



THE BRITISH MEDICAL ULTRASOUND SOCIETY



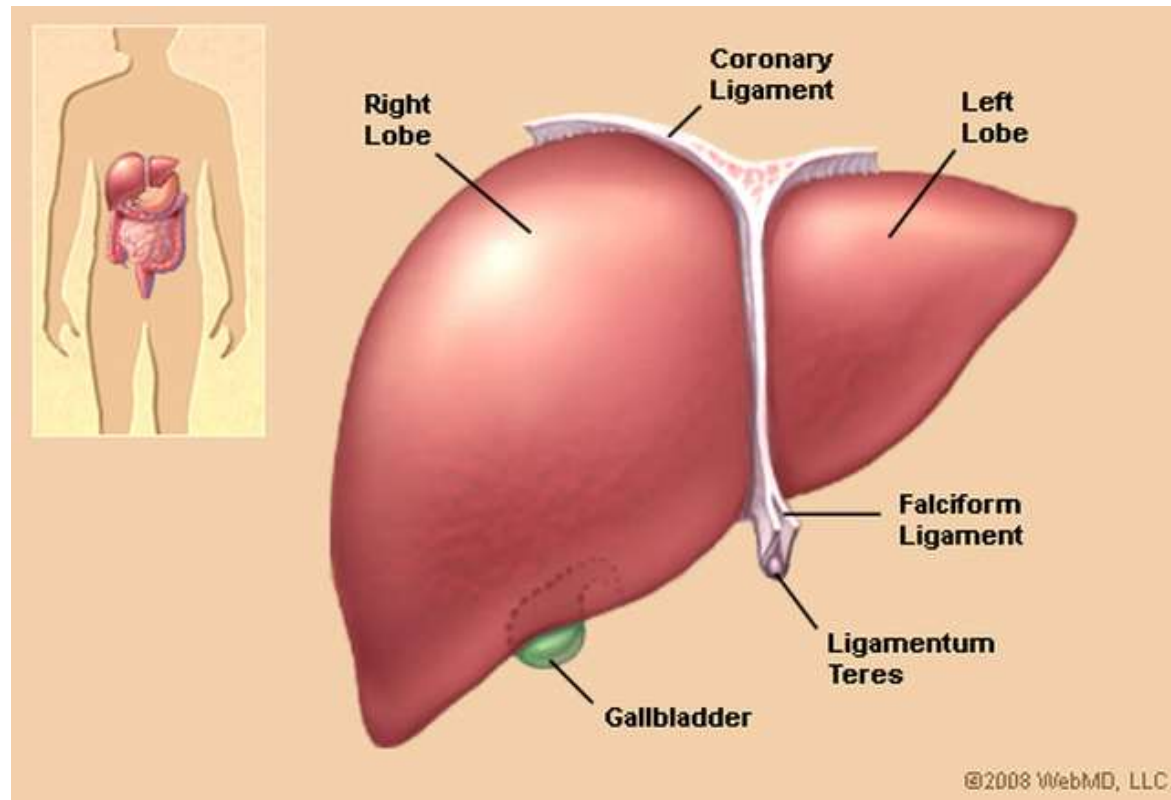
# Chronic Liver Disease: The Role of Ultrasound

Dr Pamela Parker  
Consultant Sonographer

# Aims

- Review what we know about the liver
- Diffuse disease
- HCC Surveillance
- Reporting
- Test your skills

# The Liver



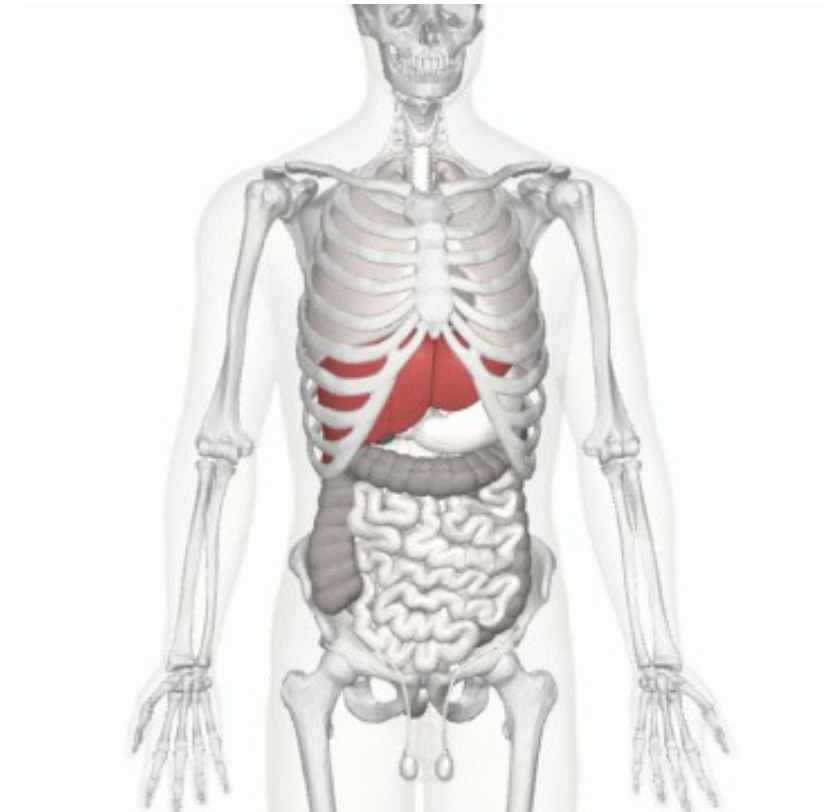
# The Liver

The liver has a wide range of functions:

- accessory digestive gland and produces bile
- detoxification
- protein synthesis
- production of biochemicals necessary for digestion
- a role in metabolism,
- regulation of glycogen storage
- decomposition of red blood cells
- hormone production

# The Liver

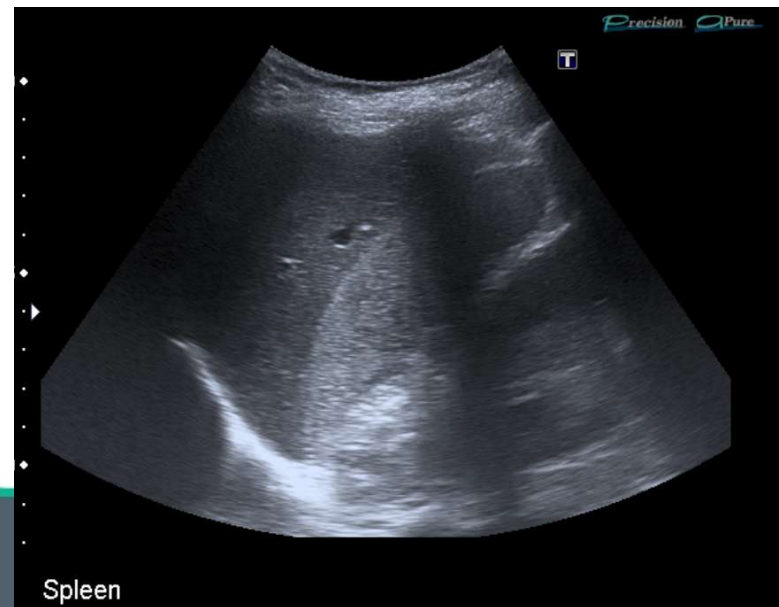
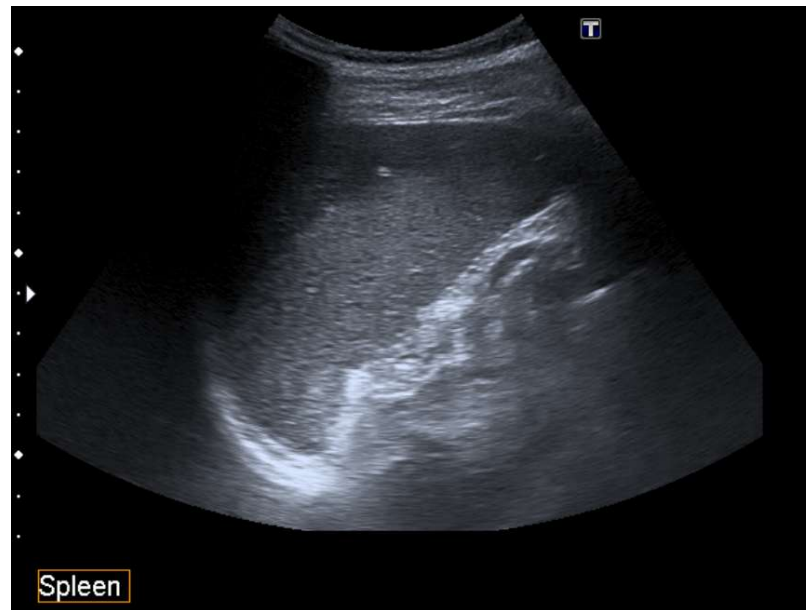
- Weighs approximately 1.5 kg
- Holds approximately 13% (0.57 litres) of total blood supply
- Non-palpable
- LLL may extend across spleen
- Riedels lobe of RLL



# Normal Variants

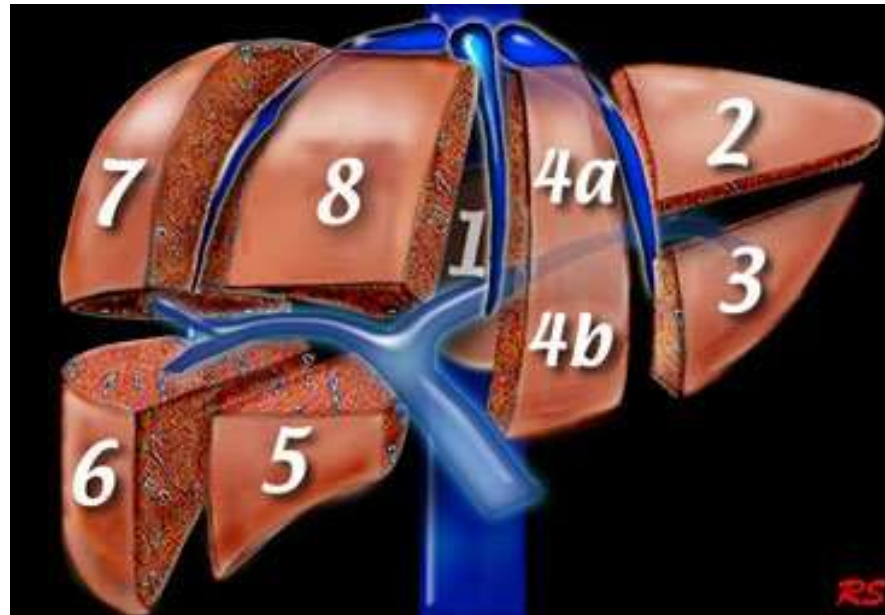


Remarkable people.  
Extraordinary place.



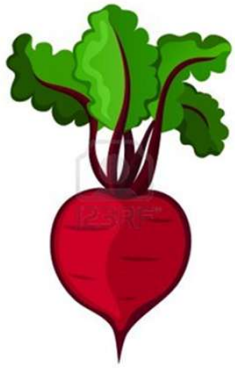
# Liver anatomy

- Eight independent segments
- Their own vascular inflow, outflow, and biliary drainage.



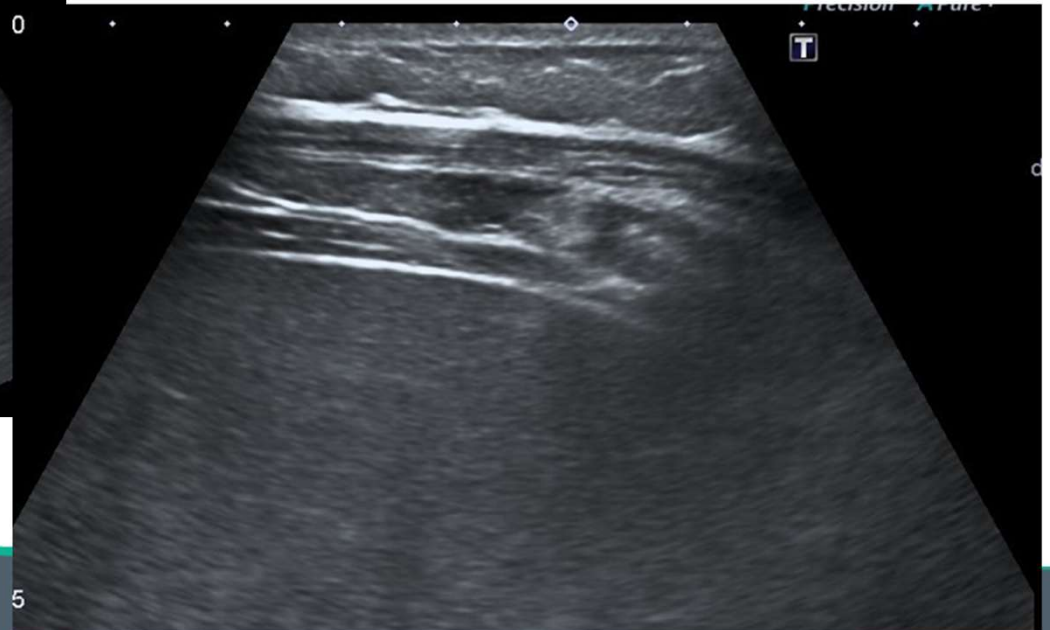
# Reasons to be scanning the liver

- **Diffuse disease**
  - **Fatty liver**
  - **Cirrhosis/ fibrosis**
  - **HCC Surveillance**
- Focal disease
  - Malignant/ benign
- Biliary disease
  - Gallstones
  - Obstruction
- Vascular disease
  - Complications of other processes (cirrhosis, cardiac)
  - Primary vascular disease (thrombosis, occlusion)
- **Reassure the patient there is no disease**



**R**  
Extraordinary place.

# Beetroot - Normal



**Remarkable people.**  
**Extraordinary place.**

# Burger – hyperechoic & diffuse



Remarkable people.  
Extraordinary place.

# Booze – heterogenous & nodular



Remarkable people.  
Extraordinary place.

# What is Liver Disease?

Liver disease occurs when the liver is damaged or its function is disrupted, which can happen gradually over time or, in rare cases, suddenly.

Chronic liver disease often progresses through stages, including hepatitis (inflammation), fibrosis (scarring), cirrhosis (severe scarring), and eventually liver failure



# Liver Disease

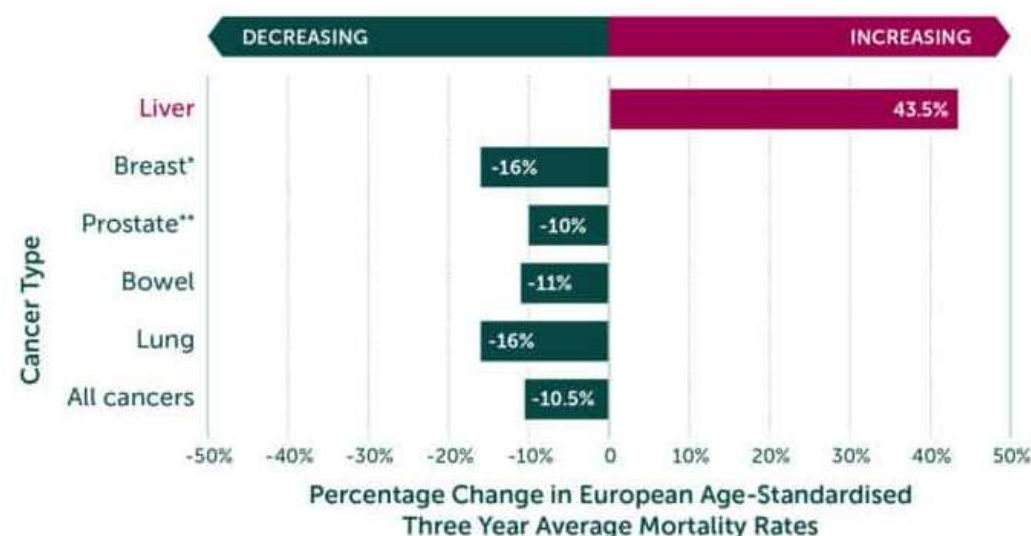
- Most recent statistics indicate half a million adults in the UK already have cirrhosis
- 10 – 20% of the UK population are at risk of liver disease
- In the 40 -49 years age group 1 in 10 deaths are due to liver disease, mostly alcoholic liver disease
- Increasing number of individuals with the complications which result from end-stage liver disease

# Liver Disease

- Liver disease is the only major cause of death still increasing year-on-year
- Liver disease is the fifth 'big killer' in England & Wales, after heart, cancer, stroke and respiratory disease
- Deaths from liver disease are predicted to double in 20 years.
- Liver disease kills more people than diabetes and road deaths combined

<http://www.britishlivertrust.org.uk/about-us/media-centre/facts-about-liver-disease/>

## Cancer Mortality



# The Real Problem

- Reported incidence is likely an underestimation of the true scale of the problem given that early disease, often asymptomatic and therefore undiagnosed
- An American study of asymptomatic patients, US was performed with subsequent liver biopsy in those found to have a fatty liver.
- This revealed that **59.4%** had either MASLD or MASH

# What Causes Liver Disease?

**Viral infections:** Hepatitis A, B, C, D, and E can inflame and damage liver tissue

**Alcohol consumption:** Excessive or long-term alcohol use can lead to alcohol-associated liver disease, including fatty liver, hepatitis, and cirrhosis

**Metabolic conditions:** Obesity, diabetes, and metabolic dysfunction-associated steatotic liver disease (MASLD) can cause fat accumulation and liver inflammation

**Genetic or inherited disorders:** Some liver diseases are passed through families – PSC, PBC, haemochromatosis

**Toxins and medications:** Certain drugs, chemicals, or environmental toxins can damage liver cells

# Healthy Lifestyles

- Many of the underlying risk factors for liver disease; obesity, hepatitis C, hepatitis B and alcoholism are preventable but still all increasing in incidence

(National End of Life Care Intelligence Network, 2012).



