Management of solid organ injury in Trauma
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Case presentation

- 26M transfer from outside hospital, s/p assault, fall onto pipe, complaining of left sided chest pain/abdominal pain, inability to void
- Workup revealed: Lt lower rib fx, high grade Lt kidney lac, suspected splenic lac
- Serial Hg at OSH 13.8 → 12.9 → 12.2
- PMHx/PSHx: noncontributory
- Transferred to Kings County Hospital
Case Presentation

- **Vitals:** P 90-110s bpm, BP 130/65, RR 20, T 97.7°F
- **Primary survey:** intact, 2 large bore IVs in place
- **Secondary Survey:** Left flank tenderness, gross hematuria
- **CT C/A/P:** L 8th rib fx, small hemo/pneumothorax, grade II/III splenic lac, grade IV kidney lac with large perinephric hematoma with extravasation of contrast from collecting system
CT images
CT Images
CT images
CT images
CT images
CT images
CT images
Worsening left flank pain, febrile, HR 100s

- Slow downtrend of Hct: 30 → 29.1 → 28.4 → 27.1
- CXR unchanged; blood cx negative
- Repeat CT A/P:
  - large retroperitoneal hematoma
  - extravasation of urine from anterior and posterior collecting system
  - Blood clots in renal pelvis, non-filling of left ureter
  - Increasing perihepatic and perisplenic fluid with extension into the lesser sac;
Operative events HD 3-4

- GU attempted stent placement in OR
  - Extravasation of urine at the ureteropelvic junction
  - Questionable placement of stent

- Post op:
  - One hour post-op, pt developed respiratory distress with desaturation to 70%, HR 140s → intubation
  - Hct decreased from 30 to 22
  - Decision was made to explore patient
Operative events HD 3-4

- Exploratory laparotomy
  - Left nephrectomy
  - Splenectomy
  - Removal of stent

- EBL: 2L

- Intra-op transfusions
  - 6U pRBC
  - 4U FFP
  - 1U platelets
  - 3L crystalloids
SICU course

- HD 5 – Extubated
- HD 7-10, pt developed ileus which resolved with NGT
- HD 14 – hematoma in renal fossa drained by IR
- HD 17 – pt discharged home
Management of blunt abdominal trauma

- Initial management and algorithms
- FAST
- Trauma grading scale
- History of nonop management
- Article
- Management of kidney injuries
  - Indications for operation
  - Renovascular trauma and nonoperative management
National Trauma Database

- **Spleen**
  - Most commonly injured abdominal organ
  - 50.7% of blunt abdominal trauma
  - 14.5% of penetrating abdominal trauma

- **Liver**
  - 2nd most commonly injured abdominal organ
  - 39.8% of blunt abdominal trauma
  - 42.3% of penetrating abdominal injury
Mechanisms of injury

- Crushing
  - direct application of a blunt force to the abdomen
Mechanisms of injury

- Shearing
  - sudden decelerations apply a shearing force across organs with fixed attachments
Mechanisms of injury

- Bursting
  - raised intraluminal pressure by abdominal compartment can lead to rupture of hollow viscus
Mechanisms of injury

- Penetration
  - Disruption of bony areas by blunt trauma that can generate sharp fragments causing secondary penetrating injury
Clues on physical exam

- **Seat belt sign**
  - Increased concern for mesenteric, bowel or lumbar spine injuries

- **Cullen Sign**
  - Periumbilical ecchymoses
  - Retroperitoneal or intraabdominal hemorrhage

- **Grey Turner sign**
  - Flank ecchymosis
  - Retroperitoneal hemorrhage

- **Kehr Sign**
  - Referred pain to shoulder
  - Signifies intra-abdominal hemorrhage, splenic injury, free air
Evaluation of blunt abdominal trauma

- ABCDEs
- Secondary survey
  - AMPLE
  - Full body examination
  - CXR/PXR/FAST
  - Frequent RE-evaluation
- Indications for immediate laparotomy
  - Hemodynamic compromise
    - + FAST
    - DPL (can detect >250cc of intraperitoneal fluid)
  - Abdominal rigidity/peritonitis
Evaluation of blunt abdominal trauma

- Hemodynamically stable
  - CT Chest/Abd/Pelvis
    - Hollow viscus injury → OR
    - +/- angioembolization if concern for active arterial bleeding
FAST

