

# Multiple Pelvic and Lower Abdominal GSW w/ Retained Bullet Fragments

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Diagnostic Radiology - RAD 4001

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# Clinical History

- 24 y/o M no PMH presented 10/28 w/ multiple GSW to lower abdomen + perineum
  - Ambulated after being shot multiple times, no LOC
  - GCS 15, c/o severe genital pain
  - VS: 96.8F, HR 68, 100/70, RR 21, SpO2 92%
  - Two entry wounds to lower abdomen, dorsal base of penis w/ deformity of penis, and left buttock
  - FAST negative, limited echocardiogram w/o abnormality
  - Labs: lytes wnl, nl plasma EtOH, UDS +benzo, +cannabis, +opiates, CBC 15.3 WBC, 14.9 Hg, 325 Plt

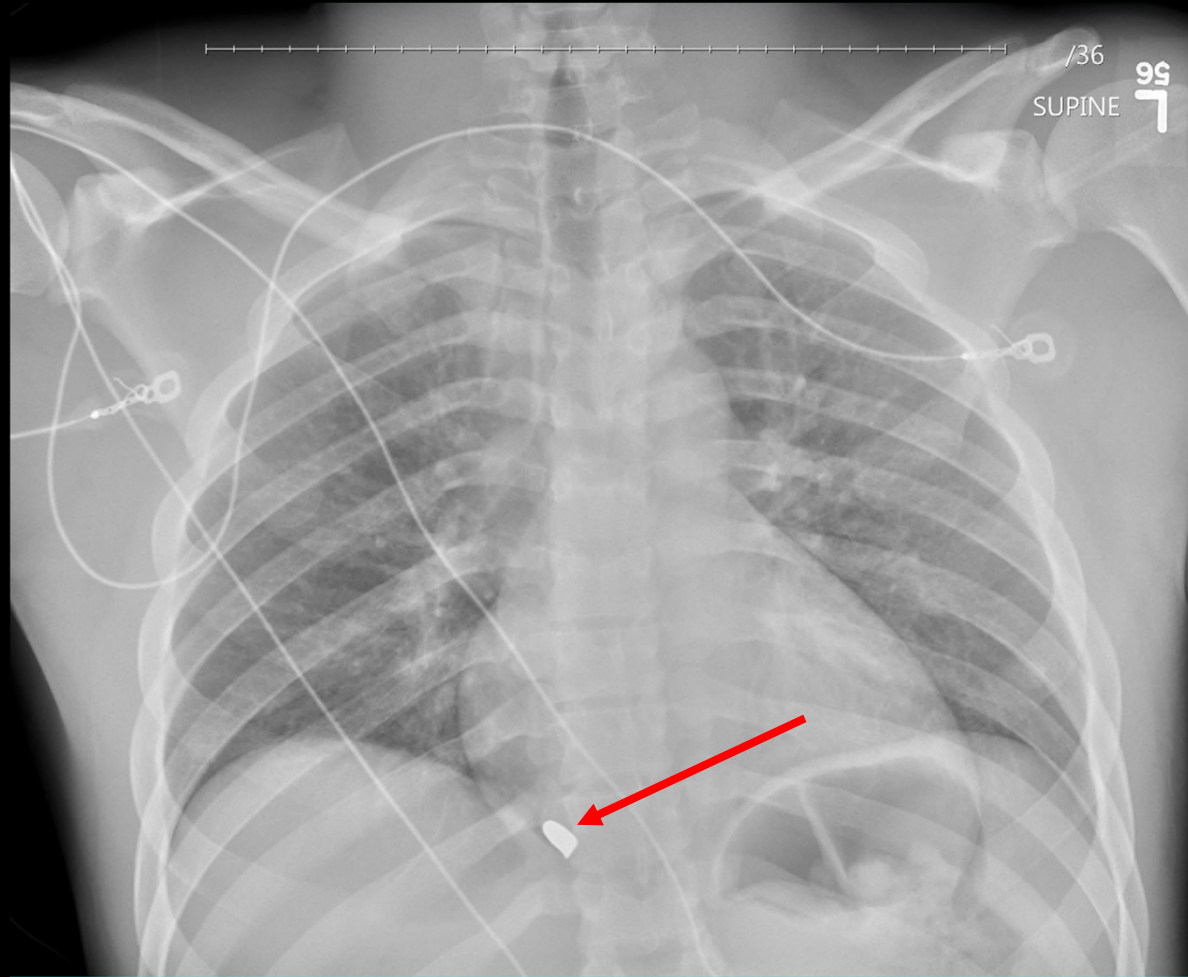
# Clinical History (cont.)

- Trauma surgery performed rigid proctoscopy, ex lap, EGD, hepatorrhaphy, abdominal closure
  - Ballistic injury at suprapubic midline, dorsal base of penis midline, ventrolateral surface of penis near base, left scrotum
  - 400 mL free intraperitoneal blood in pelvis
  - Liver laceration at segment IVb, anterior and posterior + laceration to caudate lobe → bleeding controlled w/ electrocautery
  - Bullet trajectory adjacent to lesser curvature → EGD + insufflation → no blood in stomach, no air leak
  - No rectal injury, retroperitoneal hematoma, bowel injury, stomach injury, diaphragmatic injury

# Clinical History (cont.)

- Uro consult intraop
  - L scrototesticular clot
  - Hemorrhage from l spermatic cord and avulsion of l epididymal tail w/ successful repair
  - Corpus cavernosa injury —> Bilateral corporotomies repaired w/ intact tunic
  - Intact urethra, bladder
- Post-op CT w/ contrast chest/abd/pelv

