

Pitfalls in CT Imaging of Blunt Abdominal Trauma

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Educational Objectives

- Identify common pitfalls in interpretation of blunt abdominal trauma CT studies
- Optimize CT acquisition techniques to reduce likelihood of missing potentially significant injuries
- Develop a search pattern that includes organs and areas where important lesions are commonly missed

Sources of Pitfalls

- Inadequate MDCT technique
- Artifacts
- Patient-related factors: body habitus, low cardiac output, motion, over resuscitation
- Anatomic variants, pre-existent pathology
- Subtle or uncommon injuries (misses)

MDCT Technique

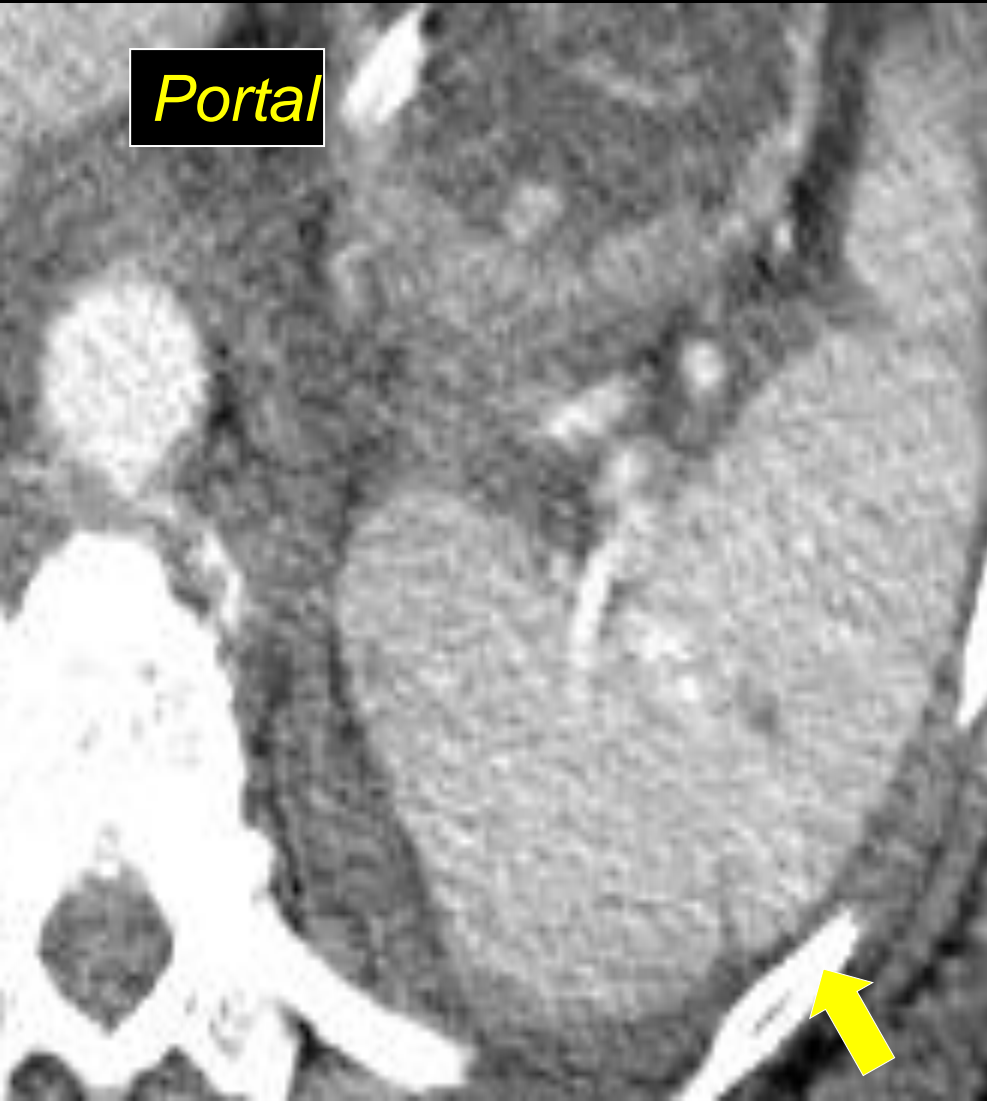
- **NO** oral contrast
- **YES** intravenous contrast at fast rate, saline chaser
- Radiation modulation techniques to lower dose, **BUT** diagnostic quality should not be compromised
- Routine orthogonal plane reformations
- Number of phases: 1, 2 or 3?
- CT cystography: full bladder, can be combined with delayed series

CT Phases in Abdomino-Pelvic Trauma

- Arterial (22 to 30 sec):
 - Optimal evaluation of vascular structures & contained vascular injuries (PS + AVF)
- PVP of upper abdomen (65 to 70 sec): detection of solid organ injury (peak parenchymal enhancement)
- Selective Delayed (5 minutes):
 - Determine integrity of renal collecting system and ureters
- **Low radiation dose** for delayed **and** arterial phases

s/p MVA

Portal



Arterial



Arterial phase > sensitive for PA

Contained vascular lesion (PA)

