The Spleen

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Anatomy:

- Normal size: 12x7 cm, 3-4 cm thick, ~150 gm
- Parietal peritoneum adherent except at hilum
- Peritoneal extensions - 4 ligaments:
  - splenocolic, splenophrenic - relatively avascular
  - Splenorenal: splenic vessels, tail of pancreas
  - Gastroplenic ligaments: short gastric vessels
Anatomy continued:
Anatomy continued

• **Splenic artery**: off celiac trunk, multiple pancreatic branches, short gastrics, left gastroepiploic, terminal splenic branches-> segmental branches-> 2\textsuperscript{nd}, 3\textsuperscript{rd} order vessels

• **Splenic vein**:  
  - Inferior to artery, posterior to pancreatic tail, body  
  - Joins SMV behind pancreatic neck-> portal vein
Splenic Vasculature:
Splenic Function:

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

- OPSI - overwhelming postsplenectomy sepsis: Fulminant bacteremia, pneumonia, meningitis
- Organisms with polysaccharide capsule: Ab + complement activation
- Normal response to reimmunization
- Suboptimal response to new antigen
- Higher quantities of Ab for encapsulated bacteria
- Decreased levels of IgM
- Peripheral mononuclear cells have suppressed IgG response
Opsonins:

- Major production site
- Tuftsin:
  - Enhances phagocytic activity
  - Spleen: major cleavage site -> decreased neutrophil function
- Properdin: initiates alternative pathway of complement activation
Idiopathic thrombocytopenic purpura - ITP:

- Low platelet count, normal bone marrow in absence of other causes of thrombocytopenia
- Autoantibody to Plt membrane Antigens -> phagocytosis, destruction
- 72% women >10 years
- 70% of affected women <40 yo
- Children:
  - Both sexes equally affected
  - Abrupt onset of severe thrombocytopenia
  - 80% spontaneous remission
  - Chronic: girls >10 yo
ITP: symptoms and diagnosis

• Symptoms:
  - Purpura, epistaxis, gingival bleeding
  - Less common: GI bleed, hematuria
  - Rare: intracerebral hemorrhage

• Diagnosis of exclusion:
  - Drugs
  - HIV
  - Myelodysplasia, CLL, NHL
  - TTP
  - Preeclampsia
  - DIC
Indications for treatment of ITP:

- Platelet Count:
  - >50,000 - no treatment
  - <50,000 – treatment if vigorous lifestyle, HTN, peptic ulcer disease
  - 30,000-50,000 no treatment, close observation
  - <20,000 hospitalization and glucocorticoids
  - All patients with severe hemorrhage: hospitalized and treated
Treatment of ITP:

1. Prednisone: 1mg/kg/day
   - 2/3 patients with Plts>50,000 in 1 week
   - 26% complete response

2. IVIG: acute bleeding, preop, pregnancy
   - 1g/kg x2 days -> increases Plt count in 3 days
   - increases efficacy of transfused Plts

3. Splenectomy
Splenectomy for ITP:

- First effective treatment before glucocorticoid therapy - > 2/3 patients complete response
- Indications:
  - Severe refractory thrombocytopenia: 6 wks of continued Plts <10,000
  - Toxic steroid dosing -> remission
  - Relapse after initial treatment: Plts <30,000 after transient or incomplete response over 3 months
  - Pregnancy:
    2nd trimester, failed IVIG and steroid course
    -> Plts<10,000 or <30,000 with bleeding
Response to splenectomy

• Systematic review of 436 articles from 1966-2004:
  - 66% complete and 88% partial response in adults - median F/U 29 months
  - 72% complete response in children and adults
  - 15% relapse - median F/U 33 months
Predictors of Successful Splenectomy

- No consistent factors
- Age, response to steroids - not a predictor
- Indium 111-platelet scintigraphy:
  - Splenic sequestration-> 87-93% response rate
  - Hepatic sequestration-> 7-30% response rate
-> long term cure rates unchanged
ITP postsplenectomy:

