Common Pediatric Fractures & Trauma

Dr.Kholoud Al-Zain

Assistant Professor

Consultant, Pediatric Orthopedic Surgeon

Jan 2021

Acknowledgement:

Dr.Khalid Bakarman

Prof. M. Zamzam

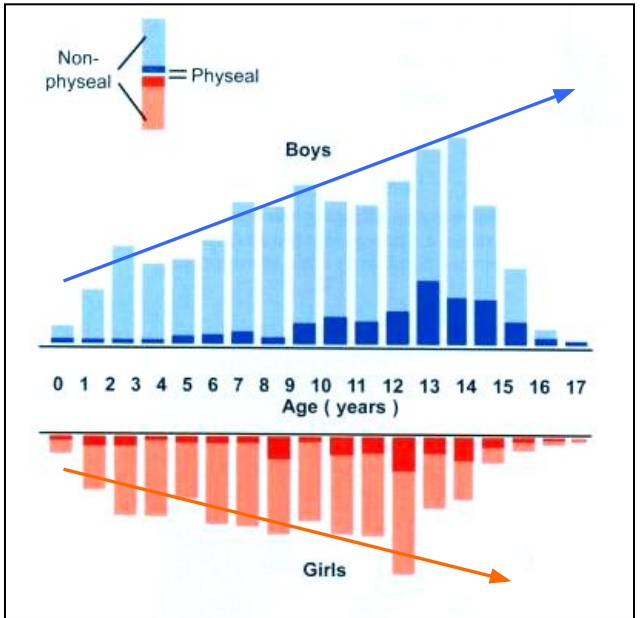
Objectives

- Introduction
- Difference between Ped & adult
- Physis # □ Salter-Harris classification
- Indications of operative treatment
- Methods of treatment of Ped # & trauma
- Common Ped #:
  - U.L □ clavicle, humeral supracondylar, distal radius
  - L.L □ femur shaft
- Example

Pediatric Fractures

Introduction

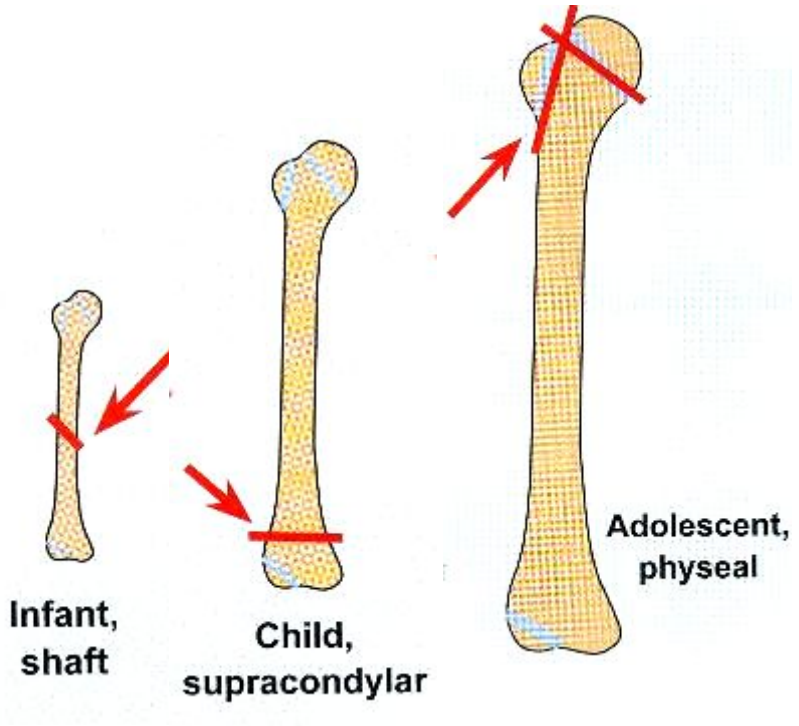
- Fractures account for ~15% of all injuries in children
- Boys > girls
- Rate increases with age
- Type of fractures vary in various age groups (infants, children, adolescents)



Mizulta, 1987

Why are Children's Fractures Different ?

- Age related fracture pattern:
  - Infants □ diaphyseal #
  - Children □ metaphyseal #
  - Adolescents □ epiphyseal



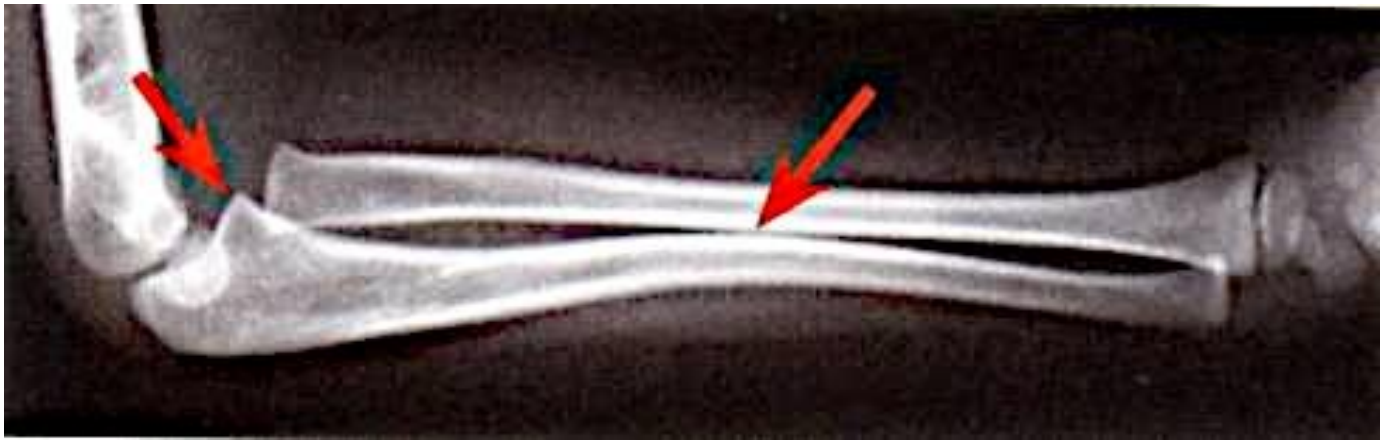
Difference Between A Child & Adult's Fractures

Why are Children's Fractures Different ?

- Anatomy Growth Plate:
  - Perfect remodeling power
  - Injury of growth plate may cause:
    - Angular deformity
    - Or over growth "Leg Length Inequality" (L.L.I)

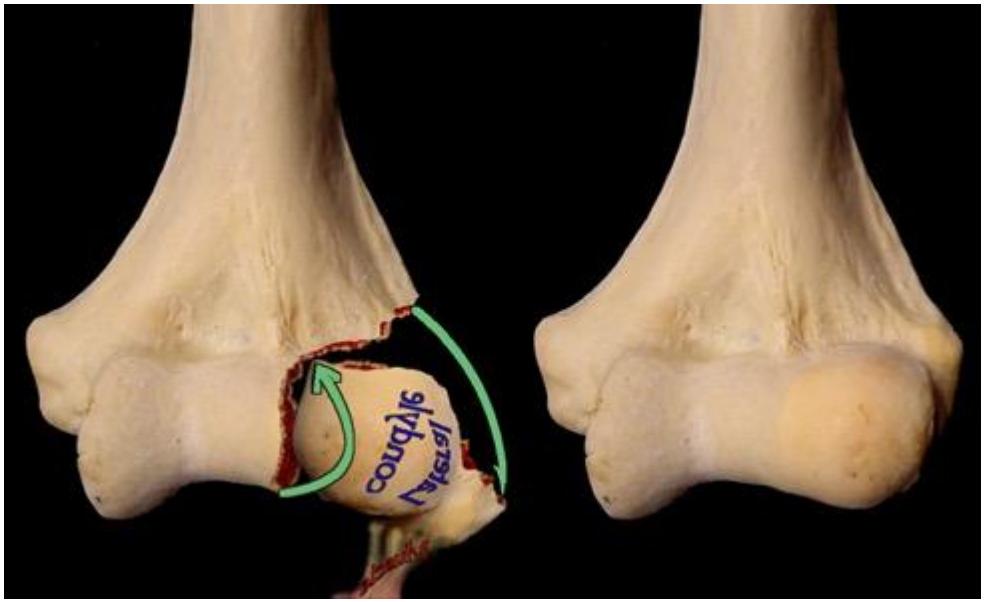
Why are Children's Fractures Different ?

- Anatomy Bone:
  - Increased (collagen : bone) ratio
    - Less brittle
    - Deformation



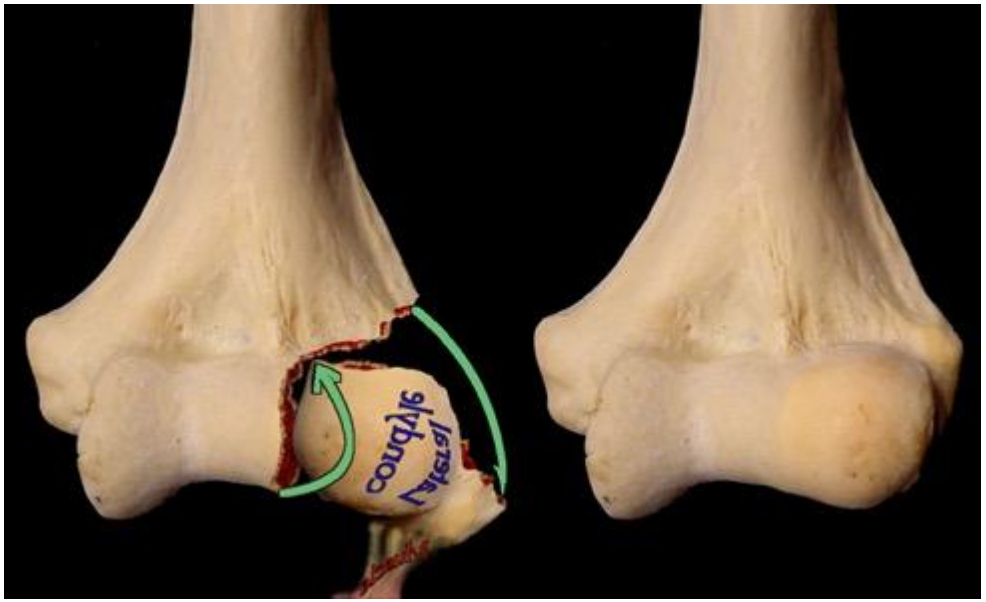
Why are Children's Fractures Different ?

