



Hepatic infectious diseases

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1. Learning Objectives

To describe and illustrate the radiologic findings in a variety of infectious liver diseases. We will discuss the relevance of each imaging method concerning detection and characterization of liver infections and highlight most typical findings.

2. Background

Liver infections are diagnosed on the basis of the clinical and laboratorial setting, epidemiologic context and imaging findings. Histological examination is sometimes required for diagnostic confirmation. Ultrasonography (US), computed tomography (CT) and magnetic resonance imaging (MRI) may highlight several morphologic characteristics or typical enhancing patterns of a specific liver infection. Imaging methods are also useful to rule out other diseases that may produce similar clinical and biochemical abnormalities, such as cholestasis, cirrhosis or diffuse metastatic disease. Liver infections are classified according to the category of the infecting agent as viral, bacterial, parasitic or fungal. Viral infections include both primary hepatitis viruses and systemic viral infections such as cytomegalovirus, HIV and herpes simplex. Bacterial infections refer to pyogenic abscesses or systemic diseases like tuberculosis. Parasitic infections include hydatid disease and schistosomiasis. The most relevant fungal infections include candidiasis and cryptococcosis.

3. Imaging Findings/Procedure Details

1. Viral infections: Acute viral hepatitis is usually caused by one of 5 viral agents: hepatitis A virus, hepatitis B virus with or without associated D virus, hepatitis C virus and hepatitis E virus. However, a vast number of other viruses may also produce acute hepatitis, including herpes virus, Coxsackie virus and adenovirus, among others. The infection may progress to chronic liver disease and cirrhosis, mainly in virus C and D infection. The imaging features of acute hepatitis are nonspecific and the diagnosis is usually based on clinical and laboratorial findings. At US, the liver is usually enlarged and has a diffuse decrease in parenchymal echogenicity, resulting in a relative increase in echogenicity of the portal radicles (Fig. 1). At CT, hepatomegaly, heterogeneous enhancement and well defined regions of low attenuation may be present. MRI shows periportal edema as high-signal-intensity areas on T2 weighted images (Fig. 2). Chronic hepatitis also has nonspecific imaging findings, resembling those of other etiologies of chronic liver disease and cirrhosis. Periportal lymphadenopathy may be detected in both acute and chronic hepatitis.

2. Bacterial infections: 2.1 Pyogenic abscesses: Pyogenic abscesses are usually polymicrobial and *Escherichia coli* is the most common bacterium involved. Routes of infection include the portal vein (embolization or seeding from an abdominal infection) hematogenous dissemination (via hepatic artery), ascending cholangitis or superinfection of the necrotic tissue. Approximately half of cases are cryptogenic. Chest and abdominal radiographs are frequently obtained at the initial evaluation. Nonspecific findings may include an elevated right hemidiaphragm, subdiaphragmatic air-fluid level, pneumonitis, consolidation, and pleural effusion. US is 80-100% sensitive. Round or oval hypoechoic masses of variable size are typical. The cluster sign describes the characteristic coalescence of small abscess cavities (Fig. 3) to form a larger, multiseptated mass (Fig. 4). Larger masses have heterogeneous appearance, with internal echoes and debris. Gas may also be present, appearing as high-intensity linear echoes with posterior reverberation artifacts. At CT pyogenic abscesses appear as well-defined low attenuation masses, with or without perilesional edema or rim enhancement. Abscesses may be complex, with internal enhancing septa (Fig. 5). At MRI, pyogenic abscesses may have variable signal intensity on T1-weighted images, depending on their protein content. As described for CT, solid components including abscess wall and septa enhance after contrast administration. T2-weighted images demonstrate hyperintensity of the fluid content in the abscess cavities and perilesional edema as increased signal intensity areas surrounding the lesion. These circumferential or triangular shaped areas usually enhance after contrast administration, although less than solid components of the abscess.

2.2 Tuberculosis

Tuberculosis is one of the most common infections worldwide. Liver involvement generally occurs in association with intestinal tuberculosis, with dissemination through the portal venous system. *Mycobacterium tuberculosis* may also reach the liver by haematogenous or lymphatic spread. The most common presentation is a nonspecific hepatomegaly, which occurs due to a fine miliary infiltration of the parenchyma (Fig. 6). Individual lesions are often below the resolution limits of imaging methods. Liver tuberculosis may also present as tuberculous hepatic abscesses or tuberculomas, usually appearing as hypoechoic round masses at US. At CT they are often hypoattenuating hypoenhancing lesions (Fig. 7). MRI shows hypointense lesions on T1-weighted images and iso- to hypo-intense lesions in T2-weighted images. Imaging findings are nonspecific, and therefore, percutaneous liver biopsy is needed in almost all patients with suspicion of tuberculous infection of the liver.

