

Cystic hepatobiliary lesions: differentiation with cross sectional imaging

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ABSTRACT

The purpose of this article is to review the imaging findings of cystic hepatobiliary lesions in the adult in order to identify any features that will help the radiologist understand and recognise the underlying disease. Cystic hepatobiliary lesions in the adult can be classified as developmental, neoplastic, inflammatory, infectious and miscellaneous. Congenital cystic liver lesions are in general simple cysts, including benign developmental hepatic cysts, hamartomas (von Meyenberg complex), Caroli disease and adult polycystic liver disease. Neoplastic cystic lesions include biliary cystadenoma-cystadenocarcinoma, cystic metastases and cystic subtypes of primary liver neoplasms

or other liver lesions (such as cystic haemangioma). Inflammatory or infectious hepatic cystic lesions include abscess (pyogenic, amoebic or fungal) and echinococcal cysts. Miscellaneous cystic liver lesions include post-traumatic haematoma, biloma, infected or haemorrhagic hepatic cysts and intrahepatic pseudocyst. In this article, specific imaging features on computed tomography and magnetic resonance imaging of hepatobiliary cystic lesions, such as presence and thickness of a cystic wall or septations, calcifications or nodularity, enhancement (in and around the lesion), will be displayed in order to help the radiologist to approach the correct diagnosis.



KEY WORDS

Cystic lesion/liver; Computed tomography/diagnosis, MR imaging/diagnosis



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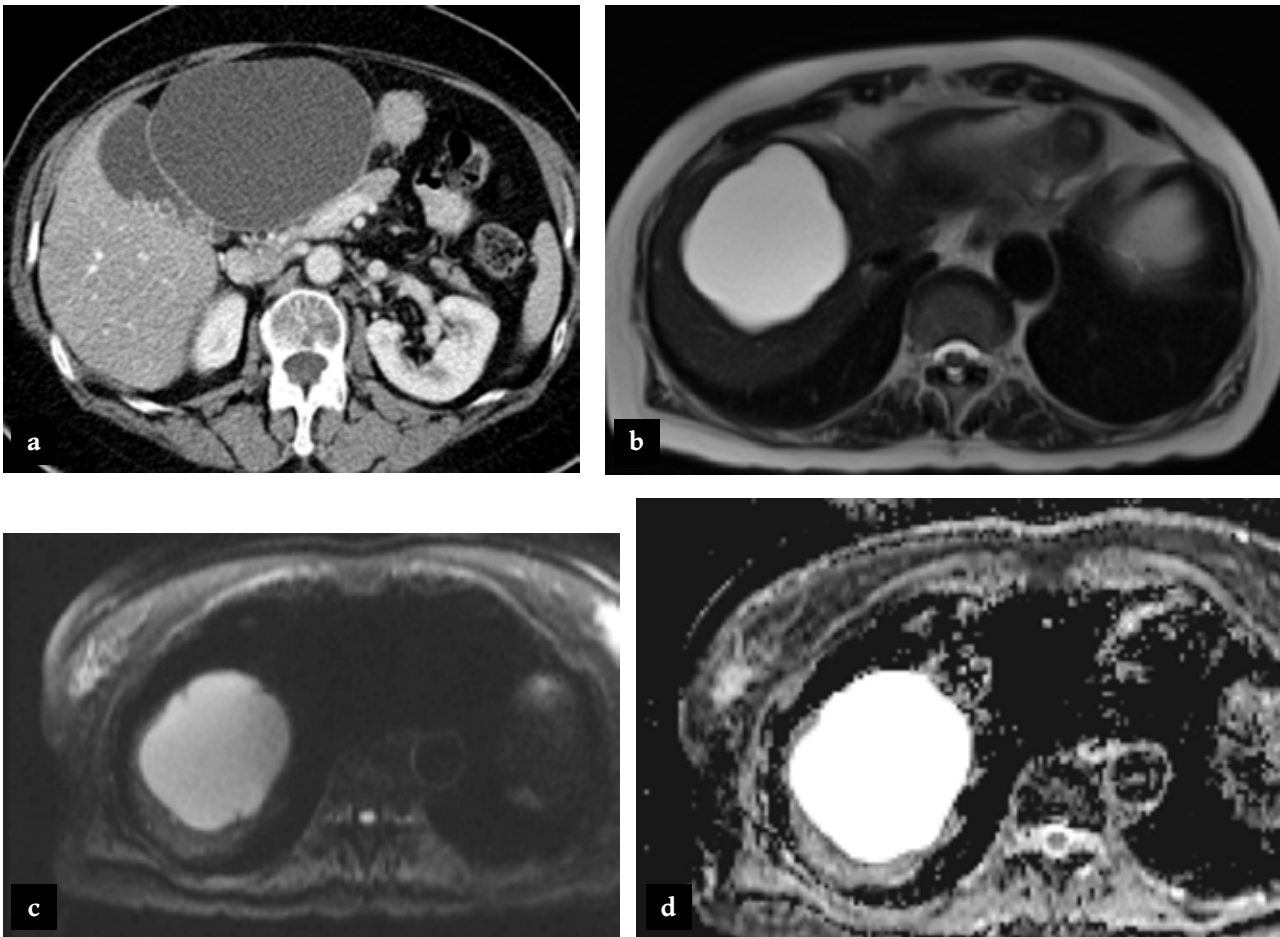


Fig 1. Benign developmental hepatic cyst. **a.** Contrast enhanced CT scan shows a water density lesion in the left lobe of the liver, adjacent to the gallbladder with sharply defined margins and smooth thin wall. **b.** Benign developmental hepatic cyst in the right lobe of the liver shows homogeneous high signal intensity on axial T2-weighted MR image. **c, d.** On MR DWI, there is no restriction of the lesion, demonstrating the clear fluid content of the cyst (compare the DWI on **c** with the ADC image on **d**).

1. Introduction

Cystic hepatobiliary lesions in the adult population can be classified as developmental, neoplastic, inflammatory or infectious and miscellaneous [1]. Depending upon the diagnosis and aetiology, there is a clinical implication regarding patient management and treatment of those cystic lesions (surgery vs percutaneous intervention vs conservative treatment) [2]. Although using only imaging features it is not always easy to characterise a cystic hepatobiliary lesion, the appropriate use of specific radiological findings together with clinical parameters, such as age and gender, history, clinical signs and patient symptoms, can help shorten the differential diagnosis and approach the correct diagnosis [3]. Familiarity with the most relevant computed tomography (CT) and MR imaging (MRI) features of hepatobiliary lesions, in cor-

relation with clinical signs and histopathological background, will assist the interpretation of liver images in daily practice.

