THE EVOLUTION AND CURRENT MANAGEMENT OF SPLENIC TRAUMA

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OBJECTIVES

- Review anatomy, physiology, and historical perspectives of the spleen
- Describe common injury patterns of the spleen
- Discuss options in management for splenic injury
- Clarify specific patient presentations and outcomes at a single level-1 institution (Reading Trauma Center)
- *Nothing to Disclose, No financial interests*

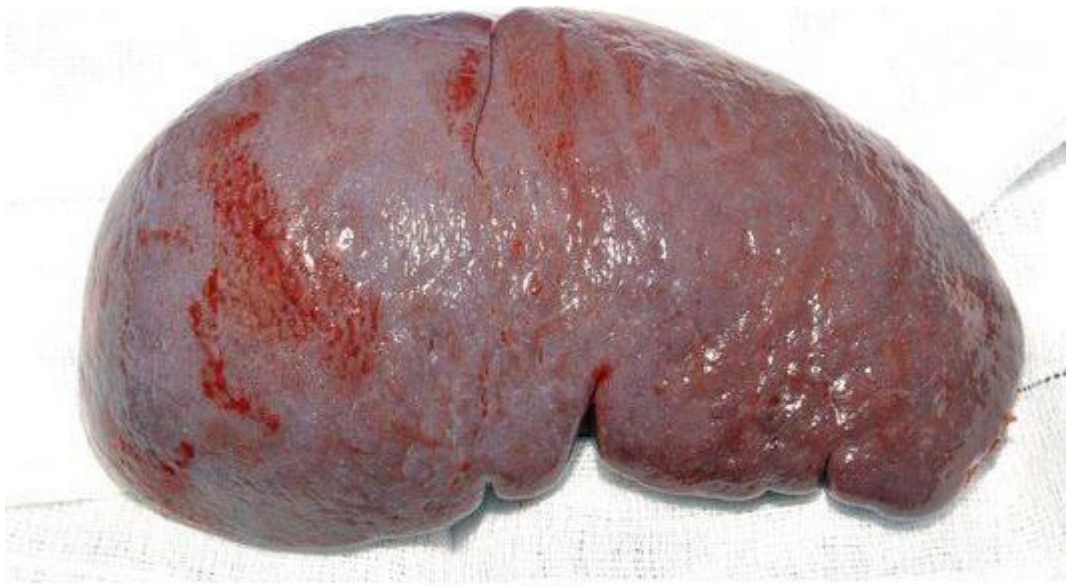
HISTORY

- Greek etymology – spleen
  - a proper working organ brings balance to the heart
  - filtered the "bad humours" from the stomach
  - too much "black bile" led to melancholy
  - when removed improved temperament and speed
- Advent of modern surgical techniques
  - 1738 described in UK
  - 1910 Mayo writings "produces no serious results"
  - mid 1900s immune consequences in pediatric removal identified
  - preservation techniques developed
- Evolution of non-operative trauma techniques
  - mirrors technology development
- Traumatic injury represents only 10-20% total annual operative splenectomies

