UPPER LIMB INJURIES IN CHILDREN AND ADOLESCENTS

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Outline

1. General introduction

- Bone and periosteum features in children and their implications in imaging of upper limb traumas
- Growth plate features and implications in imaging of upper limb traumas
- Secondary ossification center (SOC) features and implications in imaging of upper limb trauma

2. Systematic approach to upper limb trauma imaging in children and adolescents

Humerus

Elbow

Forearm

….Beyond the scope of this presentation…..

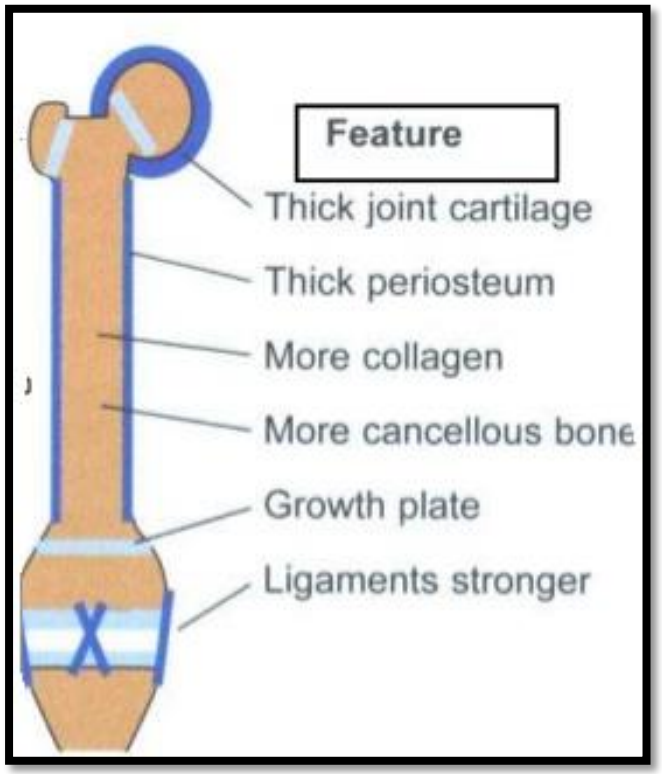
1. Wrist and Hand trauma imaging in children and adolescents:

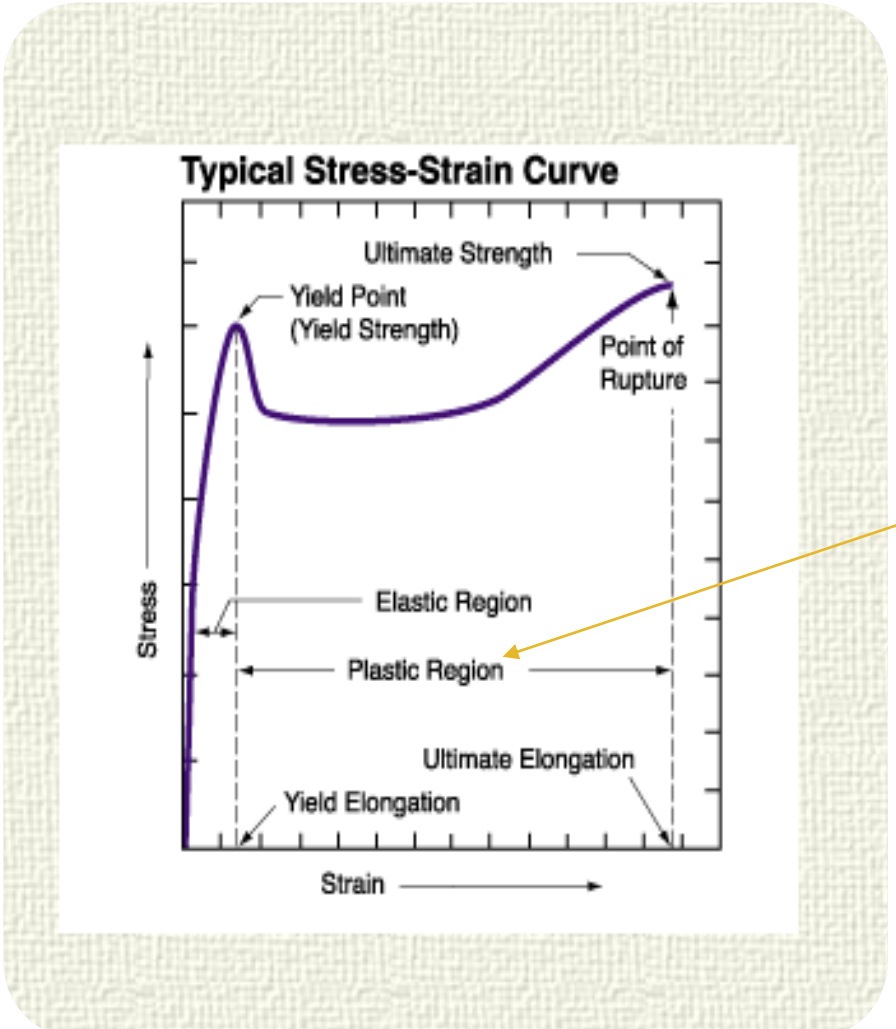
some bio-mechanical and phisiologic differences

2. Systematic review of use of US (and MRI) to assess upper limb trauma

Subspecialty , US (and, in some instances, MRI) are a useful adjunct to radiographs

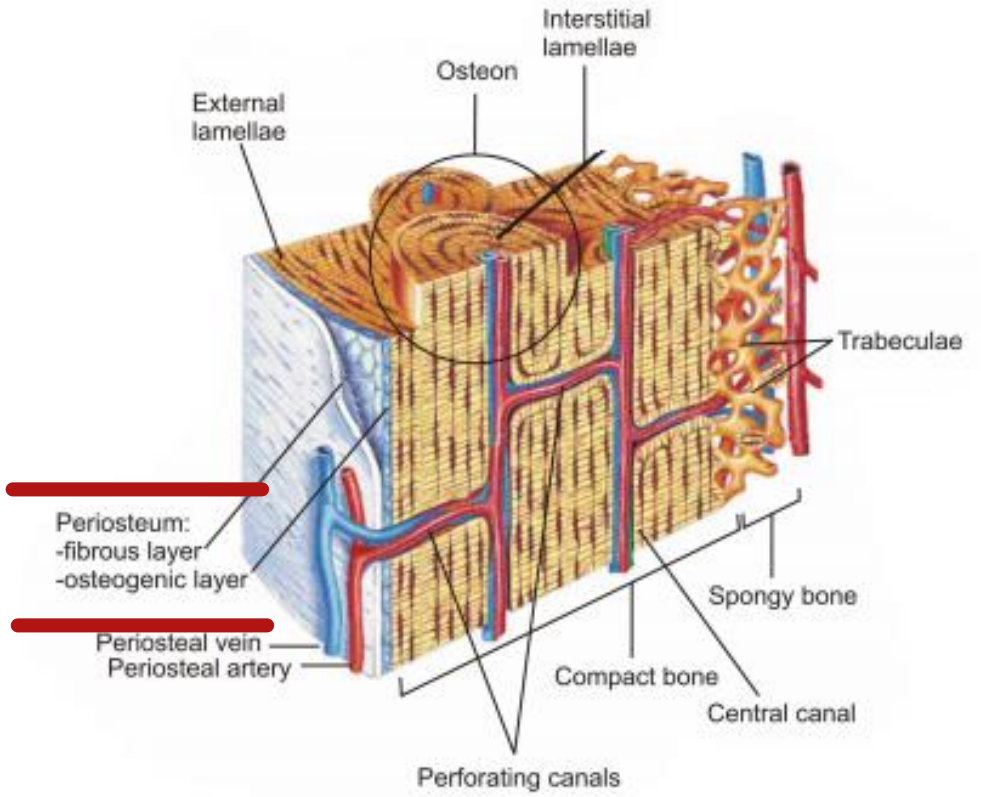
Children's bones and joints are different

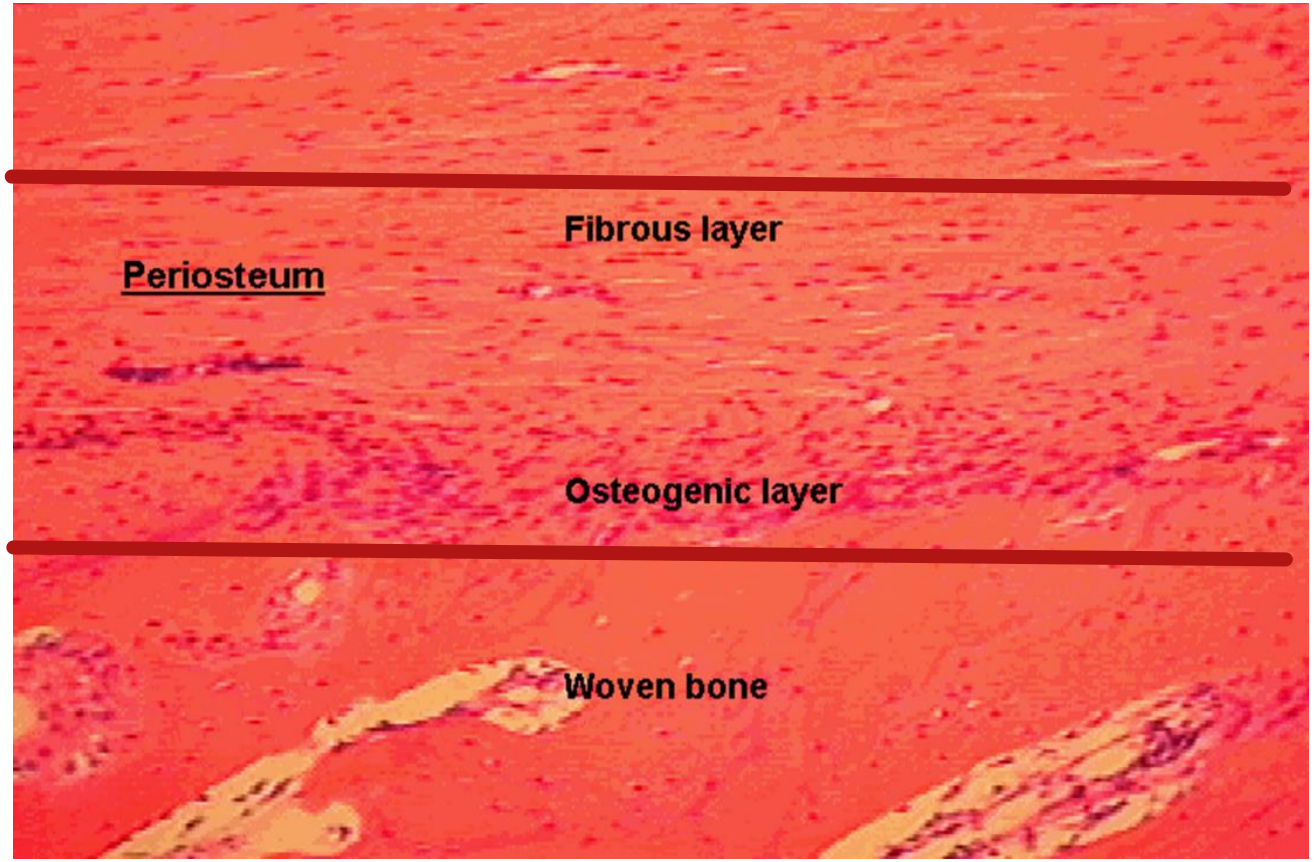




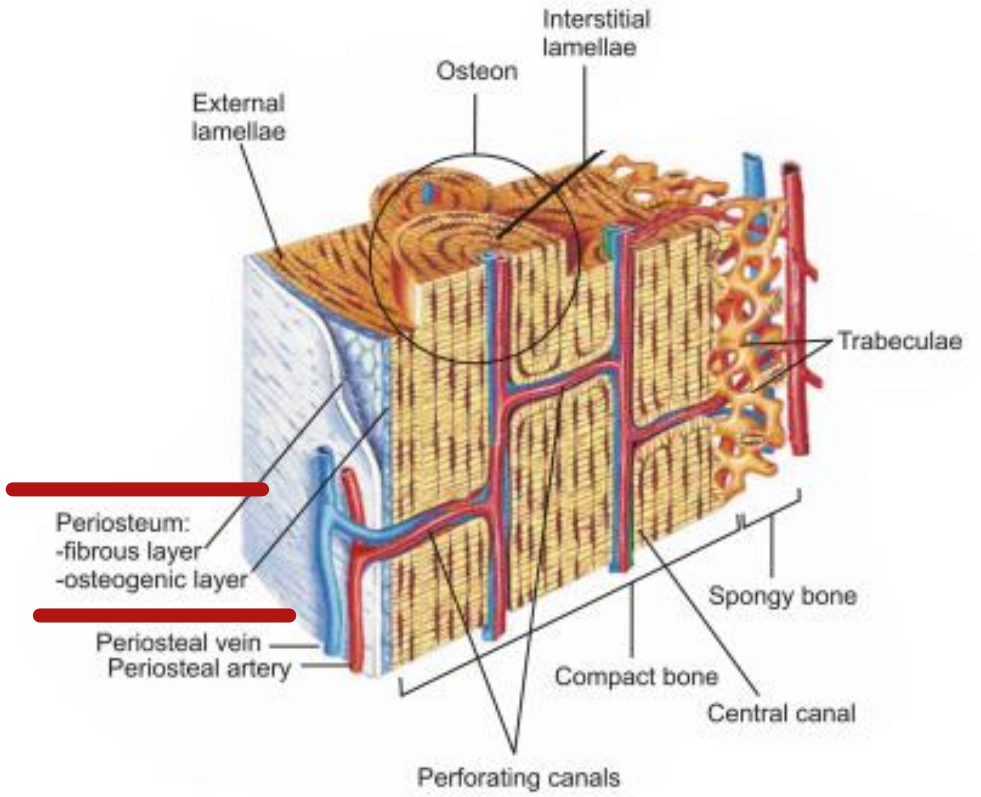
In kids large plastic region before rupture

