



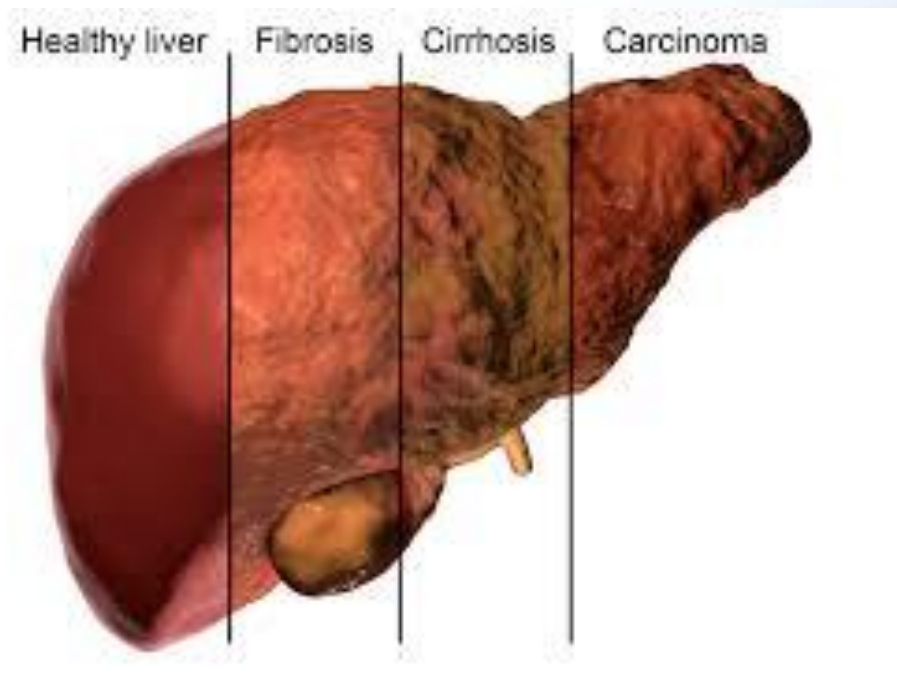
Nasjonalt Senter for Gastroenterologisk Ultrasonografi

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

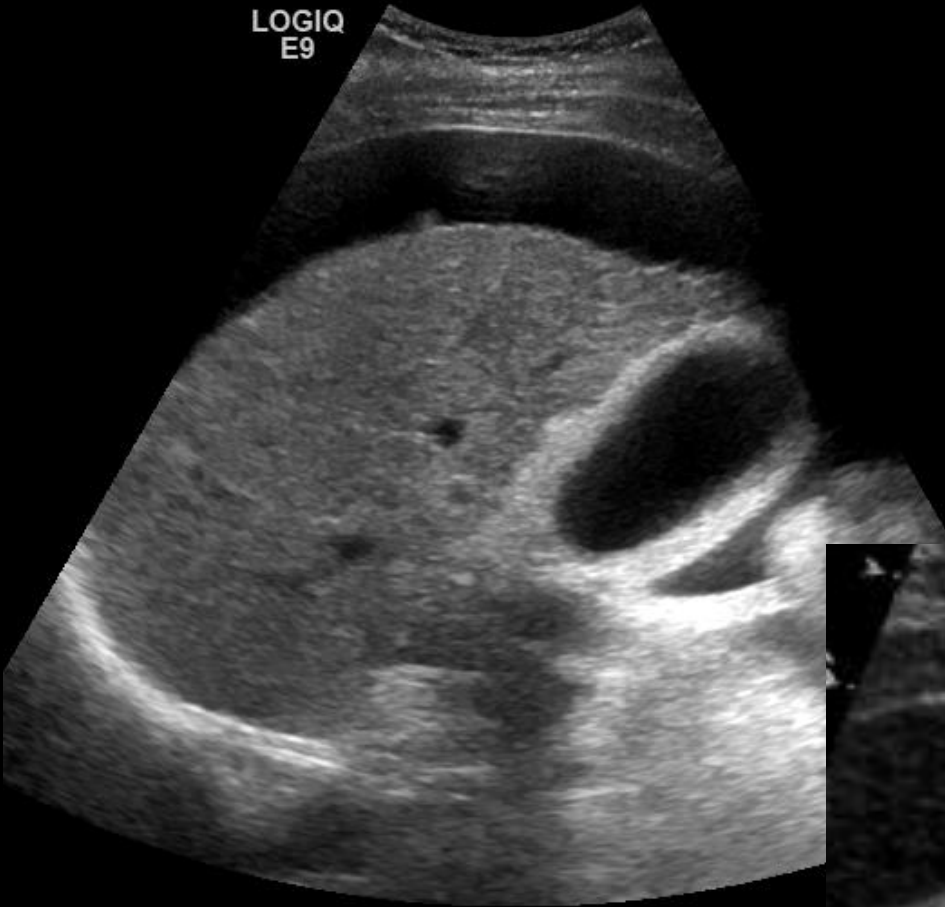
Ultralyd ved fibrose og steatose

Audun Magerøy Trelsgård
Overlege

Levercirrhose



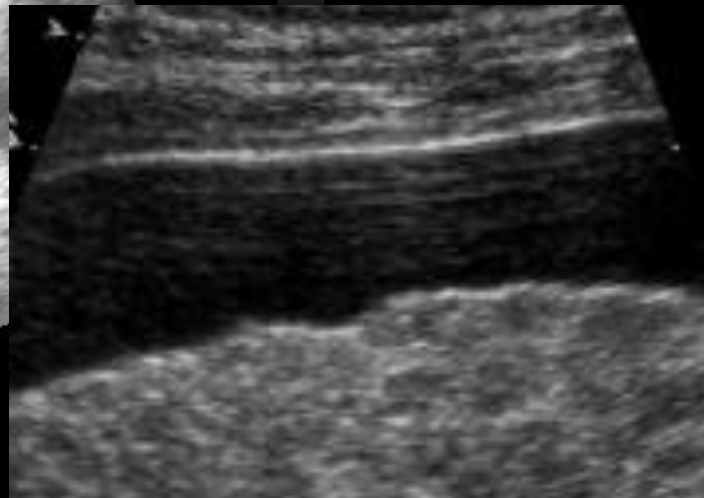
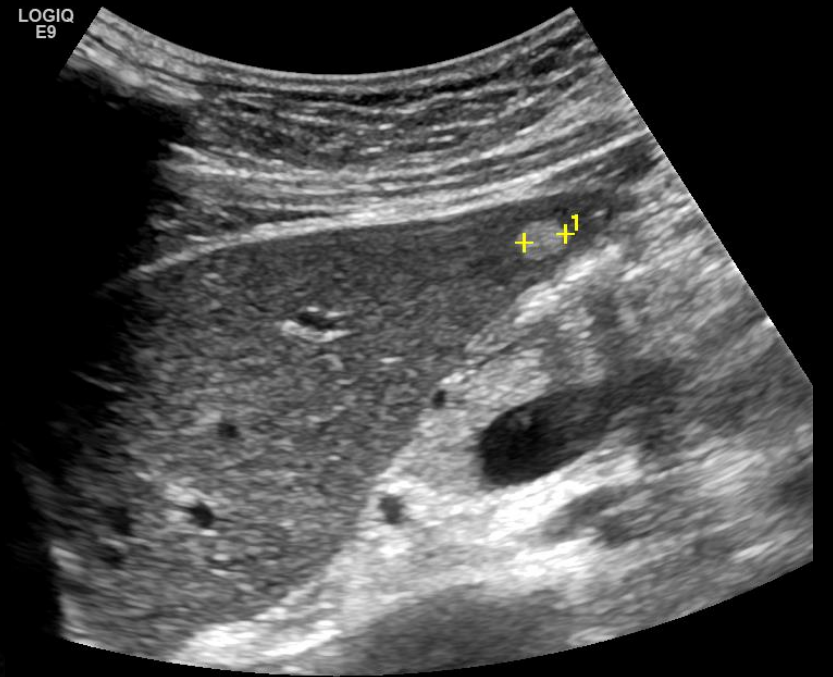
LOGIQ
E9



