Abdominal Ultrasound
Liver
Curved transducer
subcostal and/or intercostal
Colour and Power Doppler are essential
Sagittal normal right lobe of liver with the right kidney.
Portal triad - PV, HA, and bile duct

The hepatic veins drain blood from the liver into the IVC.

Right, middle and left HVS confluence with the IVC at the superior margin of the liver.

The HVs lack the hyperechoic fibrous sheath of the portal triad.
Liver segments separated by hepatic veins and portal veins

Left lobe - segments 1 (caudate lobe), 2 and 3.

Segments 7, 8 and 4 separated by main hepatic veins

Segment 5 and 6 inferior to main portal vein.
The left lobe of the liver consists of segments 1 (caudate lobe), 2 and 3. Segments 7, 8 and 4 are separated by the main hepatic veins. Segment 5 and 6 lie inferior to the main portal vein.
Falciform ligament separates the right and left lobes, is known as ligamentum teres as it descends to inferior liver margin. Hyperechoic, sometimes shadowing, and site for a patent paraumbilical vein in patients with portal hypertension.

The ligamentum venosum separates segments 2 and 3 from segment 1.
Areas of the liver which may be difficult to examine include segments 7 and 8 (at the dome of the liver, and often obscured by the right lung base) and areas immediately underneath the ribs.

Deep inspiration brings the liver down into view when scanning subcostally.

The left lobe is often accessible by scanning just below the xiphisternum. Starting in a true sagittal midline plane, then angling to either side in longitudinal planes to survey the whole area. Transverse scans are performed by angling cranially to the top of the liver, then gradually angling caudally to cover the entire area.

If gas obscures all or part of the liver, then turning the patient to the left decubitus position frequently allows better visualization.
Intercostal Views

- patient breathing gently
- supine and left decubitus
- smaller acoustic window due to rib shadows
- greatly reducing artefact
- avoiding bowel gas
- lateral and superior parts better seen
  -- align the transducer along the rib space
  - angle cranial to caudal aspect of the available space

Image: intercostal access to segments 7 and 8 demonstrates areas not seen subcostally.
Coronal scanning is another useful way of demonstrating the RLL using the intercostal spaces or right kidney as an acoustic window.

Coronal scan through the RLL demonstrating the IVC and aorta.
Focal zone placed at back third of the liver. However, this may fail to demonstrate subtle (isoechoic) and-or small lesions, move the focus up and down throughout the scan.

Image 1 focal zone set to back of liver, lesion in near field is unclear.

Image 2 focal zone anteriorly, lesion is clearly seen as a simple cyst.
Time gain compensation (TGC) should be set to display the same amplitude of echoes in the near field as the far field. In liver which attenuates sound more than normal (e.g. fatty livers) the amplification should be increased in the far field to accommodate the abnormal attenuation. If this fails, try reducing the frequency to examine the deeper areas of liver.
In slim patients subcostal scanning can give a comprehensive view of the liver, but in challenging/obese subjects intercostal scanning is necessary.

A combination of subcostal (if possible) and intercostal surveys in two patient positions will maximize acoustic access to the liver.
Some diffuse diseases result in enlargement of the liver, and frequently this is asymmetrical. Hypertrophied left and/or caudate lobes are common in patients with cirrhosis.

Reidel’s lobe,
- elongation of segment 6 below the lower pole of the right kidney
- may be misinterpreted as diffuse hepatic enlargement
- overall liver volume remains stable
- patients often have a smaller left lobe.
Normal porta hepatis, HA crosses between the PV posteriorly and the common duct anteriorly

Common variation HA lies anterior to the duct

Distinction between duct and artery is important as dilated tube may be due to biliary problems such as early obstruction, or may be due to a dilated hepatic artery which is compensating for portal vein compromise.
Colour is useful to establish the presence or absence of flow, and to determine its direction.

Doppler gives information about the vasculature which is relevant in monitoring liver disease, transplantation, liver resection and other problem-solving situations.

Image 1 – normal main PV and HA
Image 2 – power Doppler is used to locate a HA in a transplant patient
Image 3 – confluence of the HVs with the IVC
Image 1: transverse right lobe with simple cyst. Note posterior acoustic enhancement, thin capsule, anechoic, but some reverberation artefact proximally

Image 2: transverse right lobe with coarse, nodular texture consistent with cirrhosis
Focal liver lesions are extremely common. Most common is the simple cyst, which has the usual acoustic characteristics of a thin capsule, anechoic content and posterior enhancement. Image 1 shows a simple hepatic cyst. Note also that the patient has ascites.

