Learning Objectives for blunt abd. Trauma

- MDCT Trauma Protocol
- Incidence of bowel and mesenteric injuries
- Specific signs of bowel/mesenteric injuries
- Nonspecific findings of bowel/mesenteric injuries
- Plan in patients with nonspecific signs
Contrast Materials:

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

Important:

- Clamp bladder catheter to achieve full distention of bladder
ABD. TRAUMA (16 or 64) MDCT

- MDCT Technique:
  - Detector config: 16 (64) x 1.25 mm, mode 1.375:1
  - Reconstruction thickness: axial: 1.25 mm & 5 mm
  - ALWAYS use coronal and sagittal MPRs (3mm)

- Scan delay:
  - 70-80 sec or smart prep
  - 3 minute delay
  - Diaphragm to ischial tuberosity
Important:

- Single acquisition: "total body" trauma CT scan: head, cervical spine, chest, abdomen & pelvis
- Delayed scans (3 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
CT IN BLUNT TRAUMA: BOWEL + MESENTERY

- Bowel & mesenteric injuries are seen in 5% of blunt abdominal trauma at laparoscopy
- Third most common type of injury
- Mechanism:
  - Direct force crushes GI tract
  - Rapid deceleration -> shearing force between fixed and mobile portions of GI tract
  - Sudden increase in intraluminal pressure -> bursting

Hughes Tm, Elton C. The pathophysiology and management of bowel and mesenteric injuries due to blunt trauma. Injury 2002; 33: 295-302.
COMMON SITES OF INJURY TO SB

- Proximal jejunum near ligament of Treitz
- Distal ileum near ileocecal valve
- Mobile and fixed portions -> shear force

DX OF BOWEL & MESENTERIC INJURY

- Increased morbidity and mortality if dx delayed
- Caused by hemorrhage & peritonitis
- Symptoms often nonspecific: pain
- With head + cord injuries: symptoms unreliable
- Clinical assessment alone: 40% negative lap.
- Tests: peritoneal lavage, US and CT

Peritoneal lavage:
- 90% sensitivity for hemoperitoneum
- Insensitive for retroperitoneum
- Perforation missed in up to 10% (early)
- Can compromise results with CT

Ultrasound: FAST:
- 86% sensitivity for free intra-abd. fluid
- 98% specificity for free intra-abd. fluid
- Nonspecific for organ injury

http://www.google.com/search?hl=en&q=ultrasound+in+emergency+room%2C+FAST%2C+images&btnG=Search&aq=f&oq=&aqi=
TESTS FOR ABDOMINAL INJURIES

- MDCT:
  - 69-95% sensitivity for bowel & mesenteric inj.
  - 94-100% specificity for bowel & mesenteric inj.
  - Time to diagnosis significantly reduced
  - Less motion artifacts
  - Best assessment of organs and vessels

Most important CT function: distinction between injuries that require surgery from those treated conservatively

MDCT OF ABDOMINAL TRAUMA: MULTISYSTEM
• **Bowel Injuries:**
  - Complete tear of bowel wall
  - Incomplete tear that involves serosa and muscularis but not mucosa

• **Mesenteric Injuries:**
  - Active mesenteric bleed
  - Disruption of the mesentery
  - Mesenteric injury with bowel injury (ischemia)
NONSIGNIFICANT BOWEL/MESENTERIC INJURIES

- **Bowel Injuries:**
  - Hematoma
  - Tear that involves serosa only

- **Mesenteric Injuries:**
  - Isolated mesenteric hematoma
LOCATION OF BOWEL INJURIES

- Stomach injury 5%
- Duodenal injuries 11%
- Jejunal injuries 25%
- Cecum/ascending colon 7%
- Transverse colon 11%
- Descending colon 2%
- Sigmoid colon 5%
- Multiple sites 34%

