

Società Italiana di Ecografia  
in Medicina e Chirurgia

II CORSO NAZIONALE E  
SEMINARI DI  
ECOGRAFIA CLINICA  
SIEMC

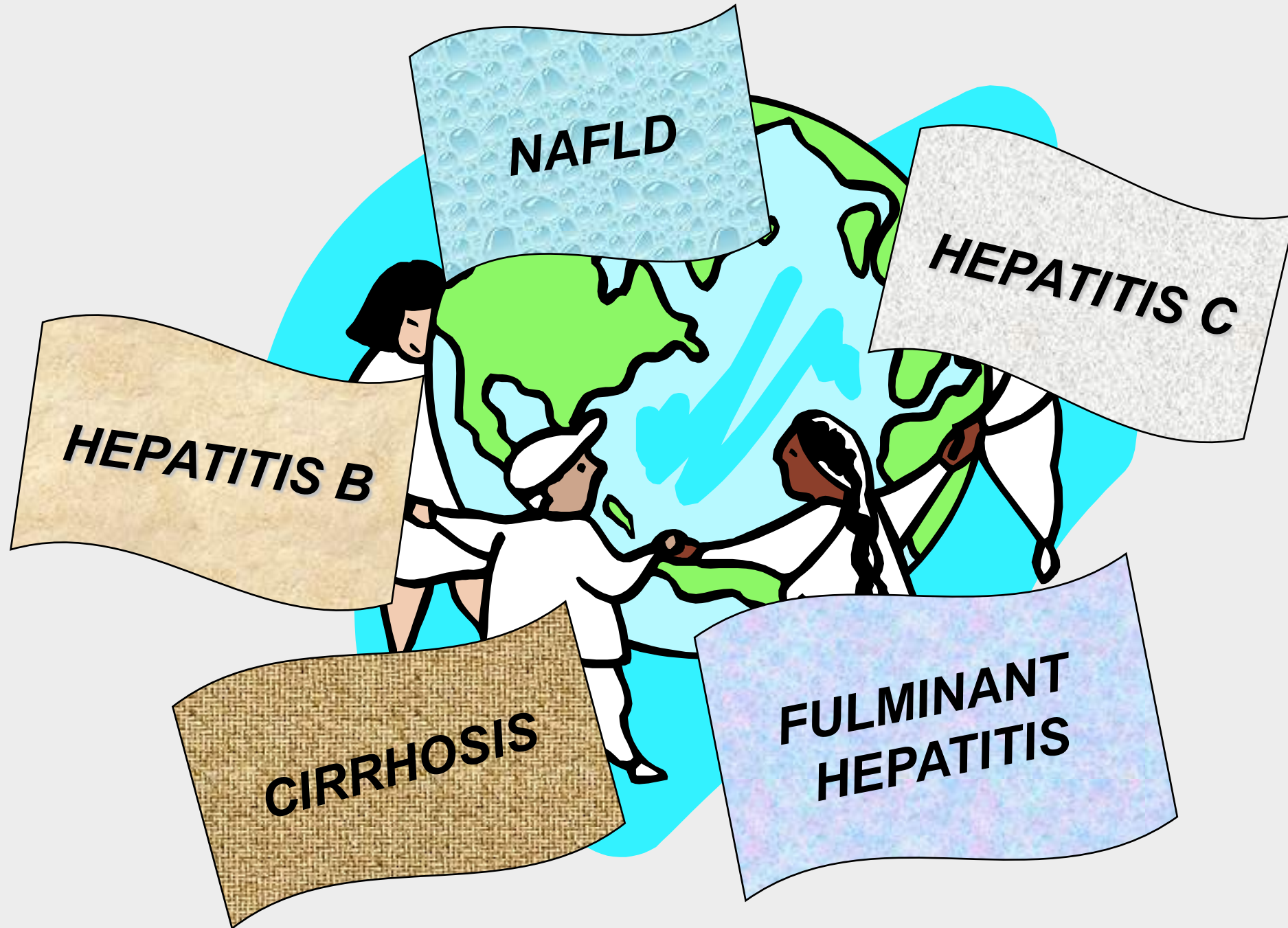


RIMINI,  
4 - 7 OTTOBRE 2015  
AQUA HOTEL + ARIA HOTEL

***Prof. A. Giorgio***

Director  
Interventional US Units  
Athena ,S.Rita  
Clinical Institutes  
*Italy*

**ULTRASOUND AND DIFFUSE LIVER DISEASE**



**NAFLD**

**HEPATITIS C**

**HEPATITIS B**

**CIRRHOSIS**

**FULMINANT  
HEPATITIS**

# **The clinical challenge—fibrosis and steatosis detection and grading**

Hepatic fibrosis is a response to chronic liver injury and a process that tends to progress to cirrhosis and end-stage liver disease. While alcohol and infection with hepatitis B virus (HBV) and hepatitis C virus (HCV) are still the leading causes worldwide, the increasing prevalence of metabolic syndrome and obesity has resulted in an increasing incidence of cirrhosis secondary to non-alcoholic fatty liver disease (NAFLD)

***J. F. Gerstenmaier , R. N. Gibson: Insight Imaging ; May 2014***

The prevalence of NAFLD is higher than previously estimated. If the incidences of obesity and diabetes continue to rise at the current rate, the prevalence of NAFLD in the US is expected to exceed 50 % in 2030, reaching epidemic status.

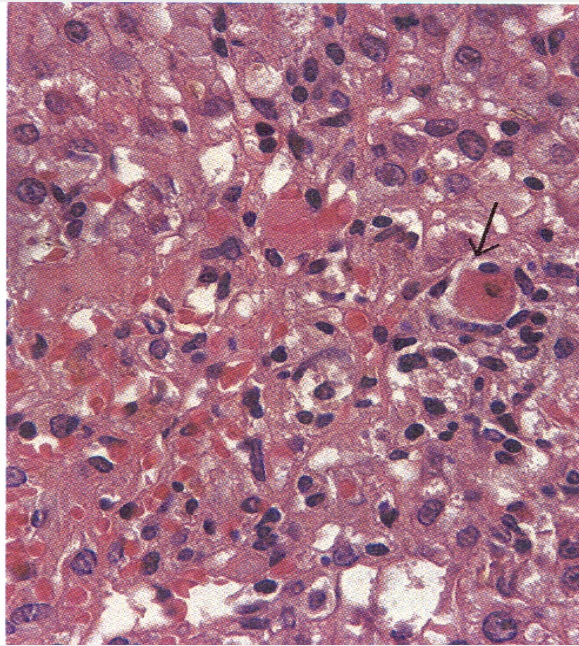
Non-alcoholic steatohepatitis (NASH), first described in 1980 , is a severe and progressive form of NAFLD and is now recognised as a major cause of cirrhosis

*J. F. Gerstenmaier , R. N. Gibson: Insight Imaging ; May 2014*

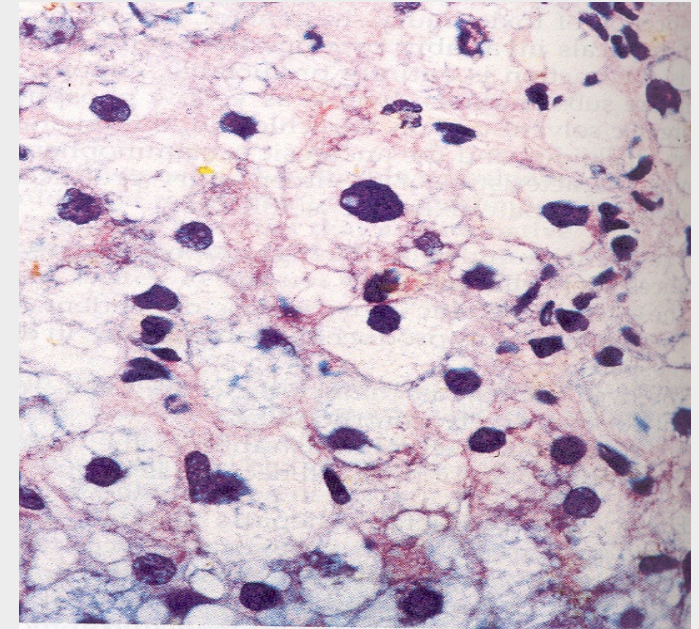
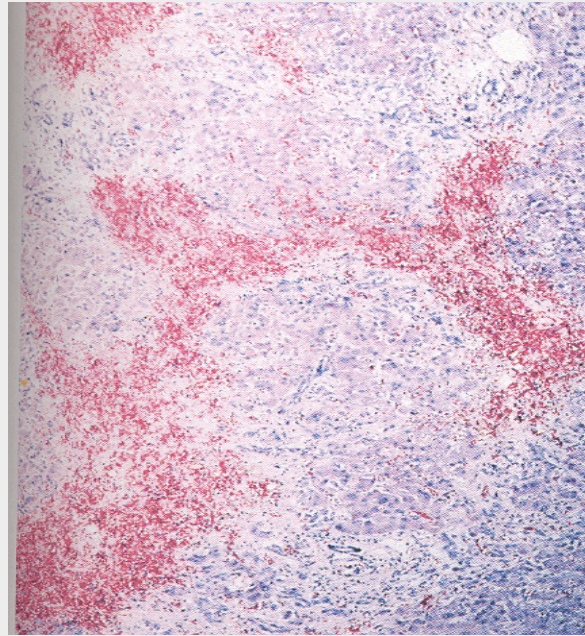


Ultrasound has a major role in the diagnosis and management of chronic liver diseases by providing diagnostic and prognostic information as well as detecting complications such as HCC and portal hypertension.

# Malattie acute diffuse del fegato



Necrosi epatociti

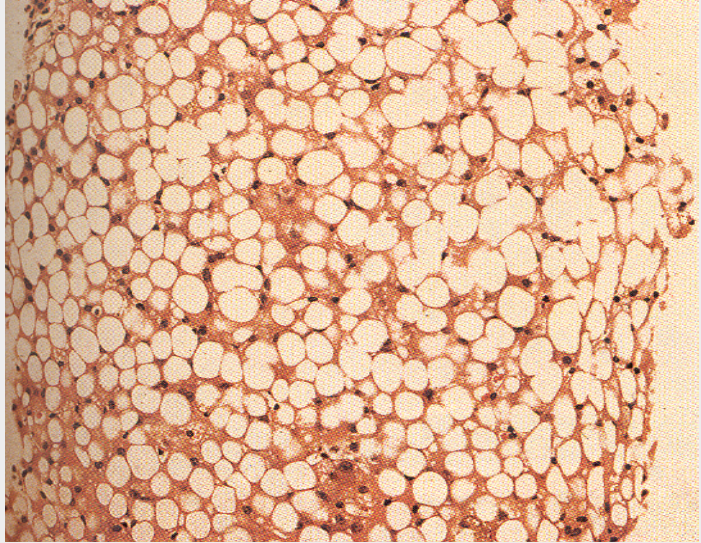
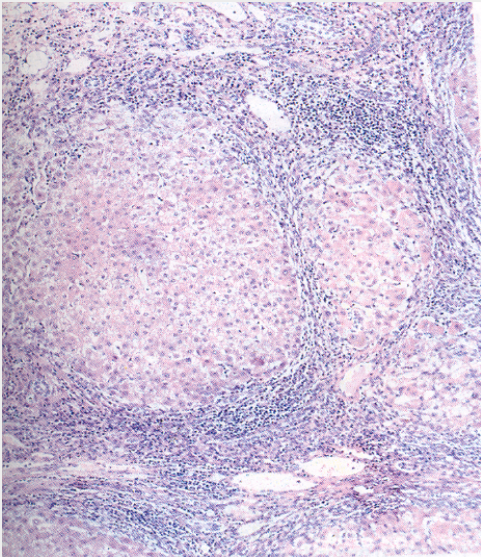
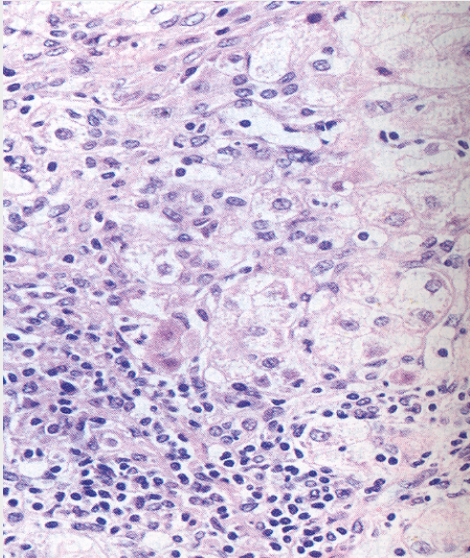


Steatosi microvescicolare



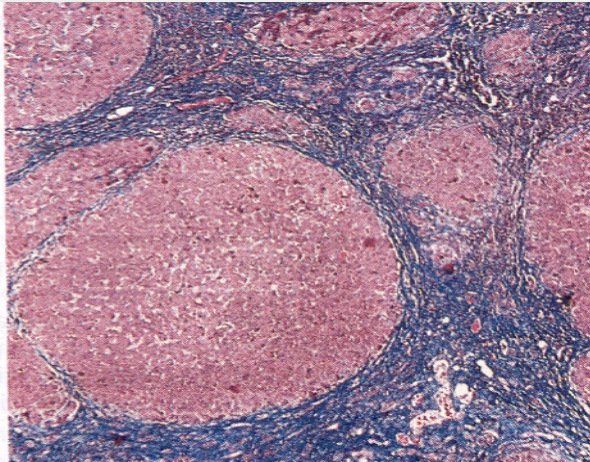
# Malattie croniche diffuse del fegato

EC

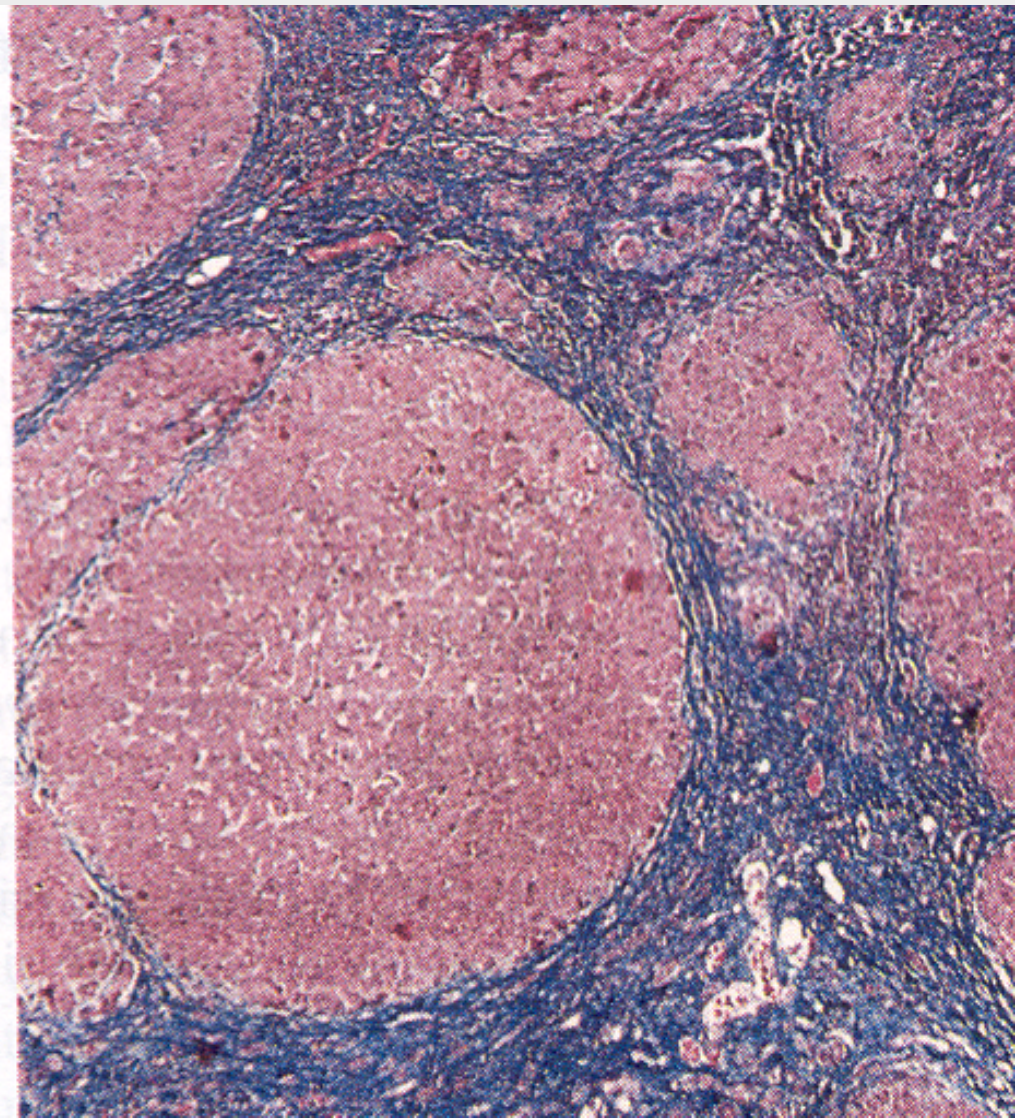


Steatosi

Cirrosi











➤ **Epatite acuta**

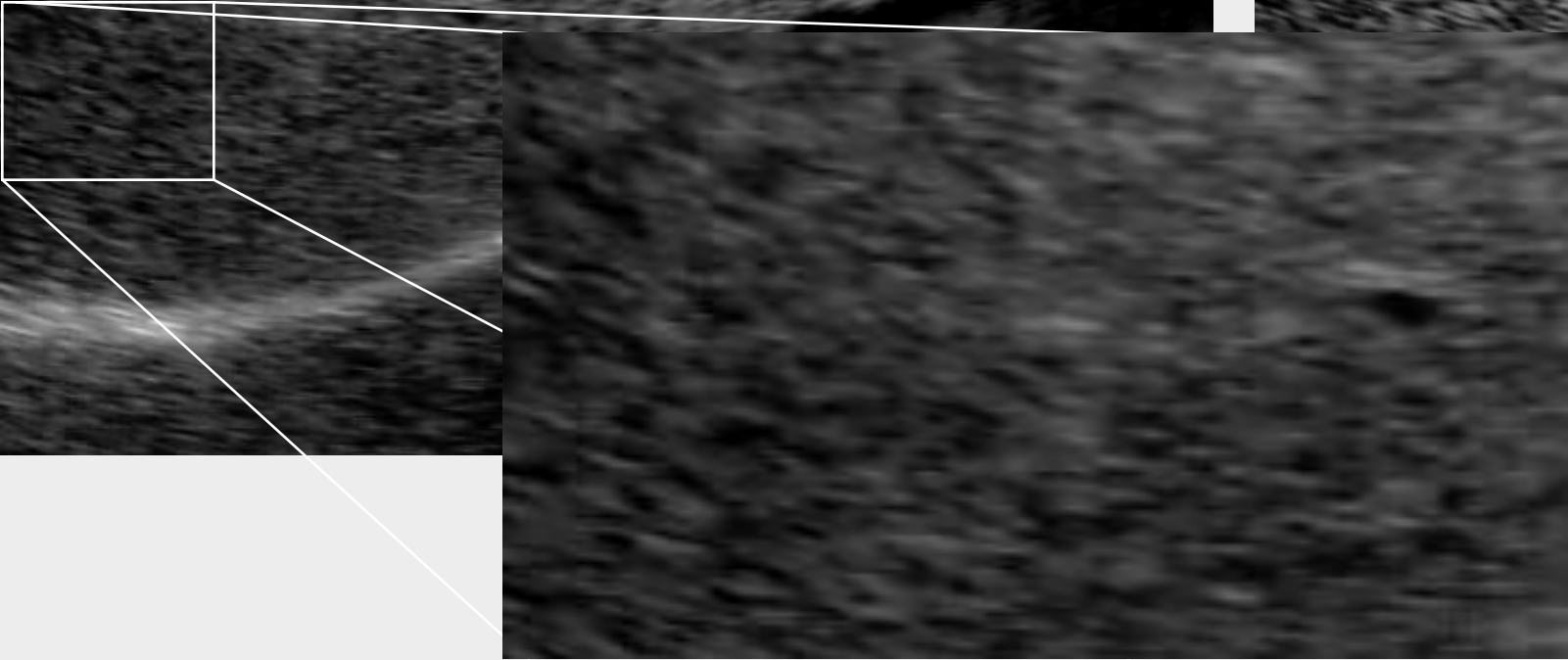
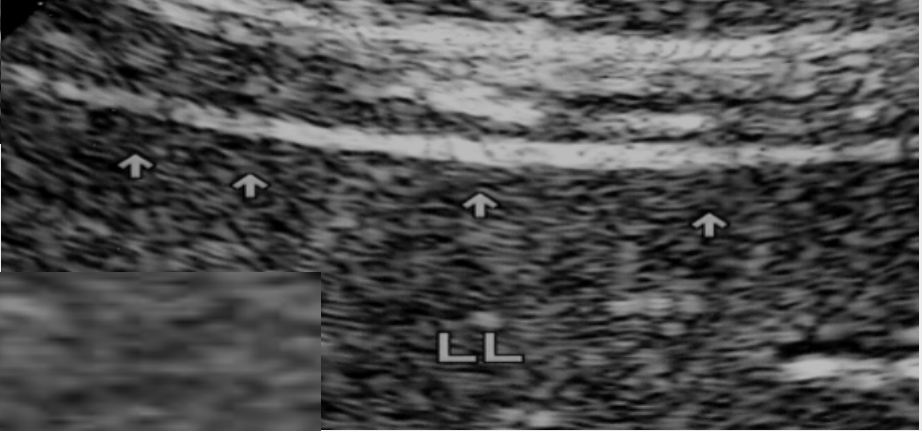
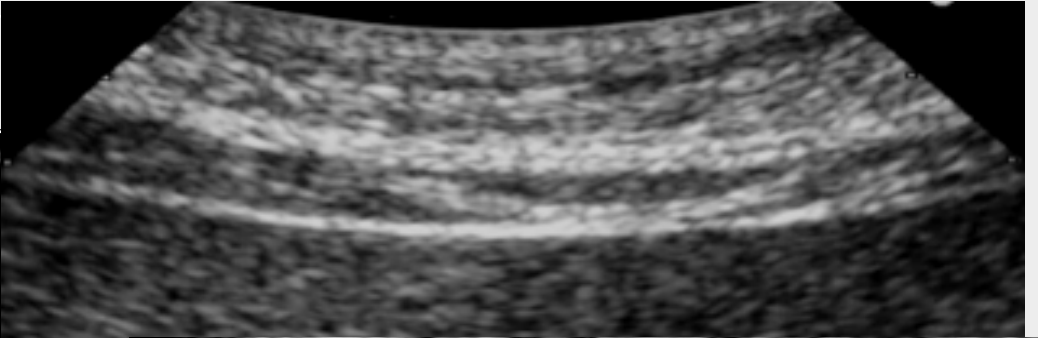
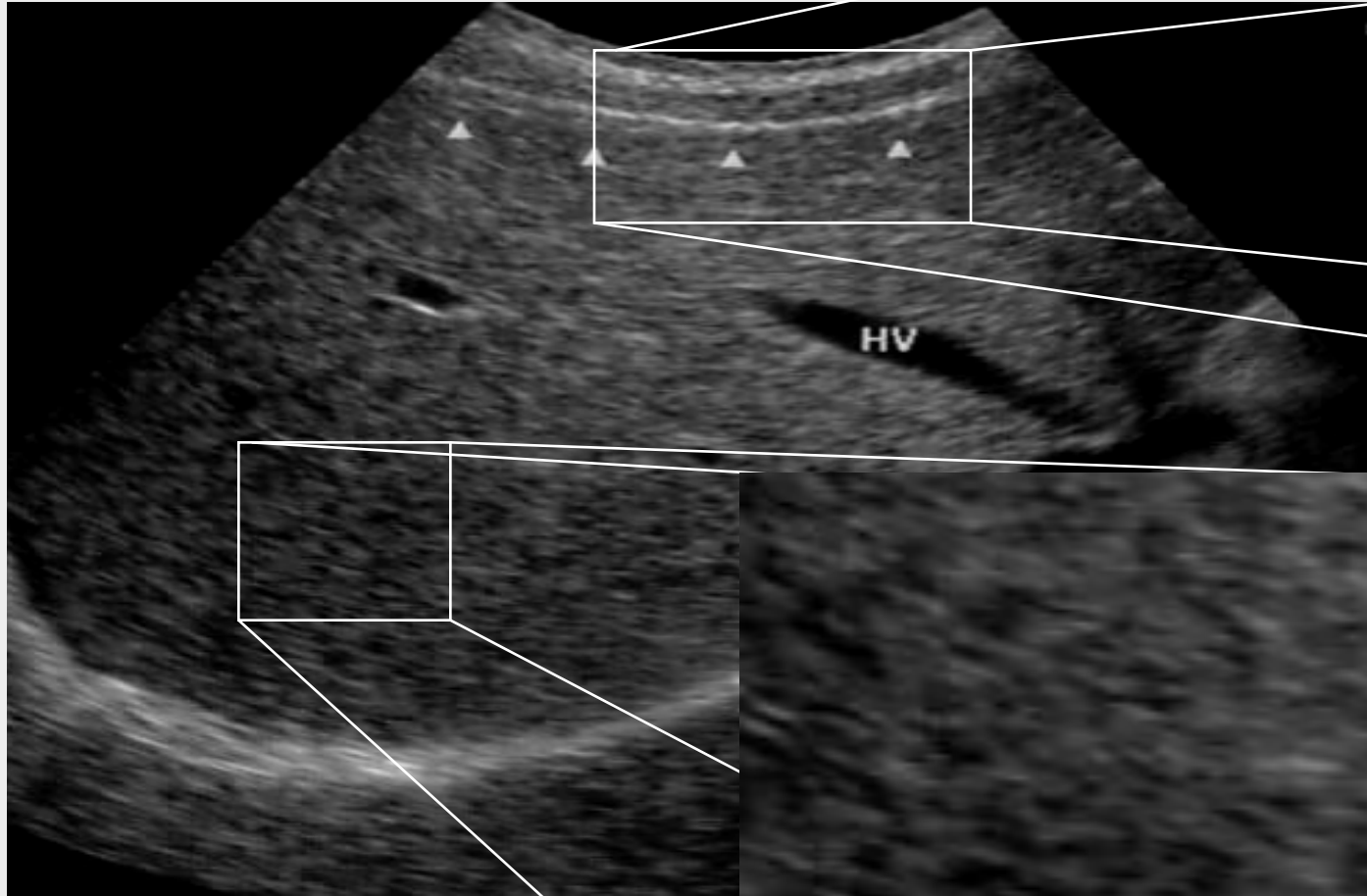
➤ **Epatite cronica**

