



Imaging features of hepatic infections

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Learning objectives

The purpose to describe the different causes of hepatic infections and review their imaging findings.



Background

Liver infections include bacterial, viral, fungal, and parasitic diseases. Some are common entities, such as viral hepatitis, hepatic abscess and hydatid disease. Other diseases are more rare and difficult to diagnose, presenting a lower level of suspicion, such as tuberculosis or fascioliasis.



Background

Imaging techniques having a high accuracy, plays a crucial role in the diagnosis of hepatic infections. Even so, the imaging findings are generally not specific, with differential diagnostic difficulties with hepatic cysts and necrotic tumors, which is why the clinical context is extremely important.

The radiologist has an important role beyond diagnosis, monitoring and even treatment with percutaneous image-guided drainage.



Imaging findings and procedure details

Hepatic Abscess





Liver abscess

- Pyogenic
- Amoebic
- Fungal

Microabscess - when smaller than 2cm.



Liver abscess

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

- Cluster sign;
- Wall enhancement;
- Double target sign;
- Perilesional edema;
- Gas.



Cluster sign

Grouping of small lesions with low attenuation or high T2 signal intensity, that gradually coalesce into a larger. Especially suggestive of a pyogenic abscess.



Liver abscess at contrast-enhanced CT

- Grouping of low attenuation lesions in the liver - cluster sign.

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Liver abscess at contrast-enhanced CT - same patient, three weeks later. Coalescence of the small lesions into a larger one.

References: *Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal*



Wall enhancement

Identified on contrast studies, virtually diagnostic of an abscess in the appropriate clinical setting.



Contrast-enhanced CT - Liver abscess

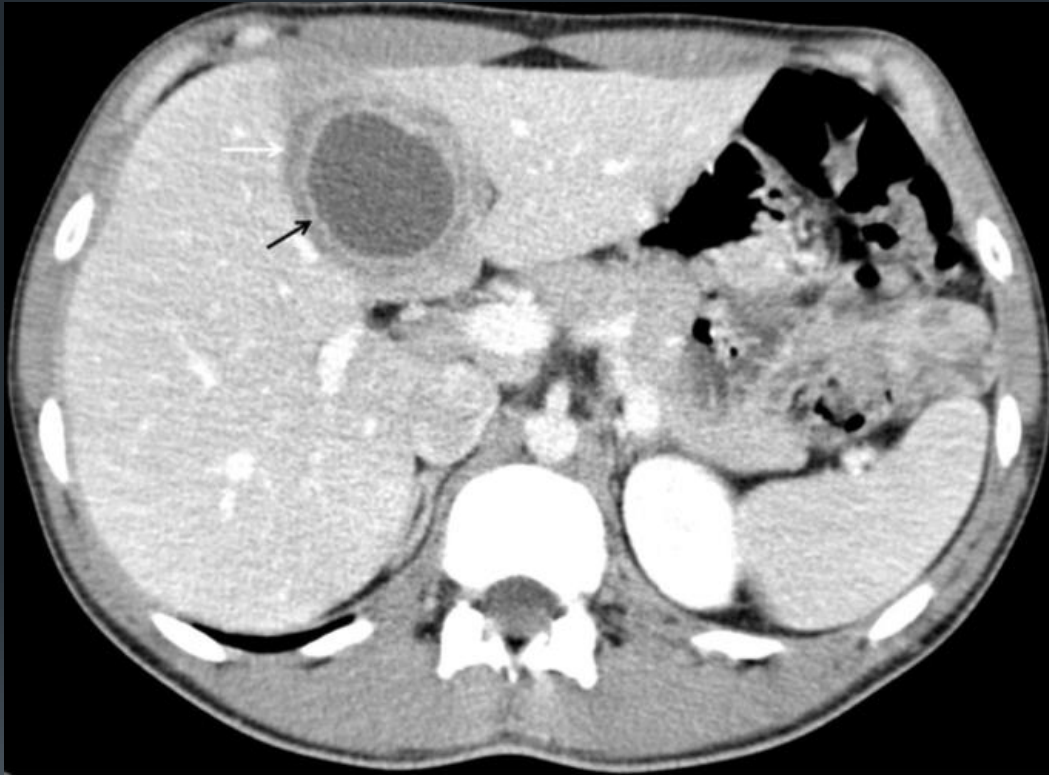
- Low attenuation liver lesion with evident wall enhancement.

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Double target sign

Zone of external low attenuation, besides the enhancement of the wall.



Contrast-enhanced CT - Amoebic abscess.

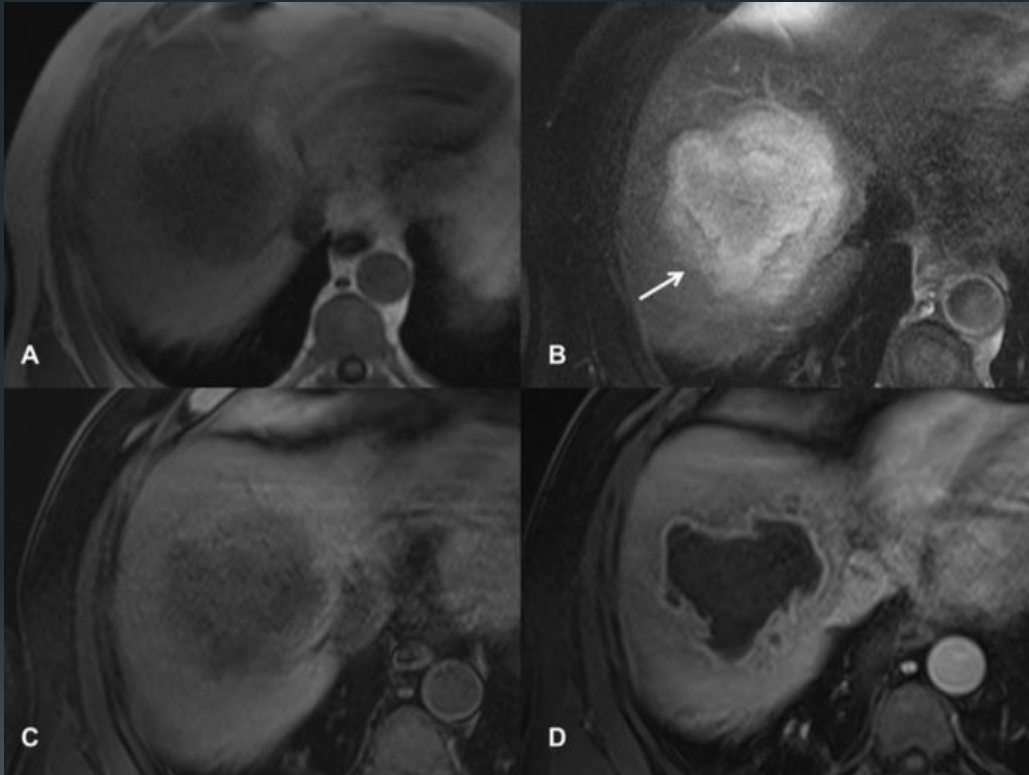
- Thick enhancing wall (black arrow) and outer hypodense rim (white arrow) - Double target sign.

