Pediatric Orthopedic Emergencies

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Pediatric Emergency Medicine
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Objectives

- Recognize common injury patterns in children by age group and mechanism of injury

- Develop evidence-based management strategies for can't miss pediatric orthopedic emergencies

Topics

- Keys to pediatric musculoskeletal anatomy/physiology

- Pediatric specific Fx/injury patterns
  - Supracondylar humerus Fx
  - Distal radius/ulna Fxs
  - Clavicle
  - Toddler Fx
  - Apophysites

- Irritable Hip (SA vs TS)

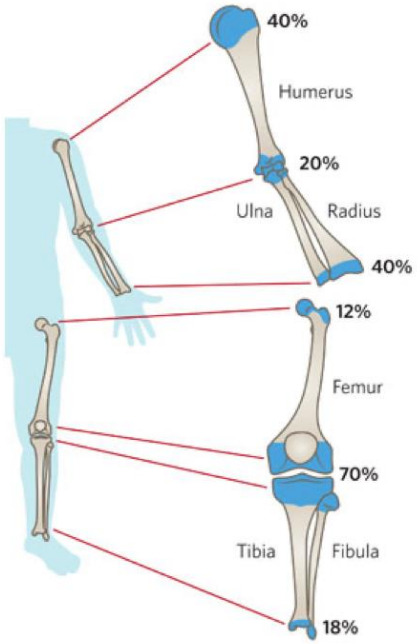
Introduction – Peds anatomy/physiology

- **Fractures > ligament/tendon injuries**

- Bone turnover/Remodeling
  - Younger age
  - Closer to physis
  - UE = away from elbow / LE = closer to knee

- Pain Control
  - Immobilize early, IN

- Evaluate joints above & below
  - Most commonly missed Fx = 2nd Fx

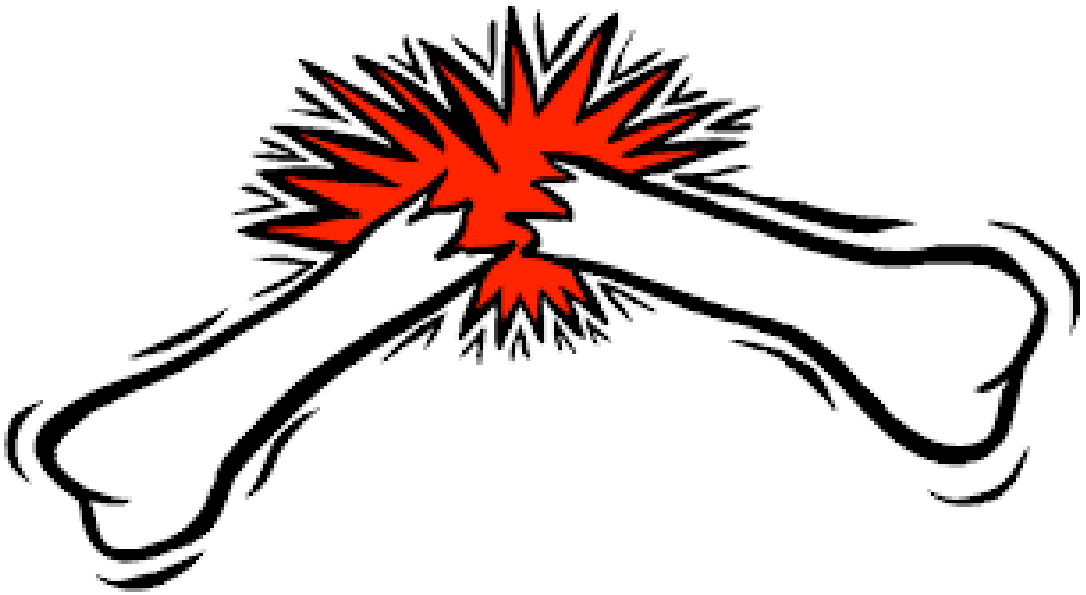


The Royal Children's Hospital, Melbourne, Australia

Introduction – Peds anatomy/physiology

- *Younger* children (equivalent adolescent/adult injuries)
  - Proximal humerus Fx **>** Shoulder dislocation
  - Lateral clavicle Fx **>** AC separation
  - Tibial spine Fx **>** ACL tear
  - Carpal (Scaphoid) Fx RARE

Specific Fx Patterns



- What type of Fx?

Buckle (Torus) Fx

- Younger children
- Relatively weak metaphysis
- Compressive load

- What type of Fx?

Greenstick Fx

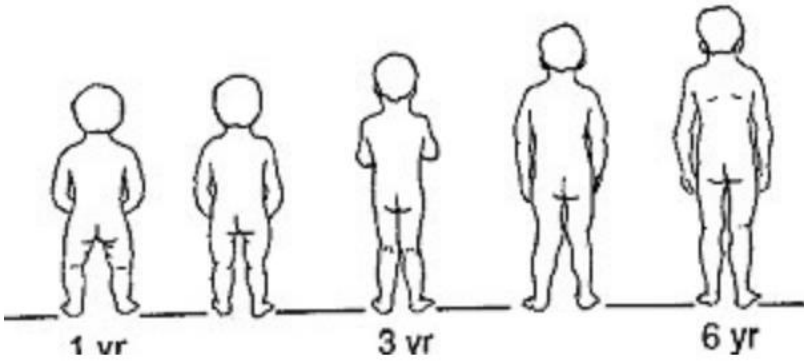
- 1 cortex breaks
- 1 cortex (periosteum) bows/remains intact
- Reduction can sometimes cause Fx completion (OK!)

- What type of Fx?

Bowing/Plastic deformity

- LESS remodeling potential
- *Refer to Ortho*

- Normal LE
  - birth = bowing
  - 18m = straight
  - 3yo = valgus
  - 5yo = straight