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

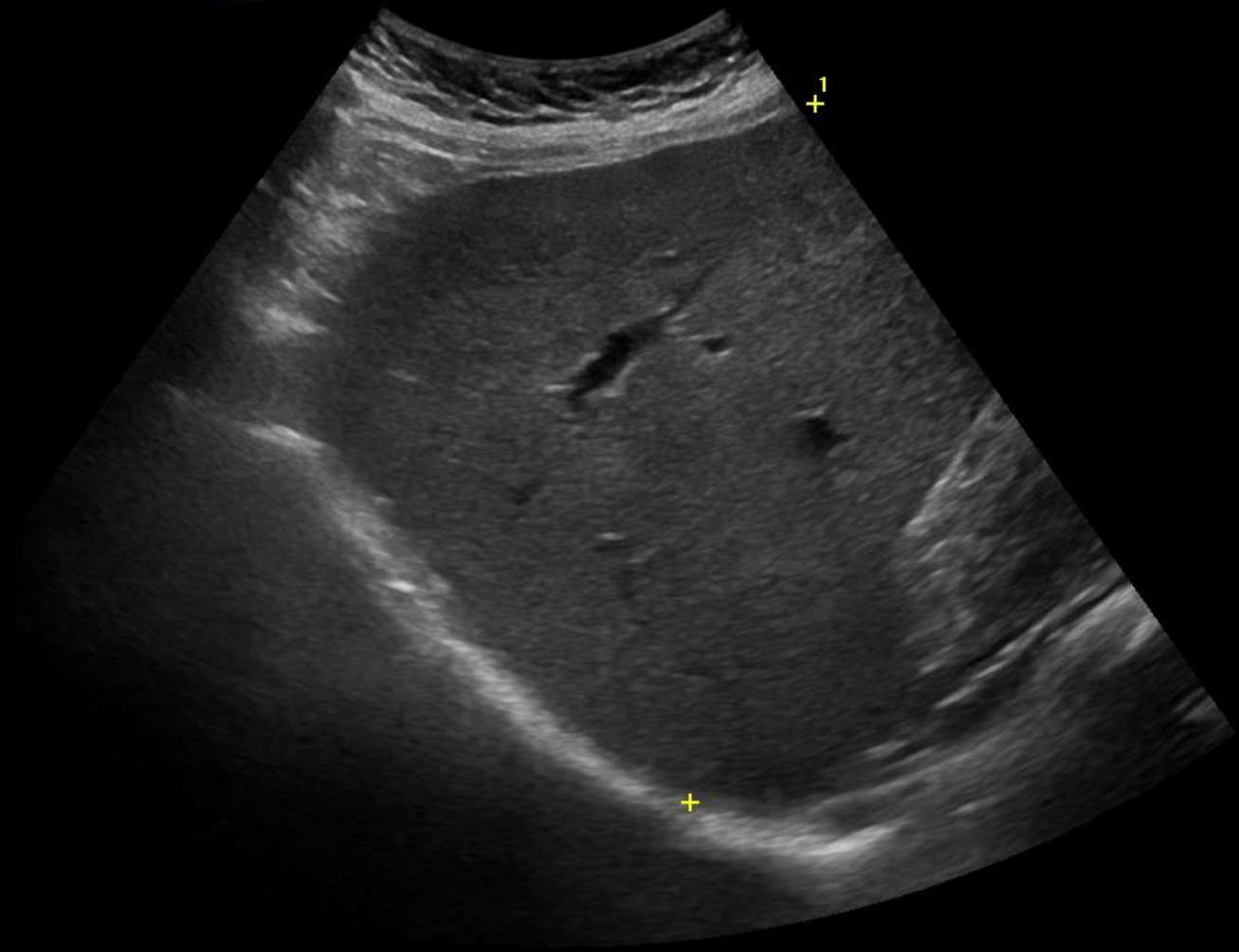
ADM

LOGIQ
E9



03/08/23

LOGIQ



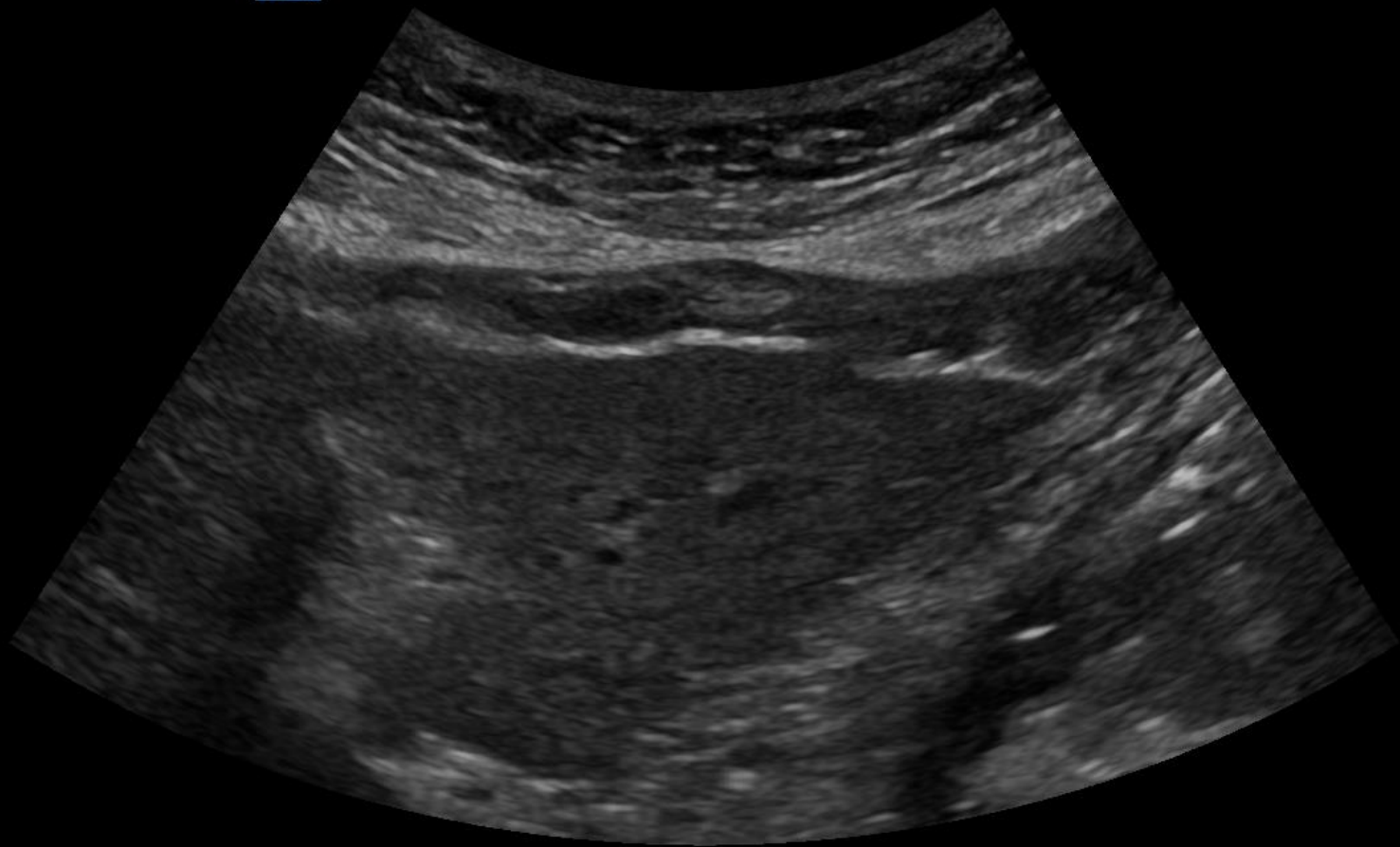
0
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10
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15
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L



1 L 13.56 cm

03/08/23

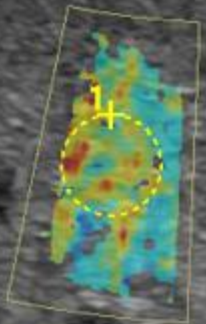
LOGIQ



0
-
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2
-
-
4
-
-
6
-
-
8



LOGIQ
E9



1 E6 16.19 kPa

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)

Authors

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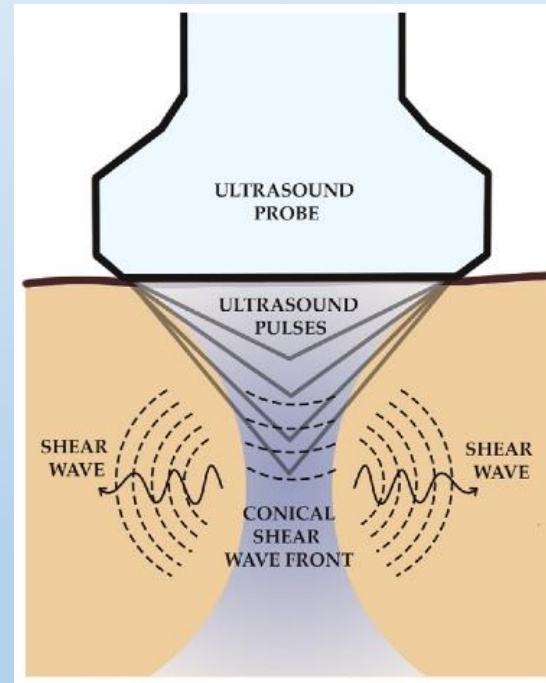
SWE guidelines

Table 2: Recommendation for Interpretation of Liver Stiffness Values Obtained with ARFI Techniques in Patients with Viral Hepatitis and NAFLD

Liver Stiffness Value	Recommendation
≤5 kPa (1.3 m/sec)	High probability of being normal
<9 kPa (1.7 m/sec)	In the absence of other known clinical signs, rules out cACLD. If there are known clinical signs, may need further test for confirmation
9–13 kPa (1.7–2.1 m/sec)	Suggestive of cACLD but need further test for confirmation
>13 kPa (2.1 m/sec)	Rules in cACLD
>17 kPa (2.4 m/sec)	Suggestive of CSPH

Note.—ARFI = acoustic radiation force impulse, cACLD = compensated advanced chronic liver disease, CSPH = clinically significant portal hypertension, NAFLD = non-alcoholic fatty liver disease.

Shear-wave elastography (SWE)



Elastografi - forberedelse

- Faste minst 3 timer
- 10 min hvile

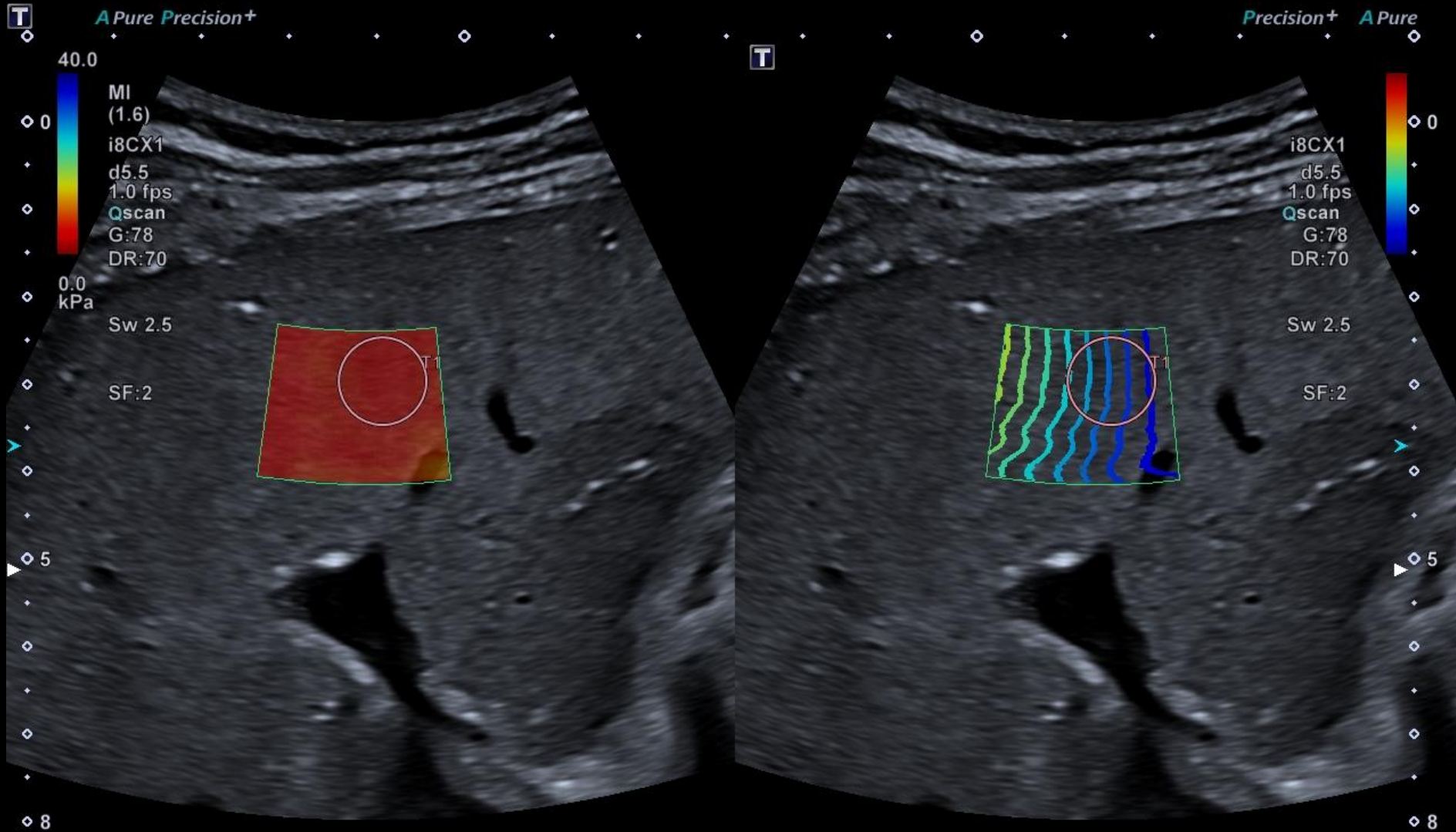


Elastografi - prosedyre

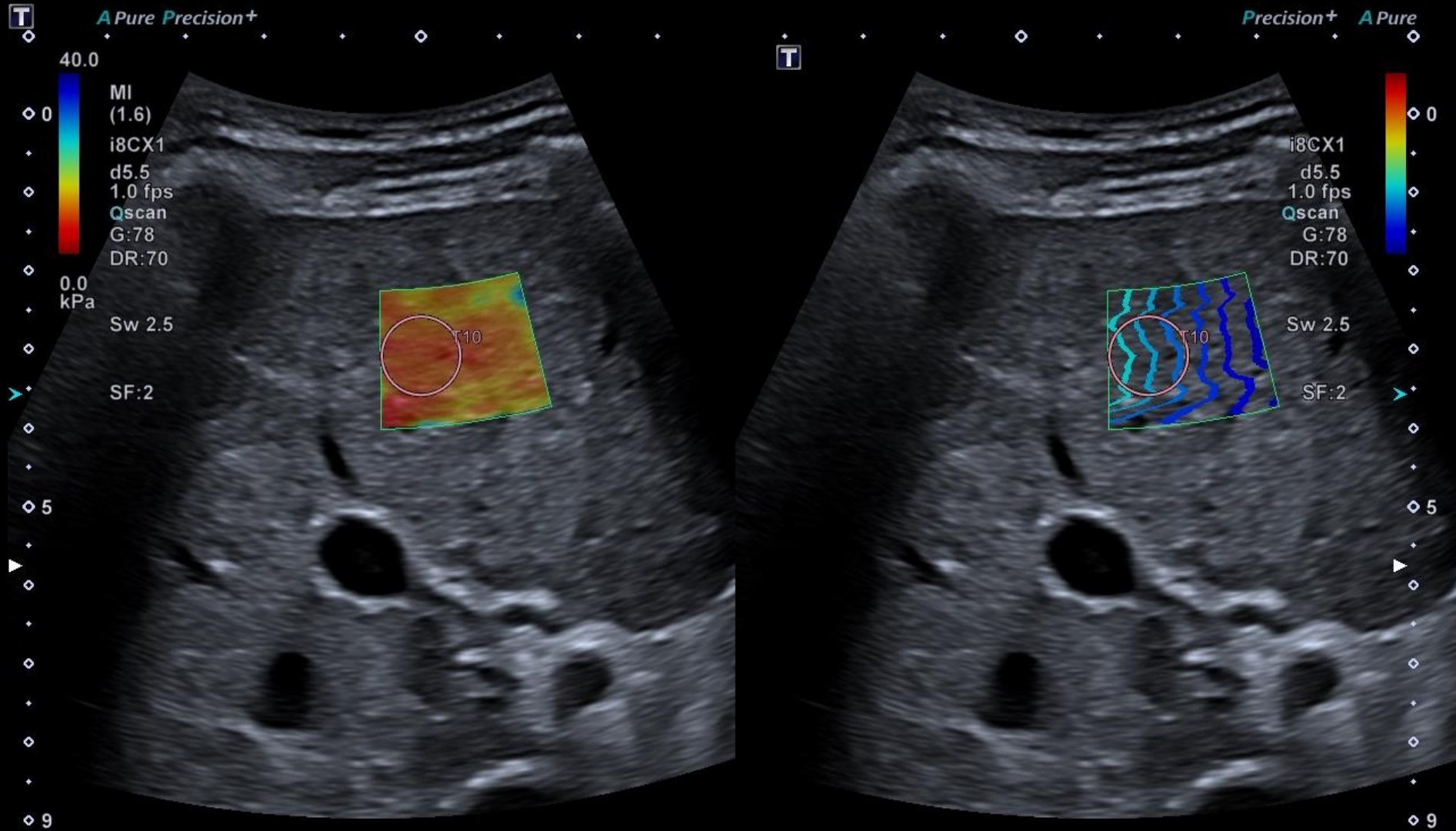
- Intercostalt høyre leverlepp
- Høyre arm over hodet
- Holde pusten (i ekspirasjon), unngå dyp inspirasjon
- Proben ca 90° ift hud
- **God kvalitet på 2D bildet**
- Måle minst 1 cm fra leverkapselen (1-2)
- Max 6 cm under lever kapsel (max total dybde 6 cm)
- 10 målinger std, men 5 er like bra
- «Penetration» kan brukes, bør dokumenteres

