The Spleen

Anatomy

- Develops in 5th week gestation from mesenchymal cells in the dorsal mesogastrium
- Adult stats
  - 12 cm long
  - 7 cm wide
  - 3-4 cm thick
  - 150g

Relationships

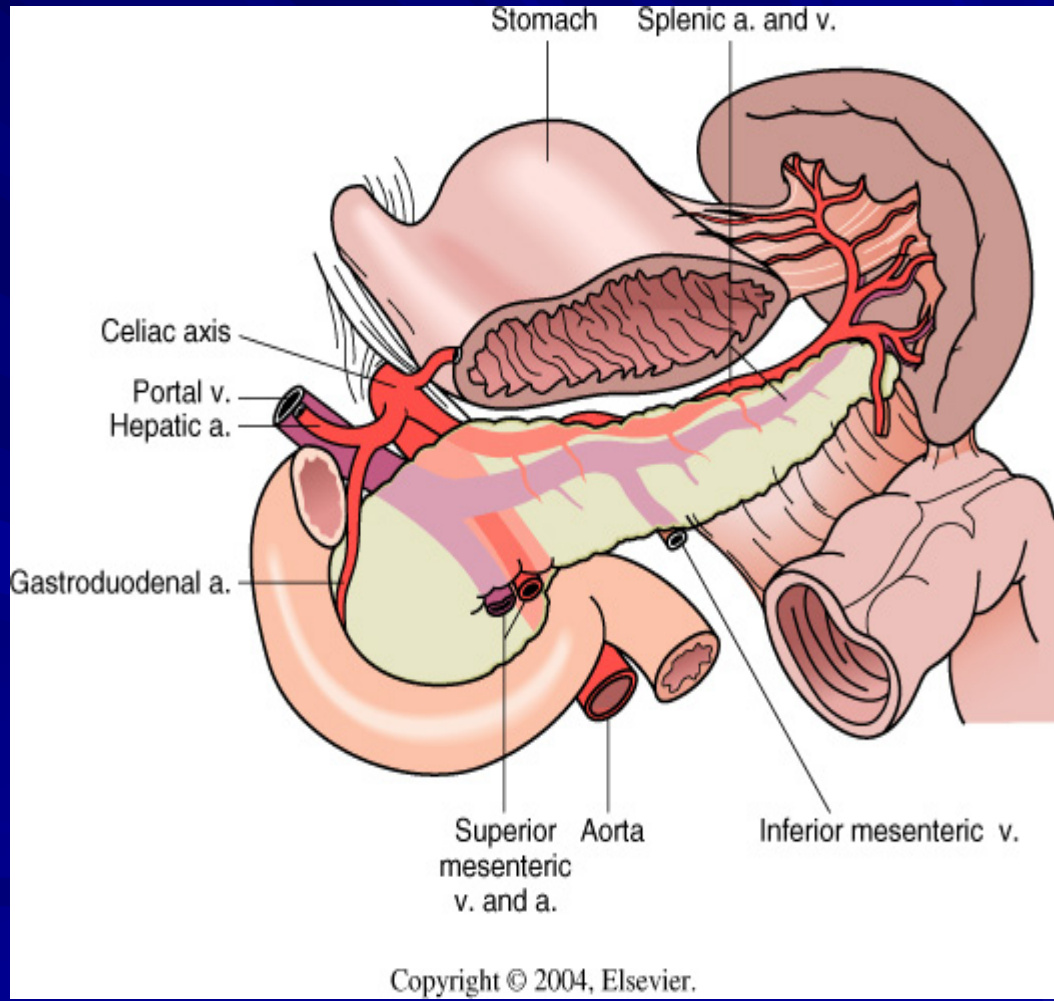
- Proximal greater curve of stomach
- Tail of the pancreas
- Left kidney
- Splenic flexure of colon