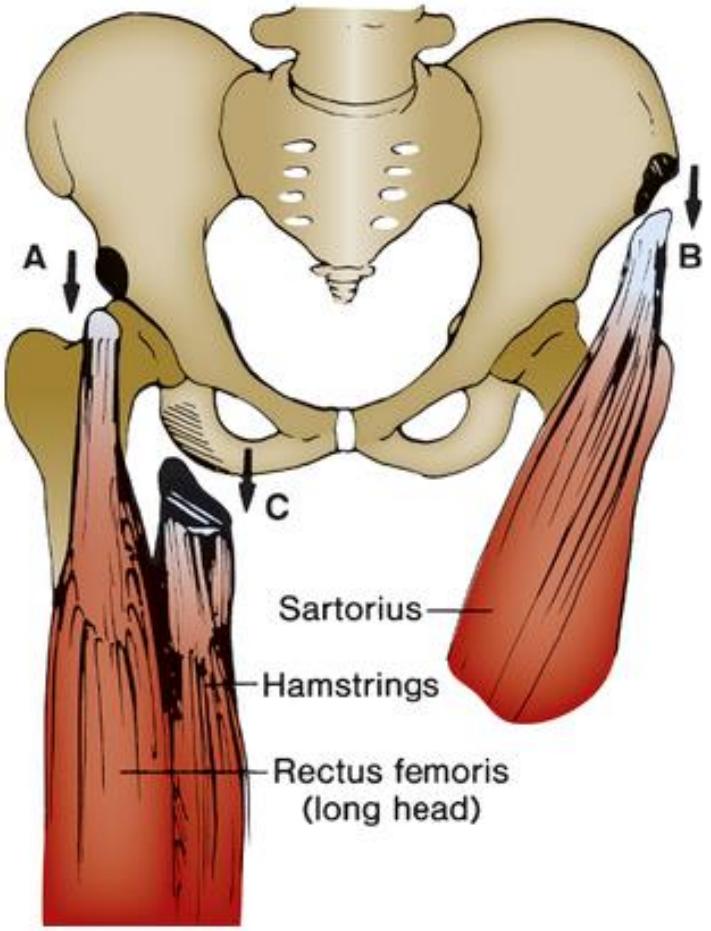


HSS

Avulsion Fx

- Common in *adolescence*
  - attachment of strong muscles to weaker apophyses (2o ossification centers) which are beginning to close
- pelvis, tibial tubercle, phalanges
- RARELY require reduction

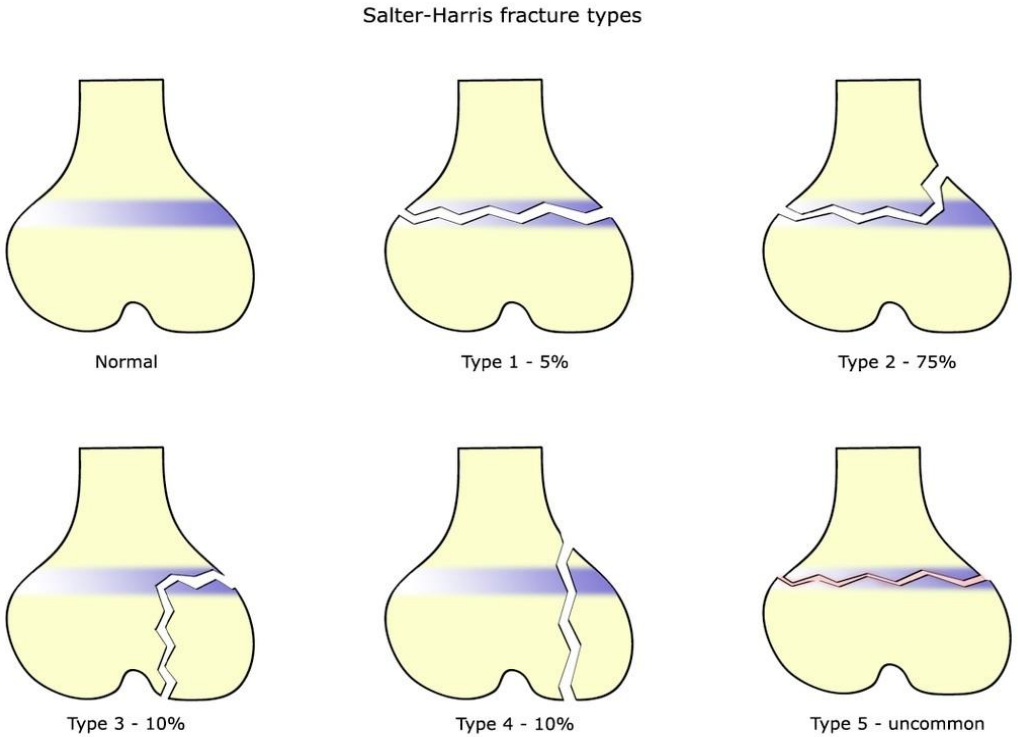
Pelvic avulsion Fxs



Fleischer & Ludwig

Physeal Injuries (Salter-Harris)

1MEME5



Gaillard, 2008

Physeal Injuries (Salter-Harris)

- SALTR / 1**MEME**5

- Peak 10-13yo
- m/c site = distal radius
- m/c = SH 2

- Growth disturbance
- Refer all *articular* injuries to Ortho (24-48hrs)

Salter-Harris 1

- *may not be radiographically evident*
- if suspect clinically → treat as Fx
  - immobilize and f/u in 7-10d

Uptodate, 2019

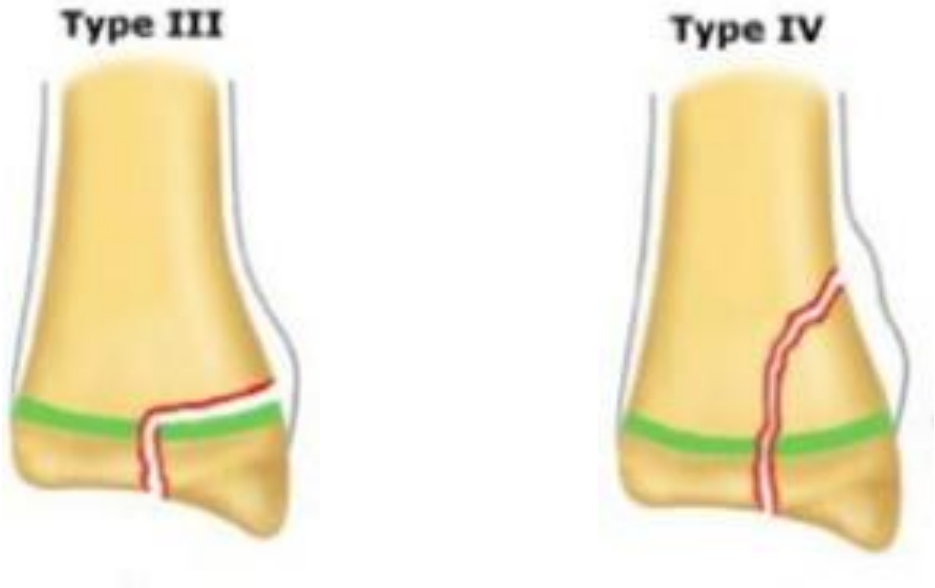
Salter-Harris 2 (M)

- most common (75%)
- good prognosis

Uptodate, 2019

Salter-Harris 3 (E) and 4 (ME)

- Epiphysis involved
  - poorer prognosis since *intraarticular*
- Ortho cx or close referral (24-48hrs)



Uptodate, 2019

Salter-Harris 5

- like SH1, difficult radiographically
- may be suggested by mechanism or effusion
  - axial load – ankle/knee
- worst prognosis
  - premature closure of physis

Uptodate, 2019

- What type of Fx?