# Not A Chance!

- World Health Organisation reports an alcohol use disorder rate of 16.3%, (8.7% dependence) in males
- 6.0% alcohol use disorder (3.2% dependence) in females in the UK.
- UK average alcohol use disorder and dependence are both higher than equivalent European

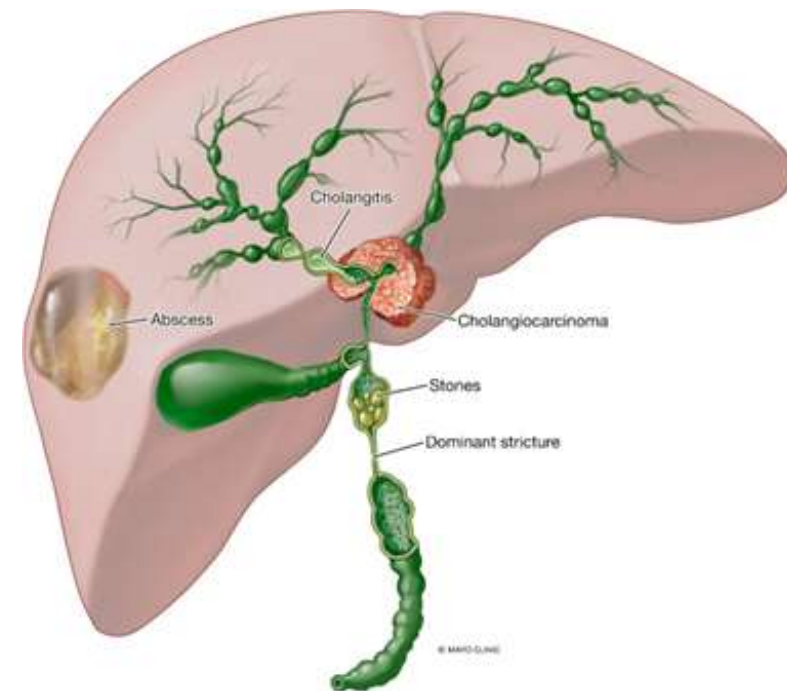


# Alcohol and Liver Disease

- The process is silent, but when liver disease has developed it presents as an acute illness with a **25-50% immediate mortality.**
- There are over 800,000 hospital admissions directly related and attributable to alcohol each year.
- The cost to the NHS of alcohol misuse has been estimated at £2.7 billion each year.

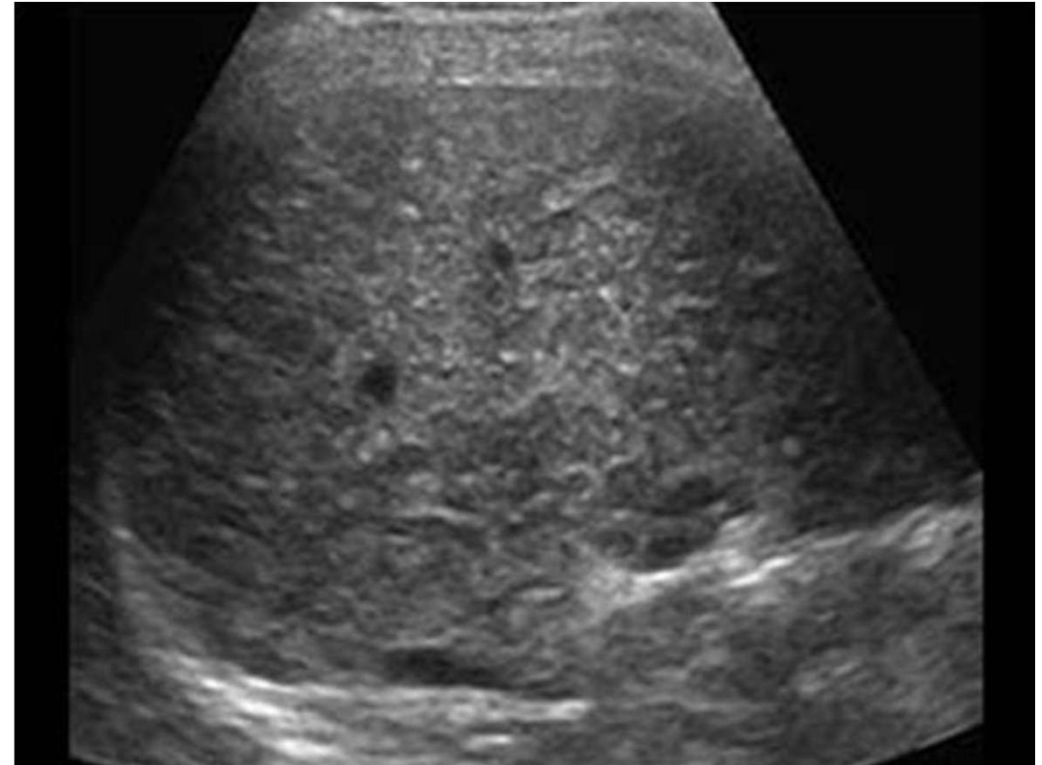
# Primary Sclerosing Cholangitis

- Primary Sclerosing Cholangitis is an uncommon chronic liver disease in which the bile ducts inside and outside the liver progressively decrease in size due to inflammation and scarring (fibrosis).
- The disease may occur alone but frequently is associated with inflammatory diseases of the colon, especially chronic ulcerative colitis.



# Identifying disease

- Imaging is performed to identify normality / evidence of disease
- Not a disease in its own right but a process
- Diffuse fatty infiltration
- The normal liver tissue is replaced by fibrous bands of tissue which creates nodules.



# What's in a name?

**MASLD, NAFLD and fatty liver disease** are different names for the same condition

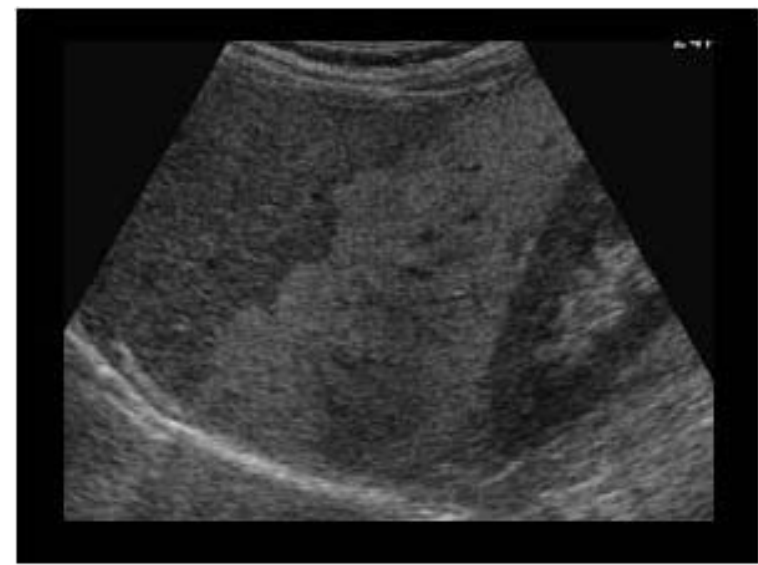
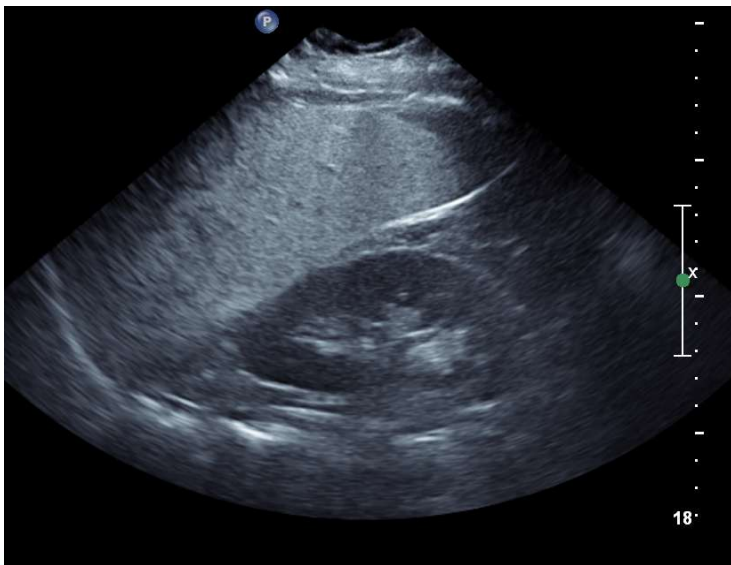
Metabolic dysfunction-associated steatotic liver disease (**MASLD**) is a long-lasting liver condition caused by having too much fat in the liver. It is closely linked with being overweight as well as conditions such as type 2 diabetes and heart and circulatory disease.

Metabolic dysfunction-associated steatohepatitis (**MASH**, previously called NASH) is a more serious stage of MASLD. In a small number of people, it can lead to liver cancer or liver failure.



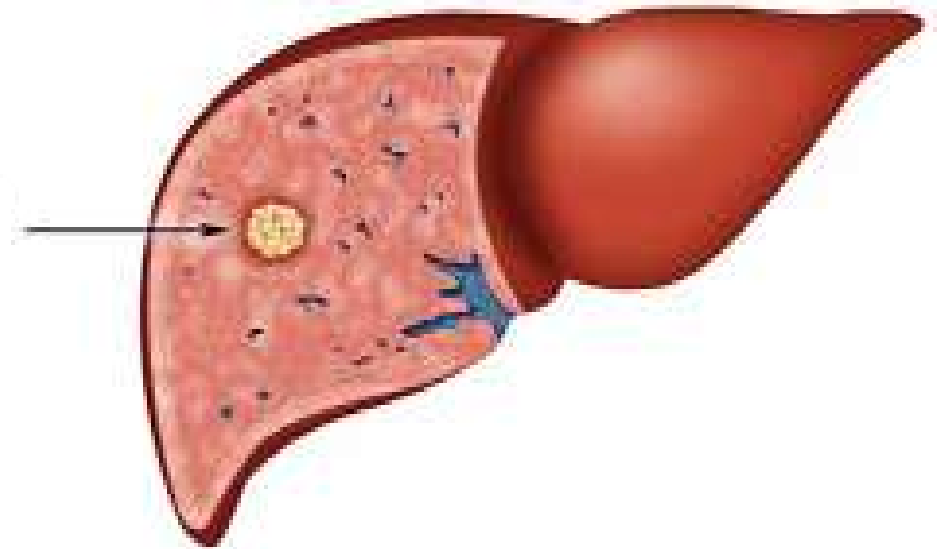
# Diffuse disease

- MASLD / Fatty liver
  - Affect 1 in 5
  - 10% risk of Hepatocellular carcinoma (HCC)



# Serial Assessment

- Prevalence of liver disease has risen by 400% in the last 40 years, and cirrhosis is the key risk factor for future development of liver cancer.
- Prevention and early detection of cirrhosis and liver cancer is more effective across the board in the long term, than waiting for people to present with advanced cancer or liver failure, hence the significant investment from NHS England, Cancer Alliance and others to invest in liver cancer detection.



# HCC surveillance: minimum standards

## Principles of hepatocellular carcinoma surveillance

- Patients suitable for hepatocellular carcinoma (HCC) surveillance should be invited to **6-monthly ultrasound scans**.
- Ultrasound scans should be performed by an appropriately trained sonographer or radiologist.
- Alpha-fetoprotein (AFP) can be considered as part of HCC surveillance, unless there are patients not suitable for blood testing.
- Surveillance leads should regularly audit their service and compare outcomes with comparable services.

Figure 1: patient pathway

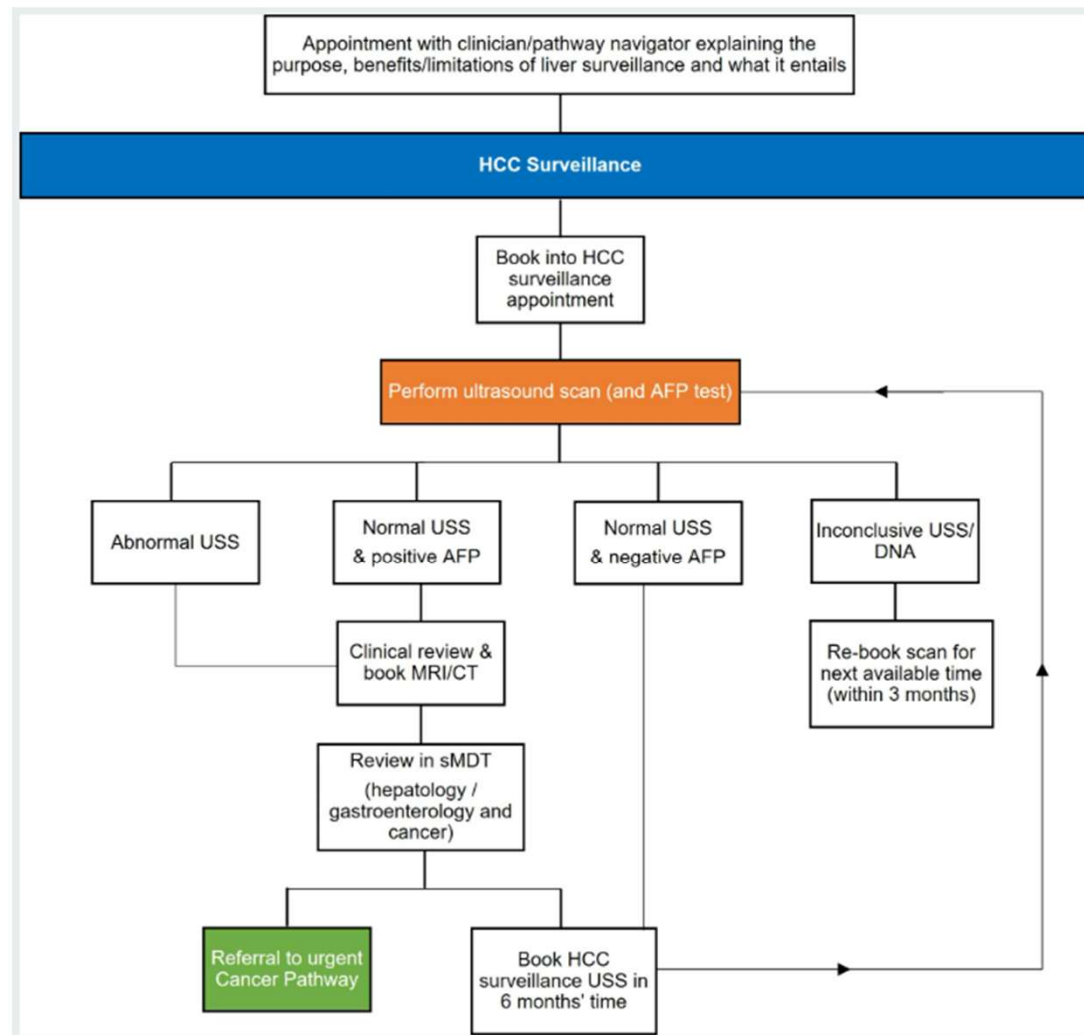


Figure 1 above is the patient pathway for hepatocellular carcinoma (HCC) surveillance. The sequence follows a pathway from enrolment in HCC surveillance and the onward journey once ultrasound has taken place.

# Exclusion criteria for HCC surveillance

Surveillance is not recommended in patients who are not fit for cancer specific therapy.

