CT imaging of hypodense Splenic lesions
How do I interpret it?

ID 53816 - Binit Sureka
EE-179

Binit Sureka[1], Pushpinder Khera[1], P. K.Garg[1], T. Yadav[1], A. Mukund[2], MK Mittal[3], P. Elhence[4]
Departments of [1]Diagnostic & Intervention Radiology, [4]Pathology & Lab Medicine
All India Institute of Medical Sciences (AIIMS) Jodhpur, India
[2]Department of Intervention Radiology, **ILBS, New Delhi**
[3]Department of Radiodiagnosis, **VMMC & Safdarjung Hospital, New Delhi**

Compliance with ethical standards

Funding: No funding was received for this study.

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from individual participant included in the study.

Learning Objectives

1. To identify focal splenic lesions on CT and classify into benign or malignant using various CT imaging parameters.

2. To characterise the lesion on CT and give most appropriate diagnosis depending on various CT parameters.

3. To tabulate all possible splenic lesions and their imaging appearance on non-enhanced and contrast-enhanced CT.

Background

- Spleen is the largest single lymphatic organ in the human body.
- It is responsible for central immunological and haematological tasks.
- Computed tomography (CT) represents the most widely applied cross-sectional abdominal imaging technique and is considered the imaging modality of choice for the evaluation of numerous abdominal pathological conditions.
- Hypodense splenic lesions are frequently encountered on abdominal CT images.
- Most hypodense lesions of the spleen can be considered benign. Various parameters in CT - cystic/solid, borders of lesion, enhancement pattern, calcification, fat, etc. can be assessed to differentiate hypodense lesions of the spleen.

INTRODUCTION

- Spleen is the largest lymphatic solid organ in the human body having important immunological and hematological functions, yet referred to as neglected organ.
- Various lesions can be encountered in the spleen which includes *congenital, infectious, inflammatory, traumatic, vascular, and neoplastic pathologies.*
- Computed tomography (CT) is the most widely used imaging modality for abdominal pathologies and often these focal splenic lesions are incidentally detected on CT.

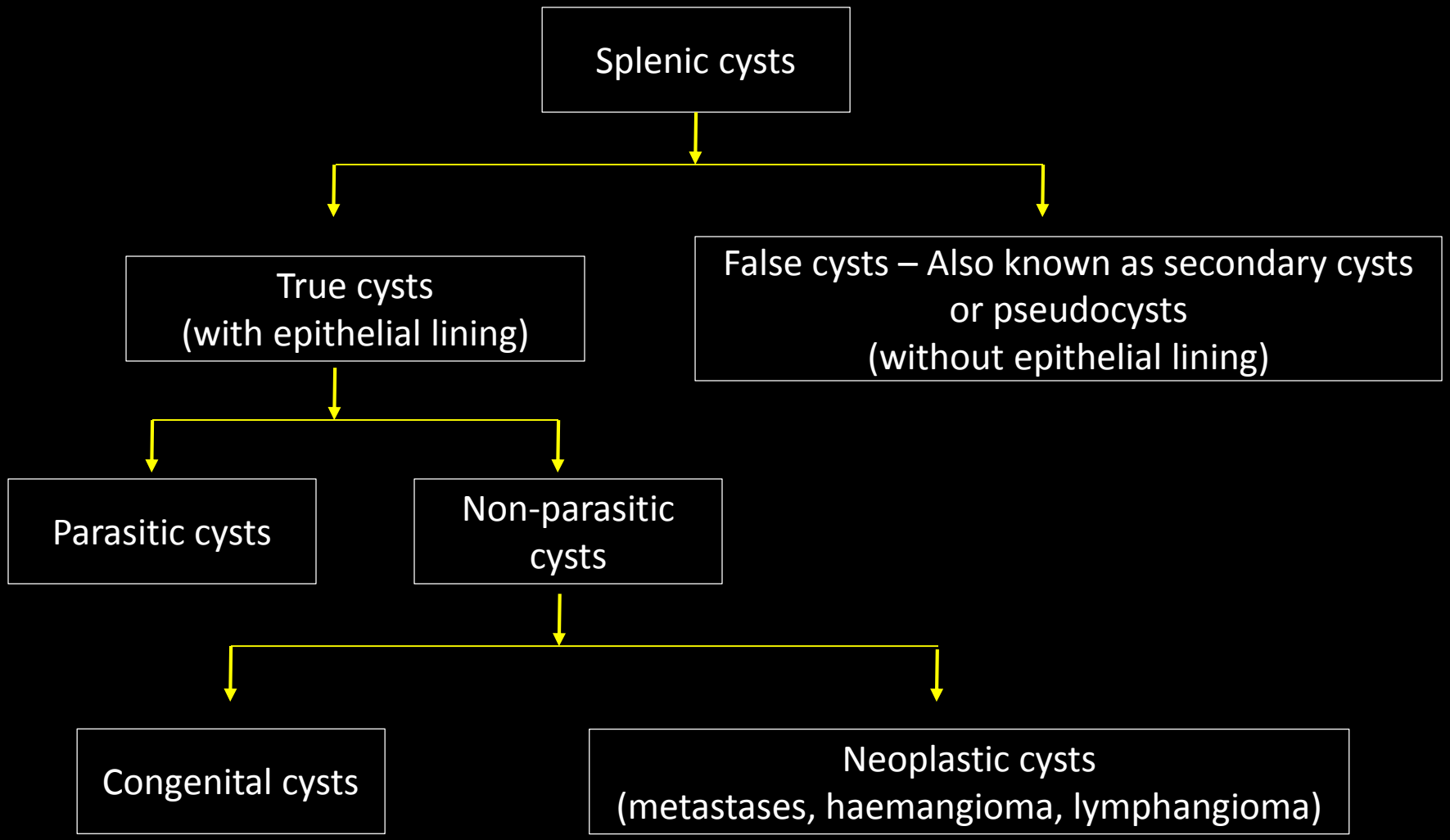
INTRODUCTION

- Interpretation of a hypodense lesion in the spleen on CT can be challenging, and often can only be performed correctly when certain imaging patterns are considered and the clinical history is taken into account.
- The purpose of this pictorial is to review and discuss the characteristic CT imaging findings of hypodense lesions of the spleen.
- Radiologists should be aware of CT imaging features of various splenic lesions.

Cysts

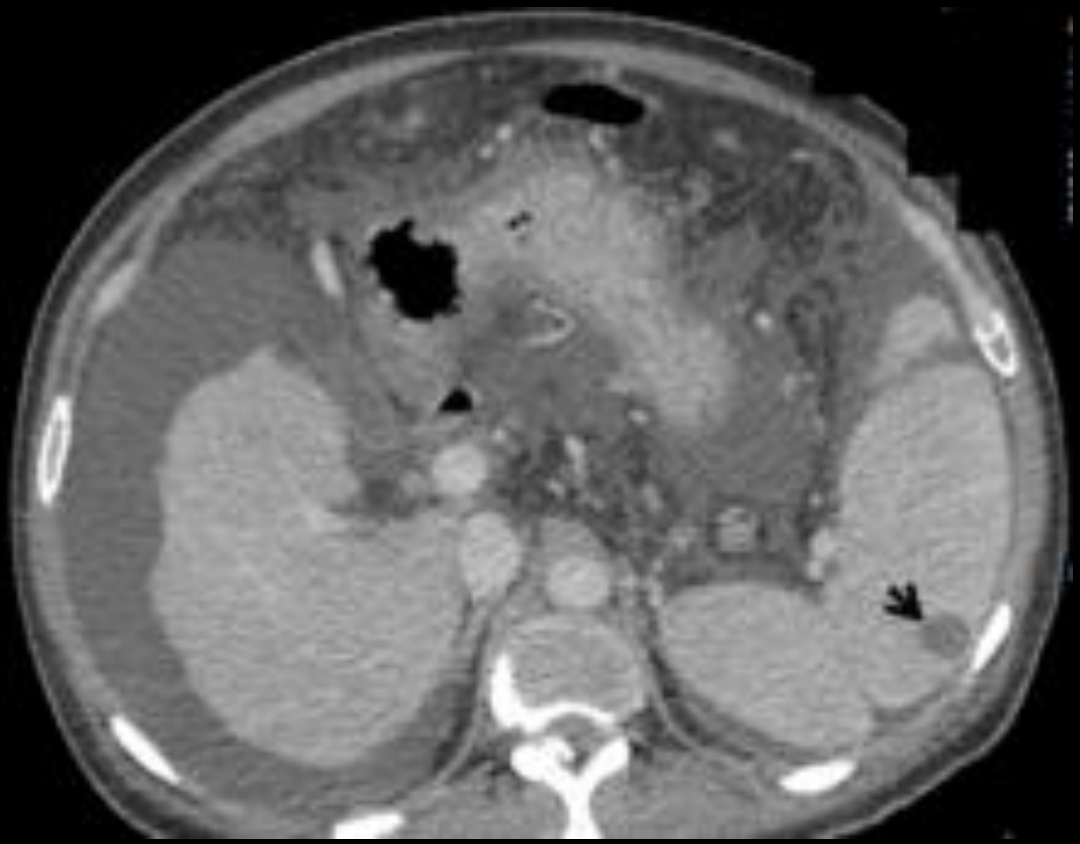
- Splenic cysts can be divided into true (with epithelial lining) and false cysts.
- True splenic cysts are further divided into parasitic and non-parasitic cysts.
- Non-parasitic cysts could be congenital or neoplastic cysts.
- Congenital cysts - 2.5% of splenic cysts. On CECT, congenital cysts are well-defined, have water attenuation (0-10HU), unilocular or multilocular and do not show enhancement.
- Parasitic cysts – Hydatid
- Neoplastic cysts represent true cysts and include metastases, lymphangioma and hemangioma.
- False cysts also known as secondary cysts or pseudocyst account for 80% of splenic cysts and are secondary to trauma, infection or infarction

