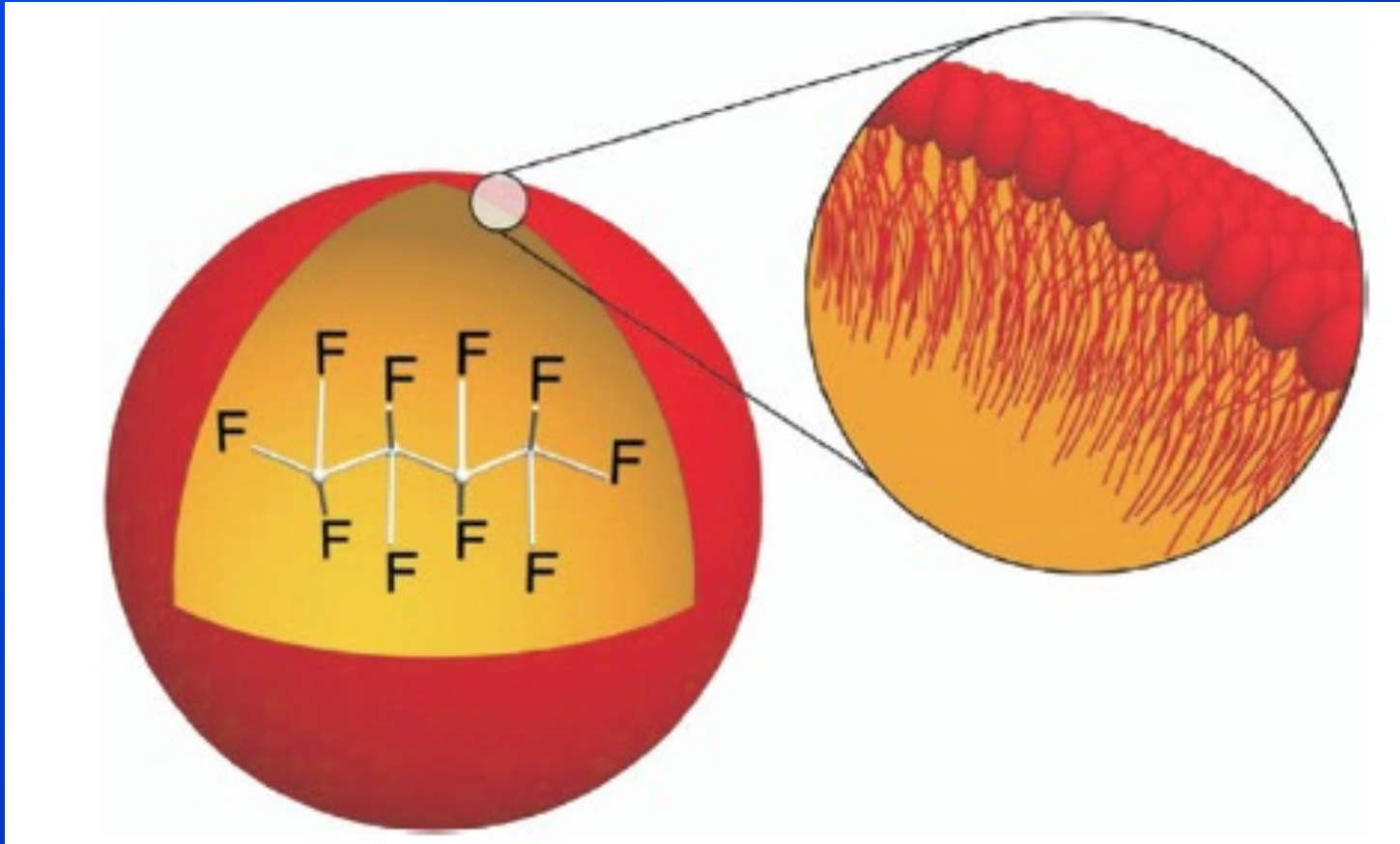
RECOMMENDATION 3

Intracavitary use of UCAs is safe (LoE 2) (Pro 27, Abs 1, Against 0).





Sonazoid



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



3 Phases of Liver Perfusion

- Arterial phase
 - 0-30 sec.
- Portal phase
 - 30-120 sec.
- Sinusoidal phase (Parenchymal)
 - 2-4(5) min
- Postvascular phase
 - 6-30 min





Indications - Liver

- Detection of focal lesions
 - metastasis
- Characterisation of benign focal lesions
 - FNH, haemangioma, adenoma
- In cirrhosis: Characterize nodules / HCC
- Guiding of biopsies
- Guiding of intervention,- eg. ablation

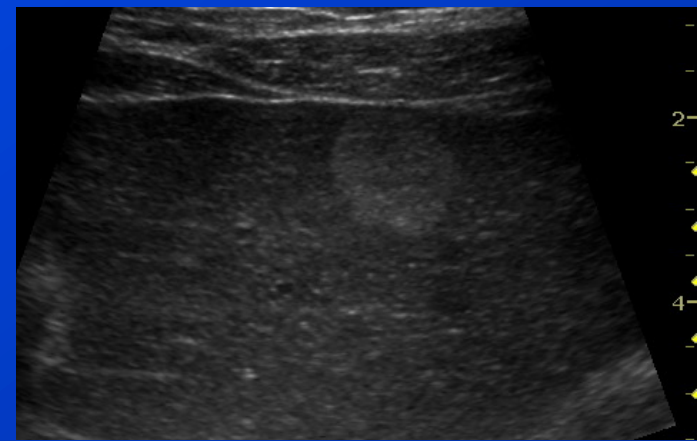


Focal Liver Lesions

	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



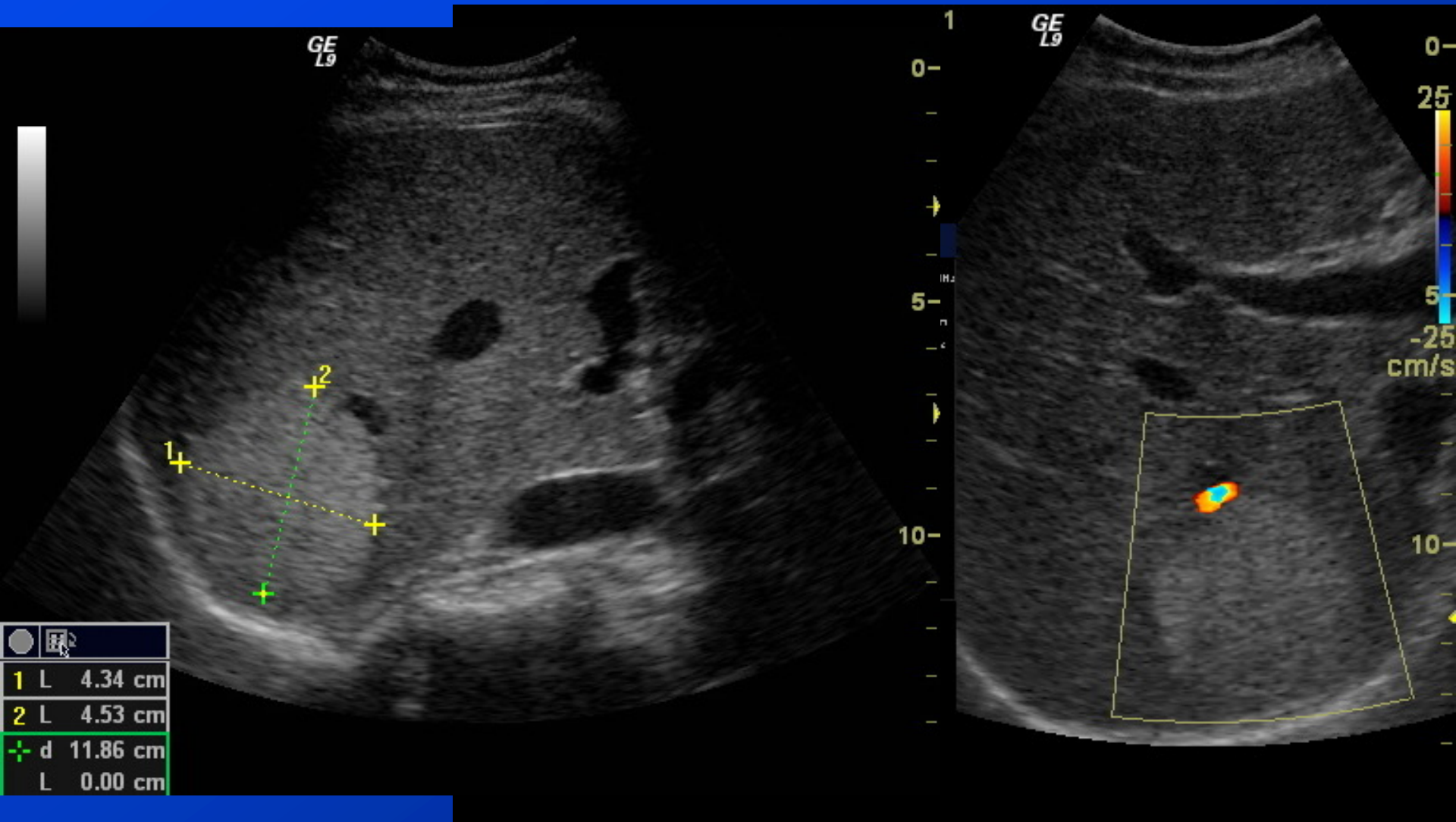
Haemangioma



- Peripheral globular contrast pooling in arterial phase
- Globular enlargement and centripetal fill-in
- Nicolau (2004):
 - 19 of 22 hemangiomas could be correctly identified in the late phase (86.4%) and 18 in the vascular phase (81.8%).
- Ding (2005):
 - sensitivity of 96.3% and specificity of 97.5% when centripetal fill-in enhancement was regarded as a positive finding of hemangioma.



Henvist fra Fra CT-lab'en- Hemangiom ?





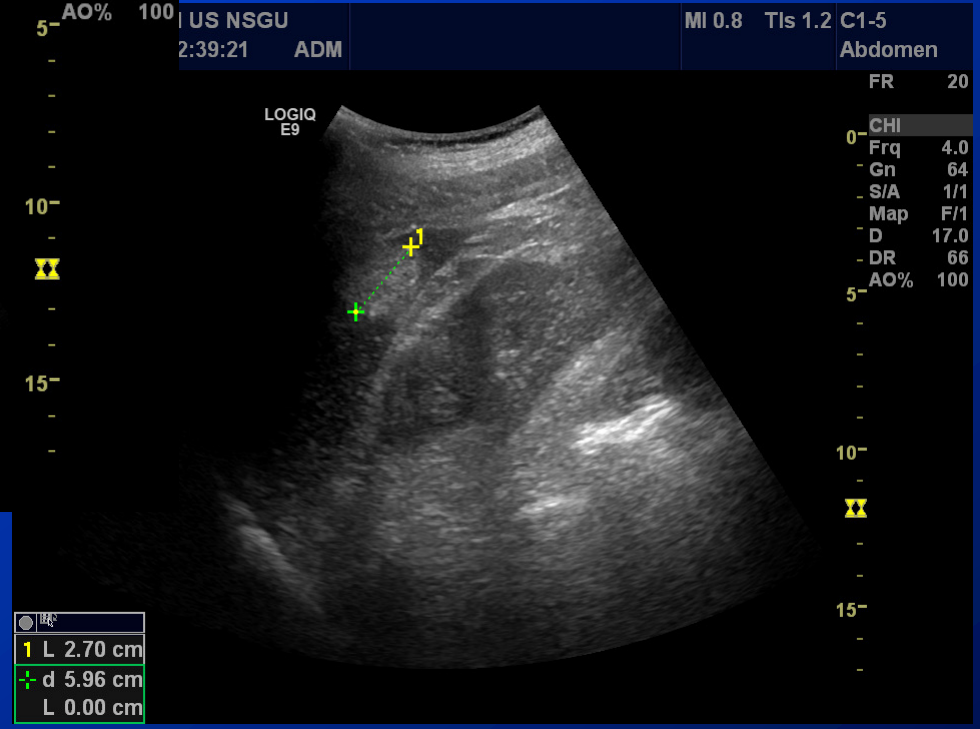
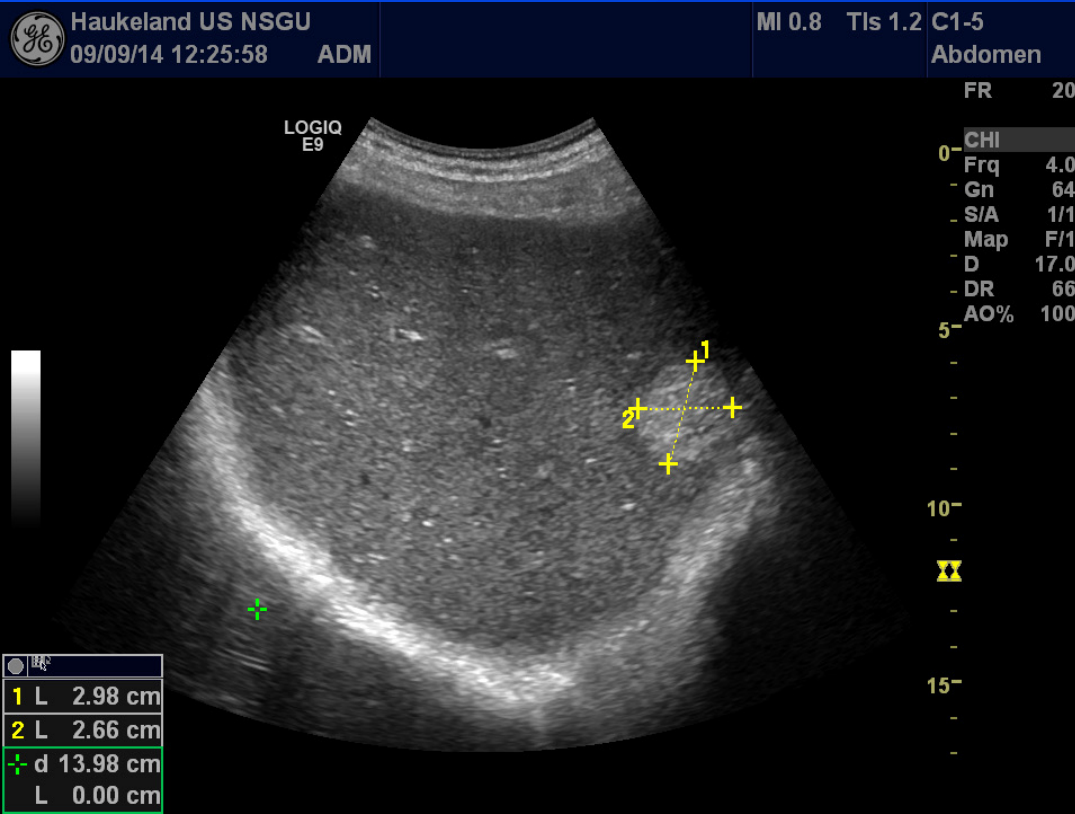
Peripheral Globular Enhancement