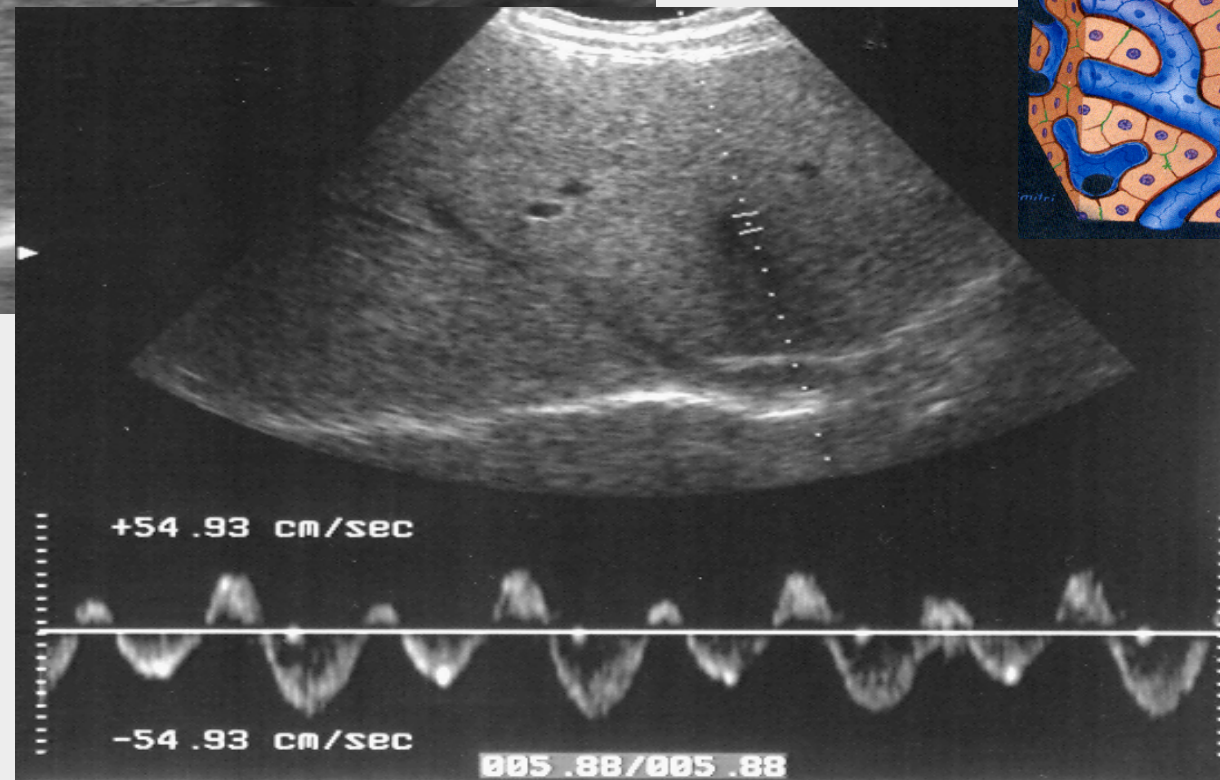
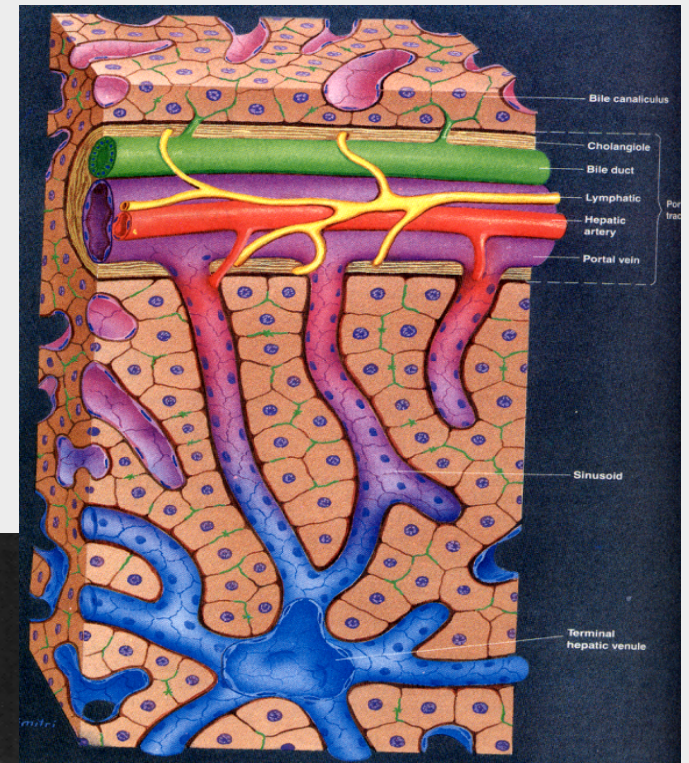
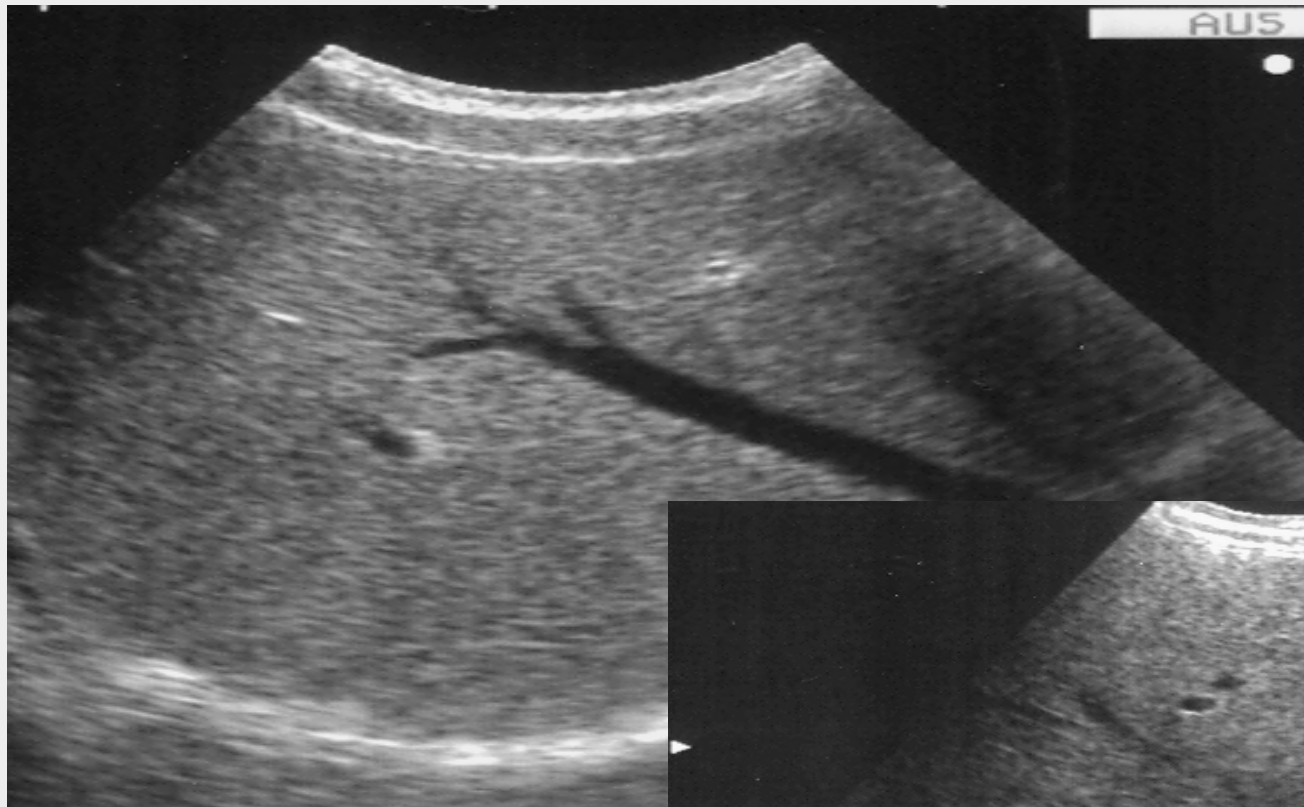
➤ **Cirrosi**

# US EVALUATION OF DIFFUSE LIVER DISEASE

- *Margins*
- *Echotexture*
- *Segments*
- *Vessels*





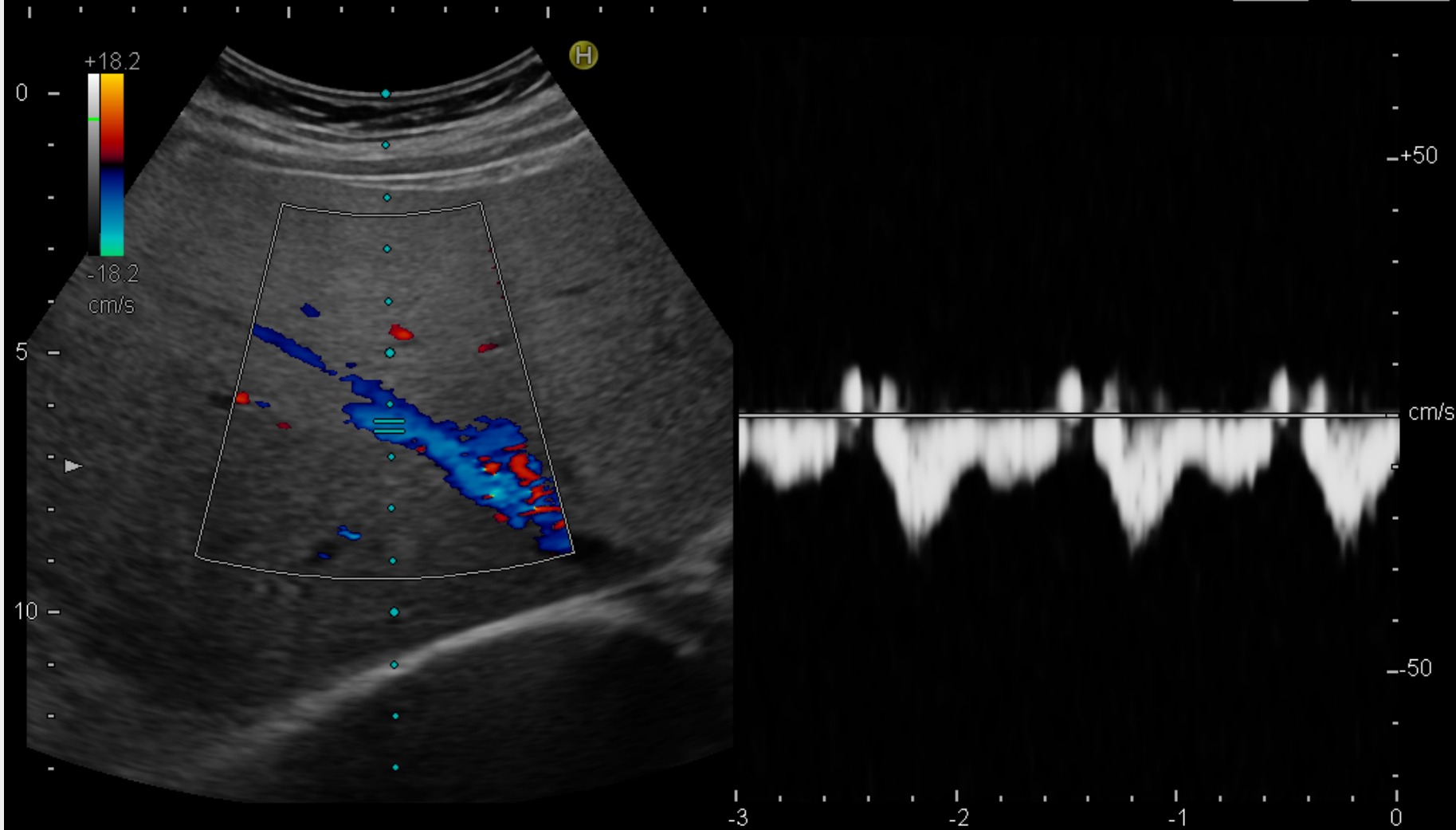


HITACHI

ADDOME

10-SEP-14 11:25:04

P:100% MI 1.0 TIS<0.4

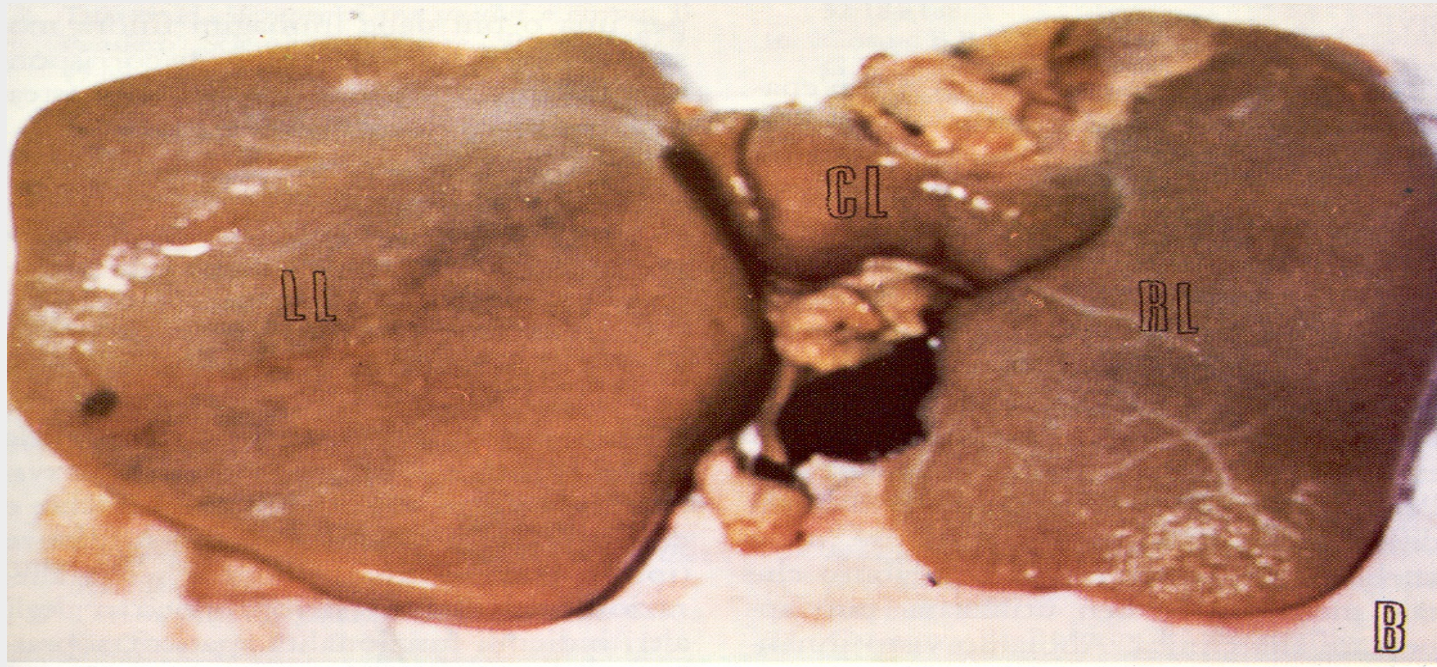


FR:4  
C715

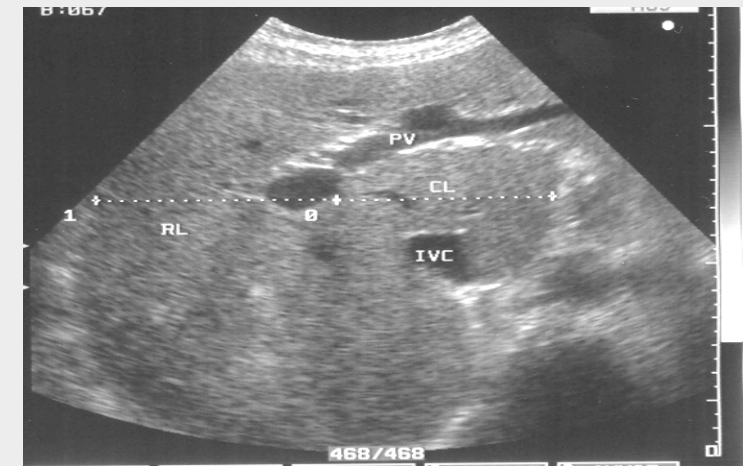
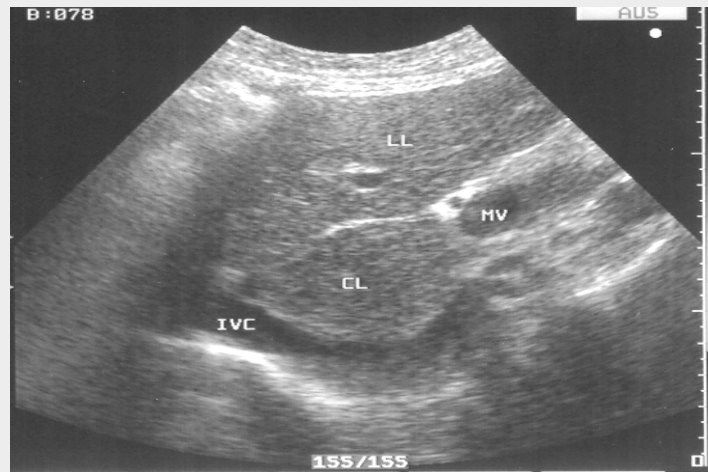
BG:14 DR:85 CG:40 CF:M  
HdTHI-R 1.3k/2.5MHz

SD:64.2 SL:2.0mm  
DG:40 WF:84  
4k/2.0MHz 0°





## SEGMENTI E MORFOLOGIA REGIONALE



# Bright Liver Tipico









HITACHI

RSJTIFYKF

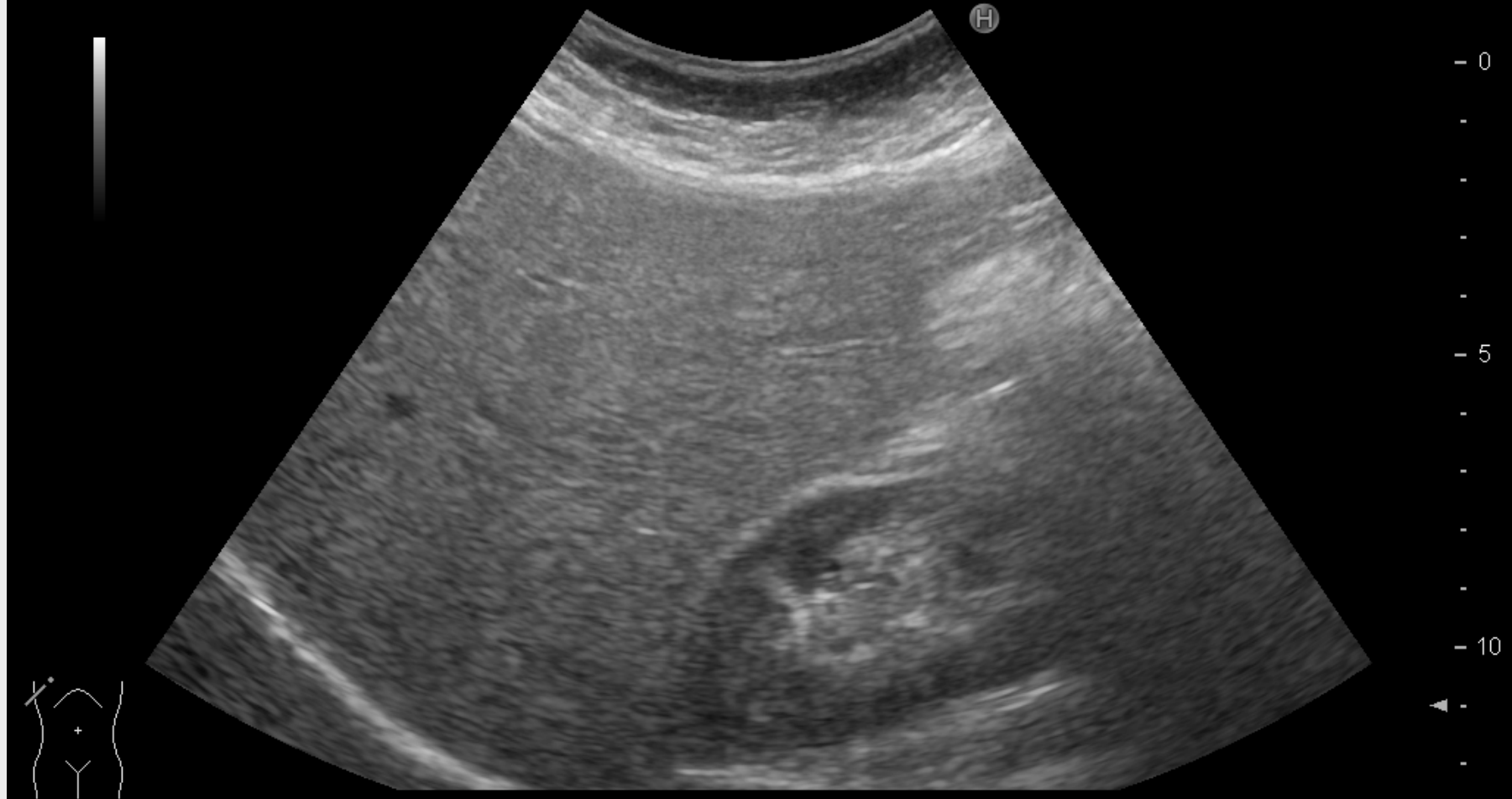
ADDOME 75

27-SEP-14 10:55:35

P:100%

MI 1.0

TIS<0.4



FR:21  
C715

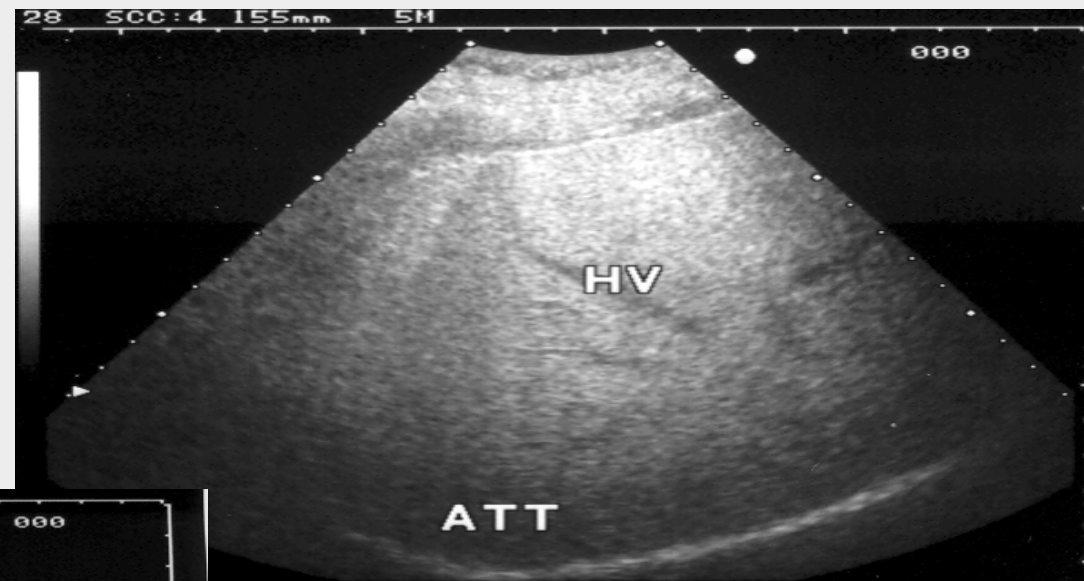
BG:17 DR:75  
HdTHI-P

Precision APure



# Bright Liver Tipico

## *Gradazione Qualitativa*



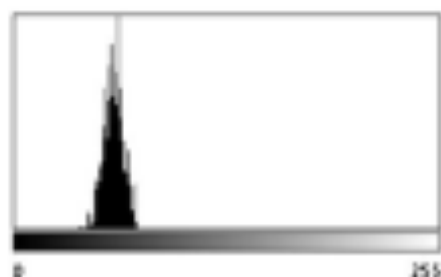
Due to substantial inter- and intraobserver variability and the reduced sensitivity in low levels of steatosis, it has been suggested that the effectiveness of steatosis detection can be increased by quantification of liver brightness.

