



Infectious Lesions of the Liver - Spectrum of Imaging Findings

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Page 1 of 37

Learning objectives

Recognize different causes of hepatic infections and review their imaging findings.

Background

Hepatic infections include bacterial, viral, fungal and parasitic diseases. Some are common, well-known entities like viral hepatitis, liver abscess and hydatid disease. Other diseases are rarer and difficult to diagnose without a higher level of suspicion, like tuberculosis or fascioliasis.

Imaging plays a crucial role in the diagnosis of hepatic infections, with all cross-sectional imaging techniques having a high accuracy in the detection of infectious lesions. There are, however, exceptions, like viral hepatitis, often with unremarkable imaging features.

Even with high accuracy, imaging findings are generally non-specific, with differential diagnostic difficulties with hepatic cysts and necrotic tumors. Therefore clinical context is extremely important.

In addition to diagnosis, the radiologist has also an important role in monitoring and even treatment with imaging-guided percutaneous drainage.

Findings and procedure details

LIVER ABSCESS

Microabscess - when smaller than 2cm.

Although imaging findings are generally non-specific, there are signs that suggest the presence of an abscess:

Cluster sign: grouping of small lesions with low attenuation or high T2 signal intensity (Fig. 1 on page), that gradually coalesce into a larger lesion (Fig. 2 on page). Especially suggestive of a pyogenic abscess.

Page 2 of 37



Fig. 1: Liver abscess at contrast-enhanced CT. Grouping of low attenuation lesions in the liver - cluster sign.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Page 3 of 37



Fig. 2: Liver abscess at contrast-enhanced CT - same patient as in Fig.1, three weeks later. Coalescence of the small lesions into a larger one.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

• Wall enhancement: identified on contrast studies, virtually diagnostic of an abscess in the appropriate clinical setting (Fig. 3 on page).

Page 4 of 37



Fig. 3: Contrast-enhanced CT. Low attenuation liver lesion with evident wall enhancement. Case of liver abscess.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

• Double target sign: in addition to wall enhancement, there may be an outer low attenuation zone (Fig. 4 on page 30).

Page 5 of 37



Fig. 4: Contrast-enhanced CT - Amoebic abscess. Thick enhancing wall (black arrow) and outer hypodense rim (white arrow) - Double target sign. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

• Perilesional edema: helps differentiate an abscess from a benign cystic lesion (Fig. 5 on page 30). A minority of malignant lesions may also show this abnormality.

Page 6 of 37



Fig. 5: Liver abscess at MRI. Irregular lesion, hypointense at T1 (A), hyperintense at T2 (B), with defined wall that enhances with contrast (C - pre-contrast T1 with fat suppression, D - portal phase). Note perilesional edema (B - arrow). *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Gas: a classic and specific sign but only present in a minority of cases (Fig. 6 on page). More common in *Klebsiella* and anaerobic infections.

Page 7 of 37



Fig. 6: Contrast-enhanced CT. Polymicrobial abscess on the caudate lobe with presence of gas (arrow). Identified agents were Streptococcus viridans and Bacteroides (anaerobe).

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

PYOGENIC ABSCESS

The most common abscesses in developed countries, they are generally caused by biliary obstruction or hematogenous spread from an intestinal infection.

Causative agent: *Escherichia coli*, other gram-negative bacteria, anaerobes. Half are polymicrobial (Fig. 6 on page).

Clinical and laboratorial findings: Pain in the right upper quadrant, fever and jaundice. May be clinically occult. Leucocytosis and abnormal liver function. Blood cultures are positive in half.

Page 8 of 37

Imaging Findings:

Cross sectional imaging techniques detect more than 90% of pyogenic abscesses.

Multiple in 50% of cases, with a coalescent pattern with gram negative bacterial infection (Fig. 1 on page).

Appearance varies with pathologic stage. In the more acute stage they have an indistinct appearance, progressing to a more well-defined, cystic appearance, as necrosis and liquefaction ensues.

US: most often a complex cystic lesion (Fig. 7 on page), but may also appear solid (Fig. 8 on page).

CT: most commonly a thick-walled lesion with low attenuation (Fig. 3 on page).

MRI: variable signal intensities on T1 and T2, depending on protein content (Fig. 5 on page 30).