2. Developmental lesions

2.1 Benign developmental hepatic cysts

Simple hepatic cysts are benign developmental lesions that do not communicate with the biliary system [4]. The current theory is that those cysts arise from hamartomatous tissue [5]. Hepatic cysts are frequently multiple, usually asymptomatic and discovered incidentally on imaging studies, representing the second most common benign hepatic lesion after haemangiomas. On CT, hepatic cysts are water-density lesions (-10 to +20 Hounsfield Units-HU), with sharply defined margins and smooth, non-enhancing wall [4]. They usually lack septa, do not

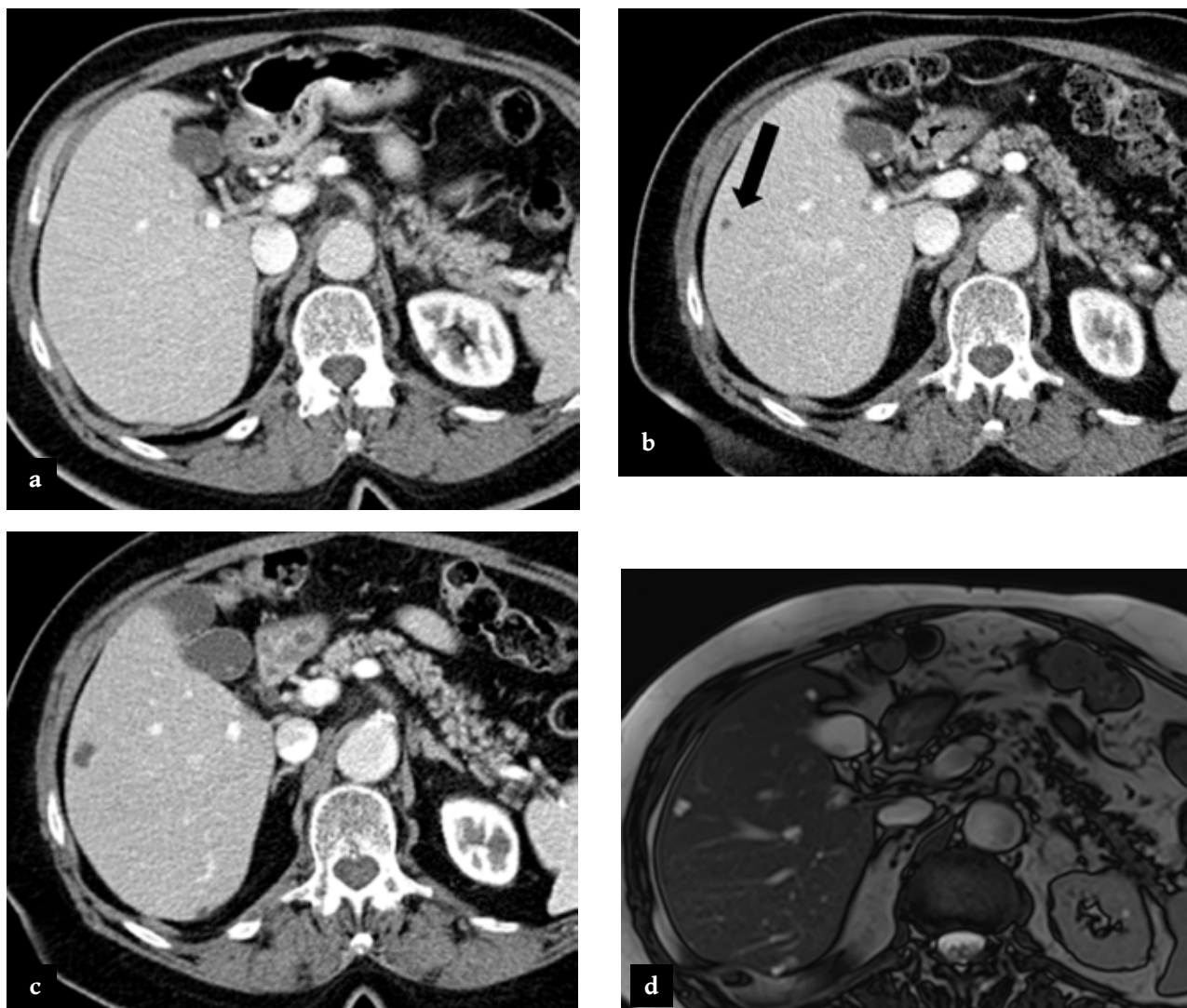


Fig. 2. Benign developmental hepatic cyst growing in size in a 65-year-old oncologic patient (bladder carcinoma). Serial CT imaging: in year 2013 (a) no hepatic liver lesion is seen in the right lobe subcapsular part of segment V; in year 2015 (b) there is a “new” lesion seen in the periphery of the liver (arrow). The small size of the lesion does not allow characterisation and a new lesion could suggest metastasis; in year 2018 (c) there is obvious growing of the lesion, with water density values (not displayed, but measured) and sharply defined margins. In year 2016 an MR image (true-fisp sequence) (d) demonstrates the high intensity of the subcapsular lesion representing a cyst. The use of true-fisp sequence might help to differentiate small cystic lesions and/or haemangiomas from other focal hepatic lesions.

contain debris and have no calcifications or mural nodules. On MRI, the high signal intensity on T2-weighted images (WI) is a typical finding that helps differentiate them from other cystic lesions. Hypointensity on T1WI, no enhancement and no restriction on Diffusion Weighted Imaging (DWI) are characteristic of a simple hepatic cyst (Fig. 1). Intracystic haemorrhage and infection are rare complications resulting in variable imaging appearances [4]. Hepatic cysts may progress or decrease in size

within a period of time. “New” small cysts (growing between two follow-up exams) may produce diagnostic challenges in patients with known neoplastic disease, specifically if the small size of the lesion does not allow accurate attenuation measurement on CT. MRI might be helpful in those cases, with the use of heavily T2WI or true-FISP (balanced FFE), a hybrid sequence, giving the high signal intensity of the cysts, as opposed to slight or absent hyperintensity of metastatic lesions (Fig. 2).