# Initial CXR, AP, Supine, 10/28

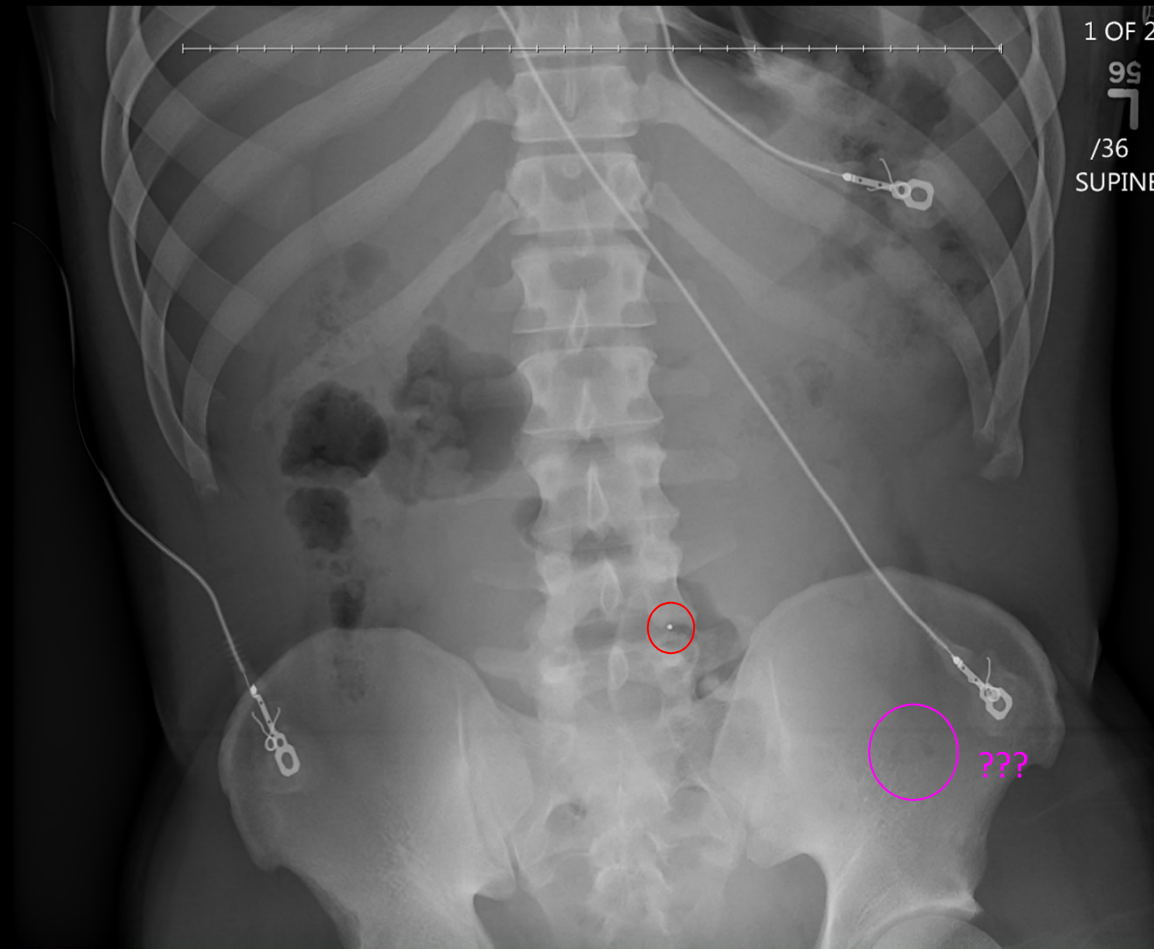


Legend:

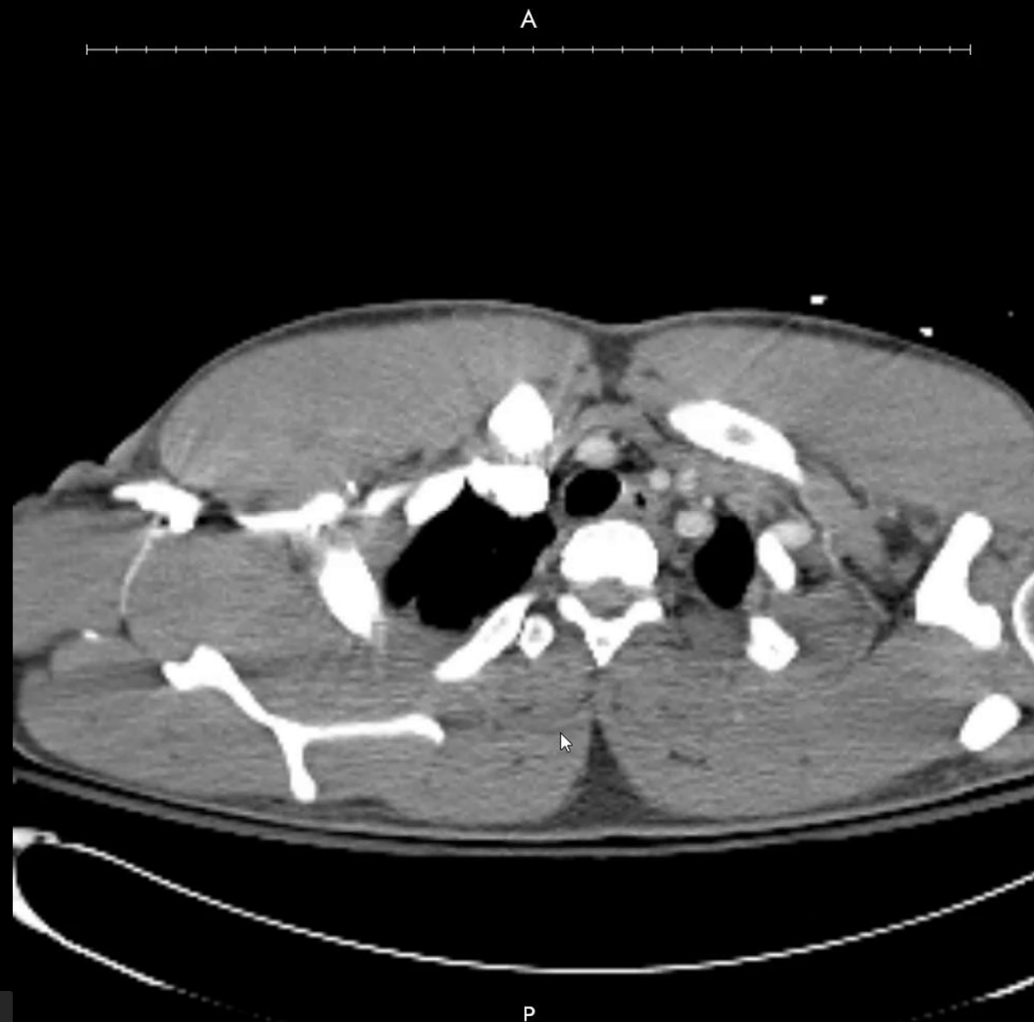
fragment

= Bullet

# Initial Abdominal Film, AP, Supine, 10/28



# CT Thorax, Axial



# CT Thorax, Coronal





# CT Thorax, Sagittal

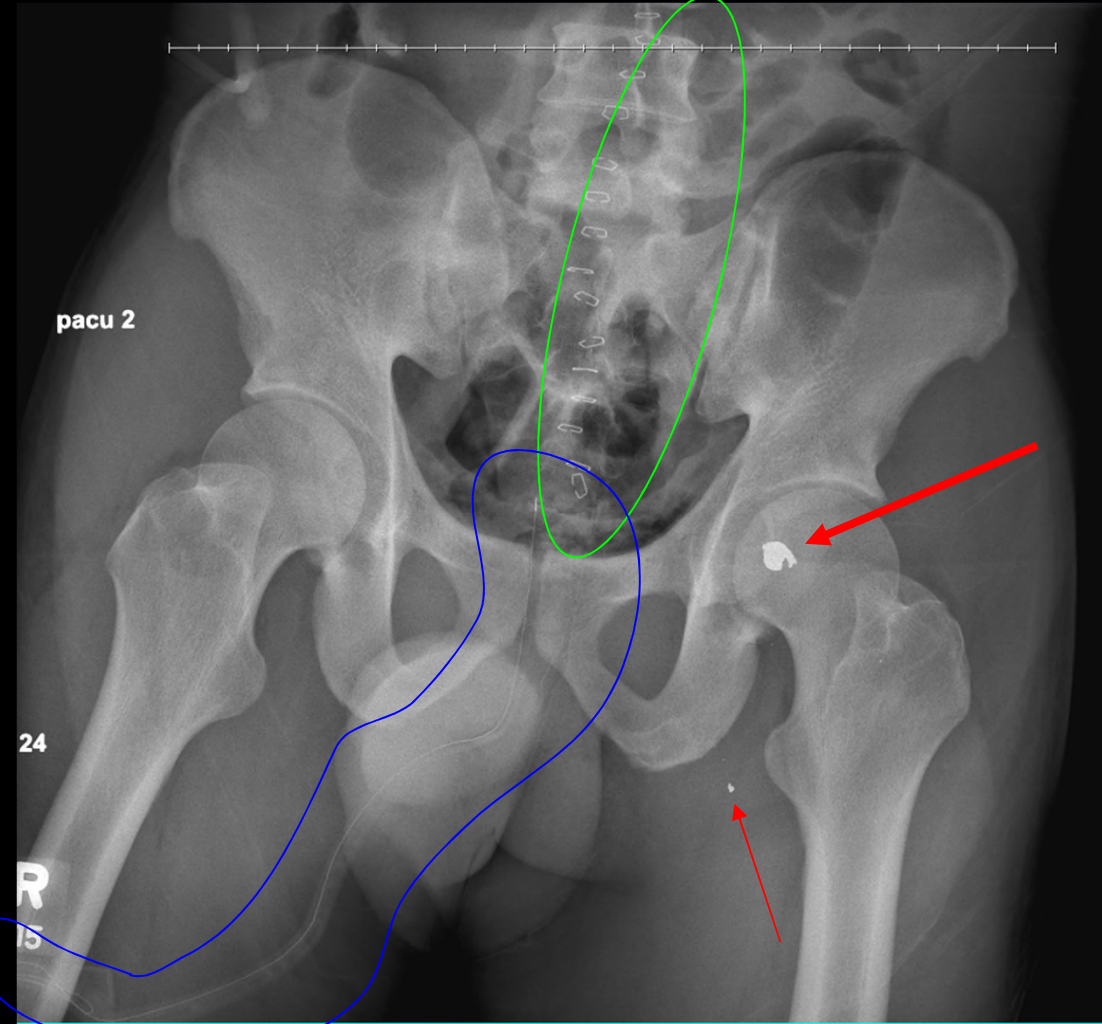


# CT Abdo, Axial

A



# Pelvis XR, AP, supine, 10/28



Legend:



Laparotomy staples

=

= Bullet

fragment

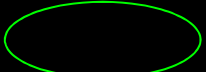


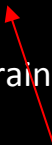

= small

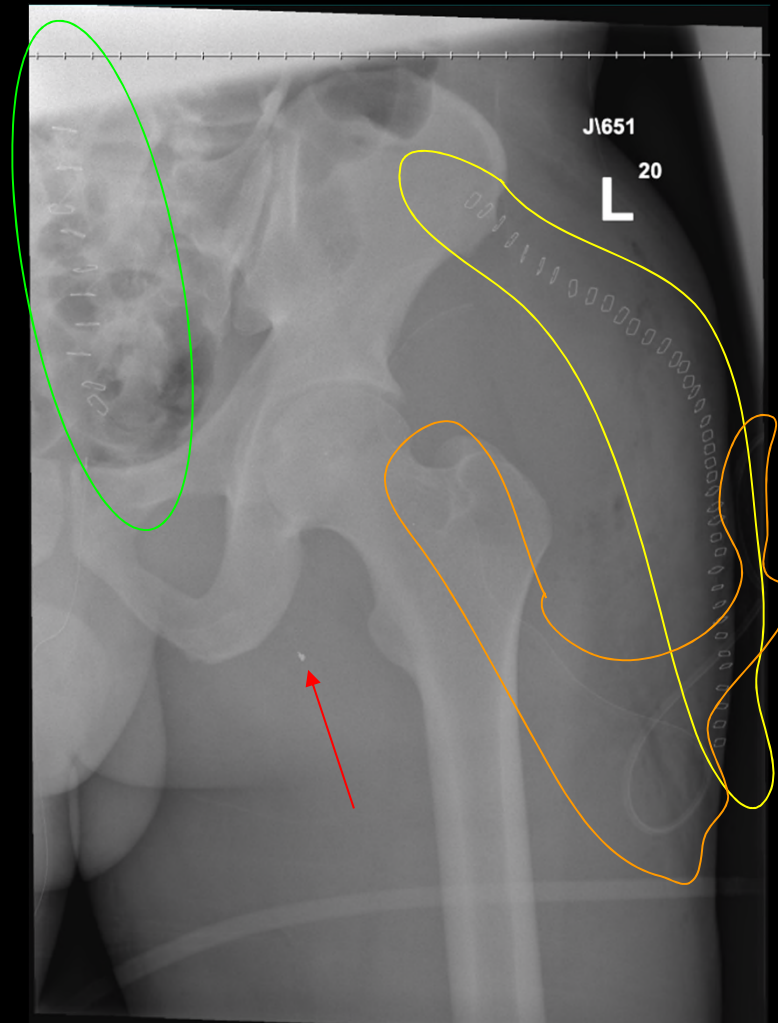
bullet fragment

= Foley

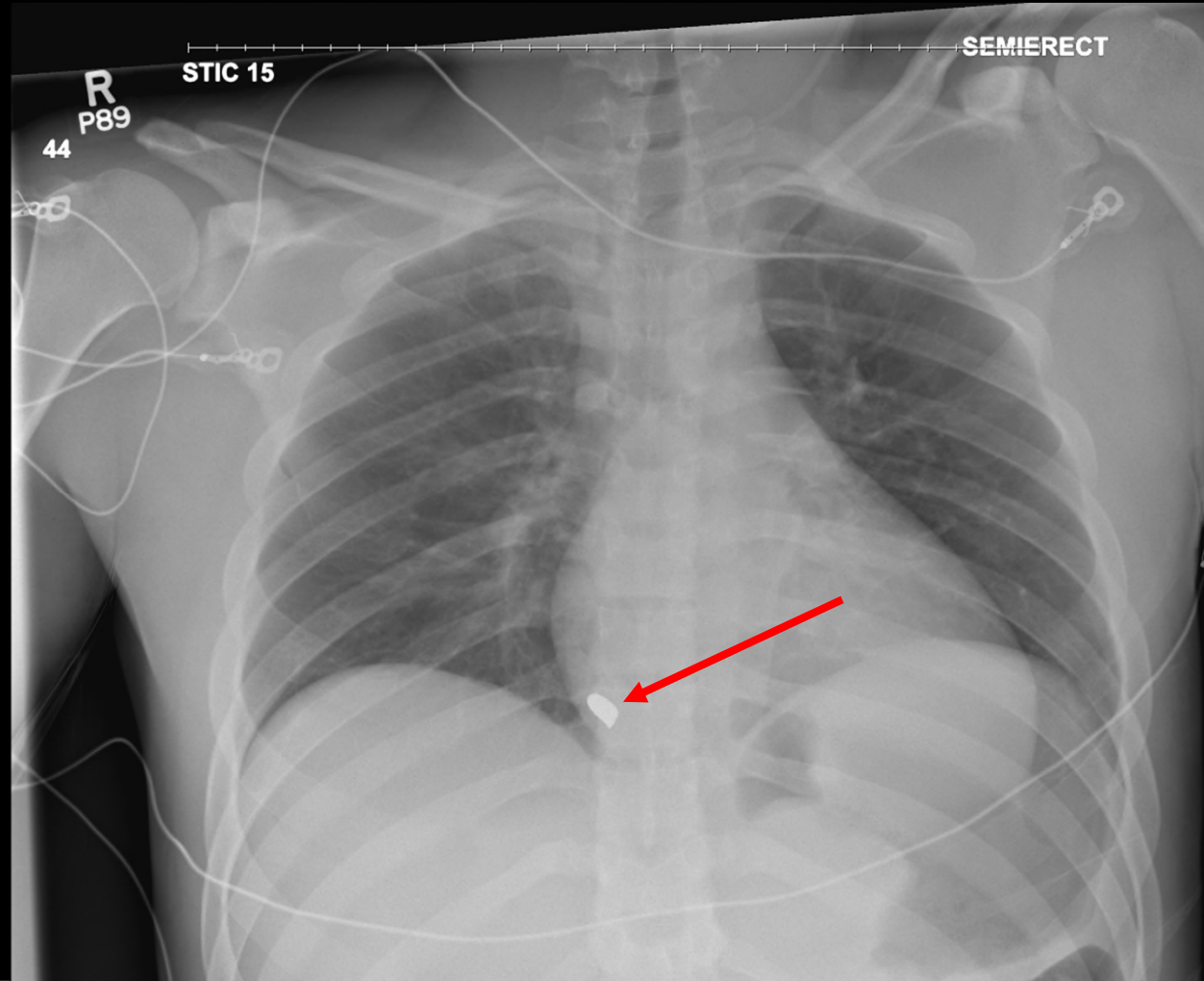
catheter

# L Pelvis XR, AP, 10/31 (Post Surgical)

- Legend:
-  = Laparotomy staples
  -  = skin
  -  = staples
  -  = drain
  -  = small bullet fragment



# F/u CXR, AP, semierect, 10/29



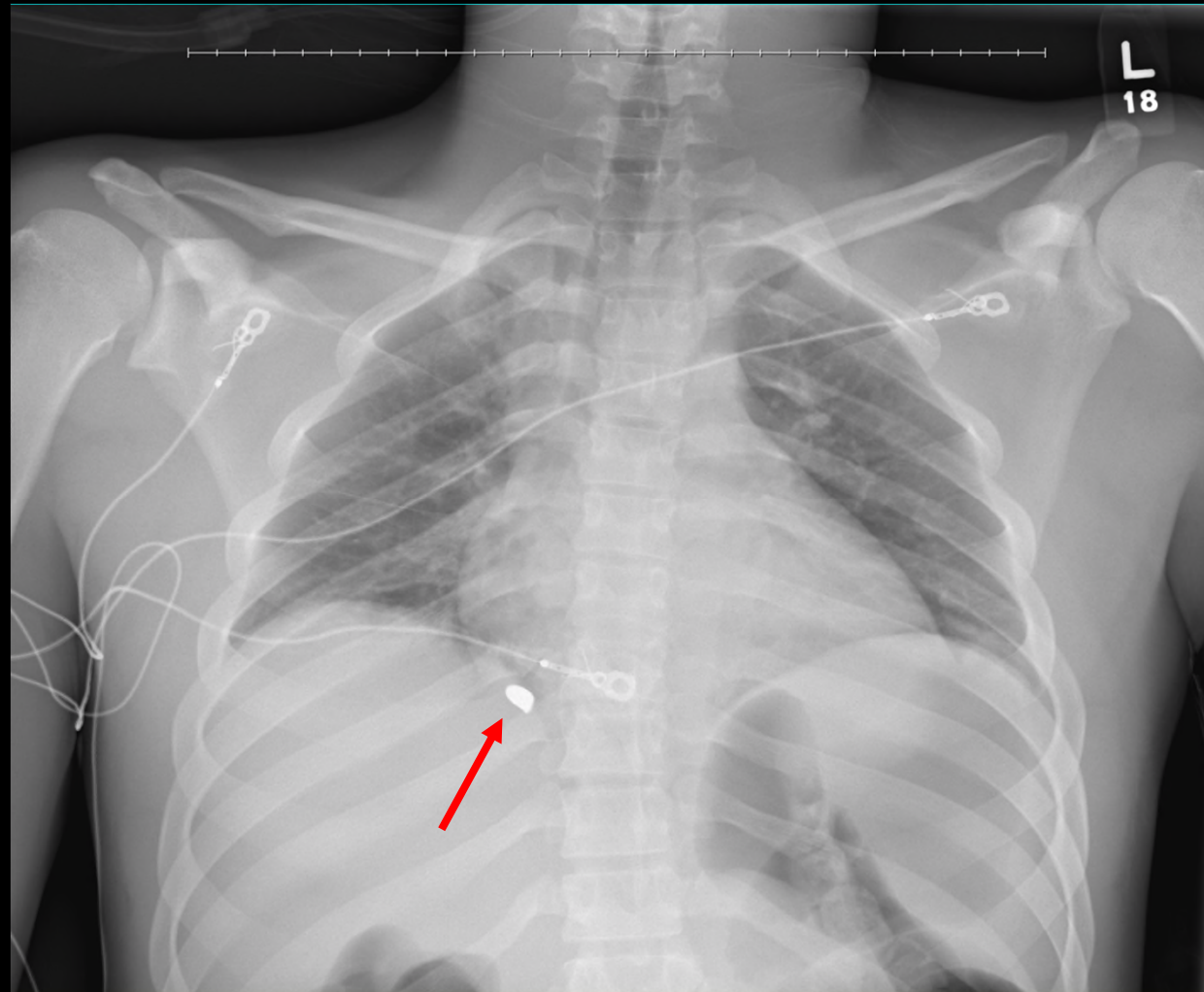
Legend:

← fragment

= Bullet



# Serial CXRs, AP, semierect, 10/30



Legend:

fragment

= Bullet

# Key Findings

- Serial CXRs: Bullet fragment in area of right atrium at T10
- Abdominal XR: Bullet fragments above pelvis and left femoral head, subcutaneous edema from gunshot wound near left hip
- CT Chest/Abdo/Pelvis w/ Contrast: **10 mm bullet fragment abutting the right atrium/right ventricle along atrioventricular groove, 4-5 cm (grade 2) liver laceration in segment IVb, scrotal hematoma, 9mm bullet fragment in left hip joint space w/o definite displaced fx, mild comminution of left inferior pubic ramus, some low-density fluid in upper abdomen likely 2/2 ventral laparotomy, subcutaneous emphysema in pelvis, left perineum, scrotum + small-volume free intraperitoneal air 2/2 bullet injury and/or ventral laparotomy**

# Key Findings (cont.)

- Pre-operative Pelvic XR: 9 mm bullet fragment over left femoral head, smaller bullet fragment medial to the left trochanter
- Post-operative L Pelvis XR: interval removal of 9mm bullet fragment over left femoral head, surgical drain in left thigh/gluteal region, unchanged small bullet fragment medial to left trochanter

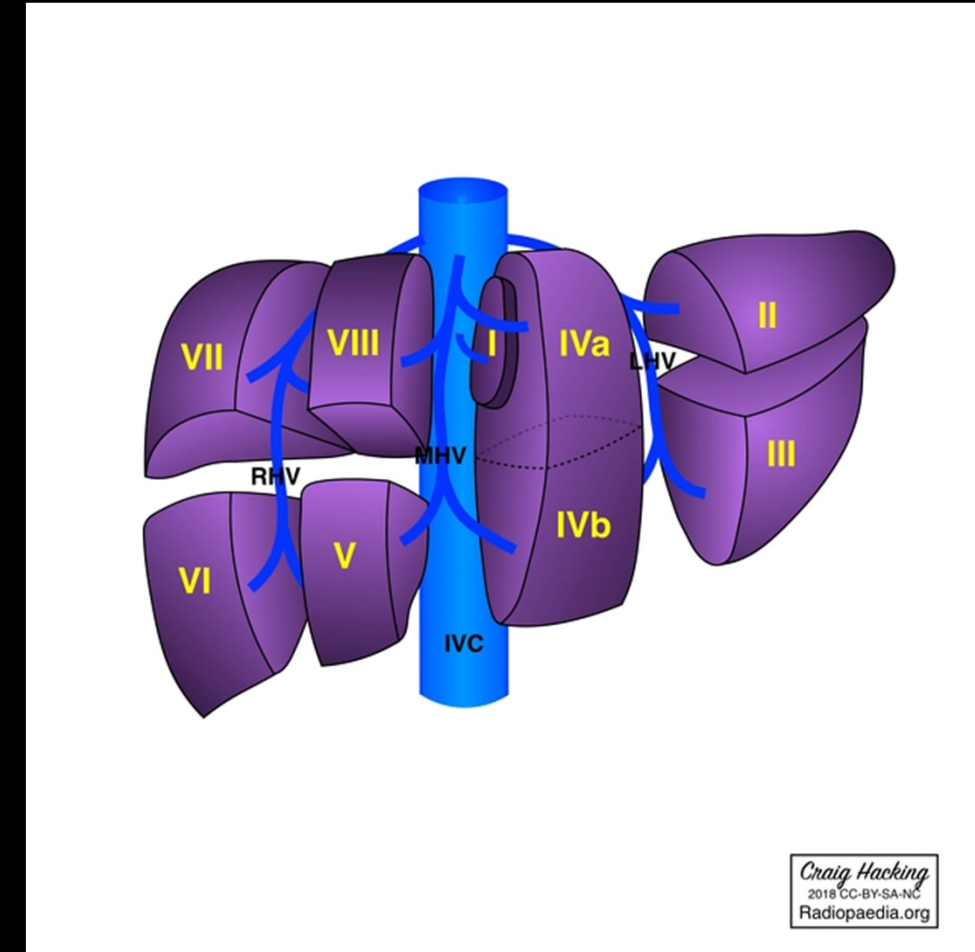


# Differential Diagnosis

- N/A

# Discussion

- Couinaud classification of hepatic segments (1)
  - Divides liver into 8 functional segments, each with their own dual vascular inflow, biliary drainage, and lymphatic drainage
  - Vertical planes divided by right, middle, and left hepatic veins
  - Horizontal planes divided by portal plane at bifurcation of portal vein



# Liver Injury Grading, American Association for the Surgery of Trauma (2)

Grade I – Subcapsular hematoma <10 percent surface area. Parenchymal laceration <1 cm in depth ([image 1](#)).

**Grade II** – Subcapsular hematoma 10 to 50 percent surface area; intraparenchymal hematoma <10 cm in diameter ([image 3](#)). Laceration: 1 to 3 cm parenchymal depth and ≤10 cm in length.

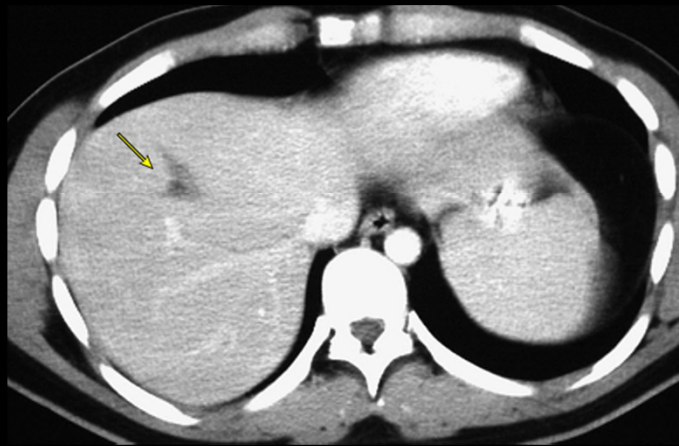
Grade III – Subcapsular hematoma >50 percent of surface area; ruptured subcapsular or parenchymal hematoma. Intraparenchymal hematoma >10 cm. Laceration >3 cm in depth. Any injury in the presence of a liver vascular injury or active bleeding contained within liver parenchyma.