Accompanying abnormalities: hepatomegaly, elevation of the right hemidiaphragm, pleural effusion and basal lung atelectasis or infiltrates.



Page 9 of 37

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Fig. 7: Liver abscess. Complex cystic appearance at US, with thickened wall. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT



Fig. 8: Two cases of liver abscesses with hypoechoic solid appearance on US. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Special cases:

Staphylococcal infection: Multiple abscess with a milliary pattern of distribution, similar to fungal abscesses (Fig. 9 on page).

Klebsiella pneumoniae abscess: Gas is more common.

Septal breakage sign - arborizing patterns of septa in the abscess cavity (Fig. 10 on page).

Turquoise sign - numerous septal breakages.

Hair-ball sign - tangled pattern of hairline content in the abscess fluid.

Page 10 of 37



Fig. 10: Contrast-enhanced CT. Klebsiella abscess in the right liver lobe. Discontinuous septa (arrow) - septal breakage sign. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Treatment: Medical therapy alone may be successful in lesions with less than 3-5cm of diameter.

Image-guided drainage (Fig. 11 on page 31) combined with antibiotics is the treatment of choice, even if multiple or plurilocular lesions, with success rates higher than 90%. Drainage is considered more effective than aspiration, although it has some disadvantages, like catheter blockage or displacement.

Some patients may need surgical drainage.

Page 11 of 37



Fig. 11: Percutaneous CT-guided drainage of the abscess of Fig.10. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

AMOEBIC ABSCESS

Causative agent: *Entamoeba histolytica.* It is the most frequent cause of liver abscess worldwide. The most common extra-intestinal complication of amebiasis.

Clinical and laboratorial findings: Patients are sicker than with pyogenic abscess. Mucous diarrhoea. Laboratory results similar to pyogenic infection. Serology positive > 90%.

Imaging findings: Lesions are often solitary and near the liver capsule. An abscess with a thick wall and perilesional edema may suggest this diagnosis (Fig. 4 on page 30).

Combination with diaphragmatic disruption is quite specific. Other associated findings include thickening of the wall of the cecum, pleural and perihepatic fluid.

Page 12 of 37

Treatment: Medical therapy is highly effective. Aspiration only in a minority of cases.



Fig. 4: Contrast-enhanced CT - Amoebic abscess. Thick enhancing wall (black arrow) and outer hypodense rim (white arrow) - Double target sign. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

FUNGAL ABSCESS

Causative agent: Candida albicans is the most common causative organism.

Clinical and laboratorial findings: Complication of immunosuppression and hematologic malignancies. Patients present with fever that does not respond to large spectrum antibiotics.

Imaging findings: Typically, there are multiple microabscesses in the liver and spleen (Fig. 9 on page). On US, the lesions may have a "wheel-within-wheel" or "bullseye" appearance, but uniformly hypoechoic nodules is the most common pattern (Fig. 12 on page).

Page 13 of 37

After treatment, foci of scarring and calcification may persist.

Treatment: Antifungal agents.



Fig. 9: Contrast-enhanced CT. Multiple hepatic microabscesses in a immunosuppressed patient with leukemia. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Page 14 of 37



Fig. 12: Same patient as in Fig.9. Liver US shows small hypoechoic nodules. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

PARASITIC DISEASE

HYDATID DISEASE

Endemic in the Mediterranean and other sheep-raising countries. Acquired by ingestion of contaminated food or contact with dogs. Liver affected in 55-75% of cases.

Hydatid cyst is composed of three layers:

- outer pericyst
- ectocyst
- inner endocyst or germinal layer.

Maturation of a cyst is characterized by development of daughter cysts.

Causative agent: Echinococcus granulosus

Page 15 of 37

Clinical and laboratorial findings: Generally asymptomatic, expansion of a cyst may cause pain and its rupture can lead to anaphylaxis.

Eosinophilia. Serology tests have a wide range of sensitivity and specificity.

Imaging findings: Variable. There are various classification systems (Table 1).

Туре 1	Cystic form, defined wall
	(Fig. 13 on page)
Type 2*	Water lily sign - detachment of the germinal layer
	(Fig. 14 on page)
Туре 3*	Daughter cysts
Туре 4	Pseudosolid lesion (hydatid sand/ compressed hydatids/calcifications)
	(Fig. 15 on page 32)
Туре 5	Massively calcified form, inactive
Table 1 - Gharbi classification of hydatid dis	(Fig. 16 on page) sease based on US.