Ligamentous Attachments

- Splenophrenic – relatively avascular
- Splenocolic – relatively avascular
- Splenorenal – extends anteriorly from L kidney to splenic hilum as a fold in which splenic vessel and tail of pancreas are found
- Gastrosplenic – continuation of the splenorenal ligament superiorly/anteriorly to the greater curvature of the stomach housing short gastric arteries and veins

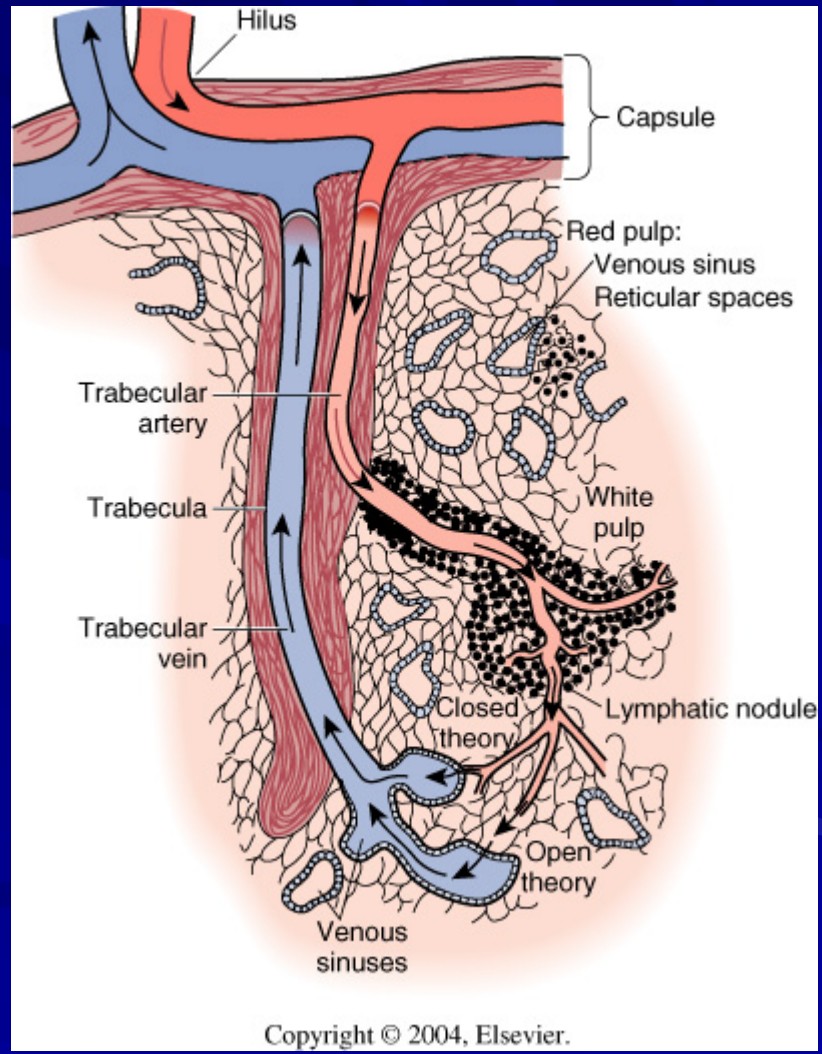
Vasculature

- Splenic artery
  - Arises from celiac
  - Courses along superior border of pancreas
  - Branches
    - Numerous pancreatic
    - Short gastric
    - L gastroepiploic
    - Terminal splenic
- Splenic vein
  - Joins SMV at right angle behind neck of the pancreas to form portal vein
  - IMV often empties into splenic vein



Splenic Function

- Fetal hematopoiesis
- Mechanical filtration
- Maintenance of normal immune function & host defenses
  - Asplenic pts have defective activation of complement by alternative pathway leaving them more susceptible to infection
  - Produces opsonins
    - Properdin – initiates alternative complement pathway
    - Tuftsin – enhances phagocytic activity of PMNs and phagocytes



The Surgeon and the Spleen

- ITP
  - Low platelet, normal bone marrow, abscess of other causes
  - Increased platelet destruction mediated by autoantibodies to platelet membrane antigens that results in platelet phagocytosis by the spleen
  - 72% pts >10yrs are female, 70% of affected females less than 40yrs.