***J. F. Gerstenmaier, R. N. Gibson: Insight Imaging; May 2014***

**The sonographic hepatorenal index (SHRI) is based on comparison between liver and kidney brightness.**

***An image including both liver and kidney is required, typically showing segment 6 of the liver and the upper pole of the right kidney. Regions of interest (ROI) of an appropriate size (>400 pixels) are selected in the liver parenchyma, excluding vessels, and renal cortex at the same field depth.***

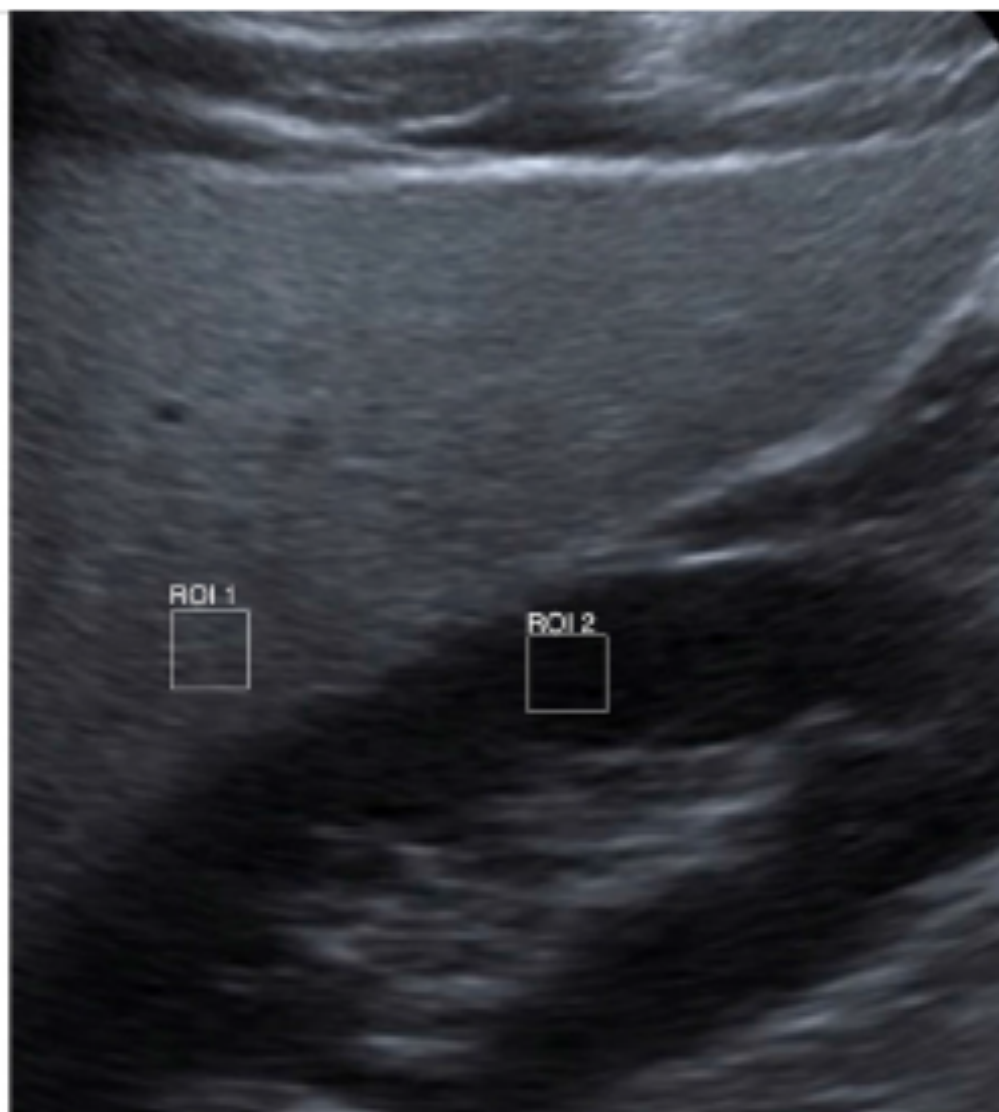
***Marshall RH, Eissa M, Bluth EI, Gulotta PM, Davis NK (2012)  
Hepatorenal index as an accurate, simple, and effective tool in  
screening for steatosis. AJR Am J Roentgenol 199(5):997–1002***



ROI 1  
Count: 1024      Min: 39  
Mean: 59.064      Max: 73  
StdDev: 6.015      Mode: 62 (89)



ROI 2  
Count: 1024      Min: 7  
Mean: 14.053      Max: 23  
StdDev: 2.578      Mode: 14 (229)





The **SHRI** is the mean liver brightness divided by the mean renal cortex brightness.

Significant correlation between histological steatosis and the SHRI has been found in several studies.

In addition, point estimates of SHRI for the prediction of *steatosis grades less than moderate or severe appear to be superior to those of qualitative grading methods.*

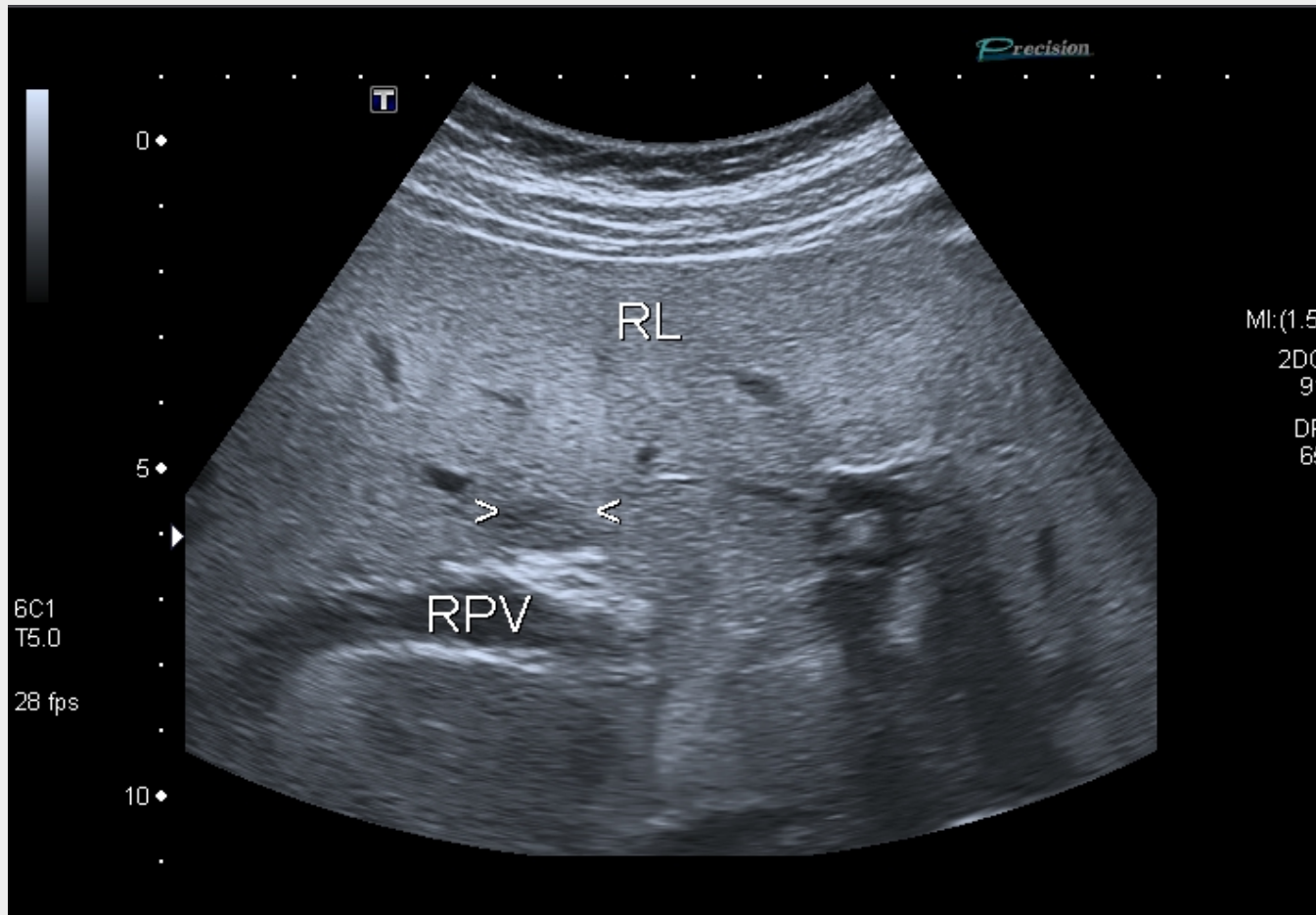
***Borges VF, Diniz AL, Cotrim HP, Rocha HL, Andrade NB (2013)  
Sonographic hepatorenal ratio: a noninvasive method to diagnose  
nonalcoholic steatosis. J Clin Ultrasound 41(1):18–25***

**An SHRI cutoff point of 1.49 had a sensitivity of 1 and specificity of 0.91 for the prediction of steatosis >5 %.**

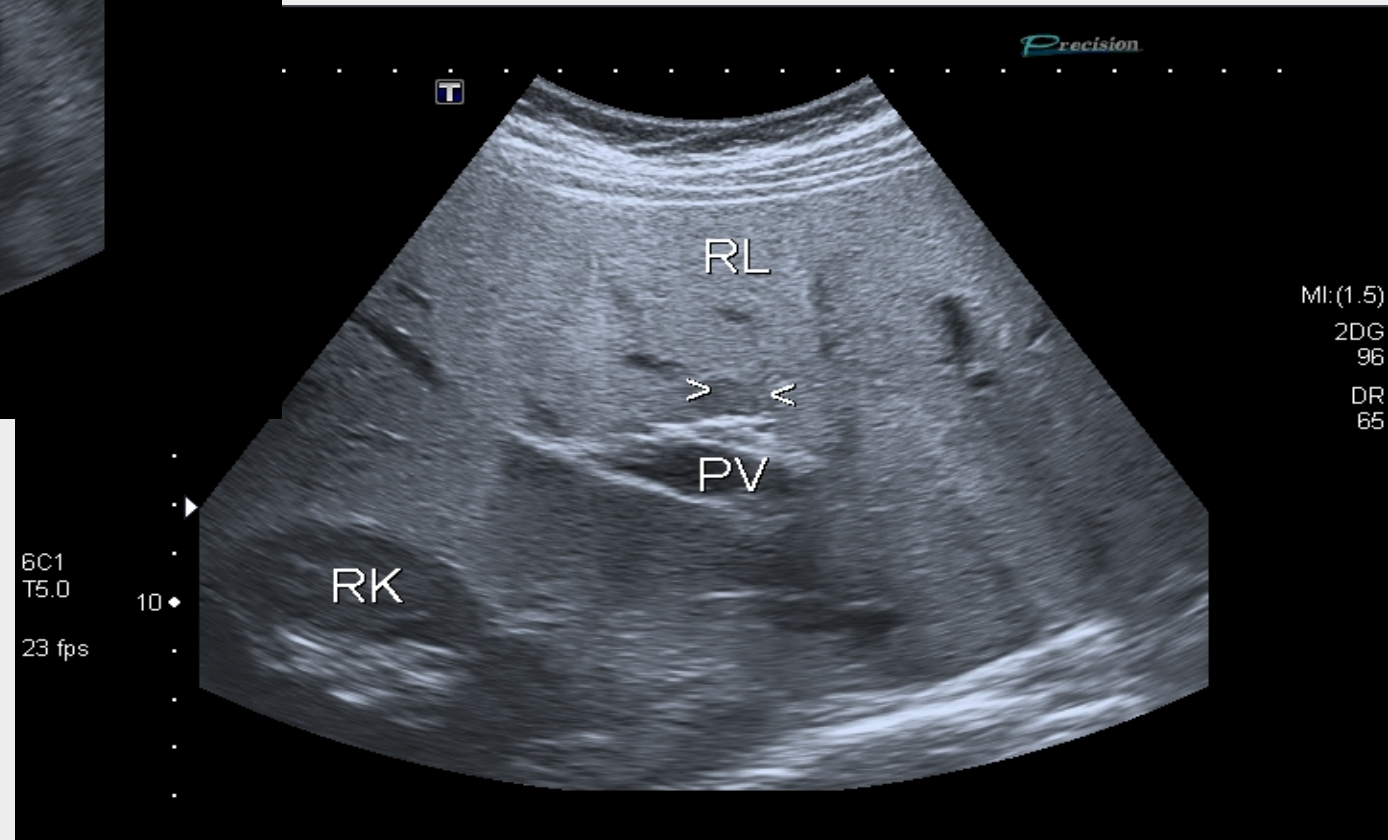
In a recent study involving patients attending general medical centres, SHRI as determined on a standard workstation without additional software showed strong correlation (Spearman's coefficient = 0.89,  $P < 0.001$ ) with 3TMR proton spectroscopy as a reference to determine the degree of steatosis .

**The authors found that SHRI cutoff points of 1.21, 1.28 and 2.15 yielded 100 % sensitivity for the diagnoses of steatosis greater than 5 %, 25 % and 50 %, respectively, with a specificity greater than 70 %.**

***Martin Rodriguez et al: Eur J Gastr Hepatol ,2014***

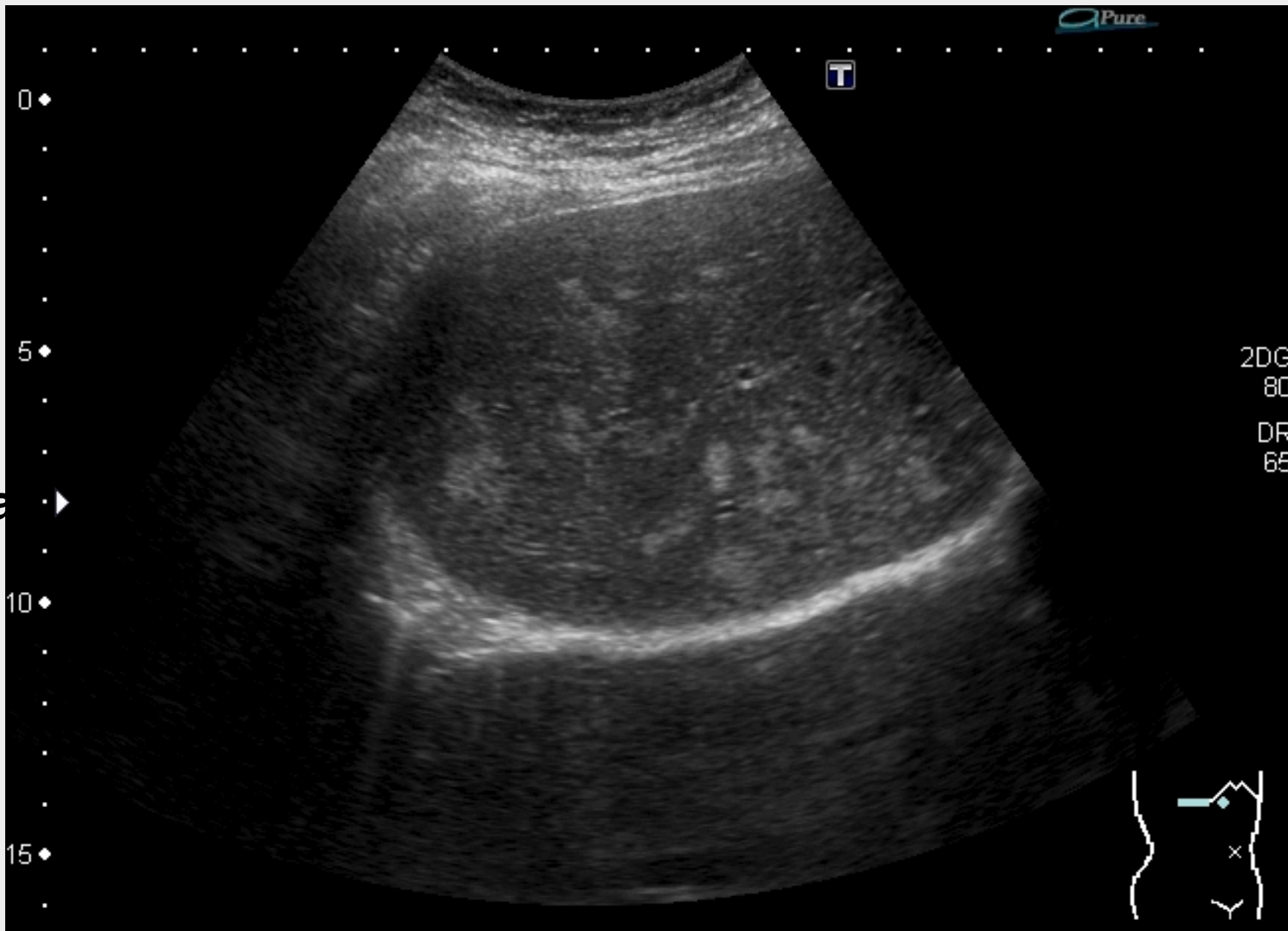


## Steatosi Focale Ipoecogena



Caturelli E et al  
Gastroenterology , 1994

Steatosi  
Multifocale  
ipercogena ▶



“Il prato  
Fiorito”

Giorgio A  
et al, 1997

# EPATITE CRONICA

- Nessun aspetto specifico
- Coarse pattern se Fibrosi > F3
- Diagnosi differenziale cirrosi
- Eventuale HCC
  