...with slow sentripetal filling

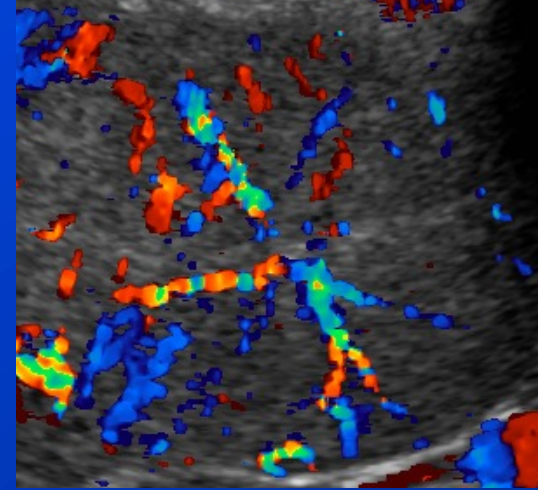


Lesion in Liver – S7





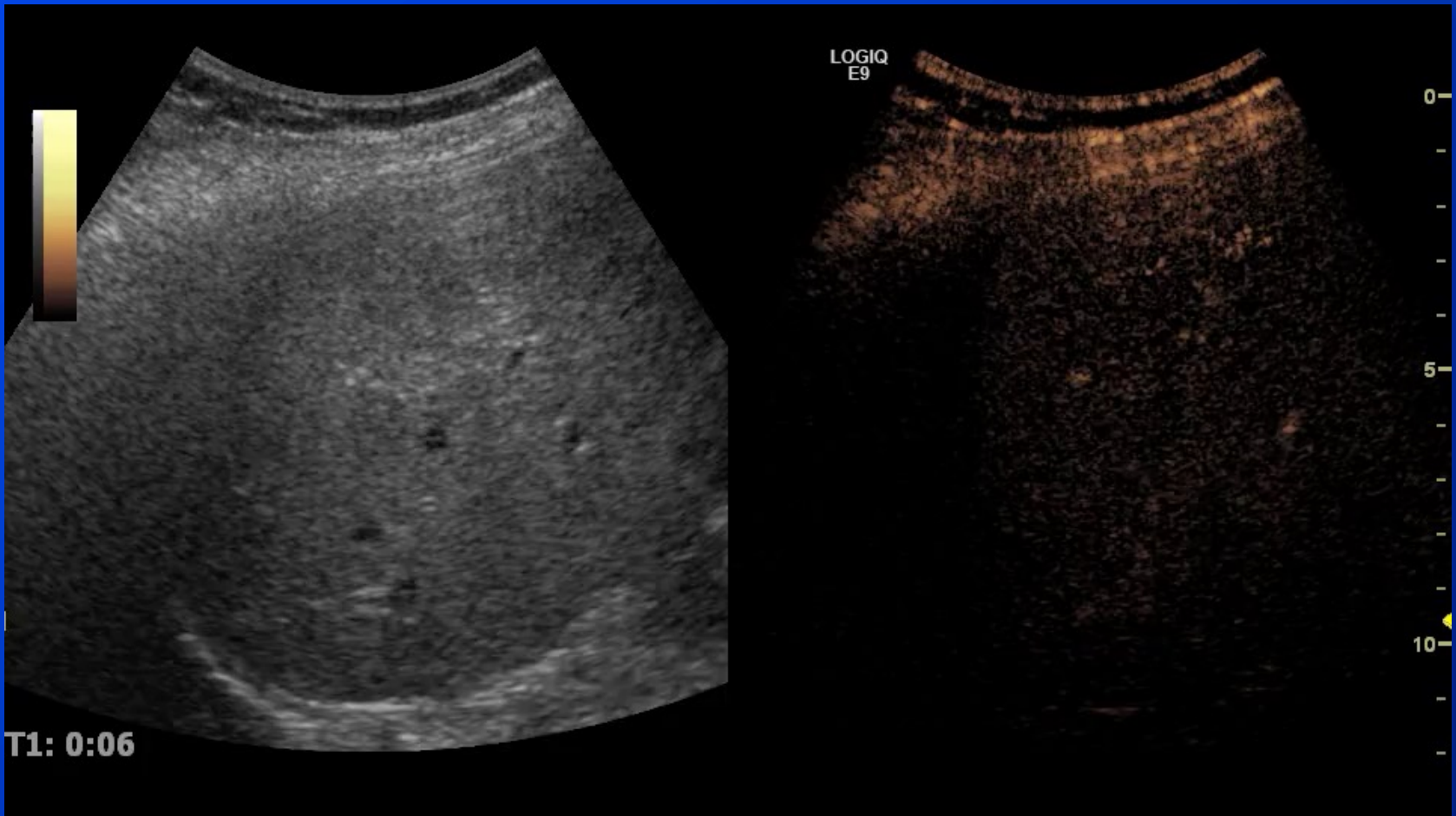
Focal Nodular Hyperplasia - FNH



- 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

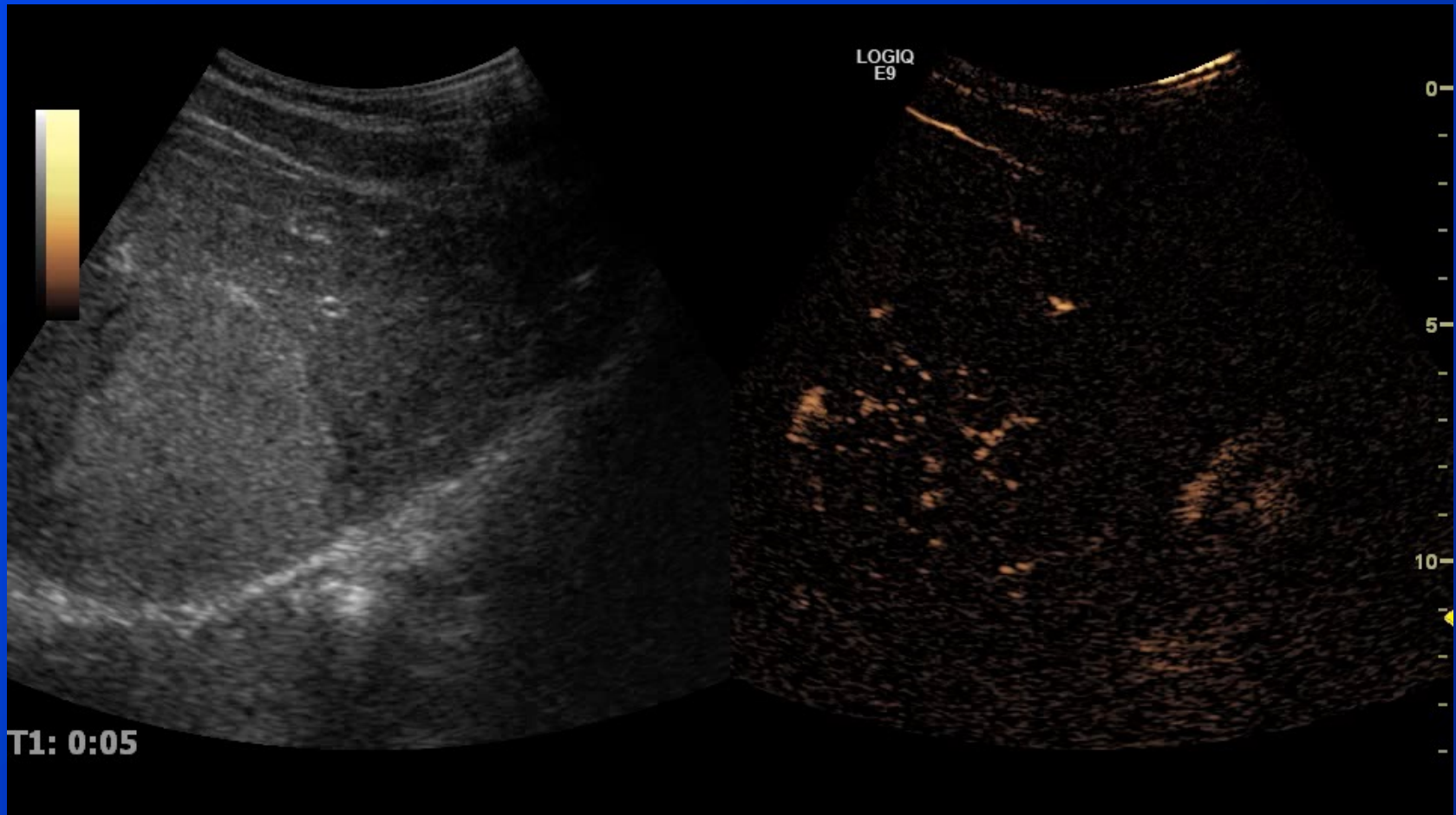


FNH - CEUS



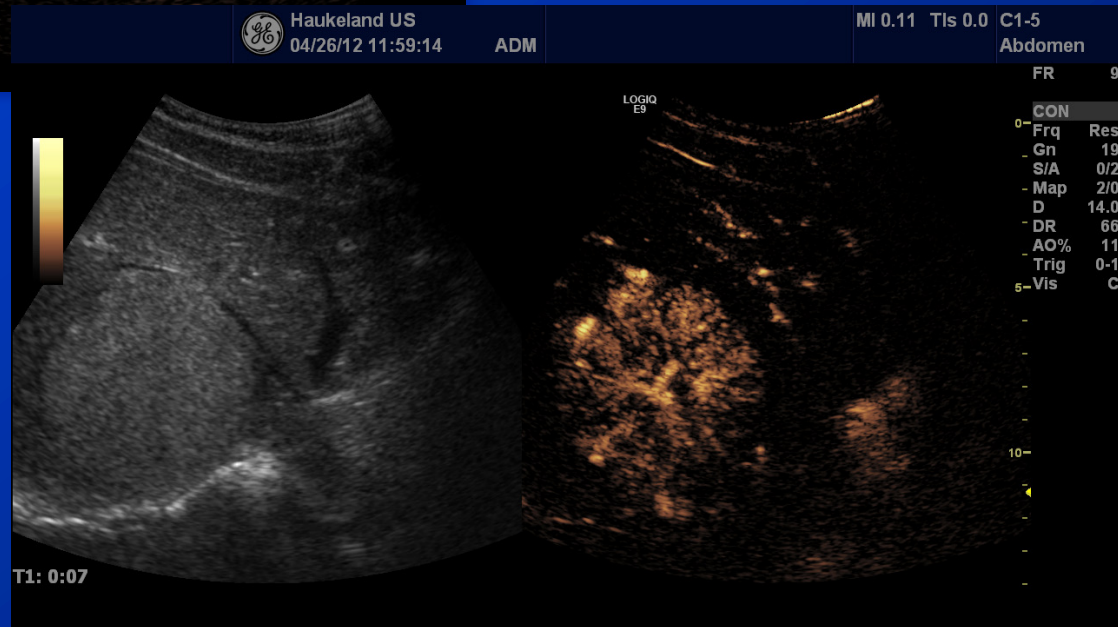
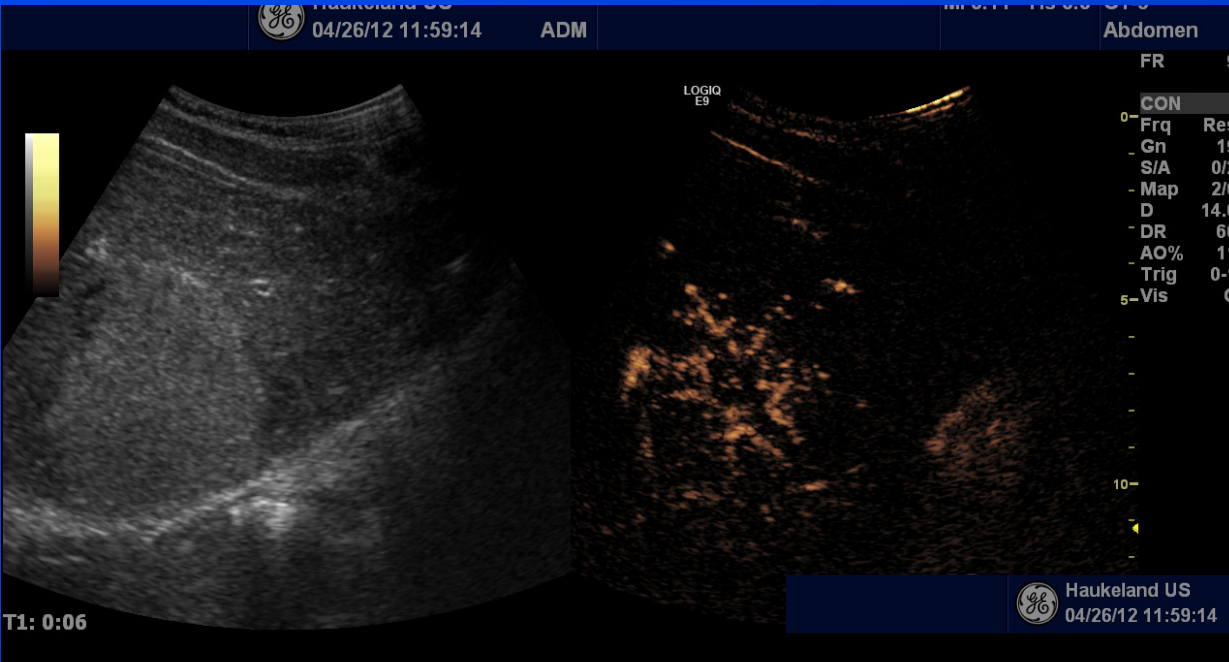


