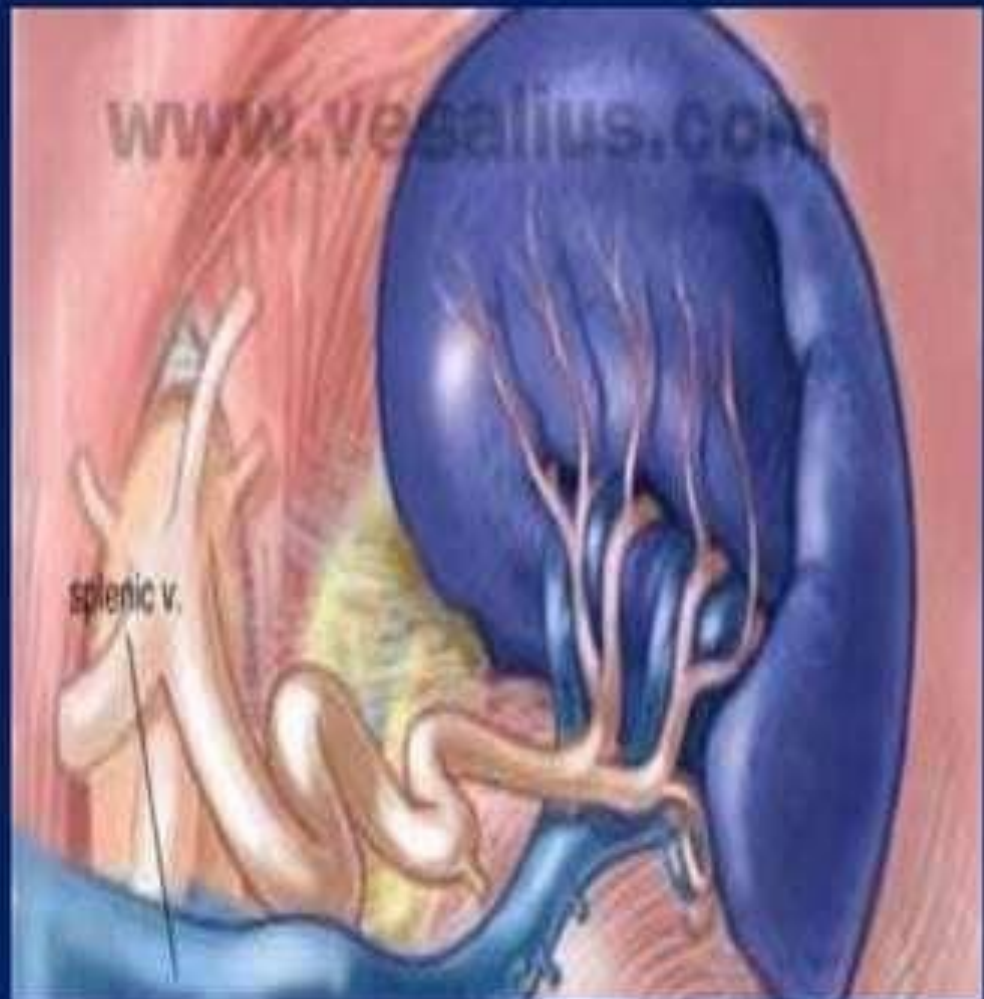
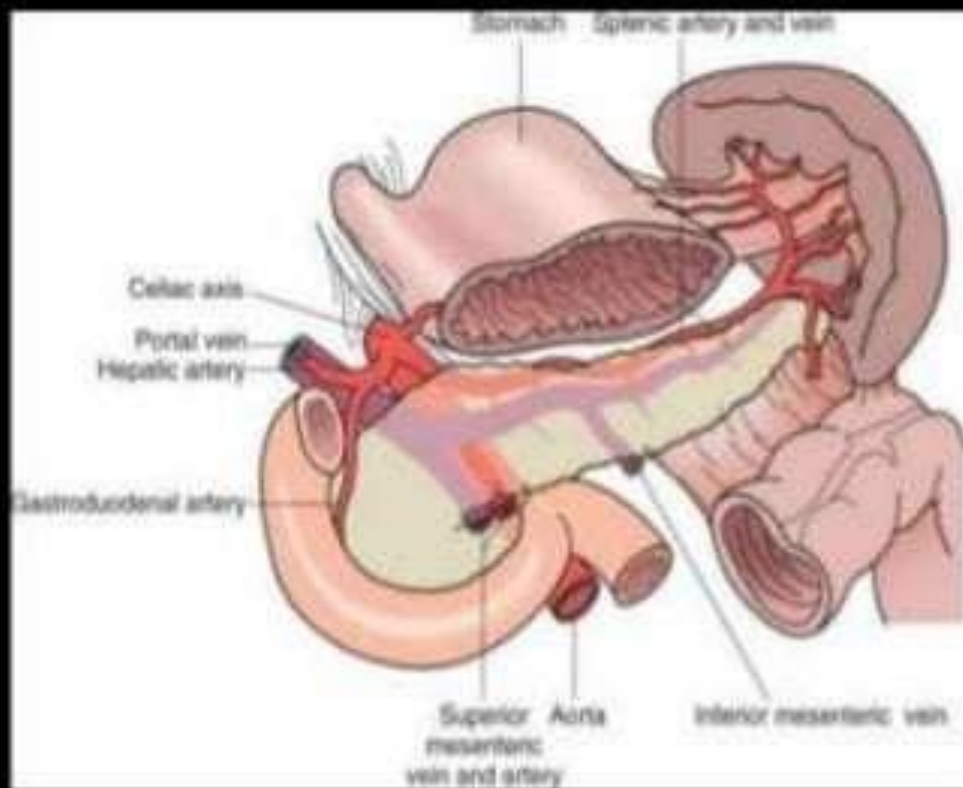


Imaging of the spleen.

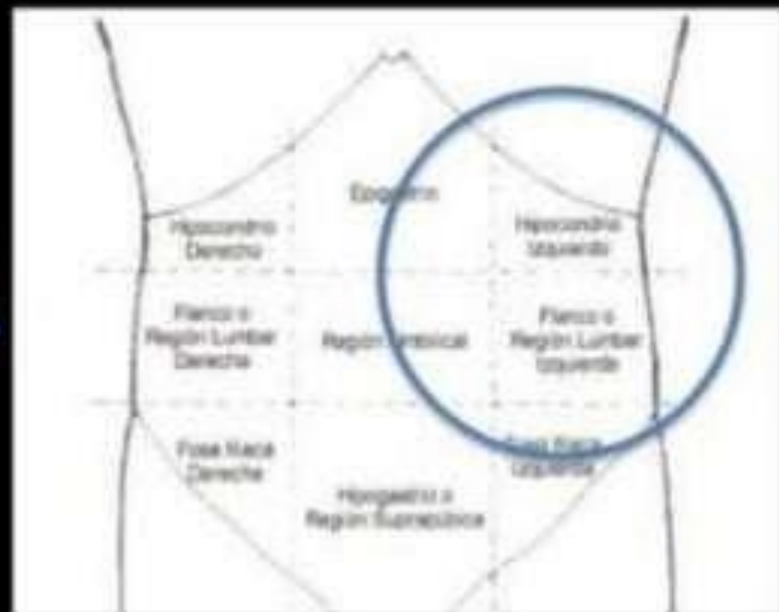
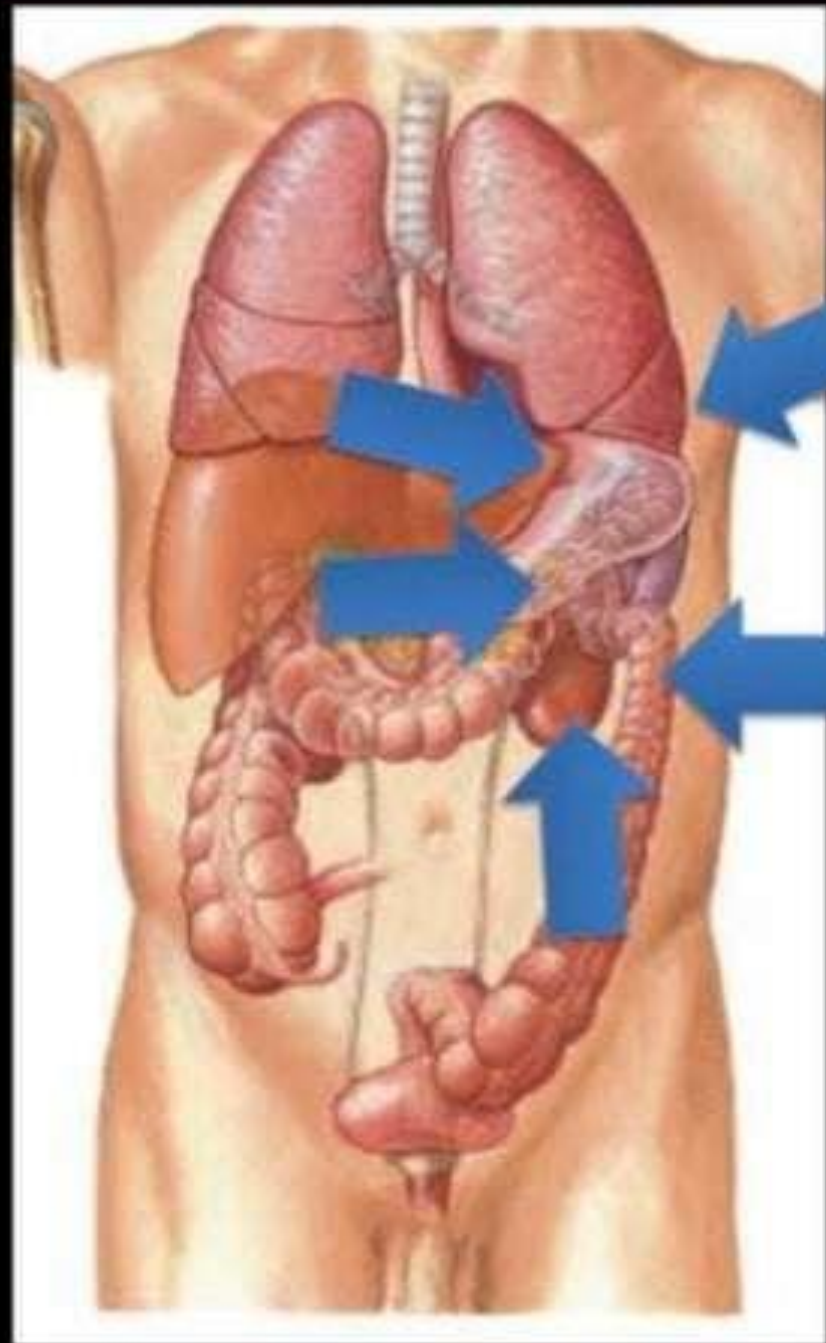


Dr/ ABD ALLAH NAZEER. MD.

Anatomy



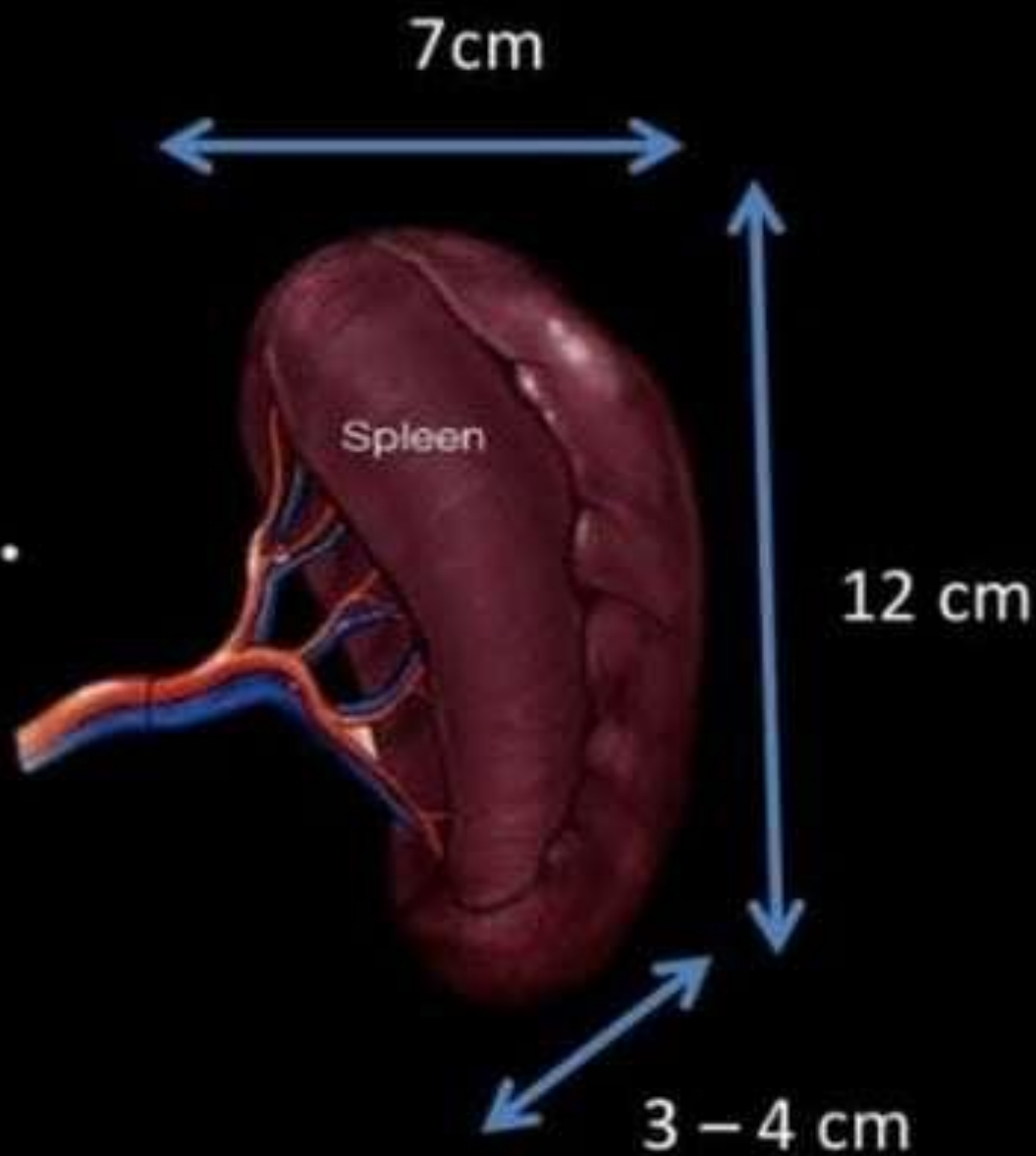
Develops from mesenchymal cells in the dorsal mesogastrium during the fifth week of gestation.

