



# Tips and Tricks in Pediatric Orthopedic Injuries

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# Disclosures

None

# Learning Objectives

By the end of this lecture, learners will be able to:

- Discuss how pediatric bone is different from adult bone
- Describe pediatric specific orthopedic injuries



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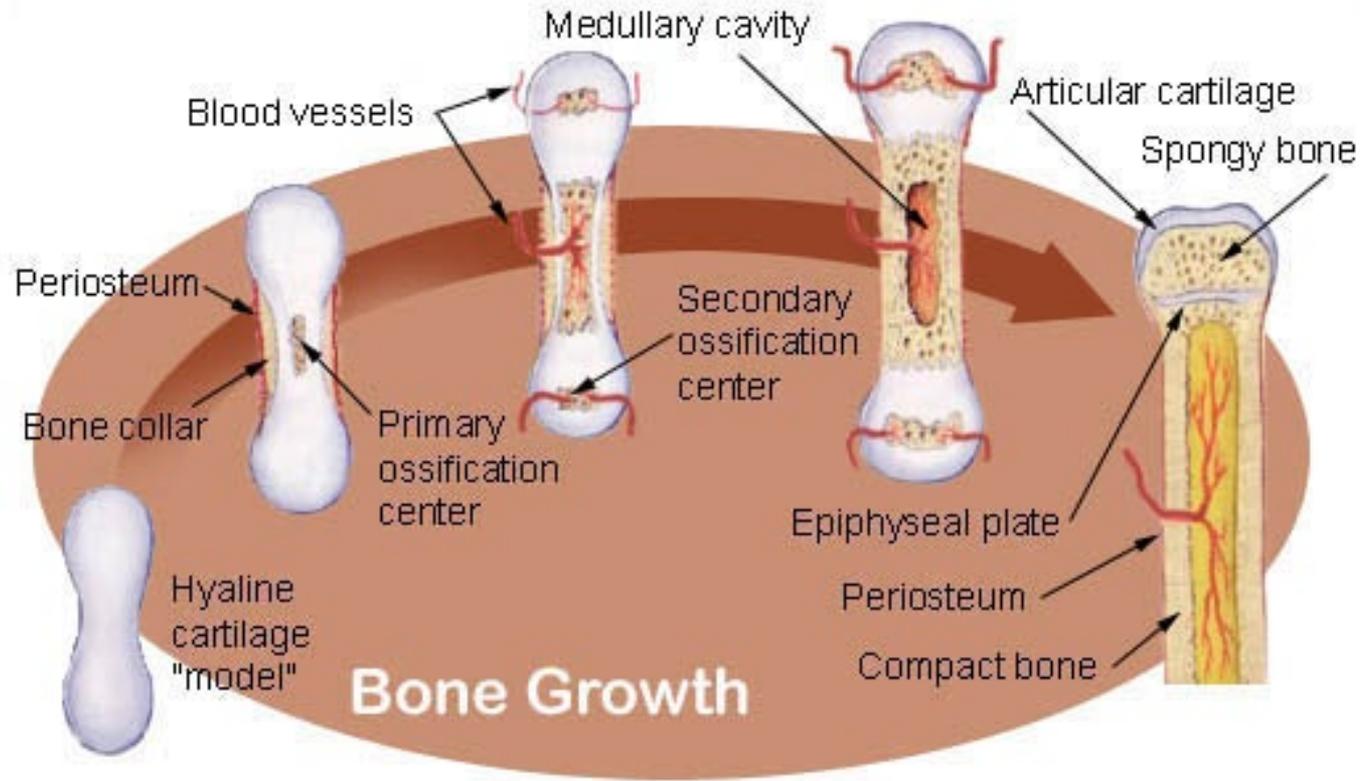




# Should I get an xray?



# Pediatric Bone Anatomy





## But what about the radiation risk?

Procedure	Approximate effective radiation dose	Comparable to natural background radiation for:
Extremity (hand, foot, etc.) X-ray	0.001 mSv	3 hours