Cysts



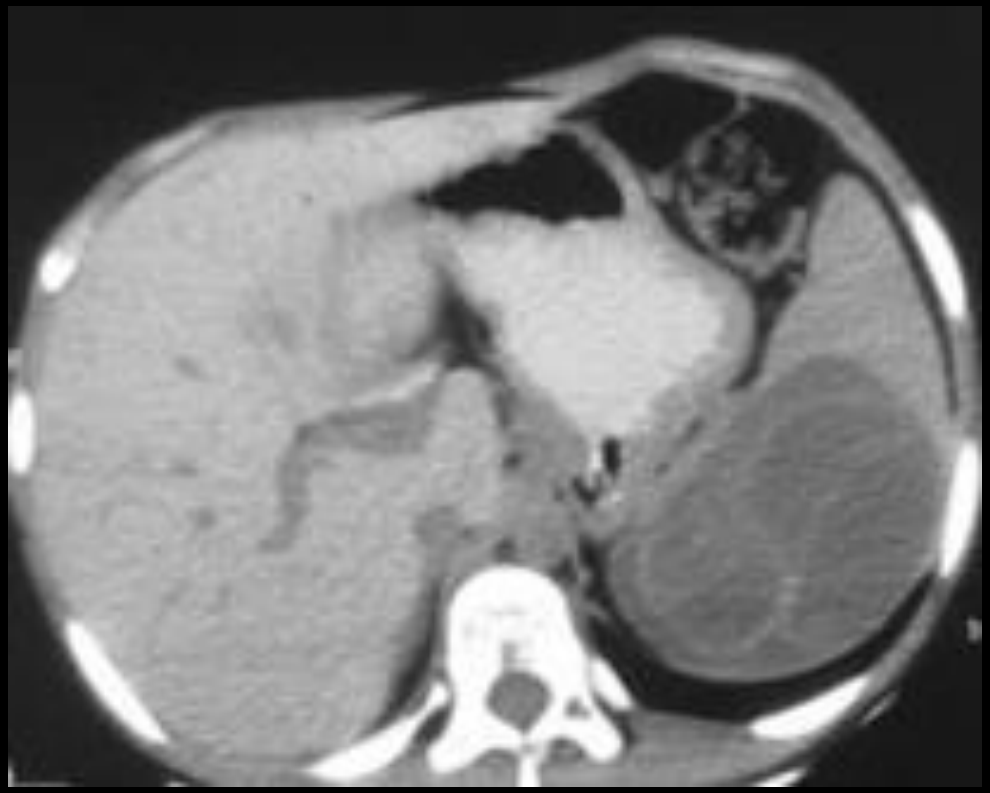
Radiographics 1996;16(1):107-29

Cysts



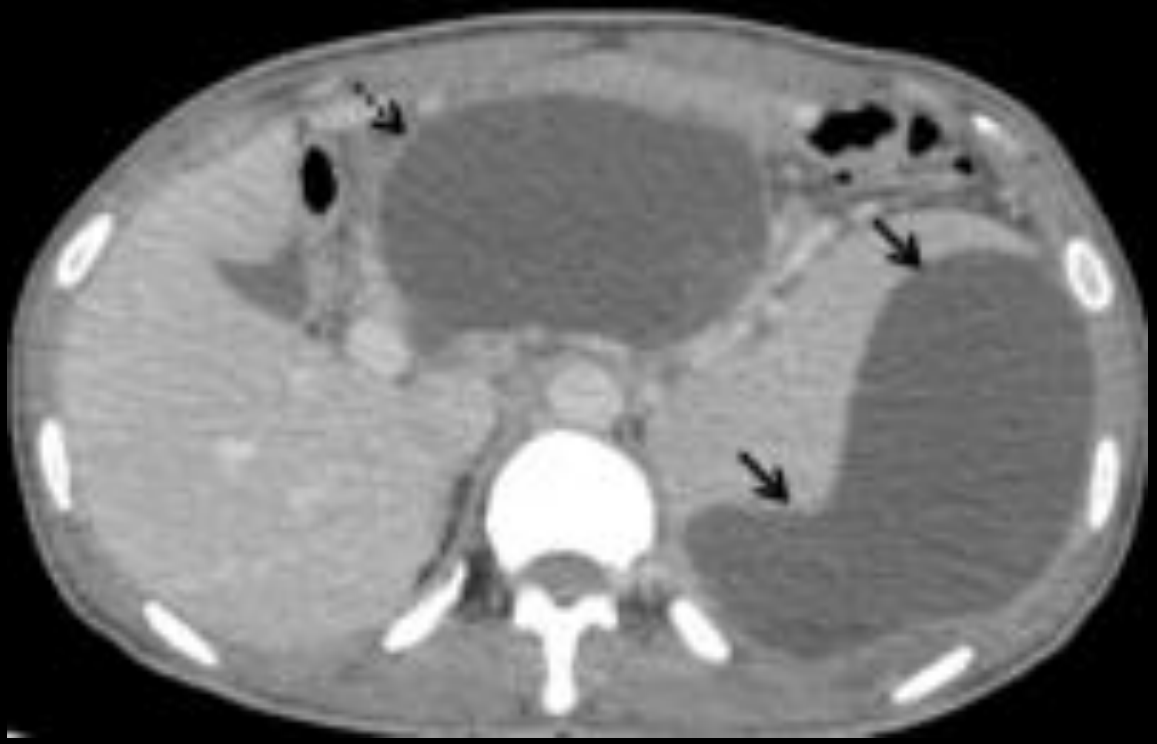
Congenital splenic cyst. Axial contrast-enhanced CT image showing well-defined water attenuation cystic lesion (arrow) in the splenic parenchyma, changes of chronic liver disease and ascites.

Cysts



Splenic hydatid. Axial plain CT image showing well-defined water attenuation cystic lesion in spleen with internal membranes in surgically proven splenic hydatid disease.

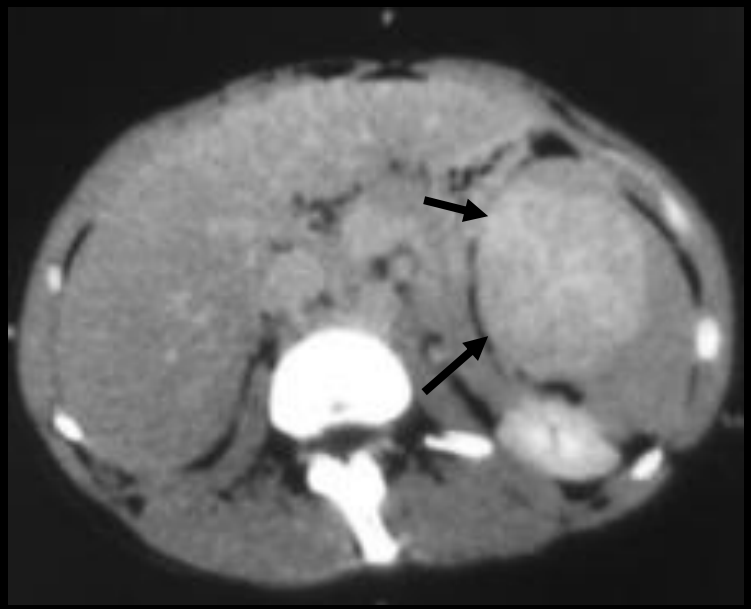
Cysts



Splenic pseudocyst. Axial contrast-enhanced CT image showing well-defined water attenuation cystic lesions in sub capsular aspect of spleen (arrow) and pancreas (dashed arrows) suggestive of pseudocyst in a case of pancreatitis.

Hemangioma

- Haemangioma are the most common primary benign splenic neoplasm, with a reported autopsy prevalence of up to 14%.
- Diffuse splenic hemangiomatosis can also occur, in which the splenic tissue is replaced by multiple hemangiomas. On non-contrast-enhanced CT, most hemangiomas are isodense or hypodense.
- Post contrast administration, haemangioma typically exhibit early, peripheral concentric or nodular enhancement, which gradually extends towards the centre similar to hepatic hemangiomas.

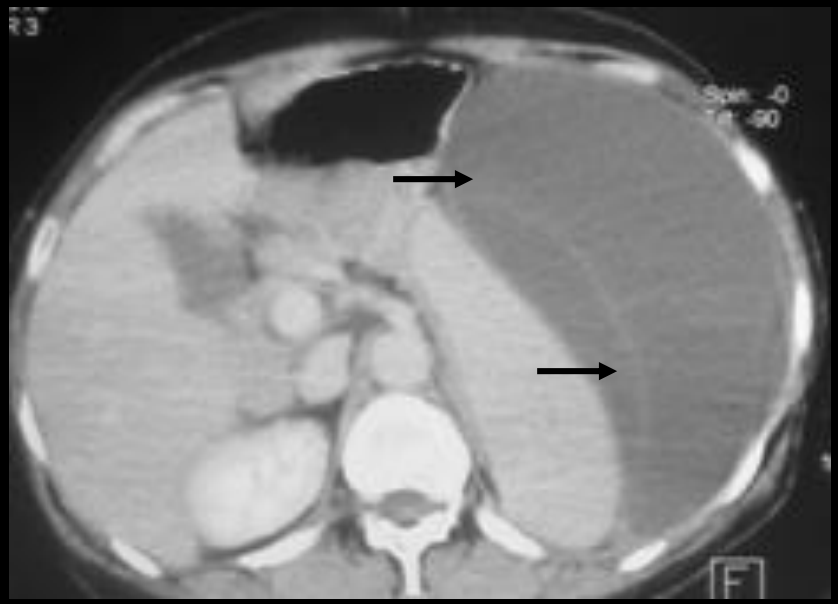


Splenic hemangioma. Axial contrast-enhanced CT portal venous phase images showing well-defined splenic lesion with homogeneous enhancement in a case of splenic hemangioma.

Radiology 1987;162(1Pt 1):73-7

Lymphangioma

- Lymphangiomas of the spleen are detected incidentally in children and young adults.
- Lymphangiomas are congenital malformations, however can be seen in children with generalised lymphangiomatosis.
- On contrast-enhanced CT, lymphangiomas are usually located adjacent to splenic capsule, have water attenuation, may be unilocular or multilocular and usually do not show internal enhancement.



Splenic Lymphangioma. Axial CT portal-venous phase image showing water-attenuation lesion adjacent to splenic capsule with thin internal septations in a case of splenic lymphangioma.

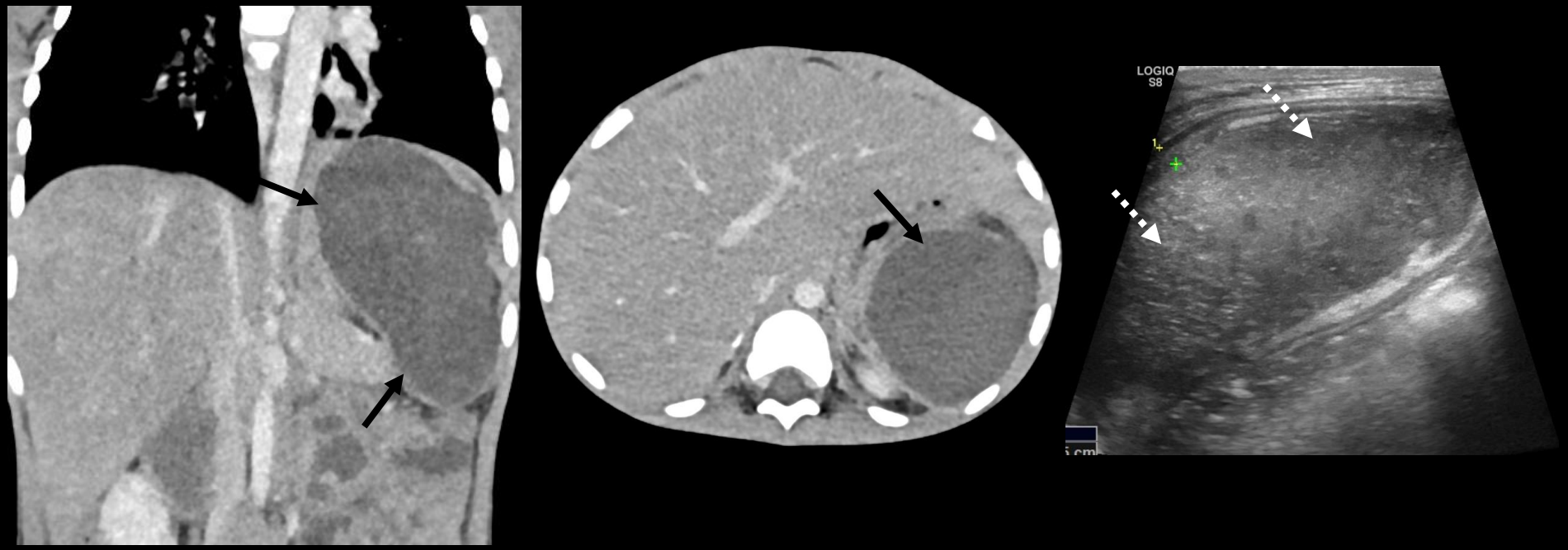
Eur Radiol 2001;11(7):1187-90

Splenic abscess

- Splenic abscesses include pyogenic, fungal and tuberculous abscesses.
- Pyogenic abscesses are caused by either haematogenous spread of bacteria, trauma, prior splenic infarction or contiguous infection. On contrast-enhanced CT, pyogenic abscesses may be single or multiple, show rim enhancement of the outer wall and appear inhomogeneous. Presence of gas is diagnostic of pyogenic abscess.
- Fungal abscesses are seen in immunocompromised patients. On CT, findings of splenomegaly and multiple abscesses <2 cm may be seen scattered in the splenic parenchyma.
- Tubercular abscesses are small (<2cm), multiple and may show mild peripheral enhancement with or without necrotic lymph nodes in the abdomen.

