High yield pediatric imaging
Pediatric Trauma
and other Pediatric Emergencies

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Overview

- Discuss epidemiology of pediatric trauma
- Discuss unique aspects of skeletal trauma and fractures in children
- Look at a few example of fractures
- Review other common pediatric emergencies
- Some Pollev Pollev.com\lynnfordham
- Lots cases
Keywords for PACs case review

- PTF
- TUBES AND LINES
- Pre call cases peds
Who to page for peds 2am Thursday morning?

<table>
<thead>
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<th>AM Readout</th>
<th>Sun 21</th>
<th>Mon 22</th>
<th>Tue 23</th>
<th>Wed 24</th>
<th>Thu 25</th>
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Faculty call shift 5pm to 8 am, for midnight to 8am, use prior day schedule.
Etiology of Skeletal Trauma in Children
Significance of pediatric injuries

- Injuries 40% deaths in 1-4 year olds
- Injuries 90% deaths in 5-19 year olds
Causes of Mortality in Childhood

- MVA most common in all age groups
- pedestrian (vs. auto 5-9)
- bicycle
- firearms
- fires
- drowning/ near drowning
Causes of Morbidity in Childhood

- falls
  - most common cause of injury in children
- non-fatal MVAs
- bicycle related trauma
- trampolines
- near drowning
- other non-fatal injuries
Trends over time

• Decrease in death rates due to unintentional injuries
  – Carseats
  – Bicycle helmets
• Increase in homicide rate
• Increase in suicide rate
MVA common injuries

- depends on impact and seatbelt status
- spine
  - craniocervical junction
  - thoracolumbar spine
- pelvis
- extremities
- sternum rare in children
Pediatric Fractures

- Fractures related to the physis (growth plate)
  - Use Salter Harris classification
- Fractures related to the non-physeal portion of the bone
  - Greenstick, incomplete, torus, plastic bowing fracture
  - Complete fractures like adults
    - Comminuted, intraarticular, etc
Salter Harris classification
Tibia
Salter Harris I
Fibula
buckle fracture
Salter Harris I
distal tibia
seen only on
follow up
Salter Harris III
Triplane fracture SH 4
Triplane fracture CT

>3mm separation will require internal fixation
Tillaux fracture Salter Harris III
Complications of Growth Plate Injury

- deformity/ fusion of the growth plate
- bony bridge formation
- shortened bone
- avascular necrosis of epiphysis
- risk of complication increases with fracture classification
Sports related injuries

- Each sport has its own unique and predictable injury patterns
  - Acute injuries
  - Overuse injuries
Baseball pitcher

Felt pop while throwing baseball

Avulsion medial epicondyle Salter Harris 1
Little league Baseball pitcher

Felt pop while throwing baseball

Avulsion medial epicondyle (and some humerus) Salter Harris 2
Slide into home base, collision w catcher
Tibial spine avulsion fracture
Hemarthrosis
Osgood Schlatter? No acute avulsion fracture tibial tubercle

Gottsegen C J et al. Radiographics 2008;28:1755-1770
Salter Harris 4
apophysis, metaphysis epiphysis fractures
Lipothromatosis
Jumpers knee
Patellar tendinopathy
Sinding-Larsen-Johansson Syndrome
Medial patellar avulsion fracture
dislocation relocation
Popliteus avulsion fracture
Femoral stress fracture
Runner

Tibial stress fracture
Other pediatric specific fractures
Torus or buckle fracture
Subtle buckle fracture

- Definite fracture
- No need to equivocate
Plastic bowing fracture

Contralateral views may be helpful
Avulsion Fracture

- bone or physis fractures before ligaments or tendons
- athletic adolescents
- common areas about the pelvis
  - Anterior superior iliac
  - Anterior inferior iliac
  - Lesser trochanter
  - Ischial tuberosity
- treat with pain medication and rest
Stubbed toe fracture: risk of osteomyelitis.
Subtle boxer fx two different kids
Supracondylar fractures are common in children.

- Need 2 views to:
  - Determine position of fragments prior to reduction
  - Assess elbow joint alignment
- Frequently get comparison film
- Beware of satisfaction of search errors.
Supracondylar fracture
Anterior humeral line

Abnormal anterior and posterior fat pads
Displaced capitellum
Supracondylar fracture present but not visualized
Radial Head Dislocation

Radiocapitellar line does not intersect the capitellum
Complete elbow dislocation

Two articulations
Hinge Ulnohumeral
Pivot Radiohumeral
Lateral condylar fracture
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<tbody>
<tr>
<td>Capitellum (lateral condyle)</td>
<td>1 year</td>
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<tr>
<td>Radial head</td>
<td>3 years</td>
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<td>Internal (medial) epicondyle</td>
<td>5 years</td>
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<tr>
<td>Trochlea</td>
<td>7 years</td>
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<tr>
<td>Olecranon</td>
<td>9 years</td>
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<tr>
<td>External (lateral) epicondyle</td>
<td>11 years</td>
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</table>
Trapped medial epicondyle
16 mo refusing to walk

Toddler fracture
Toddler’s Fracture

- 1st two years of walking
- failure to bear weight, irritability, local tenderness, swelling
- plain film or fluoroscopic diagnosis
- spiral fracture of mid-distal tibia
- does not imply child abuse
- other toddler’s fractures: calcaneus and cuboid
Toddler fracture: Repeat films

initial

10 days later

Healing fracture
Strategies for dealing with the negative plain film

- Repeat physical exam
- Get additional views same area
- Obtain opposite side for comparison
- Get views of areas above and below painful area
- Evaluate with another modality
  - US
  - MR
  - CT
  - Fluoro
- Treat as if injured, repeat films 7-14 days
Acromial fracture