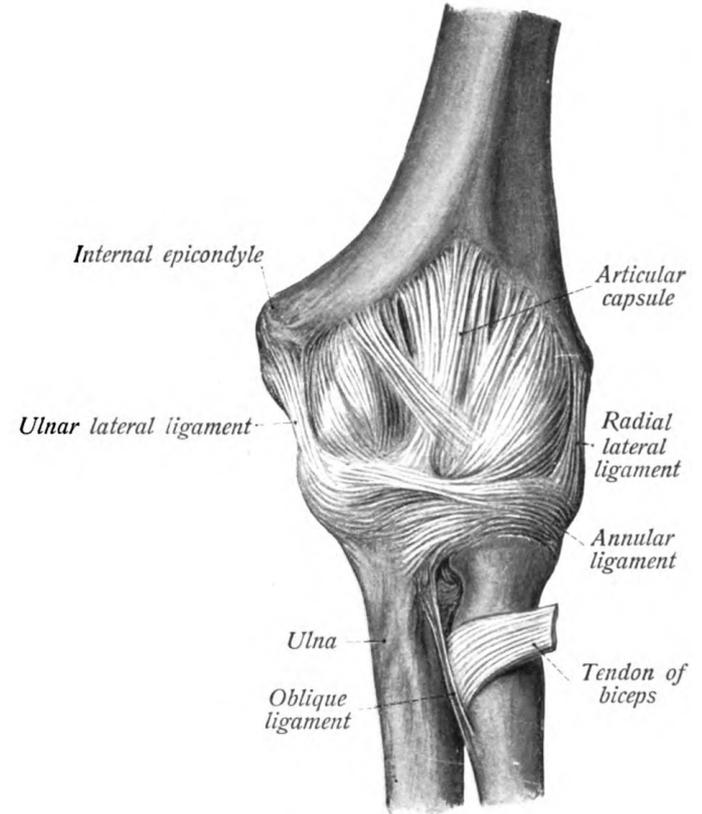
Take home point 1:

- Any point tenderness/deformity

Get the xray

# Nursemaid's elbow

- No obvious deformity /no point tenderness
- Holding arm internally rotated and in adduction
- Pulling story





Take home point 2:

**For nursemaid reduction:  
Stabilize the elbow**



Take home point 3:

**Don't forget  
the clavicle**

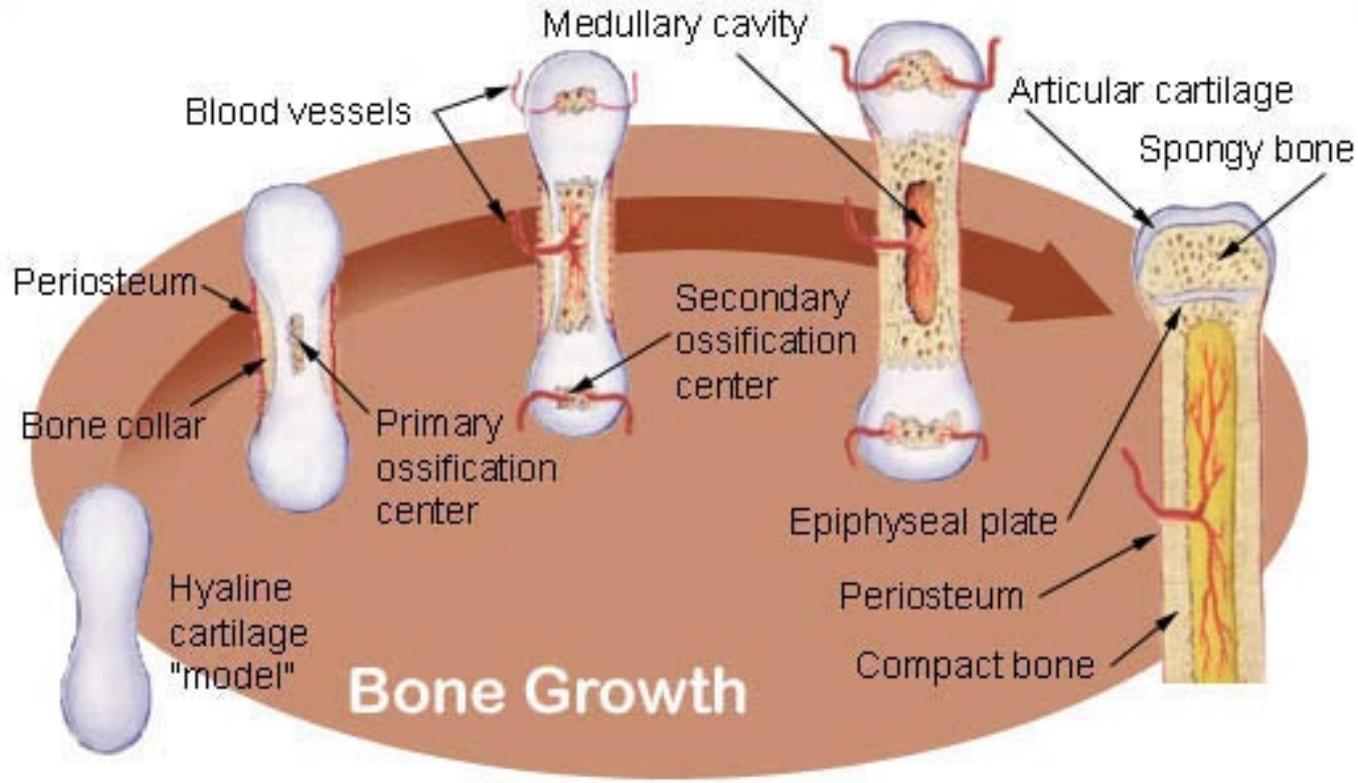




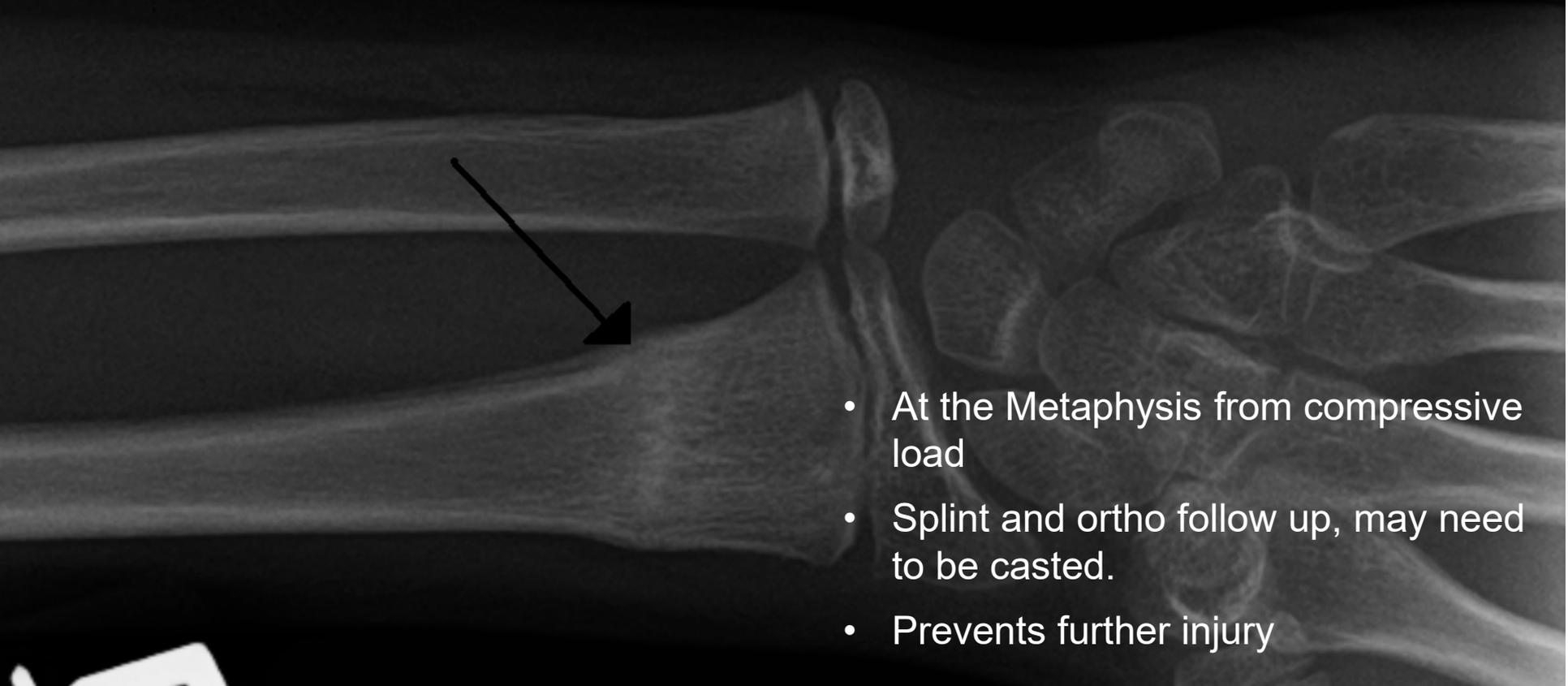
Take home point 4:

# Kids break bones in different ways than adults

# Pediatric Bone Anatomy



# Torus Fractures aka Buckle



- At the Metaphysis from compressive load
- Splint and ortho follow up, may need to be casted.
- Prevents further injury

