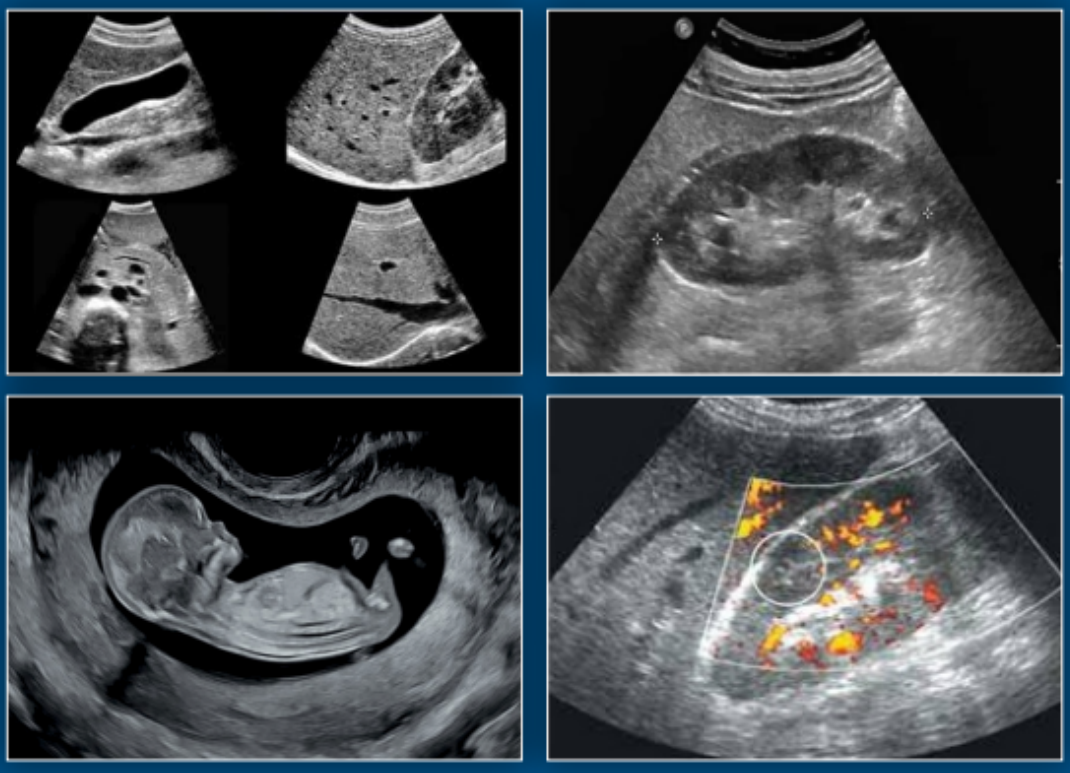
FIRST EDITION

Principle and Practices of Diagnostic

Ultrasonography

Sonographically Terminology and Reporting format



Abdomen, Obstetrics and Gynecology

Dr. P.K. Tiwari

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By

Dr. P. K. Tiwari

MD, M.Sc. (Ultrasonography)

Ph.D. (Alt Nuclear Medicine)

Founder & Chairman

P. K. Arogyam &

Dr. P.K. Tiwari Institute of Radio Imaging & Medical Sciences

President of All India Radio Imaging Association

Chief Medical & Radiological Adviser of Himalaya Medical College & Hospital

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First Impression

Published by Author

E-95, P.C. Colony Rd, Kankarbagh, Patna, Bihar 800020

Website: usgparamedicaltraining.com

Email: shubham.pat.usg@gmail.com

Phone: 9955245153

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Obstetrics and Gynaecology

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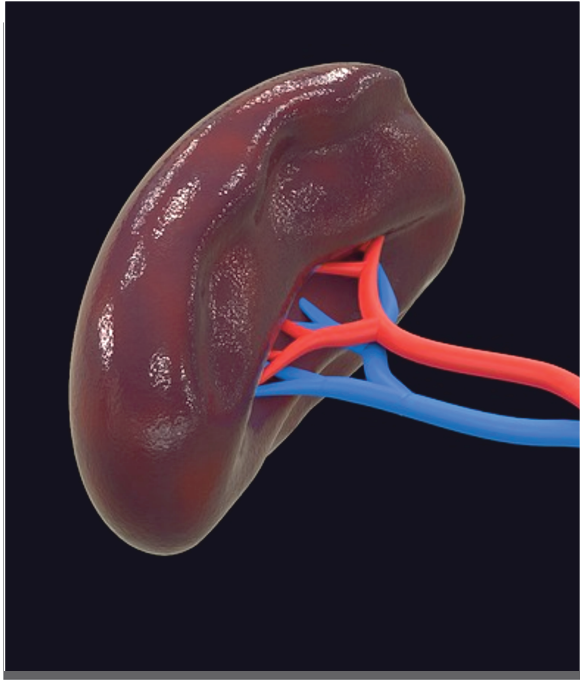
Spleen



7.1 Introduction

The **spleen** is the largest lymphoid organ, located in the left hypochondriac region of the abdomen between the fundus of the stomach and the diaphragm. It is purplish in color and varies in size among different individuals but is typically about 12 cm long, 7 cm wide, and 2.5 cm thick, with a weight of approximately 200 gm. The spleen is slightly oval-shaped, with the hilum on the lower medial side. Structures entering and leaving the spleen at the hilum include:

- Splenic artery (a branch of the celiac artery)
- Splenic vein (a branch of the portal vein)
- Lymphatic vessels