3. Parasitic infections:

3.1 Hydatid disease: Hydatid cysts are caused by a parasitic infection (*E. Granulosus*), which is endemic in the Mediterranean Basin. The parasite reaches the liver via the portal vein, after ingestion of embryos that invade the intestinal mucosa. In the liver the parasite develops to form a hydatid cyst, composed of three different layers: the outer pericyst (compressed and fibrosed liver tissue), the ectocyst (a thin membrane) and the endocyst (an inner germinal layer). At US they range from purely cystic to solid-appearing lesions (Fig. 8). Cystic components may contain internal wavy bands of a delaminated endocyst or multiple daughter cysts surrounded by hyperechoic debris. Calcifications are often seen with a peripheral distribution. At CT, Hydatid cysts usually appear as well defined hypoattenuating lesions with a perceptible wall. Calcifications are well appreciated on CT (Fig. 9). During the natural course of a hydatid cyst, complete calcification occurs. Dense calcification may be assumed to indicate the death of the cyst (Fig. 10). MR imaging can demonstrate the pericyst as a hypointense rim on both T1 and T2-weighted images, the matrix or hydatid sand, which appears hypointense on T1-weighted images and markedly hyperintense on T2-weighted images, and the daughter cysts, hypointense relative to the matrix on both T1- and T2-weighted images.

3.2 Schistosomiasis Schistosomiasis is a parasitic disease caused by blood flukes (trematodes) of the genus *Schistosoma*. Most human schistosomiasis is caused by *S. haematobium*, *S. mansoni*, and *S. japonicum*. Hepatic infection involves migration of the eggs through the portal circulation. In the liver, the eggs induce an immune response with granuloma formation and associated fibrotic changes. Chronic infection with *S. mansoni*, or *S. japonicum* may result in cirrhosis and increased risk of developing hepatocellular carcinoma. Typical US findings include an irregular liver surface and a mosaic pattern, with echogenic septa outlining polygonal areas of relatively normal liver parenchyma (Fig. 11). Cirrhosis and septal calcifications may also be seen. At CT, schistosomiasis manifests as capsular and septal calcification, with an irregular hepatic contour and parenchymal retraction due to fibrosis (Fig. 12). MRI is unable to show calcifications, but may show septa with low signal intensity on T1-weighted images and high signal intensity on T2-weighted images.

3.3 Amebiasis Amebiasis is a parasitic infection caused by the protozoal organism *E. histolytica*, which can give rise both to intestinal disease and to various extraintestinal manifestations. Liver abscess is the most common extraintestinal manifestation, and occurs when the colonic trophozoites ascend via the portal vein. At US amebic abscesses appear as round or oval hypoechoic lesions. There is often no perceptible wall. CT demonstrates a lesion with low attenuation values surrounded by an enhancing wall. Perilesional edema is commonly seen. At MRI, amebic abscesses have decreased signal intensity on T1-weighted images and increased signal intensity on T2-weighted images.

4. Fungal infections: Hepatic fungal infection usually appears in immunocompromised patients with disseminated fungal disease. The most frequent hepatic fungal infection is candidiasis, followed by cryptococcosis, histoplasmosis and aspergillosis. Fungal infections typically induce abscess formation, with a particular distribution of the fungus in the center of the lesion and a surrounding area of necrosis and inflammatory infiltrate. These lesions are usually multiple and small, rarely exceeding 1cm in diameter. At US fungal abscesses may have a hypoechoic center and hyperechoic periphery. A second pattern, usually seen in active fungal infection, consists of a central echogenic nidus surrounded by a hypoechoic rim (Fig. 13). At CT, they appear as multiple, round areas of low attenuation (Fig. 14). Contrast enhancement may occur in the center of the lesion, or, less often, at the periphery. At MRI, untreated fungal abscesses are minimally hypointense in T1-weighted images and markedly hyperintense on T2-weighted images.