The Surgeon and the Spleen

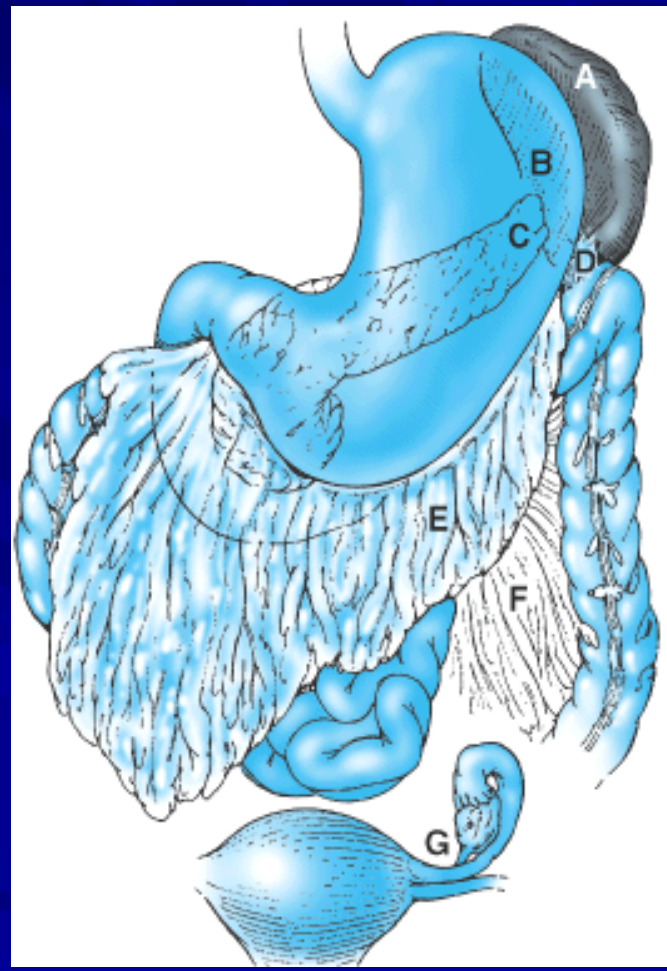
- ITP Treatment
  - Asymptomatic with plt>50 → observation
  - Asymptomatic with plt 30-50 → observation BUT careful follow-up
  - Medical treatment indicated in plt < 20-30 or for those <50 with symptoms
    - Prednisone 1mg/kg per day
      - 2/3 respond within one week of treatment
    - IgG
      - Acute bleeding or preparation for OR/delivery
      - Increases platelet count & efficacy of transfused platelets
      - Often used pre-splenectomy

The Surgeon and the Spleen

- Splenectomy for ITP
  - Established therapeutic modality before steroids
  - 2/3 pts achieve complete response
  - Indications
    - refractory severe symptomatic thrombocytopenia
    - Requirement of toxic steroid doses
    - Relapse of thrombocytopenia after initial glucocorticoid Rx
  - Consideration
    - 6 week diagnosis with persistent plt <10
    - 3 month diagnosis with transient/incomplete response to primary therapy with plt < 30
    - Women 2nd trimester who failed steroid & IgG with plt < 10 or plt <30 with bleeding
  - Results
    - Complete & permanent response 65 - 85% reported
    - If associated with confirmed splenic sequestration 87-93%
    - Most pts respond within first 10 days postop

The Surgeon and the Spleen

- Accessory Spleens
  - 10% pts with chronic ITP
  - Suggested by absence of asplenic RBC morphologic features or by nuclear imaging studies
    - Target cells
    - Howell-Jolly bodies (nuclear remnant)
    - Heinz bodies (denatured Hb)
    - Stippling
    - Spur cells