Feilkilder

- Ikke fastende (mat viktigst)
- Hjertesvikt, stuvning, nyresvikt
- Inflammasjon (inkl alkoholisk hepatitt)
- Cholestase
- Lite erfaring/opplæring
- Amyloidose og visse andre tilstander
- Gain skal være på default
- Målinger mot kanten av bildet kan gi gale verdier



Ave.T1	5.7kPa
SD.T1	0.4kPa



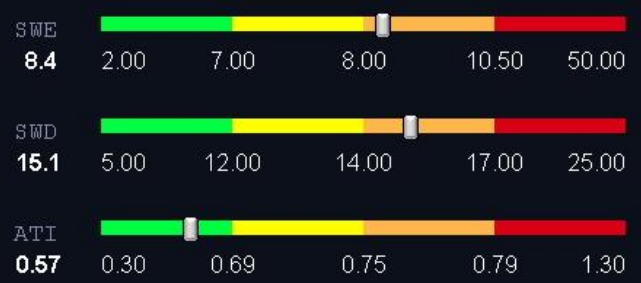
Ave.T10	8.9kPa
SD.T10	1.1kPa

Shear Wave

		Speed[m/s]		Elasticity[kPa]		Dispersion[(m/s)/kHz]		Depth[cm]
		Average	SD	Average	SD	Average	SD	
<input checked="" type="checkbox"/>	1	1.57	0.11	7.3	1.1	14.97	4.36	2.8
<input checked="" type="checkbox"/>	2	1.58	0.11	7.3	1.0	15.18	4.22	2.8
<input checked="" type="checkbox"/>	3	1.60	0.09	7.6	0.9	14.90	2.76	2.8
<input checked="" type="checkbox"/>	4	1.66	0.10	8.1	1.0	14.24	2.70	2.8
<input checked="" type="checkbox"/>	5	1.68	0.12	8.3	1.2	14.60	2.41	2.8
<input checked="" type="checkbox"/>	6	1.70	0.12	8.6	1.3	14.42	2.80	2.8
<input checked="" type="checkbox"/>	7	1.69	0.10	8.4	1.0	16.16	3.24	2.8
<input checked="" type="checkbox"/>	8	1.72	0.09	8.8	1.0	18.60	7.19	3.1
<input checked="" type="checkbox"/>	9	1.75	0.09	9.1	1.0	19.40	6.87	3.1
<input checked="" type="checkbox"/>	10	1.73	0.10	8.9	1.1	18.95	6.70	3.1

Graph Settings

#LIVER



#LIVER

- Severe
- Significant
- Mild
- Normal

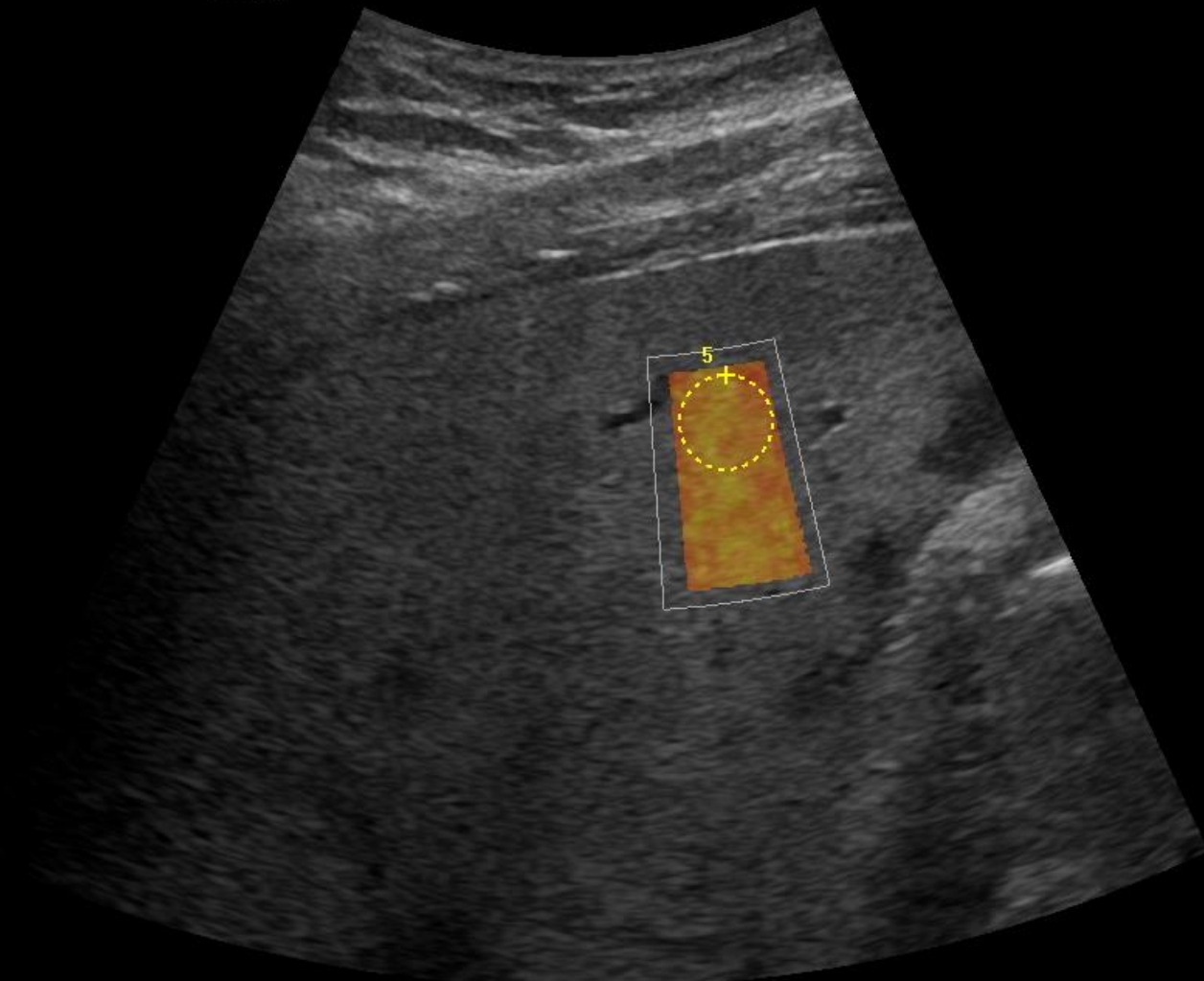
Attenuation

	ATI[dB/cm/MHz]
<input checked="" type="checkbox"/>	1 0.60
<input checked="" type="checkbox"/>	2 0.57
<input checked="" type="checkbox"/>	3 0.56
<input checked="" type="checkbox"/>	4 0.60
<input checked="" type="checkbox"/>	5 0.55

Application Measurement	Speed [m/s]	Elasticity [kPa]	Dispersion [(m/s)/kHz]	ATI [dB/cm/MHz]
Mean	1.67	8.2	16.1	0.58
SD	0.06	0.6	1.9	0.02
Median	1.68	8.4	15.1	0.57
IQR	0.12	1.2	4.0	0.04
IQR/Median	0.07	0.14	0.27	0.07

Application Measurement		Speed [m/s]	Elasticity [kPa]	Disp
	Mean	1.67	8.2	
	SD	0.06	0.6	
	Median	1.68	8.4	
	IQR	0.12	1.2	
	IQR/Median	0.07	0.14	