4. Conclusion

Most imaging findings in liver infections are nonspecific. However, if analyzed together with the clinical features and epidemiologic context, they may point at a specific diagnosis. US, CT and MRI may show complementary findings and its utilization should be guided by clinical suspicion. Blood tests and sometimes stools examination may provide valuable clues for diagnosis. Histological examination may be required for confirmation.

5. References

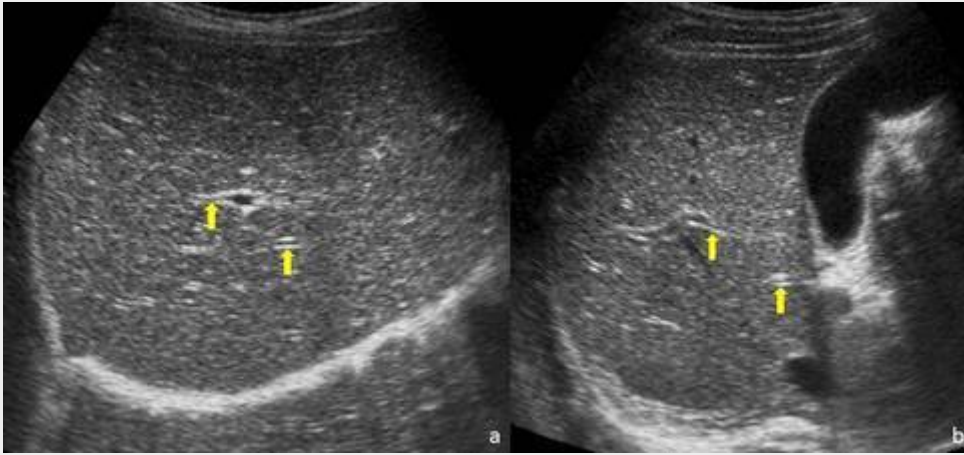
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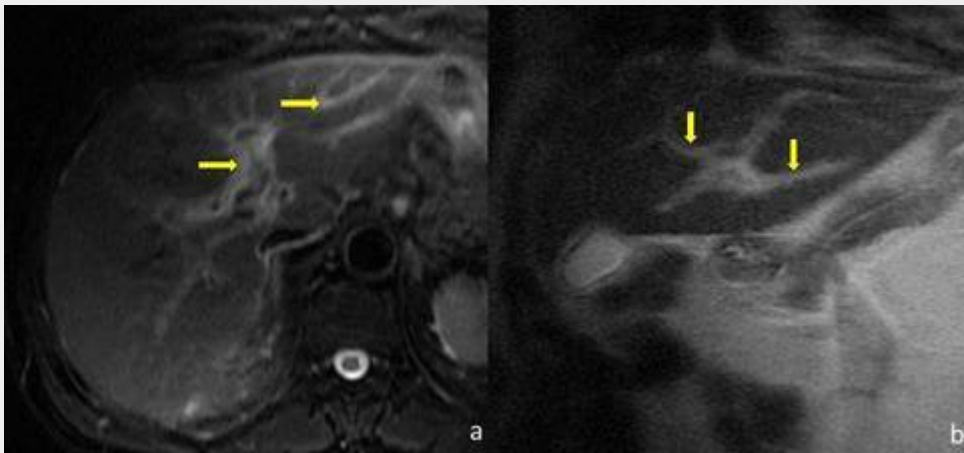
7. Mediafiles

Fig. 1



US demonstrates periportal hyperechogenicity (arrows) in a young patient with acute viral hepatitis.