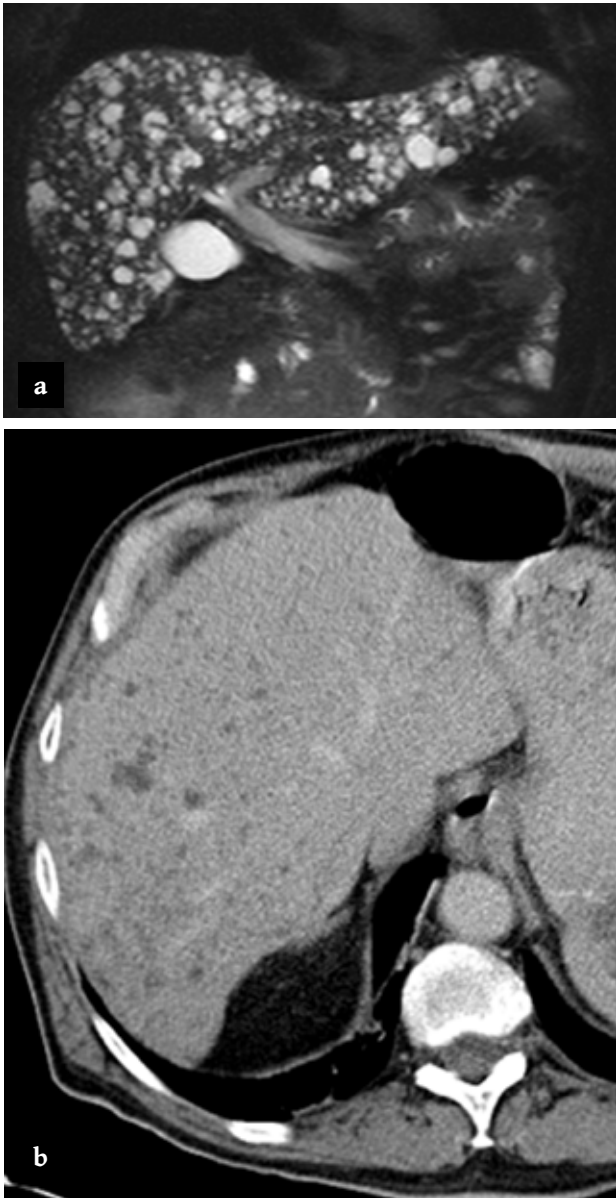


Fig. 3. Biliary hamartomas. **a.** Heavily T2WI axial MR image, demonstrates small innumerable rounded lesions of high intensity scattered throughout the liver parenchyma. **b.** Contrast enhanced CT reveals uniformly small low attenuation lesions predominantly seen in segment V and VI of the right lobe. The segmental distribution of hamartomas might produce diagnostic problems if this focal appearance of a known diffuse disease is not recognised: on surgery in this patient with colon carcinoma, liver fibrosis was seen and biopsy revealed fibropolycystic disease of the liver with hamartomas.

2.2 Biliary hamartomas (von Meyenburg complex)

Biliary hamartomas are rare malformations of the biliary tract [4]. Embryologically, the ductal plate consists initial-

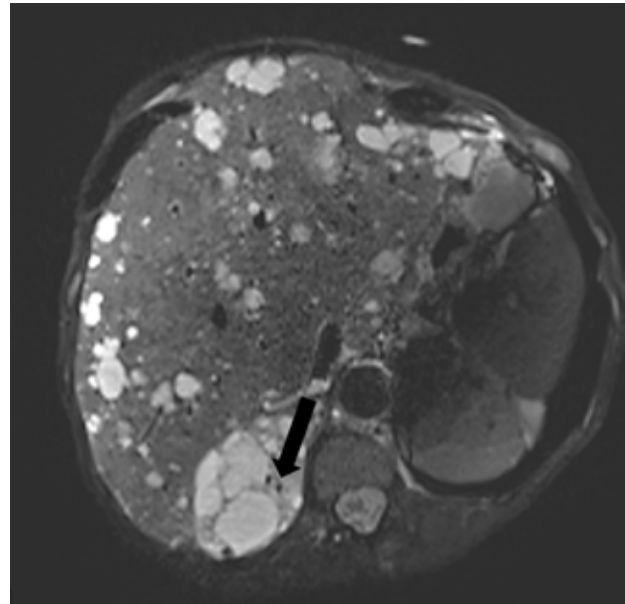


Fig. 4. Caroli disease. Axial T2WI MR image, shows multiple hyperintense cystic ectasias. The "central dot" sign (arrow) is seen as a tiny black dot structure.

ly of a double layer of cells, surrounding the portal vein branches. Later on, the two layers fuse and reabsorb, while some unfused portions of the two layers will constitute the bile ducts, that are then incorporated into the portal mesenchyma. Anomalies that affect the remodelling of the ductal plate constitute a disorder known as fibropolycystic liver disease [5, 6]. Depending upon the stage of the involution-remodelling process and the time of gestation, different clinicopathologic disorders result. Hamartomas result from ductal plate malformation of the small interlobular bile ducts [6]. Hamartomas of the liver are usually multiple small lesions (<1.5 cm in size) with cystic appearance (hypoattenuating on CT, of high signal intensity on T2WI), scattered through the parenchyma or in groups in one lobe. Occasionally, they can be mistaken for metastatic disease, because the small size on CT does not allow characterisation. Magnetic Resonance Cholangiopancreatography (MRCP) may help to differentiate hamartomas from other non-benign lesions, since hamartomas demonstrate high intensity on MRCP images (**Fig. 3**). Enhancement is seen occasionally as a peripheral rim, a finding that could lead to erroneous diagnosis. Hamartomas do not communicate with the biliary tree.

2.3 Caroli disease

Caroli disease is the result of ductal plate malforma-

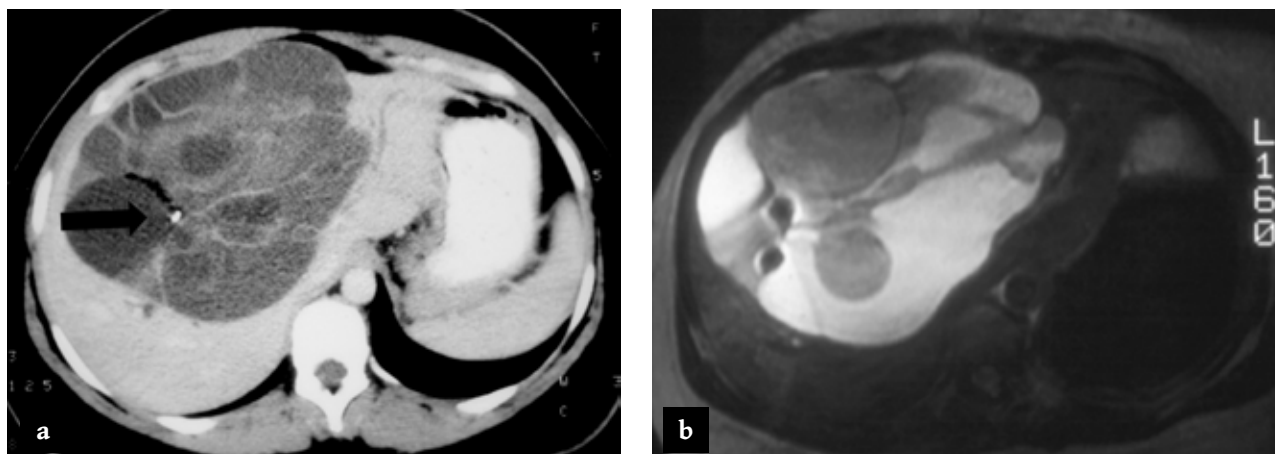


Fig. 5. Biliary cystadenoma. **a.** CT contrast enhanced image demonstrates the multilocular appearance of the cystic mass with irregular internal septations and different attenuation values of the internal loculi of the lesion. The central white “point” in the image (arrow) represents clips from previous partial removal of the neoplasm. **b.** T2WI MRI in the same patient reveals the different signal intensities of the cystic mass, with both high and low signal on T2WI, expressing the serous and non serous content of the loculi (blood, tinged bile).