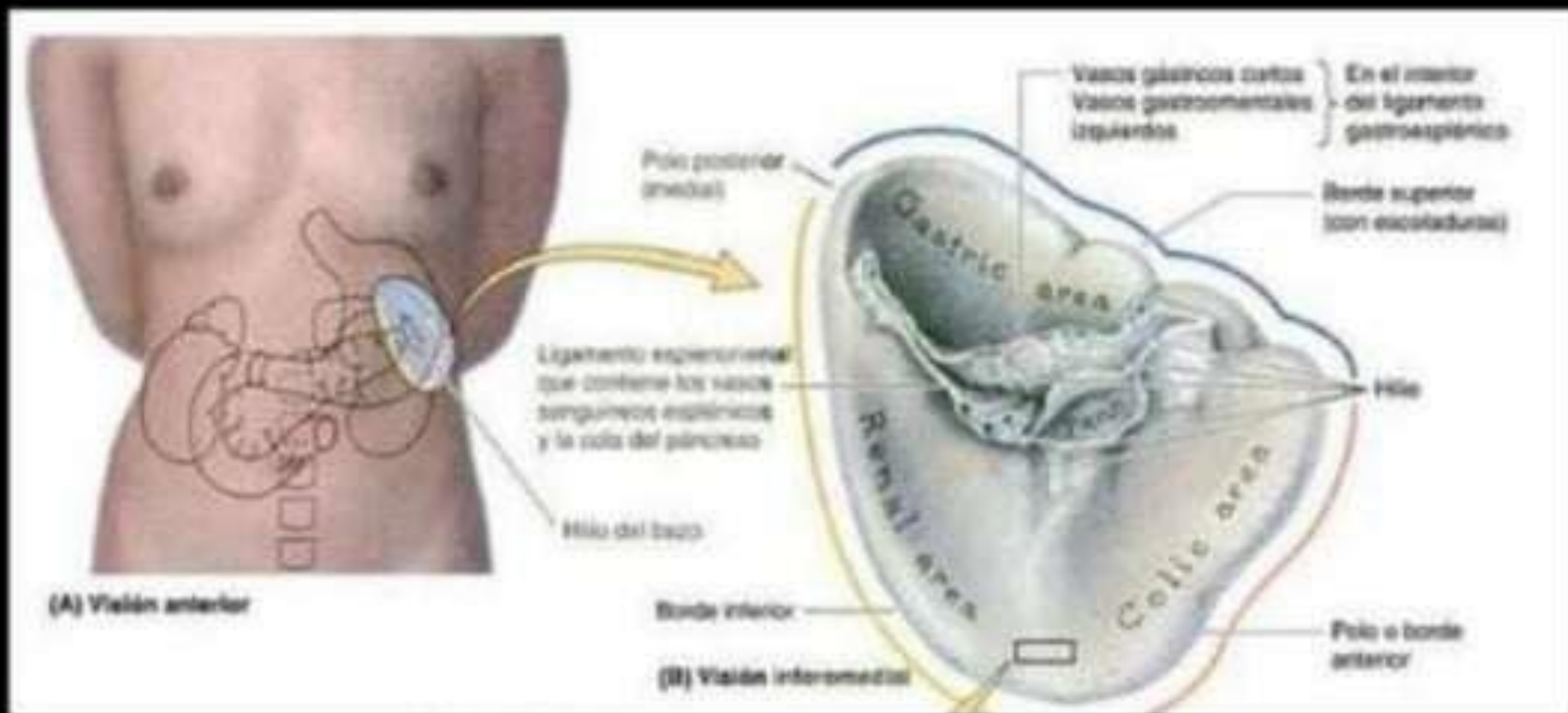




The
peritoneum
covering the
spleen, except in
the hilum.

150 gr.
(80 -300 gr).





Ligaments

- Gastrosplenic
- Splenorenal
- Splenophrenic
- Splenocolic

Blood Supply:

◆ **Splenic artery** (pattern of terminal branches)

a. Distributed type: (70%)

- Short trunk w/ many long branches over $\frac{3}{4}$ of the medial surface of the spleen.

b. Magistral type: (30%)

- Long main trunk dividing near the hilum into short terminal branches.

3. **Short gastric artery:**

Evaluation of Size of Spleen

Indications for imaging of the spleen:

1. assess size of the spleen before elective splenectomy
2. investigating a left upper quadrant pain
3. delineation of tumors or cysts of the spleen
4. characterization of splenic abscesses
5. guidance for percutaneous procedures involving the spleen

Evaluation of Size of Spleen

1. **Ultrasound:**

- Most cost-effective
- Rapid, easy to perform, no radiation
- Sensitivity – 98%

2. **CT scan:**

- High degree of resolution
- Identification of splenic lesions
- Guidance for percutaneous procedures
- Iodinated contrast material

Evaluation of Size of Spleen

1. **Plain radiography**
2. **MRI:**
 - More expensive
 - Offers no advantages in depicting abnormalities of the spleen
3. **Radioscintigraphy:**
 - *Tc-sulfur colloid* demonstrates splenic location and size
 - Very useful locating accessory spleen after splenectomy

Evaluation of Size of Spleen

1. Angiography:

- *Little diagnostic role*
- Provides an effective therapeutic modality for embolizing bleeding splenic branches in trauma

Splenic Index (SI): (by Cools)

- expresses the size of the spleen as a volume in ml.
- length x width x height (cm)
- NV: 120ml to 480ml

Splenic Function:

- Early hematopoiesis
- Mechanical filtration of senescent erythrocytes
- Infection control:
 - Pathogens within RBCs: Malaria, Bartonella
 - Clearance on unopsonized, noningested bacteria from circulation
 - Microorganisms without specific host antibody

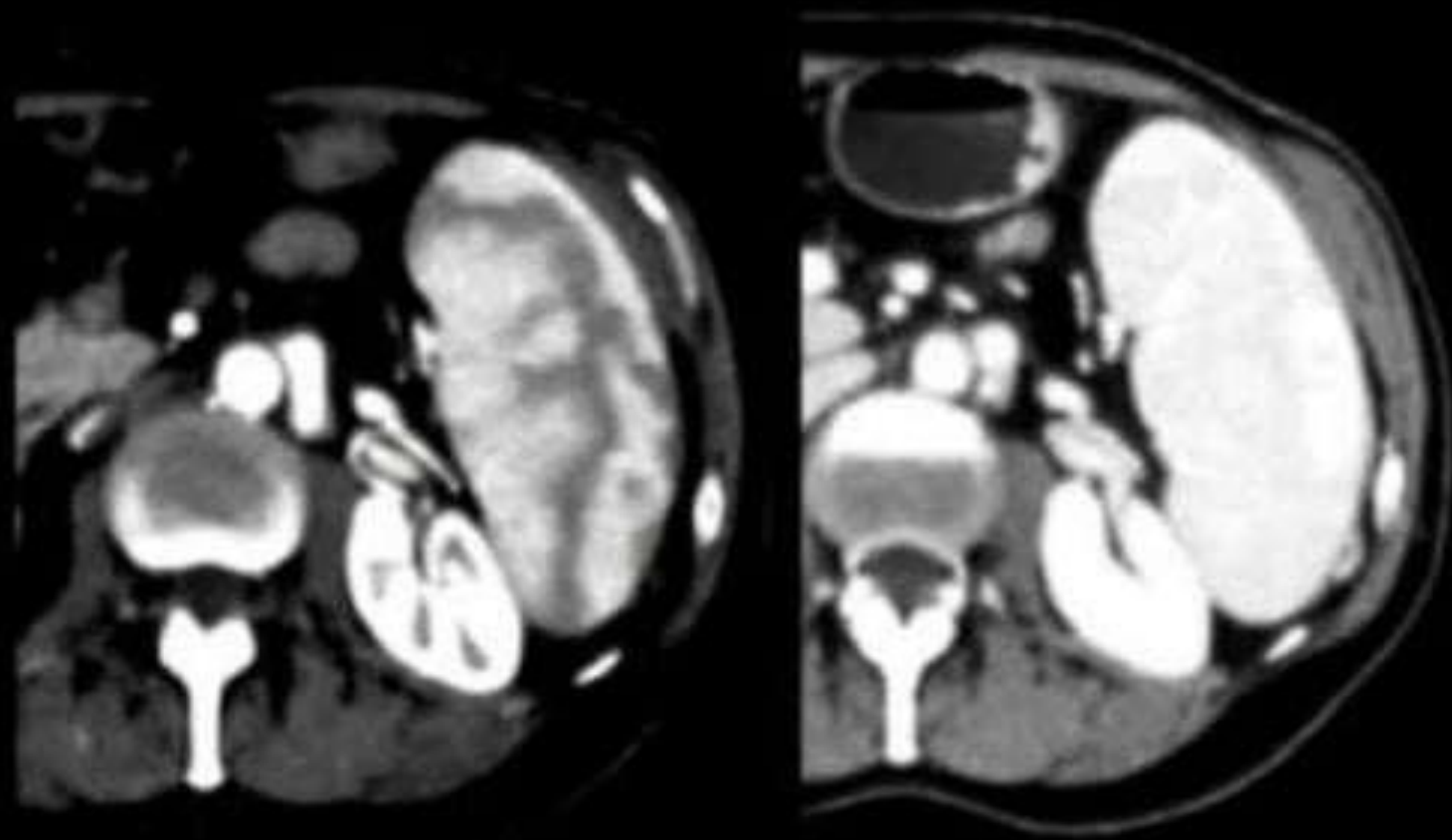
Splenic Enhancement

- Variable circulatory routes through the spleen
 - white pulp (lymphatic follicles and RE cells)
 - red pulp (interspersed vascular lakes)

Normal Enhancement



Normal Enhancement



Congenital anomalies:

Accessory spleen.

Asplenia, Polysplenia.

Hepatoliennal fusion.

Hyposplenism.

Splenic -gonadal fusion.

Splenorenal fusion.

Wandering spleen.