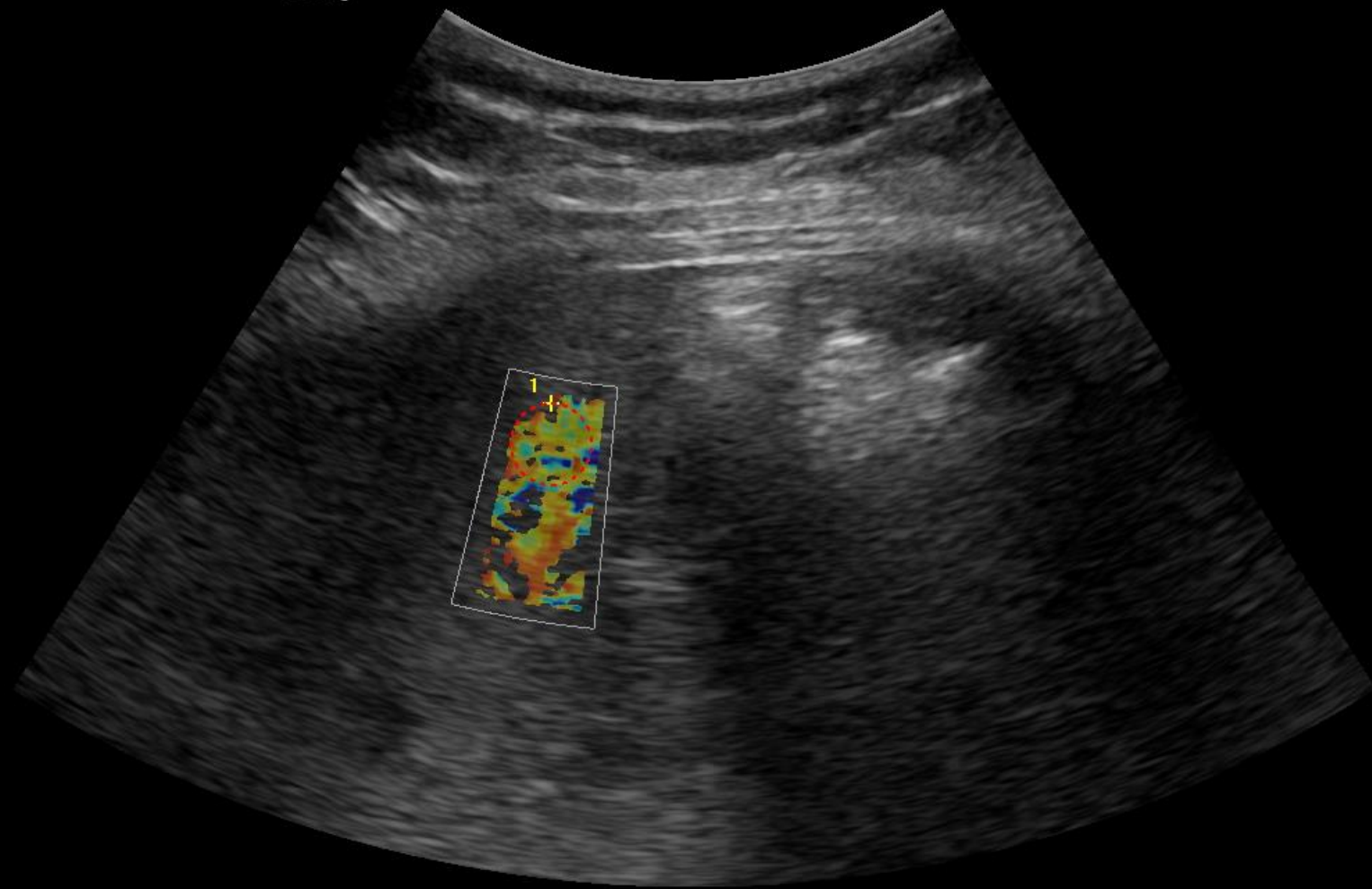
LOGIQ



0
5
10

●	E8	3.46 kPa
1	E8	3.46 kPa
2	E9	3.48 kPa
3	E10	
4	E1	3.52 kPa
5	E2	3.54 kPa

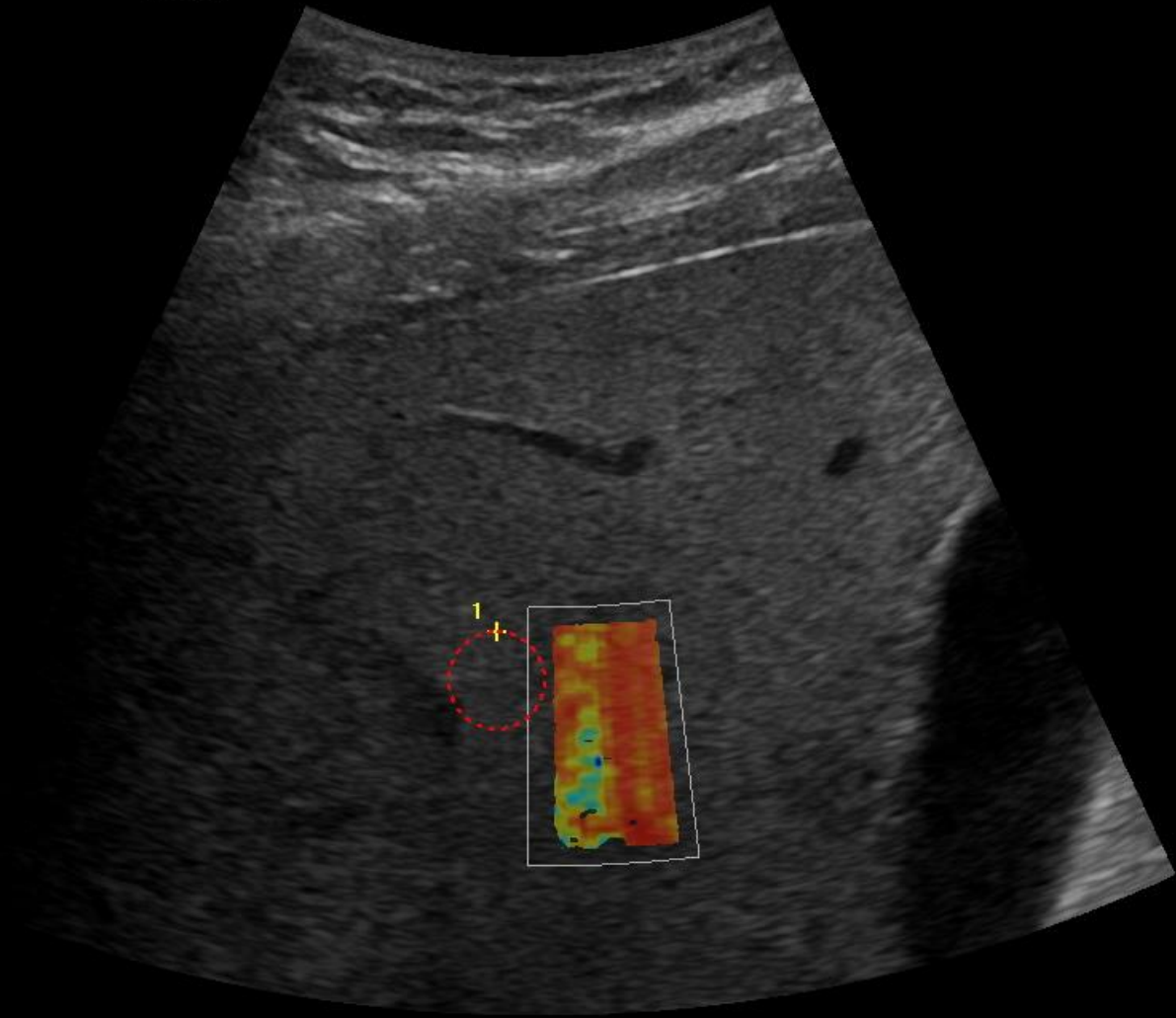
LOGIQ



0
-
-
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5
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-
-
-
10

E10 8.36 kPa

LOGIQ



0
-
-
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5
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-
-
-
-
-
L10

1 E8



Parameter	Value	m1	m2	m3	m4	m5	m6	Method
B Mode Measurements								
Stiffness, kPa								
Site1								
E1	5.61 kPa	4.55	5.61					Last
E2	5.62 kPa	6.08	5.62					Last
E3	5.70 kPa	5.70						Last
E4	4.91 kPa	4.91						Last
E5	4.73 kPa	4.73						Last
E6	5.80 kPa	5.80						Last
E7	5.25 kPa	5.25						Last
E8	6.21 kPa	6.21						Last
E9	5.03 kPa	5.03						Last
E10	5.36 kPa	5.36						Last
E Median	5.49 kPa							
E IQR	0.59 kPa							
E IQR/Median	10.8 %							
N	10							

E10	5.36 kPa	5.36
E Median	5.49 kPa	
E IQR	0.59 kPa	
E IQR/Median	10.8 %	
N	10	

LOGIQ E9 Shear Wave Elastography



Liver Fibrosis Staging

Liver Fibrosis Staging	Metavir Score	kPa	m/s
Normal – Mild	F1	5.48 kPa – 8.29 kPa	1.35 m/s – 1.66 m/s
Mild – Moderate	F2	8.29 kPa – 9.40 kPa	1.66 m/s – 1.77 m/s
Moderate – Severe	F3	9.40 kPa – 11.9 kPa	1.77 m/s – 1.99 m/s
Cirrhosis	F4	> 11.9 kPa	> 1.99 m/s

A GE study has demonstrated that LOGIQ™ E9 Shear Wave Elastography is a robust technique and capable of evaluating stiffness changes in the liver associated with fibrosis. Although a limited number of subjects were evaluated at the hospital in this study, liver stiffness measurements were shown to be useful for discriminating different stages of fibrosis. It is important to note that a small number of subjects with intermediate stages of fibrosis were evaluated in this study, and that a mix of disease etiologies were present. Therefore, the values shown may not be directly applicable to other patient populations. Data was acquired using LOGIQ E9 R5.1.0 equivalent software and the C1-6-D probe. For detailed information, please see the LOGIQ E9 Shear Wave Elastography white paper.

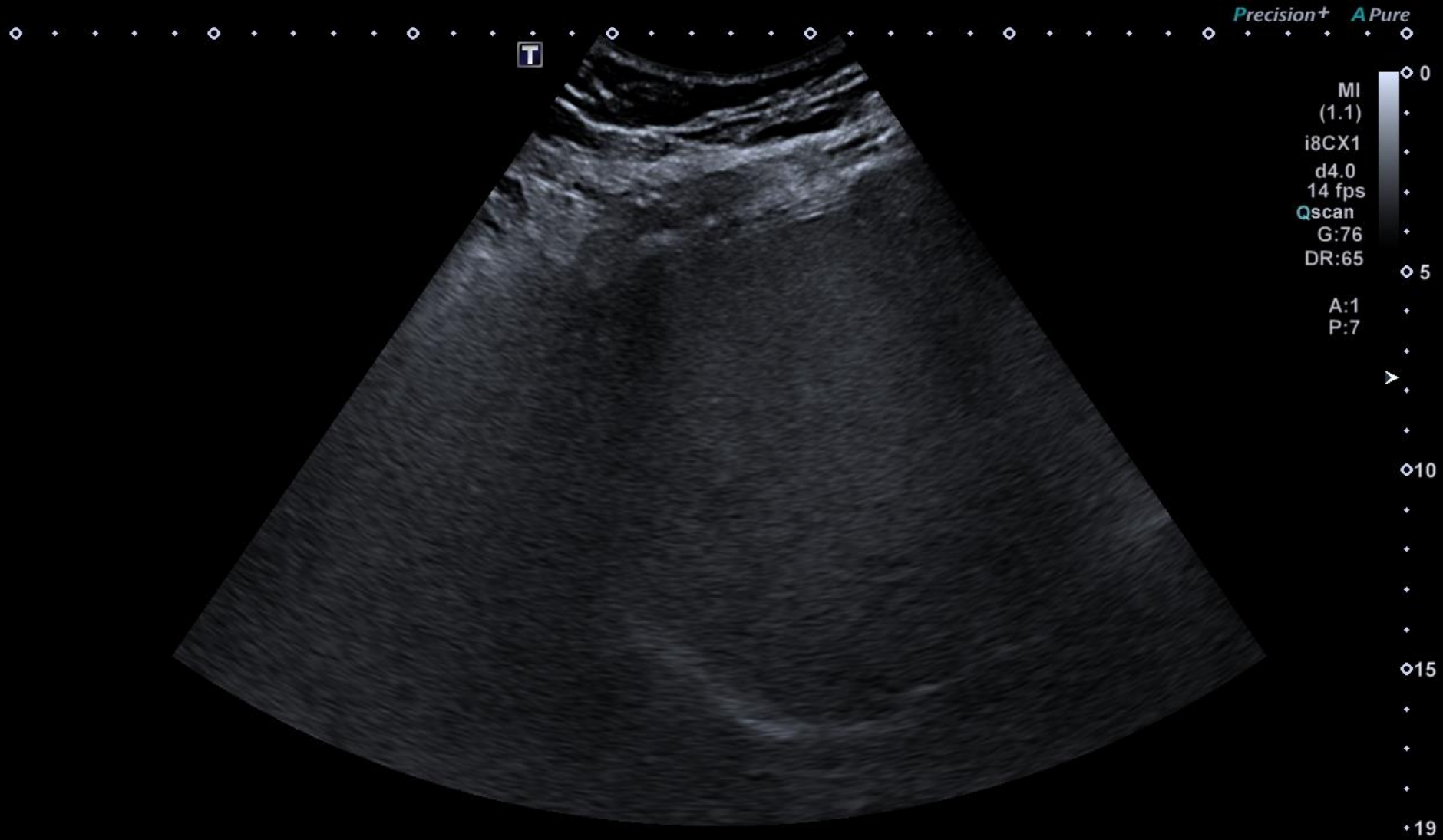
Elastografi - tolkning

- Median verdi i m/s el kPa
- IQR/median < 30% (arvet fra CAP)
- Elastografi god på skille normal fra ≥ 2 fibrose, men dårligere til å differensiere F0-F1.
- Produsentene har ulike referanseområder
- Ved dekompensert leversykdom har leverstivhetsmålinger mindre betydning



Leversteatose

Audun Magerøy Trelsgård



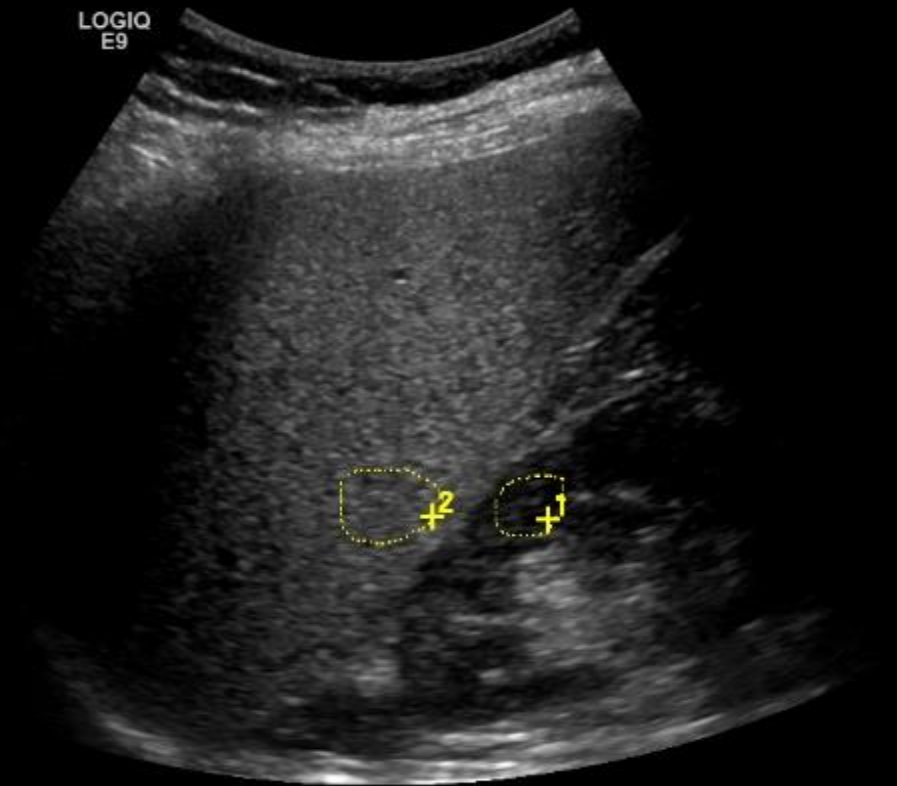


Haukeland US
02/07/12 09:48:42 ADM

MI 1.0 TIs 1.7 C1-5
Abdomen

FR 26

LOGIQ
E9



CHI
0-Frq 4.0
Gn 64
- S/A 1/1
Map F/1
- D 12.0
DR 66
- AO% 100



5"
10"

●	EL	-53.7 dB
●	EL	-42.8 dB


NAFLD

- Non-alcoholic fatty liver disease affect 25% of the world's population
- Strongly associated with type 2 diabetes, > 500 million individuals worldwide
- The management of NAFLD is ineffective, time-consuming, unable to quantify liver fat content, does not identify non-alcoholic steato-hepatitis (NASH).
- Increased risk of cirrhosis
- Projected to be the number one cause of liver transplantation in the USA by 2030
- Epidemic of obesity
- There is a gap in the clinical practice



Overordnede mål

- Identifisere pasienter med høy risiko (NASH)
- Seleksjon mtp leverbiopsi (studier?)
- Kvantitative målinger for oppfølging av høy risiko
- Identifisere lav risiko -> standard oppfølging FL
- Hvordan gjøre dette?