ANATOMY

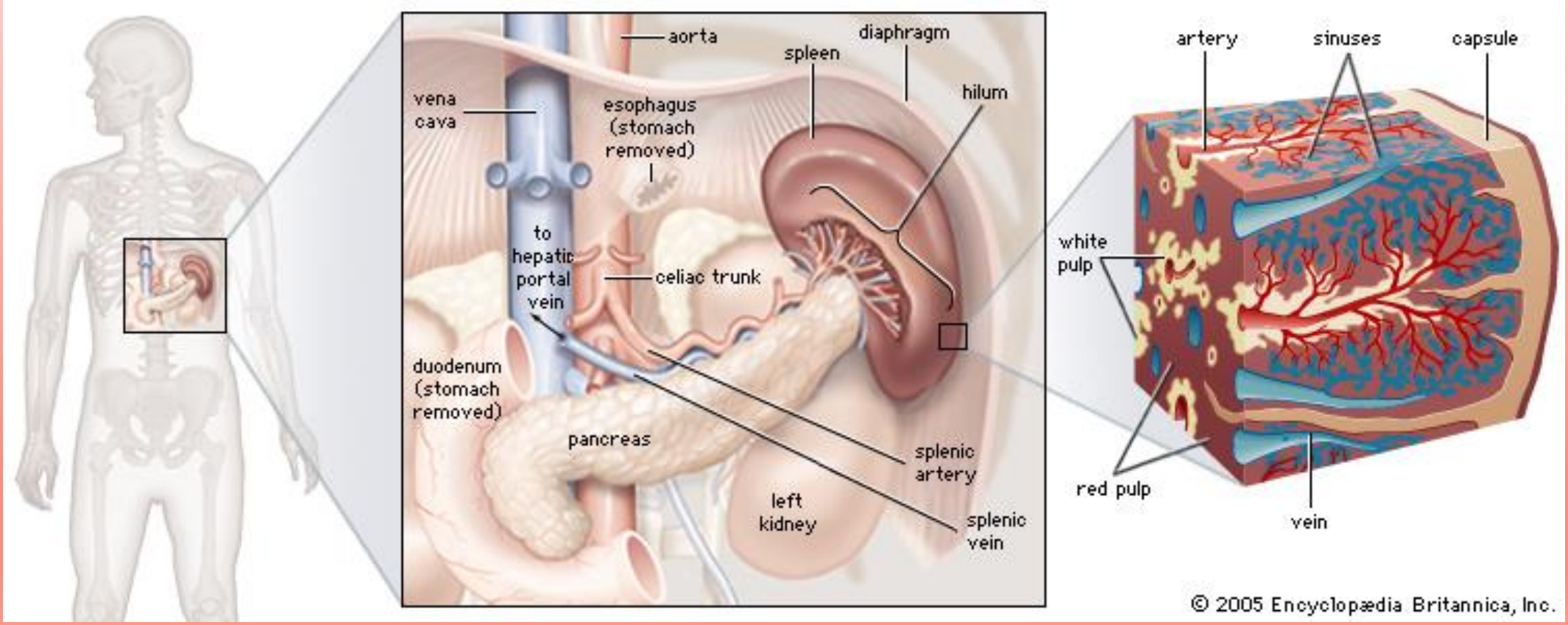
- Adult spleen
  - approximately 3x8x14 cm
  - 100-250 grams functional parenchyma enclosed in peritoneal capsule
- Splenic artery from celiac artery
- Short gastric vessels from gastroepiploic arcade
  - 4-10 branches
- Venous outflow
  - short gastrics to systemic circulation
  - splenic vein combines with IMV/SMV to form portal vein to hepatic circulation
- Tissue divided into 3 functional zones
  - red pulp, white pulp, marginal pulp


CHU Sainte-Justine
Le centre hospitalier
universitaire mère-enfant
1 cm



SPLEEN

ANATOMY


aorta
diaphragm
spleen
hilum
vena cava
esophagus (stomach removed)
to hepatic portal vein
celiac trunk
duodenum (stomach removed)
pancreas
splenic artery
left kidney
splenic vein
artery
sinuses
capsule
white pulp
red pulp
vein
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STATISTICS OF SPLENECTOMY

- Indications for splenectomy
  - 70% hematologic disorders
    - hypersplenism, staging, treatment, diagnosis
  - 10-20% incidental to other operations
  - 10-15% trauma

STATISTICS OF SPLENECTOMY

- Historically
  - Most common source of intraperitoneal solid organ injury requiring operation
- Modern imaging
  - Most common source of intraperitoneal solid organ injury (liver close), remains most common indication for operation
- Approximately 40% high grade splenic injuries will require operative intervention
- Approximately 15-20% adults and 5% children will fail nonoperative measures to require operative splenic intervention
- Special considerations
  - Geographic location and hospital resources

MECHANISM OF INJURY

- Penetrating Trauma to the spleen
  - Mainstay of all types remains a simple task:
    - Identify the trajectory, determine the injury
  - Which then becomes a simple question:
    - To operate or not to operate?
  - Tools to accomplish:
    - ATLS, laboratory evaluations, imaging choices, evolving clinical picture of patient

MECHANISM OF INJURY

- Blunt Trauma to the spleen
  - Multiple considerations in initial evaluation
    - Mechanism of impact
    - Force of impact
    - Vector of impact
    - Anatomic associations of impact zone
    - Additional areas of significant injury
    - General condition at presentation
- To operate or not to operate?