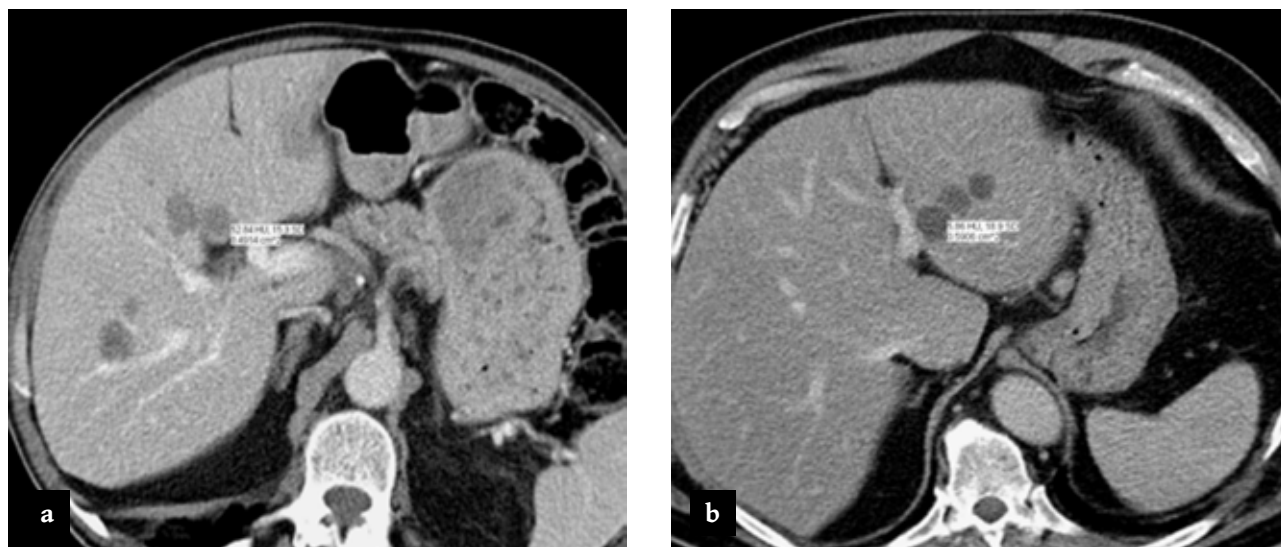


Fig. 6. Cystic metastases vs simple benign cysts on enhanced liver CT. **a.** Multiple low attenuation lesions giving the visual impression of simple cysts. However HU value is 52. **b.** Similar appearance of low attenuation lesions in the left lobe. Attenuation measurements demonstrate benign cysts (HU 5.8). Therefore it is recommended to measure the HU value of low attenuation lesions in order to avoid misinterpretation of images.

tion of the large intrahepatic ducts and is characterised as a multifocal cavernous ectasia of the biliary tree which retains communication with the bile ducts. As a fibropolycystic disease [1], Caroli is described in two types: the most common Caroli syndrome (with periportal fibrosis) and the rare proper-simple form, associated with intrahepatic stone formation and cholangitis [7]. The abnormality can be segmental or diffuse. CT

demonstrates hypoattenuating dilated cystic structures that communicate with the biliary tree. The presence of contrast enhancing central tiny dots within the cystic elements of the anomaly, called “central dot” sign, is suggestive of Caroli disease [7-9]. The central dot represents portal vein radicals. Intraluminal stones may be present. On MRI the typical cystic areas are better seen on T2WI as hyperintense cysts that communicate

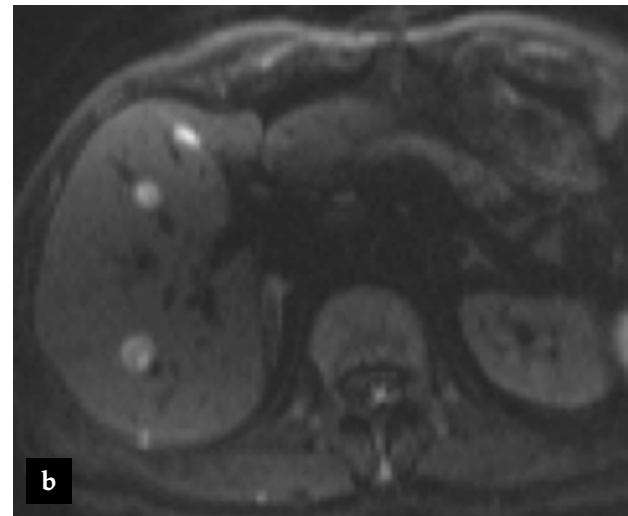
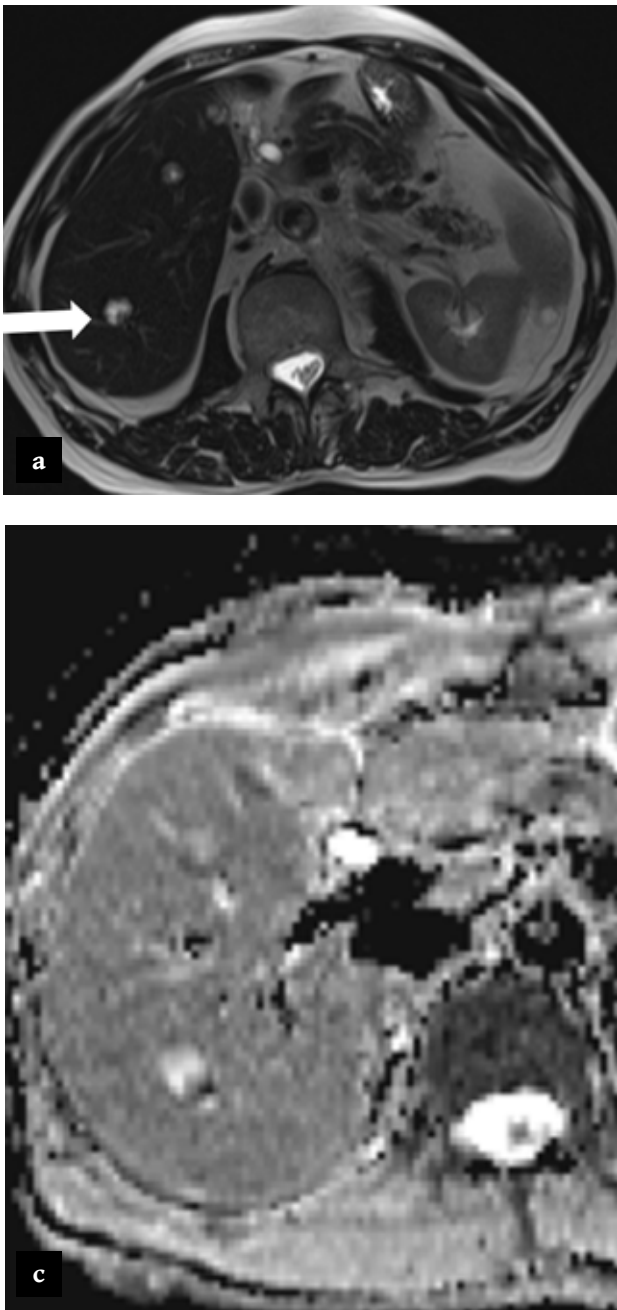


Fig 7. Cystic metastatic lesions from a gastric GIST tumour. **a.** On T2WI image there are two lesions visible with cystic elements (the larger marked with an arrow). On the DWI (800) image (**b**) and on the ADC image (**c**) there is diffusion restriction in the periphery of the lesion demonstrating cellularity. Therefore, there is viable tumour tissue in the periphery of this necrotic-cystic metastasis. DWI is recommended for the evaluation of treated GIST metastases of the liver.

