PANCREATIC TRAUMA: The other abdominal injury

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OBJECTIVES

- Participants will have an increased understanding of:
  - Pancreatic anatomy
  - Pancreatic trauma facts & figures
  - Presentation of pancreatic trauma patients
  - Diagnosis of pancreatic injury
  - Treatment of pancreatic injury
  - Implications for EMS
Why Talk About This?

- Pancreatic trauma is relatively infrequent
- Initially very hard to diagnose
- However, a delayed diagnosis can lead to a treatment challenge for the medical team and a potentially disastrous situation for the patient
- Important for EMS providers to develop an awareness of pancreatic trauma

Why?
CASE STUDY

- 26 year old male - high-speed rear impact motor vehicle collision
- Seat belt separated from car at impact
- Initial vital signs on scene
  - SBP 90 mm Hg, 140 HR, RR 30
  - Retrograde amnesia for event
  - c/o abdominal pain, left forearm pain
Upon arrival at ED
- 130/90, 130 HR, A&O x 3, GCS 15
- Abd soft, nondistended, mild tenderness to palpation both upper quadrants
- Ecchymosis- epigastric, RUQ
- Tenderness, deformity left forearm
- Radiography
  - Left radial fx

- Abdominal CT & ultrasound
  - Grade V liver laceration extending to portal vein
  - Grade III splenic laceration with large hematoma
  - Grade II right kidney injury
  - Small amount free fluid between posterior pancreas & splenic vein, suggestive of pancreatic injury

- ERP showed injury of minor pancreatic duct at junction of body & head of pancreas
During ERP, became tachycardic, hypoxic
Required fluid resuscitation, intubation
Stabilized then to OR
Operative findings
- Large nonbleeding lacerations of liver & spleen
- Retroperitoneal hematoma
- Pancreatic head necrosis with surrounding saponification
Pancreas debrided and drained

REMEMBER THIS PATIENT’S PRESENTATION FOR LATER
BRIEF OVERVIEW

Pancreatic Anatomy & Physiology
**PANCREAS**

- Gland with both exocrine and endocrine functions
- 6-10 inches in length
- 60-100 grams in weight
- Location: retro-peritoneum, 2\textsuperscript{nd} lumbar vertebral level, across midline
- Extends in an oblique, transverse position
- Parts of pancreas: head, neck, body and tail
  - Head lies in curve of duodenum
  - Tail “tickles” the spleen
B = body
H = head
N = neck
T = tail
Un = uncinate
NECK OF PANCREAS

- 2.5 cm in length
- Antero-superior surface supports the pylorus
- Superior mesenteric vessels emerge from the inferior border
- Posteriorly, SMV and splenic vein confluence to form portal vein
BODY OF PANCREAS

- Elongated, long structure
- Anterior surface, separated from stomach by lesser sac
- Posterior surface, related to aorta, lt. adrenal gland, lt. renal vessels and upper 1/3rd of lt. kidney
- Splenic vein runs embedded in the posterior surface
- Inferior surface is covered by transverse mesocolon
PANCREATIC DUCT

- Main duct runs the entire length of pancreas
- Joins common bile duct at the ampulla of Vater
- 2 - 4 mm in diameter, 20 secondary branches
- Lesser duct drains superior portion of head and empties separately into 2nd portion of duodenum
Variety of major arterial sources
- celiac, SMA and splenic

Celiac → Common Hepatic Artery → Gastroduodenal Artery → Superior pancreaticoduodenal artery which divides into anterior and posterior branches

SMA → Inferior pancreaticoduodenal artery which divides into anterior and posterior branches

Body and tail supplied by splenic artery by about 10 branches (can be up to 25)
Arterial Supply of Pancreas

- Abdominal aorta
- Common hepatic artery
- Gastroduodenal artery
- Proper hepatic artery
- Right gastroepiploic artery
- Posterosuperior pancreaticoduodenal artery
- Anterosuperior pancreaticoduodenal artery
- Posterior pancreaticoduodenal arcade
- Anterior pancreaticoduodenal arcade
- Duodenum
- Prepancreatic arcade
- Vasa recta
- Posteroinferior pancreaticoduodenal artery
- Anteroinferior pancreaticoduodenal artery