Fig. 2



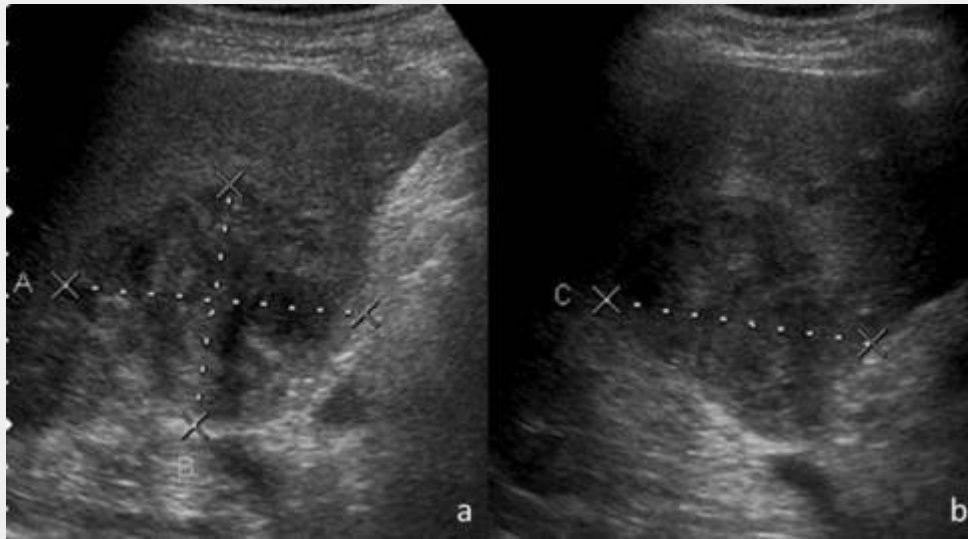
T2-weighted axial (a) and coronal (b) MRI of the liver in acute viral hepatitis. Periportal edema appears as increased signal intensity areas surrounding portal radicles (arrows).

Fig. 3



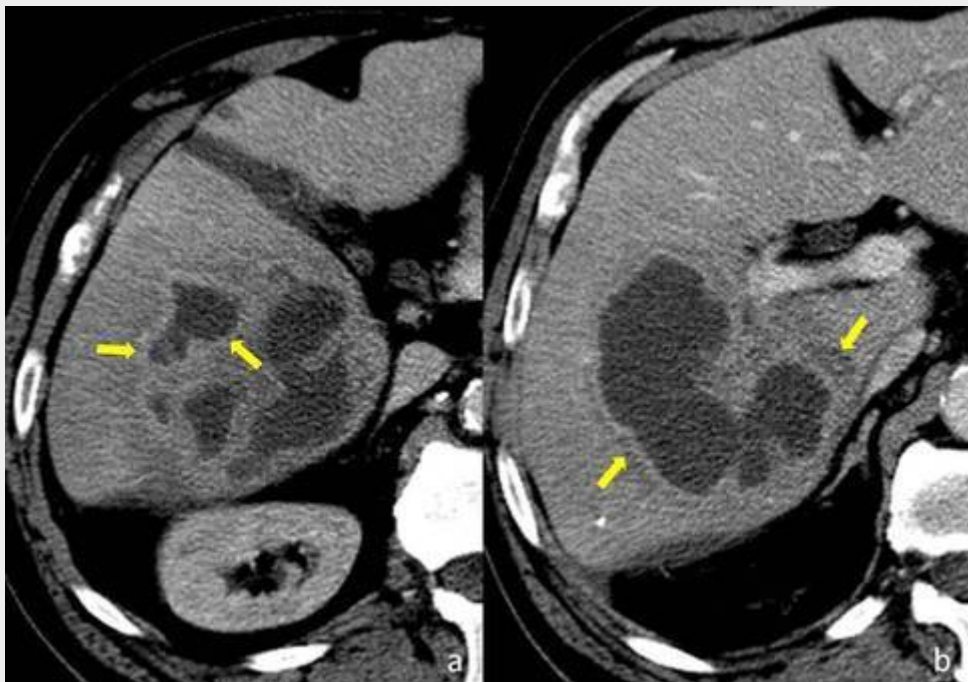
US of the liver showing three small abscess cavities (arrows), coalescing to form a larger abscess – the cluster sign.

Fig. 4



US of a pyogenic abscess of the liver. The lesion (7x6x6cm) is heterogeneous, with central hypoechoic areas and internal septa.

