



Use of Ultrasound in NAFLD

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International Hepatology Ultrasound Course 2018

The Atrium, The Royal Free Hospital
1st - 3rd June



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METABOLIC SYNDROME

and associated pathologies

Obesity

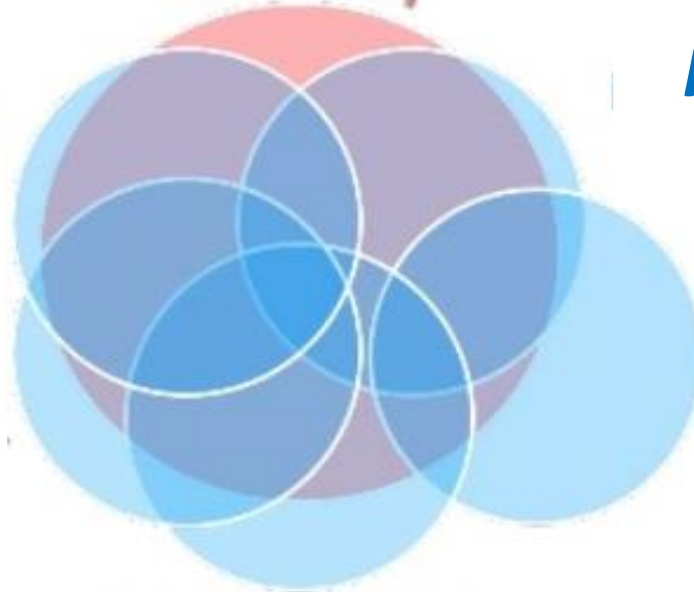
Diabetes type 2

Insulin resistance

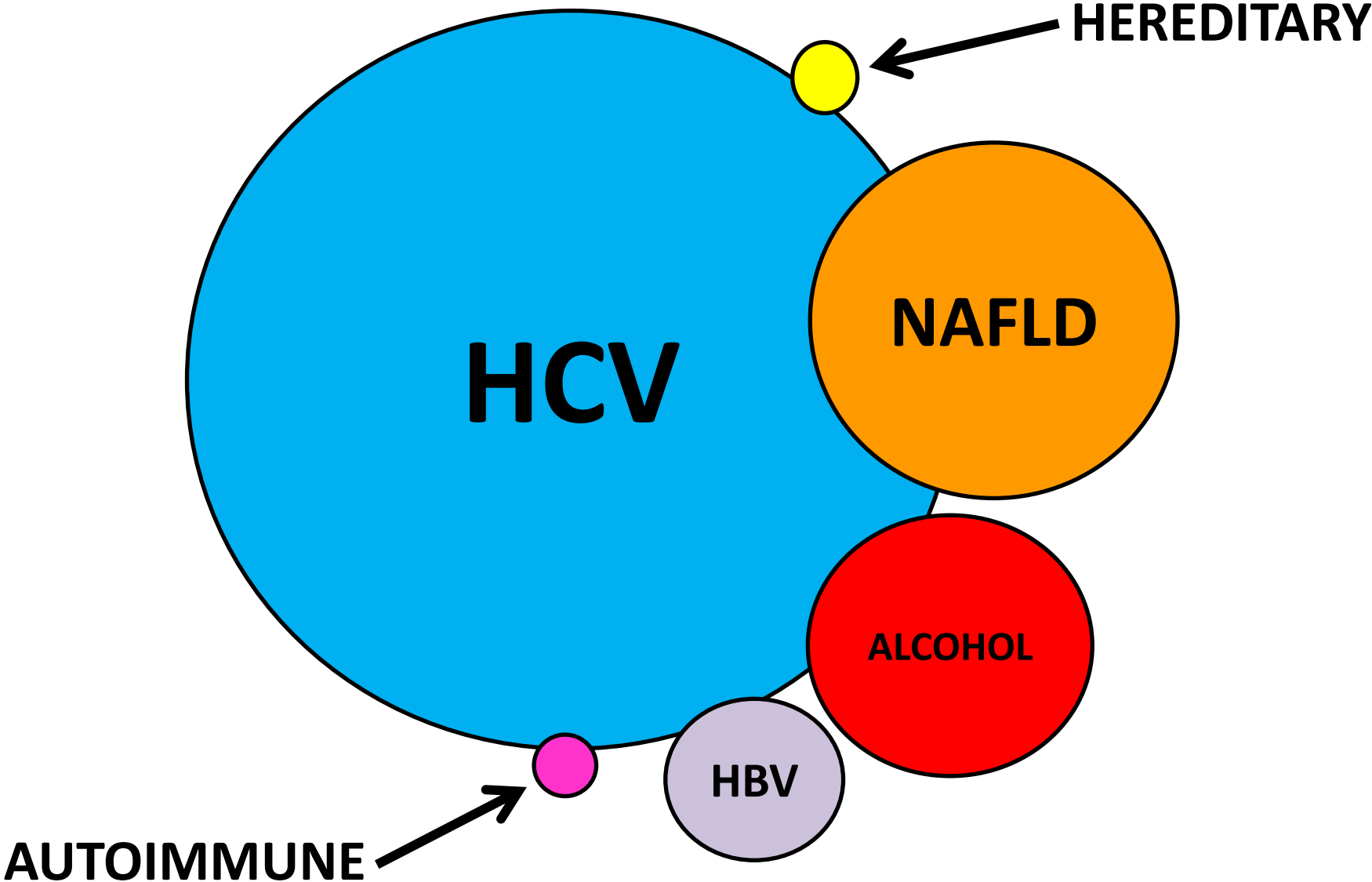
*Cardiovascular
disease*

Hypertension

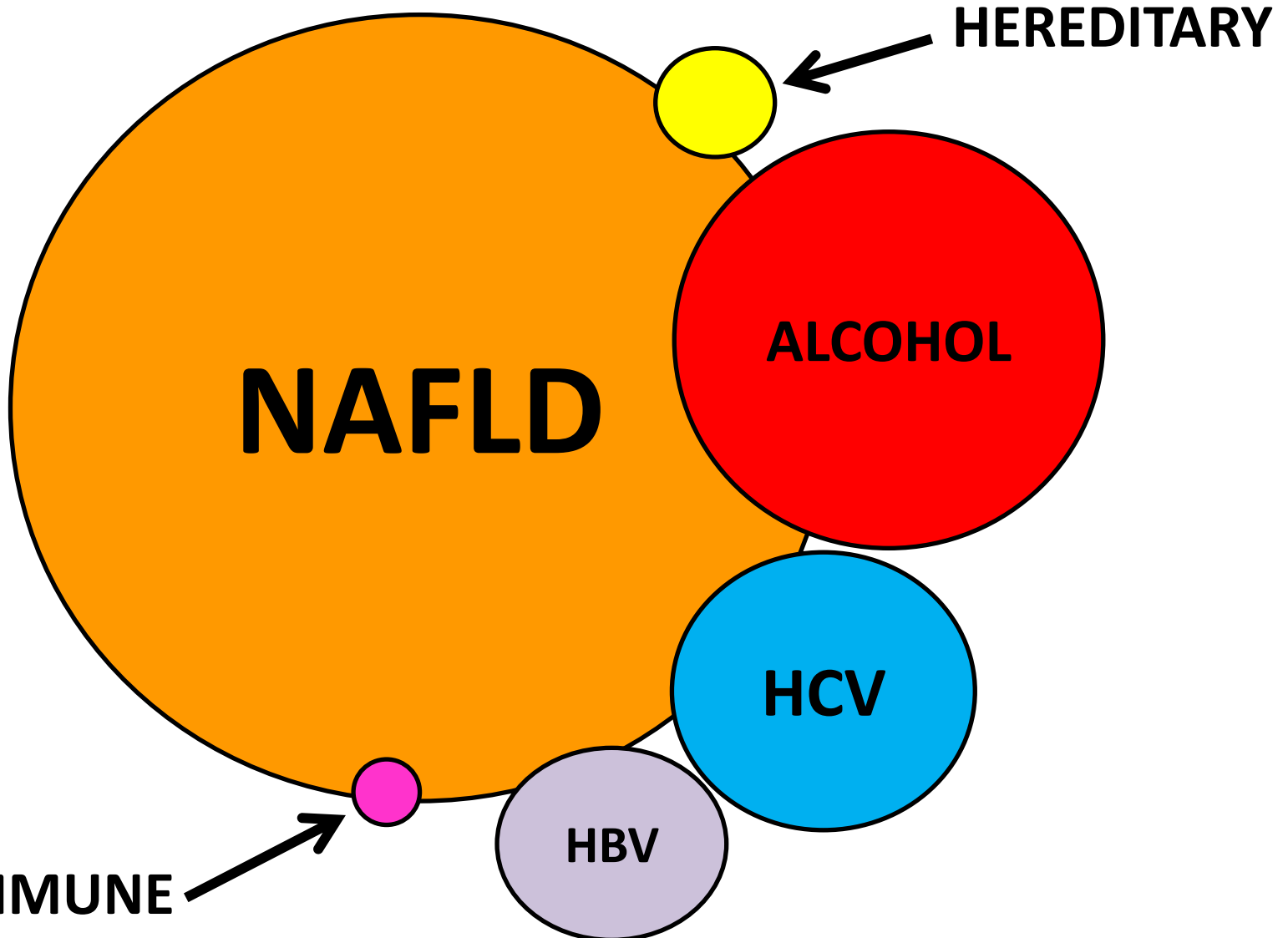
*Fatty Liver disease
(NAFLD/NASH)*



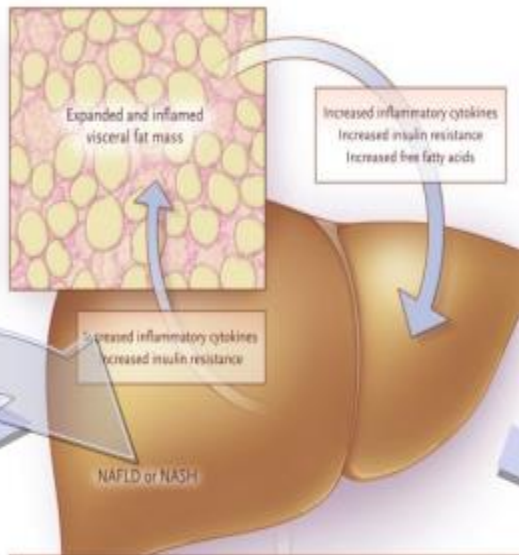
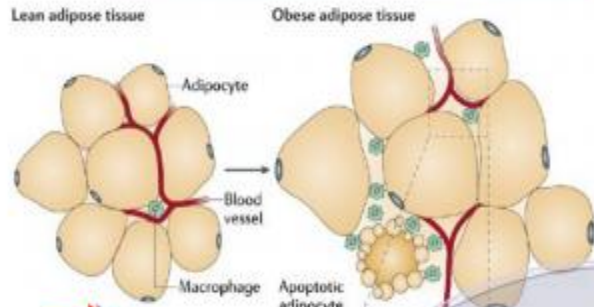
The Hepatology Menu - 2017



The Hepatology Menu - 2030



Weight gain →



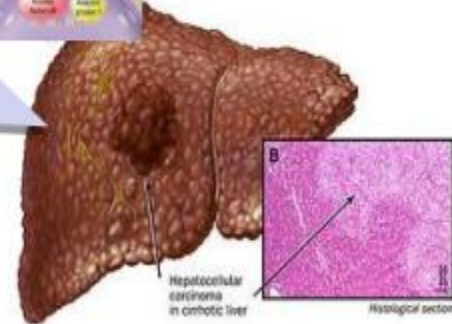
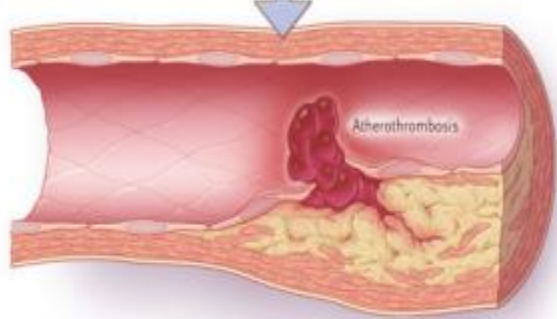
- ↑ Insulin
- ↑ Hepatocyte proliferation
- ↑ ROS damage
- ↑ Hepatocyte turnover

Chronic inflammation
 (e.g., increases in C-reactive protein, interleukin-6, tumor necrosis factor α , and other acute-phase proteins)

