Pediatric UrologicTrauma

2023 Western Pediatric Trauma Conference

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Disclosures

None

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Objectives

- Diagnosis and management of GU trauma
  - Upper tract
    - Kidney and ureter
  - Lower tract
    - Bladder
    - Urethra
    - Genital
  - Practical Applications for the GU trauma consult

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Pediatric Trauma Overview

- Blunt trauma
  - Etiology in 90% of pediatric urologic injuries
    - 90% will have coexisting injuries
      - Thorax
      - Spine
      - Pelvis and extremities
  - Hematuria – not reliable in assessing location and severity of injury*
    - History of hematuria disproportionate to severity of trauma

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Kids vs. Adults: Similarities

- AUA Uro-trauma Guidelines 2014/2017/2020:
  - **Not pediatric specific**
- Goals of care are the same :
  - Accurate/efficient use of radiographic tests
  - Appropriate diagnosis and intervention
  - Open/MIS techniques for hemostasis and drainage
  - Preserve GU function

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Kids vs. Adults: Differences

- Different “normal” for vital signs
- Stronger compensatory mechanisms:
  - Can maintain BP until 40% of circulatory volume loss
- Rapid deterioration when compensation fails

	Adult	Child	Infant
Normal respiratory rates	12-20 breaths/min	15-30 breaths/min	25-50 breaths/min
Normal pulse rates	60-80	60-140	100-190
Blood pressure	120/80	86-121/41-78	72-104/37-56

Pediatric Renal Trauma

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Pediatric Renal Trauma

- Majority secondary to blunt trauma
  - Renal injuries in 10-20% blunt abdominal trauma
- Pediatric kidney more susceptible (controversial)
  - Protected by an immature, pliable thorax, weaker abdominal muscles
  - Larger size of the kidney relative to rest of body
  - Less peri-renal fat and sits lower in abdomen
- Pre-existing renal abnormalities – 3-5 fold more common
  - Most with grade 1
- "***Diagnostically aggressive, surgically conservative***."
  - Key is timely and accurate diagnosis

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Renal Trauma: Assessment/Diagnosis

- Assess hemodynamic stability
- History and physical
  - Mechanism important* – may direct imaging
- Traumatic-Induced Hematuria: Pediatric vs Adult
  - Poor correlation with hematuria and renal injuries in kids
  - 2/3 with Grade II and > will have normal urinalysis
- Hypotension and degree of injury
  - Higher sympathetic tones - sustain normal BP's despite significant blood loss
    - (Hgb/Hct) drops significantly before orthostatic hypotension

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Grading of Pediatric Renal Trauma

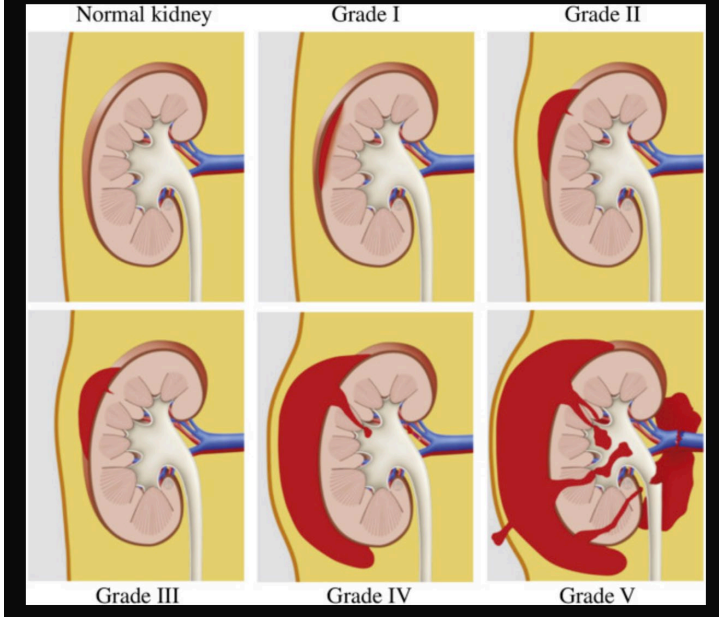

Table 2. 2011 AAST Grading of Renal Injuries

Grade of Renal Injury	Description
I	Subcapsular hematoma and/or contusion No collecting system injury
II	Laceration < 1 cm in depth and into cortex, small hematoma contained within Gerota's fascia No collecting system injury
III	Laceration > 1 cm in depth and into medulla, hematoma contained within Gerota's Fascia No collecting system injury
IV	One or more lacerations through the parenchyma into the urinary collecting system with urinary extravasation Vascular segmental vein or artery injury Renal pelvis laceration and/or complete UPJ disruption
V	Main renal artery or vein laceration or avulsion Main renal artery or vein thrombosis