A – Hilar region 54%

B – Pedicle 25%

C – Pancreatic tail 6%

D – Splenocolic ligament 2%

E – Greater omentum 12%

F – Mesentery 0.5%

G – L ovary 0.5%

Hereditary Spherocytosis

- AD disease resulting from deficiency of spectrin causing RBC membrane abnormality
- Splenectomy decreases rate of hemolysis and usually resolves anemia
- Delayed until after >4yrs to preserve immune function in group at risk for OPSI
- If gallstones (usually pigmented) present on U/S, cholecystectomy recommended at time of splenectomy

Hemolytic Anemia
Erythrocyte Enzyme Deficiency

- G6PD deficiency and pyruvate kinase deficiency – hereditary conditions associated with hemolytic anemia
  - Abnormal glucose use and metabolism → increased hemolysis
  - Pyruvate kinase deficiency
    - Autosomal recessive
    - Splenectomy reduces transfusion requirement
  - G6PD deficiency
    - X-linked
    - African, Middle Eastern, Mediterranean ancestry
    - Hemolytic anemia typically occurs in most patients after exposure to drugs or chemicals
    - Splenectomy RARELY indicated

Hemoglobinopathies

- Splenectomy in sickle cell disease
  - Acute splenic sequestration crisis
    - Severe anemia
    - Splenomegaly
    - Acute bone marrow response with erythrocytosis
    - +/- abdominal pain
    - +/- circulatory collapse
  - Hypersplenism
    - Anemia – requiring transfusions
    - Leukopenia
    - Thrombocytopenia
  - Splenic abscess
    - Fever
    - Abdominal pain
    - Tender enlarged spleen
    - +/- Leukocytosis
    - *Salmonella, Enterobacter*

Malignancy and Splenectomy Lymphoma

- Hodgkin's
  - Young adults 20-30s
  - Asymptomatic lymphadenopathy at time of diagnosis (usually cervical)
  - Constitutional symptoms
    - Night sweats
    - Weight loss
    - Pruritus
  - Histological breakdown
    - Lymphocyte-predominant
    - Nodular-sclerosing
    - Mixed-cellularity
    - Lymphocyte-depleted

Malignancy and Splenectomy Lymphoma

- Hodgkin's
  - Staging laparotomy used to be standard of care
  - With advanced imaging, nonoperative staging possible
  - Staging laparotomy and splenectomy appropriate for clinical Stage IA or IIA where pathologic staging of the abdomen will potentially alter therapeutic management

Malignancy and Splenectomy Lymphoma

- Non-Hodgkin's
  - Splenomegaly or hypersplenism
  - Splenectomy indicated for massive splenomegaly when bulk contributes to abdominal pain, fullness, and early satiety
  - Most common primary splenic neoplasm
  - Spleen involved in 50-80% pts

Malignancy and Splenectomy Leukemia

- Hairy Cell
  - 2% adult leukemias
  - Splenomegaly, pancytopenia, neoplastic mononuclear cells in peripheral blood & BM
  - Elderly men
  - Standard treatment
    - Splenectomy & Interferon α2 (previous)
    - Systemic purine analogues (current)

Malignancy and Splenectomy Leukemia

- CLL
  - Chlorambucil = mainstay of therapy
  - ? Purine analogues
  - ? BMT
  - Splenectomy for palliation of symptomatic splenomegaly

Malignancy and Splenectomy Leukemia

- CML
  - Myeloproliferative disorder
  - Philadephia chromosome
  - Progressive replacement of normal diploid elements of BM with mature-appearing neoplastic myeloid cells
  - Initial asymptomatic indolent phase
  - Accelerated phase
    - Fever
    - Night sweats
    - Progressive splenomegaly
  - Blastic phase
    - Accelerated phase +
      - Anemia
      - Infectious complications
      - Bleeding
      - Splenomegaly with splenic sequestration
  - Treatment medical
  - Splenectomy indicated for
    - Symptomatic splenomegaly
    - hypersplenism