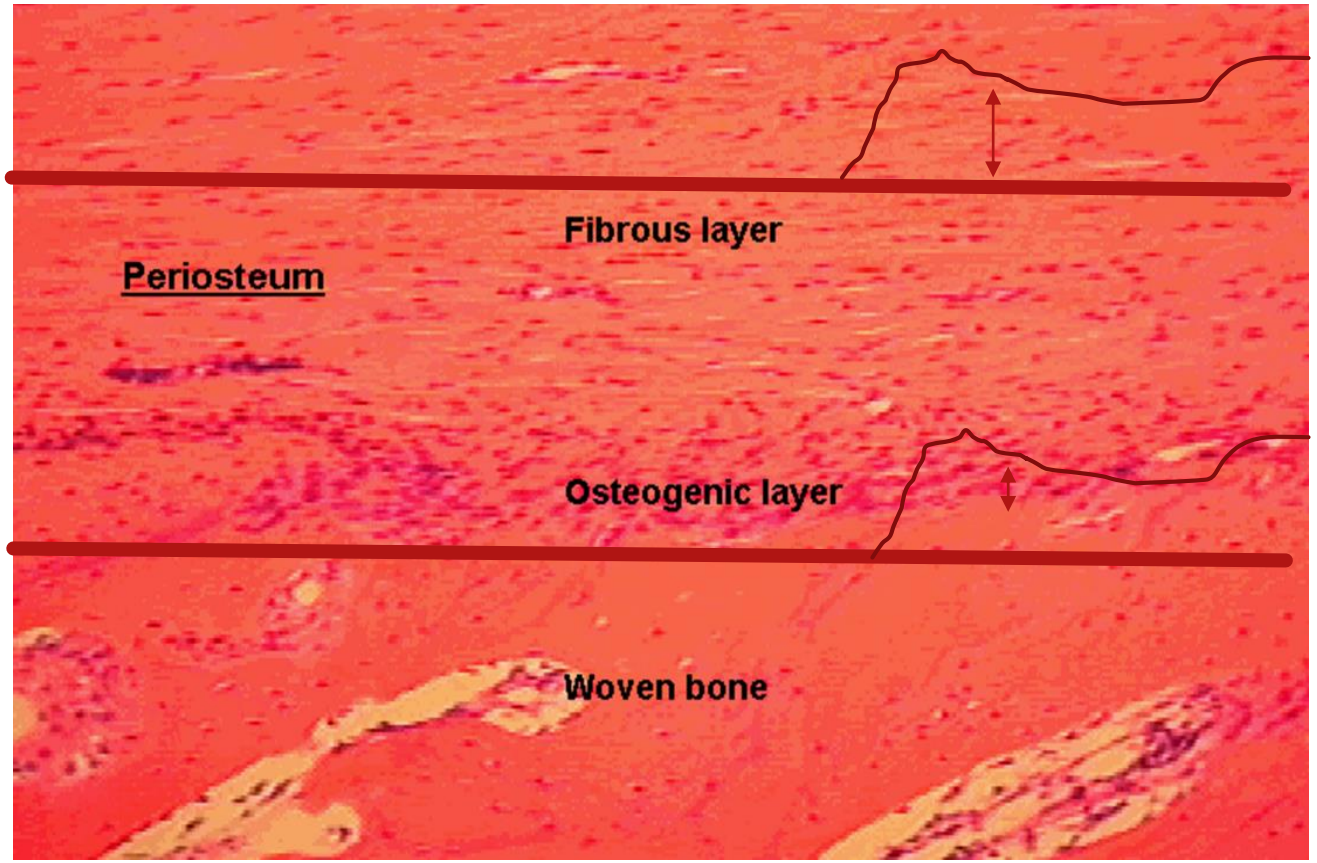
Children’s periosteum is different





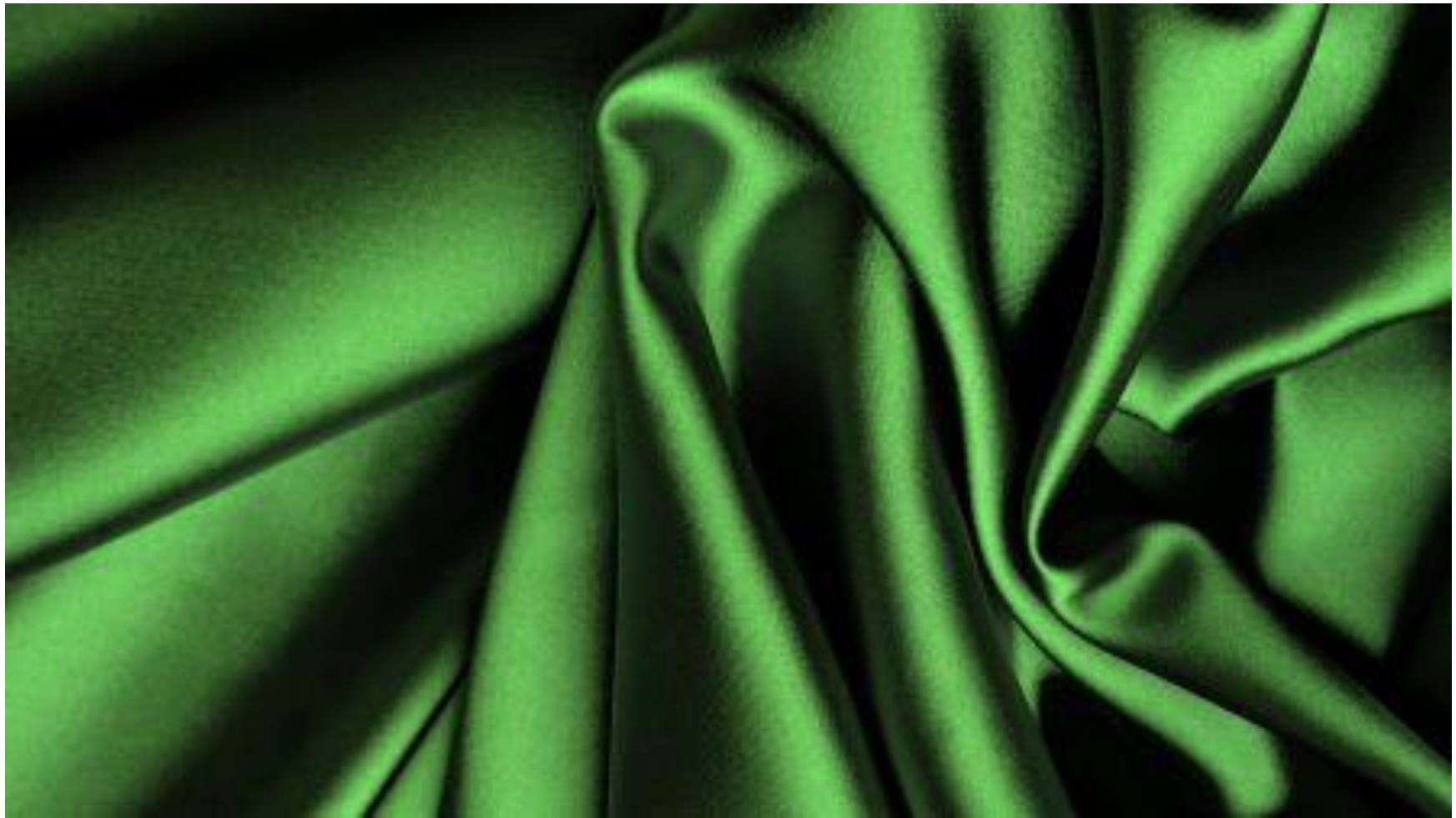
Children's periosteum is different





Periosteum is thick and strong in children but is very flexible and it can buldge or

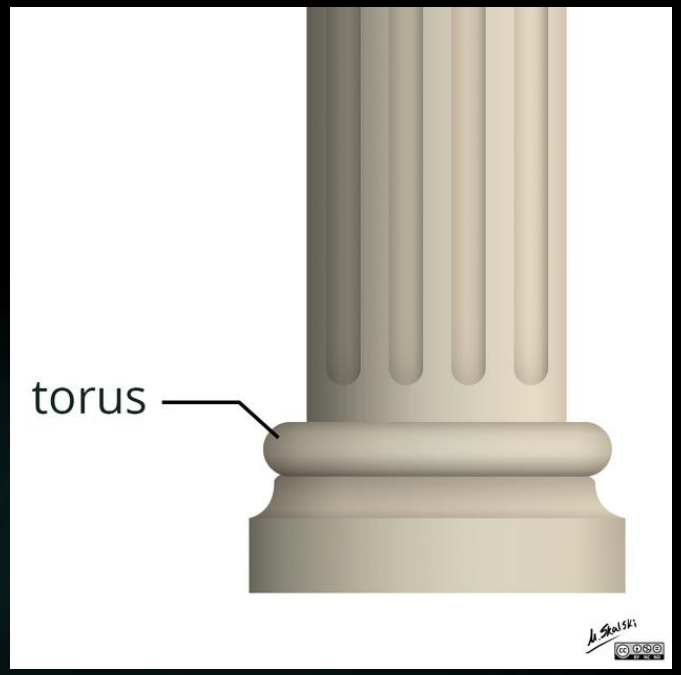
Periosteum is not visible on radiographs: it can fold without being injured



Bone + periosteum =Children's fractures are different

but
also

“Torus or Buckling fracture” and “Greenstick fracture

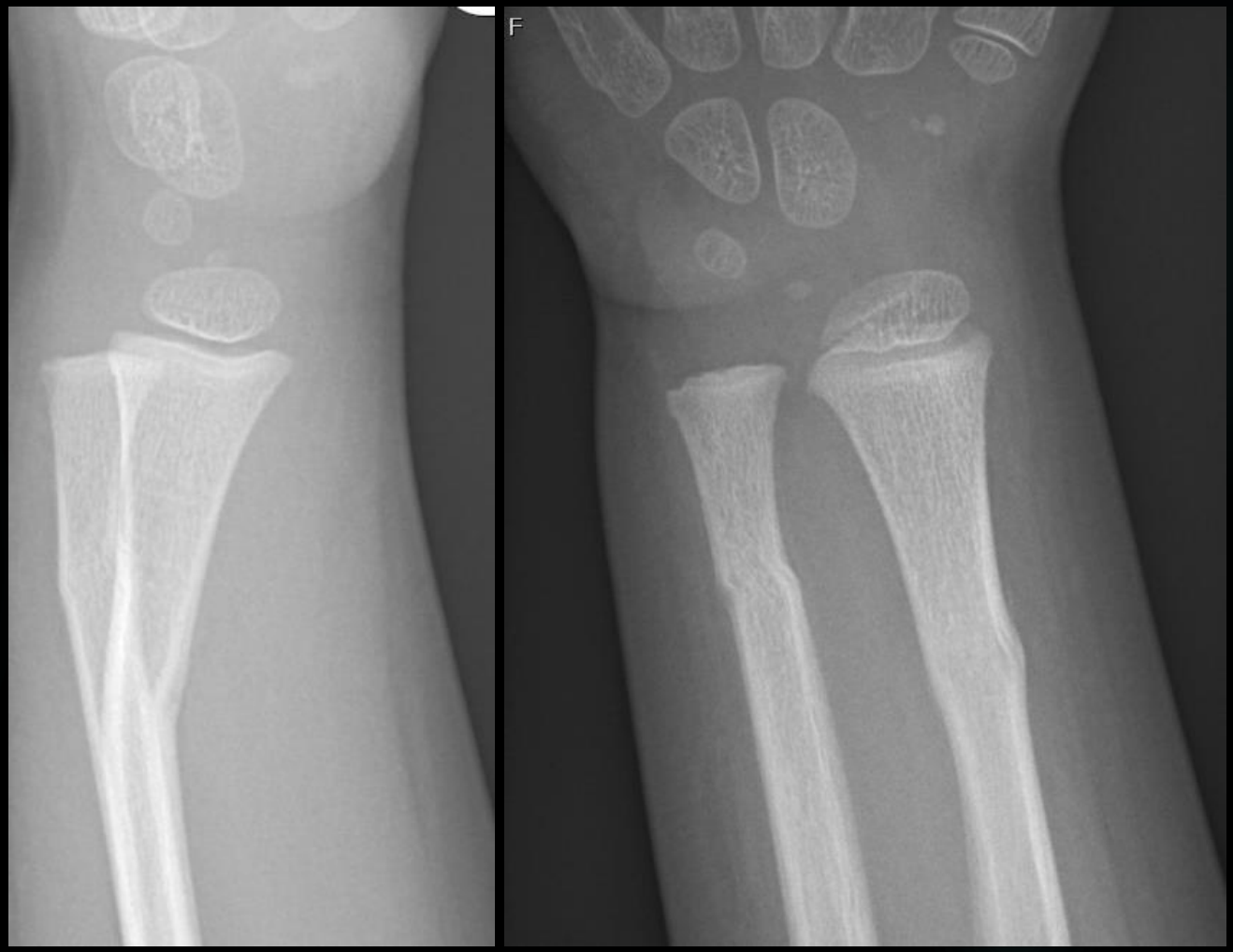


“Torus or Buckling fracture”, caused by a force acting on the longitudinal axis. There is a buckle and a break of the cortex on the opposite side. The fracture line can be visible or not

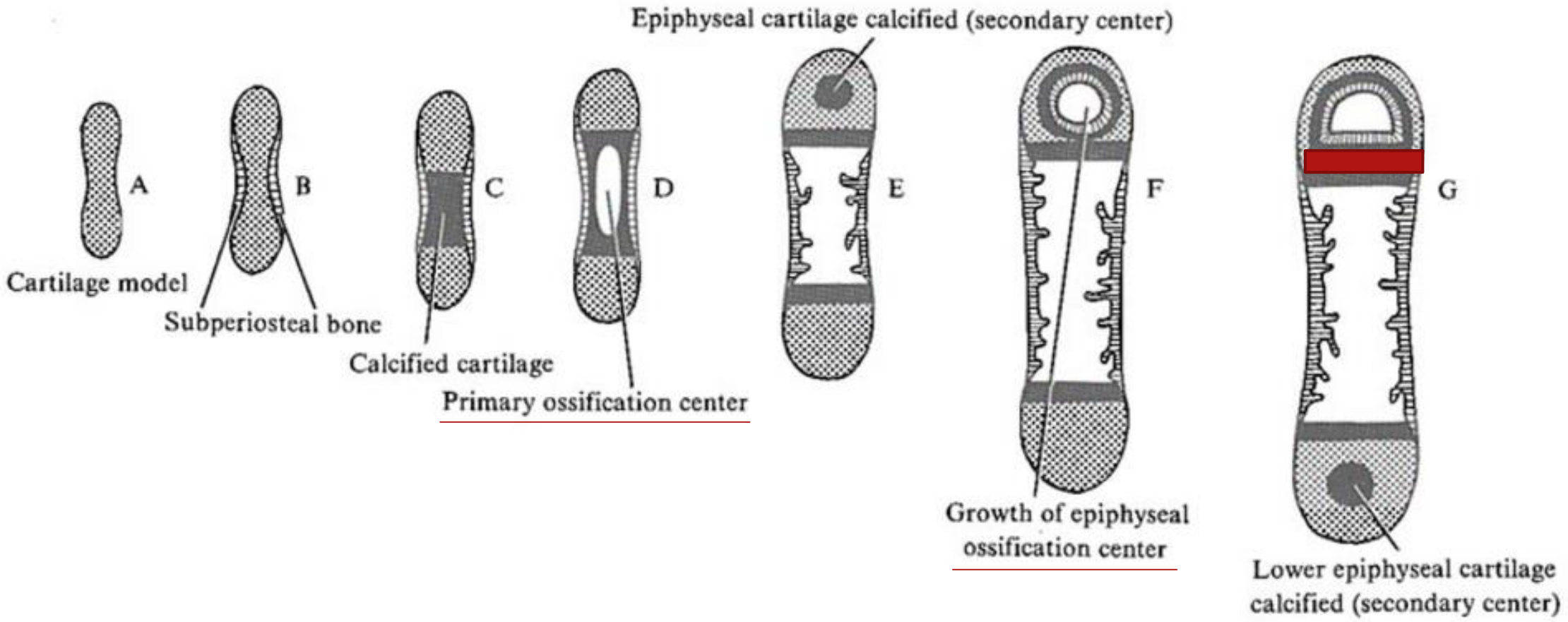
“Greenstick fracture”, a transverse fracture of the cortex which extends into the middle portion of the bone and becomes oriented along the longitudinal axis of the bone without disrupting but the opposite cortex.