FNH- Arterial Phase



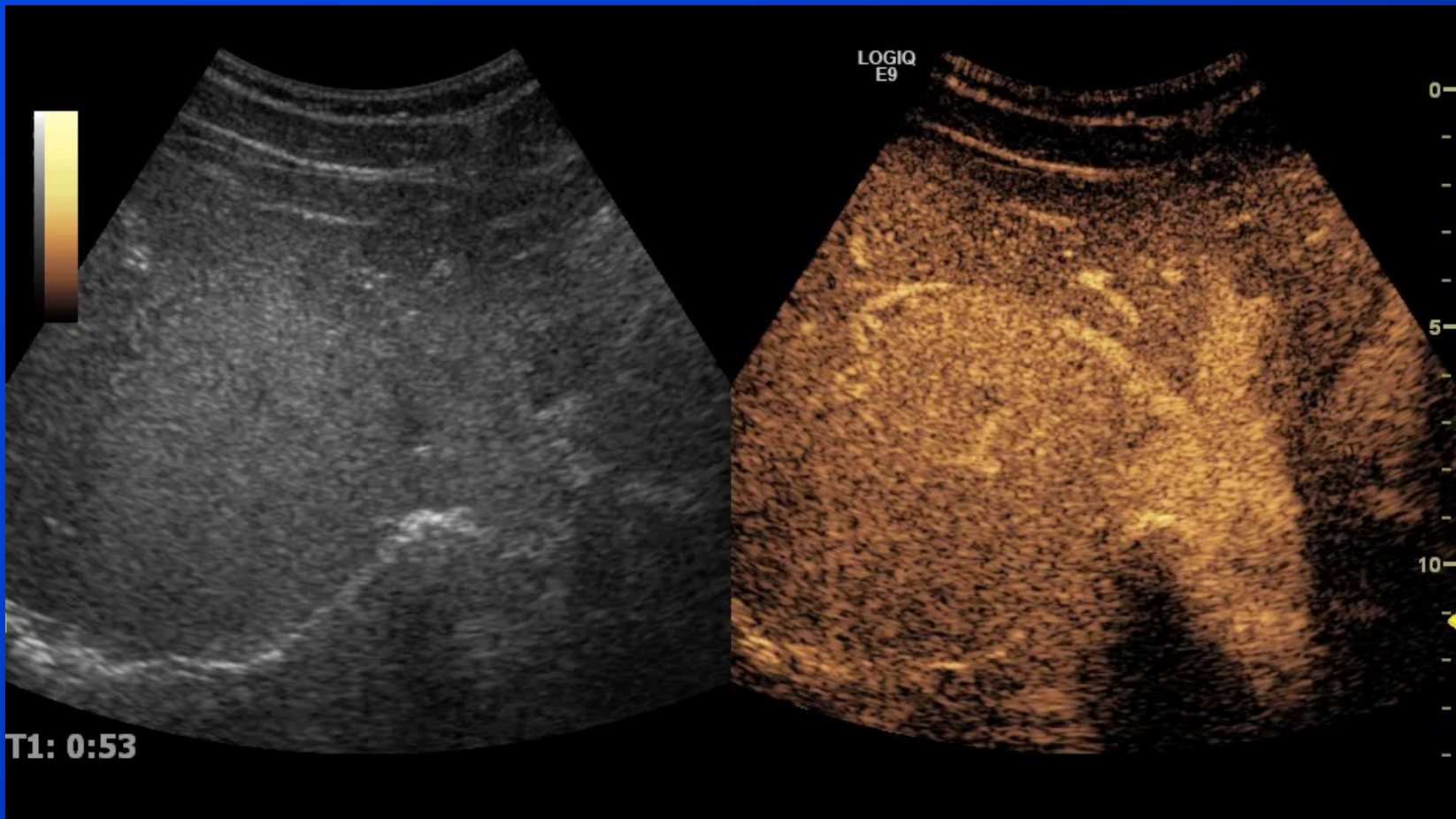


FNH



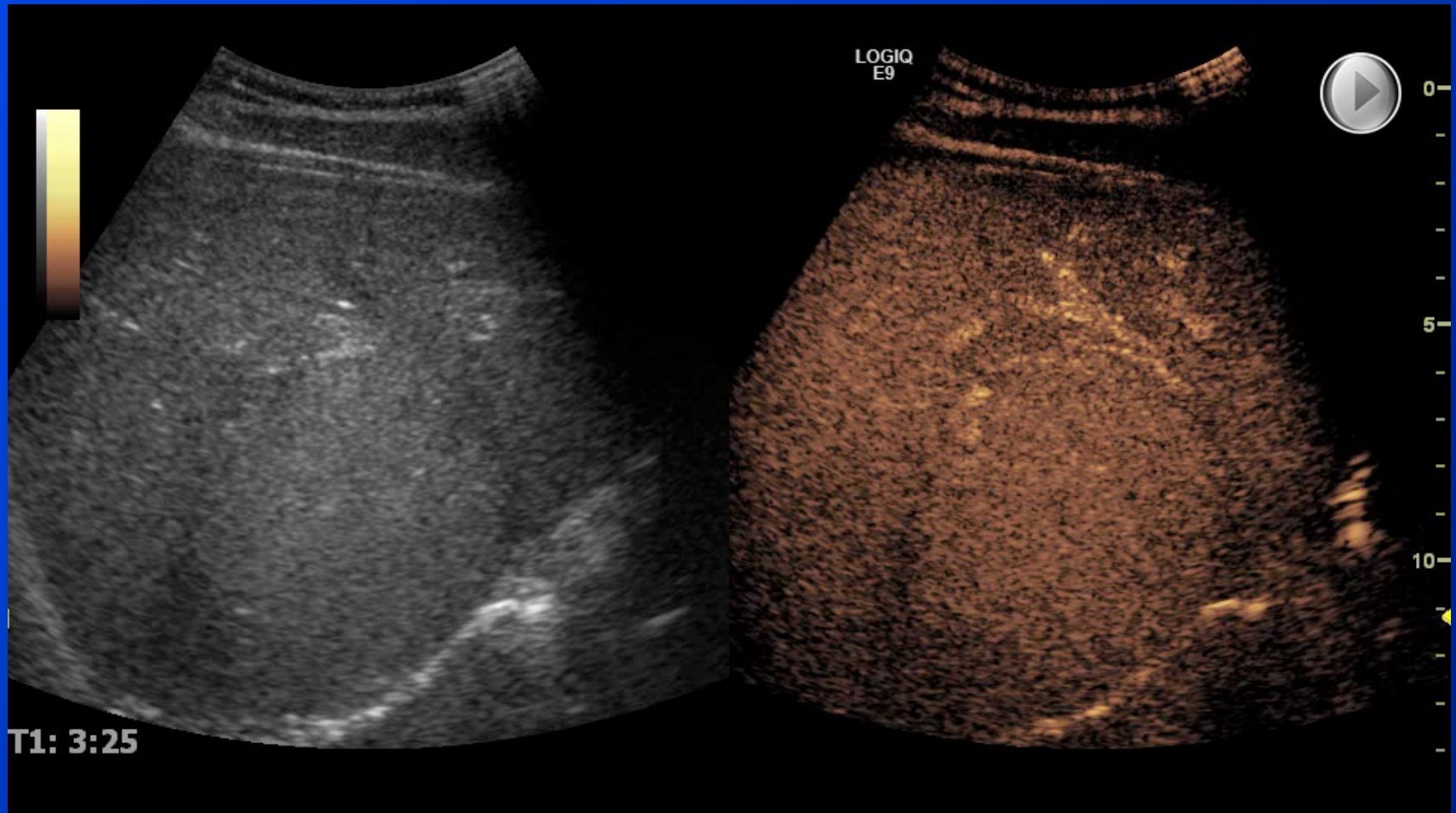


Trick: Destroy the MB by increasing the MI (Flash)



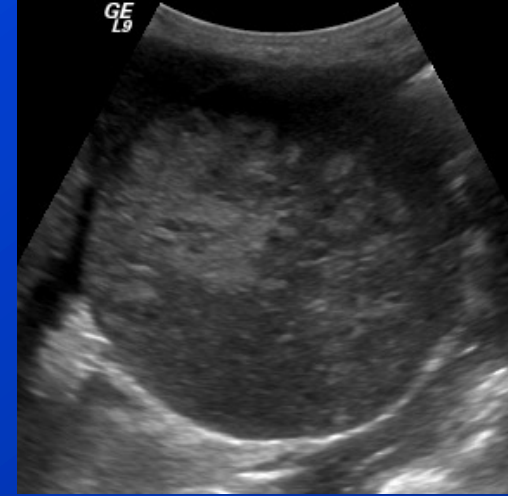


FNH – Late Phase (Sinosoidal)