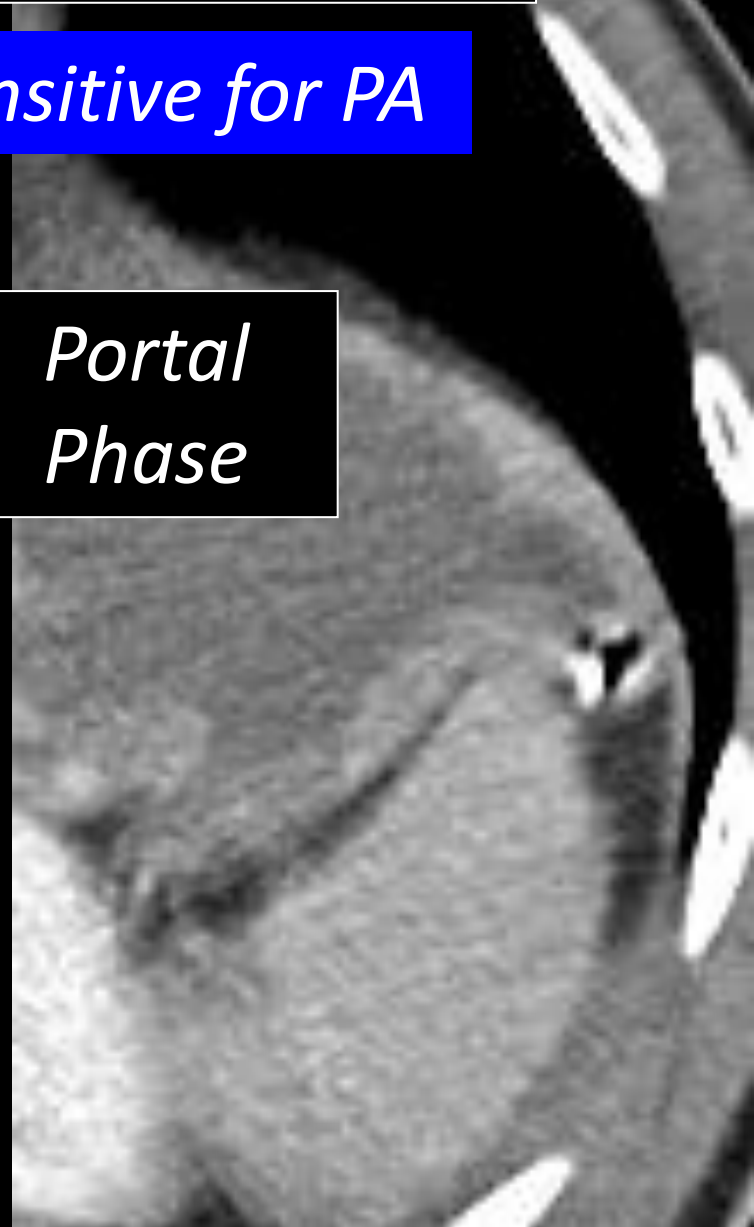
s/p MVA

Arterial phase > sensitive for PA

*Late
Arterial
Phase*



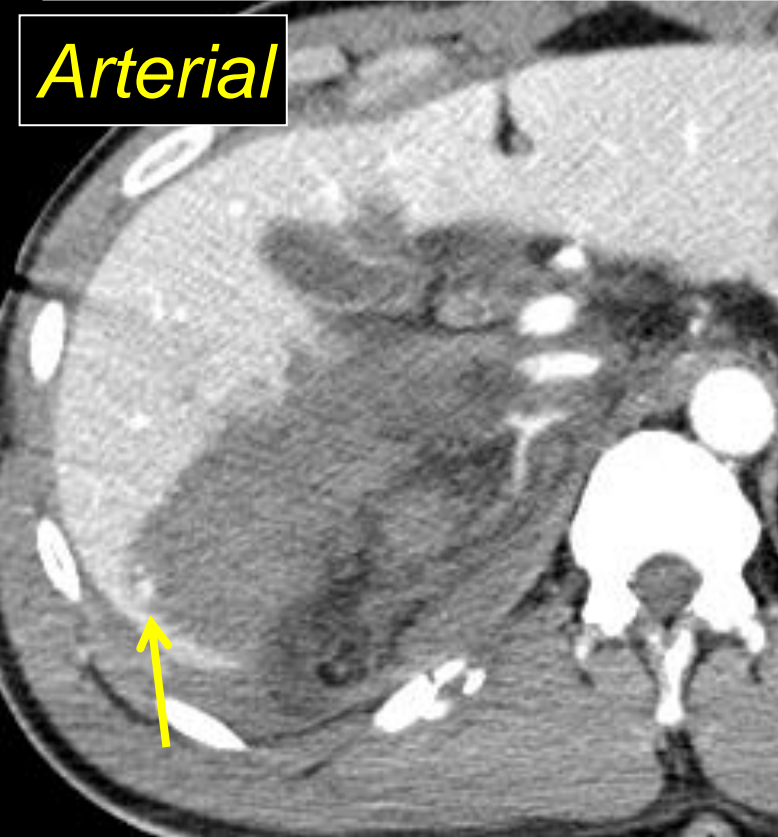
*Portal
Phase*



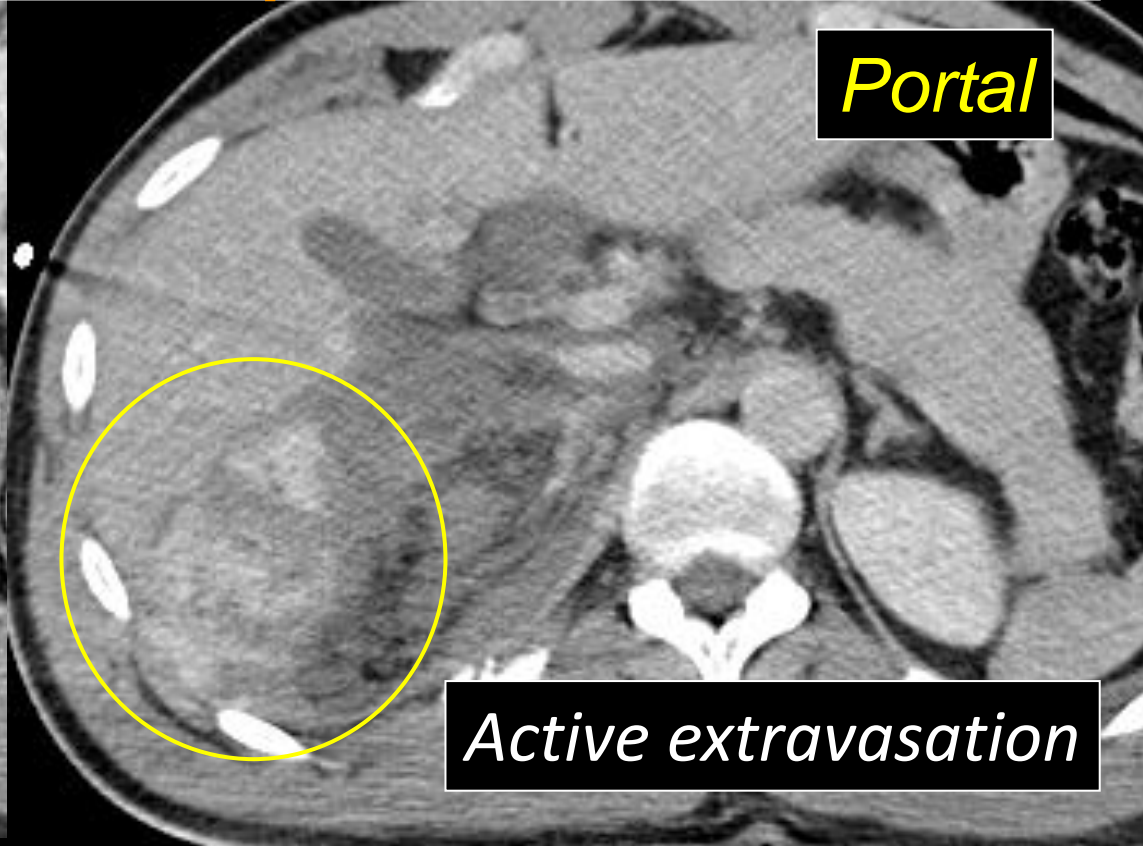
Active Extravasation

Portal: second point in time

Arterial



Portal

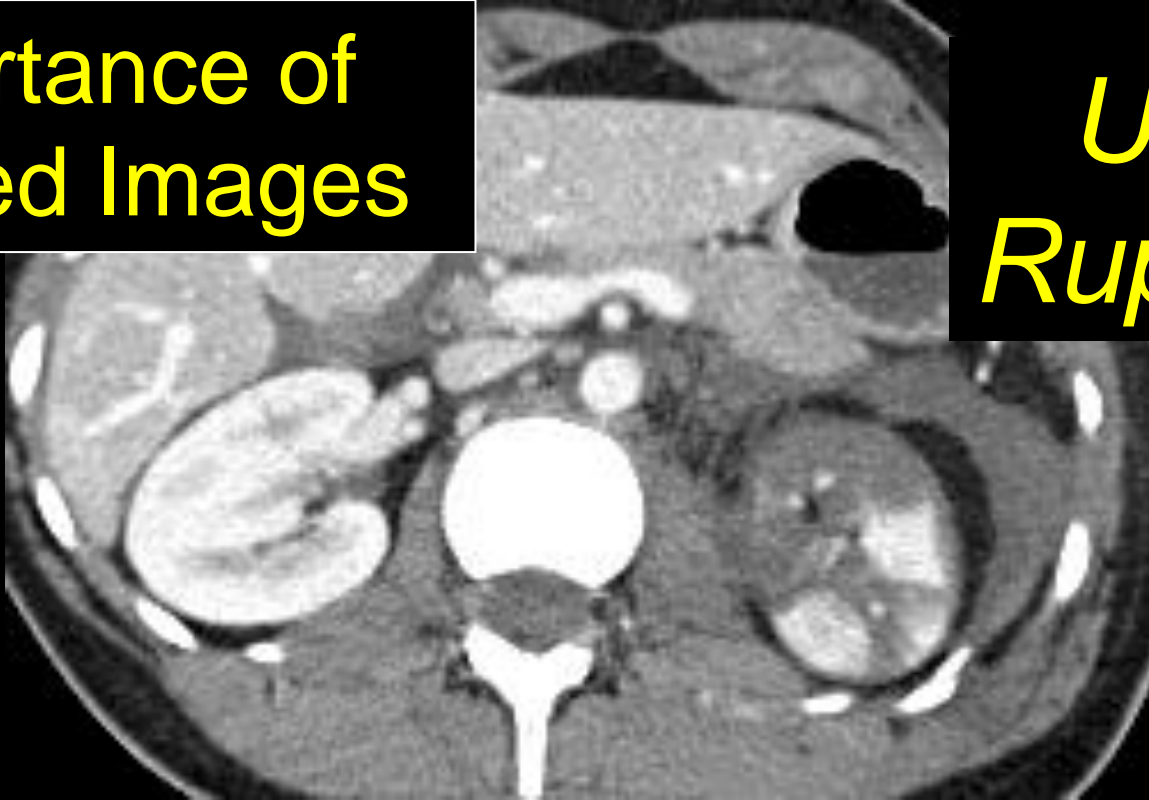


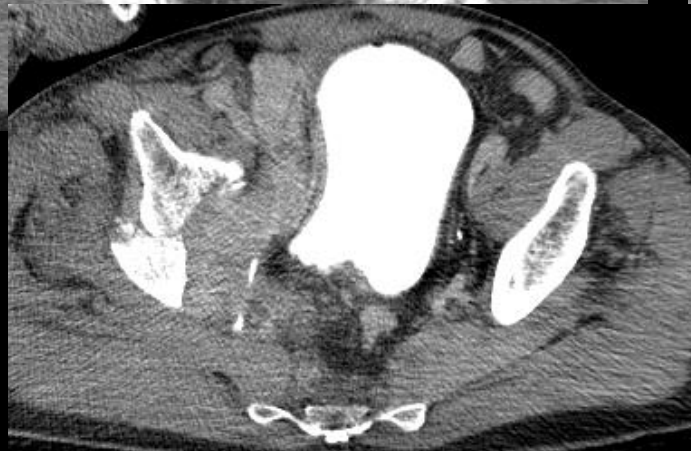
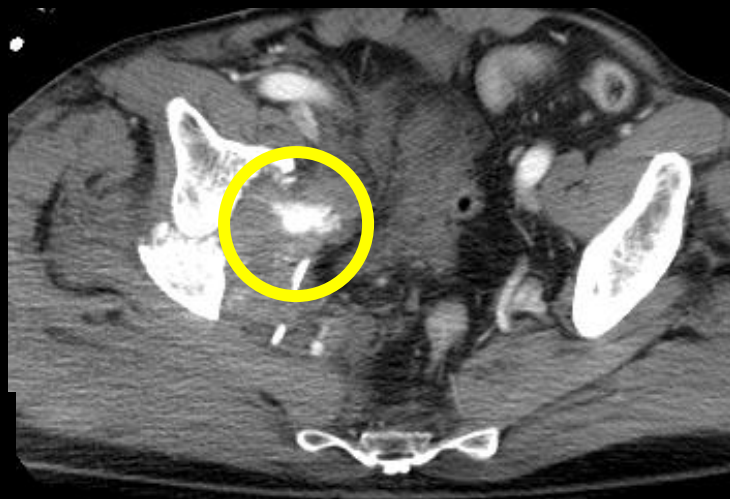
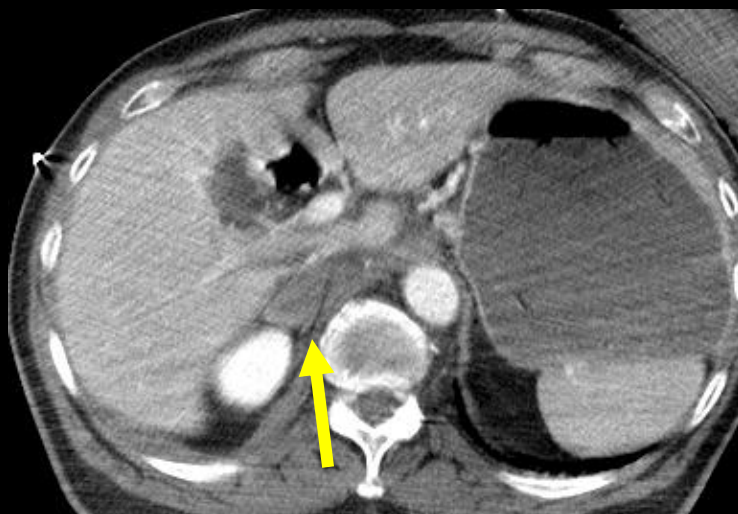
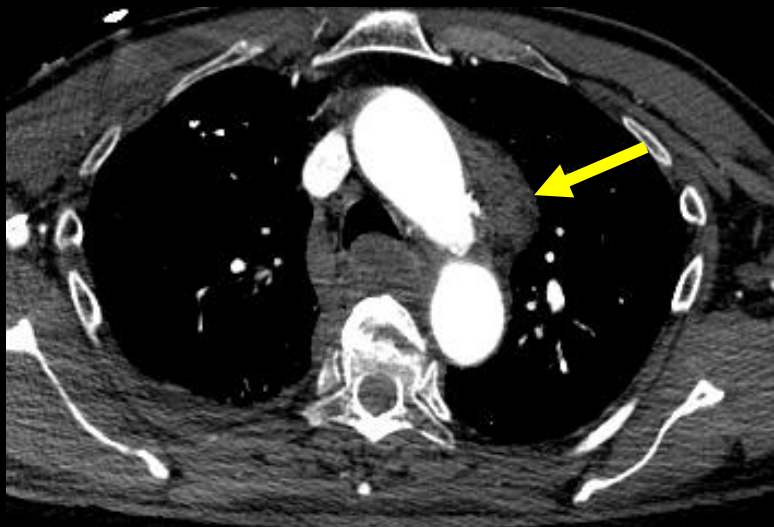
Active extravasation

Portal phase: > sensitive for active bleeding

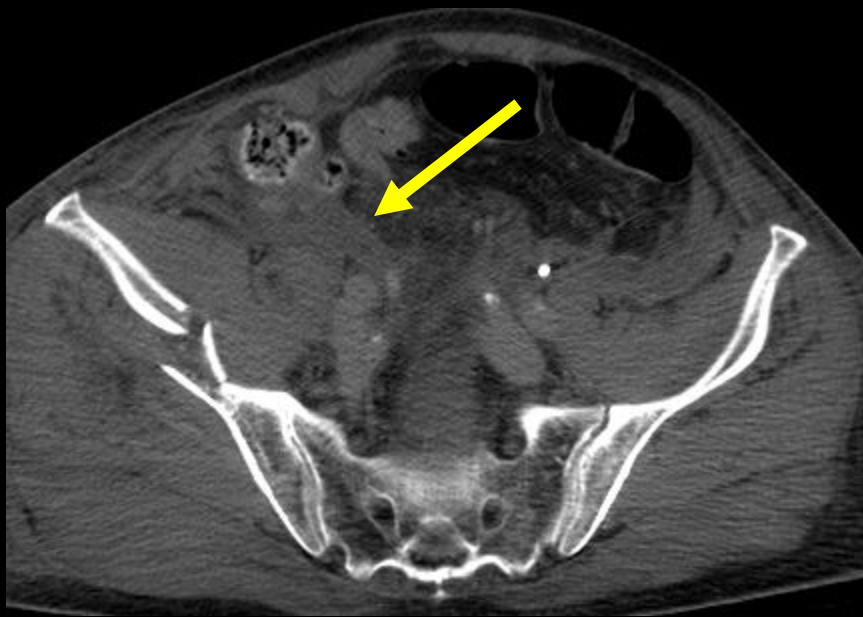
Importance of Delayed Images

UPJ Rupture

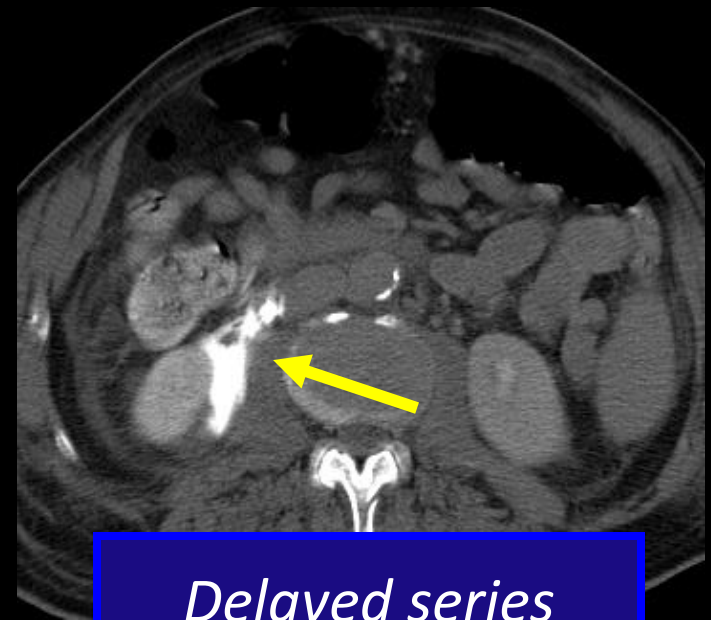




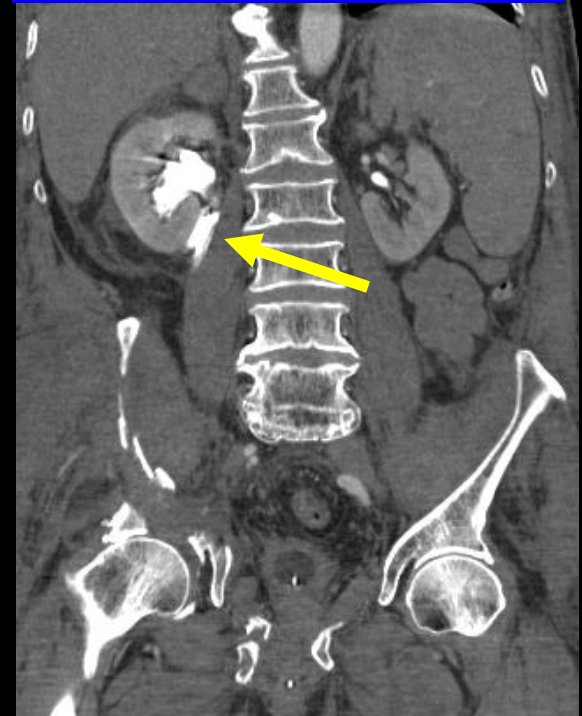
*Delayed series: pelvis only
(with cystogram)*



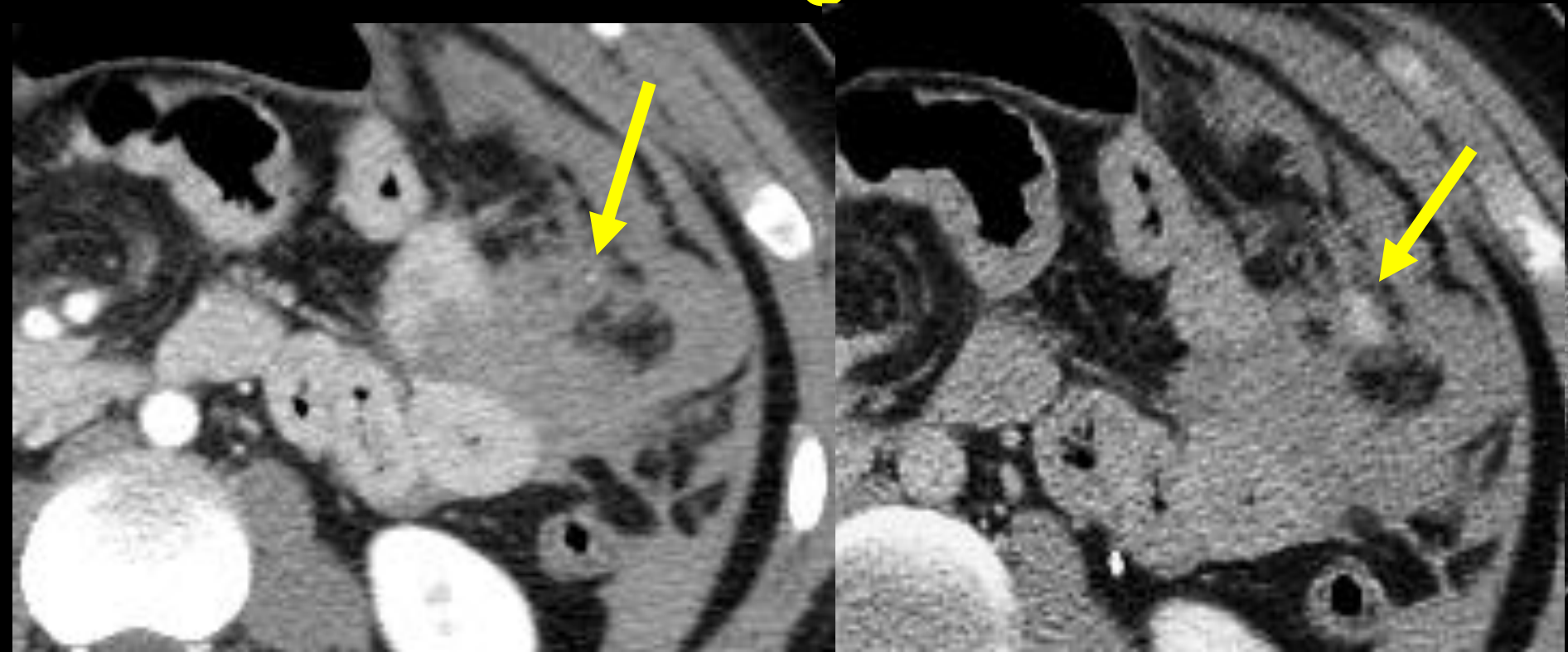
Follow-up: 5 days later



Delayed series



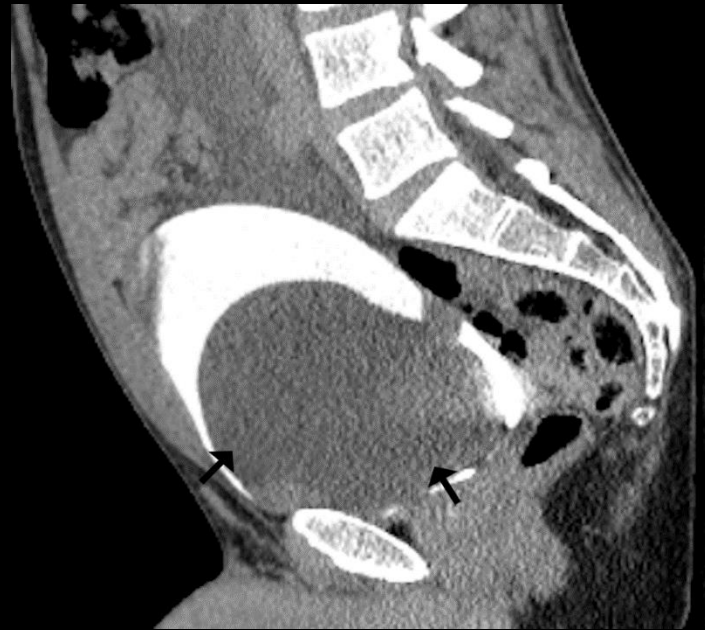
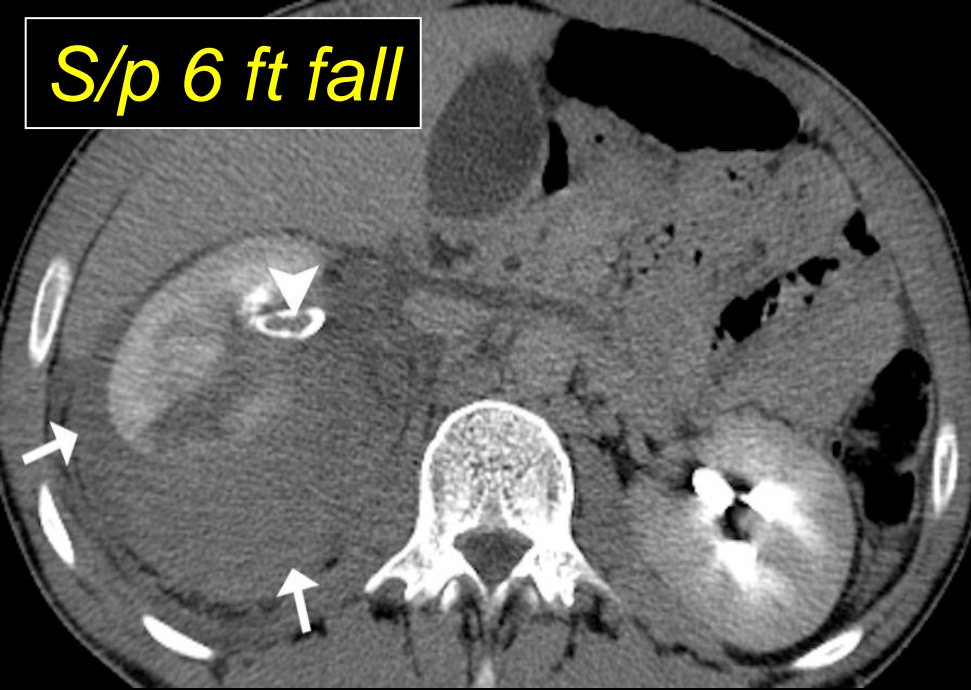
Importance of Delayed Images