Grade IV – Parenchymal disruption involving 25 to 75 percent of a hepatic lobe. Active bleeding extending beyond the liver parenchyma into the peritoneum.

Grade V – Parenchymal disruption of >75 percent of a hepatic lobe. Juxtahepatic venous injury to include retrohepatic vena cava and central major hepatic veins.

# Examples of Liver Lacerations

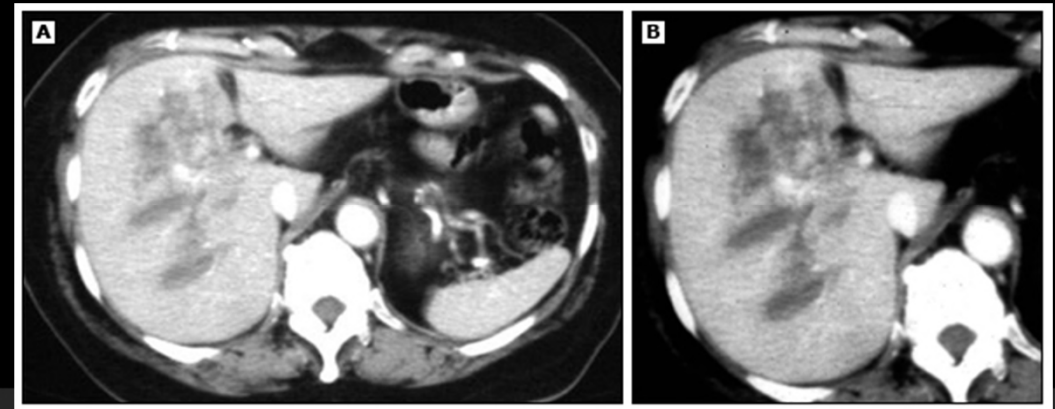
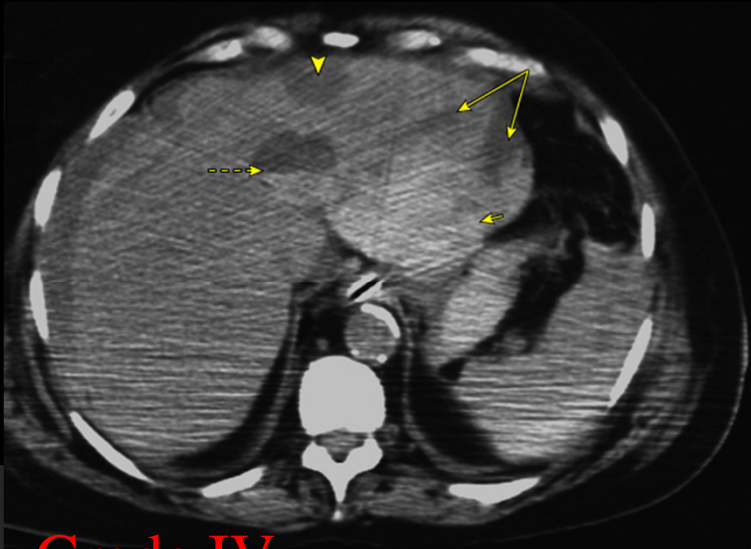
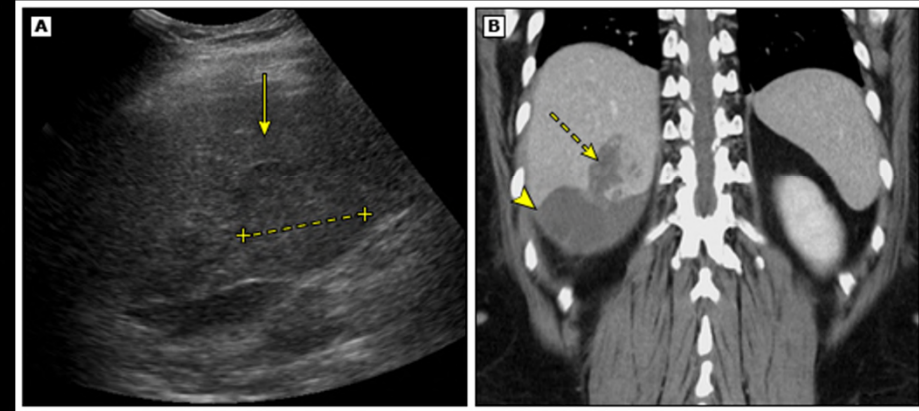
Grade I



Grade II



Grade III



Grade IV

Grade V

# Gunshot Imaging (3)

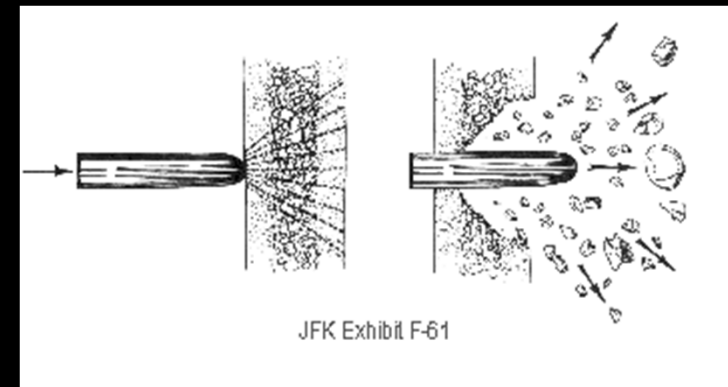
$$K = \frac{1}{2}mv^2$$

Primary objective of imaging: determine path of projectile(s), assess which tissues have been injured, estimate severity, determine need for additional studies

Mechanism of gunshots:

- Kinetic energy: Rifles > Handguns, greater wounding potential due to increased acceleration time
- Rifling = spiral grooves in gun → bullet spins while traveling to target
- Upon hitting target, non-deformed bullets tend to tumble (rotate about short axis) w/ proximal end (more mass) leading → bullets often point *towards* entry wound
- Tumbling is decreased or even eliminated if bullet deforms upon entry
- Low-velocity weapons tend to use pure lead bullets, while medium- to high- velocity weapons often have metal jacket (full or semijacket) to prevent deformation in gun barrel
- Semijacketed bullets have often have a exposed lead tip to deform on impact
- Others have open cavity at tip (hollow-point) and transform into mushroom shape on impact
- Hollow-point bullets decelerate more quickly leading to greater energy delivery to smaller amount of tissue and overall greater tissue damage