- **Accessory spleen**
10-30%. May enlarge dramatically after splenectomy

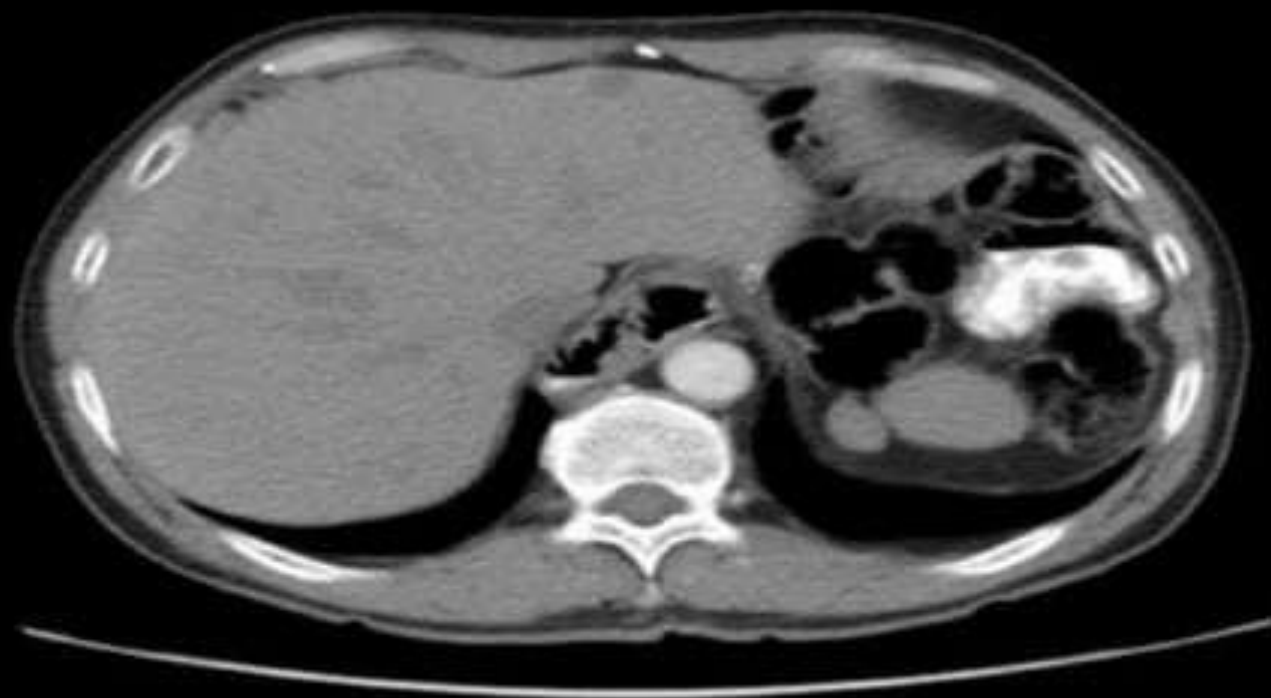


Fig. 8: Axial MDCT with contrast. SPLENOSIS.

Spenule



Asplenia/polysplenia.

Etiologies

Congenital

Surgical

Functional

- Repeated infarctions

- Splenic Artery Thrombosis

- Acute engorgement

 - Splenic sequestration crisis with
SS, malaria, splenic vein thrombosis

- Infiltration

 - Sarcoidosis, amyloidosis, cysts, tumors

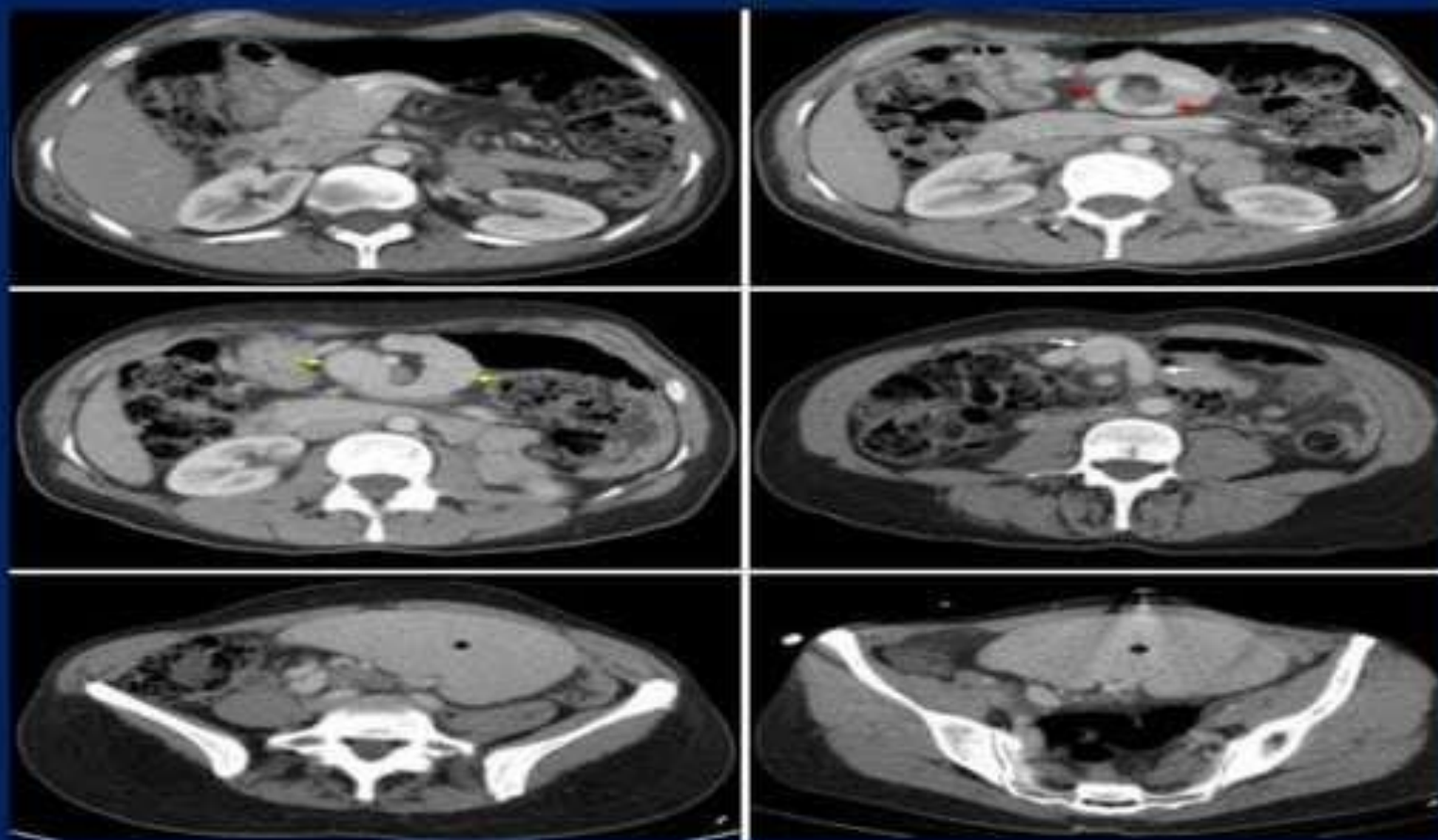


Polysplenia syndrome.

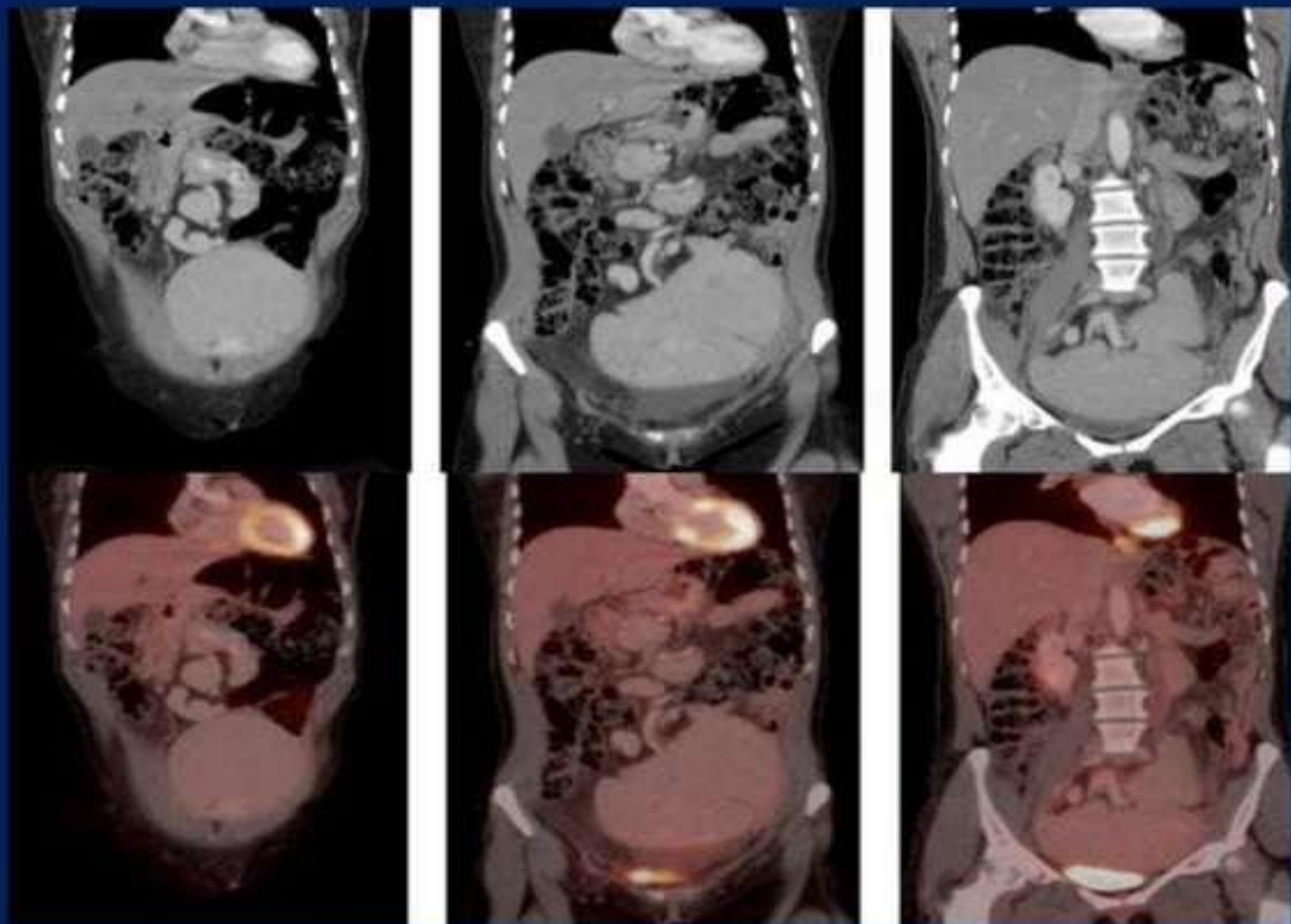


Fig. 9: Axial MDCT with contrast.HETEROTAXY SYNDROME WITH POLYSPLENIA in a 43 years old man. Multiple spleens in right upper quadrant and right-sided stomach (always ipsilateral).Midline liver (predominantly left-sided).

Wandering spleen



Axial reconstructions derived from the CT portion of the PET/CT demonstrate the 'whorled-appearance' of the long vascular pedicle extending to the ectopic spleen. The alternating bands of hypodensity and hyperdensity represent the splenic vessels and surrounding fat of the twisted splenic pedicle. [red arrow = splenic artery; yellow arrow = pancreas; white arrow = splenic vein; asterisk = spleen]



Wandering spleen

Splenic pathology.