- 
- FIB-4 (fibrose)
 - Alder, ASAT, Trombocyter, ALAT
 - FIB-4 < 1,3 kan utelukke avansert fibrose
 - Risikogrupper, fedme, metabolsk syndrom, mistenkt helseskadelig alkoholinntak
 - Blodprøve av personer med høy risiko for leversykdom
 - Artikkel gastroenterologen el tidsskriftet, Vesterhus

- 
- *the One-stop Liver Shop*

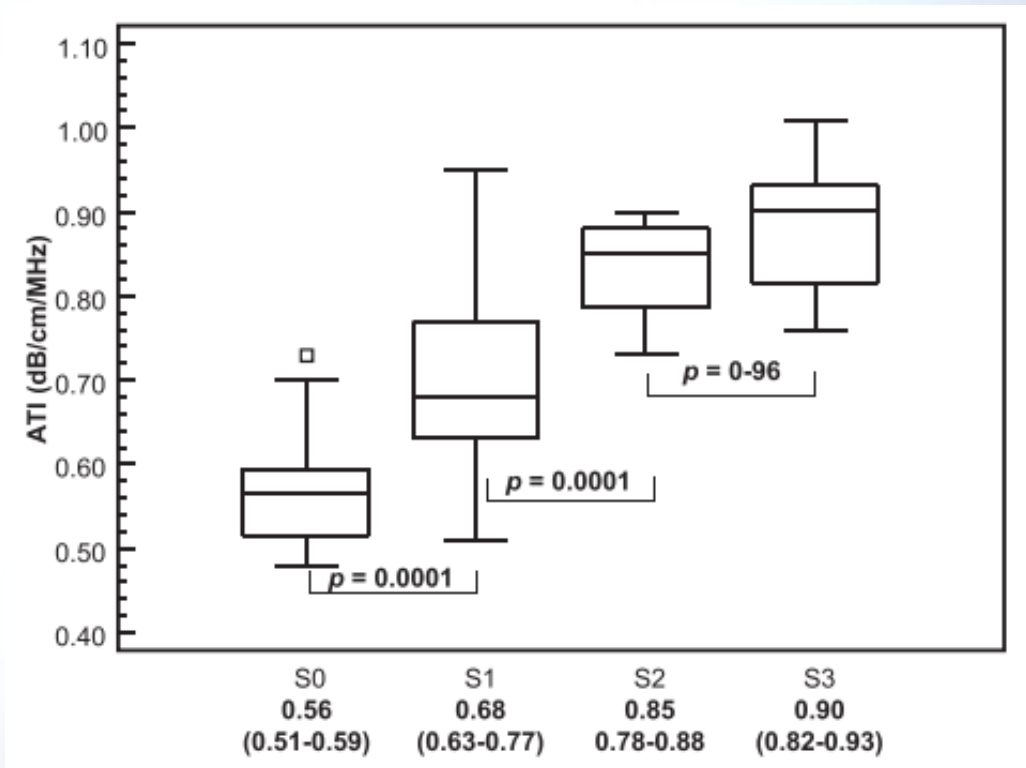
Attenuasjon

- Økt fettinnhold -> økt attenuasjon av ultralydbølgene
- CAP, controlled attenuation parameter
- UGAP, ultrasound guided Attenuation parameter
- ATI, attenuation coefficient

Attenuation imaging (ATI)

- 114 pasienter «potentially at risk of steatosis» and 15 healthy controls
- Gjennomsnittlig BMI 29,5
- 87 av 123 hadde steatose, prevalens 71%.
- MRI-PDFF

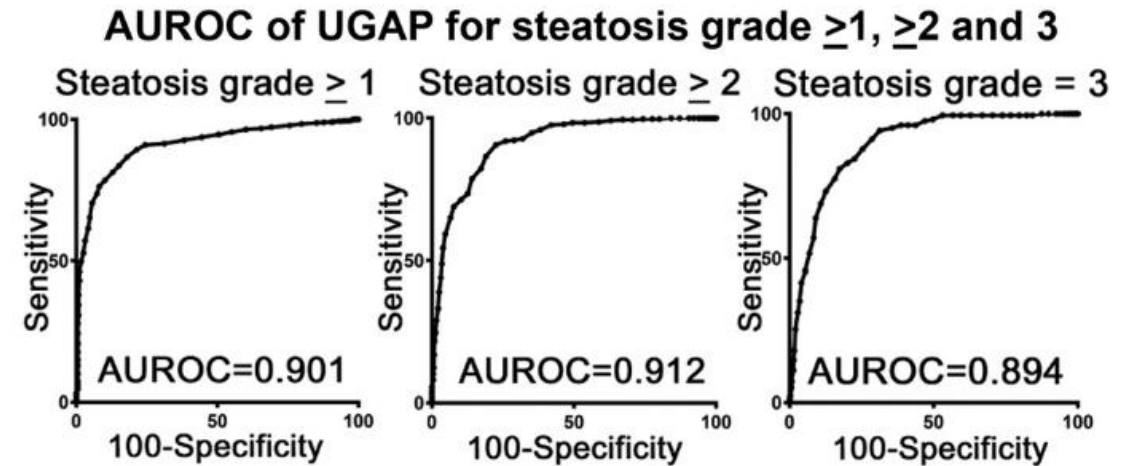
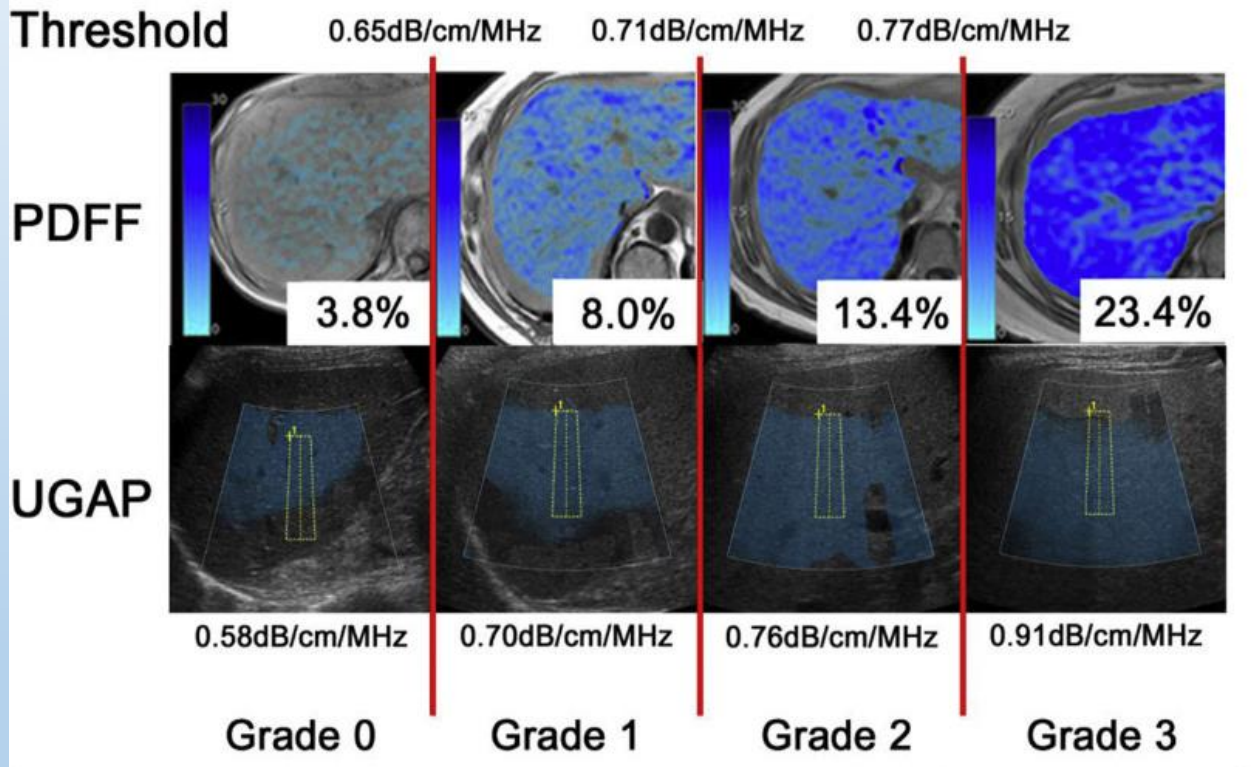
ATI



53% steatose grad1

AUROC 0,91 ved 0,63 og
0,95 ved 0,72 dB/cm/MHz.
Aller best på «rule-out»

Ultrasound-guided attenuation parameter (UGAP)



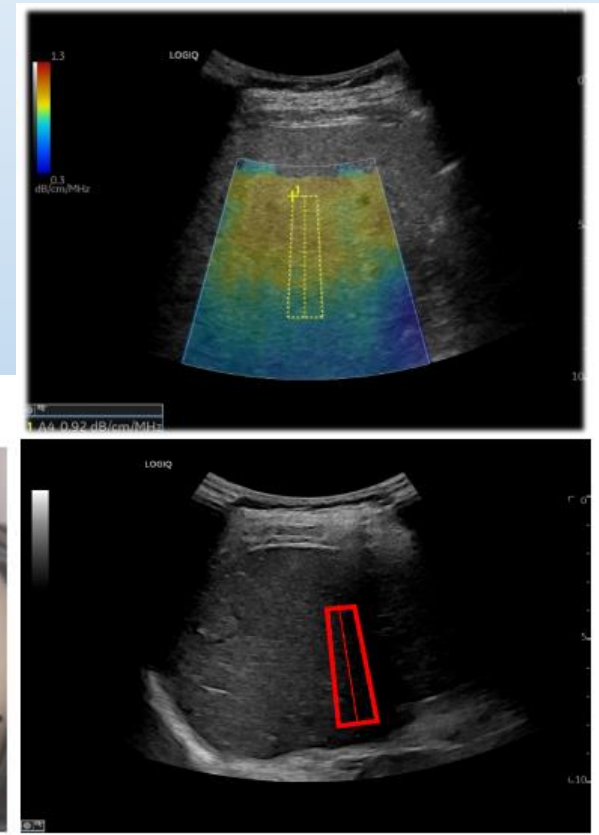
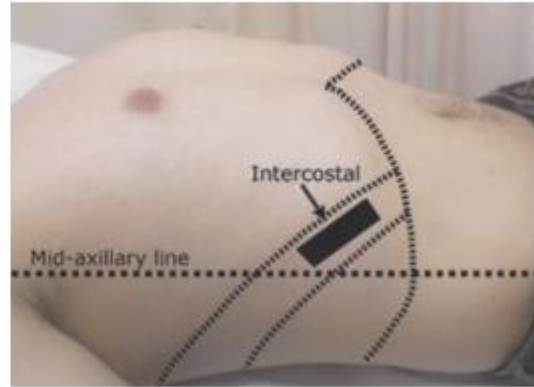
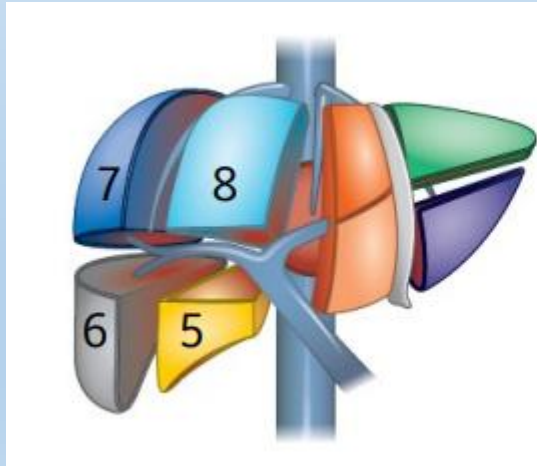
n=1010