- Linfonodo legamento epatoduodenale tumefatto + pazienti HCV

HITACHI

RSJTIFYKF

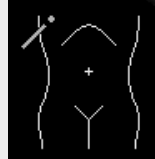
ADDOME 75

27-SEP-14 10:54:43

P:100%

MI 1.2

TIS<0.4



FR:21  
C715

BG:8 DR:75  
HdTHI-P



HITACHI

RSJTIFYKF

ADDOME 75

27-SEP-14 10:54:43

P:100%

MI 1.2

TIS<0.4



- 4

- 6

- 8



FR:21  
C715

BG:8 DR:75  
HdTHI-P



LOGIQ  
E9

LL

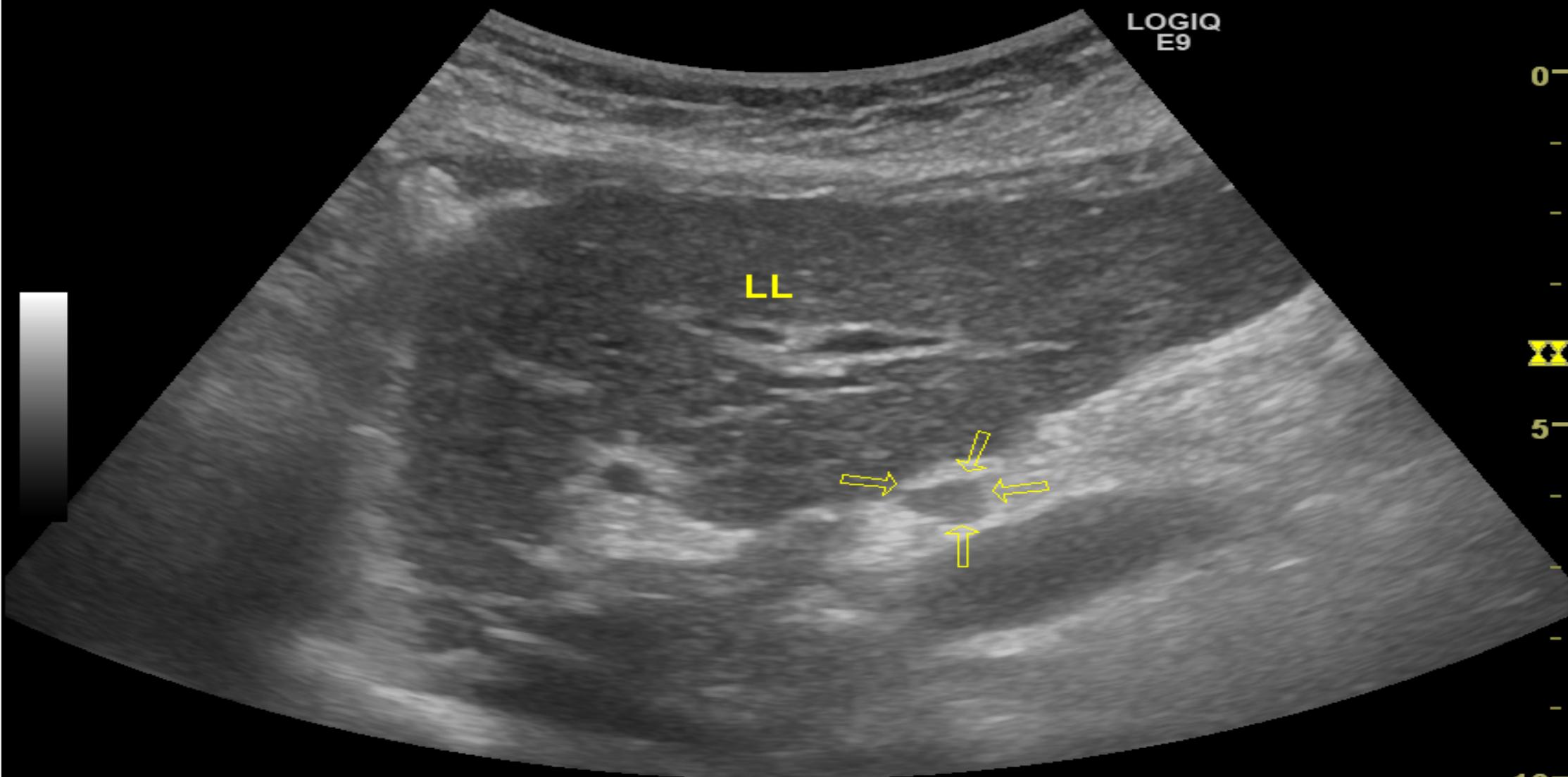
CHI

0-	Frq	4.0
	Gn	64
-	S/A	2/3
	Map	F/0
-	D	10.0
	DR	90
-	AO%	100



5-

10-





HITACHI

RSJTFYKF

ADDOME 75

27-SEP-14 09:18:40

P:100%

MI 1.0

TIS<0.4



FR:18  
C715

BG:14 DR:75  
HdTHI-P



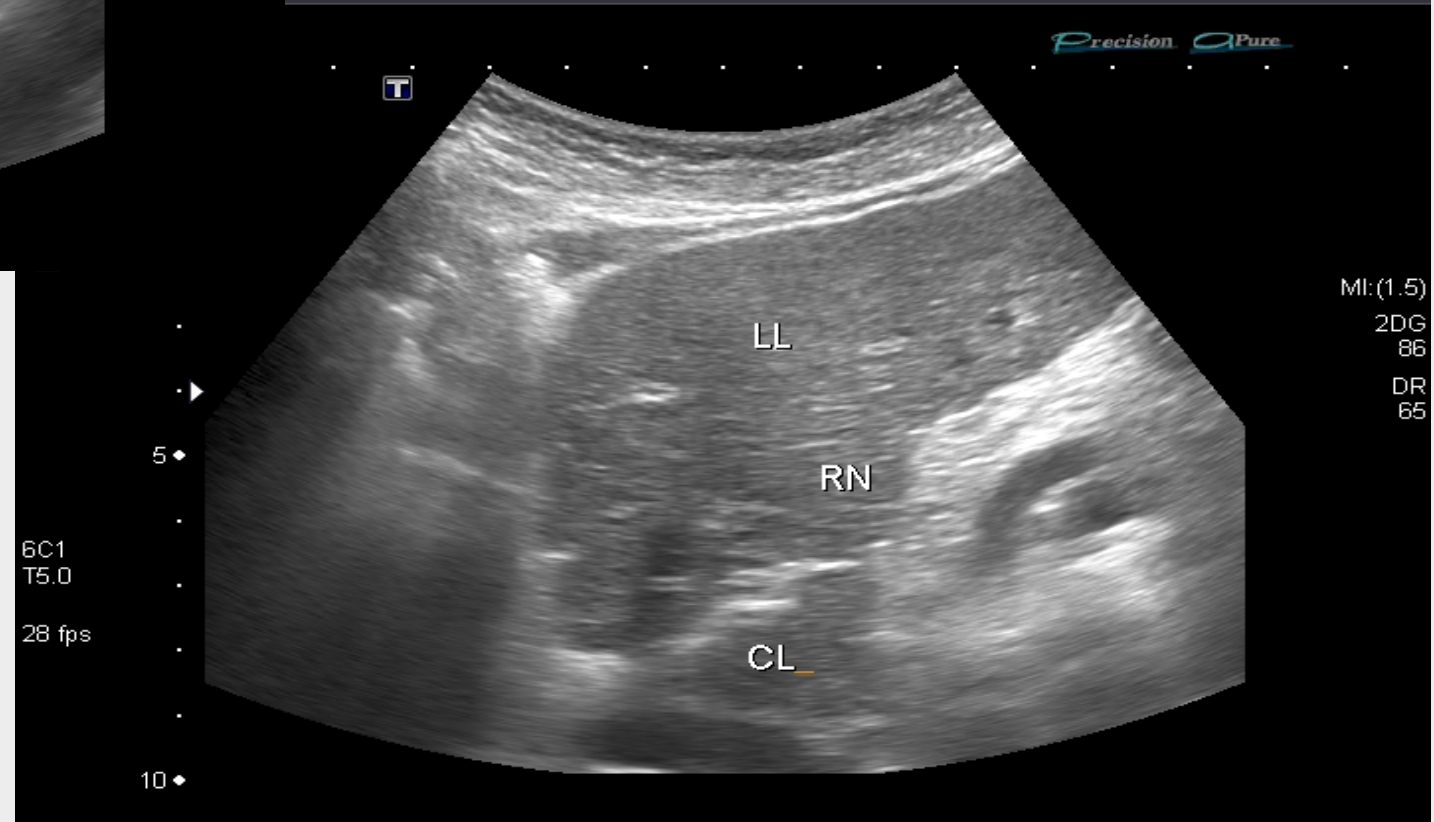
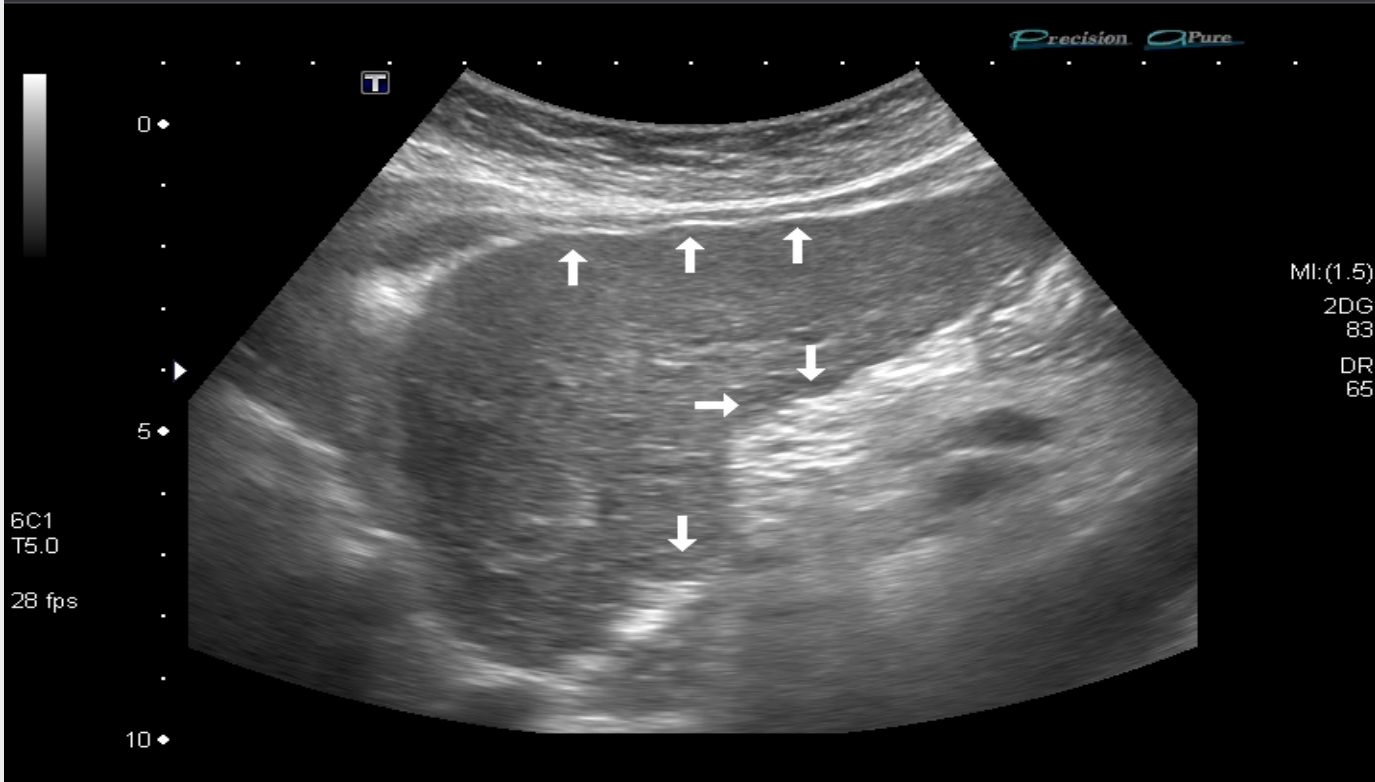


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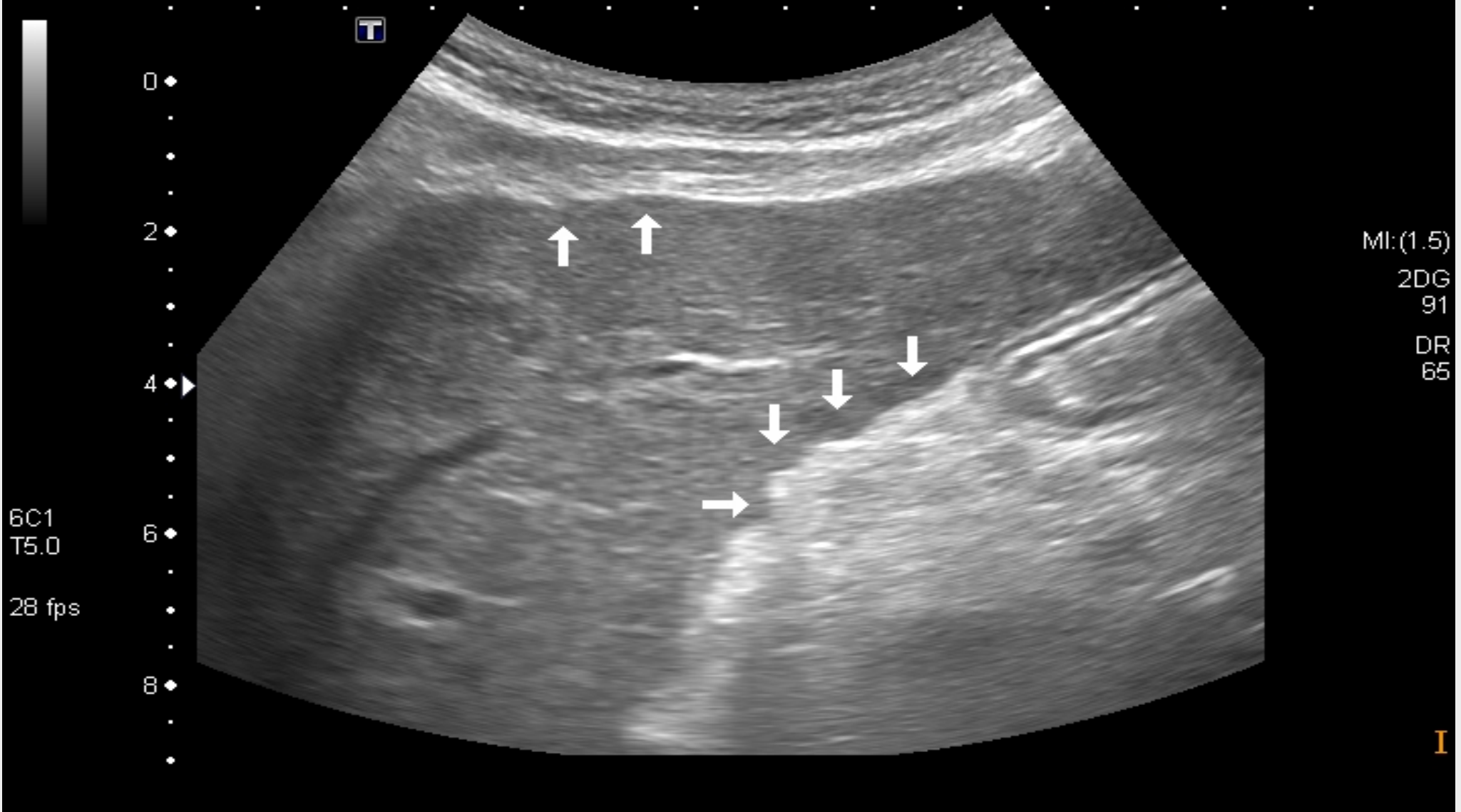
AUS

257/257

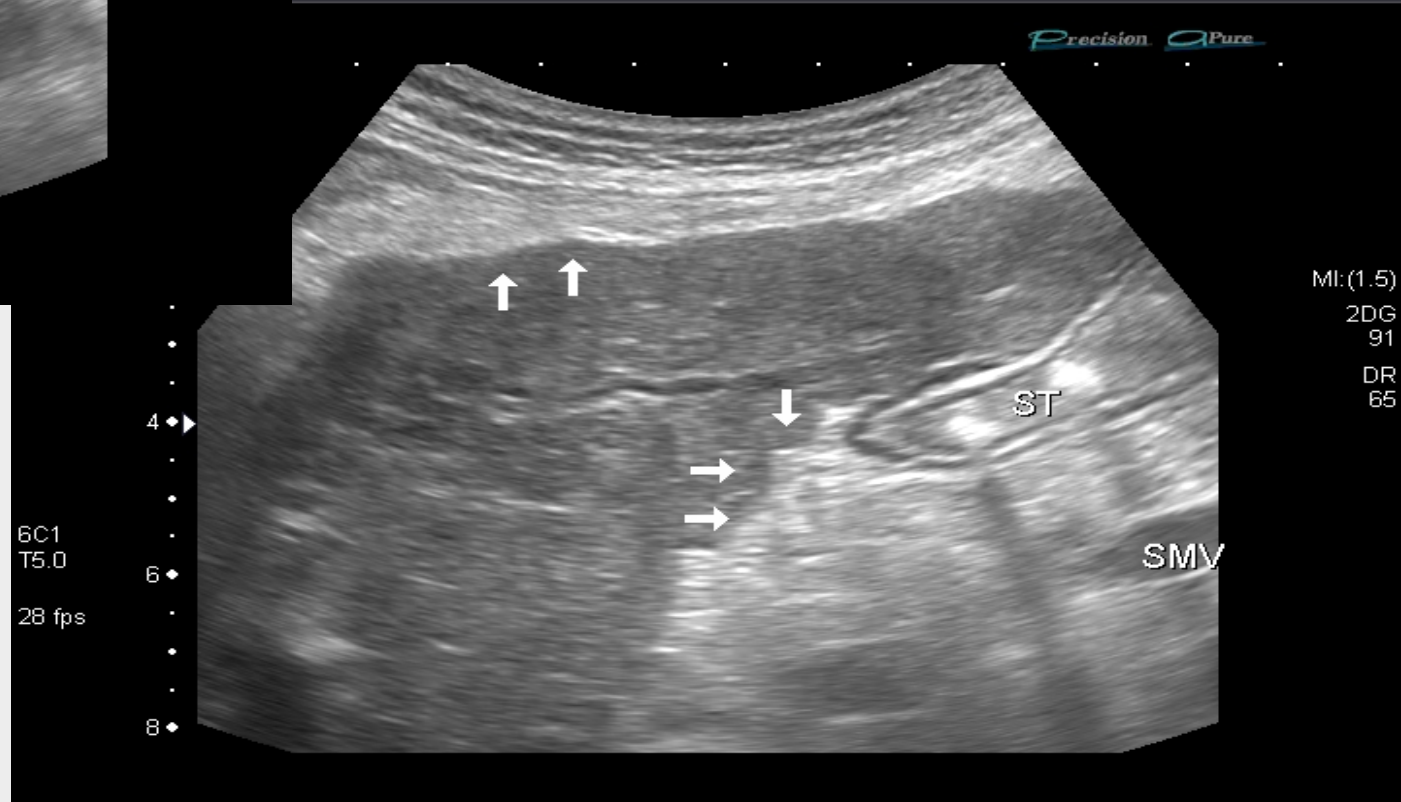
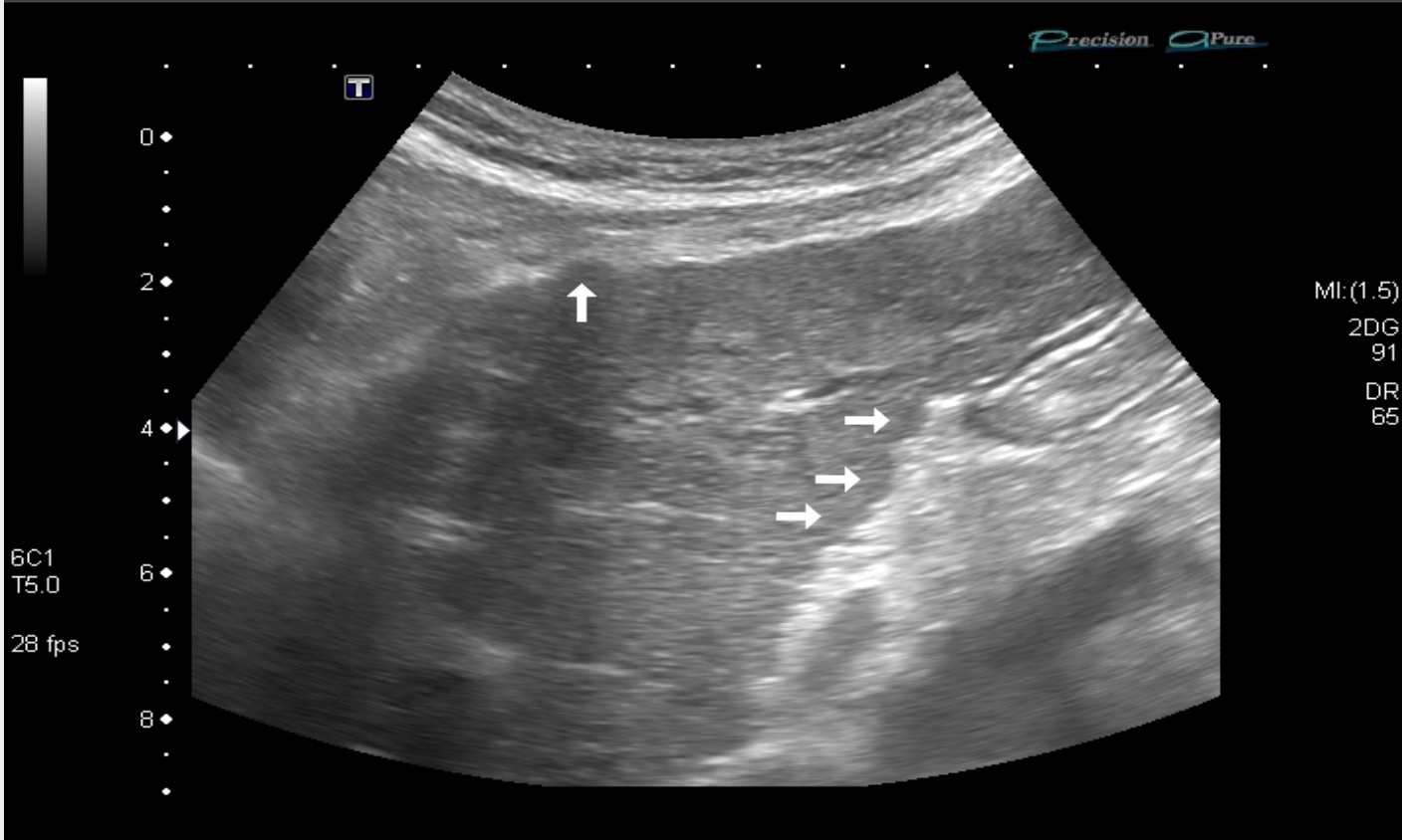




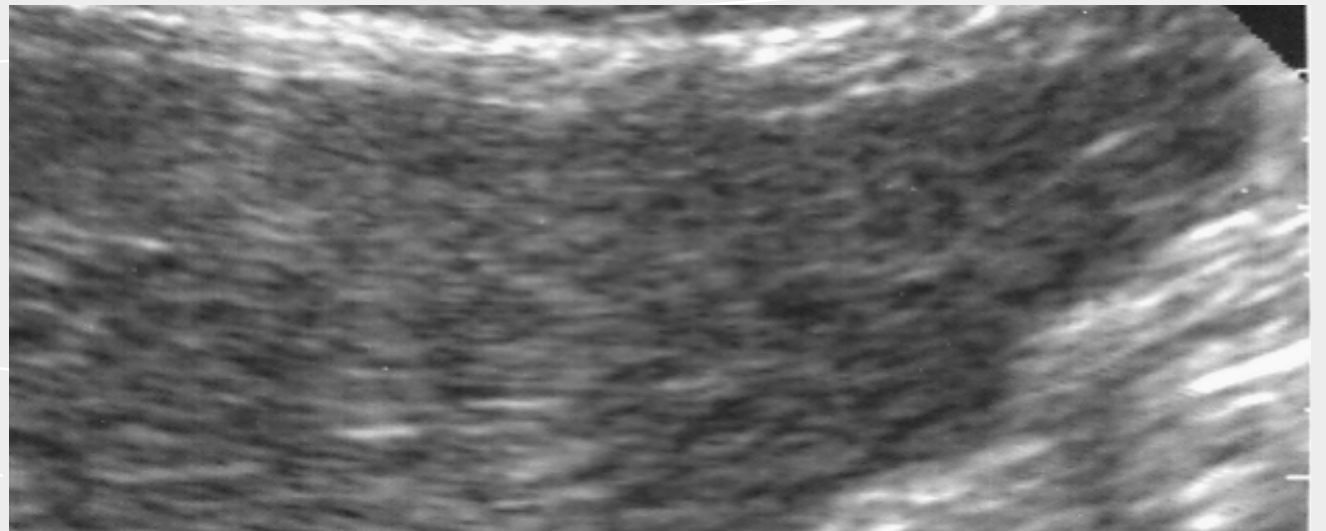
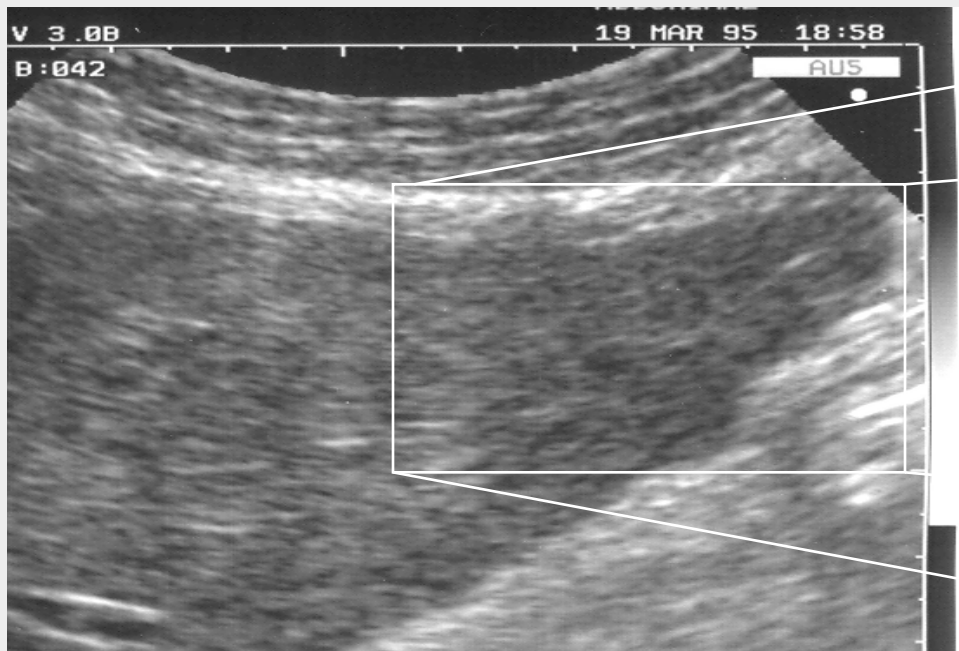
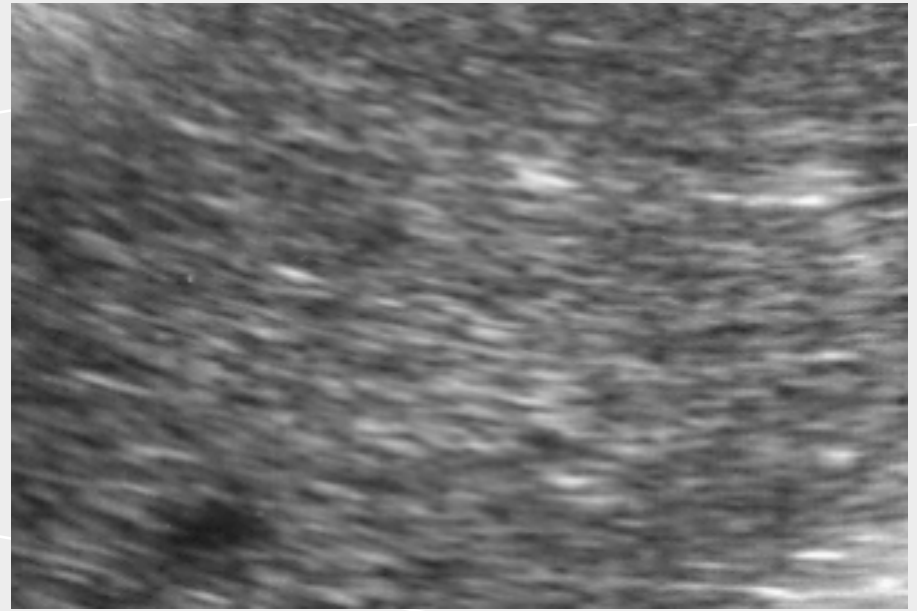
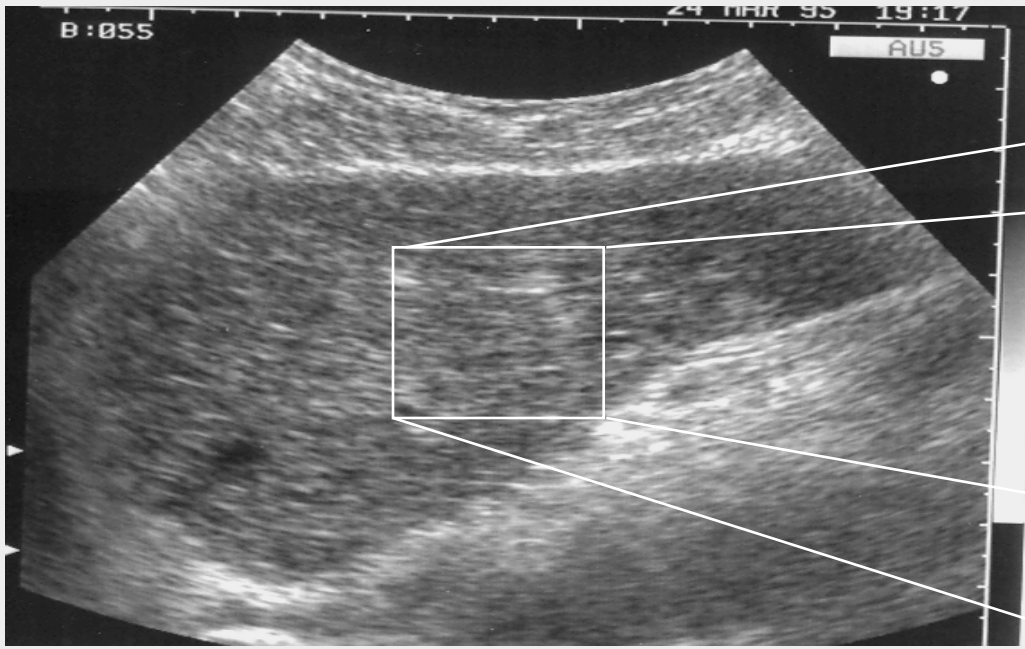
*Precision APure*