« Plastic bowing »

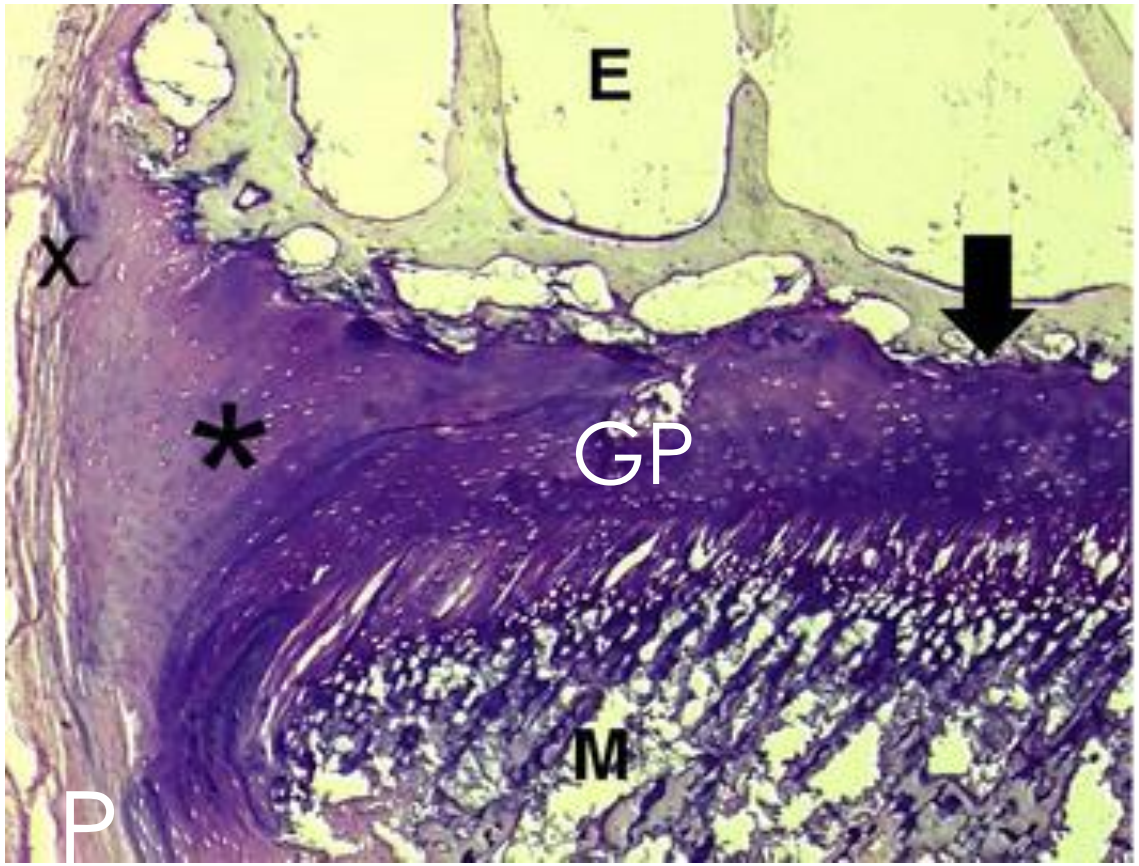
« Plastic bowing »:
if the traumatic force exceeds the elastic modulus of the bone but it is not strong enough to cause a complete fracture. No cortical break is visible.

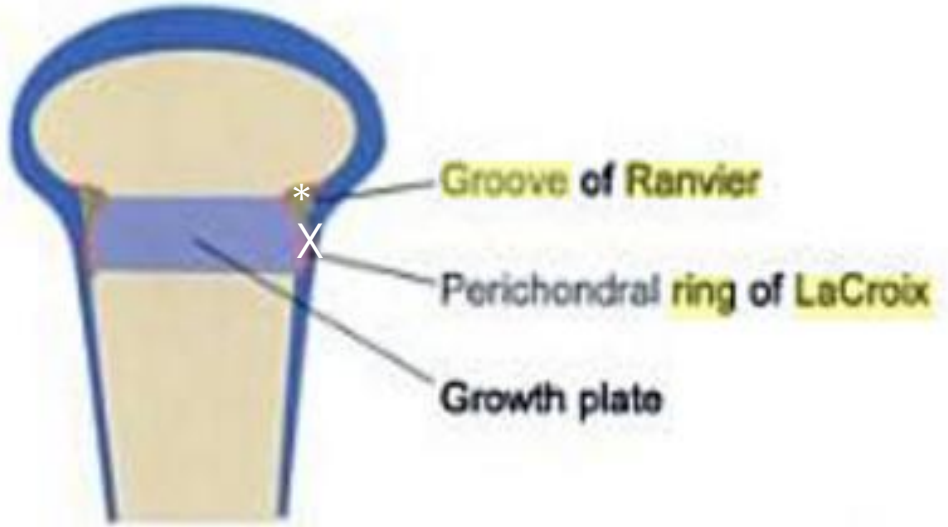


Children bon is highly dynamic:



Growth plate



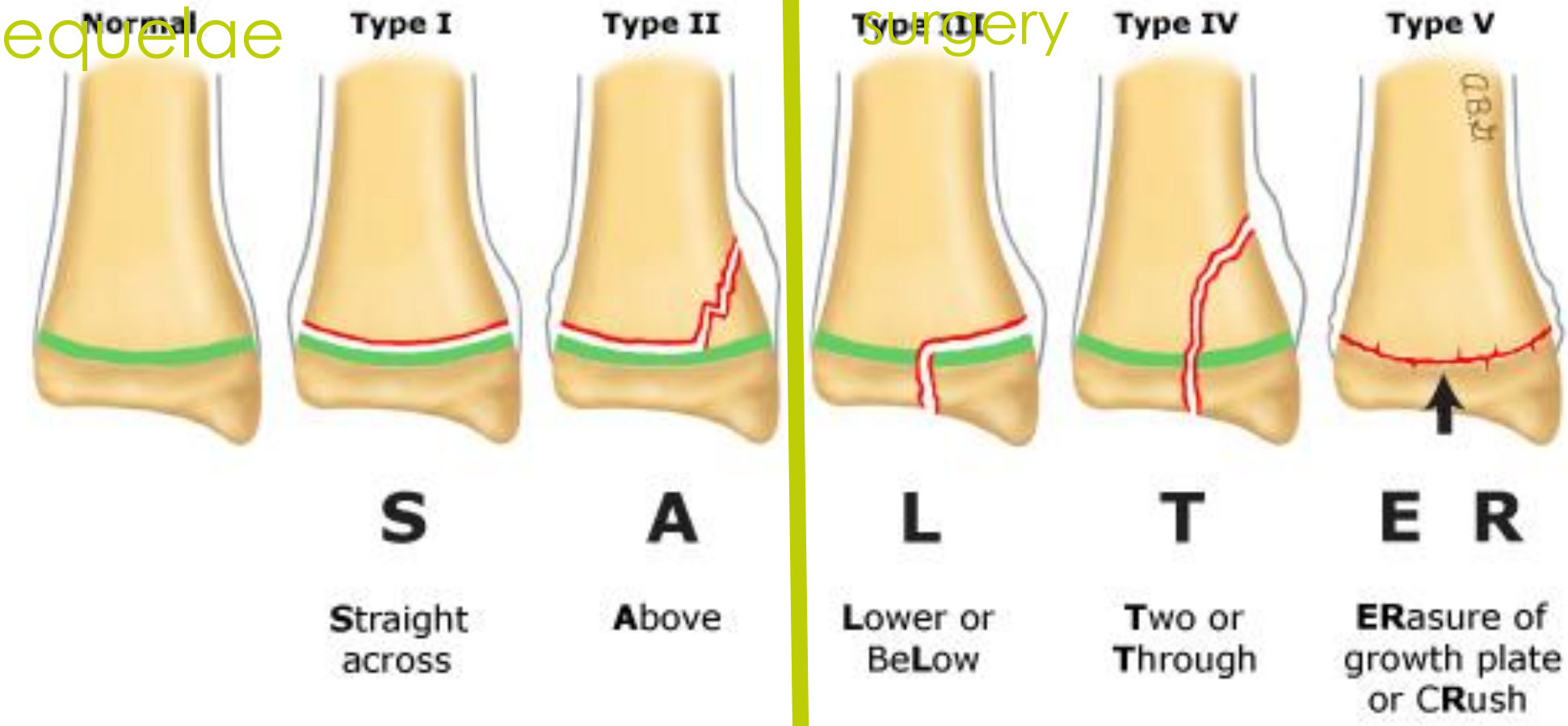


B Perichondral ring This ring consists of elements that provide strength and the capacity of the growth plate to expand in width. The groove of Ranvier (green) and perichondral ring of LaCroix (red) are shown. Based on Gamble, JG 1988.

Salter-Harris fractures

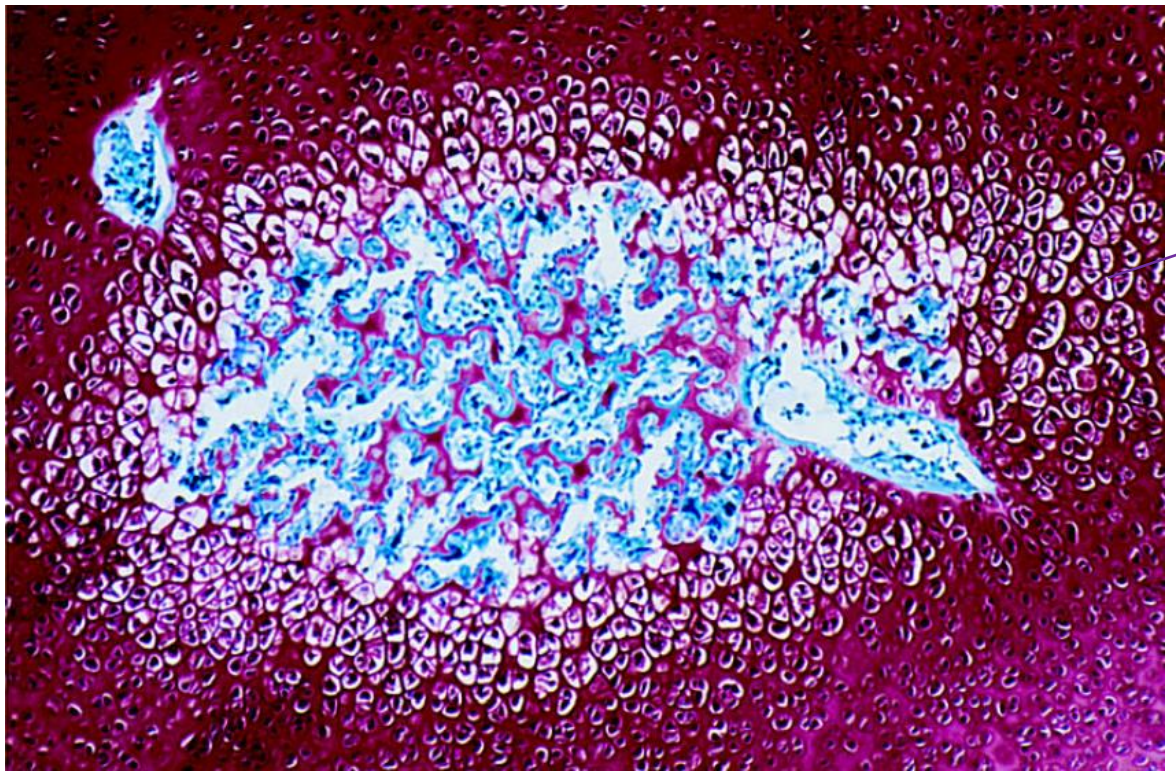
I-II: usually no sequelae

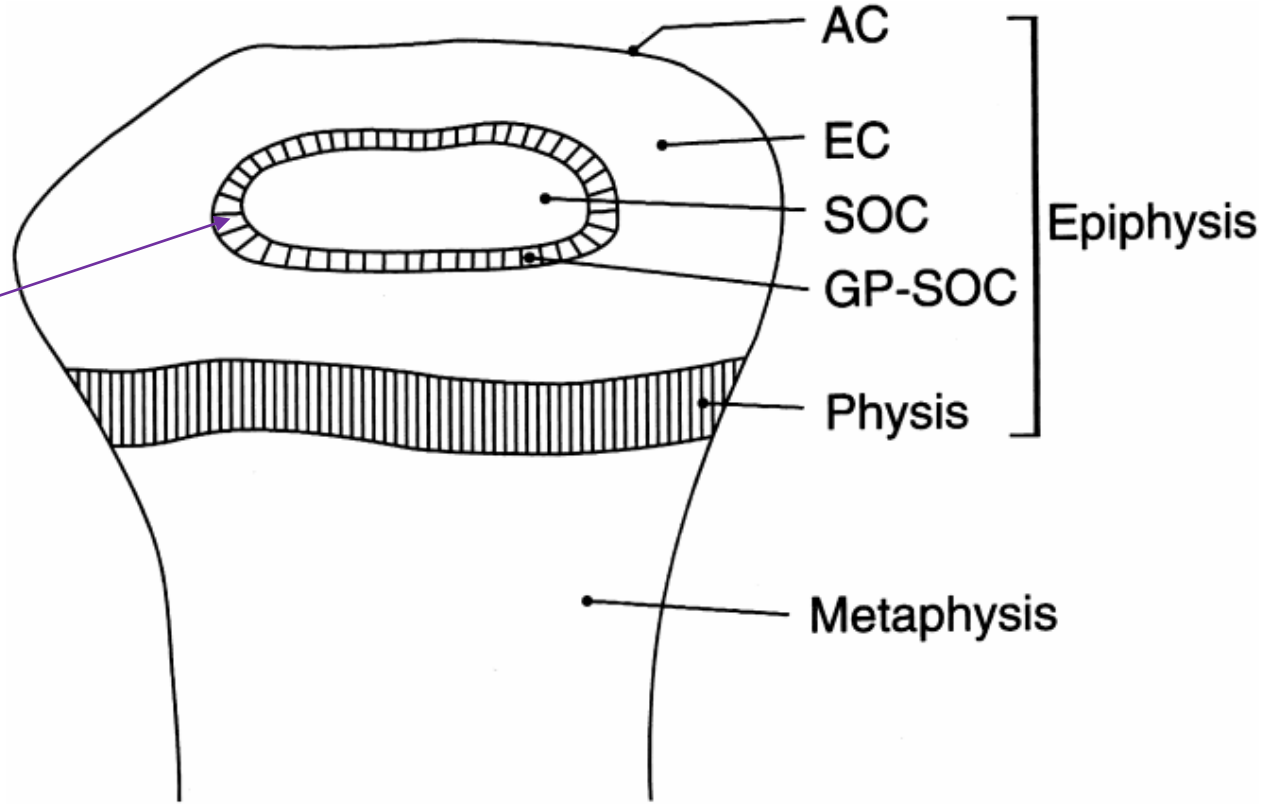
III-IV-V: shortening, deformity, surgery



Secondary ossification center (SOC

Secondary ossification center (SOC)





SOCs are protected by the GP-SOC all

Consider multiple SOC vs fracture

Fractures in children: some tips and tricks

- Periosteum is thick and strong in children but is very flexible and it can buldge or bow
- Bone is more elastic/plastic in children .
- Always rule out Salter-Harris Fracture: look at the growth plate an around
- Consider that multiple SOC can appear in the epiphysis during bone growth before diagnose an epiphyseal fracture. SOC are protected by their own GP

Humerus

Promixal Humerus Fractures

Age: teens

Mechanism:

-Direct trauma (fall on the shoulder)

-Fall on outstreched hand

-Luxation are rare

Features:

-Fracture of the surgical neck more fragment before 3 yrs

-Salter II in adolescence

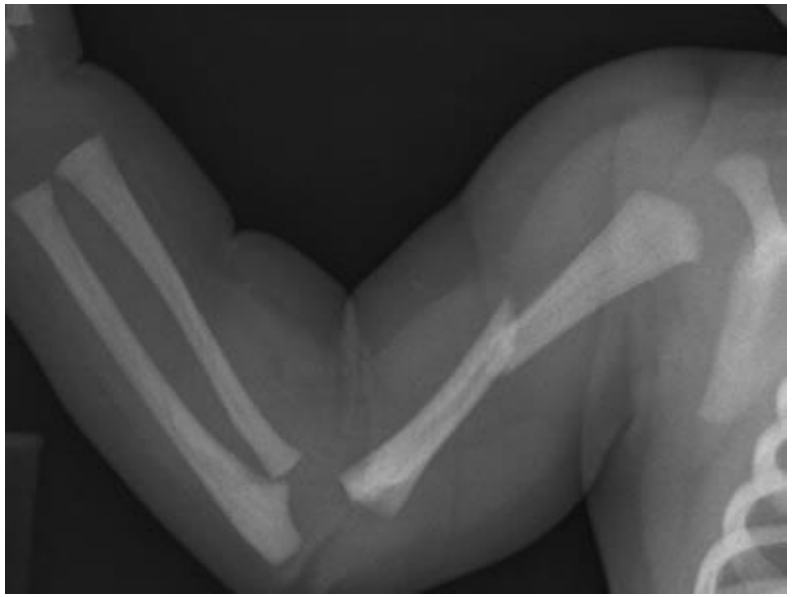
-Rule out pathological fracture (i.e. simple bone cyst)

