INVESTIGATING LIVER DISEASE Imaging modalities

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Major advances in surgical approaches to the liver required improvements in preoperative imaging. The choice of imaging modality is determined by the likely pathology and locally available equipment and expertise (Table 69.3). Charles Gardner Child , 1908–1991, surgeon, Michigan, USA. Child and colleagues from King’s College Hospital, London, UK, modified the scoring system by replacing nutritional status with prothrombin time or international nor malised ratio. - tion - Ultrasonography Ultrasonography (US) is traditionally the first imaging modality for the investigation of jaundice and right upper quadrant pain (Figure 69.3). Good quality US can characterise benign cystic lesions but is operator dependent; accurate characterisation of malignant pathologies is not possible. Body habitus and anatomical variations frequently prevent detailed examina - tion, with steatosis reducing liver penetration; US should not be used when malignancy is suspected. US can reliably identify biliary dilatation but not the aetiology , and ov erlying air-containing viscera often prevent complete examination. Contrast-enhanced ultrasonography (CEUS), introduced in the early 1990s, uses transient intravas - cular bubbles to di ff erentiate normal liver parenchyma from solid tumours. CEUS increases US sensitivity and specificity by assessing real-time lesion vascularity with an accuracy for focal liver lesions of 90%. Computed tomography Modern spiral computed tomography (CT) technology has increased the accuracy of diagnosis and staging of liver lesions, and contrast-enhanced CT is currently the most - widely used and best validated modality . Fine detail of liver lesions with resolutions of 6–8 /uni00A0 mm is possible, liver algorithms allow characterisation and density data identify cystic lesions (Figure 69.4a). The early arterial phase following intravenous contrast detects small hepatocellular carcinomas (HCCs) owing to their predominantly arterial blood supply . The venous phase demonstrates branches of the intrahepatic portal vein and the hepatic veins. Inflammatory liver lesions often exhibit rim enhancement with intravenous contrast, whereas haemangi - omas characteristically show late venous enhancement. CT is extremely accurate when assessing the stage and resectability of liver tumours apart from peritoneal metastases. Magnetic resonance imaging Magnetic resonance (MR) of the liver is superior to CT in char - acterising focal lesions (Figure 69.4b). The resolution for small metastases is superior and is further improved by liver-specific and Jeremiah G Turcotte first proposed the scoring system in 1964. In 1972, RN /uni00A0 Pugh -

Figure 69.3 Ultrasound scans of the liver. (a) Normal liver /uni00A0 and (b) surveillance for a patient with cirrhosis demonstrating hepatocellular carcinoma (arrow).

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Imaging modality Principal indication Ultrasonography Standard /f_i rst-line investigation CEUS 90% accurate for focal lesions Spiral CT Investigation of malignancy Cancer surveillance Anatomical planning for liver surgery MRI Alternative to spiral CT Characterisation of liver lesions Liver-speci /f_i c contrast agents are taken up by hepatocytes, which are absent in malignant lesions, which consequently contrast with the enhanced background liver MRCP First-line, non-invasive cholangiography Investigation and surveillance of parenchymal liver disease (sclerosing cholangitis, autoimmune cholangitis) for the development of malignancy ERCP Therapeutic procedure only Imaging the biliary tract when endoscopic intervention is required (stones, strictures, iatrogenic and traumatic injury) PTC Biliary tract imaging when ERCP not possible or failed EUS Generally for examination of the extrahepatic biliary tree and pancreas Caudate lobe, hilar nodes and liver parenchyma can be assessed Octreotide scanning Form of scintigraphy used to identify and localise NETs and carcinoid tumours Particularly useful to exclude metastatic disease HIDA scanning Determination of the patency of the intra- and extrahepatic biliary system and investigation of biliary atresia and jaundice following liver transplantation Angiography To detect vascular involvement by tumour Treatment of vascular pathology (pseudotumours, haemobilia, iatrogenic injuries, trauma) PET scanning To quantify tumour spread Differentiate benign and malignant pathologies Laparoscopy To detect peritoneal and serosal disease, assess the extent of tumours and spread ± laparoscopic Ultrasonography to determine the relationship of tumours to vascular structures and biopsy of liver tumours ultrasonography and super /f_i cial lesions CEUS, contrast-enhanced ultrasonography; CT, computed tomography; ERCP , endoscopic retrograde cholangiopancreatography; EUS, endoscopic ultrasonography; HIDA, hepatobiliary iminodiacetic acid; MRCP , magnetic resonance cholangiopancreatography; MRI, magnetic resonance imaging; NET, neuroendocrine tumour; PET, positron emission tomography; PTC, percutaneous transhepatic cholangiography. /uni00A0 (a) Figure 69.4 Computed tomography (CT) and magnetic resonance imaging (MRI) scans of the same patient following a road traf /f_i c accident and fall from a motorcycle. CT scan (a) was interpreted as a traumatic haematoma, but the MRI scan carcinoma. (b) (b) demonstrated an incidental hepatocellular

contrast agents, particularly in di ff erentiating between small HCCs and regenerative nodules. Magnetic resonance cholan giopancreatography (MRCP) provides excellent, non-invasive imaging of the intra- and extrahepatic biliary tract with an accuracy comparable to direct cholangiography . Positron emission tomography Positron emission tomography (PET) scanning is a functional test that demonstrates the metabolic activity of a tissue. A variety of tracers are available depending on the process being investigated. For the investigation of malignancy 18 F-2-fluoro-2-deoxy-d-glucose is commonly used, and detec tion depends on the avid uptake of glucose by malignant cells compared with benign or inflammatory tissue. Deoxyglucose is 18 labelled with the positron emitter fluorine-18 (F-FDG) which is administered prior to PET imaging. A three-dimensional image of the whole body is obtained, highlighting areas of increased glucose metabolism (Figure 69.5). A positive PET scan result does not always indicate malignant disease (inflam mation being the most common cause of a false-positive result), and conversely false-negative results occur. A critical mass is required for adequate uptake to be detectable, and resolution is similar to CT and MRI. PET scanning is particularly useful for the detection of metastatic disease and confirmation of lymph node involvement, serving as ‘its own control’ if some lesions prove to be FDG avid and some are

cold. Angiography Angiography is almost exclusively employed when therapeutic intervention is considered; occlusion of arteriovenous malfor mations, embolisation of bleeding sites in the liver and the treatment of liver tumours by transarterial chemoembolisation (TACE). Octreotide scan Octreotide scanning is a form of scintigraphy in which radio isotopes attached to drug carriers are taken up by specific tissues or processes (Figure 69.6). Octreotide is an octapeptide that pharmacologically mimics somatosta tin. When radiolabelled with indium-111 and administered intravenously it is taken Gerald Klatskin , 1910–1986, pathologist, Yale School of Medicine, New Haven, CT , USA. - - up by tumour cells containing somatostatin receptors; emitted gamma radiation is detected by a scintillation camera and a whole-body image constructed. It is particularly useful for the identification of carcinoid and neuroendocrine tumours (NETs) and metastatic disease, with a 75–100% sensitivity for - detecting pancreatic NETs.

(b) Figure 69.5 Computed tomography scan (a) and positron emission tomography scan (b) of a patient with a large colorectal metastasis and hilar lymph

adenopathy. Figure 69.6 Octreotide scan demonstrating liver metastases from a neuroendocrine tumour with additional metastatic disease in medias

tinal lymph nodes.

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