Buckley JC, McAninch. J Trauma. 2011

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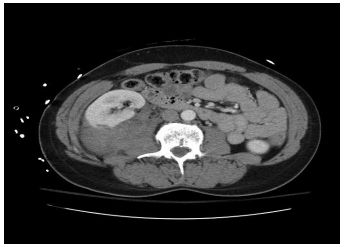
Grading of Pediatric Renal Trauma

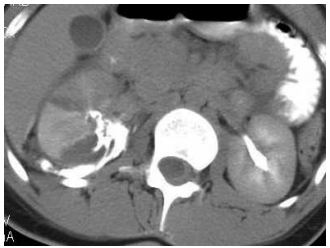
Grade 1

Grade 2



Grade 3

Grade 4



Grade 5

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Pediatric Renal Trauma: Imaging

- All penetrating trauma
- Blunt trauma
  - Significant deceleration/High velocity
    - Fall from >15ft, strike to the abdomen/flank with a foreign object, MVC
  - Significant orthopedic injuryies (rib, spine, pelvis)
    - Bruising of the torso, clinical signs of peritonitis
  - Gross Hematuria
  - Microhematuria (>50 RBC/HPF) + shock (SBP<90)

Santucci et al , 2004

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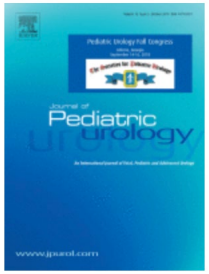
Pediatric Renal Trauma: Imaging

- CT urogram:
  - Tri-phasic with delayed imaging for ureteral evaluation
  - Most sensitive
  - “Split dose” protocol if radiation concern
- IVP:
  - Unstable patient going to OR, also check contralateral kidney
  - Contrast 2 cc/kg IV x 1, KUB scout and 10-15 minutes later
- FAST:
  - Highly specific (95-100%), not as sensitive (22-85%)

What About Renal Ultrasound?



Renal ultrasound to evaluate for blunt renal trauma in children: A retrospective comparison to contrast enhanced CT imaging

- Edwards *et al*, Journal of Pediatric Urology, 2020

- 76 patients, 4 blinded reviewers
  - Sensitivity 79-100%, NPV 97-100%
  - Frequently missed Grade 1/2 injuries
  - All Grade 3/4 had hematuria (gross or micro > 50RBC/HPF)

- If no hematuria, US may be sufficient to rule out clinically significant renal trauma

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Pediatric Renal Trauma: Management

- Surgical exploration:
  - Same indications as adults
  - < 10-20%, high nephrectomy rate
- Expectant management:
  - Does not mean non-operative, just close monitoring first
  - 25-50% with Grade 3-5 eventually require intervention
- Stent, nephrostomy tube, angioembolization

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Coccolini,et al. Kidney and uro-trauma: WSES-AAST Guidelines. World J Emerg Surg. 2019 Dec 2;14:54.

Absolute Indications for Intervention

- Hemodynamic instability due to renal bleeding
  - Grade V renovascular injury
- Expanding or pulsatile retroperitoneal hematoma
- Inability to stop persistent or delayed hemorrhage by selective vascular embolization
  - Most result in nephrectomy

Relative Indications for Exploration

- Finding a retroperitoneal hematoma at time of surgical exploration for intra-abdominal injuries
  - Controversial
  - Single-shot IVP to verify contralateral renal function
- CT-documented high grade injury with intra-abdominal injuries that require abdominal exploration
  - Controversial
  - High nephrectomy rate

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Renal Trauma: Expectant Management

- Serial exams, vital signs, H&H, urine output
  - Transfuse as needed
- Bedrest until gross hematuria resolves
- Look for signs of symptomatic urinoma
  - Flank pain, ileus, fevers
- Prophylactic antibiotics to prevent seeding of urinoma
- Follow–up imaging 48 hrs after initial may be needed (IV-V)
  - Clinical sx: ongoing blood loss, abdominal distention, hemodynamic instability

