Blunt Abdominal Trauma: Injury to the Epigastrium

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Blunt Abdominal Trauma (BAT)

- Trauma is the leading cause of death in the United States in persons under 45 years of age
- Because it primarily affects the young, trauma causes more lost years of productive life than cancer and cardiovascular disease combined
- Blunt trauma accounts for 2/3 of all injuries
- Majority of abdominal injuries are due to blunt trauma; 10% of trauma fatalities are due to abdominal injury
Mechanisms of injury

- **Compression**: direct blow or against a fixed object (seat belt, spinal column)
  - Generally results in tears or subcapsular hematomas in solid organs
  - Increased intraluminal pressure can cause rupture of hollow organs

- **Deceleration**: stretching and linear shearing between fixed and movable structures
  - Rupture of supporting elements at junction between fixed and free segments of organs
  - Thrombosis of vessels contained within supporting elements

http://www.emedicine.com/EMERG/topic1.htm
Injuries resulting from blunt abdominal trauma

- **Common:**
  - Liver – most commonly injured in all abdominal trauma (blunt and penetrating)
  - Spleen – most commonly injured organ in blunt trauma
  - Kidney – increasing frequency (increased detection)
  - Bladder (extraperitoneal)

- **Rare:**
  - Pancreas
  - Bowel
  - Adrenal
  - Bladder (intraperitoneal)
First, a brief review of retroperitoneal anatomy.

Note the crowding of the numerous soft organs in the epigastrium, with little bony protection. Unlike small bowel, these organs are fixed in place, and so cannot move out of the path of blunt traumatic forces.
Abdominal Retroperitoneum

- Inferior vena cava
- Abdominal aorta
- Duodenum (retroperitoneal)
- Pancreas
- Right kidney
- Left kidney

Netter FH. Atlas of Human Anatomy. 2nd ed.
Epigastric region

- IVC
- Right adrenal
- Right kidney
- Duodenum
- Transverse colon
- Abdominal aorta
- Left adrenal
- Pancreas
- Left kidney

Options for evaluating BAT

• **Plain film**
  – Difficult to evaluate soft-tissue injury
  – May reveal free intraperitoneal air or signs of bowel obstruction

• **Deep peritoneal lavage**
  – Rapid detection of hemoperitoneum
  – Invasive
  – Risk of visceral and vascular injury
Options for evaluating BAT

• **CT** – *gold standard for BAT evaluation*
  – MDCT: high-resolution images and reconstructions allow improved detection and management of soft-tissue injury, hemorrhage, etc

• **Ultrasound** – increasing use
  – Safe for unstable patients; decreased costs
  – Limitations: fluid-filled bowel *versus* hemoperitoneum; extraperitoneal fluid *versus* intraperitoneal fluid; cystic masses can look like fluid collections; obesity

• **MRI** – not used in initial evaluation of BAT
Our Patient

JO, a 23-yr-old woman kicked in the stomach by a horse

- Imaging at outside hospital suggested pancreatic injury; JO was transferred to BIDMC for more complete evaluation
Initial plain films were normal

Images from PACS, BIDMC
CT: the diagnostic modality of choice in initial evaluation of blunt abdominal trauma
CT: pre-contrast

Mesenteric hematoma

Blood attenuation in duodenal wall

Images from PACS, BIDMC
Post-contrast: Pancreatic injury

Fluid surrounding pancreas

Blood surrounding pancreatic head

Images from PACS, BIDMC
Pancreatic injury in BAT

- **Epi**: uncommon – seen in 0.2-12% of blunt trauma
  - associated visceral injuries are very common (50-90% of patients)
- **Mechanism**: 
  - compression against vertebral column
  - shear across pancreatic neck
- **Sequelae**: Ductal leakage ➔ pancreatitis, which can lead to pseudocysts, fistulas and abscesses (20% mortality)
- **Grading**: based on injury to main pancreatic duct:
  - minor injuries usually heal spontaneously and are treated conservatively
  - injuries involving main pancreatic duct require surgical intervention
CT findings in pancreatic injury

- CT sens/spec for pancreatic injury over 80%; dependence on interpreter experience and timing of evaluation
- **Contusion**: areas of low attenuation with heterogeneous foci and diffuse enlargement of pancreas
- **Laceration**: areas of linear, irregular low attenuation within normal parenchyma
- **Nonspecific**: thickening of anterior pararenal fascia; blood/fluid tracking along mesenteric vessels; fluid in lesser sac; fluid between pancreas and splenic vein
Renal injury

Extravasation of IV contrast

Ischemic kidney
Renal injury

Right kidney

Left kidney

Ischemic kidney

Images from PACS, BIDMC
Renal injury in BAT

• **Epi:** Seen in 10% of trauma patients; blunt trauma accounts for 80% of renal injuries
  – Left-sided predominance (1.3:1) – thought to be due to anatomic protection of right renal artery beneath inferior vena cava and duodenum