- Anatomy Cartilage:
  - Difficult X-ray evaluation
  - Size of articular fragment often under-estimated



Why are Children's Fractures Different ?

- Anatomy Cartilage:
  - Difficult X-ray evaluation
  - Size of articular fragment often under-estimated

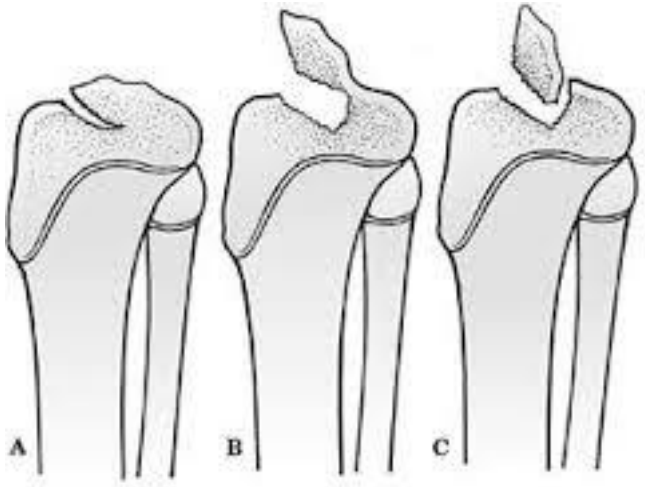


Why are Children's Fractures Different ?

- Anatomy Periosteum:
  - Metabolically active
    - More callus, rapid union, increased remodeling
  - Thickness and strength
    - Intact periosteal hinge affects fracture pattern
    - May aid reduction

Why are Children's Fractures Different ?

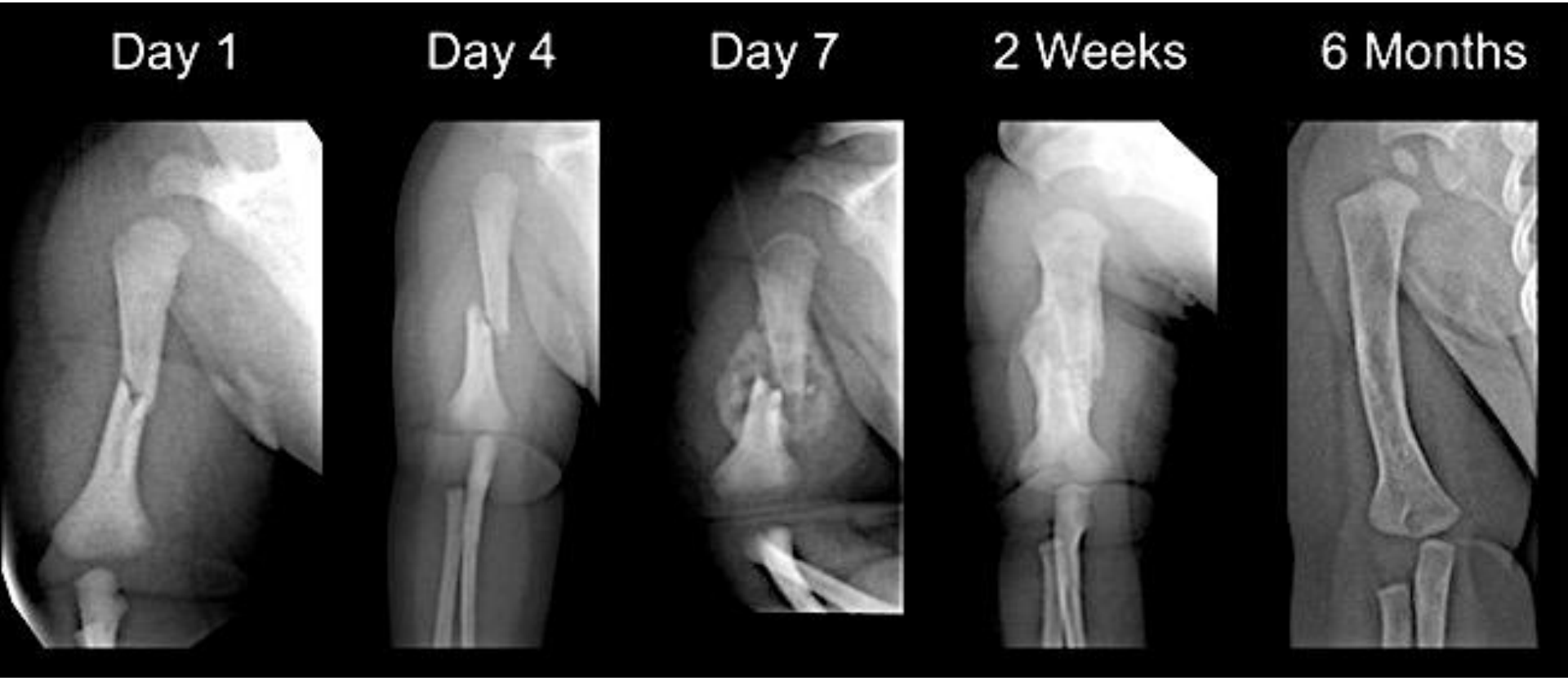
- Anatomy Ligaments:
  - Functionally stronger than bone.
  - Higher proportion of injuries that produce sprains in adults result in fractures in children.

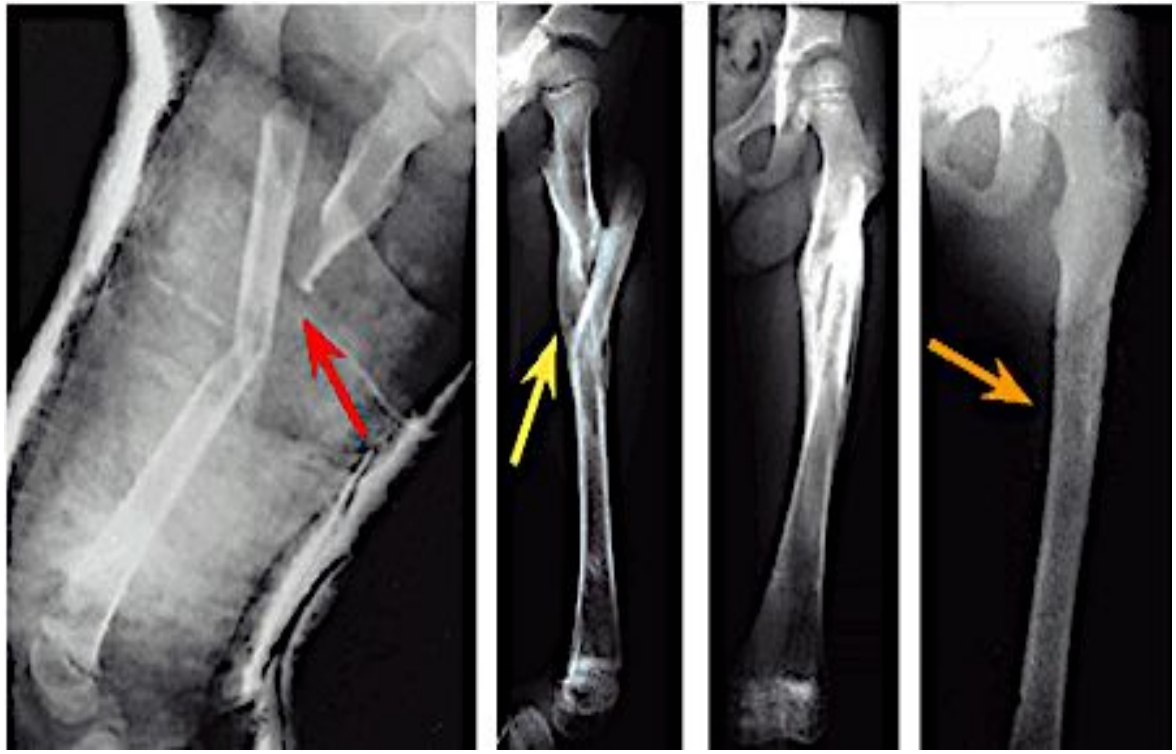


Why are Children's Fractures Different ?