Fig. 5



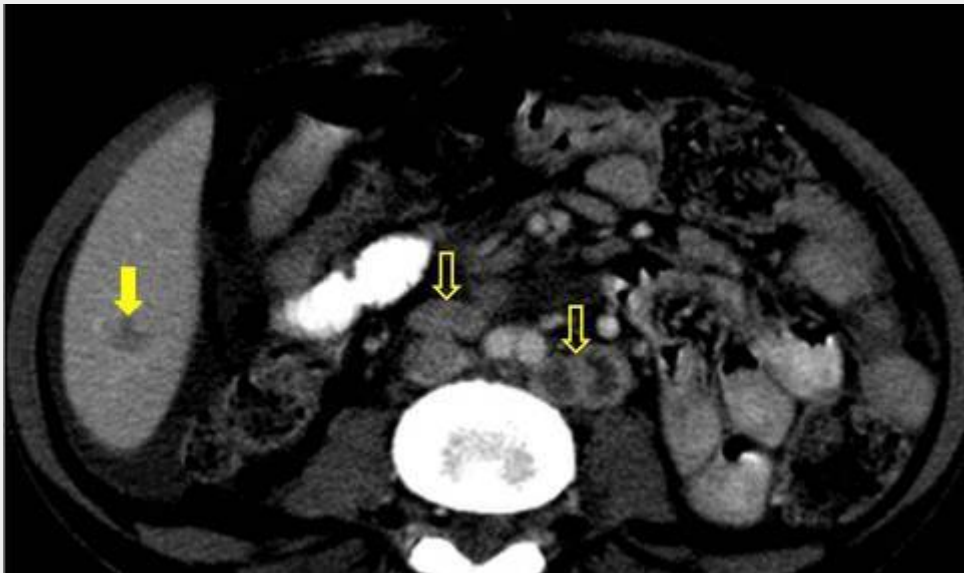
Contrast-enhanced CT of a male patient with a pyogenic abscess of the liver. The lesion is a multilocular 10cm mass, with peripheral and septal enhancement (arrows in a). Heterogeneity of the surrounding parenchyma is also visible (arrows in b).

Fig. 6



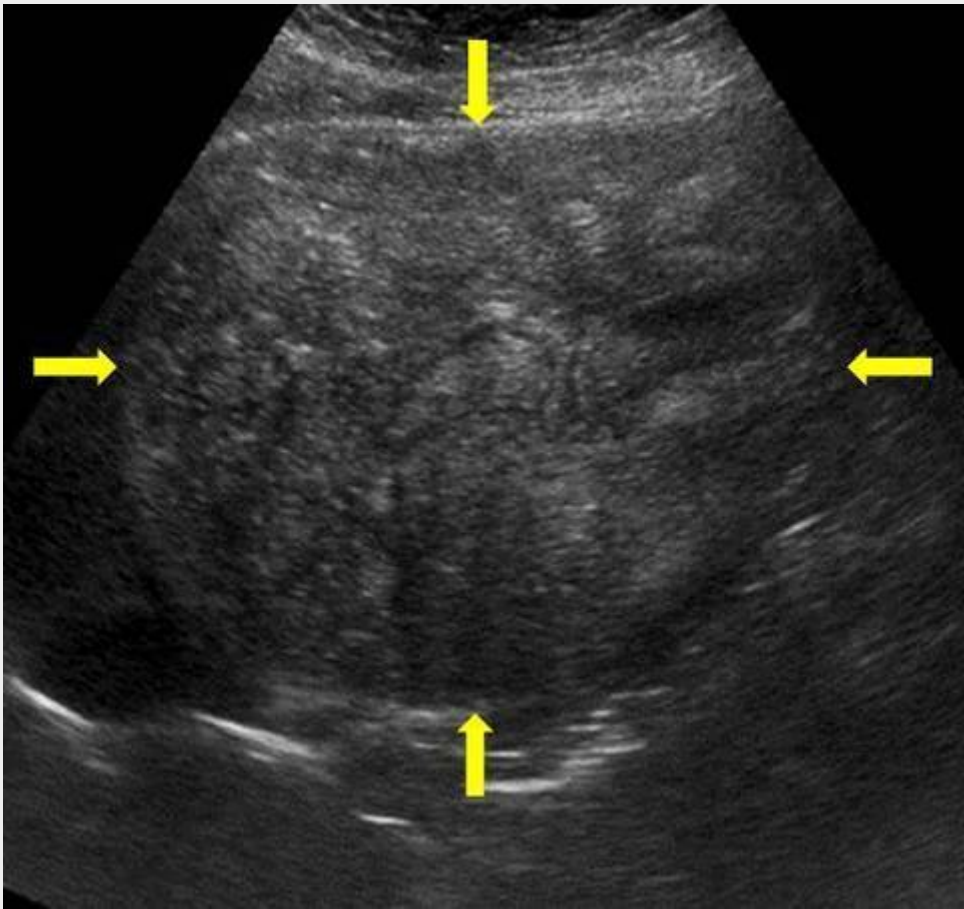
Contrast-enhanced abdominal CT of a young woman demonstrates an enlarged liver with heterogeneous parenchyma (*) and multiple hypoenhancing nodules in the spleen (arrows).