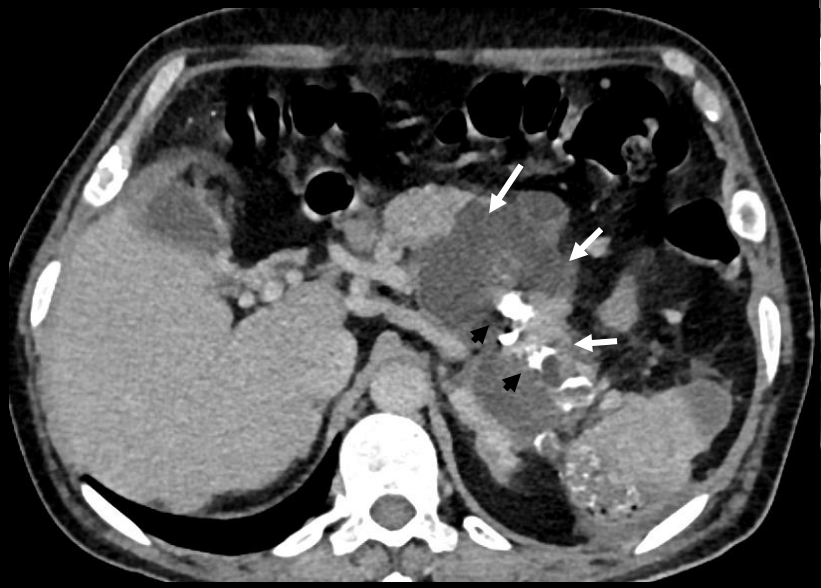
World J Surg 1990;14(4):513-6

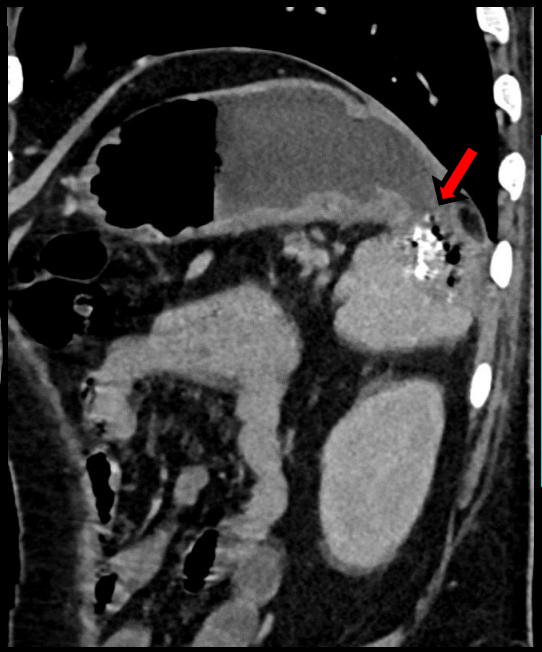
Splenic pyogenic abscess

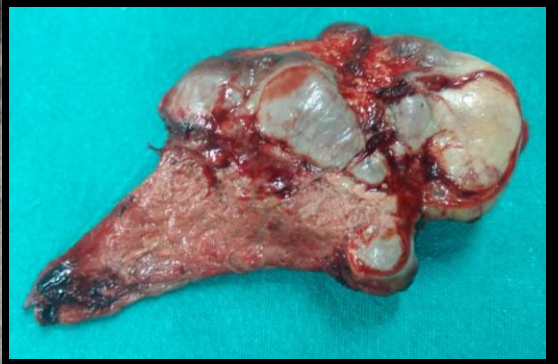


4-year-old-child with splenic pyogenic abscess. Coronal and axial CT portal-venous phase image showing hypodense collection (arrow) within the spleen with thick enhancing walls s/o infected liquefied abscess. Ultrasound image of the same patient showing hetereechoic collection (dashed arrows) within the splenic parenchyma

Gastro-splenic fistula resulting into Splenic abscess

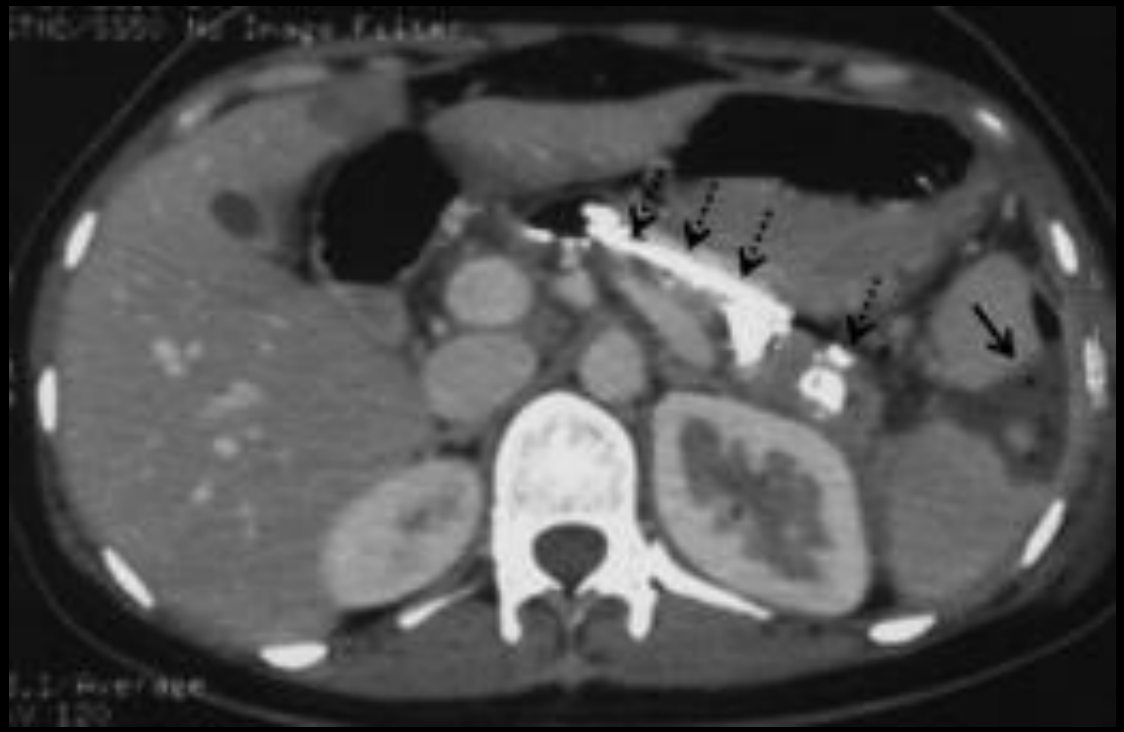






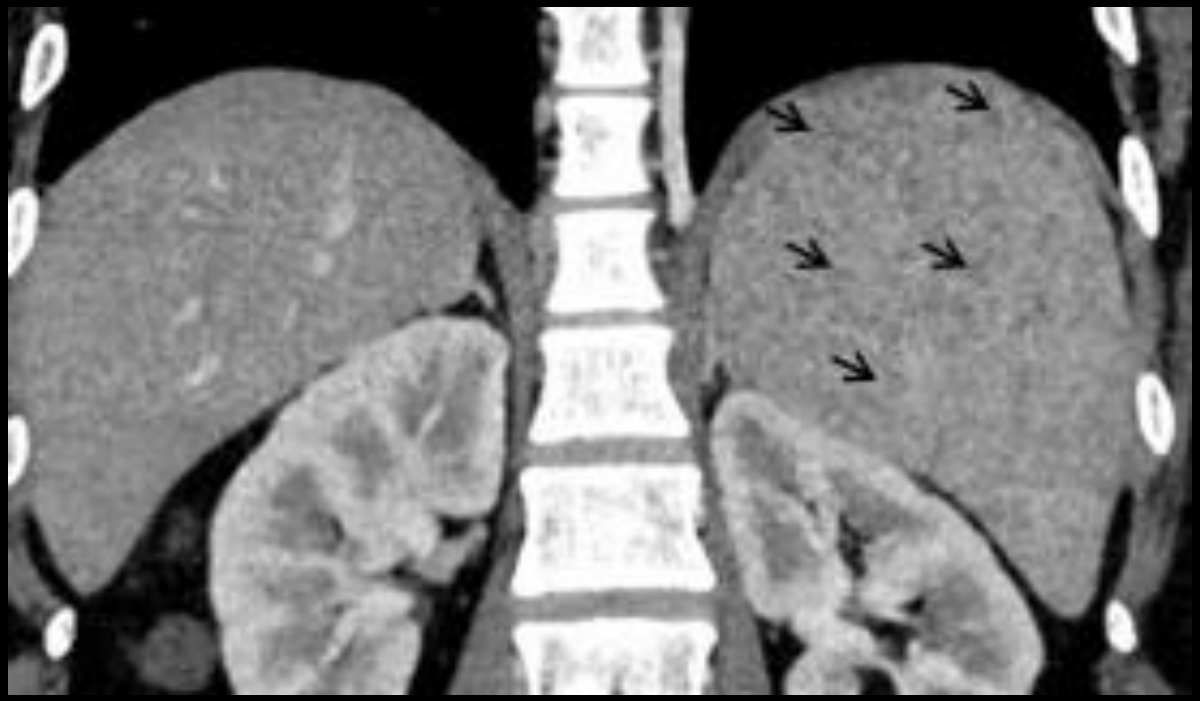
47-year-old-male with past history of glue embolization of splenic artery aneurysms presenting with fever, vomiting and pain abdomen: Axial CECT image showing changes of necrotizing pancreatitis (white arrows) with hyperdense glue material (arrowheads) in pancreatic bed. Sagittal reformatted image showing gastro-splenic fistula (red arrow) and hypoattenuating collection with glue particles in the splenic parenchyma. Post-operative specimen of the patient.