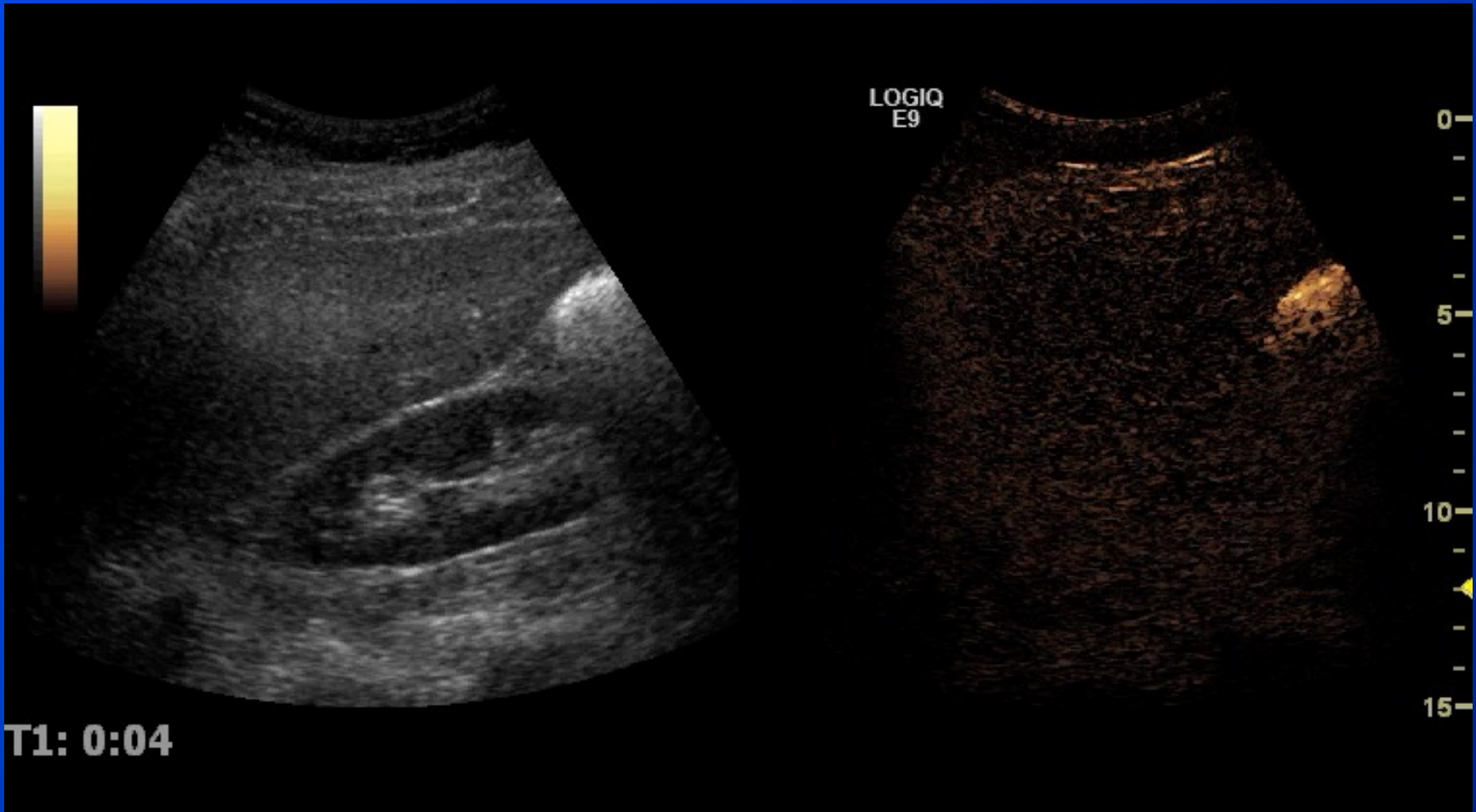
Liver cell adenoma



- 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

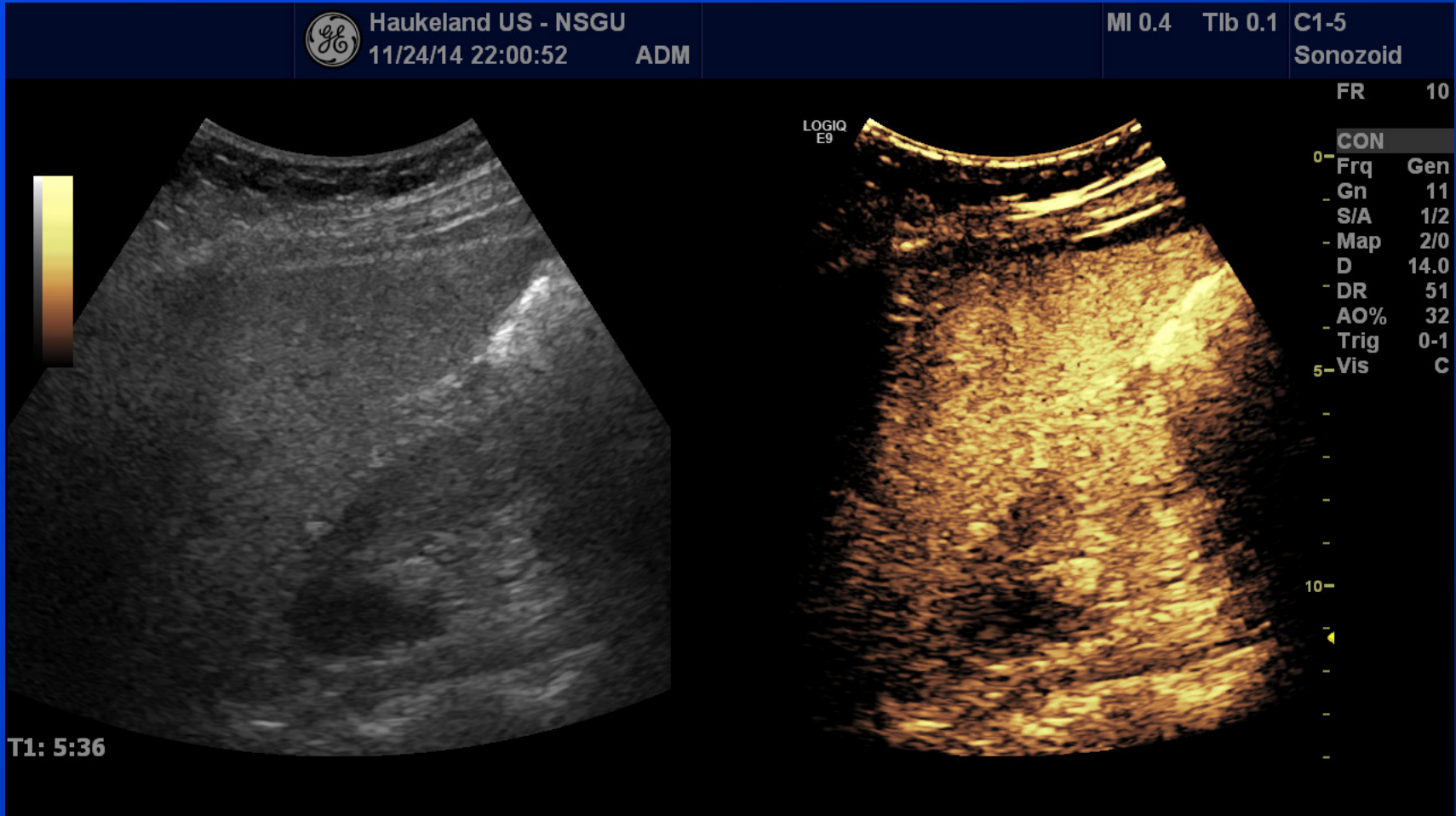


Hepatic Adenoma





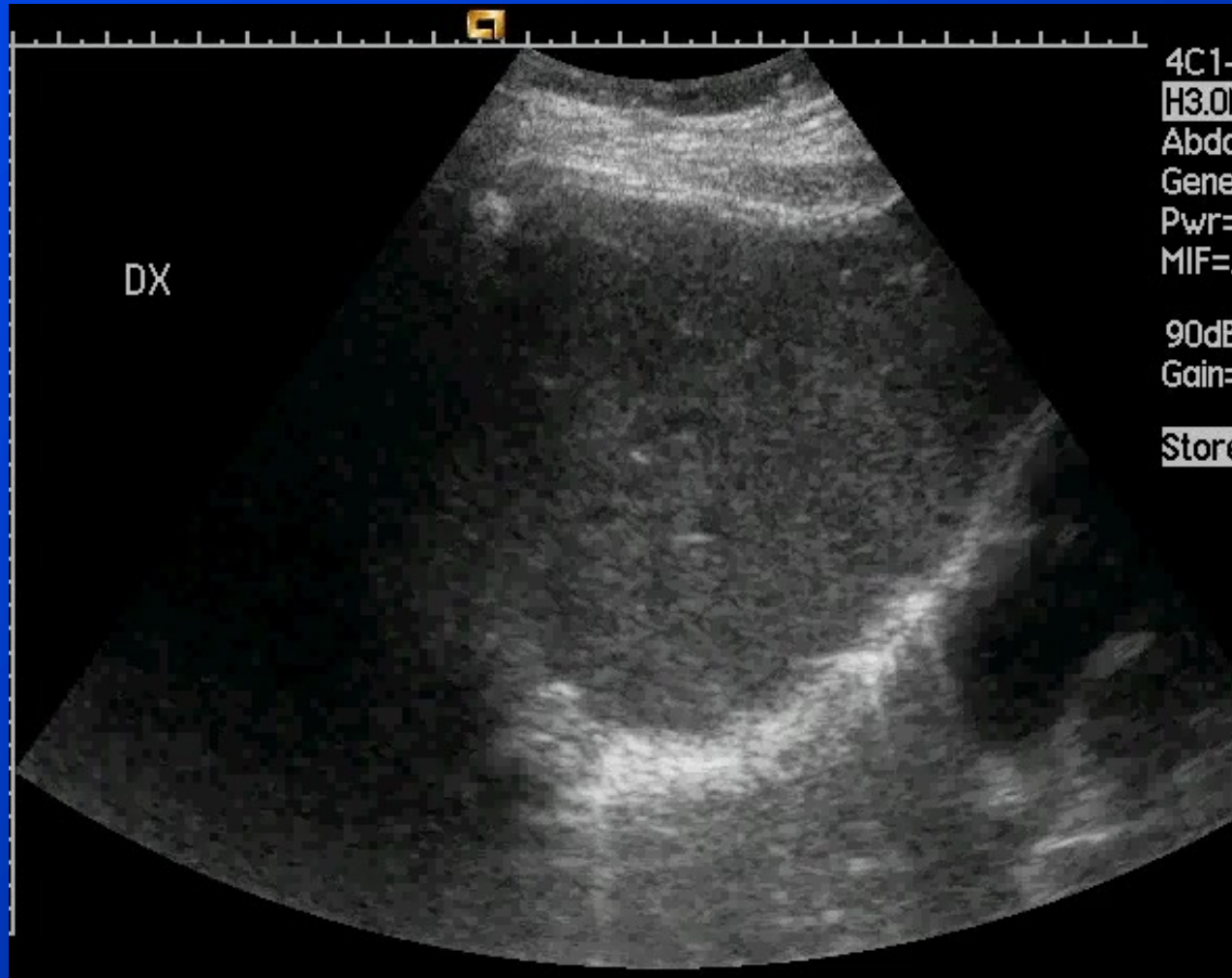
Sinusiodal Phase





Liver Metastasis ?

Before contrast injection





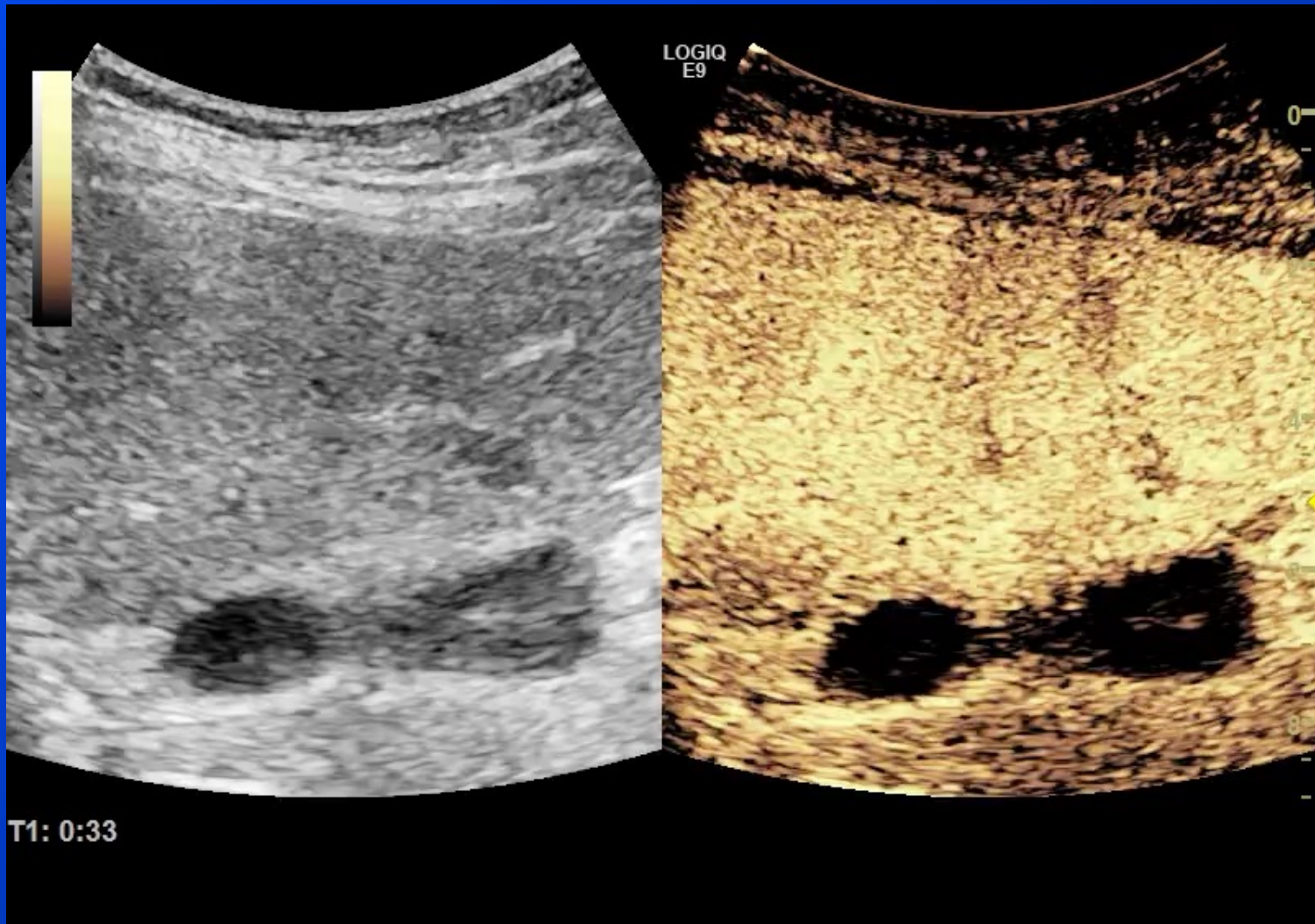
Liver Metastasis ?

After contrast injection in late phase





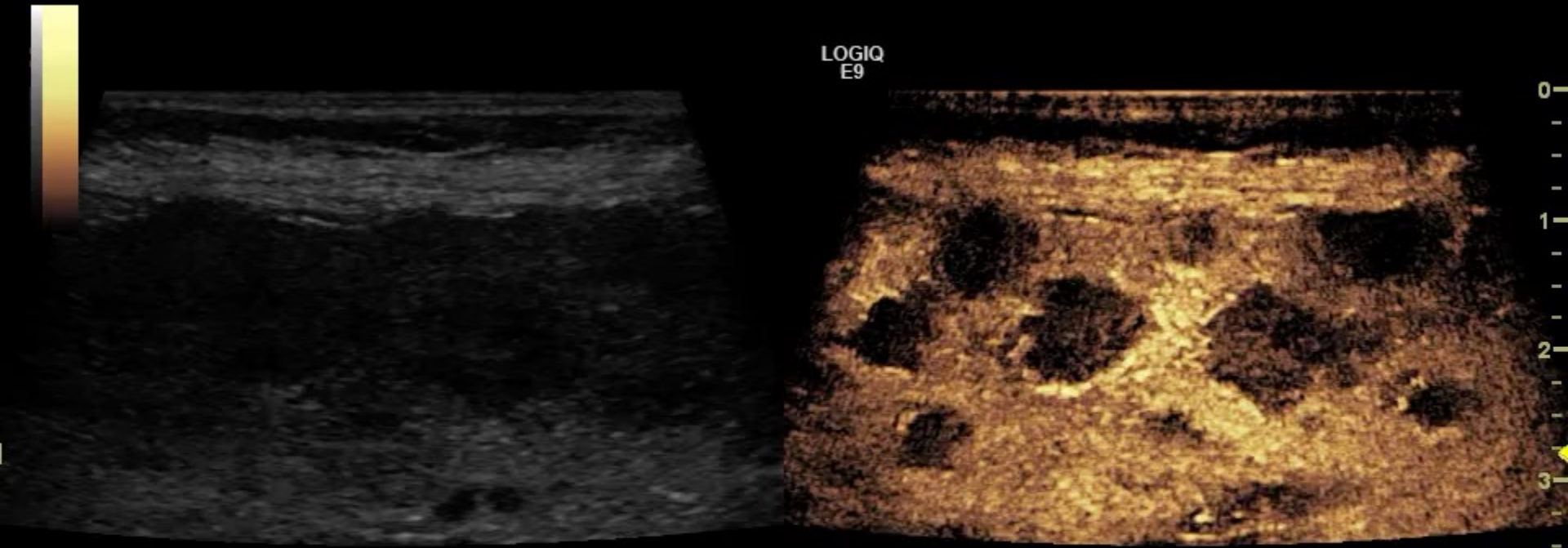
Early wash-out typical for mets



Not easily observed on CT and MRI



High-Frequency 9 MHz LA probe Post-vascular phase (Kupffer)