Normal Spleen

Cyst

Hamartoma

Hemangioma

Lymphangioma

Splenic abscess

Splenic artery aneurysm

Calcifications

Splenic Infarction

Sickle Cell Disease

Splenomegaly

Sarcoidosis

Pseudotumor

Peliosis

Gaucher's Disease

Trauma

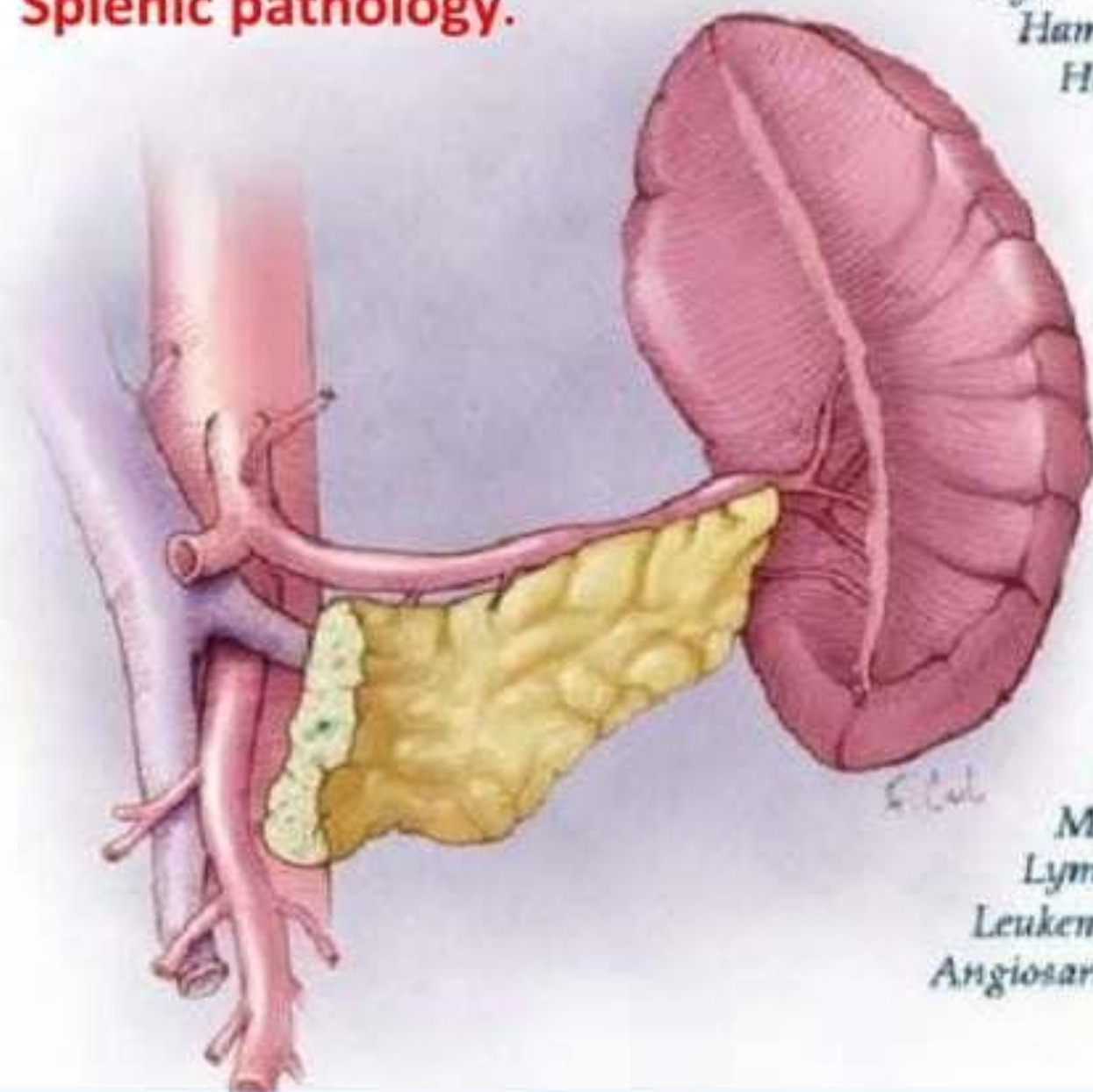
Thoratrast

Metastases

Lymphoma

Leukemia

Angiosarcoma



Splenic cyst D/D

Table 1
Classification of Cystic Masses of the Spleen

Classification	Cystic Entity
Congenital	True cyst
Inflammatory	Pyogenic abscess, echinococcal cyst, fungal abscess
Vascular	Infarction, peliosis
Posttraumatic	Hematoma, false cyst
Neoplastic	
Benign	Hemangioma, lymphangioma
Malignant	Lymphoma, metastasis

Inflammatory masses

■ Pyogenic abscess

- Localized collection of pus most commonly caused by infection (75%), penetrating trauma (15%)
- S/S: Fever, chills & left upper quadrant tenderness

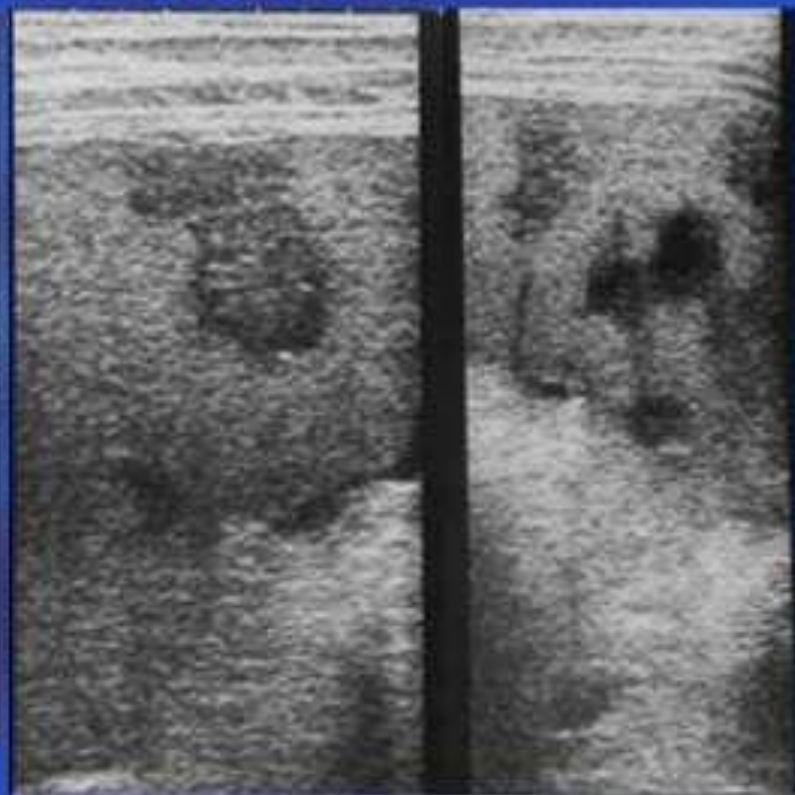
■ Fungal abscess

- Multiple, most commonly in immunocompromised individuals
- Pathogen: *Candida albicans*, *Aspergillus fumigatus*, *Cryptococcus neoformans*

■ Echinococcal cyst

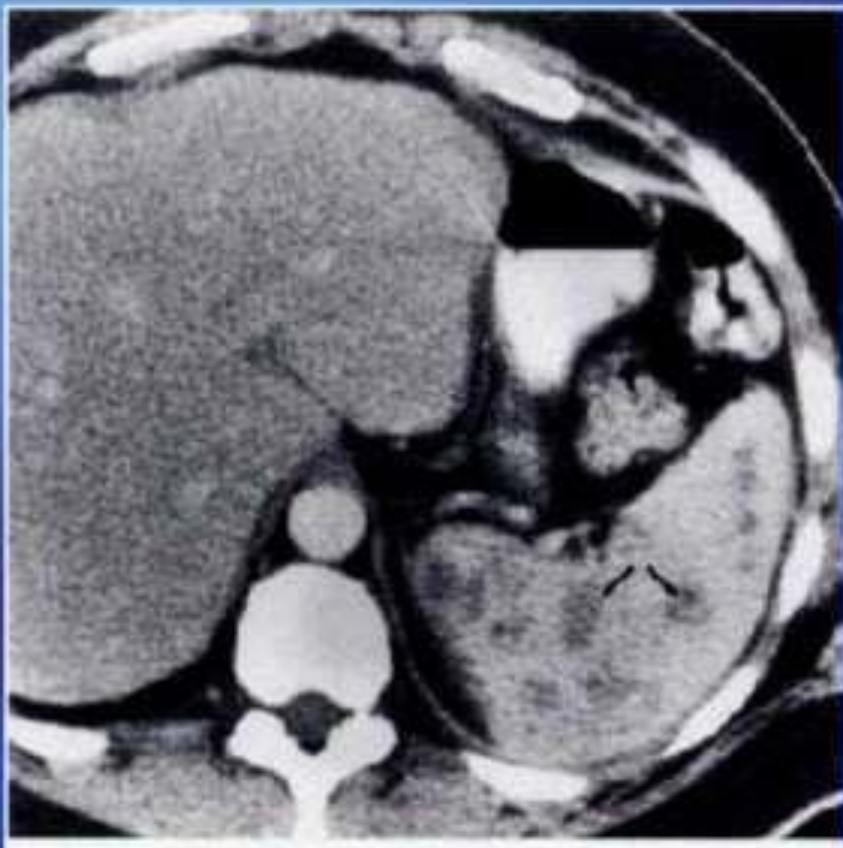
- Involves liver & lung mainly, in endemic areas (Argentina, Greece & Spain)
- S/S: nonspecific (abdominal pain, fever & splenomegaly)

Pyogenic Abscess



- Multiple hypodense nonenhancing areas in an enlarged spleen
- Gas bubbles & rims enhancement may be presented
- Poorly defined hypoechoic lesion and few of them appeared anechoic

Fungal Abscess: 45 y/o man with AML

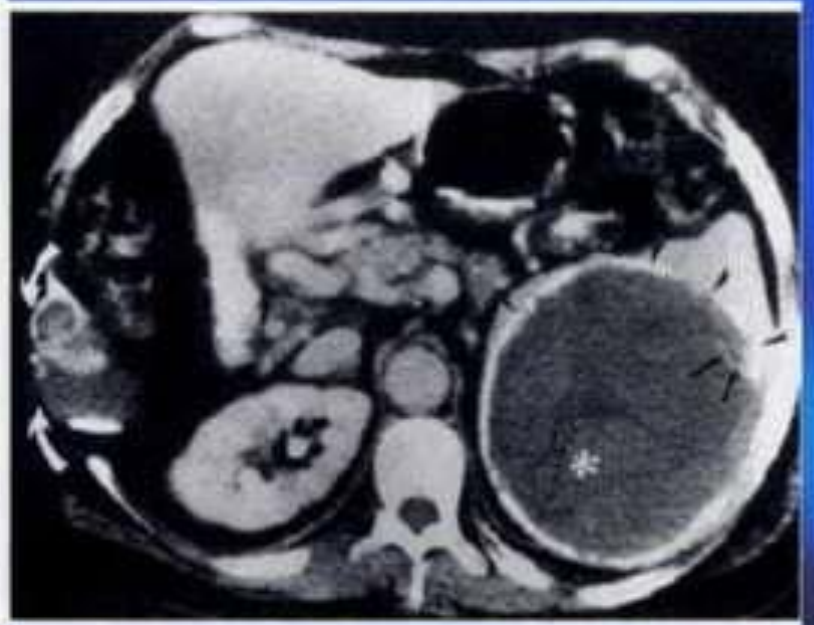


- Well demarcated hypodense areas with range from few mm to 2cm in size
- Rim enhancement was not seen



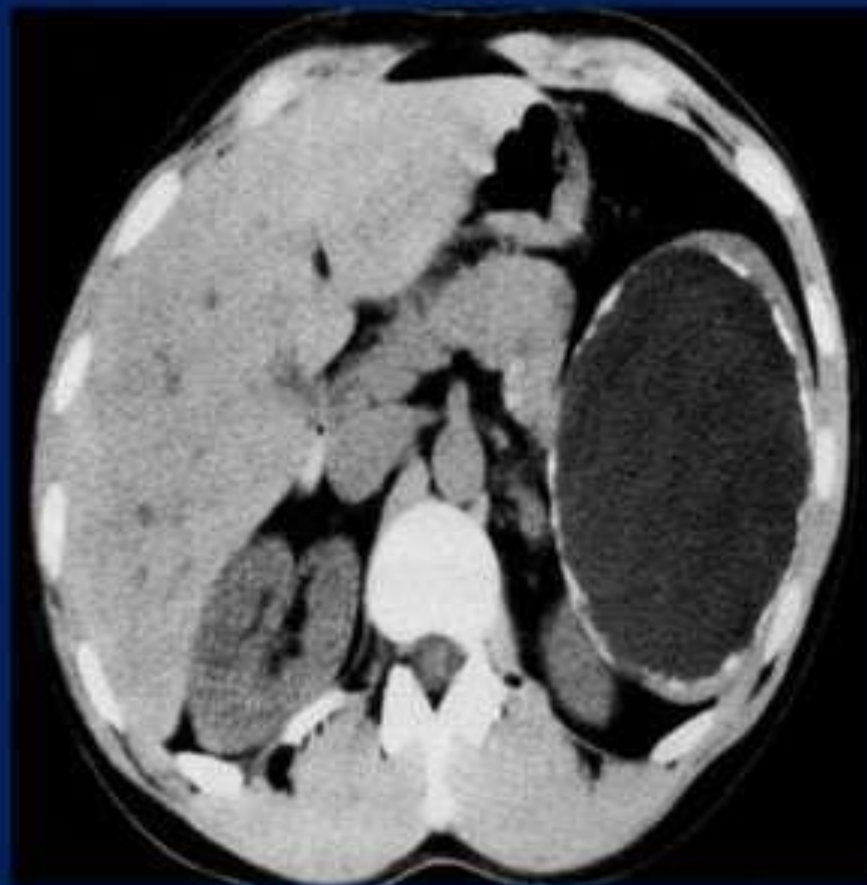
- Multiple hypoechoic (necrotic hyphae) areas with hyperechoic concentric band (viable fungal element)

Echinococcal cyst



- Sharply marginated, round or ovoid mass
- Ringlike calcification in the periphery
- Daughter cyst & hydatid sand may present

Splenic hydatid cyst.



