Splenic Injury 2010

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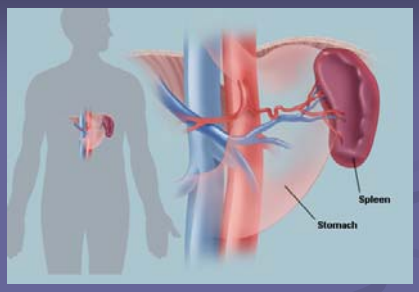
Splenic Anatomy

- Located under diaphragm on left – posterior, superior, lateral
- Splenic artery and vein run along superior border of pancreas
  - Artery originates from celiac trunk
  - Vein combines with SMV to form portal vein
- Spleen also supplied by short gastric arteries from vascular arcade of stomach



Splenic function

- Red pulp
  - Filter old red blood cells
  - Capture of bacteria
  - Bacterial antigens presented to lymphocytes in adjacent white pulp
- White pulp
  - Largely filled with lymphocytes which produce immunoglobulins
  - Production of opsonins
  - Complement activation

AAST Injury grading scale

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

History

- Splenectomy first mentioned in mid 16th century
- Bessel-Hagen reported 37 splenectomies for ruptured spleen in German literature in 1900 (etiology unknown)
- National Research Council (1942): Splenectomy "in the experiences of the American Expeditionary Force in the war of 1917 to 1919, was associated with a mortality of practically 100%"

History

- WWII – mortality of splenectomy decreased to 10 – 20%
- 1900 – First report of splenorrhaphy (Mayo)
- 1968 – First publication describing non-operative management
- 1995 – First reported series of angioembolization

Evaluation

- Airway & breathing always come first
- Spleen can come into play as early as "Circulation"
- Most penetrating splenic injuries require laparotomy
- Evaluation for blunt trauma
  - Diagnostic peritoneal lavage
  - FAST
  - CT Scan

Management options

- Splenectomy
- Splenorraphy
- Non-operative management
- Angioembolization

Splenectomy

- Definitively treats splenic injury
- Usually results in cessation of bleeding
- Complications
  - Early
    - Post-op bleeding
    - Infection
  - Late
    - Adhesions / bowel obstruction
    - Overwhelming post-splenectomy infection (OPSI)

Splenorraphy

- First described in children
- Various techniques
  - Electrocautery
  - Partial resection
  - Splenic wrap

Non-operative management

- First described in pediatric patients as a response to OPSI
- Upadhyaya et al (1968) – Surgery, Gynecology, and Obstetrics (Journal of American College of Surgeons)

Non-operative management

- Bedrest
- Serial labs
- Serial abdominal exams
- NPO
- How long?

Studies

- Velmahos et al (2000)
- Peitzman / EAST study (2000)
- Myers et al (2000)
- Smith et al (2007)

Velmahos (2000)

- Retrospective review of non-op spleens
- 105 patients total
- 53 selected for non-operative management
- 48% successful
- Factors independently associated with failure
  - CT grade >= 3
  - Transfusion greater than 1 unit prbc
  - AIS >= 3

Peitzman (2000)

- Retrospective, multi-institutional study
- Angioembolization rarely used
- Mortality
  - 25.9% Directly to OR
  - 16.5% Failed non-op
  - 4.2% Successful non-op
- Direct to OR more severely injured
- Failure of non-op management increased significantly with grade of injury

Peitzman (2000)

- 60.9% of failures within first 24 hours
- 86.2% within first 96 hours
- 85% of those with contrast extravasation on CT underwent laparotomy
- Laparotomy rates by injury grade (including those who went straight to OR)
  - 1: 25%
  - 2: 30%
  - 3: 50.7%
  - 4: 83%
  - 5: 98.7%

Myers et al (2000)

- Retrospective review of blunt splenic injuries
- No angioembolization
- NOM successful in 94%
- Same success in age >55

Smith et al (2007)

- Retrospective NTDB review to determine length of observation necessary
- 1999 – 2004
- No mention of angioembolization
- 89% initially managed non-operatively
- 78% success rate
- No mortality difference between successful and failed non-op management

Smith - Failures

- Failure time ranged from 2 hours to 368 days
- 95% of failures occurred within 72 hours
- Day 14: 97% of failures
- Day 30: 99.5% of failures
- Increasing grade associated with higher failure rates (grades 1 and 2 similar)

Angioembolization

- Rationale: Non-surgically control arterial bleeding in an attempt to increase rates of successful non-operative management
- Can embolize either main splenic artery or selectively embolize smaller distal vessels
- Complications
  - Spleen: bleeding, infection, infarction, coil migration
  - Procedural: arterial dissection

Sclafani et al (1995)

- First series published in literature
- 150 non-operative spleens
- 60 underwent embolization
- 98.5% salvage rate

Cocanour et al (2000)

- Retrospective review of non-operative spleens in age greater vs. less than 55
- Previous theories held that NOM contraindicated in age>55
  - Older spleen less likely to stop bleeding
  - Older adults tolerate bleeding poorly
- Angioembolization used selectively
- Overall failure rate 14%
- No difference between age groups

