Imaging the liver and biliary tract

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Abstract

Several imaging modalities are used to investigate the liver and biliary tract. The commonest is ultrasound, which is safe, cheap and readily available. It is often used as a screening modality. Computed tomography or magnetic resonance imaging or both are often the next modalities of choice, and are used to explore any unusual findings detected on ultrasound. Fluoroscopic imaging procedures, such as percutaneous cholangiography and endoscopic retrograde cholangiopancreatography, are often used when intervention is required, usually for therapeutic reasons.

In this article, we describe the role of the each of these imaging modalities in benign and malignant hepatobiliary disease, summarize their use in commonly encountered conditions, such as gallstones, cirrhosis and focal liver lesions, and delineate their advantages and disadvantages. Often, a combination of different modalities is required to reach the final diagnosis. We also describe the complementary role of other less commonly used modalities.

Keywords bile ducts; computed tomography; diffuse liver disease; focal liver disease; gallstones; liver function tests; magnetic resonance imaging; ultrasound

What's new?

- The availability of three-dimensional imaging allowing reconstructions in any plane
- Newer, more liver-specific magnetic resonance imaging (MRI) contrast agents
- Diffusion-weighted MRI and positron emission tomography-computed tomography for further characterization of focal lesions

Imaging of the gallbladder and biliary tree

Plain radiography

This is rarely used in investigating liver and biliary pathology. Only 10–20% of gallstones are calcified enough to be seen on a plain abdominal radiograph. Calcifications may be due to gallstones, a 'porcelain gallbladder', which predisposes to cancer, or milk of calcium bile. Occasionally, the biliary system is seen to contain air, which may be caused by endoscopic retrograde cholangiopancreatography (ERCP), biliary enteric-fistula or biliary infections.

Ultrasonography (US)

Biliary disease: US is the commonest imaging investigation used in the initial assessment of hepatobiliary disease. It is non-invasive, quick, and easy. No ionizing radiation is involved. It is the ideal modality for gallstones, biliary dilatation and for image-guided procedures.

The gallbladder (GB) can be visualized clearly in the fasting state in most patients (Figure 1). It appears as an oval hypoechoic structure with a thin uniform smooth wall. It may be invisible because of a contracted GB, agenesis of the GB, calcified GB wall or the presence of intramural or intraluminal gas.

On US, most gallstones are highly reflective, cause an acoustic shadow and are generally mobile (Figure 2). False-negatives occur when stones are smaller than 3 mm, hidden behind a GB fold or cystic duct, if there is sludge present within the GB, or due to technical factors, such as patient habitus or operator inexperience. False-positives are uncommon but occur because of polyps, folds (spiral valve at the neck of the GB) or cholesterolosis of the GB. US provides no information about GB or cystic duct pathway function.

US has a positive predictive value and a negative predictive value of 92% and 95% respectively in patients with a clinical diagnosis of cholecystitis and a positive Murphy's sign[1] (Figure 2). It is also of value in diagnosis of complications of cholecystitis, such as GB perforation, gangrenous cholecystitis and emphysematous cholecystitis. Other GB pathologies identifiable on US include carcinoma and adenomyomatosis. In chronic cholecystitis, the GB is contracted, fibrosed and thick-walled, and differentiation from GB neoplasm may be difficult.

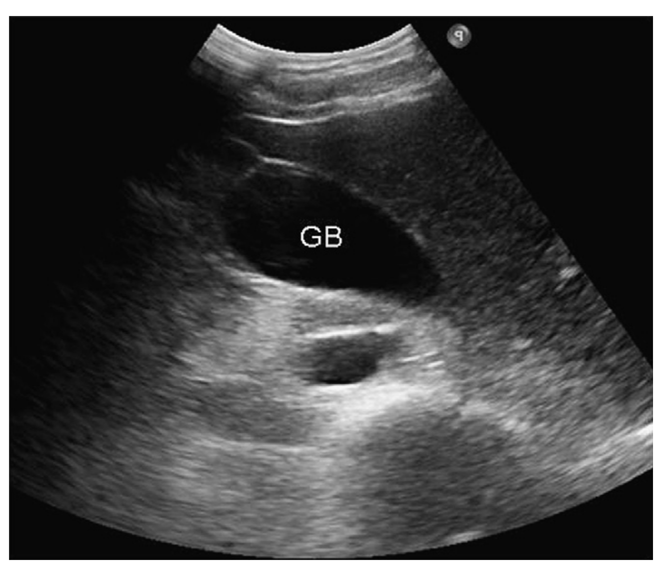

Figure 1 A normal gallbladder (GB) in the fasting state is distended and has a thin wall.

