MANAGEMENT OF SOLID ORGAN INJURIES
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Introduction
• Solid organ injury is a leading cause of significant morbidity and mortality following injury.
• Identification of serious solid organ injury may be challenging.
• Many injuries, however, manifest during the initial assessment and treatment period. Thus, early identification is essential.

Epidemiology
• Trauma remains leading cause of mortality under the age of 44.
• Solid organ injuries are a leading cause of mortality following closed head injury.
• Estimates indicate that by 2020, 8.4 million individuals will die annually as a result of trauma in the United States.
Case Presentation

- 22-year-old female involved in high-speed head-on MVC.
- Scene data: 2 deaths in other vehicle
- Field vitals: HR 140, RR 18, BP 101/80

Pre-hospital Care

- The goal is to deliver the patient rapidly to the hospital for definitive care and to provide initial stabilization without further harm.

- Principles
  - Maintain airway and obtain IV access
  - Protection of spinal cord
  - Communication with medical control
  - Rapid transfer to facility capable of dealing with injuries (e.g. Trauma Center)

Initial Care (Prehospital/Hospital)

- Control airway and breathing. Intubate if airway compromise, hemodynamically unstable, or evidence of severe brain injury.
- Provide supplemental oxygen
- IV fluids with rapid initiation of blood products if evidence of severe hemorrhage present.
- Control external sources of hemorrhage.
- Immobilize fractures (e.g. pelvis) to prevent continued hemorrhage.
- Rapid assessment of degree of neurologic injury
- Prevent/treat hypothermia.
Initial Assessment and Resuscitation

• Primary Survey: Identification and treatment of life threatening injuries.
  • Airway with cervical spine precautions
  • Breathing
  • Circulation
  • Disability
  • Exposure

Patient Scenario

• Vital signs: HR 140, BP 90/80, RR 28, Temp 35
  • Airway: Speaking rapidly and anxious
  • Breathing: Tachypneic and equal
  • Circulation: 18 guage catheters bilateral upper extremities, 2 units PRBC transfused
  • Disability: Moves all extremities, GCS 15
  • Exposure: Pelvic instability, left lower extremity internally rotated and shortened. Blankets applied.

Abdominal Assessment

• Vital Signs and Physical Exam
  • Investigational Studies
    • FAST
    • DPA/DPL
    • CT Abdomen/Pelvis
Focused Assessment with Sonography in Trauma (FAST)
- First used in 1996
- Rapid
- Sensitivity 86-99%
- May be able to detect as little as 100 ml of blood
- Cost effective
- Views: Pericardiac, perihepatic, perisplenic, and peripelvic spaces.
- User dependent with inherent limitations of ultrasound.
- Useful in unstable patient

FAST
- **Advantages**
  - Easy
  - Rapid
  - No radiation
  - Portable
  - Low Cost
- **Disadvantages**
  - Examiner dependent
  - Obesity
  - Gas (subcutaneous and hollow viscus)
  - Low Sensitivity for free fluid less than 500 cc
  - False negative rate and false positive rate reported to be higher than previous studies.

Diagnostic Peritoneal Lavage (DPL)
- First described in 1965
- Rapid
- Accurate, predictive value greater than 90%
- Able to detect minimal blood
- High sensitivity, low specificity
- Useful in unstable patient, gross blood predictive in intra-abdominal hemorrhage.
DPL

- **Indications**
  - Unexplained shock
  - Potential false-negative FAST
  - General anesthesia for extra-abdominal procedure without prior abdominal evaluation

- **Contraindications**
  - Clear indications for laparotomy
  - Relative
    - Previous laparotomy
    - Pregnancy
  - Morbid obesity

CT Scan

- Gold standard
- Hemodynamically normal
- Provides excellent imaging of solid organs (liver and spleen).
- Determines the source and amount of bleeding
- Reveals associated injuries: pancreas, genitourinary, orthopedic.
- Poor for hollow viscous injury

CT Scan

- Not for use in the hemodynamically unstable
- Resuscitate, consider DPL or FAST, and early transfer if not able to definitively deal with underlying injury.
Solid Organ Injuries

- Difficult to diagnose on physical exam
- May lead to significant blood loss
- Grading of solid organs dependent on degree of hematoma, laceration, or avulsion.