- Physiology
  - Better blood supply rare delayed and non-union

Remodeling






1
2
15

Humerus Fracture Remodeling




Physis Fractures

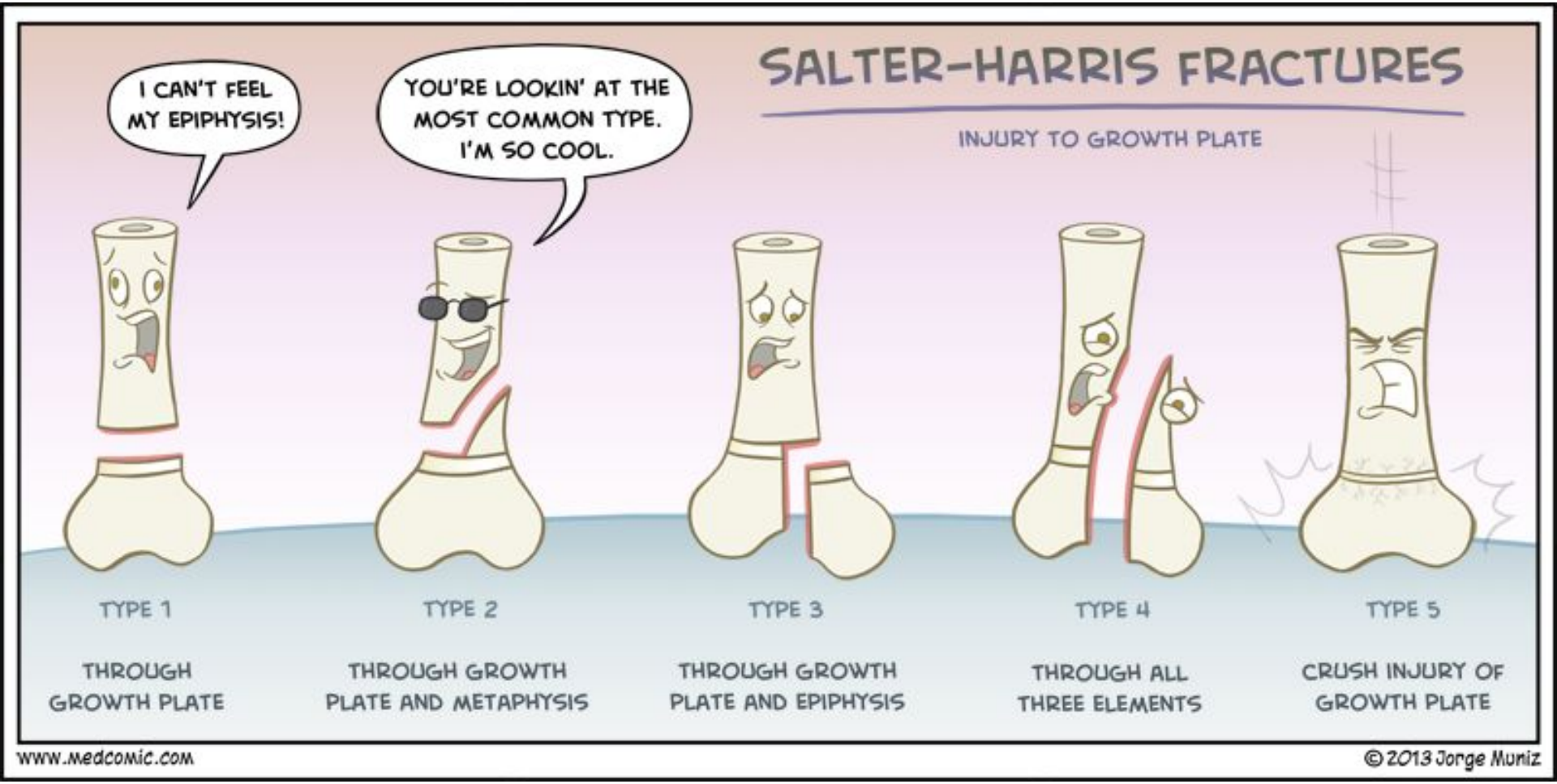
Physis Injuries

- Account for ~25% of all children's #
- More in boys
- More in upper limb
- Most heal well rapidly with good remodeling
- Growth may be affected

Physis Injuries- Classifications

Salter-Harris

Salter-Harris Classification



Salter-Harris Classification

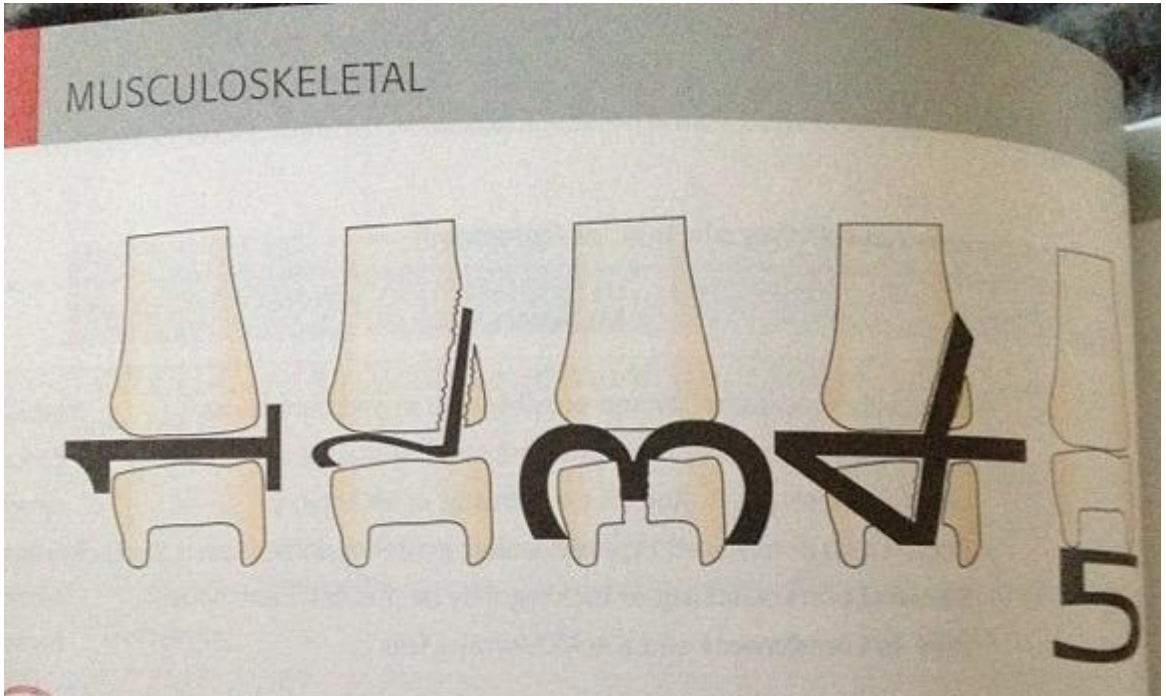


FIGURE 11-7. Mnemonic for Salter-Harris fractures. Imagine the number of the type drawn through the epiphyseal plate. Type 1 is a fracture of the growth plate (physis). Type 2 is a metaphyseal fracture. Type 3 is an epiphyseal fracture. Type 4 goes through both. This mnemonic doesn't work well for type 5, so you just have to remember it is a crush injury of the physis.

Temporal Arteritis (Giant Cell Arteritis)

Physis Injuries- Complications

- Physeal bridging < 1%
- Cause affecting growth (varus, valgus, or even L.L.I)
- Keep in mind:
  - Small bridges (<10%) may lyse spontaneously
  - Central bridges more likely to lyse
  - Peripheral bridges more likely to cause deformity

Physis Injuries- Complications

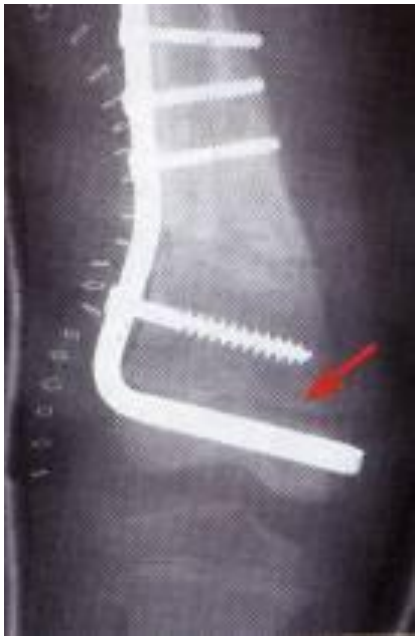
- Peripheral bridges more likely to cause deformity

Physis Injuries- Complications

- Peripheral bridges more likely to cause deformity

Physis Injuries- Complications

- Take care with:
  - Avoid injury to physis during fixation
  - Monitor growth over a long period (18-24 m)
  - When suspecting physeal bar do MRI



Indications of Operative Treatment

General Management

Indications for surgery

- Open fractures
- Severe soft-tissue injury
- Fractures with vascular injury
- Compartment syndrome
- Multiple injuries
- Displaced intra articular fractures (Salter-Harris III-IV)
- Failure of conservative means (irreducible or unstable #'s)
- Malunion and delayed union
- Adolescence
- Head injury
- Neurological disorder
- Uncooperative patient