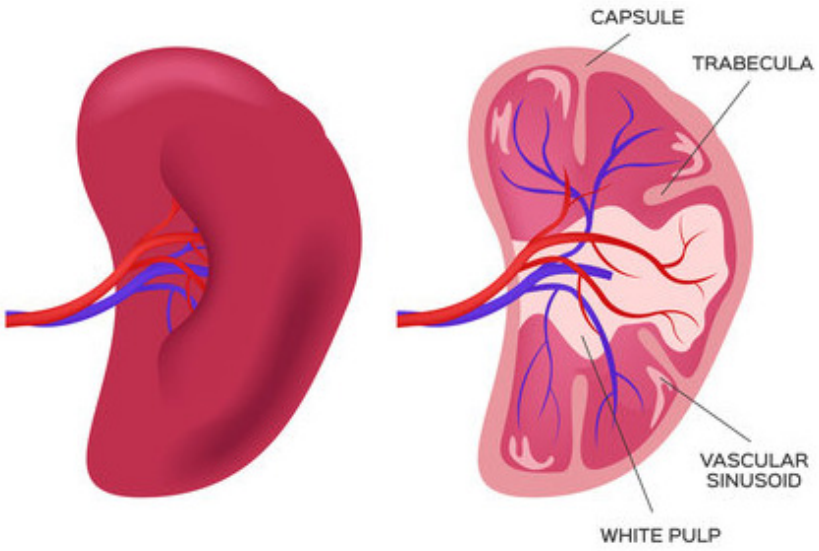


Figure 7.1 Diagram showing the shape and structure of spleen.

Functions of spleen

- *Red pulp*: Mechanical filtration of red blood cells, in mice; reserve the monocytes.
- *White pulp*: Active immune response through humoral and cell – mediated pathways.
- It's macrophages engulf or phagocytize and destroy worn out blood cells, live or dead pathogens, cell debris etc.
- In the embryonal stage it produces RBCs.
- Some antibodies are synthesized here.
- In adult stage spleen works as a blood bank. It's sinues serves as reservoirs of blood when required their blood is squeezed into circulation.
- The size of spleen increases at the time of malaria because lymphocytes and dead RBCs number I increased in it at that time.
- Spleen stores iron.
- Stores blood .
- Spleen produces all types of blood cells during fetal life.
- Production of opsonins, properdin and tuftsin.
- Spleen can store up to 350 ml blood, can rapidly return to the circulation according to the need e.g., hemorrhage.
- Spleen helps in immunity by production T and B lymphocytes.

Terminology

pitting—the splenic process of cleaning red blood cells of unwanted material

polyclinic—having many small islands of splenic tissue

portal hypertension—the elevation of blood pressure within the portal venous system

red pulp—specialized tissue within the spleen that performs its phagocytic function

Reed–Sternberg cells—the cells that indicate the presence of Hodgkin lymphoma

sarcoidosis—a systemic disease that result in the development of granulomas throughout the body

sickle cell anemia—an inherited disease in which the body produces abnormally shaped red blood cells

splenic cleft—a congenital anomaly in which the spleen is divided into two portions by a band of tissue

splenic hamartoma—benign splenic mass that has been associated with Beckwith–Wiedemann syndrome and tuberous sclerosis

splenic infarct—an area within the spleen that has become necrotic because of a lack of oxygen

splenic lymphangioma—benign tumor composed of lymph spaces

blunt trauma—non-penetrating injury to the body

culling—the splenic process of removing irregular red blood cells from the bloodstream

erythropoiesis—the process of making red blood cells of the tissue in that area granulomatous disease—an inherited disease that disrupts the normal immune system and causes it to malfunction resulting in immunodeficiency; chronic inflammation can lead to the development of granulomas in several organs.

hemangioma—a benign tumor composed of blood vessels.

heterotaxia syndromes—a situation in which the organs of the chest and abdomen are abnormally arranged

histoplasmosis—a disease that results from the inhalation of an airborne fungus that can affect the lungs and may spread to other organs

hydatid cyst—a cyst that results from the parasitic infestation of an organ by a tapeworm

lysis—breaking down of a cellular membrane

mononucleosis—an infectious disease caused by the Epstein–Barr virus

accessory spleen—a small, round island of splenic tissue often located near the splenic hilum or near the tail of the pancreas; also referred to as a splenial, a pedunculus, or a supernumerary spleen

angiosarcoma—a rare malignant tumor of the spleen that is derived from blood vessels

asplenia—the congenital absence of the spleen

auto splenectomy—the gradual fibrosis and dysfunction of the spleen secondary to disease

Beckwith–Wiedemann syndrome—a growth disorder syndrome synonymous with enlargement of several organs including the skull, tongue, and liver

splenic torsion—the twisting of the splenic vasculature causing a disruption in the blood supply to the spleen and subsequent ischemia

splenomegaly—enlargement of the spleen

selenosis—the implantation of ectopic splenic tissue possibly secondary to splenic rupture

splenial—an accessory spleen

tuberous sclerosis—a systemic disorder that leads to the development of tumors within various organs

wandering spleen—a highly mobile spleen

white pulp—specialized lymphatic tissue within the spleen

Ultrasound image of normal spleen

- Spleen has smooth and hyper Echogenic borders.
- Echogenicity is equal to the liver.
- Normal spleen has homogenous structure.
- Vessels can be seen in normal spleen.