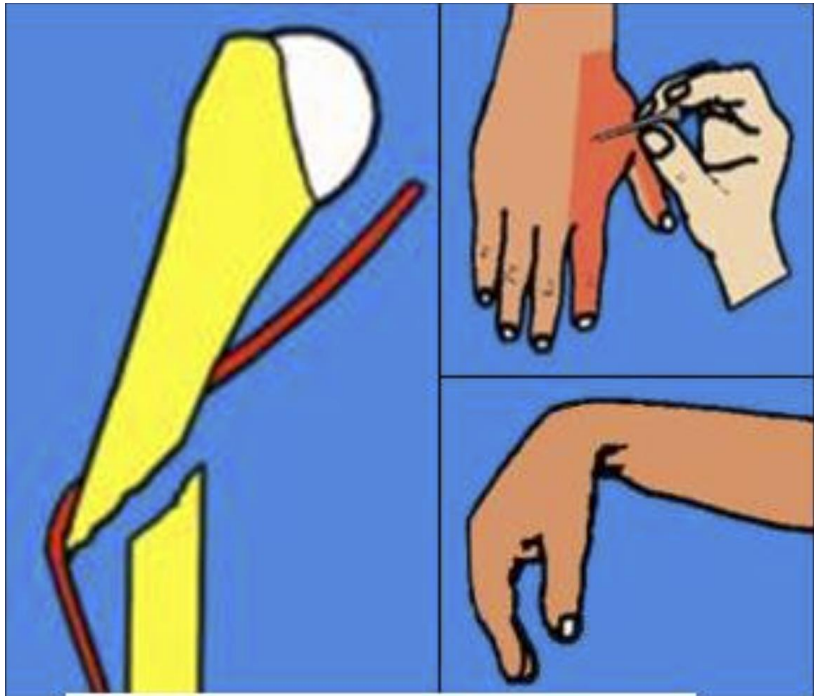
Humeral diaphyseal fracture

Age:birth, teenagers

Mechanism:

- Obstetrical trauma
- Direct trauma





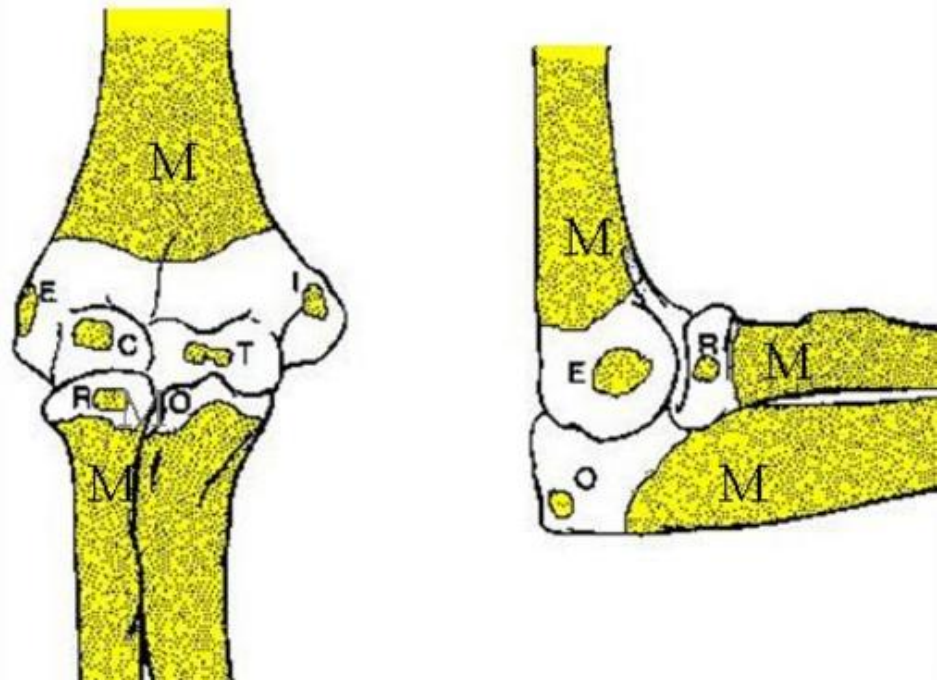
Check for our paralysis of the radial nerve!!!

Elbow

-

CRITOE

6m-2a: C : capitellum
3a-6a: R : radial head
5a-7a : I : internal epicondyle
7a-10a: T : trochlea
8a-10a: O : olecranon
11a-12a: E: external epicondyle



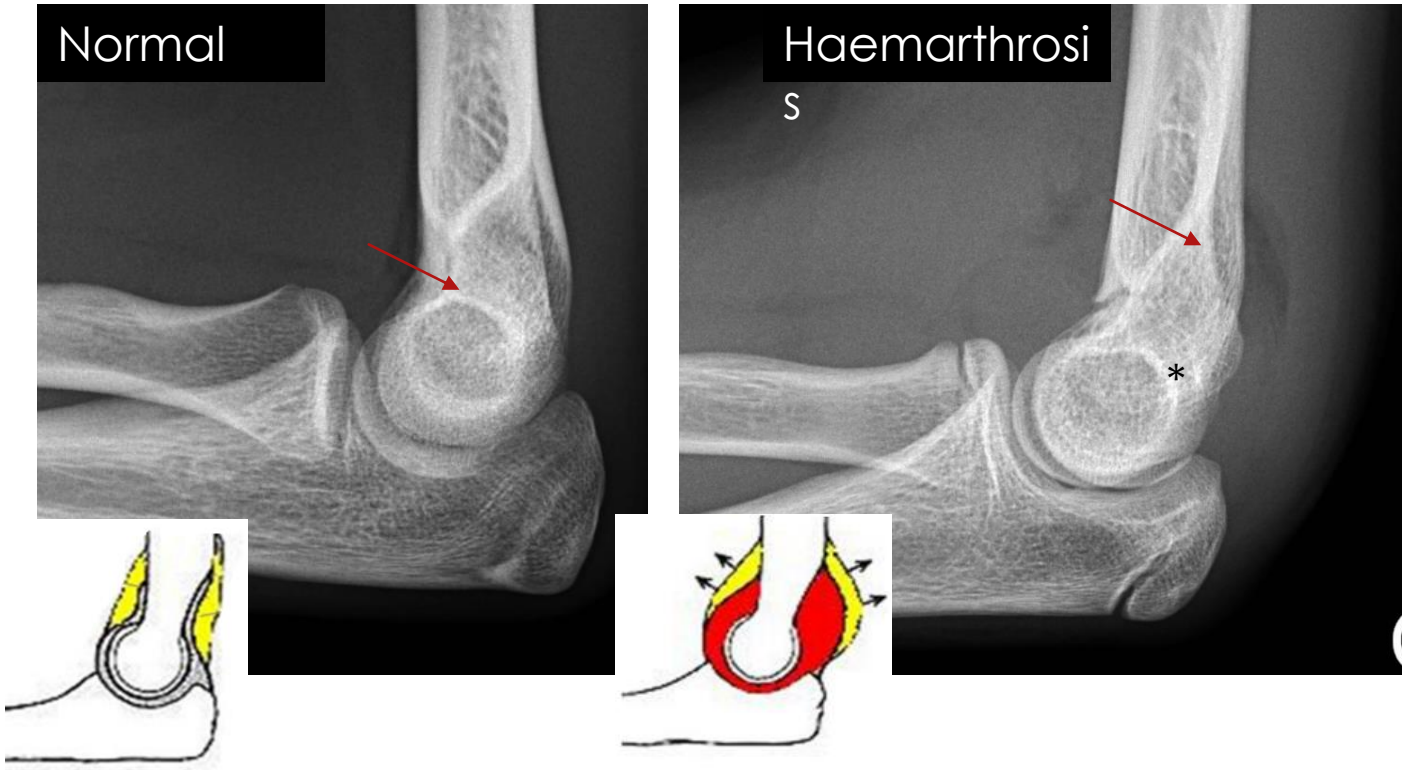
!Open your book or…

Haemarthrosis

Hemarthrosis : criticial sign

Usually the capsule is adjacent to
he bone and the pad is adjacent
o the capsule.

f there is hemarthrosis :
he pads are displaced

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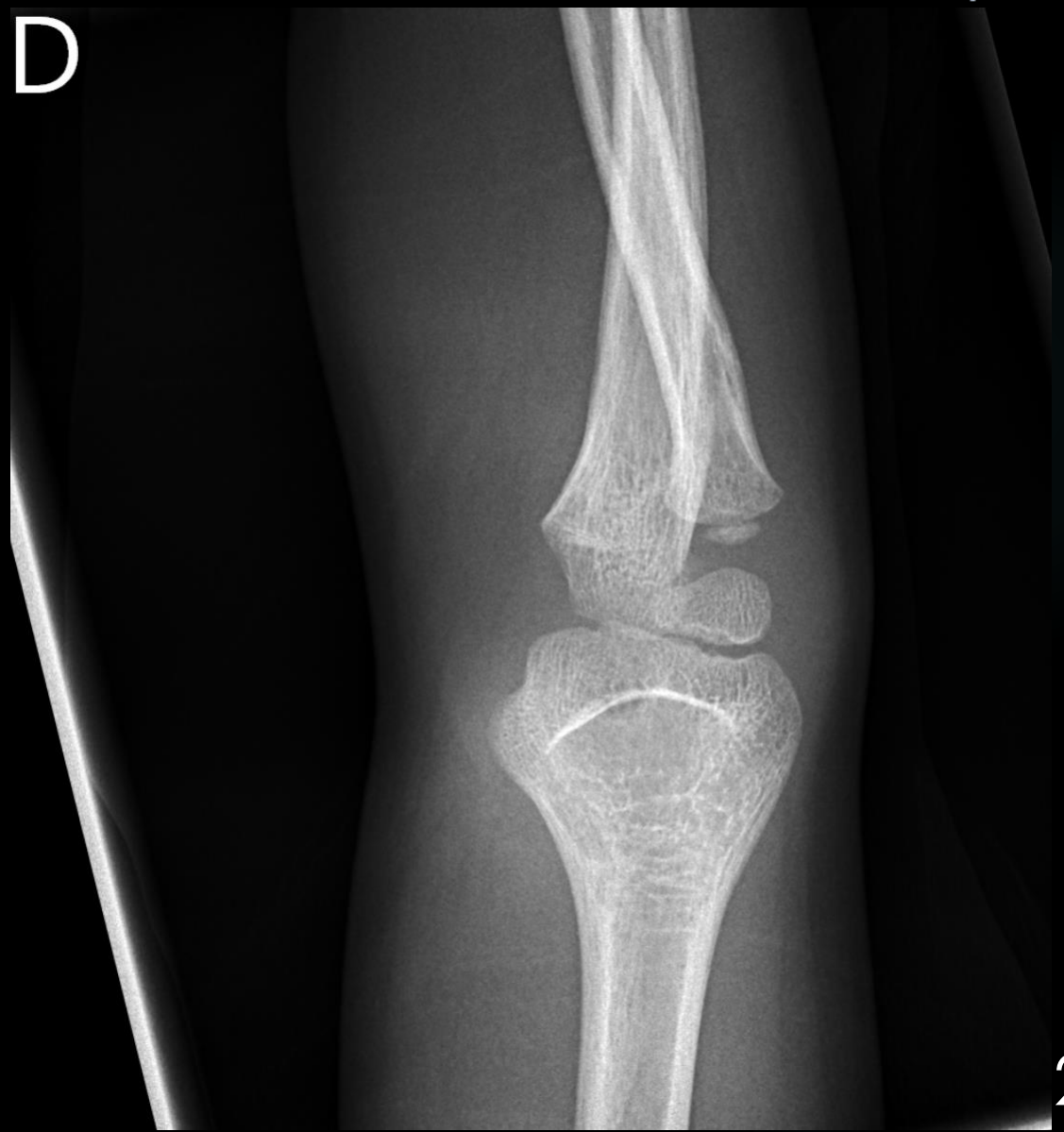
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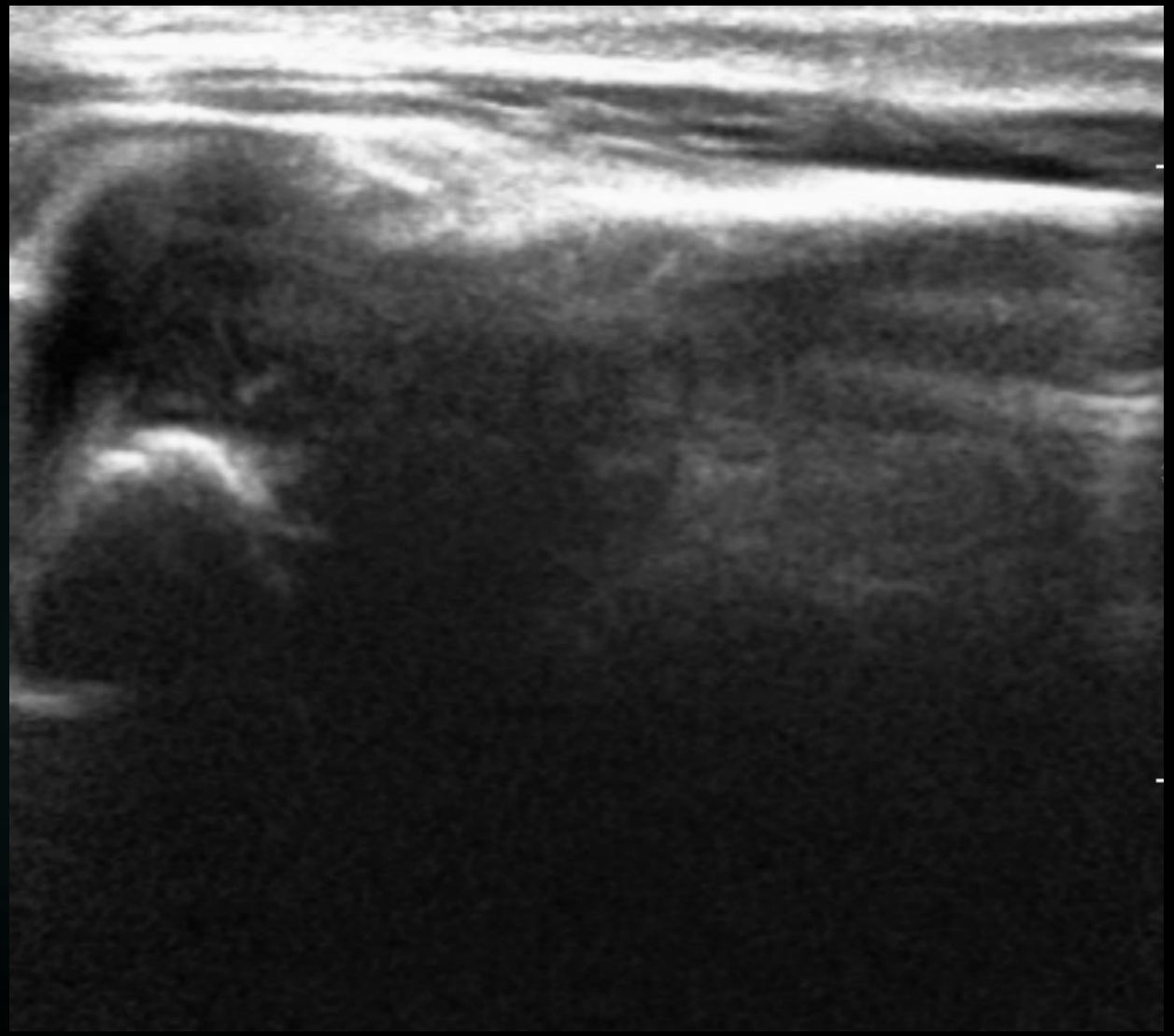