Splenic pyogenic abscess



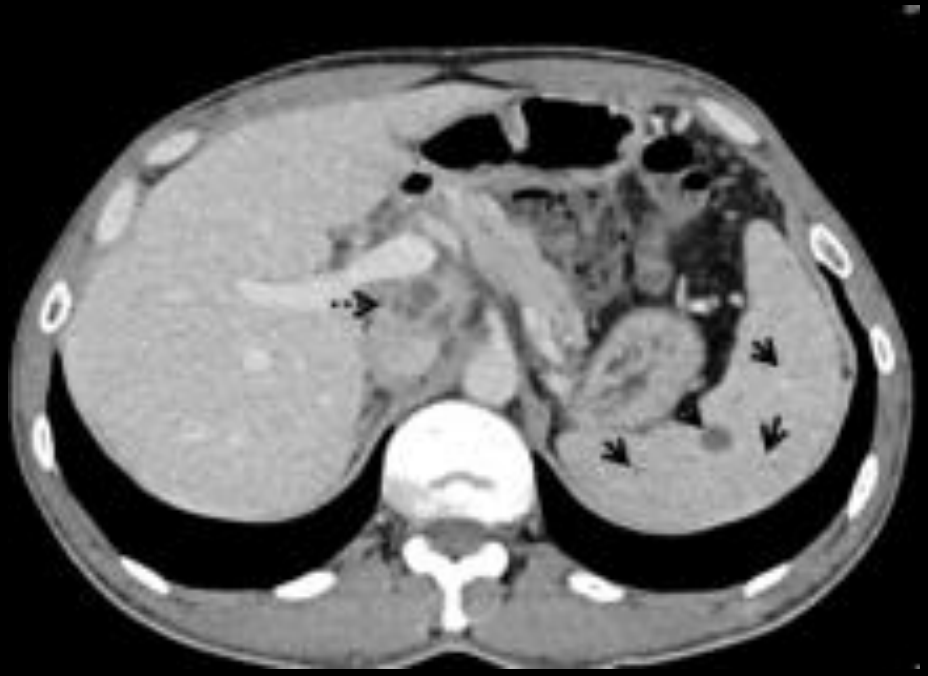
Splenic pyogenic abscess. Axial CT portal-venous phase image showing infected liquefied abscess (arrow) with air foci in Chronic calcific pancreatitis

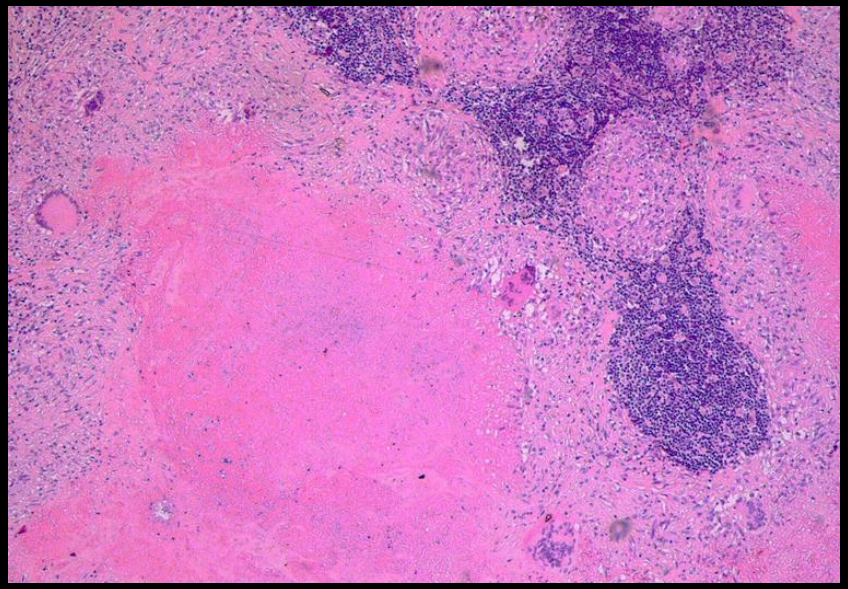
Splenic fungal abscesses



Splenic fungal abscesses. CT portal-venous phase showing splenomegaly with multiple ill-defined hypoattenuating lesions (arrows) scattered in splenic parenchyma due to *Candida* infection.

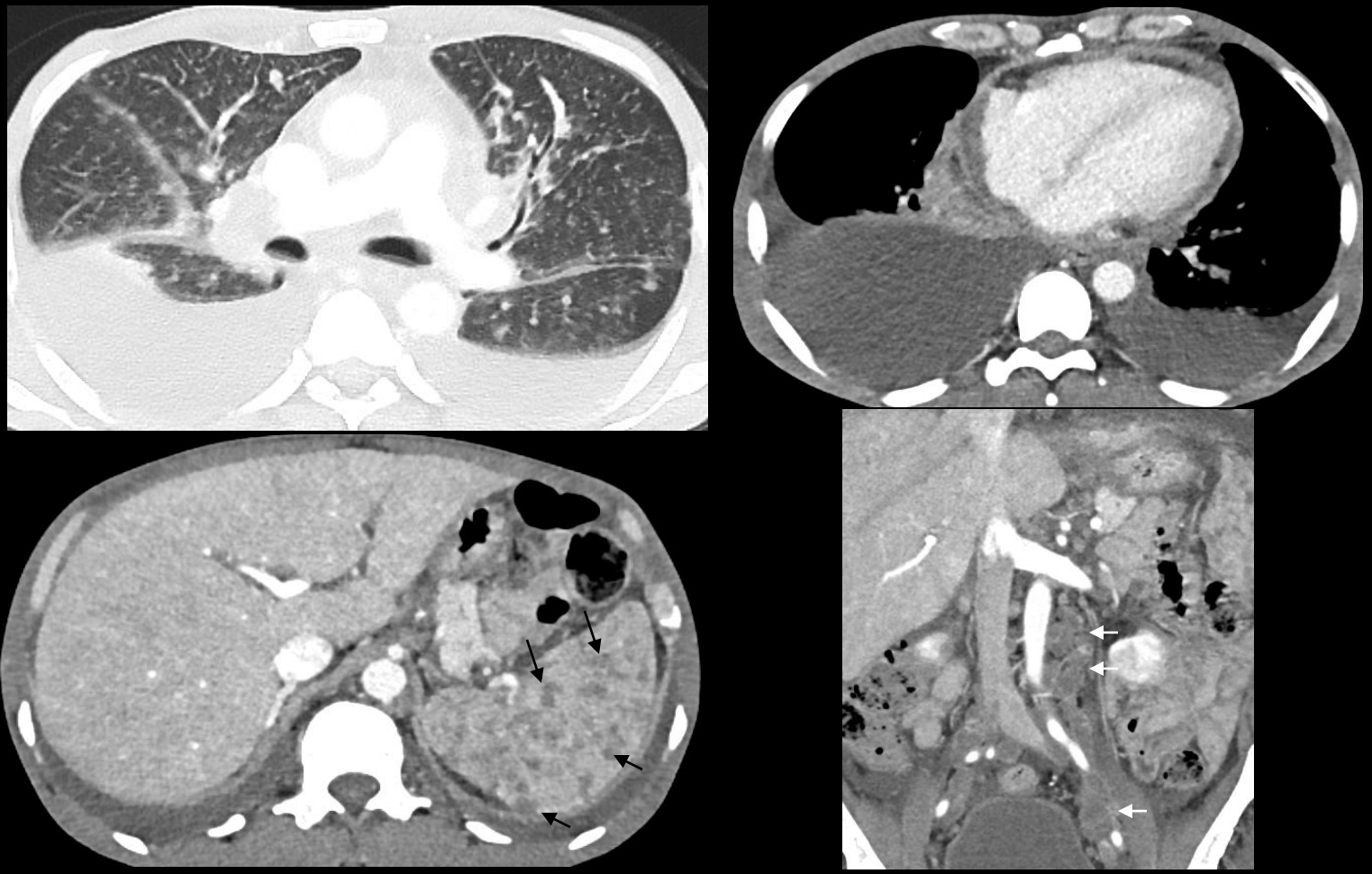
Splenic tuberculosis





Splenic tuberculosis. Axial contrast-enhanced CT portal-venous phase showing multiple micro-abscesses (arrows) in spleen with necrotic periportal conglomerated lymph nodes (dashed arrow) in a known case of tuberculosis. Histopathology specimen showing Caseous necrosis of the lymph node

Splenic tuberculosis



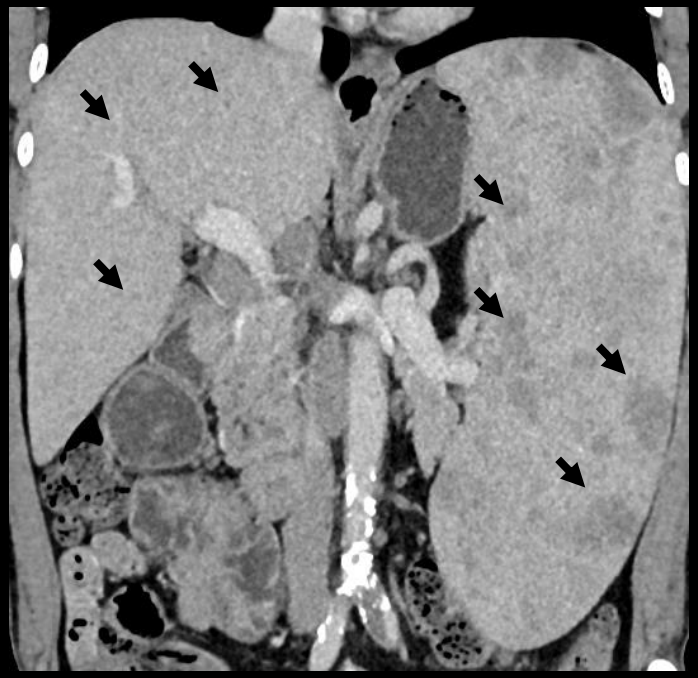
Case 2 of disseminated tuberculosis with splenic involvement. Axial contrast-enhanced CT showing miliary nodules within the lung parenchyma, bilateral pleural effusion, innumerable hypoattenuating lesions studded in splenic parenchyma (arrows) and necrotic abdominal-pelvic lymphadenopathy (white arrows)

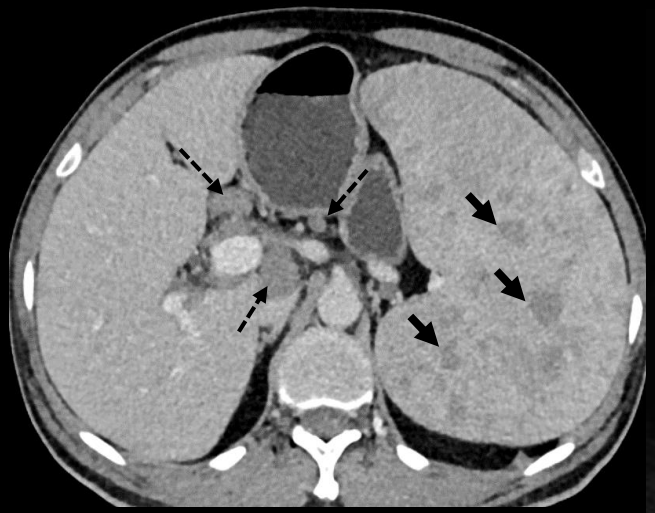
Sarcoidosis

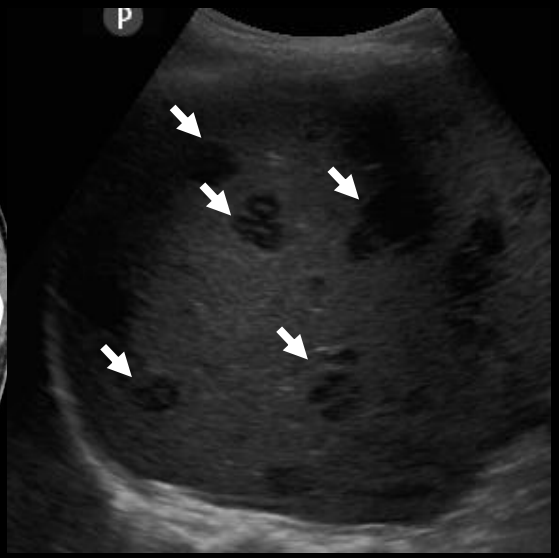
- Sarcoidosis is a granulomatous systemic disease and may infrequently involve the spleen.
- On contrast-enhanced CT, the most important finding inpatients with sarcoidosis is splenomegaly.
- Splenic granulomas do not enhance more than the splenic parenchyma and have attenuation higher than the splenic cysts.[5]
- Multiple small hypodense lesions can simultaneously be seen in liver and differentiation from tuberculosis may be difficult on imaging.
- Isolated involvement of spleen in tuberculosis is rare.
- Lymphadenopathy in the splenic hilum is an important adjacent finding in splenic sarcoidosis.