PVP CT

5 minute delay

S/p 6 ft fall



F/u 2 d

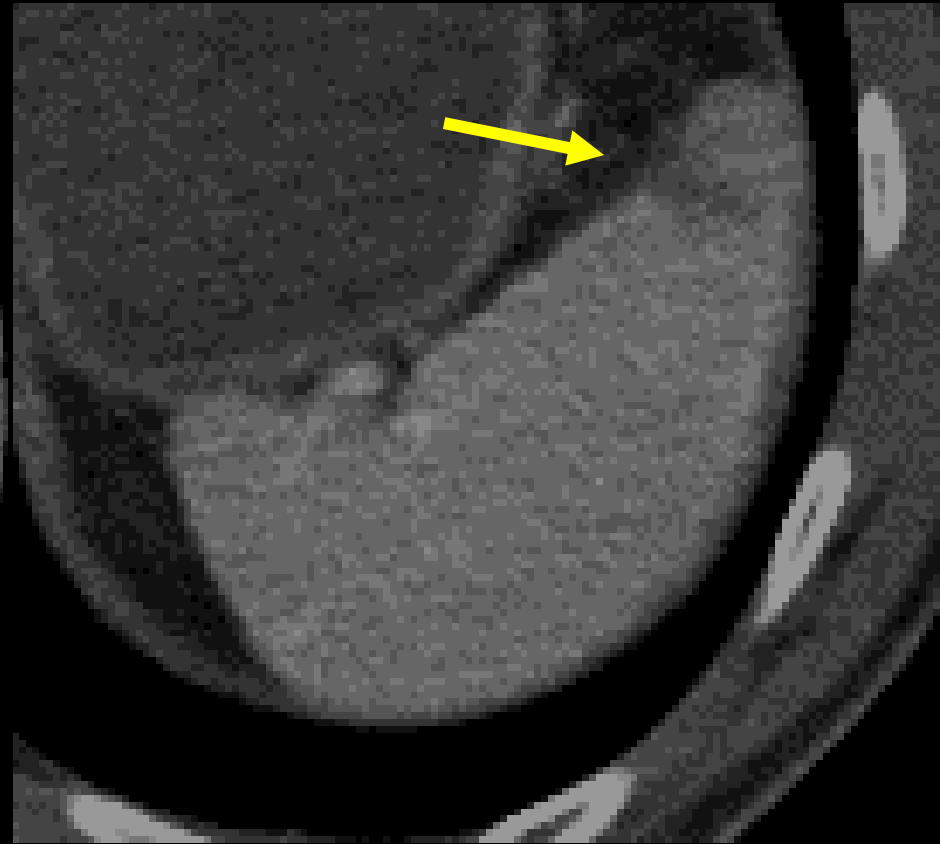
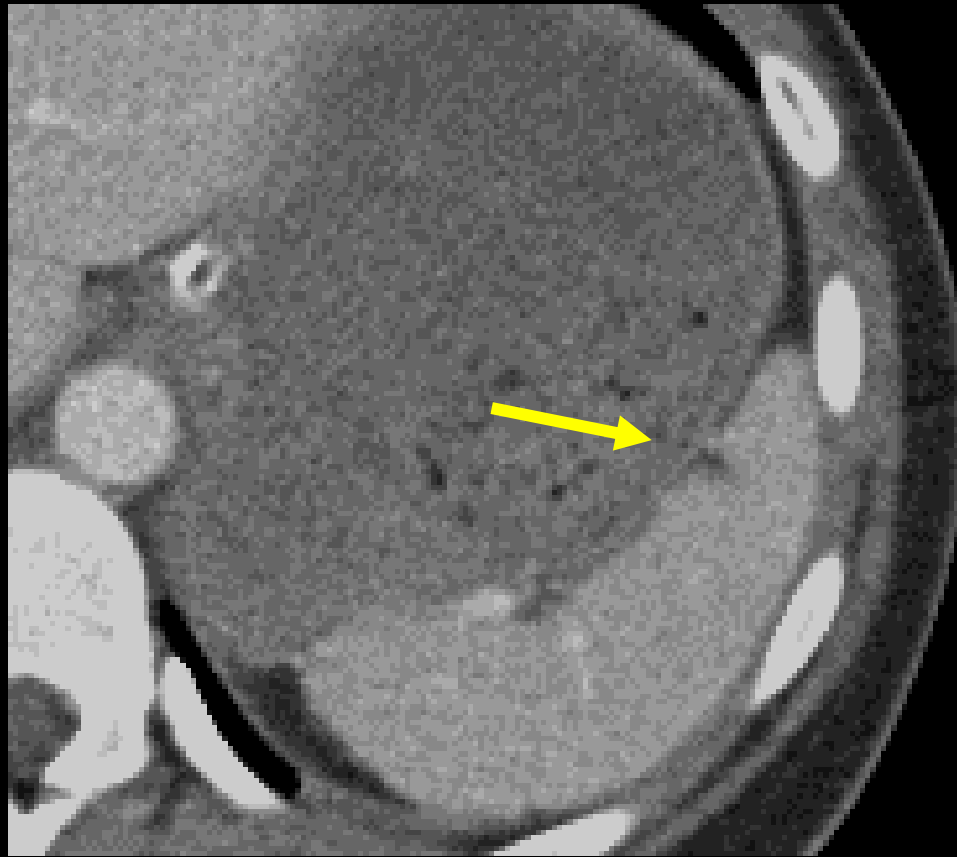


*Collecting
System Injury
seen only
On delayed CT*

Problematic Anatomic Variants

- Splenic clefts
 - very common finding
 - often source of confusion
 - clefts: well defined, linear, medial
 - true laceration: irregular, surrounded by blood
 - may be indistinguishable

Splenic Clefts vs. Lacerations?



Easily (but important!) Missed Injuries

Lawson CM et al. Missed injuries in the era of the trauma scan. J Trauma 2011: 26,000+ trauma scans, > 8 years

- Bowel and Mesentery
- Pancreas
- Diaphragm
- Major vessels: arteries, veins

Bowel Trauma

- Challenging diagnosis: most commonly missed significant injury!
- 1-2% abdominal trauma patients
- Leading cause of failed conservative therapy and delayed laparotomy
- Delay in diagnosis (8-12 hs!!) is important cause of morbidity and mortality in blunt trauma

CT Findings – Bowel Injury

- Bowel wall discontinuity

SPEC
Sens

- Extraluminal air
- Intramural hematoma/Intraluminal bleeding
- Bowel wall thickening
- Bowel wall enhancement
- Pneumatosis

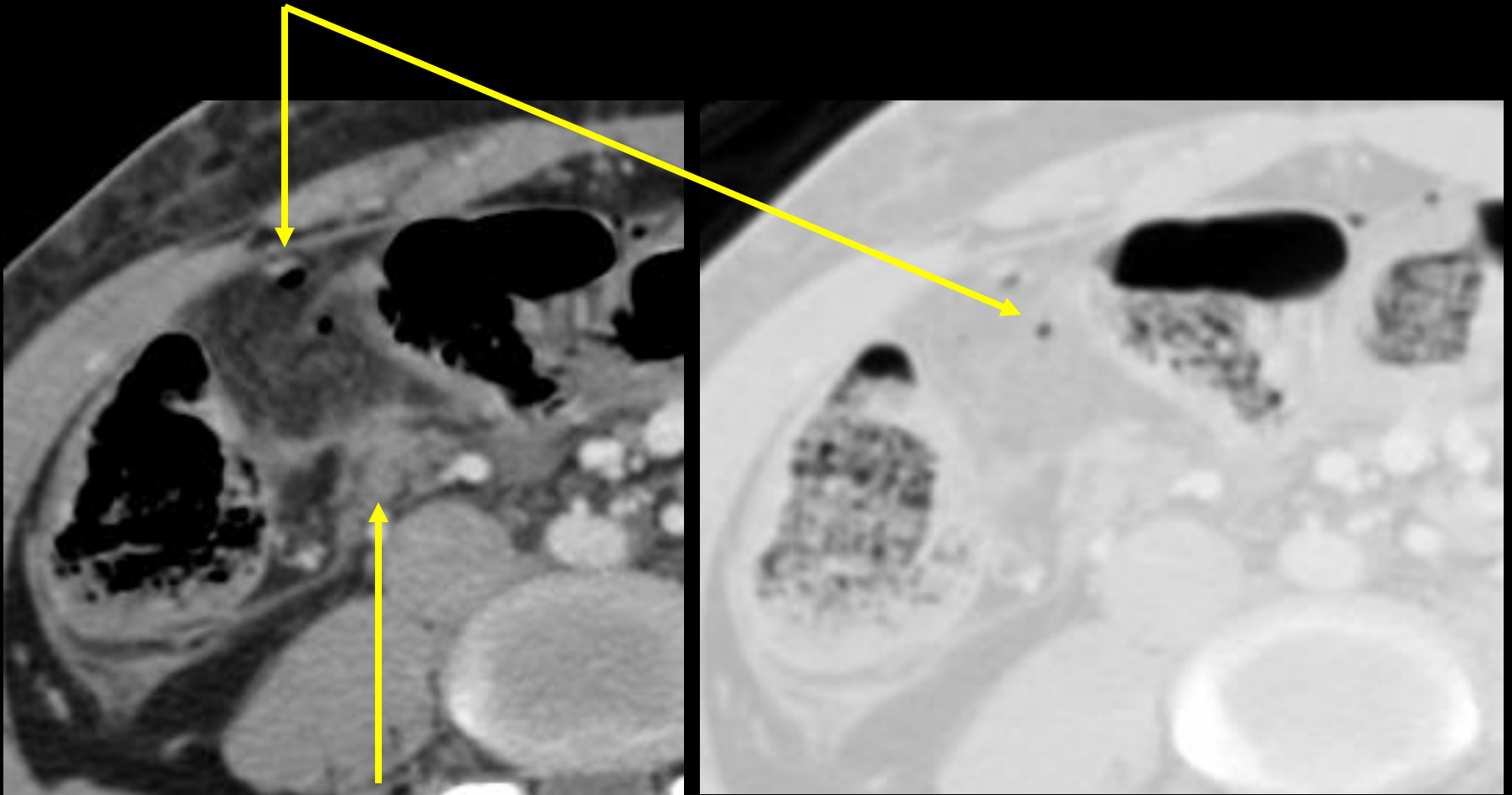
- Free intra- or retroperitoneal fluid

SENS
Spec

Extraluminal Air

- Intra- or retroperitoneal
- Appropriate window settings (lung or bone)
- Sensitivity: 50-75%, may appear over time!
- Pitfalls (FP, ↓ Spec.):
 - DPL
 - Barotrauma and mechanical ventilation
 - Bladder rupture
 - “Pseudopneumoperitoneum” - Extraperitoneal

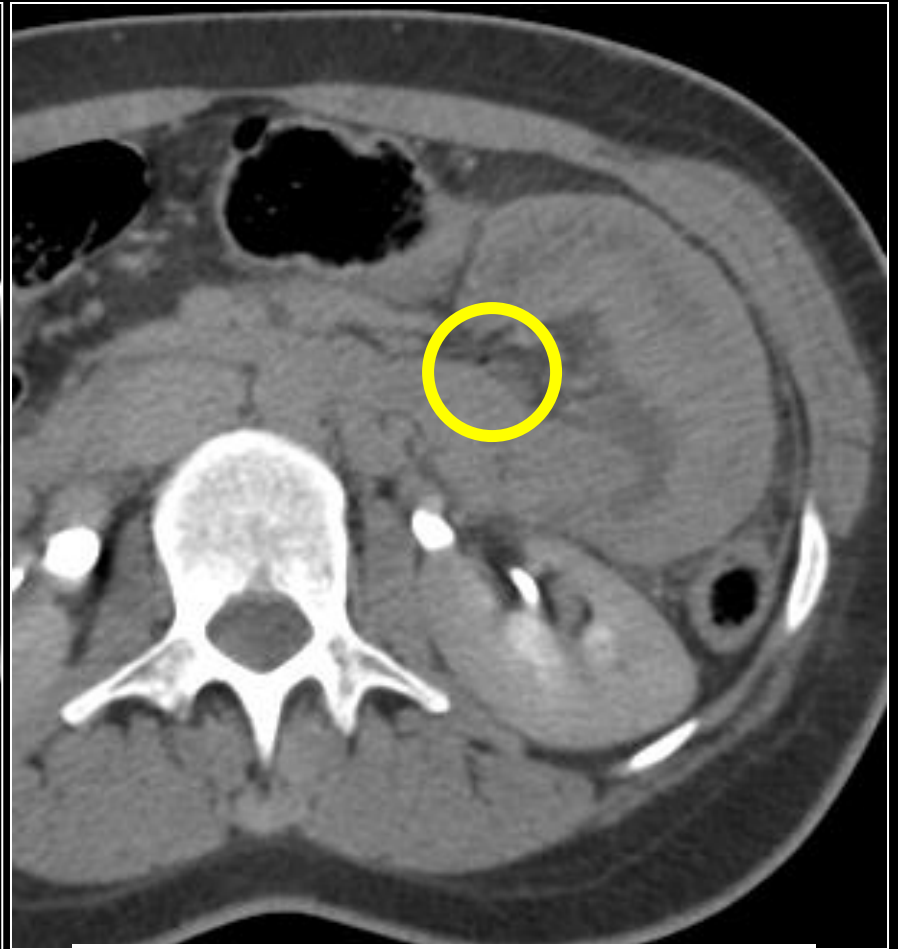
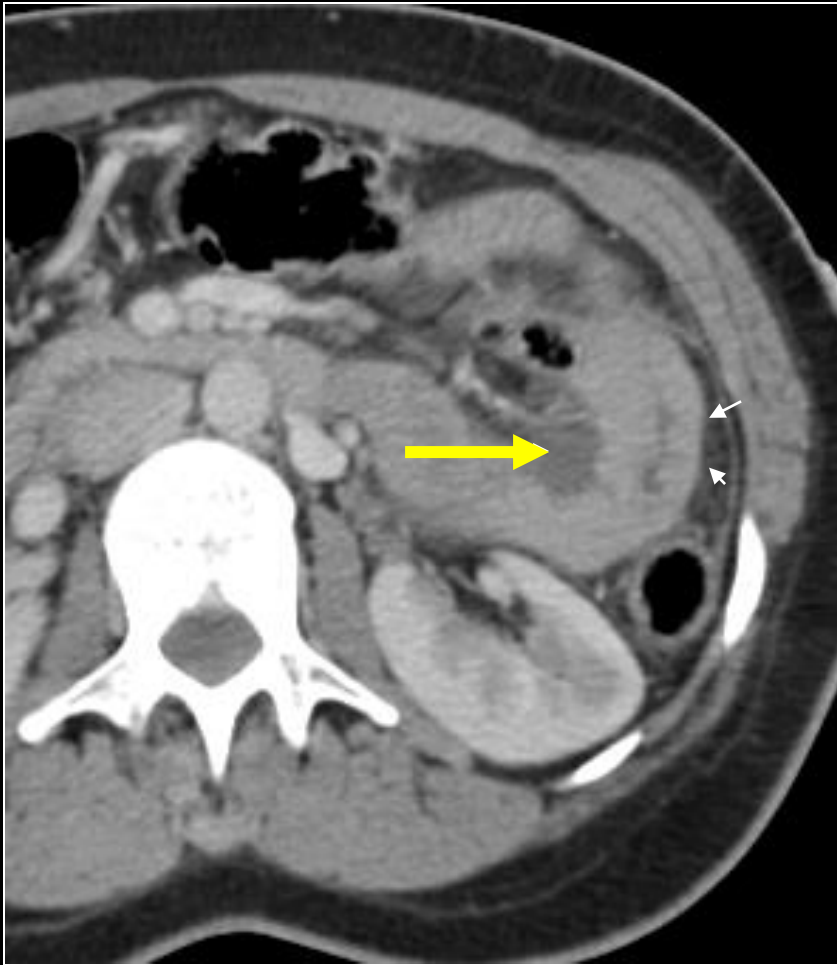
Free Air