B:042

AUS

B:067

:084

AUS

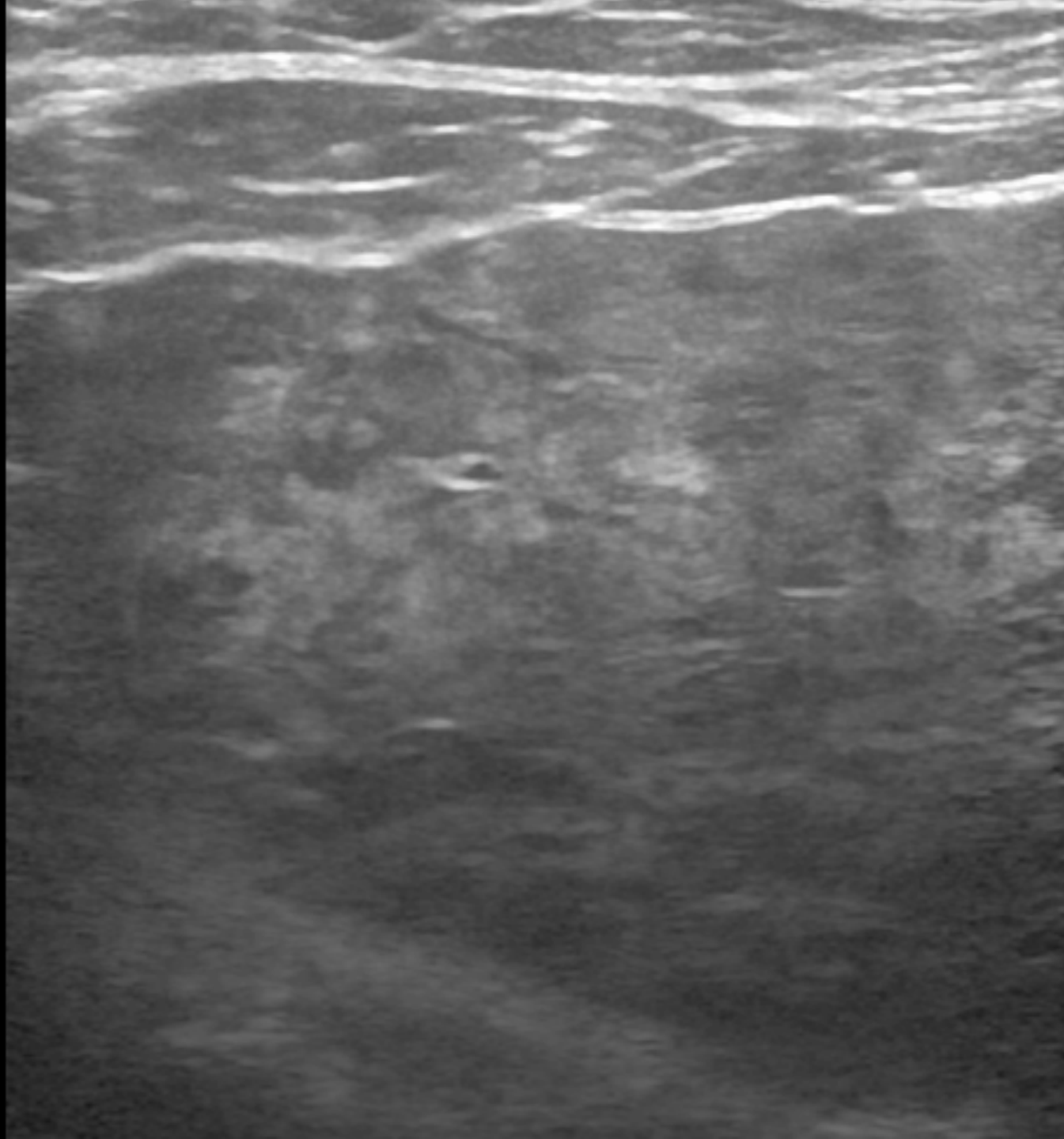
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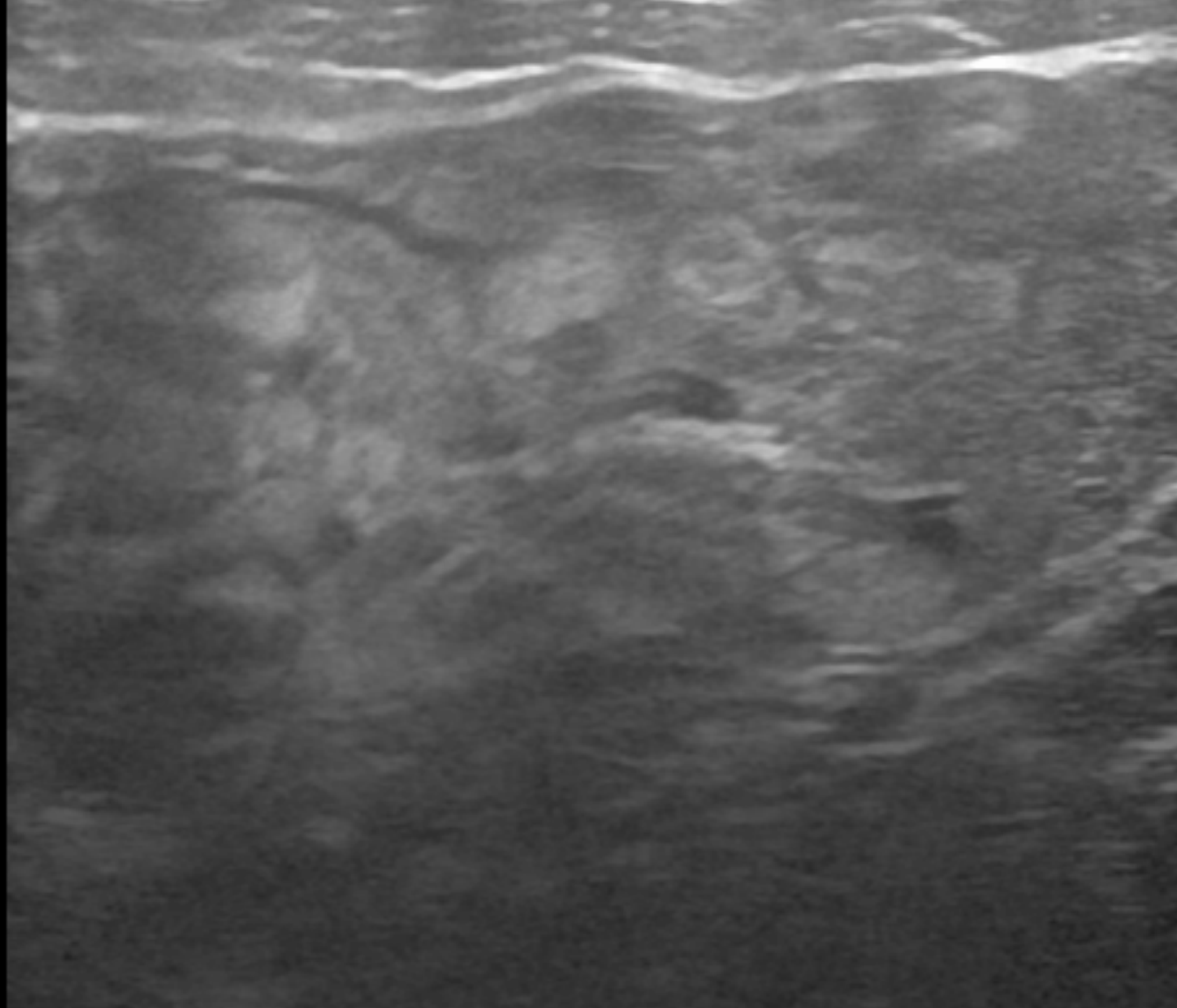
FAPATI | P. OBSTET | P. CARDIO | P. REPORT | P. ANNOT

Di Lelio et al. Radiology 1989.  
Simonoski et al. BrJ Radiol, 1999.

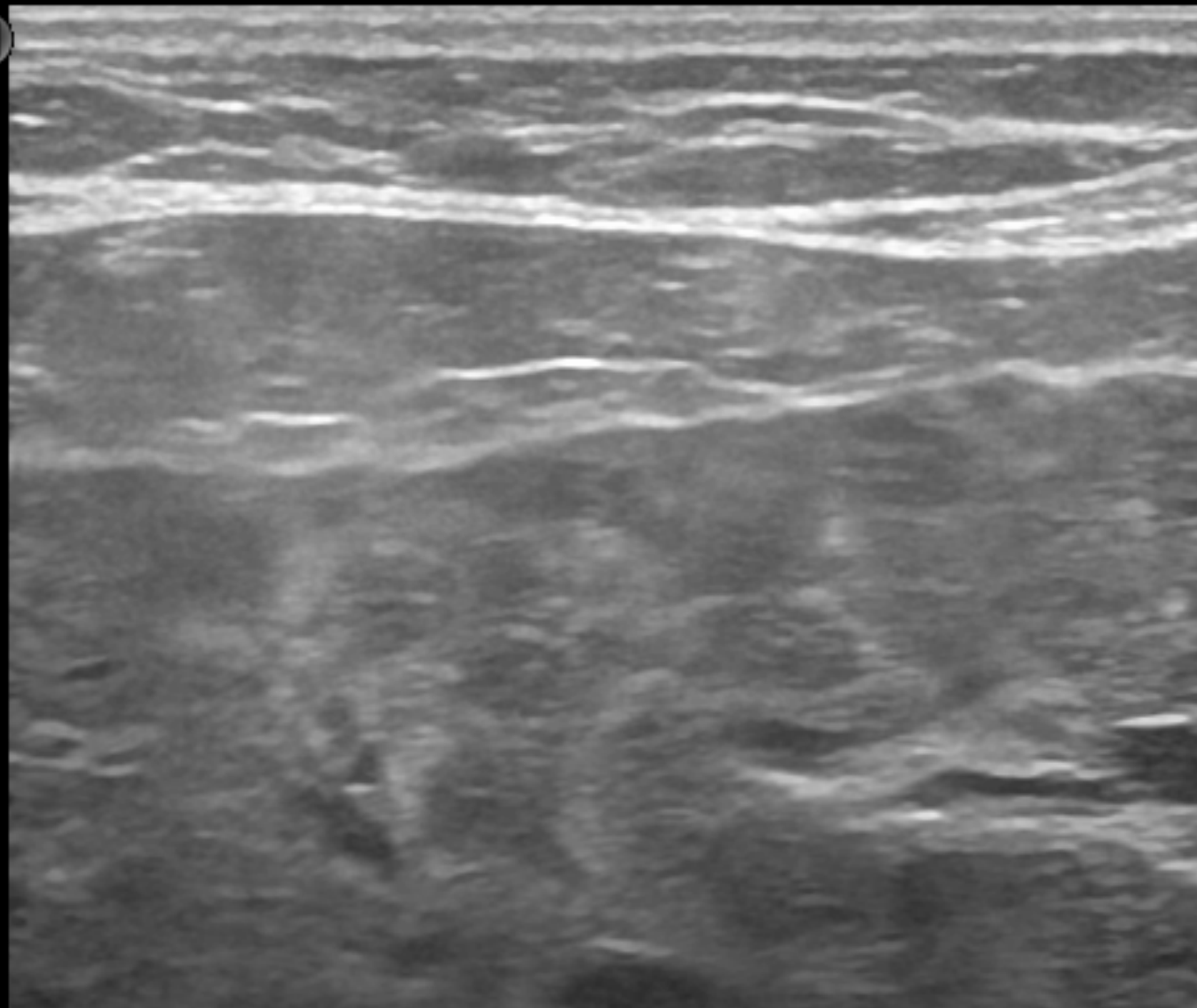


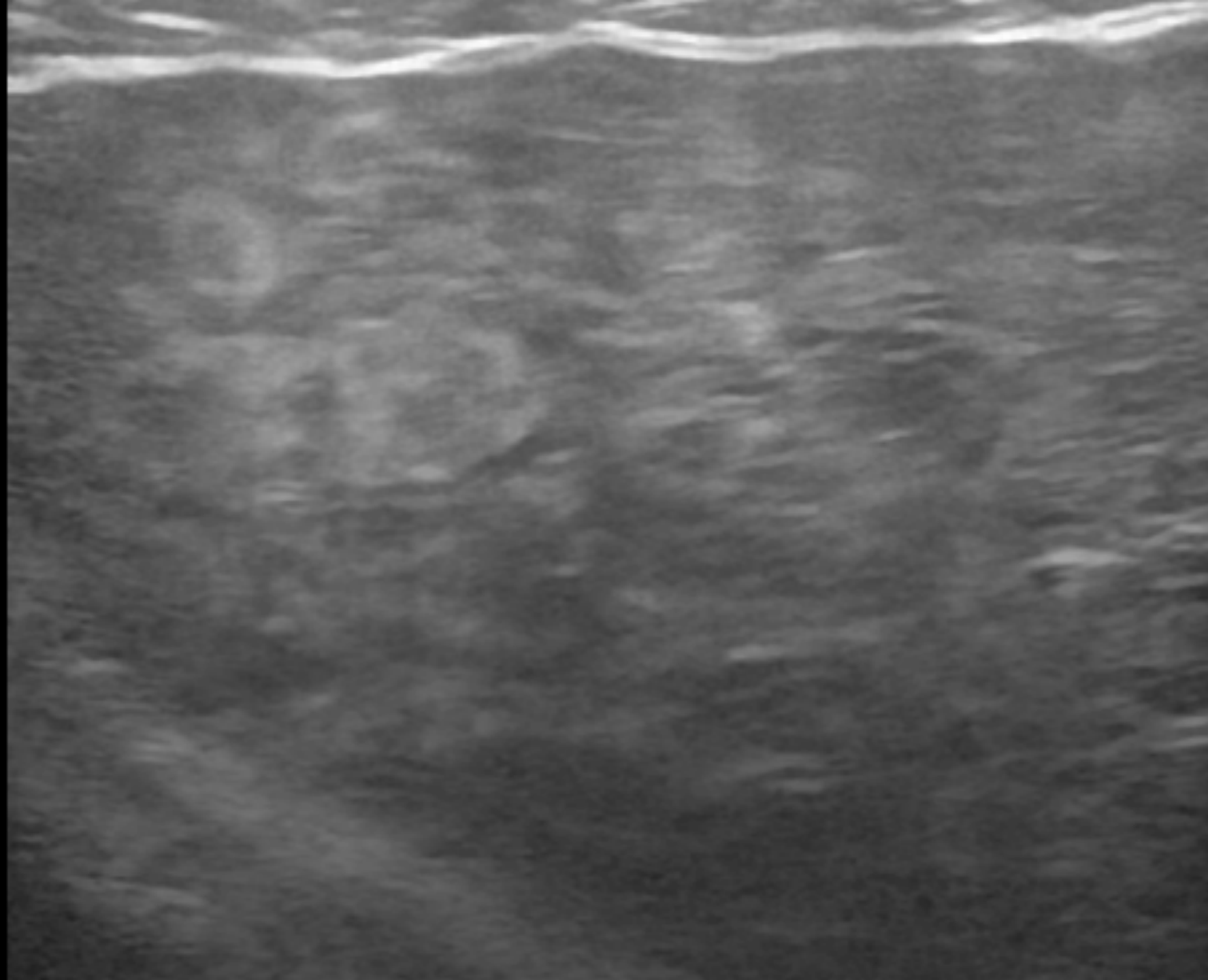




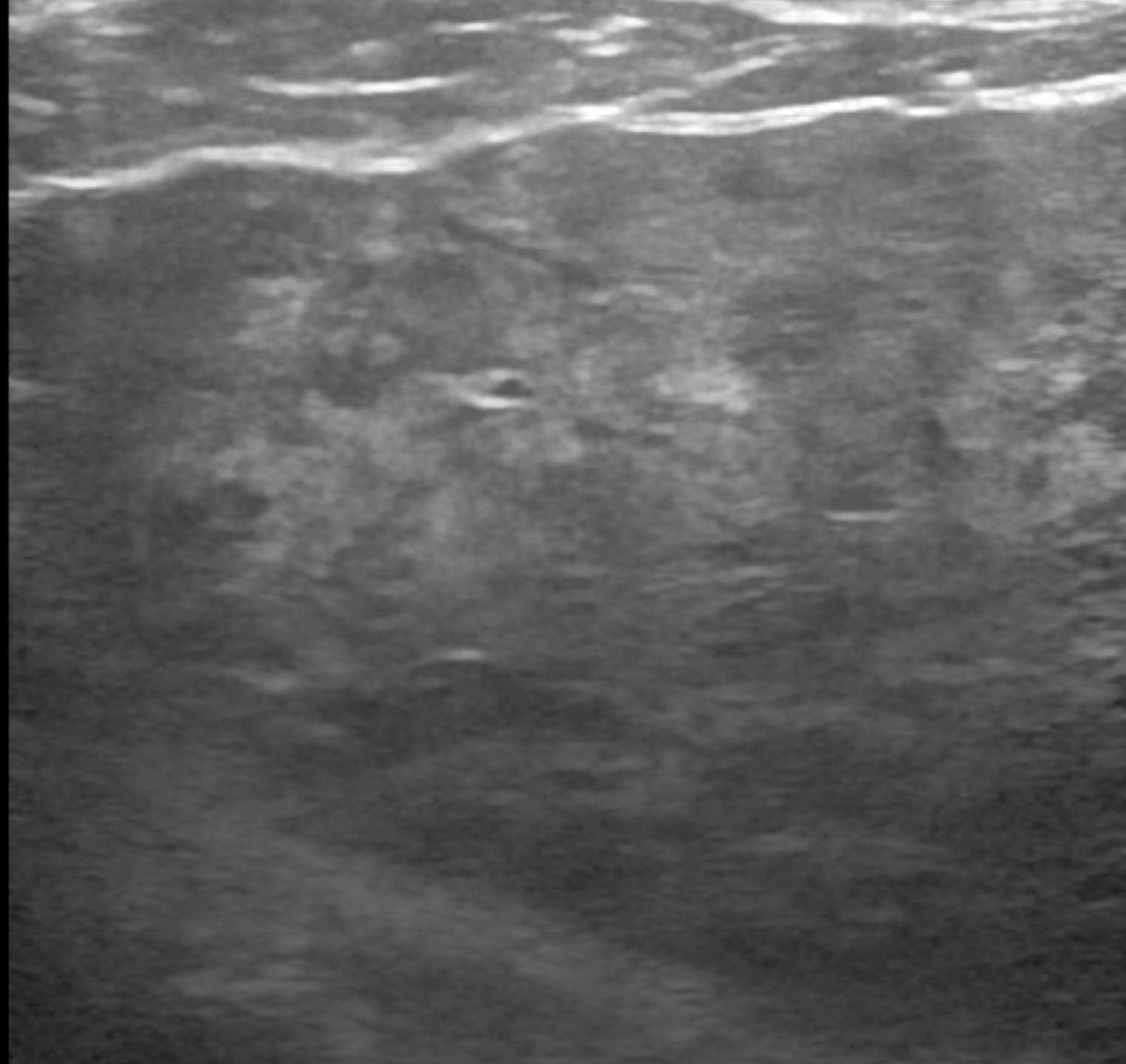


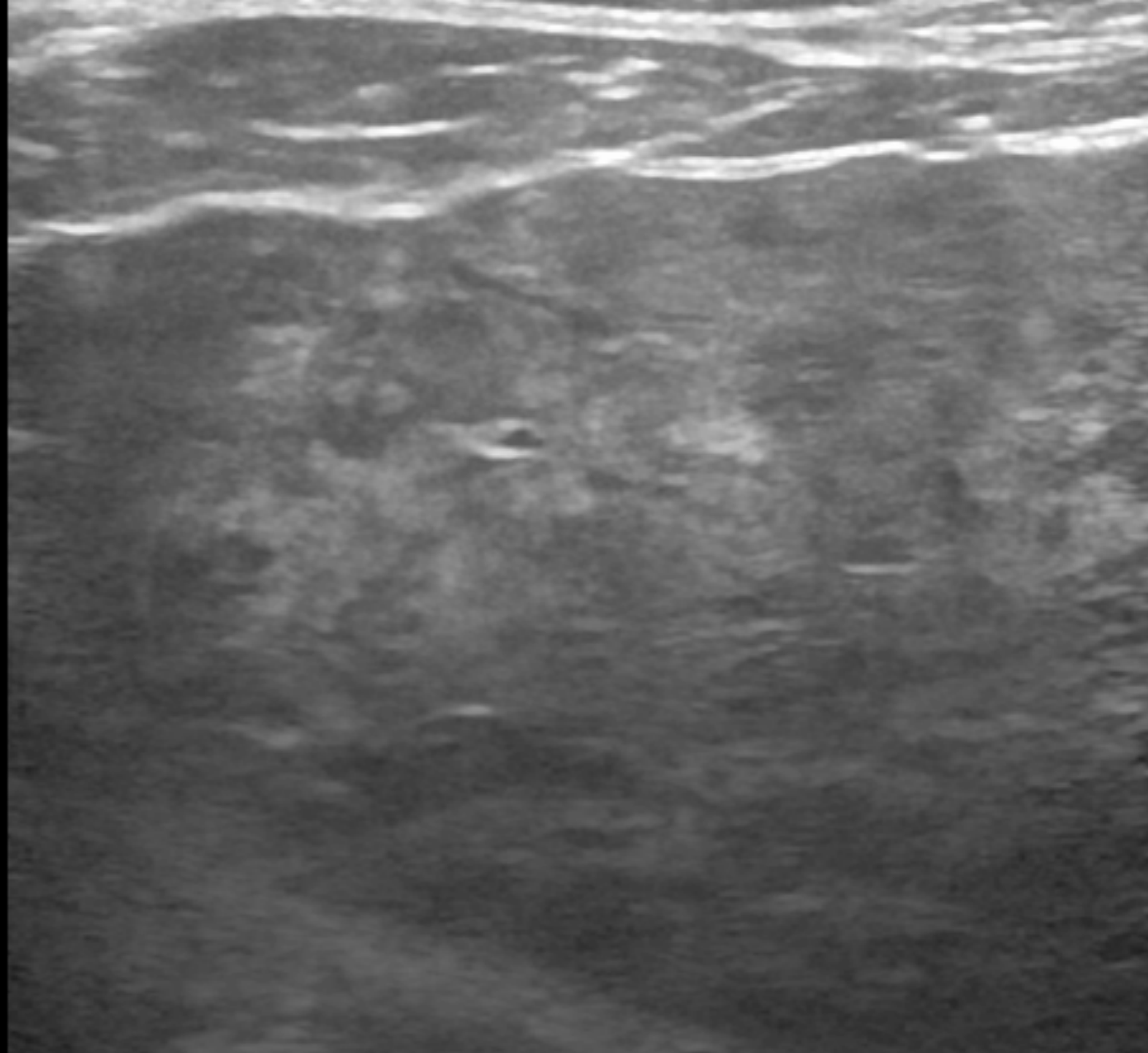
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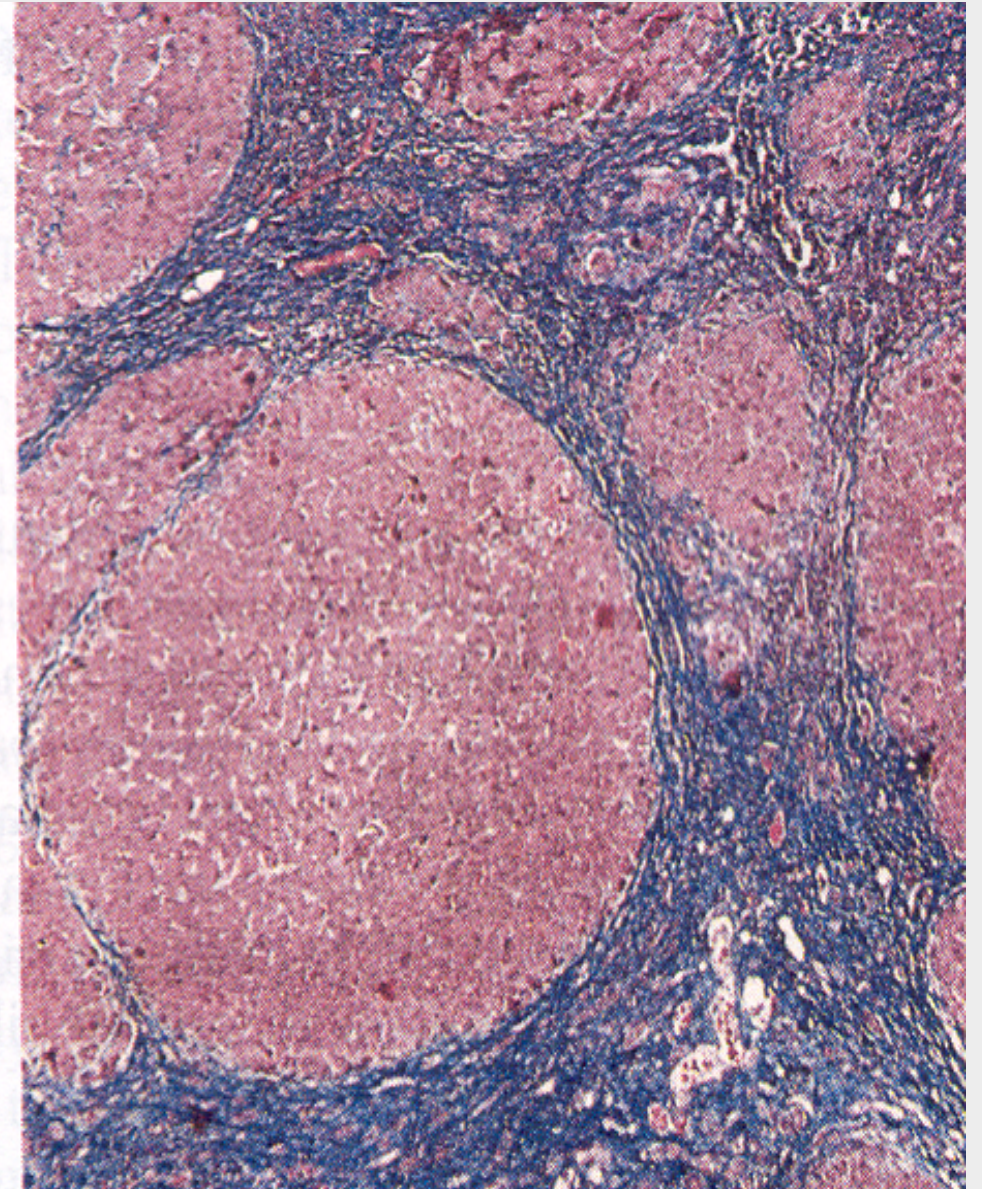