Vascular masses

■ Infarction

- Arterial: occlusion of splenic artery or its branches
 - Thromboembolic disease: hemolytic anemias, endocarditis, SLE, pancreatic carcinoma
- Venous: thrombosis of splenic sinusoids
 - Massive splenomegaly
- S/S: Splenomegaly & acute upper quadrant pain, worsens on deep inspiration

■ Peliosis

- Presence of widespread blood-filled cystic spaces within the splenic parenchyma
 - Vary in size & may not contain an epithelial lining
- Associate with malignant hematologic disease (Hodgkin lymphoma & myeloma), tuberculosis
- S/S: asymptomatic, usually detected incidentally

Infarction

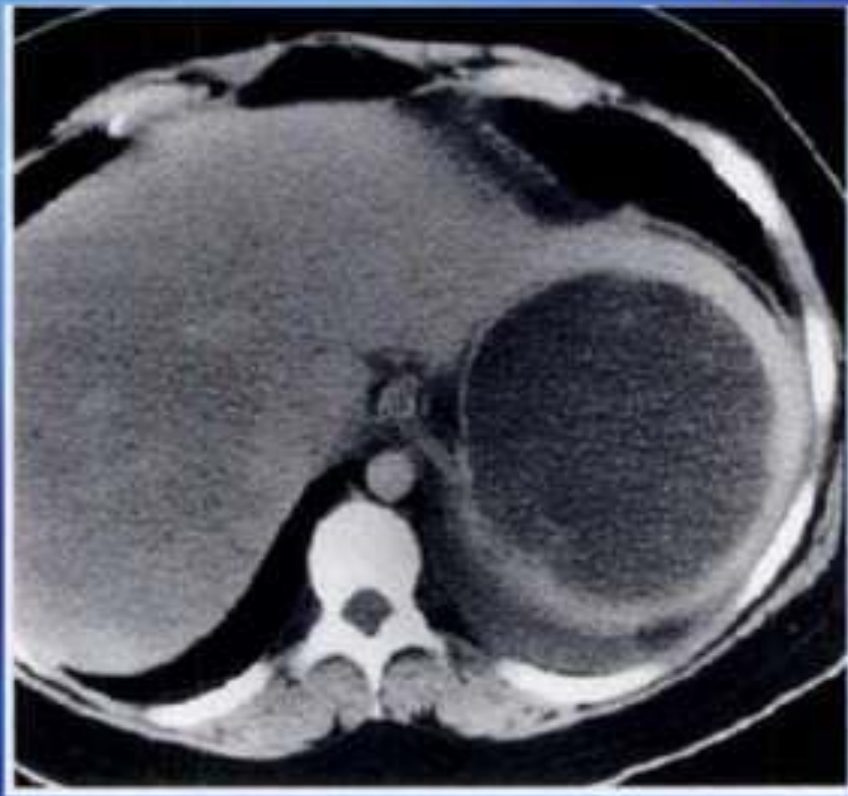


- Heterogenous, ill-defined complex splenic mass with hypoechoic areas throughout the parenchyma (hemorrhagic debris of infarction)



- Well-defined, hypoechoic mass
- More rounded & better delineated, secondary to ensuing fibrotic reaction

Infarction



- Acute phase
- Well-defined hypodensity area



- Subacute phase
- Multiple hypodensity areas (infarction & necrosis)
- Difficult to differentiate from other cystic masses

Peliosis

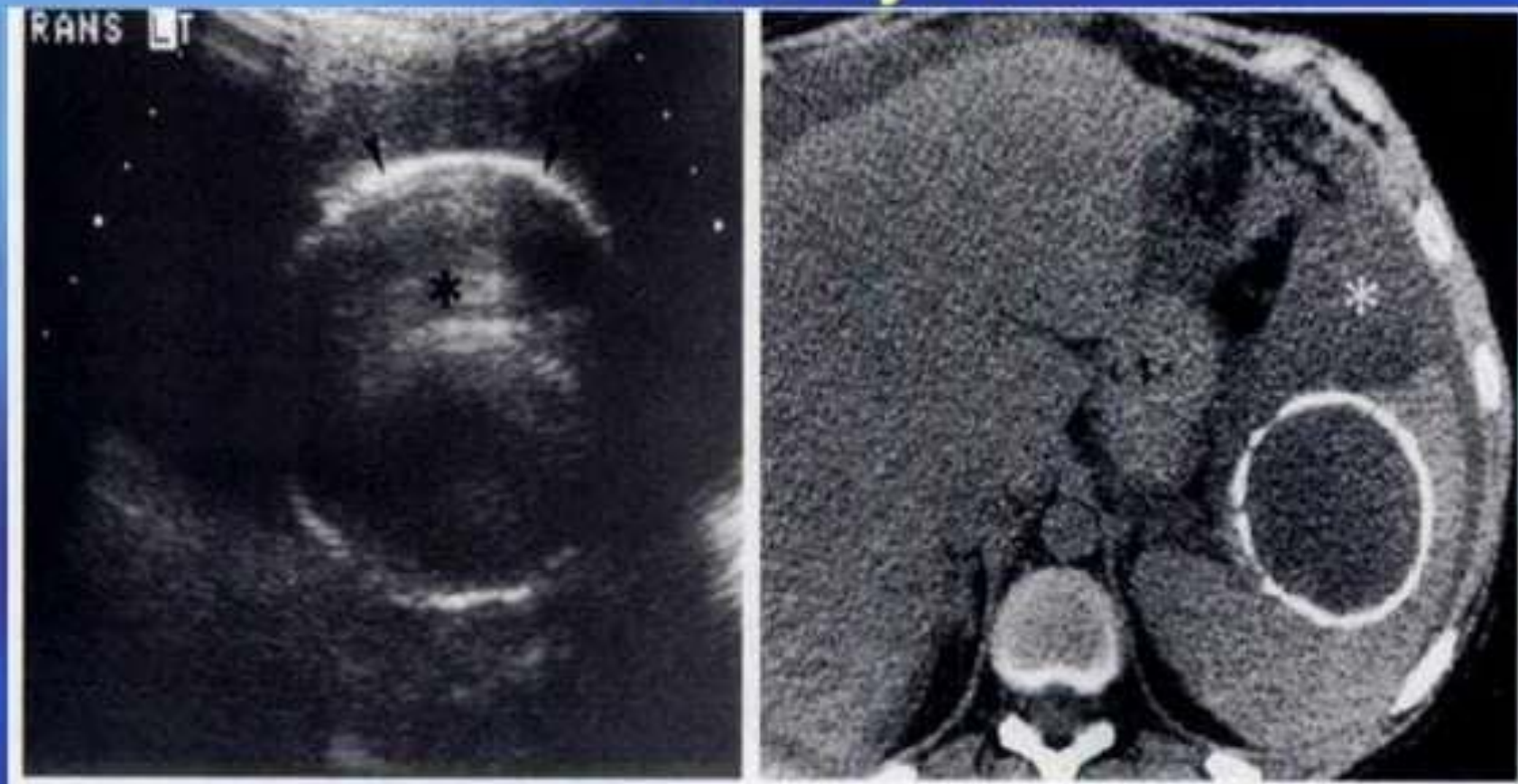


- Multiple hypodense, rounded lesions of different sizes throughout the splenic parenchyma
- *: hemoperitoneum

False Cyst

- = pseudocyst, without an inner epithelial lining
- End stage of intrasplenic hematoma
- History of trauma to the left upper quadrant

False cyst



- Well defined, rounded splenic mass with a thick wall, brightly echogenic (calcification)

- Homogenous hypodense splenic cyst with calcification within the wall

Neoplastic masses

- Benign Neoplastic masses
 - Hemangioma
 - Lymphangioma
- Malignant
 - Lymphoma
 - Metastasis

Benign neoplastic masses

■ Hemangioma

- Proliferation of vascular channel of various size
- Most common primary neoplasm of spleen
 - Asymptomatic & found incidentally
 - Large mass => pain & splenomegaly

■ Lymphangioma

- Single or multiple (lymphangiomatosis), filled with lymph
- Asymptomatic

Hemangioma

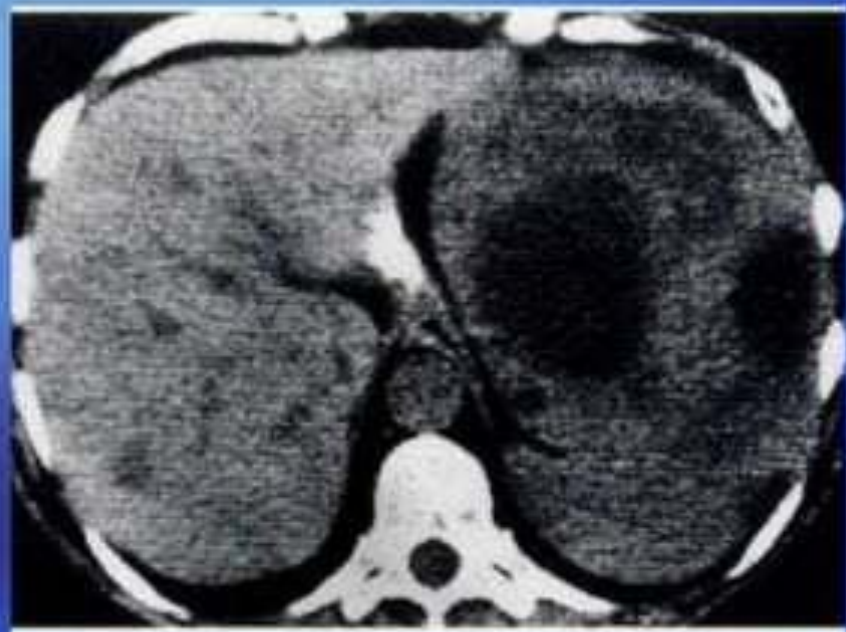


- Large, complex, hyperechoic mass with scattered internal hypoechoic foci

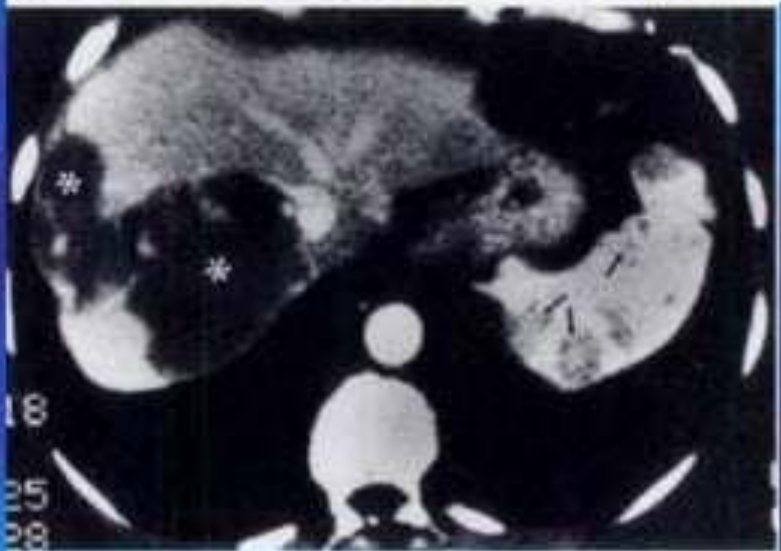


- Cystic hemangioma
- Color doppler flow may show blood flow within the solid portions