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Fall On Outstretched Hand (FOOSH)

- Wrist (Radius, Ulna, Scaphoid Fxs)
- Supracondylar Humerus Fx
- Proximal Humerus Fx
- Clavicle Fx

Clavicle Fxs

- **newborn** = birth trauma
- **infants/children** = FOOSH or direct blow
  - greenstick or complete

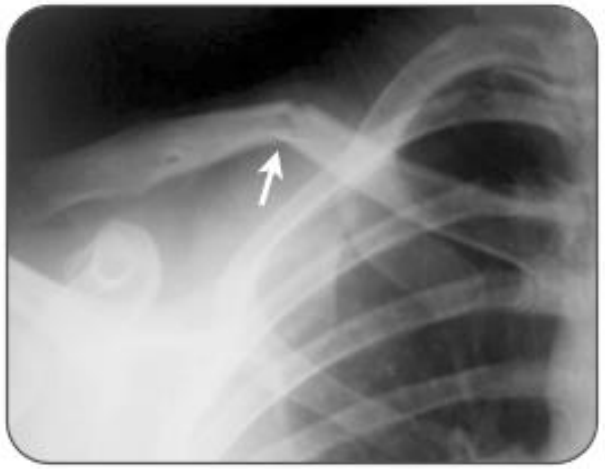
Clavicular Fractures

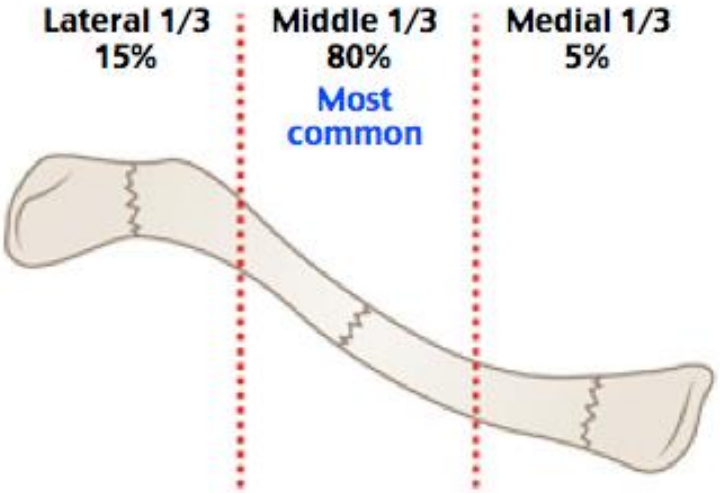
Nondisplaced

Angulated

Displaced

Comminuted





Rosh Review, 2016

Clavicle Fx

- Shaft (middle 1/3)
  - Immobilization
    - Sling/swathe x3 wks → restrict high-risk activities x3 mos

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- Lateral
  - Non-displaced = Immobilization
  - Surgical = Displaced, severe AC dissociation (Rockwood 4-5)

Clavicle Fx

- Medial
  - Rare but potentially life-threatening
  - Anterior SC dislocation
    - 2-3x more common, less serious
  - **Posterior SC dislocation**
    - Rare but potentially life/limb threatening
    - Structures: trachea, esophagus, subclavian bvs, brachial plexus
    - Immediate Ortho Cx + CTA (OR reduction, Thoracic/Vascular surgery)

Case

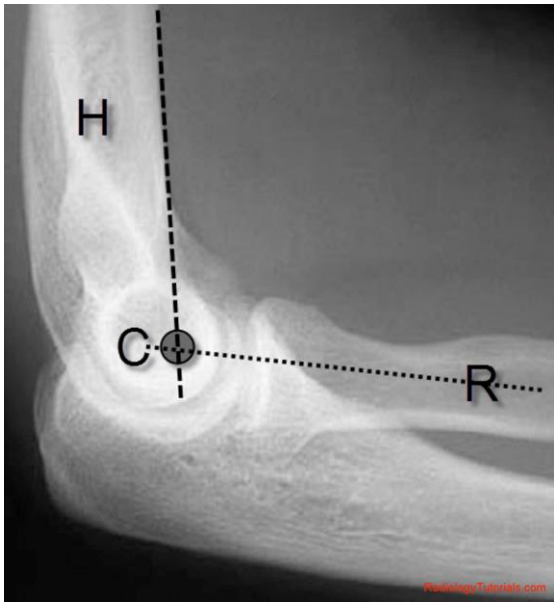
- 8yoM. Fell from monkey bars onto R outstretched hand. Elbow held straight, refuses to flex, +++ edema.