Hypercoagulation and hypofibrinolysis
 (e.g., increases in fibrinogen, factor VII, plasminogen activator inhibitor 1, and other coagulation factors)

Atherogenic dyslipidemia
 (e.g., increased triglycerides, decreased HDL cholesterol, increased small, dense LDL cholesterol, postprandial lipemia)

Dysglycemia and (hepatic) insulin resistance



- Genotype
- Maldpt. Resp.
- Soft drinks
- Fructose
- Smoke
- Ageing
- Obesity/ T2DM
- Met Syndrome
- Sedentary lifestyle
- Poor dietary habits



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 Nature Reviews | Immunology

Targher G et al. NEJM 2010
 Miele L et al. Gastroenterology 2008
 Miele L et al. Hepatology 2009
 Miele L et al. J Hepatol 2009
 Miele L et al. Am J Gastro 2003
 Miele L et al. Gut 2001
 Beale G, Miele L et al. BMC Cancer 2009
 Targher G, Miele L et al. Sem Thromb Haemostasis 2008

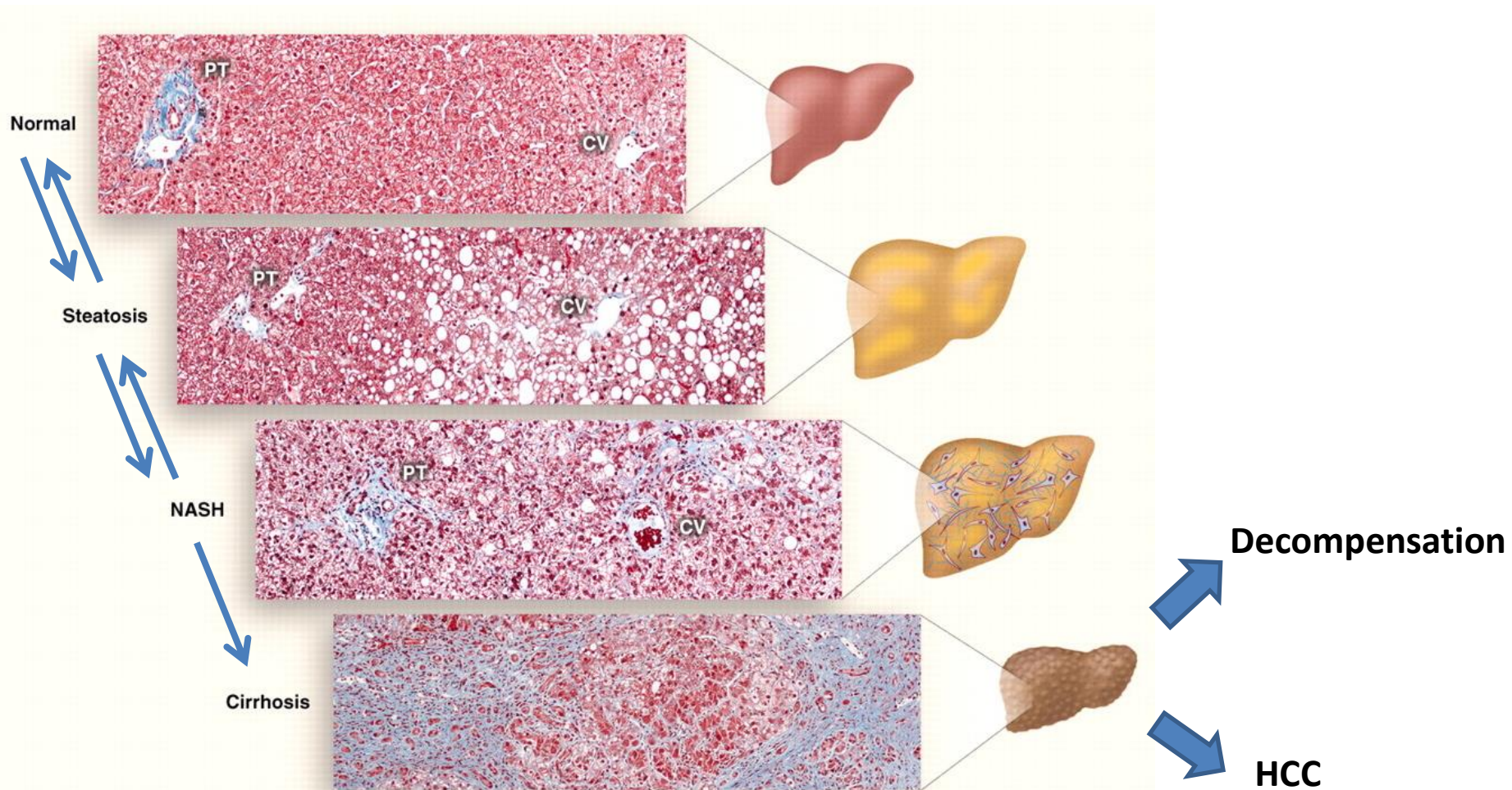
LIVER STEATOSIS

Accumulation of fat within the liver as a non-specific response to a wide variety of etiologies.