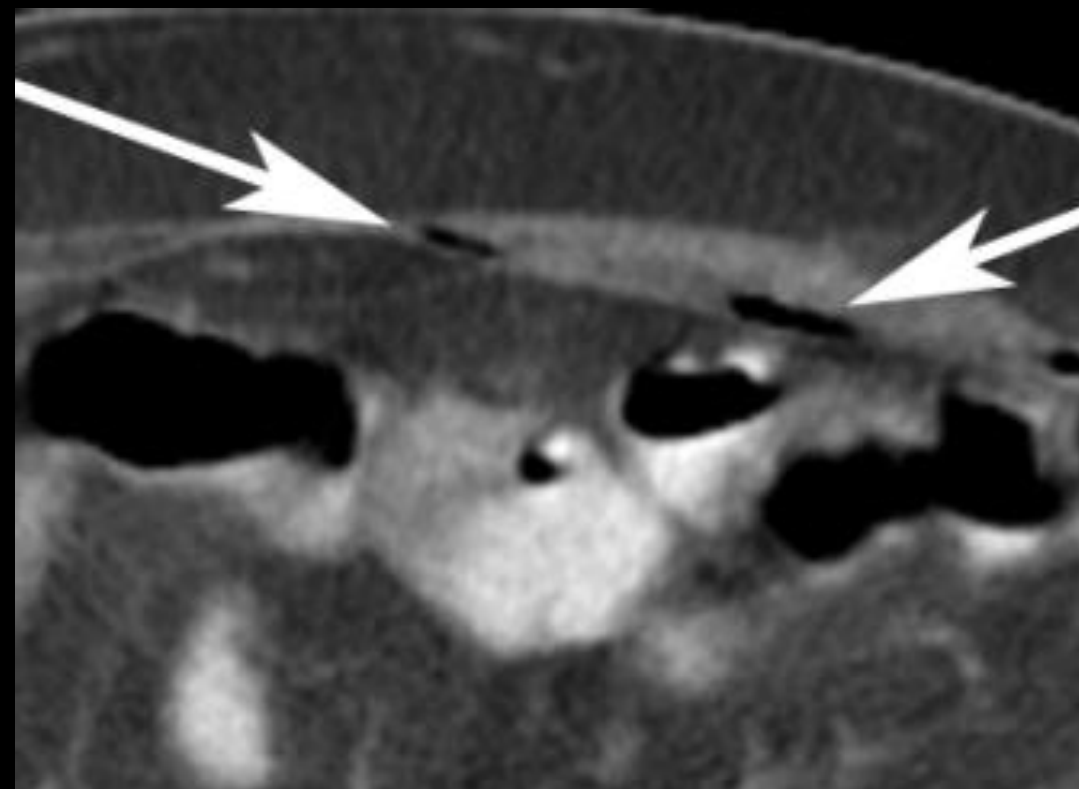
Mesenteric Hematoma

Laparotomy: 1 cm perforation in ileum

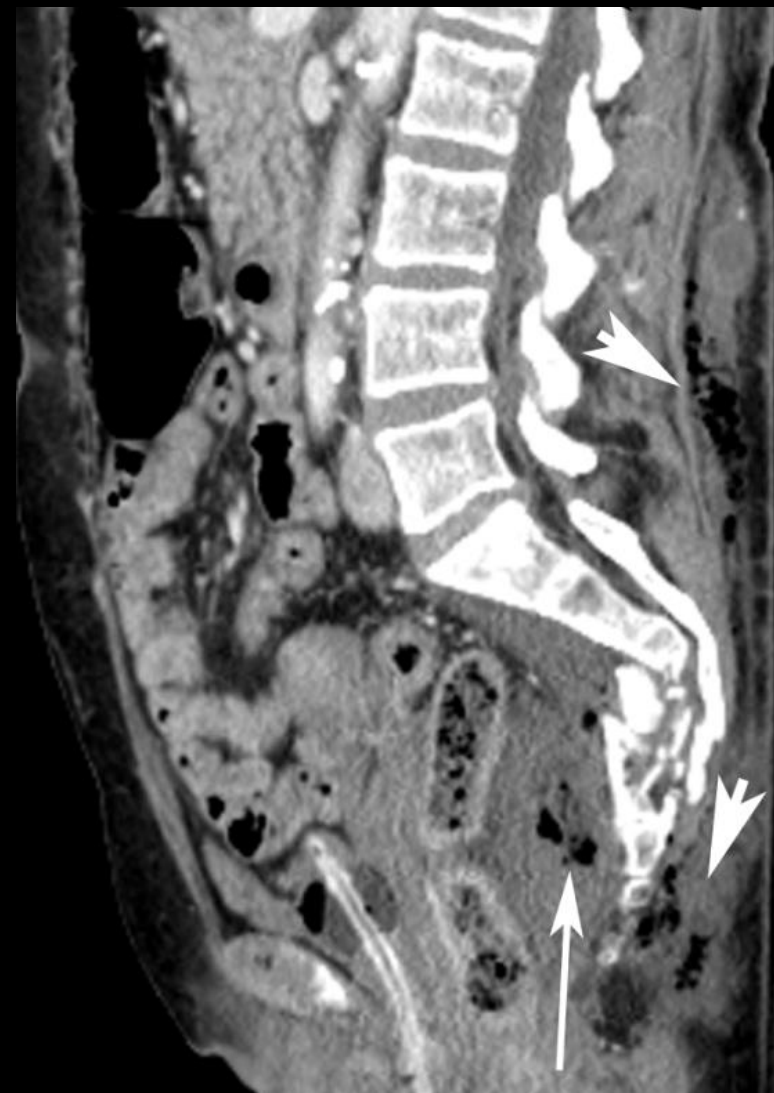
Delayed Images: “Second Look”



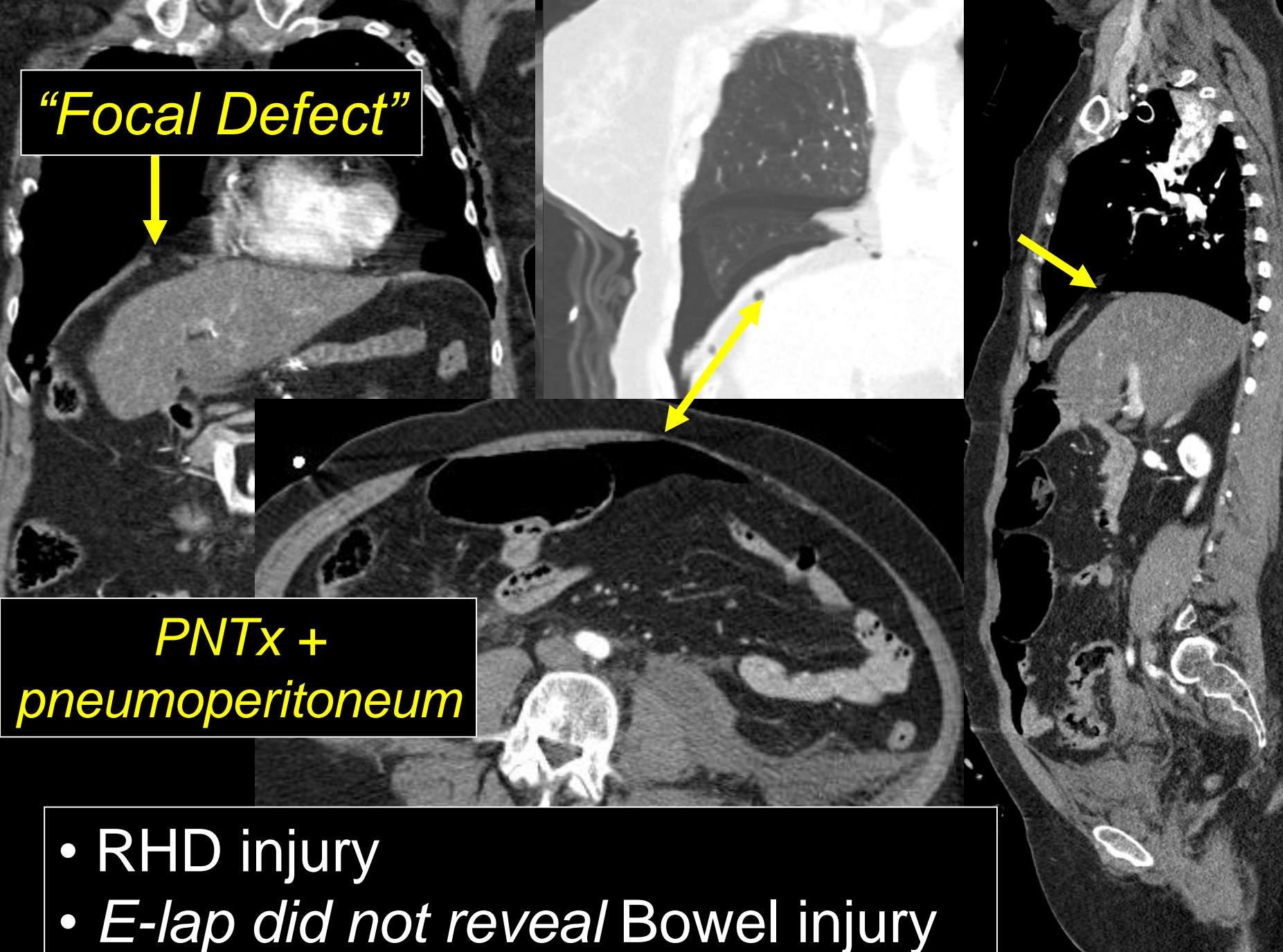
*5 minute delayed CT
OR: jejunal perf*



Pseudopneumoperitoneum



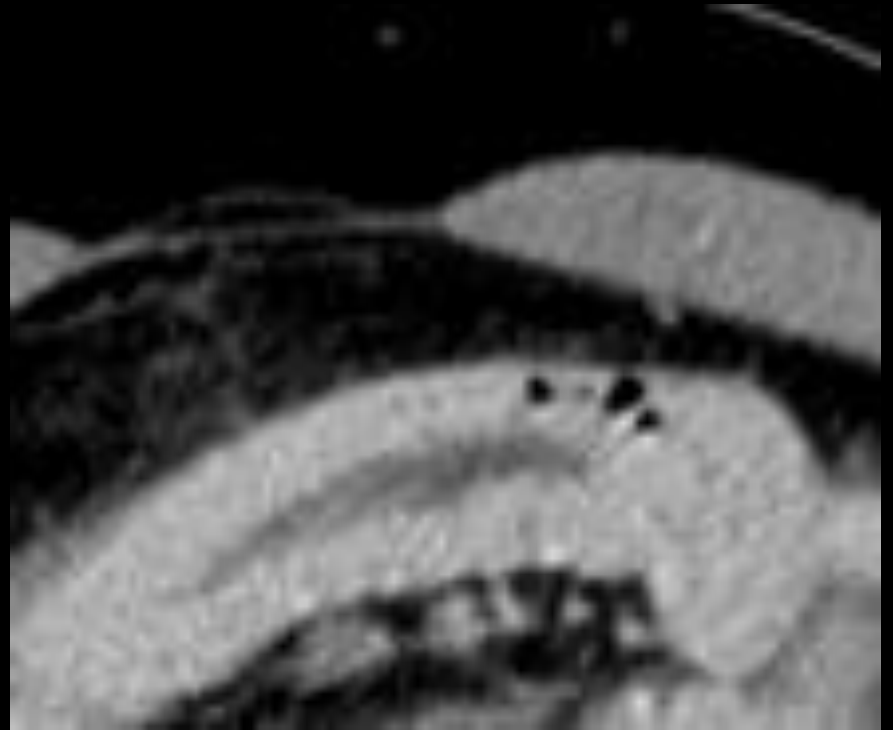
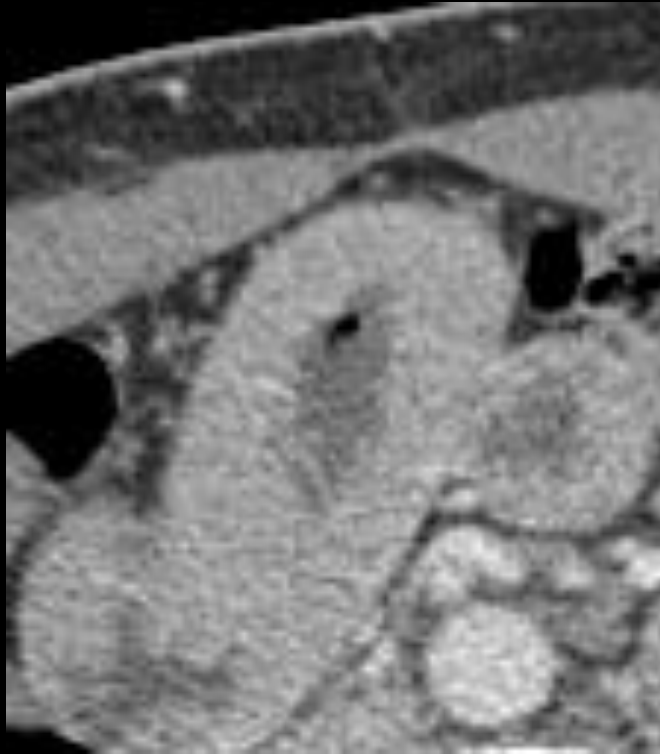
"Focal Defect"



Bowel Wall Thickening as Sign of Injury

- Unequivocal, localized thickening: contusion, hematoma, ischemia (i.e., “surgical” lesion)
- Associated high attenuation free fluid
- Triangular accumulations of fluid between leaves of mesentery
- Diffuse thickening: hypoperfusion complex (“shock bowel”)
 - Additional associated findings

Bowel Injury or Physiologic Finding?



Bowel Injury or Physiologic Finding?