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Perilesional edema

Helps differentiate an abscess from a benign cystic lesion. A minority of malignant lesions may also show this abnormality.



Liver abscess at MRI.

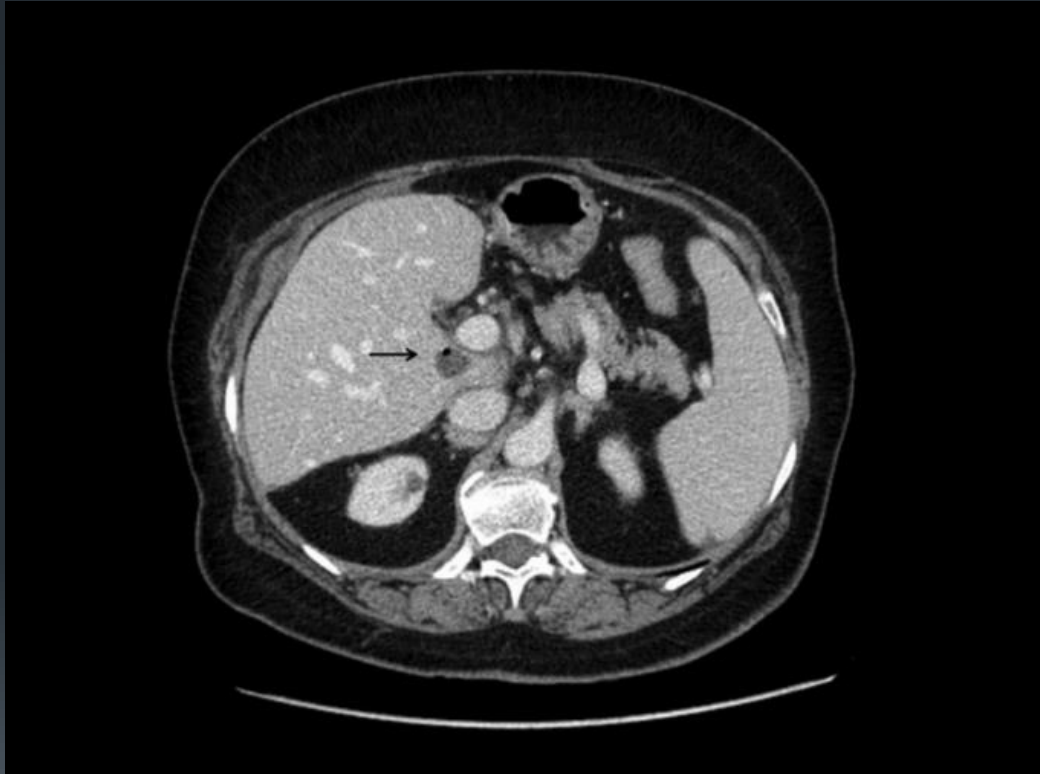
- Irregular lesion, hypointense at T1 (A), hyperintense at T2 (B), with defined wall that enhances with contrast (C - pre-contrast T1 with fat suppression, D - portal phase). Note perilesional edema (B - arrow).

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Gas

A classic and specific sign but only present in a minority of cases. It's more common in *Klebsiella* and anaerobic infections.



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, University Hospital of Coimbra – Coimbra, Portugal



Liver abscess

- Pyogenic
- Amoebic
- Fungal



Pyogenic abscess

The most common abscesses in developed countries. Usually caused by biliary obstruction or hematogenous spread from a intestinal infection.

Causative agent: *Escherichia coli*, other gram-negative bacteria, anaerobes. Half are polymicrobial.

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.



Pyogenic abscess

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.
- 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.

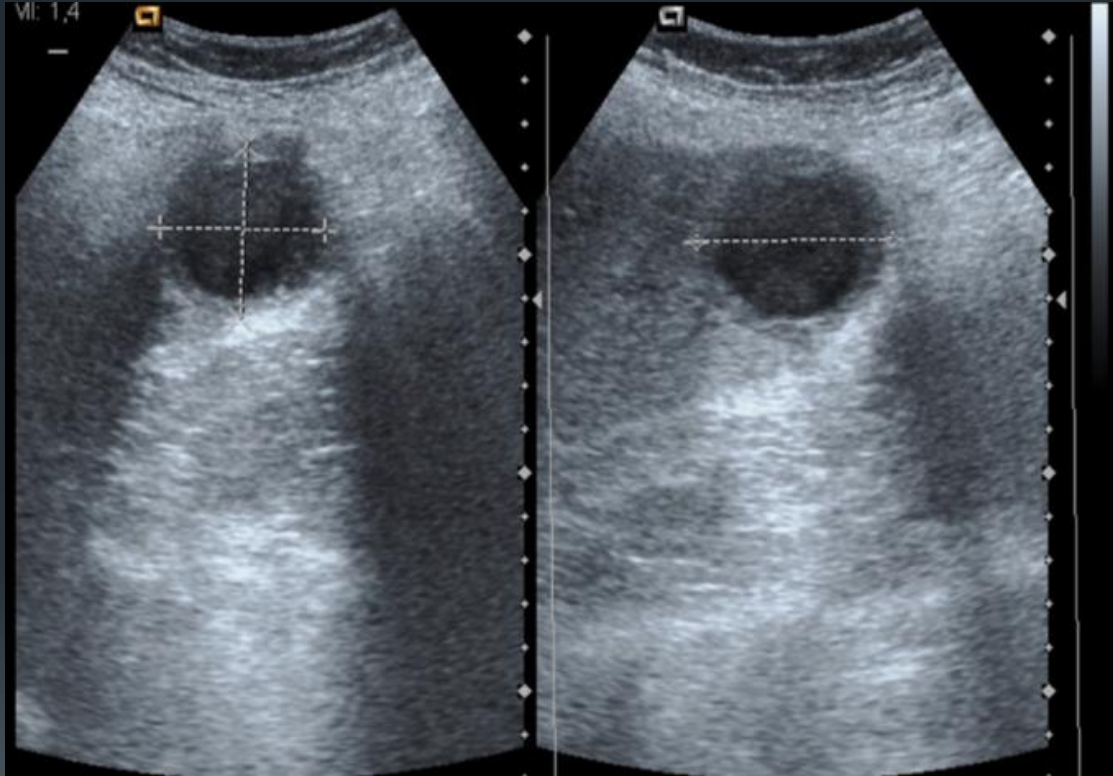


Pyogenic abscess

Imaging Findings:

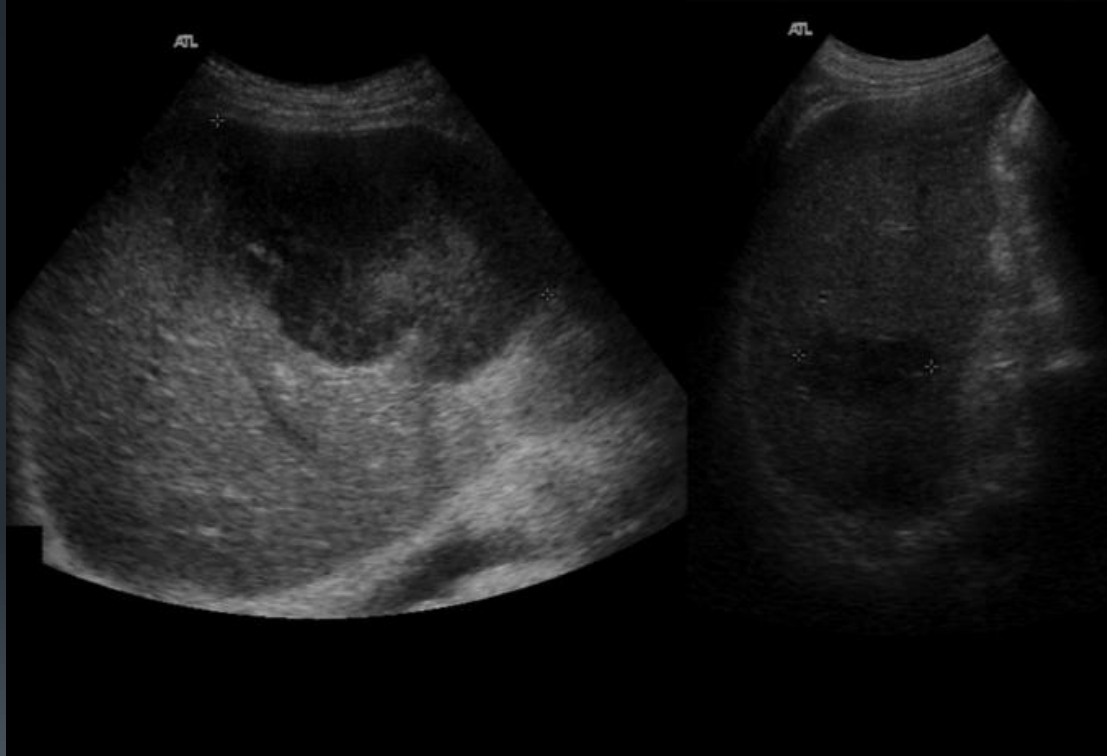
- US: most often a complex cystic lesion, but may also appear solid.
- CT: most commonly a thick-walled lesion with low attenuation.
- MRI: variable signal intensities on T1 and T2, depending on protein content.

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



Liver abscess. Complex cystic appearance at US, with thickened wall.

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



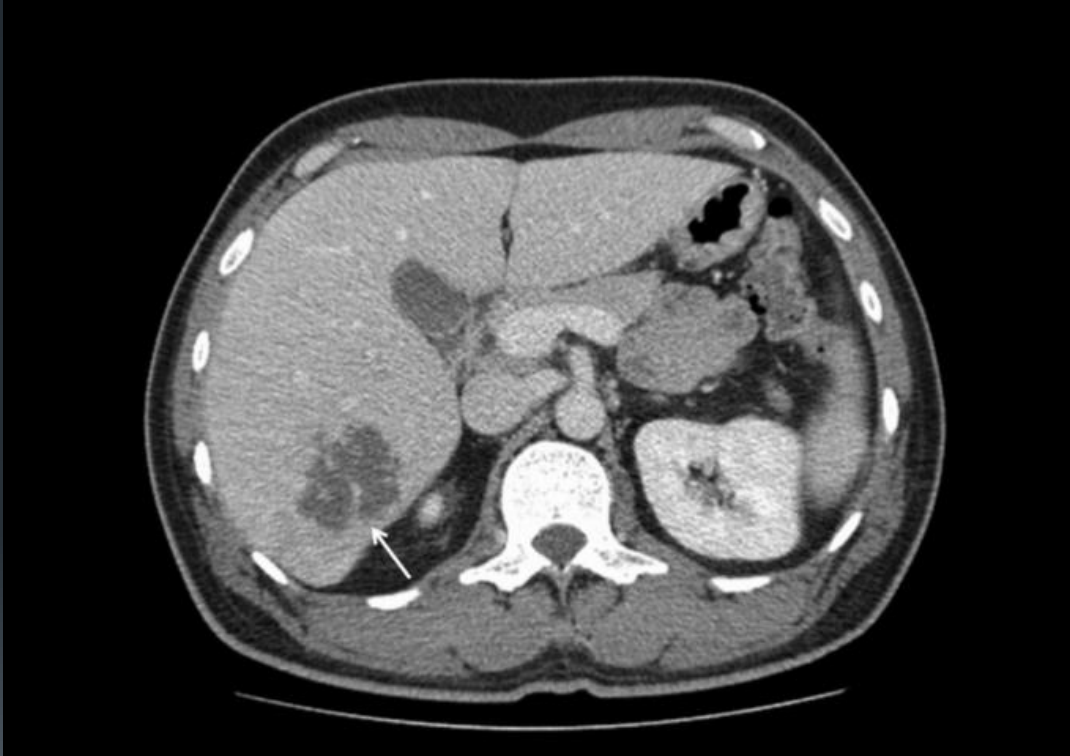
Two cases of liver abscesses with hypoechoic solid appearance on US.