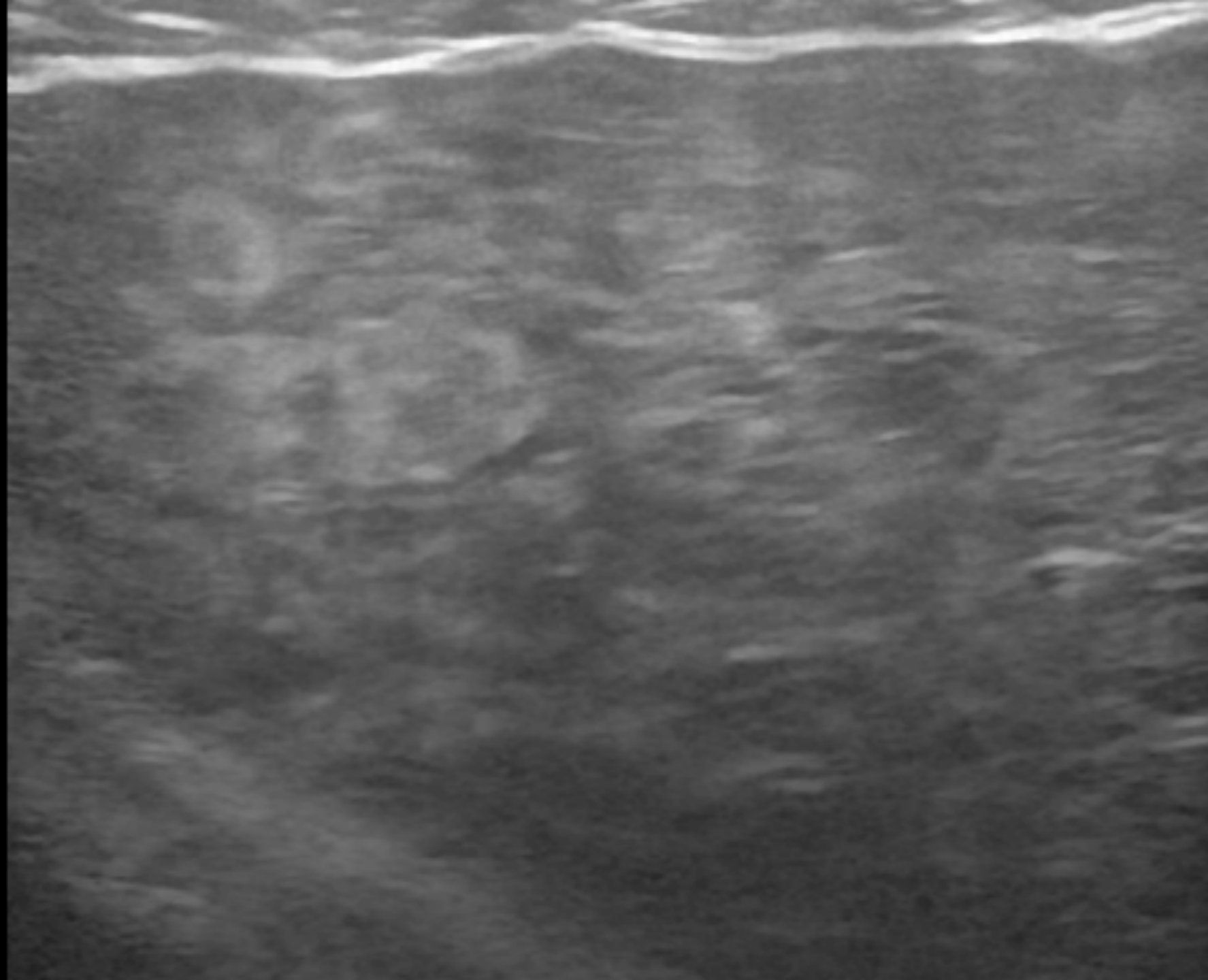




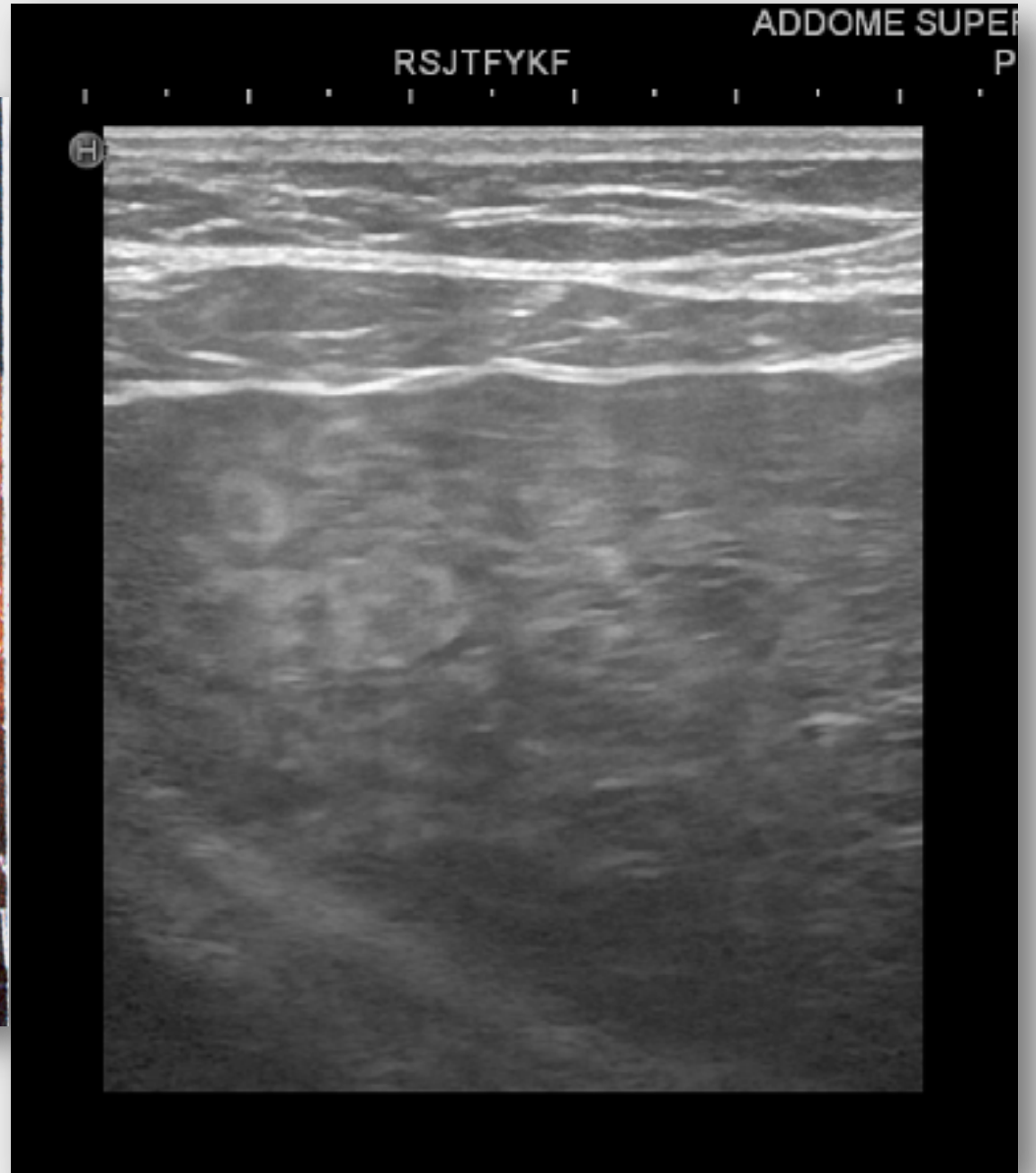








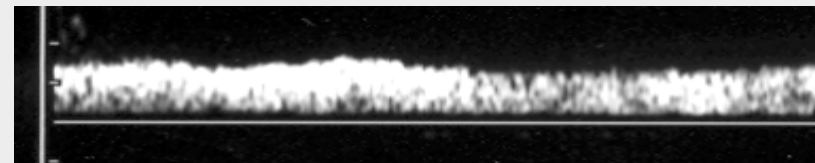
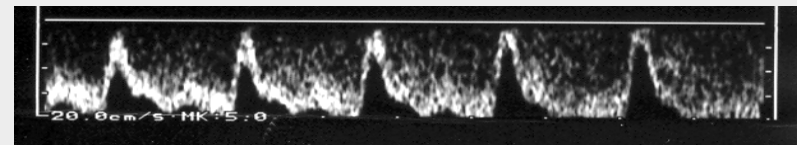
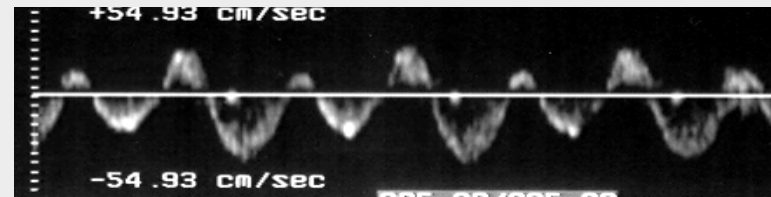




# Fibrosi

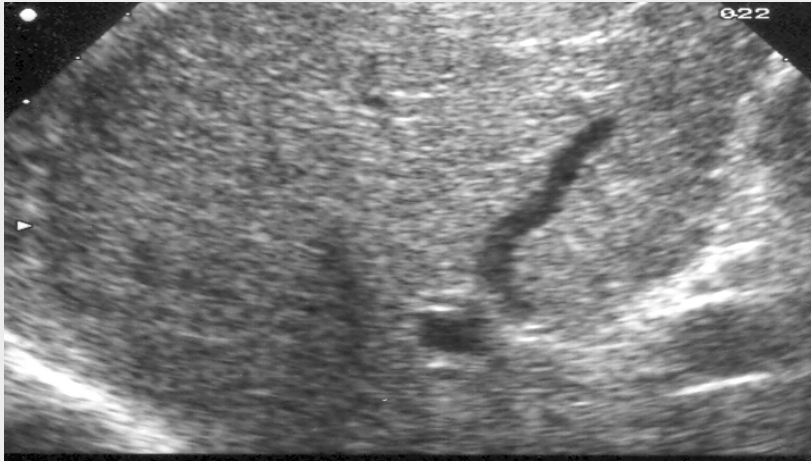
## Segni vascolari

- **Vene sovraepatiche (Waveform)**
  - **Tipo 0 – trifasico**
  - **Tipo 1 – bifasico**
  - **Tipo 2 - monofasico**



Bolondi et al. Radiology 1992.

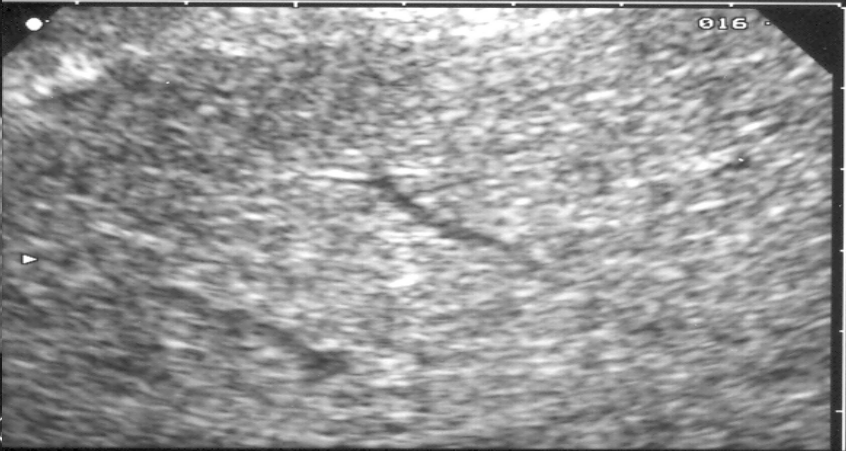




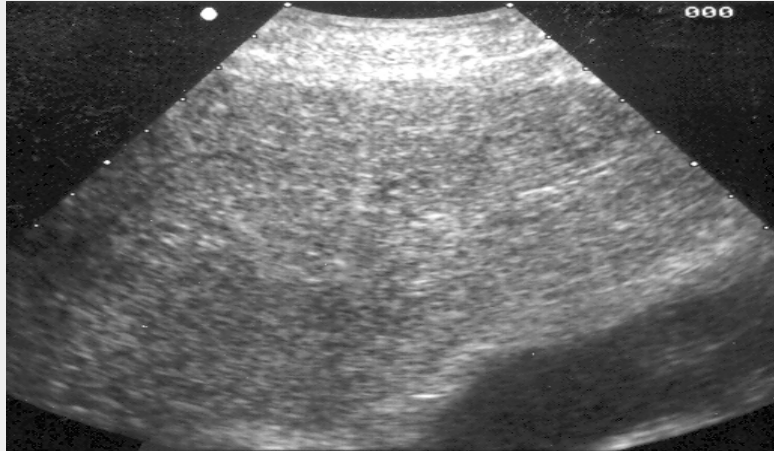
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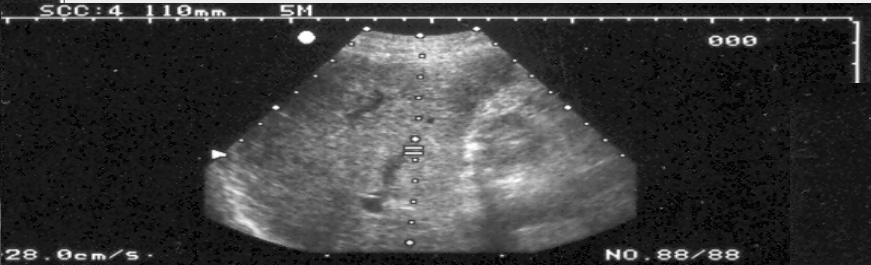
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NO. 118/118  
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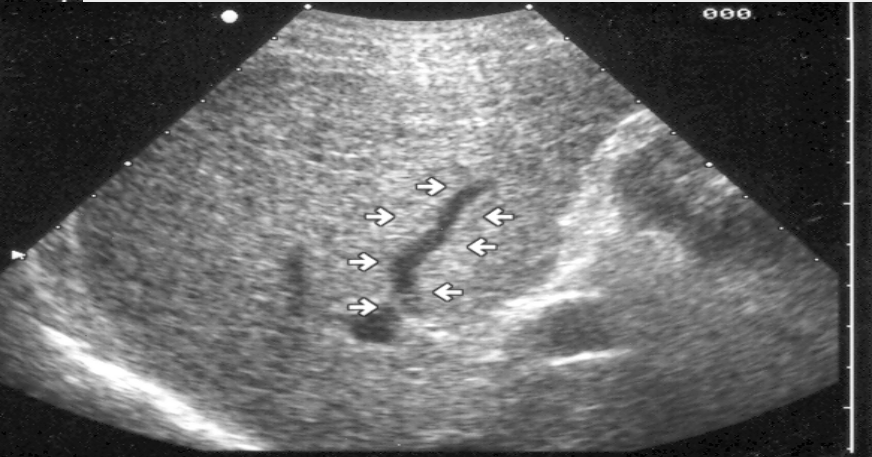
NO. 118/  
SERV. ECOINTERVENTISTICA-0SP. COTUGNO NA



28.0 cm/s

28.0 cm/s - MK: 5.0

SERV. ECOINTERVENTISTICA-0SP. COTUGNO NA  
DF: 4K/2.5M    WF: 100    0:0°  
DG: 18 DYN: 30    SL: 3.0    [PM]  
ACCEL.    RT-VELO    VASCI

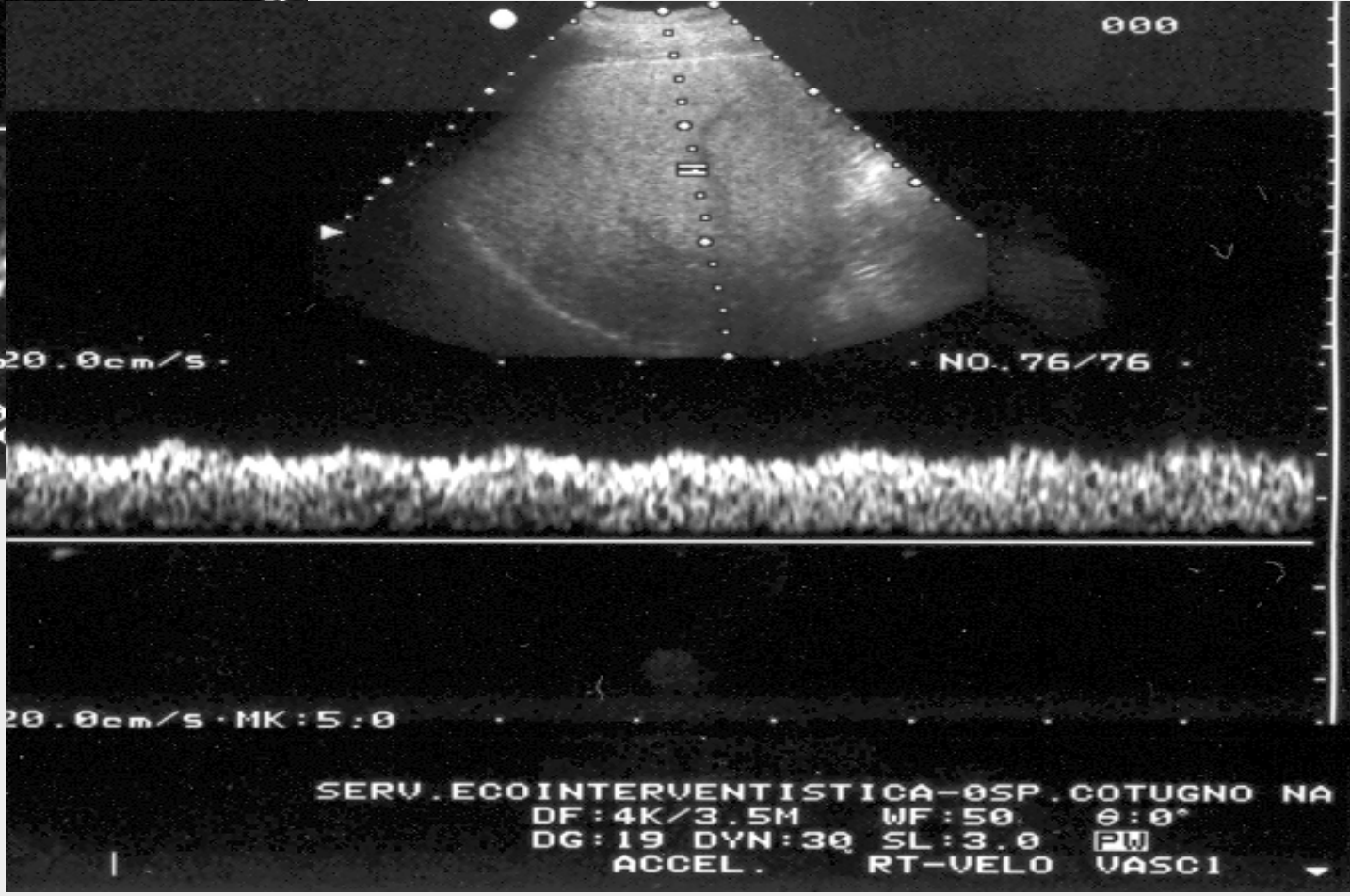
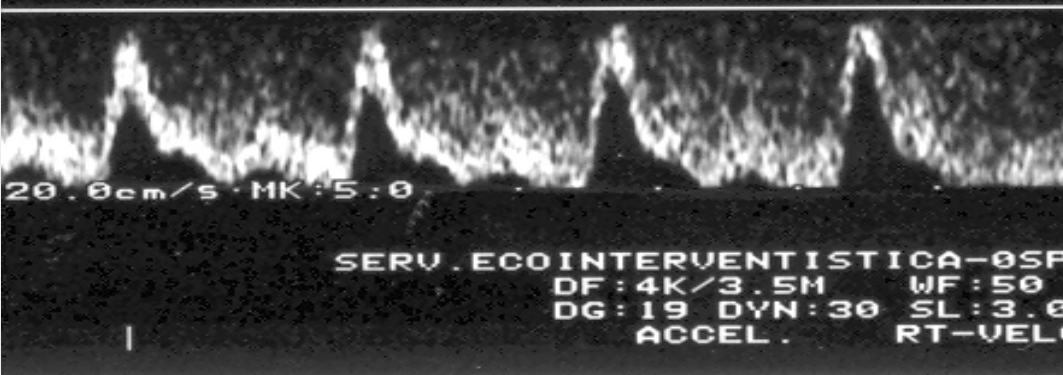
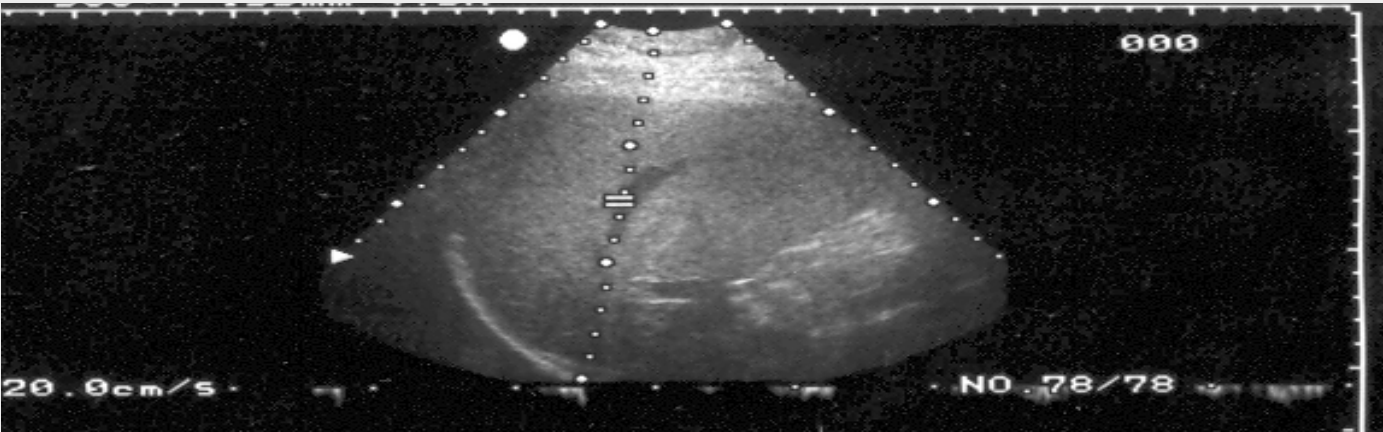


NO. 118/111  
SERV. ECOINTERVENTISTICA-0SP. COTUGNO NA

***Hepatic portal vein flow pattern in correlation with intrahepatic fat deposition and liver histology in patients with chronic hepatitis C.***

**Dietrich CF et al. AJR , 1998; 171: 437-443**

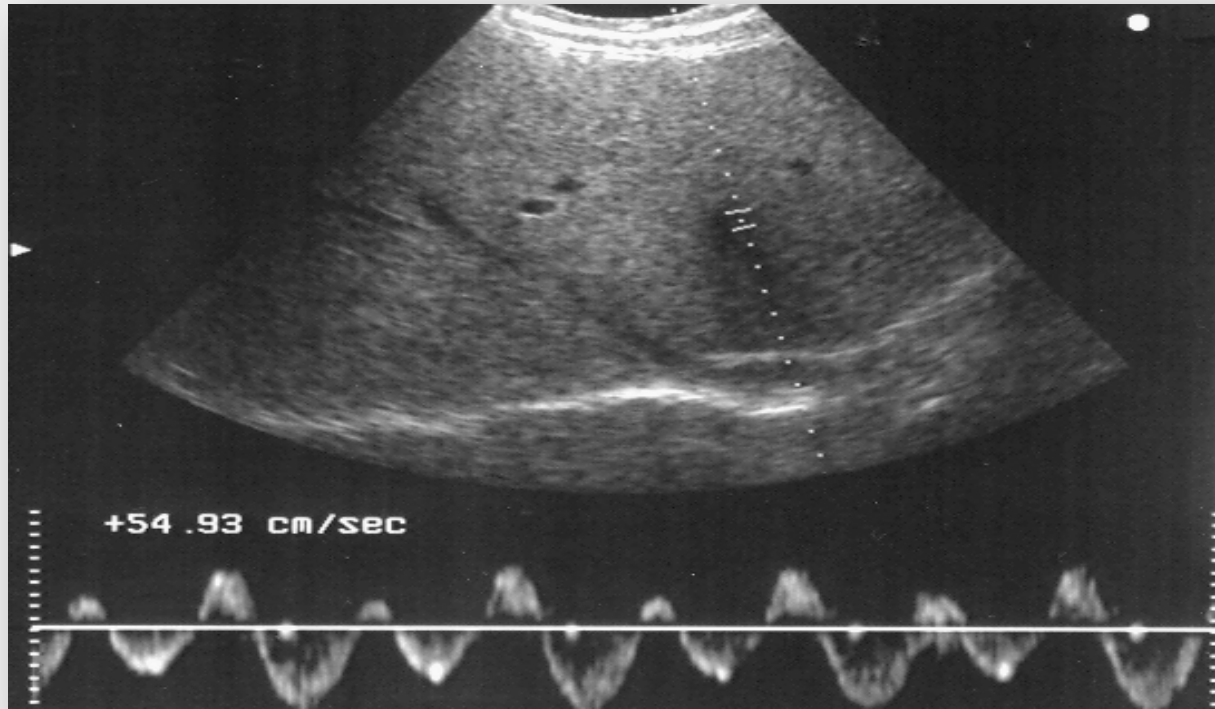




Albrecht et al. AJR 1999.