- Injuries may present late, leading to further difficulty in assessment and management.
- The most common solid organs injured spleen and liver.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type of Injury</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Subcapsular, &lt;10%</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear, &lt;1cm in depth</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Subcapsular, 10-50%, &lt;5 cm diameter</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear, 1-3 cm in depth</td>
</tr>
<tr>
<td>III</td>
<td>Hematoma</td>
<td>Subcapsular, &gt;50%, ruptured; intraparenchymal hematoma &gt;5cm</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>&gt;3cm in parenchymal depth or involving trabecular vessel</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Segmental or hilar vessels, major devascularization (&gt;25%)</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Completely shattered spleen</td>
</tr>
</tbody>
</table>

Key Principles

- Hemodynamically unstable patients require immediate laparotomy.
  - Splenectomy

- Non-operative management is an option in the hemodynamically stable patient ONLY.
- No patient should die as a consequence of non-operative management.
Changes in Approach to Splenic Injury

- Initial thought that the spleen has no purpose
- **Cellular and humoral immunity:** IgM production, opsonization of bacteria, tuftsin production, immune response to bloodborne antigens, hematopoiesis
- Splenectomy has no consequences
- **Development of OPSI**
  - The spleen cannot heal
  - The spleen does heal with return of tensil strength within 6 weeks of injury.
- Non-operative management of splenic injury routinely results in bleeding at some point
  - Bleeding occurs in less than 10% of individuals that initially undergo no-operative management of splenic injury.

Immunologic consequences of splenectomy: OPSI

- Lifelong risk for Overwhelming Post-splenectomy infection (OPSI)
  - Caused by pneumococcus, meningococcus, Haemophilus influenzae
  - Initial Symptoms: fever, chills, muscle aches, headache, vomiting, diarrhea, and abdominal pain
  - Progressive symptoms: bacteremic septic shock, extremity gangrene, convulsions, and coma
  - Mortality rate of 50-80%
  - From onset of initial symptoms, 68% of those deaths occur within 24 hours and 80% occur within 48 hours
  - Prevention: routine vaccinations and prophylactic antibiotics

Evolution of Splenic Management

- Routine non-operative management- very high mortality
- 1920s—Due to high mortality of non-operative management, splenectomy performed for all splenic injuries. Mortality significantly improves as a result.
- 1980s Splenic preservation by splenorrhaphy
- 1990s—Non-operative evaluation becomes routine in pediatric population. Non-operative management in adults not well defined.
- 2000s—Non-operative management extended to adults with hemodynamic stability with good results.

- Nonoperative management of blunt injury to the spleen and liver
- Class II data support non-operative management of injuries to the liver or spleen
- Severity of grade of injury to the liver or the spleen is not a contraindication to non-operative management
- Contrary to observations by Buntain 1988; Resciniti 1988; Powell 1997; Cathay 1998; Bee, 2001


- Hypotheses:
  - Degree of patient injury based on ISS and hemodynamics will correlate with frequency of operation
  - AAST Grade of splenic injury will predict frequency of operation
  - Quantity of hemoperitoneum will correlate with frequency of laparotomy

Results (Peitzman et al)

- 1455 patients admitted to 15 different Level I trauma centers.
- 38.5% of patients underwent immediate operative intervention 61.5% of patients Admitted with planned non-operative management; of this group
  - 10.8% failed non-operative management and underwent laparotomy

- National Trauma Data Bank form 1997-2003
- 22,887 adults with blunt splenic injury.
- 3085 grade IV and V injuries
- Nonoperative management was attempted in 40.5% of grade IV and V injuries.
- Nonoperative management failed in 54.6% of the grade IV and V patients

- National Trauma Data Bank from 1999-2004.
- 23,532 adults with blunt splenic injury.
- Conclusion...“We conclude that at least 80% of blunt splenic injury can be managed successfully nonoperatively, and that patients should be monitored from 3 to 5 days postinjury.”