WTA Spleen Management Algorithm Update 2016

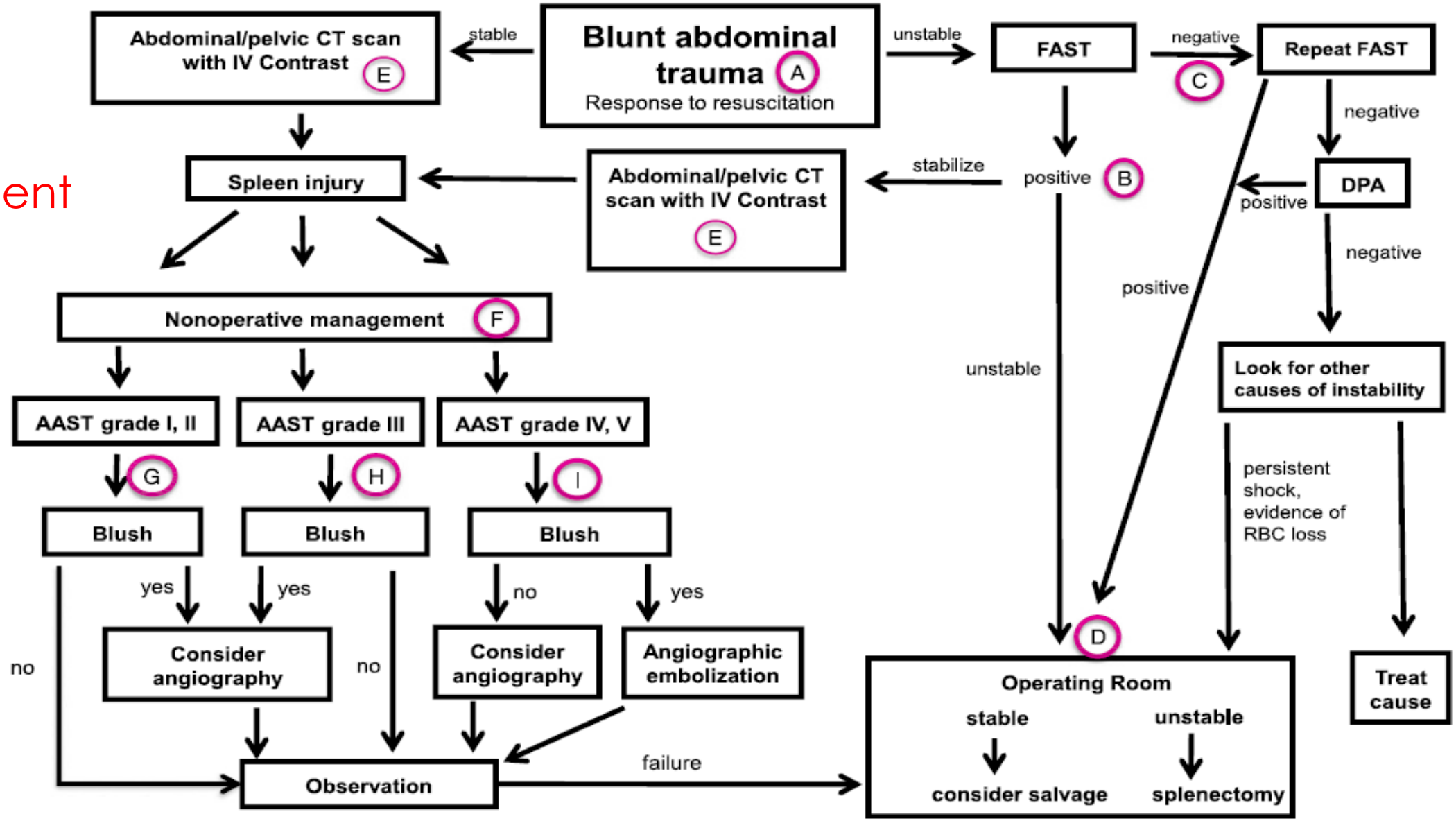


Figure 1. Western Trauma Association algorithm for the management of adult blunt splenic injury.

EAST PMG 2012 Note: Update In progress

Selective nonoperative management of blunt splenic injury: An Eastern Association for the Surgery of Trauma practice management guideline

Nicole A. Stassen, MD, Indermeet Bhullar, MD, Julius D. Cheng, MD, Marie L. Crandall, MD, Randall S. Friese, MD, Oscar D. Guillamondegui, MD, Randeep S. Jawa, MD, Adrian A. Maung, MD, Thomas J. Rohs, Jr, MD, Ayodele Sangosanya, MD, Kevin M. Schuster, MD, Mark J. Seamon, MD, Kathryn M. Tchorz, MD, Ben L. Zarzuar, MD, *and* Andrew J. Kerwin, MD

BACKGROUND: During the last century, the management of blunt force trauma to the spleen has changed from observation and expectant management in the early part of the 1900s to mainly operative intervention, to the current practice of selective operative and nonoperative management. These issues were first addressed by the Eastern Association for the Surgery of Trauma (EAST) in the Practice Management Guidelines for Non-operative Management of Blunt Injury to the Liver and Spleen published online in 2003. Since that time, a large volume of literature on these topics has been published requiring a reevaluation of the current EAST guideline.