Malignancy and Splenectomy Metastasis

- 7% of cancer patients on autopsy
- Primary solid tumors that can metastasize to spleen
  - Breast
  - Lung
  - Melanoma
- Primary splenic tumors are most commonly vascular → splenectomy is appropriate for diagnosis, treatment, or palliation of the following:
  - Hemangioma
  - Angiosarcoma
  - Lymphangioma
  - lymphangiosarcoma

Splenic Cysts

- True cysts (nonparasitic)
  - 10% of all nonparasitic cysts
  - 2-3rd decade
  - Characterized by squamous epithelial lining, many congenital
  - Often positive for CEA and CA 19-9
  - No increased malignant potential
  - Usually found incidentally since asymptomatic (<8 cm)
  - When symptomatic
    - Vague upper abdominal fullness
    - Abdominal discomfort
    - Early satiety
    - Pleuritic chest pain
    - SOB
    - Left back or shoulder pain
    - Renal symptoms from L kidney compression
    - +/- palpable abdominal mass
  - When symptomatic or large, surgery indicated
    - Total or partial splenectomy
    - Cyst wall resection or partial decapsulation
    - Open or laparoscopically

Splenic Cysts

- True cysts (parasitic)
  - most true cysts in areas of hydatid disease
  - *Echinococcus*
  - Cyst wall calcifications or daughter cysts
  - Although uncommon in North America, diagnosis should be excluded prior to invasive diagnostic or therapeutic procedures that may risk spillage of cyst contents → anaphylactic shock
  - Splenectomy with avoidance of rupture
  - Cysts sterilized with injection of 3% NaCl solution, alcohol, or 0.5% silver nitrate

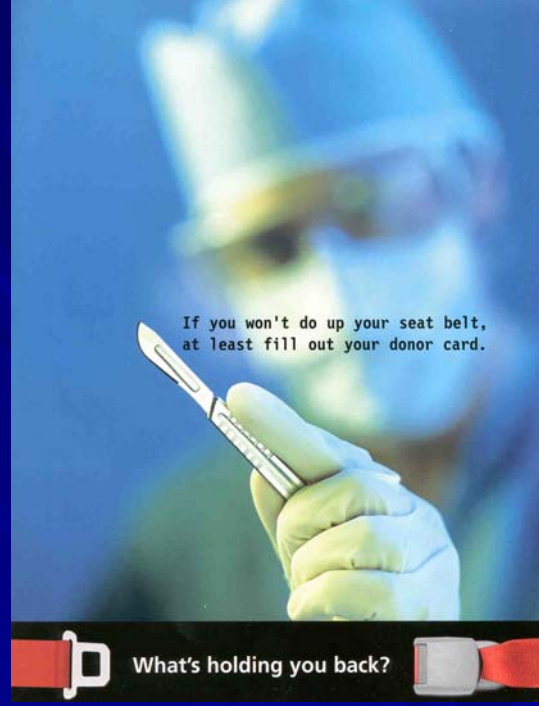
Splenic Cysts

- Pseudocysts
  - 70-80% nonparasitic cysts of spleen
  - Prior history of trauma
  - NOT epithelial lined
  - +/- focal calcifications
  - Unilocular, smooth, and thick walled
  - < 4cm → Observation
  - Symptomatic (LUQ pain /L shoulder pain) → surgical Rx
    - Partial splenectomy
    - Total splenectomy
    - Percutaneous drainage (may be reasonable initial approach)
      - Up to 90% success rate of image-guided percutaneous drainage