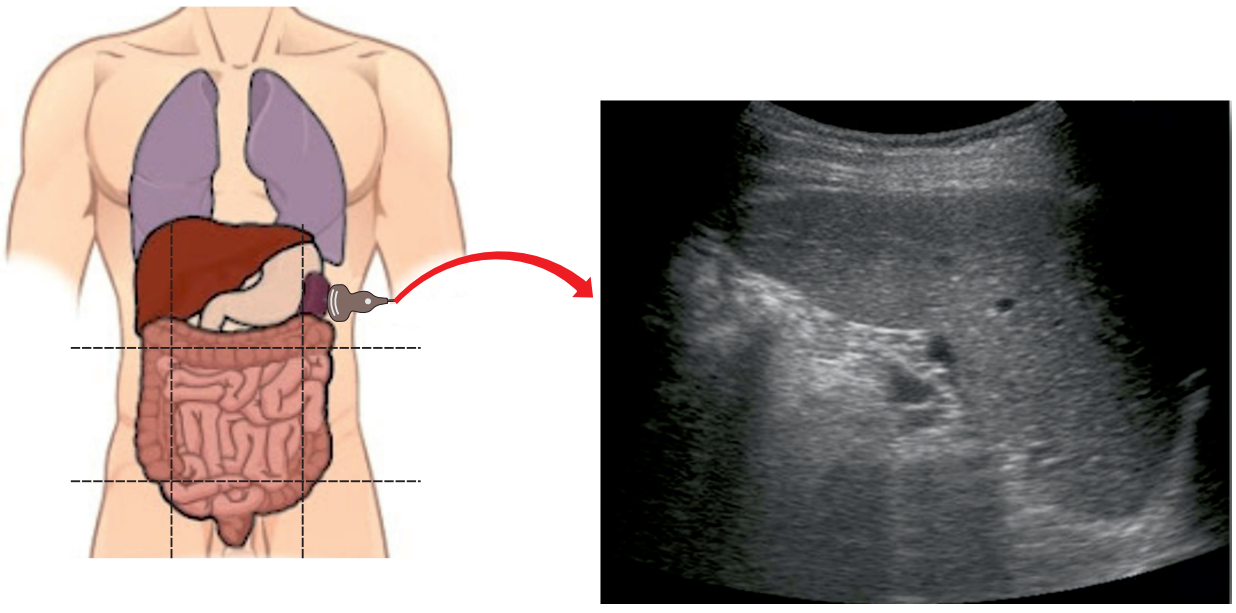


Figure 7.2 Diagram showing position of transducer as well as ultrasound image of spleen

Pathology of the spleen

- Splenomegaly
- Splenic Cyst
- Hematoma
- Splenic carcinoma

Splenomegaly

Splenomegaly, also known as an enlarged spleen, is a medical condition characterized by an increase in the size of the spleen beyond its normal dimensions. It is not a disease itself but rather a symptom of an underlying condition.

Causes

There are numerous potential causes of splenomegaly, including:

1. **Infections**: Viral, bacterial, and parasitic infections, such as mononucleosis, malaria, or endocarditis, can lead to spleen enlargement.
2. **Liver Diseases**: Certain liver conditions, including cirrhosis and portal hypertension, can cause the spleen to enlarge.
3. **Blood Disorders**: Hematological disorders, such as leukemia, lymphoma, or hemolytic anemia, may result in splenomegaly.
4. **Inflammatory Conditions**: Chronic inflammatory diseases, like rheumatoid arthritis or systemic lupus erythematosus (SLE), can lead to an enlarged spleen.
5. **Congestive Heart Failure**: In cases of heart failure, the spleen may become enlarged due to increased blood volume and congestion.
6. **Storage Disorders**: Certain metabolic disorders, such as Gaucher's disease, can cause abnormal storage of substances in the spleen, leading to enlargement.
7. **Trauma or Injury**: Blunt trauma to the abdomen can result in spleen enlargement due to internal bleeding.

Symptoms

Splenomegaly may not always cause noticeable symptoms, especially in its early stages. However, when present, the following symptoms can be associated with an enlarged spleen:

- Abdominal pain or discomfort, especially in the upper left quadrant.
- Feeling of fullness or bloating in the abdomen.
- Fatigue and weakness.
- Easy bruising or bleeding.
- Recurrent infections.

Blood Tests: Complete blood count (CBC) and other blood tests can help evaluate the overall health and detect any underlying blood disorders.

Ultrasound image of splenomegaly

- Size of spleen will increase.
- Echogenicity of spleen will decrease.

- Borders will remain hyperechoic.
- Vessels will see dominantly.

Figure 7.3 Enlarged Spleen with increased parenchymal echogenicity.

Splenic Cyst

A splenic cyst is a fluid-filled sac or cavity that forms within the spleen.

Types of Splenic Cyst:

1. Congenital Cysts: Some splenic cysts are present from birth and are considered congenital.
2. Infectious Cysts: Cysts can form as a result of infections, such as abscesses or parasitic infections.
3. Inflammatory Cysts: Inflammation or trauma to the spleen can lead to the development of inflammatory cysts.
4. Pseudocysts: Pseudocysts are fluid collections that occur as a result of pancreatitis, with the fluid extending into the spleen.
5. Parasitic Infections: Certain parasitic infections, such as hydatid disease caused by Echinococcus, can result in cysts within the spleen.

Classification

Splenic cysts can be classified into the following types:

1. **True cysts**: True cysts are lined by a distinct cellular lining, separating the cystic contents from the surrounding splenic tissue.
2. **False cysts** (**Pseudocysts**): Pseudocysts lack a distinct cellular lining and are filled with fluid, debris, and inflammatory material.

Symptoms

Many splenic cysts are asymptomatic and are incidentally discovered during imaging studies for unrelated conditions. When symptoms occur, they may include:

- Abdominal pain or discomfort, particularly in the left upper quadrant.
- Feeling of fullness or bloating in the abdomen.
- Palpable mass in the abdomen, depending on the size of the cyst.
- Symptoms related to complications, such as infection or rupture.

Ultrasound image of simple cyst

- Simple cyst may be single or multiple.
- It may be round or oval.
- Borders of cyst will be thin, smooth and hyper echoic.
- Lumen of cyst appears anechoic.
- Can be present at any part of the spleen.
- Measurement of cyst is done cross.