METHODS: The National Library of Medicine and the National Institute of Health MEDLINE database was searched using Pub Med (www.pubmed.gov). The search was designed to identify English-language citations published after 1996 (the last year included in the previous guideline) using the keywords *splenic injury* and *blunt abdominal trauma.*

RESULTS: One hundred seventy-six articles were reviewed, of which 125 were used to create the current practice management guideline for the selective nonoperative management of blunt splenic injury.

CONCLUSION: There has been a plethora of literature regarding nonoperative management of blunt splenic injuries published since the original EAST practice management guideline was written. Nonoperative management of blunt splenic injuries is now the treatment modality of choice in hemodynamically stable patients, irrespective of the grade of injury, patient age, or the presence of associated injuries. Its use is associated with a low overall morbidity and mortality when applied to an appropriate patient population. Nonoperative management of blunt splenic injuries should only be considered in an environment that provides capabilities for monitoring, serial clinical evaluations, and has an operating room available for urgent laparotomy. Patients presenting with hemodynamic instability and peritonitis still warrant emergent operative intervention. Intravenous contrast enhanced computed tomographic scan is the diagnostic modality of choice for evaluating blunt splenic injuries. Repeat imaging should be guided by a patient's clinical status. Adjunctive therapies like angiography with embolization are increasingly important adjuncts to nonoperative management of splenic injuries. Despite the explosion of literature on this topic, many questions regarding nonoperative management of blunt splenic injuries remain without conclusive answers in the literature. (*J Trauma Acute Care Surg.* 2012;73: S294–S300. Copyright © 2012 by Lippincott Williams & Wilkins)

KEY WORDS: Guideline; spleen; blunt abdominal trauma; surgery.

TABLE 1. Spleen Organ Injury Scale—2018 Revision

AAST Grade	AIS Severity	Imaging Criteria (CT findings)	Operative Criteria	Pathologic Criteria
I	2	– Subcapsular hematoma <10% surface area – Parenchymal laceration <1 cm depth – Capsular tear	– Subcapsular hematoma <10% surface area – Parenchymal laceration <1 cm depth – Capsular tear	– Subcapsular hematoma <10% surface area – Parenchymal laceration <1 cm depth – Capsular tear
II	2	– Subcapsular hematoma 10–50% surface area; intraparenchymal hematoma <5 cm – Parenchymal laceration 1–3 cm	– Subcapsular hematoma 10–50% surface area; intraparenchymal hematoma <5 cm – Parenchymal laceration 1–3 cm	– Subcapsular hematoma 10–50% surface area; intraparenchymal hematoma <5 cm – Parenchymal laceration 1–3 cm
III	3	– Subcapsular hematoma >50% surface area; ruptured subcapsular or intraparenchymal hematoma ≥5 cm – Parenchymal laceration >3 cm depth	– Subcapsular hematoma >50% surface area or expanding; ruptured subcapsular or intraparenchymal hematoma ≥5 cm – Parenchymal laceration >3 cm depth	– Subcapsular hematoma >50% surface area; ruptured subcapsular or intraparenchymal hematoma ≥5 cm – Parenchymal laceration >3 cm depth
IV	4	– Any injury in the presence of a splenic vascular injury or active bleeding confined within splenic capsule – Parenchymal laceration involving segmental or hilar vessels producing >25% devascularization	– Parenchymal laceration involving segmental or hilar vessels producing >25% devascularization –	– Parenchymal laceration involving segmental or hilar vessels producing >25% devascularization
V	5	– Any injury in the presence of splenic vascular injury with active bleeding extending beyond the spleen into the peritoneum – Shattered spleen	– Hilar vascular injury which devascularizes the spleen – Shattered spleen	– Hilar vascular injury which devascularizes the spleen – Shattered spleen

Vascular injury is defined as a pseudoaneurysm or arteriovenous fistula and appears as a focal collection of vascular contrast that decreases in attenuation with delayed imaging. Active bleeding from a vascular injury presents as vascular contrast, focal or diffuse, that increases in size or attenuation in delayed phase. Vascular thrombosis can lead to organ infarction.

Grade based on highest grade assessment made on imaging, at operation or on pathologic specimen.

More than one grade of splenic injury may be present and should be classified by the higher grade of injury.

Advance one grade for multiple injuries up to a grade III.