Splenic Abscess

- Uncommon (0.7%)
- Potentially fatal (mortality 80% for multiple abscesses in immunocompromised to 15-20% in previously healthy unilocular abscesses)
- 70% result from hematogenous spread (endocarditis, osteomyelitis, or IVDA)
- *Staphylococcus, Streptococcus, Enterococcus,* GN enteric organisms
- Clinical presentation (nonspecific/insidious)
  - Abdominal pain, usually vague
  - Fever
  - Peritonitis
  - Pleuritic chest pain
  - +/- splenomegaly
  - CT or U/S to diagnose
  - 2/3 solitary, 1/3 multiple (reversed in pediatric population)
- Treatment
  - Unilocular → CT-guided drainage + IV Abx (75-90% success)
  - Multilocular → splenectomy, drainage LUQ, IV Abx

Spleen Trauma



- Trend toward nonoperative management
- Spleen in most common intraabdominal organ injured in blunt trauma
- Spleen receives approximately 5% of cardiac output
- Kehr's sign highly correlates with splenic injury

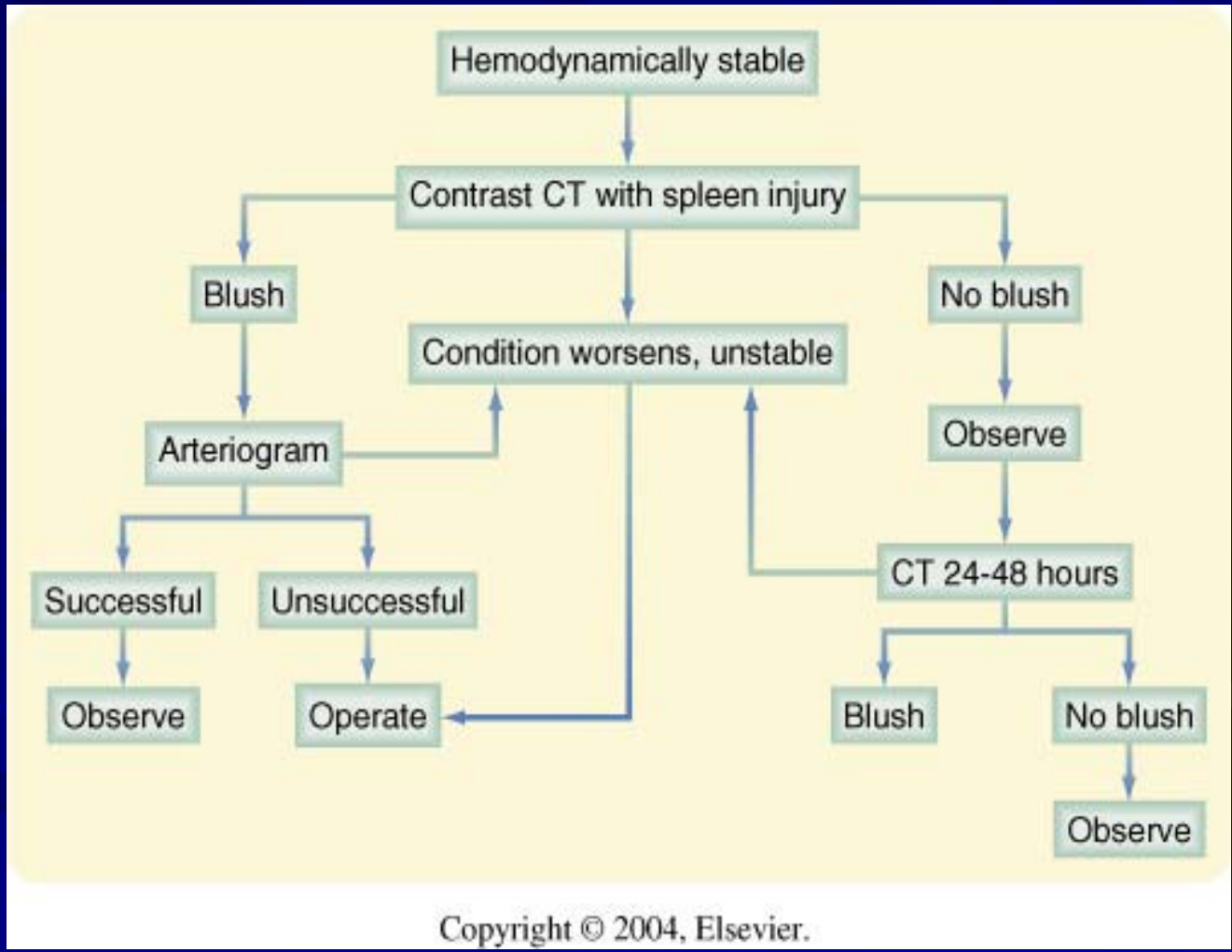
AAST Splenic Injury Scale (1994)