T1: 11:02



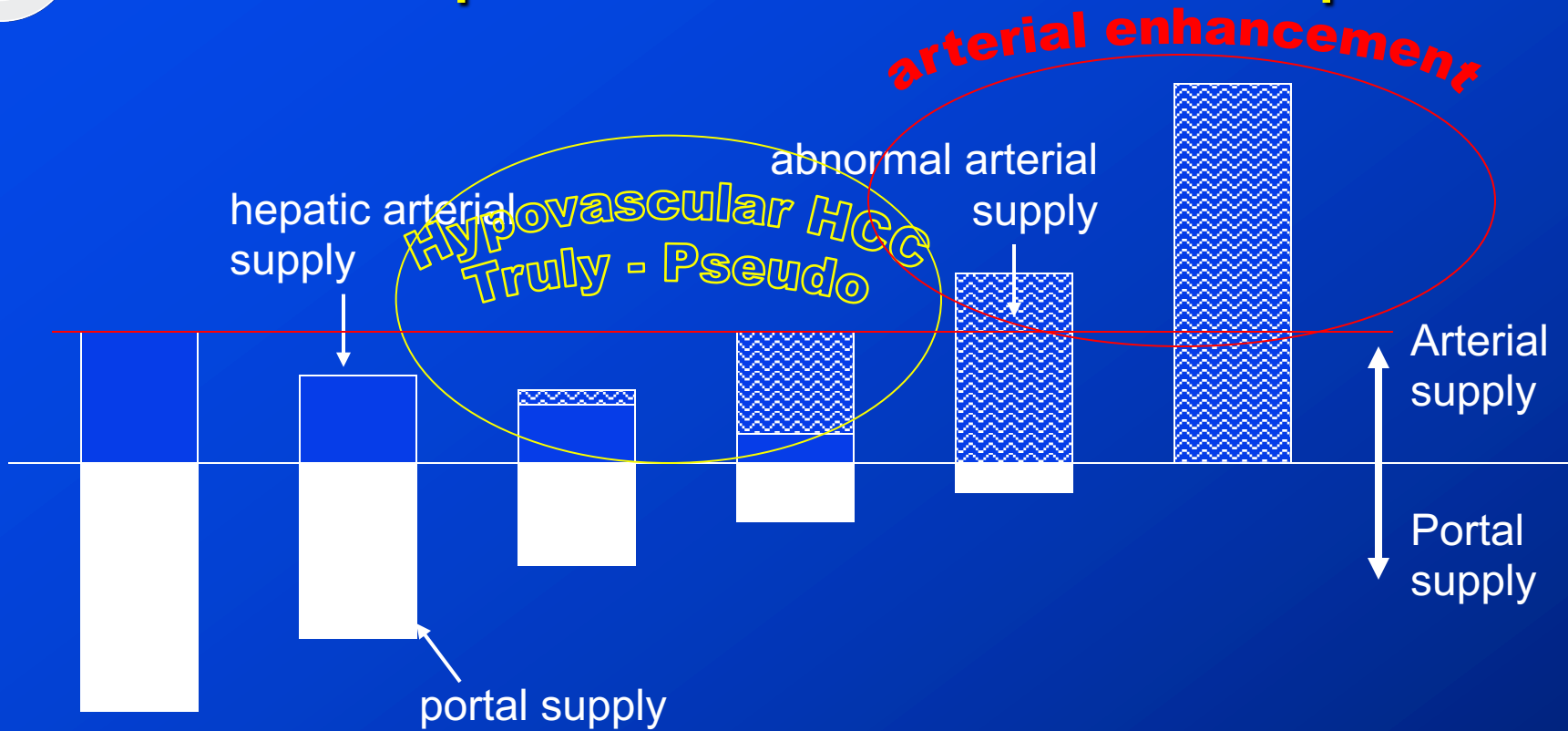
HCC facts

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



The Sequence of HCC Development



LRN ~ LGDN ~ HGDN ~ e-HCC ~ wdHCC ~ classical HCC

early HCC

*from: Matsui, Clin Hep Gastro, 2005.
(based on CT-arteriportal-angiography)*



CEUS in HCC

RECOMMENDATION 16

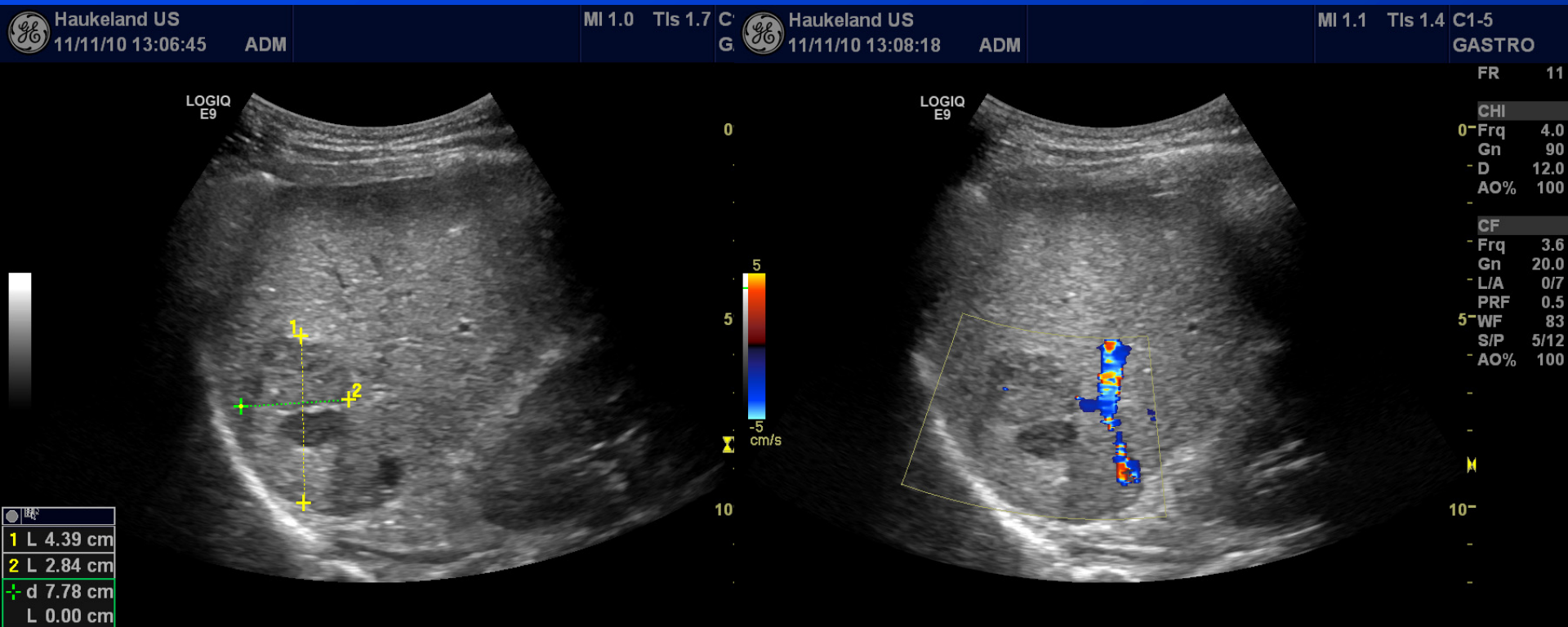
CEUS can be utilized in first line to characterize FLL found in patients with liver cirrhosis to establish a diagnosis of malignancy (CEUS LR-M) or specifically of HCC (CEUS LR-5), but CT or MR imaging remain required for accurate staging unless contraindicated (LoE2, weak recommendation) (Pro 29, Abs 0, Against 0).

RECOMMENDATION 17

CEUS can be utilized when CT or MR imaging is inconclusive, especially in FLL in cirrhotic liver not suitable for biopsy, to assess the probability of a lesion to be an HCC (LoE3, weak recommendation) (Pro 29, Abs 0, Against 0).

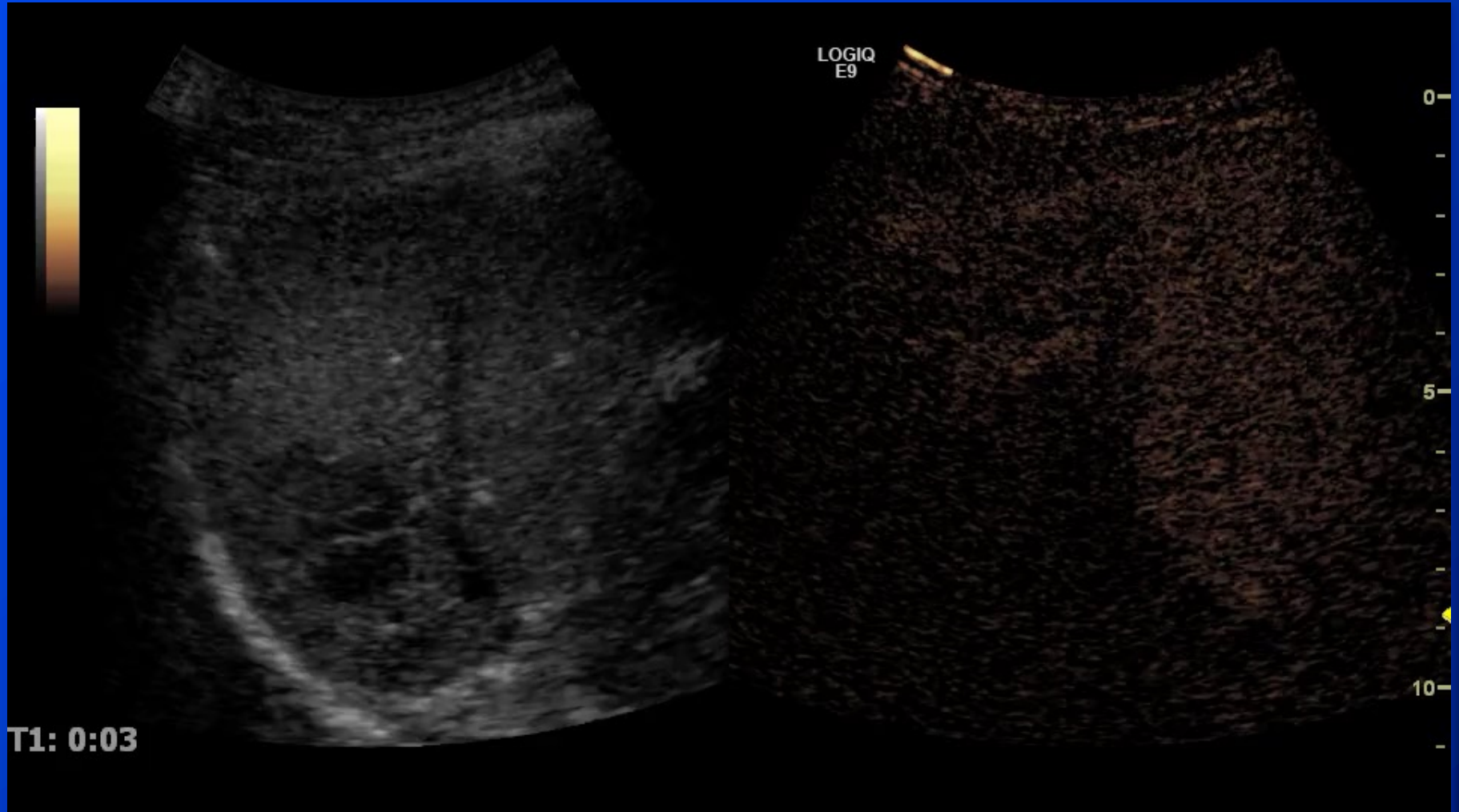


CEUS in cirrhosis (AIH) – HCC?





SonoVue in AIH – HCC?





Probability of HCC in Cirrhosis

Which nature is expected to have a focal liver lesion newly detected in a cirrhotic liver?

From a likelihood approach:

65% HCC if 1-2cm,

85% HCC if 2-3cm,

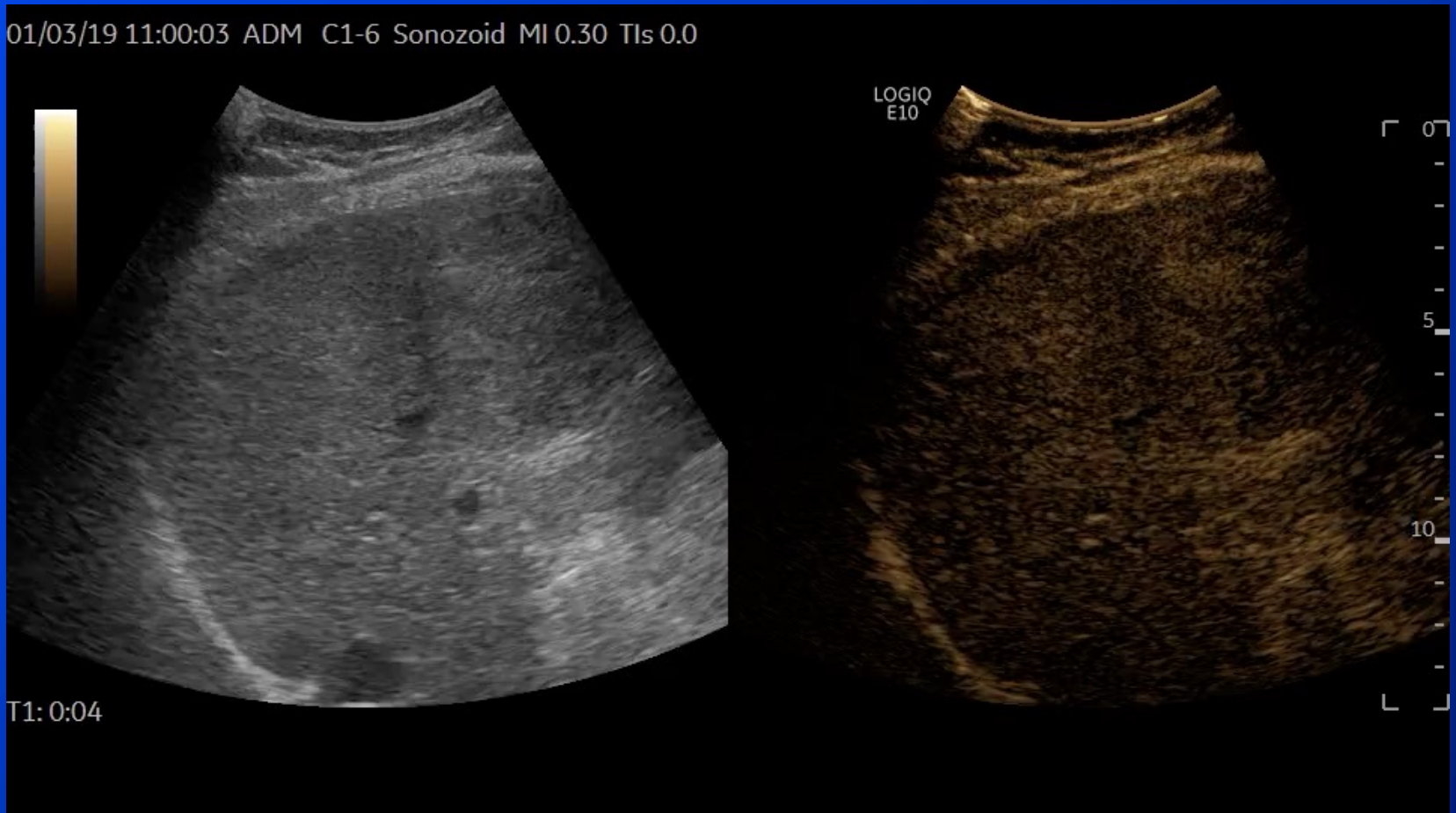
>90-95% if >3 cm

If not an HCC, consider:

1. Regenerative dysplastic nodule
2. Hemangioma
3. Cholangiocellular carcinoma
4. Lymphoma



CEUS of tumor



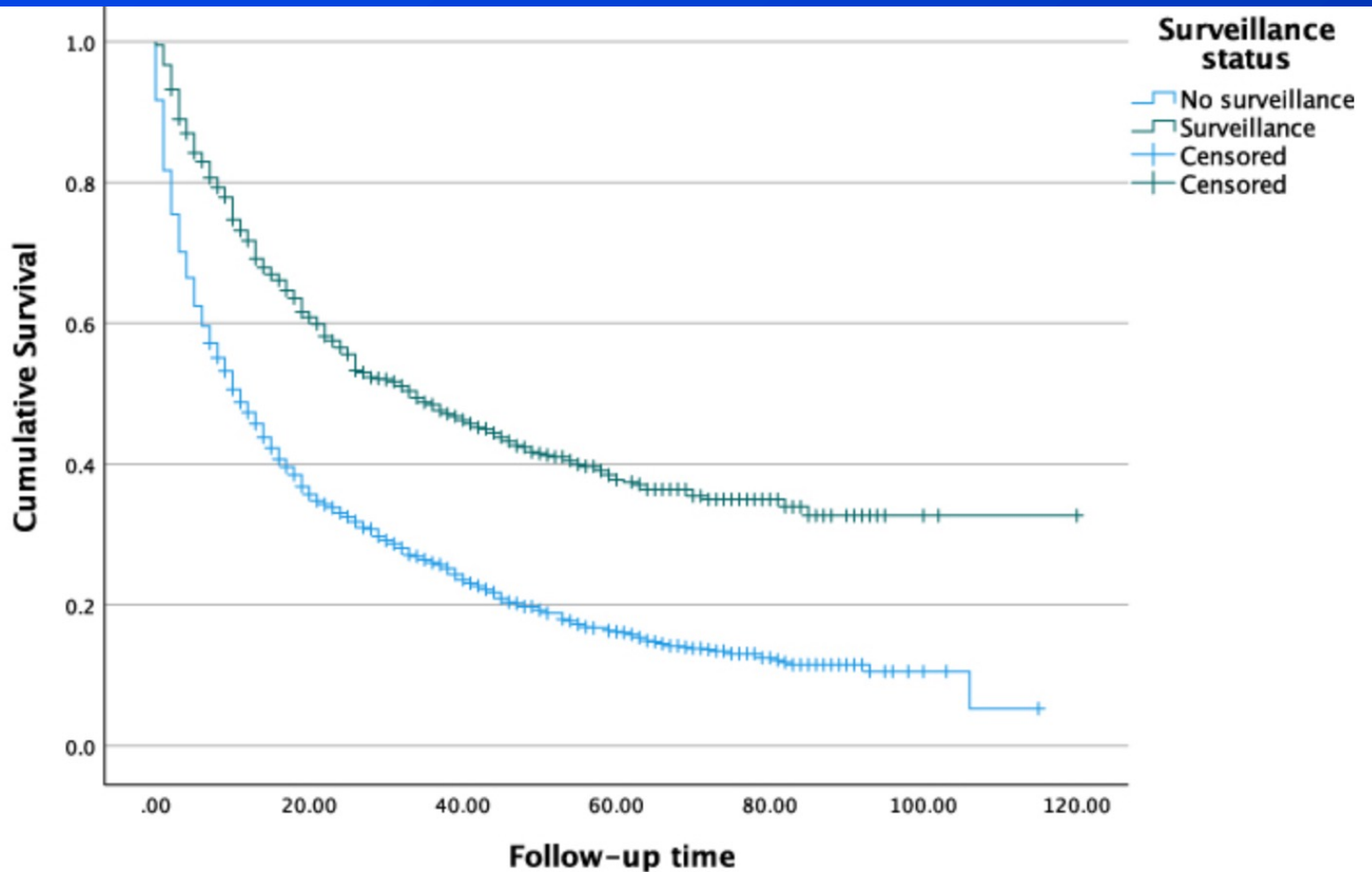


Surveillance

- *International guidelines recommend surveillance of populations at high risk with abdominal ultrasound every six months with or without alpha fetoprotein (AFP)*
 - *All patients with liver cirrhosis*
 - *HBV carriers?*
- At a cutoff value of 20 ng/mL, AFP was found to have a sensitivity between 49% and 71% and a specificity between 49% and 86% in detecting HCC smaller than 5 cm



HCC surveillance – new study



Number at risk

Surveillance:	1073	481	269	117	38	3	0
Non-surveillance:	1638	526	253	119	40	3	0



FNH versus HCC



FNH



HCC



New European Guidelines on CEUS

Paul S. Sidhu, Vito Cantisani, Christoph F. Dietrich,
Odd Helge Gilja, Adrian Saftoiu, Eva Bartels,
Michele Bertolotto, Fabrizio Calliada, Dirk-André Clevert,
David Cosgrove, et al.

With compliments of Georg Thieme Verlag

www.thieme.de

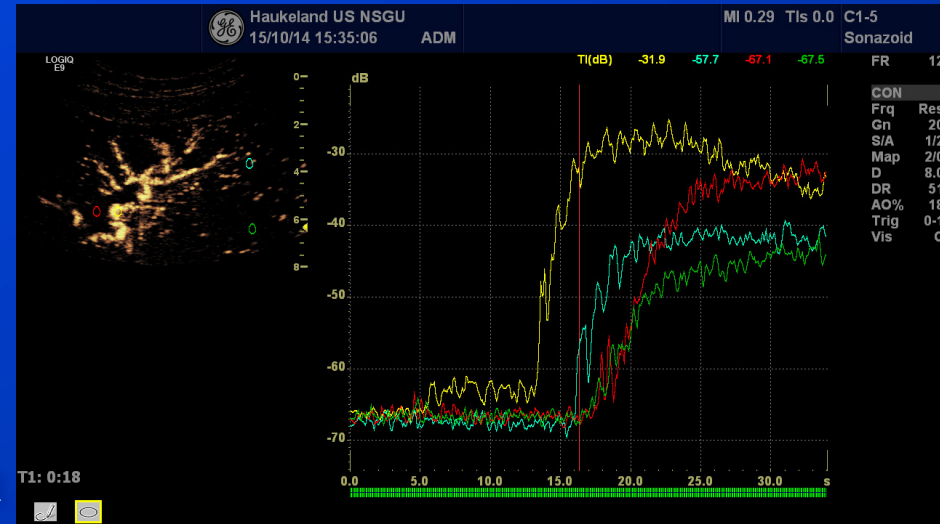
The EFSUMB Guidelines and
Recommendations for the
Clinical Practice of Contrast-
Enhanced Ultrasound (CEUS) in
Non-Hepatic Applications:
Update 2017 (Long Version)

Includes 74 recommendations



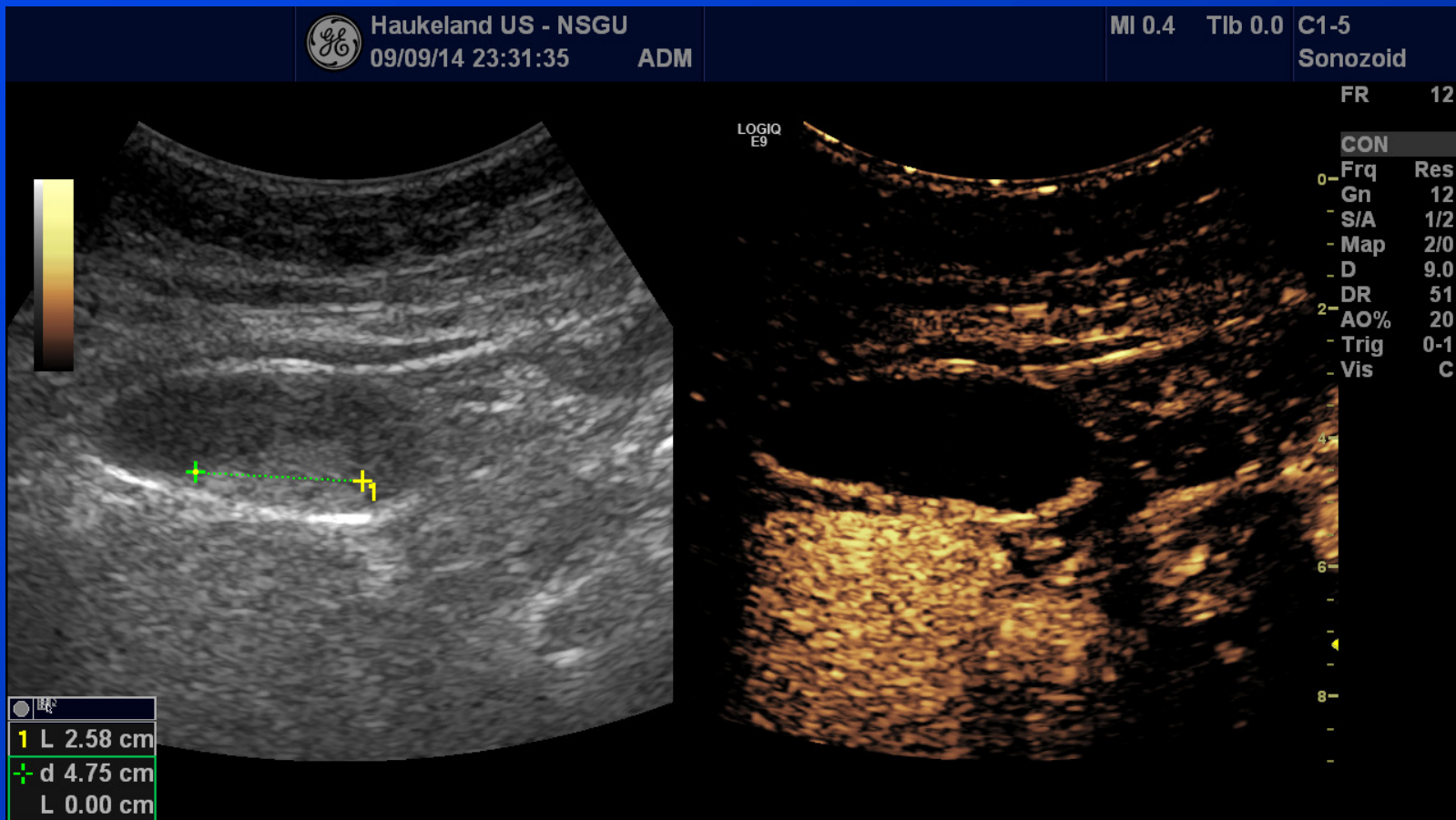
Non-liver CEUS Applications

- Gallbladder tumors
- Kidney scanning
- Pancreas
- Bladder reflux
- Blaunt abdominal trauma
- Transcranial scanning
- Spleen
- Intestines
- ...>30 clinical applications of CEUS





Gallbladder Tumor? or Sludge?





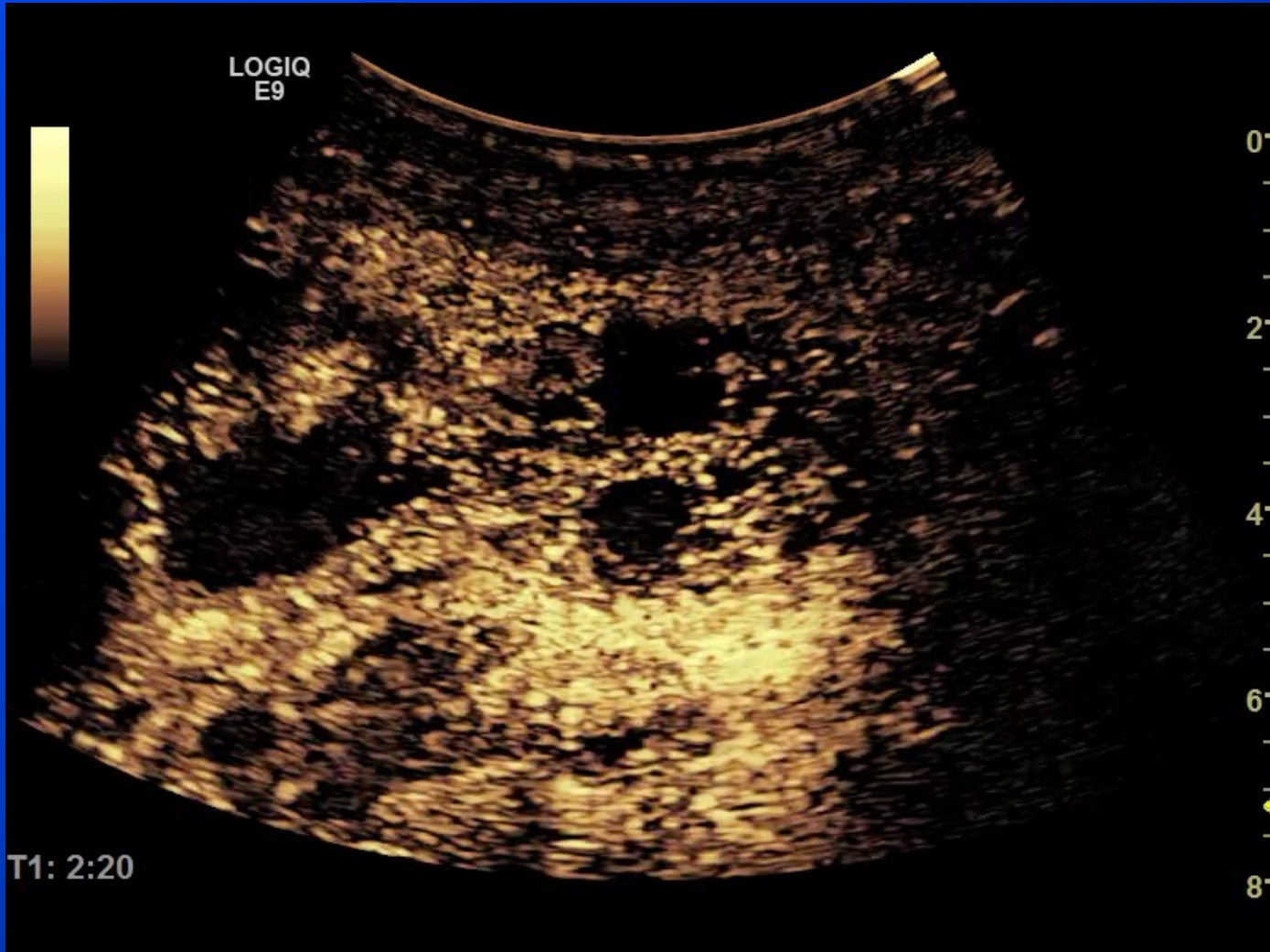
Female-65 years

Chronic subcostal pain





CEUS of gallbladder





Pancreas: PDAC vs. NET

RECOMMENDATION 25

In solid pancreatic lesions detected on ultrasound, CEUS can be used to reliably characterize ductal adenocarcinoma (LoE 1a, GoR A). Broad consensus (18/0/2, 90 %)

RECOMMENDATION 26

CEUS can be used to distinguish between pancreatic ductal adenocarcinoma and neuroendocrine tumors (LoE 1a, GoR A). Strong consensus (20/0/0, 100 %)