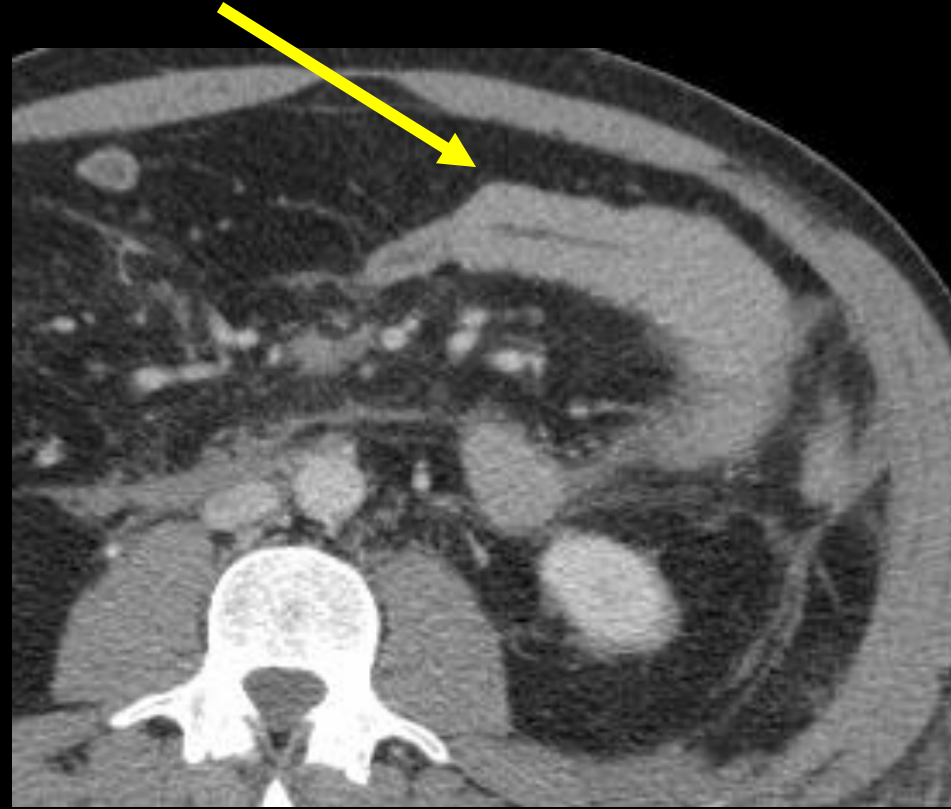


Peristalsis



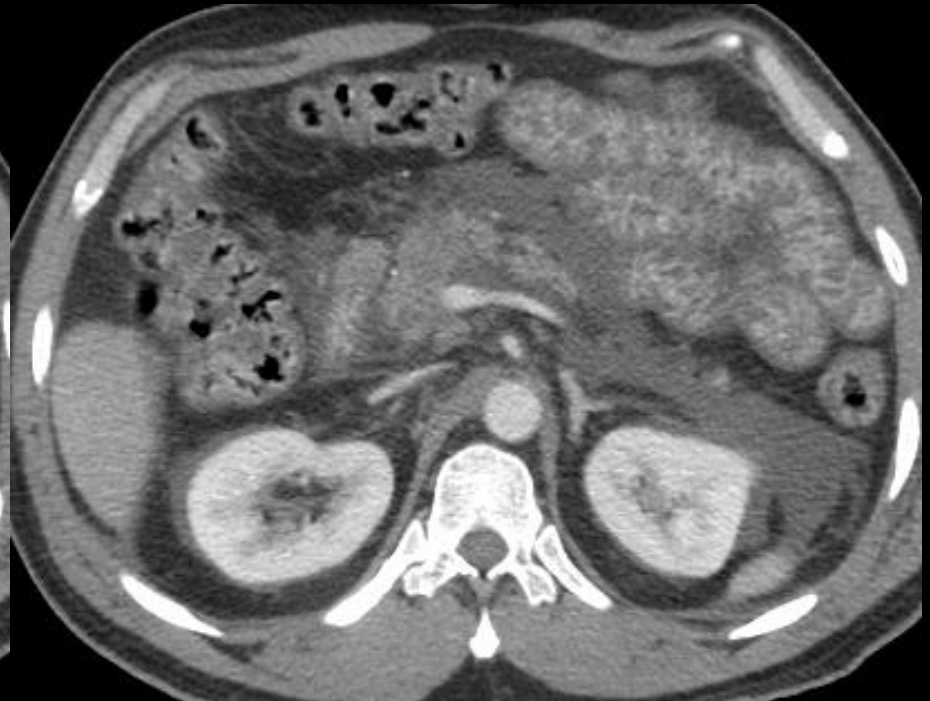
Injury

Bowel Wall Thickening: FOCAL



True Positive Finding: Bowel Trauma

MVC, Shock Hypoperfusion complex

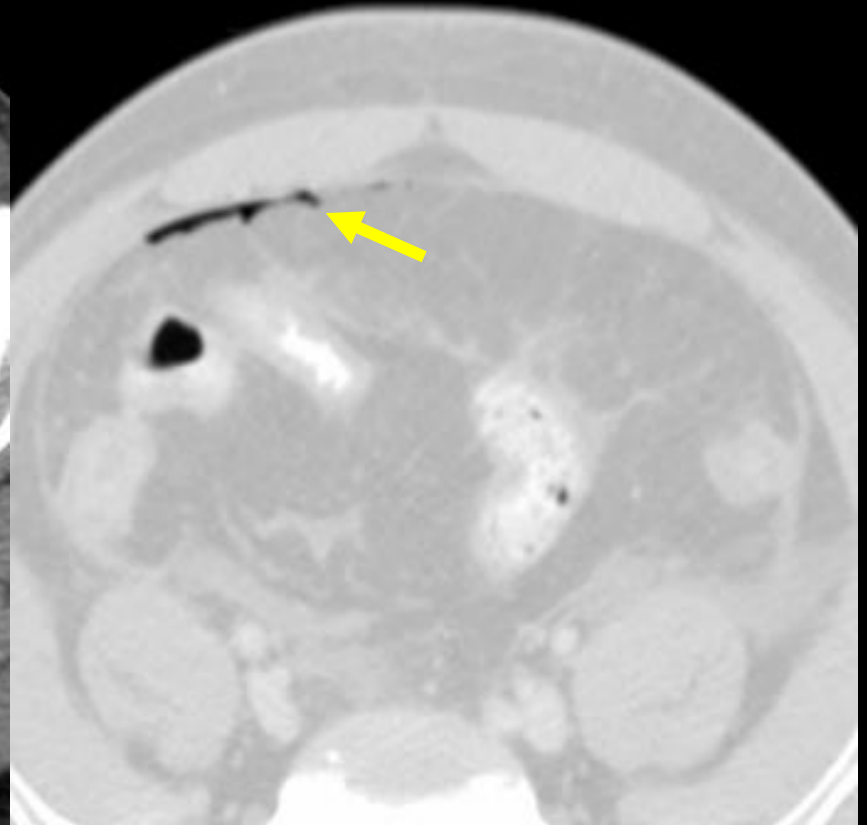
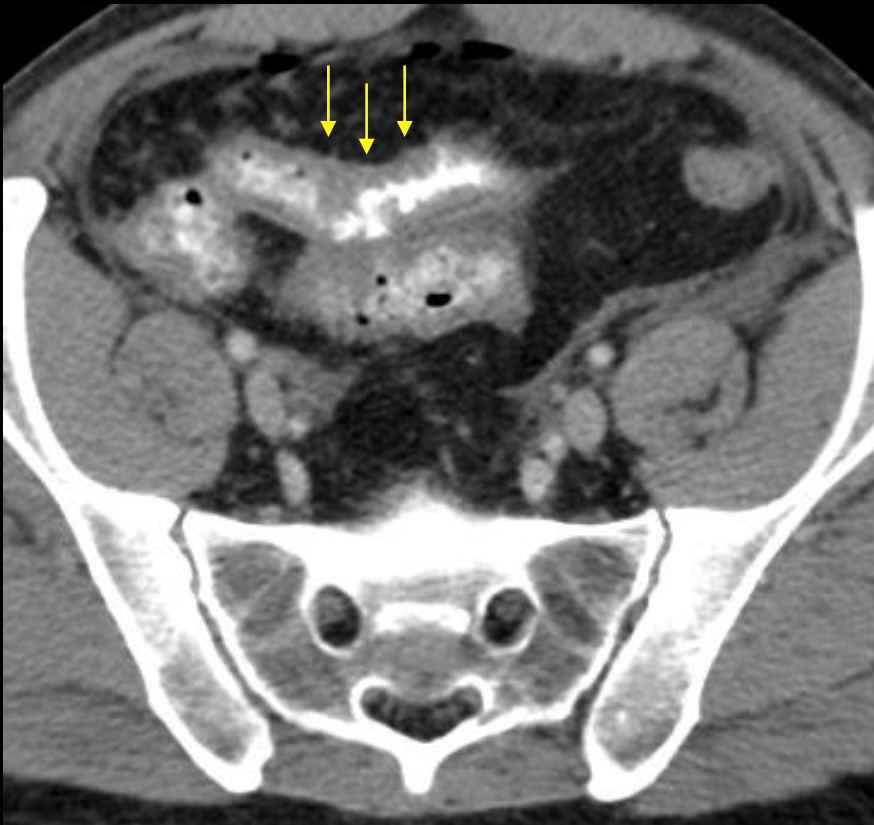


Bowel Injury: Value of Repeat Scan



Admission CT

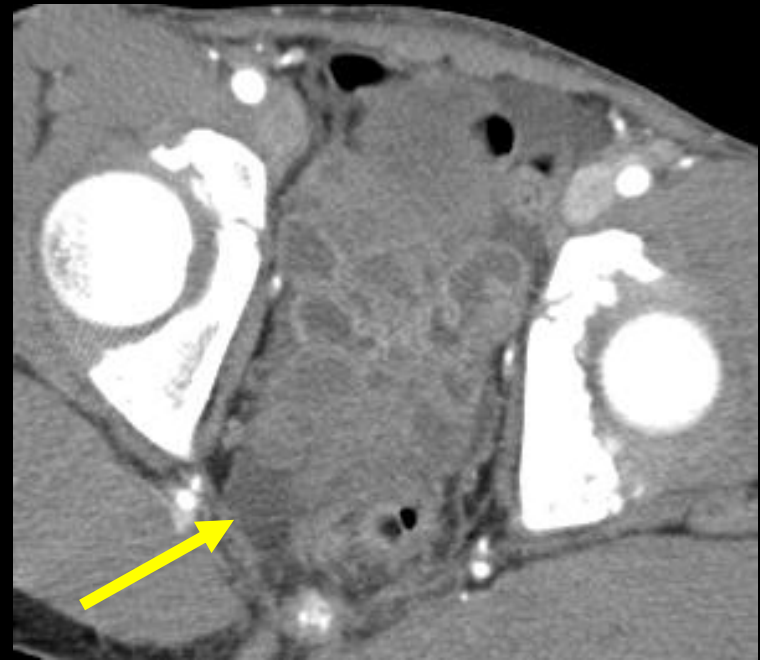
12 Hours Later, with OC



Laparotomy: ileal perforation

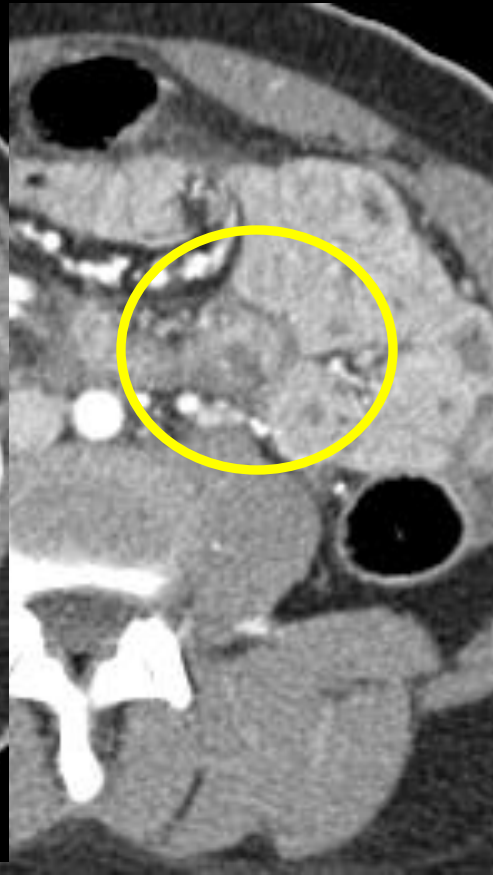
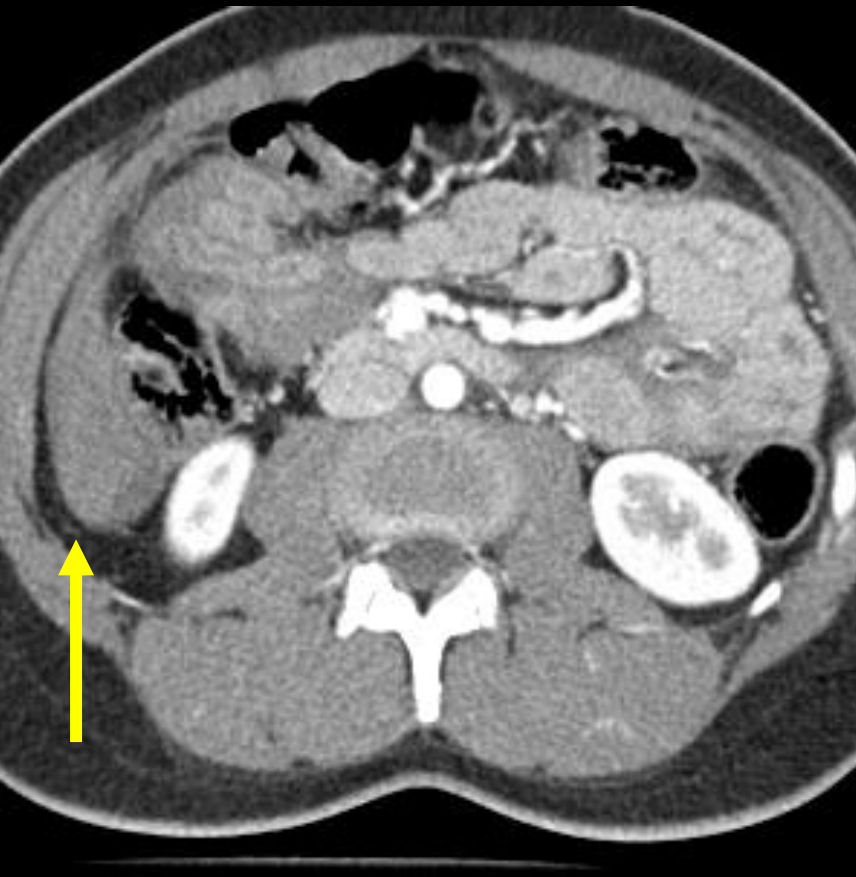
Free Intraperitoneal Fluid

- In females of reproductive age, isolated free fluid in the pelvis
- Small pockets of low attenuation fluid can be found in the pelvis 3%–5% of male blunt tx patients, in the absence of hollow or solid organ injury
- Recommendation: close clinical observation and, if necessary, repeat CT



* Drasin TE, et al. *AJR* 2008; 191:1821–1826
Yu, et al *Radiology* 2010; 256:799–805

Free Intraperitoneal Fluid



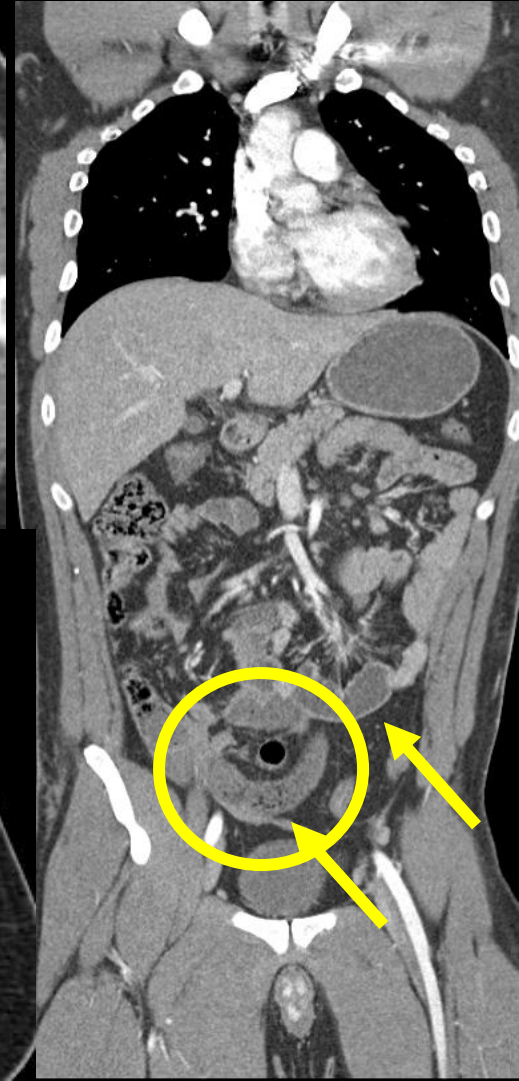
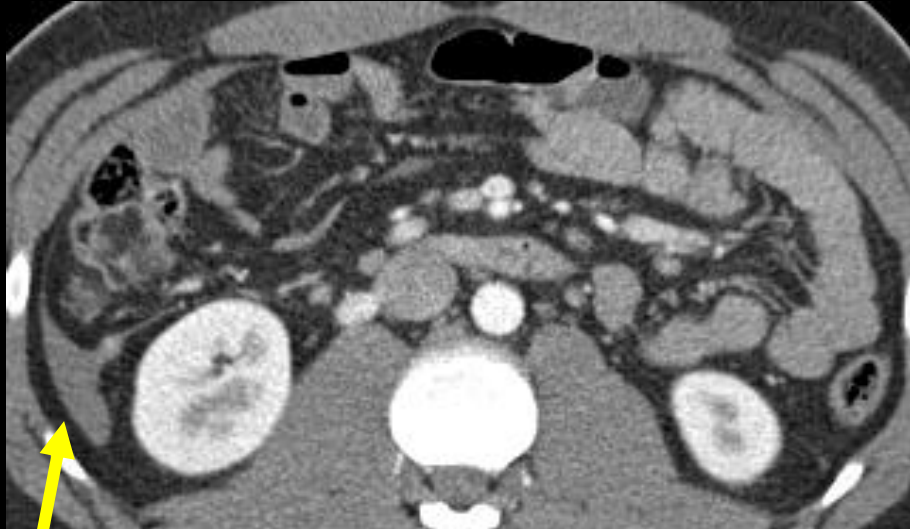
Jejunal Perforation

Ischemic Mesenteric Laceration: “bucket-handle tear”

- Rare life-threatening blunt injury difficult to detect prospectively on CT and for which delays in diagnosis & surgical management can result in poor outcomes.
- CT has limited sensitivity but good specificity for detecting ischemic mesenteric laceration, with segmental bowel hypo enhancement considered the most predictive sign.