Fig. 7



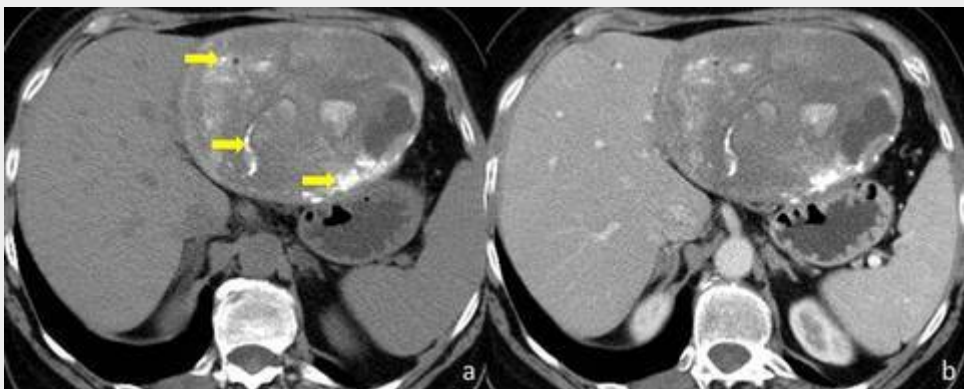
Contrast-enhanced abdominal CT of a patient with abdominal tuberculosis. In this image there is a hypoenhancing nodule in segment VI of the liver, corresponding to a tuberculous abscess (arrow). There are also multiple retroperitoneal enlarged lymph nodes (open arrows), those on the left with necrotic center, also related to the tuberculous infection.

Fig. 8



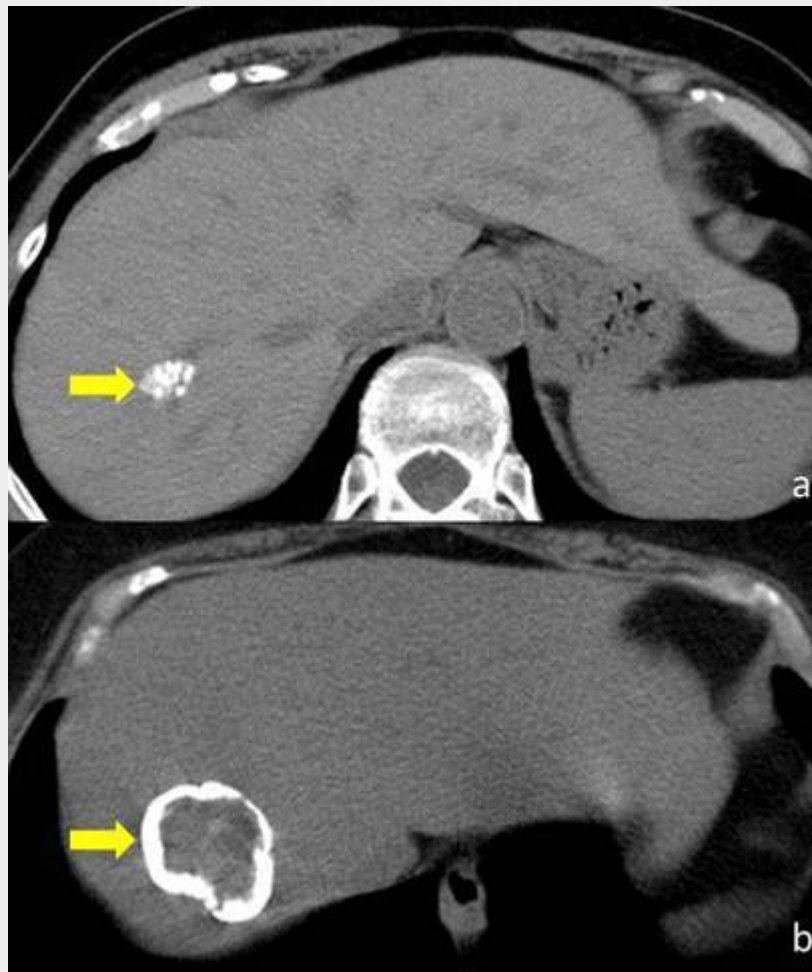
US demonstrates a large, heterogeneous hydatid cyst occupying the left lobe of the liver.