Conditions Associated with Fatty Liver			
Most Common	Common	Rare	Congenital
Alcohol overuse Insulin resistance Obesity Hyperlipidemia	Viral infection <u>Hepatitis C</u> <u>Hepatitis B</u> Drug use <u>Steroids</u> Chemotherapeutic agents Amiodarone Valproic acid	Nutritional or dietary abnormality Total parenteral nutrition <u>Rapid weight loss</u> <u>Starvation</u> Surgery (eg, jejunio-ileal bypass) Iatrogenic injury Radiation therapy	Monogenic disorders Metabolic disorders Fatty oxidation defect Organic aciduria Aminoacidopathy Storage disorders Glycogen storage disorder α_1 -Antitrypsin deficiency <u>Wilson disease</u> <u>Hemochromatosis</u> Other Cystic fibrosis Dysmorphic syndromes associated with obesity Bardet-Bridel Prader-Willy

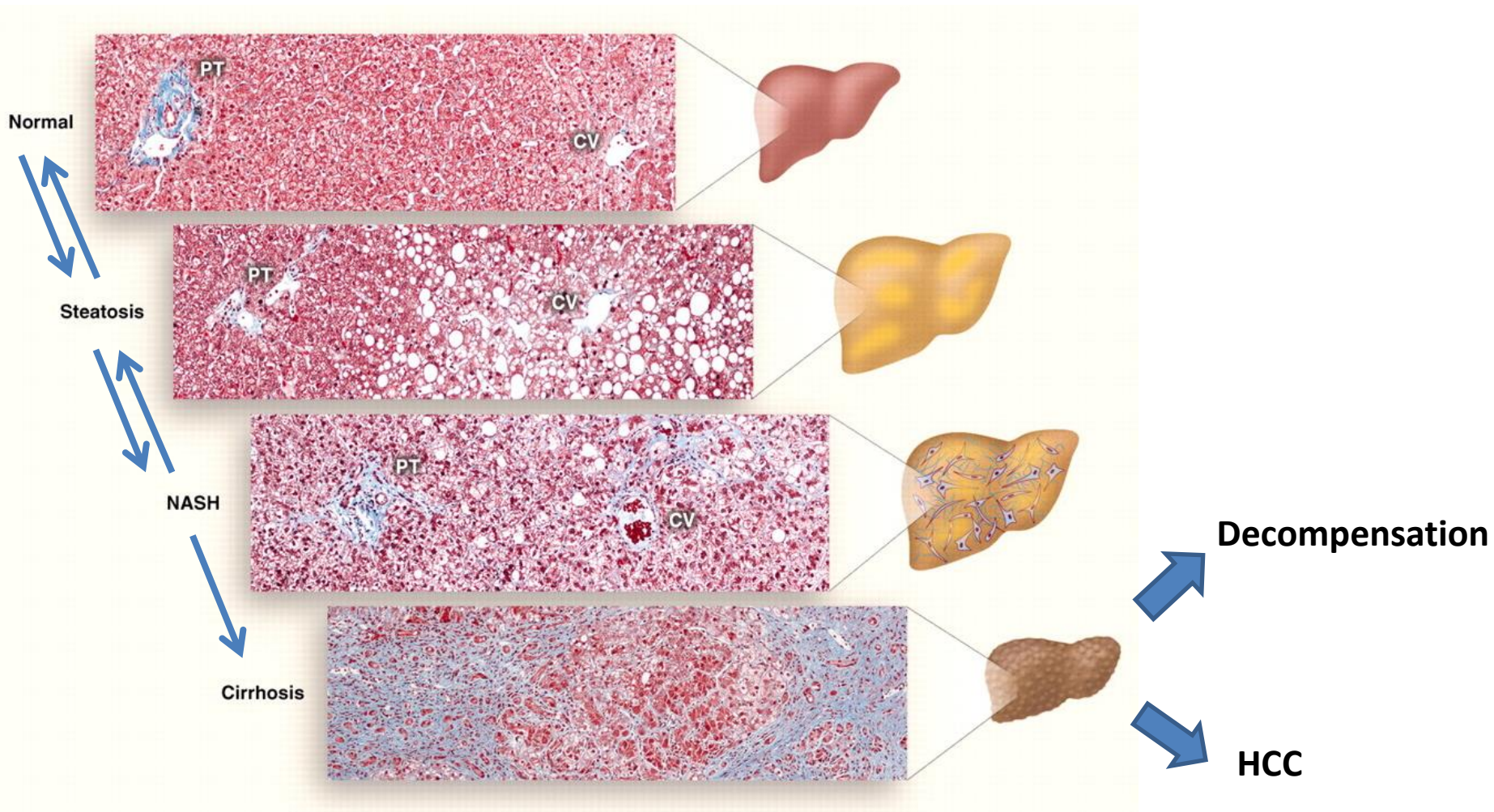
NAFLD

Non-Alcoholic Fatty Liver Diseases

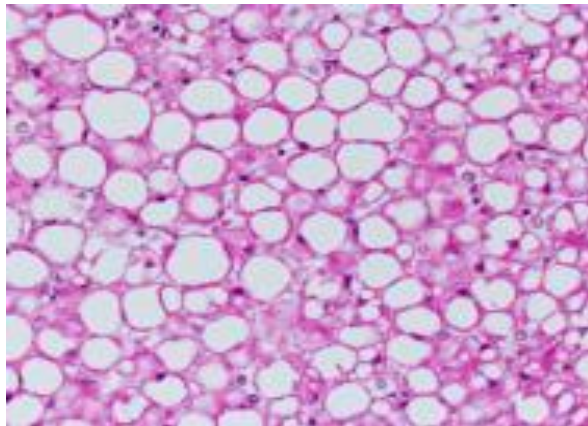


NAFLD

Non-Alcoholic Fatty Liver Diseases



LIVER STEATOSIS



□ The diagnosis can be made histologically when more than 5% of hepatocytes contain fat as lipid vacuoles in the cytoplasm.

□ When the fat accumulated into the liver affects over 20-25% of hepatocytes it can be sonographically detected as an increased echogenicity of liver parenchyma.

Clinical US in Liver Steatosis

In liver steatosis three different features can influence its sonographic appearance:

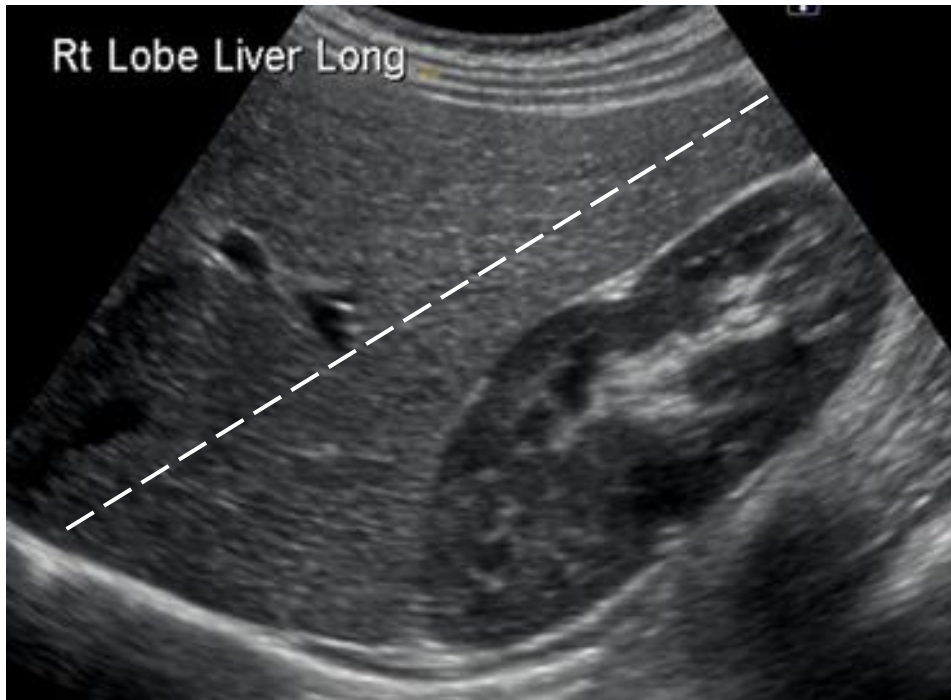
1. The size of the liver
2. The amount of fat in the liver
3. The distribution of fat in the liver

Clinical US in Liver Steatosis

In liver steatosis three different features can influence its sonographic appearance:

1. The size of the liver
2. The amount of fat in the liver
3. The distribution of fat in the liver

Clinical US in Liver Steatosis



**Longitudinal Right lobe = 17 cm
(n.v. \leq 15 cm)**

Usually the **right lobe** of the liver is enlarged and the liver **margins** are **rounded**

Clinical US in Liver Steatosis

In liver steatosis three different features can influence its sonographic appearance:

1. The size of the liver
2. The amount of fat in the liver
3. The distribution of fat in the liver

Clinical US in Liver Steatosis

Amount of fat

3 grades of liver steatosis can be sonographically described according to the appearance of **liver echogenicity, liver-kidney contrast, gallbladder wall, vessels and diaphragm**

✓ **Grade 1** or mild steatosis

↑ Ultrasound beam reflection

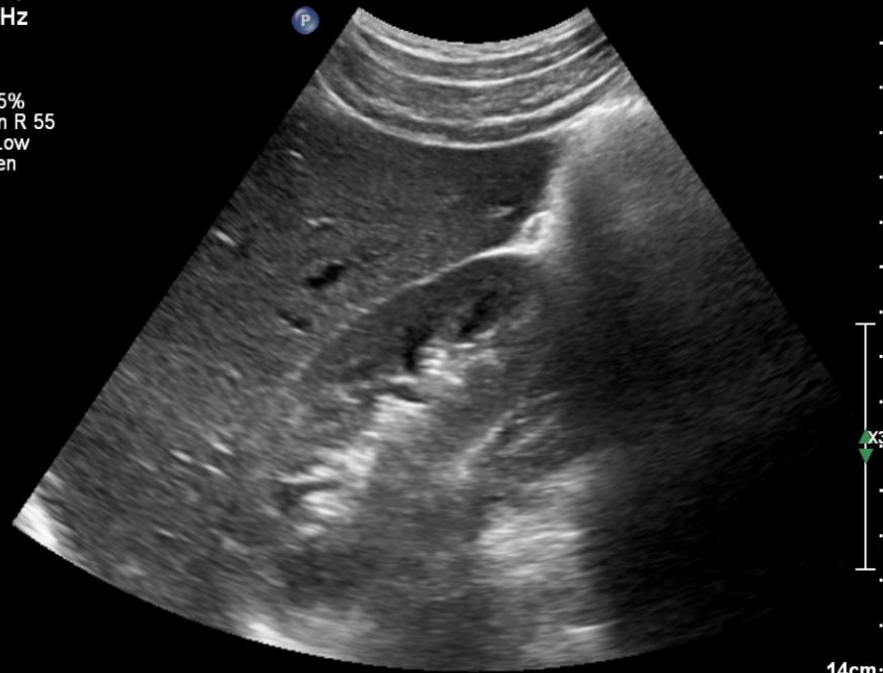
✓ **Grade 2** or moderate steatosis

↑ Ultrasound beam attenuation

✓ **Grade 3** or severe steatosis

↑↑ Ultrasound beam attenuation

Abd Gen
C5-1
35Hz
RS
2D
65%
Dyn R 55
P Low
Gen



TIS0.5 MI 0.8
FR 28Hz
RS
2D
42%
C 57
P Low
HRes



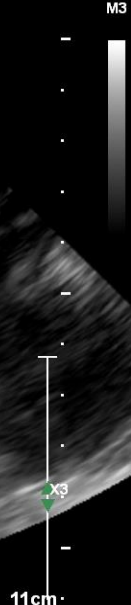
Abd Gen
C5-1
40Hz
RS
2D
62%
Dyn R 55
P Low
Gen