Murphy GP, et al. Current Urol Rep.2017

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Predictors for Intervention

CT Predictors:

- Reese, Journal of Urology, 2014
  - Blood clot in collecting system
  - Dislocated renal fragments
  - Urinoma > 4 cm

- Husmann, Journal of Urology, 2014
  - Perinephric hematoma > 2.5 cm
  - Active bleed on CT
  - Lateral extravasation with no distal ureter seen
  - Medial extravasation

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Pediatric Renal Trauma: Follow-Up

- Follow-up imaging:
  - Grade 1/2 – not recommended
  - Grade 3/4/5 – US, CT, MRI
  - Renal functional scans if concerned about prognosis/BP

- Other follow-ups:
  - UA and BP at 6 weeks and 12 weeks

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Patient GR

- 11 yo s/p bike crash – fell on handle bars

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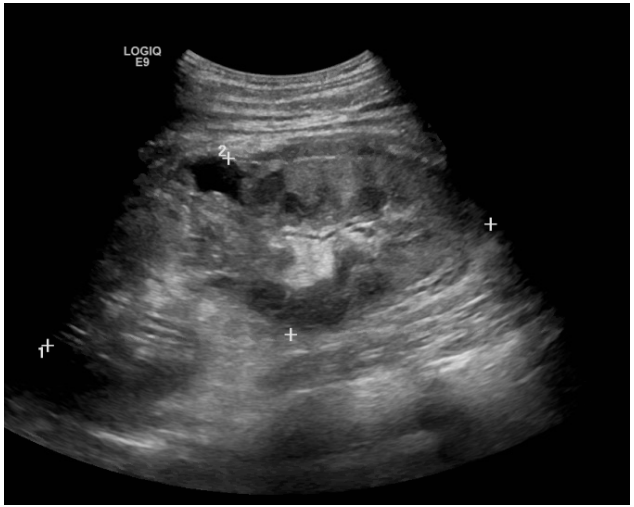
Patient GR

- Conservatively managed, then febrile day 3



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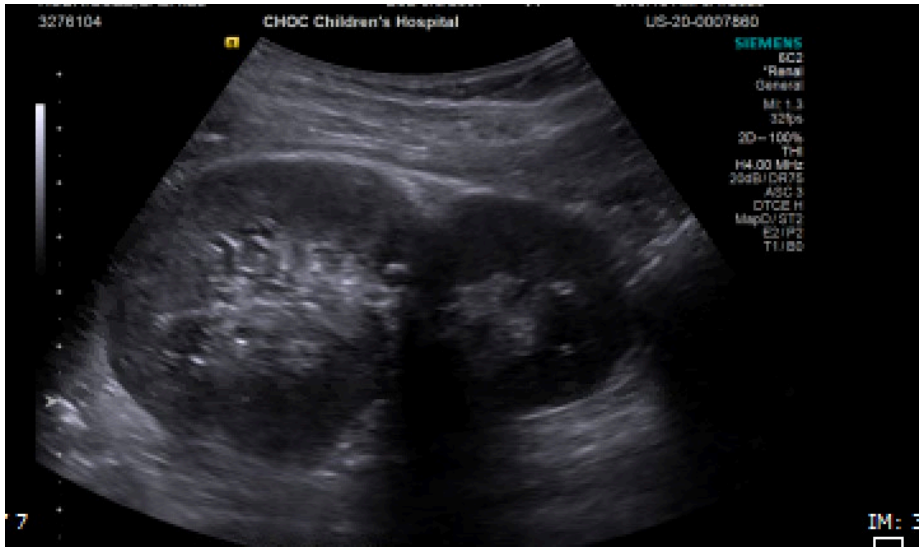
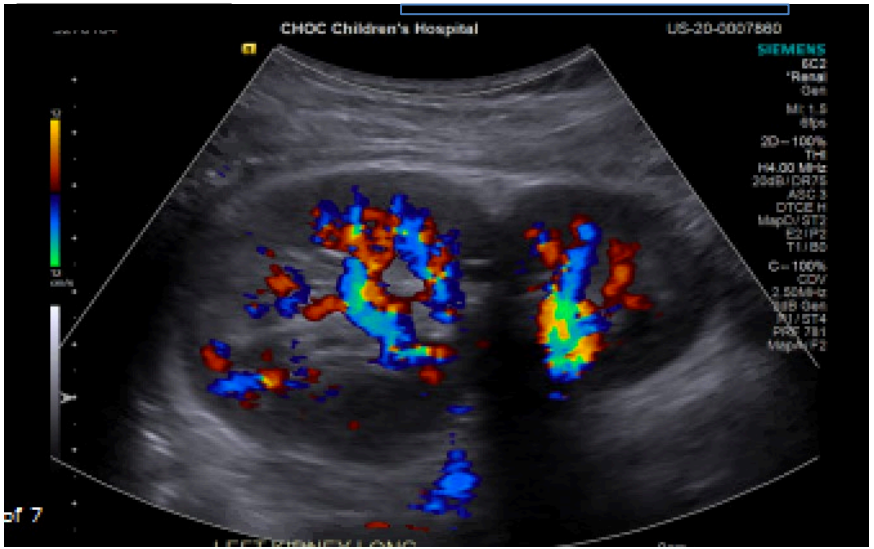
Patient GR