15

# Greenstick fracture

- 50% of fractures <12 yr
- Incomplete fracture at diaphyseal-metaphyseal junction
- Often need to fracture completely to obtain anatomic alignment
- Ortho consult

# Apophyseal injuries

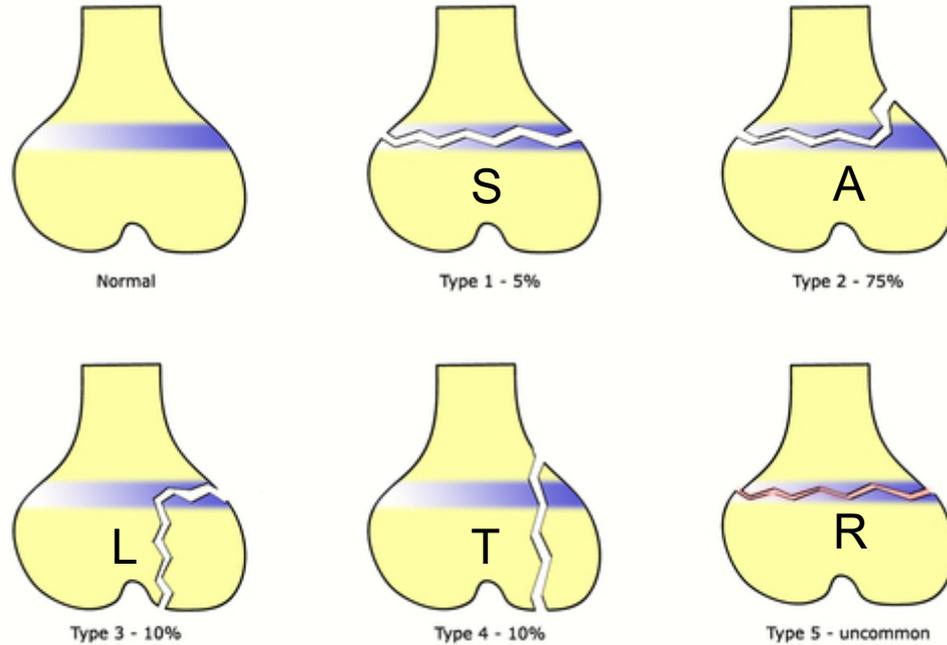
- **Apophyses**-the normal bony outgrowths that arise from separate ossification centers and eventually fuse with the bone in time.
- Repeated microtrauma from muscle/tendon imbalance
- Ex: Osgood Schlatter's- quadriceps tendon



[James Heilman, MD.](#)

[https://commons.wikimedia.org/wiki/File:Radiograph\\_of\\_human\\_knee\\_with\\_Osgood%E2%80%93Schlatter\\_disease.png](https://commons.wikimedia.org/wiki/File:Radiograph_of_human_knee_with_Osgood%E2%80%93Schlatter_disease.png)

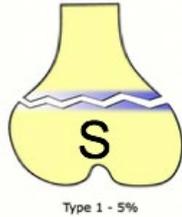
# Physeal Fractures- Salter Harris



Dr Frank Gaillard (MBBS, FRANZCR).  
<https://commons.wikimedia.org/wiki/File:SalterHarris.jpg>

*F. Gaillard  
2010*

# Salter Harris I



- Through growth plate
- X-ray negative but point tenderness over physis
- Treatment: immobilize and ortho f/u



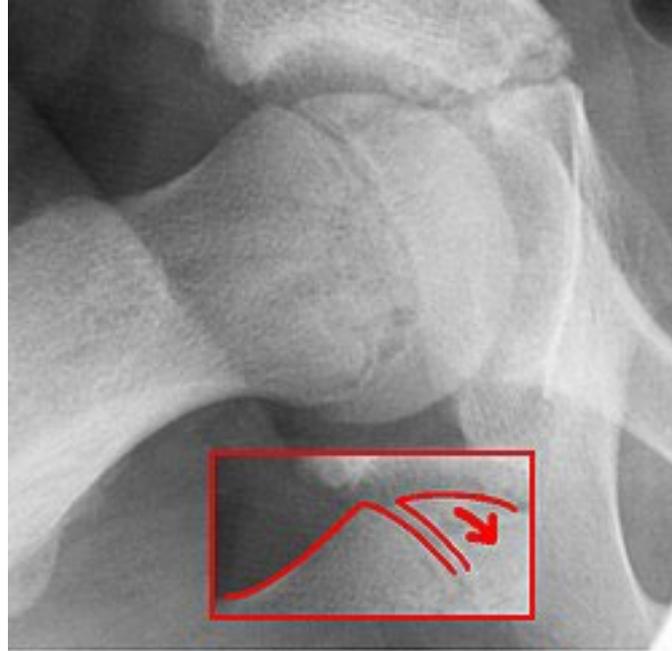
Dr Frank Gaillard (MBBS, FRANZCR). <https://commons.wikimedia.org/wiki/File:SalterHarris.jpg>