RESOURCES

- EAST PMG – most recent published update 2012
- WTA Algorithm – update published 2017
  - Both are treatment strategies
  - Review of all literature/outcomes available at time of publication
  - Updated per organizational cycle

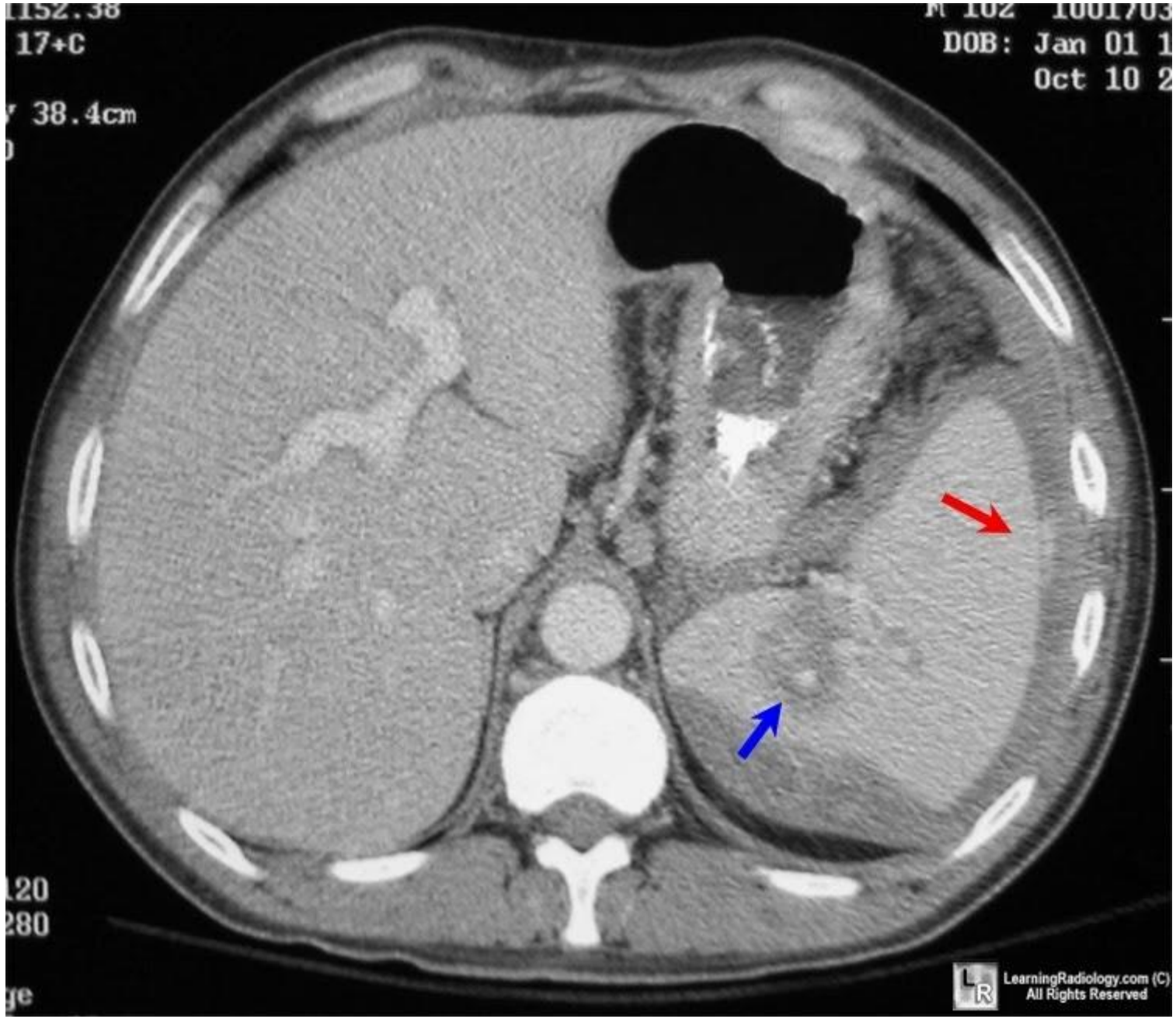
- AAST Grading scales – update published 2018
  - Combines 3 factors: Image, Operative, Pathologic
    - Highest of 3 criteria will become assigned grade
  - Review of all available literature
  - Used to facilitate research, risk stratification, quality, billing/coding
  - Grading scale does NOT address treatment strategies

TREATMENT OF INJURY

- Observation
  - Serial exams, laboratory, imaging = Clinical Vigilance
  - Failure requiring intervention
    - Clinical signs of shock – BP, HR, UO
    - Laboratory evidence of ongoing bleeding
      - Transfusion requirement
      - 60-70% within first 12 hours after admission
      - 10% greater than 1 week after injury
  - Reasons for failure
    - Ongoing bleed
    - Hematoma remodeling and breakdown
    - Pseudoaneurysm formation and rupture
    - Additional traumatic injury