2.4 Adult polycystic liver disease

This is an autosomal dominant disorder, often found in association with renal polycystic disease [2, 5, 10]. The numerous hepatic cysts are of various sizes, have similar appearance to the benign developmental cysts and may demonstrate complications such as internal haemorrhage or infection (see section “Miscellaneous lesions” below). MRI is more sensitive than CT for differentiating complicated cysts. Although usually asymptomatic, patients with polycystic liver disease may demonstrate liver dysfunction, hepatomegaly or Budd-Chiari syndrome.

3. Neoplastic lesions

3.1 Undifferentiated sarcoma

This is a rare malignant tumour seen in older children or young adolescents [3, 11]. Usually the tumour presents as a large solitary cystic mass with a peripheral pseudocapsule. Internal septation may be present. CT and MRI show the cystic components together with septations and sometimes calcification(s). The myxoid and necrotic or haemorrhagic appearance of the mass is evident as a complicated cystic lesion with inhomogeneous densi-

with the biliary tree as seen on MRCP [4]. Using hepatobiliary contrast agents, it is possible to demonstrate the communication of the cysts with the bile ducts on the hepatobiliary secretion phase of the contrast agent. The “central dot” sign is seen as a tiny black dot structure on T2WI (**Fig 4**). Caroli disease is associated with cystic renal disease and can progress to cirrhosis or develop into cholangiocarcinoma, with a higher prevalence than in the normal population. Superinfection of the cysts is not uncommon.

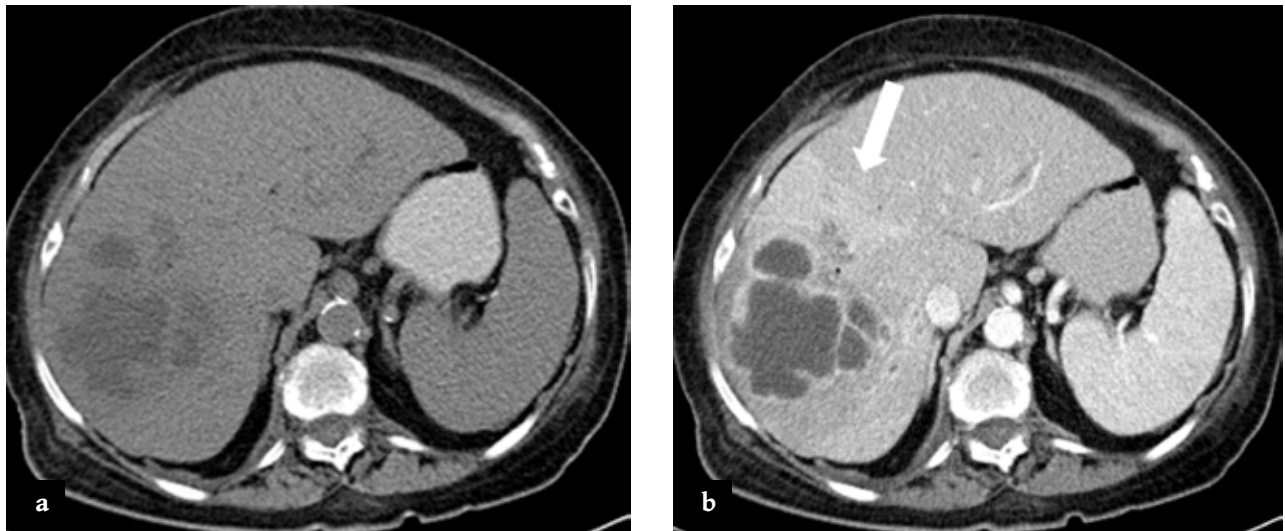


Fig. 8. Pyogenic abscess. Non enhanced (a) and contrast enhanced (b) CT of the liver demonstrate an amorphous cystic lesion in the right lobe with irregular septations and peripheral, as well as septal enhancement. Note the reactive enhancement of the adjacent liver (arrow).

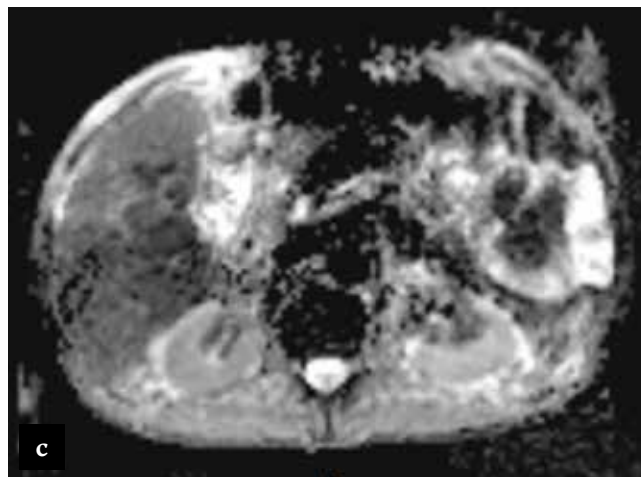
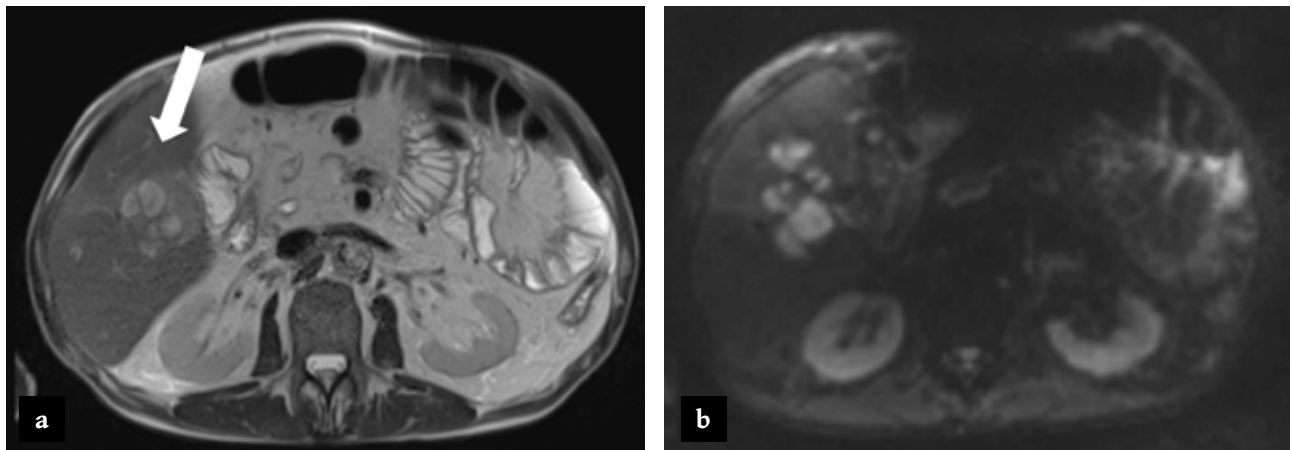


Fig. 9. Pyogenic abscess in the right hepatic lobe in a patient after liver transplantation. a. The multilocular cystic appearance of the lesion (arrow) resembles a grape (“cluster of grapes” sign). DWI (800) (b) and ADC (c) image of the lesion demonstrate diffusion restriction seen in abscesses (reduced signal intensity on ADC image as opposed to high signal intensity on DWI image).