Abdom Imaging 2014;39(3):570-87.

Sarcoidosis

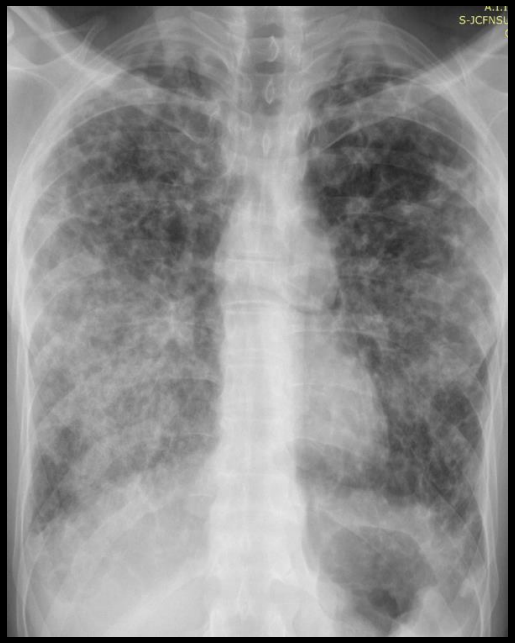


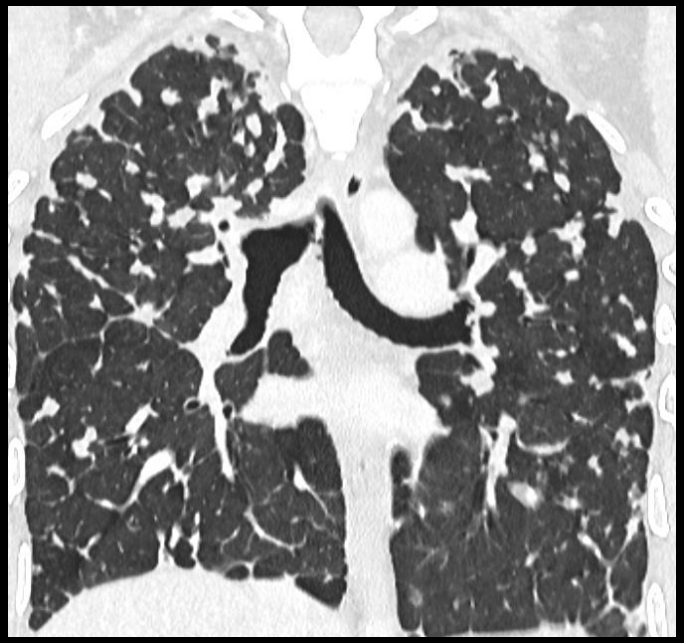


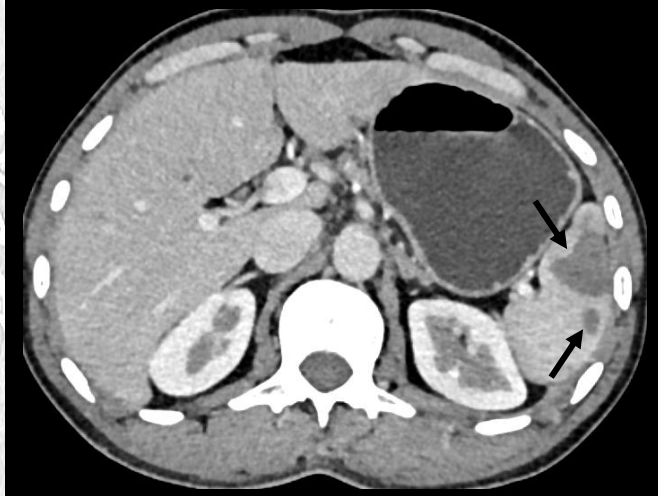


62-year-old-male with splenic sarcoidosis. Coronal and axial contrast-enhanced CT portal-venous phase showing hepatosplenomegaly with multiple tiny hypodense lesions in liver and relatively larger lesions in spleen (arrows). In addition multiple homogeneously enhancing non-necrotic lymph nodes (dashed arrows) are seen at porta and peripancreatic region. Ultrasound image of the same patient showing multiple hypoechoic lesions (white arrows) in splenic parenchyma.

Sarcoidosis

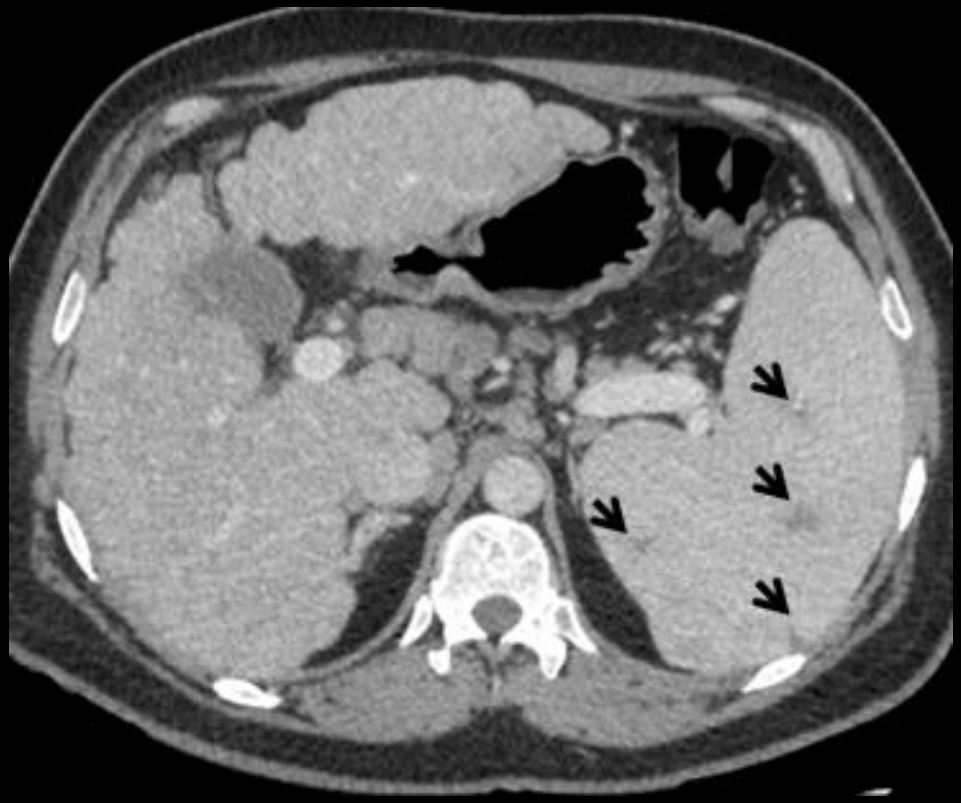






44-year-old-male with multi-systemic involvement in sarcoidosis. Chest radiograph showing coarse reticulonodular opacities in bilateral lung parenchyma. Coronal CT lung window image of the same patient showing peribronchovascular and perilymphatic nodules. Axial CECT abdomen showing multiple hypoattenuating lesions in splenic parenchyma. On biopsy it was found to be of granulomatous etiology likely sarcoidosis.

Sarcoidosis



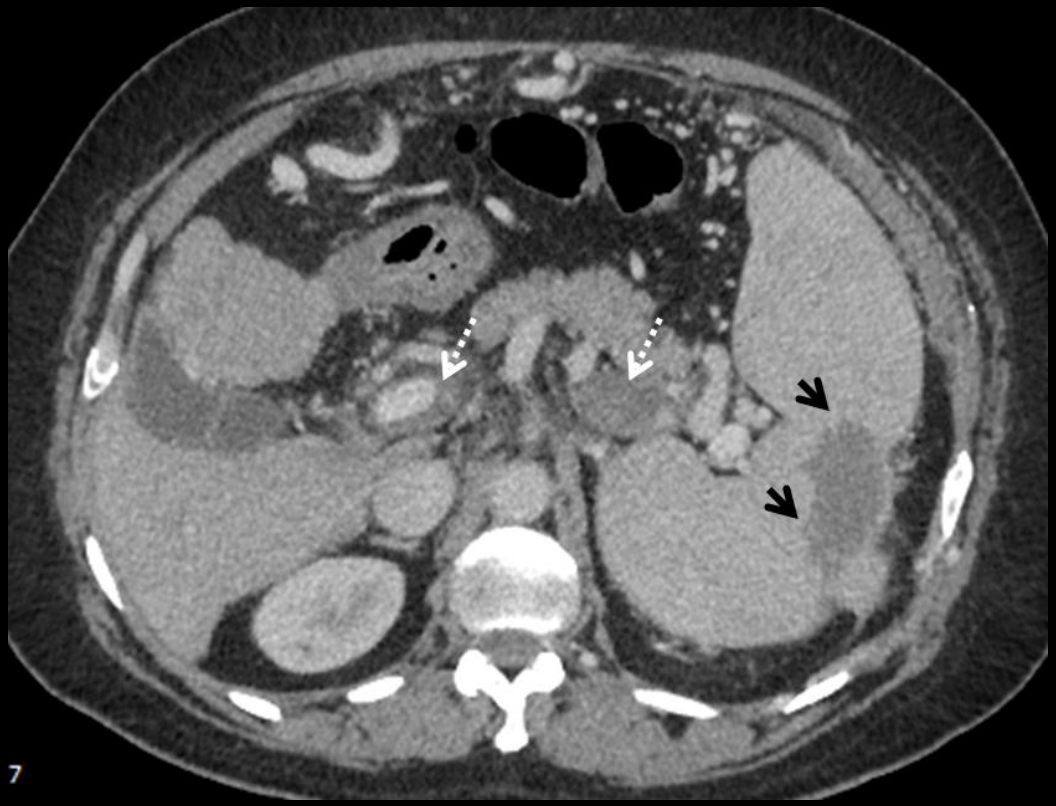
Splenic sarcoidosis. Axial contrast-enhanced CT portal-venous phase showing multiple hypodense lesions (arrows) scattered in the splenic parenchyma and cirrhotic architecture of liver in a biopsy proven case of hepatosplenic sarcoidosis.