Examples include:

- those with decompensated cirrhosis who would not be candidates for liver transplant if hepatocellular carcinoma was diagnosed (Child-Pugh B8 or worse)
- those with very impaired performance status

## Child-Pugh Scoring for Cirrhosis

Points →	1	2	3
Total bilirubin, mg/dL	<2	2-3	>3
Serum albumin g/L	>35	28-35	<28
Prothrombin time INR	<1.7	1.7-2.2	>2.2
Ascites	None	Mild	Severe
Hepatic encephalopathy	None	Grade 1/2	Grade 3/4

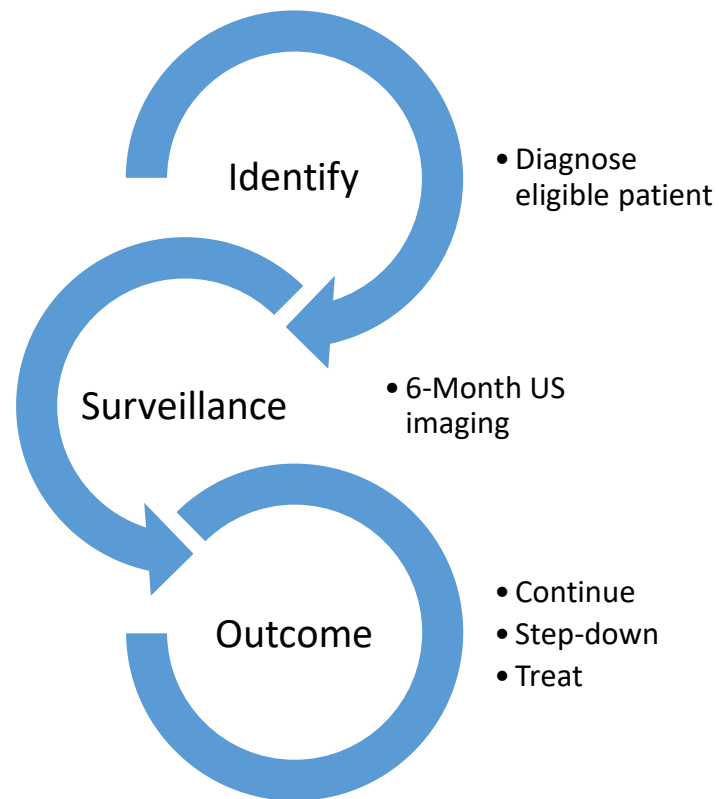
Class	Points	Surgical Risk	1-yr Survival
A	5-6	Good	90%
B	7-9	Moderate	80%
C	10-15	Poor	45%

# HCC: delivering quality ultrasound surveillance

16 minimum standards

- All HCC US surveillance episodes should be requested under a dedicated imaging procedure code for HCC US surveillance (USRLV: US Surveillance liver hepatocellular Carcinoma)
- HCC US surveillance services should have a nominated lead radiologist and sonographer responsible for supporting training, service delivery and quality assurance.
- Imaging during HCC US surveillance examinations should focus on identifying HCC and the complications of liver disease
- Documentation of US surveillance examinations should use a standardised, structured report, including the Liver Imaging Reporting and Data System (LI-RADS), US surveillance or equivalent classification [ACR Liver Imaging Reporting & Data System \(LI-RADS®\)](#)

# HCC Surveillance cycle





**Remarkable**  
**Extraordinary** *Normal Liver, Fatty Liver, and Cirrhosis*

© 2003 Wadsworth, a division of Thomson Learning, Inc.

# Stages of MASLD = how much scarring?

**MASLD / Fatty liver (fibrosis stage 0):** build-up of fat, no damage and there is no scarring. This can be fully reversed.

**MASH with mild fibrosis (fibrosis stage 0 or 1):** No or very little scarring. Healthy living can undo the damage and reverse MASLD.

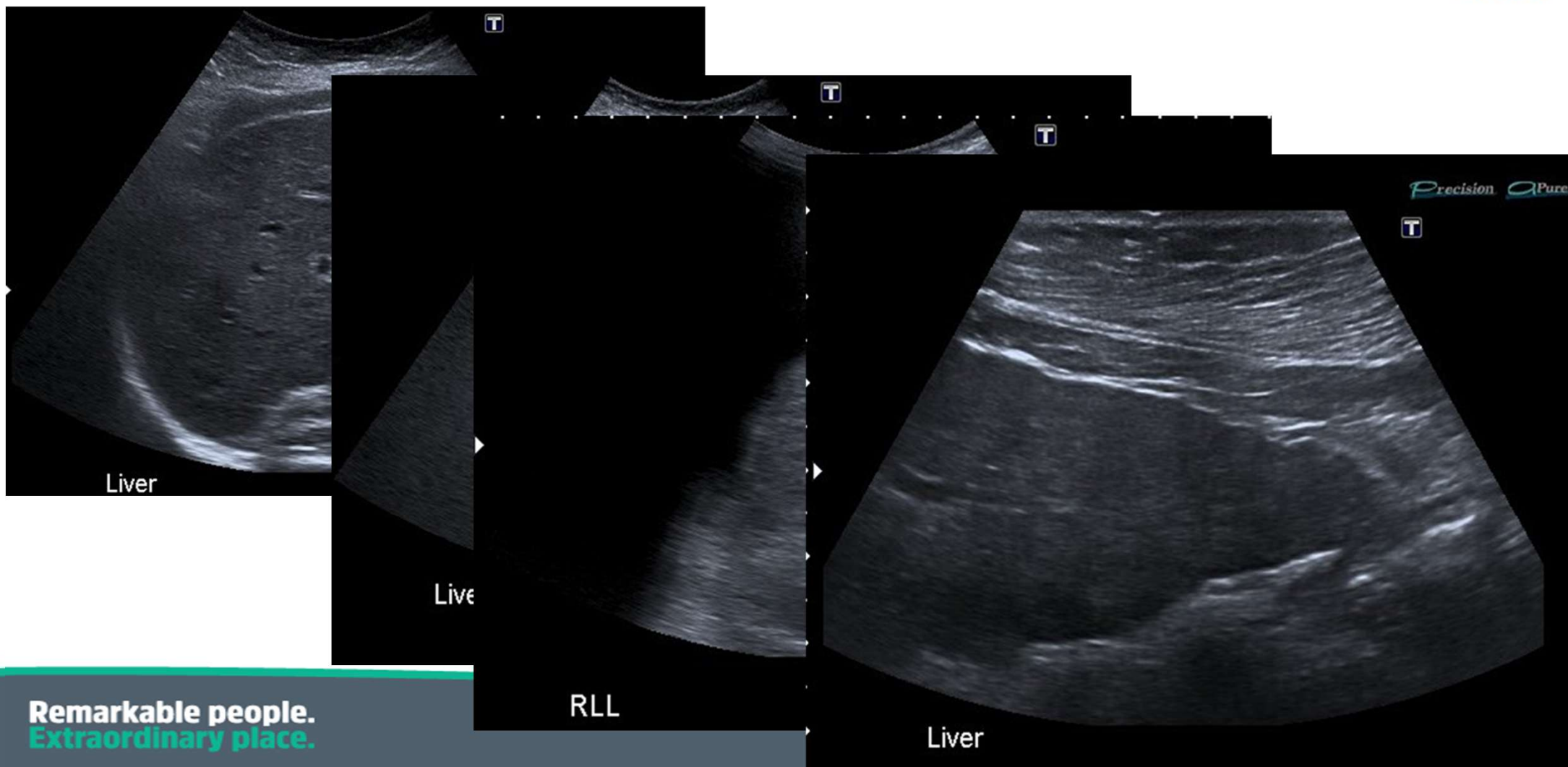
**MASH with moderate fibrosis (fibrosis stage 2):** Inflammation and damage have caused some scarring. Liver is probably still working well and the damage can mostly be repaired.

**MASH with advanced fibrosis (fibrosis stage 3):** Increased scarring but providing source of damage is stopped, it is still possible to be partially reversed

**Cirrhosis (fibrosis stage 4):** predominate scarring causing change to shape and texture. Liver can keep working and even repair some damage at this point.

Prolonged and non-reversed cirrhosis can lead to life-threatening conditions including liver cancer and liver failure

# Diffuse Disease



Remarkable people.  
Extraordinary place.

# Diagnosis

- LFT's
  - Early or asymptomatic liver disease: Many patients with chronic liver disease (CLD) or cirrhosis may have normal or near-normal LFTs due to the liver's large functional reserve
- Ultrasound
- Doppler assessment
- Liver Biopsy

# Liver Function Test

Liver chemistry test	Clinical implication of abnormality
ALT	Hepatocellular damage
AST	Hepatocellular damage
Bilirubin	Cholestasis, impair conjugation, or biliary obstruction
ALP	Cholestasis, infiltrative disease, or biliary obstruction
PT	Synthetic function
Albumin	Synthetic function
GGT	Cholestasis or biliary obstruction
Bile acids	Cholestasis or biliary obstruction
5'-nucleotidase	Cholestasis or biliary obstruction
LDH	Hepatocellular damage, not specific

NILS

# FIB-4 Calculator

Advanced Liver Fibrosis Assessment



Updated: April 2024



Reviewed By: Safdar Hussain, MLT (Founder)

Assess Liver Fibrosis Risk Easily & Accurately

MASLD / NAFLD & Viral Hepatitis Screening

## Patient Biomarkers

Age:	55
AST:	42 U/L
ALT:	35 U/L
Platelets:	150 $\times 10^9/L$

Calculate FIB-4 Score



## Result:

1.92

Indeterminate Zone

Low Risk

Indeterminate

High Risk

Borderline Result - Further Testing Required



Blood-Based Biomarkers

Liver Fibrosis Severity

FibroScan Testing

Remarkable  
Extraordinary

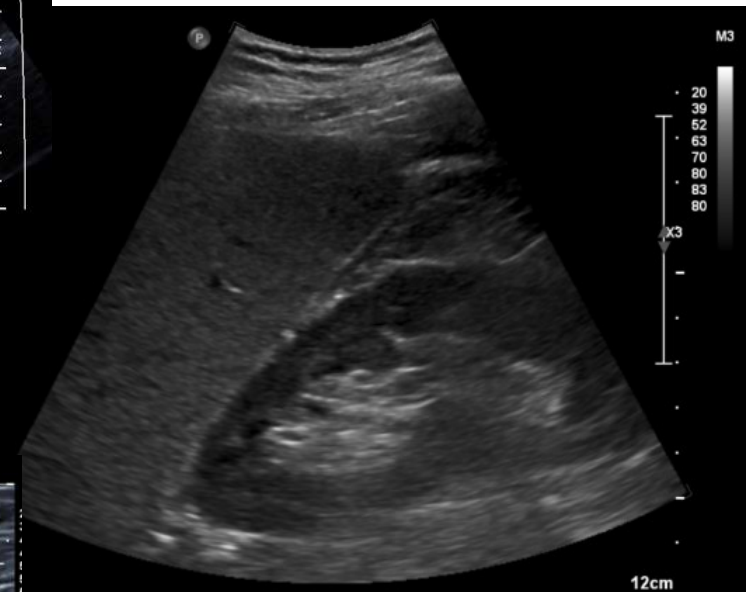
# Ultrasound



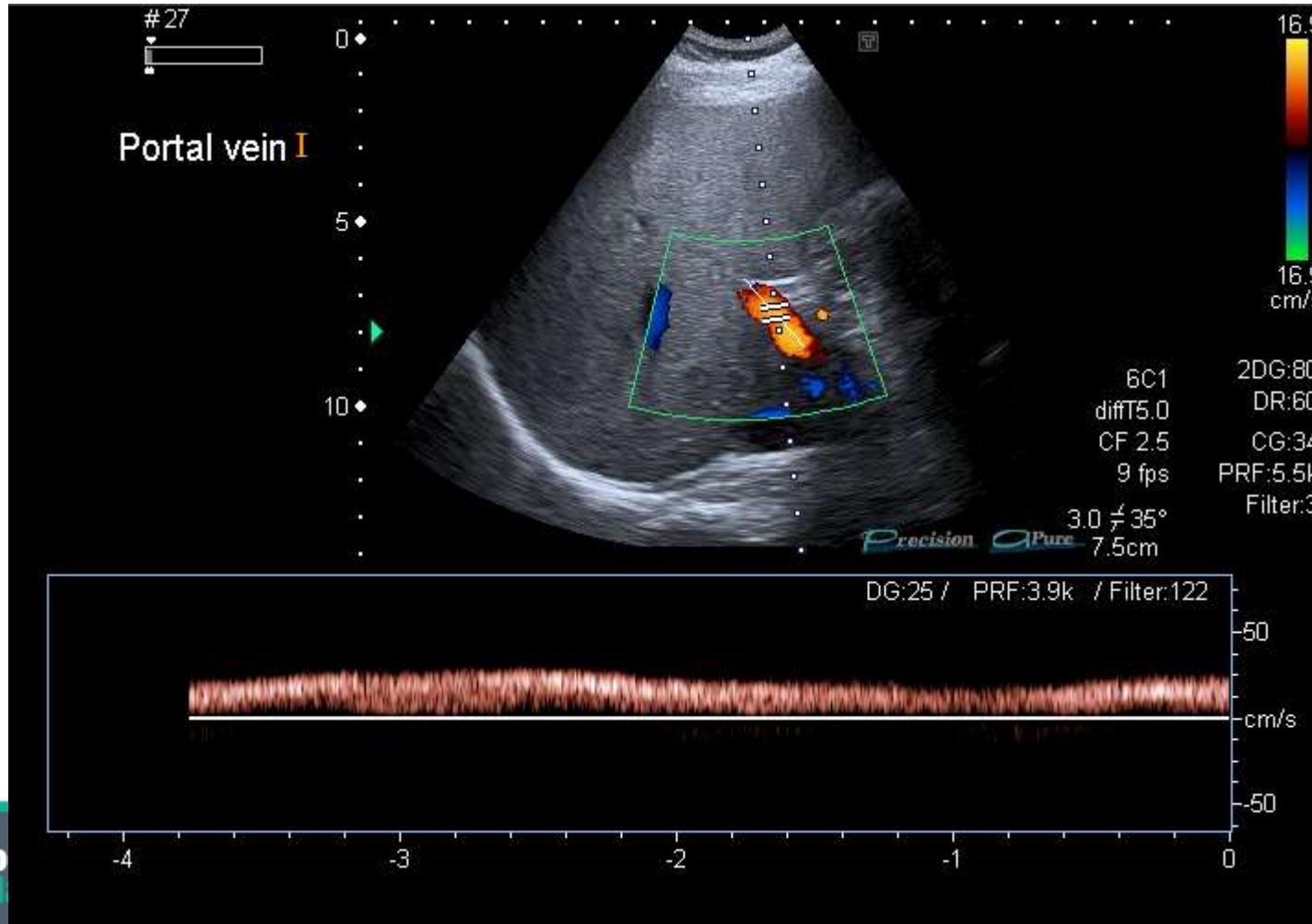
- Features of a normal or fatty liver are well defined, specific and easily recognised
- The pathological processes which contribute to fibrosis, and cirrhosis, become more difficult to distinguish.

# Minimum dataset

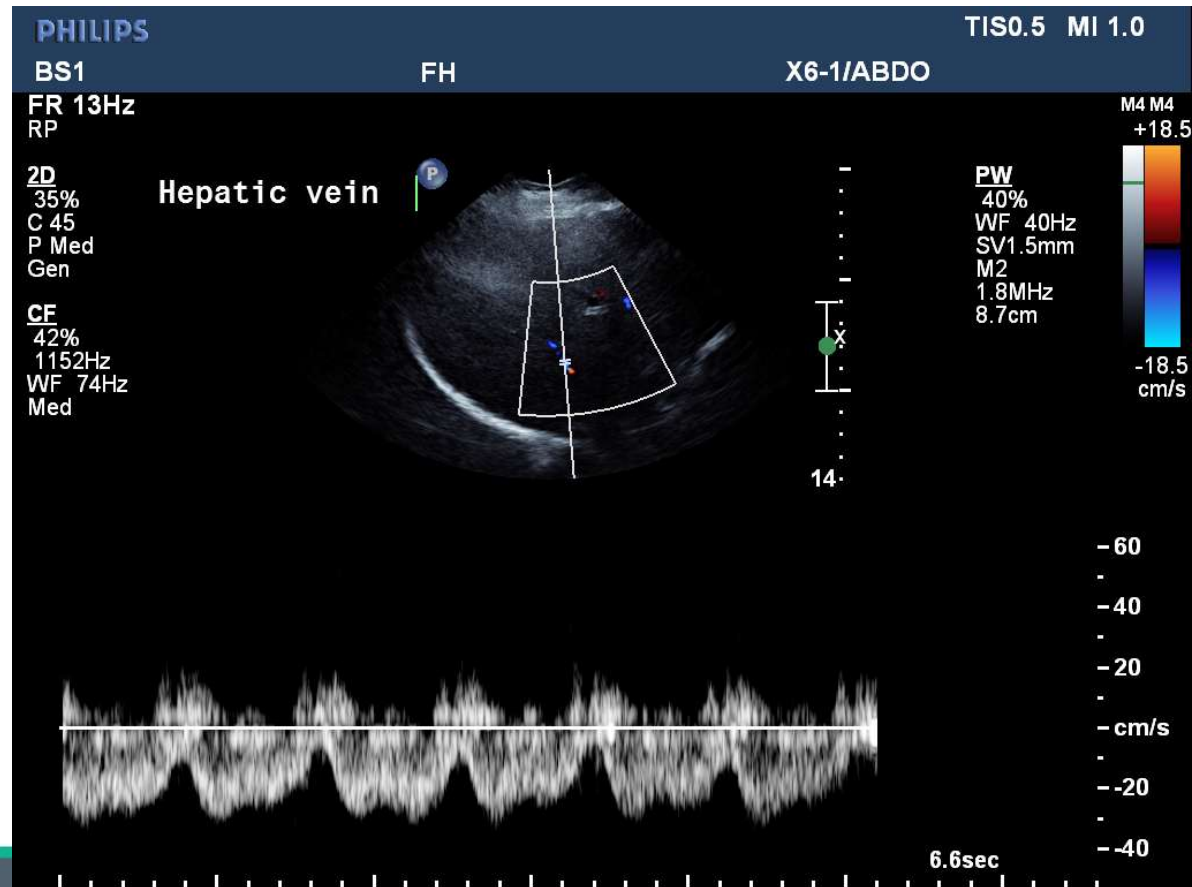
- B-mode assessment of liver parenchyma
- High frequency assessment of liver margin
- Liver size
- Spleen size
- PV flow
- HV flow
- Presence of ascites