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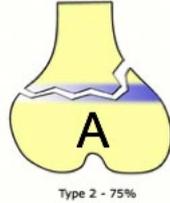
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# SCFE



# Salter Harris II



- Like I, but metaphysis also involved
- Treatment
  - immobilize and ortho f/u
  - if displaced/angulated → reduce



Dr Frank Gaillard (MBBS, FRANZCR). <https://commons.wikimedia.org/wiki/File:SalterHarris.jpg>

[Gilo1969. https://commons.wikimedia.org/wiki/File:Salter\\_Harris\\_2\\_demo.jpg](https://commons.wikimedia.org/wiki/File:Salter_Harris_2_demo.jpg)

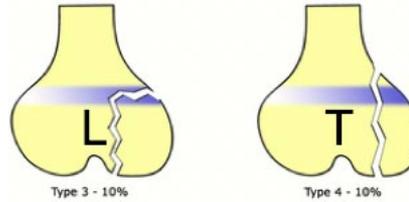


# Seymour Fracture





# Salter Harris III, IV



- Type III, through epiphysis
- Type IV, through both epiphysis and metaphysis
  
- Ortho Consult in ED

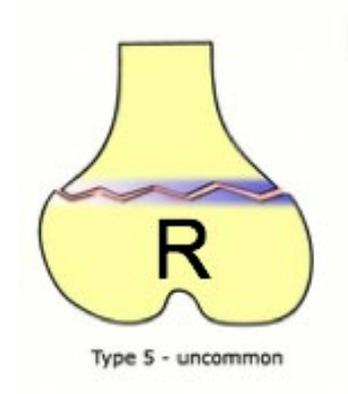


Dr Frank Gaillard (MBBS, FRANZCR). <https://commons.wikimedia.org/wiki/File:SalterHarris.jpg>

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# Salter Harris V

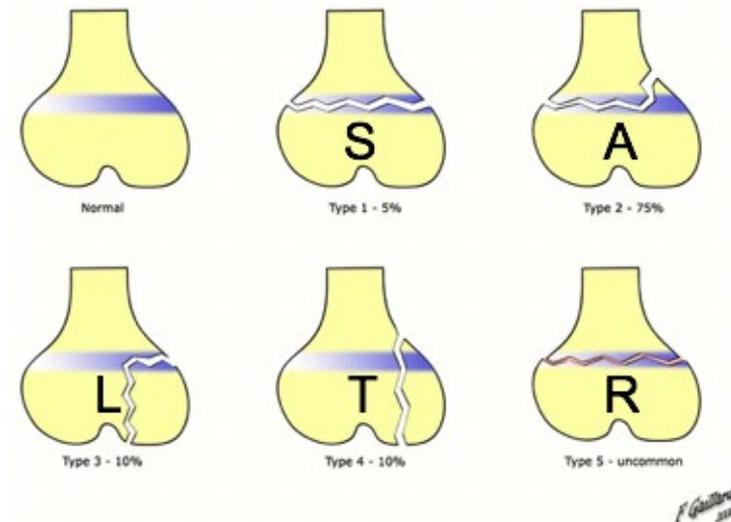
- Rare, Axial Compression
- Often difficult to diagnose on x-ray
- Suspect it based on clinical hx
  
- Treatment: Ortho Consult in ED



Dr Frank Gaillard (MBBS, FRANZCR). <https://commons.wikimedia.org/wiki/File:SalterHarris.jpg>

