Selected Trauma Topics

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Injuries to the Liver
Evaluation

- Fully mobilize both lobes
  - Divide the triangular and coronary ligaments
  - Avoid hepatic vein and retro hepatic cava
- Exposure of junction of hepatic veins and cava
  - Median sternotomy
  - Divide diaphragm and pericardium
Operative Management
Temporary Control

- Essential
- Allows anesthesia time to catch up
- Allows evaluation of other injuries
- Various techniques
Techniques for Temporary Control of Hemorrhage
Options

- Manual compression
- Perihepatic packing
- Pringle maneuver
- Packing can compress the cava, decrease venous return and reduce LV filling
Pringle Maneuver

- Time limit
- Controls bleeding from branches of hepatic artery or portal vein
- Persistent hemorrhage indicates retrohepatic cava or hepatic vein injury
- Used in conjunction with packing
Hepatic Vascular Isolation

- Pringle maneuver
- Aortic hiatal control
- Suprarenal and suprahepatic vena caval control
- Relatively ineffective
Atriocaval Shunt

- Achieves hepatic vascular isolation
- Maintains some venous return to the RA
- Technically difficult
- Associated with high mortality
Techniques for Definitive Management
Simplest Options

• Manual Compression
  - Grade I or II

• Topical hemostatic measures
  - Electrocautery
  - Argon beam
  - Thrombin
  - Fibrin glue
More Advanced

- **Suture hepatorrhaphy**
  - Grade III or IV
  - Reserved for lacerations 3 cm or less in depth
  - Can cause hepatic necrosis
  - Capsule must be intact

- **Finger fracture**
  - Selective ligation of bleeding vessels
  - Reserved for deep lacerations
  - Allows ID and control of bleeding vessels
More Advanced

- Hepatic artery ligation
  - Limited role
  - Useful only for arterial hemorrhage

- Intrahepatic balloon
  - Hand-crafted in the OR
  - May not be sufficient for major arterial bleeding
More Advanced

- Resectional debridement
  - Used for peripheral injuries
  - Allows exposure of deeper injuries

- Perihepatic packing
  - Most significant advance in the tx of hepatic injuries to occur in the past 25 years
  - Purposeful and directed
Additional Options

- Anatomic resection and transplantation
  - Limited success
  - Technically challenging
Subcapsular hematoma
- Arises when parenchyma is disrupted but capsule is intact
- Range from minor to ruptured central hematomas

Grade I or II
- Involve <50% of liver surface, not expanding
- Leave alone
Uncommon Injury

• Grade III
  - Expanding
  - Should be explored
  - Result from uncontrolled arterial hemorrhage
  - Packing alone may not be successful
  - IR

• Ruptured Grade III or IV
  - Exploration + selective ligation
To Drain or not to Drain?
Outcomes

• Overall mortality = 10%

• Exsanguination = most common

• Liver-related complications
Complications

• Post-op hemorrhage
  - Coagulopathy
  - Missed vascular injury
  - Angio + embolization

• Abscesses
  - Penetrating = more common
  - IR drainage
  - 12\textsuperscript{th} rib resection
Complications

• Bilomas
  - Can be infected
  - Drainage

• Biliary fistula
  - 3% of patients with major injuries
  - Majority close spontaneously
Complications

- PSA
  - Develop secondary to initial injury mgmt
  - Can rupture into the parenchyma, bile duct or adjacent branch of portal vein
  - Hemobilia
Injuries to the Bile Ducts and Gallbladder
Extrahepatic Bile Duct Injuries

- Characterized by bile accumulation in RUQ
- CBD – sm lac, no tissue loss vs lac involving 25-50% of duct
- Hepatic ducts – individual - ligate
- Intrapancreatic
Galbladder Injuries

• Cholecystectomy

• One caveat

• Make sure that gb is not required for reconstruction
Injuries to the Diaphragm
Diaphragm Injuries

- 75% left-sided following blunt trauma
- Often difficult to diagnose
- Acute injuries repaired through abdomen
- Laparoscopy is both diagnostic and therapeutic
For Your Own Good

- Directed, purposeful packing
- Selective ligation = YES
- Parenchymal sutures = NO
- Diaphragm laceration = prolene
- FULLY mobilize both the liver and spleen
Hollow Viscus Injuries
Blunt Trauma
Evaluation

- Hollow viscus injury uncommon after blunt trauma
- Serious consequences if missed or delayed
- Clinical clues
- Index of suspicion
Physical Examination

- When in doubt, …
- Seat-belt sign
- Abdominal tenderness
- Beware distracting injuries and the unevaluable patient
Diagnostic Tests

- Ultrasonography (FAST)
  - Highly specific, moderately sensitive
  - Does not distinguish solid organ from hollow viscus injury

- CT scan
  - Hemodynamic stability
  - Free fluid does not mandate exploration
CT

- Number of abnormal findings correlated with true presence of an injury
  - 1 abnormality = 36% TP; > 1 = 83% TP