Haan et al (2001)

- Stable patients considered for NOM
- Laparotomy at discretion of surgeon for head injury, age, associated injuries
- Celiac angio on all patients with splenic injury by CT scan
- Embolization if angio positive
- 64% operated on immediately
- 36% underwent angio

Haan (2001)

- 68% of angiograms were negative
  - 8% required laparotomy for bleeding
  - Non-op salvage rate 93% in this group
- 32% embolized
  - 8% required laparotomy
  - 92% non-operative salvage rate
- 10% of angiogram patients underwent repeat angio, with none requiring laparotomy

Haan (2001)

- Of note, 64% operated on despite only 12% presenting with hypotension
  - Delayed instability
  - Associated injuries
  - Neurologic injuries
- Overall, improved splenic salvage compared to EAST study

Western Trauma study (2003)

- Retrospective from 4 centers
- Did not include patients who went straight to OR
- 155 patients
- All patients embolized
- No attempt to protocolize care
- Overall splenic salvage rate 87%
- Salvage decreased with increasing grade, though statistically not significant
- Grade 4,5 had greater than 80% salvage rate

Western Trauma (2003)

- Overall high failure in those with AV fistula
- Age greater than 55 did just as well
- Major complication rate 20%
  - Bleeding
  - Infection
  - Missed injury
- Complications did not affect salvage rate
- 14 re-angio, 7 re-embolized, all salvaged
- Significantly improved splenic salvage in grades 3,4,5 than EAST study

Haan et al (2004)

- Retrospective review
- Mid-study became more selective regarding who underwent angio
  - Noticed low yield in low grade injuries
  - Changed institutional protocol
- Splenic salvage decreased with increasing grade
- Grade 4,5 still had >80% salvage
- Significant improvement for grades 3 – 5 compared to EAST study
- Only statistically significant marker of failure was AV fistula

Smith et al (2006)

- More data from one of the WTA study institutions
- Stable patients taken for angio if blush on CT scan, or ongoing bleeding
- 41 patients embolized
- Overall failure rate of NOM was 14%
- Increasing failure rate with increasing grade in embolized and non-embolized patients
- 27% failure rate with embolization (all grades 3-5)
- Re-embolization not attempted

Wu et al (2007)

- Angioembolization for contrast extravasation or large hemoperitoneum
- Compared to group before angio
- Patients with additional intra-abdominal injury excluded
- Better non-op success in group undergoing angioembolization
- Small study

Duchesne et al (2008)

- 154 patients with splenic injury and contrast extravasation
- Two groups
  - Early years splenectomy
  - Later years angioembolization
- Results
  - No difference in transfusion (5.1 v 7.9 units)
  - No mortality difference (18% v 14%)
  - Hospital LOS similar (16.1 v 14.1 days)

McCray et al (2008)

- Retrospective review of non-op spleens 2002 – 2007
- Primarily to determine length of observation necessary
- Contrast blush: embolization or operation
- Bedrest with sequential hemoglobin checks until stable
  - At least 24 hours for grade 1
  - At least 36 hours for grade 2 – 5
- Overall non-op success rate 96%
- 14 of 15 failures within 48 hours

Follow-up imaging

- Weinberg et al (2007)
  - Repeat CT 24 – 48 hours
  - 5% pseudoaneurysm rate by CT
  - 39% of those negative angio (false positive CT)
  - All true positives embolized
  - All did well but nothing to compare to
- Sharma et al (2005)
  - Repeat CT did not change management
  - All who were taken to OR after repeat CT had clinical signs
  - Concluded CT was unnecessary

Overwhelming Post-splenectomy Infection (OPSI)

- First described by King and Shumaker in 1952 in pediatric patients
- Further described by Singer in 1973
- Worries led to development of splenic salvage strategies

OPSI

- Due to encapsulated organisms
  - >60% pneumococcus
  - Capsular polysaccharides
- Presents with fever, brief URI
- Progresses quickly to shock, DIC, Multi-system failure
- Mortality approximately 50%

OPSI

- Much less common than originally thought
- Cullingford et al (1991)
  - 628 trauma patients with splenectomy
  - Incidence of OPSI was 0.21 per 1000 person-years
  - 42% occurred >5 years after splenectomy
- According to EAST study, lifetime risk of death from sepsis after splenectomy for trauma is approx 0.02%
- No prospective data

OPSI – current recommendations

- Immunize within 2 wks
- Vaccines
  - Polyvalent pneumococcal vaccine (PPV23)
  - H. Influenza type b
  - Meningococcal polysaccharide vaccine
- Re-vaccination
  - Recommended at 5 years for high-risk

So what should I do in real life?

- Penetrating – operate vs. selective management
- Blunt
  - Unstable: FAST or DPL with laparotomy if positive
    - Vaccines
  - Stable: CT scan
  - Splenic injury on CT scan
    - Non-operative management
    - Angio if contrast extravasation on CT scan
    - Embolization if angio positive
    - Bedrest, serial labs, physical exam