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Pyogenic abscess

- **Special cases:**
 - **Staphylococcal infection:** Multiple abscess with a milliary pattern of distribution, similar to fungal abscesses.
 - **Klebsiella pneumoniae abscess:**
 - Gas is more common.
 - Septal breakage sign - arborizing patterns of septa in the abscess cavity.
 - Turquoise sign - numerous septal breakages.
 - Hair-ball sign - tangled pattern of hairline content in the abscess fluid.



Contrast-enhanced CT. Klebsiella abscess in the right liver lobe. Discontinuous septa (arrow) - septal breakage sign.

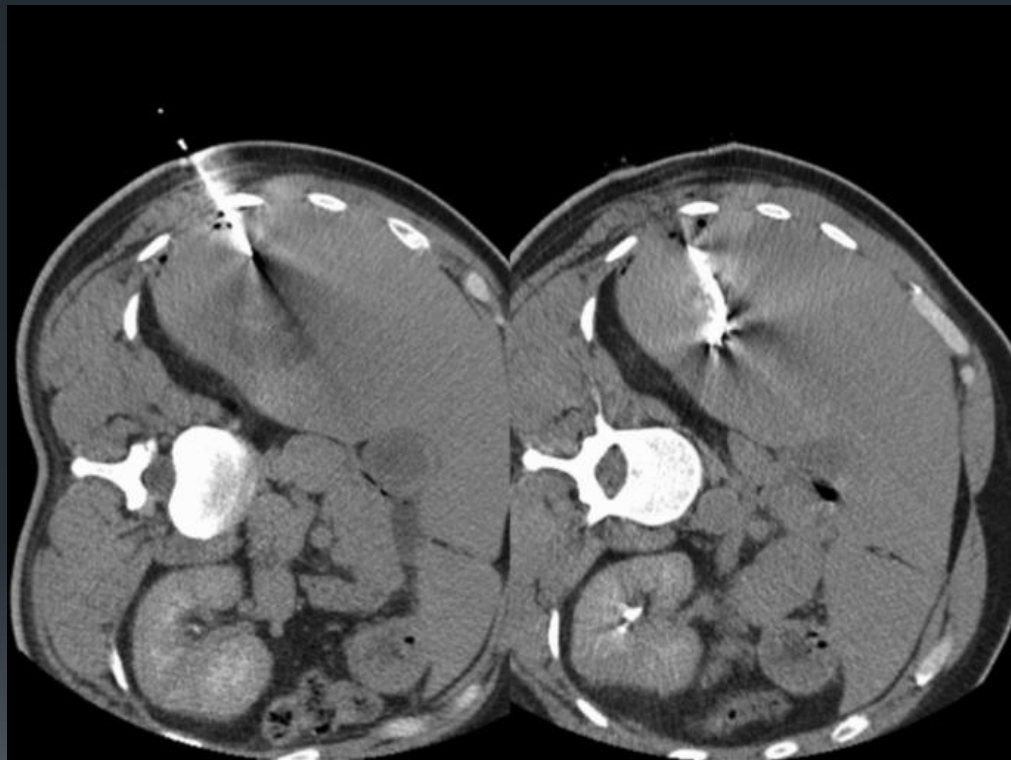
References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Pyogenic abscess

- **Treatment:**

- Medical therapy alone may be successful in lesions with less than 3-5cm of diameter.
- Image-guided drainage 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.



Percutaneous CT-guided drainage of the abscess

*References: Medical Imaging, University Hospital of Coimbra –
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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%.



Amoebic abscess

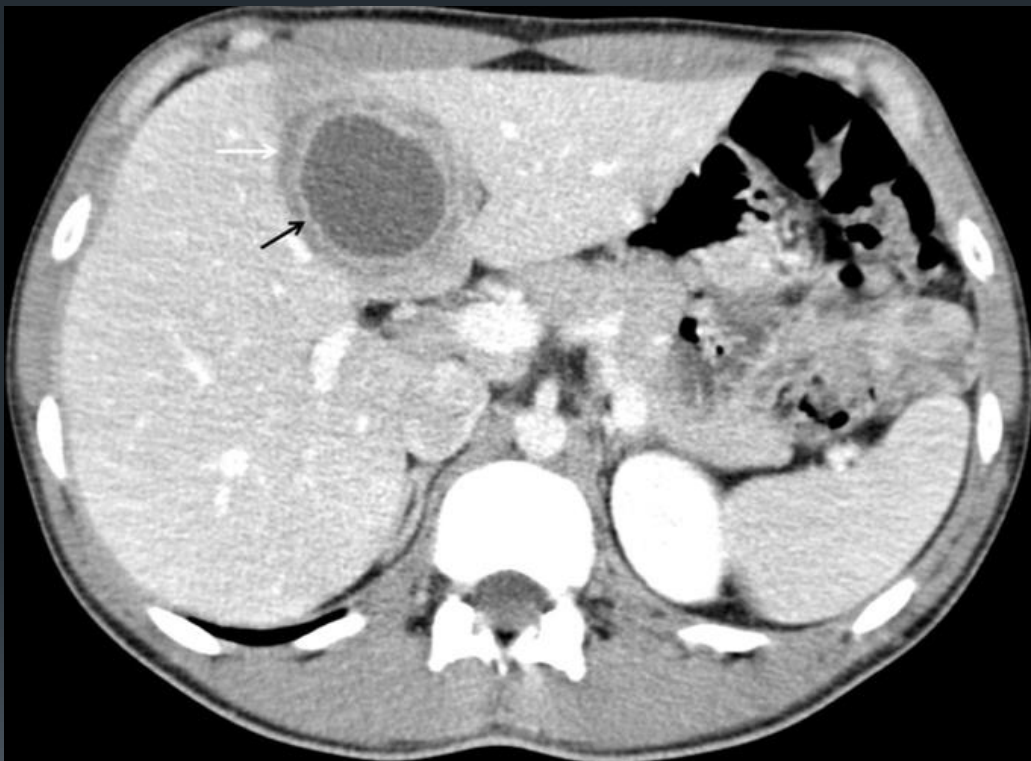
Imaging findings: Lesions are often solitary and near the liver capsule. An abscess with a thick wall and perilesional edema may suggest this diagnosis.

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



Amoebic abscess

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



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

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Contrast-enhanced CT - Amoebic abscess _
Double target sign.