2 weeks later
r/o pneumonia

Right 5th and 6th rib fractures c/w non accidental trauma
Child abuse

- Not generally worked up in the ER
  - If child being admitted will generally perform survey next morning
- Usually admitted on clinical grounds
- Call Pediatric radiologist on call
- Skeletal survey includes
  - 2 views of skull
  - AP/ lateral CXR, C, T, L,S spine
  - AP appendicular skeleton in segments
  - Oblique ribs, AP chest, AP pelvis
  - Additional views as needed
    - AP & Lateral joints

High specificity NAT
Cervical spine Trauma: epidemiology

- majority injuries are to the occiput to C2 level for children less than 9 years old
  - SCIWORA (Spinal Cord Injury without Radiographic Abnormality)
- children older than 9, adult type injuries
- mechanism of injury predicts findings
Pediatric C-Spine protocol at UNC

- AP & Lateral in children up to 8
  - need to be able to see ring C1
  - need to see to T1 on lateral
- AP, Lateral open mouth odontoid over 8
  - see tip and body of odontoid to base C2
  - see lateral masses
  - see to T1 on lateral
- C spine CT encouraged
- MR in symptomatic patients
Craniocervical dissociation

4 year old unrestrained passenger in front seat with airbag
Craniocervical dissociation

7 year old bicycle vs. auto

Blood around spinal cord
Important measurements

- dens to basion
  - 8 mm normal
  - 14 abnormal
- Atlas dens interval ~3mm
  - 0.5 mm difference flex to ext
- prevertebral soft tissues
  - @C2 3.5 mm
  - @C6 7.9 mm
Os odontoideum with pseudosubluxation
C2 synchondrosis fracture

18 month old female restrained in car seat
refuses to walk following MVA
Thoracic and Lumbar Spine
Chance fracture
Other common pediatric problems on call

Child with abnormal breathing
Croup

6 month to 3yos
Steeple sign due to subglottic edema
Viral
Benign self limited
Epiglottitis

- Life threatening
- Haemophilus influenzae
- 3.5 yo mean unvaccinated
- Second peak teens

Normal Epiglottis
Membranous Croup

- Aka Bacterial tracheitis
- 6-10yos
- Potentially life threatening
- Mucous in airway can mimic
- Can repeat images post cough

https://radiologykey.com/airway/
Retropharyngeal abscess

Extend neck CT to the level of carina to evaluate for mediastinal extension
Airway abnormalities

Adenoidal hypertrophy

Vallecular cyst
Esophageal foreign bodies
Button battery in esophagus

Note tracheal displacement, compression and lung hyperinflation
Child with a limp
Septic arthritis

Request patient be made NPO at time of US to facilitate tap for septic arthritis
Radiographic Findings in SCFE

• Obese preadolescent Boys
• plain film diagnosis
• may be subtle on AP view alone
• Klein’s line
• frog leg lateral helpful
• true lateral preferred in acute slip
• SH 1
Infant with bilious emesis

- True emergency
- Can’t exclude malrotation with volvulus on plain film
- Upper level case
- UL call peds rad attending

Malrotation with volvulus
Bowel obstruction in appendicitis
Dilated bowel loops with appendicolith consistent with appendicitis
Toddler with crampy abdominal pain
Intussusception
Intussusception Air enema reduction
Intussusception

- Can not exclude on plain film
- Use US to screen/ evaluate viability of bowel
  - Can only treat ileocolic or colonic intussusception
  - SB intussusception spontaneously resolve or surgery
- Usually reduction with air enema
- Epic order is FL Barium enema-intussusception
NICU FILMS AT NIGHT
NICU with decompensation

NEC with perforation and large volume pneumoperitoneum
NICU tube check

NEC
Pneumatosis with perforation and small volume free air
Pneumatosis w portal venous gas
1 month old with emesis in NICU

Right inguinal hernia
Emesis in 9 day old in NICU

Right inguinal hernia
Asymmetric inguinal soft tissues
Low UVC
TUBES AND LINES
Umbilical lines normal

- UVC umbilicus to RA
- UAC umbilicus to T6-10 or below L3
UVC UAC normal

UVC umbilicus to RA
UAC umbilicus to T6-10 or below L3
3 day old with left adrenal m
normal course of UVC
UVC low
UAC ok at T6
UVC to left PV
UVC to right PV
UAC at T 12, advanced on cross table
Result of UVC tip below diaphragm

Intrahepatic hematoma and hemoperitoneum
Endotracheal tube in esophagus
Check feeding tube

Feeding tube to LMBB
Eval feeding tube

Corpak to RMSB, perforated to pleural space
Eval VPS
10 year old with headache
Emesis and hydrocephalus due to trapped shunt
Eval programable shunt pre and post MRI

Summary

• Lots to know about kids!
• Use keyword PTF to mark good cases
• Protocol CT & MRs carefully
• Use AAST scores for peds trauma
• If you consult on a film, dictate it with the peds attending on in the morning
• Question? Call/page pediatric radiologist on call
• Call me if on call attending not available
Keywords for PACs case review

- PTF
- TUBES AND LINES
- Pre call cases peds