# Gunshot Imaging (cont.)

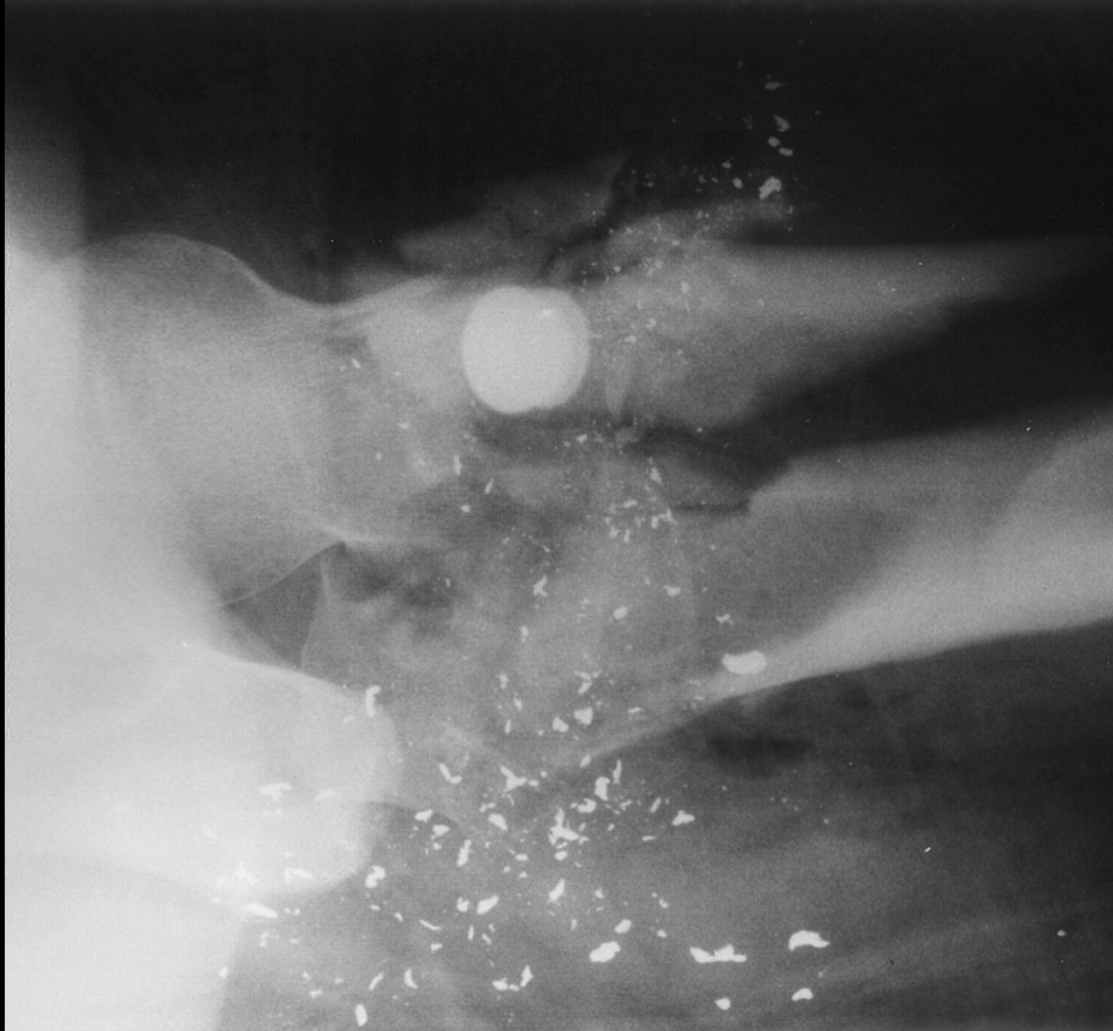


JFK Exhibit F-61

Image source: <http://mcadams.posc.mu.edu/medical.htm>

## Mechanism of injury

- Damage is most severe in friable soft tissue, such as liver and brain
- Temporary cavitation of tissue remote to bullet track can also cause injury (more likely with high-velocity weapons)
- Bones alter course of bullets, slow them down, and increase deformation/fragmentation
  - Carefully examine for beveling of bone towards direction of travel (trauma physicians cannot reliably distinguish between entry and exit wounds)
- Semijacketed, hollow-point, non-jacketed, and soft-point bullets often leave a trail of metal fragments
- Low-velocity weapons fired at medium- to long- range is less likely to be fatal
  - Less kinetic energy → bullet travels deeply in subcutaneous tissue but tends to stop at fascia, esp. when entering at shallow angle to skin
- High-velocity fragmentation leads to “lead snowstorm” with conical distribution
- Shotguns
  - Severe at close range → combined mass of multiple pellets
    - Contact injuries result in further damage from combustion gas
  - Often superficial at long range
  - Pellets can be made of lead or ferromagnetic steel (distinguishable on radiograph → lead deforms)