- Response within 10 days postop
- Durable response: >50,000 on POD#3
  >150,000 on POD#10

- Chronic ITP: ? Accessory spleen if unresponsive to continued treatment with steroids and azathioprine
Summary of splenectomy series:

• Laparoscopic splenectomy:
  - 85% immediate response
  - 4% relapse rate
  - 15% accessory spleen
• Open Splenectomy:
  - 81% immediate response
  - 12% relapse rate
  - 16% accessory spleen
ITP and HIV

- 10-20% develop ITP
- Splenectomy safe
- No increased risk of disease progression
- Absence of spleen in asymptomatic phase of HIV may delay disease progression
Splenectomy for Benign Hematologic Conditions:

1. Hereditary spherocytosis:
   - autosomal dominant spectrin deficiency -> small, spherical rigid erythrocytes
   - anemia, jaundice, splenomegaly
   - Attempt delay of splenectomy after age 4
   - High incidence of gallstones: lap cholecystectomy

2. Other erythrocyte abnormalities: hereditary eliptocytosis, pyropoikilocytosis etc.
Splenectomy for Malignancies:

1. Hodgkins lymphoma:
   - Decreased operative staging: improved imaging techniques: CT, lymphangiography, PET scan
   - Periop mortality <1%, major complication <10%

2. Non-Hodgkins Lymphoma:
   - Massive splenomegaly, abdominal pain fullness, early satiety
   - Treatment of hypersplenism associated anemia, thrombocytopenia, neutropenia
   - Improved survival for low grade NHL confined to spleen (108 versus 24 months)
Splenectomy for Malignancies:

3. Hairy Cell leukemia:
- splenectomy and Alpha – 2 interferon replaced by systemic purine analogues
- Hypersplenism refractive to medical therapy
- Response lasts ~10yrs without further treatment

4. CLL:
- Palliation of symptomatic splenomegaly- 100% success
- Treatment of cytopenia- 60-70% success
Splenectomy for Malignancies:

5. CML:
   - Palliation of symptomatic splenomegaly and hypersplenism

6. Metastasis:
   - Breast, lung, melanoma
   - Vascular tumors
   - Splenectomy for palliation if needed
Splenectomy for benign conditions:

1. Splenic cysts
   a. True cysts:
      • parasitic:
        - Hyatid cysts (ecchinococcus), splenectomy to avoid spillage
      • nonparasitic:
        - 10% of all nonparacytic cysts, most often due to trauma
        - lined by squamous epithelium
        - Often positive for Ca 19-9, CEA, but benign
        - Symptoms related to size
        - Open or laparoscopic: partial splenectomy, cyst wall resection, partial decapsulation
Splenectomy for benign conditions:

• 1. Splenic cysts
  b. Pseudocysts:
  - 70-80% of nonparasitic cysts;
  - History of trauma
  - Asymptomatic <4cm, no treatment
  - Left upper quadrant pain, referred shoulder pain → partial splenectomy
  - 90% success rate of image-guided percutaneous drainage
Splenic Abscess:
- uncommon, potentially fatal
- 70% hematogenous spread: endocarditis, osteomyelitis, IVDU
- Multiple abscesses in immunocompromised patients
- Organisms: GPCs: strep, staph, enterococcus; GNR: enteric organisms; Mycobacteria; Fungal: candida-immunosupression
- Symptoms: nonspecific abdominal pain, peritonitis, pleurtitic chest pain
- Treatment: unilocular: CT-guided drainage, IV antibiotics
  Multilocular+ failure of response: immediate splenectomy
Splenectomy for benign conditions:

3. Wandering Spleen:
- Failure of formation of peritoneal attachments
- unusually long splenic pedicle
- Recurrent episodes of abdominal pain from intermittent torsion of vascular pedicle and tension
- CT scan for diagnosis: lack of contrast enhancement
- Splenectomy versus splenopexy
Splenic Trauma:

- Most common indication for laparotomy after blunt trauma
- Most commonly injured abdominal organ in blunt trauma
- Mechanism:
  - MVC, MCC, falls, PVA, bicycle crashes, sports
  - Injuries:
    - rapid deceleration -> avulsion along ligaments
    - Efficient energy transfer form chest wall
    - Direct punctures from rib fracture
Diagnosis of Splenic Trauma:

1. Historically PE:
   - peritoneal signs (42-72% accurate)
   - Bruising over LUQ
   - Kehr sign: left upper quadrant pain, with referred left shoulder pain
   - Hypotension, tachycardia -> suspicious for hemorrhage, not attributed to other source
   - Confounding factors: head, spinal cord injury, substance abuse
   - West et al: development of trauma systems: mortality from delayed/missed recognition of splenic hemorrhage still major cause of preventable death
Diagnosis of Splenic Trauma cont:

2. DPL:
   - Introduced in 1965 by Root
   - standard of care for blunt abdominal trauma for 20 yrs
   - Originally: 10ml blood aspirated=> +
   - Now: 1L crystalloid infusion=> >100,000 RBCs, 500 WBCs
   - Sensitivity: 99%, Specificity: 95-98%
   - Drawback: “nontherapeutic laparotomies”
Diagnosis of Splenic Trauma cont:

3. CT scan: revolutionized management of splenic trauma => Grading scale

<table>
<thead>
<tr>
<th>GRADE</th>
<th>TYPE</th>
<th>INJURY DESCRIPTION</th>
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<tbody>
<tr>
<td>I</td>
<td>Hematoma Subcapsular, &lt;10% surface area</td>
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<tr>
<td></td>
<td>Laceration Capsular tear, &lt;1 cm parenchymal depth</td>
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<tr>
<td>II</td>
<td>Hematoma Subcapsular, 10%-50% surface area; intraparenchymal, &lt;5 cm in diameter</td>
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<tr>
<td></td>
<td>Laceration Capsular tear, 1-3 cm parenchymal depth, which does not involve a trabecular vessel</td>
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<tr>
<td>III</td>
<td>Hematoma Subcapsular, &gt;50% surface area or expanding; ruptured subcapsular or parenchymal hematoma</td>
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<td></td>
<td>Intraparenchymal hematoma &gt;5 cm or expanding</td>
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<td></td>
<td>Laceration &gt;3 cm parenchymal depth or involving trabecular vessels</td>
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<tr>
<td>IV</td>
<td>Laceration Laceration involving segmental or hilar vessels producing major devascularization (&gt;25% of spleen)</td>
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<tr>
<td>V</td>
<td>Laceration Completely shattered spleen</td>
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<tr>
<td></td>
<td>Vascular Hilar vascular injury which devascularizes spleen</td>
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Diagnosis of Splenic Trauma cont:

4. Ultrasound
- Introduced in 1990s
- FAST (focused abdominal sonogram for trauma):
  • noninvasive, rapid, low cost
  • Presence of intraperitoneal fluid, replaced DPL
  ⇒ OR without CT scan in unstable patient
  ⇒ stable patient: screening for CT scan
  • Limited by obesity, bowel gas and subcutaneous emphysema
- Sensitivity: 90-93%, Specificity: 99%
Indications for Surgery:

- Urgent laparotomy for hemodynamic instability and ongoing hemorrhage:
  - SBP < 90 mmHg
  - HR > 120 beats/min
  - No response to 1-2L crystalloids
- Optimal decisions apparent in retrospect!
- Risks of prolonged hemorrhage outweigh risks of nontherapeutic laparotomy!
Trauma Exploration:

- Midline incision preferred
- Rapid evacuation of blood and clots to assess other sources of injury: liver, mesentery, abdominal packing
- Splenic mobilization:
  - Dorsal and medial traction on spleen: => define splenorenal and splenophrenic ligament- divide under direct vision
  - Incision begins at phrenocolic ligament- ligaments of stomach near highest short gastric vessel
Splenic mobilization:

**Figure 19.** Open splenectomy: incision of phrenicocolic ligament. With the spleen retracted medially, the phrenicocolic ligament is incised.