Methods of Treatment of Pediatric Fractures & Trauma

1) Casting still the commonest

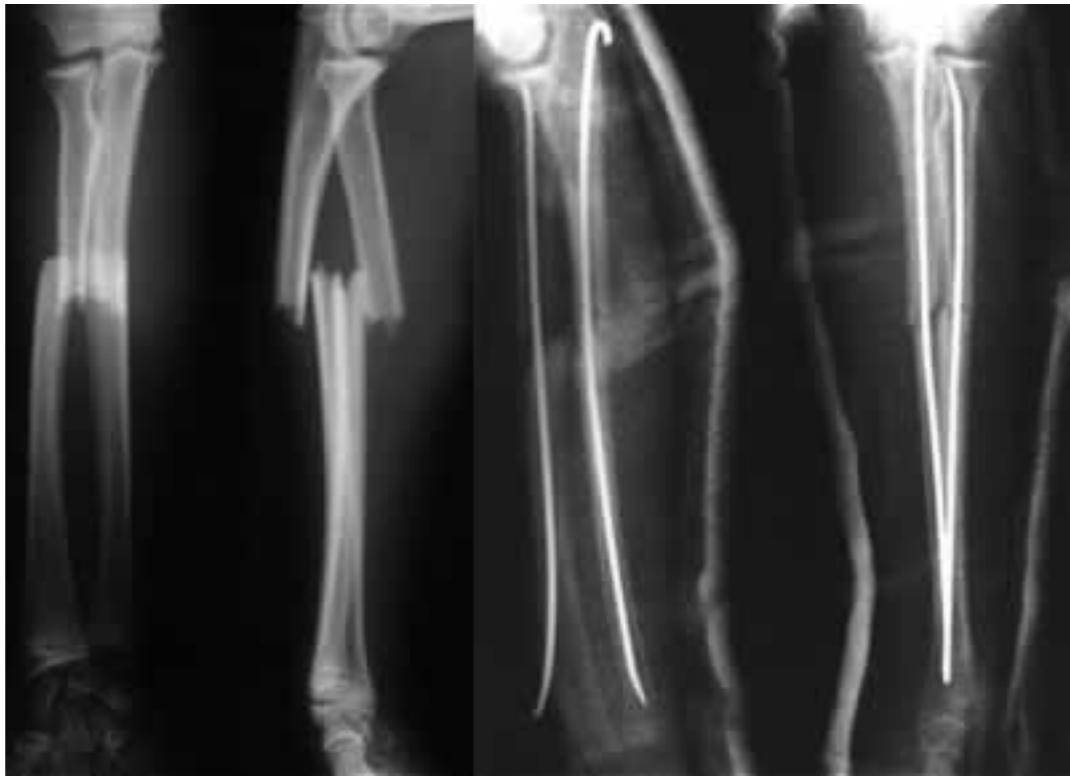
1) Casting still the commonest

1) Casting □ still the commonest

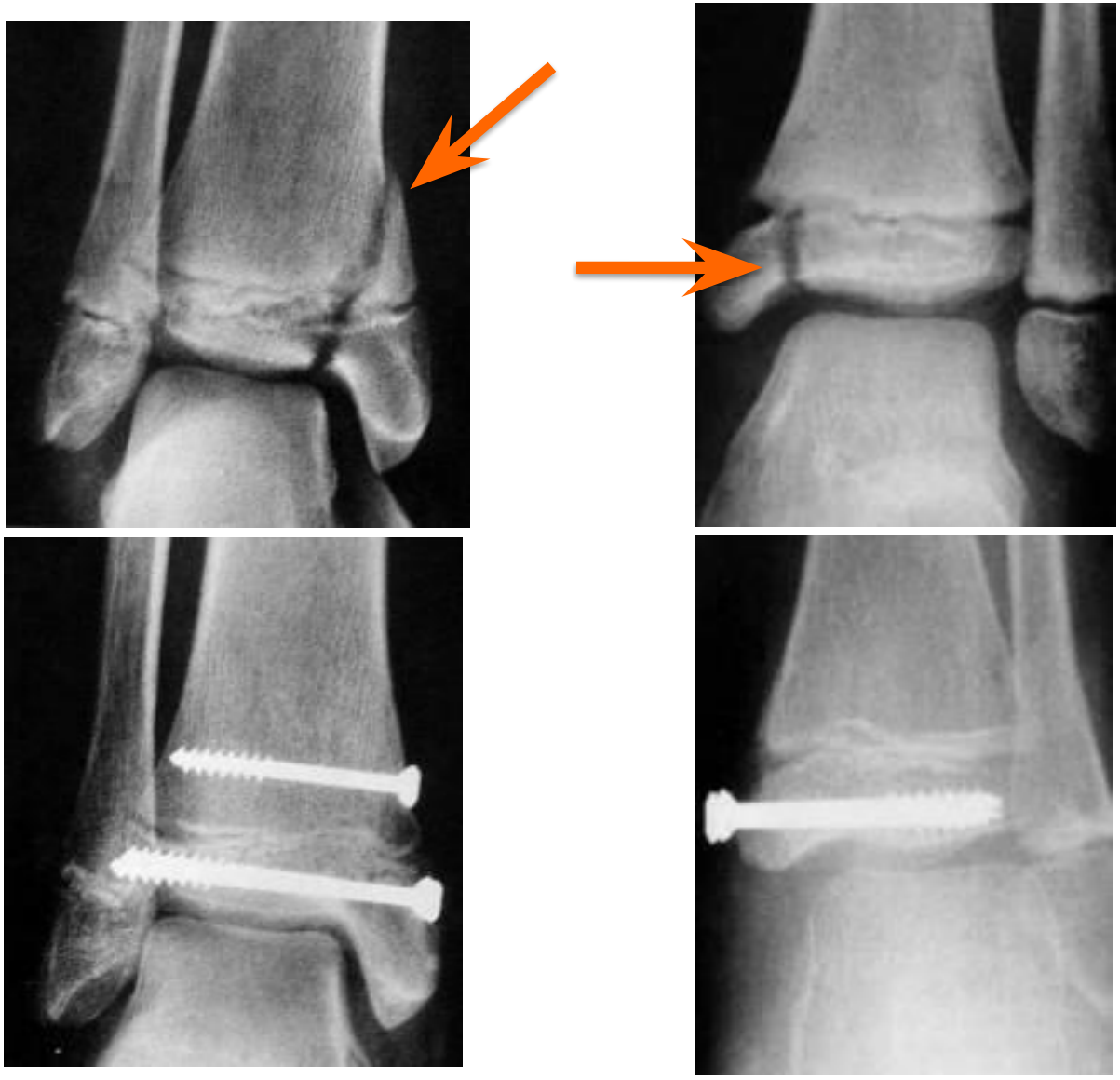
2) K-wires

- Most commonly used internal fixation (I.F)
- Usually used in metaphyseal fractures

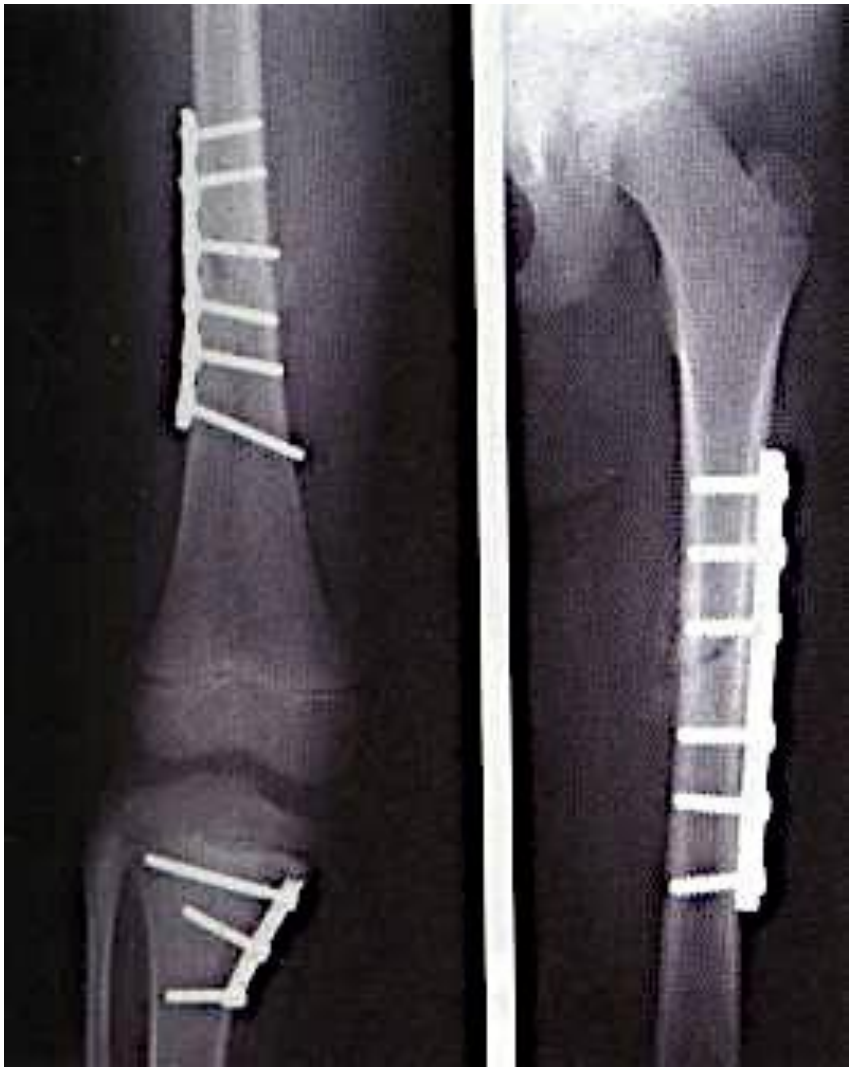
3) Intramedullary wires (Elastic nails)