- 1 year follow-up; BP 120’s/80





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Complications of Renal Trauma

- Trauma-Induced Renal Vascular Hypertension
  - Usually within 36 months
    - If sustained, renal scan to determine function
      - <20% with HTN, nephrectomy
  - May need MRI/CT angio to rule out AV fistula, pseudoaneurysm
    - May be treated with embolization
- Trauma-Induced Chronic Flank Pain
  - 7% in ≥Grade 3, usually no specific cause identified
  - Pain management, possible nephrectomy (with extreme caution)

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Pediatric Renal Trauma: Sports?

MECHANISM OF RENAL INJURY	PERCENTAGE OF RENAL INJURIES CAUSED BY BLUNT TRAUMA IN A PEDIATRIC POPULATION
Motor vehicle collision (including MV vs. pedestrian)	45%
Bicycle accidents (including dirt bikes and motor cross)	17%
Contact sports	12%
All-terrain vehicle accident	10%
Sports—miscellaneous (sledding, skiing, snowboarding, horseback riding, rollerblading, etc.)	7%
Falls	6%
Abuse/assault	3%

- Solitary kidney:
  - Normal anatomy
  - Normal position
  - Wear protection

↓

Cleared for contact sports

- Should discuss seat belt, car seat, etc.

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Renal Trauma Summary

- Imaging is crucial in the evaluation of upper tract injuries
  - Findings will dictate treatment and predict outcomes
  - **Must have delayed imaging**
- Majority of renal injuries will be managed expectantly
- 95% of clinically stable patients with Grade IV managed non-operatively will not require open procedure
- > 95% will retain a clinically functional kidney

Umbreit, Husmann. Urology. 2009. 74;579.

Practical Application – “Street Smarts”

- Delayed imaging necessary
    - If/when missed, can do KUB to see if extravasation
- Check the UA
- Don’t forget about IR – try to save any and all renal function
- On-the table IVP – 1 initially then 10min
    - 2ml/kg (peds – SBP>90 for accurate study)
- Don’t open the retroperitoneum*
- Can you play football with one kidney?
    - You play football with one brain

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Pediatric Trauma: Ureter

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Pediatric Ureteral Trauma

- Rare, < 4% of penetrating injuries
  - 10% with concomitant renal or bladder injuries
- Ureter is well protected: Small target, flexible & mobile
  - Upper part: by vertebral column & paraspinal muscles
  - Lower part: by bony pelvis
- High clinical suspicion, may present in a delayed fashion
- Iatrogenic:
  - Adult patients with colorectal or GYN surgeries
  - Ureteroscopy most common in pediatric
- Diagnosis: Tri-phasic CT or retrograde ureterogram*

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Ureteral Injury Management

- Contusions – gun shot wound or crush injury
  - Stent if recognized early
  - Nephrostomy tube, staged reconstruction if late
- Gunshot wound (high velocity)
  - Tissue necrosis can occur 3-5 days after
    - Delayed urine leak
    - If near ureter, consider stenting
- Iatrogenic - Location dependent
  - Proximal: Ureteropyelostomy, ureteroureterostomy
  - Mid: Ureteroureterostomy, trans u-u
  - Distal: Reimplant, psoas hitch, boari flap

