Injuries to the Liver, Biliary Tract, Spleen, and Diaphragm

Kaushik Mukherjee MD
Bryan Collier DO
Beep beep beep beep.....

- 19 y/o male unrestrained driver, T-boned in MVC
- Airway intact, following commands
- Bilateral breath sounds
- Bilateral femoral pulses
- HR 95, BP 114/64, RR 18-20, O2 Sat 100% on NRB
What’s next?
What’s next?

1. Diagnostic laparoscopy
2. Ex Lap
3. Left tube thoracostomy
4. Left thoracotomy
What’s Wrong with this Picture?

Intraluminal air above the diaphragm
What’s Wrong with this Picture?
TGF

- Injury to left hemidiaphragm with herniation
- Grade IV splenic laceration without extravasation
- Left renal laceration
- Extraperitoneal bladder rupture
- Multiple pelvic fx
- Left femur fx
- Right tib-fib fx
- Bilateral sacral fx (zone 2)
Traumatic Diaphragmatic Rupture

- Up to 5% of patients after blunt trauma
- 70% left-sided predominance (liver is a good shock absorber)
- Mean size of injury is 13 cm
- Diagnosis can be difficult on all imaging modalities, so you have to prove the absence of injury

**Why laparotomy?**
- 80% of patients have associated intra-abdominal injuries (including this one)
- Laparoscopy=OK to look but will be difficult to address all injuries via this method
- Thoracotomy good for delayed repair but may need thoracoabdominal incision
- If you put in a chest tube and see a liter of blood come out don’t necessarily go to thoracotomy—it could be coming from the abdomen
Question

Category 7 Item 19

A security guard sustains a left thoracoabdominal stab wound. He is alert, talking, and hemodynamically stable. On examination the abdomen is soft and nontender. The most appropriate management would be

(A) observation

(B) ultrasonography

(C) laparotomy

(D) thoracoscopy

(E) laparoscopy
Stable left thoraco-abdominal stab

1. Observe
2. US
3. Ex lap
4. Thoracoscopy
5. Diagnostic laparoscopy
Stable left thoraco-abdominal stab

- Outlined area (nipple to costal margin) **high risk for missed diaphragmatic injury**
- NO imaging of the diaphragm is 100% accurate
- Risk for delayed presentation with herniation/strangulation of bowel
- **Dx laparoscopy** superior—may be able to repair injury laproscopically as well (although possible risk of PTX). If neg go home from RR
- **Laparotomy** is the next best thing
- **Thoracoscopy** problematic due to positioning in case of other intra-abdominal injuries
- **US + observation** is an option but not really either alone
- If stab wound is in the box need to do a window
Category 7 Item 25

A 25-year-old man is taken to the emergency department after falling 15 feet onto his right side. At the scene, systolic blood pressure was 60 mm Hg. On arrival he is alert, with a blood pressure of 110 systolic after receiving 2 L of crystalloids. He has bilateral breath sounds. His vital signs have remained normal since receiving the crystalloids. The computed tomographic (CT) scan shown is obtained.

The most appropriate next step would be
What’s the next step?

1. Ex lap
2. Admit for obs
3. Angiography
4. Laparoscopy
Blunt Liver Injury Management

• Should attempt nonop mgmt for blunt liver injuries with stable hemodynamics (i.e. 75% of grade IV injuries can be managed nonop) **but high complication rate (50%)**
• Laparoscopy not currently indicated (may be needed later to drain hemoperitoneum or biliary ascites)
• Predictors of need for OR
  – Platelets < 200K
  – > 3L fluids in first 4 hrs
• **Angiography**
  – Reduces blood transfusion and rate of sepsis
  – Still requires OR in 25% of cases
  – You need to manage the patient’s resuscitation
  – Consider bladder pressure monitoring
Liver Segmental Anatomy

- Overall mortality from liver injuries 10%
  - Exsanguination
  - MODS
- Blunt = higher mortality
- Penetrating = higher infection rate
- Complications
  - Delayed hemorrhage
  - Biliary fistula/biloma
  - Local infection