TREATMENT OF INJURY

- Interventional Radiology and Angioembolization
  - Diagnostic and therapeutic
    - High grade injury
    - Active extravasation
    - Pseudoaneurysm vs AV fistula
    - Aggressive post-procedural monitoring
    - Same as initial observation group = Clinical Vigilance
  - Failure requiring operative intervention
    - Same as initial observation group
    - Anatomic considerations
    - Up to 10% failure rates reported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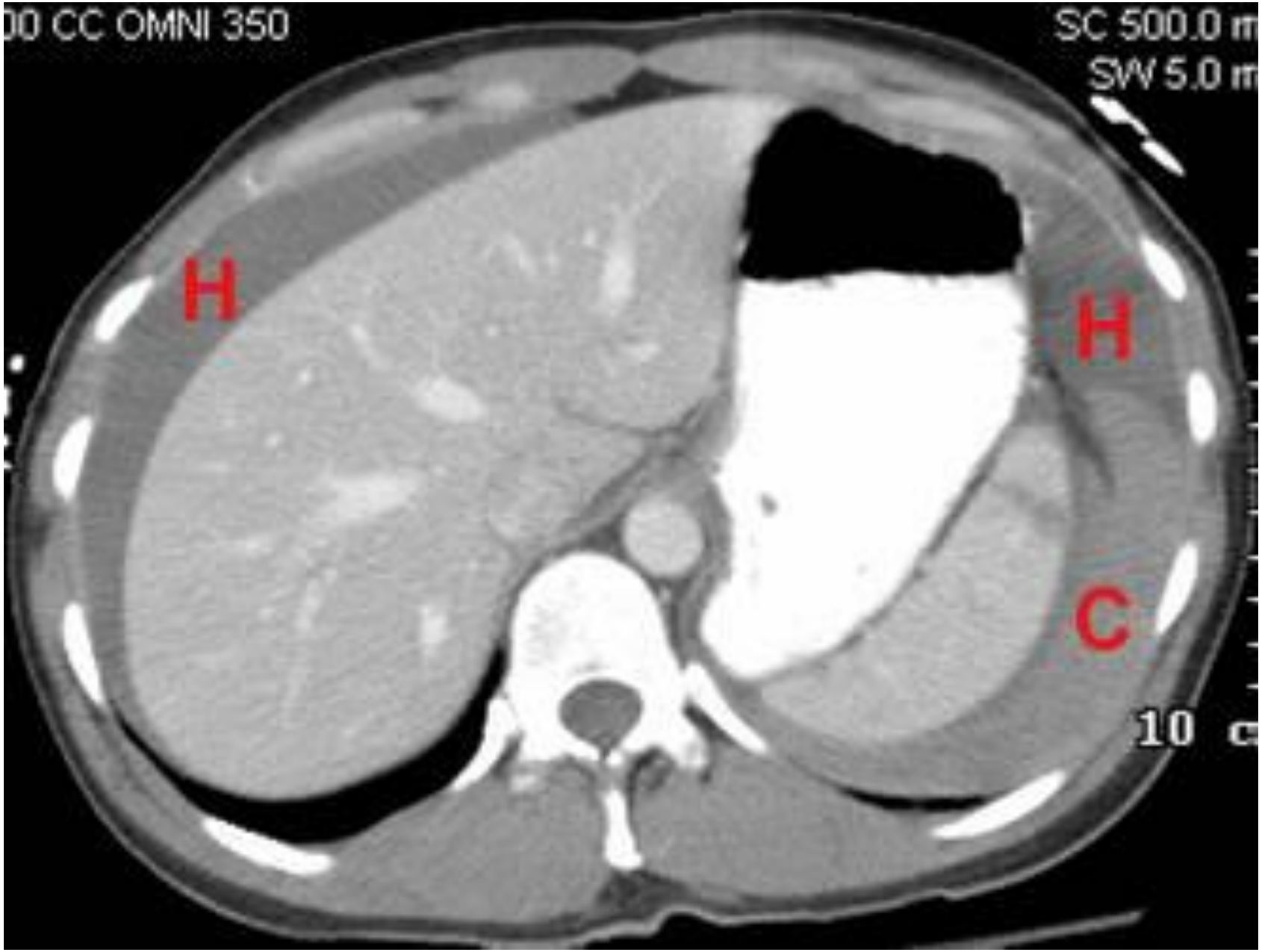
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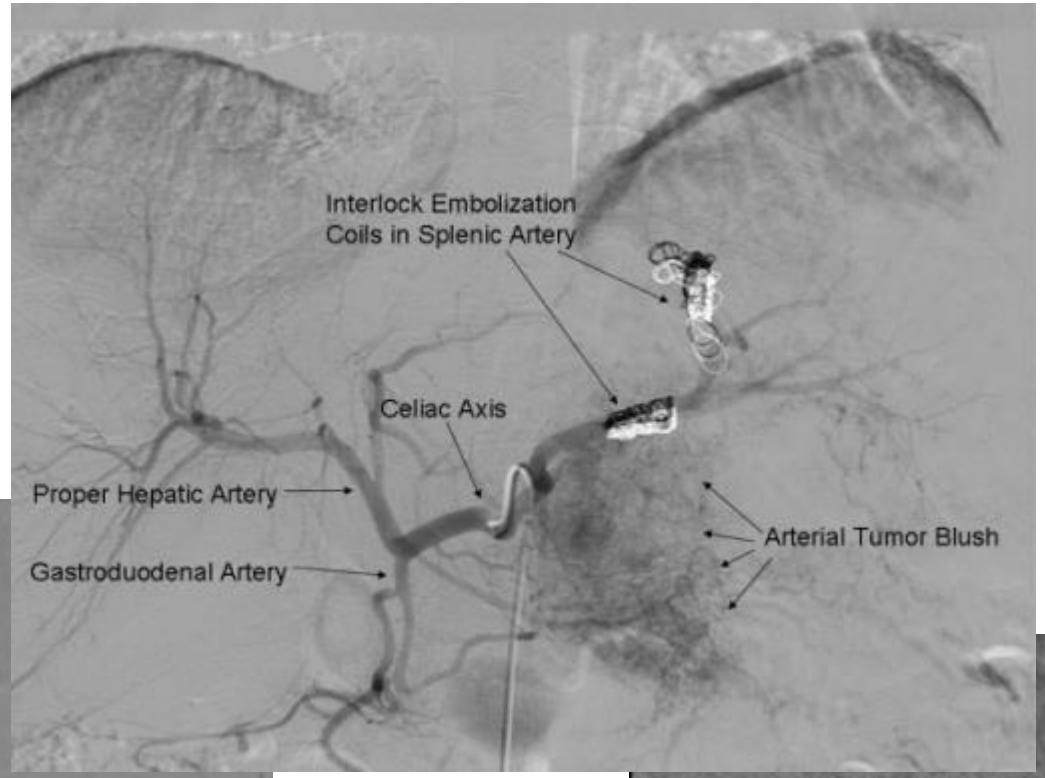
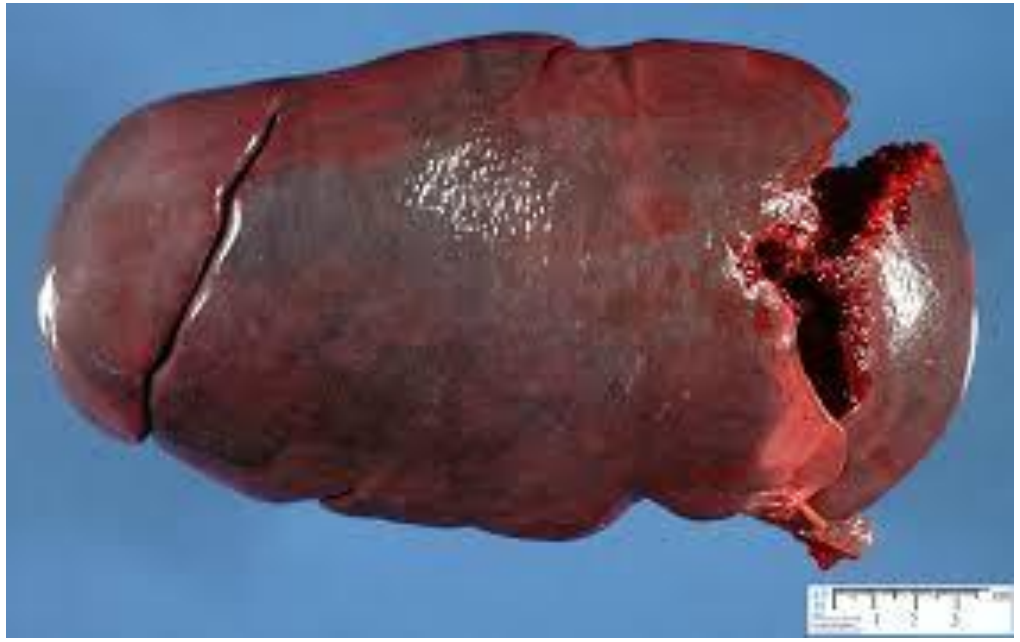
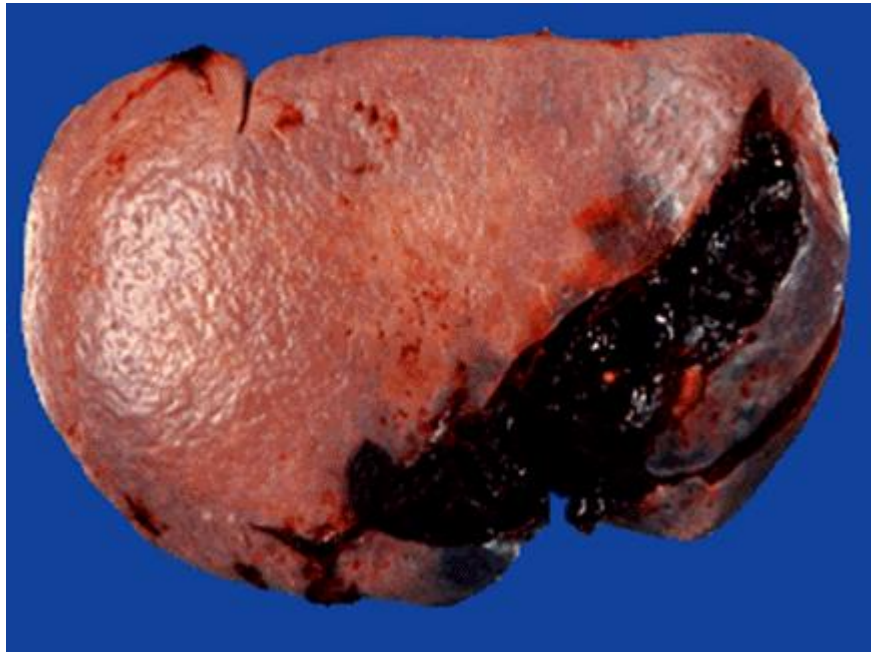