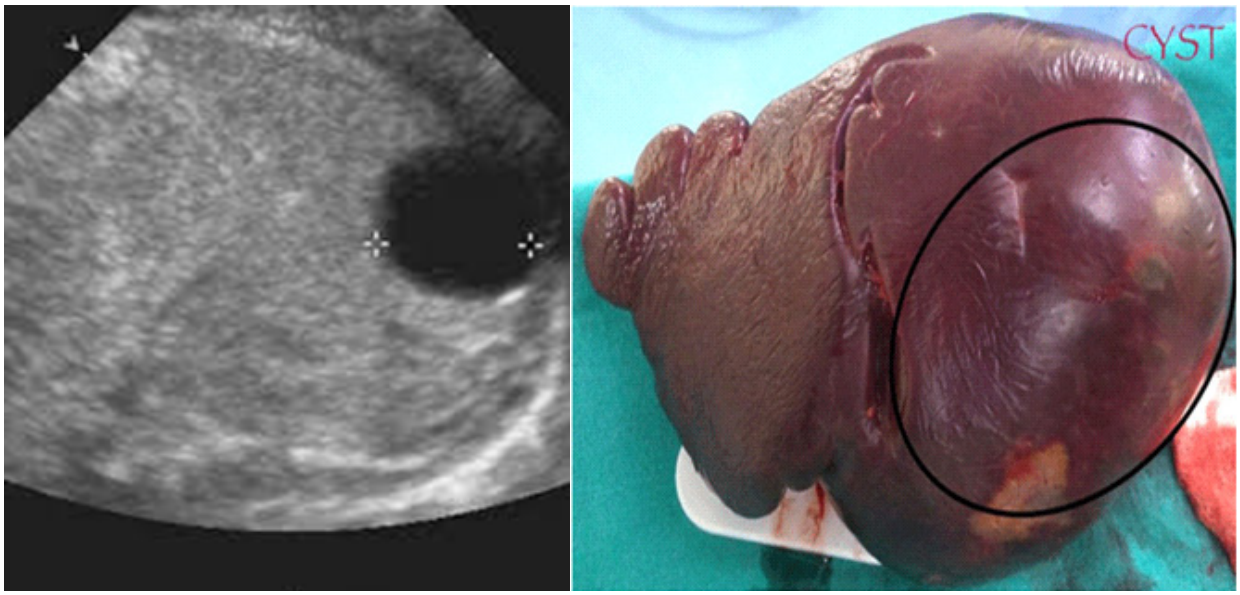


Figure 7.4 Enlarged spleen with splenic cyst.

Complex cyst / Splenic Abscess

The cyst when present with internal echoes is called complex cyst, the Echogenic dots in the lumen of the cyst occurs due to pus or blood, there will be history of trauma.

Ultrasound image of complex cyst

- Cyst will produce echogenic dots/ septations in the anechoic lumen.
- Complex cyst may be heterogeneous
- Like simple cyst it may be single or multiple.
- May be round or oval.
- Cyst will have regular borders, with irregular borders cyst needs to further investigations (biopsy).

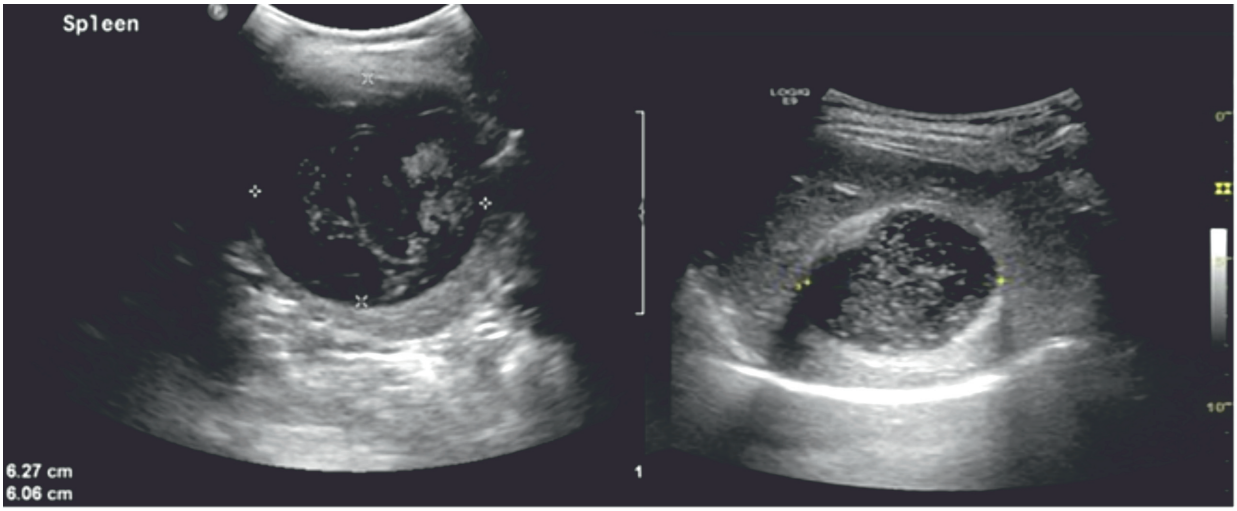


Figure 7.5 Enlarge spleen with splenic abscess

Congenital cyst

The cyst which is present from birth is called congenital cyst.

Ultrasound image of congenital cyst

- Congenital will be single.
- No any septations between the cysts.
- Lumen of the cyst appears anechoic.
- There will be no internal echoes in the cyst.
- Borders of the cyst will be hyper Echogenic.
- Congenital cyst will be round or oval.