TIS0.5 MI 0.8
Abd Gen
C5-1
43Hz
RS
2D
61%
Dyn R 55
P Low
Gen



TIS0.5 MI 0.8
M3



Clinical US in Liver Steatosis

Grade 1 or mild steatosis

Diffuse increase in the echogenicity of liver tissue (**bright liver**) compared to the echogenicity of the right renal cortex (**liver-kidney contrast**). Normal visualization of diaphragm, gallbladder wall, hepatic veins contour and lumen, portal branches walls

Abd Gen
C5-1
31Hz
RS

TIS0.3 MI 1.3

2D
63%
Dyn R 55
P Low
HGen

P

M3

- 0

- 5

- 10

- 15

X3



Abd Gen
C5-1
31Hz
RS

TIS0.3 MI 1.3

2D
63%
Dyn R 55
P Low
HGen



M3

- 0

- 5

- 10

- 15

Abd Gen
C5-1
31Hz
RS

1150.3 MI 1.2

P

M3

2D
68%
Dyn R 55
P Low
HGen



16cm

Clinical US in Liver Steatosis

Grade 2 or moderate steatosis

Further increased brightness with reduced visualization of hepatic veins contour and lumen, portal branches walls, gallbladder wall.

Diaphragm remains still well defined.

ELASTPQ

TIS0.1 MI 1.3

C5-1
31Hz
RS

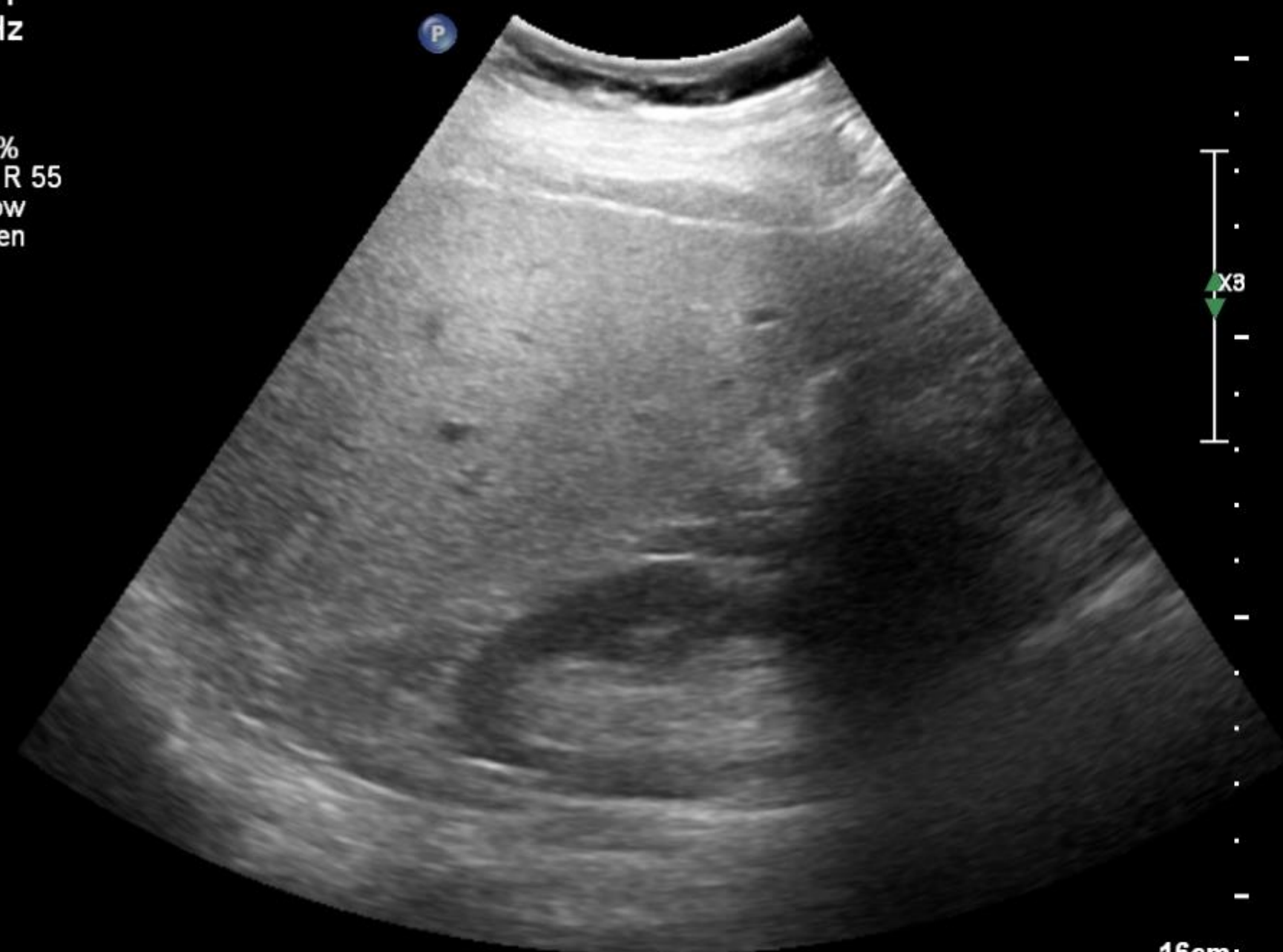
P

M3

2D
75%
Dyn R 55
P Low
HGen



16cm



ELASTPQ
C5-1
31Hz
RS

TI 0.1 MI 1.3

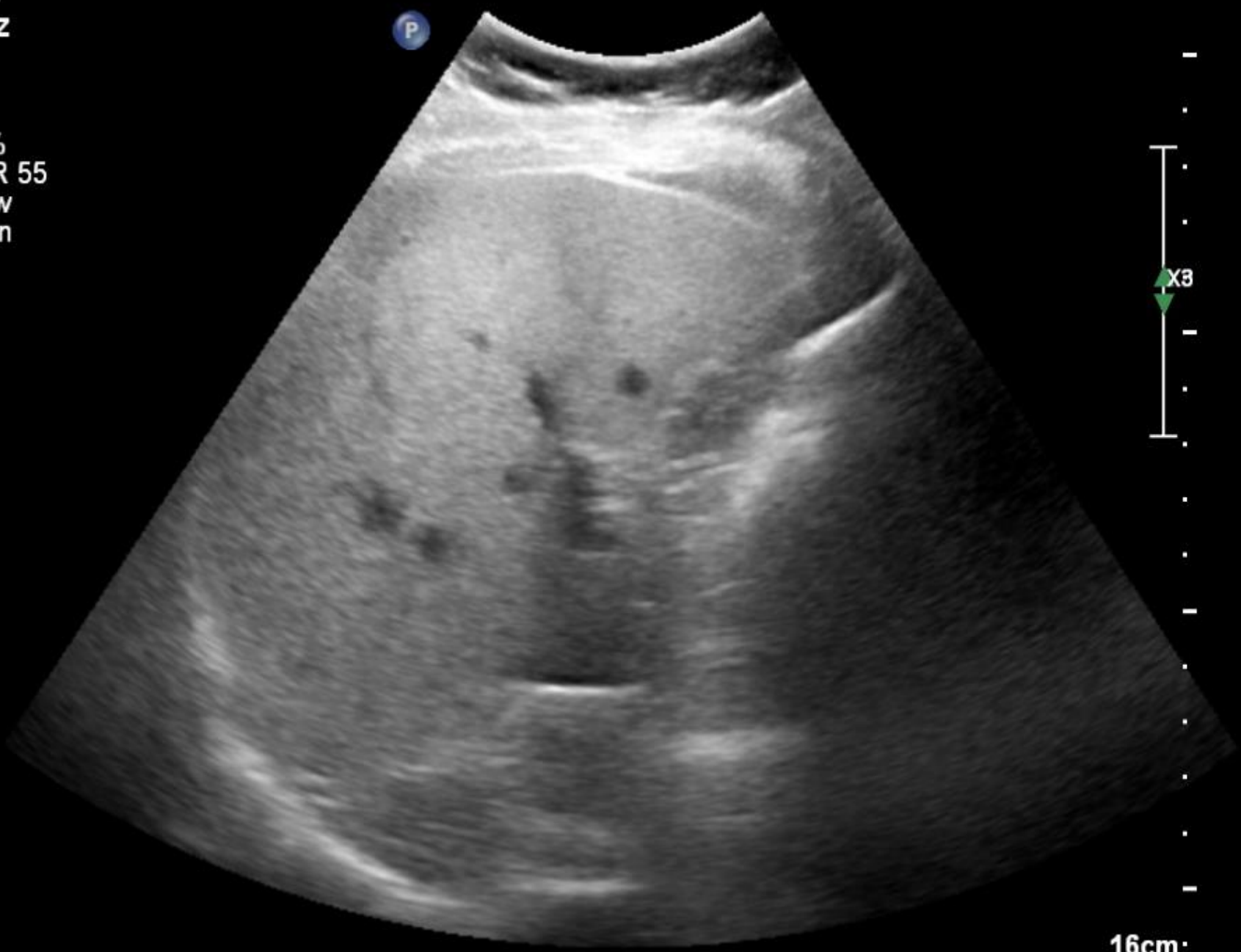
M3

2D
75%
Dyn R 55
P Low
HGen

P



16cm



Abd Gen
C5-1
29Hz
RS

1150.9 MI 0.9

M3

P

2D
65%
Dyn R 55
P Low
Gen



18cm

Clinical US in Liver Steatosis

Grade 3 or severe steatosis

The attenuation of ultrasound beam does not allow to visualise the diaphragm profile.