Peds Elbow

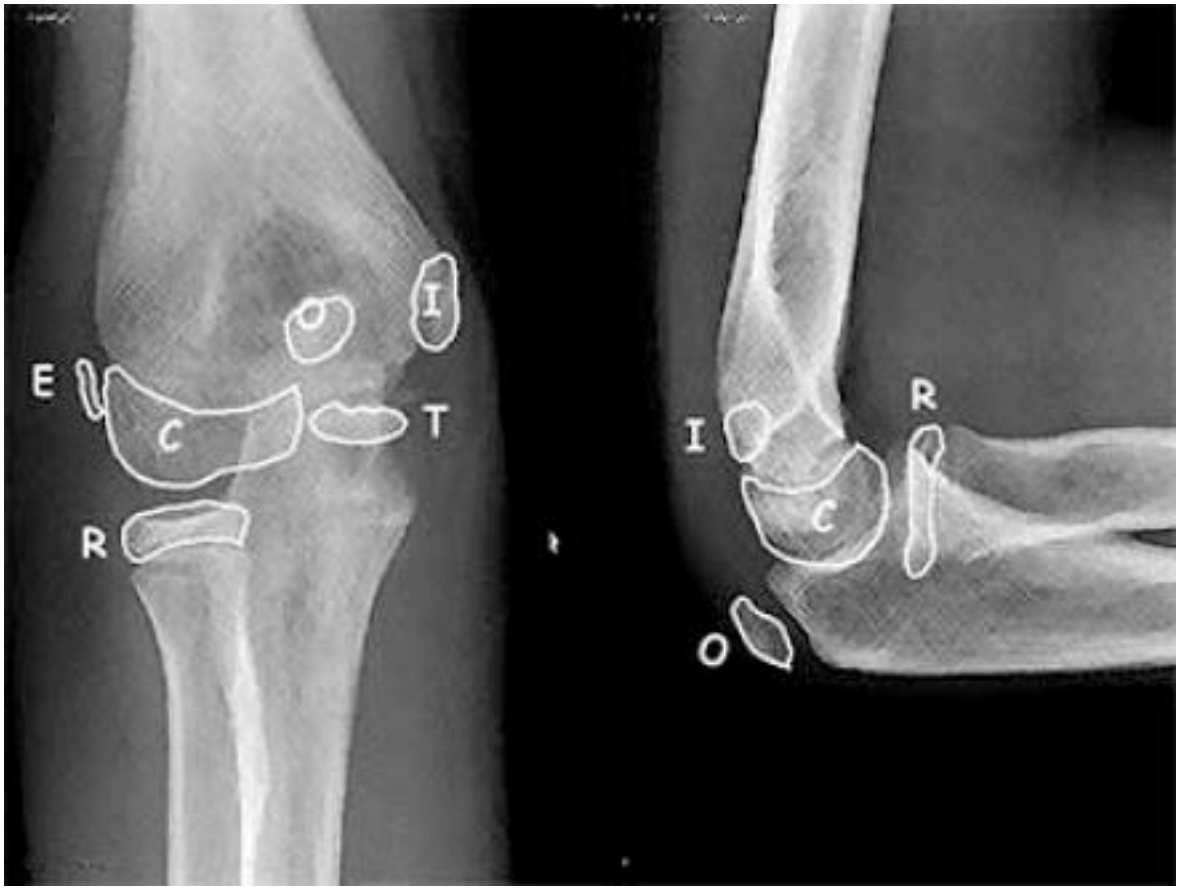
- Fat pads
- Radial head/neck

- Anterior humeral line
- Radiocapitellar line

- CRITOE
  - Ages variable, order same



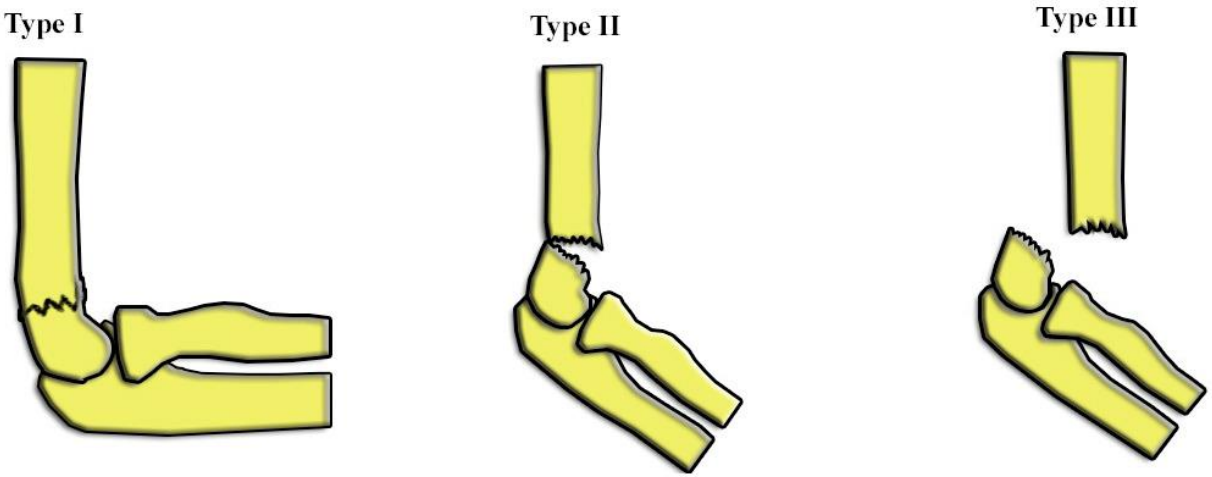
CRITOE (1 3 5 7 9 11)



The Radiology Assistant

Supracondylar Humerus Fx

- m/c elbow Fx in Peds (60%)
- 3-10yo (esp 5-7yo)
- FOOSH w extended elbow

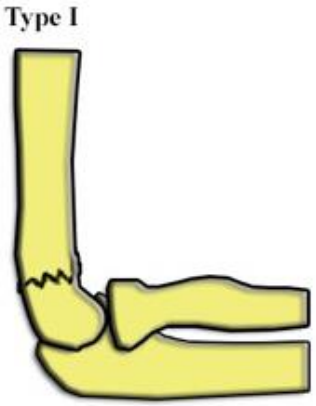


Gartland classification

S. Benoudina Radiopedia, 2015

Supracondylar Humerus Fx

- Type 1 = Non-displaced
  - NON-operative (often only see fat pads)
  - Posterior splint OR Long arm cast initially if min swelling
    - arm neutral OR pronation w 90deg elbow flexion
  - Ortho referral in 1-3 weeks



Supracondylar Humerus Fx

- Type 2 = Displaced with *intact post cortex*
  - Cx Ortho for reduction + splint OR operative repair
    - sometimes subdivided 2A = NO rotation / 2B = rotational deformity → operative repair
  - Elbow flexion can further compress *brachial artery* if NOT yet reduced → AVOID FLEXION splinting (20-30 deg)

Supracondylar Humerus Fx

- Type 3 = Completely displaced w *NO cortical contact* (anterior and posterior cortices violated)
  - Cx Ortho for operative repair
  - Elbow flexion can further compress *brachial artery* if NOT yet reduced → AVOID FLEXION splinting (20-30 deg)

Complications

- Most common nerve affected = **Anterior Interosseus (AIN)**
  - proximal branch of *median n*
  - *motor* only
    - flexor policis longus
    - radial 1/2 flexor digitorum profundus
    - pronator quadratus

- **Compartment syndrome**
- **Brachial artery injury**
- Other nerve injuries

Forearm (Radius/Ulna Shaft) Fxs

- 3rd m/c Fx in PEDS

- Ring structure = r/o 2nd Fx or RUJ dislocation (wrist, elbow)
  - Monteggia >> Galeazzi in PEDS

- Often unstable (40-60%)
- Ulnar bowing

- Rx = sugar tongue splint / Long arm cast + Ortho referral

Forearm (Radius/Ulna Shaft) Fxs

- Consider Ortho Cx (highest risk for failed reduction)
  - Angulation >10-15deg
  - Rotational deformity
  - Age >10-12yo
  - Proximal 1/3 radius Fx