- Celiac trunk
- Left gastric artery
- Left gastroepiploic artery
- Splenic artery
- Spleen
- Caudal pancreatic artery
- Great pancreatic artery
- Dorsal pancreatic artery
- Inferior pancreatic artery
- Superior mesenteric artery
- Upper jejunal arteries
EXOCRINE

- Constitutes 80% to 90% of the pancreatic mass
- Colorless, odorless, and isosmotic alkaline fluid that contains digestive enzymes (amylase, lipase, and trypsinogen)
- Inactive as move through pancreatic duct to bile duct
- Activated when enter duodenum
500 to 800 ml pancreatic fluid secreted per day

- Enzymes digest carbohydrates, proteins, and fats

- Alkaline pH results from secreted bicarbonate which serves to neutralize gastric acid and regulate the pH of the intestine
ENZYMES

- **Amylase**
  - only digestive enzyme secreted by the pancreas in an active form
  - functions optimally at a pH of 7
  - hydrolyzes starch and glycogen to glucose, maltose, others

- **Lipase**
  - function optimally at a pH of 7 to 9
  - emulsify and hydrolyze fat in the presence of bile salts
IF PANCREATIC ENZYMES LEAK

BAD NEWS FOR PATIENT

- Digest fat
- Surrounding tissue
- Saponification, necrosis
ENDOCRINE

- Accounts for only 2% of the pancreatic mass
- Nests of cells - islets of Langerhans
- Four major cell types
  - Alpha (A) cells secrete glucagon
  - Beta (B) cells secrete insulin
  - Delta (D) cells secrete somatostatin
  - F cells secrete pancreatic polypeptide
- Secreted into blood capillaries instead of ducts
INSULIN

- Synthesized in the B cells of the islets of Langerhans
- 80% of the islet cell mass must be surgically removed before diabetes becomes clinically apparent
GLUCAGON

- Secreted by the A cells of the islet
- Glucagon elevates blood glucose levels through the stimulation of glycogenolysis and gluconeogenesis
**SOMATOSTATIN**

- Secreted by the D cells of the islet
- Inhibits the release of growth hormone
- Inhibits the release of almost all peptide hormones
- Inhibits gastric, pancreatic, and biliary secretion
- Used to treat both endocrine and exocrine disorders
EXCITING STATISTICS

- Overall rate of blunt pancreatic injury seen in Level I trauma centers is relatively low.
- Pancreas estimated to be 10\textsuperscript{th} most injured organ.
  - Usually requires significant force.
- Of 100 patients with blunt trauma, fewer than 10 will have documented pancreatic injury.
BLUNT TRAUMA

- Relatively protected position high in retroperitoneum
- Injured much less frequently with typical blunt trauma (MVC, sports, etc) than spleen and liver
- MVC’s are cause of 90% of major non-penetrating injuries of pancreas
- 50% of those from impact of steering column on upper abdomen
- Compressed against vertebra
  - Often causes transection
Incidence of pancreatic injury with penetrating trauma is much higher

- GSW, stabbings to back, flank and abdomen frequently include pancreatic injury
  - 20-30% of patients with penetrating trauma
- Highest frequency of pancreatic injury occurs from GSW and is almost always associated with concurrent injury to other abdominal organs
Because the blunt force required to injure the pancreas is so significant and penetrating trauma usually injures multiple organs, a pancreatic injury is rarely a solitary injury.

Multiple organ injury is a red flag suggesting the possibility of a pancreatic injury.
In one multi-year review, in only 2% of closed abdominal injuries was a major pancreatic laceration the only injury.