*Abnormal
Bowel Wall
Enhancement*

*Seat Belt Sign
+
Free fluid*



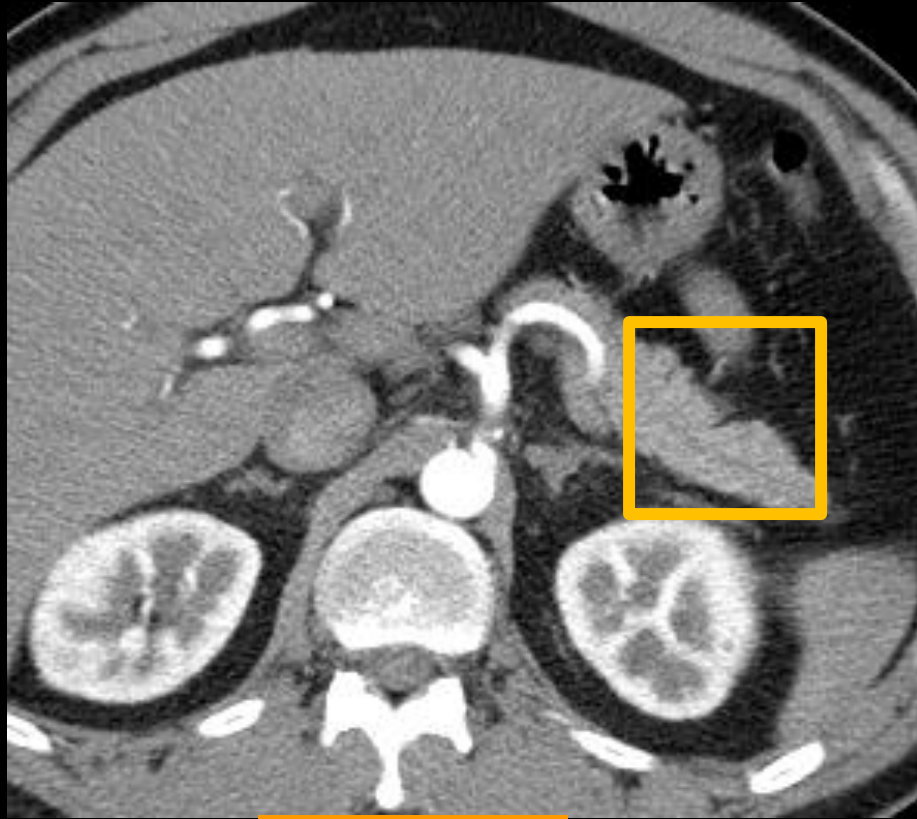


Buckle Handle Tear

Pancreas: Problematic Variants

- Pancreatic clefts
 - linear hypoattenuating defects oriented perpendicular to long axis of the gland
 - usually contain fat
- Lobulations, fatty replacement
 - Anatomic variants common, usually in the head, may mimic laceration
 - Fatty replacement: elderly, obese, diabetics
- Solution: delayed images (5 min), repeat CT (24 to 48 hours), MR as problem solver

Pancreatic Clefts vs. Lacerations?



Cleft

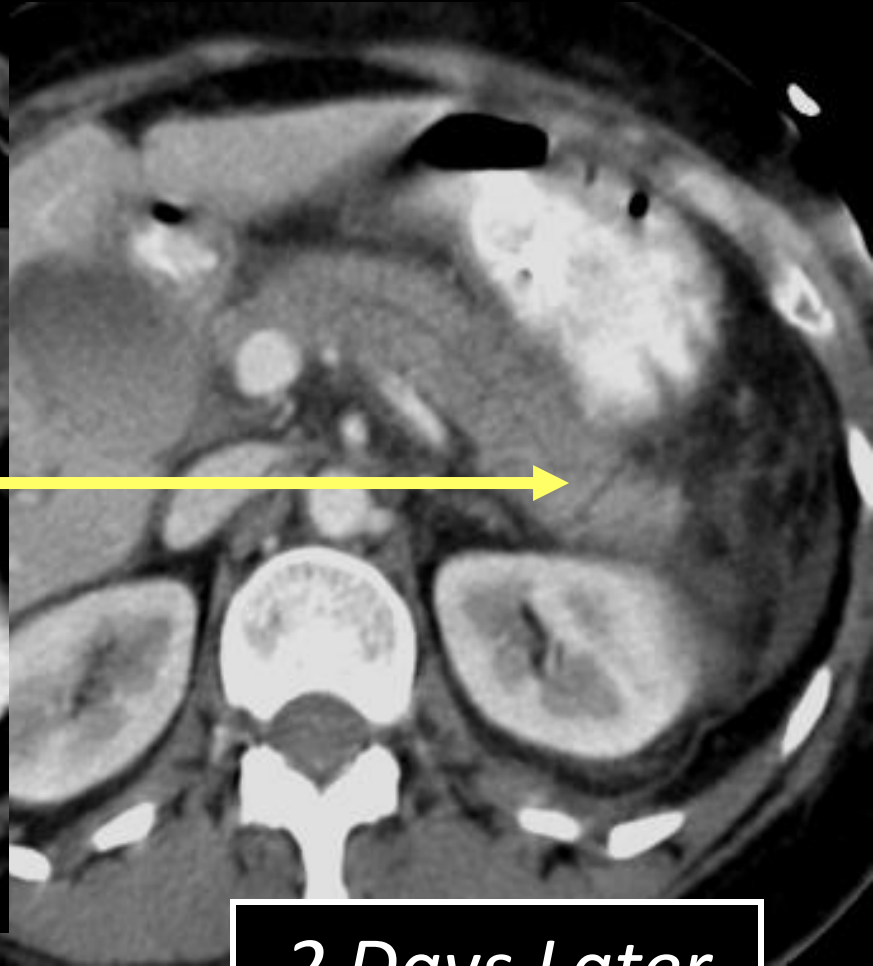


Laceration

Subtle Injuries

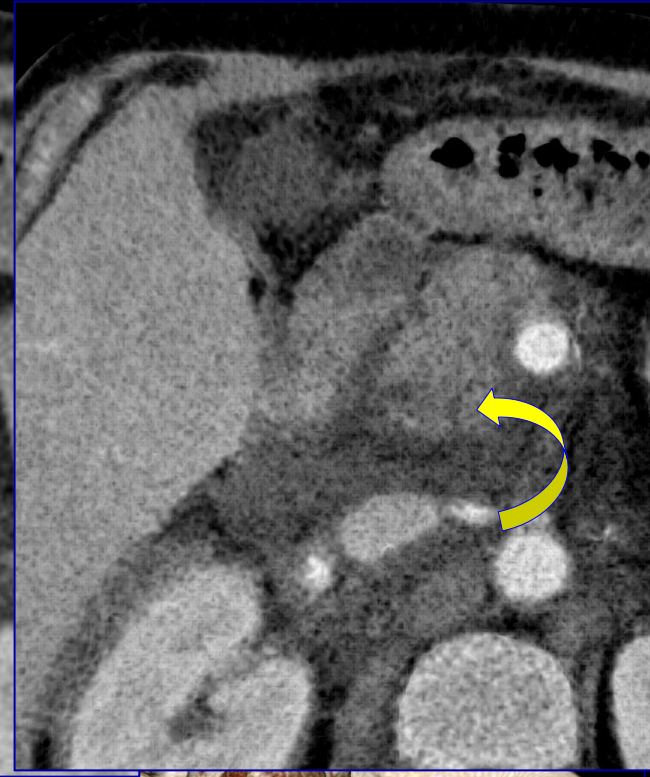
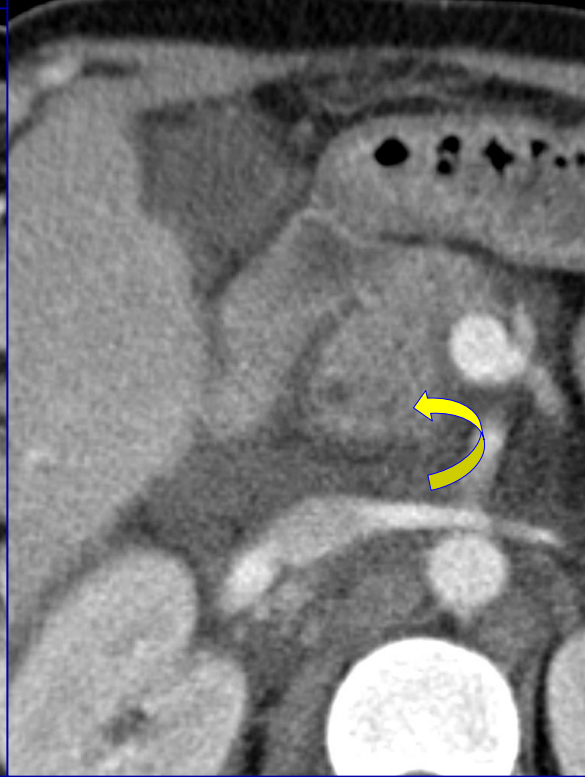


Admission



2 Days Later

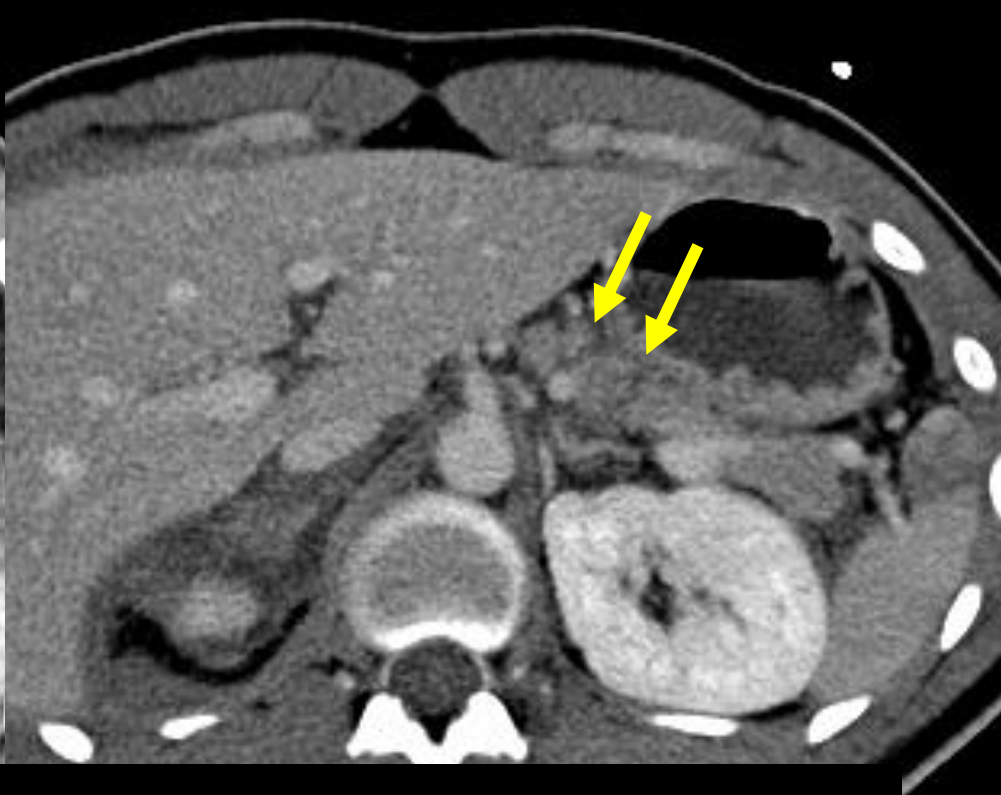
Right lateral vector and associated injuries



32 yo m high speed mva with right lateral AP force vector

Intervention: embolization for vascular injuries conservative tx of pancreatic injury.

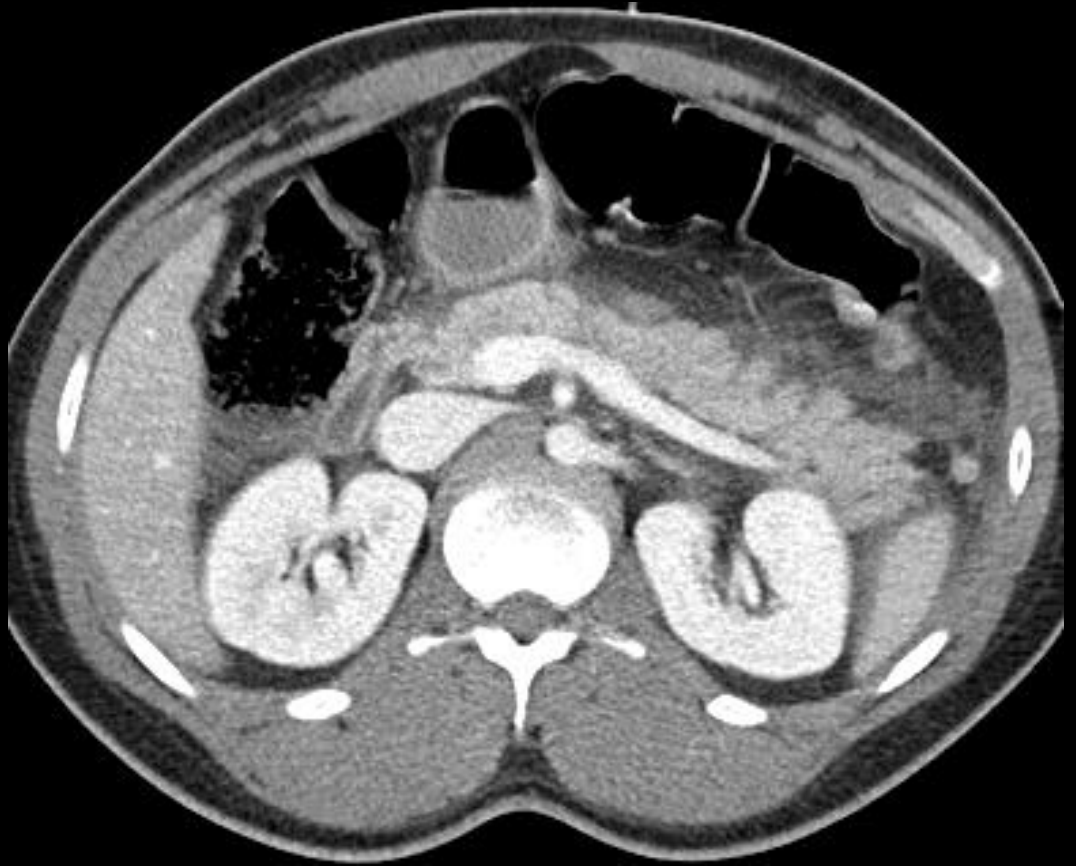




21 yo struck by a van which then ran over his abdomen

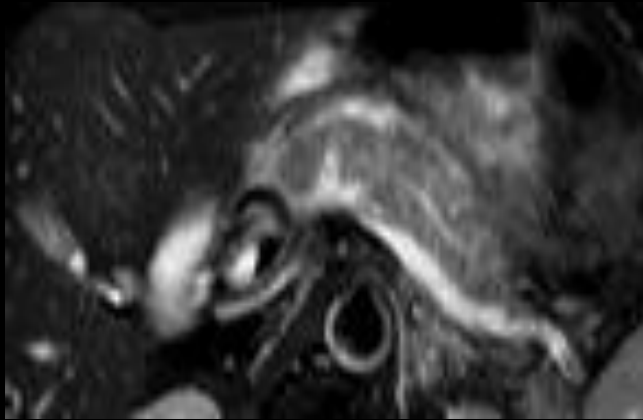
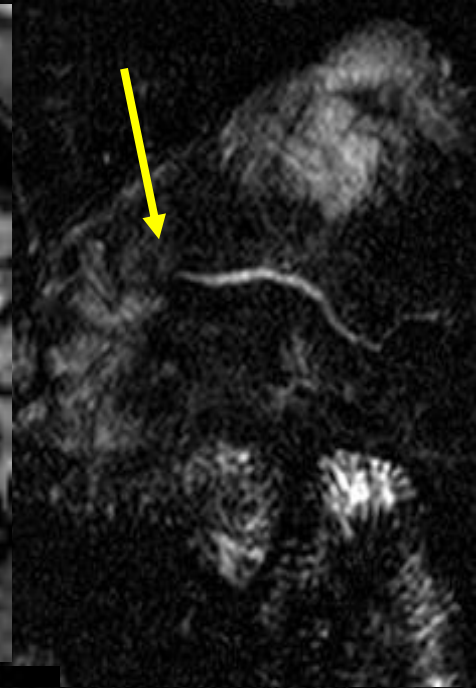
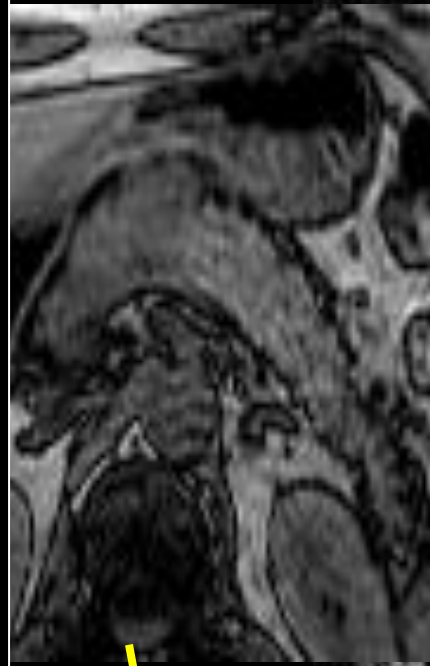
At surgery, widespread contusion & laceration and pancreatectomy was required.