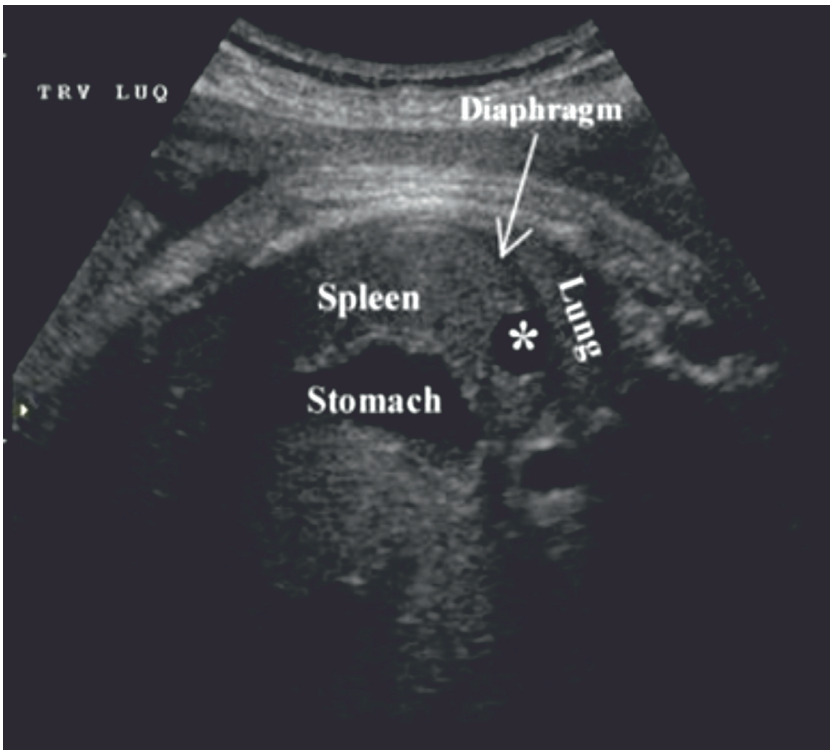


Figure 7.6 Splenic Cyst

Echinococcal cyst

It occurs due to external microorganism named Echinococcal which is present in the cattle so most commonly occurs in animal handlers.

Ultrasound image of the Echinococcal cyst

- It may be round or oval.
- Lumen of the cyst appears hypoechoic with few internal dots.
- Echinococcal cyst has regular but double layered walls.
- It can occur at any age after birth.

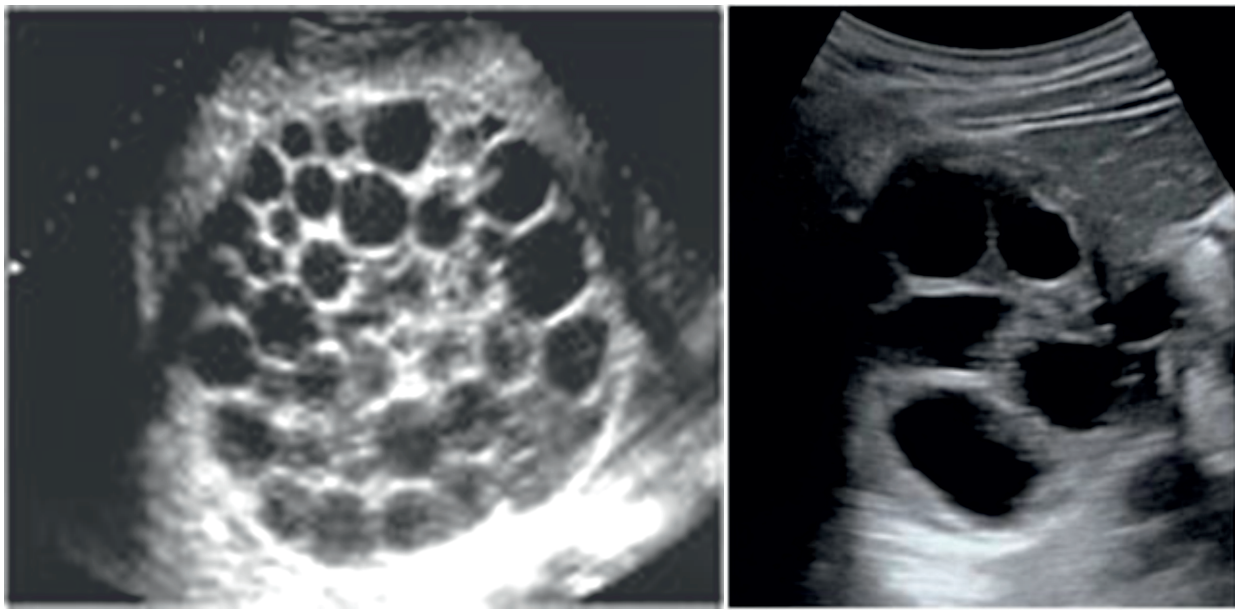


Figure 7.7 Multiple Cystic lesion seen at splenic fossa with internal daughter cyst and echoes-? Echinococcal cyst.

Splenic Hematoma

A mass of usually clotted blood that forms in a tissue, organ, or body space because of broken blood vessels.

Ultrasound image of splenic hematoma

- In hematoma there will be anechoic cyst with internal echoes.
- Cyst may be heterogeneous in u/s.
- Wall or borders may be round or irregular.
- There will be history of trauma.

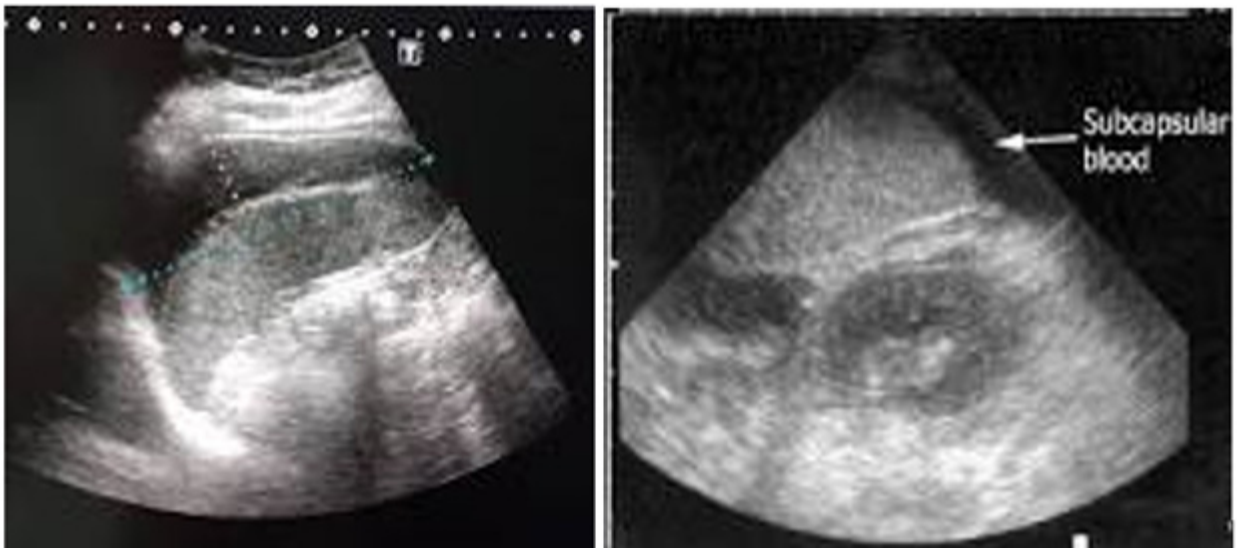


Figure 7.8 Echogenic dense area seen at anterior wall of spleen -? Splenic Hematoma