Interlock Embolization
Coils in Splenic Artery
Celiac Axis
Proper Hepatic Artery
Gastroduodenal Artery
Arterial Tumor Blush





COMPLICATIONS OF TREATMENT – OPERATIVE

- Postoperative complications
  - Surgical bleeding
  - Gastric distension, necrosis
  - Pancreatic injury
  - Thrombocytosis
  - Pulmonary – effusion, infection,
  - Venous Thromboembolism - DVT or PE
- Immunologic dysfunction
  - Overwhelming Post-Splenectomy Sepsis
    - Lifetime risk
      - Adult 0.03%
      - Pediatric 0.06%
      - Encapsulated organisms
        - Pneumococcus, meningococcus, Hemophilus
        - Vaccinations

COMPLICATIONS OF TREATMENT – NON-OPERATIVE

- Failure of non-operative management choices
  - ❖Risk of missing additional intra-abdominal injuries
    - ❖Pancreas, Small bowel 5-10%
  - ❖Cyst, abscess, pseudoaneurysm of spleen
    - ❖Percutaneous vs operative management
  - ❖Vascular injury/pseudoaneurysm at access site
    - ❖Topical therapy vs operative management
  - ❖Pulmonary – effusion, infection
    - ❖Percutaneous vs operative management
  - ❖Transfusion reactions
  - ❖VTE (DVT or PE)
    - ❖Increasing body of evidence supports prophylaxis as soon as 24 hours!!

CONTROVERSIES IN MANAGEMENT

- Overall management
  - Geriatric considerations
  - Pediatric considerations

- Surgical management
  - Laparoscopy?
    - In very selective patients – success!

- Angiography and embolization
  - Routine vs selective
    - Anatomic considerations, vascular injury, amount of hemoperitoneum
  - Location of embolization
    - Proximal vs segmental
  - Femoral vs Radial artery access
  - Type of embolization material
    - Gelfom vs coils vs alternative materials

READING TRAUMA CENTER

	Total Spleen Injury	Non-operative management	OR or IR Intervention	Hybrid Room
2017	48	33	15	NA
2018	65	51	14	9
2019	54	41	13	6

QUESTIONS?

Follow up with interest or questions any time!

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TRAUMA
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AMBULANCE
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