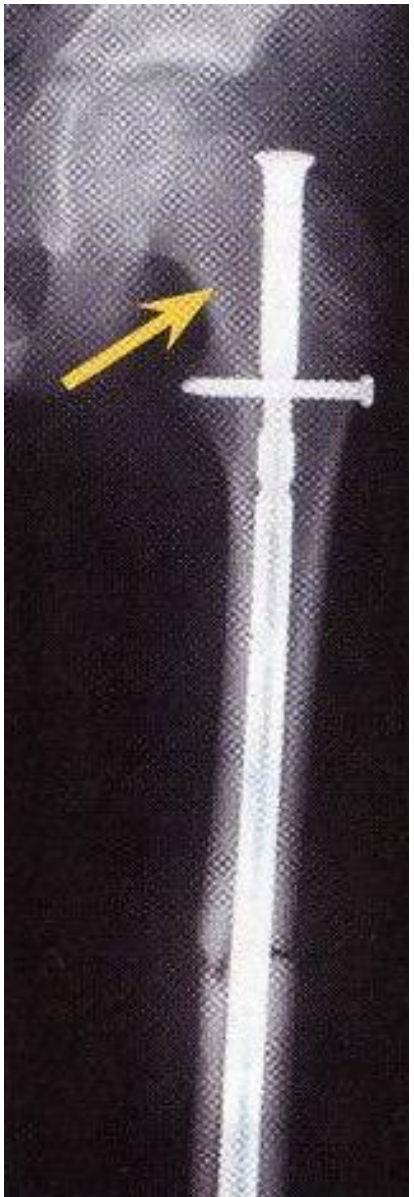
4) Screws



5) Plates specially in multiple trauma



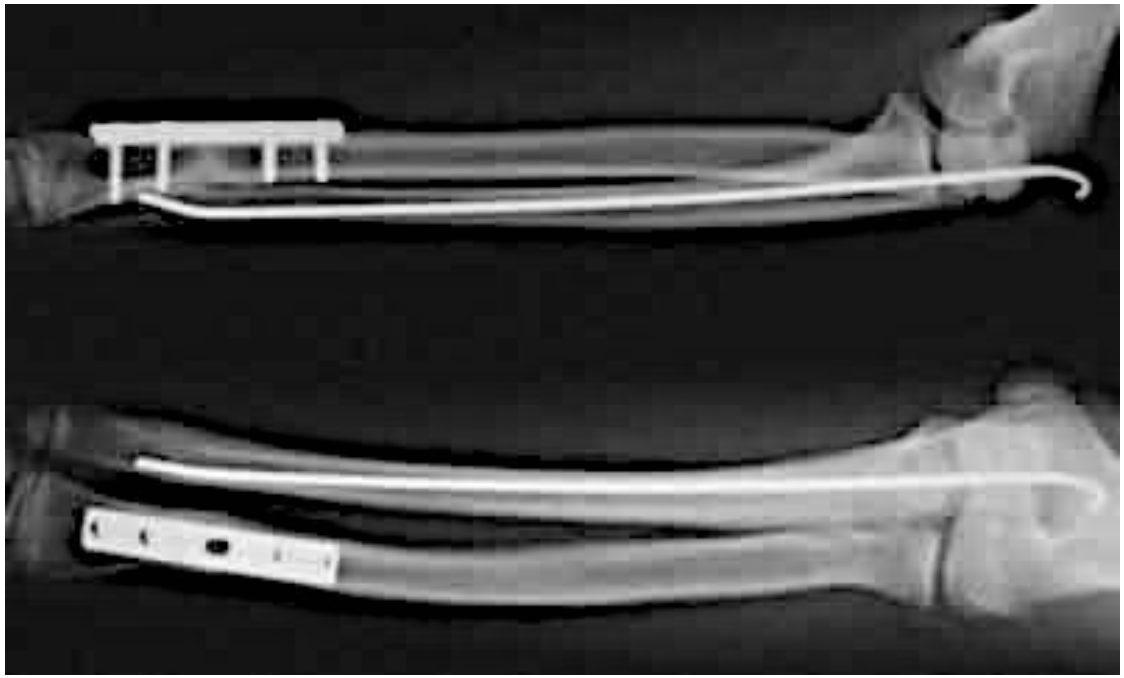
6) I.M.N □ only in adolescents (>12y)



7) Ex-fix usually in open

Methods of Fixation

Combination



Common Pediatric Fractures

Common Pediatric Fractures

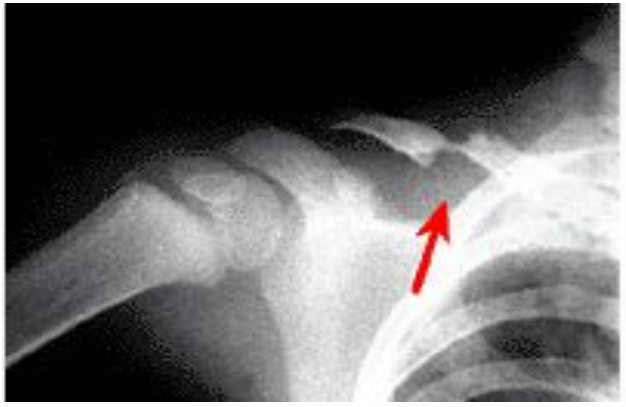
- Upper limb:
  - Clavicle
  - Humeral supracondylar
  - Distal radius

- Lower Limbs:
  - Femur shaft (diaphysis)

Clavicle Fractures

Clavicle

- 80% □ occur in the shaft
- The periosteal sleeve always remains in the anatomic position (remodeling is ensured)



Clavicle # - Incidents

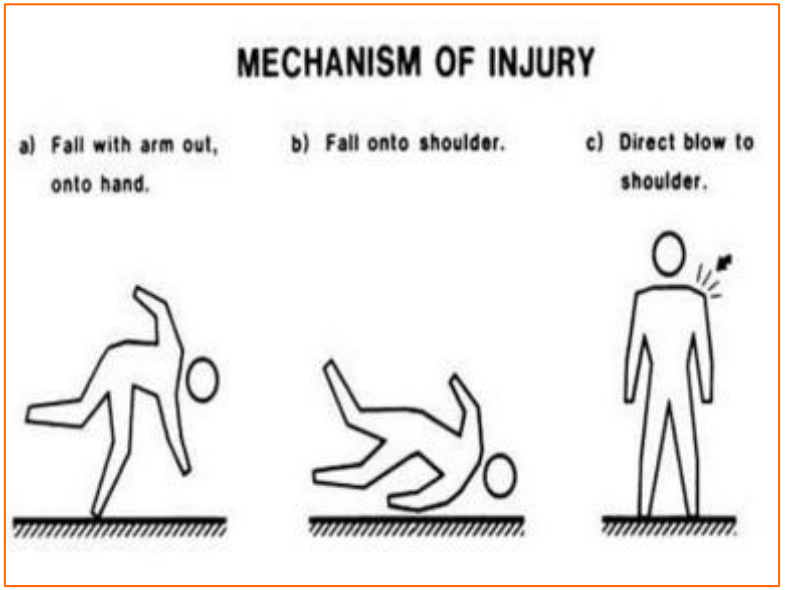
- 8-15% □ of all pediatric #
- 0.5% □ of normal SVD
- 1.6% □ of breech deliveries
- 90% □ of obstetric #

Clavicle # - Mechanism Injury

- Indirect □ f
- Direct:
  - The most common mechanism
  - Has highest incidence of injury to the underlying:
    - N.V &,
    - Pulmonary structures
- Birth injury

Clavicle # - Mechanism Injury

- Indirect fall onto an outstretched hand
- Direct:
  - The most common mechanism
  - Has highest incidence of injury to the underlying:
    - N.V &,
    - Pulmonary structures
- Birth injury



Clavicle # - Examination

- Look □ E
- Feel:
  - Tender # site
  - As a palpable mass along the clavicle (as in displaced #)
  - Crepitus (when lung is compromised)
- Special tests □ I
  - N.V injury
  - Pulmonary injury

Clavicle # - Examination

- Look Ecchymosis
- Feel:
  - Tender # site
  - As a palpable mass along the clavicle (as in displaced #)
  - Crepitus (when lung is compromised)
- Special tests I
  - N.V injury
  - Pulmonary injury

Clavicle # - Reading XR

- Order AP view
- Location:
  - (medial, middle, lateral) ⅓
  - Commonest # site
- Type # transverse, segmental, comminuted
- Displacement %
- Open or closed see air on XR

Clavicle # - Reading XR

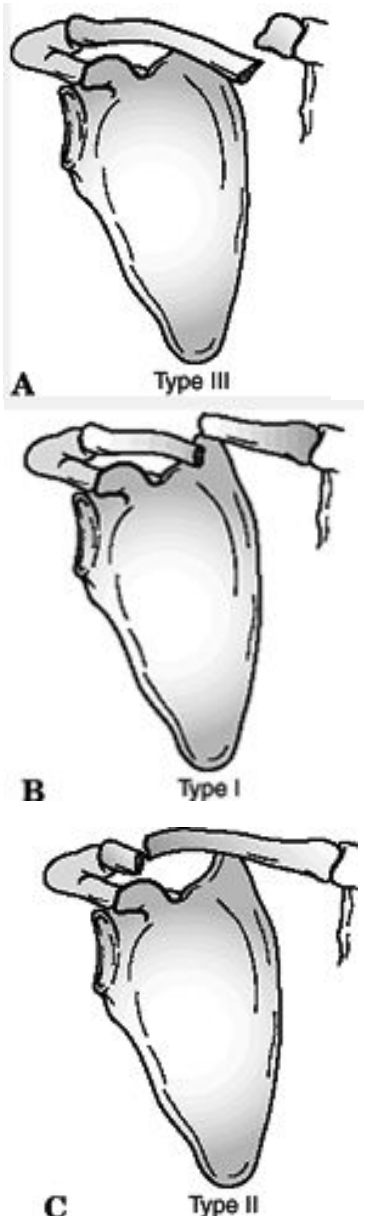
- Order AP view
- Location:
  - (medial, middle, lateral) ⅓ commonest middle ⅓
  - Commonest # site middle/lateral ⅓
- Type # transverse, segmental, comminuted
- Displacement %
- Open or closed see air on XR