Grade	Type	Injury Description
I	Hematoma	Subcapsular, < 10% surface area
	Laceration	Capsular tear, < 1 cm parenchymal depth
II	Hematoma	Subcapsular, 10-50% surface area; intraparenchymal, < 5cm in diameter
	Laceration	1-3cm parenchymal depth, does NOT involve trabecular vessel
III	Hematoma	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parenchymal hematoma Intraparenchymal hematoma > 5cm or expanding
	Laceration	> 3cm parenchymal depth or involving trabecular vessels
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen)
	Vascular	Hilar vascular injury that devascularizes spleen

Splenorrhaphy

- Superficial hemostatic agents
  - Grade I and II
- Suture repair
  - Grade II and III
  - May tear spleen further when tied
  - Pledgets reduce tearing
- Absorbable mesh wrap
  - Grade III and some IV
- Resectional debridement
  - Major fractures
  - At least 1/3 mass required to maintain immunocompetence

Nonoperative Management
(Hemodynamically Stable Patient)



Nonoperative Management (EAST Guidelines)

- Level I
  - Insufficient data to suggest NOM as level I recommendation for initial management of blunt injuries to liver and/or spleen in hemodynamically stable patient.

- Level II
  1. Class II and mostly class III data to suggest that NOM of blunt hepatic and/or splenic injuries in a hemodynamically stable patient is reasonable.
  2. Severity of hepatic or splenic injury (as suggested by CT grade or degree of hemoperitoneum), neurologic status, and/or presence of associated injuries are not contraindications to NOM.
  3. Abdominal CT is most reliable method to identify and assess the severity of injury to the spleen or liver.

- Level III
  1. Clinical status of the patient should dictate frequency of follow-up scans.
  2. Initial CT of abdomen should be performed with oral and IV contrast agents to facilitate diagnosis of hollow-viscus injuries.
  3. Medical clearance to resume normal activity status should be based upon evidence of healing.
  4. Angiographic embolization is adjunct in NOM of the hemodynamically stable patient with hepatic and splenic injuries and evidence of ongoing bleeding.

Vaccinations

- Should be administered preoperatively if possible (preferably 2 weeks)
- Vaccines for
  - *H. influenzae* type B
  - Meningococcal serogroup C
  - Polyvalent pneumococcal vaccine
- Penicillin prophylaxis still practiced in children during first few years after splenectomy

CASE #1

- 38 yo WF
- L abdominal pain for several months
  - Increasing in severity and frequency
  - Limits activities of daily living and sleeping
  - Pain worse with deep breathing
  - Denies N/V, early satiety, change in bowel habits
  - Denies history of trauma
- Went to see her PCP

CASE #1

- PMH: noncontributory
- PSH: cyst excision 4th ventricle 2001, L knee surgery ’86
- Soc Hx: Denies T/E/D

CASE #2

- 51 yo WF
- History significant for developing endocarditis after total tooth extraction
- Developed pseudoaneurysm of SMA branch → resection June 2005
- Persistent abdominal pain

CASE #2

- PMH: COPD, Anxiety
- PSH: Resection of pseudoaneurysm 6/22/05