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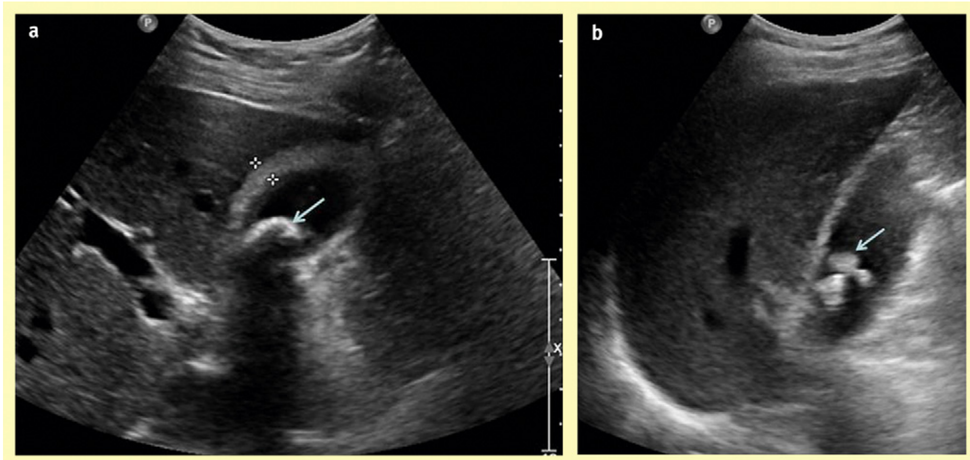

Figure 2 Acute cholecystitis with gallstone and acoustic shadow. Note the thickened wall (**) of the gallbladder and the acoustic shadowing caused by the gallstone (arrow). Not all stones cause a shadow on ultrasound as demonstrated in **b** (arrow).

US is also reliable in assessing for biliary duct dilatation. The common hepatic duct (CHD) measures 4–5 mm in diameter and is seen in almost all patients. The intrahepatic ducts (IHD) are seen only if they are dilated (Figure 3). The common bile duct (CBD) is usually seen within the head of the pancreas (Figure 4). The presence of gas in overlying stomach or transverse colon may hinder good visualization.

The CBD usually measures up to 6 mm in diameter up to the age of 60 with a further allowance of 1 mm per decade of age thereafter.[2] Previous surgery in the region, in particular cholecystectomy, can also account for non-pathological increases in diameter. Other causes of duct dilatation include intestinal hypomobility, hyperalimentation and prolonged fasting.

If true dilatation is found, an obstructive lesion should be considered. A 'double duct sign' refers to a dilated pancreatic duct and a dilated CBD, and is usually due to ampullary or pancreatic head neoplasia. Conversely, bile duct obstruction without dilatation is seen in patients with low-grade or intermittent obstruction resulting from stricture or small stones and in patients with sclerosing cholangitis.

US is only 21–63% accurate for detecting bile duct stones[3,4]; if no obvious cause for obstruction is seen further investigation is mandatory.

Liver disease: US is used as a screening tool for suspected diffuse or focal liver disease. It allows the architecture of the liver to be easily assessed. A normal liver has a uniform homogenous echotexture. The echogenicity is affected by several factors, such as the equipment, the transducer frequency and the setting on the US. It is best to compare the echogenicity against internal structures, most commonly the right renal cortex. The liver is slightly hyperechoic or isoechoic with respect to the renal cortex, provided the latter is normal (Figure 5).

US is highly sensitive in differentiating cystic from solid lesions, but not as sensitive as CT or MRI in characterizing focal solid liver lesions (Figure 6). The sensitivity for detecting liver metastases is 40–70%.[5] It is generally unable to detect lesions

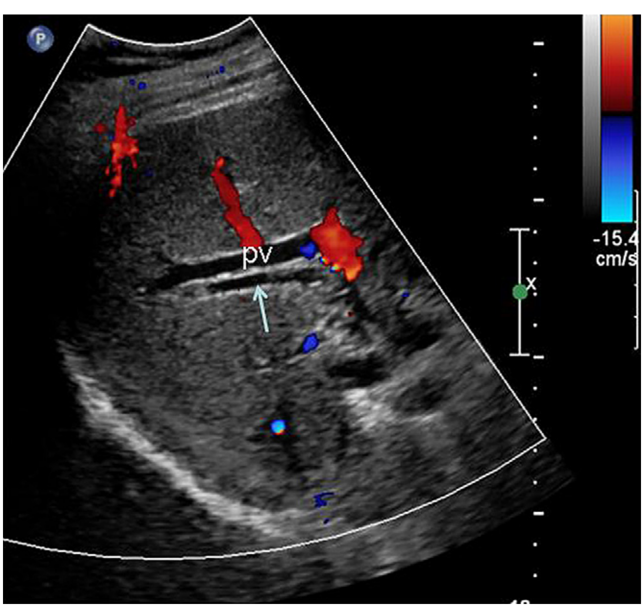

Figure 3 Normally the intrahepatic ducts (IHD) are not seen on ultrasound. When visualized it is usually indicative of biliary obstruction (arrow). Note the adjacent portal vein (pv). The proximity of the dilated IHD to the pv produces the so-called parallel sign.

Figure 4 The normal portal vein (pv) and common bile duct (**).