- Purpose of FAST exam:
  - To rapidly determine intraperitoneal bleeding in a hemodynamically unstable patient
- 4 views
FAST
FAST

A

FLUID

LIVER

KIDNEY
<table>
<thead>
<tr>
<th>Grade</th>
<th>Liver</th>
<th>Spleen</th>
<th>Kidney</th>
</tr>
</thead>
</table>
| I     | Subcapsular hematoma <10%  
Laceration <1cm | Subcapsular hematoma <10%  
Laceration <1cm deep | Contusions, subcapsular hematoma, nonexpanding |
| II    | Subcapsular hematoma 10-50%  
Laceration 1-3 cm | Subcapsular hematoma 10-50%  
Laceration 1-3 cm | Nonexpanding hematoma, perirenal hematoma confined to retroperitoneum  
Laceration <1cm parenchymal depth |
| III   | Subcapsular hematoma >50%  
Intraparenchymal hematoma >10cm or expanding  
Laceration >3cm | Subcapsular hematoma >50%  
Intraparenchymal hematoma >5 cm or expanding  
Laceration >3cm | Laceration >1 cm without collecting system rupture or urinary extravasation |
| IV    | Parenchymal disruption 25-75% of hepatic lobe or  
1-3 Couinaud's segments in a single lobe | Laceration involving segmental or hilar vessels with major devascularization (>25% of spleen) | Laceration of parenchyma extending through the renal cortex, medulla and collecting system, main renal artery or vein with contained hemorrhage |
| V     | Parenchymal disruption >75% of lobe, >3  
Couinaud's segments  
Juxtahepatic venous injuries | Completely shattered spleen, hilar vascular injury that devascularized the spleen | Laceration – completely shattered kidney, avulsion of renal hilum that devascularized the kidney |
Nonoperative management of blunt abdominal trauma: the role of sequential diagnostic peritoneal lavage, computed tomography, and angiography.

**Group I – Bedrest Only (n=19)**
- No extravasation
  - Successful n=18
  - Required embolization n=1 -- successful

**Group II – Bedrest + coil embolization of splenic artery (n=18)**
- Two pts Requiring laparotomy (between both groups)

**Group III – exploratory laparotomy without angio/embolization (n=8)**
- 35/36 underwent splenic salvage
Abdominal trauma, from operative to nonoperative management

- **DPL**
  - High sensitivity, low specificity
  - Caveats: unreliable for distinguishing retroperitoneal injuries and ruptured diaphragm

- **FAST**
  - High sensitivity, low specificity

- **CT scan**
  - Solid organ injuries
  - Drawbacks: radiation, need for contrast
  - Benefits: can show potential complications for pancreatic and duodenal injuries (pancreatitis, pseudocyst, fistula, abscess)
  - **CT grading system does not predict need for operation or embolization after liver/spleen trauma**
Prospective observational study to identify predictive factors requiring laparotomy and failure of NOM

46 pts met criteria for multiple solid organ injury
- 15 pts underwent immediate exlap
- 31 pts underwent NOM
  - 23 pts successfully managed nonoperatively
  - 8 pts failed – underwent exlap
Operative group vs NOM group

Operative group had:
- Higher transfusion requirements
- Increased crystalloid resuscitation
- A drop in hct >20% within 1st hour
- Higher lactate levels
- Higher solid viscus score
Failed NOM vs successful NOM

Failed NOM group had:

- Higher solid viscus score and ISS
- Lower GCS
- Hypotension was present at admission
- Required more crystalloids and transfusions

Cause of failure

- 4 pts – delayed splenic (3) and kidney bleed
- 4 pts – nontherapeutic lap (2 liver lacs, 1 mesenteric lac, 1 pancreatic injury)
Renal Trauma: overview

- 3% of all trauma admissions, 10% of abdominal trauma
- Signs and symptoms
  - Flank pain
  - Microscopic or gross hematuria
- Emergent exploration
  - Hemodynamic instability
  - Penetrating traumas requiring laparotomy for other injuries
- Anatomic variations
  - Pelvic kidneys, horseshoe kidneys
  - Multiple renal arterial, venous and ureteral duplications
Renal Trauma: workup

- Urinanalysis
- CT A/P with 5 minute delayed imaging
  - Delayed imaging will reveal urinary extravasation
- Special considerations
  - Pediatric trauma + hematuria
    - Kidneys are relatively larger compared to their body size
    - More prone to injury
  - De-acceleration injuries
    - Floating in fat, fixed at two points: the vascular pedicle and the ureters
  - Commonly associated injuries
    - Lower rib, lumbar vertebral or transverse process fractures
Non operative management