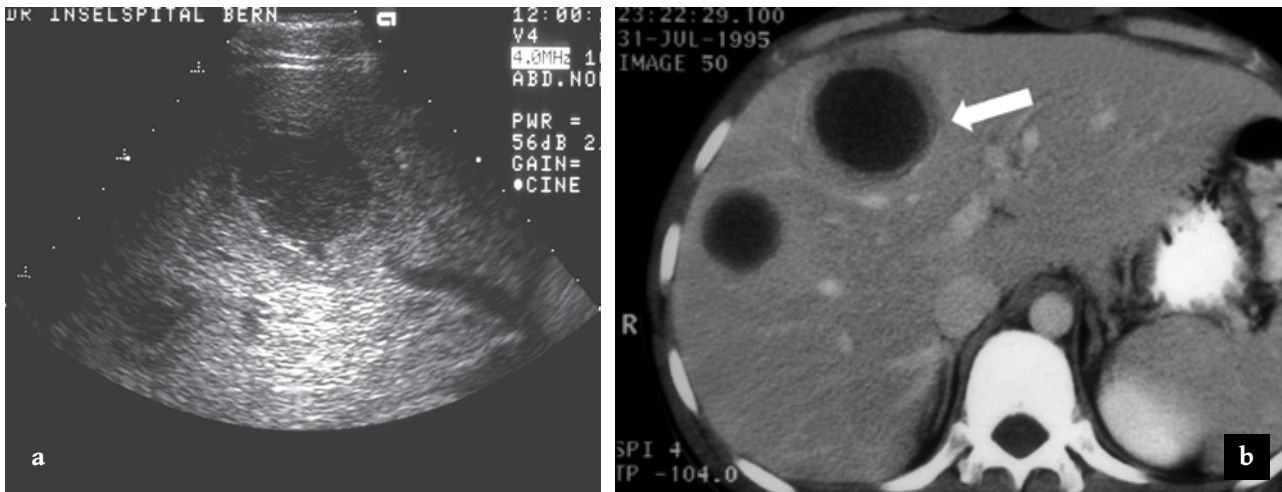


Fig. 10. Amoebic abscesses in a young man. **a.** Sonography of the right liver lobe demonstrates two hypoechoic lesions, the smaller one looking like a “donut” (with central low and peripheral high echogenicity). **b.** Contrast enhanced CT demonstrates the typical appearance of the amoebic lesions (double target sign), by means of a cystic lesion with an enhancing periphery and a low attenuation zone between the normal parenchyma and the hepatic lesion (arrow).

ty-attenuation values and inhomogeneous signal intensities on cross-sectional imaging.

3.2 Biliary cystadenoma and cystadenocarcinoma

Biliary cystadenomas and cystadenocarcinomas are rare multilocular cystic tumours, accounting for 5% of tumours of biliary origin. Cystadenomas are premalignant lesions that can progress to carcinoma [2, 3]. Seen mostly in middle aged women, they manifest with pain or jaundice. They are rather multiloculated lesions compared to solitary cysts, with irregular septation and different fluid contents due to mucus, blood or tinged bile, producing different intralocular attenuation or signal intensity values on CT and MRI (Fig. 5). Punctate calcifications can be visible as well. Due to the malignant potential of cystadenoma, treatment requires surgical resection [12].

3.3 Cystic metastases

Hepatic metastases may be seen as cystic lesions as a result of necrosis and cystic degeneration (i.e. because of rapidly growing hypervascular masses as seen in neuroendocrine tumour metastases), as a manifestation of mucinous colonic carcinoma or as a metastasis of ovarian cancer [2, 13]. Thick irregular walls, enhancing septations or mural nodule(s), internal debris (due to haemorrhage or necrosis) and perilesional enhancement are seen on CT and MRI. Metastases from ovarian cancer are seen as cystic serosal implants on the visceral peritoneal

surface of the liver, giving the specific impression of sub-capsular lesions. This differs from the haematogeneous hepatic metastatic lesions seen rather centrally in the liver parenchyma.

Small cystic metastases may be seen as having similar attenuation to that of benign cysts by means of CT if they are small. Therefore not only the visual assessment is recommended, but the absolute measurement of the HU values is necessary in order to avoid erroneous diagnoses (Fig 6).

One specific entity that needs attention is the metastatic gastrointestinal stromal tumour (GIST). GIST metastatic hepatic lesions may become cystic specifically after treatment and usually appear larger than the initially pre-treated lesion. This “progress” in size may be erroneously interpreted as “progress” of the disease, although this is an expected finding after successful treatment of GIST metastases. Caution is needed in such cases. DWI MRI is recommended in order to differentiate either a simple cyst from a cystic metastasis or to evaluate active tumour components in cases of a treated GIST metastasis with current cystic appearance (Fig.7).

3.4 HCC after embolisation

Treated primary (i.e. hepatocellular carcinoma) or secondary malignant lesion(s) may appear cystic on imaging [2, 10]. Knowledge of the patient’s history and comparison with previous examinations if available are essential

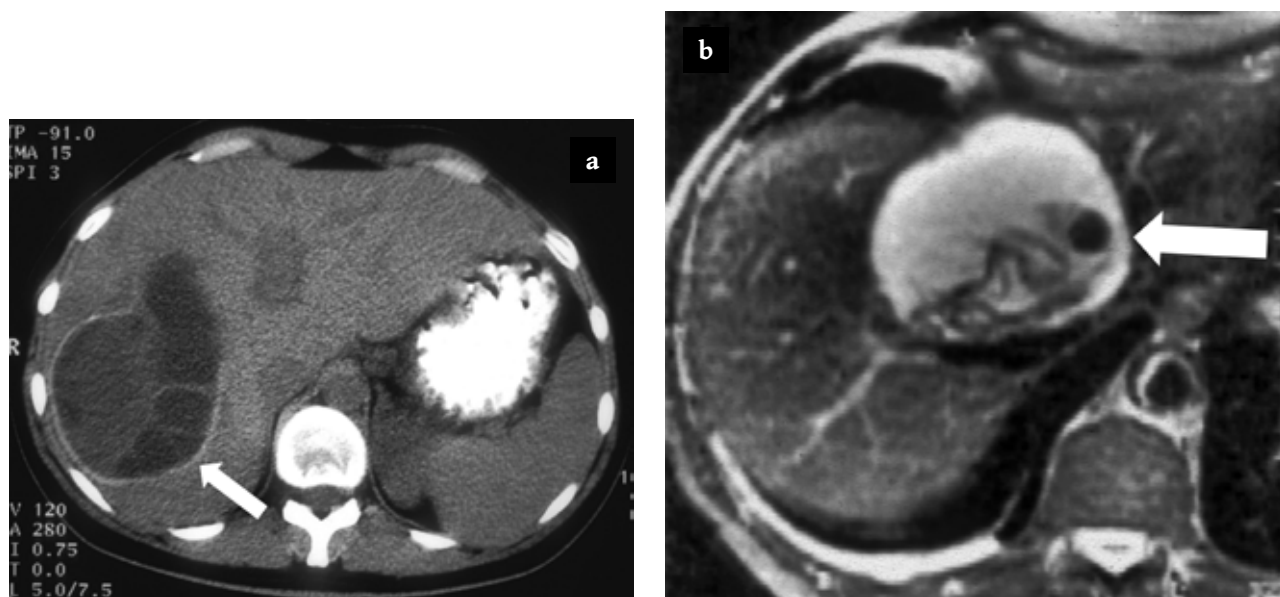


Fig. 11. Hydatid cyst of the liver. **a.** Non enhanced CT demonstrates a cystic mass in the right lobe with peripheral high attenuation capsule revealing calcifications (arrow). Note the septations and the inhomogeneous “cystic” content of the lesion. **b.** T2WI of another patient reveals the low signal intensity of the daughter cysts and the internal membranes (arrow).

for the radiologist in order to be able to proceed to the correct interpretation of the cystic hepatic lesion seen on imaging of an oncologic patient. Current interventional percutaneous hepatic lesion ablation techniques (such as radiofrequency or microwave ablation) may produce similar cystic defects of the hepatic parenchyma and therefore clinical information is of paramount importance.