*References: Medical Imaging, University Hospital of Coimbra –
Coimbra, Portugal*



Fungal abscess

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

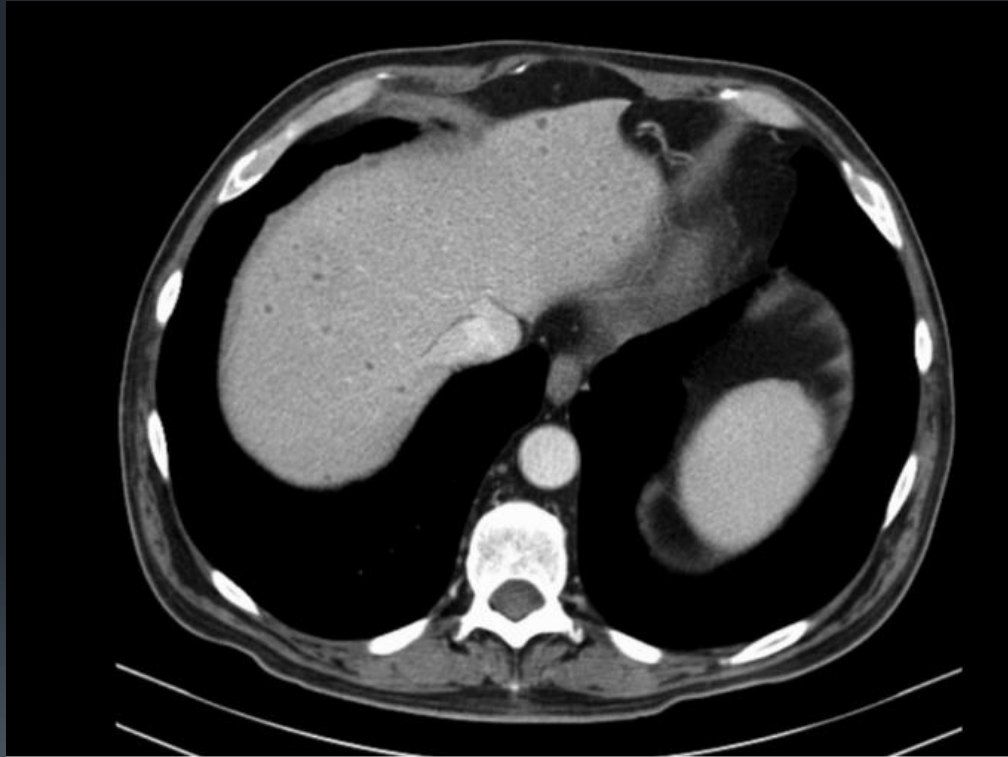
Clinical and laboratorial findings: Complication of immunosuppression and hematologic malignancies. Patients present with fever that does not respond to large spectrum antibiotics.



Fungal abscess

Imaging findings: Typically, there are multiple microabscesses in the liver and spleen. On US, the lesions may have a "wheel-within-wheel" or "bulls-eye" appearance, but uniformly hypoechoic nodules is the most common pattern. After treatment, foci of scarring and calcification may persist.

Treatment: Antifungal agents.



Contrast-enhanced CT. Multiple hepatic microabscesses in a immunosuppressed patient with leukemia.

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Same patient - Liver US shows small hypoechoic nodules.

References: *Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal*

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.



Hydatid Disease

Causative agent: *Echinococcus granulosus*

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.



Hydatid Disease

- **Imaging findings:**
 - Variable
 - There are various classification systems:
 - Gharbi classification
 - OMS classification

WHO classification of cystic echinococcosis (CE) / Gharbi classification
International consensus classification

CE 1 / Type 1

Unilocular simple cysts

Active

CE 2 / Type 3

Multivesicular multiseptated cyst

Active

CE 3 / Type 2

Floating membrane (water lily sign)