UGAP GE

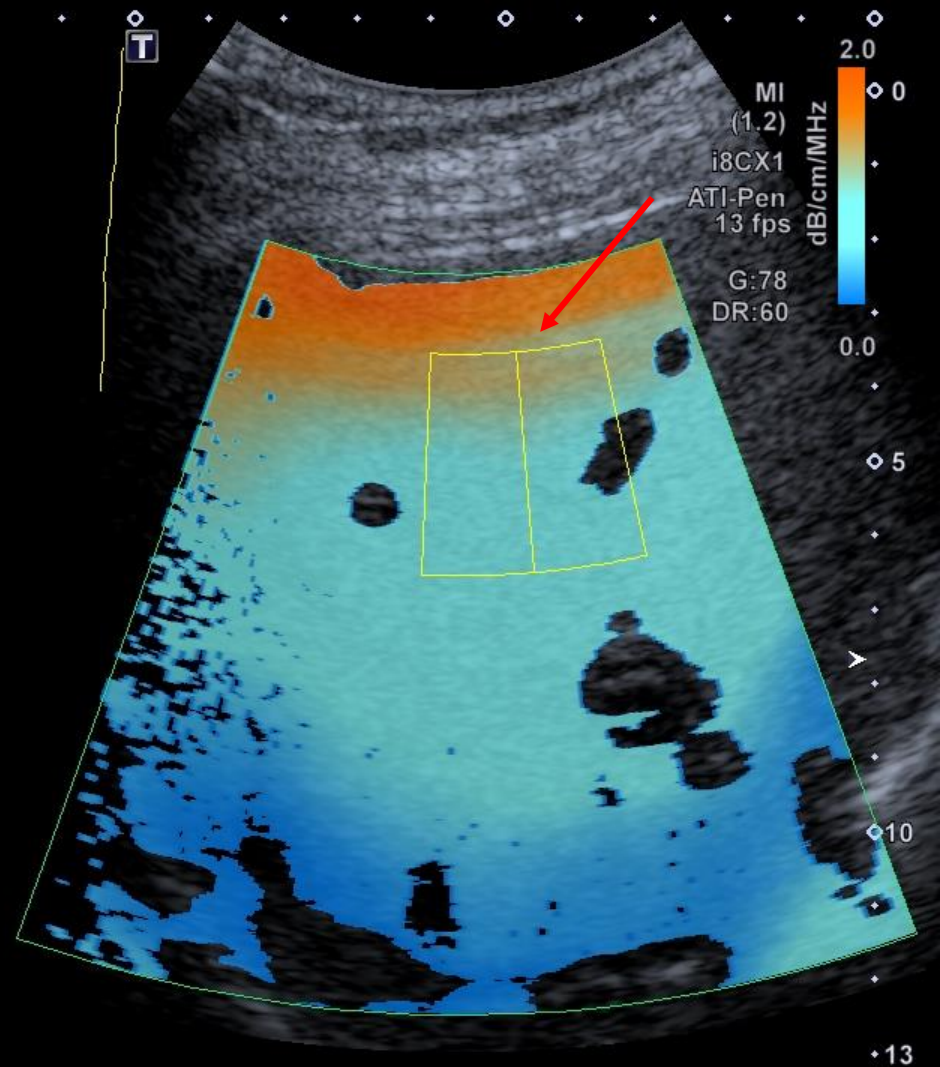
	UGAP		
	$\geq S1$	$\geq S2$	S3
AUROC (95% CI)	0.901 (0.891 – 0.928)	0.912 (0.894 – 0.929)	0.894 (0.873 – 0.916)
Attenuation coefficient cutoff value (dB/cm/MHz)	0.65	0.71	0.77
Attenuation rate cutoff value (dB/m)	228	249	270

Table 2. AUROCs, 95% CI and cutoff values of UGAP for the prediction of $\geq S1$, $\geq S2$ and S3 steatosis.

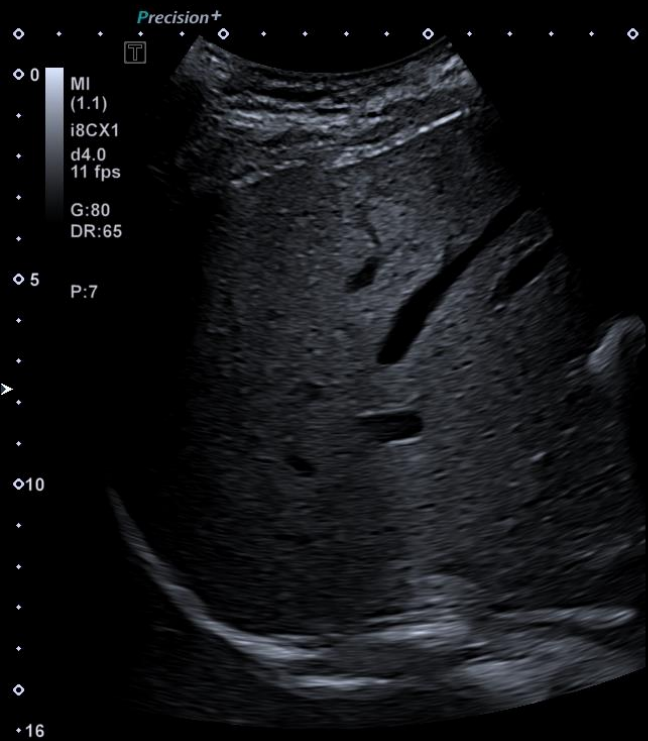
- Faste 4-6 t
- Godt 2 D bilde
- Unngå kar
- IQR/median < 30%



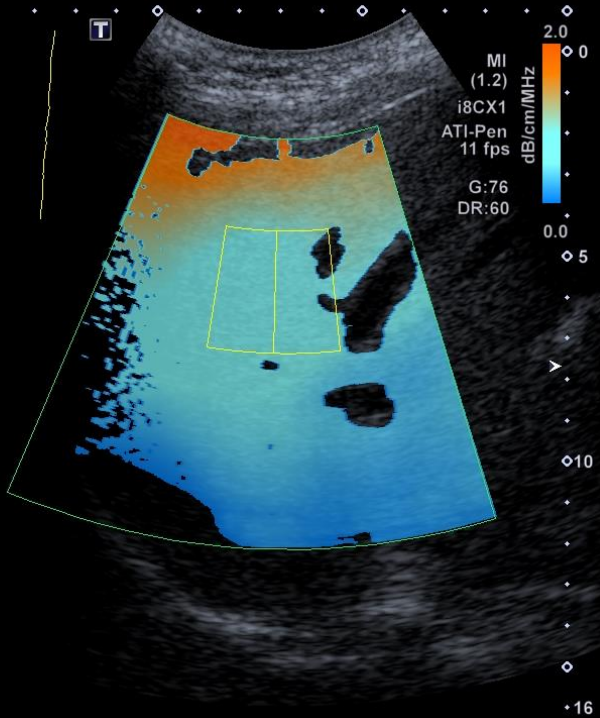
Bilder fra GE



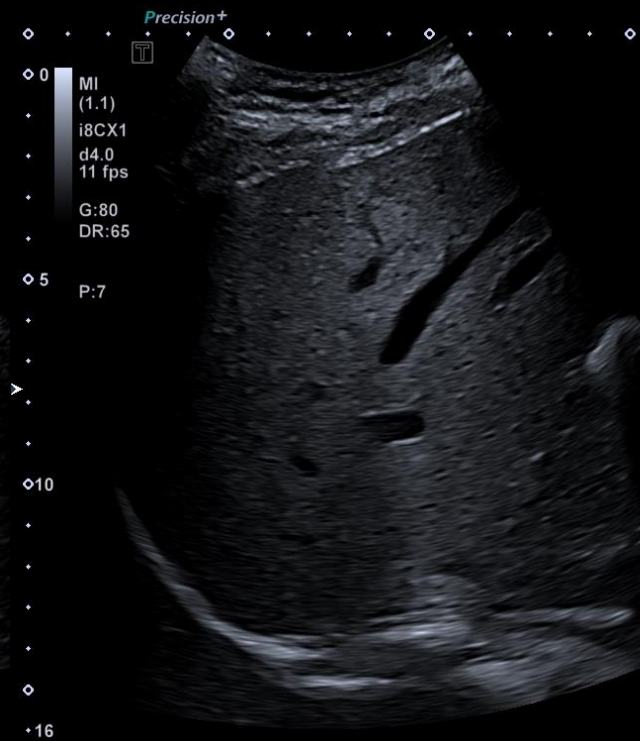
0.86 dB/cm/MHz (R² 0.96)



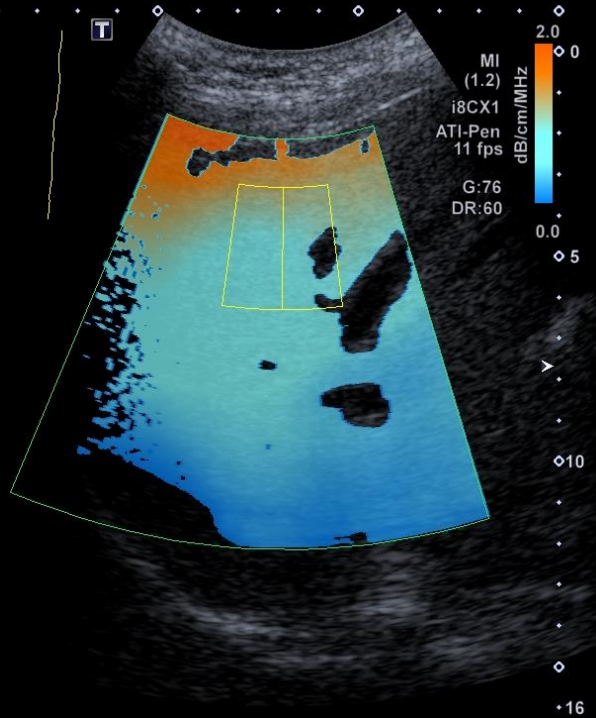
0.70 dB/cm/MHz (R^2 0.98)



13



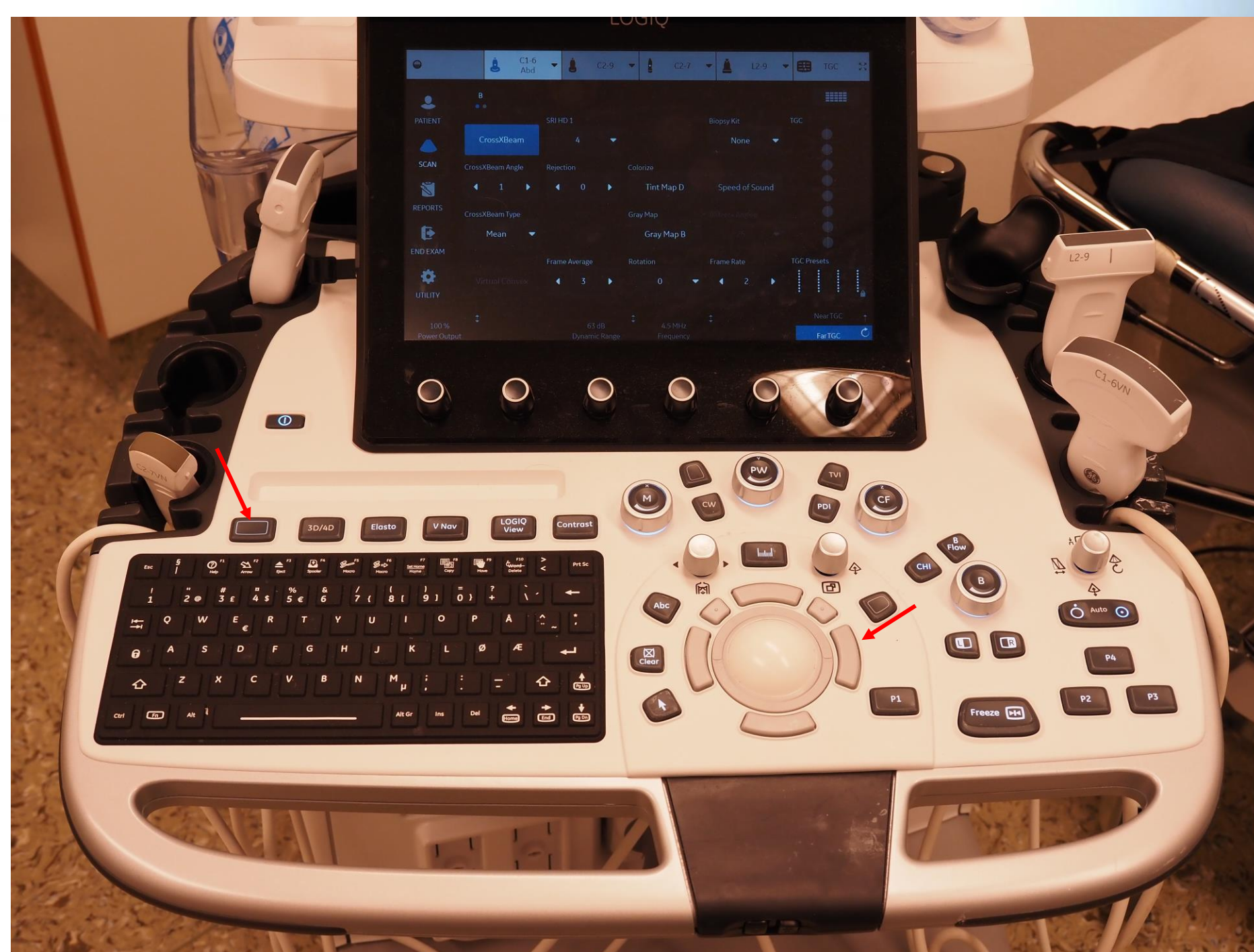
0.79 dB/cm/MHz (R^2 0.96)



13

General Electric (GE)





1. UGAP
2. Høyre knapp
3. Freeze
4. Høyre knapp/P1

LOGIQ

C1-6 Abd C2-9 C2-7 L2-9 TGC

- PATIENT
- SCAN
- REPORTS
- END EXAM
- UTILITY

B UGAP

Visualization

B Ref Color Ref **Color Dual**

Quality Map

UGAP BLUE

Min Value Max Value Attenuation Map Compress Transparent

0.3 1.3 UGAP2 7 44

Auto Measurement Skip Frame

Multi 10

UGAP Indicator Map

UGAP BLUE rect Rep.