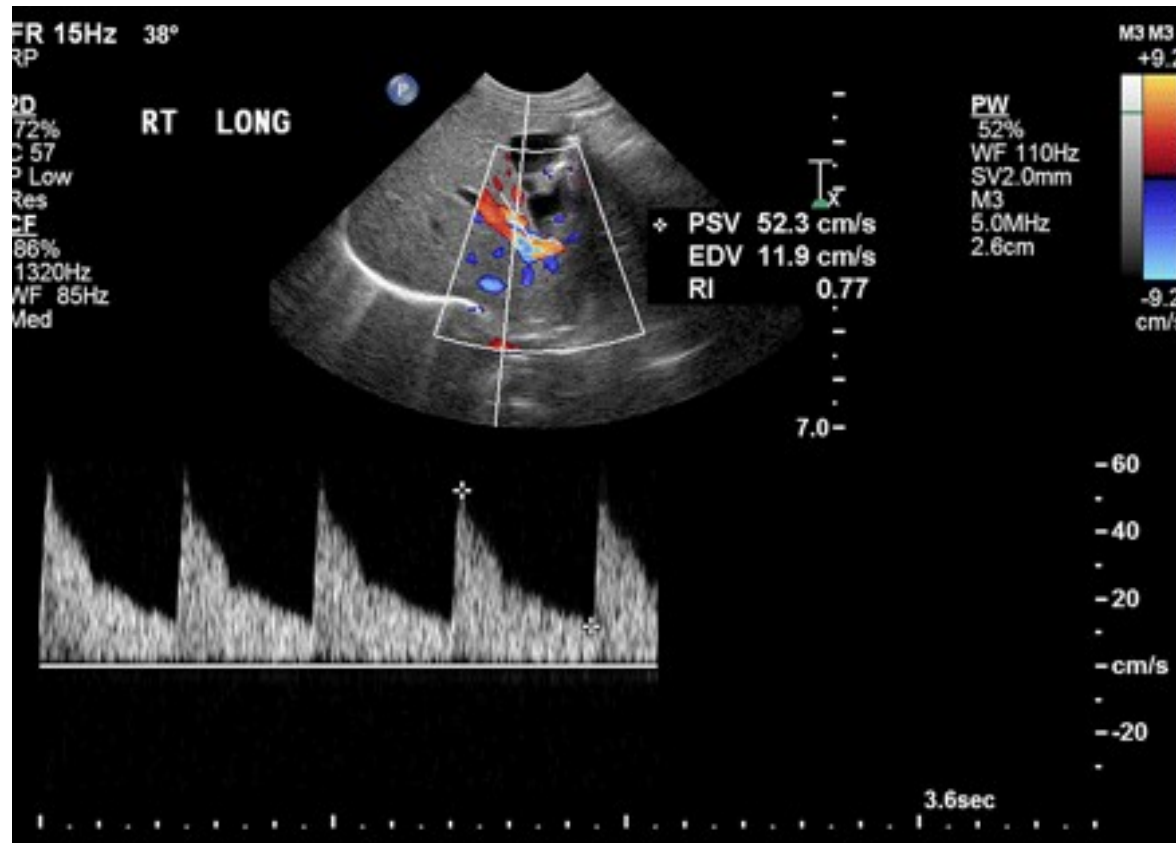
# Normal Portal vein >10 cm/s



# Hepatic vein



## Hepatic artery – useful to note if PV not seen



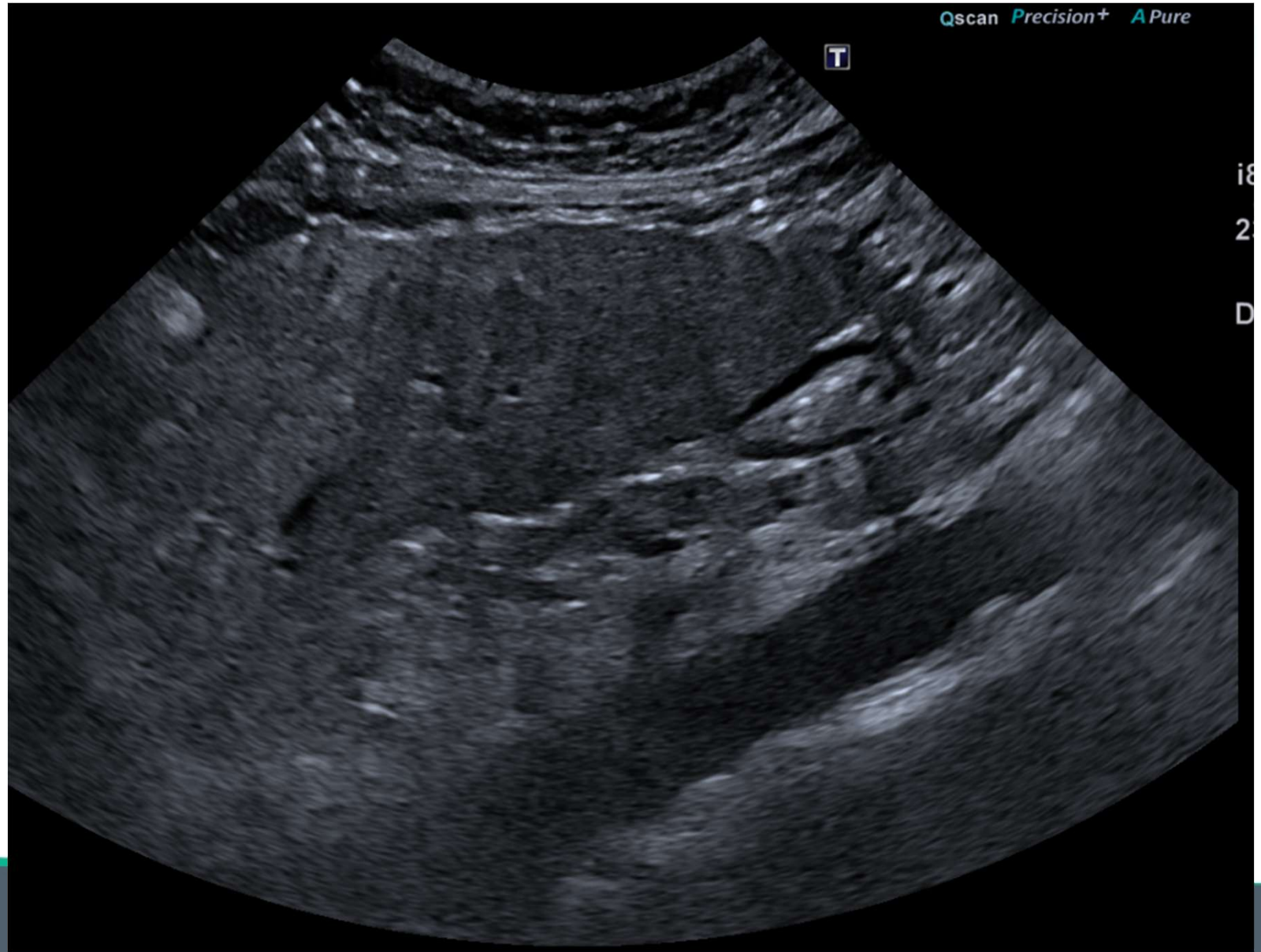
# Cirrhosis – Making the Diagnosis

## HISTOLOGICAL DIAGNOSIS!!

### Ultrasound signs:

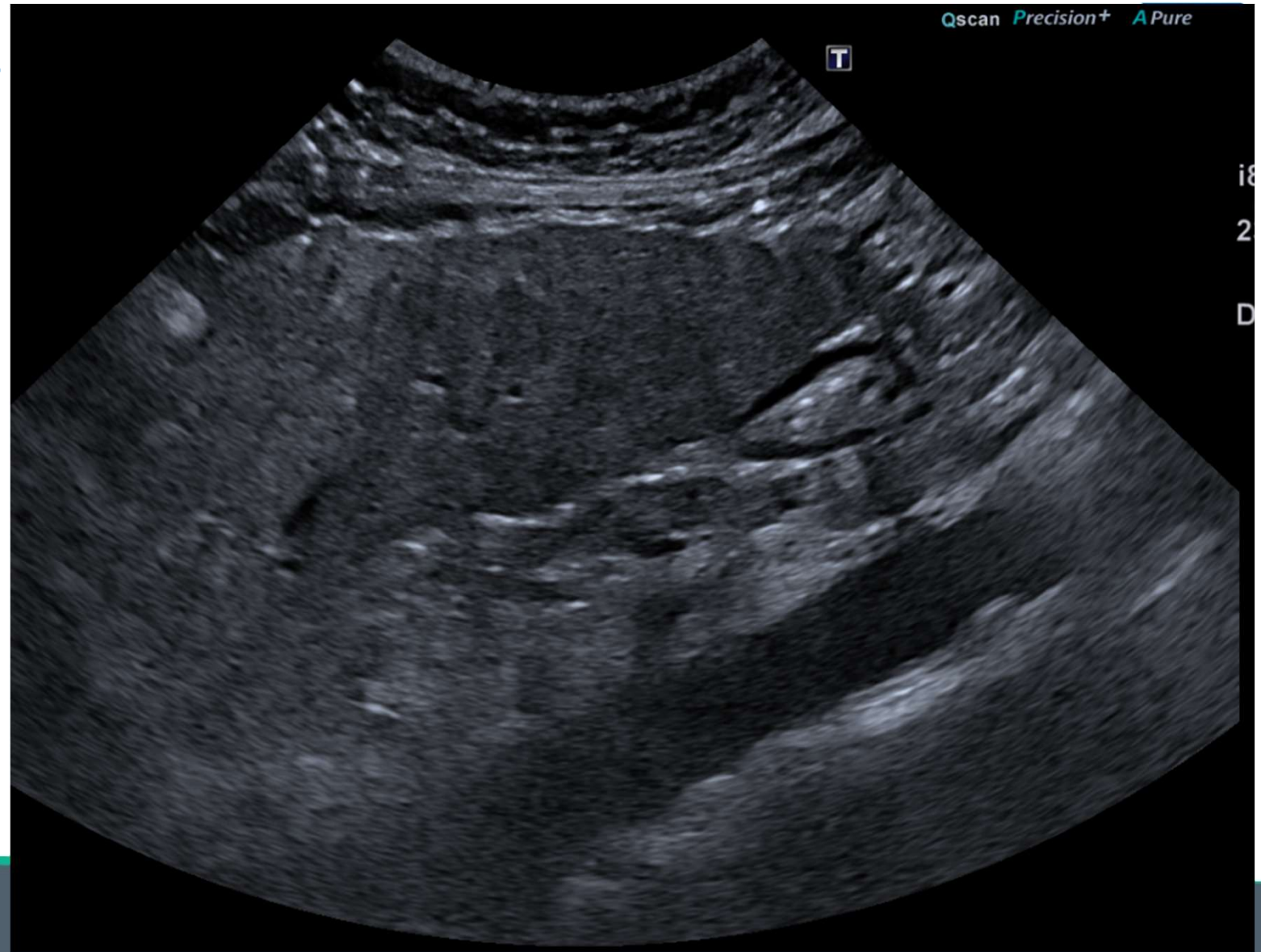
- surface nodularity: (88% sensitive, 82-95% specific)
- overall coarse and heterogeneous echotexture
- segmental hypertrophy/atrophy (see above)
  - caudate width: right lobe width  $>0.65$  (43-84% sensitive, 100% specific )
  - reduction of the transverse diameter ( $<30$  mm) of the medial segment of the left lobe (segment IV)

# Surface Nodularity



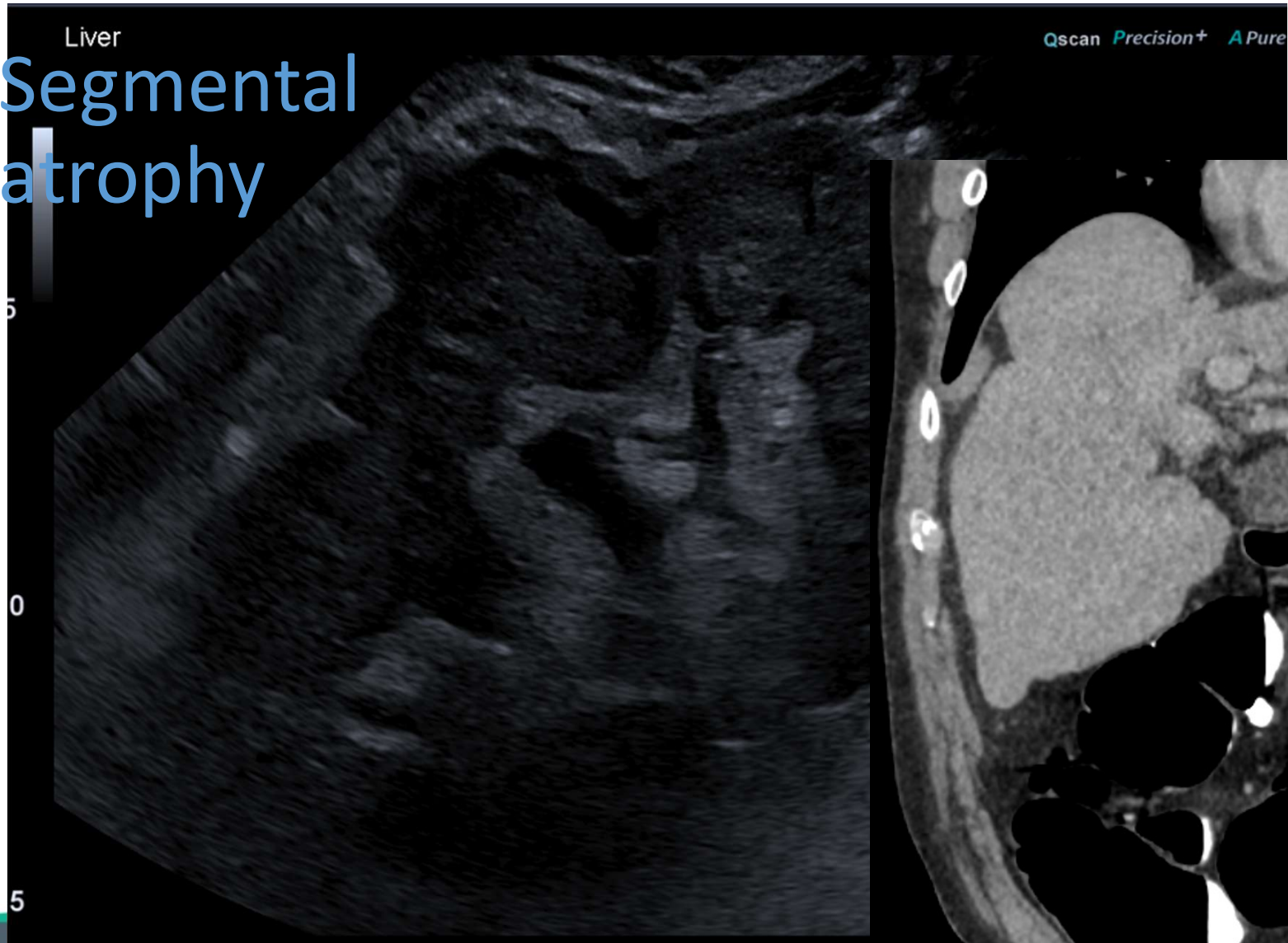
Remarkable people.  
Extraordinary place.

# Heterogenous & nodular



Remarkable people.  
Extraordinary place.

