

Imaging of the liver: pictorial review of the most common pathologies

Introduction

The incidence of liver disease has been steadily increasing over the last 20–30 years. In developing countries, this is mainly the result of infective processes such as hepatitis C, while in developed countries liver problems are often related to increased or excessive alcohol consumption and obesity.

Clinical symptoms of liver disease are very non-specific and include abdominal pain, mainly in the right upper quadrant and epigastrium, nausea and vomiting. Abnormal laboratory tests with elevated hepatic enzyme levels can help narrow the diagnosis, but diagnostic imaging plays a crucial role in establishing the correct diagnosis and directing the patient's treatment.

This article reviews the radiological presentation of common hepatic pathologies and considers clinical indications for different imaging modalities.

Diffuse hepatic disease

Fatty infiltration

Fatty infiltration of the liver is a reversible process caused by triglyceride accumulation within hepatocytes. It is very common and can be caused by alcoholism, obesity, diabetes mellitus, parenteral nutrition, glycogen storage disease and chemotherapy. The typical sonographic appearance shows increased echogenicity of the liver compared to renal parenchyma (Figure 1), while non-contrast computed tomography examination shows ill-defined areas of decreased attenuation.

The involvement of the liver may be diffuse or focal. Diffuse changes are visible through the whole liver and are easily diagnosed. Focal changes, which include focal fatty infiltration or focal fatty sparing, can create the appearance of pseudomasses and represent a diagnostic challenge, especially in patients with known malignancy. Characteristic locations of fatty sparing are

the periportal region, caudate lobe and parenchyma adjacent to the gall bladder fossa.

Abnormal fatty areas usually have an angular and geometric margin, with normal vascularity and no features or evidence of mass effect. Ultrasonography has 85% accuracy in the diagnosis of this condition, with 100% sensitivity and 56% specificity. Magnetic resonance imaging of the liver provides a definite diagnosis in patients with unequivocal ultrasound results. T1WI and in-and-out of phase sequences are the best for characterization of fatty lesions (Kaszniak-Brown, 2011).

Liver cirrhosis

Liver cirrhosis occurs as a chronic response to repeated episodes of hepatocellular injury and is most commonly caused by alcohol abuse and chronic viral hepatitis. Pathologically, it consists of hepatocyte necrosis, fibrotic changes, fatty infiltration

and nodular degeneration, which can be macro- or micronodular in appearance.

Radiological examinations (ultrasound, computed tomography and magnetic resonance imaging) reveal a small contracted liver with an irregular, lobulated outline and coarse nodular texture (Figures 2a–c). Well-established cirrhosis includes a small fibrotic right lobe of the liver, with regenerative enlargement of the caudate and left lobe. Associated findings of portal venous hypertension are also commonly present: ascites, splenomegaly and porto-systemic varices with re-canalization of the para-umbilical vein.

However, the biggest challenge in cross-sectional imaging presents a differentiation between regenerative nodules (normal sequel of fibrotic process), dysplastic nodules (precursors of hepatocellular carcinomas) and hepatocellular carcinomas. Magnetic resonance imaging is the most successful technique in detecting and characterizing nodules in the cirrhotic liver using the combination of standard sequences (T1, T2 and gradient echo) with dynamic gadolinium enhancement and hepatocyte-specific contrast media (Kaszniak-Brown, 2011).

Benign liver lesions

Haemangioma

Haemangiomas are the most common benign hepatic lesion and are present in 4–20% of the general population. They are more common in women (female to male ratio 5:1), and their incidence increases with age. Haemangiomas are usually asymptomatic (85%) and detected incidentally. However, they can present

Figure 1. Diffuse fatty liver infiltration on ultrasound examination, showing the significant difference in echogenicity between hepatic and renal parenchyma.



Figure 2. Liver cirrhosis on (a) ultrasound, (b) computed tomography and (c) magnetic resonance imaging examination showing irregular outline of small liver, nodular parenchyma and ascites.



Dr Joanna Kasznia-Brown is Consultant Radiologist in the Department of Radiology, Musgrove Park Hospital, Taunton TA1 5DA



Figure 3. Haemangioma on magnetic resonance imaging examination with dynamic contrast enhancement showing typical peripheral nodular enhancement with delayed filling of blood vessels in central part of the lesion.

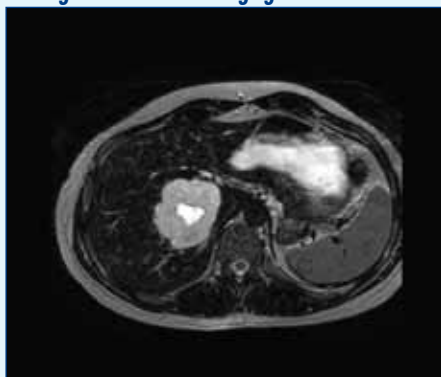
with symptoms of abdominal pain, nausea or vomiting, as a result of haemorrhage, thrombosis, rupture or compression of adjacent structures.