* pathognomonic.

Page 16 of 37



Fig. 13: Hydatid cysts. A - Type 1 hydatid cyst at US. B - Another patient. Simple appearing hydatid cyst at contrast-enhanced CT, except for a defined wall. This cyst was however complex at US.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Page 17 of 37



Fig. 14: Liver hydatid cyst. A - Type 2 cyst at US, with detachment and colapse of the germinal layer - water lily sign. MRI: B - Pericyst is hypointense and matrix is hyperintense at T2. C - Pericyst and matrix are hypointense at T1. D - After contrast injection, portal phase, there is no internal enhancement.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Page 18 of 37



Fig. 15: Hyperechoic liver lesion, solid appearing. At CEUS (contrast-enhanced ultrassound), there is no internal enhancement. Case of type 4 hydatid cyst. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Page 19 of 37



Fig. 16: Massively calcified hydatid cysts. A - Type 5 lesion at US. B - CT. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

US: there is an additional sign - the snowflake sign - caused by free-floating protoescoleces or hydatid sand.

CT: 50% have wall calcifications (Fig. 17 on page) and 75% have detectable daughter lesions (Fig. 18 on page 33).

Page 20 of 37



Fig. 17: Contrast-enhanced CT. Cystic lesion of the liver with wall calcifications. Case of hydatid cyst.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Page 21 of 37



Fig. 18: Hydatid cyst. A - Pre-contrast CT axial plane. B - Contrast-enhanced CT, coronal reformat. Presence of smaller hypodense lesions inside the cyst (arrow) - daughter cysts.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

- MRI: best demonstrates the pericyst, the matrix and the daughter cysts (Fig. 14 on page).
- Pericyst hypointense rim both at T1 and T2.
- Matrix (hydatid sand) hypointense at T1 and hyperintense at T2.
- Daughter cysts hypointense relative to the matrix at T2.

Treatment: Includes drainage with instillation of a scolicidal agent, complemented with medical therapy with albendazole.

Page 22 of 37

ECHINOCOCCUS MULTILOCULARIS CYST

Endemic to central and northern Eurasia and North America, less common but more invasive that hydatid disease. Caused by direct contact with definitive hosts (foxes) or ingestion of contaminated food.

Imaging Findings: Multilocular alveolar cysts scattered throughout the liver, the most frequent site of involvement (Fig. 19 on page 34).

Hailstorm pattern (US) - multiple echogenic nodules with irregular and indistinct margins.

In latter stages, central calcifications develop on regions of necrosis.

Hepatic hilar involvement - up to 50% of cases, causing dilatation of intra-hepatic ducts and atrophy by hypoperfusion of affected liver segments.

Treatment: Being highly invasive, patients are usually subjected to wide resections or liver transplant.



Page 23 of 37

Fig. 19: Contrast-enhanced CT of Echinococcus multilocularis infection. Multiple lowattenuation lesions scattered throughout the right liver lobe. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of

Coimbra - Coimbra/PT

FASCIOLIASIS

Hepato-biliary infection, suspected in endemic regions or recent travellers to Central and South America, South-eastern Asia and the Mediterranean.

Acquired by ingestion of contaminated water or aquatic plants. The parasites exit the intestine, migrate through the peritoneal cavity and invade the liver.

Causative agent: Fasciola hepatica

Clinical and laboratorial findings: Characterized by two phases.

- Hepatic phase: 1-3 months after ingestion, parasites migrate through the liver capsule and parenchyma, toward the biliary ducts. Right upper quadrant pain, fever, urticaria, hepatomegaly, eosinophilia.

- Biliary phase: intermittent right upper quadrant pain, with or without cholangitis and cholestasis.

Serology and parasitology tests are useful for confirmation.

Imaging findings: Multiple small nodular and branching linear lesions, predominantly subcapsular, which are hypoechoic on US, hypodense on CT, T1 hypointense and T2 hyperintense (Fig. 20 on page).