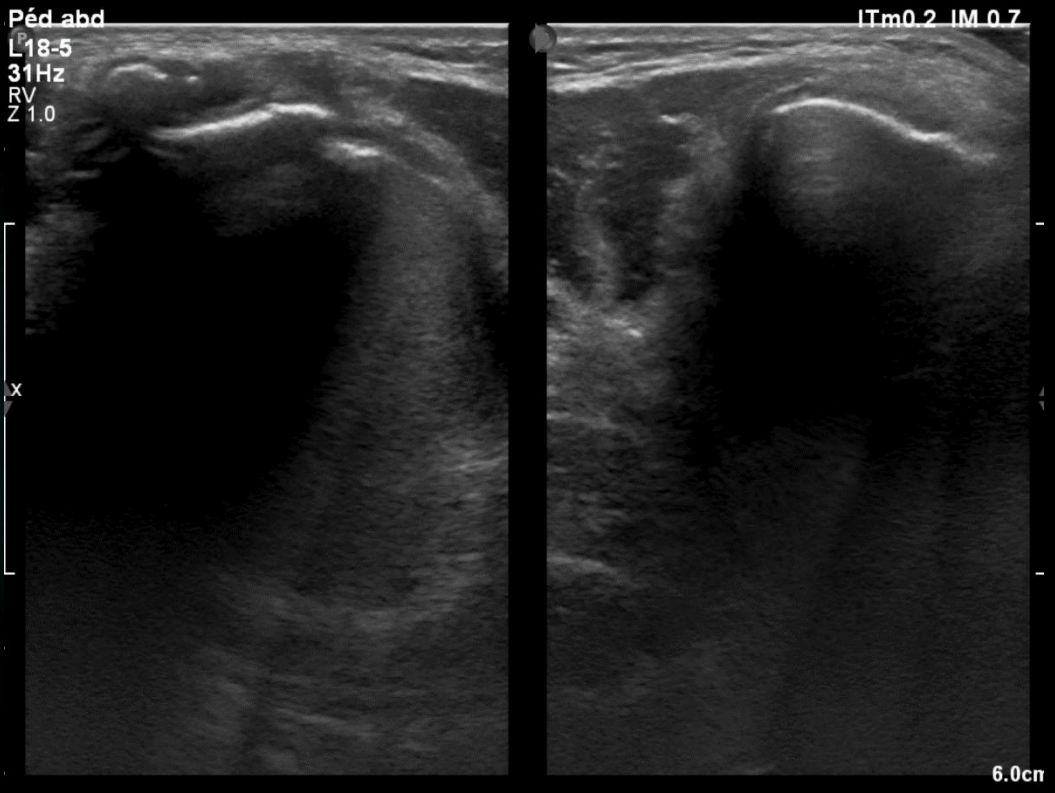
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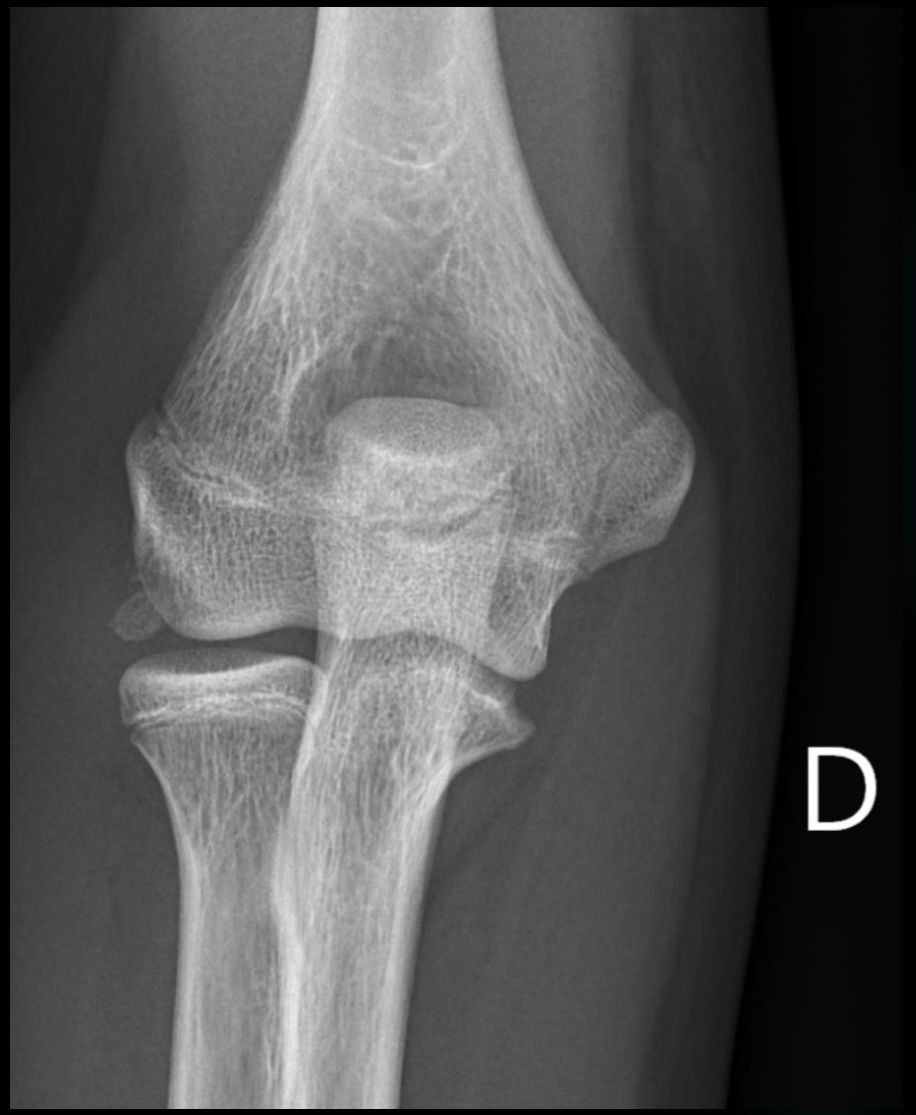
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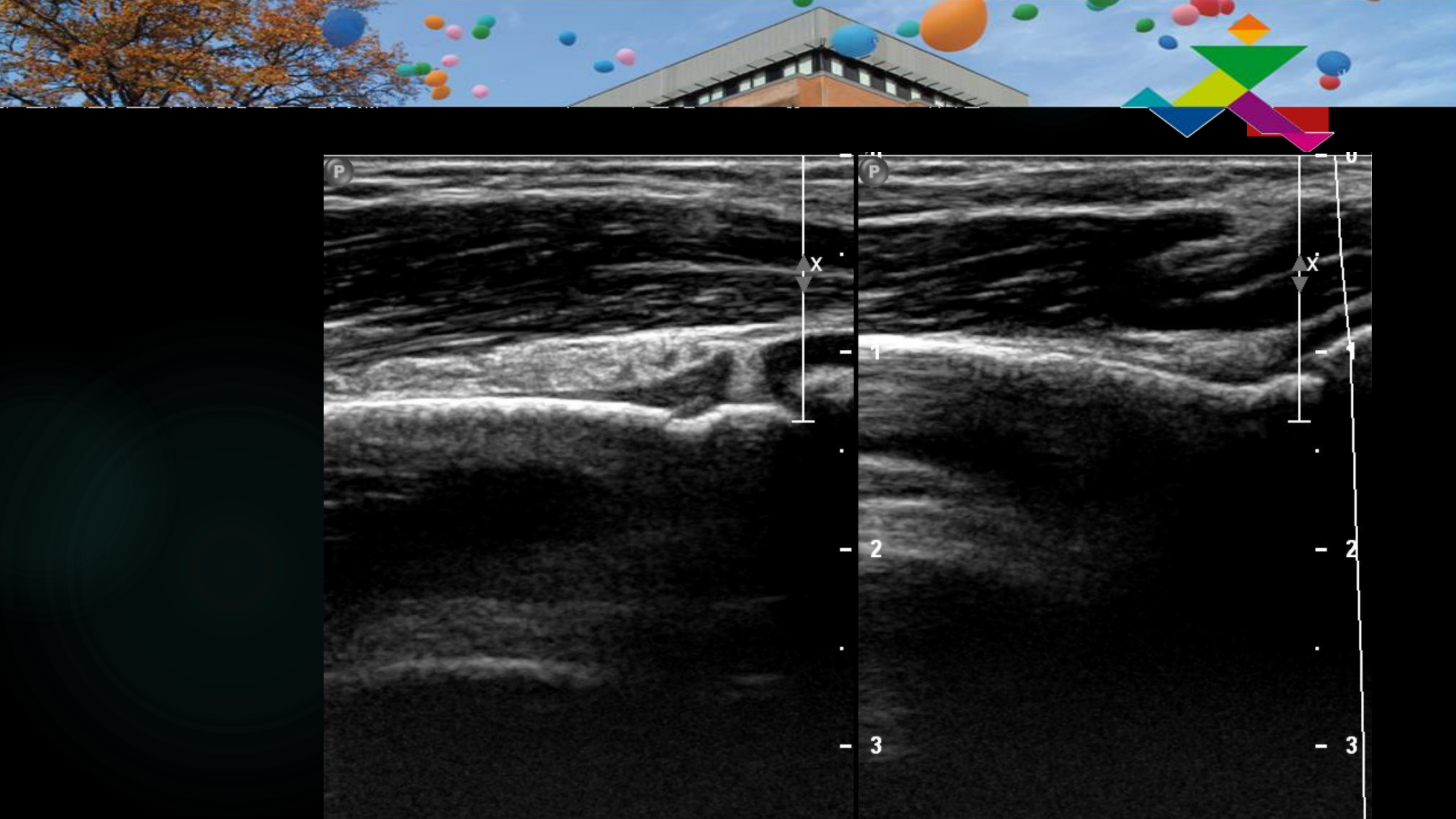
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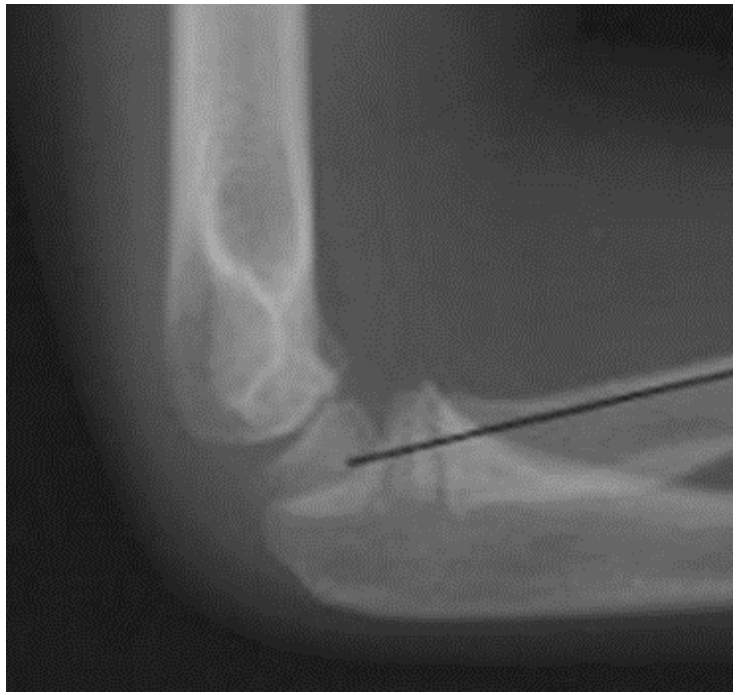
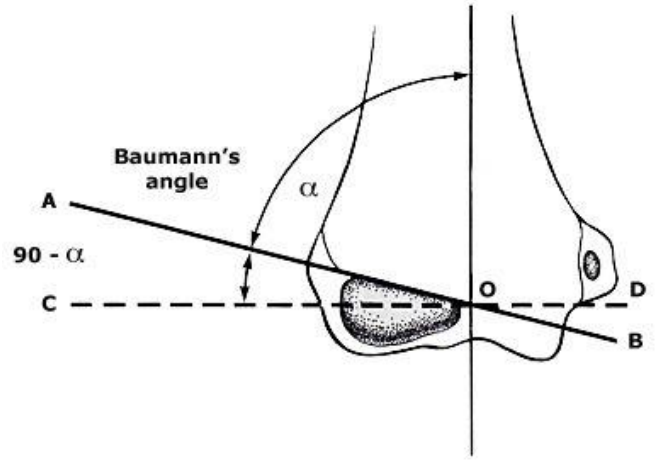
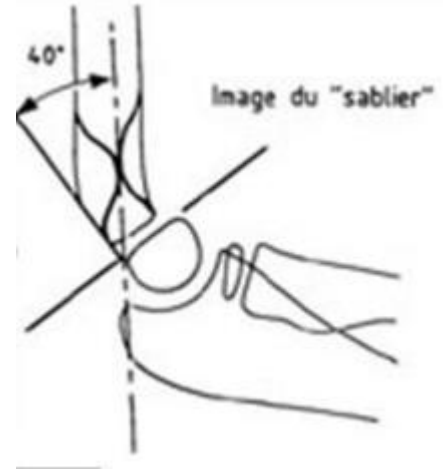
Capitellum : a endless dilemma

Baumann's Angle : coronal displacement

Humero-condyle angle : AP displacement







Elbow’s normal landmarks

Anterior humeral line:

- Extension of the anterior cortical humerus

usually passes through the middle third of the humeral condyle

Radius axis

- Must go through the capitellum
- If not, consider that it could be a luxation of the radial head (Monteggia’s Fracture)

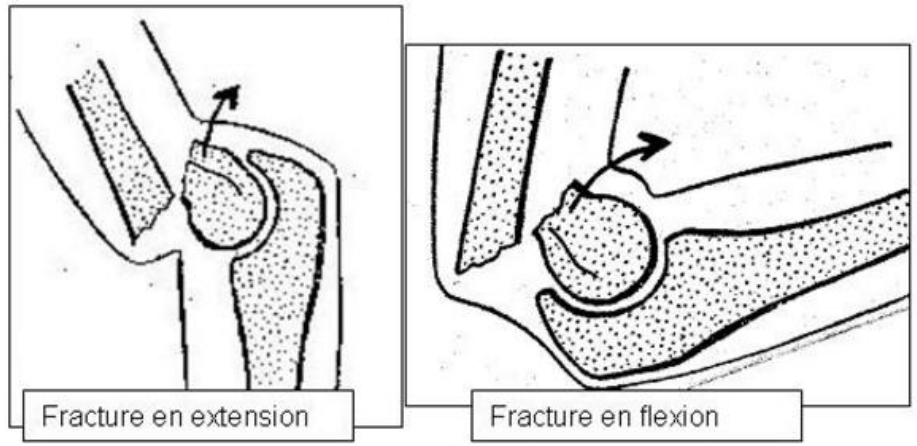
Elbow: supracondylar fracture: 60%

Age: peak 7 yrs

Mechanism: fall on the elbow

Extension (95%)

Flexion (5%)



Classification Lagrange et Rignault

Extention

Stade I: anterior break,non displaced

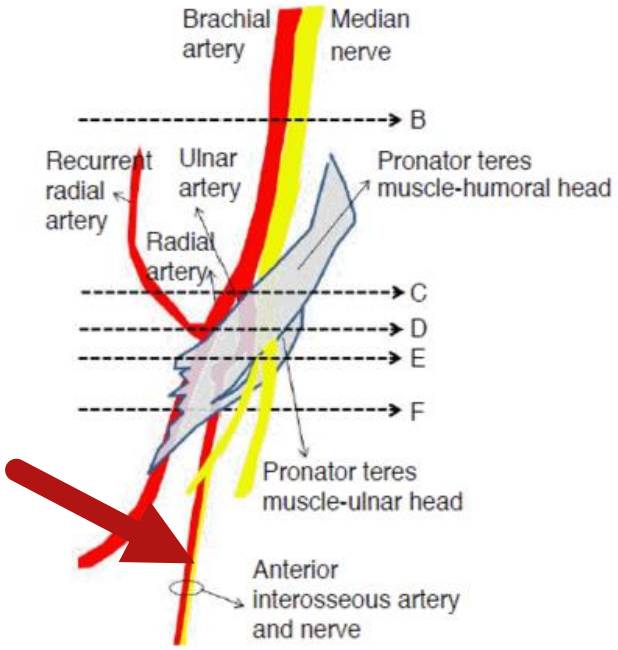
Stade II : anterior anterior break, displaced posterior periosteum intact