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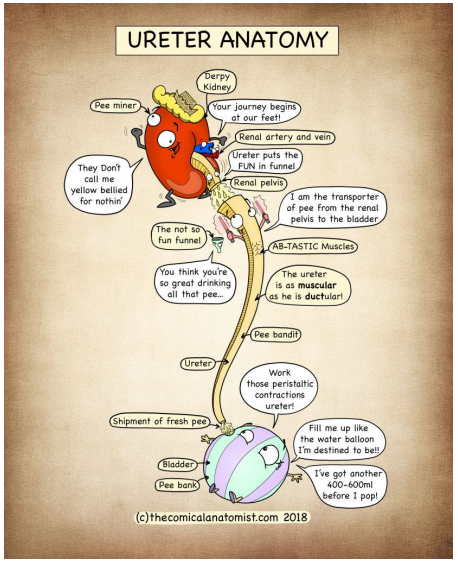
Practical Application – “Street Smarts”

- Don’t forget the ureter
- Is the patient going to OR?
  - If stable, can primarily repair
- May need maximal drainage
  - Catheter in addition to stent
- Consider in delayed presentations
  - Persistent flank/abd pain, prolonged ileus, ↑BUN/Cr, ↑drain ouput, nausea/vomiting
- Ask about previous surgeries



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Pediatric Trauma: Bladder

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Pediatric Bladder Trauma

- Rare in pediatrics (<2% requiring OR)
  - More susceptible than adult bladder
    - Higher position in abdomen, especially when full – intraperitoneal rupture
    - Less muscular protection by abdominal wall
    - Less pelvic/abdominal fat
  - Associated with multi-organ trauma
    - Less commonly associated with pelvic fractures compared to adults
  - Mortality rate 20%
  - Blunt trauma most common

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Sivit, C.J., et al. . AJR Am J Roentgenol, 1995. 164: 1243.

Pediatric Bladder Trauma

- Evaluation and management similar to adults
  - Extraperitoneal vs. intraperitoneal
- Cystogram:
  - Contrast volume should be at least 50% expected capacity
  - Capacity (cc) = [Age (years) + 2] x 30
- Important to elicit relevant surgical history:
  - Trocar injury from laparoscopic appendectomy
  - Bladder augmentation susceptible

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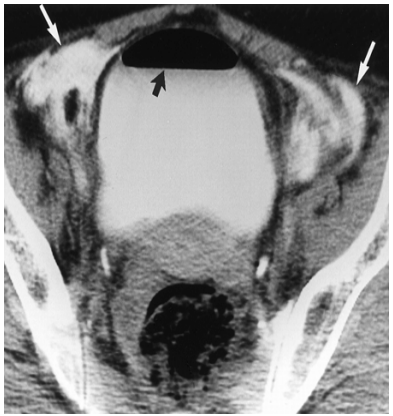
Extraperitoneal Bladder Injuries

- Extraperitoneal
  - Most common
  - 85% associated with pelvic fracture
    - 10% of pelvis fracture sustain lower GU injury
  - “Tear drop” Deformity
    - Pelvic hematoma compression

“Flame sign”



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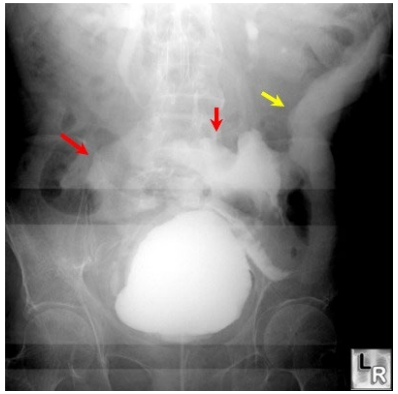
Intraperitoneal Bladder Injuries

- Intraperitoneal
  - Sudden blow to abdomen or pelvis
    - Increase in intravesical pressure
  - Dome is weakest part of bladder
    - Peritoneal surface across the dome
  - Cystogram
    - Contrast outlining loops of bowel
  - Associated with severe intrabdominal injuries
  - Consider if no urine back with catheterization



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Management of Bladder Injuries

- Determined by:
  - Mechanism (blunt vs. penetrating)
  - Classification (extraperitoneal vs. intraperitoneal)
- Surgical exploration indicated:
  - All penetrating bladder injuries
  - Intraperitoneal bladder injuries
  - Extraperitoneal bladder injuries if:
    - Bladder neck injury (high incontinence rates), vaginal or rectal injury, catheter not draining secondary to clots, bony spicule into bladder