- Free fluid without solid organ injury = most common finding

- 13% incidence of blunt bowel injury with an initial negative scan
<table>
<thead>
<tr>
<th>Finding</th>
<th>True Positive CT Scans (%)</th>
<th>False Positive CT Scans (%)</th>
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</thead>
<tbody>
<tr>
<td>Unexplained intraperitoneal fluid</td>
<td>74</td>
<td>79</td>
</tr>
<tr>
<td>Pneumoperitoneum</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>Bowel wall thickening</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Mesenteric fat stranding</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Mesenteric hematoma</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Extravasation of luminal content</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Extravasation of vascular content</td>
<td>9</td>
<td>0</td>
</tr>
</tbody>
</table>
DPL

- WBC > 500 cells/mm³
- Alkaline phosphatase > 10 IU/L
- Amylase > 20 IU/L
- Must be done in delayed fashion – increased risk of FN
Penetrating Trauma
Evaluation

• Easier

• Diagnostic options

• When in doubt, …

• Better to be wrong in the OR than in radiology
Options

- **GSWs**
  - Generally necessitate exploration
  - Tangential wounds

- **SWs**
  - Lower incidence of intraabdominal injury
  - LWE
  - Laparoscopy
  - ELAP
  - Observe
Role of CT

- Identify peritoneal violation, injury to RP structures
- GSWs
  - Wounds to lower back or flank
  - Triple contrast
- SWs
  - Wounds to lower back or flank
  - Triple contrast
Operative Management
General Approach

- Pre-op Abx – continue for 24 hrs
- Explore through midline
- Control bleeding
- Control GI contamination
Stomach

- Exposure
  - Visualize from pylorus to GE junction
  - Open lesser sac
- Tx dictated by injury severity
  - AAST injury grading system
- Primary repair
  - Majority of injuries
Small Bowel

- Run the bowel
  - 4 hands 4 eyes
  - Ligament of Treitz to ileocecal valve
  - Control bleeding and perforations as found

- Primary repair vs resection
  - AAST injury grading system
  - Length of resection
  - Bowel viability
Colon

• Historically
  - Colostomy was mandatory for penetrating colon trauma
  - Experience with primary repair gained favor
• Stone and Fabian (Ann Surg 1979)
  - Prospective randomized trial – diversion vs primary anastomosis
  - High risk patients were excluded – all colostomy
Categorization

- Nondestructive
  - Involve <50% of wall without devascularization
  - 80% of colon wnds – amenable to primary rpr
  - Standard Tx regardless of associated injuries or comorbidities
  - Suture line failure <1%
Categorization

- Destructive
  - Involve >50% of wall, complete transection or tissue loss with devascularization
  - Optimal management is controversial
  - Comorbidities or transfusion requirements of 6 units or more increase suture line failure
  - Know all your options – different than small bowel
Destructive Wounds

- Account for 20% of colon wnds
- 50 - 75% = no risk fcts to prompt diversion
- Overall diversion rate = 5 - 10%
- Majority can be managed by either primary repair or with resection + anatomosis
Full-thickness Colon Injuries

Nondestructive
- Primary Repair

Destructive
- +Comorbidity
  >6 units PRBCs
  Diversion
- -Comorbidity
  ≤6 units PRBCs
  Resection + Anastomosis
Rectum

• Recognition of rectal injuries is difficult

• Anyone with penetrating wound to pelvis, perineum, buttock or upper thigh

• DRE

• Rigid sigmoidoscopy
Classification

- **Intraperitoneal**
  - Serosalized portions of the upper 2/3 of the rectum
  - Managed like colonic injuries
- **Extraperitoneal**
  - Posterior portion of the upper 2/3 of the rectum + lower 1/3 (no serosa)
  - Management dictated by accessibility
Rectum

- Rigid sigmoidoscopy is more sensitive in detecting EP injuries
- The possibility of a missed IP injury associated with a negative screen should prompt operative exploration if clinical suspicion is high
Penetrating Rectal Injury

Intraperitoneal

Primary repair or resection/anastomosis*

Upper two-thirds:
Same as Intraperitoneal
Proximal diversion at surgeon’s discretion (based on complexity of wound and status of patient)

Extraperitoneal

Lower one-third:
Wound is accessible
Primary repair
Proximal diversion at surgeon’s discretion (based on complexity of wound and pt status)
Presacral drainage for posterior wounds

Wound is inaccessible
Proximal diversion and presacral drainage
Presacral Drainage

- Lithotomy

- Curvilinear incision between coccyx and anus

- Bluntly enter presacral space

- Place penrose which is gradually withdrawn
Figure 6  Presacral drainage is provided through a curved incision midway between the anus and the tip of the coccyx. With blunt dissection, two fingers are inserted between the rectum and the hollow of the sacrum. Penrose drains are inserted and sutured to the skin.
Impact of Damage Control

- Small Bowel
  - Restore continuity
- Colon
  - Anastomosis vs diversion vs anastomosis + proximal diversion
  - A cautionary tale
For Your Own Good