• **Mechanism:**
  – sudden deceleration/direct blow can cause renal dislocation
  – stretching of renal arteries can cause immediate avulsion or delayed thrombosis

• **Sequelae:** 80% are contusions/minor lacerations that heal spontaneously; persistent bleeding or complete infarction require surgical intervention
CT findings in renal injury

- CT important in both diagnosis and patient management: provides both functional and morphologic information
- Absence of contrast nephrogram reveals devascularized areas
- Helical CT can image specific renal artery injury
- **Contusion**: delayed and non-homogenous excretion of contrast material
- **Laceration**: linear or wedge-shaped hypodensity
- **Fracture**: involvement of full depth of renal parenchyma + disruption of collecting system
Duodenal hematoma

Image from PACS, BIDMC
Duodenal injury in BAT

• 
  
  **Epi:** Bowel injury seen in 4-5% of major BAT; associated non-bowel injuries in 50%
  – Retroperitoneal duodenum most common site of injury
  – Duodenal hematomas are very uncommon!

• **Mechanism:**
  – Compression between spine and impacting body;
  – Shearing at fixed points (e.g. ligament of Treitz)

• **Sequelae:**
  – Duodenal hematoma: resolves in 1-3 weeks
  – Duodenal perforation: surgical intervention required
CT findings in duodenal injury

- **Nonspecific (perforation vs. hematoma):**
  - Thickening of duodenal wall
  - Presence of fluid in right anterior pararenal space

- **Specific to perforation:** Extraluminal gas and/or oral contrast in right anterior pararenal space

- **Duodenal hematoma:**
  - Initial heterogeneous, high attenuation region in duodenal wall due to blood accumulation
  - Isodensity, then hypodensity as clot resolves
Intraperitoneal bleeding

- Intraperitoneal blood in Douglas' pouch (HU = 50)
- Air in rectum

Image from PACS, BIDMC
Intraperitoneal fluid in BAT

- Is often sole finding on CT in blunt abdominal trauma
- Tracks down right and left paracolic gutters into pelvic reflection of peritoneum
- Large amounts of blood can accumulate in pelvis without significant hemoperitoneum apparent in upper abdomen
CT: detection of intraperitoneal fluid

• CT very sensitive for detecting even small amounts of intraperitoneal fluid or hemorrhage

• “Sentinel clot” sign: with multiple sites of hemoperitoneum, blood with highest CT attenuation is in proximity of site of hemorrhage

• Blood attenuation on CT:
  – Free blood: 20-45 HU
  – Clotted blood: 40-100 HU
  – Active bleeding: within 10 HU of contrast density inside adjacent major vessel
How extensive was the pancreatic injury?

...The role of MRI...
MRI: characterization of soft tissue injury

- MRI is more sensitive for soft tissue anatomy and pathology
- No advantage over CT in initial evaluation, but can be invaluable in characterization of subtle soft tissue injury, as in the pancreas
- Role of MRCP: evaluate damage to pancreatic duct – key factor in surgical versus conservative treatment
Pancreatic injury: characterization with MRI

Lacerations in head of pancreas

Pancreatic head contusion

Laceration in body of pancreas

Images from PACS, BIDMC
Duodenal hematoma on MRI
Sequelae

- JO was admitted to BIDMC one day after the injury
- Her intra-abdominal injuries were managed conservatively (MRCP did not show laceration of pancreatic duct)
- PICC line was placed on day two post-injury; initial inappropriate placement corrected on day three
- Follow-up CT imaging was performed 10 days after initial CT
  - the findings…?
10-day follow-up: Pancreatic pseudocyst

Image from PACS, BIDMC
Pancreatic pseudocyst

Image from PACS, BIDMC
Why did the kidney not infarct completely??

- Initial work-up demonstrated ischemic lower pole in left kidney
- Extravasation of IV contrast into peritoneal cavity would suggest transection of renal artery
- Follow-up CT indicated improved perfusion of lower renal pole
- Interesting anatomy…
Bilateral accessory renal arteries
Accessory renal arteries

• Transection of inferior accessory renal artery originating from common iliac artery, leading to contrast extravasation and infarct of inferior renal pole

• Development of collateral perfusion from main renal artery and remaining accessory renal artery
Our patient’s course

• JO had a stable hospital course, and was discharged home 13 days after admission

• *Incidental note*: JO received a PICC line for parenteral nutrition. Initial follow-up CXR revealed inappropriate positioning of the line....
PICC line terminating in L jugular vein
The PICC line was repositioned, and subsequently revealed some more interesting anatomy....
A Left-sided SVC!

Image from PACS, BIDMC
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References

References

• http://www.emedicine.com/EMERG/topic1.htm