Hemangioma



- Unenhanced CT
 - Hypodensity masses resemble cysts

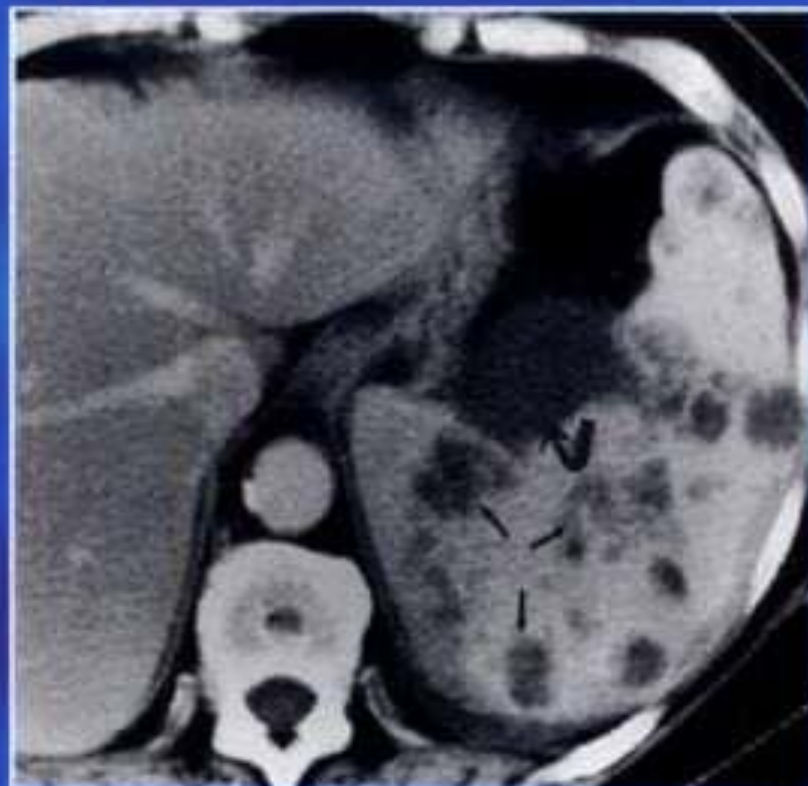


- Delayed enhancement within the solid portion => hemangioma

Lymphangioma



- Well defined, hypoechoic mass that may have internal septations



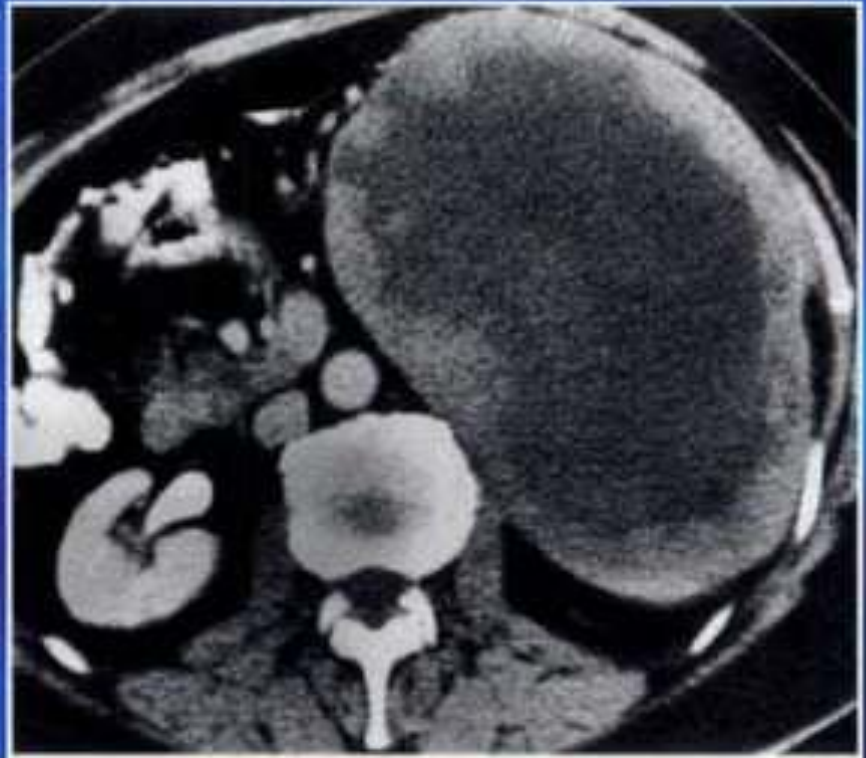
- Hypodensity, sharply marginated & not enhanced

Malignant neoplastic masses

■ Lymphoma

- Most common malignant splenic neoplasm
- S/S: nonspecific, could mimic abscess
- secondary infection => abscess formation
- 3 patterns:
 1. infiltrative without definite discrete masses
 2. Miliary with small (<2cm) deposits of lymphomatous cells
 3. Massive: large lymphomatous masses can be seen

Lymphoma



- Ill defined, central hypoechoic mass
- Acoustic enhancement

- Large, ill-defined hypodensity (central necrosis) mass
- Difficult to differentiate from abscess



Splenic Lymphoma.

Malignant neoplastic masses

■ Metastasis

- Uncommon, in only 7% patients with widespread malignancy
- 50% from melanoma, the remain from adenocarcinoma of breast, lung, colon, ovary, endometrium & prostate
- Symptoms related to size

Metastasis



- Irregular, hypoechoic lesion with central hyperechogenicity (necrotic debris within mass)



- Large solid irregular hyperechoic mass

Metastasis



- Multiple ill defined hypodensity with thin walls & no calcifications, solid part: enhance heterogenous



- Large ill-defined hypodensity lesion

Table 2
Differential Diagnosis of Cystic Splenic Masses

Cystic Splenic Lesion	Single Cystic Mass	Multiple Cystic Masses	Unilocular Cystic Mass	Multilocular Cystic Mass	Peripheral Calcifications	Thick, Irregular Borders	Thin, Smooth Borders
Congenital							
True cyst	+++	-	+++	+	-	-	+++
Inflammatory							
Pyogenic abscess	+++	++	++	++	-	+++	-
Echinococcal cyst	++	++	+	+++	++	-	+++
Fungal abscess	-	+++	+++	-	-	-	+++
Vascular							
Infarction	++	+	++	+	-	+++	++
Peliosis	+	+++	+++	-	-	+++	+
Posttraumatic							
Hematoma	+++	++	+++	+	-	++*	+++*
False cyst	+++	-	+++	+	+++	-	+++
Neoplastic							
Benign							
Hemangioma	+	+	++	-	++	+++	-
Lymphangioma	++	+++	+	+++	+	-	+++
Malignant							
Lymphoma	+	+	+	-	-	+++	-
Metastasis	+++	+++	++	+	-	+++	++

Note.—+++ = frequently occurs, ++ = occasionally occurs, + = rarely occurs, and - = never occurs.

*Dependent on the stage of evolution of the hematoma.

Splenomegaly

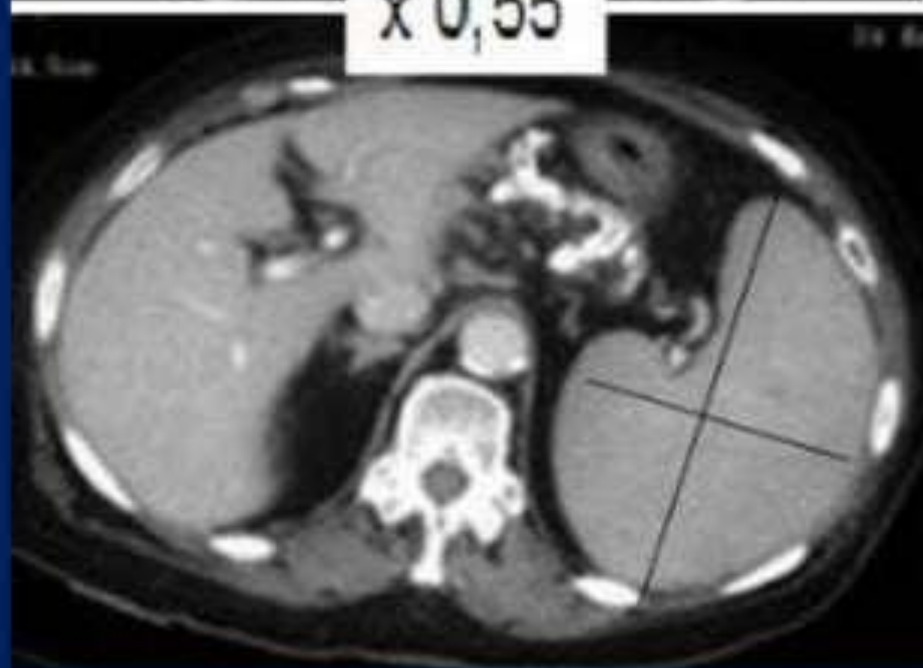




x 0,55

.....
 $8 \times 4 \times 8 = 360 = 198 \text{gr}$

NORMAL 240gr



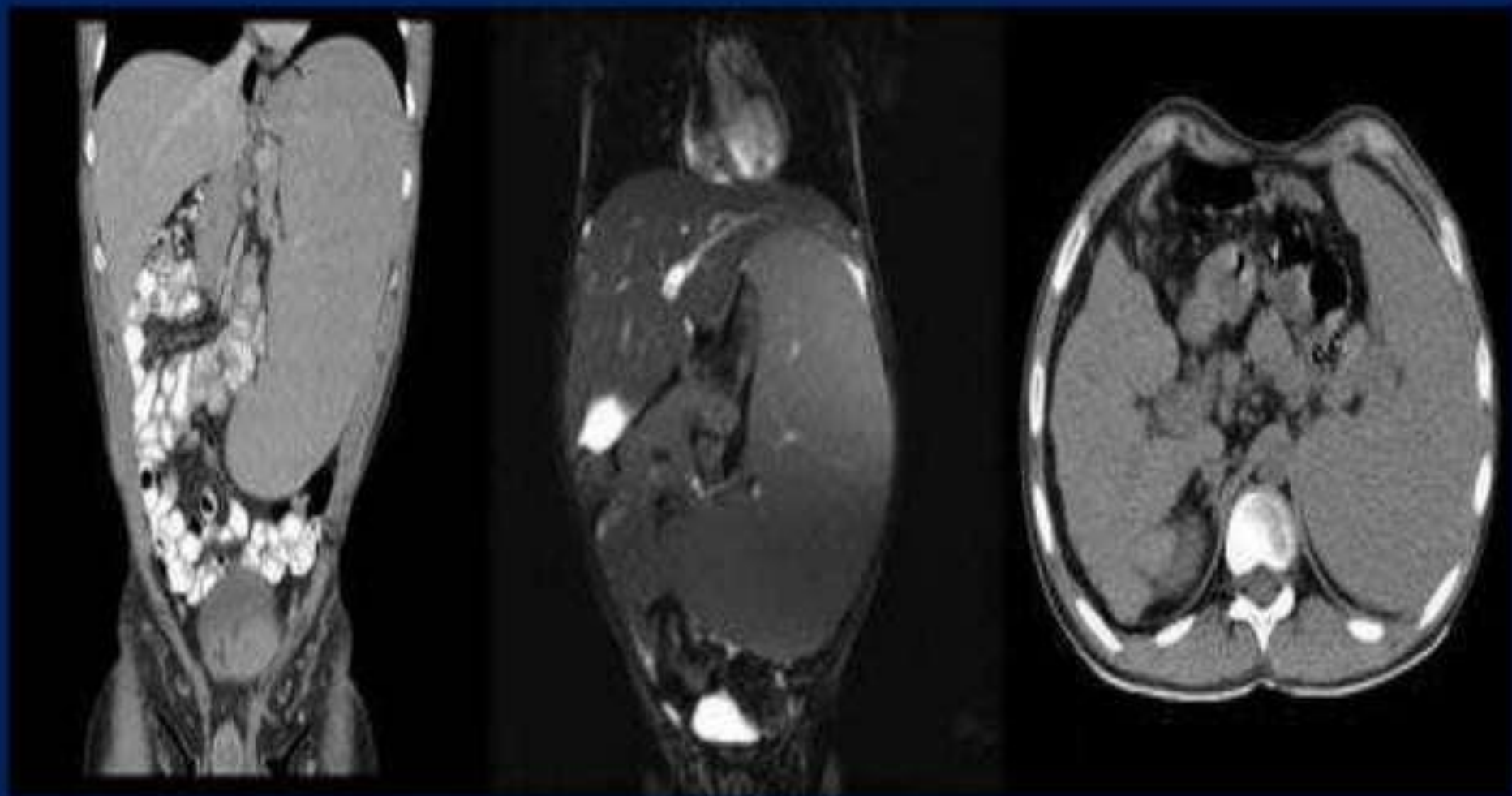
$13 \times 10 \times 15 = 1950 = 1070 \text{gr}$

Table 4. Causes of Splenomegaly.

Causes of Splenomegaly	Causes of Massive Splenomegaly
<u>Hematologic</u>	
Red-cell membrane defects	Thalassemia major
Hemoglobinopathies	
Autoimmune hemolytic anemias	
<u>Rheumatologic</u>	
Rheumatoid arthritis	
Systemic lupus erythematosus	
Sarcoidosis	
<u>Infectious</u>	
Viral	Visceral leishmaniasis
Bacterial	Hyperreactive malarial splenomegaly syndrome
Mycobacterial	<i>Mycobacterium avium</i> complex
Fungal	
Parasitic	
<u>Congestive</u>	
Hepatic cirrhosis	
Venous thromboses (hepatic, portal, splenic)	
Congestive heart failure	
<u>Infiltrative</u>	
Lymphomas	Lymphomas
Myeloproliferative neoplasms	Myeloproliferative neoplasms
Metastatic cancer	Gaucher's disease
Amyloidosis	
Gaucher's disease	
Niemann-Pick disease	
Glycogen storage diseases	
Hemophagocytic syndrome	
Langerhans'-cell histiocytosis	

**Splenomegally with
portal hypertension**





Splenomegally

Case 39-2008: A 51-Year-Old Woman
with Splenomegaly and Anemia



Splenic marginal-zone lymphoma,

Splenic Trauma/Injury

The **spleen** is the intra-abdominal organ most *frequently injured* in blunt trauma.



Organ Injury Scaling-American Association of the Surgery of Trauma (OIS-AAST)

Grade	Injury Description
I	<i>Haematoma:</i> Subcapsular, <10% surface area <i>Laceration:</i> Capsular tear, <1cm parenchymal depth
II	<i>Haematoma:</i> Subcapsular, 10-50% surface area Intraparenchymal, <5cm diameter <i>Laceration:</i> 1-3cm parenchymal depth not involving a parenchymal vessel.
III	<i>Haematoma:</i> Subcapsular, >50% surface area or expanding. Ruptured subcapsular or parenchymal haematoma. Intraparenchymal haematoma >5cm <i>Laceration:</i> >3cm parenchymal depth or involving trabecular vessels
IV	<i>Laceration:</i> Laceration of segmental or hilar vessels producing major devascularization (>25% of spleen)
V	<i>Laceration:</i> Completely shattered spleen <i>Vascular:</i> Hilar vascular injury which devascularized spleen

A way to remember this system is:

- Grade 1 is less than 1 cm.
- Grade 2 is about 2 cm (1-3 cm).
- Grade 3 is more than 3 cm.
- Grade 4 is more than 10 cm.
- Grade 5 is total devascularization or maceration.