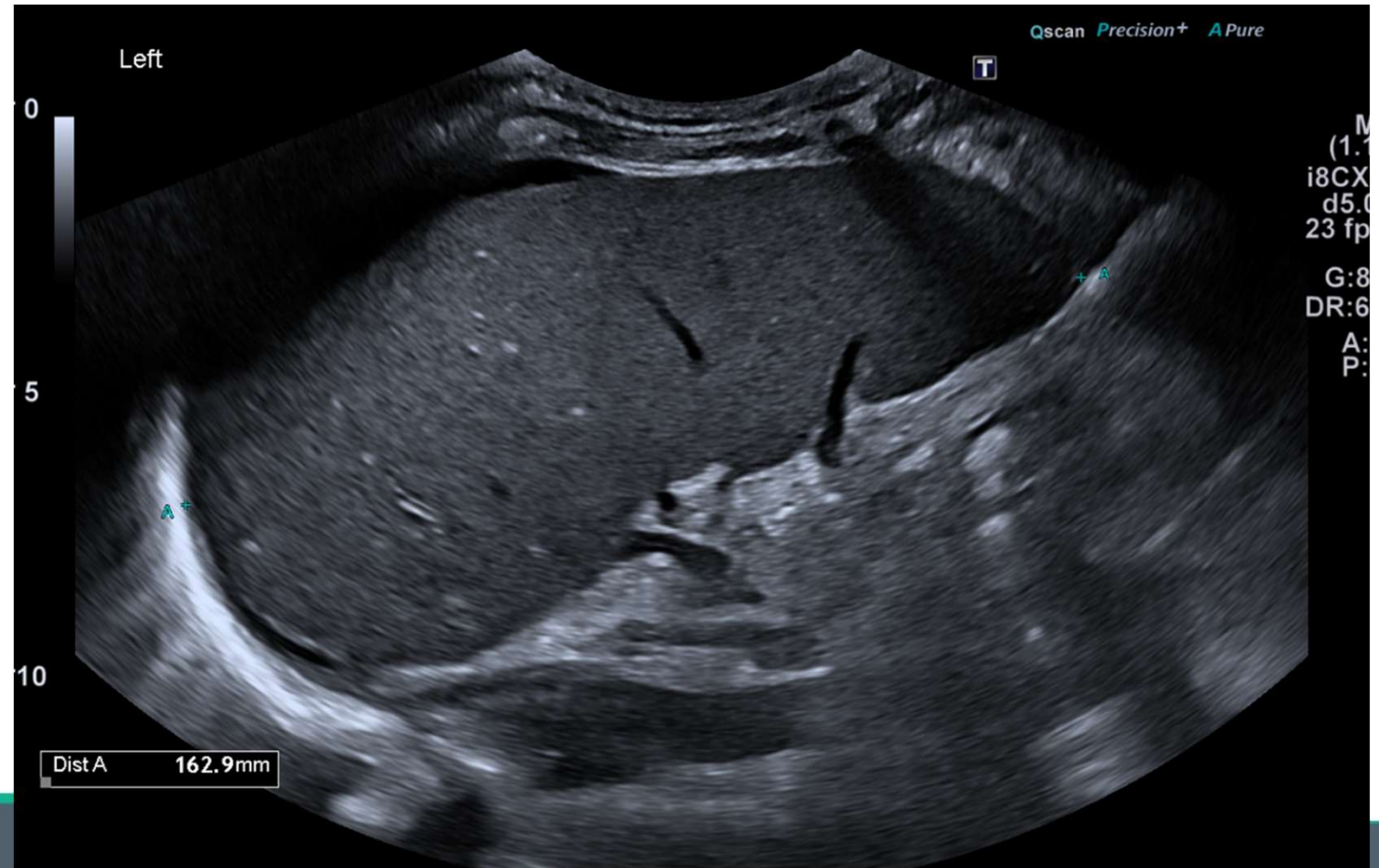
# Segmental atrophy



Remarkable people.  
Extraordinary place.

# Portal Hypertension

- Splenomegaly (13cm)
- Varices
- Reversed flow



# Portal hypertension

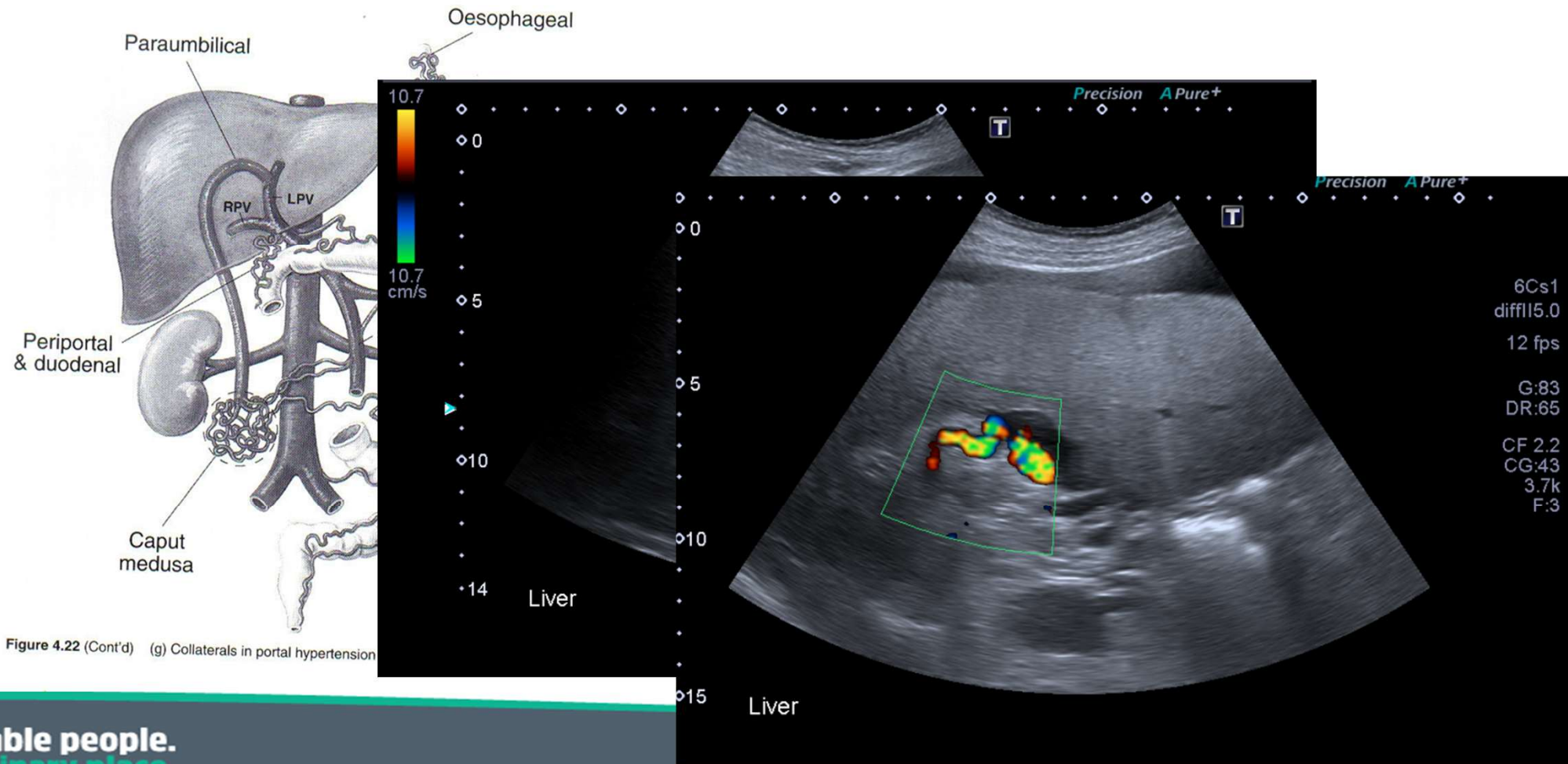
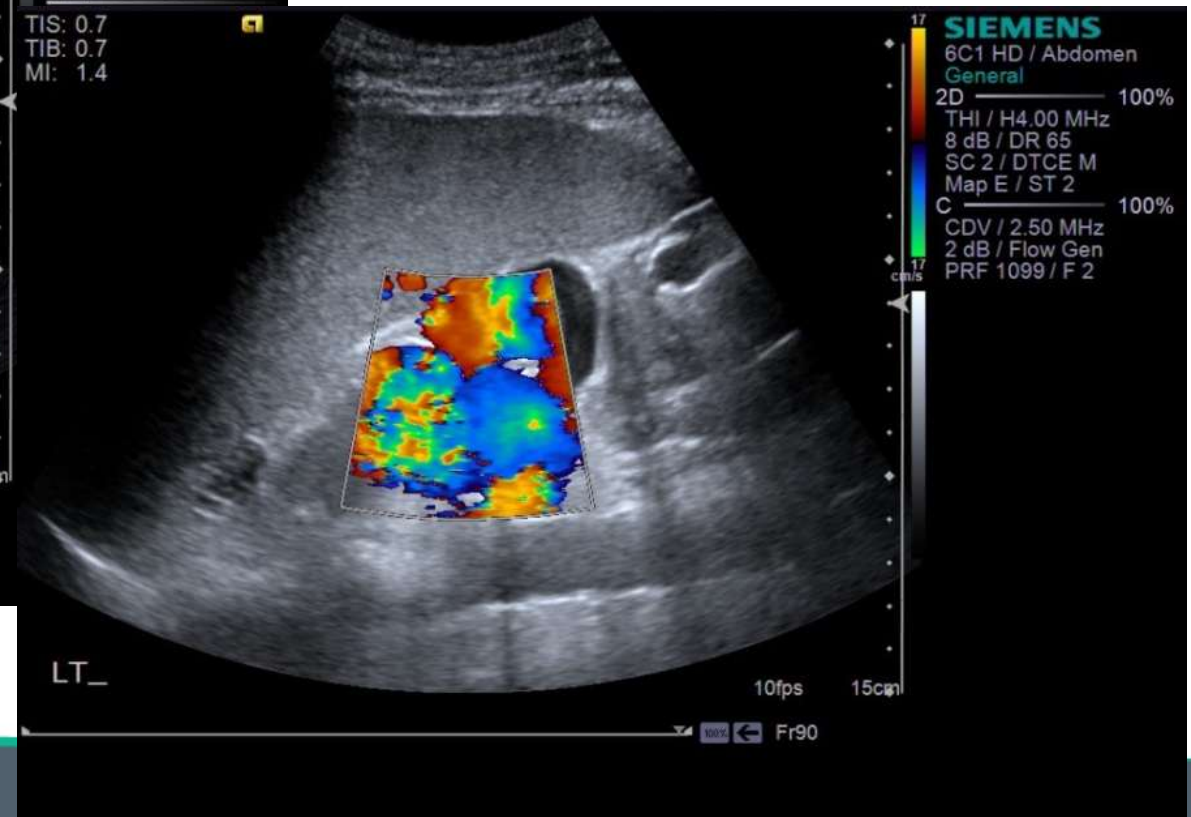
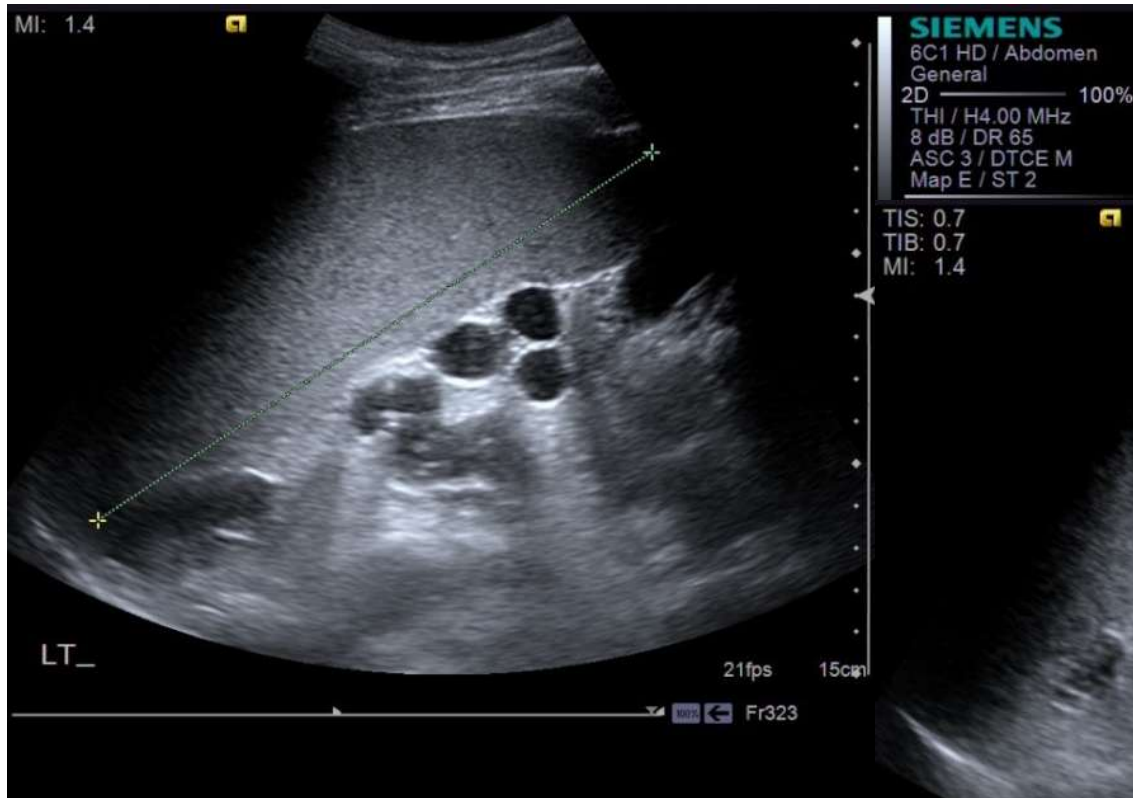


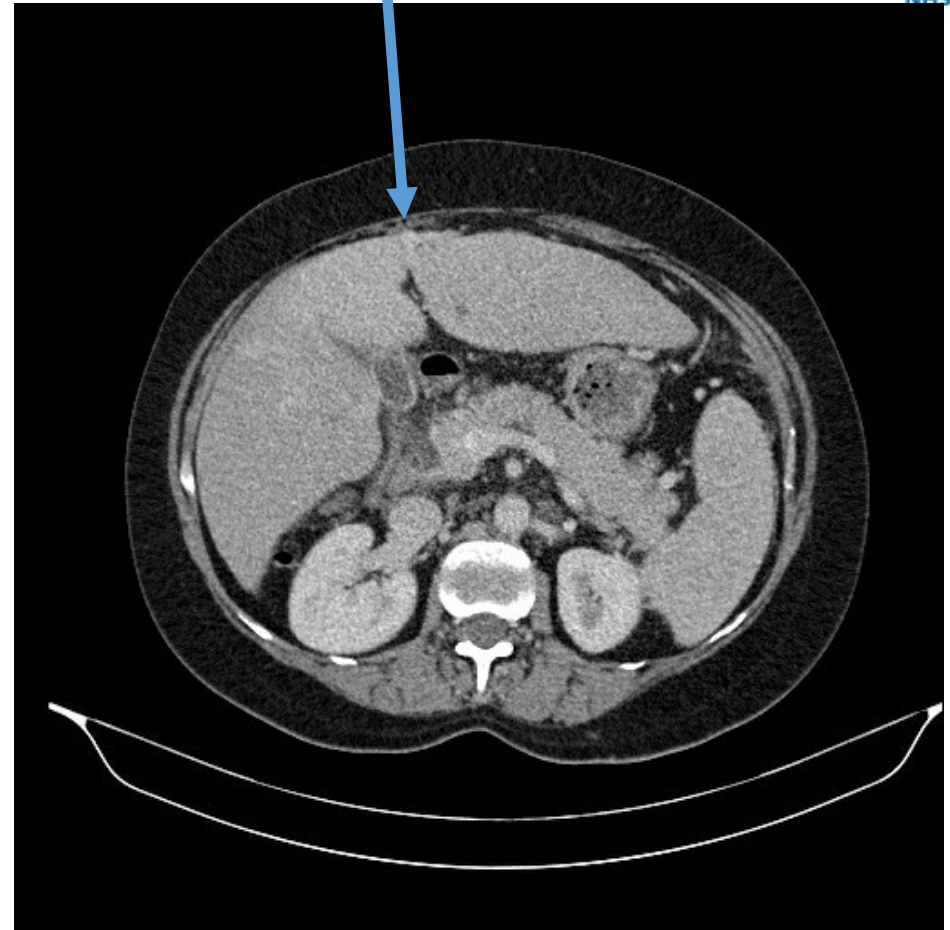
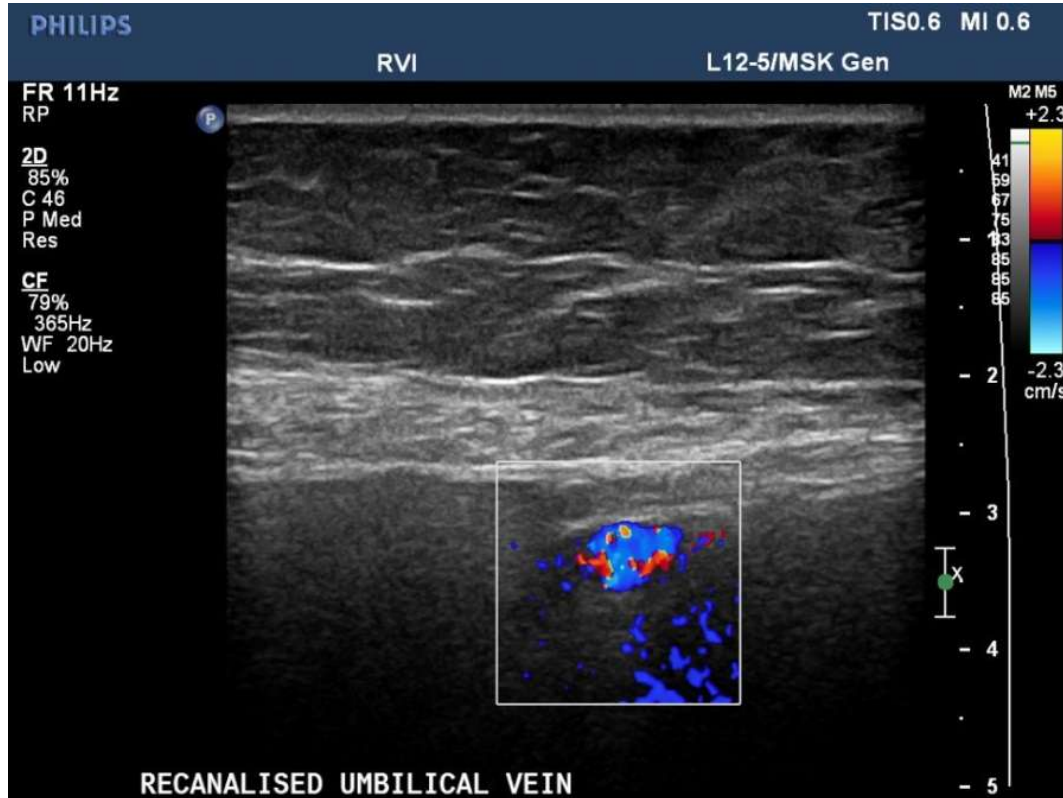
Figure 4.22 (Cont'd) (g) Collaterals in portal hypertension