# Doppler waveform of hepatic veins in healthy children.

Jequier S, Jequier JC, Hanquinet S, Gong J, Le Coultre C, Belli DC.



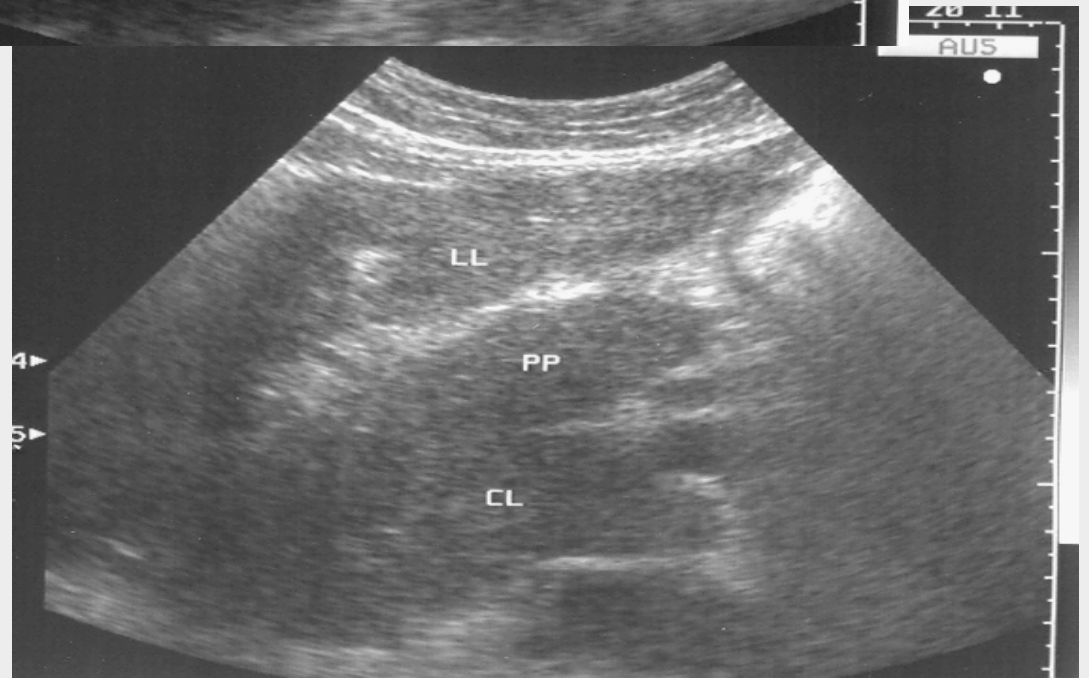
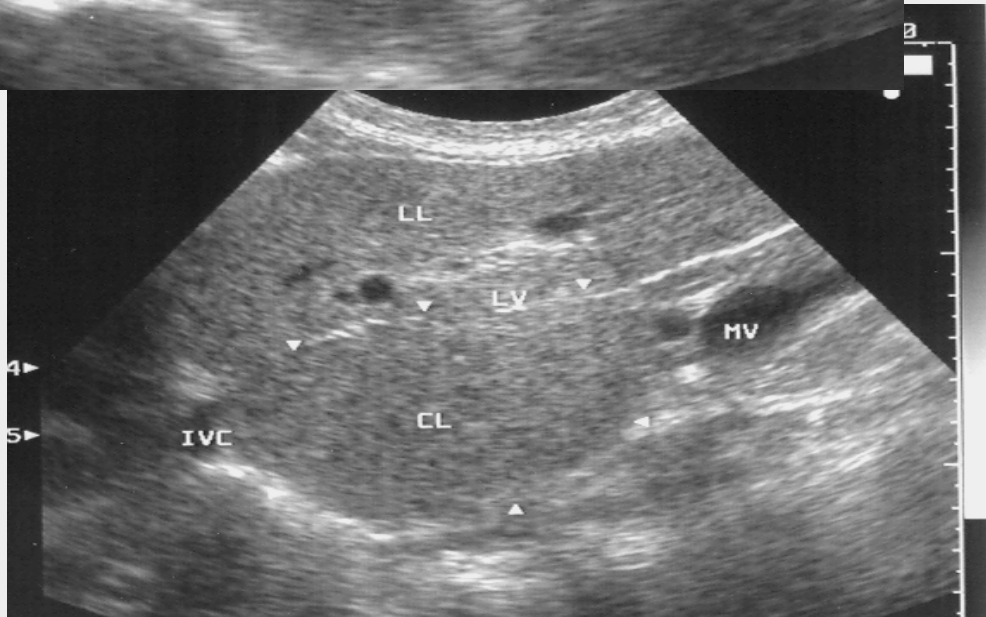
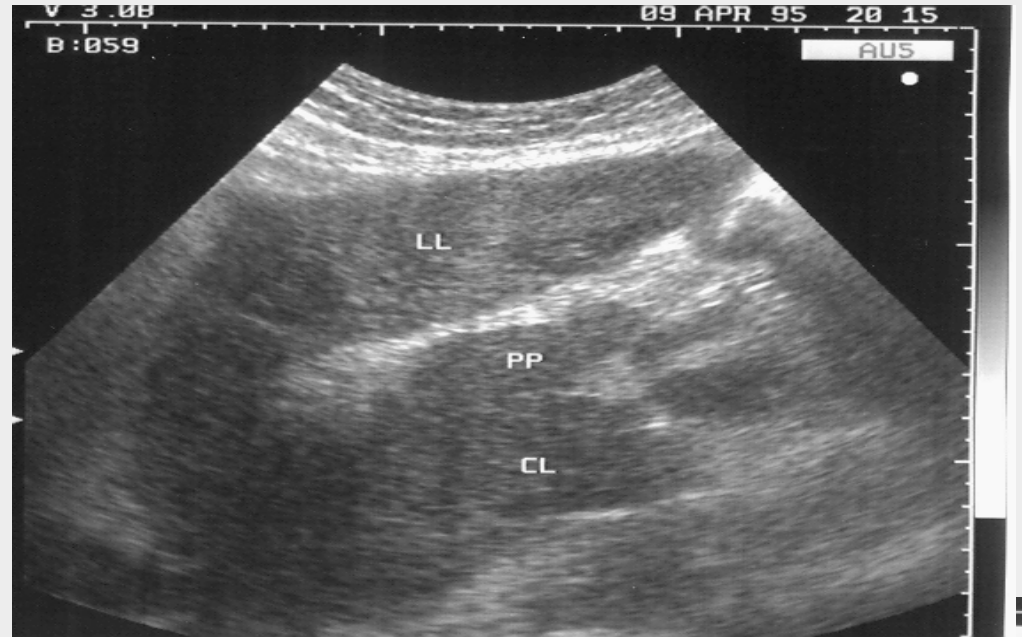
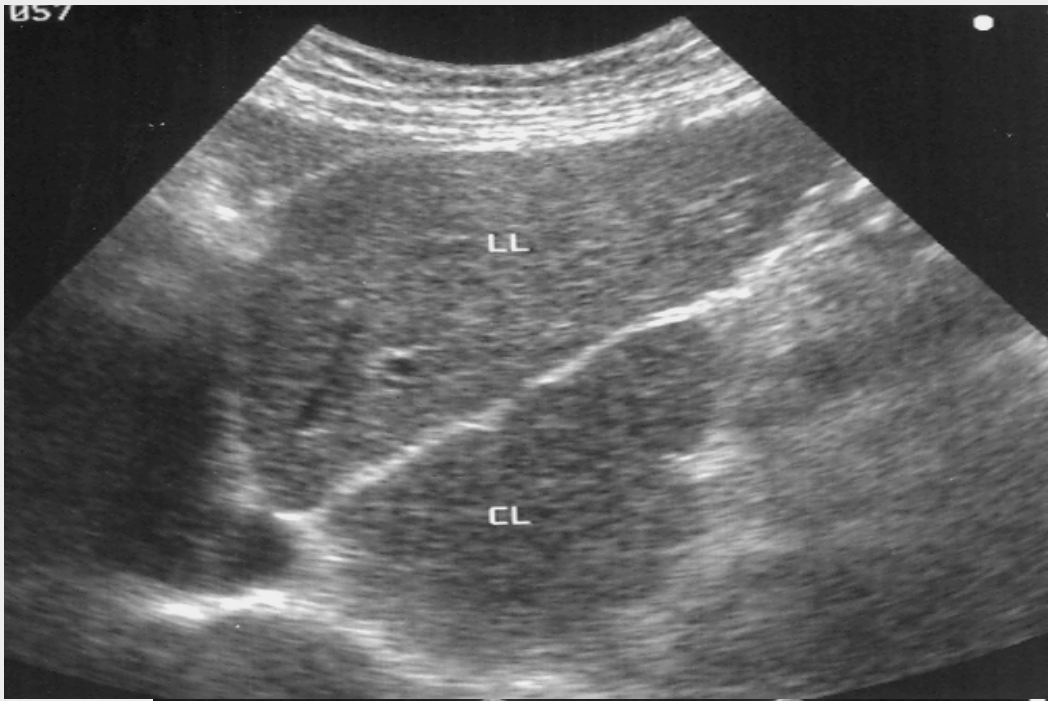
AJR Am J Roentgenol 2000 Jul;175(1):85-90

# LIVER CIRRHOSIS: US FINDINGS

## *REGIONAL CHANGES IN HEPATIC MORPHOLOGY*

- **ENLARGEMENT OF LEFT LOBE**
- **HYPERTROPHY OF CAUDATE LOBE**
- **SHRINKAGE OF RIGHT LOBE**
- **DECREASE DIAMETER OF SEGMENT IV**

*C/RL  
RATIO*







0

5

10

LL

LV

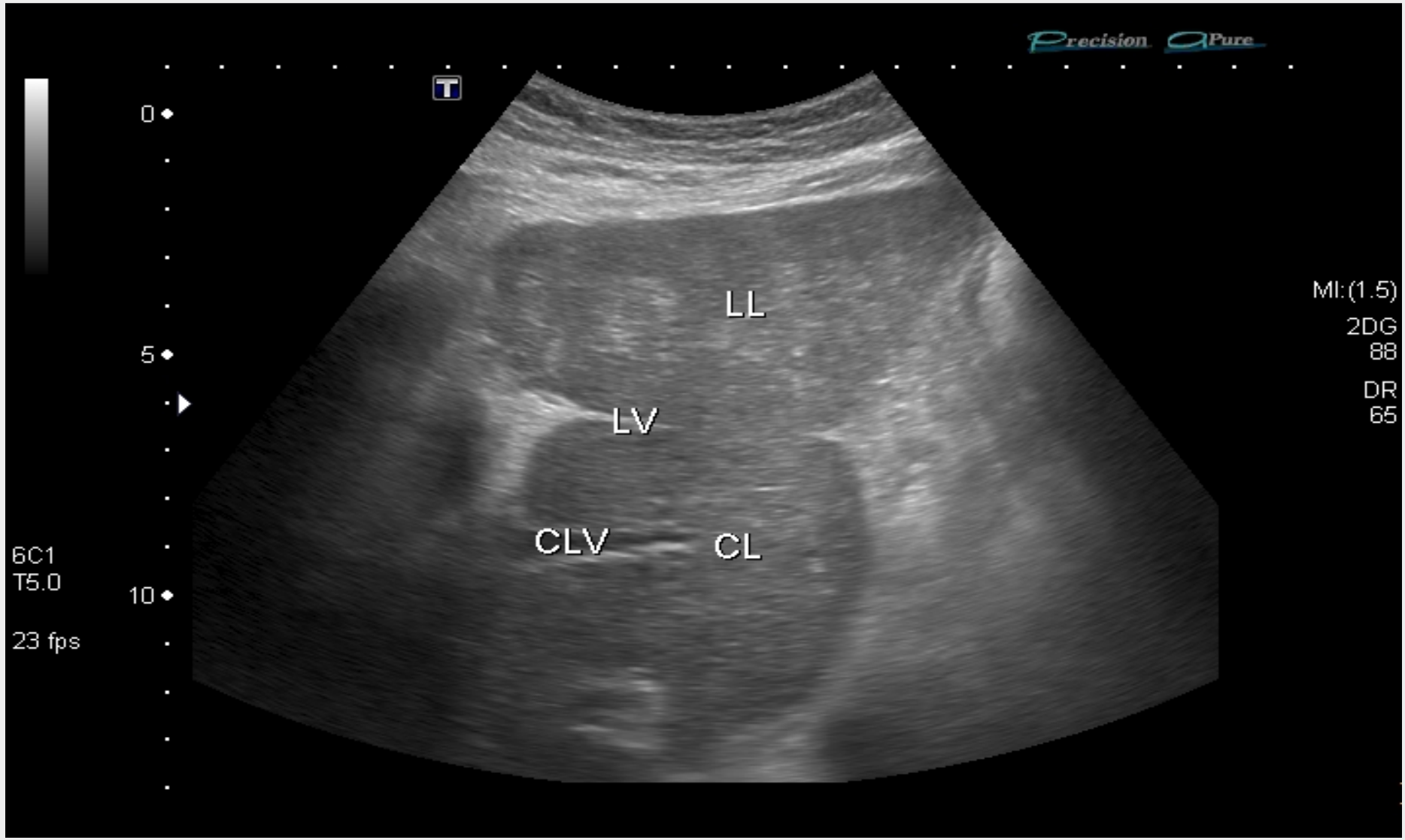
CLV

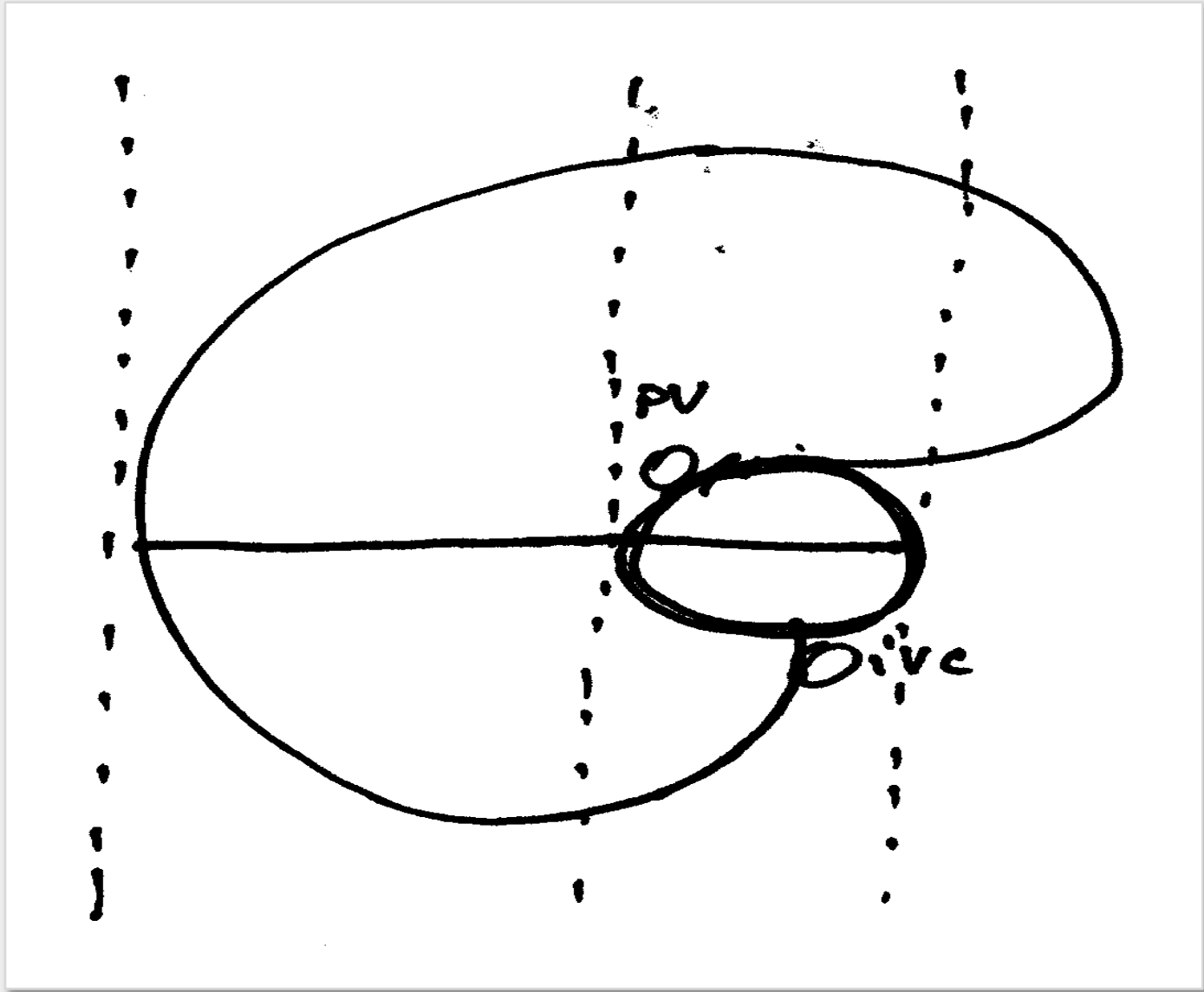
CL

MI: (1.5)  
2DG  
88  
DR  
65

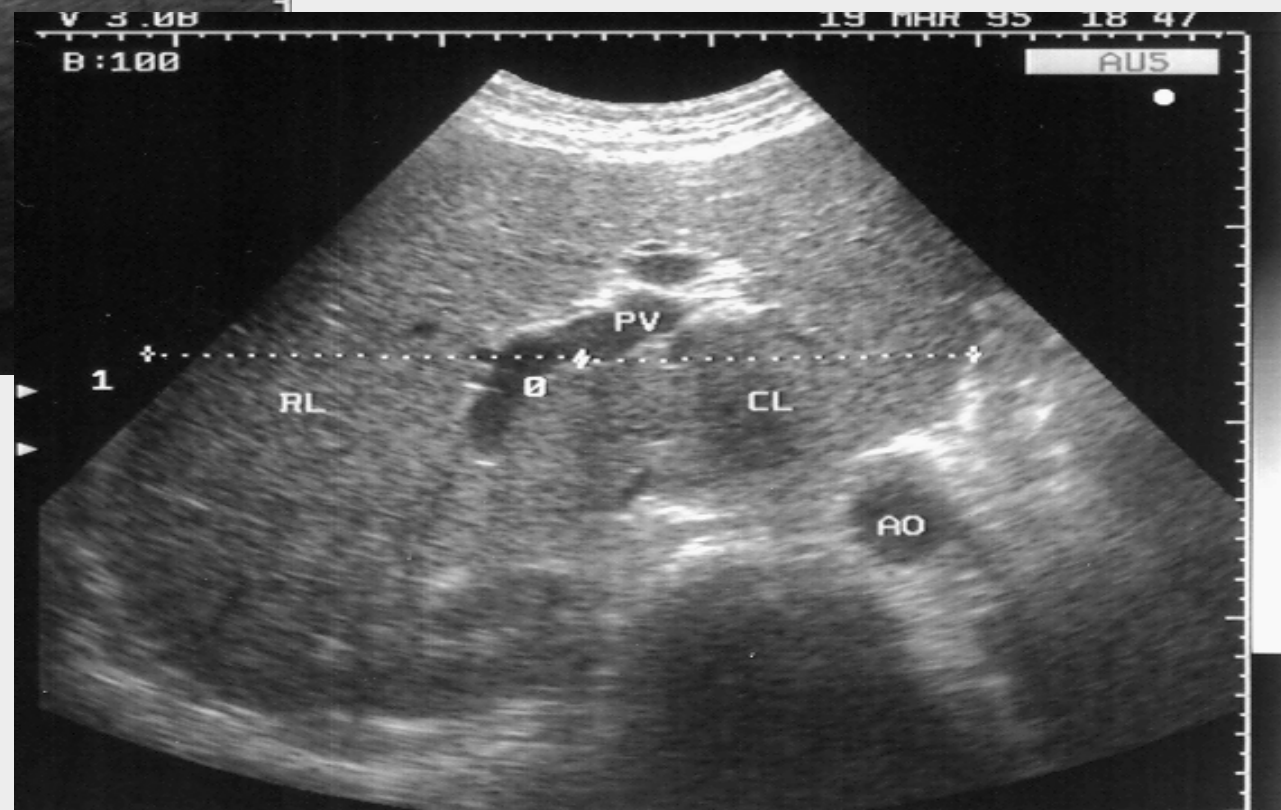
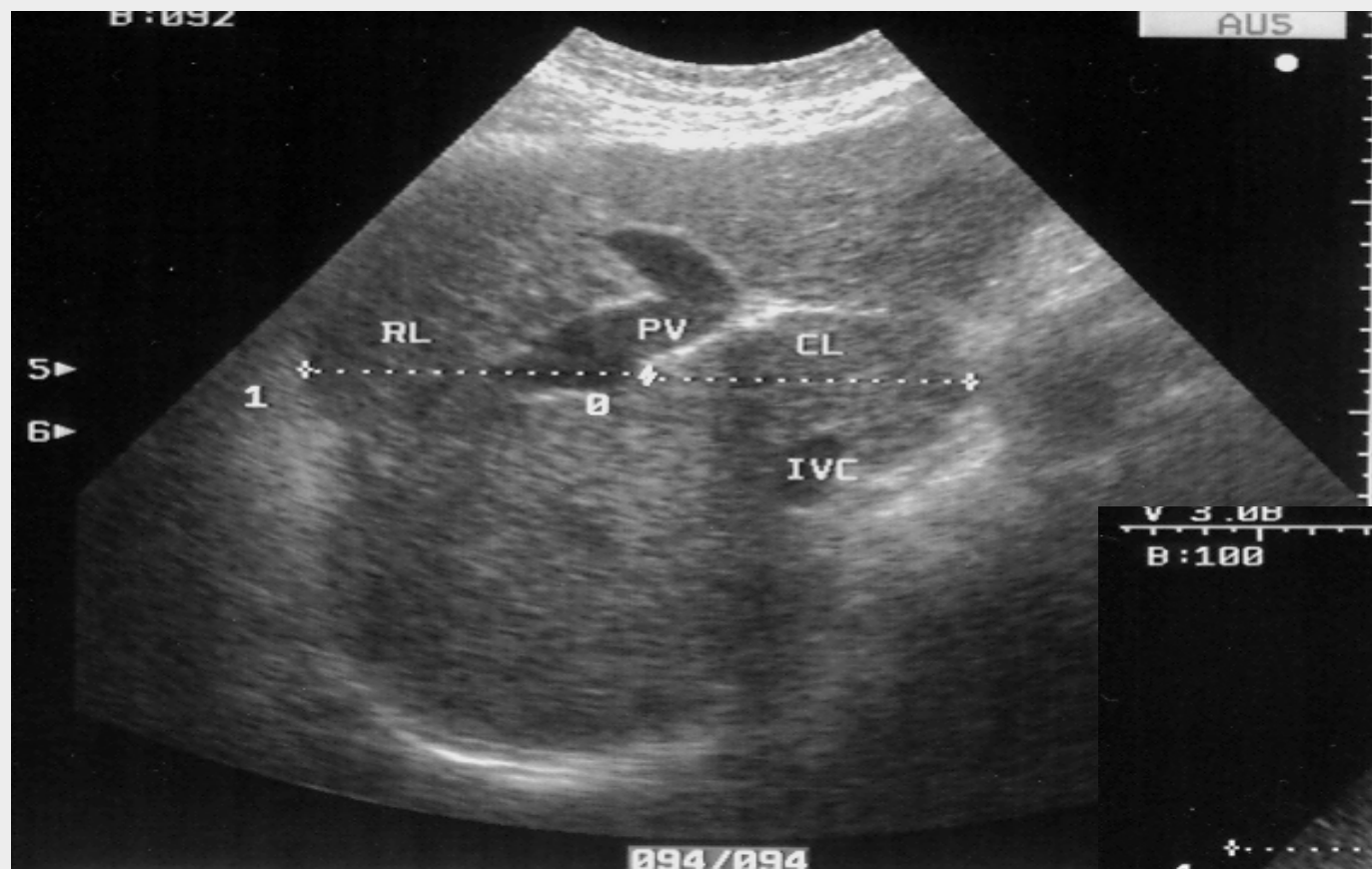
6C1  
T5.0

23 fps



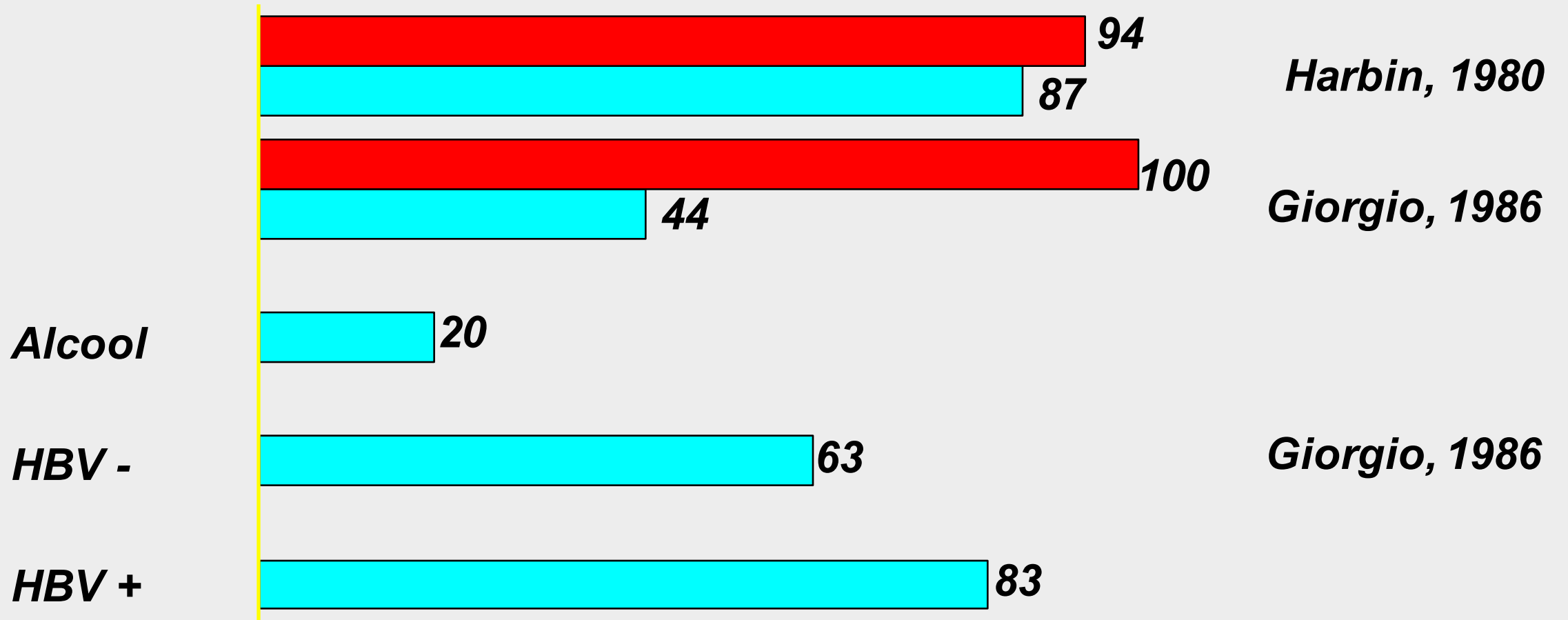


Harbin et al. Radiology 1980  
Giorgio et al. Radiology 1986



# C/RL RATIO IN LIVER CIRRHOSIS

**■ % SPECIFICITY**  
**■ % SENSITIVITY**





With the high prevalence of diffuse liver disease there is a strong clinical need for noninvasive detection and grading of fibrosis and steatosis as well as detection of complications

# Elastography

**There is a correlation between hepatic parenchymal pathology and liver stiffness**

***As a surrogate marker of fibrosis and cirrhosis, the measurement of liver stiffness forms the basis of elastography .***

Stiffness, or the rigidity of an object, is the extent to which it resists deformation in response to a force applied.