UGAP GREEN

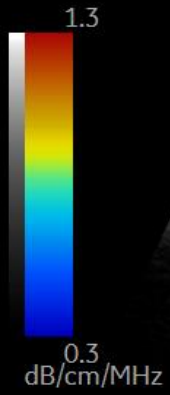
UGAP Red

Cancel

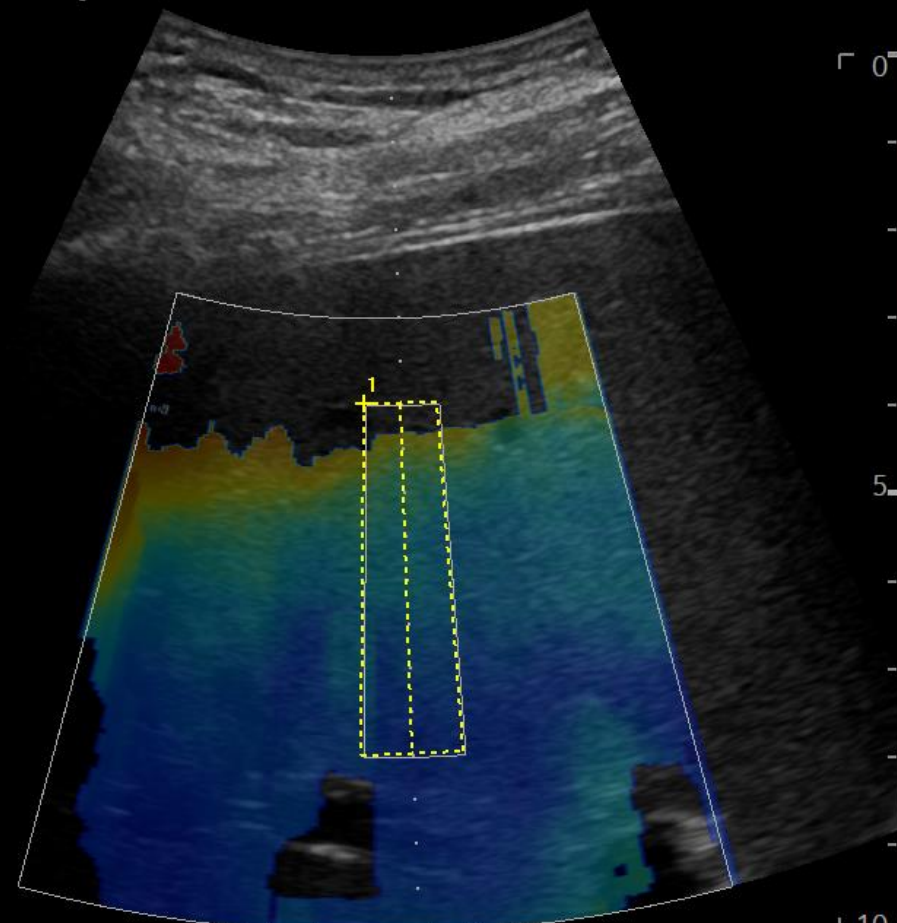
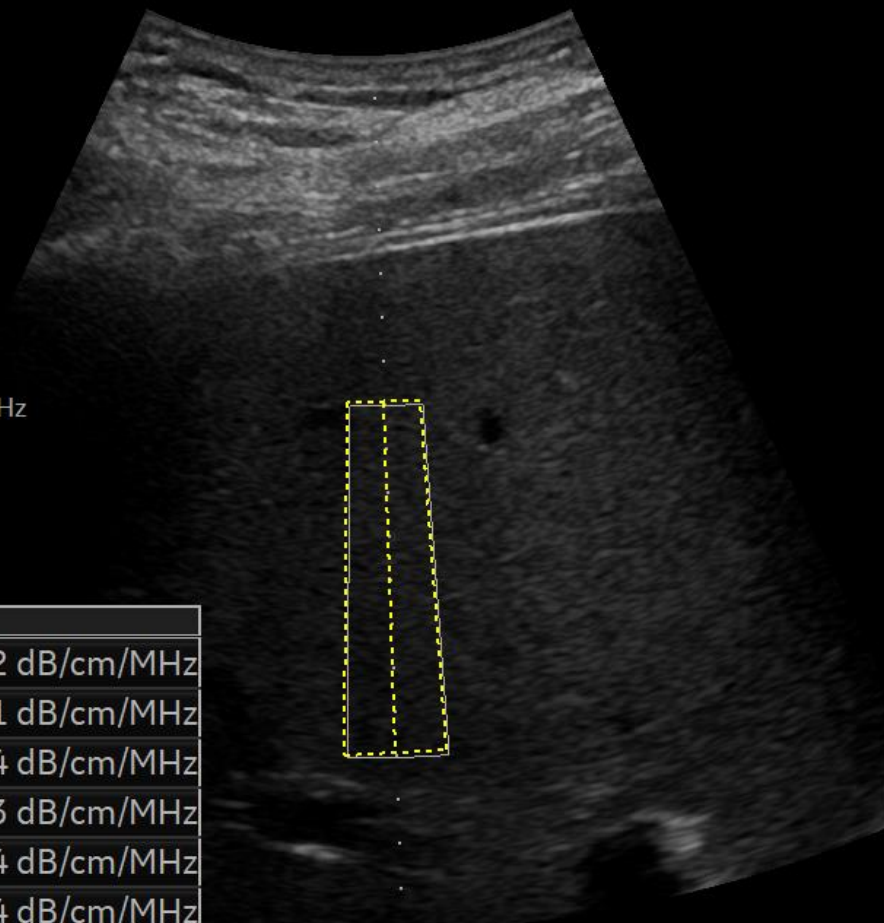




LOGIQ



ROI	Value
2 A2	0.62 dB/cm/MHz
3 A3	0.61 dB/cm/MHz
4 A4	0.64 dB/cm/MHz
5 A5	0.63 dB/cm/MHz
6 A6	0.64 dB/cm/MHz
7 A7	0.64 dB/cm/MHz
8 A8	0.69 dB/cm/MHz
9 A9	0.69 dB/cm/MHz
1 A10	0.73 dB/cm/MHz

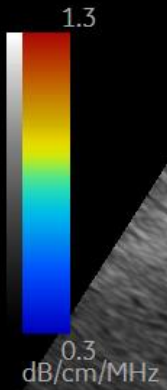


Parameter	Value
CHI	
Frq	6.0
Gn	44
D	10.0
U	
Frq	3.5
T	44
AO%	100

L10



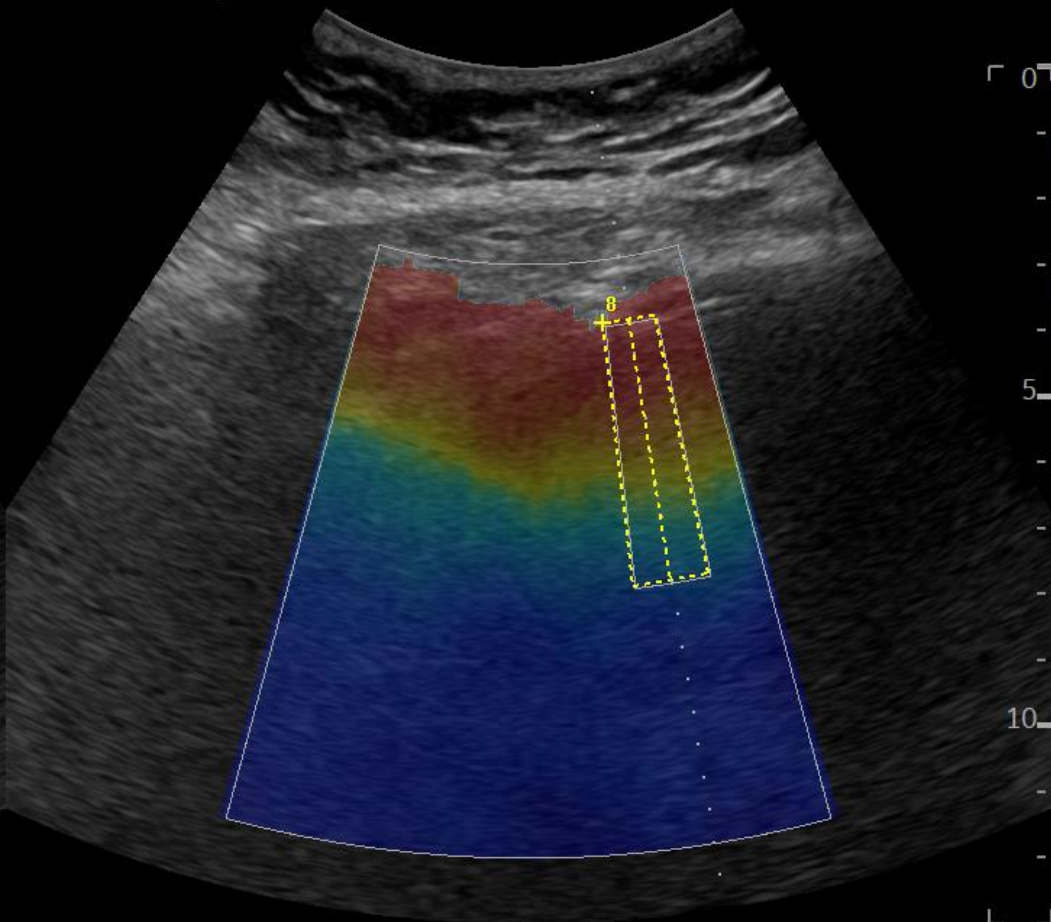
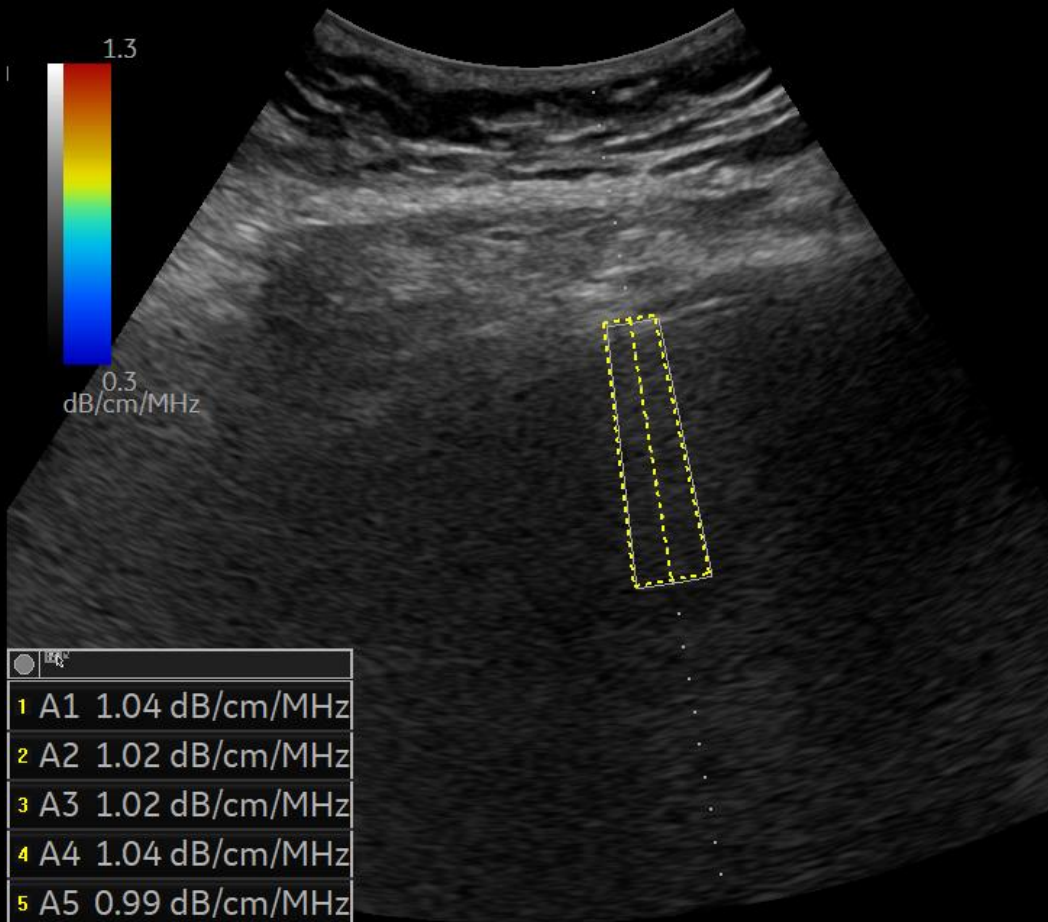
LOGIQ