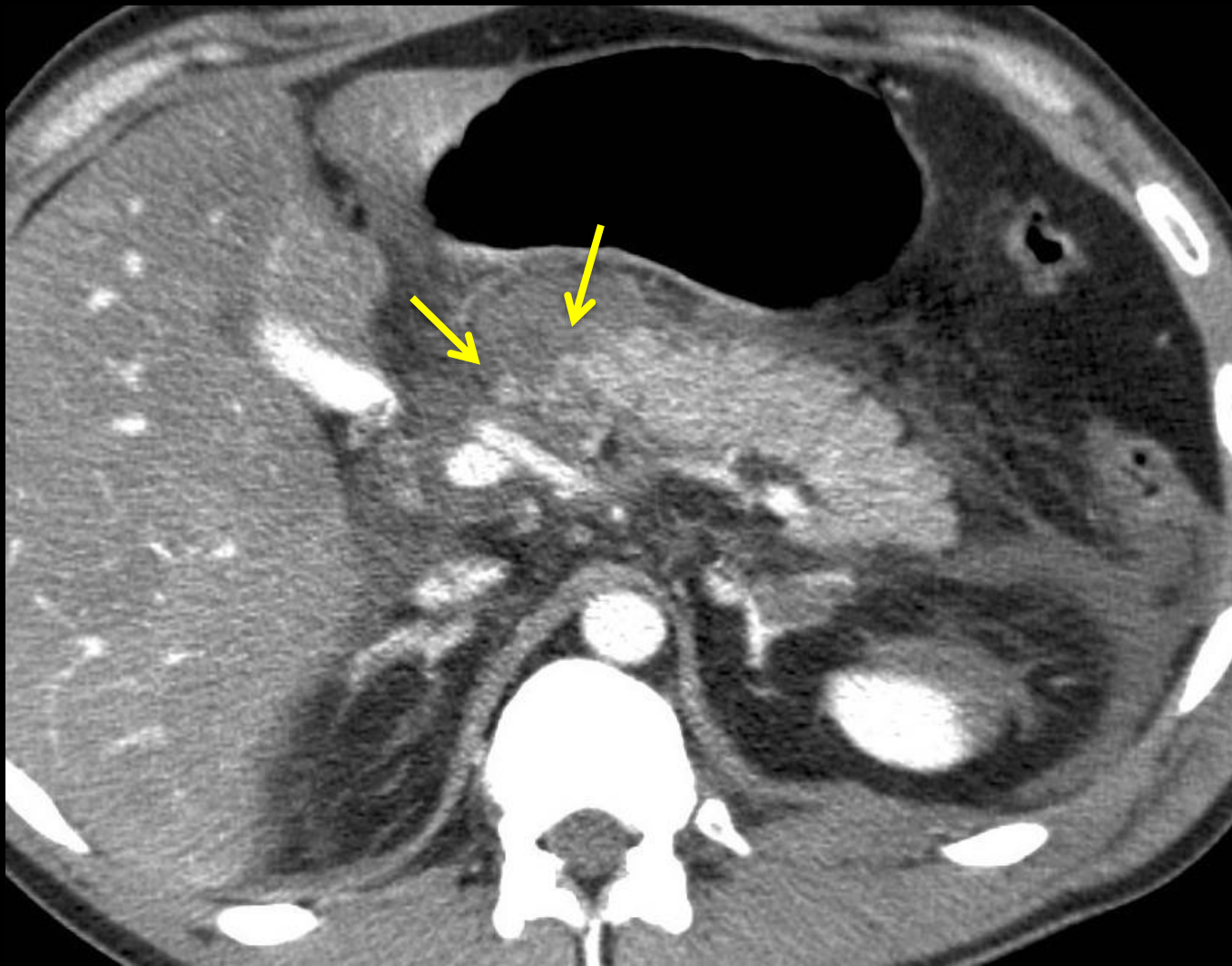
*Aggressive Fluid
Resuscitation
Peri-pancreatic
Fluid*



MR in Pancreatic Trauma

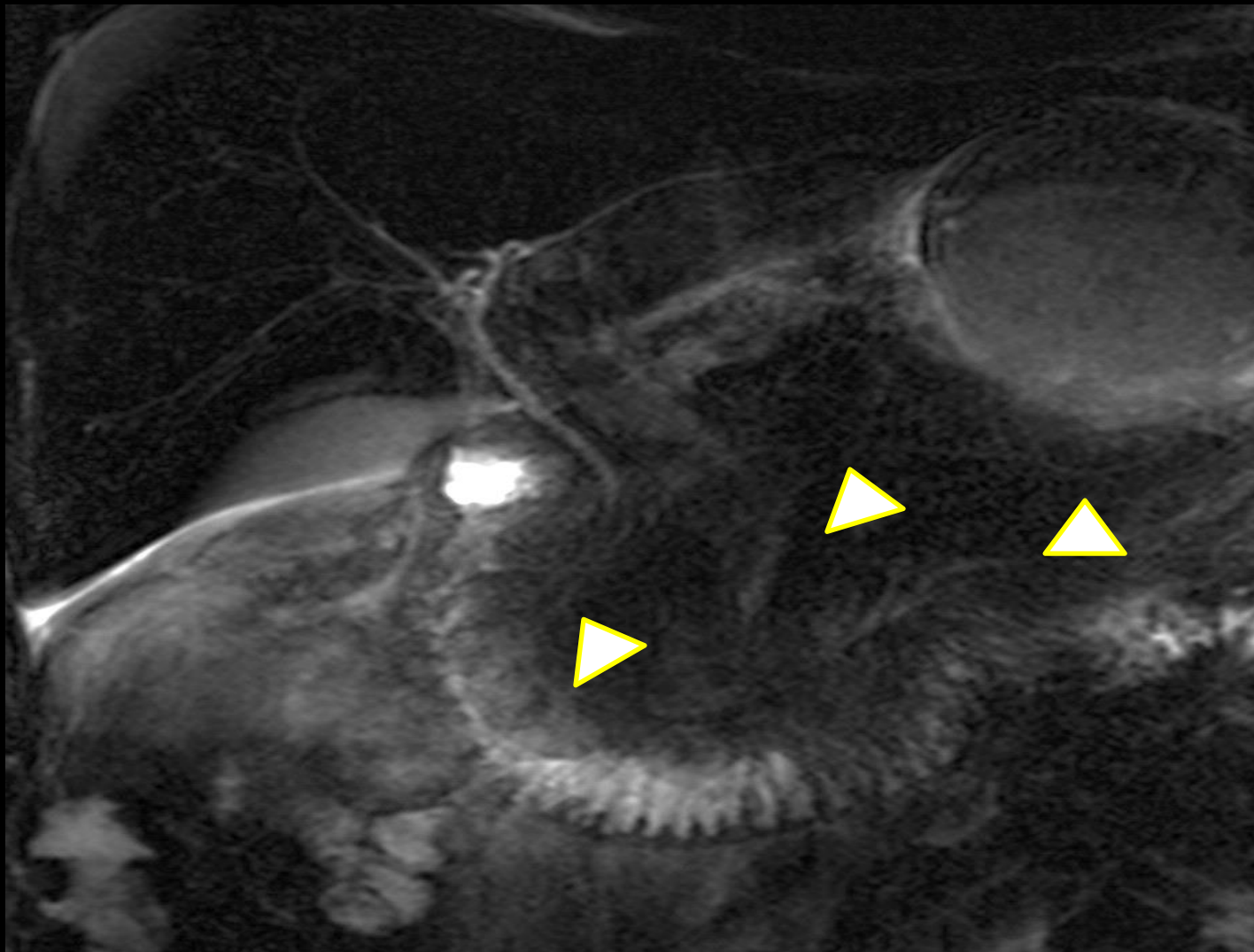
- *Confirm / clarify questionable CT findings*
- *Evaluation of pancreatic duct: non-invasive alternative to ERP*
- *Follow-up of panc lacs: young patients/children (radiation)*
- *Monitoring of fluid collections / duct stenosis **





Depth Laceration?, Duct ?

Superficial!

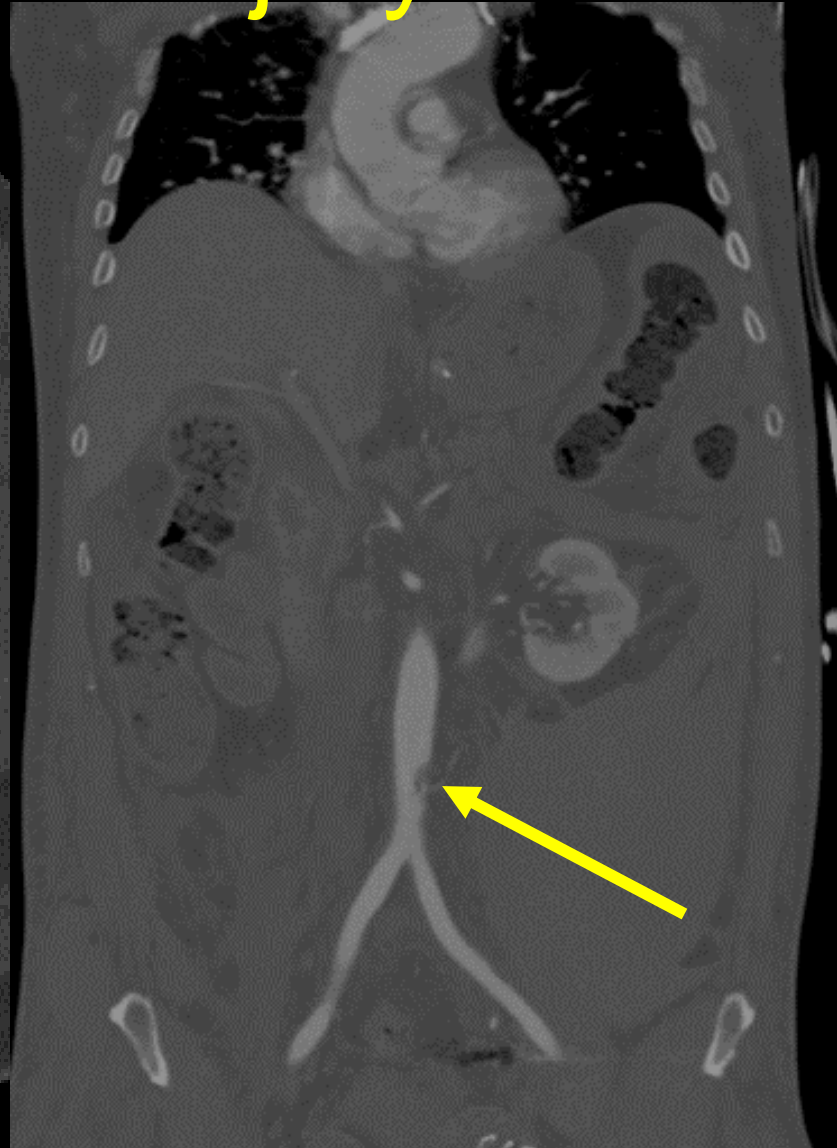
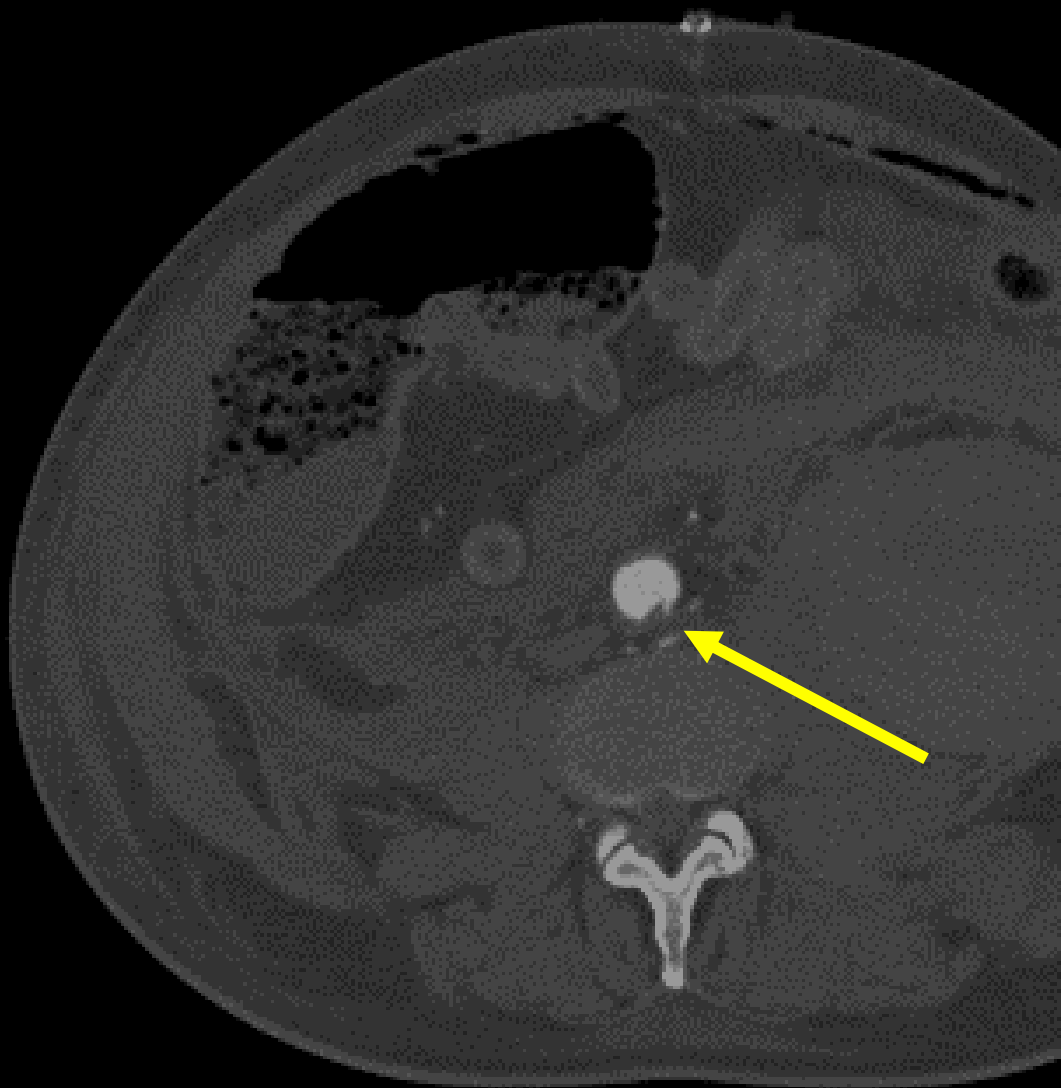