The most common location is the posterior aspect of the right lobe of the liver, usually in the periphery, and lesions may be multiple in up to 50% of cases.

The typical sonographic appearance of a haemangioma is a well-defined round or oval homogeneous lesion of increased echogenicity. Doppler examination shows no evidence of increased flow; blood flow is very slow in vascular channels, which creates the structure of haemangioma. The classic appearance of haemangioma is present on contrast-enhanced examinations (computed tomography and magnetic resonance imaging): an initial peripheral nodular enhancement with complete filling of blood vessels in the central part of the lesion on delayed images (*Figure 3*).

Difficulties with this technique are often noted in the bigger lesions, which may contain a central scar or irregular nodule

Figure 4. Haemangioma in right lobe of the liver with necrotic centre, presenting as a central scar on magnetic resonance imaging.



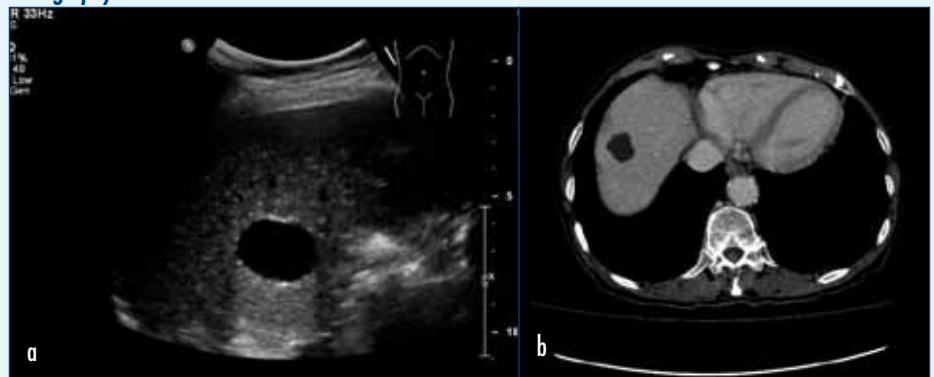
of fibrotic or necrotic tissue (*Figure 4*), which remains un-enhanced even on very delayed images. Necrotic metastatic disease may also have a similar appearance and further magnetic resonance imaging sequences have to be performed.

Liver cysts

After haemangiomas, simple liver cysts are the second most common benign hepatic lesions, occurring in approximately 2–10% of the population. They are again more common in women, and increase in frequency with age.

Sonographic criteria for diagnosis of a simple cyst include a well-defined lesion of low echogenicity, anechoic with posterior acoustic enhancement. The accuracy of ultrasound for diagnosis of cysts is 95–99%. The typical appearance of a simple cyst on computed tomography or magnetic resonance imaging is a very well-defined water-density or signal lesion with no visible walls and no contrast enhancement. Cysts usually have a typical appearance and do not represent a diagnostic challenge (*Figure 5*).

Figure 5. Typical appearance of simple cysts in the right lobe of liver on (a) ultrasound and (b) computed tomography examination.



Liver abscesses

Common causes of liver abscesses are bacterial (85%), fungal (9%) and amoebic (6%). They may develop through five major routes: biliary, portal vein, hepatic artery, direct extension from other organs or traumas. Possible causes include underlying biliary disease, diverticulitis, inflammatory bowel disease or surgical intervention. Most abscesses are multiple, occur in the right lobe of the liver, and have nearly 100% mortality if untreated.

Abscesses are easily visible on radiological examinations as ill-defined heterogeneous lesions with irregular margins and peripheral contrast enhancement (*Figure 6*).

Correlation of the imaging findings with clinical examination and patient history is essential, as cystic or necrotic metastases can have an identical appearance.

Focal nodular hyperplasia and hepatic adenomas

Focal nodular hyperplasia and hepatic adenoma are benign liver lesions, most commonly seen in young women between 20–40 years of age (85–90% of cases).

INTERPRETATIONS

Focal nodular hyperplasia is a tumour-like condition, vascular or hamartomatous in origin and is composed of normal hepatocytes, Kupffer cells and bile duct proliferation without connection to the normal biliary tree. Hepatic adenomas are composed of hepatocytes and do not contain Kupffer cells, biliary ducts or central portal veins.

Hepatic adenomas are linked to use of oral contraceptives or anabolic steroids, and glycogen storage disease. In contrary to previous beliefs, oral contraceptives do not cause focal nodular hyperplasia, but do stimulate its growth.

Lesions are usually solitary and located in the periphery of the right lobe of the liver. These are very well defined, similar to liver parenchyma with a strong arterial enhancement.