- Anastomosis – hand-sewn preferred
- Pre-sacral drains = YES
- When in doubt, leave skin OPEN
- Drains – TBD
- Be like Gunnery sergeant Tom Highway
Injuries to the Pancreas
Pancreatic Trauma

- Occurs in 3 - 12% of patients with abdominal trauma
- Overall mortality rates 9 - 34%
- Morbidity rates 30 - 60%
Outcome

- Status of main pancreatic duct

- Time from injury to definitive management of ductal injury
Diagnosis
Role for Amylase

- ↑ amylase should increase suspicion
- Often not elevated initially
- Sens = 48-85%; Spec = 0-81%
- Amylase may be normal in 40% with blunt pancreatic injury
CT

- Parenchymal fracture
- Fluid in lesser sac or between splenic vein and pancreas
- IP or RP hematoma
- Thickened left anterior renal fascia
# History & Exam

- **Hallmark of Diagnosis**

<table>
<thead>
<tr>
<th>History</th>
<th>Blow to epigastrium</th>
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</thead>
<tbody>
<tr>
<td>Steering wheel</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Physical exam</th>
<th>Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epigastric contusion</td>
<td></td>
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<tr>
<td>Epigastric tenderness</td>
<td></td>
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</tbody>
</table>
Operative Diagnosis

- Demands *thorough* exploration
- Check all portions duodenum
- Explore lesser sac
- Investigate all hematomas in epigastrium
Ductal Integrity

- Determination of pancreatic duct integrity is important

- Different management approaches exist
Ductal Interrogation

- Intra-op pancreatography
  - Duodenotomy
- ERCP
- MRCP
- Operative exploration and examination
Indicators of Ductal Injury

- Direct visualization of the duct
- Complete transection of the gland
- Laceration of > 50% of the gland
- Severe maceration
- Leakage of pancreatic fluid
Basic Principles

- Recommended pancreaticorrhaphy
- Evaluate main ductal status
- Drainage
- Distal resection

*Fogelman and Robinson, Am J Surg, 1961*
Evolution of Care

- Step by step approach
  - 62 cases of pancreatic injury
- Hemostasis
- Conservative debridement
- Control of pancreatic secretions

Pancreatic Trauma: A Simplified Management Guideline

Joe H. Patton, Jr., MD, Sean P. Lyden, MD, Martin A. Croce, MD, F. Elizabeth Pritchard, MD, Gayle Minard, MD, Kenneth A. Kudsk, MD, and Timothy C. Fabian, MD

Introduction: Recent literature supports a conservative trend in the management of pancreatic injuries. Contrary to this trend, some recommend defining ductal integrity by pancreateography, implying that the results alter management. This study examines our recent 5-year experience with a simplified approach to all pancreatic injuries.

Methods: Retrospective analysis of patients sustaining pancreatic injuries was performed.

Results: One hundred thirty-four patients were identified. Overall mortality was 13%, and pancreatic-related mortality was 2%. Analyses were based on 124 pancreatic injuries among patients who survived >12 hours. Thirty-seven proximal injuries were treated with drainage alone, with a pancreatic morbidity of 11%. Eighty-seven distal pancreatic injuries occurred, 54 with indeterminate ductal status. Twenty-four had high probability for duct injury and were treated by distal resection; 30 with a low probability of ductal injury were drained. Pancreatic morbidity was not different between these groups.

Conclusions: Pancreatic injuries including those with indeterminate ductal status can be successfully managed with low morbidity and mortality using this simplified management protocol.
Previous Experience

- Proximal injuries could be managed with closed suction drainage with low morbidity
- Distal injuries can be managed with a simplified management algorithm

Patton et al, J Trauma, 1997
Algorithm for Pancreatic Injuries

Pancreatic injuries

Proximal

Duct injury? Yes No

Closed suction drainage

Distal

Duct injury? Yes No Indeterminate Yes

Low probability High probability Distal pancreatectomy
Conclusions

- Injuries to the pancreas after trauma are relatively uncommon.
- Represent a significant source of morbidity and mortality relative to overall incidence.
- Related to the accuracy and timing of diagnosis, the completeness of the operative procedure and the diligence that is required in the postoperative period to identify and treat potential complications.
Conclusions

• Prompt diagnosis requires a high index of suspicion and appropriate tests performed in a timely fashion

• Subsequent operative treatment is dictated by the pattern and severity of injury
Treatin’ Pancreatic Injuries

are like eating crawfish ...
Eat the tail ...
suck the head
Duodenal Injuries
Combined Injuries
• Rare
• Penetrating
• Associated injuries = primary cause of mortality
• Major vascular injury
• Whipple for combined injury to pancreas, duodenum and CBD
• Repair and drain when possible
For Your Own Good

- Pancreatic resection – interlocking u stitches
- Drain stays for 10 days
- When in doubt drain
- Afferent and efferent tubes for duodenal injuries
- There are ALWAYS two holes
- Do not be afraid to open one hole to look for the second – much worse to miss second hole