Because of anatomic position, isolated pancreatic injury may occur with penetrating trauma to the midback (stabbing, impalement).
MORBIDITY & MORTALITY

- Many blunt pancreatic injuries are not immediately recognized
- So higher morbidity and mortality rates
- Not so much with penetrating because usually mandates emergency surgical exploration
MORBIDITY & MORTALITY

- Delay of diagnosis of blunt pancreatic injury more than 24 hours has been reported as the leading cause of increased morbidity.
- Major ductal injuries result in mortality rates of 13-31%, increasing with number of associated vascular injuries.
- Overall mortality.
PRESENTATION

- Pancreatic injury can be frighteningly symptom free early post-injury.
- No signs, symptoms, lab findings specific to pancreatic injury.
- Symptoms of injury to other structures commonly mask or supersede those of pancreatic injury.
- Notoriously difficult to detect by physical findings and as illustrated by our case study, patients may have minimal (or nebulous) physical signs.
**PRESENTATION**

- High index of suspicion based on location of trauma/injury
  - Seat belt marks
  - Flank ecchymosis
  - Penetrating injuries (flank, mid back)
- Trauma from anterior-posterior force vector with deceleration and an anterior truncal seat belt mark
  - Aortic, small bowel, pancreas
Epigastric pain out of proportion to physical findings could be one possible sign of pancreatic injury.

May see abdominal distension, signs of peritoneal irritation, retroperitoneal fluid or air, pleural effusion, back pain.
POSSIBLE INJURIES TO PANCREAS

- Simple puncture of body or tail of pancreas
  - highly complex & difficult injury
- Injury to pancreatic head with involvement of biliary & pancreatic ductal systems
- Proximity of portal vein, abdominal aorta & inferior vena cava to pancreatic head increases risk of exsanguinating hemorrhage
  - Exsanguinating hemorrhage due to concurrent vascular injury accounts for greatest number of deaths in patients with pancreatic trauma
COMMON ASSOCIATED INJURIES

- Spleen
- Liver, common bile duct
- Stomach
- Intestinal- duodenal, colon
- Diaphragm
- Ribs
- Spinal
  - With isolated injury from blunt trauma, spinal fracture usually seen with small children
  - Caused by direct abdominal blows from malpositioned seat belts or child abuse
- Head- simply based on common MOI
DIAGNOSIS OF PANCREATIC INJURY

- Physical findings?
- Routine chest, abdominal X-rays?
- Peritoneal lavage?
- CT scan- inaccurate, incomplete
  - Read as negative in up to 40% of pts with operatively proven pancreatic injury
  - Can be suggestive of pancreatic injury- fluid between splenic vein & posterior border of pancreas
**DIAGNOSIS**

- Ultrasound
  - Prehospital?
  - Not helpful with acute injury

- ERP or ERCP
  - Endoscopic retrograde cholangiopancreatography
  - Direct visualization of biliary tract
  - Injection of radiographic dye into ducts
  - Absence or presence of ductal injury
LABORATORY FINDINGS

- Serum amylase levels
  - Persistently elevated or rising levels after blunt abd injury may be a sign of pancreatic injury
- Poor correlation between actual level of amylase and extent of pancreatic damage
- Enough to prompt further testing
  - Elevations can also be caused by duodenal or hepatic injury or pt intoxication
PREHOSPITAL TREATMENT

- Prehospital care dependent on MOI and pt presentation
  - PMH, meds, physical exam
- RAPID TRANSPORT
- Maintain airway, oxygenation
- Pain control??
- Q 5 min vitals
- Resuscitation and support as needed

Trust your judgment!!!
HOSPITAL COURSE

- Operative management remains the rule
- Rapid hemorrhage control
- High index of suspicion and recognition of pancreatic injury
TREATMENT OF PANCREATIC TRAUMA

- Prohibitive morbidity of conservative management makes surgery the treatment of choice

- Presence of retroperitoneal hematoma isn’t always recognized as significant evidence for pancreatic injury
TREATMENT