Infarct

- Splenic infarct is caused by localised or global hypoperfusion of splenic parenchyma due to occlusion of splenic artery and its branches.
- Large splenic infarctions are usually caused by thromboembolic conditions whereas micro infarctions can be seen in patients with sickle cell anaemia, lymphoma and leukaemia.
- On contrast-enhanced CT, splenic infarctions present as non-enhancing wedge shaped, hypodense area with the base towards the splenic capsule.
- Complications of splenic infarction are secondary abscess formation, rupture and subsequent haemorrhage.

Insights Imaging 2013;4(1):65-76.

Infarct



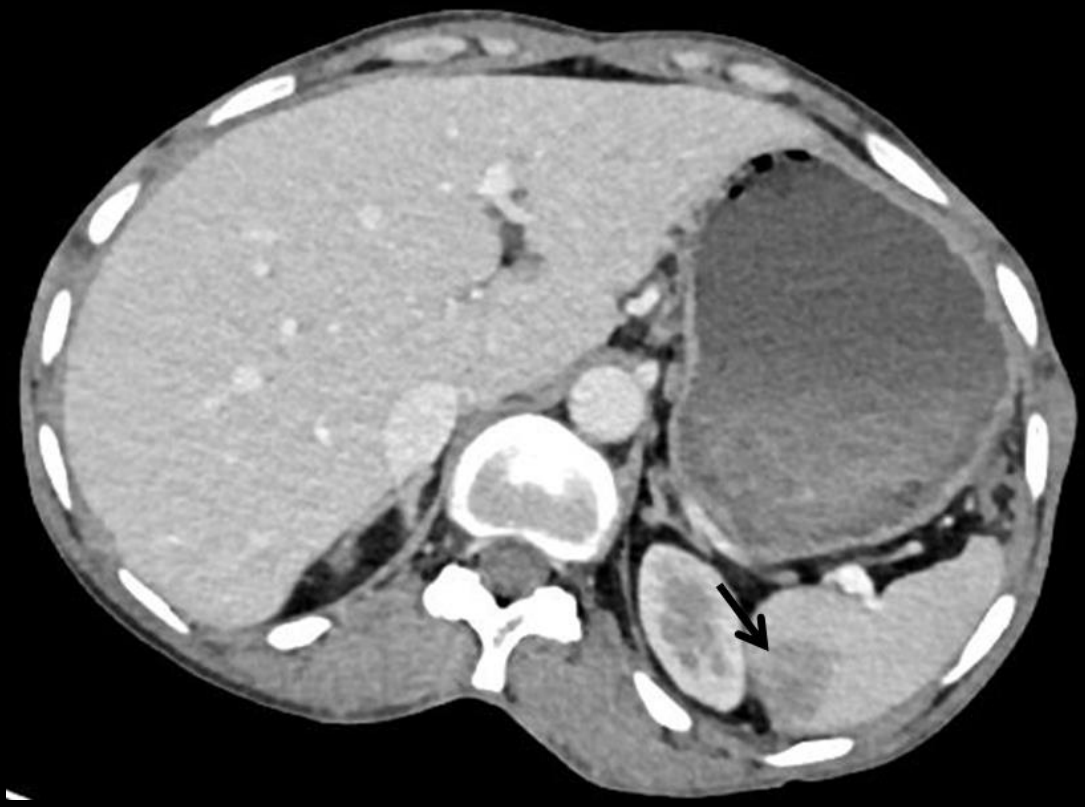
Splenic infarct. Axial contrast-enhanced CT portal-venous phase showing splenomegaly with peripheral wedge-shaped hypoattenuating liquefied infarct (arrows) and thrombosis in spleno-portal axis (dashed arrows).

Hamartoma

- Hamartomas of the spleen, also known as splenomas are rare benign neoplasms composed of malformed splenic red pulp elements.
- Associations - Tuberous sclerosis and Wiskott-Aldrich syndrome.
- On CECT, hamartomas appear as solitary, well-defined, hypodense solid lesion which shows prolonged contrast enhancement.
- This is due to stagnant blood flow within the sinuses of the red pulp.
- Calcifications, central areas of necrosis as well as macroscopic fat may be observed.
- The prolonged contrast retention on CT assists in differentiating hamartomas from malignant tumours.

Pediatr Radiol 1996;26:657-60

Hamartoma



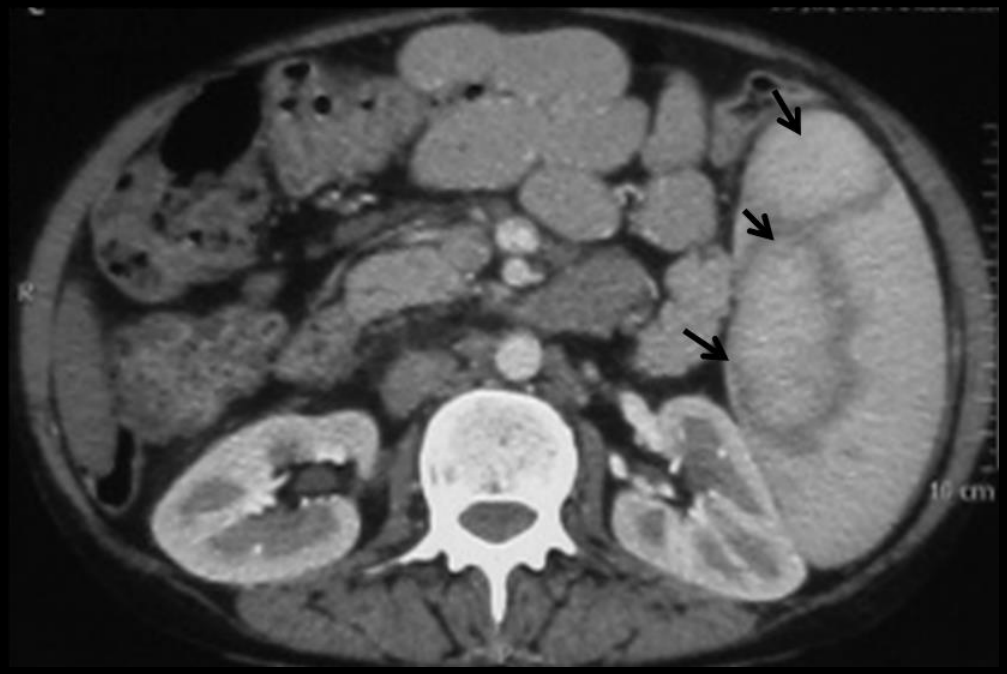
Splenic hamartoma. Axial CT portal-venous phase image showing well-defined hypovascular lesion (arrow) in spleen in a proven case of splenic hamartoma.

Peliosis

- Peliosis of the spleen is rare is associated with oral contraceptives, steroids, HIV/AIDS, and hematologic malignancy.
- Histopathologically, peliosis is characterised by dilated sinusoids with fluid-and blood-filled cavities within the splenic parenchyma.
- It is extremely difficult to diagnose on imaging.
- On contrast-enhanced CT, peliosis exhibits multiple, small ill-defined, hypodense or hyperdense lesions.
- Different patterns of enhancement have been reported including early peripheral enhancement with delayed centripetal enhancement, similar to haemangiomas or internal septal enhancement with or without splenomegaly.

Am J Surg 2011;202(2):e17-9

Peliosis



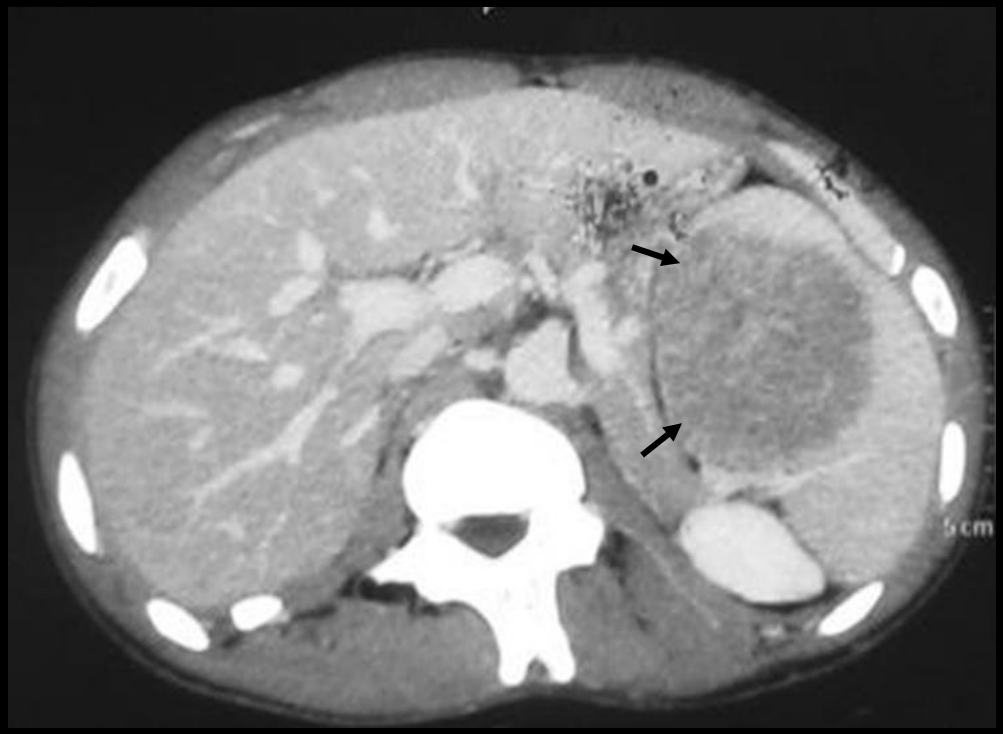
Splenic peliosis. Axial contrast-enhanced CT portal venous phase image showing multiple ill-defined geographic hypoattenuating lesions (arrows) in a case of splenic peliosis.