Other abnormalities: peri-hepatic lymphadenopathies, subcapsular haemorrhage and hepatic necrosis in the hepatic phase, bile duct dilatation and wall thickening in the biliary phase. The worm itself may be identified (Fig. 21 on page 35).

Treatment: Medical therapy.

Page 24 of 37



Fig. 20: Fascioliasis at contrast-enhanced CT. A - Coronal reformat, subcapsular nodular hypodense lesions. B - Axial plane, linear distribution of lesions (arrow). *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Page 25 of 37



Fig. 21: US of the gallbladder reveals a small tubular image - the parasite. *References:* Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

SCHISTOSOMIASIS

Endemic to tropical and subtropical areas. These parasites penetrate the skin and migrate to the mesenteric vein. Their eggs may be carried to the liver. Imaging findings reflect periportal fibrosis, with marked enhancement after contrast. *S. japonicum* may cause a turtleback appearance on CT.

Page 26 of 37

OTHER INFECTIONS

Hepatic Tuberculosis - a frequent infection worldwide, tuberculosis affects the liver in different ways. Generalized miliary tuberculosis: most common, hepatic involvement usually not detected by imaging studies, ocasionally low attenuation foci scattered throughout the liver (Fig. 22 on page). Localized liver tuberculosis: either a disseminated nodular form or a focal tuberculous abscess or tuberculoma (Fig. 23 on page). In the healing stage, calcifications are detected (Fig. 24 on page). Imaging studies are non-specific and almost all patients require biopsy for diagnosis.



Fig. 22: Abdominal contrast-enhanced CT in a patient with pulmonary tuberculosis. Scattered low attenuation lesions in the liver and spleen.

Page 27 of 37

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT



Fig. 23: Contrast-enhanced CT in a immunocompromised patient. Hypodense nodule with central necrosis (arrow) - Tuberculous abscess.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

Page 28 of 37



Fig. 24: Contrast-enhanced CT. Coarse liver calcification in the right lobe in a patient with previous hepatic tuberculosis.

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra - Coimbra/PT

- Viral Hepatitis causative agents: hepatitis viruses (usually A, B, C, D, E), herpes, adenovirus. Although a common liver infection, it has often unremarkable or non-specific imaging findings in the acute phase, including hepatomegaly, peri-portal edema and lymphadenopathies. Ocasionally starry night pattern at US. Radiology has a more important role in excluding differential diagnosis. Chronic viral hepatitis resemble early stage liver cirrhosis.
- **HIV infection -** predisposes to opportunistic infections like *Mycobacterium avium* complex, *Pneumocystis* and cytomegalovirus.
- **Cat-scratch disease** caused by *Bartonella henselae*. Dissemination occurs in 5-10% of cases with granuloma formation in the liver.

Page 29 of 37

Images for this section:



Fig. 4: Contrast-enhanced CT - Amoebic abscess. Thick enhancing wall (black arrow) and outer hypodense rim (white arrow) - Double target sign.

Page 30 of 37



Fig. 5: Liver abscess at MRI. Irregular lesion, hypointense at T1 (A), hyperintense at T2 (B), with defined wall that enhances with contrast (C - pre-contrast T1 with fat suppression, D - portal phase). Note perilesional edema (B - arrow).



Fig. 11: Percutaneous CT-guided drainage of the abscess of Fig.10.

Page 32 of 37



Fig. 15: Hyperechoic liver lesion, solid appearing. At CEUS (contrast-enhanced ultrassound), there is no internal enhancement. Case of type 4 hydatid cyst.

Page 33 of 37



Fig. 18: Hydatid cyst. A - Pre-contrast CT axial plane. B - Contrast-enhanced CT, coronal reformat. Presence of smaller hypodense lesions inside the cyst (arrow) - daughter cysts.

Page 34 of 37



Fig. 19: Contrast-enhanced CT of Echinococcus multilocularis infection. Multiple lowattenuation lesions scattered throughout the right liver lobe.

Page 35 of 37



Fig. 21: US of the gallbladder reveals a small tubular image - the parasite.

Page 36 of 37

Conclusion

The radiologist has a fundamental role in the management of hepatic infections, from diagnosis, to monitoring and even treatment.

There are certain characteristic imaging findings, although even when there are less specific findings, the clinical context allows for a most likely diagnosis.

Personal information

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Page 37 of 37