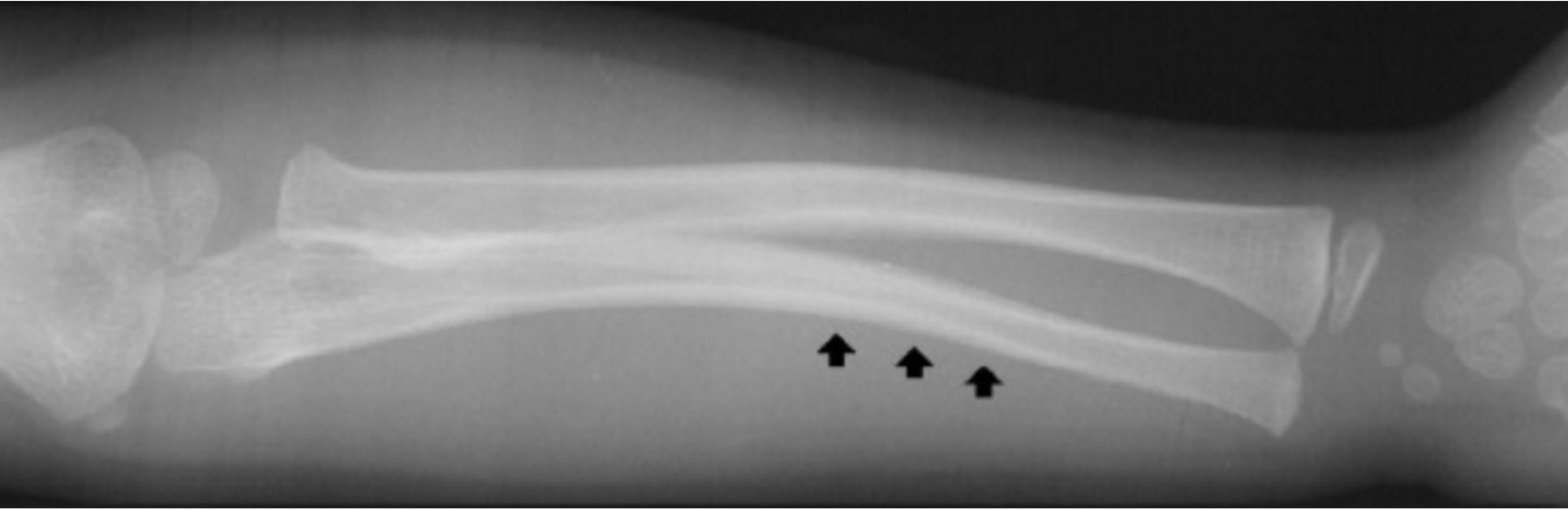
# Salter Harris Fractures- SALTR

- If point tenderness at growth plate, at minimum should splint



Dr Frank Gaillard (MBBS, FRANZCR). <https://commons.wikimedia.org/wiki/File:SalterHarris.jpg>

# Forearm point tenderness



Yamamoto. Am J EM 2012

# Bowing Fracture



- Longitudinal force with plastic deformation
- Microfractures
- Usually ulna, occasionally fibula
- Treatment
  - Splint in ED
  - ALL should be referred to orthopedic surgeon
  - <20deg in <4 yr may not need surgery



Take home point 5:

# Image the other side



# Image the other side



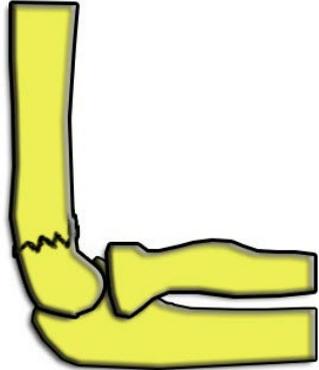


Take home point 6:

**Respect supracondylar  
fractures, check NV  
status**

# Supracondylar fractures

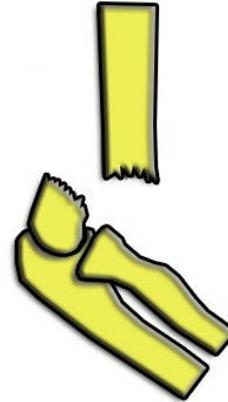
Type I



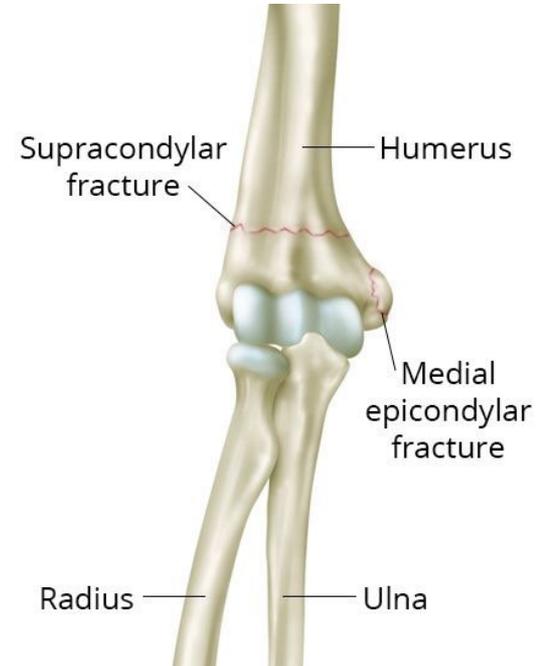
Type II



Type III



## Gartland classification



<https://orthoinfo.aaos.org/en/diseases--conditions/elbow-fractures-in-children/>