*Figure 1* Shown are the anatomic divisions of the liver.
Hepatic Venous Anatomy

Figure 2  Depicted are the venous drainage and suspensory attachments of the liver.
## Grading of Liver Injuries

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
</table>
| **I** (not always seen on CT) | **Hematoma:** subcapsular, non-expanding, <10%  
**Laceration:** capsular tear, non-bleeding, < 1 cm deep |
| **II** | **Hematoma:** subcapsular, non-expanding, 10-50% intraparenchymal, non-expanding, <10 cm  
**Laceration:** capsular tear, bleeding, 1-3 cm deep, < 10 cm long |
| **III** | **Hematoma:** subcapsular, >50%, expanding, or ruptured with bleeding intraparenchymal, expanding or > 10 cm  
**Laceration:** > 3 cm deep |
| **IV** | **Hematoma:** intraparenchymal, ruptured with bleeding  
**Laceration:** parenchymal disruption, 25-75% of lobe or 1-3 segments |
| **V** | **Laceration:** parenchymal disruption, >75% of lobe or 4 segments  
**Vascular:** Juxtahepatic venous injuries—high mortality |
| **VI** | **Vascular:** hepatic avulsion—near 100% mortality |
The Pringle Maneuver

• Options
  – Digital control
  – Non-crushing clamp
  – Rummel tourniquet
  – Vessel loop + hemostat

*Figure 4* The Pringle maneuver controls arterial and portal vein hemorrhage from the liver. Any hemorrhage that continues must come from the hepatic veins.
Perihepatic packing

- Strategic placement of packs to control hepatic hemorrhage
- Can be successful even for perihepatic venous injuries
- Using packs to create *compression vectors*, thus achieving hemostasis (see *Top Knife*)
Role of the R2 in the Trauma OR

*Figure 5* Manual compression of large hepatic injuries temporarily controls blood loss in hypovolemic patients until the circulating blood volume can be restored.
Bleeding is coming from right upper quadrant
Take down falciform ligament.
Inspect and palpate liver.
Temporarily control bleeding with packing or Pringle maneuver, as needed.
Make initial assessment of grade of liver injury.

Minor injury (grade I or II)
Apply topical agents.
Do not drain.
Close abdomen.

Moderate to severe injury (grade III, IV, or V); bleeding is controlled with Pringle maneuver
Divide coronary and triangular ligaments and open liver parenchyma as needed to expose injuries.
Apply topical agents to areas with minimal injury.
For superficial injuries, ligate individual bleeding vessels or close parenchyma with sutures.

Moderate to severe injury (grade III, IV, or V); bleeding is not controlled with Pringle maneuver
Divide coronary and triangular ligaments as needed to gain exposure.
Use topical agents and buttressed sutures as indicated.
If bleeding persists, use packs, potentially as definitive treatment.

Bleeding is controlled
Close abdomen without drains.

Bleeding continues (mostly low pressure before Pringle maneuver)
Suture bleeding vessels, even those deep in the parenchyma.
Pack abdomen if necessary.
Drain as indicated; close abdomen.

Bleeding continues (mostly high pressure before Pringle maneuver)
Suture bleeding vessels, even those deep in the parenchyma.
If necessary, ligate right or left hepatic artery.
Drain as indicated; close abdomen.

Bleeding is controlled
Close abdomen without drains.
Remove packs in 1 or 2 days.

Abdomen is not packed
Remove packs in 1 or 2 days.

Abdomen is packed

Follow for postinjury complications (bleeding, abscess, hemobilia, etc.).
Evaluate and treat with arteriography, embolization, imaging, and drainage, as indicated.

Angio
Question

Category 7 Item 9

A 35-year-old man develops a biloma after blunt liver trauma. An initial attempt at computed tomographic (CT)-guided percutaneous drainage of the biloma is unsuccessful. The next step in management of this patient should be

(A) exploratory laparotomy with debridement of necrotic parenchyma and omentoplasty

(B) a second drain; somatostatin

(C) laparoscopy with drainage

(D) drainage and endoscopic retrograde cholangiopancreatography (ERCP) with sphincterotomy

(E) exploratory laparotomy and hepaticojejunostomy
Biloma failing perc drain...