ELASTPQ

TIS0.1 MI 1.3

C5-1
24Hz
RS

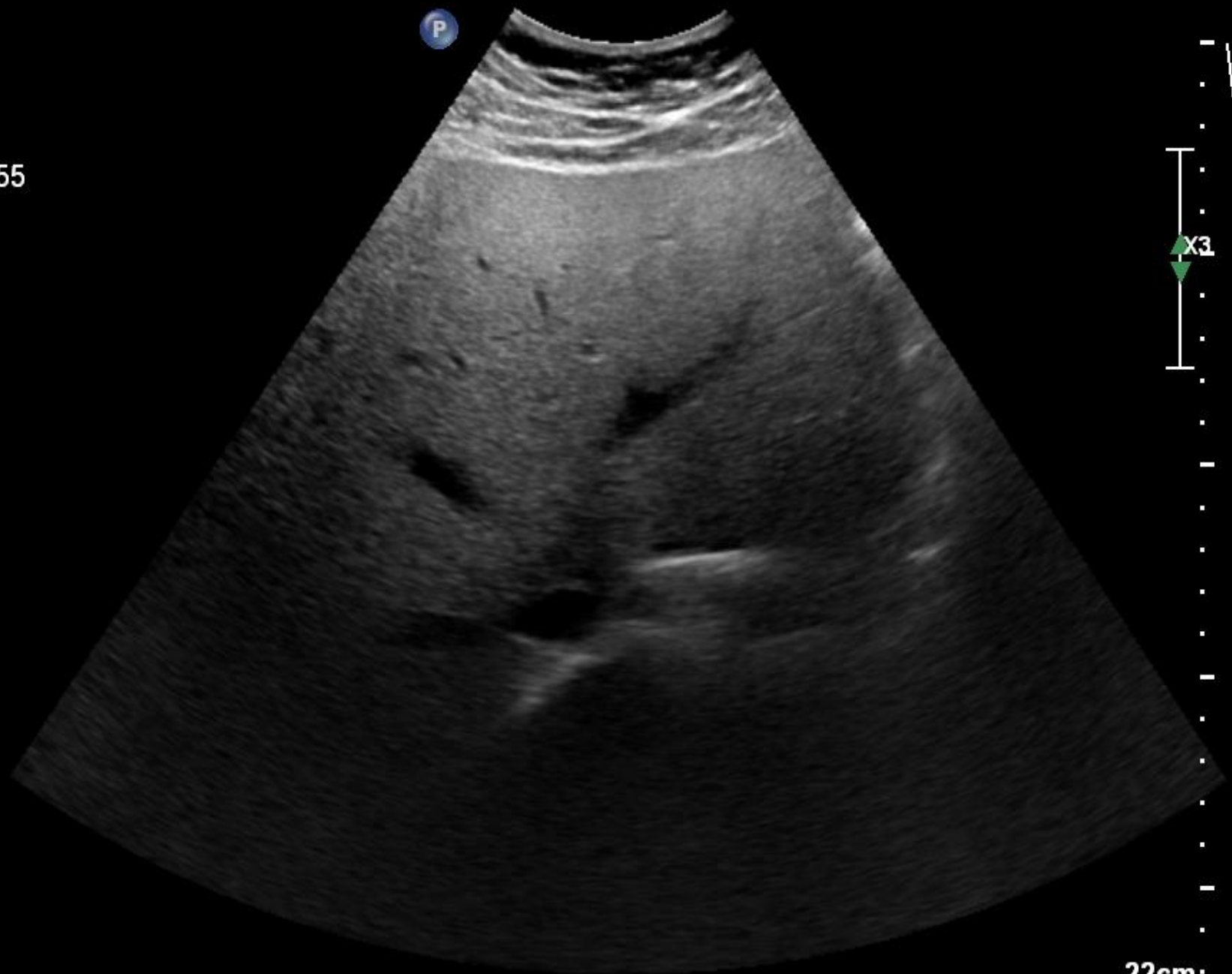
P

2D
75%
Dyn R 55
P Low
HGen

M3

x3

22cm



ELASTPQ

TISO.1 MI 1.3

C5-1
24Hz
RS

P

M3

2D
75%
Dyn R 55
P Low
HGen



22cm



ELASTPQ

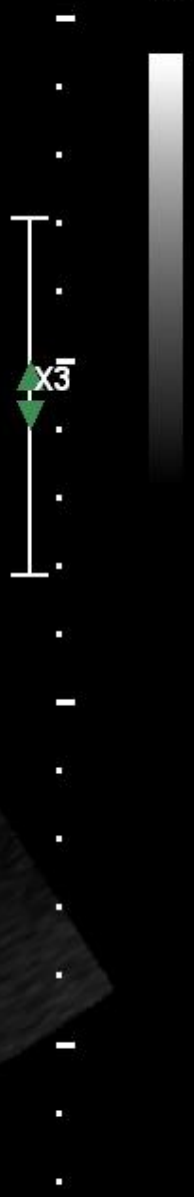
TIS0.1 MI 1.3

C5-1
28Hz
RS

P

M3

2D
70%
Dyn R 55
P Low
HGen



18cm



ELAST PQ

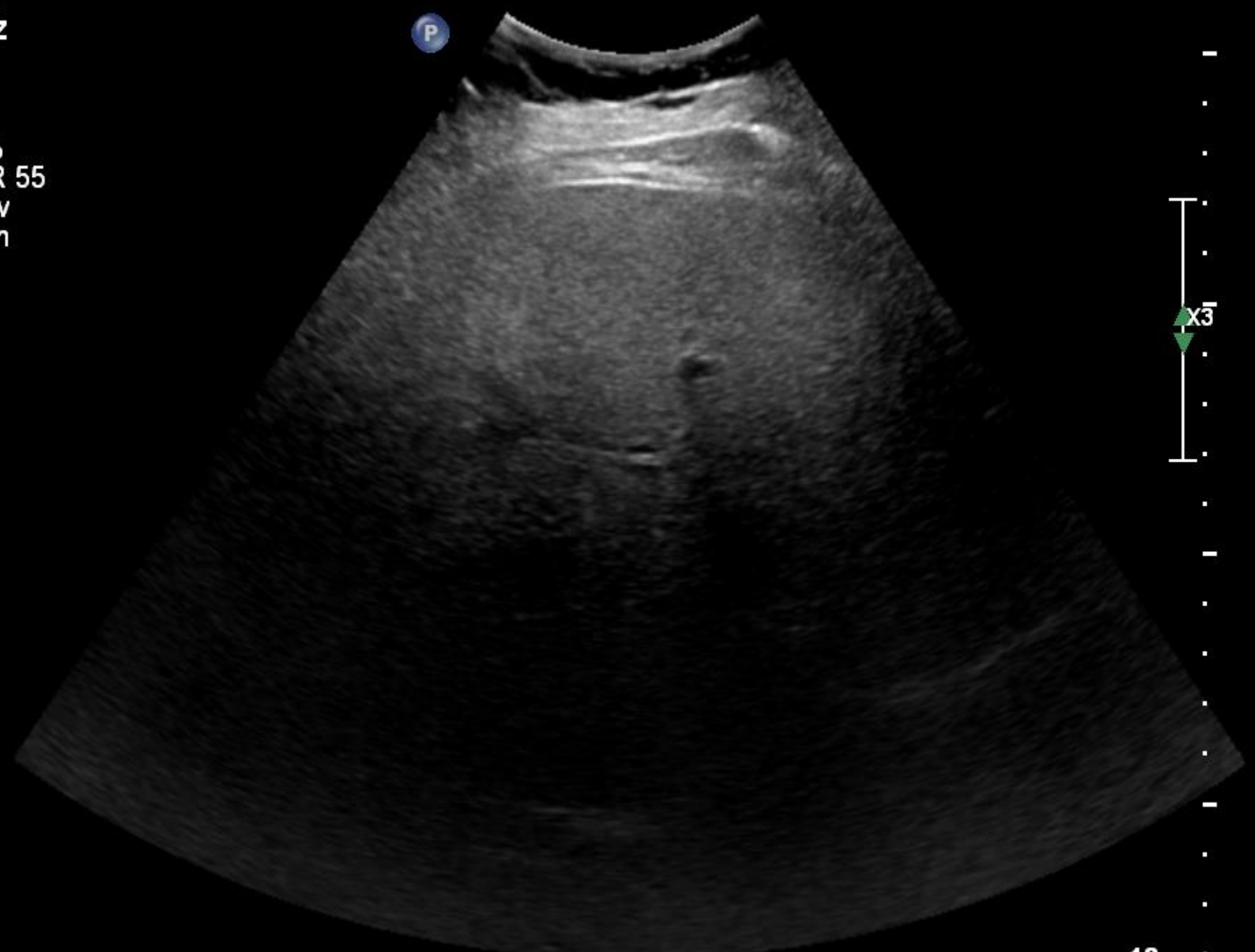
1150.1 MI 1.3

C5-1
28Hz
RS

P

M3

2D
70%
Dyn R 55
P Low
HGen



18cm

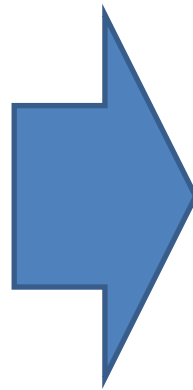
Clinical US in Liver Steatosis

Grade 3 or severe steatosis

In this case the deep liver segments cannot be appropriately assessed and **focal liver lesions can potentially be missed.**

Clinical US in Liver Steatosis

Grade 3 or severe steatosis



**In case of HCC surveillance
an enhanced second-level
imaging (CT or MRI) are
strongly advised**

Clinical US in Liver Steatosis

In liver steatosis three different features can influence its sonographic appearance:

1. The size of the liver
2. The amount of fat in the liver
3. The distribution of fat in the liver

Clinical US in Liver Steatosis

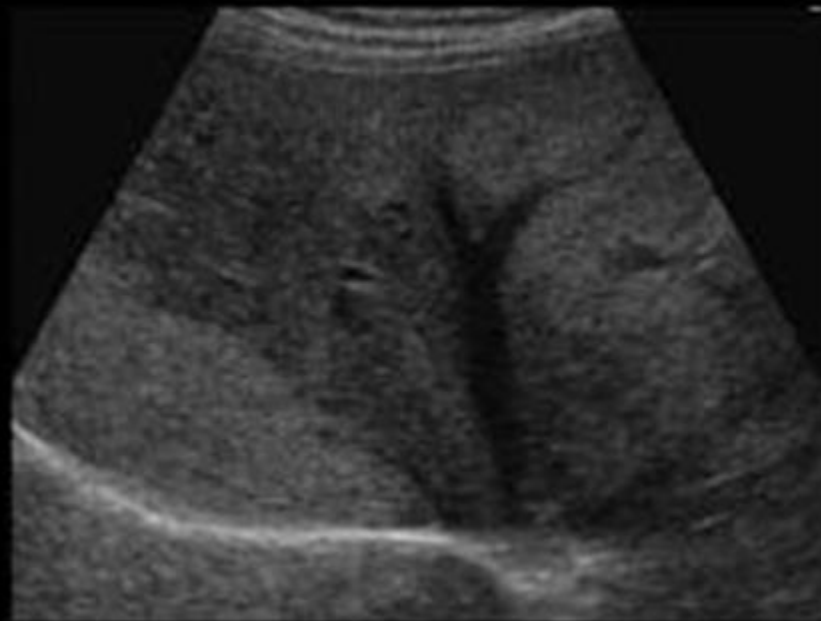
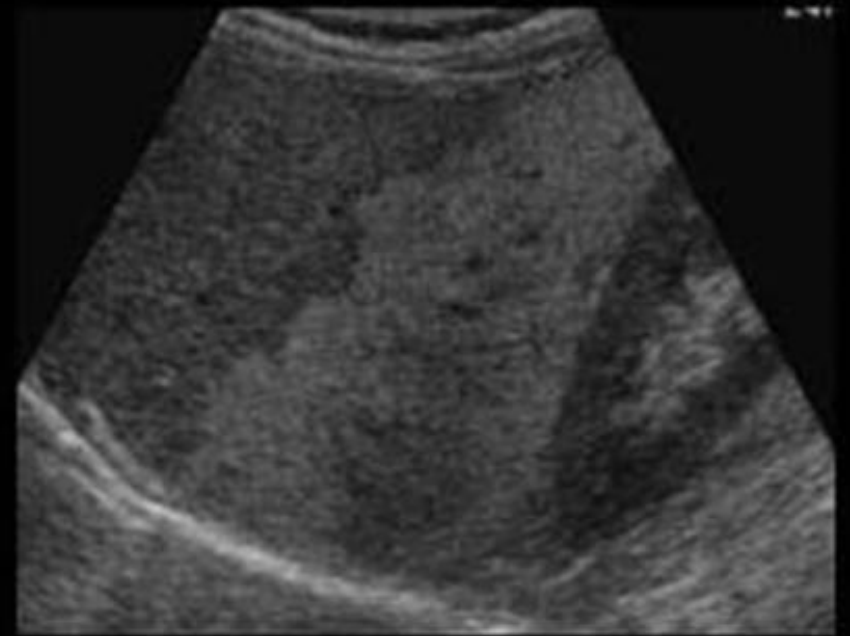
Distribution of fat