Littoral cell angioma

- Littoral cell angioma is rare vascular tumours that arise from the littoral cells lining the splenic red pulp sinuses.
- Usually these tumours are benign and detected incidentally.
- Rare cases of malignant transformation have been reported.
- On contrast-enhanced CT images, littoral cell angioma usually present as solitary or multiple, ill-defined, hypodense lesions that show peripheral early enhancement with uniform enhancement on delayed scans.
- Imaging findings of littoral cell angioma are non-specific and may be confused with hemangioma and hamartoma

Abdom Imaging 2011;36(6):735-8

Littoral cell angioma



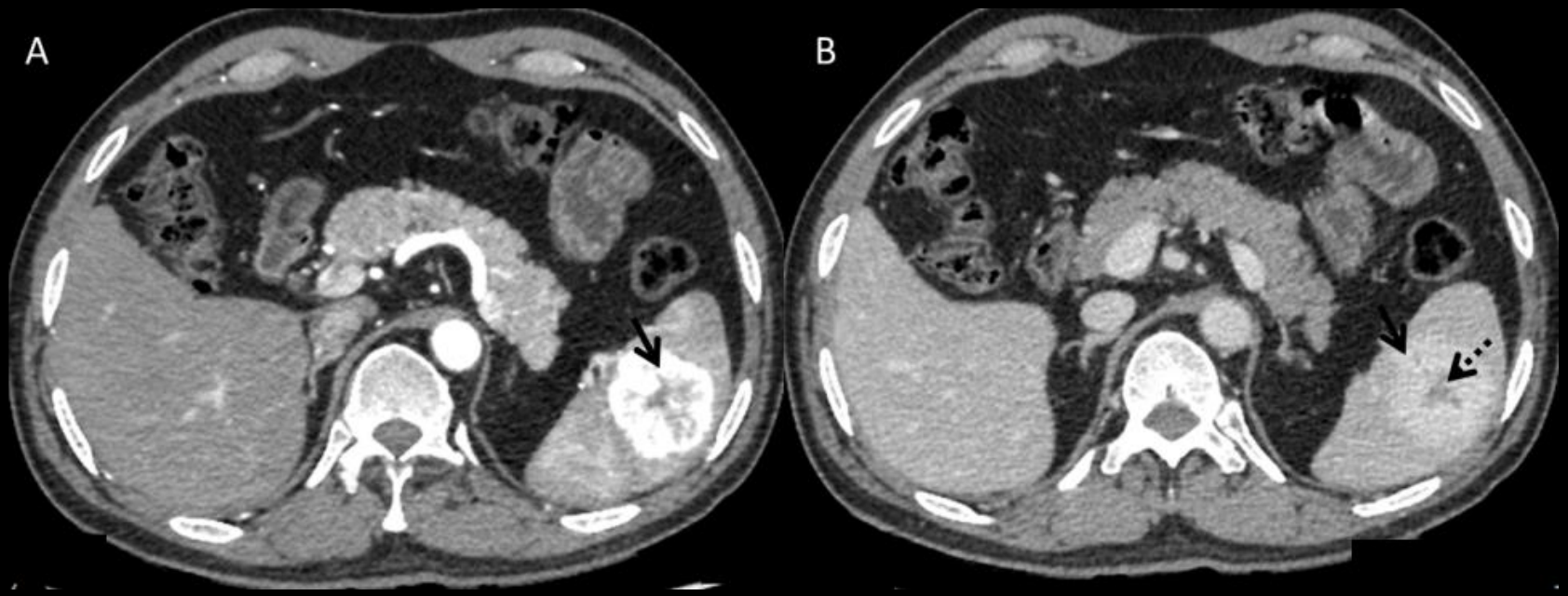
Splenic littoral cell angioma. Axial contrast-enhanced CT portal venous phase images showing well-defined hypoattenuating lesion showing minimal internal enhancement in a surgically proven case of littoral cell angioma of spleen.

Sclerosing angiomatoid nodular transformation of the spleen (SANT)

- SANT lesion of the spleen is benign vascular lesions also known as “focal nodular hyperplasia” of the spleen.
- These lesions are mixture of jumbled small blood vessels - capillaries, small veins, sinusoids; inflamed fibrocellular and sclerotic stroma between the nodules.
- On CT, these lesions show ‘‘spoke wheel’’ pattern of enhancement on the early arterial phase, with progressive central fill in the delayed imaging.
- Central stellate scar may or may not be seen

Abdom Imaging 2011;36(6):735-8

Sclerosing angiomatoid nodular transformation of the spleen (SANT)



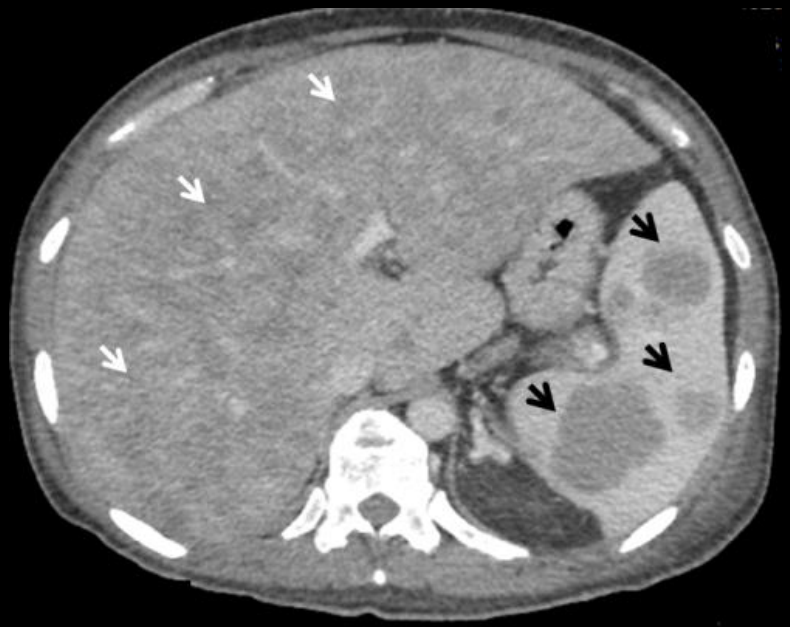
SANT tumor of spleen (A) Axial contrast-enhanced CT arterial phase showing hypervascular lesion with spoke wheel type of enhancement pattern (B) and in portal-venous phase showing gradual retention of contrast and non-enhancing central scar (dashed arrow) in a surgically proven SANT tumor of spleen.

Malignant neoplasms Lymphoma

- Most common malignant tumour of the spleen.
- Isolated primary splenic lymphoma represents <2% of all lymphomas and is non-Hodgkin type.
- Secondary lymphomatous involvement of spleen is much common.
- On CECT, lymphomatous involvement of spleen is seen as isolated splenomegaly with or without focal lesion, single solitary lesion, multiple small lesions, or as a large lesion >10cm.
- The presence of hilar lymphadenopathy and splenomegaly may be a pointer towards splenic lymphoma in the context of the clinical history

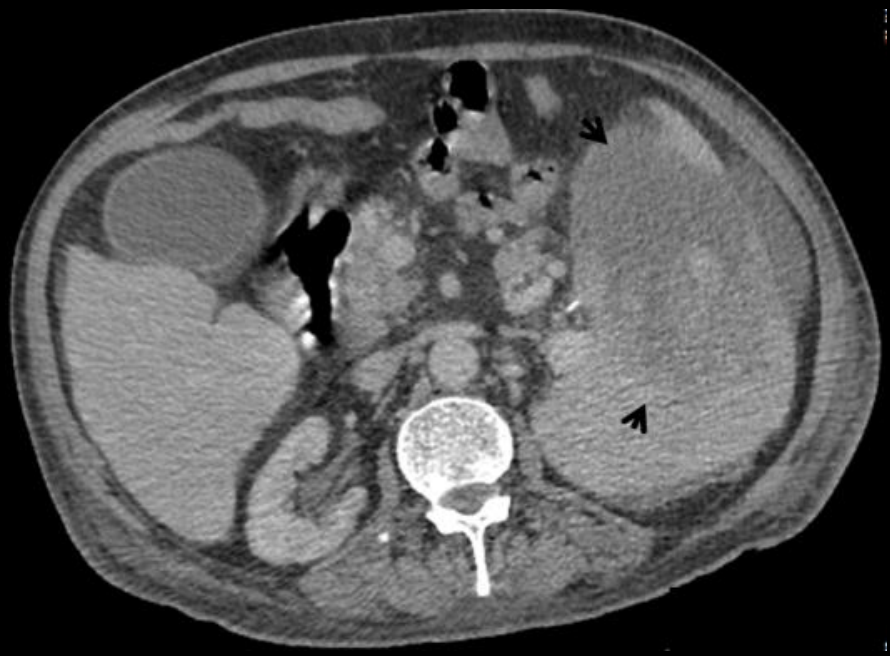
. *PLoSOne* 2013;8:e80264

Malignant neoplasms
Lymphoma



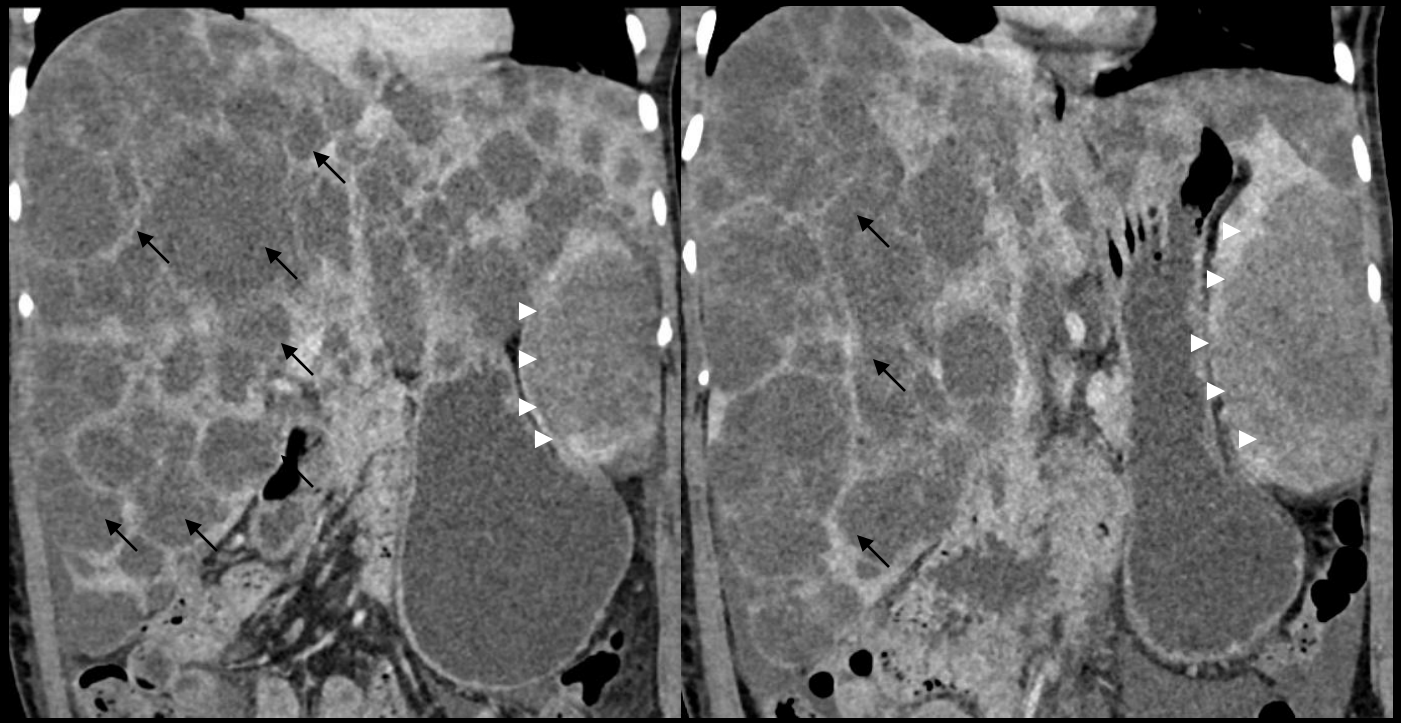
Splenic lymphoma secondary involvement. Axial contrast-enhanced CT portal-venous phase showing multiple variable sized hypodense lesions (black arrows) within the splenic parenchyma with features of hepatomegaly and heterogeneous infiltrative ill-defined hypodense lesions (white arrows) in liver in a biopsy proven case of hepatosplenic lymphoma.