Transitional

CE 4 / Type 4

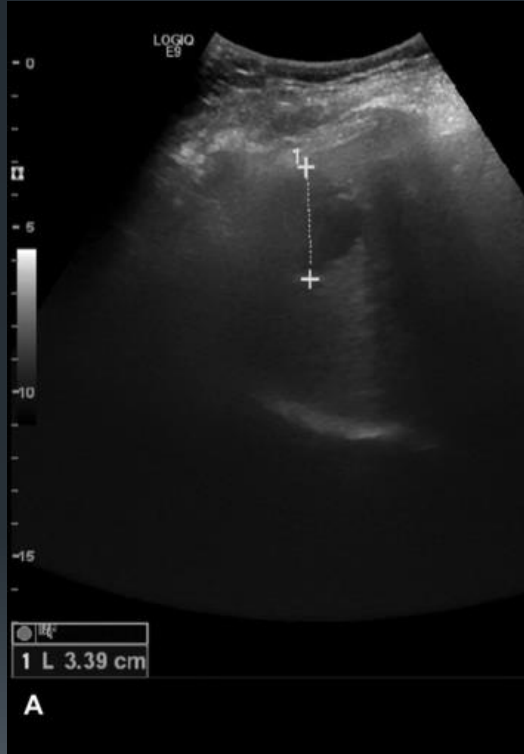
Heterogeneous degenerative contents

Inactive

CE 5 / Type 5

Thick calcified wall

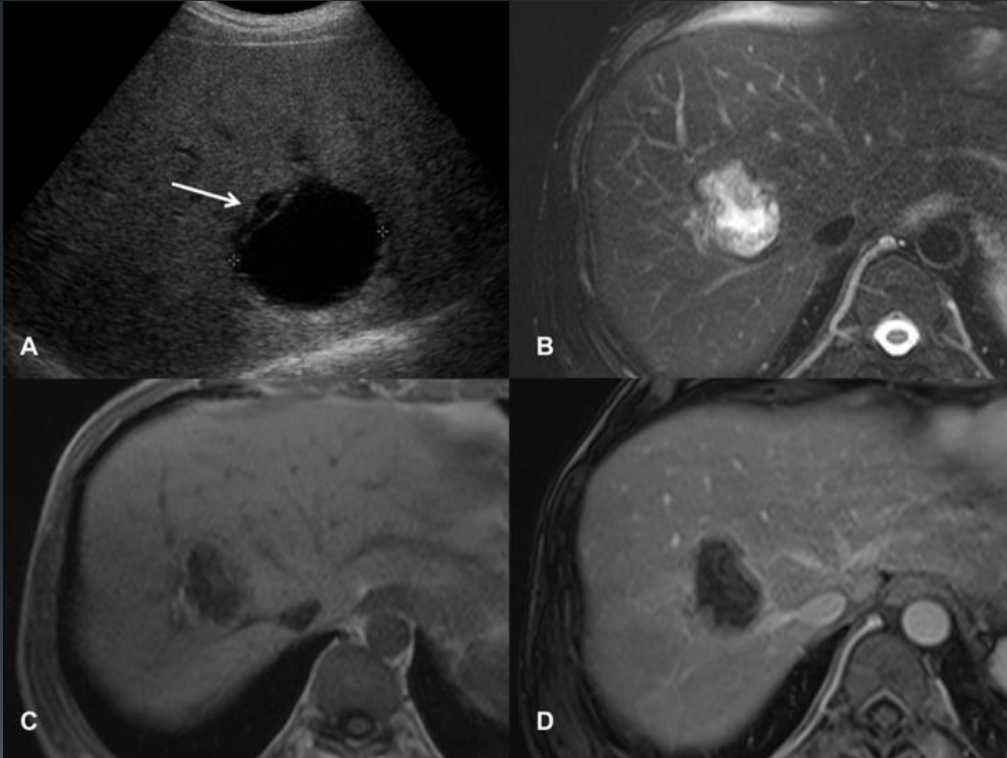
Inactive



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, University Hospital of Coimbra – Coimbra, Portugal



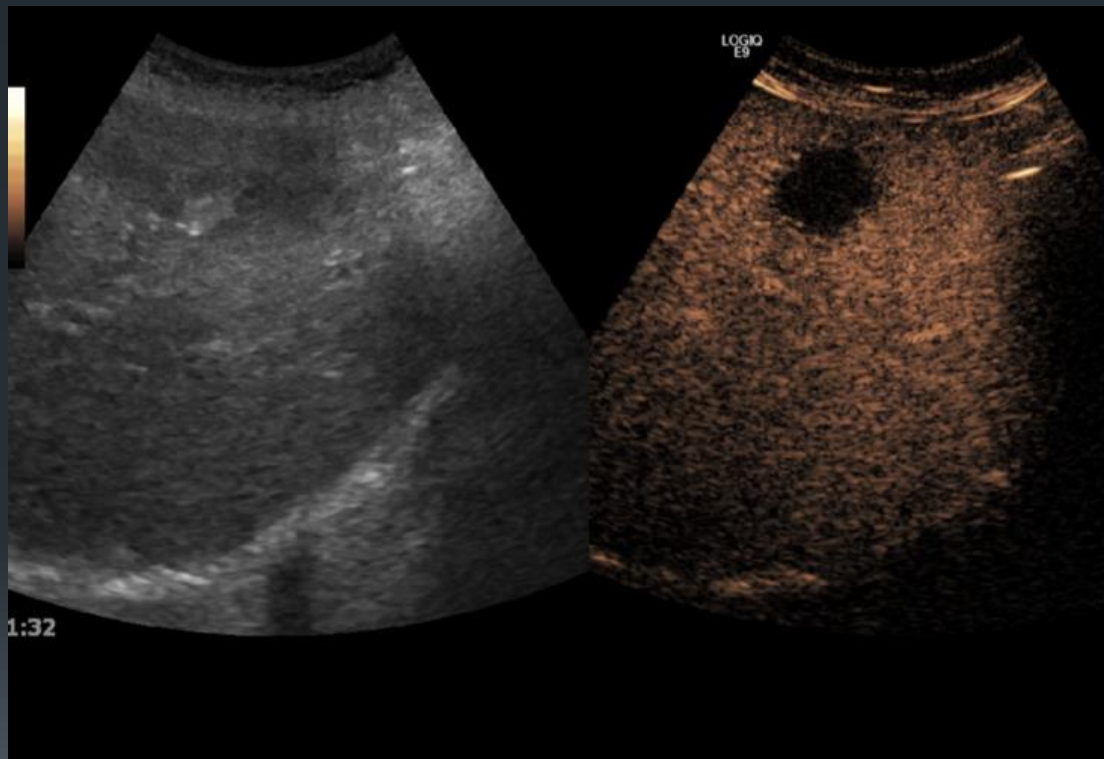
Liver hydatid cyst.

- A - Type 2 cyst at US, with detachment and collapse 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, University Hospital of Coimbra – Coimbra, Portugal



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

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Massively calcified hydatid cysts. A - Type 5 lesion at US. B - CT.

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Massively calcified hydatid cysts - Type 5

*References: Medical Imaging, University Hospital of Coimbra –
Coimbra, Portugal*



Hydatid Disease

US:

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

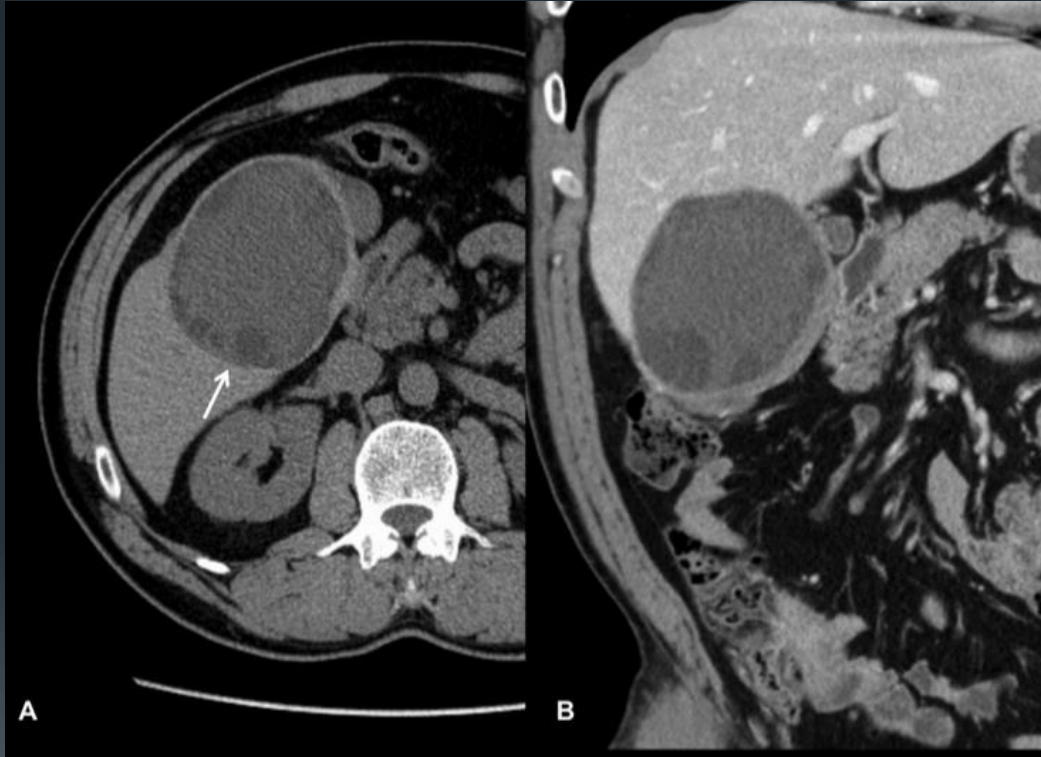
CT:

- 50% have wall calcifications and 75% have detectable daughter lesions.