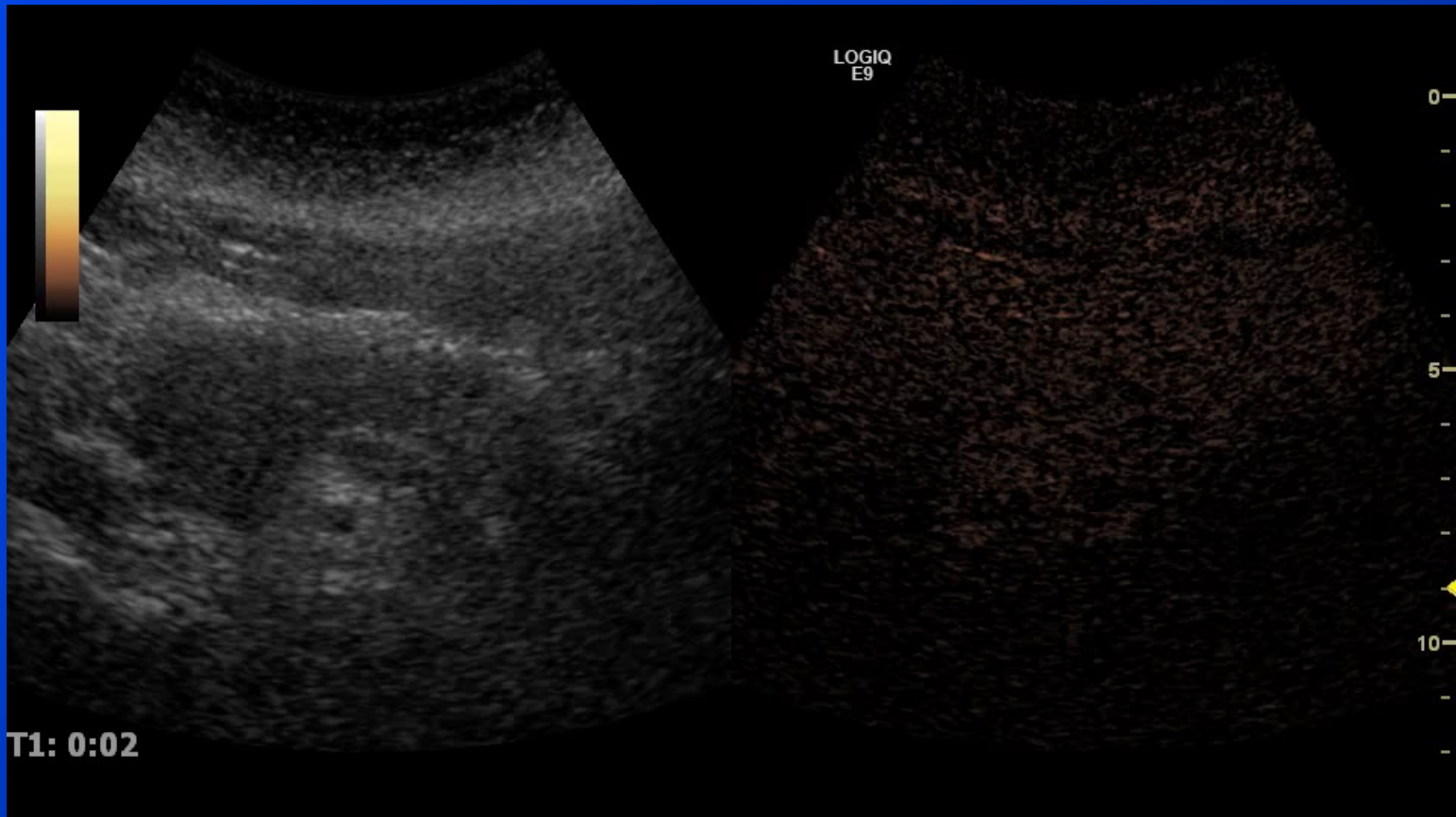


Pancreatic Cancer





CEUS of Arterial Phase



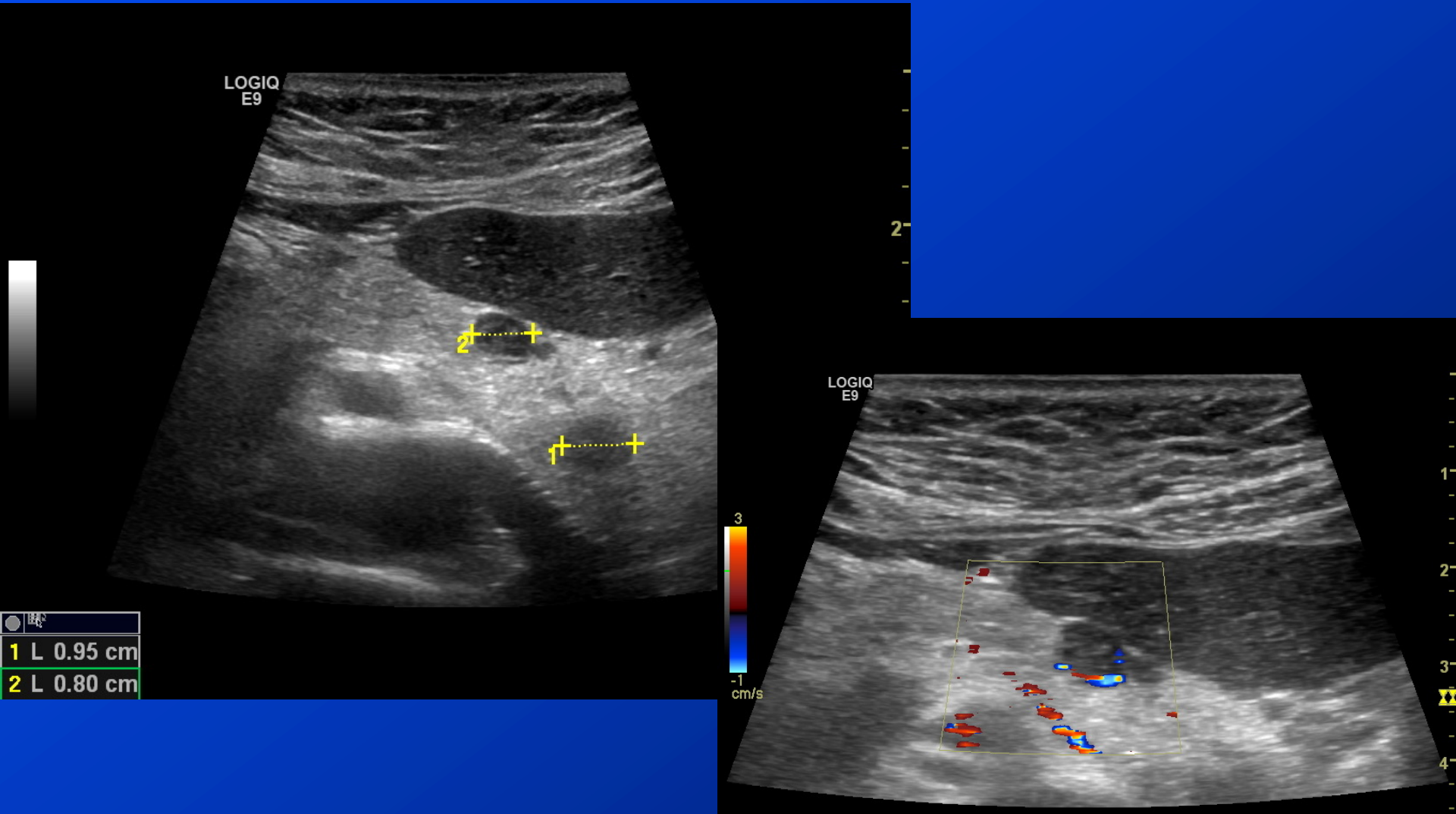


Patient History

- Female, born 1961
- Watery diarrhoea since spring 2009
- Weightloss 10 kg
- CT: One lesion in the tail of the pancreas
- EUS: Showed 2 lesions in the pancreas
- External ultrasound...