Carcinoma of spleen

Cancer of the spleen, (abnormal growth of cells called cancer). It has the capacity to spread the surrounding structures.

Ultrasound image of splenic carcinoma

- Lumen of carcinoma appears hypoechoic.
- It will mostly find in irregular shape.
- It will ill define because it does not possess walls.
- Mass with large size wills disturbs the structure of the spleen.

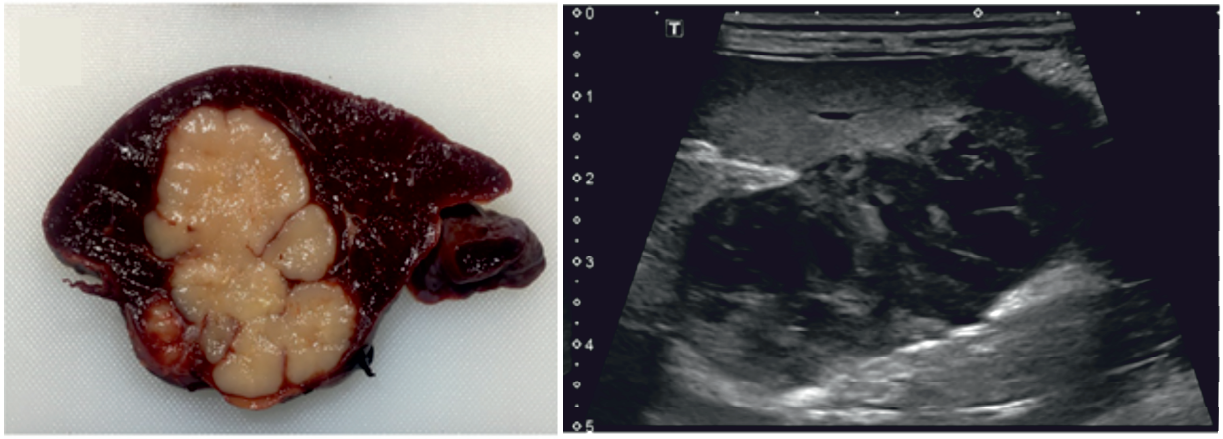


Figure 7.9 A hypoechoic irregular heterogenous dense area seen at mid and lower pole of spleen-? Splenic Mass

Splenic Calcification

Splenic calcification refers to the presence of calcium deposits in the spleen

Causes

Splenic calcification can be attributed to several factors, including:

1. **Infections**: Chronic infections, such as tuberculosis or fungal infections, can lead to splenic calcification.
2. **Granulomatous Diseases**: Certain granulomatous diseases, like sarcoidosis, can cause calcium deposits in the spleen.

3. **Infarcts and Hematomas**: Splenic infarcts (localized tissue death) and hematomas (collections of blood) can undergo calcification during the healing process.
4. **Metabolic Disorders**: Certain metabolic disorders, such as sickle cell disease, can lead to splenic calcification.
5. **Radiation Therapy**: Prior radiation therapy to the abdomen or spleen can result in calcification.
6. **Inflammatory Conditions**: Chronic inflammatory conditions affecting the spleen can lead to calcification.

Symptoms

Splenic calcification itself may not cause any symptoms and is often discovered incidentally during imaging studies for unrelated reasons. However, the underlying conditions that lead to splenic calcification may present with symptoms related to the specific disease.

Sonological Features of Splenic Calcification

1. **Hyperechoic Foci**: On ultrasound, calcifications appear as bright or hyperechoic foci within the spleen. The calcium deposits reflect more sound waves back to the transducer, resulting in brighter echoes on the ultrasound image.
2. **Well-defined Borders**: Splenic calcifications typically have well-defined borders, making them stand out from the surrounding splenic tissue.
3. **Variable Size and Distribution**: The size and distribution of calcifications within the spleen can vary depending on the underlying cause. Calcifications may appear as single or multiple foci, and their distribution can be focal or diffuse.
4. **Shadowing**: Calcifications can produce posterior acoustic shadowing, meaning that the sound waves are blocked by the dense calcium deposits, causing a dark or shadowed area behind the calcification on the ultrasound image.
5. **No Color Flow on Doppler Ultrasound**: When using Doppler ultrasound to assess blood flow in the spleen, calcifications do not exhibit color flow signals, as they are non-vascular structures.