Malignant neoplasms
Lymphoma



Primary splenic lymphoma. Axial contrast-enhanced CT portal-venous phase showing large relatively well-defined heterogeneous hypodense mass (arrows) in the splenic parenchyma in a biopsy confirmed primary splenic lymphoma. Note is made of changes of chronic liver disease and perisplenic fluid.

Malignant neoplasms Lymphoma



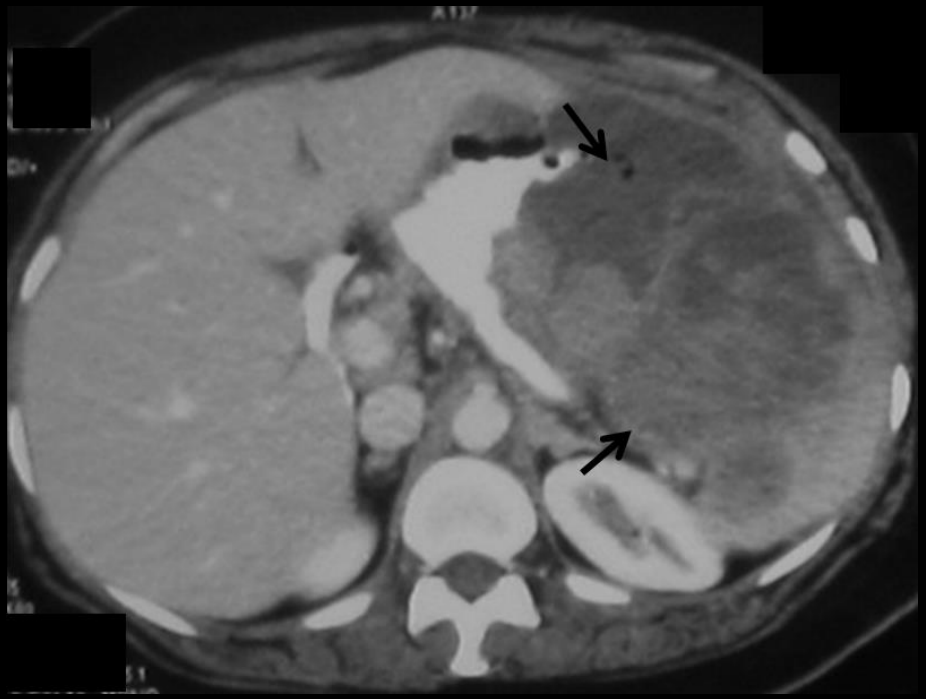
Splenic lymphoma: 55-years-old-male: Axial contrast-enhanced CT portal-venous phase showing multiple variable sized cystic lesions replacing the liver parenchyma in a case of polycystic liver disease (PCLD). There is e/o splenomegaly with heterogeneous enhancing lesion in splenic parenchyma (arrowheads) which turned out to be lymphoma.

Malignant neoplasms
Angiosarcoma

- Angiosarcoma is an aggressive malignant neoplasm seen in cases of history of exposure to thorium dioxide (Thorotrast) and vinyl chloride
- Age - 50-70 years of age
- The tumour may result from malignant transformation from other benign splenic neoplasms, such as hemangiomas, lymphangiomas or hemangioendotheliomas.
- On CT, the lesion can be solitary or multiple and show heterogeneous enhancement with or without loco regional extension and liver metastases

Insights Imaging 2013;4(1):65-76.

Malignant neoplasms
Angiosarcoma



Splenic Angiosarcoma. Axial CT portal-venous phase image showing large heterogeneously enhancing splenic mass lesion (arrows) with internal cystic and necrotic components infiltrating into the stomach in a biopsy proven case of splenic Angiosarcoma.

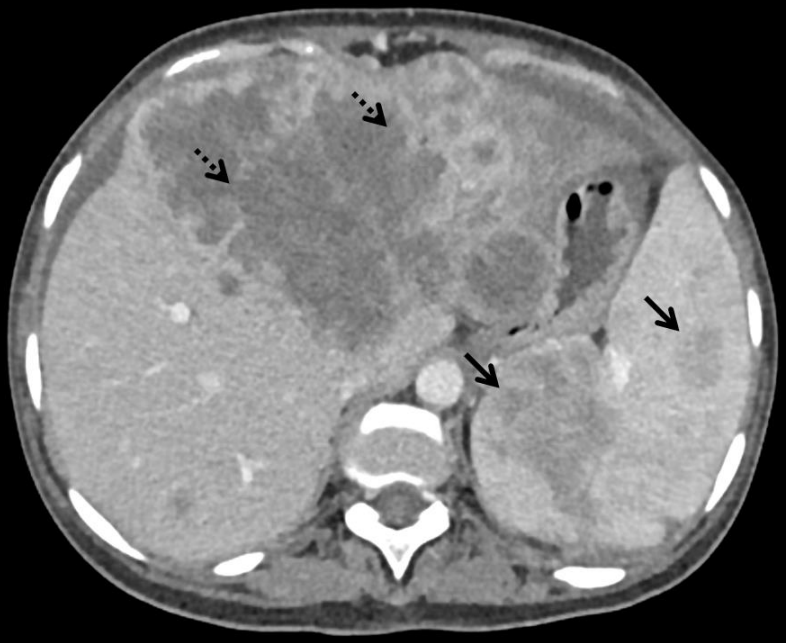
Malignant neoplasms Splenic metastases

- The most common primary tumors to metastasize in the spleen are breast, lung, pancreas, ovary, and melanoma.

- On contrast-enhanced CT, metastatic lesions are typically solitary or diffuse, solid, heterogeneous or cystic and show heterogeneous enhancement

Insights Imaging 2013;4(1):65-76.

Malignant neoplasms
Splenic metastases



Splenic metastasis. Axial contrast-enhanced CT image showing heterogeneously enhancing ill-defined hypovascular lesions (arrows) within the splenic parenchyma and liver (dashed arrows) in case of metastasis from carcinoma ovary.

CT imaging features of hypodense splenic lesions

Splenic Lesion	Non-contrast CT	Contrast-enhanced CT
Congenital cyst	Random, well-defined usually solitary cyst having water-attenuation	No enhancement
Parasitic cyst	Random, well-defined, solitary or multiple , water-attenuation	No enhancement; faint wall enhancement ±
Neoplastic cyst	Random, solitary or multiple, well or ill-defined hypoattenuating lesions	Wall or internal enhancing solid components
False cyst/Pseudocyst	Subcapsular, solitary well-defined water-attenuation	No enhancement unless infected
Splenic abscess	Random, solitary /multiple ill-defined hypo lesions ; air foci ±	Rim enhancement

CT imaging features of hypodense splenic lesions

Splenic Lesion	Non-contrast CT	Contrast-enhanced CT
Hemangioma	Random, solitary or multiple, well or ill-defined hypoattenuating lesions	Centripetal enhancement then fills in
Lymphangioma	Solitary or multiple, well-defined adjacent to capsule, uni / multilocular	No internal enhancement
Sarcoidosis	Random, multiple, ill-defined hypo lesions, lymphadenopathy	Faint peripheral rim enhancement
Tuberculosis	Random, multiple, ill-defined lesions, necrotic lymphadenopathy	Faint peripheral rim enhancement
Infarction	Wedge shaped hypoattenuating lesion towards the capsule	No enhancement

CT imaging features of hypodense splenic lesions

Splenic Lesion	Non-contrast CT	Contrast-enhanced CT
Peliosis	Random, multiple ill-defined lesions, associated with peliosis hepatis	No or mild enhancement
Hamartoma	Random, solitary well-defined lesion	Uniform enhancement on delayed scans
Littoral cell angioma	Random, multiple ill-defined	Peripheral early enhancement with delayed uniform enhancement
Sclerosing angiomatoid nodular transformation -(SANT)	Random, solitary well-defined	Spoke-wheel enhancement; central scar mimicking 'focal nodular hyperplasia'
Lymphoma	Random, solitary or multiple ill-defined lesions, splenomegaly, lymphadenopathy	Minimal to no enhancement
Metastases	Random, solitary or multiple ill-defined lesions	Central/peripheral enhancement
Angiosarcoma	Random, solitary or multiple ill-defined lesions	Peripheral or internal heterogeneous enhancement; liver metastases; invasion

Conclusion

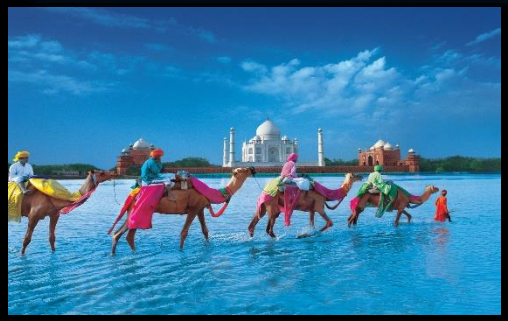
- ✓ In general, the majority of hypodense splenic lesions on CECT, represent benign lesions that require no further work-up. However, certain imaging appearances—such as ill-defined lesion borders, presence of solid, contrast-enhancing components and increased attenuation of the lesion—must draw the attention of the radiologist to a potentially more relevant disease.

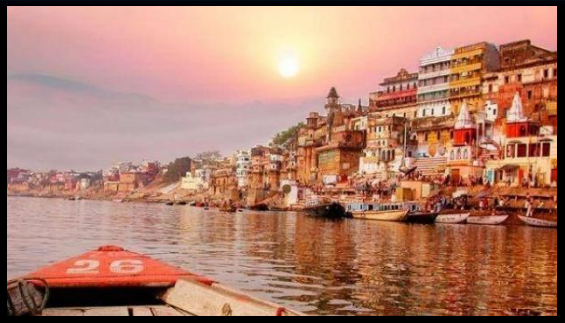
- ✓ For correct interpretation, hypodense lesions of the spleen need to be evaluated in the clinical context of the history, because CT imaging appearances of certain entities are overlapping and often cannot be distinguished with certainty .

- ✓ In the presence of a newly diagnosed, hypodense lesion of the spleen on contrast-enhanced, portal-venous CT, the answers to the following questions can help in clarifying the diagnosis: Is there a known primary tumour? Does the patient have any other signs of metastatic disease? Does the patient suffer from sarcoidosis or tuberculosis? Does the patient have fever? Is there a recent history of trauma?

Author Information:

Dr Binit Sureka (MD,DNB,MBA, Fellowship Abdominal Imaging)
Assistant Professor, Dept. of Diagnostic & Intervention Radiology
All India Institute of Medical Sciences (AIIMS), Jodhpur, India
Email: binitsurekapgi@gmail.com
surekab@aiimsjodhpur.edu.in (Tel: +91-9013082292)





References:

1. Alabousi et al. CPDR 2014
2. Karlo et al. Insights Imaging 2013
3. Ricci et al. Clinical Imaging 2016