FINDINGS SPECIFIC TO BOWEL INJURY

- Bowel discontinuity: 7% (4/54)
- Extraluminal contrast material: 6% (3/54)
- Extraluminal air: 20% (11/54), high spec.
- Associated mesenteric features
  - Mesenteric foci of fluid or blood* (interloop, triangular)
  - Fat stranding due to bowel injury (streaky mesentery)
  - Retroperitoneal air (duodenum: air & fluid/contrast in anterior pararenal space); asc. & desc. colon)

Sentinel clot!
SENTINEL CLOT SIGN FOR VISCERAL INJURY

SENSITIVITY 84%; 3 FP; sentinel clot the only sign in 14%

OTHER CAUSES: INTRAPERITONEAL AIR (78%)

- Mechanical ventilation
- Pulmonary barotrauma
- Peritoneal lavage
- Pneumothorax
- Chest injury
- Entry of air through fallopian tubes
- Intraperitoneal laceration of bladder (trauma or due to cystography)
- Pseudoperitoneum in abdominal wall

DUODENAL TRAUMA

- Uncommon: only 1% of abdominal trauma
- Direct compression of duodenum against spine
- Duodenal rupture (perf.) vs. intramural hematoma
  - Rupture requires emergency surgery
  - Hematoma usually treated conservatively
- Concomitant injuries may involve liver, pancreas, colon, stomach and small bowel
CT OF DUODENAL TRAUMA

- **Duodenal rupture:**
  - Gas, water-density fluid, blood or extravasated oral contrast in right anterior pararenal space

- **Duodenal hematoma**
  - Mass in duodenal wall due to a hematoma
  - Obstructive symptoms within 48 hours of injury

- **Both conditions**
  - Duodenal wall thickening
  - Right anterior space fluid or hemorrhage

- **Important to distinguish as management differs!**
DUODENAL RUPTURE

Blood and water-density fluid in anterior pararenal space and thick-walled duodenum (contusion)
DUODENAL HEMATOMA

SENSITIVITY \leq 12\%, SPECIFICITY 100\%
FLUID IN INTRA- OR EXTRAPERITONEAL SPACES

- Hemorrhage
- Leakage of bowel contents
- Leakage of urine
- Pancreatic juice
- Residual from peritoneal lavage
FINDINGS SPECIFIC TO MESENTERIC INJURY

- **Mesenteric extravasation**
  - Specificity of 100%
  - Seen in 17% (9/54)
  - Indication for urgent laparotomy

- **Mesenteric vascular beading**
  - Indicative of vascular injury
  - Seen in 39% (21/54)

- **Termination of mesenteric vessels**
  - Abrupt termination of mesenteric art.or veins
  - Seen in 35% (19/54), highly specific (1 FP)
FINDINGS LESS SPECIFIC TO BOWEL AND MESENTERIC INJURY

- **Bowel:**
  - **Bowel wall thickening:**
    - focal wall contusion
    - diffuse: overhydration or shock bowel
  - **Abnormal bowel wall enhancement:**
    - patchy or irregular suggestive of full thickness injury
    - absent or decreased -> ischemic bowel
OVERHYDRATION & SHOCK BOWEL

Overhydration

Shock bowel with liver lac
FINDINGS LESS SPECIFIC TO BOWEL AND MESENTERIC INJURY

- **Mesentery**
  - Mesenteric infiltration:
    - Mesenteric injury with or without bowel injury; high sensitivity; seen in 69%
    - DDx: mesenteritis
  - Mesenteric hematoma:
    - Laceration of mesenteric vessel
    - May not need surgery, if not active bleed
  - Bowel features (wall thickening & abnl. enh.):
    - Secondary to mesenteric injury indicative of vascular compromise; may be delayed!
COMMON FEATURES: BOWEL/MESENTER. INJURIES

- **Intraperitoneal & Extraperitoneal Fluid:**
  - Intraperitoneal fluid associated with bowel/mesenteric injuries common (93%, 50/54)
  - Specificity low because of other concomitant injuries or pre-existing disease