**Figure 20.** Open splenectomy: dissection of areolar plane. The spleen is delivered to the midline by means of blunt and sharp dissection of the areolar plane between the kidney and the pancreas.
Splenic mobilization continued:

- Continued tension --> divide deeper layers of connective tissue --> encounter adrenal, leave undisturbed
- Mobilize posterior pancreas complex: pancreas + splenic vein) off aorta
- Pack LUQ to anteriorize spleen into wound
- Examine spleen
Splenectomy

- **Indications:**
  1. Unstable patient
  2. Extensive injury with continued bleeding
  3. Bleeding from hilar injury
  4. Other life threatening injuries
- Divide short gastrics- avoid injury to stomach
- Divide splenic artery + vein: avoid tail of pancreas
- No drain needed
Splenorrhaphy:

- Since late 1970s, peak in mid 1980s
- Reasoning
  - Recognition of risk of OPSI with splenectomy
  - Left upper quadrant dead space: potential for subphrenic abscess
- Decreased number of splenorrhaphies with rise in nonoperative management and awareness of risks of blood transfusions in 1990s

=> now 10%
Splenorraphy continued:

4 types:

1. Superficial hemostatic agents:
   - For grade I-II injuries: cautery, oxidized cellulose, topical thrombin, absorbable gelatin sponge

2. Suture repair:
   - For grade II-III injuries
   - Pledged sutures: telfon, absorbable gelatin sponge wrapped in oxidized cellulose
Suture Repair

Cellulose

Sponge
Splenorraphy continued

3. Mesh Wrapping:
- Grade III and IV injuries
- Resorbable mesh: polyglycolic acid, polyglactin
- Keyhole at splenic hilum; mesh sac for spleen

4. Resectional debridement:
- Major fractures involving upper and lower pole => grade II or IV
- Raw surfaces re-approximated
- 1/3 of splenic mass needed to maintain immunocompetence
Mesh Wrapping
Nonoperative management:

• Originated in pediatric surgery with fear of OPSI
• 70-90% children, 40-50% adults treated in large volume trauma centers
• Fundamental rules: hemodynamic stability, adequate monitoring available
• Dependent on injury grade: I+II account for 60-70%
Nonoperative management:

- Failure of nonoperative management:
  - Vascular blush on CT scan:
    2/3 failures related to pseudoaneurysms
    Angiographic embolization reduces failure rate
  - Predictors of failure:
    Age > 55
    Higher injury grades: III-V
    Amounts of intraperitoneal blood
  - Further studies needed
Vascular blush

Pre -

Post- embolization
Summary: Management of Splenic Trauma

Figure 56-9 Algorithm for nonoperative management of splenic injuries in the hemodynamically stable patient. CT, computed tomography. (From Bee TK, Croce MA, Miller PR, et al: Failures of splenic nonoperative management: Is the glass half empty or half full? J Trauma 50:231, 2001.) www.lww.com
Morbidity after Splenectomy:

• Postsplenectomy thrombocytosis:
  - Hemorrhagic or thromboembolic phenomena
  - Increased in patients with myeloproliferative DO
  - Life-long increased risk in pulmonary emboli

• OPSI:
  - Anytime after splenectomy
  - Lifetime increase in risk for fatal PNA, sepsis
  - Higher risk after splenectomy for malignancy
  - Higher risk in children (1:300) vs adults (1:800)
Morbidity after Splenectomy

- OPSI continued:
  - organisms: S. pneumoniae (50-90%), H. Influenza, N Menigitis, Strepp sp, Salmonella, Capnocytophagia canimorsus (dog bites)

- Prophylaxis:
  - Vaccines: PPV23, H. influenza type B, meningococcal polysaccharide - within 2 weeks of surgery
  - Re-vaccination controversial except PPV23 for high risk patients
Morbidity after Splenectomy

- **Antibiotics:**
  - PCN prophylaxis in children common
  - No data on reduction of OPSI in adults or children
  - Early empiric coverage for febrile illness

- **PATIENT EDUCATION** about OPSI!
Thank You!