- 85-90% successful

Complications of non-operative management of kidney injuries can be managed with percutaneous interventions
- Drainage of urinomas, collections, urinary stent placement
- Less successful for renovascular trauma
  - Selective angioembolization, stent placement
Operative management

- Indications for exploration
  - Signs of continued renal bleeding
    - Pulsatile/expanding/uncontrolled hematoma
  - Grade V injuries – avulsion of the vascular pedicle

- Relative indications
  - Major devitalized parenchyma with other intra-abdominal injuries (higher rate of complications)
  - Persistent urinary extravasation or sepsis
  - Ureteropelvic junction injuries – rarely resolve spontaneously
    - Complications include: urinoma, ileus and infection
Operative management (cont)

- Arterial thrombosis
  - Controversy on management
  - >12 hrs ischemic time – allow kidney to atrophy
Surgical management

- Standard midline trauma laparotomy
- Kidney exposure
  - Proximal vascular control b4 opening Gerota’s fascia if attempting salvage
  - If unstable patient, direct approach through Gerota’s fascia
Gain proximal vascular control for L kidney

- Retract transverse colon superiorly and anteriorly
- Retract small bowel to the right and superior
- Incise posterior peritoneum right above IMV over the aorta
- Continue dissection superiorly until L renal vein encountered
- Mobilize and retract left renal vein to gain control of L renal artery
- Incise white line of Toldt with medial rotation of the left colon
Gain vascular control of R kidney

- Dissect out R renal artery, posterior to vein and to the right of the aorta
- Identify R renal vein travelling to IVC
- Mobilize R colon and reflect medially
Renal salvage

- Control any significant bleeders
- Excise devitalized tissue
- Repair collecting system with watertight absorbable suture
- Tension free repair of capsule with pledgets
- Omental flap if other injuries present
Nephrectomy without prior vascular control

- Medial visceral rotation
- Vertical incision of Gerota’s fascia to deliver kidney anteriorly
- Control hilum with digital compression
- Ligate artery and vein
- Identify and ligate ureter
Conclusions

- 20 pts with b/l renal artery occlusion
  - Surgical revascularization successful in 9/16 pts (56%)
- 139 pts with unilateral renal artery occlusion
  - Surgical revascularization successful in 9/34 pts (26%)
    - Decreased renal function in 67% of these patients at mean 1.8 yr follow up
  - Hypertension in 34/105 pts who were observed
- Surgical revascularization rarely successful in unilateral renal artery occlusion
- Attempt indicated in pts with b/l renal artery occlusion or a unilateral kidney
Angiointervention: high rates of failure following blunt renal injuries.

- 434 pts
  - 416 pts with NOM
    - 337 (81%) successful NOM
    - 79 pts (19%) required angiography
      - 22 pts (27.8%) underwent embolization
        - 6pts failed embolization
        - Higher blood transfusion requirement
      - 57 pts not requiring embolization
        - 7 pts (12%) failed embolization

- Conclusion: 16% of pts failed embolization
Factors associated with a poor outcome following renovascular injuries

- Blunt trauma
- Grade V injuries
- Attempted arterial repair
Analysis of Diagnostic angiography and angioembolization in the Acute Management of renal Trauma Using a National Data Set

James Hotaling, Sorenson, Thomas G. Smith, III, Rivara, Wessells, Voelzke
J Urol, 185 (2011), pp. 1316-1320

Initial angioembolization failed 100% in Grade IV and V injuries
- With serial AE, 78% of grade IV and 83% of grade V injuries did not require nephrectomy
- 10 pts eventually required nephrectomy in Grade IV and Grade V injuries
8 pts with main renal artery occlusion or dissection

6 pts were successfully stented
  ◦ 2 pts had contrast extravasation requiring angioembolization

4 pts had kidney atrophy

2 pts had successful stent patency and functional kidneys

One pt had nephrectomy from severe renal HTN

One pt lost to follow up

One was normotensive with unknown stent patency
Summary

- Blunt abdominal solid organ injuries can be managed expectantly given hemodynamic stability.
- Angioembolization highly successful for management of blunt liver and splenic traumas, less successful in blunt renal trauma.
- Multiple solid organ injury can be managed nonoperatively, with caution.