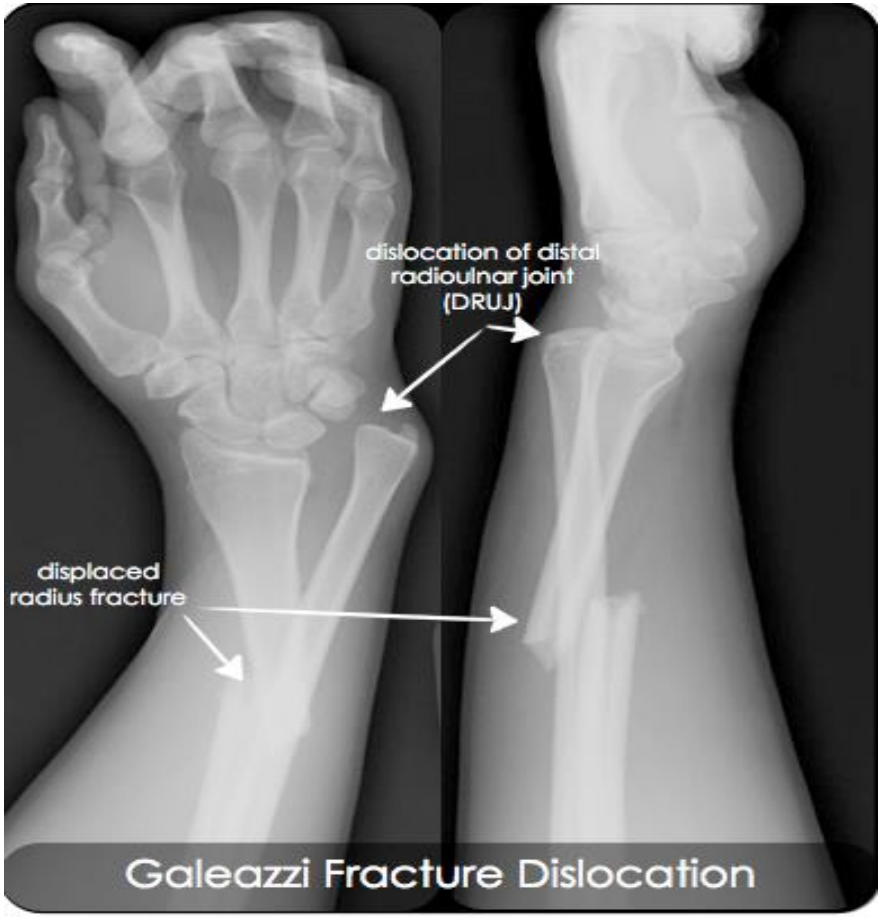
Forearm (Radius/Ulna Shaft) Fxs

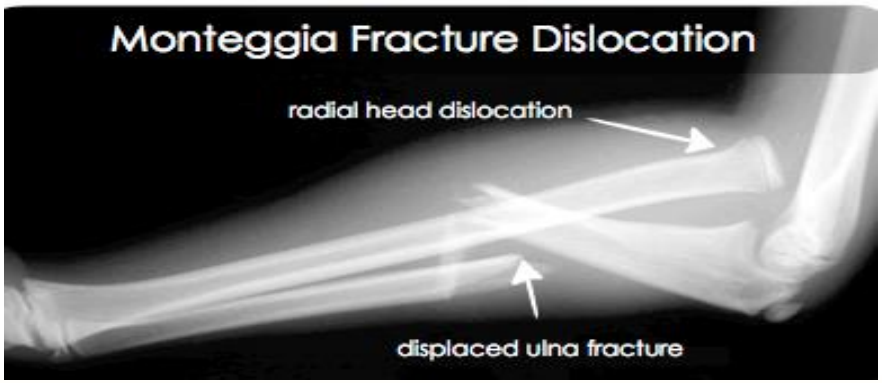
- Acceptable angulation ↔ Remodeling potential
  - *Younger* age *(<10yo*)
  - More *distal* (near wrist physis) – closes by *14-16yo*

Table of Acceptable Reduction (Tolerances)

Age	*Angulation (°)*	*Malrotation (°)*	*Bayonet Apposition*
0-9 years	<15	<45	Yes, if <1cm short
≥10y, mid to distal shaft	<15	<30	No
≥10y, proximal shaft	<10	0	No
Approaching skeletal maturity (<2y growth remaining)	0	0	No

Orthobullets.com

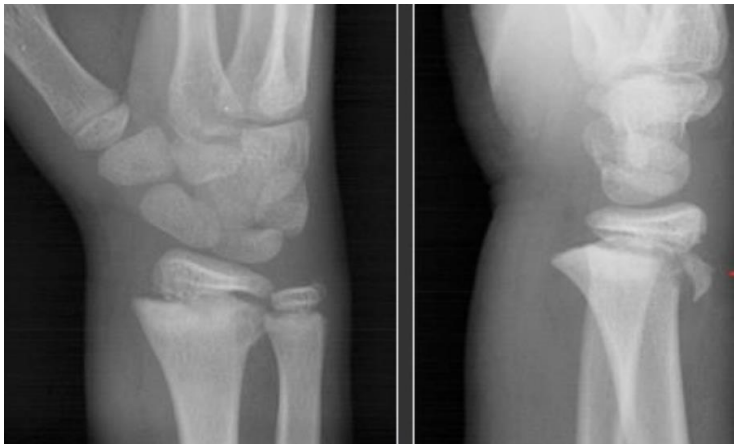




Rosh Review, 2016

Wrist (Distal Radius/Ulna) Fxs

- m/c Fx in PEDS/adolescents <16yo
  - <10yo = buckle
  - 6-12yo= physeal
  - Adolescent = complete Fxs



Orthobullets.com

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- Acceptable angulation ↔ Remodeling potential
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"Classically" Acceptable Angulation for Closed Reduction in Pediatric Forearm Radius Fractures
(controversial with ongoing discussion)

	Shaft / Both bone fx			Distal radius/ulna
Age	*Acceptable Bayonetting*	*Acceptable Angulations*	*Malrotation**	*Dorsal Angulation*
< 9 yrs	< 1 cm	15-20°	45°	30 degrees
> 9 yrs.	< 1 cm	10°	30°	20 degrees

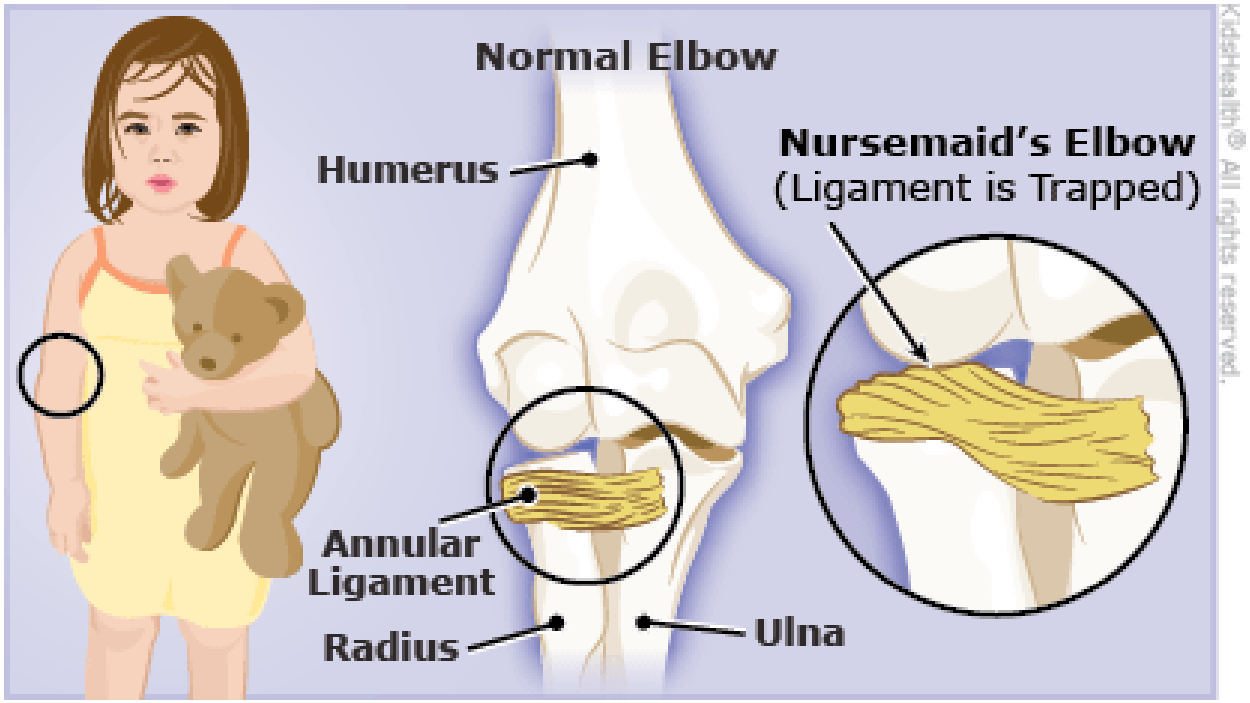
Orthobullets.com

Case

- 2yoF. L arm held to side, refuses to lift it. Problem started shortly after playing with another kid at daycare. Appears well, arm appears normal, no edema.