# Portal Hypertension



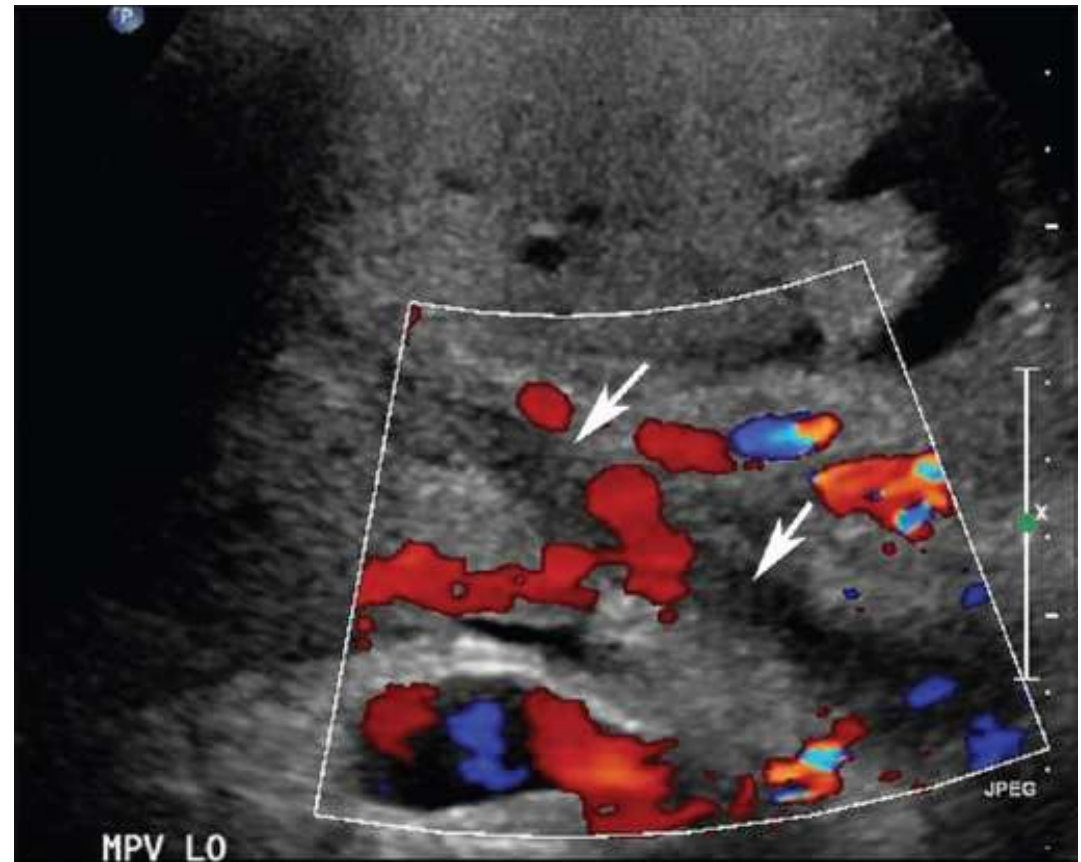
Remarkable people.  
Extraordinary place.

# Portal Hypertension

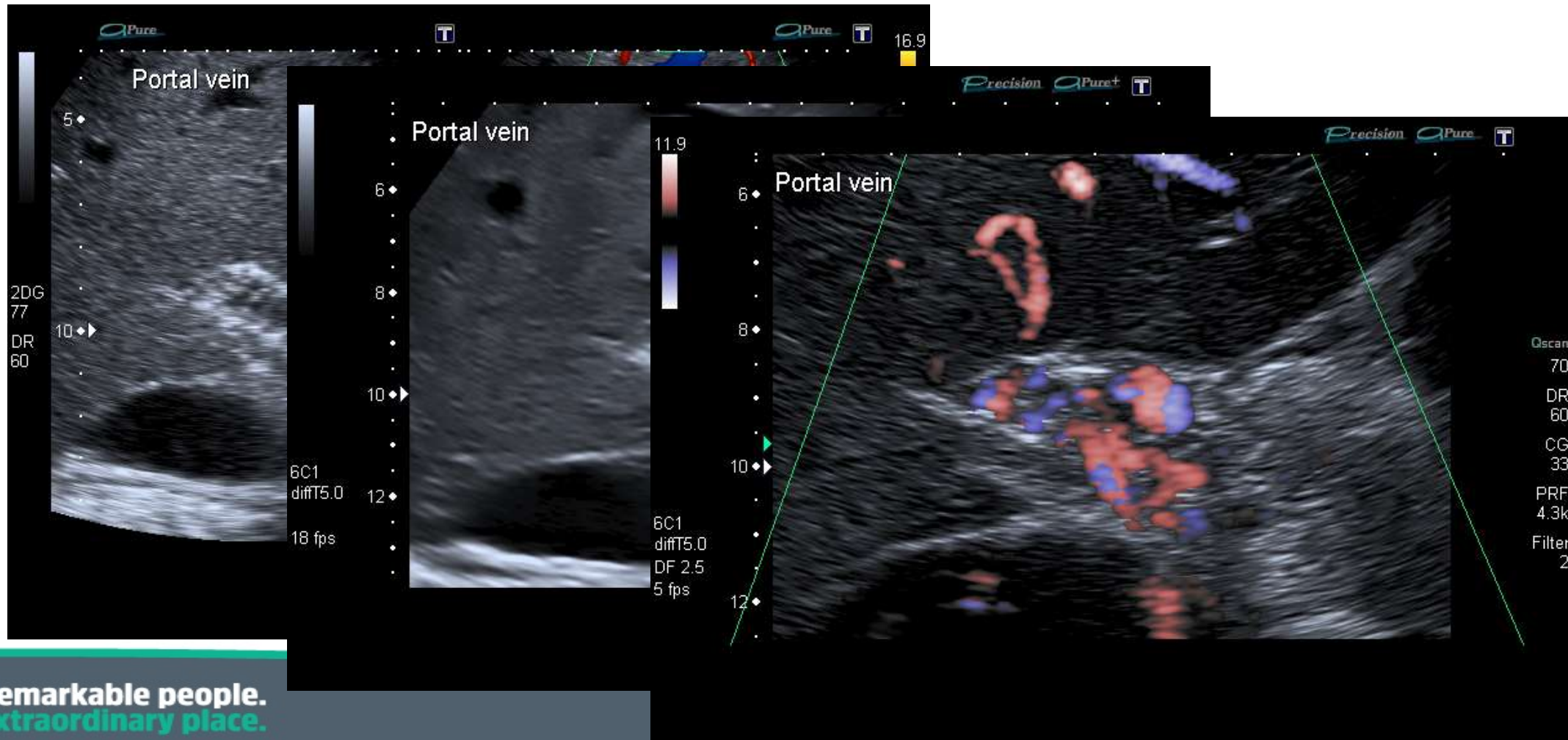


# Portal vein thrombosis

- As well as cirrhosis it can be seen in pancreatitis, diverticulitis, post-splenectomy and HCC.
- Must be aware of Doppler settings
  - Scale, gain, angle, write priority, etc



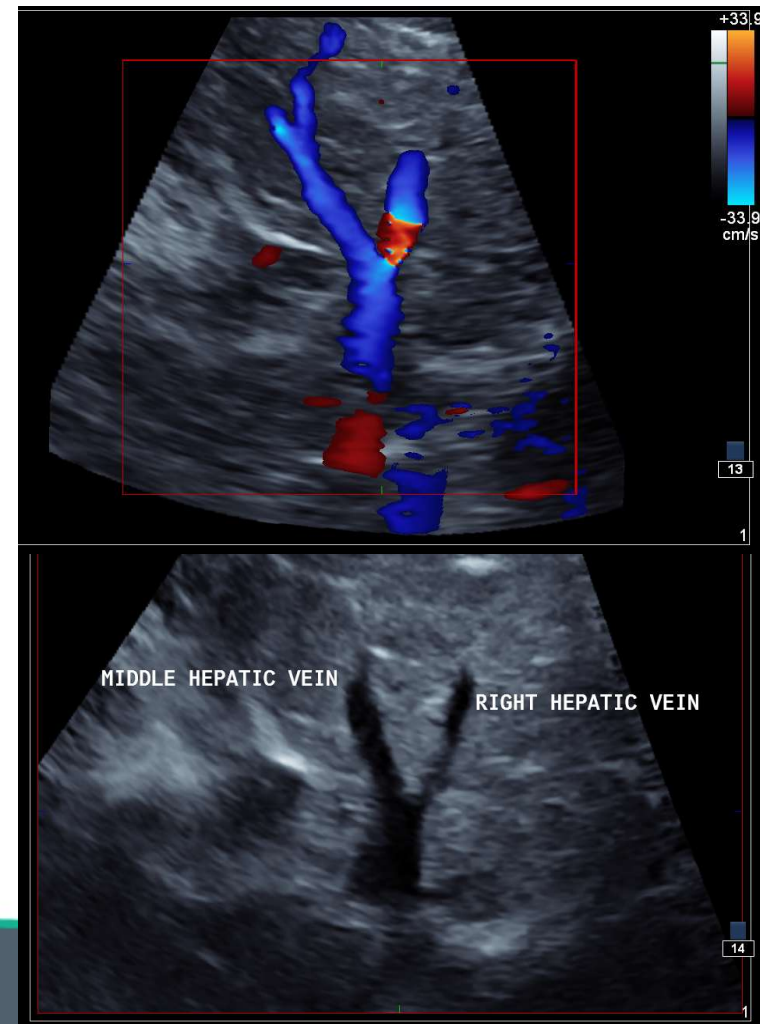
# PV thrombosis- cavernous transformation



**Remarkable people.**  
**Extraordinary place.**

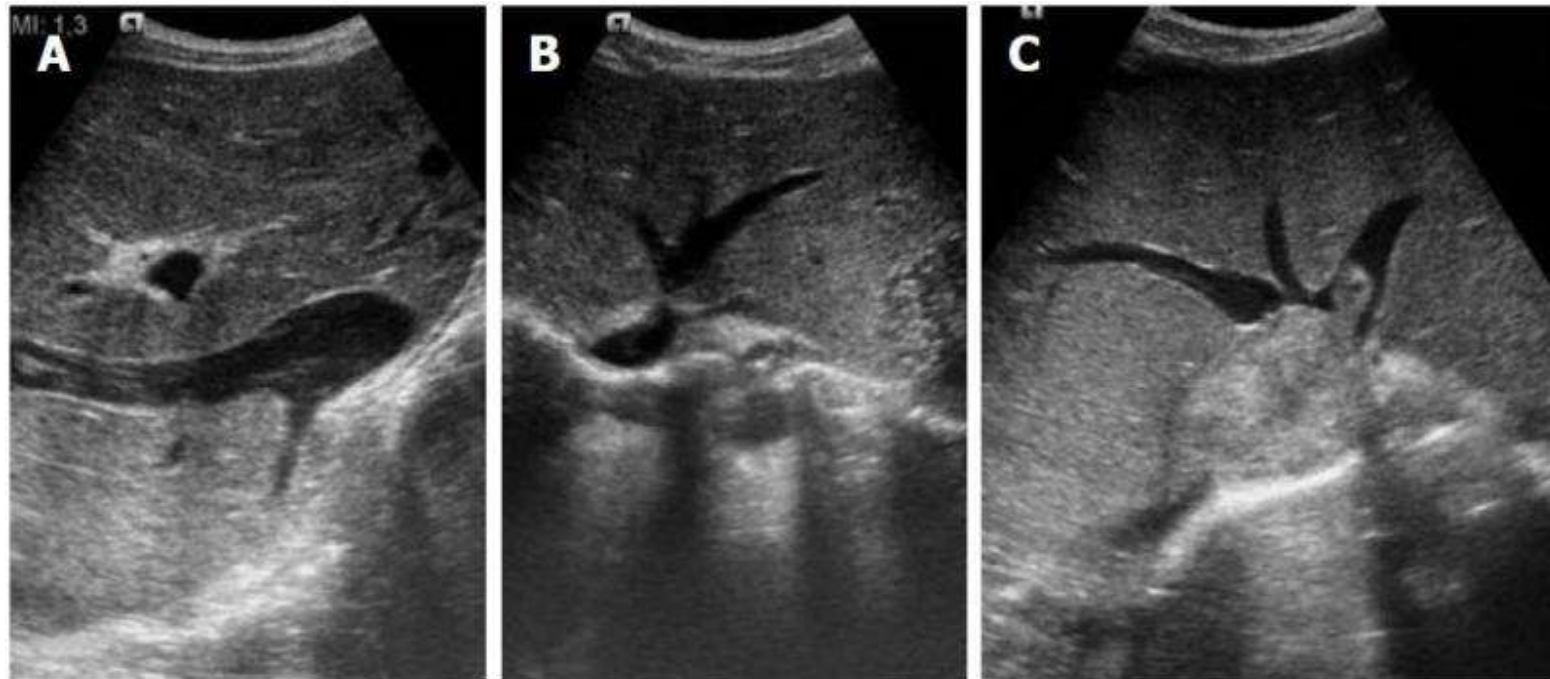
# Budd-Chiari

- Thrombosis/ occlusion of the HVs
- Often get caudate sparing or hypertrophy due to separate venous drainage.
- Present with rapid onset ascites, hepatomegaly and jaundice
- More common in women.
- Usually requires shunts or sometimes transplantation.



# Budd-Chiari

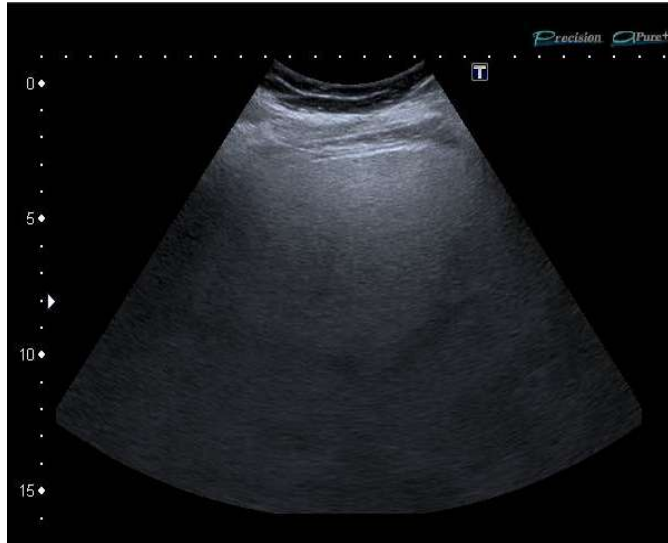
- primary (spontaneous), secondary (stricture, extrinsic compression).