- Conservative resection of pancreas is likely to be followed by leakage of enzymes and further tissue destruction.
- Attempts to reconstruct a damaged pancreatic duct system are not justified:
  - Little morbidity from distal pancreatectomy
  - Do splenectomy?
  - Endocrine & exocrine deficiency are small and transient
  - Easier to achieve hemostasis
Grade 1- contusion/hematoma
  ▪ Simple drainage
Grade 2- minor capsular disruption
  ▪ Debridement, drainage
Grade 3- major ductal injury
  ▪ Distal pancreatic resection
Grade 4- severe crush injury
  ▪ Debridement, drainage and/or resection depending on exact location of injury
Whipple (pancreatoduodenectomy)
  ▪ required for up to 3% of isolated pancreatic injuries and 10% of severe pancreatoduodenal trauma
Resection margin oversewn to prevent leak of pancreatic juice

Specimen with tumor and associated lymph nodes
TRANSECTED NECK OF PANCREAS
DISTAL PANCREATECTOMY
COMPLICATIONS

- 70% related to vascular injury
- Hemorrhage
- Infection, sepsis
- Fistula
- Pseudocyst
- Abscess
- Others
  - Paralytic ileus, gastric outlet obstruction, ARDS
  - Peritonitis secondary to extravasation of activated pancreatic enzymes- high mortality
Unlike spleen, few data suggest that pre-existing diseases of the pancreas result in higher risk of injury or higher mortality rate when pancreas is injured.

Pre-existing pancreatitis or diabetes negatively affects the overall mortality and morbidity rates.

Post-injury development of pancreatitis or diabetes mellitus is associated with a significant increase in morbidity and mortality rates.
CASE STUDIES
26 yo female, stepped on by horse over midline upper abdomen

Initial physical exam remarkable only for slight upper abdominal tenderness

During transport, c/o increasing epigastric & back pain with nausea

Developed diffuse abd tenderness and rigidity
Trauma surgeon suspects closed pancreatic injury

Exploratory laparotomy
- large retroperitoneal hematoma

Further exploration revealed body of pancreas was completely transected just to left of portal vein
- Gross peripancreatic fat necrosis

Splenectomy and distal pancreatectomy performed

Many complications, including ARDS, infections, DIC

Discharged day 31
PATIENT # 2

- 28 yo male mechanic run over by truck while laying on his back, partially beneath another motor vehicle
- Wheel of truck passed over his mid-abdomen
- Pt demonstrated immediate signs/symptoms of severe shock and was treated appropriately by EMS providers
Upon arrival to hospital, taken for immediate laparotomy without further investigation due to clear evidence of continuing intraperitoneal bleeding

Apparent source of bleeding was tear in transverse mesocolon, which was still bleeding

Large retroperitoneal hematoma noted, but lesser sac not explored

No other lesions noted at that time
Continued deterioration even with assisted ventilation & antibiotic therapy

Surgical exploration of lesser sac and abscess cavity

Pancreas had been transected at level of neck and was gangrenous

Lesser sac was filled with infected hematoma and necrotic tissue

Distal pancreatectomy & splenectomy were performed with drainage

Slow pt improvement with discharge after 11 weeks
PATIENT # 3

- 19 yo logger sustained blunt abdominal trauma when crushed under falling timber
- On scene-Pale, 90/60, no external signs of injury
- Upon arrival at ED, c/o mild abdominal pain with mild epigastric tenderness with no guarding or rigidity
  - 120/70, 110
- Normal chest x-ray, free fluid seen on abdominal ultrasound, but no organ injury seen
- Managed conservatively
8 hours later, developed increasing abd distension with guarding and rigidity

Exploratory laparotomy done at 24 hours post-injury
- 600 cc intraperitoneal blood
- Liver lac
- Transection of pancreas at neck
- Distal pancreatectomy with splenectomy
SUMMARY

- Rapid transport, high index of suspicion
- Prompt, early operative management
- NOM can increase complications
  - No change to outcomes in pancreatic injury over the past 20 years
- Delay of > 24 hours will significantly increase complications, length of stay, mortality
- Common complications include vascular injuries with hemorrhage, fistula, abscess
QUESTIONS

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REFERENCES