1. Ex lap, debride, omental flap
2. 2$^{nd}$ drain + somatostatin
3. Laparoscopic drainage
4. Drainage + ERCP/sphincterotomy
5. Ex lap/hepaticoJ
Bilomas

• Form weeks→months after hepatic trauma
• More common in Grade IV+ injuries
• Symptoms:
  – Asymptomatic
  – RUQ pain, fullness
  – Fever
  – Jaundice
• Diagnosis:
  – Difficult to differentiate from abscess/hematoma on CT

• Treatment
  – Perc drain + ERCP/sphincterotomy (internal + external drainage)
  – If this fails, can do ex lap, debridement, omentoplasty
  – HepaticoJ for extrahepatic bile duct injury
  – Laparoscopic drain placement not used
  – Somatostatin not useful in this setting
A 24-year-old man who was the restrained driver in a high-speed motor vehicle crash arrives in the emergency department with a systolic blood pressure of 80 and heart rate of 120. After infusion of 2 L of saline, blood pressure normalizes and the heart rate is 80.

His only complaint is of pain in the left upper quadrant of the abdomen. The abdominal computed tomographic (CT) scan shown is obtained. Eighteen hours after admission, systolic blood pressure is 80, heart rate is 120, and hemoglobin is 6 g/dL.

The most appropriate management now would be

(A) infusion of factor VIIa

(B) laparotomy

(C) repeat CT scan

(D) angiography with embolization

(E) transfusion of 2 units of packed RBCs and continued observation
What’s the Plan?

1. Factor VIIa
2. Ex lap
3. Repeat CT
4. Angiography with embolization
5. 2 units PRBC and observe
Question

Category 7 Item 38

Multi-institutional studies of current treatment for blunt injury to the spleen demonstrate that nonoperative management

(A) is associated with a mortality risk > 30% in hemodynamically abnormal patients

(B) is not appropriate unless the patient is in a level I or II trauma center

(C) is appropriate for children but not for adults

(D) is not amenable to management by guidelines

(E) most commonly fails at 48 to 96 hours after injury
Nonop Management of Blunt Splenic Injury

1. >30% mortality in unstable patients
2. Not appropriate except in trauma center
3. OK for kids, not adults
4. Not amenable to guidelines
5. Fails 48-96 hrs post-injury
### Table--CT grading of spleen injury

<table>
<thead>
<tr>
<th>Grade</th>
<th>Hematoma</th>
<th>Laceration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Subcapsular, &lt;10%</td>
<td>Capsular tear &lt;1 cm</td>
</tr>
<tr>
<td>2</td>
<td>Subcapsular, 10%-50%, pulp &lt; 2 cm</td>
<td>Capsular tear 1-3 cm</td>
</tr>
<tr>
<td>3</td>
<td>Subcapsular, &gt;50% pulp &gt;2 cm</td>
<td>&gt;3 cm</td>
</tr>
<tr>
<td>4</td>
<td>Ruptured pulp, active bleeding</td>
<td>&gt;25% devitalized</td>
</tr>
<tr>
<td>5</td>
<td>Shattered spleen</td>
<td>Hilar injury—devitalized</td>
</tr>
</tbody>
</table>

When to Put the Spleen in the Bucket

- Nonop mgmt more successful in kids: 95% (peds), 80% (adult)
- Consider repeat CT in 3 days to look for pseudoaneursym
- 10.8% failure rate for *blunt splenic injury in adults*, 60% in first 24 hrs
- **37% mortality rate** for nonop mgmt in the face of persistent tachycardia and hypotension
- **Predictors of nonop mgmt failure**
  - Age > 55 yrs
  - ISS > 25
  - Persistent abd pain/peritonitis
  - High grade injury
  - Contrast blush
  - Lots of hemoperitoneum
- Now that nonop mgmt has failed for our patient, ex lap is the only acceptable option
  - Another CT scan or giving blood will just delay the inevitable
  - Angio for pseudoaneurysm or large injury with extravasation in stable patients.