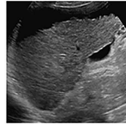
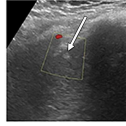

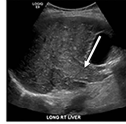

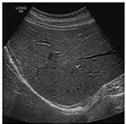
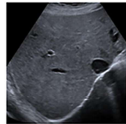
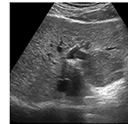
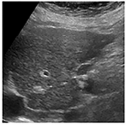
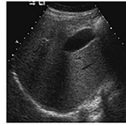
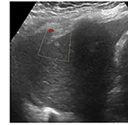


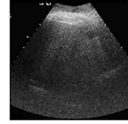
**Remarkable people.**  
**Extraordinary place.**

# Limitations



# Reporting LI-RADS

- **Liver Imaging Reporting and Data System Ultrasound Surveillance**
- standardised system with recommendations for imaging technique, interpretation and reporting for surveillance of HCC using unenhanced ultrasound in patients at high risk for developing HCC.
- As a surveillance tool, it is not intended to diagnose HCC, which requires dynamic assessment with contrast-enhanced studies

US Categories	Definition	Examples
US-1: Negative	No observation <b>OR</b> Only definitely benign observation(s)	 Advanced cirrhosis with ascites but no focal liver observation
US-2: Subthreshold	Observation(s) < 10 mm in diameter, not definitely benign	 A subcentimeter hyperechoic observation (arrow) is identified that warrants short-interval follow-up in 3-6 months to ensure stability
US-3: Positive	Observation(s) ≥ 10 mm in diameter, not definitely benign <b>OR</b> New thrombus in vein  Observation may be a solid nodule of any echogenicity or area of parenchymal distortion ≥10 mm with one or more of the following manifestations: <ul style="list-style-type: none"> <li>• Ill-defined area of heterogeneity</li> <li>• Refractive edge shadows</li> <li>• Loss of normal hepatic architecture</li> </ul>	 Solid hypoechoic observation ≥ 10 mm in size (arrow), not definitely benign is present in the left lobe of the liver  New thrombus in main portal vein (arrow)  Parenchymal distortion resulting in loss of normal portal triads (arrow)
Visualization Score	Definition	Examples
A: No or minimal limitations	Limitations if any are unlikely to meaningfully affect sensitivity  <b>Comment:</b> Visualization A is assigned even when mild heterogeneity of the liver is present due to underlying cirrhosis, as long as the liver is well-visualized in near entirety.	 Homogeneous liver  Minimal beam attenuation  Liver visualized in near entirety
B: Moderate limitations	Limitations may obscure small masses  <b>Comment:</b> Visualization B is assigned when there is moderate parenchymal heterogeneity, ultrasound beam attenuation, or shadowing obscuring portions of the liver.	 Moderately heterogeneous liver  Moderate beam attenuation  Some portions of liver not visualized
C: Severe limitations	Limitations significantly lower sensitivity for focal liver lesions  <b>Comment:</b> Visualization C is assigned when there is severe parenchymal heterogeneity, ultrasound beam attenuation, or shadowing obscuring majority (>50%) of liver.	 Severely heterogeneous liver  Severe beam attenuation (> 50% of diaphragm not visualized)  Majority (>50%) of liver not visualized

# Reporting – Non LI-RADS, Standardised text

## Liver Outcomes for HCC surveillance

- The liver has normal homogenous appearance. Capsule is smooth with no nodularity
- The liver is homogenous but demonstrates increased echogenicity associated with evidence of fatty infiltration. Capsule is smooth with no nodularity
- The liver demonstrates increased echogenicity and has a nodular capsule. Findings commonly associated with chronic liver disease.
- The liver has a heterogenous appearance and nodular capsule. Findings indicate chronic liver disease.

No new focal lesions identified / New focal lesion identified requiring senior review for management advice

# Imaging Summary

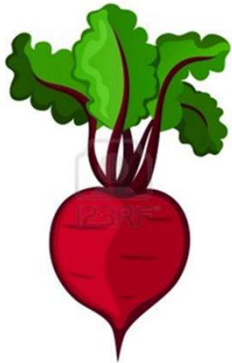
- Ultrasound is front line investigation for a range of liver disease, focal and diffuse
- Minimum dataset includes high frequency assessment of margin and Doppler waveforms.
- Ascites is important
- Focal liver lesions are difficult without CEUS / MRI
- Don't underestimate the value of Doppler of PV



**R**  
Extraordinary place.

# How would you classify the following images?

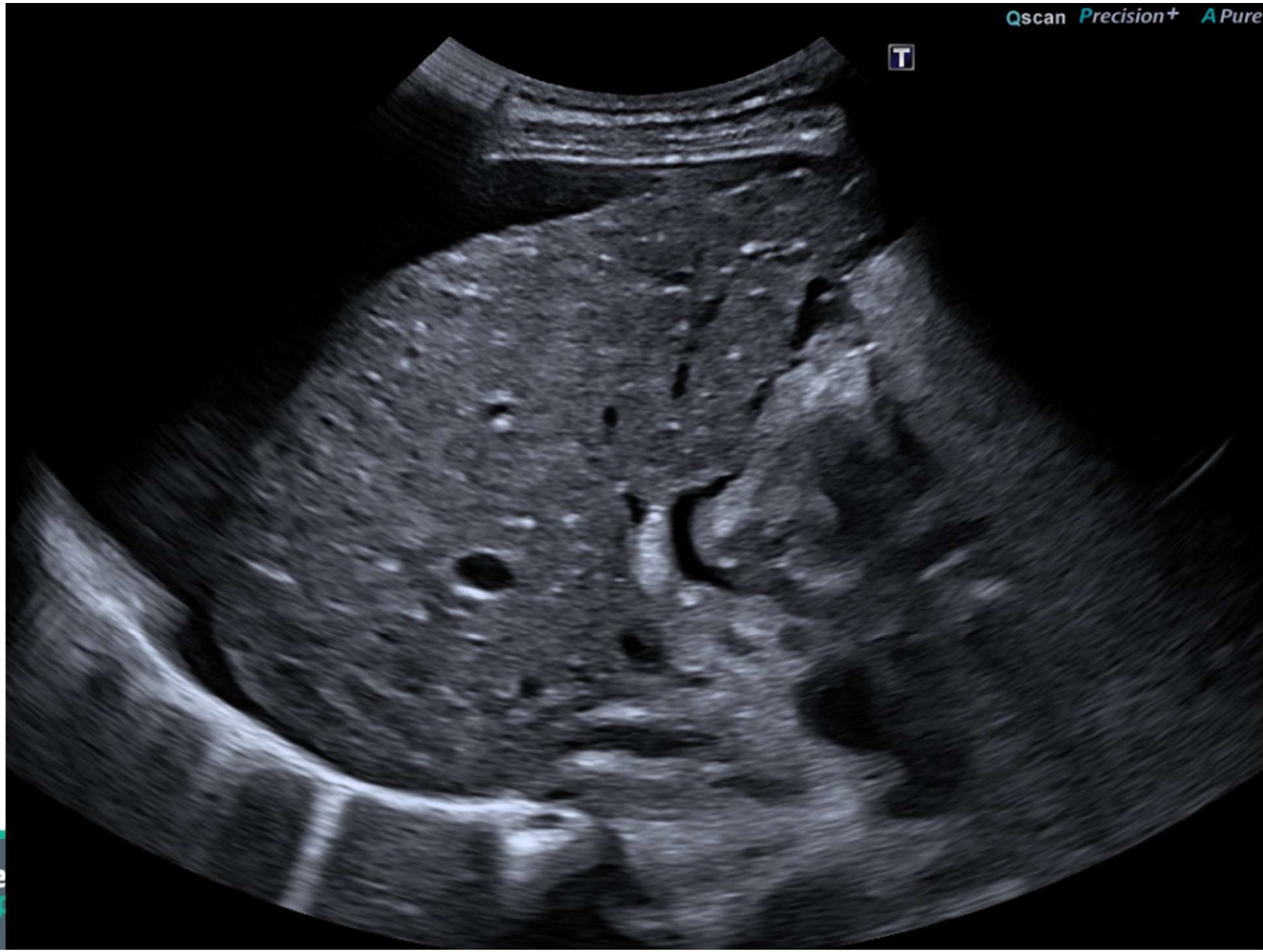
- Three options:



Qscan Precision+ APure

T

**NHS**  
University  
Hospitals  
NHS Trust



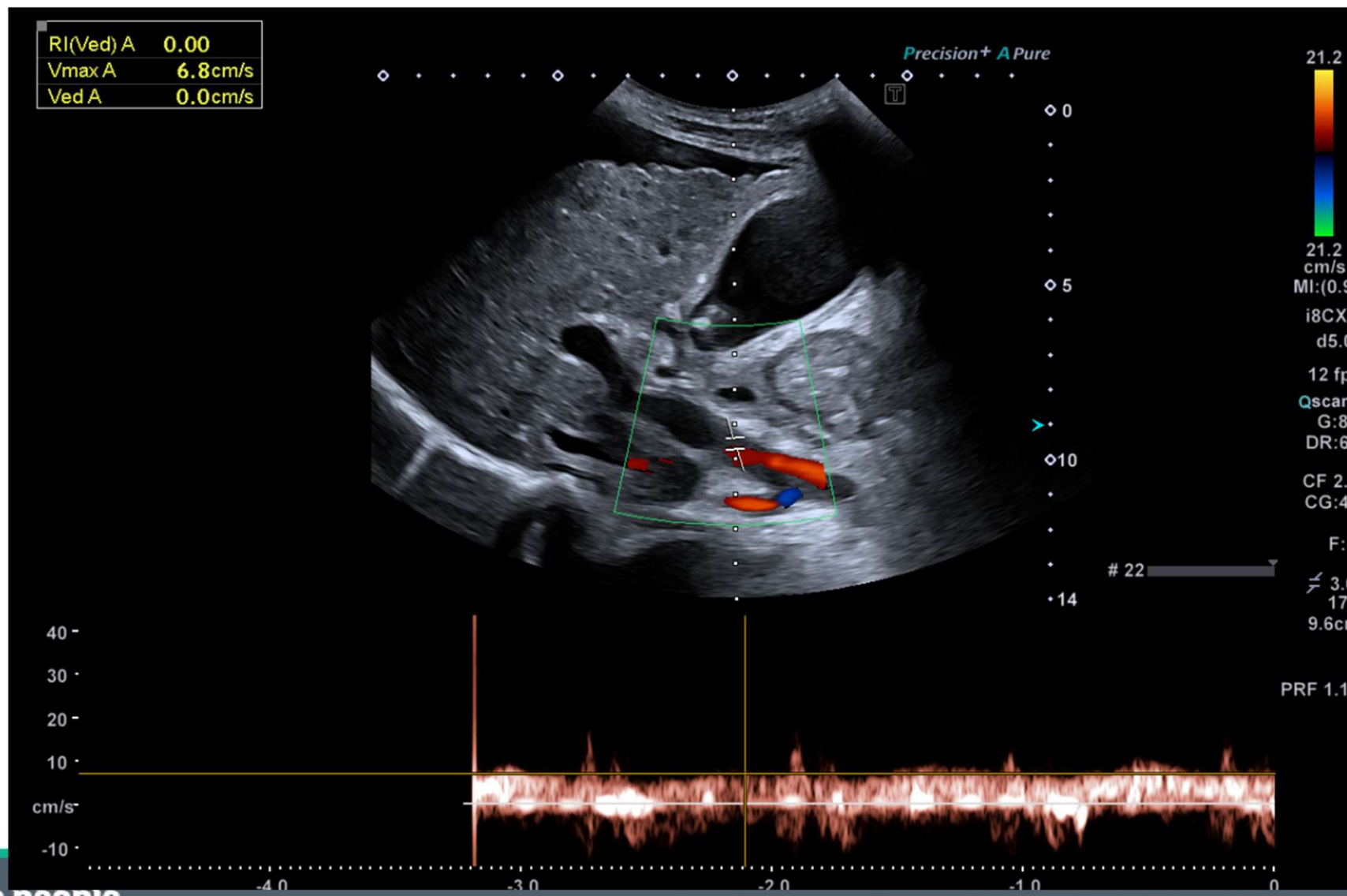
Remarkable pe  
Extraordinary p

Qscan Precision+ A Pure

HS  
University  
Hospitals  
Trust



Remarkable people.  
Extraordinary place.



**Remarkable people.**  
**Extraordinary place.**



The liver has a heterogenous appearance and nodular capsule. Findings indicate chronic liver disease.

No new focal lesions identified

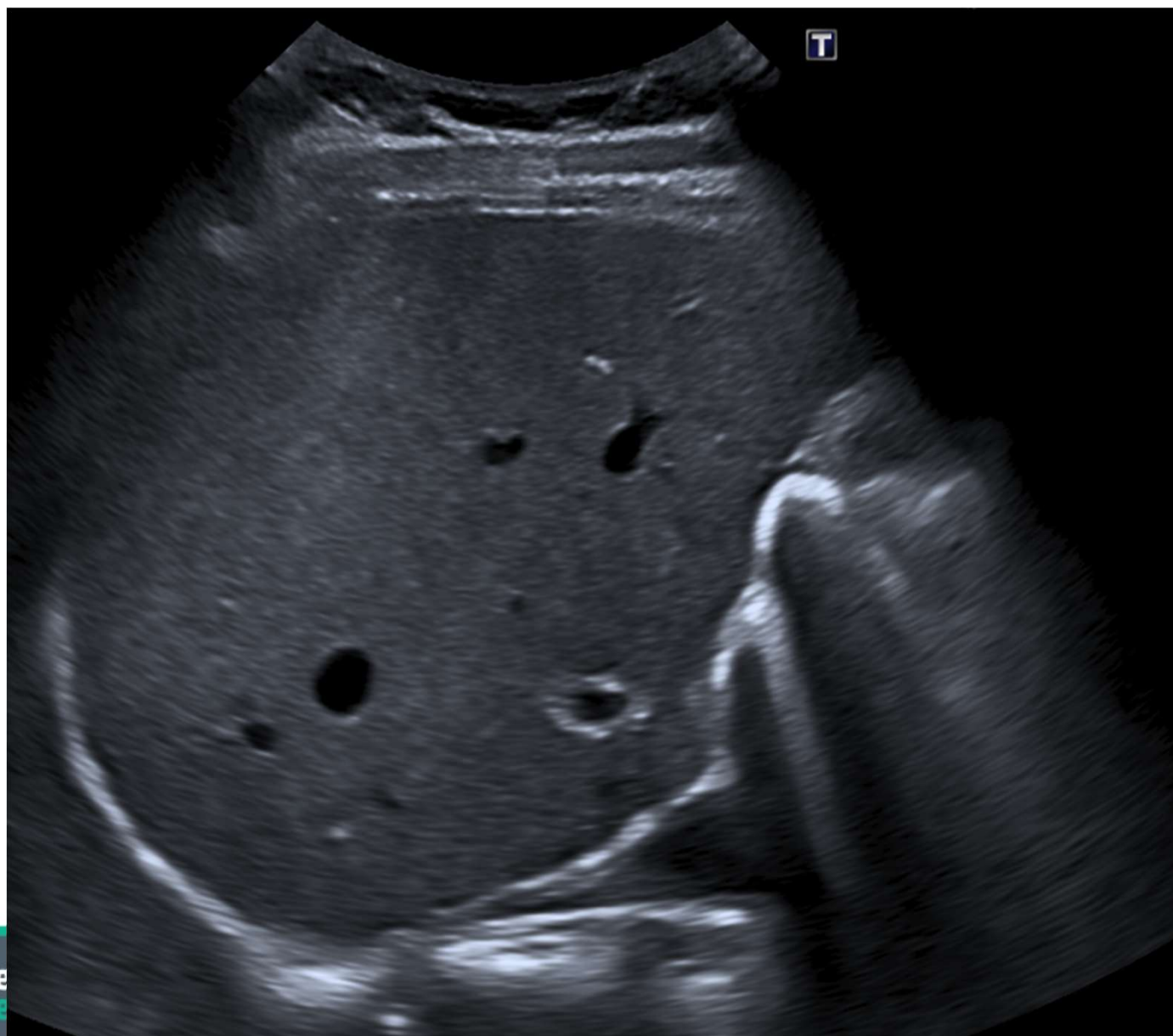






The liver is homogenous but demonstrates increased echogenicity associated with evidence of fatty infiltration. Capsule is smooth with no nodularity