- What's going on?
- How to fix the problem?

Nursemaid's Elbow



Nemours Foundation

Nursemaid's Elbow

- Annular ligament
- **5mos-5yo**
- MOI = pulled/lifted, *many cases falls or unwitnessed*

- <u>Exam</u>
  - Pronated, partially flexed, adducted
  - Well-appearing
  - No/minimal edema and point tenderness
  - Pain w elbow flexion, pro/supination
  - Often identifies wrist pain

Nursemaid's Elbow

- Reduction techniques – the "click"
  - Hyperpronation
  - Supination/Flexion
  - Should regain function in 5-10mins

PHOTO COURTESY OF PETER PRYOR, MD

https://www.merckmanuals.com/professional/multimedia/video/v23370720

Merck Manual

Nursemaid's Elbow

- Edema OR Failure to return function
  - consider alternative Dx and obtain *XR*

- Suspected non-reduced annular ligament subluxation
  - discharge in a sling/posterior splint with Ortho f/u

Case

- 2yoM. Unwitnessed fall down 2 stairs. Now refuses to bear weight on R leg.

Toddler's Fracture

- AKA CAST = **C**hildhood ***A****ccidental* **S**piral **T**ibial Fx
- 9mos-3yo

- H/o minor or no trauma, rotational
- Refusal to bear weight
- Point TTP, pain w twisting of syndesmosis

- XR normal or spiral/oblique Fx through mid-distal tibia
- Immobilize

Toddler Fracture

Spiral fracture

- 9 months to 3 years of age
- NOT related to non-accidental trauma (ambulating toddler)
- Child presents with limp
- Rx: Long leg cast

Rosh Review, 2016

Case

- 13yoM runner presents for R knee pain for several months. No acute injuries. There is isolated TTP over his tibial tubercle. What is the name of this disease?

- Same Pt, but with BL heel pain. TTP at calcaneal insertion site. What is the name of this disease?

Apophysitis

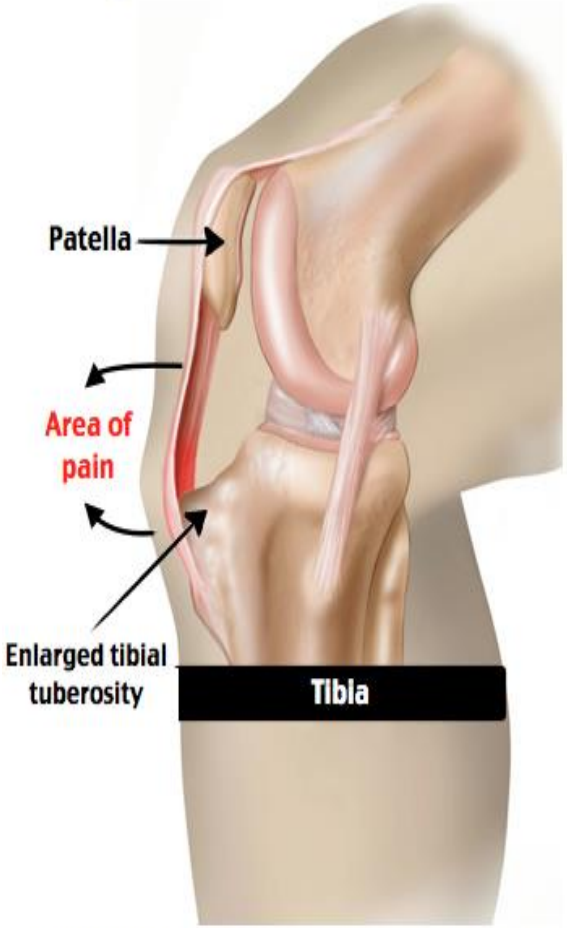
- **Apophysis**
  - bony tubercle arising from 2o ossification center
  - site of tendon attachment

- Overuse → inflammation at insertion site
- Adolescents/rapidly growing (10-15yo)
- M>F
- Can get partial/complete avulsion Fx of tubercle

Osgood-Schlatter Disease

- *Patellar tendon* insertion site at tibial tubercle apophysis
- Isolated TTP, worse w knee extension
  - running, jumping
- Rx = NSAIDs, continue normal activity

Osgood-Schlatter Disease



- **Rupture of growth plate** at the tibial tuberosity
- **Rapidly growing** adolescents
- More common in **athletes**
- Pain and tenderness at **tibial tubercle**

Rosh Review, 2016

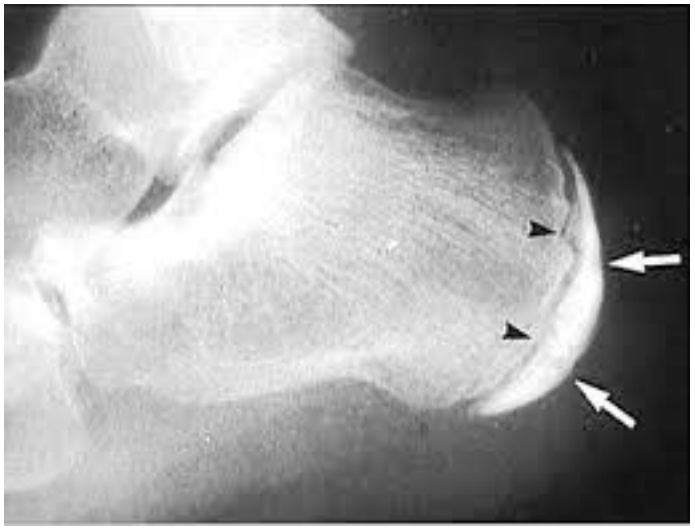
Sindig-Larsen-Johansson Disease

- Traction tendinitis (overuse) of patellar tendon at <u>inferior patella</u>
- Similar age, sports, management as OSD

Tooshikafs (Wikipedia)