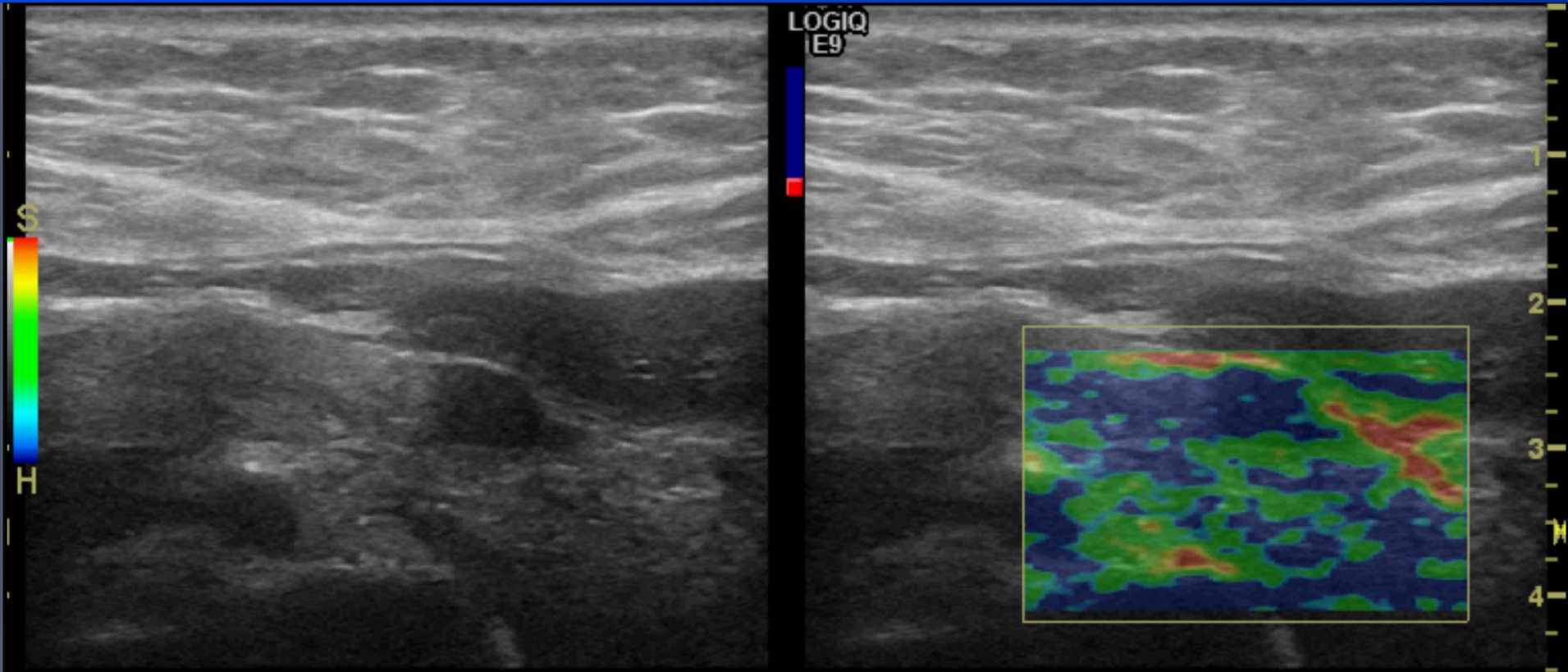


B-mode Pancreatic Lesions



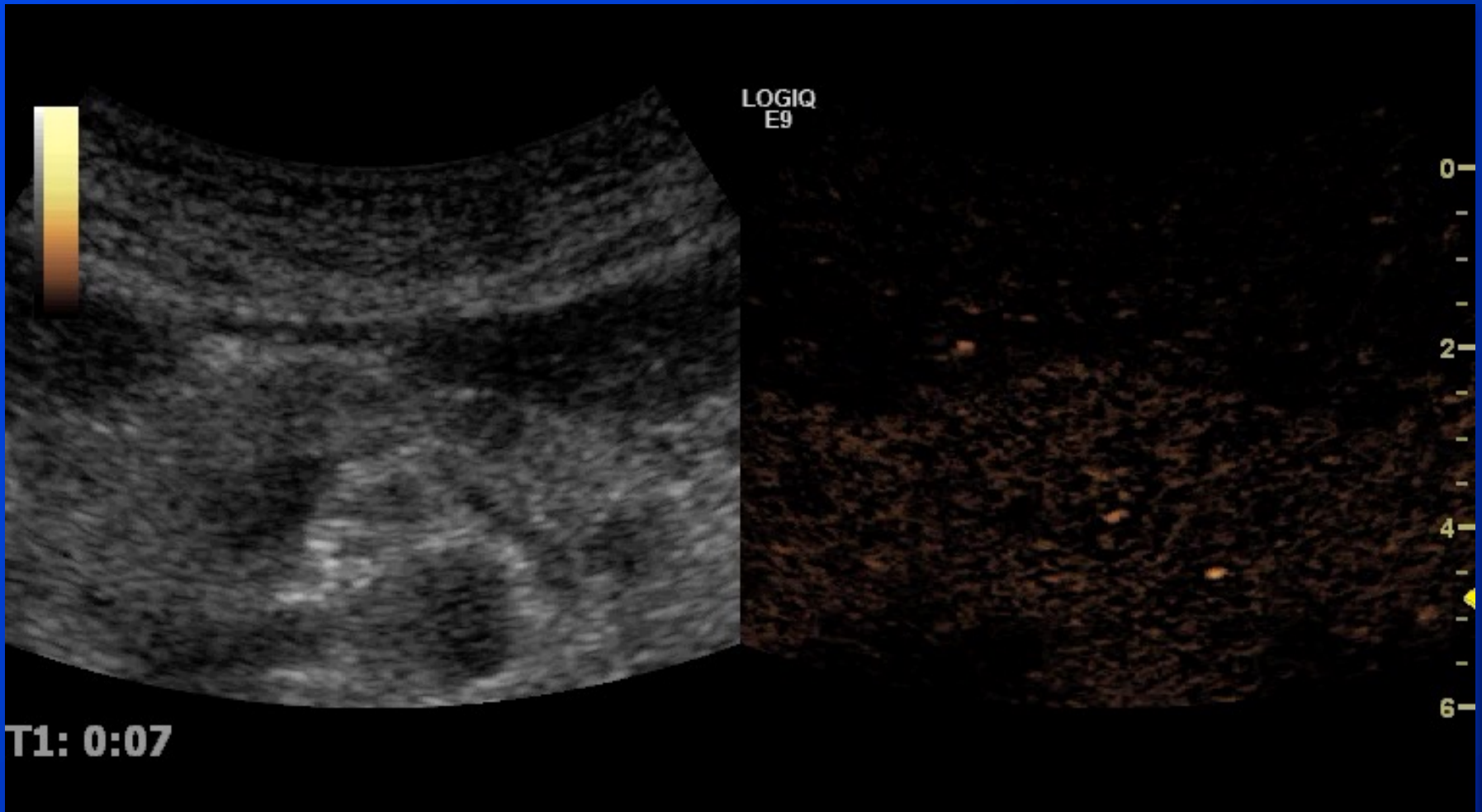


Elastography



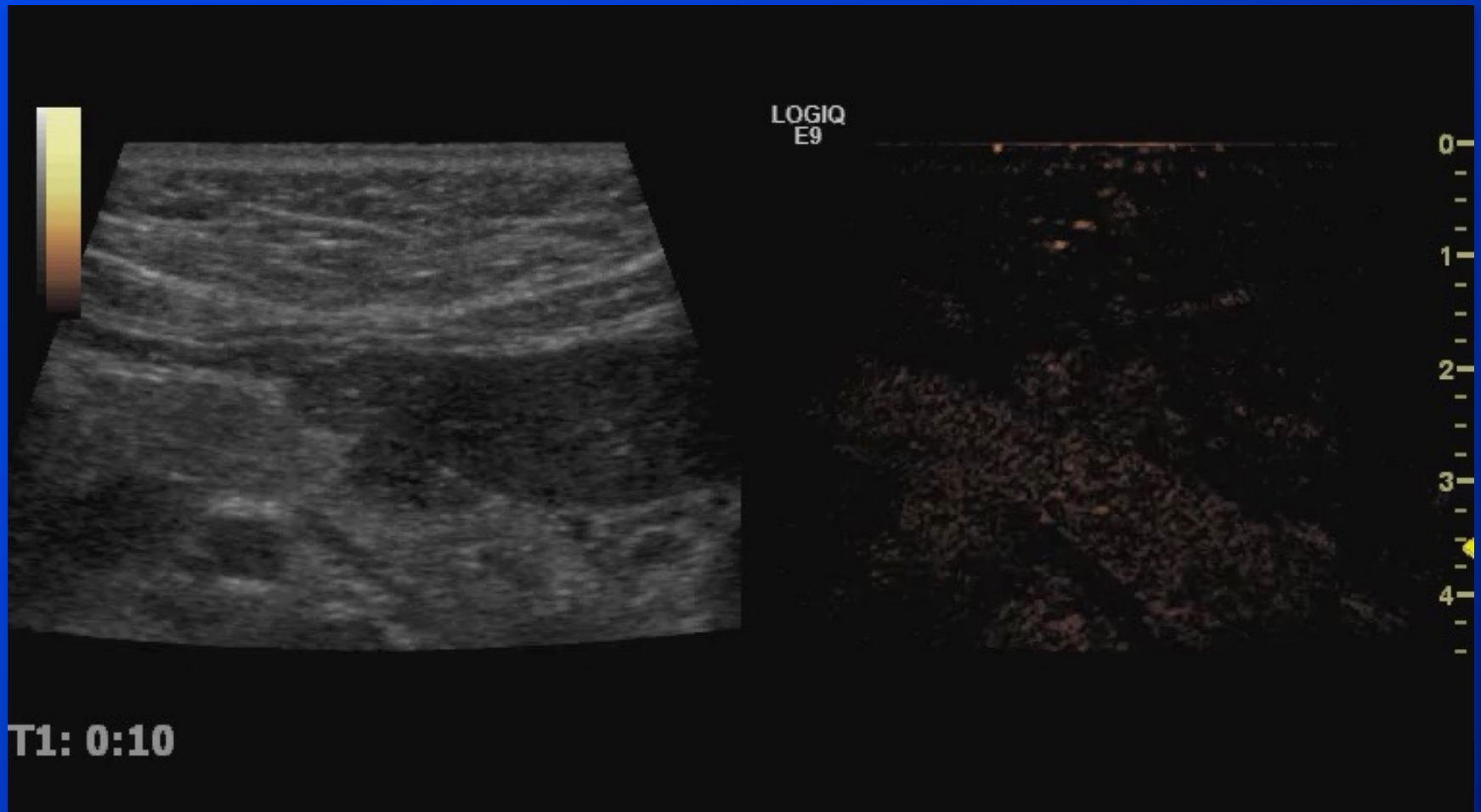


CEUS with 3,5 MHz CLA probe





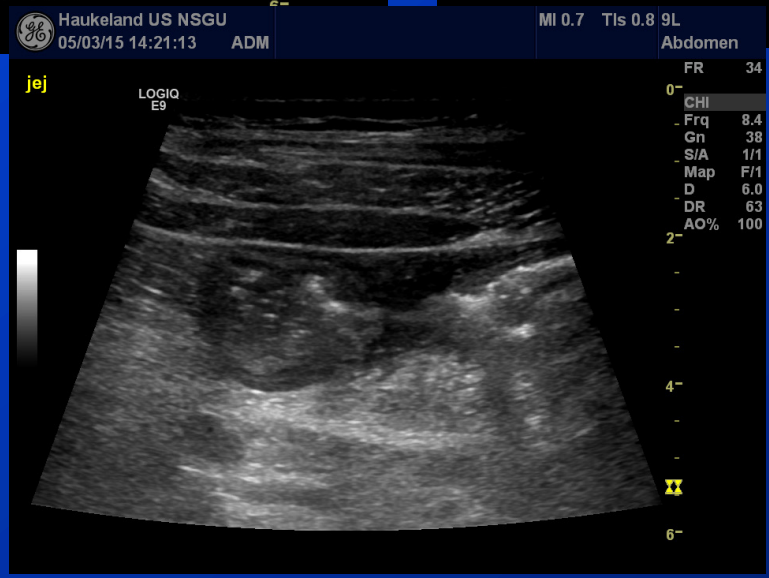
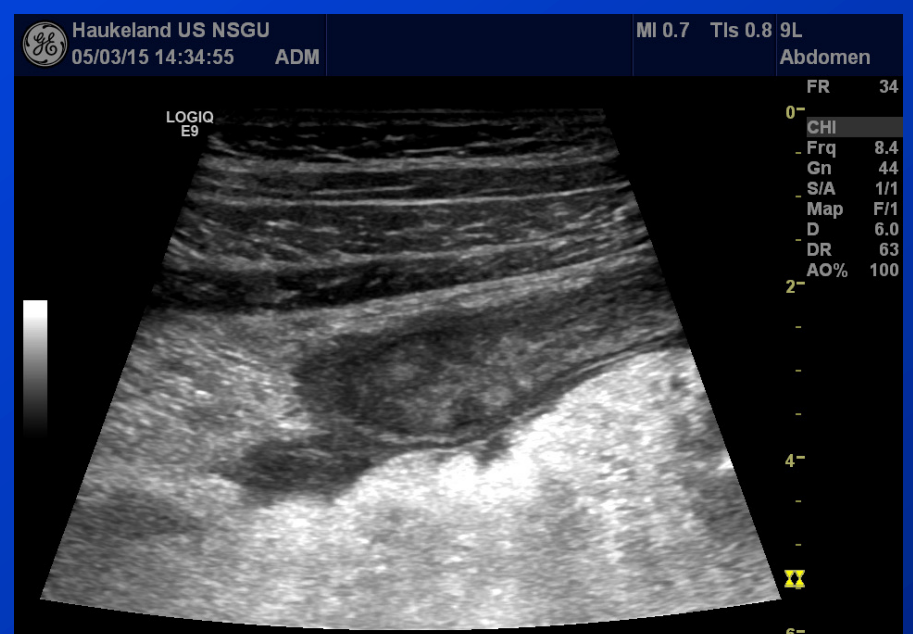
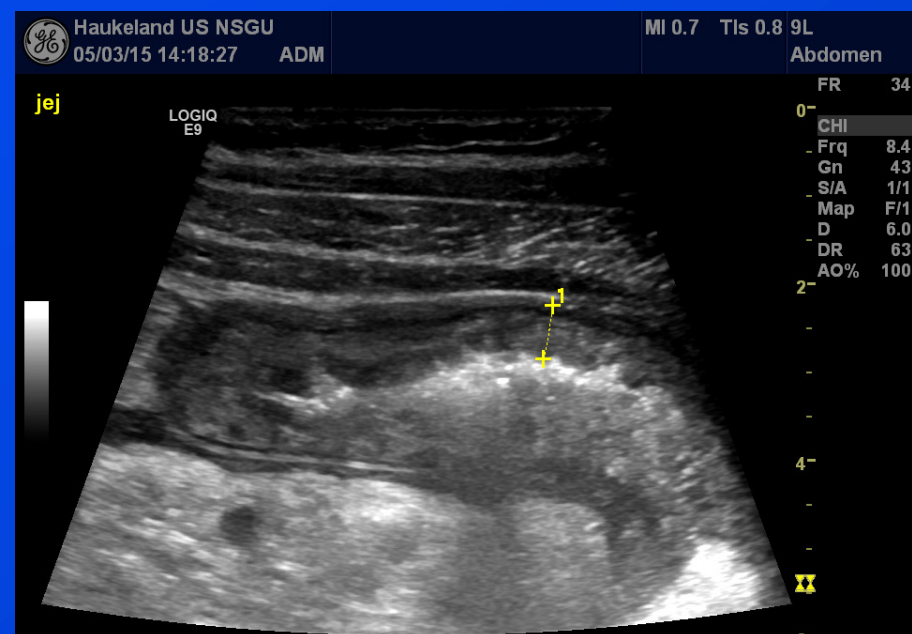
Pancreatic Tumor – High-f CEUS



9 MHz linear probe

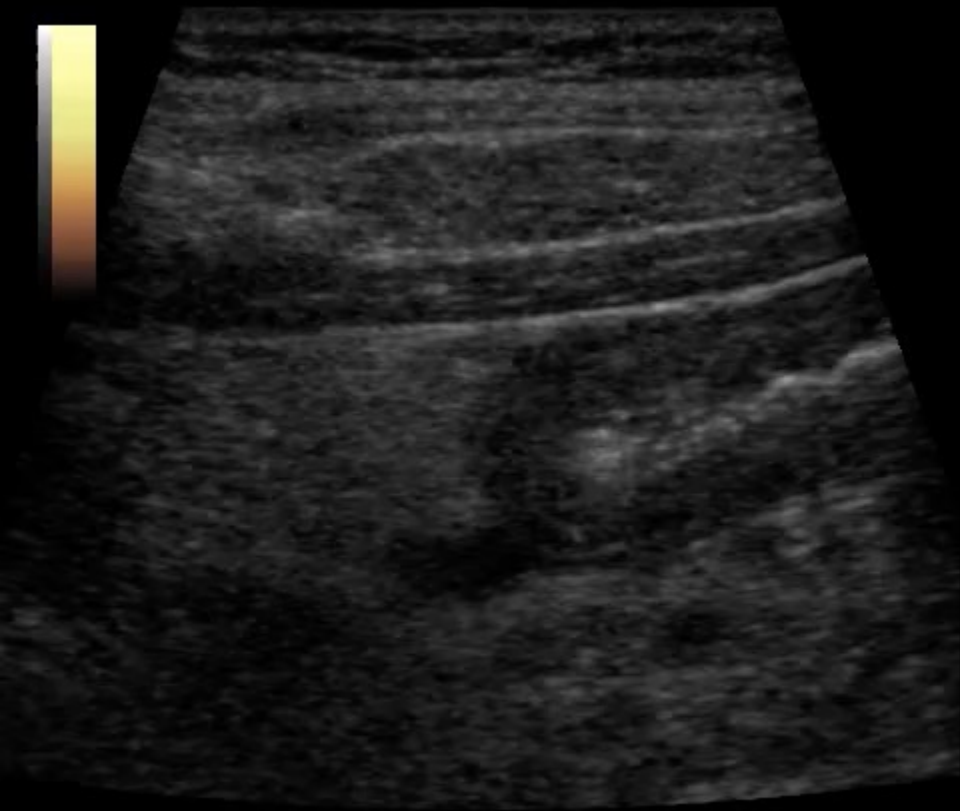


Crohn Patient



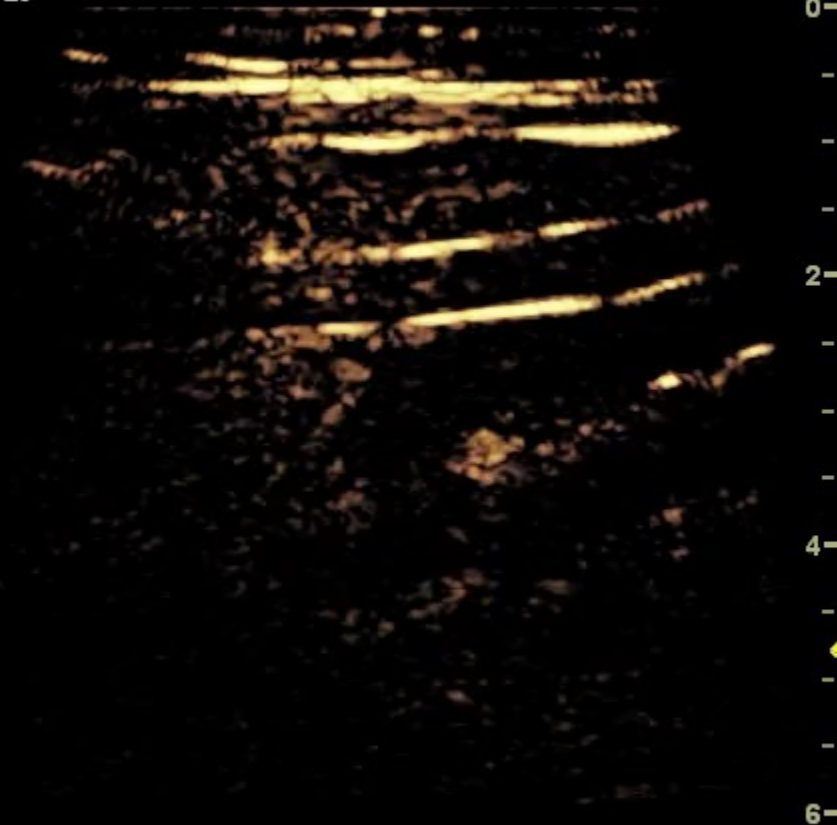


CEUS of Jejunal loop and surrounding tissue



T1: 0:01

LOGIQ
E9





Konklusjon

- Kontrast-undersøkelser har etablert seg i klinikken med over 30 indikasjoner
- SonoVue og Sonazoid er lett å anvende i klinisk praksis og forlenger ikke undersøkelsestiden mer enn 5-10 minutter
- Uklare CT-funn blir nå henvist til UL med kontrast
- Kontrastundersøkelser av fokale lever lesjoner diskriminerer mellom benigne og maligne lesjoner og bedrer karakteriseringen av benigne lesjoner
- CEUS er trygt å bruke bl.a. ved alvorlig nyresvikt

Ultrasound

Waves and bubbles that make a difference