3.5 Cystic subtypes of primary liver lesions

Cystic subtypes of primary liver neoplasms are rare. Cystic degeneration of hepatocellular carcinoma (HCC) and giant haemangioma have been described [2, 10]. The cystic changes are either due to treatment (described in a previous section) or to fast growth, necrosis or haemorrhage of the lesion (such as in a giant haemangioma). In cases of haemangiomas with cystic changes, diagnosis is supported by the typical contrast nodular enhancement of the lesion from the periphery towards the center seen on CT and MRI.

4. Inflammatory-infectious lesions

4.1 Abscess

Abscesses can be classified as pyogenic, amoebic or fungal. Pyogenic abscesses are caused by bacteria which enter the liver through the portal vein system or the biliary

tree (through portal phlebitis and ascending cholangitis respectively). Amoebic abscesses are caused by *Entamoeba histolytica* and fungal abscesses by *Candida albicans* [2, 14].

Imaging findings depend upon the stage of infection: initially pyogenic abscesses usually appear as unilocular thick walled lesions of low attenuation on CT, with peripheral rim enhancement and perilesional oedema seen as hyperenhancement on CT and MRI (**Fig. 8**). Later on, pyogenic abscesses frequently manifest as a cluster of multiple cystic lesions, representing different stages of contamination, giving the appearance of “cluster of grapes” (**Fig. 9**) [2]. Presence of air is not a common finding, but is diagnostic for a gas-forming organism. In cases that the clinical signs are not supporting the diagnosis, MRI is helpful using DWI sequence because it demonstrates diffusion restriction and low intensity of the cystic lesion on ADC images (**Fig. 9**). Amoebic abscesses have a specific appearance, known as “the double target” sign, due to increased rim enhancement in the periphery and reactive changes of the surrounding liver parenchyma (**Fig. 10**). Although percutaneous drainage of a pyogenic abscess is the treatment of choice if antibiotics are not able to cure the disease, in the case of amoebic abscess this is not recommended.

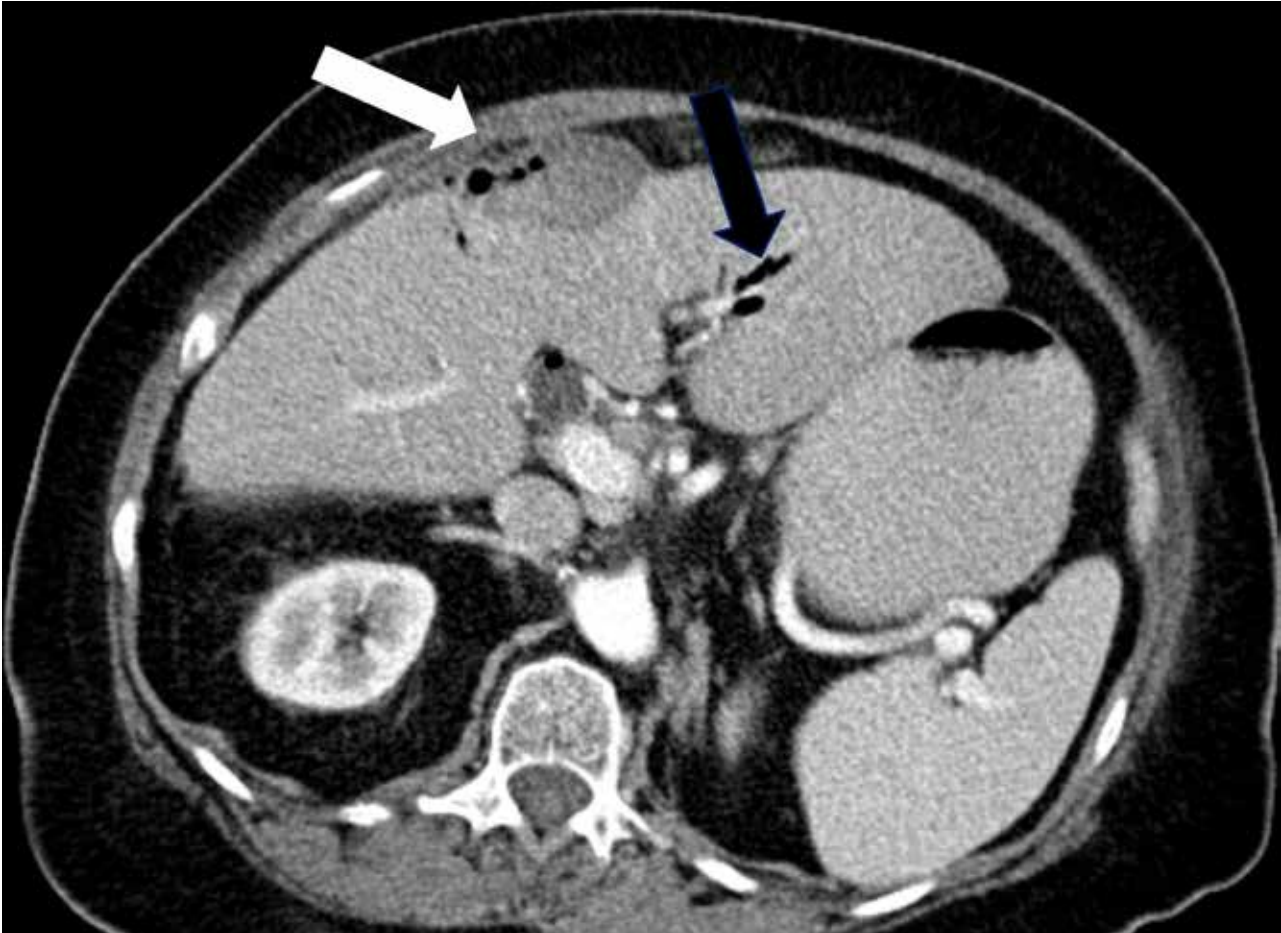


Fig. 12. Intrahepatic, subcapsular biloma after endoscopic retrograde cholangio-pancreatography to remove choledochal stones. The contrast enhanced CT image reveals a subcapsular cystic lesion with the presence of air (white arrow). Note aerobilia as well (black arrow). History is essential (i.e. intervention-endoscopy) in order to proceed to the correct diagnosis.