Most focal nodular hyperplasia are less than 5 cm in diameter, while adenomas are bigger, mostly 6–10 cm in diameter. They are usually asymptomatic, but may present with abdominal pain or vomiting if they become haemorrhagic or necrotic.

Focal nodular hyperplasia contains a central stellate scar of fibrosis, which does not enhance with contrast on delayed images (Figure 7). Unfortunately, only 20% of focal nodular hyperplasia have a classical central scar appearance on imaging, which makes diagnosis more difficult. Focal nodular hyperplasia does not undergo malignant transformation, in contrast to hepatic adenomas. Therefore, it is important to differentiate hyperplasia from adenomas, hepatocellular carcinomas or metastases.

Malignant liver lesions

Metastases

The liver is the most common metastatic site after regional lymph nodes, with an incidence of metastatic carcinoma 20 times greater than primary carcinoma. The true prevalence of metastatic disease is unknown, but 30–70% (depends on the primary tumour) of patients who die of cancer have liver metastases on autopsy. The typical primary tumour is often of gastrointestinal origin: colon (42%), stom-

ach (23%) or pancreas (21%), followed by breast (14%) and lung (13%), with spread through the portal vein, hepatic artery or lymphatics.

Metastases are usually multiple and involve both lobes of the liver. They present as an irregular lesion with ill-defined margins and usually decreased attenuation of computed tomography examination (Figure 8). Characteristics of the lesions depends on the primary site of the tumour (hypervascular: carcinoid tumours, renal cell carcinoma or malignant melanoma; calcified: mucinous carcinoma, neuroblastoma or osteogenic sarcoma), but most lesions show some degree of enhancement in the arterial hepatic phase.

If imaging findings are non-specific and the primary neoplasm cannot be identified, biopsy of the liver metastases is needed to guide the correct treatment.

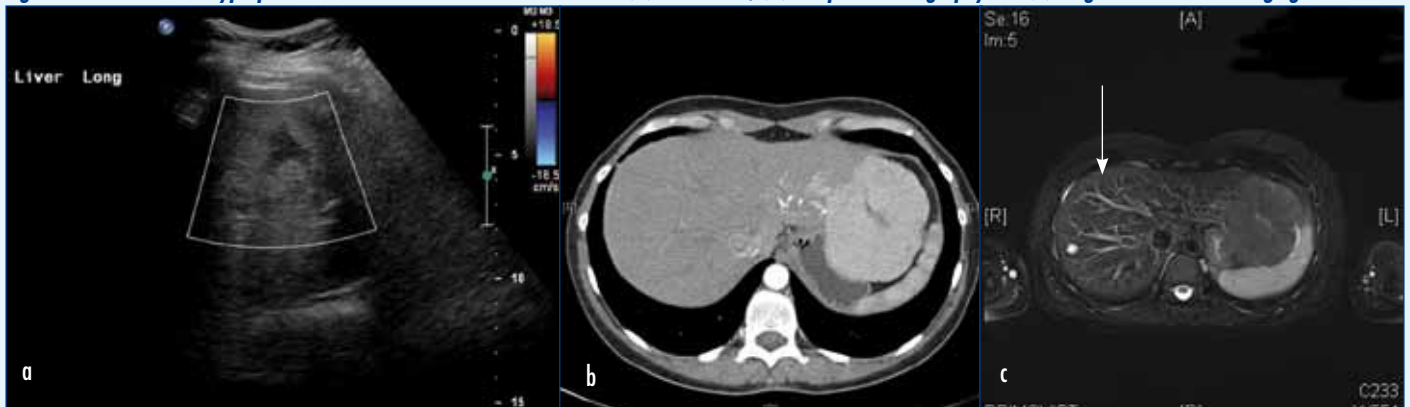
Hepatocellular carcinoma

Hepatocellular carcinoma is the most common primary visceral malignancy in the

Figure 6. Hepatic abscess in a septic patient: (a) chest X-ray showing a pocket of air under the right hemidiaphragm (arrow), (b) ultrasound showing heterogeneous fluid collection within the liver, (c) computed tomography showing heterogenous lesion in the right lobe (arrow) with an irregular peripheral enhancement and a small amount of air.



Figure 7. Focal nodular hyperplasia with a characteristic central scar on (a) ultrasound, (b) computed tomography and (c) magnetic resonance imaging.