- **Location:**
  - Retroperitoneal fluid -> retroperitoneal segment of bowel
  - Retroperitoneal blood -> close to site of injury

- Hemoperitoneum + no parenchymal organ injury = bowel or mesenteric injury
Abdominal Wall Injury:
- Abdominal wall injury (e.g., seat belt injury = soft tissue stranding, tear, hematoma) associated with bowel or mesenteric injuries in 17% (9/54)
• Multiple injuries incl. liver/spleen
• Large size of patients
• Metallic monitoring devices
• Arms in imaging field
• Chaotic scene at imaging site
### SENSITIVITY & SPECIFICITY IN DIAGNOSING SURGICALLY IMPORTANT BOWEL/MESENTERIC INJURY

<table>
<thead>
<tr>
<th>Sign</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowel wall defect</td>
<td>11</td>
<td>100 *</td>
</tr>
<tr>
<td>Extraluminal contrast</td>
<td>8</td>
<td>100 *</td>
</tr>
<tr>
<td>Intraperitoneal air</td>
<td>24</td>
<td>95</td>
</tr>
<tr>
<td>Thick large bowel wall</td>
<td>18</td>
<td>97 *</td>
</tr>
<tr>
<td>Thick small bowel wall</td>
<td>45</td>
<td>76</td>
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<tr>
<td>Retroperitoneal air</td>
<td>5</td>
<td>98</td>
</tr>
<tr>
<td>Abnormal bowel enhanc.</td>
<td>8</td>
<td>90</td>
</tr>
</tbody>
</table>

**Positive (negative) Likelihood ratio useful** * * *

# Sensitivity & Specificity in Diagnosing Surgically Important Bowel/Mesenteric Injury

<table>
<thead>
<tr>
<th>Sign</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retroperitoneal fluid</td>
<td>37</td>
<td>52</td>
</tr>
<tr>
<td>Mesenteric vessel beading</td>
<td>50</td>
<td>95 *</td>
</tr>
<tr>
<td>Abrupt mes. vessel term.</td>
<td>45</td>
<td>93 *</td>
</tr>
<tr>
<td>Mesenteric vessel extrav.</td>
<td>26</td>
<td>100 *</td>
</tr>
<tr>
<td>Focal mesenteric hematoma</td>
<td>45</td>
<td>90</td>
</tr>
<tr>
<td>Mesenteric air</td>
<td>21</td>
<td>95</td>
</tr>
<tr>
<td>Intraperitoneal fluid</td>
<td>100</td>
<td>26 *</td>
</tr>
<tr>
<td>Mesenteric fluid +/or strand.</td>
<td>84</td>
<td>66</td>
</tr>
</tbody>
</table>

CONCLUSIONS: BOWEL/MESENTERIC INJURY

- Recognize significant bowel/mesenteric injuries
- CT signs of significant injuries:
  - Bowel wall defect
  - Free air (intraperitoneal, retroperitoneal or mesenteric)
  - Intraperitoneal bowel contrast material
  - Extravasation of contrast from mesenteric vessels
  - Evidence of bowel infarct
- CT signs: high specificity, low sensitivity!
CONCLUSIONS: BOWEL/MESENTERIC INJURY

Signs for injury needing surgery:

- Mesenteric hematoma combined with bowel thickening
- Significant amount of free fluid without solid organ injury
CONCLUSIONS: MESENTERIC INJURY

- Two additional useful signs for mesenteric injury:
  - Mesenteric vascular beading
  - Abrupt termination of mesenteric vessels
- Both with high specificity and more frequently seen than mesenteric extravasation
CONCLUSIONS: BOWEL/MESENTERIC INJURY

- Nonspecific features of significant bowel or mesenteric injury:
  - Decision for surgery depends on clinical judgment
  - Reevaluate with CT within 6-8 hours

- MDCT negative for bowel and/or mesenteric injury -> CT screening tool to discharge a patient