No new focal lesions identified



Qscan Precision 7.0 are



**NHS**  
University  
Hospitals  
NHS Trust

Remarkable people  
Extraordinary places

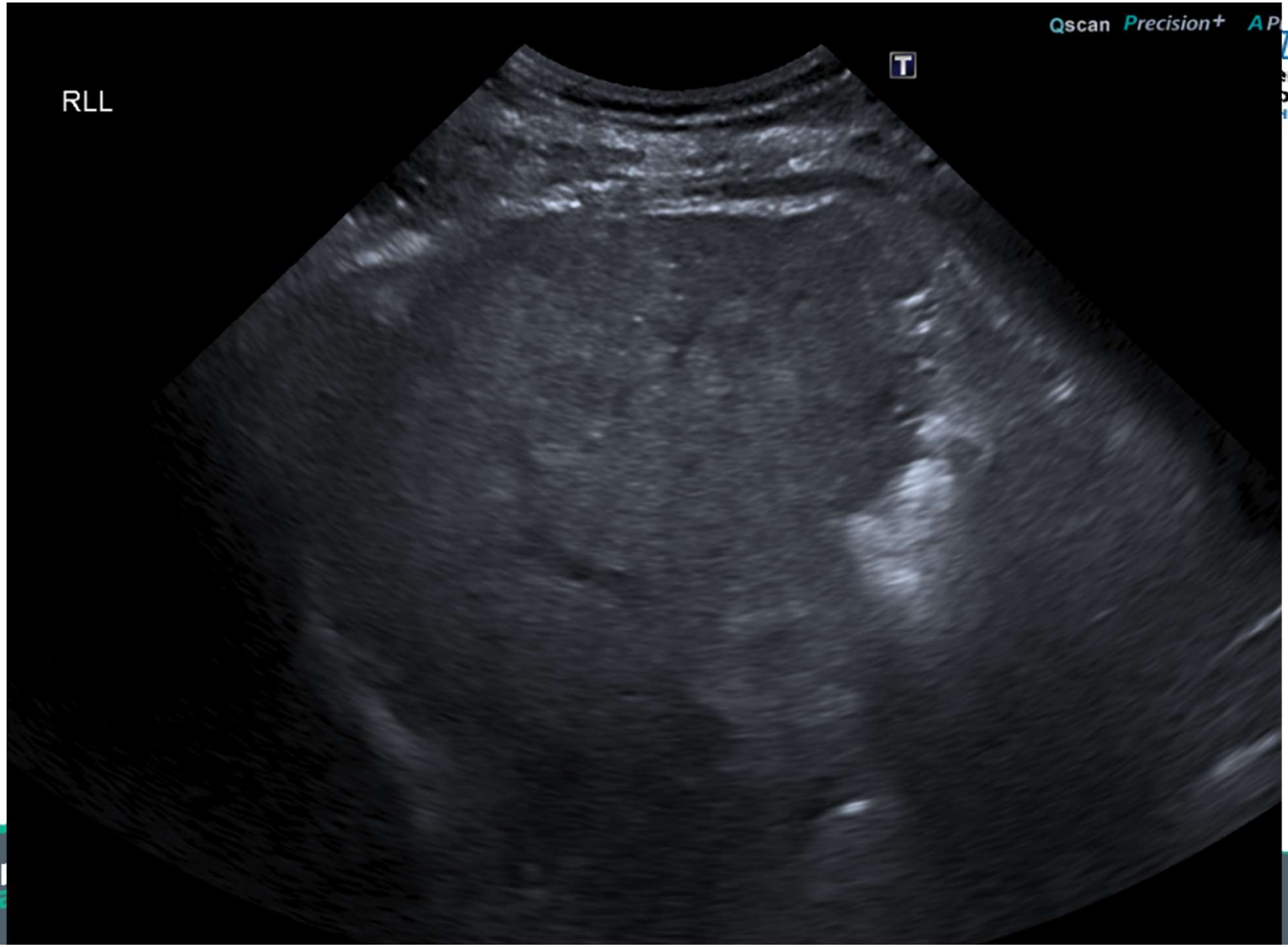


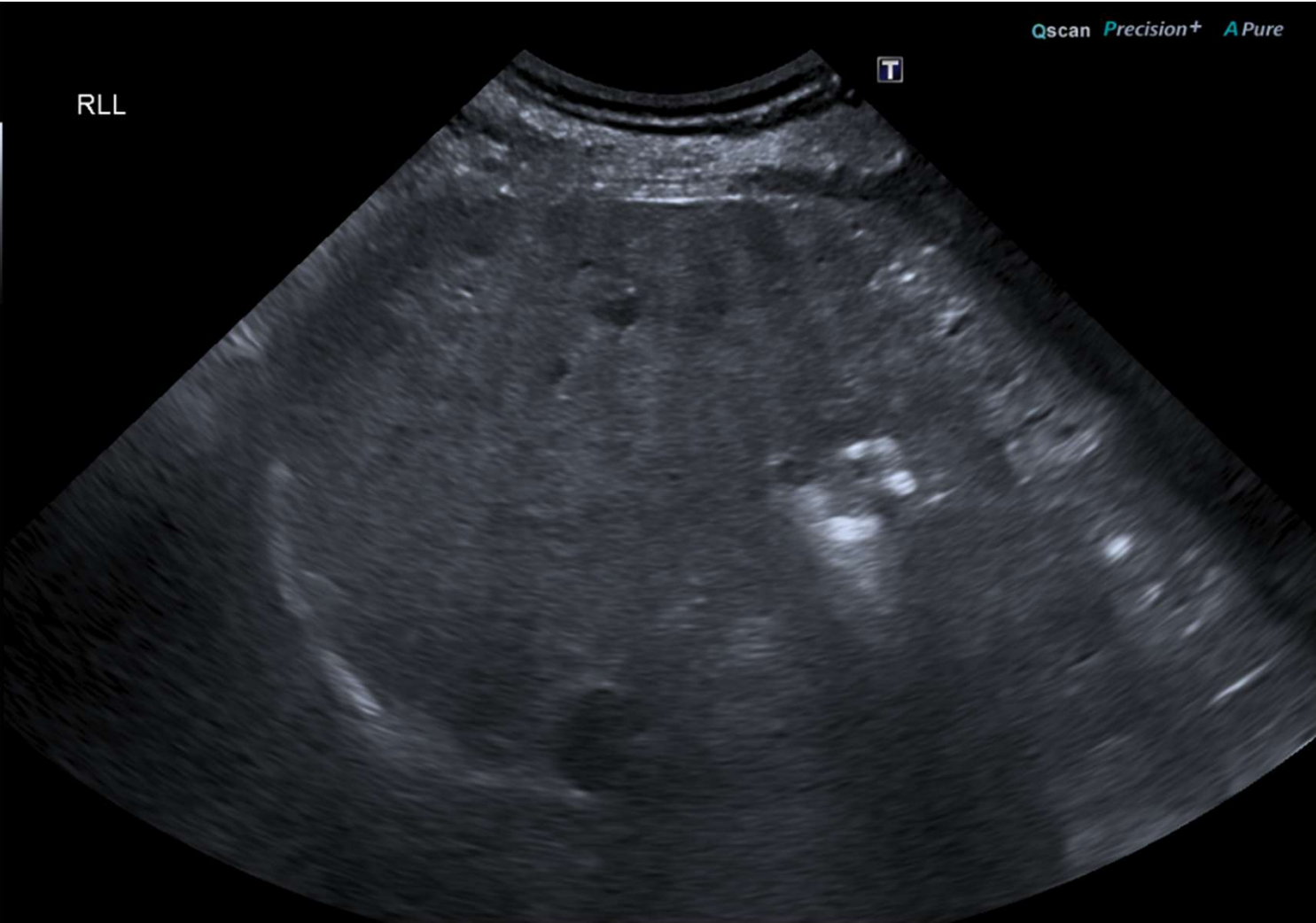
The liver is homogenous but demonstrates increased echogenicity associated with evidence of fatty infiltration. Capsule is smooth with no nodularity

No new focal lesions identified

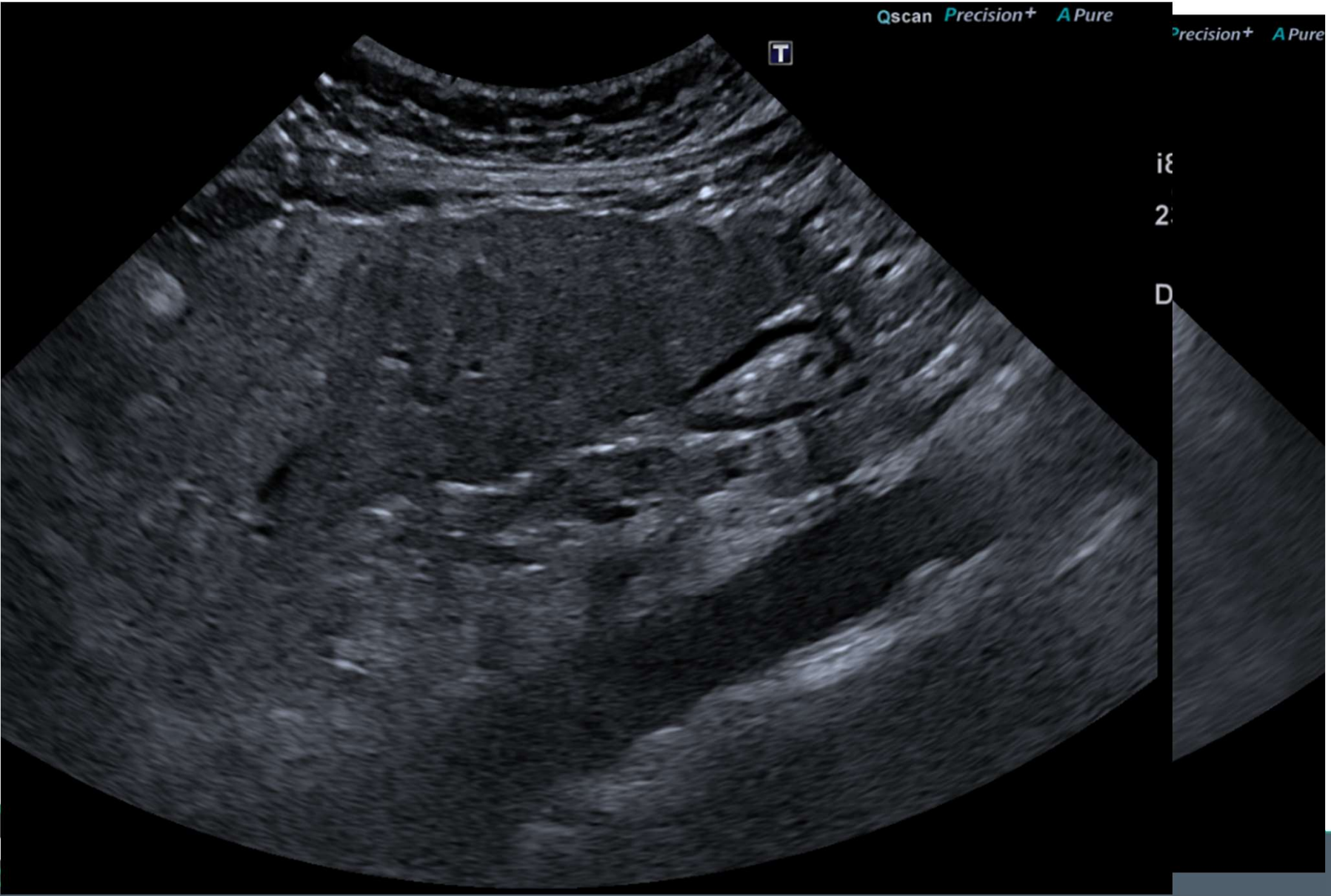
RLL

T





Remarkable people.  
Extraordinary place.

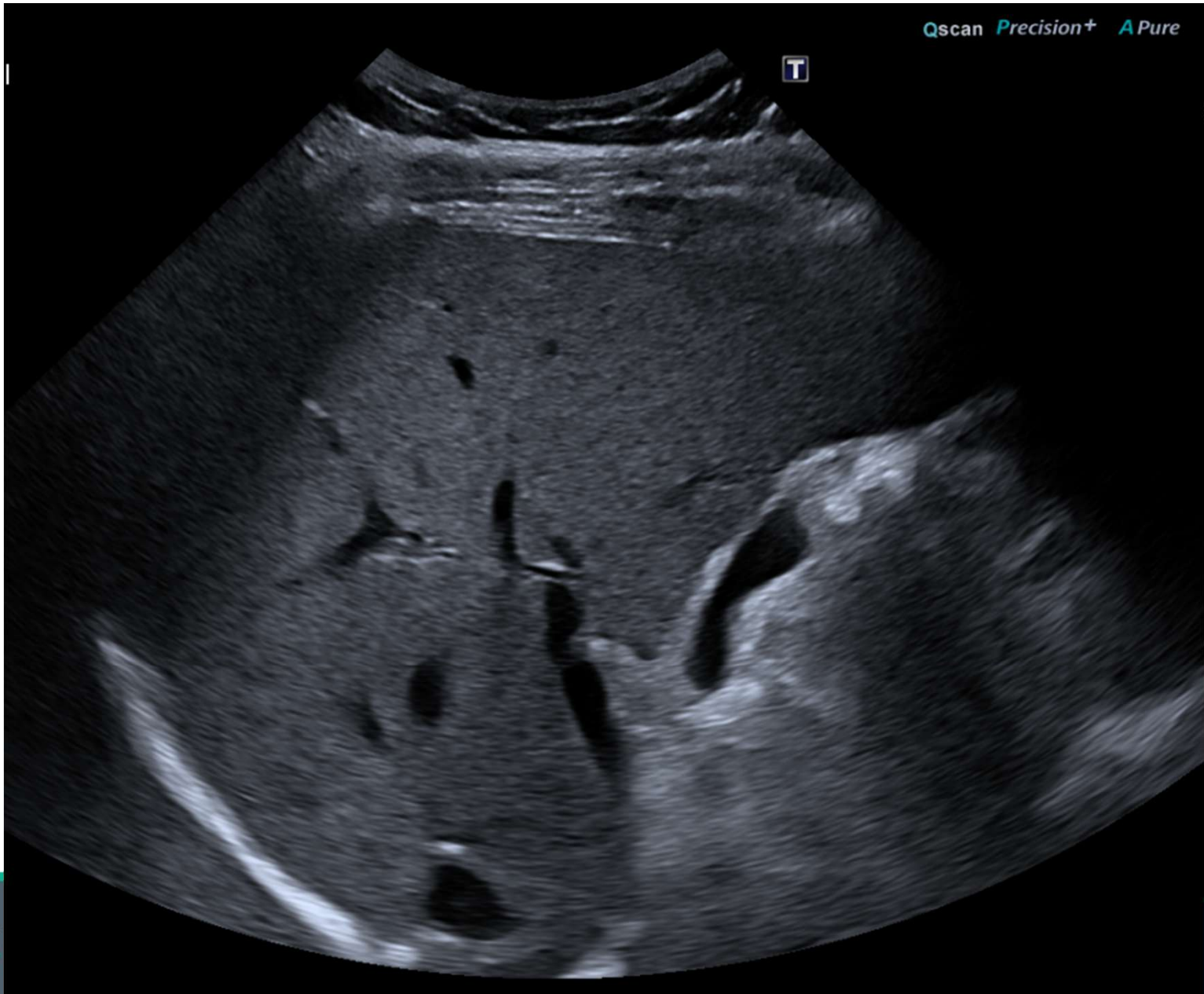


Remarkable people  
Extraordinary places

Beetroot, booze or burger?

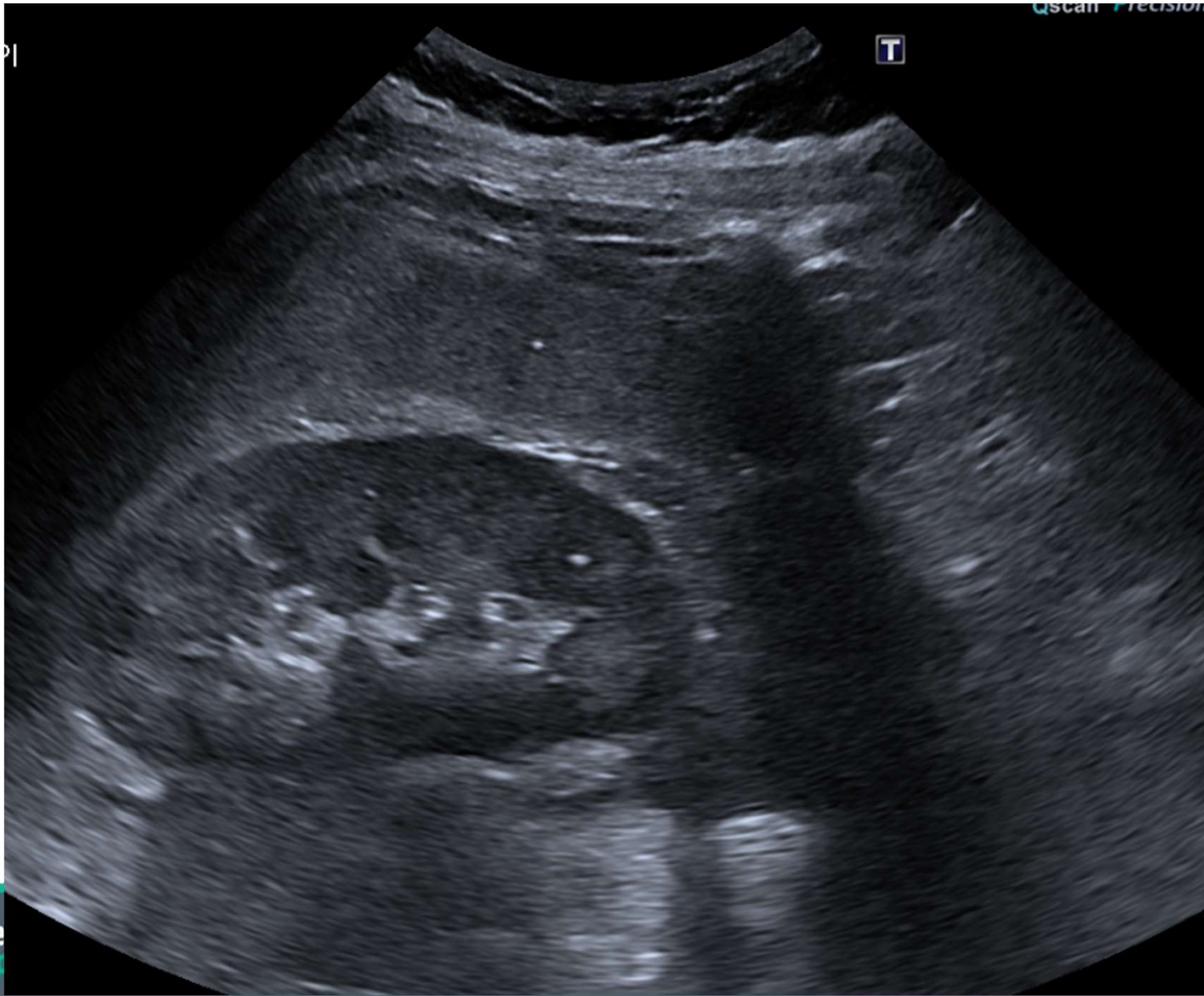
Qscan Precision+ A Pure

T



**NHS**  
University  
of Hospitals  
NHS Trust

Remarkable people.  
Extraordinary place.



Beetroot, booze or burger?

And Finally?

Suspected HCC  
– MRI  
Confirmed



Remember, in many cases, diffuse liver disease is a reversible condition

Thank you for your  
attention

Any questions?



RSPCA

The RSPCA's Stapeley Grange centre said the hedgehog was now "doing well"