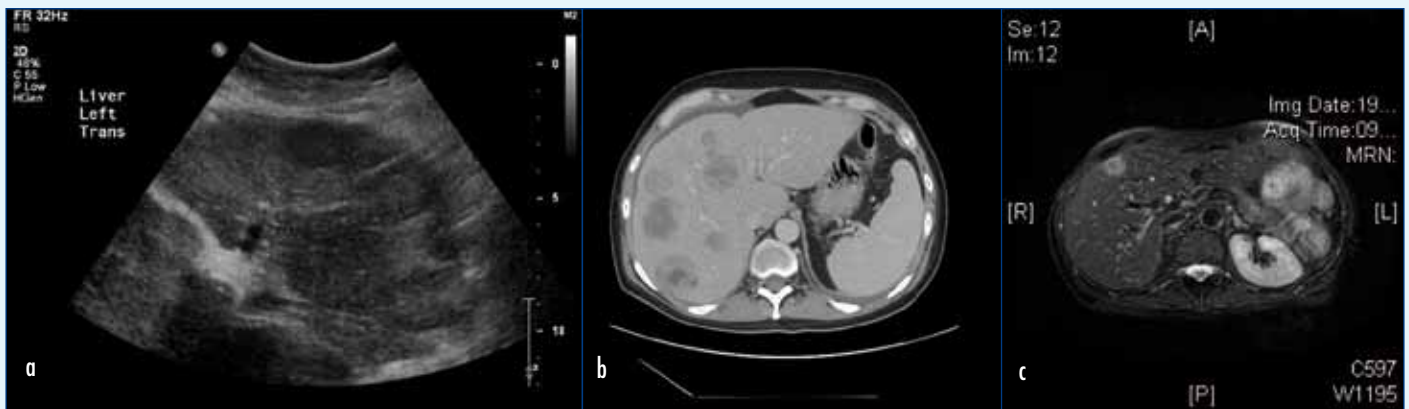


Figure 8. a. Ultrasound, (b) computed tomography and (c) magnetic resonance imaging show multiple liver metastases (arrow) in a patient with known colorectal carcinoma.

world, with an incidence of 5–20% in Asia and Africa, and 0.2–0.8% in Europe. Any patient with chronic liver disease is at increased risk of developing hepatocellular carcinoma (Figure 9). Predisposing factors include liver cirrhosis (often caused by alcohol), chronic hepatitis, various carcinogens or metabolic disease. There are three histological patterns: solitary (25%), multiple (25%) and diffuse (50%). Prognosis is usually poor, with greater than 90% mortality within 5 years.

Conclusions

Developments in imaging techniques, particularly computed tomography and magnetic resonance imaging, enable the accurate evaluation of a wide variety of focal and diffuse liver diseases. Common benign conditions such as haemangiomas, fatty infiltration or cysts do not require further treatment. However, early diagnosis of a malignant process would prompt urgent surgical or oncological treatment, which can significantly affect the patient's condition and life expectancy.

The combination of radiological findings and accurate clinical information allows a specific diagnosis to be achieved in many cases, with a significant reduction in the number of percutaneous or open liver biopsies. **BJHM**

Conflict of interest: none.

Kasznia-Brown J (2011) Imaging the liver: use of different modalities. *Br J Hosp Med* 72(5): M69–M72

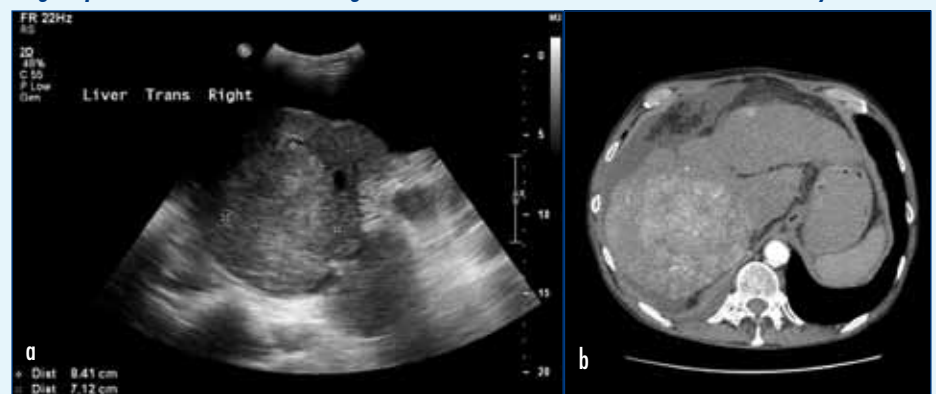
Further reading

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Figure 9. a. Ultrasound and (b) computed tomography examination show cirrhotic liver with ascites. Large hepatocellular carcinoma in the right lobe with second small lesion in left lobe anteriorly.



KEY POINTS

- An increasing number of patients with acute and chronic liver problems present the challenge of establishing an accurate diagnosis, and then providing the correct treatment.
- Patients with chronic liver impairment are at an increased risk of developing malignant disease and require regular, life-time monitoring.
- Malignant processes can mimic focal benign liver lesions and detailed investigations should be regarded as mandatory in these patients.
- The wide spectrum of imaging modalities, including complex magnetic resonance imaging examinations, allows differentiation between malignant and benign liver lesions, with a significant reduction in the number of biopsies.