Clavicle # - Reading XR

Clavicle # - Allman Classification

<u>Allman classification:</u>

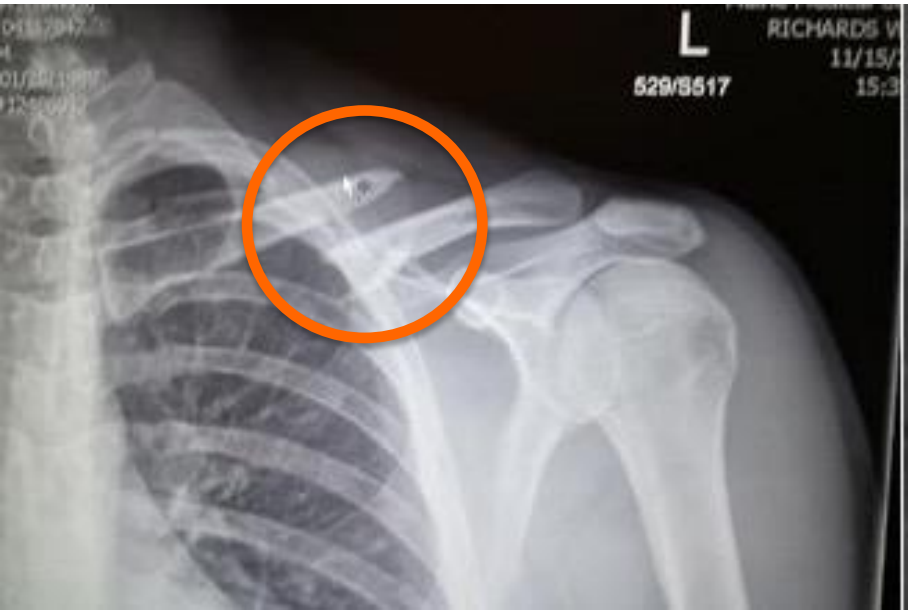
- Type I medial 1/3
- Type II middle 1/3 (most common)
- Type III lateral 1/3



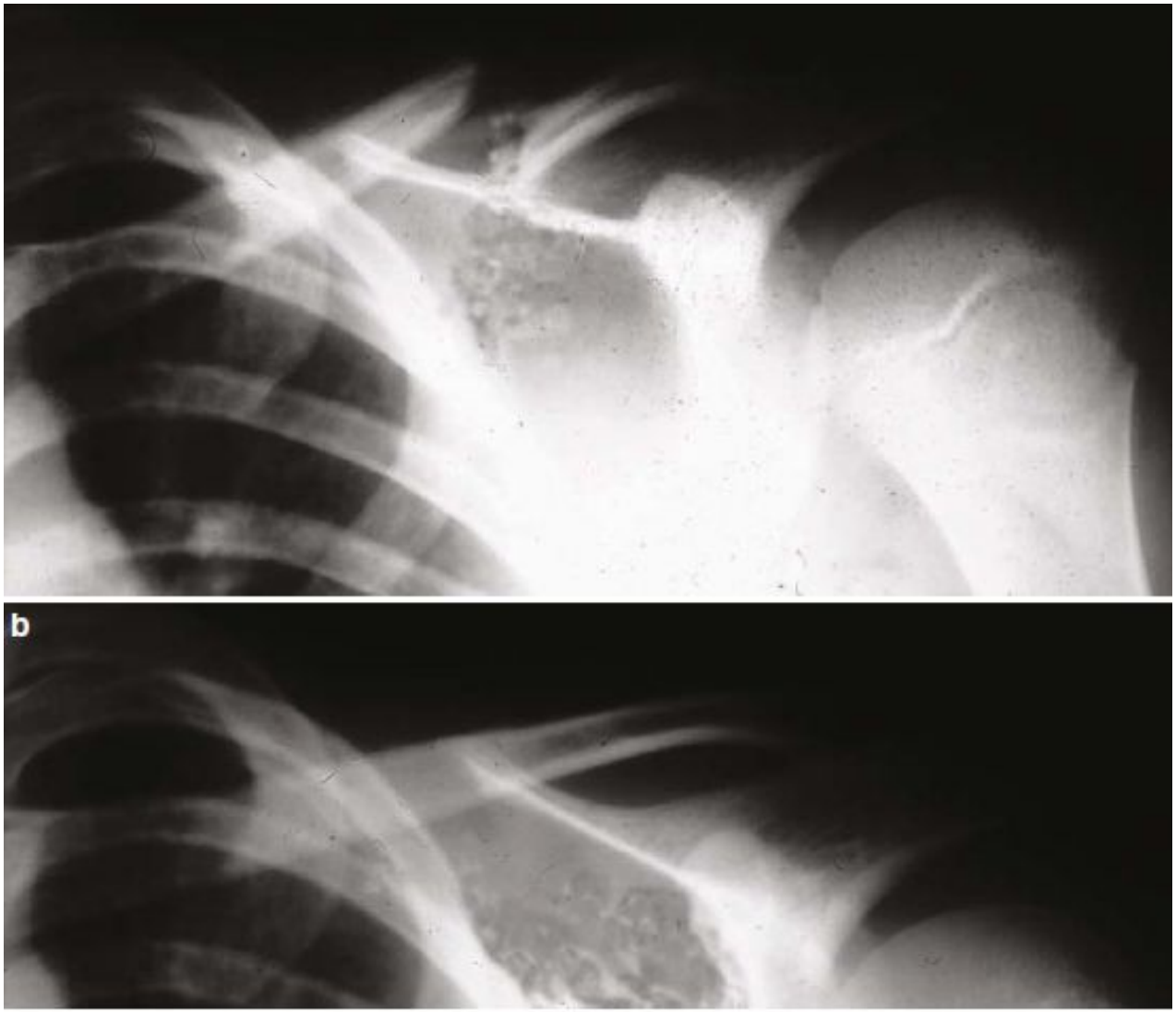
Clavicle # - Treatment

- Newborn (< 28 days):
  - No orthotics
  - Unite in 1w
- 1m – 2y:
  - Figure-of-eight
  - For 2w
- 2 – 12y:
  - Figure-of-eight or sling
  - For 2-4 weeks

Clavicle # - Remodeling



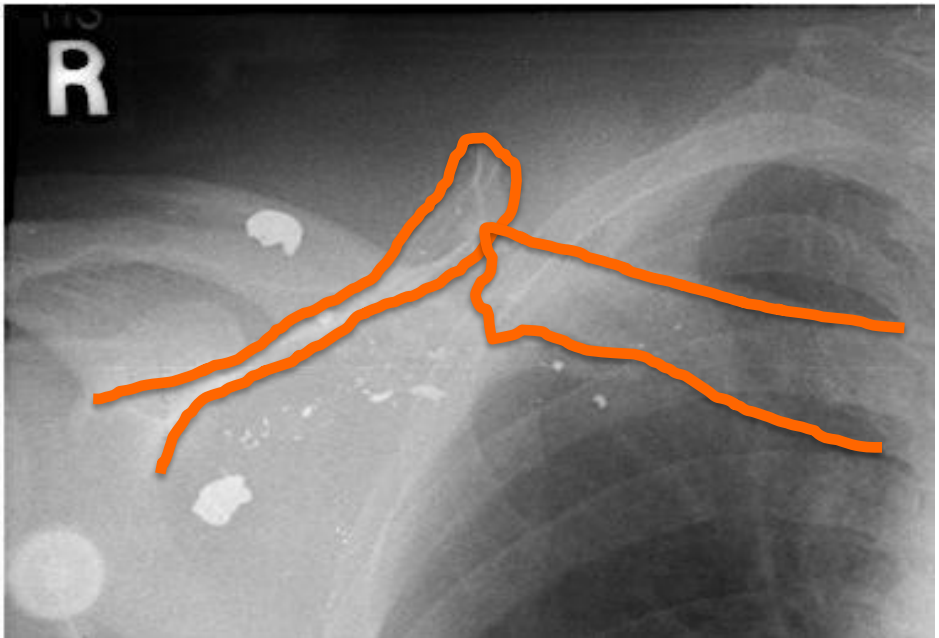
Clavicle # - Remodeling



Clavicle # - Treatment

<u>Indications of operative treatment:</u>

- Open #’s, or
- Neurovascular compromise
- Pulmonary injury



Clavicle # - Complications (rare)

- From the #:
  - Malunion
  - Nonunion
  - Secondary from healing:
    - Neurovascular compromise
    - Pulmonary injury
- In the wound:
  - Bad healed scar
  - Dehiscence
  - Infection

Humeral Supracondylar Fractures

Supracondylar #- Incidences

- 55-75% □ of all elbow #
- M:F 3:2
- Age □ 5 - 8 years
- Left (non-dominant) side □ most frequently #