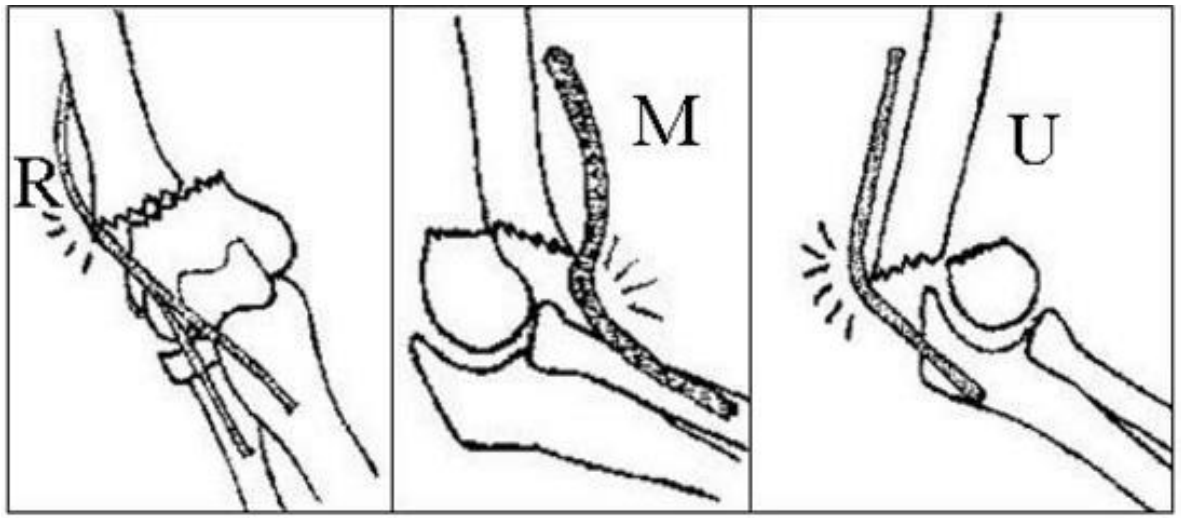
Stade III: Rotation or translation without

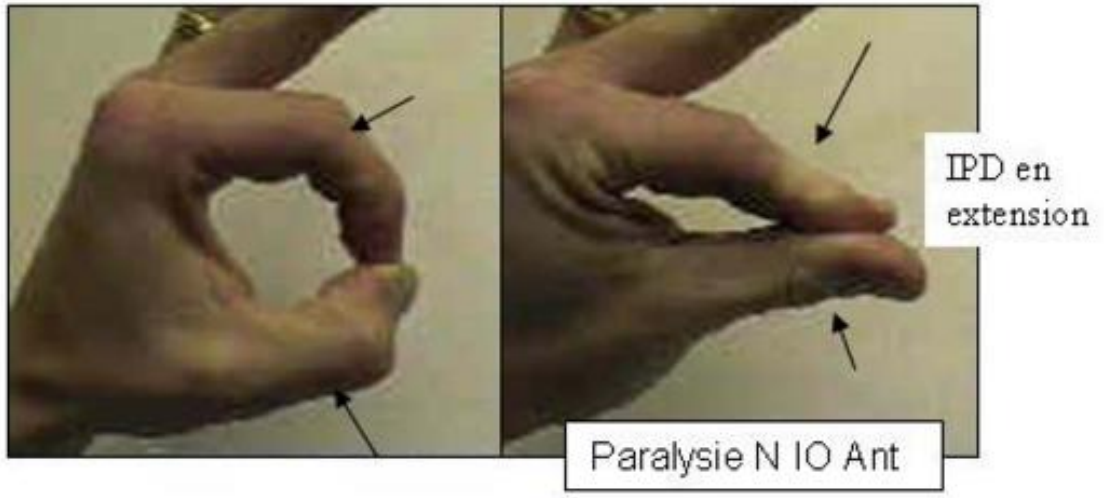
Elbow: supracondylar fracture (60% elbow fractures)

Rule out a nerve paralysis in displaced fractures.

AION is the most frequently injured nerve







Elbow: medial epicondyle fracture (10%)

Age: peak 7-15 yrs
Mechanism: fall on the outstreched hand with elbow in valgus

In 50% of patient postero-lateral luxation

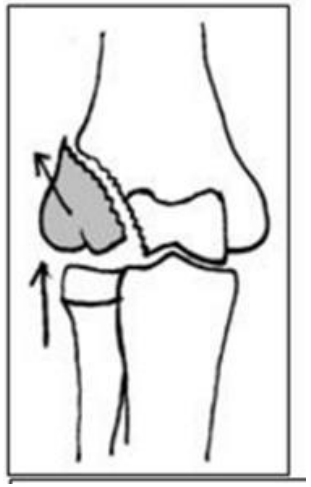
Classification Watson-Jones

Grade I: fragment non displaced or <5mm
GradeII: fragment dispaced > 5mm
Grade III: fragment incarcerated into the joint
Grade IV: luxation associated

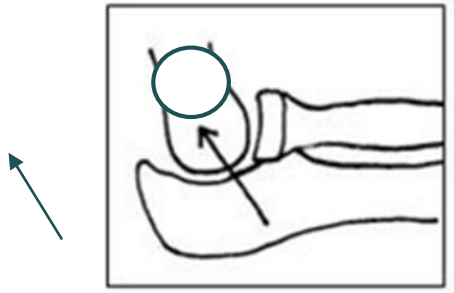
Elbow: medial epicondyle fracture (10%)

Elbow: lateral epicondyle fracture (10%)

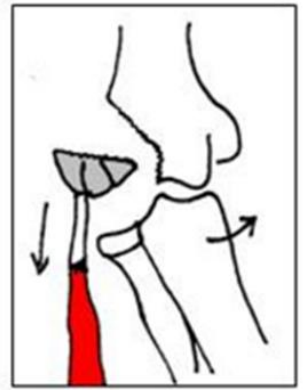
Age: 6-8 yrs



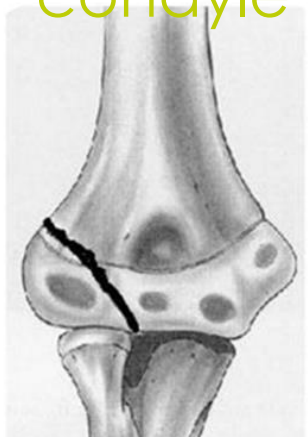
Compression and extension: radial head vs lateral condyle



Compression and flexion: olecranus vs lateral condyle

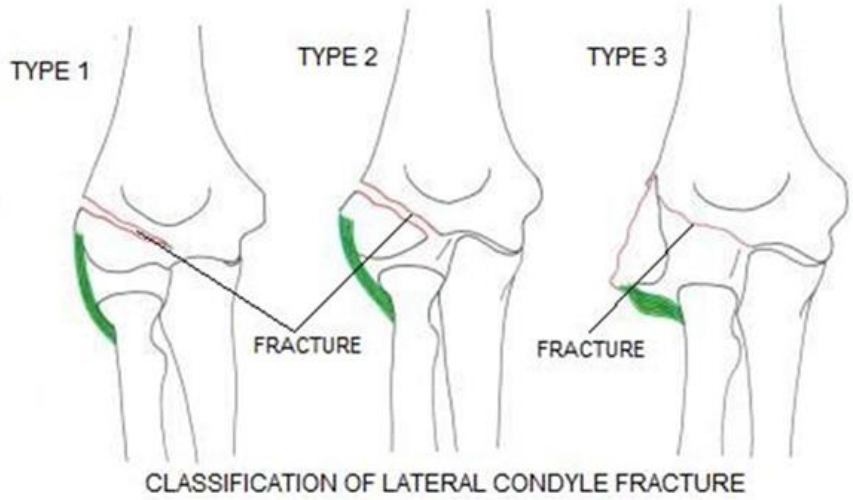


Traction in extension, **varus** and supination: **!Extensor muscles!**

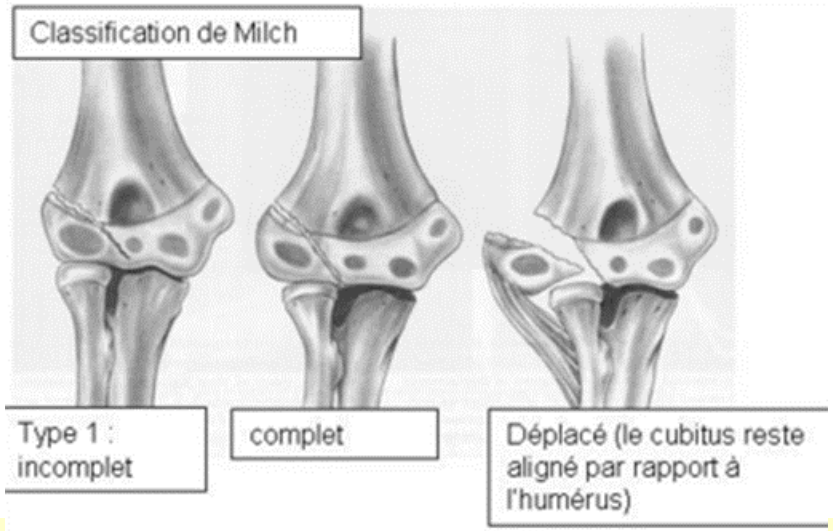


It is a Salter IV

Elbow: lateral epicondyle fracture (10%)



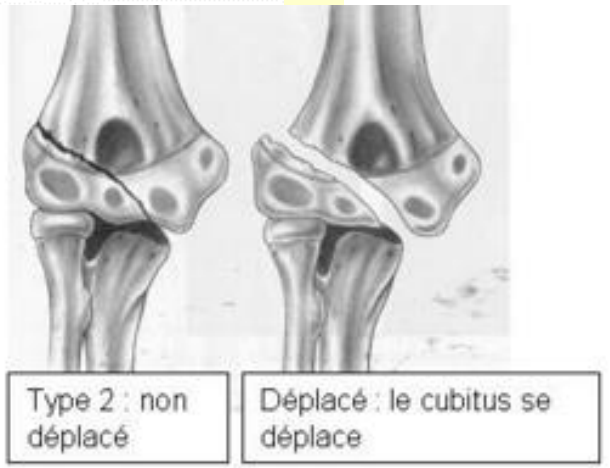
CLASSIFICATION OF LATERAL CONDYLE FRACTURE



2) de Milch

-type 1: Lateral to the throclear gro
Incomplete/complete

-type 2: Medial to the throclear gro
Incomplete/complete



Elbow: radial neck (10 % elbow fractures)

Age: peak 4-15 yrs

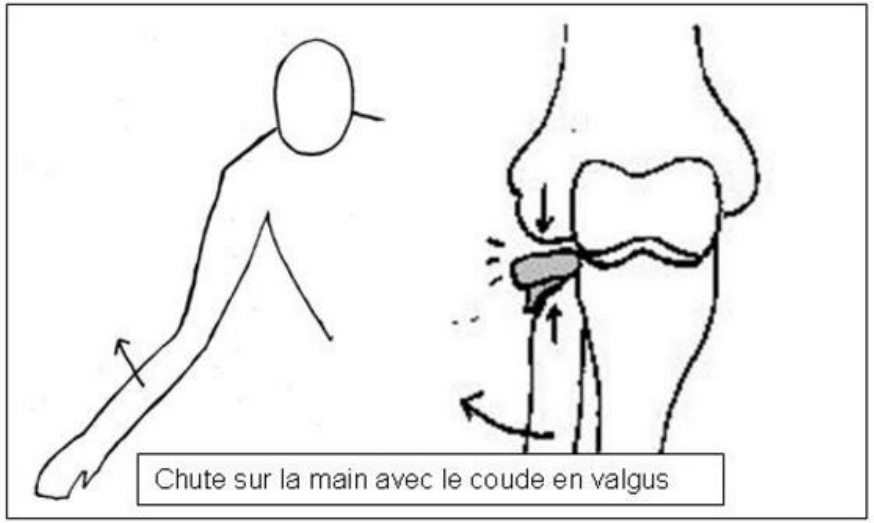
Mechanism:

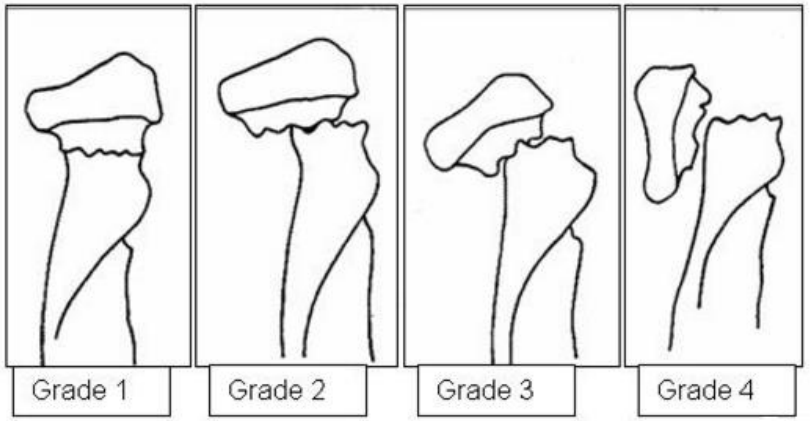
High energy trauma fall on the outstreched hand with elbow in valgus

In 50% of patient postero-lateral luxation

Judet's classification :

-grade 1: non diplaced
-grade 2: laterally diplaced < 50%, angulation < 30°
-grade 3: angulation >30°, <60°
-grade 4 : angulation >60°





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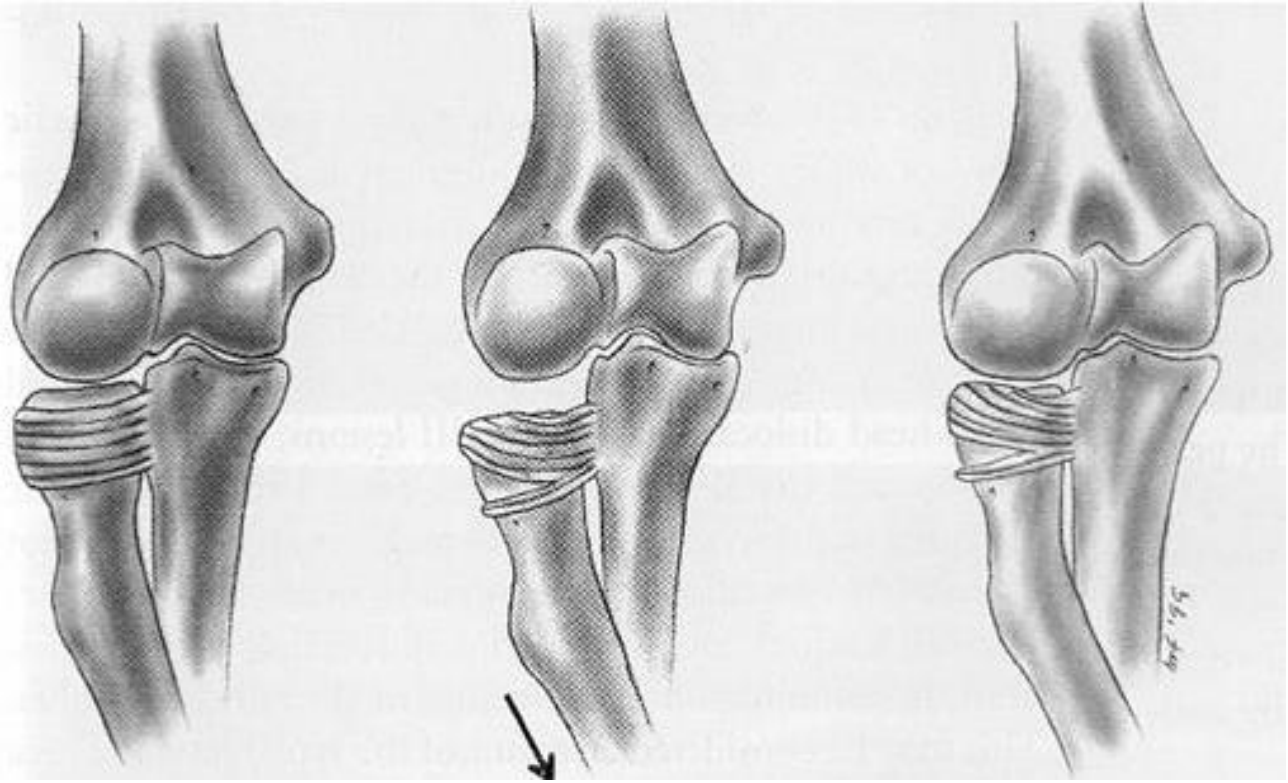
« Nursemaid’s elbow », « pulled elbow » » »