Elasticity is the tendency of solid materials to return to their original shape after being deformed by a force applied and removed.

# Elastography

In elastography, such force is coupled with a system that measures the deformities caused by the force.

**Ultrasound elastography techniques include**

- transient elastography (FibroScan®),**
- acoustic radiation force impulse imaging (ARFI),***
- shear wave mode elastography***
- strain elastography***

Real-time elastography for noninvasive assessment of liver fibrosis  
in chronic viral hepatitis

Friedric - Rust M et al, AJR 2007



- ✓ **real-time elastography is a new method for measurement of tissue elasticity integrated in a sonography machine and is technically different from transient elastography**

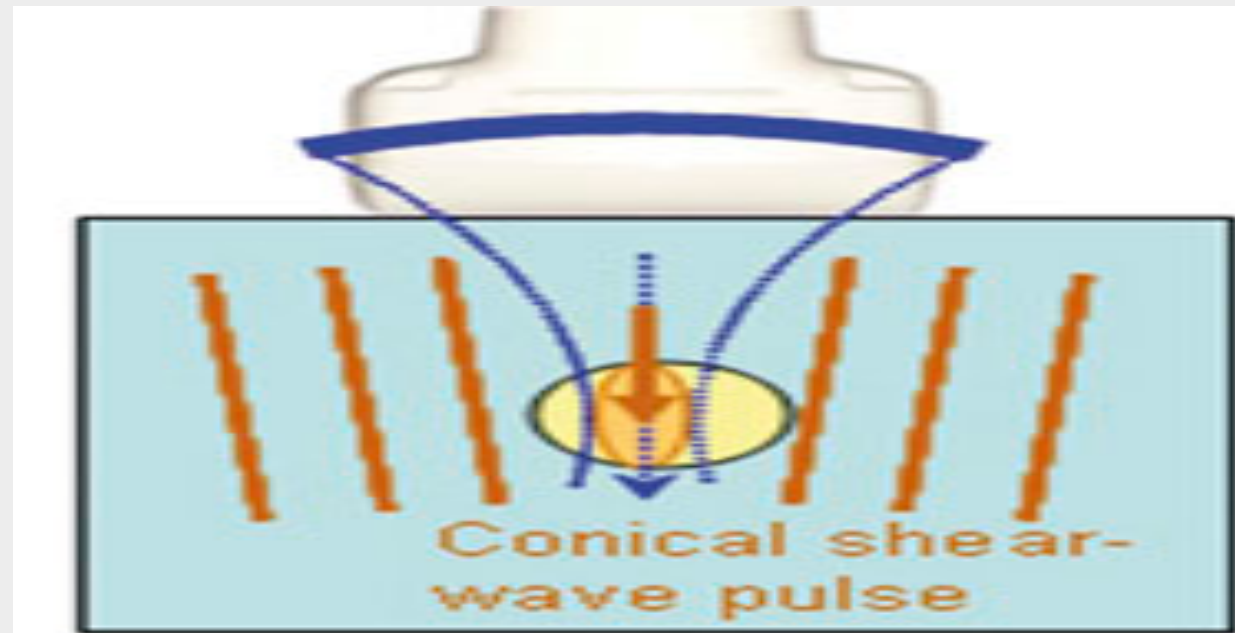


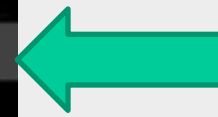
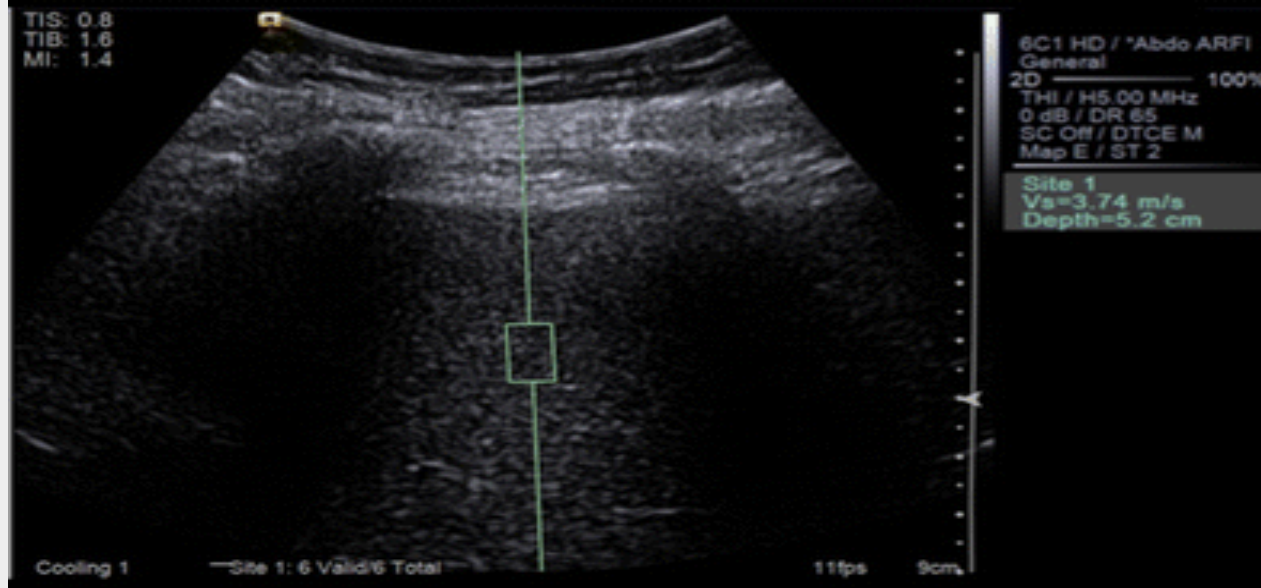
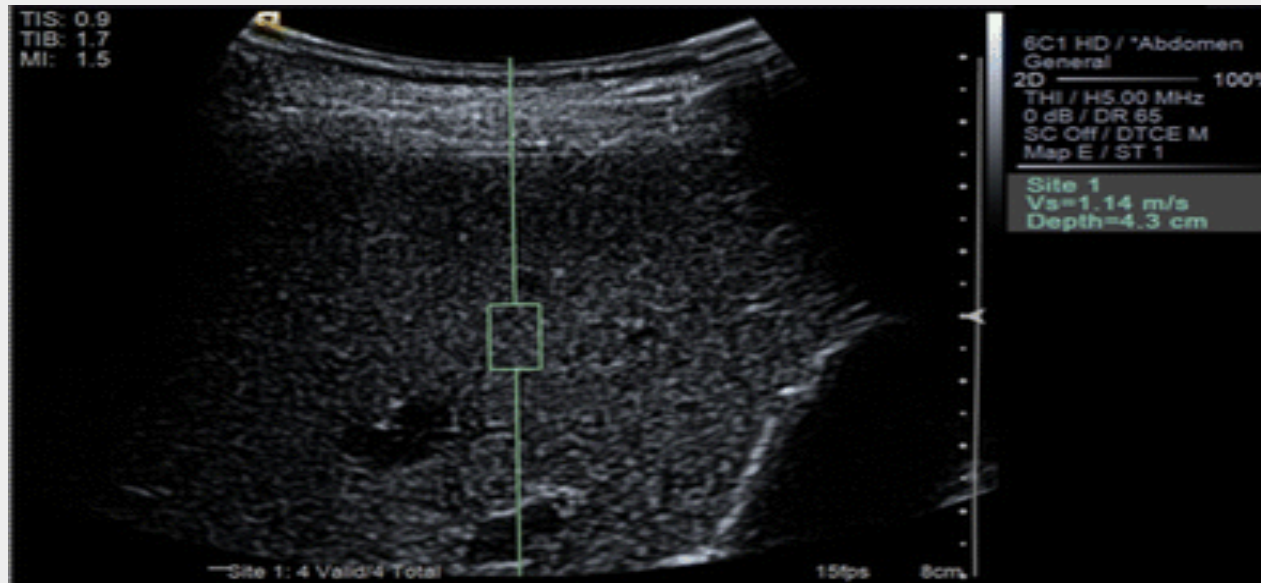
# Acoustic force radiation impulse

- Acoustic Force Radiation Impulse (ARFI) technology is a technique that has been incorporated into an imaging ultrasound unit. A 5 mm × 10 mm region of interest (ROI) cursor is placed during real-time B-mode scanning.

# Acoustic force radiation impulse

- The tissue in the ROI is excited with a short duration (262  $\mu\text{s}$ ) fixed frequency (2.67 MHz) ultrasound pulse to displace tissue locally. The resultant shear wave propagates laterally with a velocity that is proportional to the square root of tissue elasticity and detected with ultrasound-based correlation methods.
- **The speed of the shear wave is measured directly in meters per second and is displayed on the screen**







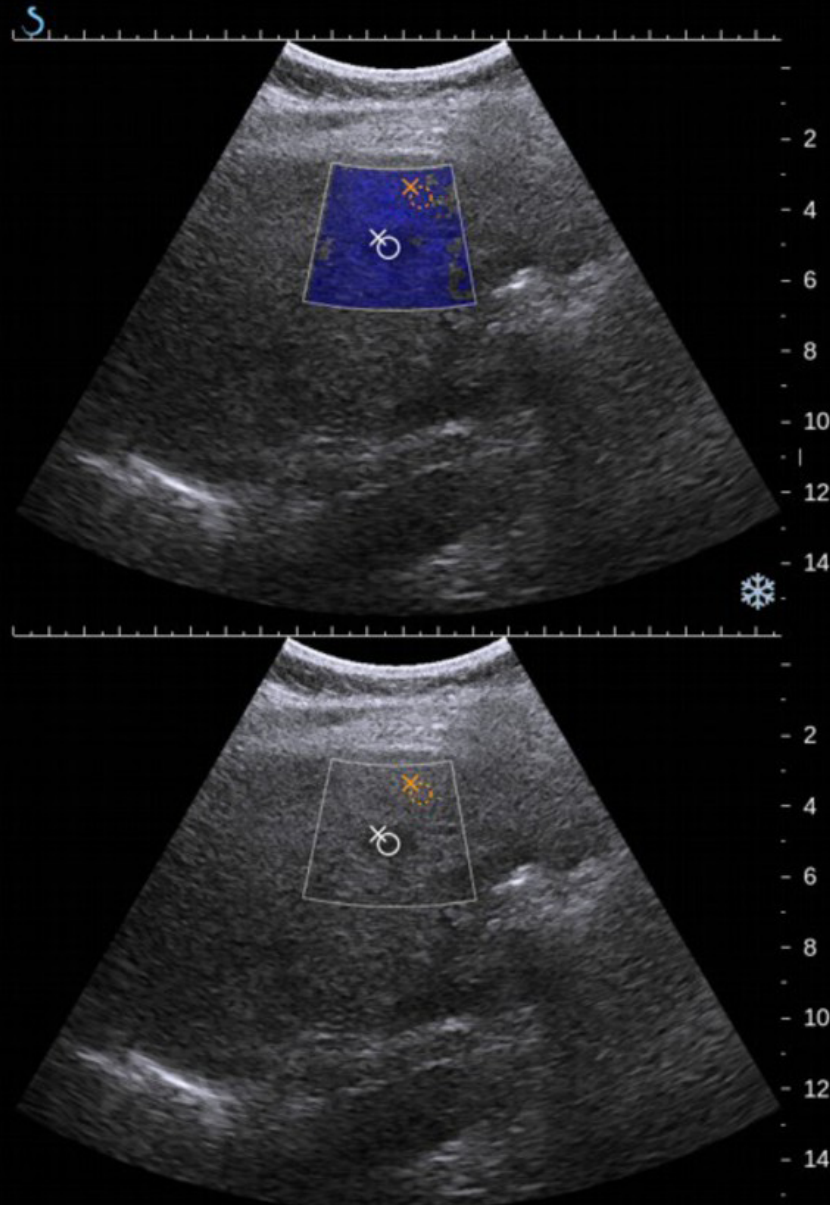
**Shear-waves  
Radiation  
Force Impulse**



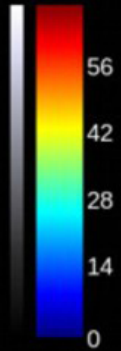
Tissue 1540 m/s  
Super Compound On  
SuperRes 2  
Pen / FR  
Map 3 / 64 dB / Medium  
Gain 40 %  
Fr. 7 Hz  
Zoom 100 %

WE™  
Gen  
Map 1  
Dpa, 50 %  
Persist. Medium  
Smooth. 5  
Gain 70 %  
SWE Standard

41/41



+70 kPa

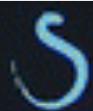


× Q-Box™ ratio

Mean 2.69 kPa  
Min 1.22 kPa  
Max 4.46 kPa  
Std Dev 0.9

Mean 3.84 kPa  
Min 1.05 kPa  
Max 9.73 kPa  
Std Dev 2.1

Ratio 0.7



B

Gen/Med/H  
M 1/61 dB/Med  
T 1540 m/s  
SC/SR 5  
G 66 %  
Fr. 5 Hz

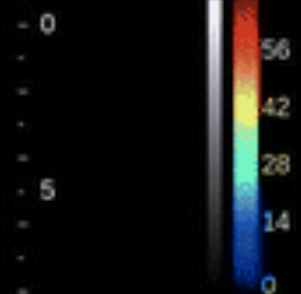
SWE™

Std/Med  
M 1/Med  
S 5/O 50 %  
G 70 %

Z 100 %



+70 kPa



Q-Box™

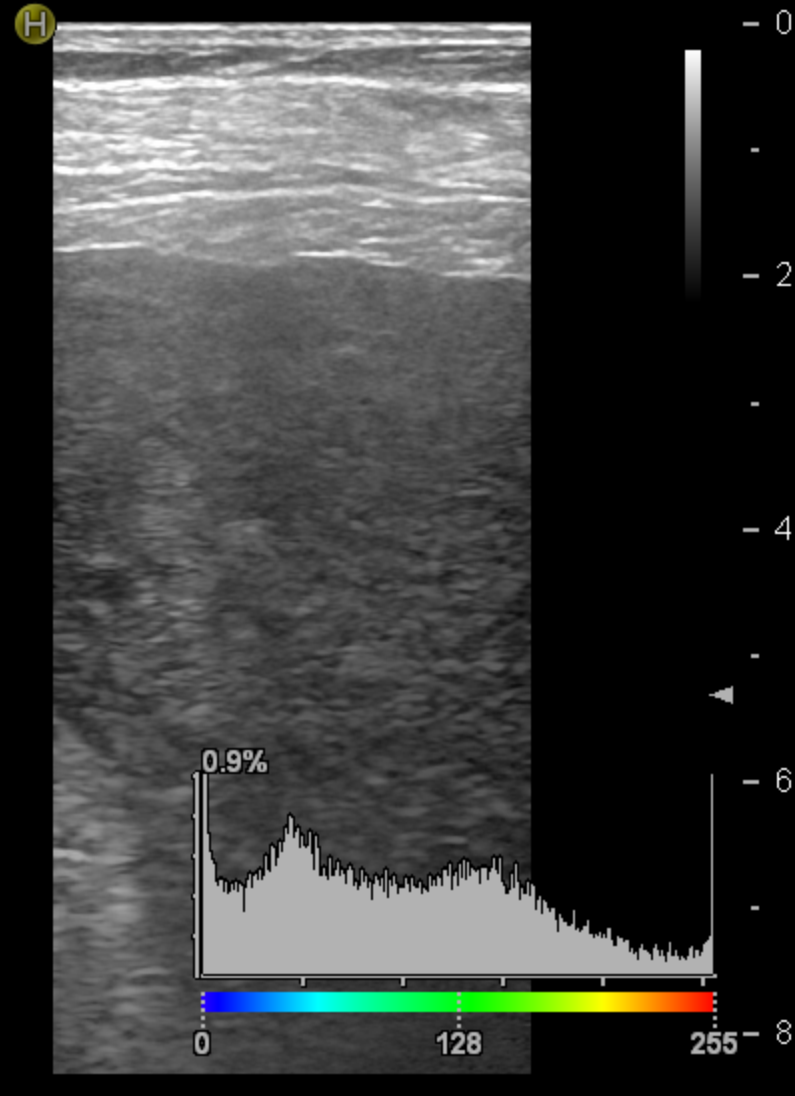
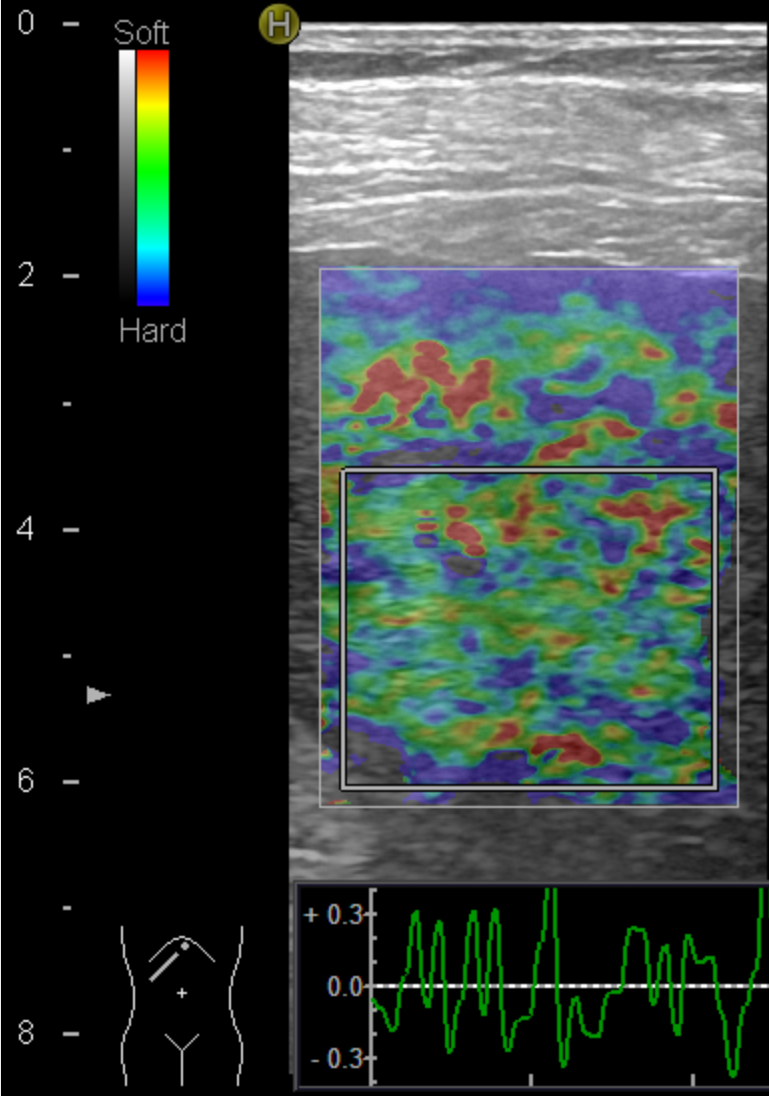
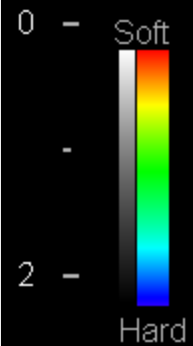
Mean 60.17 kPa  
Min 52.36 kPa  
Max 71.00 kPa  
Std Dev 4.5  
Diam 15.0 mm  
Display saturated

RSJTIFYKF

P:100%

MI 0.8

TIS<0.4



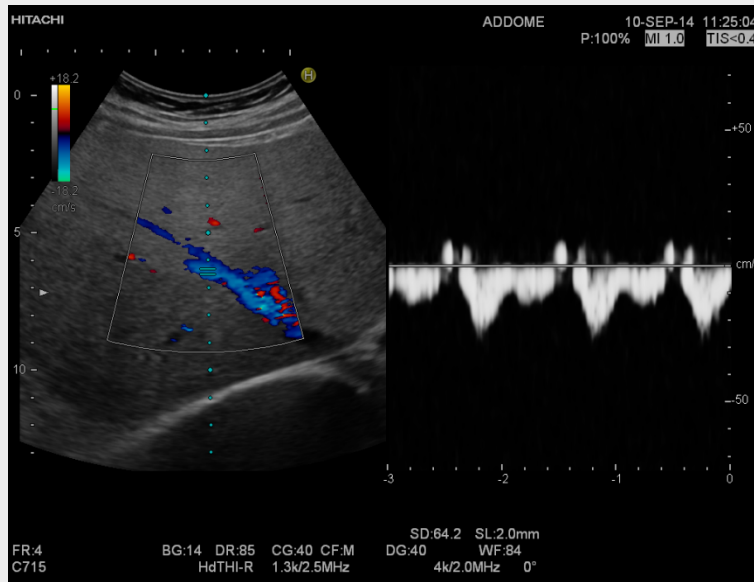
Str. Histo

C	109.2 mm	MEAN	97.3	SD	67.4	%AREA	34.87 %
COMP	44.13	LF INDEX	2.98				

FR:14 BG:31 DR:70 F.Rej:4 N.Rej:4 FR:14 BG:31 DR:70  
 L52 dTUI W.D Low PL:36% L52 dTUI W.D



# Le modifiche US nel controllo delle malattie diffuse del fegato



# Le modifiche US nel controllo delle malattie diffuse del fegato



# Main “take-home” messages

- ✓ B-mode US is **the principal US imaging technique** in the evaluation of diffuse liver **disease, liver parenchyma and liver margins**
- ✓ B-mode US is relied upon in **HCC surveillance**, and **CEUS** is useful in the evaluation of possible HCC
- ✓ Fibrosis can be **NOW** detected and staged with reasonable accuracy using **sonoelastography**
- ✓ US detection of steatosis is currently reasonably accurate but grading of severity is of limited accuracy