IMAGING OF BLUNT ABDOMINAL TRAUMA, PART I

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Learning Objectives for blunt abd. Trauma

- General imaging considerations in abd. trauma
- Features and grading of trauma to liver
- Findings often associated with liver trauma
- Features and grading of trauma to spleen
- Features and grading of trauma to pancreas
ROLE OF CT IN TRAUMA

- To guide management of patients
- To identify patients with internal injury
- To triage patients for emergent intervention:
  - Surgery
  - Interventional management (endovascular)
DEDICATED ABD. TRAUMA MDCT

- **Contrast Materials:**
  - **Oral contrast (if possible):** 3 cups of 450 ml of 2.2% Gastrografin (10 mL/450 of water)
  - **IV contrast:** 3 cc/sec for 150 ml
  - **Rectal contrast** (for penetrating trauma: 40 cc of Conray 60% in 1000 mL normal saline: use 500-1000 mL as tolerated

- **Important:**
  - Clamp bladder catheter to achieve full distention of bladder
DEDICATED ABD. TRAUMA MDCT

- **16 (64) - slice MDCT:**
  Detector configuration: 16 (64) x 0.625 mm, reconstruction thickness and interval: 5 mm

- **Scan delay:**
  80 sec or smart prep, diaphragm to ischial tuberosity

- **Important:**
  - Single acquisition: “total body” trauma CT scan: head, cervical spine, chest, abdomen & pelvis
  - Delayed scans (5 min) optional: parenchymal organs, excretory system incl. bladder, vasc. extravasation
  - CT cystogram for bladder injury: 300-400 cc of 20 cc of 60% contrast/500 cc of sterile saline
Always use ROI for fluid in trauma!

- Water density (1-10 HU)
- Mixed density (10-20 HU): urinary bladder, bowel, gallbladder rupture
- Hemoperitoneum: CT attenuation > 30 HU
- Sentinel clot (45-70 HU): densest close to injury
- Active arterial extravasation: > 100 HU
HEMOPERITONEUM VS. WATER-DENSE TRAUMATIC INTRAPERITONEAL FLUID
IDENTIFY LIFE-THREATENING INJURIES

- Active extravasation
- Massive hemorrhage
- Major vascular injuries
- Signs of shock
- Bowel perforation
IDENTIFY ACTIVE BLEEDING

Active extrav. from spleen -> embolization
LIVER INJURIES

• Prevalence:
  - occurs in up to 25% of patients with blunt abdominal trauma undergoing CT

• Mortality
  - ~ 4 - 12% overall
  - 50-80% with juxtahepatic venous injury

LIVER TRAUMA: IDENTIFY

- Liver laceration
- Hematoma (54 HU, 28-82)
- Active hemorrhage (155 HU, 91-274)
- Juxtahepatic venous injury
  - (Periportal low attenuation)
  - (Flat IVC)

PARENCHYMAL INJURY TO LIVER

- **BLUNT TRAUMA:**
  - Hematoma
    - subcapsular or intraparenchymal hematoma
  - Laceration
    - linear, stellate, “bear claw” lacerations
  - Bleeding
    - recognize arterial or venous injury with extrav.
      (overall art. extrav. = 18.4%; spleen = 17.7%)

- **PENETRATING TRAUMA:**
  - subcapsular hematoma & linear laceration, extrav.
GRADING HEPATIC INJURY

- **Hematomas**
  - I: < 1 cm diameter
  - II: 1 - 3 cm
  - III: > 3 cm

- **Lacerations**
  - I: < 1 cm deep
  - II: 1 - 3 cm
  - III: > 3 cm

- **Parenchymal disruption**
  - IV: 25 - 75% of hepatic lobe, 1-3 segments
  - V: >75% of hepatic lobe, >3 segments

- **Juxtahepatic venous injury**
  - VI: vena cava, central hepatic veins, avulsion

INTRAHEPATIC LAC, GRADE III

> 3 cm, no hemoperitoneum

“Bear Claw” Lac
LIVER INJURY: GRADE IV AND V

IV: Parenchymal disruption: 1-3 segments

V: Parenchymal disruption: > 3 segments
BARE AREA OF THE LIVER

- **Injury to the bare area:**
  - right lobe injury more frequent than left
  - about 25% of liver injuries limited to bare area

- **Liver lacerations into the bare area:**
  - usually results in retroperitoneal bleed:
  - bleeding into right anterior pararenal space or perirenal space
CT PREDICTOR OF FAILURE FOR NON-OPERATIVE MANAGEMENT

- Active bleeding on CT
- Injury grade above III
  - injury of main trunks of hepatic veins twice as likely to fail
  - hepatic veins injured in 13% of patients with liver injury
  - IVC injured (retrohepatic IVC: 50% mortality)
- Overall nonoperative success rate:
  - 80% in adults, 97% in children

FOLLOW-UP CT IN BLUNT LIVER TRAUMA

• **Indications for CT in low grades:**
  – abdominal pain in RUQ, jaundice, fever, anemia or melena

• **Indications for CT in grades IV to VI:**
  – identify complications (7 to 10 days post injury*):
    – bile leakage (biloma, bile peritonitis; 2.8 to 7.4%)
    – delayed hemorrhage (1.7% to 5.9%)
    – abscess (0.6% to 4%)
    – pseudoaneurysm of hepatic artery & hemobilia (1%)