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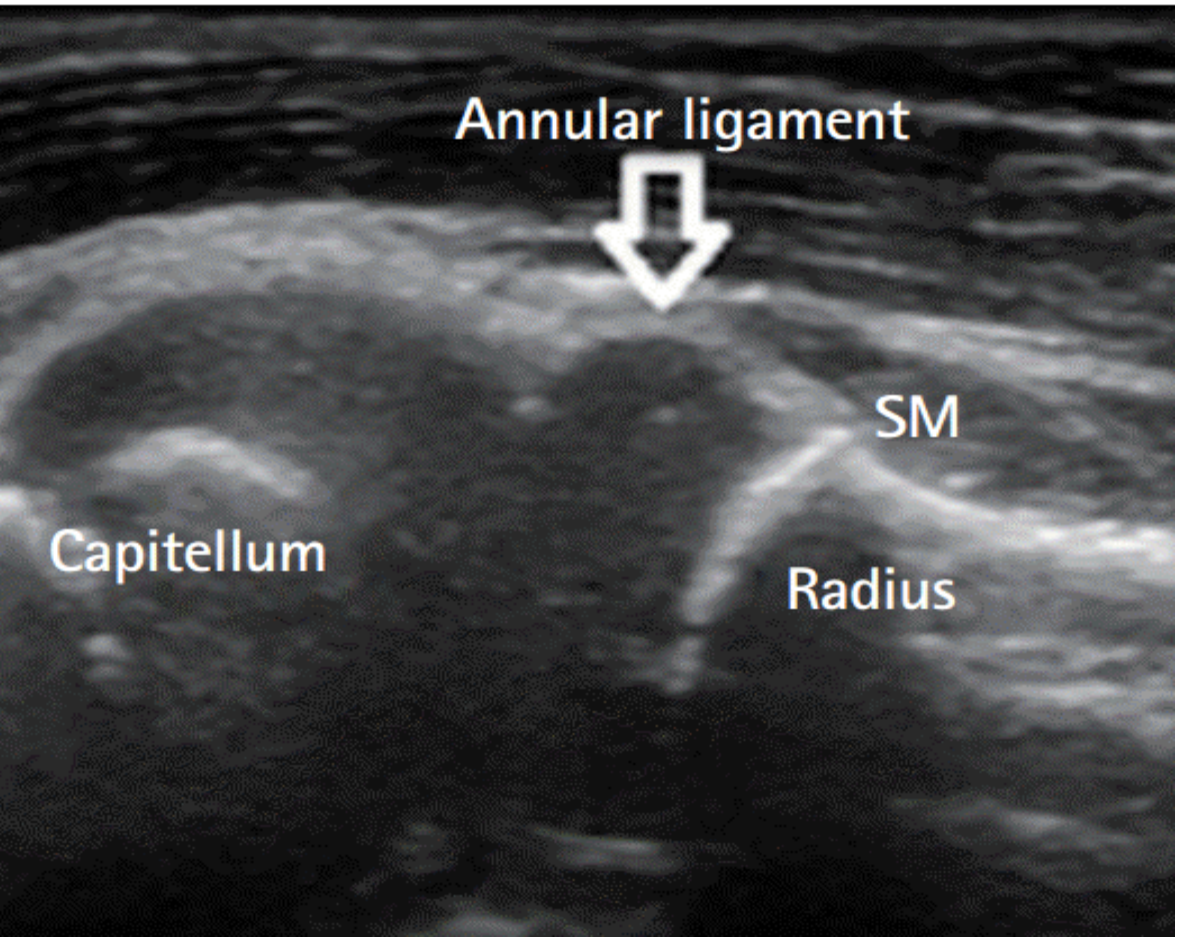
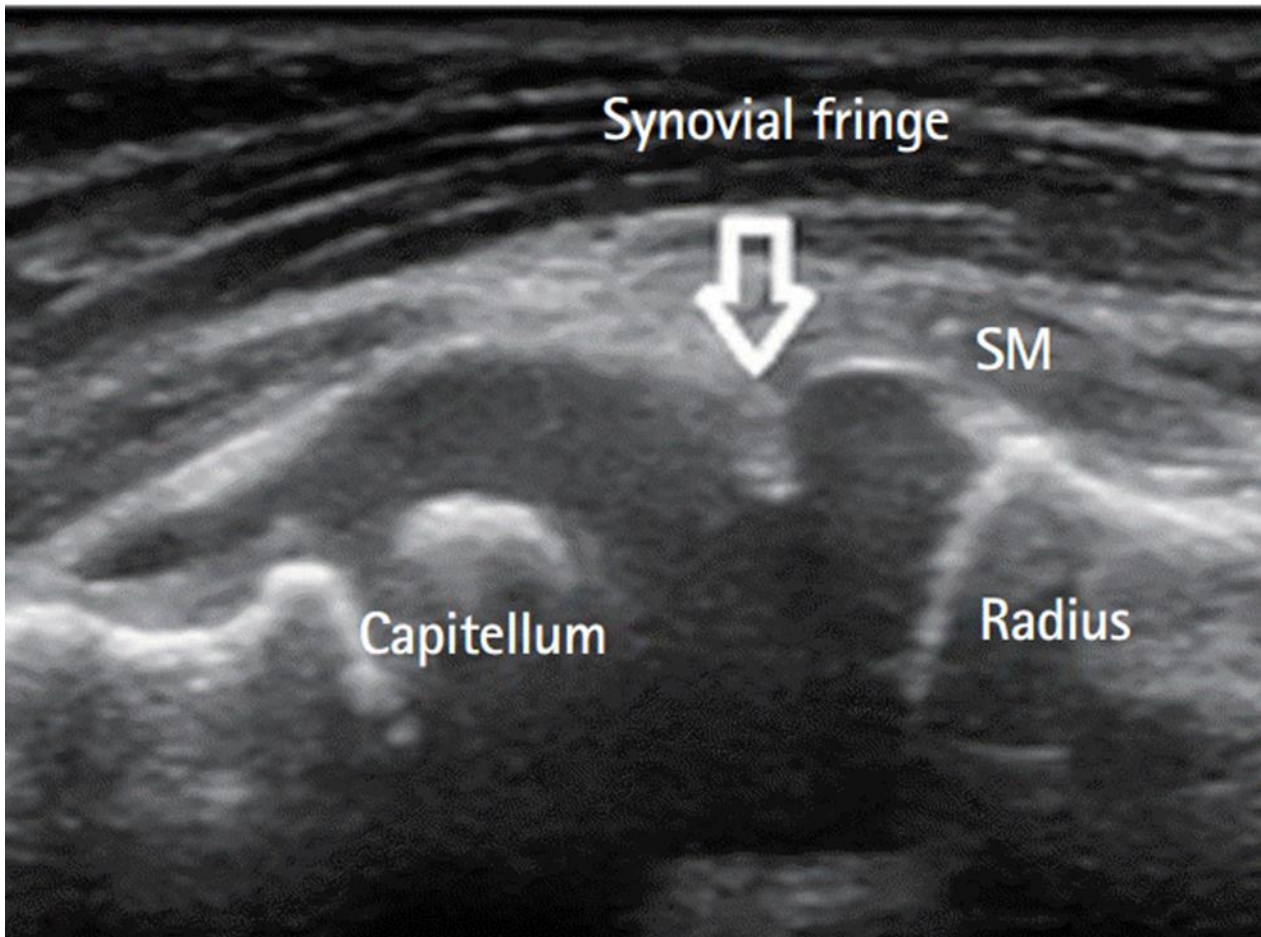
« Nursemaid’s elbow » or « pulled elbow »





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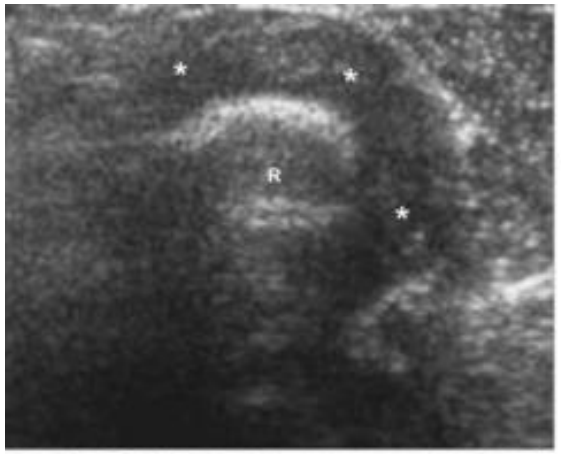
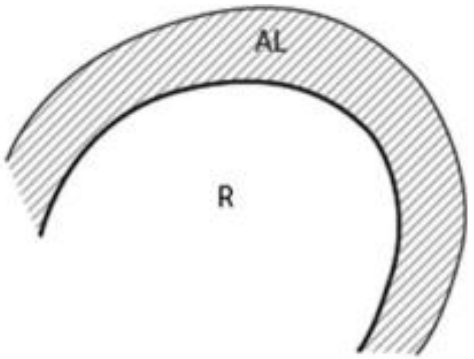
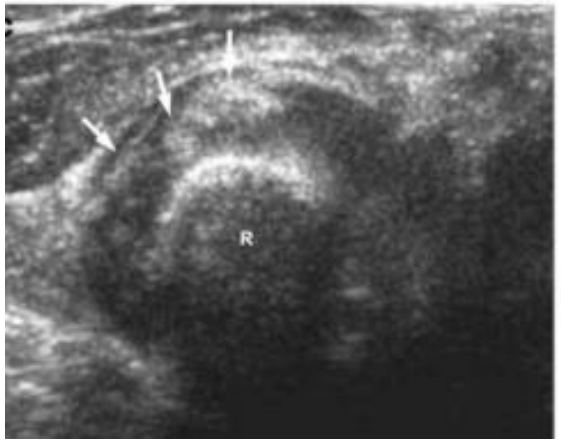
«Nursemaid’s elbow » or « pulled elbow »: US axial view







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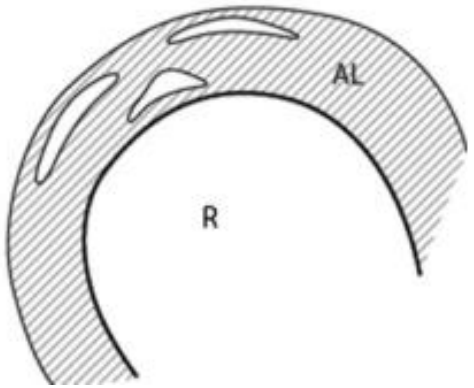

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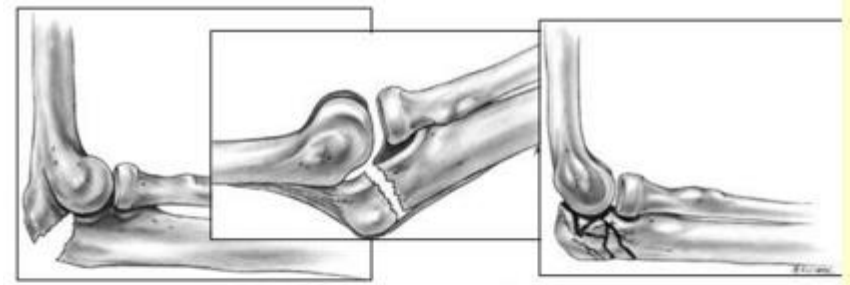
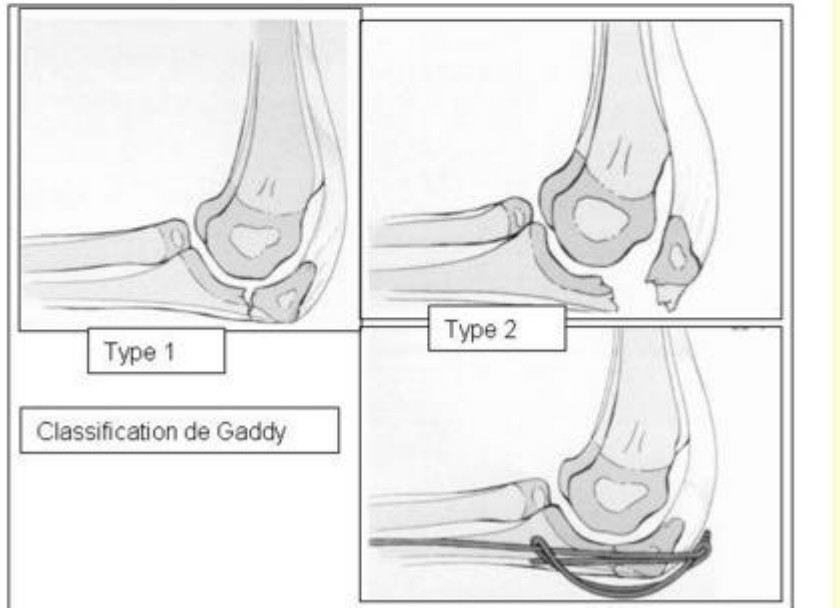
Elbow: olecranon (5%)





Elbow: luxation (3%)