Fig. 9



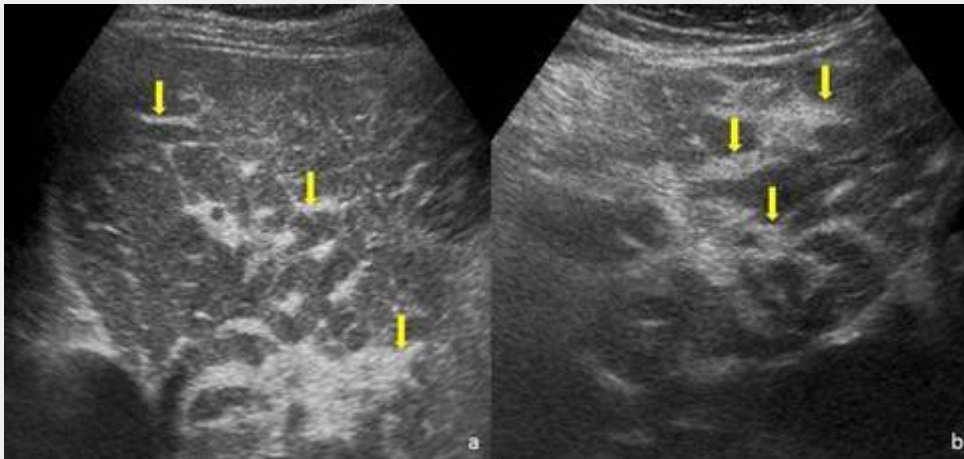
Non-contrast (a) and contrast-enhanced (b) abdominal CT show a large heterogeneous hydatid cyst in the left lobe of the liver (the same shown in Fig. 10). Non-contrast image (a) obviates multiple calcifications (arrows).

Fig. 10



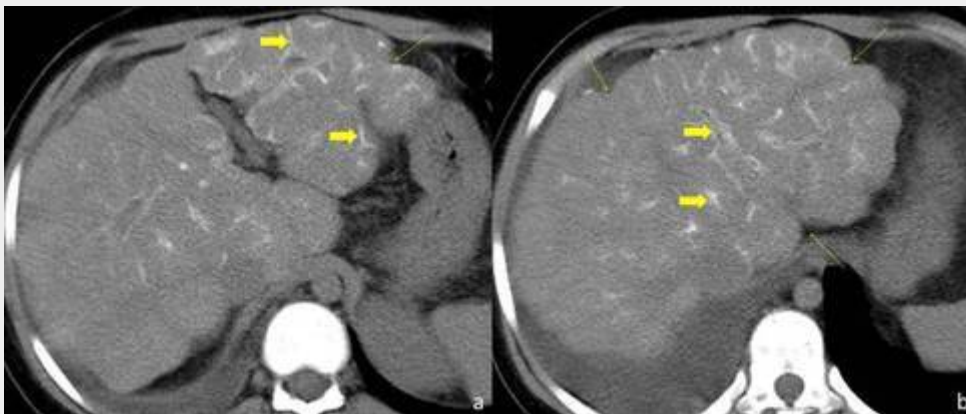
Abdominal CT of two different patients show calcified hydatid cysts (arrows). The cyst shown in a) has diffuse, coarse calcifications. In b) the cyst has peripheral calcifications.

Fig. 11



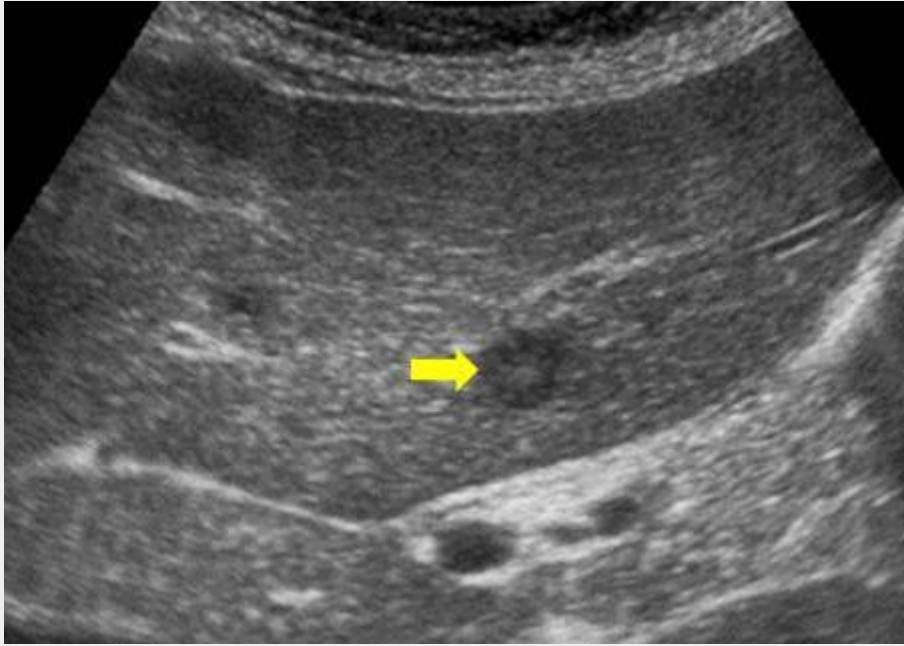
Hepatic US of a young girl with schistosomiasis. Septa are thick and hyperechoic (arrows), bounding areas of normal liver parenchyma.