Grade I



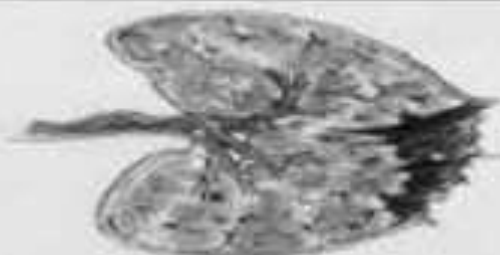
Small non-ruptured subcapsular hematoma

Grade II



Capsule split

Grade III



Deep parenchymal laceration

Grade IV

Art. injured



Large section of parenchyma detached

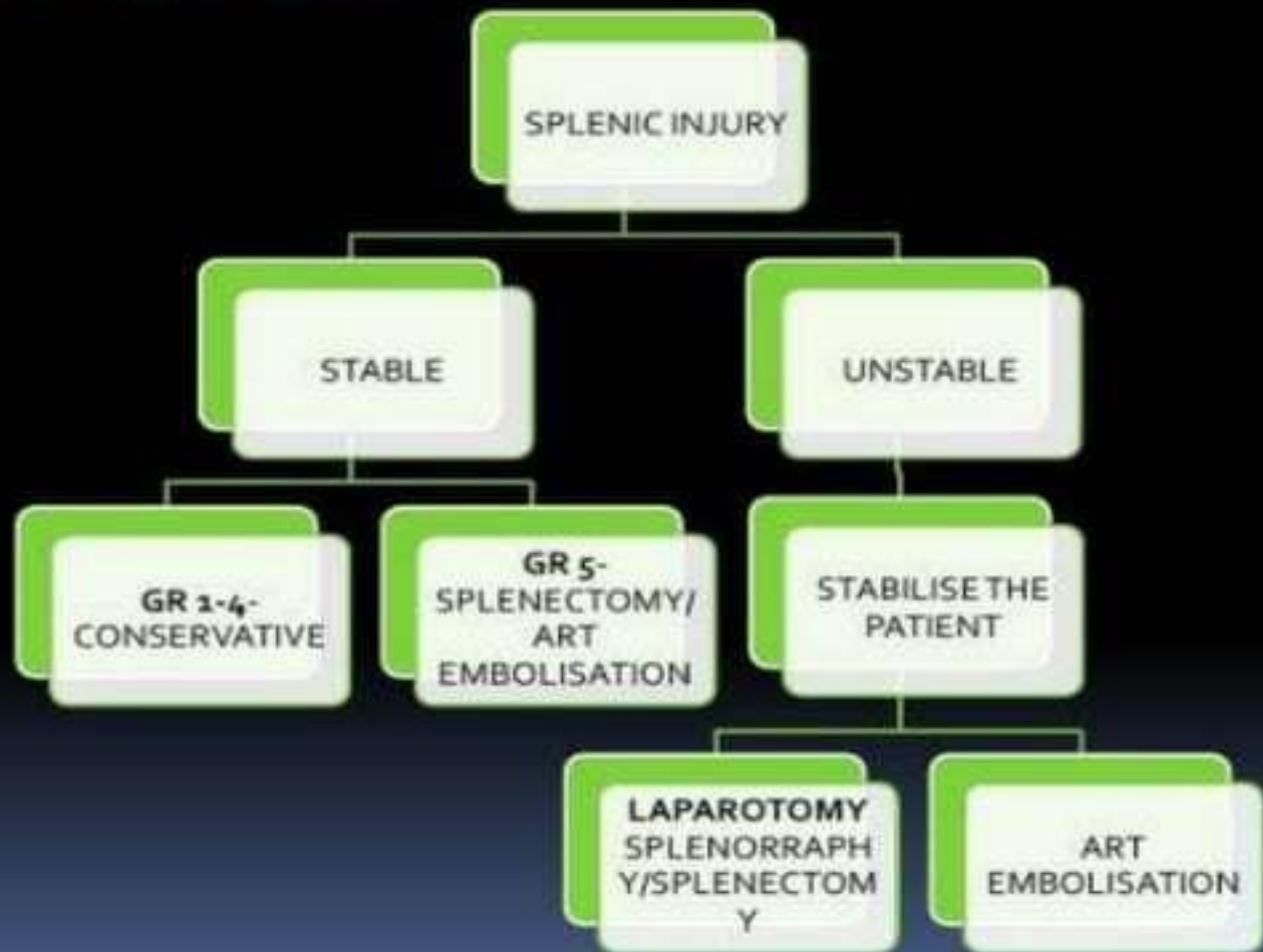
Grade V

Avascular splenic artery, vein



Transverse injury

MANAGEMENT



Plain film findings for spleen trauma

- *left lower rib fracture*
- The classic triad indicative of acute splenic rupture
 - *Left hemidiaphragm elevation*
 - Left lower lobe atelectasis
 - Pleural effusion

Grade I

Hematoma

Subcapsular,
< 10% surface area

Laceration

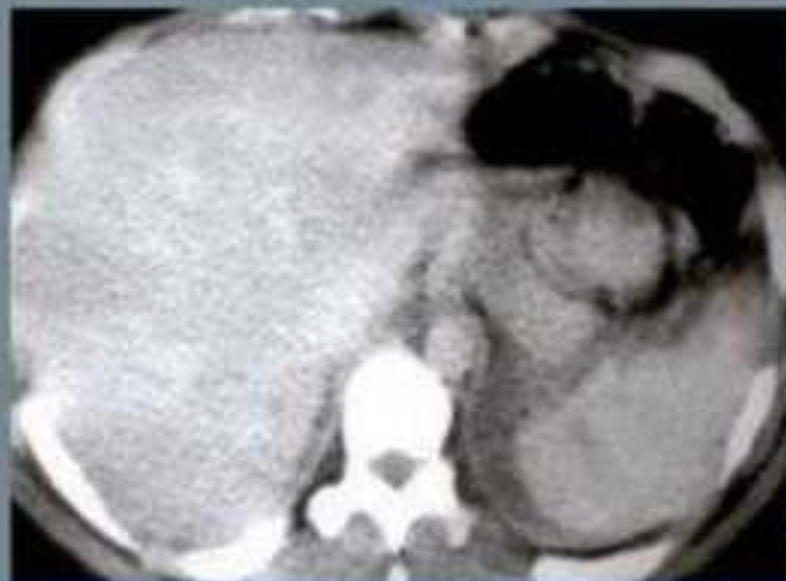
Capsular tear,
< 1cm parenchymal depth



Classification

Organ Injury Scaling

Grade 1 Contrast-enhanced CT scan
Haematoma Subcapsular, <10% surface area
Laceration Capsular tear, <1cm parenchymal depth



Grade II

Hematoma

Subcapsular, 10-50% surface area;
intraparenchymal, <5cm in diameter



Laceration

1-3cm parenchymal depth;
trabecular vessels not involved



Classification

Organ Injury Scaling

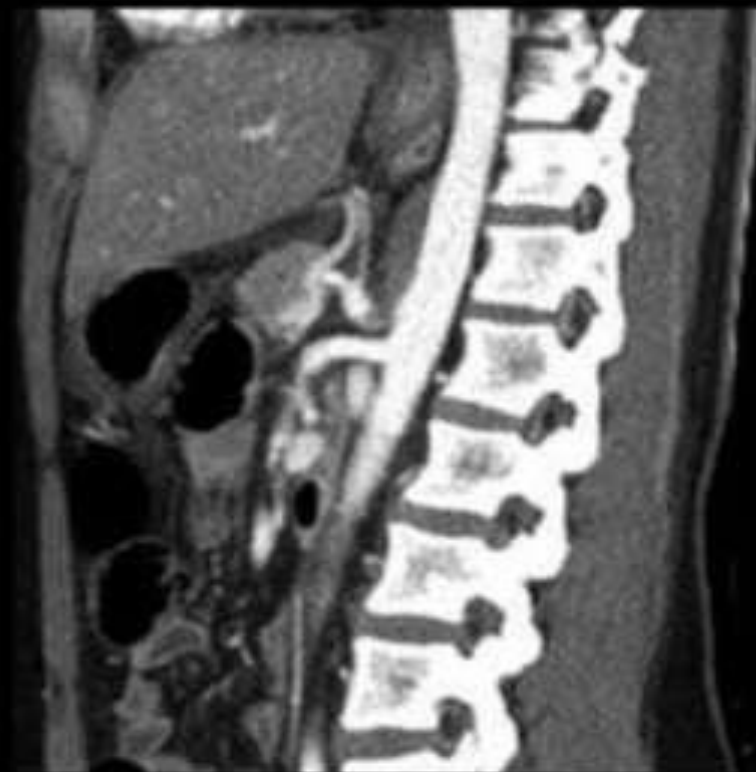
Grade 2 Contrast-enhanced CT scan

Haematoma Subcapsular, 10-50% surface area Intraparenchymal,

5cm diameter Laceration 1-3cm parenchymal depth not involving a parenchymal vessel



Parenchymal Contusion



Hypodense intraparenchymal area with irregular contours

Grade 11-111 laceration.