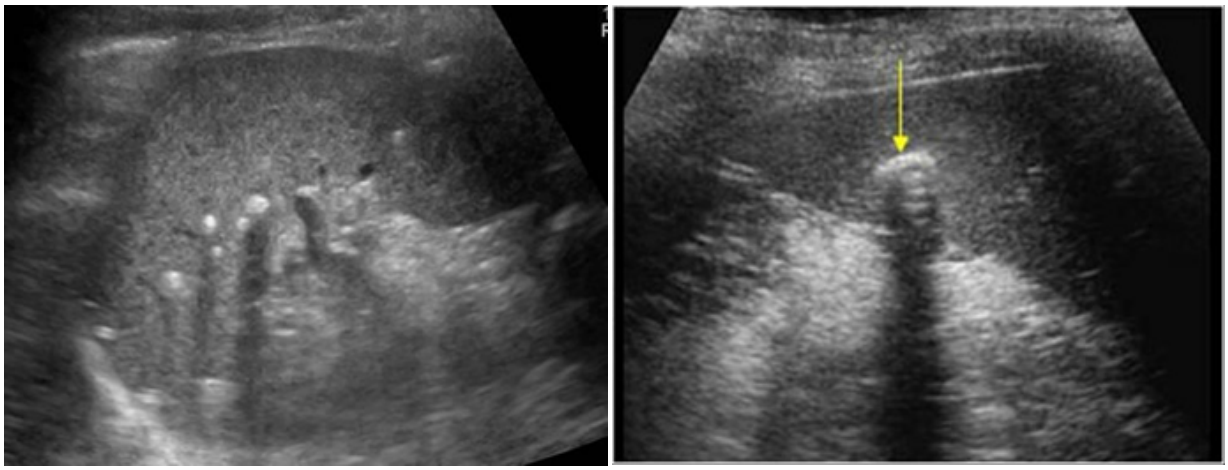
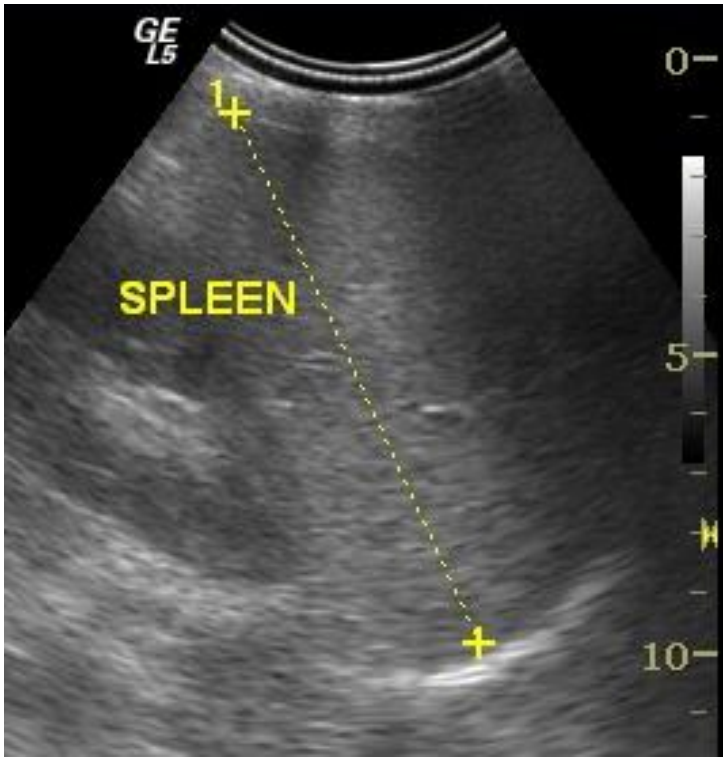


Figure 7.10 Echogenic Bright Fossi seen at surface of spleen casting posterior acoustic shadow-? Splenic calcification

REAL TIME USG OF SPLEEN



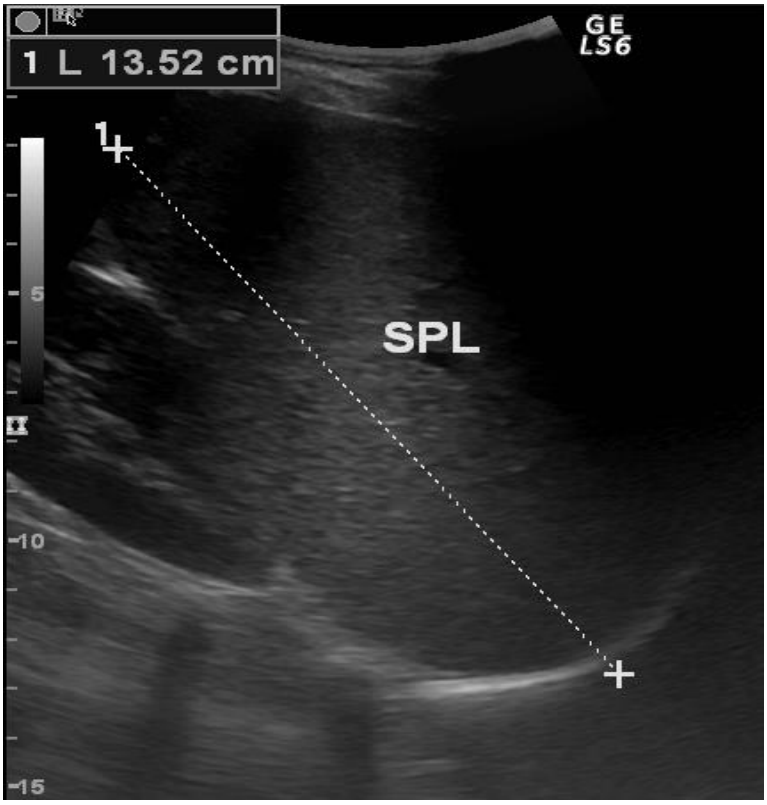
(Report)

Spleen - Measures 11.37 cm. Normal in shape, size and echo texture. Splenic veins appear Normal. No cyst, mass, hematoma or SOL seen.

Impression

- **Sonographically normal scan of spleen. No detectable lesion seen.**

REAL TIME USG OF SPLEEN



(Report)

Spleen - Measures 13.52 cm. Mild Enlarged in shape, size and echo texture. Splenic veins appear normal. No cyst, mass, hematoma or SOL seen.