The most common solid lesion is the benign hemangioma. (Image 2) They are usually well-defined and hyperechoic. However, in a fatty liver the hemangioma may appear hypoechoic, as the reference background liver is now relatively hyperechoic compared with normal liver. (image 3)
A further common benign focal lesion is focal nodular hyperplasia. These are frequently isoechoic with background liver and more difficult to spot than typical hemangiomas.
The most common malignant lesion is the liver metastasis. Many cancers metastasize to the liver and this may be the first presentation of the disease. Metastases have a broad spectrum of ultrasound appearances, including hyper-, hypo- and isoechoic, necrotic/cystic and calcified.

Liver metastases are particularly difficult to identify when small, and a normal baseline ultrasound scan in a patient at high risk for liver metastases can be misleading.
Suspected fatty liver most common indication with abnormal liver function tests. Fat is no longer considered exclusively a benign disease, as it can lead to steatohepatitis and in some cases to cirrhosis. Diffuse fat deposition in the liver demonstrates increased echogenicity, with increased hepato-renal contrast, increased attenuation of the sound beam and decreased prominence of the portal tracts.

Fat may be irregularly distributed in the liver, and may appear in focal areas. Focal areas of sparing are also common.

These may pose diagnostic dilemmas, and must be distinguished from focal lesions. In most cases the anatomical position (adjacent to the porta or gallbladder fossa), the angular edges of the area and its lack of mass effect (vessels proceed through the area unhindered) will indicate that this is only focal fatty change.
Cirrhosis is the end result of chronic liver most common causes are hepatitis, alcohol and fat.

The liver undergoes fibrotic change which distorts the normal architecture, frequently becomes nodular and shrunken, causing an increase in the pressure of the portal vein (portal hypertension), splenomegaly, varices and ascites.

Image 1: micronodular cirrhosis demonstrates a lobulated outline, which is highlighted by the adjacent ascites.

Image 2: macronodular cirrhosis. It may be difficult to confidently exclude focal lesions in such livers.
Image 1: Cirrhosis may cause asymmetry in the liver – for example caudate lobe hypertrophy.

Image 2: Left lobe hypertrophy with right lobe atrophy – note the gallbladder in the deep fissure between the lobes.

Image 3: Ascites outlines the nodular nature of the liver, with deep interlobar fissure.
Portal hypertension may cause changes in the portal venous flow including reversal, thrombus, and splenomegaly. Ensure the vessel is not perpendicular to the beam.
Dysplastic nodules in cirrhotic livers may start out benign. However, an increase in altered angiogenic arterial supply may trigger malignant transformation into hepatocellular carcinoma (HCC). Roughly 90% of HCCs occur in the background of cirrhosis.
Small lesions may be obscured by lung bases and/or ribs.

Ensure you use a variety of acoustic windows, scan planes and patient positions to evaluate the entire organ.

Example: the small cyst in Image 1 is partially concealed by rib shadows when the patient is supine. In Image 2 the patient has been turned onto the left side, and the cyst is now clearly visible using an intercostal approach.
Gas-containing abscesses may be misinterpreted as adjacent gas filled bowel.

Bowel can be recognized by:

- Seeing an anterior wall in front of the gas shadow
- Following the path of its tubular structure
- Looking for peristalsis
- Recognizing its appropriate anatomical site (although bowel loops can be situated superior or anterior to some livers, especially when they are shrunken)

Take into account the presenting symptoms and patient history to avoid missing an abscess.

Image 1 demonstrates a gas-containing subphrenic abscess.

Image 2 is a CT scan of the same fluid collection, demonstrating gas within the abscess.
Summary

- Evaluation of the liver demands a comprehensive survey through all the tissue. The practitioner must use a variety of scan planes, acoustic windows and patient positions in order to achieve this.
- It is important to utilize optimum equipment settings in order to interpret the appearances. Constant evaluation of the image with necessary changes in the settings throughout the scan is necessary to avoid pitfalls and interpret appearance accurately.
- Diagnosis must be made in the context of the patient’s presenting symptoms and any past history. Utilizing tools such as Doppler help to maximize the information available from the ultrasound scan.
Thank You