Age: 4-15 yrs

Mechanism:
Fall on the outstreched hand

Posterior
more frequent

Divergent:
Proximal radio-ulnar joint injured

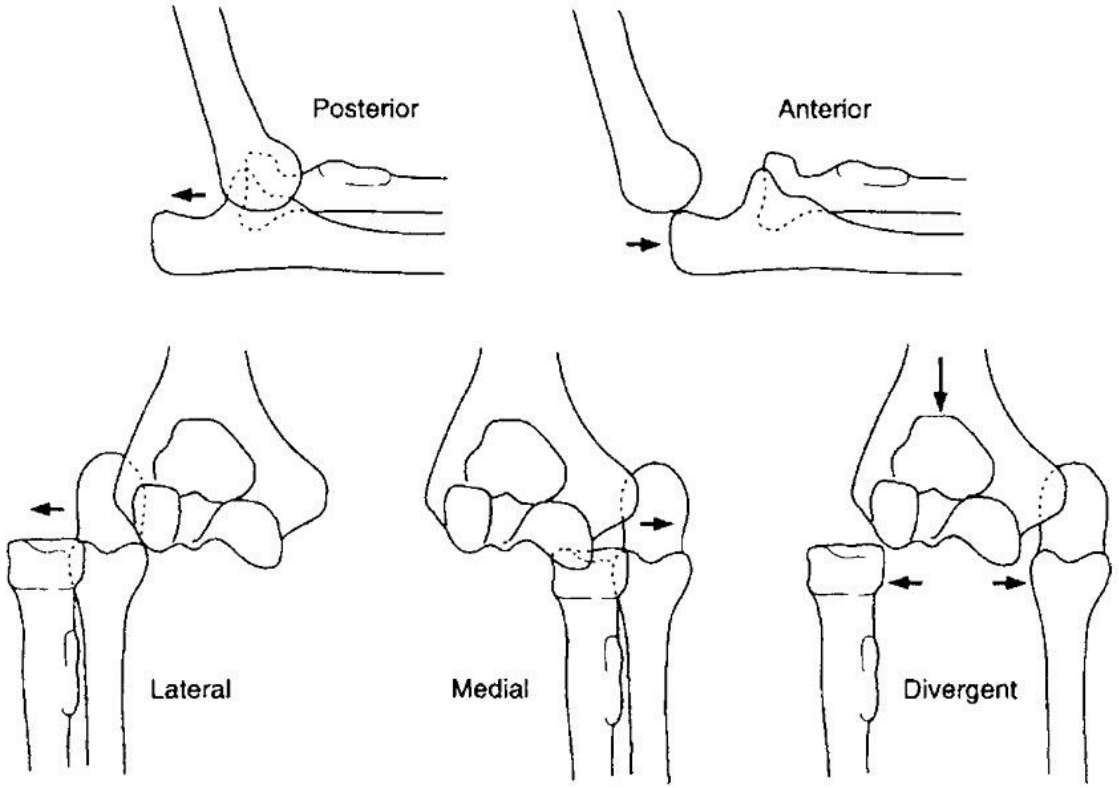
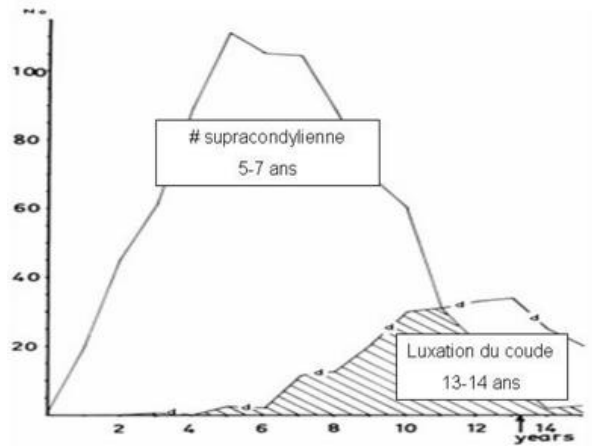
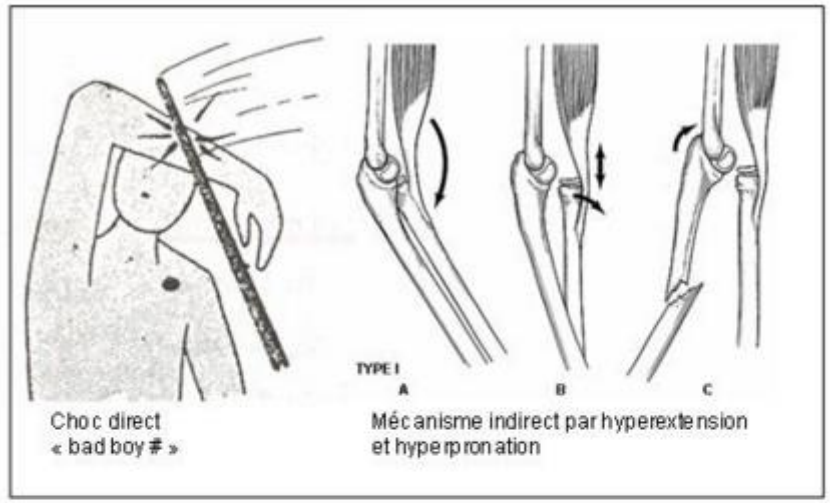


Fig. 13(b). Classification of elbow dislocations.
(Reproduced with permission from Bruce, D., Browner, B. D., Jupiter, J. B., Levine, A. M. & Trafton, P. G. *Skeletal Trauma. Fractures, Dislocations and Ligamentous Injuries*, vol. 2. Philadelphia: Saunders, 1992.)



Monteggia's fracture



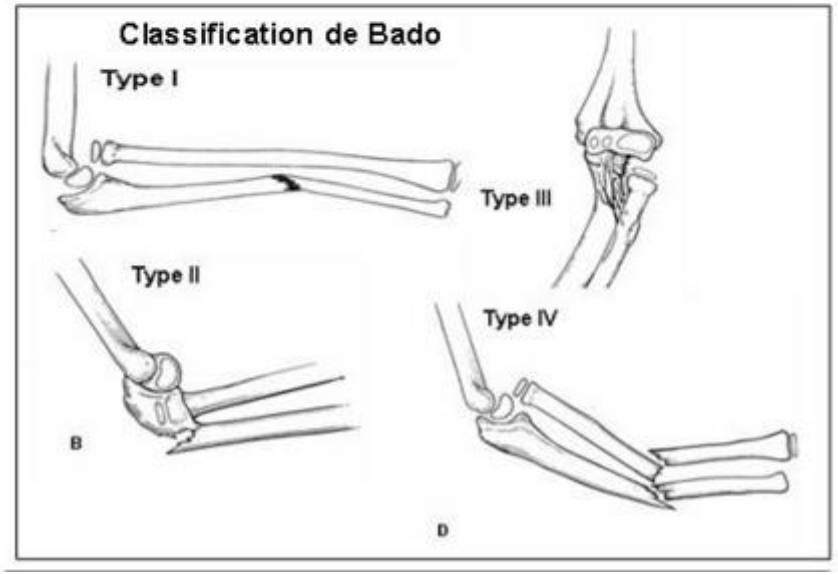
Classification de Bado

-**Type 1** (+++ 65%) extension: **anterieur** luxation of radial head + # ulna diaphysis

-**Type 2**: flexion : **posterior** luxation + # 1/3 sup ou 1/3 moy ulna

-**Type 3:** adduction: **external** luxation + # proximale ulna metaphysis

-**Type 4:** type 1 + # middle 1/3 radial diaphysis **(double fracture)**



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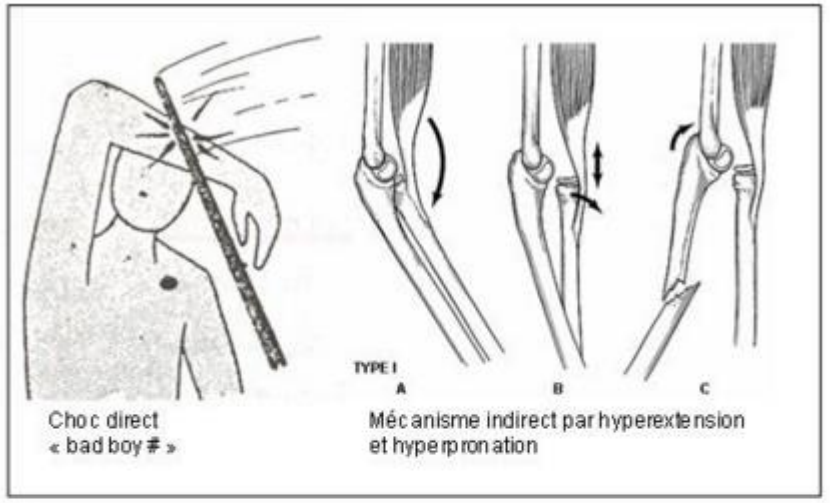
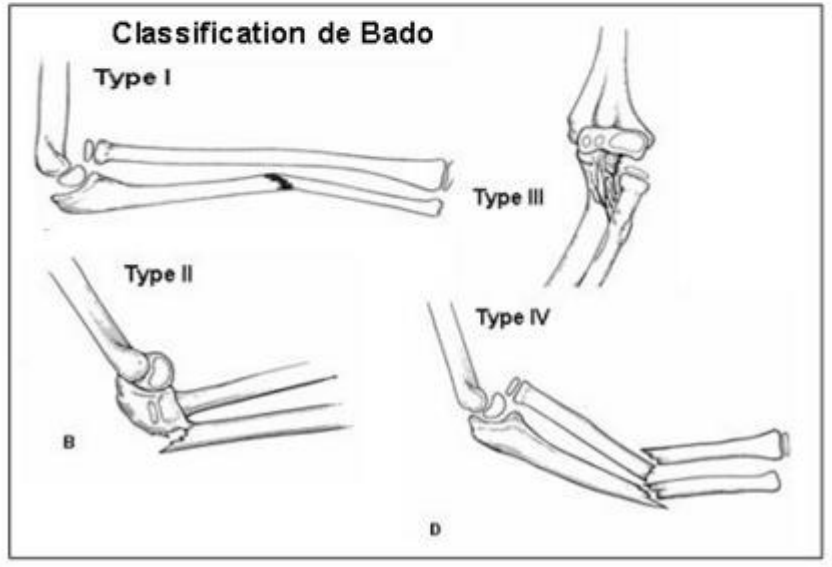
Monteggia’s fracture





Forearm fracture

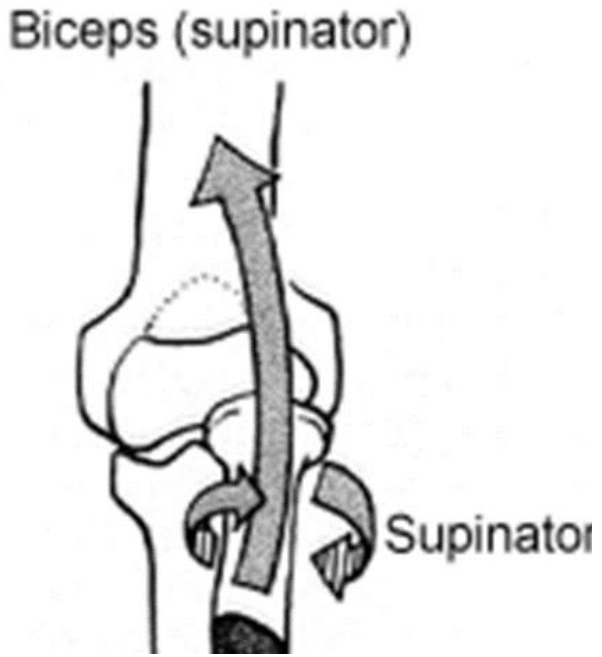
Mecanism:

-Fall on outstreched end

-Rarely, direct trauma

Biomechanics : rule of thumb

The pronator quadratus (distally) and pronator teres (inserting on the middle portion of the radius) actively pronate the forearm, while the biceps and supinator (proximal insertions) provide



Galeazzi's fracture (2.8%)

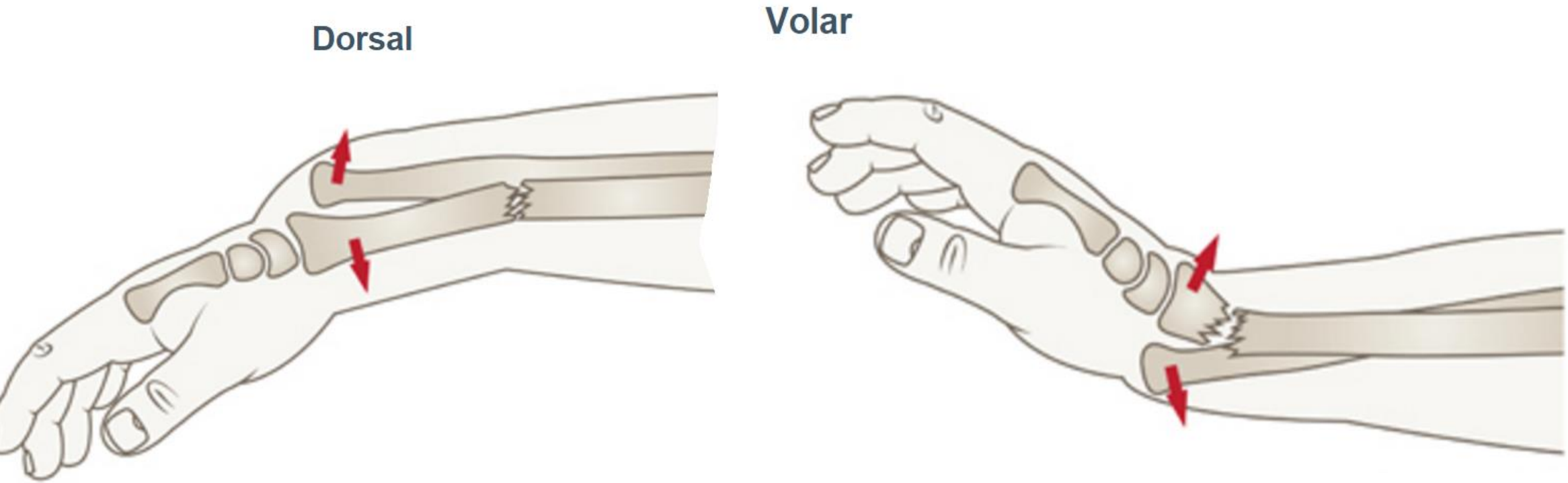
Age: peak 9-13 yrs
« Necessity fracture» in adults but conservative treatment in chidren

Mechanism:
Fall on outstreched hand in hyperpronation

!Consider injury **of DRUJ**

-

Galeazzi’s fracture

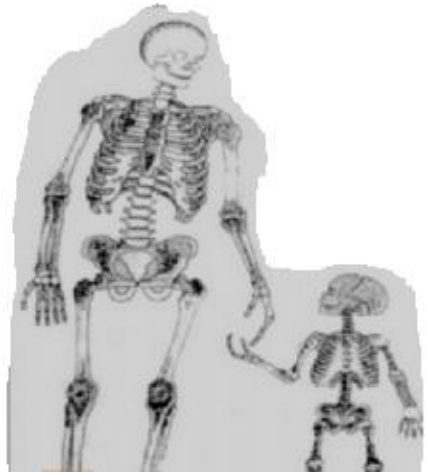


Take home messages

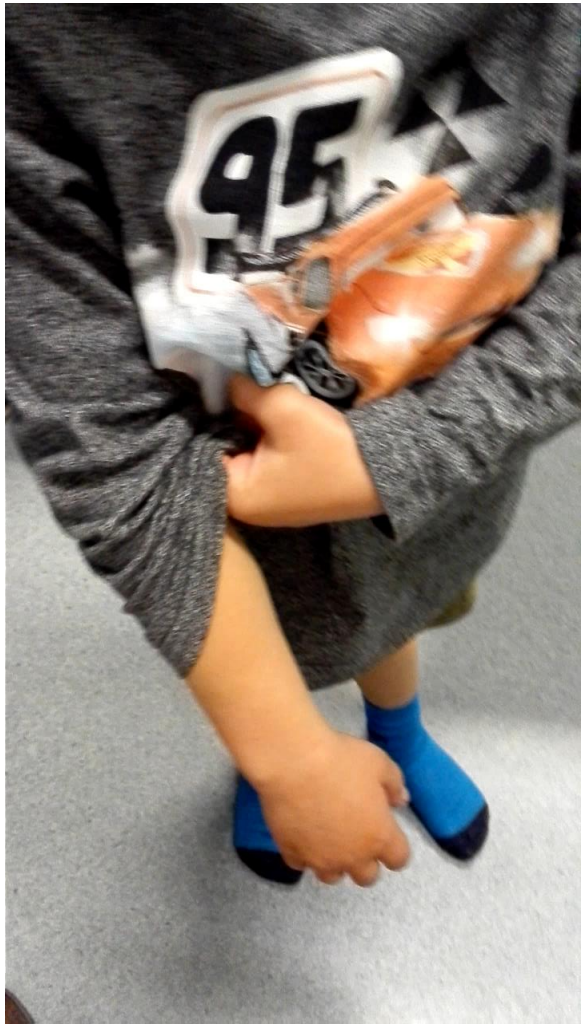
- Periosteum is thick and strong in children but is very flexible and it can buldge or bow
- Bone is more elastic/plastic in children .
- Consider incomplete fracture in children
- Always rule out Salter-Harris Fracture: look at the growth plate and around it
- Consider that multiple SOC can appear in the epiphysis during bone growth before diagnose an epiphyseal fracture.
- Compare to the opposite side in case of doubt

Children's MSK system is different in many ways.

….Think different when facing a upper limb trauma in kids…..



Ask the kid if you are right!



THANK YOU FOR YOUR ATTENTION

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Universitair Kinderziekenhuis
Koningin Fabiola

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