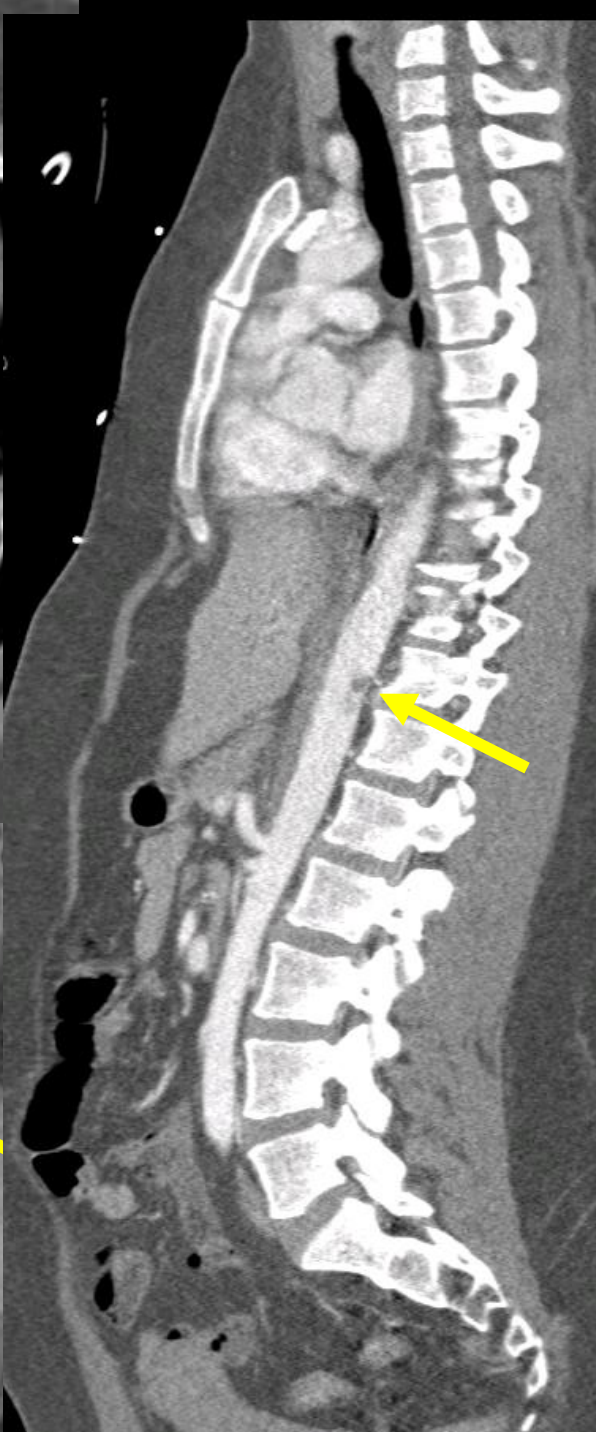
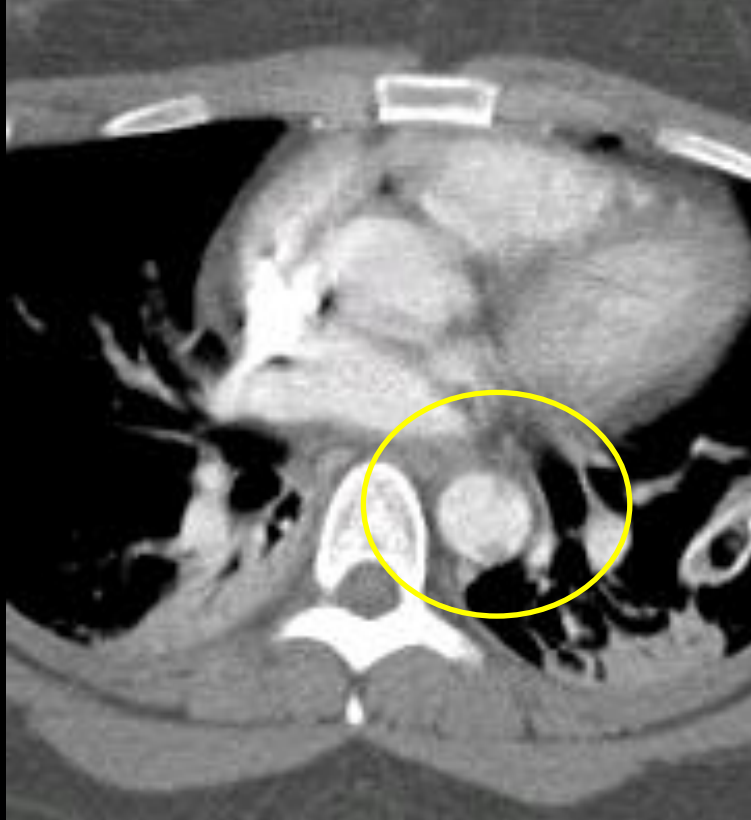
Blunt Abdominal Ao Injury

- Rare (increasingly being recognized) incidence < 1 % - 0.03% BAT patients
- Most commonly associated injuries spine fractures (44%)
- Free ao rupture (32%), P/A (16%), & injuries without aortic external contour abnormality intimal flaps (34%) or intimal tears (18%).

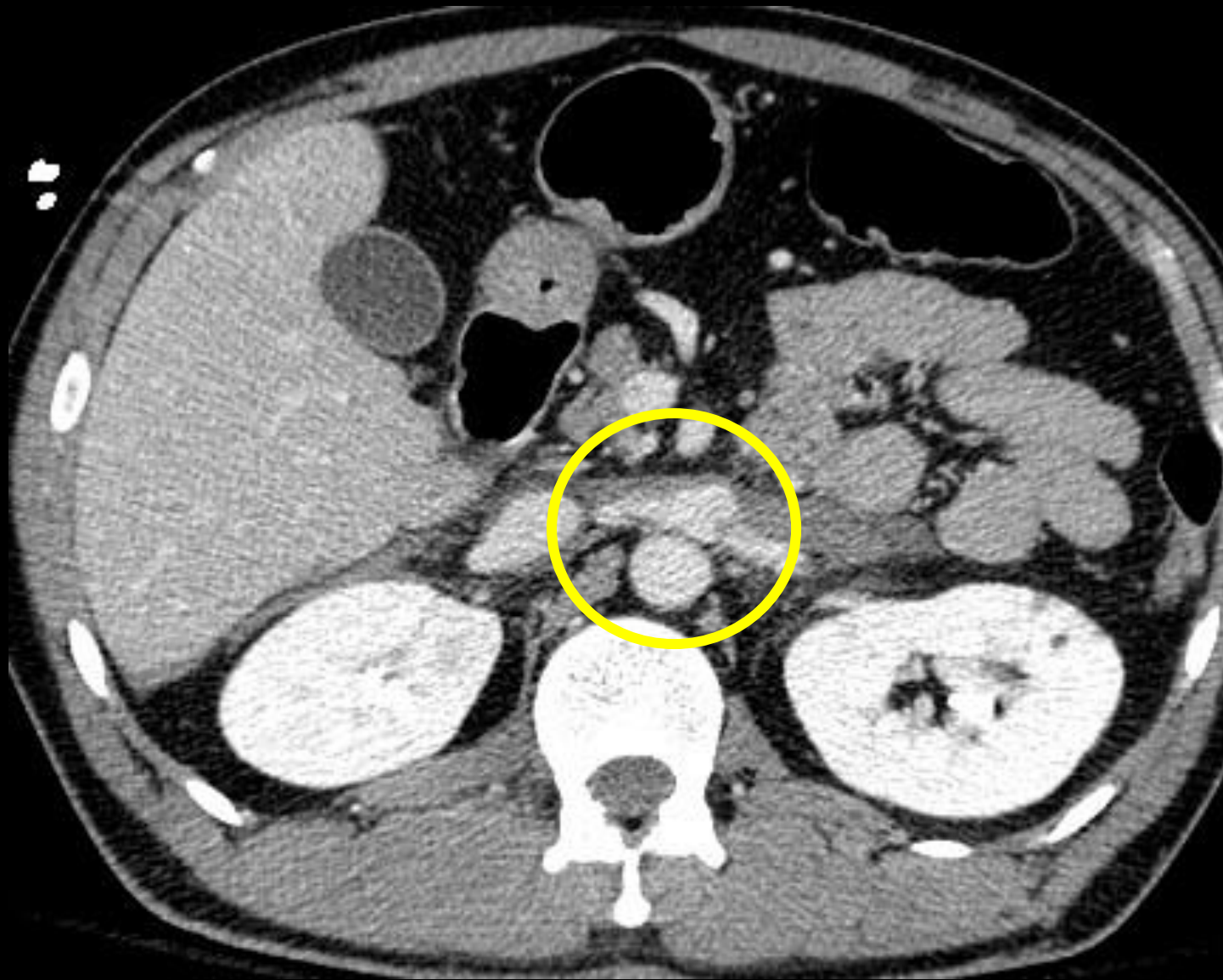
Shalhub S, et al. J Trauma Acute Care Surg. 2014; 879-885
Mellnick VM, et al Emerg Radiol (2012) 19:301–307

Major Vascular Injuries: Blunt Abdominal Ao Injury





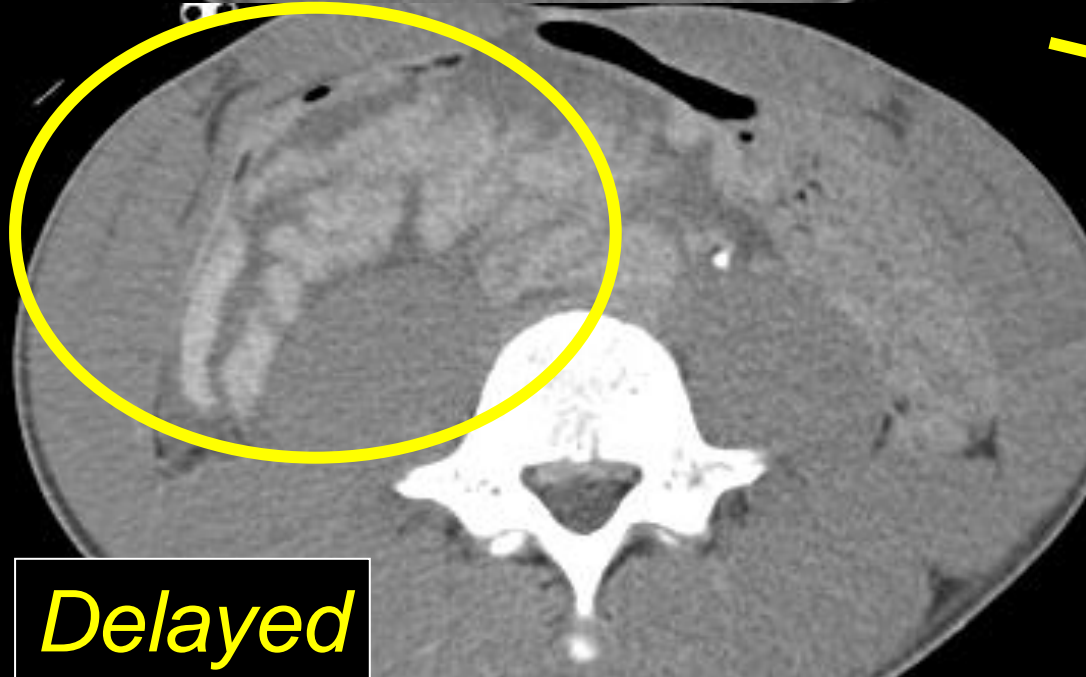
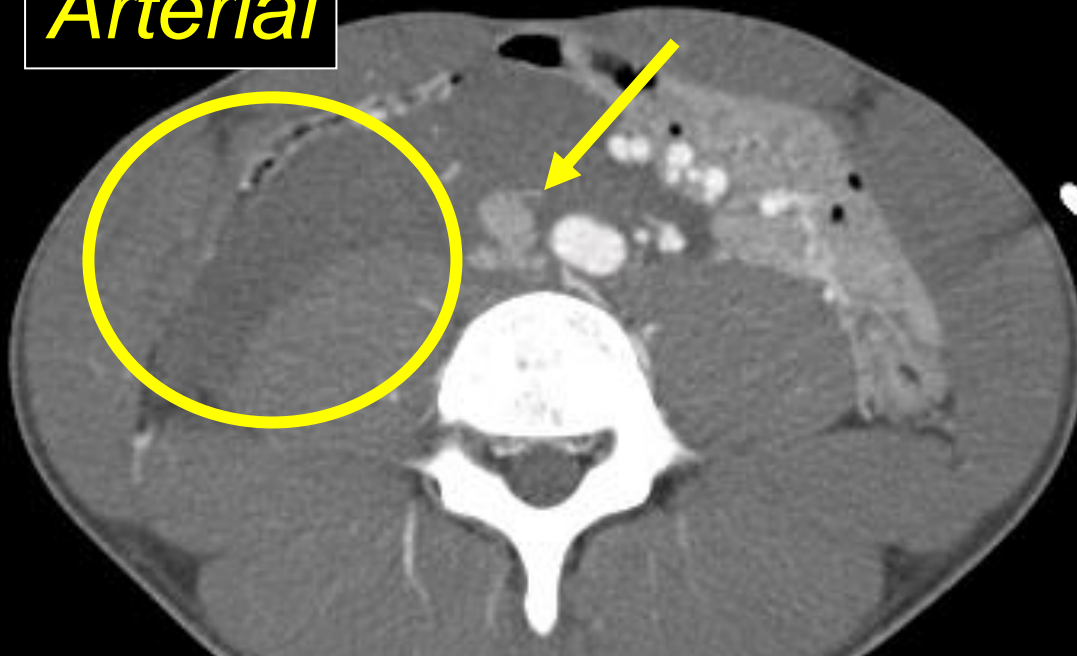
Venous Injuries



IVC Injury

- Blunt IVC injury more likely to show extravasation, contour abnormality, and associated hepatic laceration
- Prognosis influenced by segment injured, proximity to heart & active extravasation
- Mortality > suprahepatic > retrohepatic > Suprarenal
- > injured infrarenal IVC

Arterial

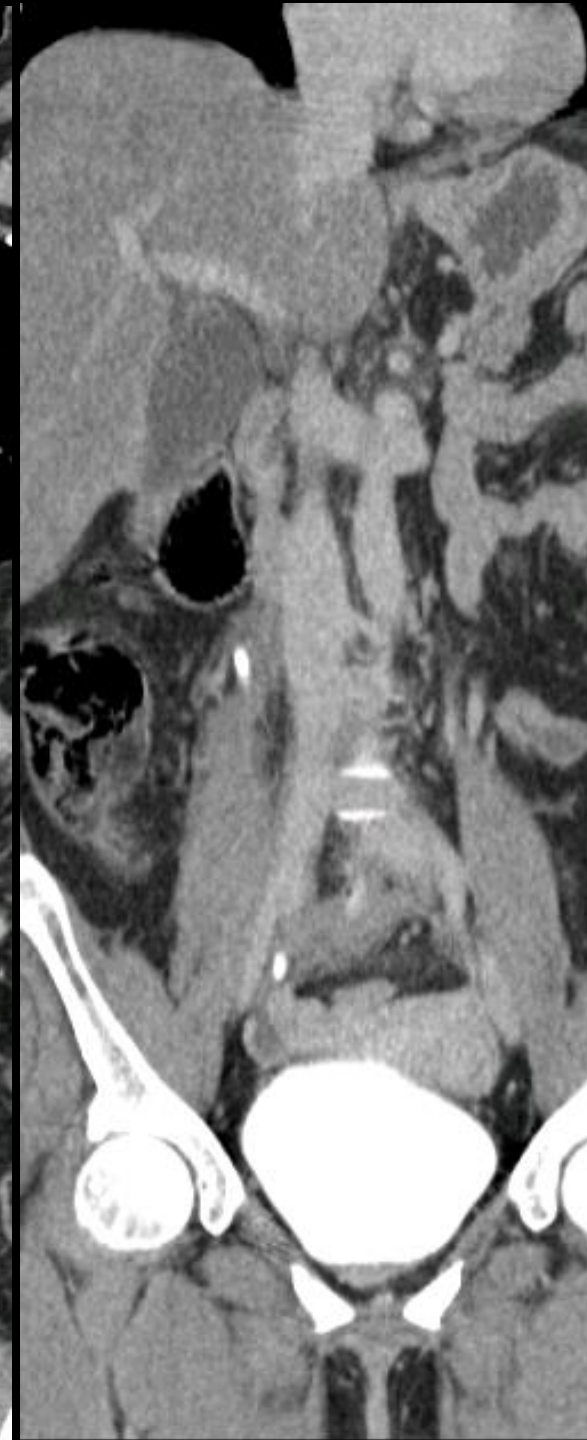


Delayed

IVC Injury



IVC Injury



Conclusion

- Dual-phase CT technique to decrease risk of missing injuries
- Develop a search pattern that includes organs and structures where important lesions are commonly missed: bowel, pancreas, diaphragm, vessels
- ? Significant injury on initial CT: admit, observe, repeat CT if necessary (bowel: short interval)



*Thank you for your
attention!*

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