S. Benoudina

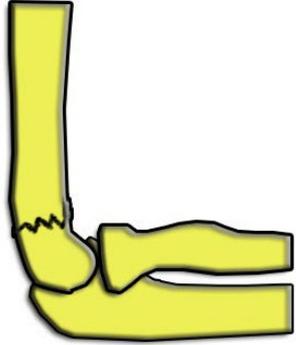
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# Supracondylar fractures

Type I



Type II



Type III



## Gartland classification



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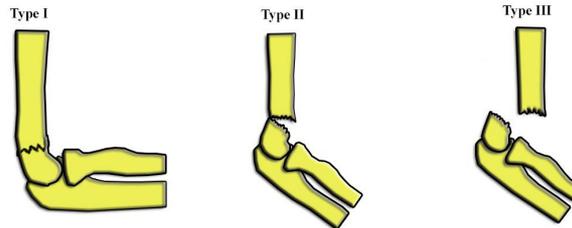
# Nerve Injuries Associated With Pediatric Supracondylar Humeral Fractures: A Meta-analysis

*Jessica C. Babal, BS, Charles T. Mehlman, DO, MPH, and Guy Klein, BS*

- Meta-analysis of supracondylar fractures
- N=5154
- 10-20% had traumatic neurapraxia
- Flexion had more than Extension
- Almost all have complete recovery without intervention

# Supracondylar fractures-treatment

- Type 1 long arm cast, for 4 weeks, ortho follow up in 3-7 d
- If displaced, need surgery
  - Type II – typically next day
  - Type III – same day



Gartland classification

Image: [Benoudina Samir](https://creativecommons.org/licenses/by-sa/4.0/deed.en) License: <https://creativecommons.org/licenses/by-sa/4.0/deed.en> S. Benoudina



# Pain control

- 5 yo here with upper extremity deformity

**IN Fentanyl (1-2mcg/kg)  
before xray**



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# A Randomized Clinical Trial of Ibuprofen Versus Acetaminophen With Codeine for Acute Pediatric Arm Fracture Pain

- RCT with n=336
- Ibuprofen at least as effective as acetaminophen with codeine for pain control
- Less adverse effects: nausea, vomiting, dizziness



Drendel et al. Ann Emerg Med 2009

Take home point 7:

# Ibuprofen for pain control at home





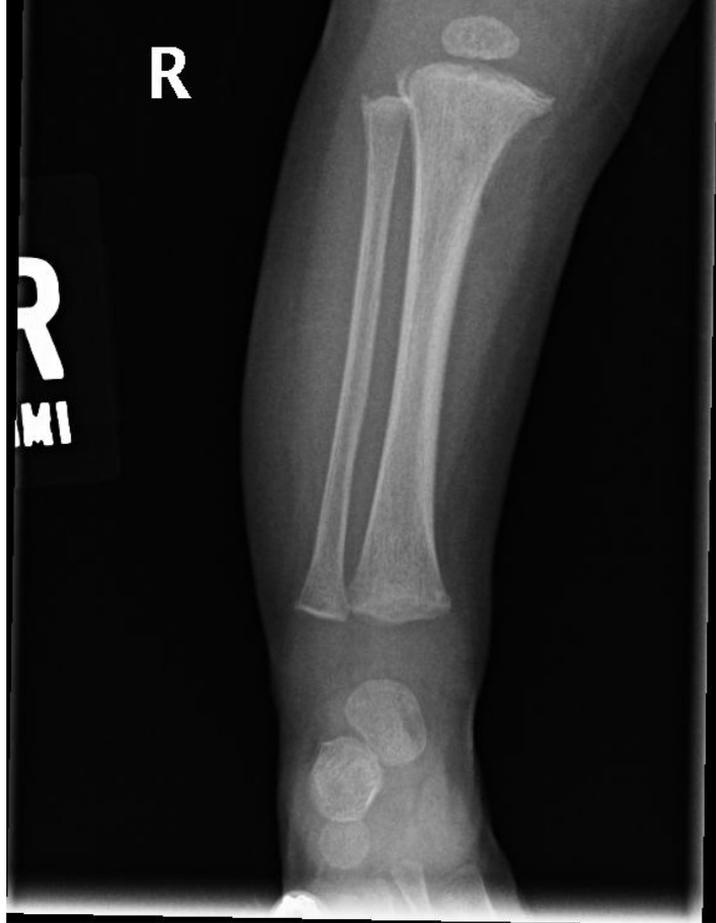
# Case

- 3 mo old fell out of bed





Barber et al 2014



Images courtesy of Matthew Zapala, MD

# Concerning fractures for NAT

**TABLE 1** Specificity of radiologic findings in infants and toddlers<sup>19</sup>

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High specificity<sup>a</sup>