- ✓ Geographic Fatty Liver
- ✓ Focal fatty sparing area
- ✓ Focal fatty infiltration area

Clinical US in Liver Steatosis

Distribution of fat

- ✓ **Geographic Fatty Liver**
- ✓ Focal fatty sparing area
- ✓ Focal fatty infiltration area



The fat has an **irregular distribution** within the liver with large areas giving to the liver a **geographic appearance**

Clinical US in Liver Steatosis

Distribution of fat

- ✓ Geographic Fatty Liver
- ✓ Focal fatty sparing area
- ✓ Focal fatty infiltration area



They may mimic focal liver lesions (haemangioma, FNH, adenoma, HCC, metastasis).

Clinical US in Liver Steatosis

Distribution of fat

- ✓ Geographic Fatty Liver
- ✓ Focal fatty sparing area
- ✓ Focal fatty infiltration area

Clinical US in Liver Steatosis

Distribution of fat

□ Typical distribution:

- around the gallbladder
- porta hepatis and portal bifurcation
- below the liver capsule
- adjacent to the falciform ligament

□ Typical sonographic features:

- small hypoechoic areas
- irregular contour
- sharp angulated boundaries and interdigitation with the normal tissue
- absence of mass effect (no vessel displacement-distortion-encasement, no bulging effect of gallbladder and liver capsule)