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

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



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, University Hospital of Coimbra – Coimbra, Portugal*



Hydatid Disease

MRI:

- Best demonstrates the pericyst, the matrix and the daughter cysts.
 - 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.



Hydatid Disease

Treatment:

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



Echinococcus Multilocularis Cyst

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



Echinococcus Multilocularis Cyst

Imaging Findings:

- Multilocular alveolar cysts scattered throughout the liver, the most frequent site of involvement.
- 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.



Contrast-enhanced CT of *Echinococcus multilocularis* infection. Multiple low-attenuation lesions scattered throughout the right liver lobe.

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



Echinococcus Multilocularis Cyst

Treatment:

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



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*



Fascioliasis

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.



Fascioliasis

Imaging findings:

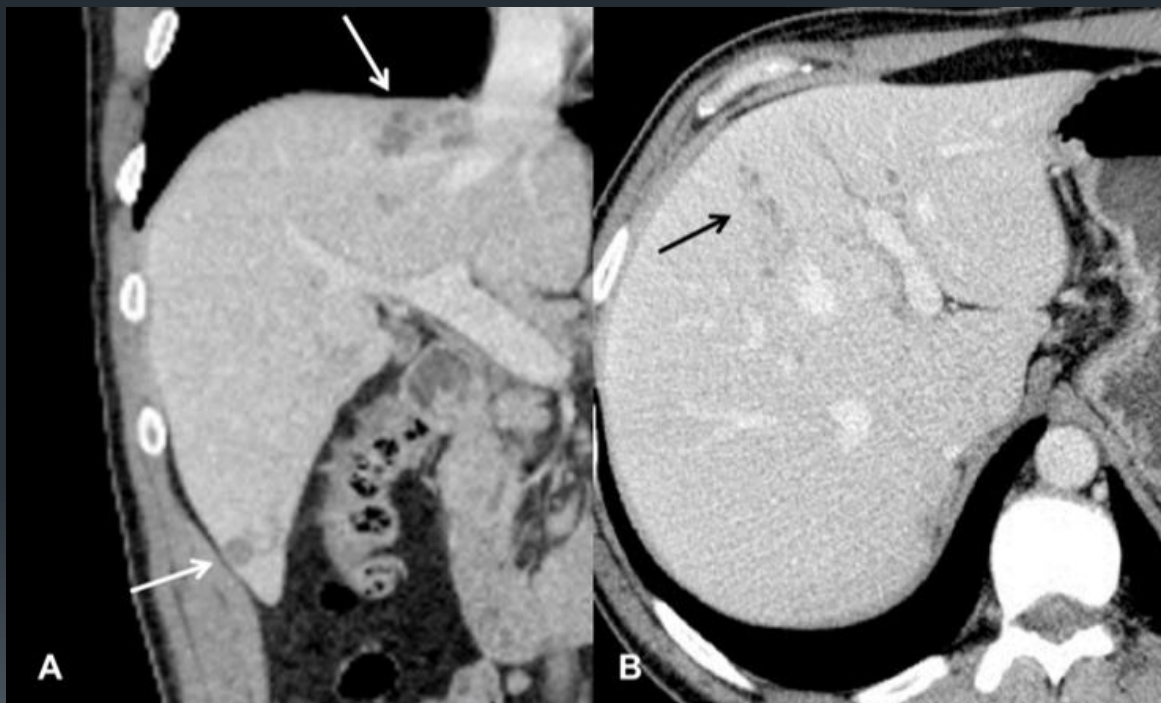
- Multiple small nodular and branching linear lesions, predominantly subcapsular, which are hypoechoic on US, hypodense on CT, T1 hypointense and T2 hyperintense.

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.

Treatment:

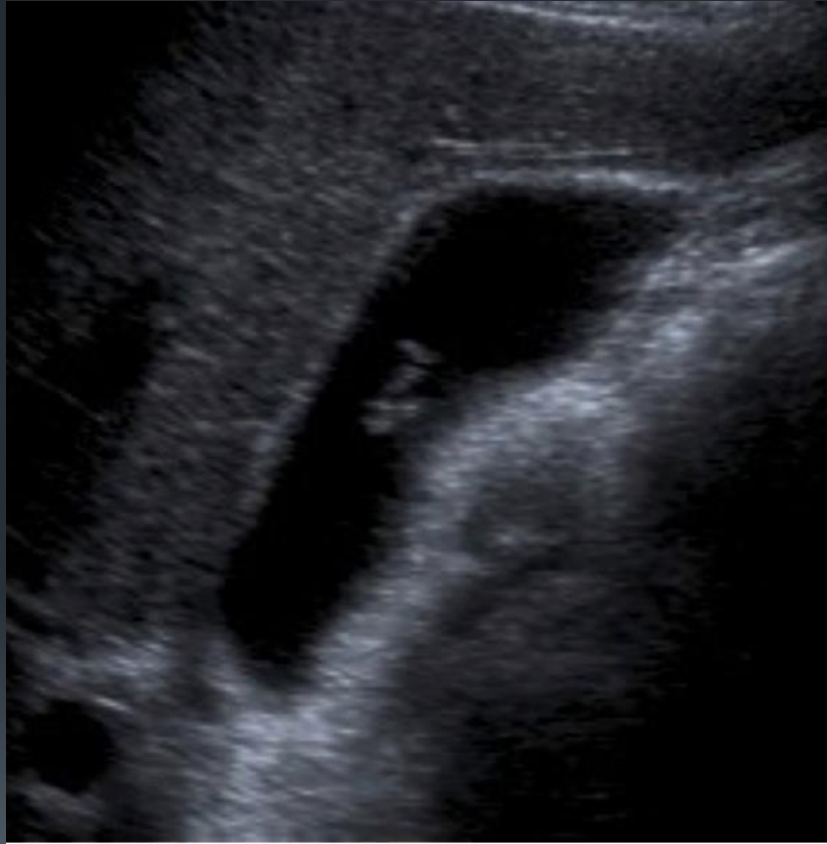
- Medical therapy.