4.2 Echinococcal cysts

Hepatic echinococcosis is commonly seen in the Mediterranean region, caused by *Echinococcus granulosus*. The hydatid cyst is composed of three layers: the outer pericyst, the endocyst and the ectocyst [14, 15]. Maturation of the cyst is characterised by daughter cyst production in the periphery, a result of endocyst invagination. On CT a hydatid cyst appears as a well demarcated cystic lesion with calcification of the peripheral wall and internal septations, that may also demonstrate calcifications (**Fig. 11**). Calcification is not a sign of inactive disease. Inhomogeneous content can be seen due to the presence of daughter cysts. The periphery of those daughter cysts and the endocyst membrane show a typical low signal intensity on T2WI (**Fig. 11**). The latter is a helpful imaging finding for diagnosing a hydatid cyst utilising MRI [15]. Superinfection of a hydatid cyst may be challenging

in the differential diagnosis, specifically regarding treatment, avoiding percutaneous drainage of the lesion.

5. Miscellaneous lesions

5.1 Biloma

Biloma is the result of rupture of the biliary system. This can be spontaneous, traumatic or iatrogenic following surgery or interventional procedures. Bilomas can be located intrahepatically or in the subcapsular or perihepatic spaces [10]. On CT and MRI bilomas have a cystic appearance. Diagnosis is based on imaging findings, in combination with the clinical history and the location of the lesion (**Fig. 12**). HU values measurement is usually not helpful alone and late phase imaging with hepatobiliary contrast agents on MRI might help to demonstrate the accumulation of the contrast agent in the biloma collection.

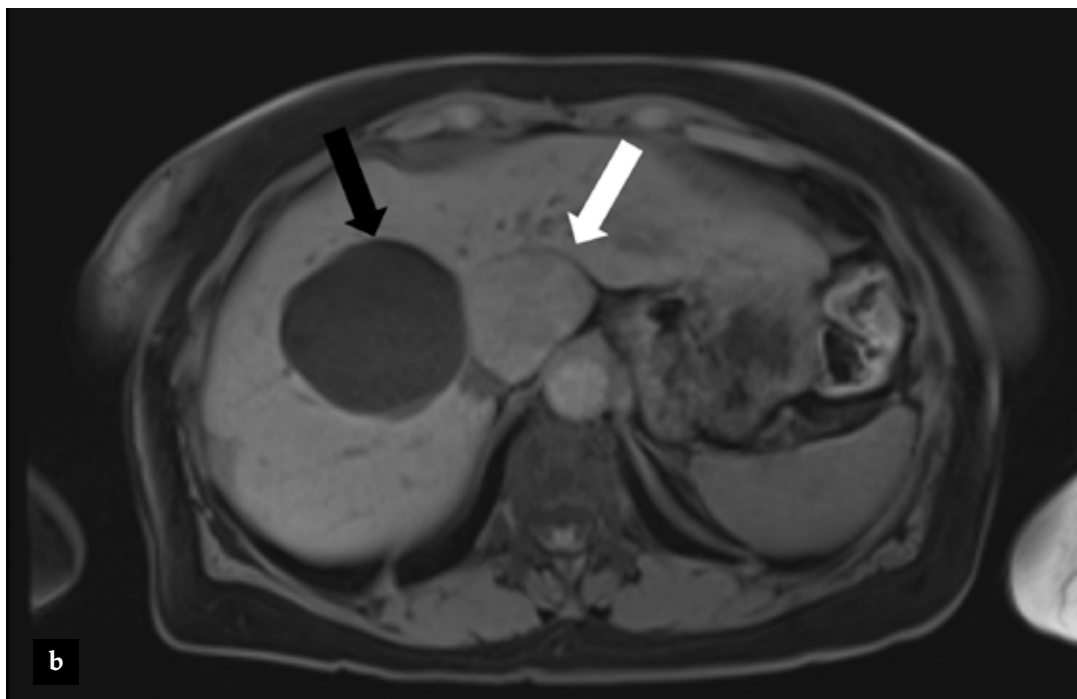


Fig. 13. Complicated cysts. **a.** Axial T2WI of the liver demonstrates two cysts in the right lobe of the liver with similar high signal intensities. **b.** T1WI with fat suppression shows that the content of the liver cysts is different. The larger, laterally located, lesion has the expected low signal intensity of a simple benign cyst (black arrow). The smaller, medially located, lesion reveals a high signal intensity (white arrow), suggesting haemorrhagic or proteinaceous material.

5.2 Haematoma

Trauma and intervention or surgery are the usual reasons for an intrahepatic haematoma, although haemorrhage in a pre-existing solid liver neoplasm can be seen as well [16]. Size and location of the bleeding are important factors for the symptoms seen. Since CT is the first imaging technique in those cases, a haematoma is easily detected as a high attenuation area, with or without extravasation of contrast agent depending upon the stage of bleeding. MRI demonstrates the typical changes of paramagnetic effect of methaemoglobin with high signal on T1WI and low signal on T2WI. Older or chronic haematomas are liquified cystic lesions.

5.3 Infected or haemorrhagic hepatic cysts

Simple benign developmental cysts may become infected or haemorrhagic, resulting in an atypical imaging appearance. Although complications are usually symptomatic, sometimes complicated cysts are incidentally revealed, without a clear history of symptoms [2, 4, 10]. CT may demonstrate high attenuation values and sometimes calcifications in chronic complicated cysts. MRI reveals different signal intensity specifically on T1WI (without or preferably with fat suppression technique) (**Fig. 13**). In case of a symptomatic complicated cyst, drainage or surgical resection is considered.

5.4 Hepatic extrapancreatic pseudocyst

Pseudocysts after interstitial oedematous pancreatitis can be seen anywhere in the abdomen, although their location in or around the liver is not common. Cystic

changes due to necrotising pancreatitis however can be seen around the liver a couple of weeks after the onset of pancreatitis. The pathway is the extension of peripancreatic fluid collections or necrotic collections from the lesser sac into the hepatogastric ligament [2, 10]. Correct diagnosis is based on patient history and other radiological signs of pancreatitis in the pancreas and peripancreatic areas.

6. Conclusions

The characterisation of a cystic focal liver lesion is sometimes challenging. Although clinical information, such as history and laboratory findings are additional important elements for the correct diagnosis, modern imaging by means of CT and MRI can presume the correct diagnosis in the majority of cases. The size and the number of the lesion(s), density or intensity of the central areas (clear fluid vs necrotic, haemorrhagic or proteinaceous material), the presence of calcifications (such as in hydatid cyst or cystadenoma-carcinoma), presence of septations (abscess, cystadenoma, Caroli disease), presence, thickness and enhancement of the wall (metastasis, abscess), internal nodule (cystadenoma, GIST metastases) and appearance on heavily T2WI MRI, including MRCP, presence of communication (Caroli disease) or absence of communication with the biliary tree (hamartomas, benign cysts, polycystic disease), are specific imaging features that can help radiologists to suggest the correct diagnosis in addition to demographic and clinical information. **R**

Conflict of interest

The authors declared no conflicts of interest.

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