Fig. 12



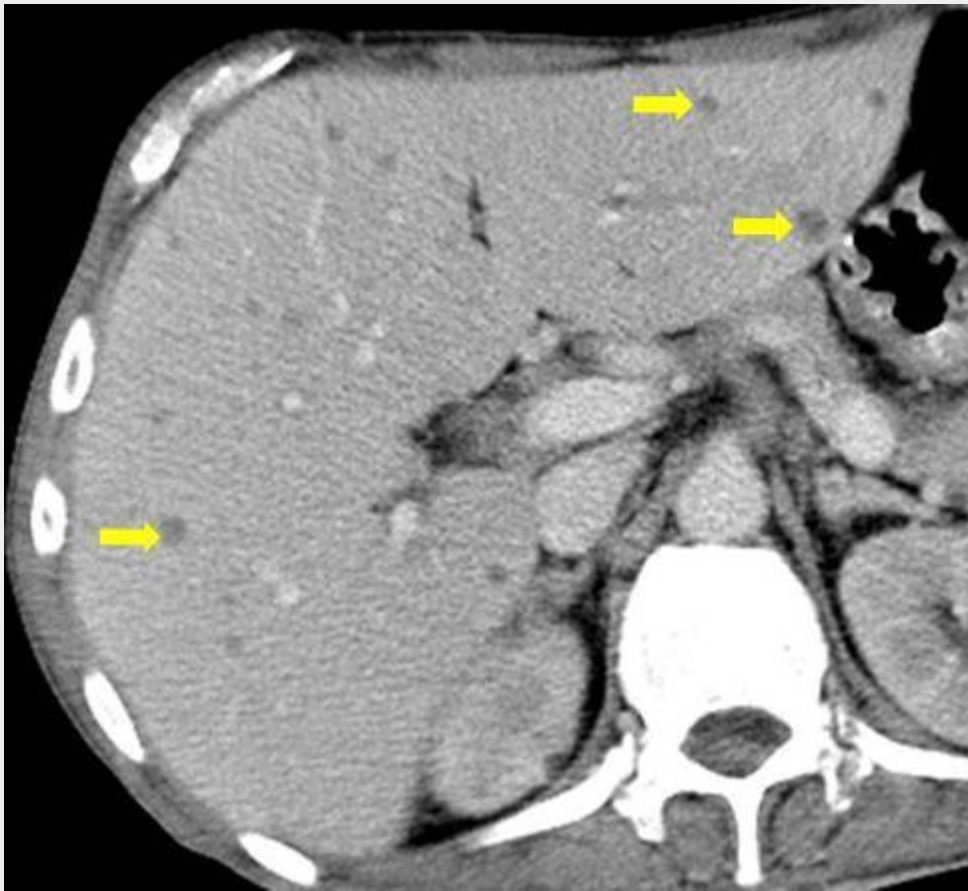
Non-enhanced abdominal CT demonstrates an enlarged liver with surface depressions (thin arrows) and multiple septal calcifications (thick arrows), predominantly in the left lobe.

Fig. 13



US demonstrates a round, well demarcated lesion in the left lobe of the liver with a hyperechoic center and a hypoechoic rim (arrow).

Fig. 14



Contrast-enhanced abdominal CT shows multiple round hypoenhancing lesions in the liver parenchyma (arrows). This patient had disseminated cryptococcosis with hepatic microabscesses.