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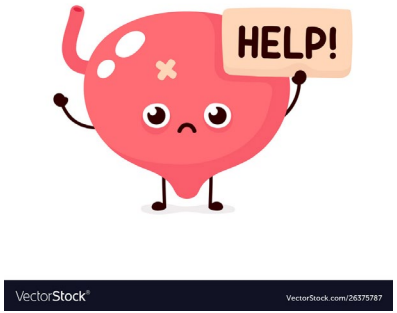
Practical Application – “Street Smarts”

- Ask about prior surgeries
  - Trocar injury
- Ask about other injuries – pelvic
- Are they going to the OR?
- Is a catheter in?
- Was the bladder imaged appropriately?
  - If not and already had CT, conventional cystogram with post-drainage films



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Pediatric Trauma: Urethra

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Pediatric Urethral Trauma

- Pediatric urethra is well protected:
  - Shape & elasticity
  - Suspect if pelvic fracture or significant perineal trauma
- Signs/symptoms similar to adults:
  - Perineal/genital hematoma
  - Blood at meatus or introitus
  - Inability to void
- Imaging warranted
  - Triad: Perineal/genital hematoma, blood at meatus or introitus, inability to void
  - Fracture of pubic rami, diastasis of pubic symphysis from blunt trauma
- Diagnostics:
  - Boys – RUG
  - Girls – cystoscopy/vaginoscopy

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Urethral injury management

- Immediate treatment includes:
  - Broad-spectrum antibiotics
  - Assessment of bladder neck competence
  - Urinary drainage
    - Often catheter drainage is sufficient for bulbar urethra
- Females – stable, exam under anesthesia, primary repair
  - More significant injuries – bladder neck/urethral involvement
    - Up to 30% with severe bladder neck/urethral injuries will require some type of proximal urinary diversion to achieve continence

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Practical Application – “Street Smarts”

- Is there a catheter already?
- Has the patient voided?
- UA?
- RUG – do it yourself
  - Radiology resident may not be the best
  - If catheter already placed, can do peri-cath RUG
- When in doubt, scope catheter in
  - Most likely would need general anesthesia
- Going to OR for anything else?

Photos Courtesy of: Kai-Wen Chuang, MD

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Pediatric Trauma: Scrotum/Testes/Penis

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Scrotal and Testicular Trauma

- Penetrating trauma (ex. dog bite)
  - Concern for possible urethral/rectal involvement
  - Check tetanus immunization, rabies status of animal
- Blunt trauma (ex. fall, sports-related)
- Ensure testes not involved
  - Trauma can mask true cause of pain (TORSION)
- Treatment
  - Broad-spectrum antibiotics, irrigation/debridement, primary closure with drains
  - Human bite: Close by secondary intention

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Ng D. J Emerg Med. 2018

Testicular Trauma

- Blunt trauma
  - Scrotal ecchymosis, swelling, and potentially hematoma
  - Typically sports/athletics
- Penetrating trauma
  - Focal scrotal tissue damage
  - Scrotal ecchymosis, swelling, possible hematoma
  - 40-60% testicular injuries in penetrating scrotal injuries
- Evaluation
  - H&P
  - Ultrasound
- Hematocele
  - 50 – 80% risk of rupture of tunica albuginea
    - 85% sensitivity
- Surgical exploration usually indicated

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Pediatric Penile Trauma

- Blunt more common than penetrating
- Fracture (still see it in pediatrics)
  - Sex, Masturbation, “Fell out of bed with erection”
  - Associated urethral injury – RUG or cystoscopy
- Often iatrogenic
  - Circumcision complication - amputation, electrocautery
- Hair-tie strangulation
  - Mimics paraphimosis, can lead to amputation
- Zipper injury, toilet seat

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Practical Application – “Street Smarts”

- Always get an ultrasound – even if superficial skin
- Clean the wound copiously
  - Don’t assume ED will
- Even pediatric patients can have penile fracture

Conclusions

- Pediatric trauma has unique differences than adults
- Timely and accurate diagnosis is key
- Most renal trauma can be managed expectantly
- High suspicion of bladder neck injuries with pelvic fractures
- Often multiple organ systems affected

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Questions, Comments, Anecdotes?