Impression

- **Mild Splenomegaly.**

REAL TIME USG OF SPLEEN

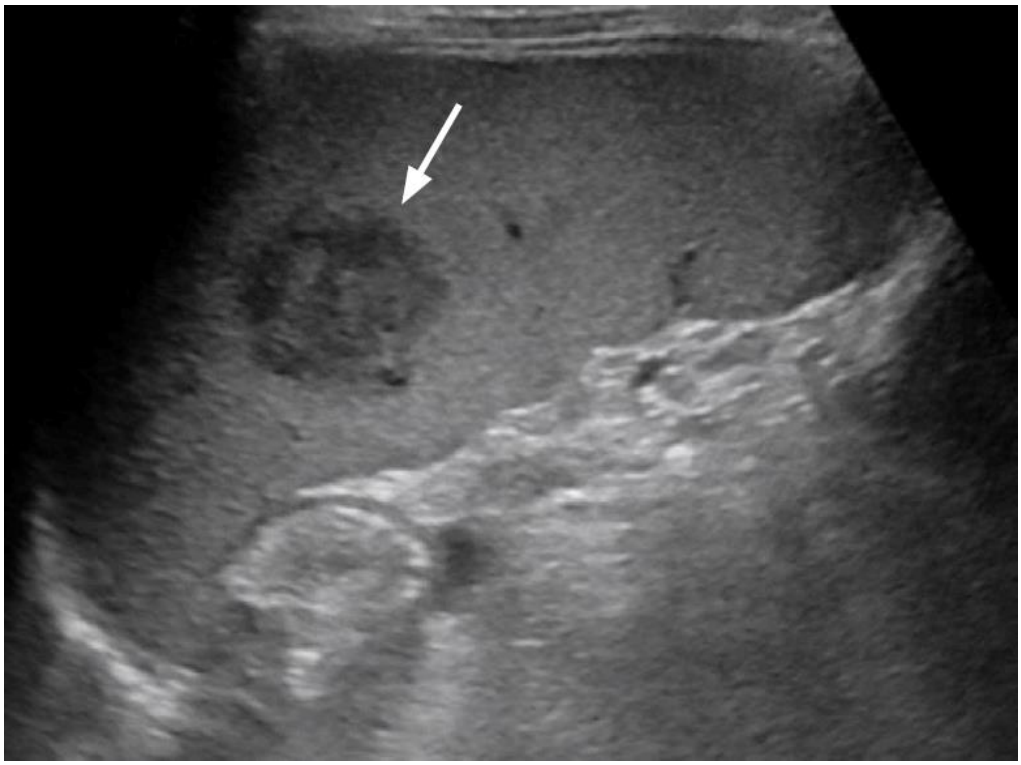
(Report)

Spleen - Measures 13.54 cm. Mild Enlarged in shape, size and echo texture. A small anechoic cystic area measures 3.43 x 3.12 cm seen at mid pole of Spleen. Suggested-? Splenic Cyst. Splenic veins appear normal.

Impression

- **Mild Splenomegaly with Splenic Cyst.**
- **Adv. – Further Workup/ Other Investigation.**

REAL TIME USG OF SPLEEN



(Report)

Spleen - Measures 16.54 cm. Moderate Enlarged in shape, size. A hypoechoic complex area with mixed echotexture measures 6.87 x 5.98 cm and having volume 40 ml seen at lower pole of spleen. Suggested-? Splenic Abscess. Splenic veins appear normal.

Impression

- **Moderate Splenomegaly with Splenic Abscess.**
- **Adv. – Further Workup/ Other Investigation.**

SELF TEST

Q 1. Which of the following is the primary function of the spleen?

A) Detoxification of blood
B) Production of bile
C) Storage of iron
D) Filtration of blood and immune response

Q 2. The spleen is located in which quadrant of the abdomen?

A) Right upper quadrant
B) Left upper quadrant
C) Right lower quadrant
D) Left lower quadrant

Q3. What is the term for the condition where the spleen is abnormally enlarged?

A) Splenomegaly
B) Splenitis
C) Splenectomy
D) Splenomalacia

Q 4. Which of the following structures is not associated with the spleen?

A) Hilum
B) Capsule
C) Portal vein
D) White pulp

Q 5. Which blood vessels supply blood to the spleen?

A) Splenic artery and vein
B) Hepatic artery and vein
C) Renal artery and vein
D) Mesenteric artery and vein

Q 6. The red pulp of the spleen is primarily involved in which of the following functions?

A) Filtration of blood
B) Production of white blood cells
C) Storage of platelets
D) Immune response

Q 7. What is the role of the white pulp in the spleen?

A) Hematopoiesis
B) Removal of old red blood cells
C) Immune response and production of antibodies
D) Storage of iron

Q 8. Where is the spleen typically located on ultrasound imaging?

A) Right upper quadrant
C) Right lower quadrant
B) Left upper quadrant
D) Left lower quadrant

Q 9. What is the normal echogenicity of the spleen compared to the liver on ultrasound?

A) Hypoechoic
C) Isoechoic
B) Hyperechoic
D) Anechoic

Q10. Which of the following conditions can be detected by splenic ultrasound?

A) Splenomegaly
C) Splenic cysts
B) Splenic infarct
D) All of the above

Q 11. What measurement on ultrasound is considered indicative of splenomegaly?

A) Length greater than 11 cm
C) Length greater than 15 cm
B) Length greater than 12 cm
D) Length greater than 17 cm

Q 12. Which of the following ultrasound findings is typical of a splenic abscess?

A) Anechoic area with posterior enhancement
B) Hyperechoic mass with shadowing
C) Complex cystic structure with internal echoes
D) Homogeneous hypoechoic lesion

Q 13. What is the most common benign lesion of the spleen detectable by ultrasound?

A) Hemangioma
C) Metastasis
B) Lymphoma
D) Abscess

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Review of ultrasound provides practical and comprehensive coverage of ultrasound images, focusing on the essential structures encountered in daily practice. Through concise text, ultrasound images paired with corresponding photographs, and full-color anatomical and technique illustrations, this resource offers today's students a robust foundation in regional ultrasound anatomy.

P.K. Arogyam
Health and Wellness Research Center

Institute of Radiology Imaging & Medical Science

E-95, P.C. Colony Rd, Kankarbagh, Patna, Bihar 800020
Phone: 9955245153

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