**Differential diagnosis
with tumours**

ELASTPQ

TIS0.1 MI 1.3

C5-1
31Hz
RS

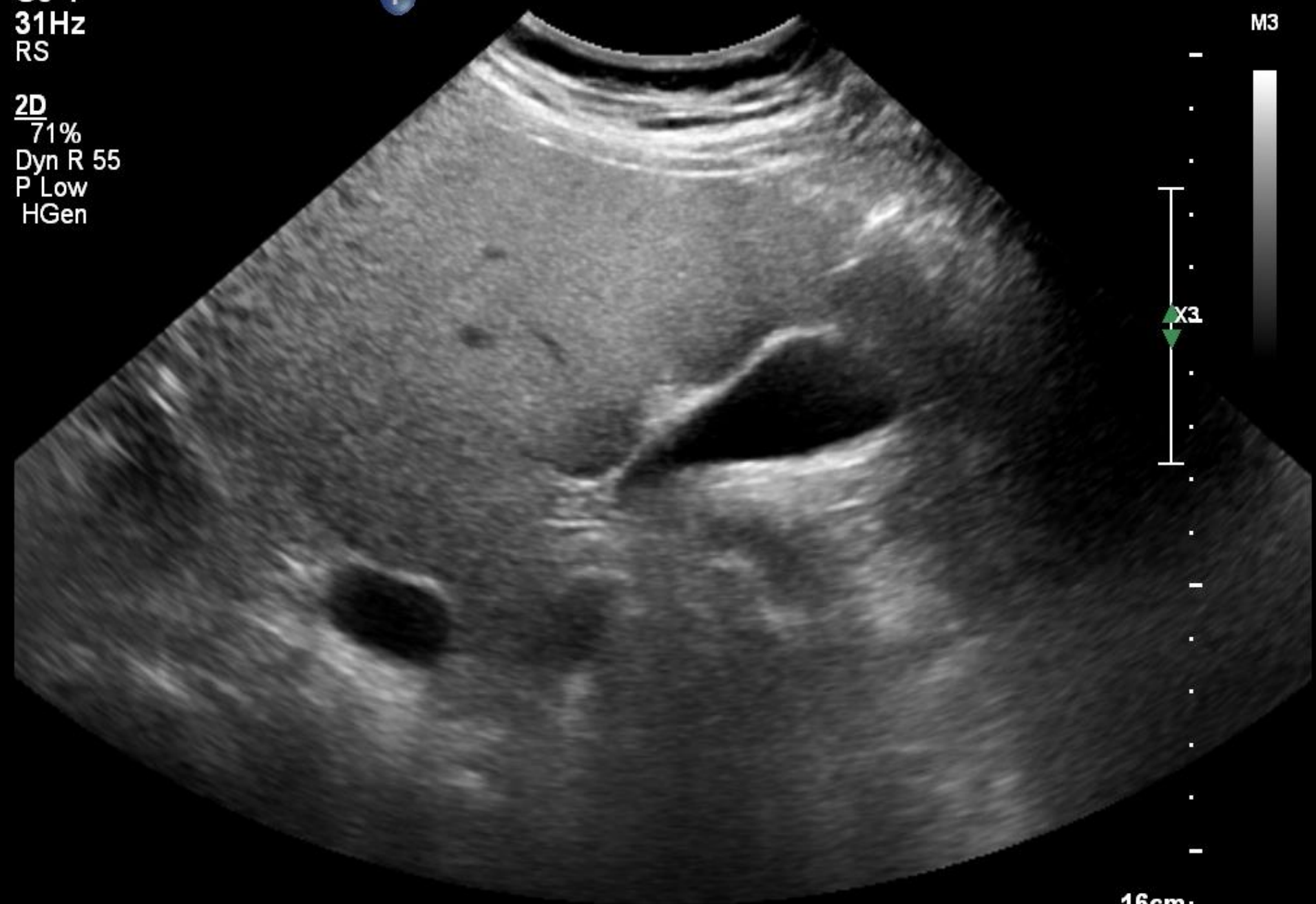
P

M3

2D
71%
Dyn R 55
P Low
HGen



16cm



Abd Gen

TIS 0.5 MI 0.8

C5-1
35Hz
RS

P

M3

2D
65%
Dyn R 55
P Low
Gen

X3

14cm



Abd Gen

C5-1

35Hz

RS

2D

65%

Dyn R 55

P Low

Gen

TISO.5 MI 0.8

P

M3

X3

14cm



Clinical US in Liver Steatosis

Distribution of fat

- ✓ Geographic Fatty Liver
- ✓ Focal fatty sparing area
- ✓ Focal fatty infiltration area

Clinical US in Liver Steatosis

Distribution of fat

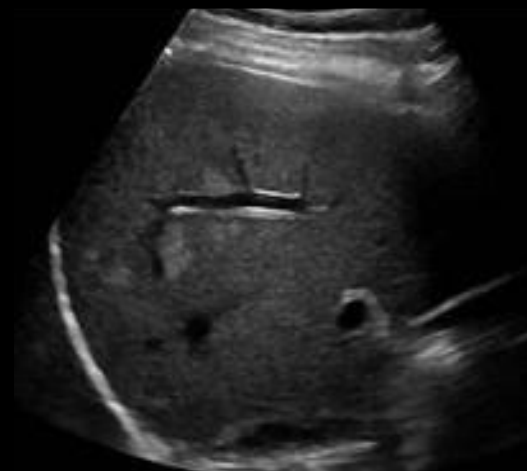
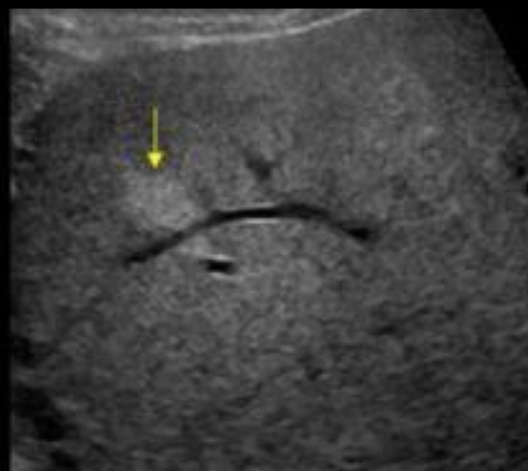
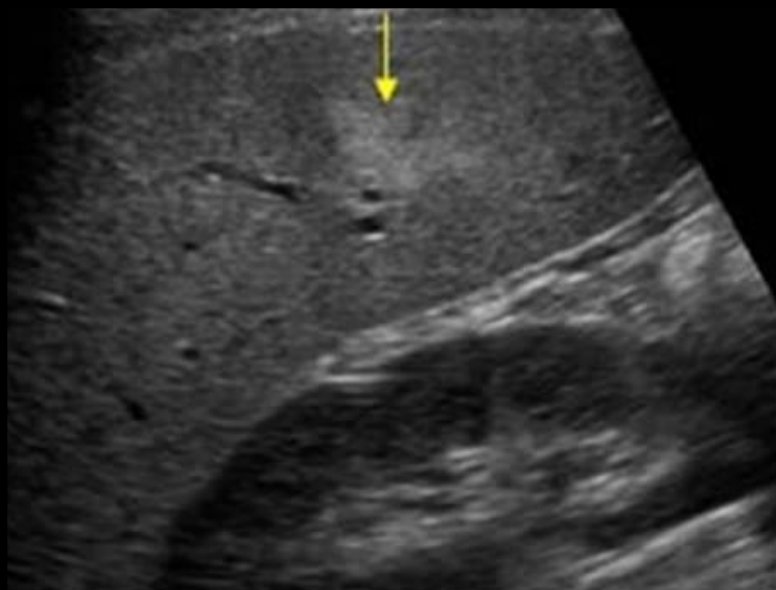
No typical distribution:

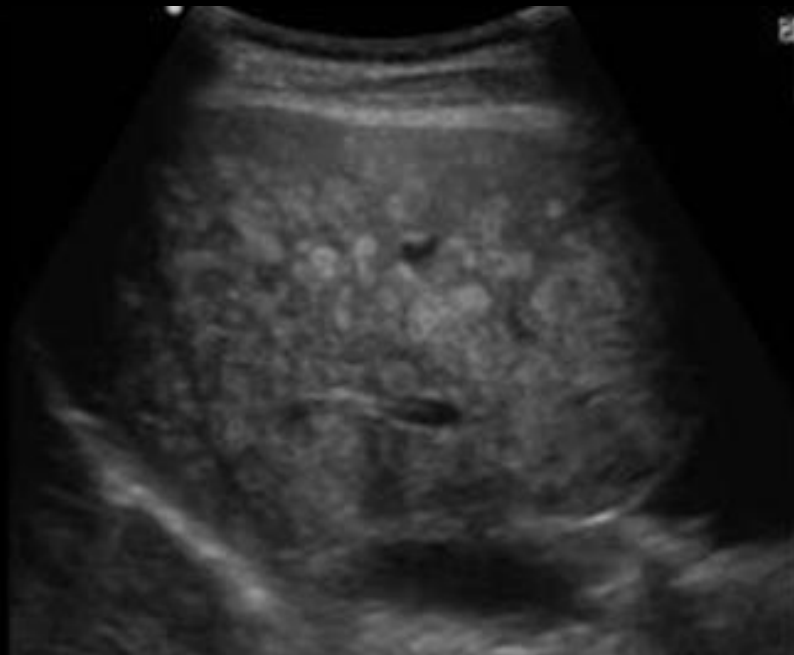
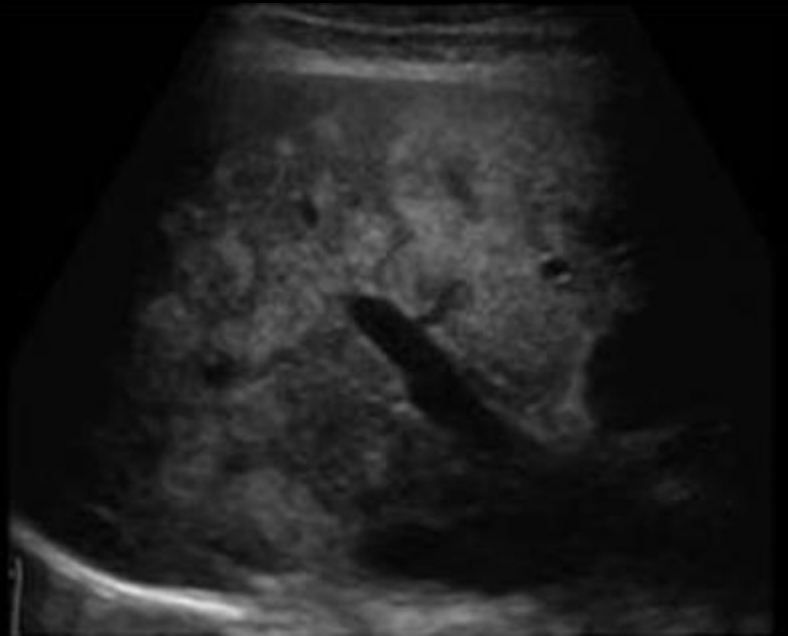
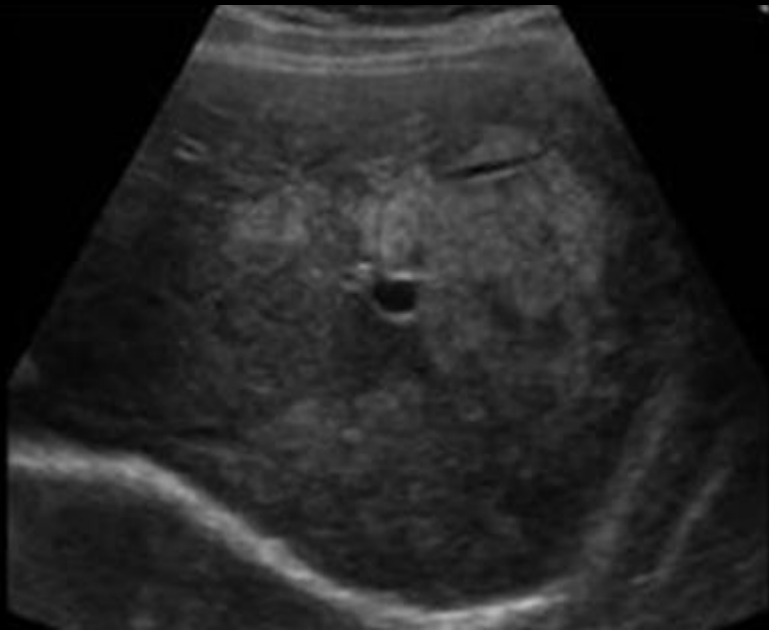