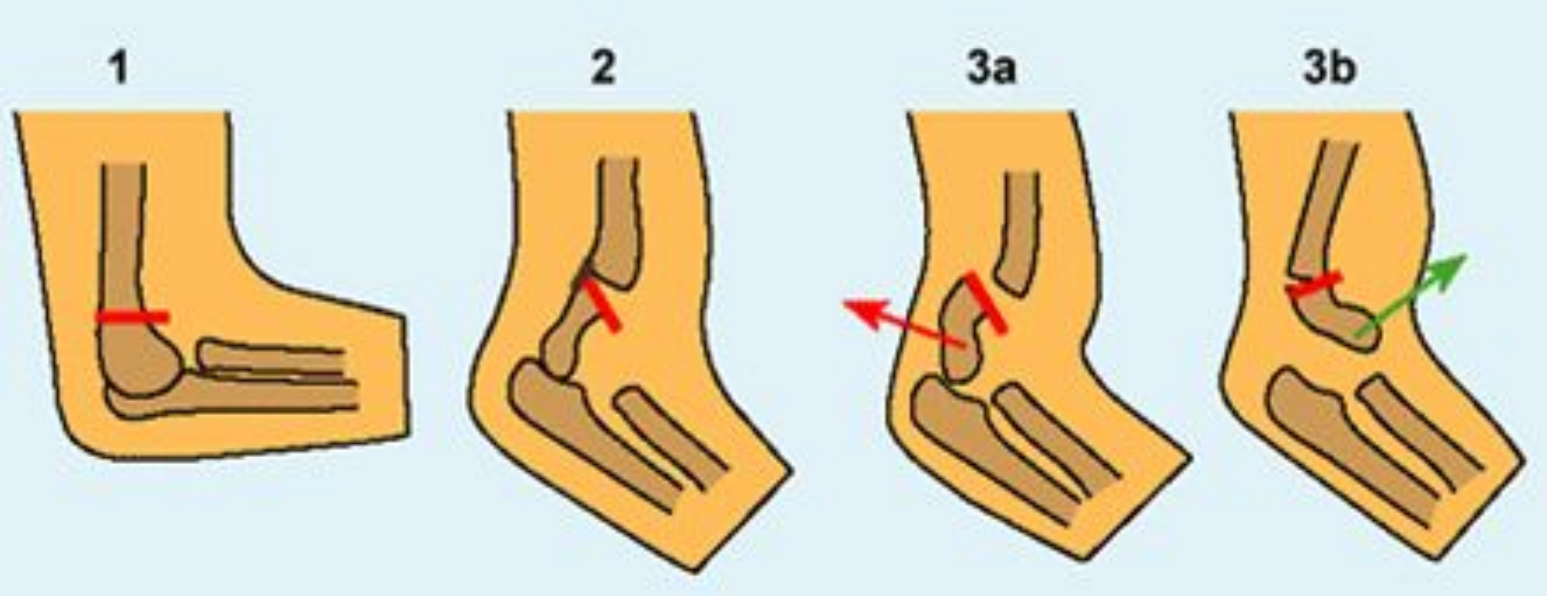
Supracondylar #- Mechanism of Injury

- Indirect:
  - Extension type
  - >95%
- Direct:
  - Flexion type
  - < 3%

Supracondylar #- Clinical Evaluation

- Look:
  - Swollen
  - S-shaped angulation
  - Pucker sign (dimpling of the skin anteriorly)
  - May have burses
- Feel:
  - Tender elbow
- Move:
  - Painful & can't really move it
- Neurovascular examination

Supracondylar #- Gartland Classification



Type-III Complete displacement (extension type) may be:

- Posteromedial (75%), or
- Posterolateral (25%)

Supracondylar #- Gartland Classification

Type-III Complete displacement (extension type) may be:

- Posteromedial (75%), or
- Posterolateral (25%)

Supracondylar #- Gartland Classification

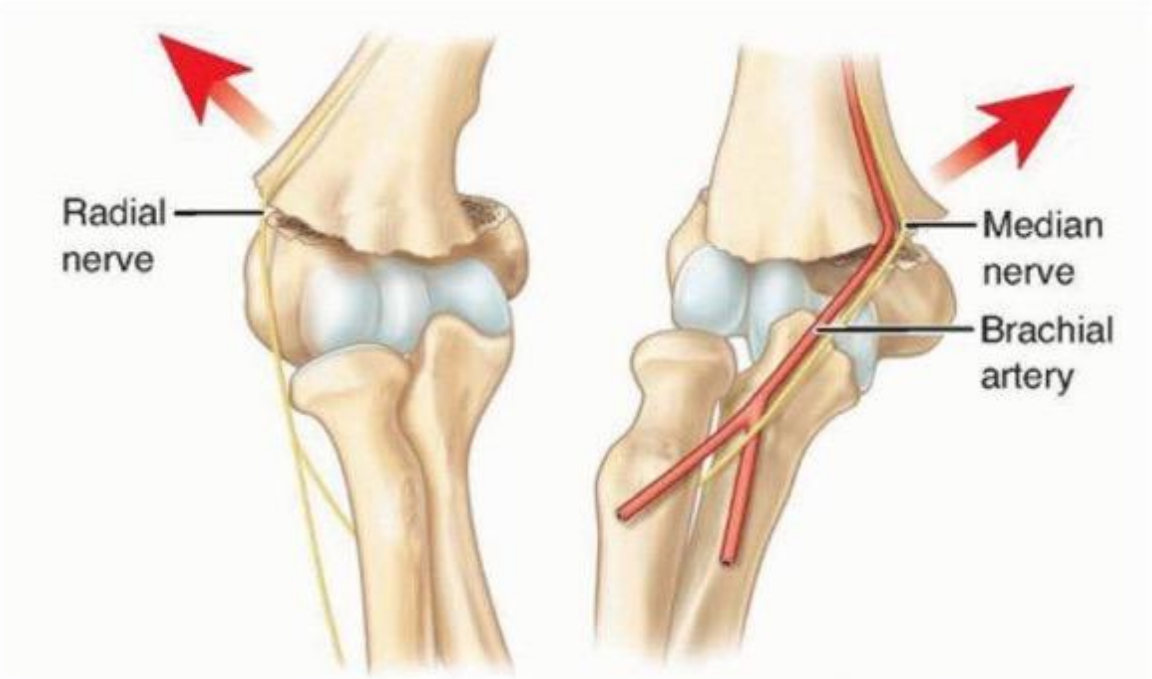
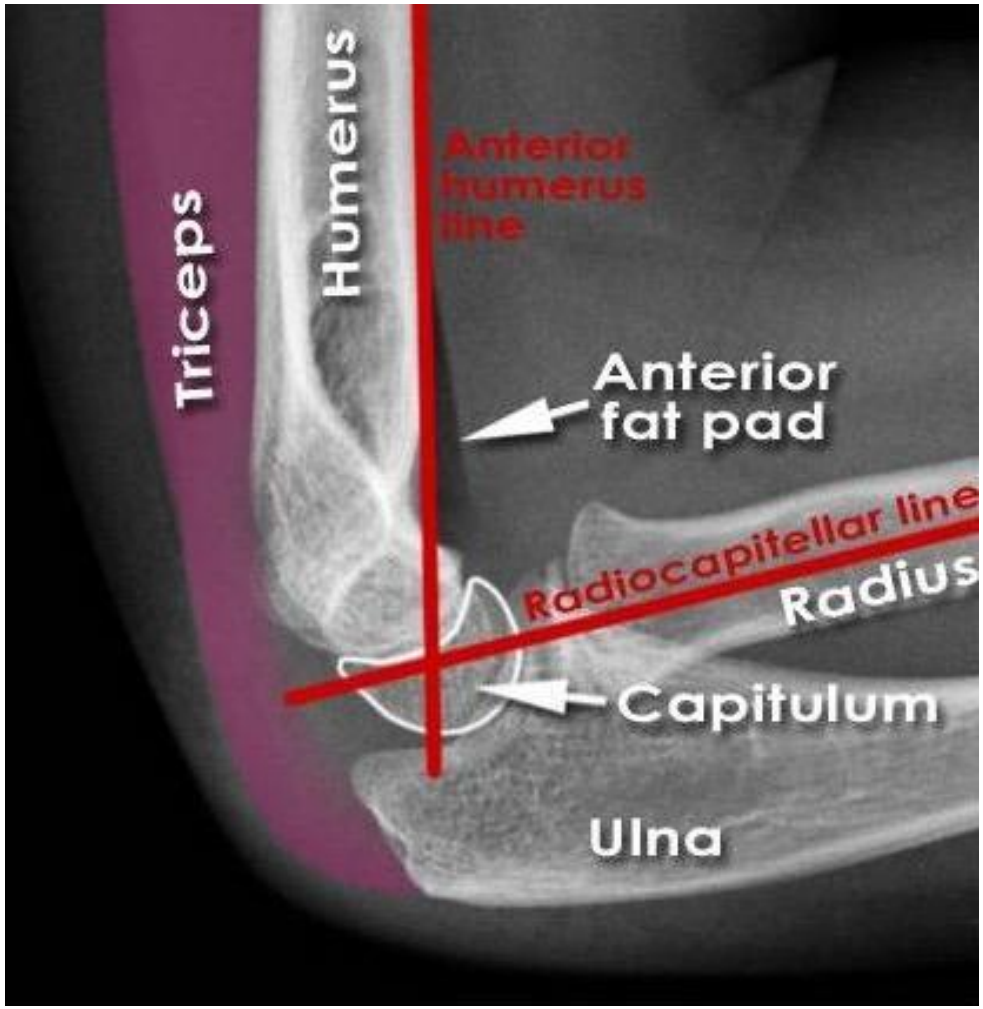