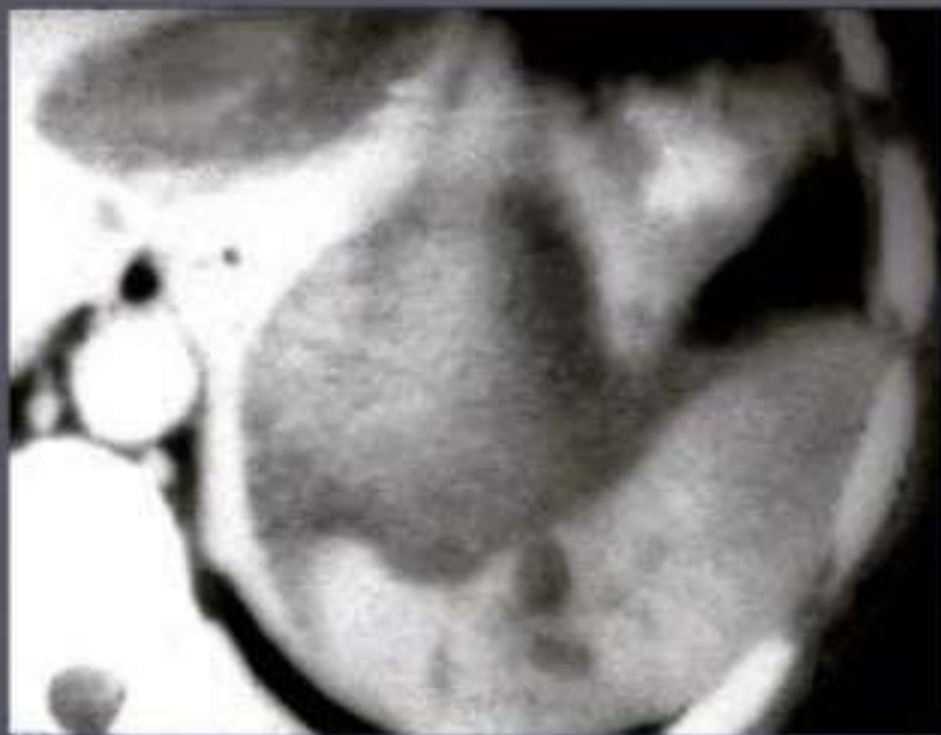
Grade III

Hematoma

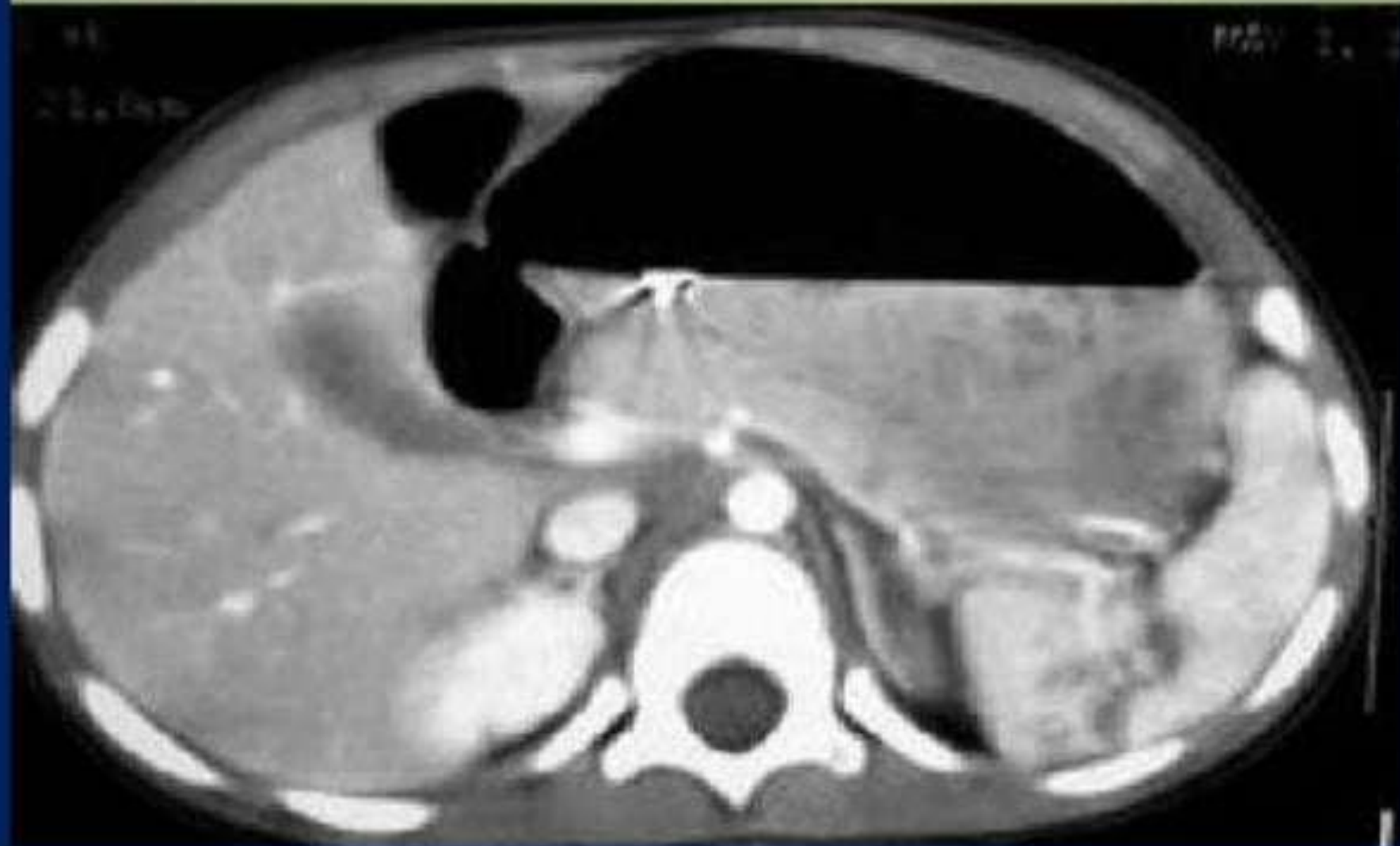
Subcapsular, >50% surface area or expanding;
ruptured subcapsular or parenchymal hematoma;
intraparenchymal hematoma >5 cm or expanding

Laceration

>3cm parenchymal
depth or involving
trabecular vessels



Grade 3





Grade 111 tear, measuring more than 3 cm.

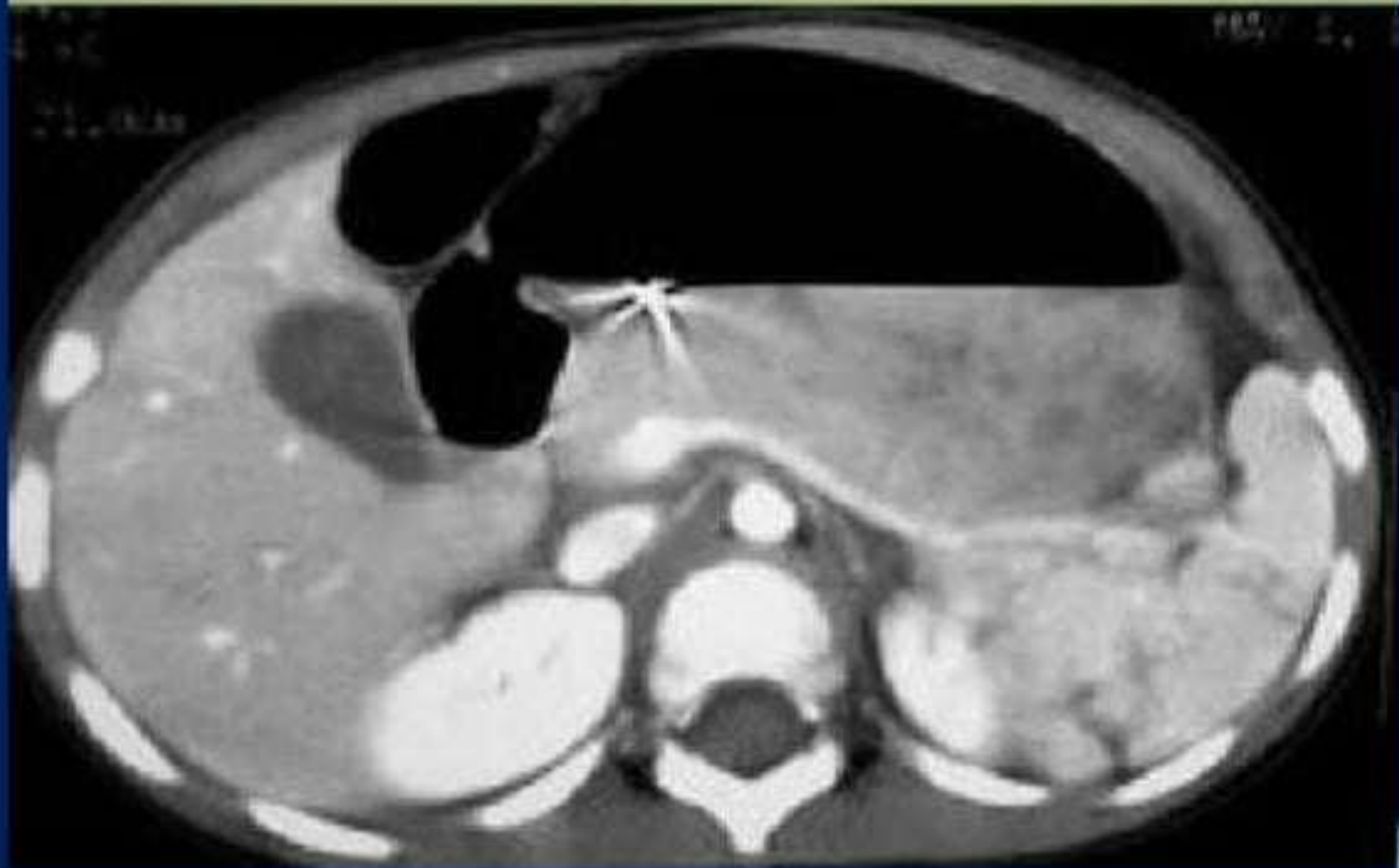
Grade IV

Laceration

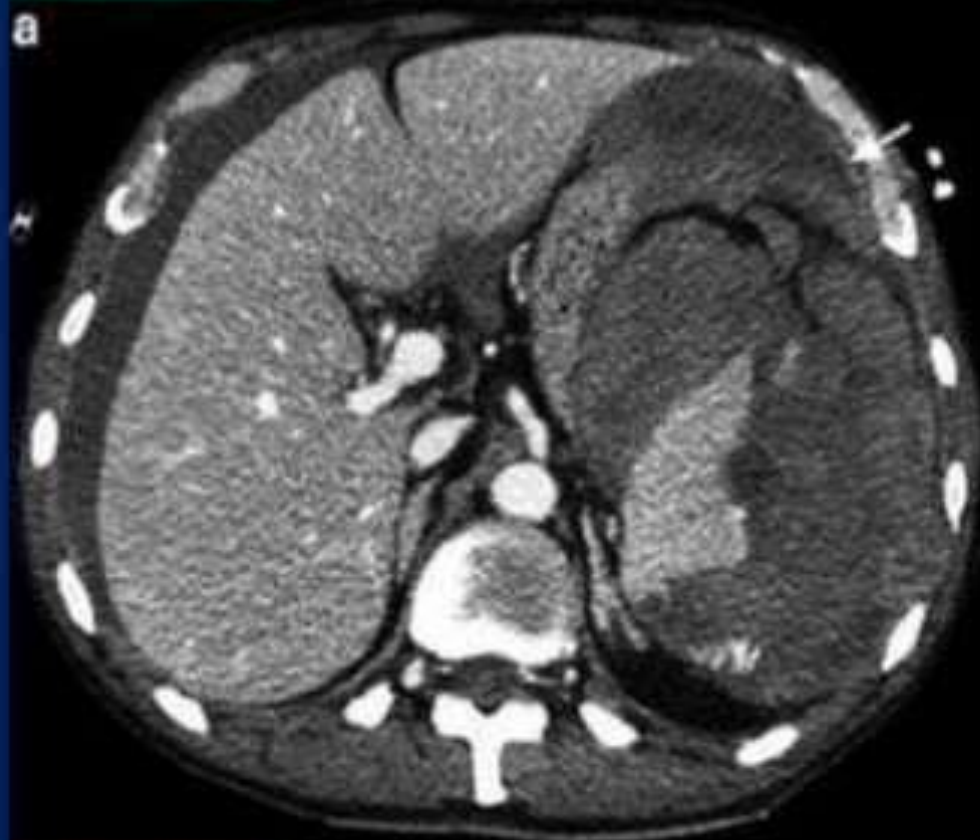
Involves segmental or hilar vessels producing major devascularization (>25% of spleen)



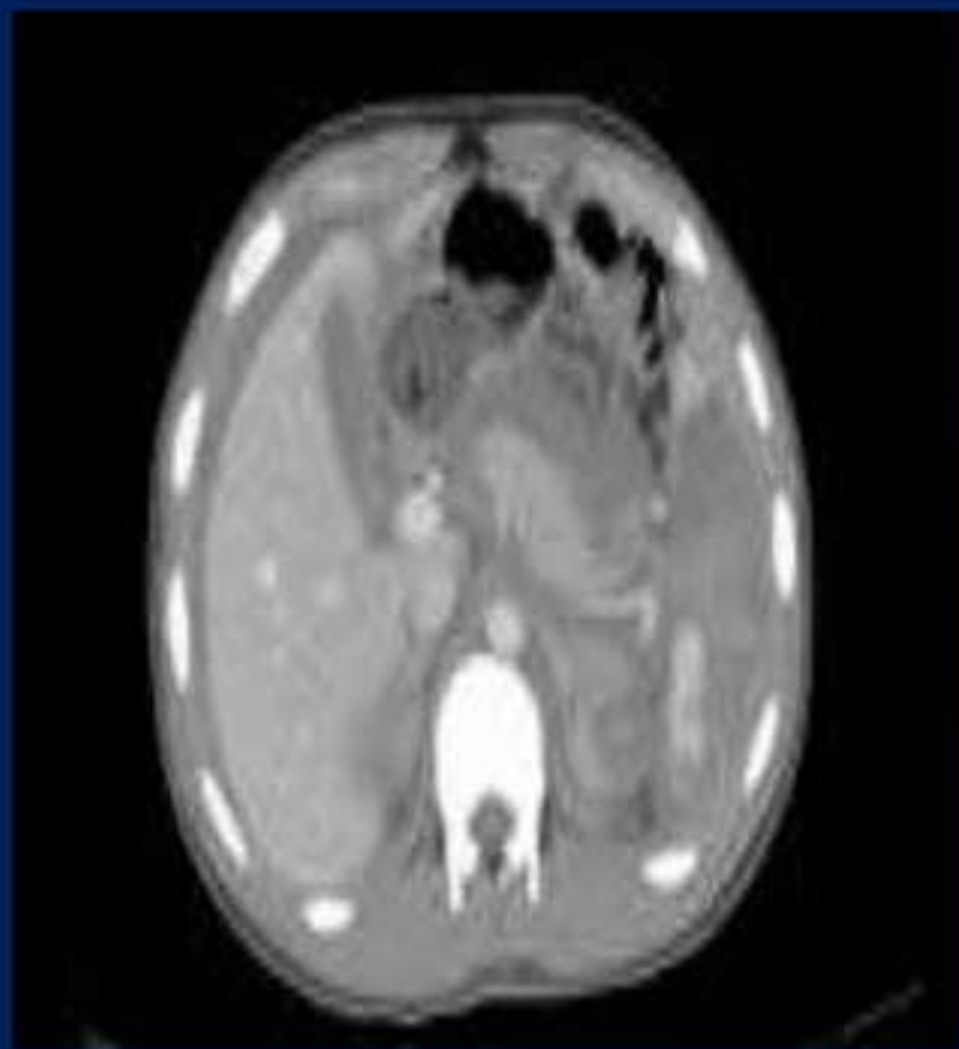
Grade 4



Subcapsular Hematoma



- Crescent-shaped perisplenic
- Compresses the splenic parenchyma



Grade 1V Tear.

Grade V

Laceration

Completely shattered spleen



Vascular

Hilar vascular injury that devascularizes spleen





Shattered spleen with large
intrasplenic hematoma

Parenchymal Laceration

- Superficial, **linear hypodensity**, usually less than 3 cm in length
- Fracture - involves two visceral surfaces, or if its length is more than 3 cm
- Multiple fractures - Scattered spleen



Thank You.