Harborview Experience 2001-2011

<table>
<thead>
<tr>
<th>Year</th>
<th>Successful Non-</th>
<th>Failure of Non-</th>
<th>Non-operative Management</th>
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<tbody>
<tr>
<td>2001</td>
<td>98</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>97</td>
<td>3</td>
<td></td>
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<tr>
<td>2003</td>
<td>89</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>76</td>
<td>24</td>
<td></td>
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<tr>
<td>2005</td>
<td>59</td>
<td>41</td>
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Harborview Experience 2001-2011 Requiring Splenectomy following Initial Non-Operative Management

- SI < 0.9, no biliary
- SI < 0.9, biliary
- SI > 0.9, no biliary
- SI > 0.9, biliary
Harborview Experience 2001-2011

- Any hypotension (<90 mmHg) associated with any grade of splenic injury was associated with an 80% failure of non-operative management.
- Arterial extravasation associated with 4 fold increase rate of non-operative failure.
- Shock index greater than 0.9 associated with an 8 fold increase of non-operative failure.
- Combination of blush and elevated shock index associated with 16 fold increase rate of non-operative failure.

- Most non-operative failures occur with 24 hours 72%, but may occur up to 10-14 days later.
- Any evidence of elevated SI mandates continued monitoring until resolution for at least 24 hours. This management strategy would miss only 2% of non-operative failures.

Liver Trauma

- Blunt injury most common mechanism
- High risk due to:
  - Large organ
  - Friable parenchyma
  - Ligamentous attachments
AAST Grading Liver Trauma

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<td>Hematoma subcapsule, &gt;30% surface area or expanding or ruptured subcapsular hematoma with active bleeding, &lt;10 cm in diameter</td>
</tr>
<tr>
<td>IV</td>
<td>Subcapsular or intraparenchymal hematoma with active bleeding</td>
</tr>
<tr>
<td>V</td>
<td>Hematoma ruptured into peritoneal cavity causing 20-50% of a hepatic lobe or more than 30% of a lobe segment</td>
</tr>
<tr>
<td>VI</td>
<td>Vascular hepatic injury (e.g., arterioportal venous injury, segmental or major main hepatic vein)</td>
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Indications for intervention

- Laparotomy for continued blood loss with hypotension, tachycardia, decrease urine output, and decreasing HCT not responsive to IVF therapy.
- Operative rate
  - 3-11% with multiple injuries
  - 0-3% when isolated

Operative Management

- Packing – within and/or without
- Pringle
- Balloon tamponade
- Angiography
Retrohepatic Caval Injury and Repair

Schrock Shunt for Vascular Control

Bile duct injury
- With non-operative management-4% incidence of continued bile leak. Increased 10 fold in Grade IV and V injuries.
- HIDA scan with delayed imaging if bile duct injury suspected
- ERCP with decompression and stenting may be both diagnostic and therapeutic.
- May require operative washout for delayed bile leak and peritonitis.
Solid Organ Injury Non-Operative Management

- Grade I and II injuries
  - Low incidence of failure (2% overall)
  - No hemodynamic instability and no blush: observe 24 hours in ICU.
  - Episode of hemodynamic instability requires additional 24 hours of observation in ICU.

- Grade III-V injuries
  - Incidence of failure (10% overall)
  - No hemodynamic instability and no blush: observe up to 48 hours (at least 24 hours in ICU).
  - Episode of hemodynamic instability requires additional 24 hours of observation in ICU.
  - Blush on CT, consider angioembolization.

Case Presentation

- Transferred by air to HMC.
- Immediately taken to OR for Damage Control.
  - Midline laparotomy with subsequent median sternotomy to control hepatic outflow.
  - Repair of retrohepatic caval injury, liver packing, splenectomy, drainage of pancreas.
  - Blood received in OR: 32 units P’RBCs, 29 units FFP, 12 units platelets, 4 packs of cryoprecipitate.
- Total OR time 98 minutes

Case Presentation

- Transferred to ICU
  - Initial vitals: Temp 34.9, HR 120, BP 120/54...patient demonstrated evidence of persistent intra-abdominal bleeding with resuscitation.
  - Taken back to OR for distal pancreatectomy, and liver repacking.
  - Chest/abdomen remained open.
Case Presentation

- 2 days later underwent liver pack removal, temporary abdominal closure, and sternal closure.
- Subsequent underwent abdominal closure, C2 fracture stabilization, and pelvic fixation.
- Discharged 81 days later to rehab facility.
- Currently 2 years post injury, back to work and doing well.

QUESTIONS