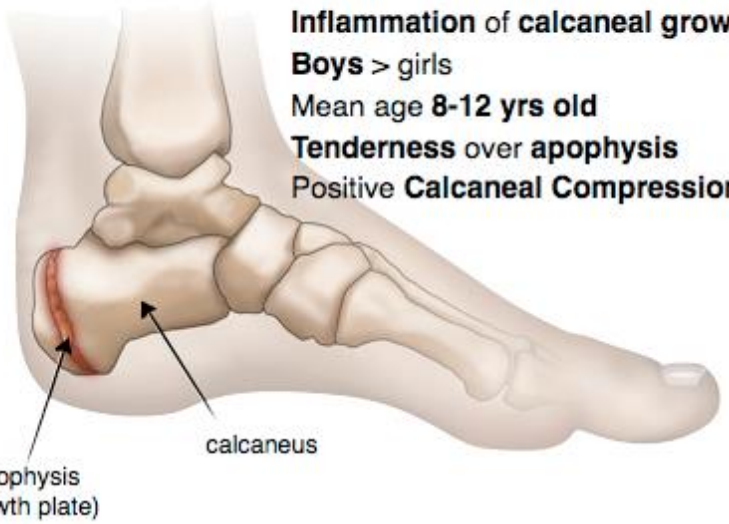
Sever's Disease

- *Achilles tendon* insertion site at calcaneus apophysis
- 50-60% BL
- Isolated TTP, calcaneus squeeze test
  - running, jumping



Sever Disease

(Calcaneal apophysitis)



Inflammation of **calcaneal growth plate** (apophysis)

Boys > girls

Mean age **8-12 yrs old**

Tenderness over **apophysis**

Positive **Calcaneal Compression Test**

Rosh Review, 2016

Pediatric Septic Arthritis

- m/c by hematogenous spread
- m/c ages *6-24mos* (50% < 2yo)
- 35% hip joint
  - risk of AVN

- *Overall* = Staph aureus
- *Adolescents, young adults* = GC
- *Indolent, <5yo* = **Kingella kingae** (GNB)

The acutely irritable Hip: Septic Arthritis vs Toxic Synovitis

- DDX
  - Legg-Calve-Perthes, osteomyelitis, psoas abscess

  *Lower abdominal, testicular, gynecologic pathology

- **Kocher Criteria (CBC, ESR) + CRP + BCx**

- PXR (AP + frog-leg), US, Bone scan, MRI

- Septic arthritis
  - Suspect if aspirate >50K WBC, >75% PMN
  - Definitive = pos GS/Cx

Differentiating Between Septic Arthritis and Transient Synovitis of the Hip in Children: An Evidence-Based Clinical Prediction Algorithm*†

BY MININDER S. KOCHER, M.D.‡, DAVID ZURAKOWSKI, PH.D.‡, AND JAMES R. KASSER, M.D.‡, BOSTON, MASSACHUSETTS

Investigation performed at Children's Hospital, Harvard Medical School, Boston

Kocher Criteria to Determine Risk for Pediatric Septic Joint	
Non-weight bearing on affected side	*Probability of Septic Arthritis* • 4/4 = 99% • 3/4 = 93% • 2/4 = 40% • 1/4 = 3%
ESR > 40 mm/hr	
Fever	
WBC > 12,000	

Factors Distinguishing Septic Arthritis from Transient Synovitis of the Hip in Children

A Prospective Study

By Michelle S. Caird, MD, John M. Flynn, MD, Y. Leo Leung, MD, Jennifer E. Millman, BA, Joann G. D'Italia, CWOCN, CRNP, and John P. Dormans, MD

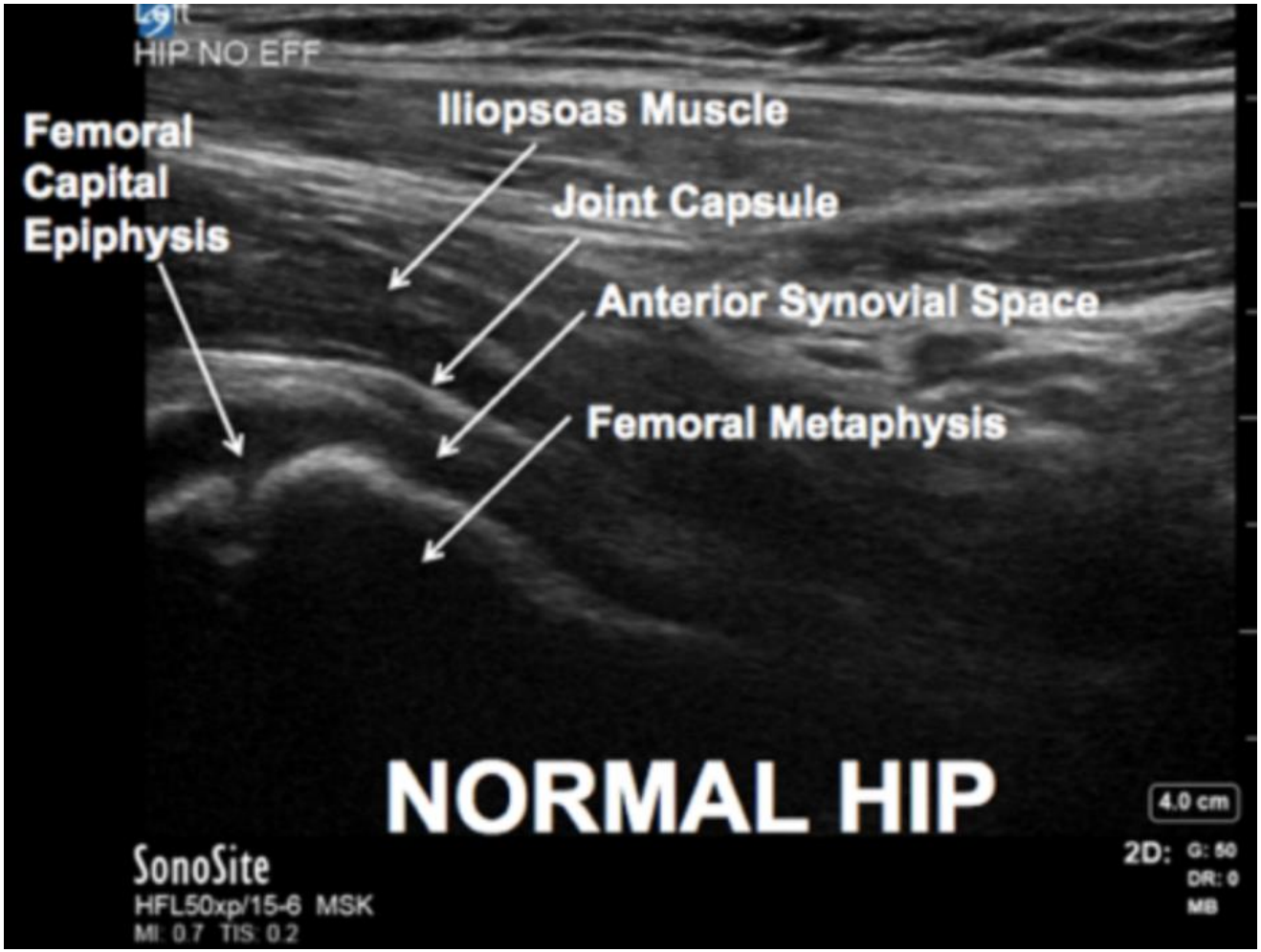
Investigation performed at the Division of Orthopaedics, The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania

- CRP > 2.0mg/dL (>20mg/L)

TABLE IV Predicted Probability of Septic Arthritis

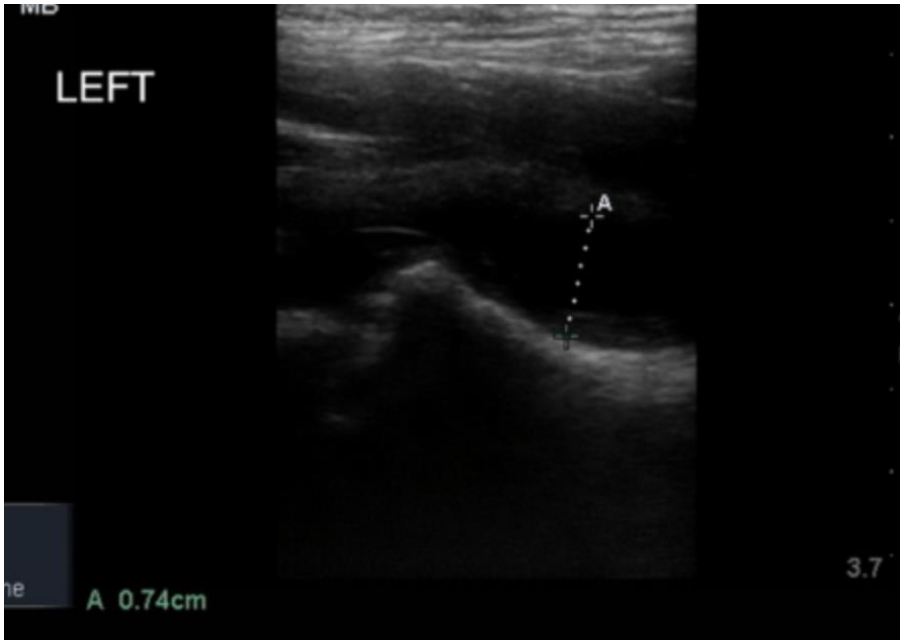
No. of Factors	Septic Arthritis (N = 34) *(no. [%])*	Transient Synovitis (N = 14) *(no. [%])*	Predicted Probability of Septic Arthritis *(%)*	
			Current Study	Study by Kocher et al.[1]
0	1 (3)	3 (21)	16.9	0.2
1	3 (9)	6 (43)	36.7	3
2	3 (9)	2 (14)	62.4	40
3	9 (26)	2 (14)	82.6	93.1
4	15 (44)	1 (7)	93.1	99.6
5	3 (9)	0	97.5	

Hip US


HIP NO EFF
Femoral Capital Epiphysis
Iliopsoas Muscle
Joint Capsule
Anterior Synovial Space
Femoral Metaphysis
NORMAL HIP
4.0 cm
2D:
SonoSite
HFL50xp/15-6 MSK
MI: 0.7 TIS: 0.2

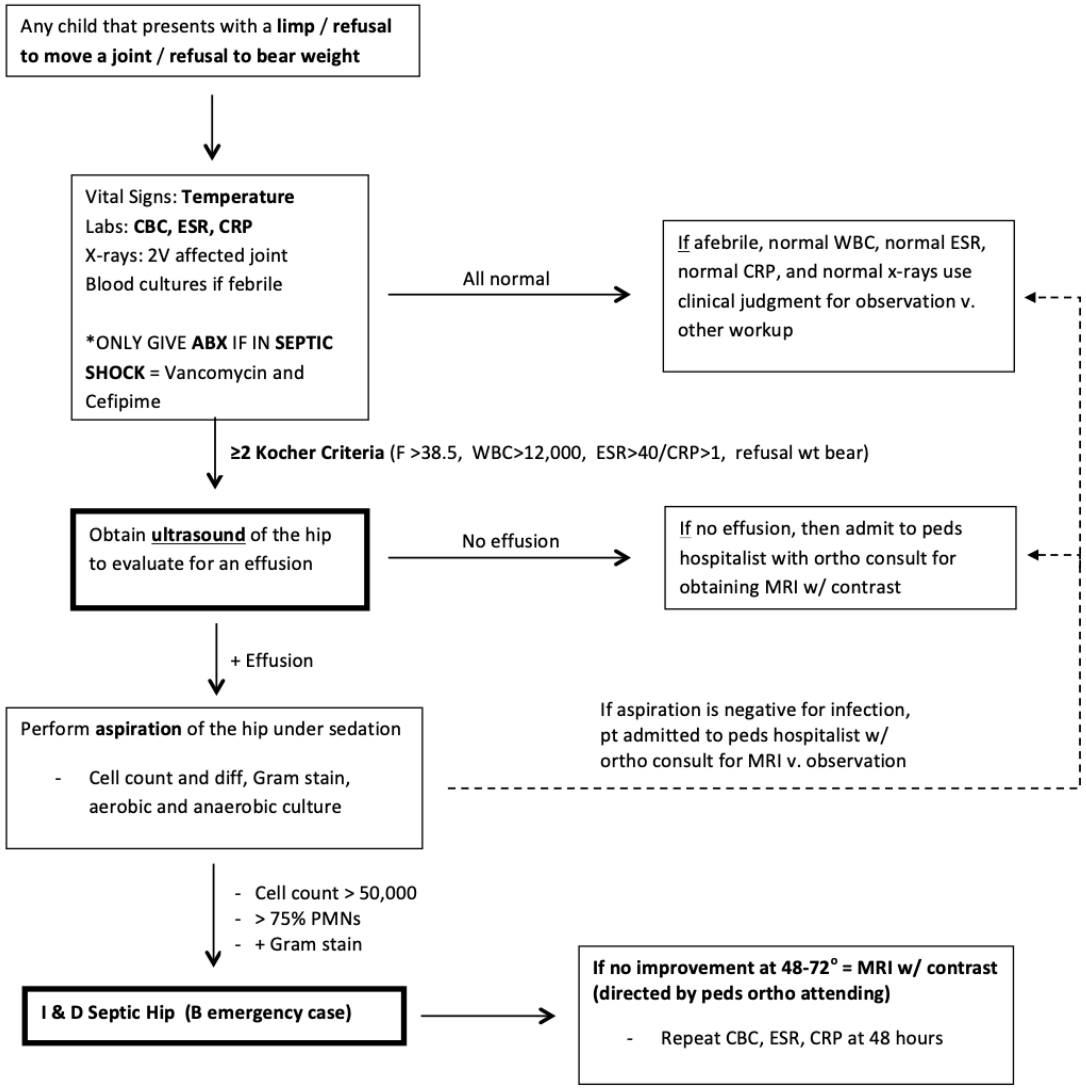
Hip US

- Effusion (>5mm or >2mm difference from CL side)



ACEPNow

UK Pediatric SEPTIC JOINT ALGORITHM



Thank you

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