●	1	A1	1.04 dB/cm/MHz
●	2	A2	1.02 dB/cm/MHz
●	3	A3	1.02 dB/cm/MHz
●	4	A4	1.04 dB/cm/MHz
●	5	A5	0.99 dB/cm/MHz
●	6	A6	1.01 dB/cm/MHz
●	7	A7	1.01 dB/cm/MHz
●	8	A8	1.02 dB/cm/MHz

CHI	
Frq	2.5
Gn	36
D	13.0

U	
Frq	3.5
T	44
AO%	100



10
L



Haukeland Sykehus
03/11/23 09:52:40

ADM

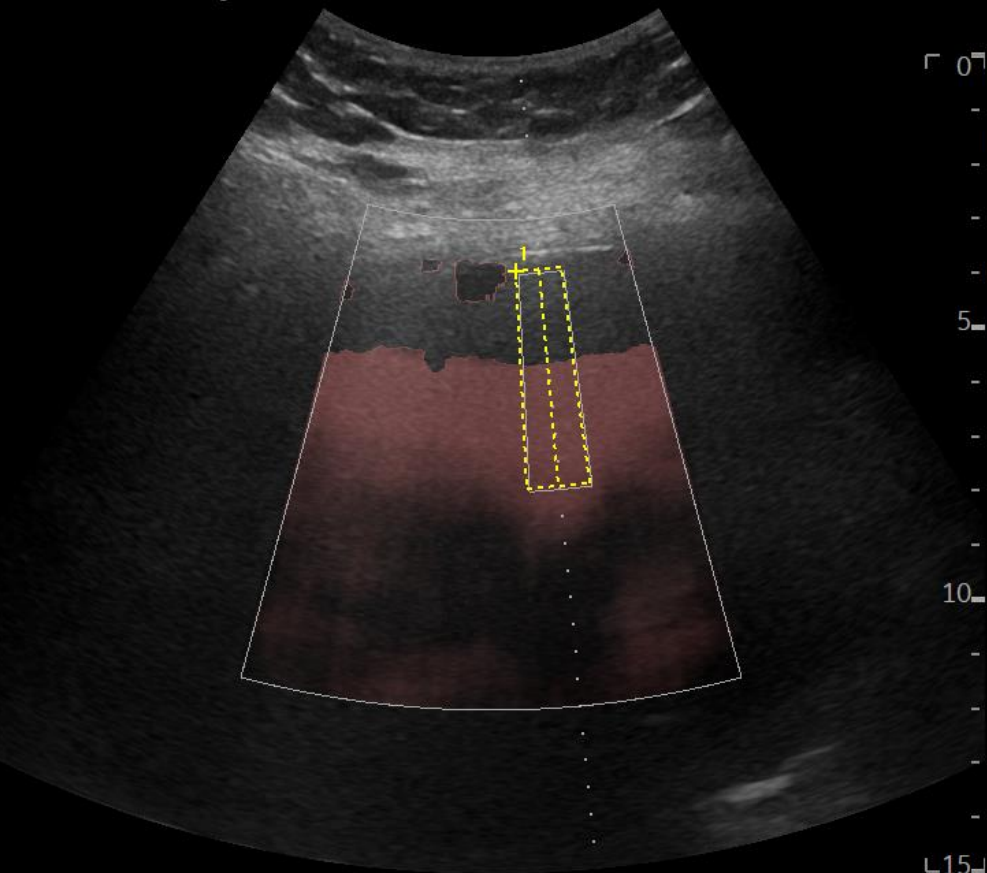
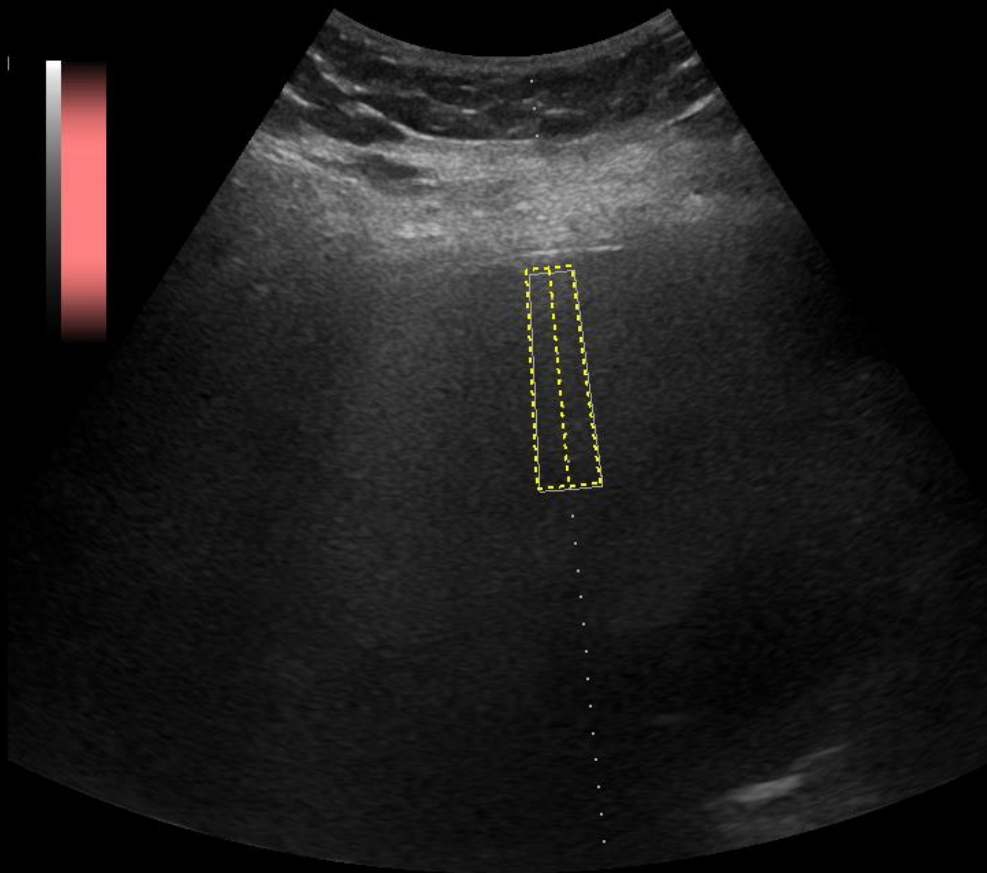
MI 1.3

TIs 1.0

C1-6
Abdomen

FR 18

LOGIQ



CHI	
Frq	4.5
Gn	44
D	15.0
-	
U	
Frq	3.5
T	44
AO%	100

10
15

A1 0.82 dB/cm/MHz



Haukeland Sykehus
03/11/23 09:54:14

ADM

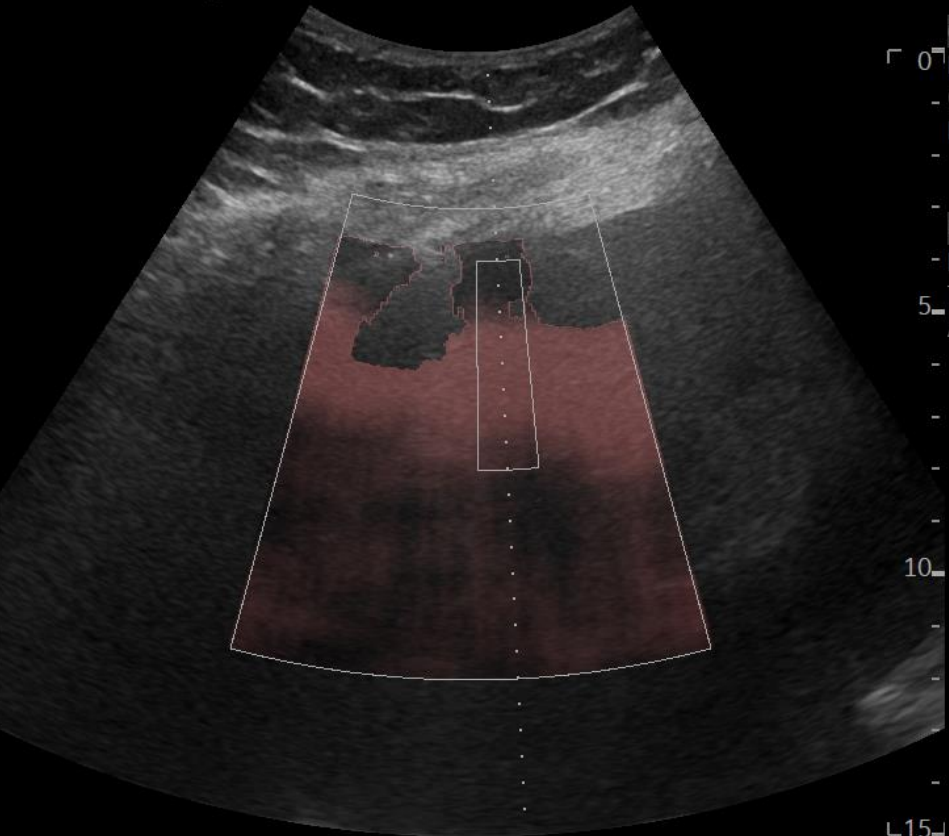
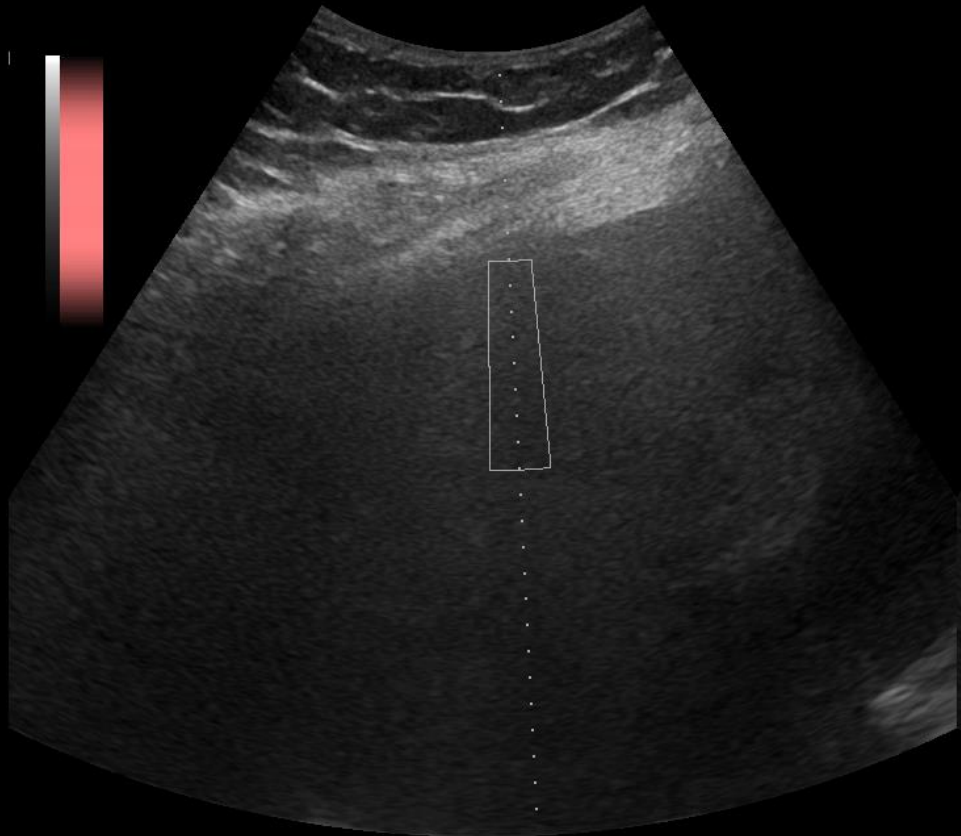
MI 1.3

TIs 1.0

C1-6
Abdomen

FR 18

LOGIQ



CHI	
Frq	4.5
Gn	44
D	15.0
U	
Frq	3.5
T	44
AO%	100

10
15



Parameter	Value	m1	m2	m3	m4	m5	m6	Method
B Mode Measurements								
Attenuation,dB/cm/MHz								
Site1								
A1	0.82	0.82						Last
A2	0.85	0.85						Last
A3	0.88	0.88						Last
A4	0.81	0.81						Last
A5	0.86	0.86						Last
A6	0.84	0.84						Last
A7	0.86	0.86						Last
A8	0.86	0.86						Last
A9	0.84	0.84						Last
A10	0.83	0.83						Last
A11	0.82	0.82						Last
Med	0.84							
IQR	0.03							
IQR/Med	4.0%							
N	11							