High-velocity rifle injury to hip

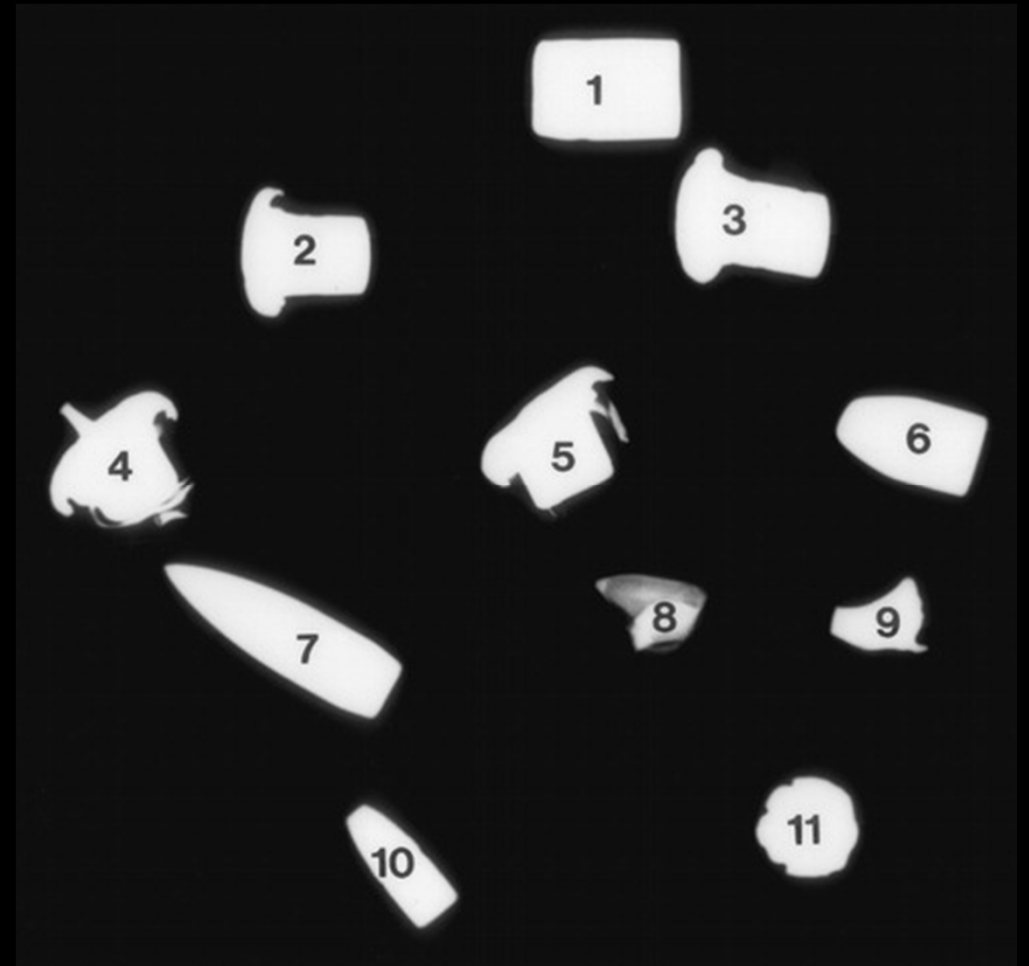


Shotgun injury to shoulder

# Expended Bullet Images

## Legend:

- 1 - soft-point 0.44 magnum
- 2,3 - hollow-point 0.38 special
- 4,5 - hollow-point semi-jacketed 9-mm
- 6 - solid-point fully jacketed 9-mm
- 7 - 7.62-mm fully jacket rifle
- 8 - jacket fragment of soft-point rifle
- 9 - lead fragment of soft-point rifle
- 10 - solid-point nonjacketed 0.22
- 11 - hollow-point nonjacketed 0.22





# Urogenital Trauma Classification

Urethral Trauma, Goldman (4):

Type I: posterior urethra stretched but intact

Type II: urethra disrupted at the membranous-prostatic junction above the urogenital diaphragm

Type III: disruption of the membranous urethra, extending below the urogenital diaphragm and involving the anterior urethra

Type IV: bladder neck injury, with extension into the proximal urethra

Type IVa: injury to the base of the bladder, with periurethral extravasation simulating a type IV urethral injury

Type V: isolated anterior urethral injury

Bladder Trauma, American Association for the Surgery of Trauma (5):

Grade 1: Hematoma, partial thickness laceration

Grade 2: Extraperitoneal bladder wall laceration <2 cm

Grade 3: Extraperitoneal bladder (>2 cm) or intraperitoneal bladder (<2 cm) laceration

Grade 4: Intraperitoneal bladder wall laceration >2 cm

Grade 5: Intraperitoneal or extraperitoneal bladder wall laceration extending into the bladder neck or ureteric orifice

# Final Diagnosis

- Retained 10 mm bullet fragment abutting RA/RV
- Grade IIb liver laceration, segment IVb w/o extravasation or pseudoaneurysm
- Retained 9 mm bullet fragment w/n posterior I hip joint space
- Comminuted I inferior pubic ramus fx
- Scrotal hematoma
- No bladder or ureteral injury

# Outcome

- Cardiology + CV Surgery consulted for bullet in myocardium
  - TTE + TEE revealed no foreign body w/n the heart, no functional deficit, no effusion
- Underwent I & D + removal of foreign body L hip 10/30
  - Open L ischium fx, open left femoral head fx w/ foreign body, open left hip joint w/ posterior capsulotomy
- Discharged 11/6 on POD#8 after being cleared by PT/OT
  - F/u in 2 weeks w/ Dr. Gary (orthopedic trauma), Dr. Wang (urology), and Dr. Meyer (trauma)

# ACR appropriateness Criteria

- the ACR recommendation for penetrating injury to the lower abdomen / pelvis w/ suspected lower urinary tract injury lists fluoroscopy retrograde cystography and CT pelvis w/ bladder contrast as “usually appropriate”
- In this case, patient was hemodynamically unstable and immediately taken for operative mgmt + mechanism of injury was GSW

**Variant 1:**

**Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma.  
Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Fluoroscopy retrograde cystography	Usually Appropriate	☼☼☼
CT pelvis with bladder contrast (CT cystography)	Usually Appropriate	☼☼☼☼
CT pelvis with IV contrast	May Be Appropriate	☼☼☼
Radiography pelvis	May Be Appropriate	☼☼
Fluoroscopy retrograde urethrography	May Be Appropriate	☼☼☼
CT pelvis without IV contrast	May Be Appropriate	☼☼☼
CT pelvis without and with IV contrast	Usually Not Appropriate	☼☼☼☼
Arteriography with possible embolization abdomen and pelvis	Usually Not Appropriate	Varies
Radiography intravenous urography	Usually Not Appropriate	☼☼☼
US pelvis (bladder and urethra)	Usually Not Appropriate	○
MRI pelvis without and with IV contrast	Usually Not Appropriate	○
MRI pelvis without IV contrast	Usually Not Appropriate	○
Tc-99m MAG3 scan kidney	Usually Not Appropriate	☼☼☼

# Cost of Imaging

- 3 x CXR, CT Chest w/ contrast, CT Abdo w/ contrast, pelvis AP DX, wrist DX, HIP 1 view DX, NO read hip fluoro, TTE x 2, TEE x 1
  - ct abdo → \$5,540
  - ct chest → \$3,936
  - CXR → \$683 x 3 = \$2,049
  - pelvis AP DX → \$719
  - wrist → \$771
  - hip 1 view dx → \$719 (??)
  - fluoro → ??
  - TTE x 2 → ??
  - TEE x 1 → ??

# Take Home Points

- Imaging of gunshot wounds is useful for initial management and/or post-operative decision-making
- Different gun and bullet varieties result in markedly different pathology and clinical outcomes
- Trauma classification systems exist for various types of injuries, including liver, ureteral, and bladder

# References

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Questions?