BILE LEAKS

- AAST guidelines for grading liver injury do not take into account bile leaks
- Difficult to predict who will develop a bile leak
- Bile leak asymptomatic in up to 50%
- Symptoms develop if bile infected or biloma large
- Gallbladder injury uncommon: 2-3% with blunt trauma (distended gallbladder!)
LIVER LAC GRADE V + BILE LEAK

Percutaneous Drainage of Biloma
Hepatic repair progresses predictably: Resolution

- Hemoperitoneum 1 week
- Laceration 3 weeks
- Subcapsular hematoma 6-8 weeks
- Parenchymal homogeneity 4-8 weeks
- Hematoma, biloma years

SPLENIC INJURIES

- **Splenic injury**
  - most commonly injured organ following blunt abdominal trauma

- **Incidence of splenic injury**
  - splenic injury accounts for 40-50% of patients with abdominal organ injury
GRADING SPLENIC INJURY

- **Subcapsular hematoma**
  - I < 10% surface area
  - II 10 - 50%
  - III > 50% or expanding

- **Parenchymal hematoma**
  - I < 5 cm diameter
  - II > 5 cm or expanding

- **Laceration (parenchyma)**
  - I < 1 cm
  - II 1 - 3 cm
  - III > 3 cm

- **Devascularization (hilar or segmental vessel damage -> major devasc.)**
  - IV > 25% of spleen

- **Shattered Spleen**
  - V completely shattered or hilar vascular injury, no perfusion

HILAR DEVASCULARISATION

Grade IV
**NONOPERATIVE MANAGEMENT**

- Overall success rate: 65%
- Failed conservative management

<table>
<thead>
<tr>
<th>Grade</th>
<th>% Surgical Intervention</th>
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<tbody>
<tr>
<td>I</td>
<td>0%</td>
</tr>
<tr>
<td>II</td>
<td>8%</td>
</tr>
<tr>
<td>III</td>
<td>19%</td>
</tr>
<tr>
<td>IV</td>
<td>~100%</td>
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<tr>
<td>V</td>
<td>all had initial surgery</td>
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SPLENIC INJURIES: COMPLICATIONS

- Active hemorrhage
  - hyperattenuating area on portal venous phase with persistent hyperattenuation or increase in size on 5 minute delay

- Pseudoaneurysm
  - hyperattenuating area on portal venous phase with wash-out on 5 minute delay (acts like other vessels)

Multiple pseudoaneurysms
PANCREATIC INJURIES

- Incidence: in 1% - 3% of blunt abd. trauma
- Greatest mortality when delay in Dx
- 70% of adults (15-30% children) have associated injuries
- Amylase
  - initially is neither sensitive nor specific
  - 1-2 days later will be elevated in 80-90%
- Initial CT sensitivity 68-80%
PANCREATIC INJURIES

- More common under 40 years of age
- Mechanism: compression against spine
- Association with liver and duodenal injuries
- CT findings: initially may be normal
- Early recognition of duct disruption important because of possible delayed complications:
  - Fistula, pseudocyst, abscess
**PANCREATIC ORGAN INJURY AAST SCALE**

- **Grade I (A*)**
  - minor contusion, superficial lac, duct intact
- **Grade II (A)**
  - major contusion, major lac, duct intact
- **Grade III (B)**
  - duct injury, distal transsection
- **Grade IV (C)**
  - proximal transsection, ampulla injury
- **Grade V (C)**
  - massive disruption of pancreatic head

PANCREATIC INJURIES

Grade I & II: minor/major contusion or laceration
Grade III: distal duct disruption
Grade IV: Proximal transection, ampullary injury
Grade V: Pancreas head, duodenal crush injury

Patel et al, Br J Radiol 1998;71:985-990
CT FINDINGS OF PANCREATIC INJURY

- **Focal or diffuse enlargement/edema**
  - focal area of low attenuation = contusion
  - look for asymmetry of the pancreatic septations
  - heterogeneous enhancement

- **Hemorrhage/fluid in anterior pararenal space**
  - between pancreas and splenic vein
  - around SMA

- **Duct injury** (occurs in about 15% of patients)
  - CT sensitivity low: ERCP or MRCP better; MDCT?
  - implied disruption if laceration is > 50% pancreas thickness
PANCREATIC DISSECTION, GRADE III

Immediately post trauma

ERCP after CT
MIMICKER OF TRAUMATIC PANCREATITIS

Overhydration
MDCT OF PANCREATIC INJURY

- 9/95 (9.5%) patients with blunt abdominal trauma

- Six with MP duct injury, 3 without

- Detection of duct injury was
  - 97.7% in pancreatic phase
  - 100% in portal venous phase
  - 96.8% in equilibrium phase

- High interobserver agreement

TAKE HOME MESSAGE FOR INTRA-
AND RETROPERITONEAL INJURY

- Dedicated trauma protocol
- Timing of iv contrast material critical (smart prep)
- Identify/characterize intraperitoneal fluid collections
- Identify active bleeding
- Identify abdominal parenchymal injuries
- Grade parenchymal injuries for management
- Obtain delayed scans in selected instances