Fascioliasis at contrast-enhanced CT

- A - Coronal reformat, subcapsular nodular hypodense lesions.
- B - Axial plane, linear distribution of lesions (arrow).

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



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

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



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.

Other Infections





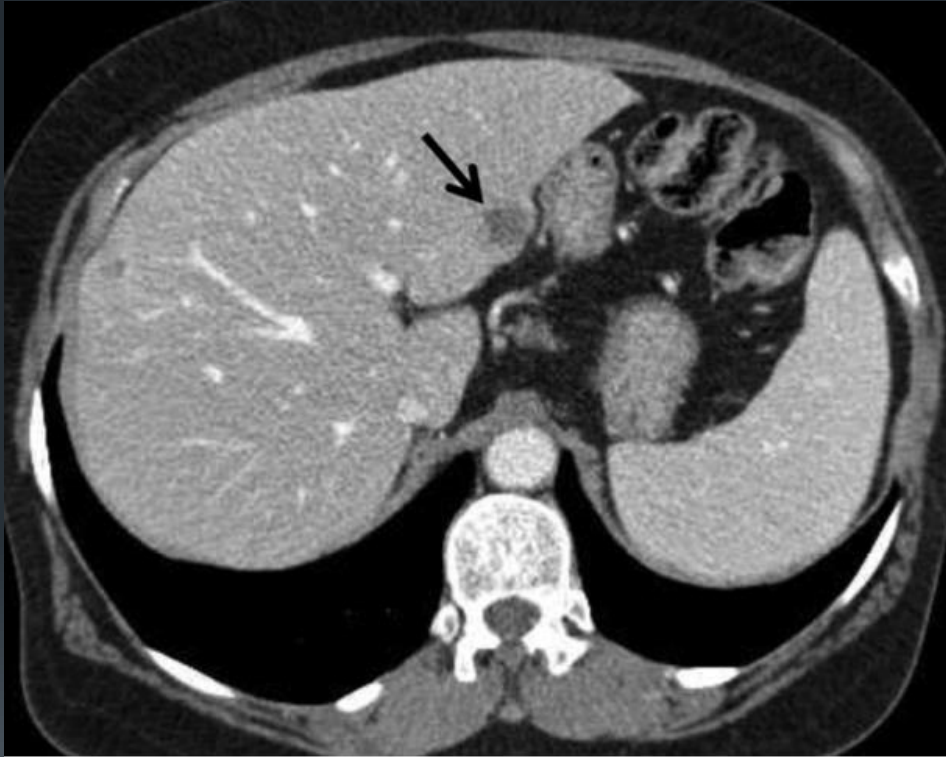
Hepatic Tuberculosis

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



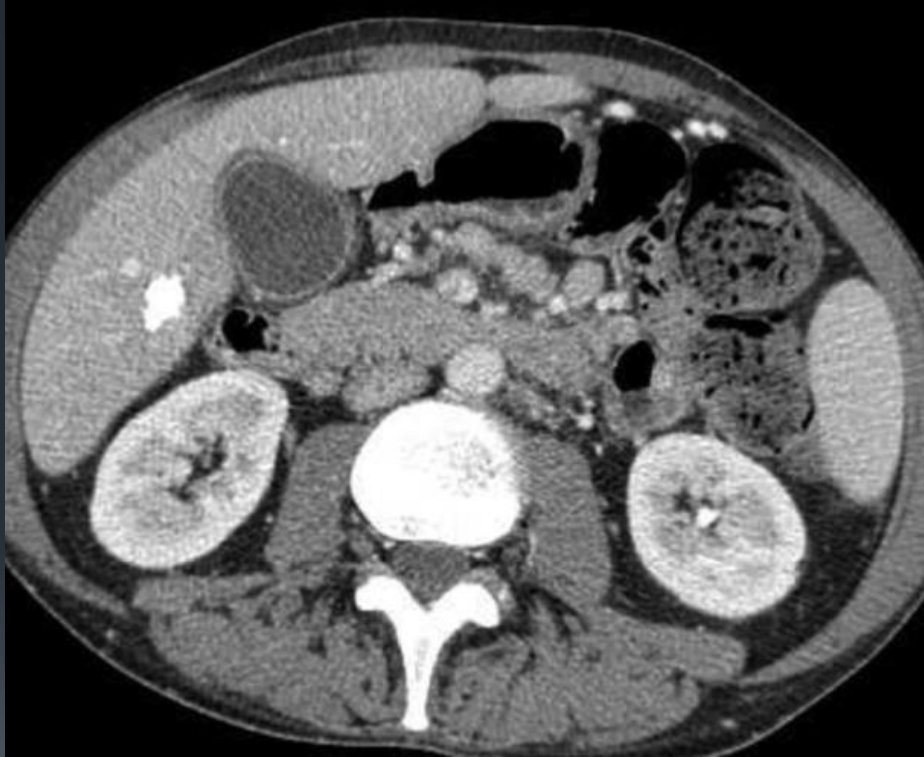
Abdominal contrast-enhanced CT in a patient with pulmonary tuberculosis. Scattered low attenuation lesions in the liver and spleen.

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



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

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



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

References: Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal



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. Occasionally 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.



Contrast-enhanced CT. Multiple hepatic microabscesses in a immunosuppressed patient with HIV.

***References:** Medical Imaging, University Hospital of Coimbra – Coimbra, Portugal*



Contrast-enhanced CT. Multiple hepatic microabscesses in a immunosuppressed patient with HIV

References: Medical Imaging, Faculty of Medicine of Coimbra, University Hospital of Coimbra – Coimbra, Portugal



Cat-scratch disease

Caused by *Bartonella henselae*. Dissemination occurs in 5-10% of cases with granuloma formation in the liver.



Conclusion

The role of the radiologist is essential in cases of liver infections, from diagnosis to, monitoring and treatment.

In addition to the characteristic aspects of imaging, in cases where these are less specific, the clinical context plays a fundamental role in the diagnostic aid.



References

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