CMLs

Rib fractures, especially posteromedial

Scapular fractures

Spinous process fractures

Sternal fractures

Moderate specificity

Multiple fractures, especially bilateral

Fractures of different ages

Epiphyseal separations

Vertebral body fractures and subluxations

Digital fractures

Complex skull fractures

Common, but low specificity

Subperiosteal new bone formation

Clavicular fractures

Long-bone shaft fractures

Linear skull fractures

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<sup>a</sup> Highest specificity applies in infants.

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**TABLE 3** When Is a Fracture Suspicious for Child Abuse?

- 
- No history of injury
  - History of injury not plausible—mechanism described not consistent with the type of fracture, the energy load needed to cause the fracture, or the severity of the injury
  - Inconsistent histories or changing histories provided by caregiver
  - Fracture in a nonambulatory child
  - Fracture of high specificity for child abuse (eg, rib fractures)
  - Multiple fractures
  - Fractures of different ages
  - Other injuries suspicious for child abuse
  - Delay in seeking care for an injury
- 

Flaherty et al 2014



Take home point 8:

# Think about NAT

Take home point 9:

# Kids remodel amazingly well



Crawford et al 2012

# Take home points

- Get the x-ray
- For Nursemaid's reduction: stabilize the elbow
- Don't forget the clavicle
- Kids break bones in different ways than adults
- If there's any doubt, image the other side
- Respect supracondylar fractures
- Ibuprofen for pain control at home
- Think about NAT
- Kids remodel amazingly well

# Questions?

# References

- 1.) [Yamamoto LG](#)<sup>1</sup>. Reduction of bowing forearm fractures in the ED under propofol sedation. [Am J Emerg Med](#). 2012 Jan;30(1):249.e1-4. doi: 10.1016/j.ajem.2010.09.025. Epub 2010 Oct 29.
- 2.) Bandi S, Drone E, Vera A, et al. (September 27, 2020) Seymour Fracture in a Pediatric Patient: A Case Report. [Cureus](#) 12(9): e10687. doi:10.7759/cureus.10687
- 3.) Manning Ryan, Letecia. Evaluation and management of supracondylar fractures in children. Up to date. Accessed 1/14/19.
- 4.) [Babal JC](#)<sup>1</sup>, [Mehlman CT](#), [Klein G](#). Nerve injuries associated with pediatric supracondylar humeral fractures: a meta-analysis. [J Pediatr Orthop](#). 2010 Apr-May;30(3):253-63. doi: 10.1097/BPO.0b013e3181d213a6.
- 5.) [Drendel AL](#)<sup>1</sup>, [Gorelick MH](#), [Weisman SJ](#), [Lyon R](#), [Brousseau DC](#), [Kim MK](#). A randomized clinical trial of ibuprofen versus acetaminophen with codeine for acute pediatric arm fracture pain. [Ann Emerg Med](#). 2009 Oct;54(4):553-60. doi: 10.1016/j.annemergmed.2009.06.005. Epub 2009 Aug 19.
- 6.) [Flaherty EG](#), [Perez-Rossello JM](#), [Levine MA](#), [Hennrikus WL](#); [American Academy of Pediatrics Committee on Child Abuse and Neglect](#); [Section on Radiology, American Academy of Pediatrics](#); [Section on Endocrinology, American Academy of Pediatrics](#); [Section on Orthopaedics, American Academy of Pediatrics](#); [Society for Pediatric Radiology](#). Evaluating children with fractures for child physical abuse. [Pediatrics](#). 2014 Feb;133(2):e477-89.
- 7.) [Crawford SN](#)<sup>1</sup>, [Lee LS](#), [Izuka BH](#). Closed treatment of overriding distal radial fractures without reduction in children. [J Bone Joint Surg Am](#). 2012 Feb 1;94(3):246-52. doi: 10.2106/JBJS.K.00163.
- 9.) Barber, I. & Kleinman, P.K. [Pediatr Radiol](#) (2014) 44(Suppl 4): 613. <https://doi-org.ucsf.idm.oclc.org/10.1007/s00247-014-3099-5>