Typical sonographic features:

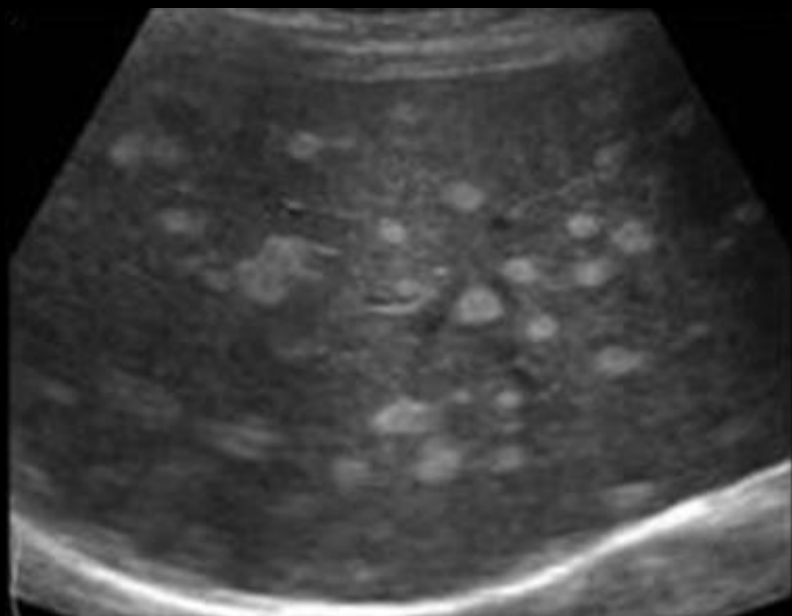
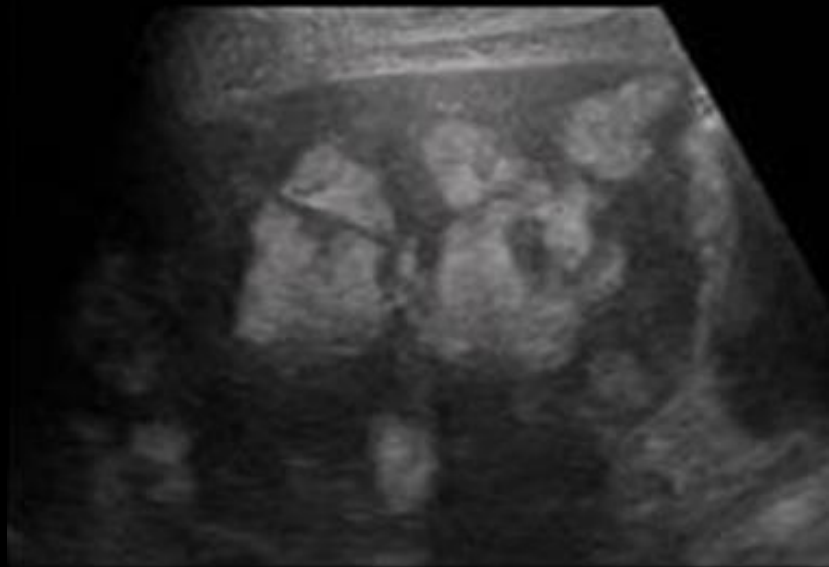
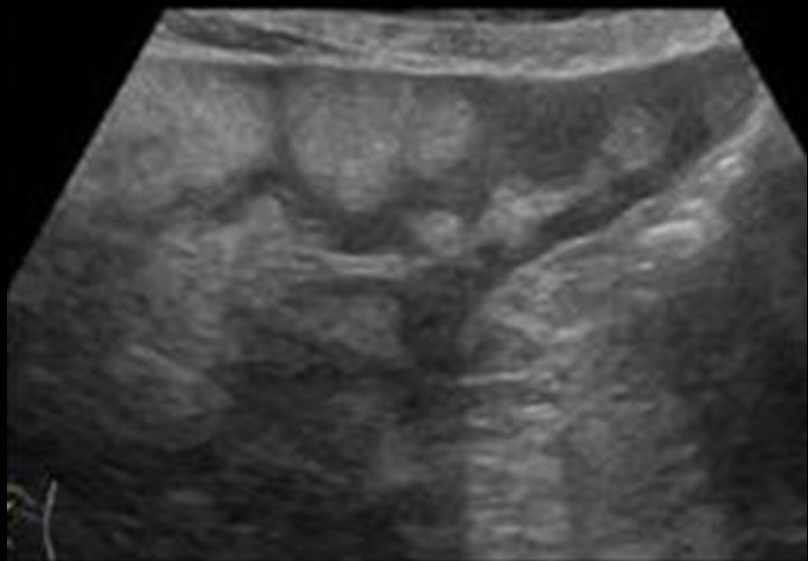
- small hyperechoic areas
- irregular contour
- sharp angulated boundaries and interdigitation with the normal tissue
- absence of mass effect (no vessel displacement-distortion-encasement, no bulging effect of gallbladder and liver capsule)

**Differential diagnosis
with tumours**





21



Abd Gen

TIS0.3 MI 1.3

C5-1
31Hz
RS

2D
61%
Dyn R 55
P Low
HGen

P

M3

- 0

- 5

- 10

- 15

x3



Abd Gen

TIS0.3 MI 1.2

C5-1
35Hz
RS

P

M3

2D
59%
Dyn R 55
P Low
HGen



Abd Gen
C5-1
28Hz
RS

2D
63%
Dyn R 55
P Low
HGen

P

TIS0.2 MI 1.3



0
5
10
15
*** bpm

Clinical US in Liver Steatosis

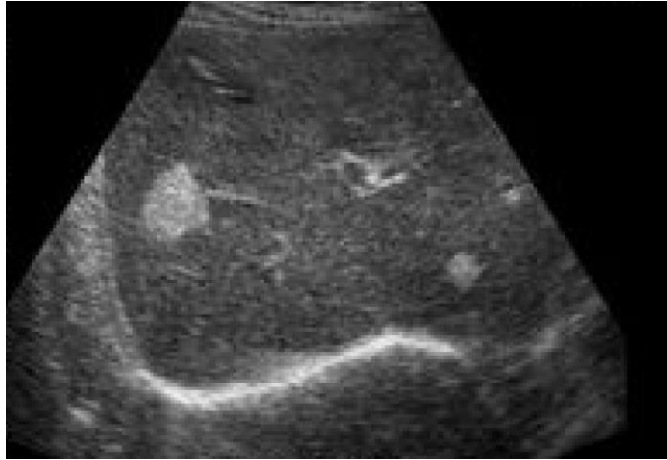
Distribution of fat



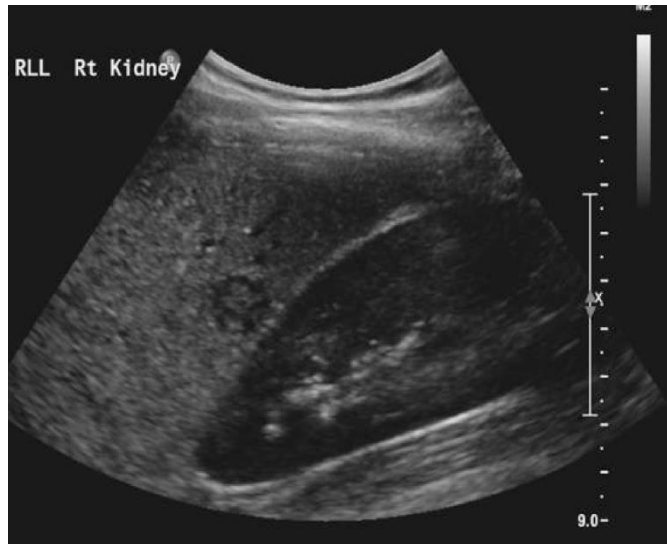
An enhanced second-level imaging (CEUS, CT or MRI) is strongly recommended



Clinical US in Liver Steatosis



The hepatic steatosis may change the expected appearance of a sonographic finding.



For example a hepatic haemangioma which is typically hyperechoic may become hypoechoic on the background of hepatic steatosis.

TAKE HOME MESSAGES

- ❑ Ultrasound is useful for assessing and staging liver steatosis, and identifying different patterns of fat distribution
- ❑ Severe steatosis with high posterior attenuation can potentially “cover” an underlying focal lesion.
- ❑ Focal fatty sparing/infiltration areas may mimic a focal liver lesion (haemangioma, adenoma, HCC) and sometimes the differential diagnosis may be difficult. In this case an enhanced second level imaging is strongly advised

THANK YOU