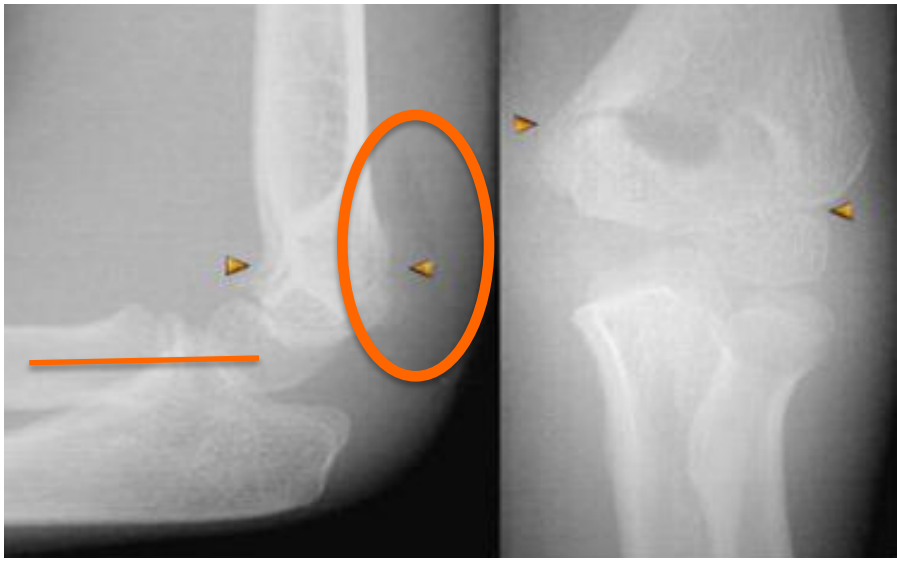
FIG 2 • Relationship to neurovascular structures. The proximal metaphyseal spike penetrates laterally with posteromedially displaced fractures and places the radial nerve at risk. With posterolaterally displaced fractures, the spike penetrates medially and places the median nerve and brachial artery at risk.

Normal XR Lines

- Anterior Humeral Line
- Hour-glass appearance
- Fat-pad sign
- Radio-capitellar line



Type 1



- Anterior Humeral Line
- Hour-glass appearance
- Fat-pad sign
- Radio-capitellar line

Type 2

Type 3

Supracondylar #- Treatment

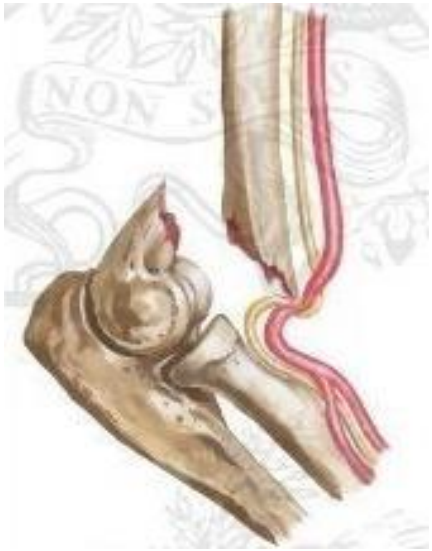
- Type-I:
  - Above elbow cast (or splint), at 60-90 degrees
  - For 2-3 weeks
- Type-II:
  - Closed reduction & above elbow casting, or
  - Closed reduction with percutaneous pinning (if: unstable or sever swelling), & above elbow cast (splint)
  - For 4-6 weeks
- Type III:
  - Attempt closed reduction & percutaneous pinning
  - If fails open reduction & percutaneous pinning (ORIF)
  - For 4-6 weeks
  - Direct ORIF if open # or with neurovascular injury

Supracondylar #- Treatment

Supracondylar #- Treatment

Supracondylar #- Complications

- Neurologic injury (7% to 10%):
  - Median and anterior interosseous nerves (most common)
  - Most are neurapraxias
  - Requiring no treatment
- Vascular injury (0.5%):
  - Direct injury to the brachial artery, or
  - Secondary to swelling (compartment syndrome)



Supracondylar #- Complications

- Loss of motion (stiffness)
- Myositis ossificans
- Angular deformity (cubitus varus)
- Compartment syndrome

Supracondylar #- Flexion Type 3

Distal Radial Fractures (Metaphysis)

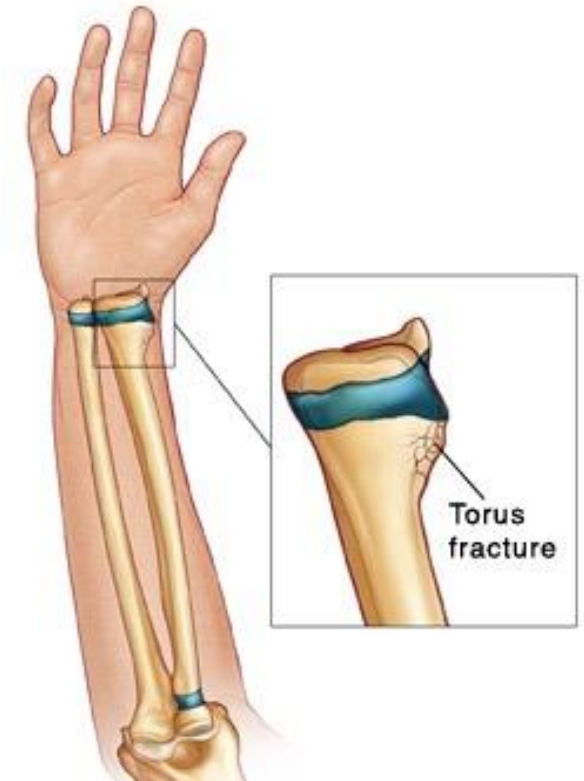
Classification

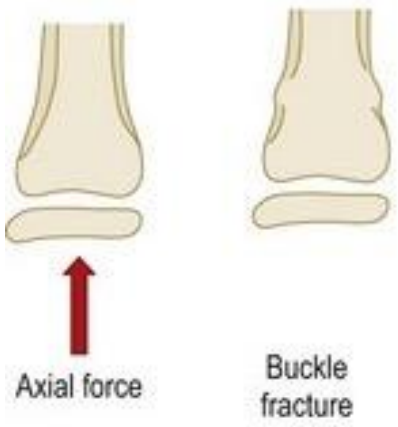
- Depending on pattern:
  - Torus (buckle) only one cortex is involved
  - Incomplete (greenstick)
  - Complete

Distal Radius Metaphyseal Injuries

Torus (buckle) fracture:

- Are stable
- Immobilized for pain relief in below elbow cast, 2-3 weeks





Distal Radius Metaphyseal Injuries

Torus (buckle) fracture:

Distal Radius Metaphyseal Injuries

<u>Torus (buckle) fracture:</u>





Distal Radius Metaphyseal Injuries

<u>Incomplete (greenstick):</u>

- Greater ability to remodel (why ?)
- Closed reduction and above elbow cast, with supinated forearm to relax the brachioradialis muscle

Distal Radius Metaphyseal Injuries

Incomplete (greenstick):

Distal Radius Metaphyseal Injuries

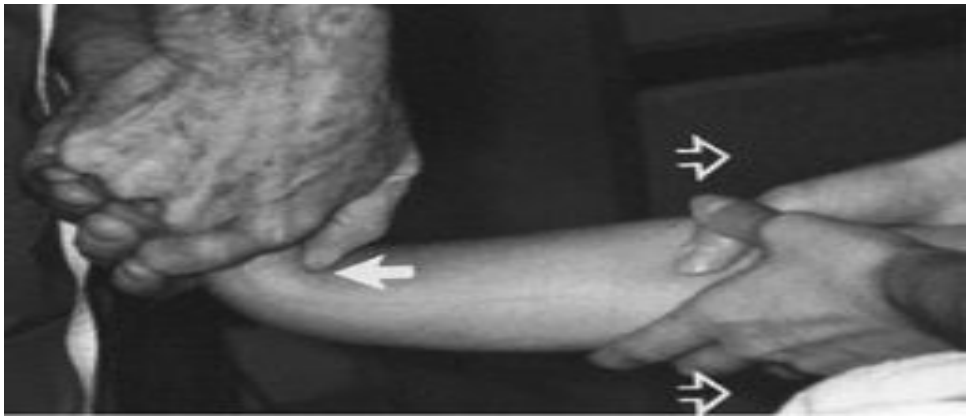
Complete fracture:

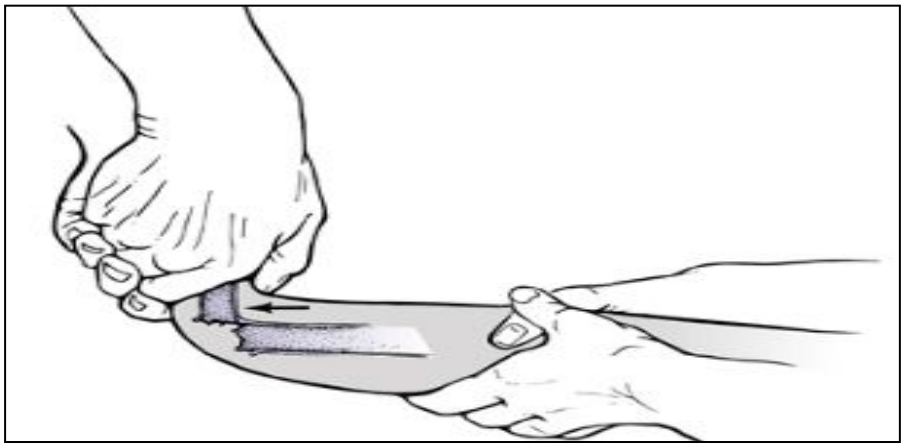
- Closed reduction, then well molded above elbow cast for 6-8 w
- Or open reduction and fixation (internal or external)

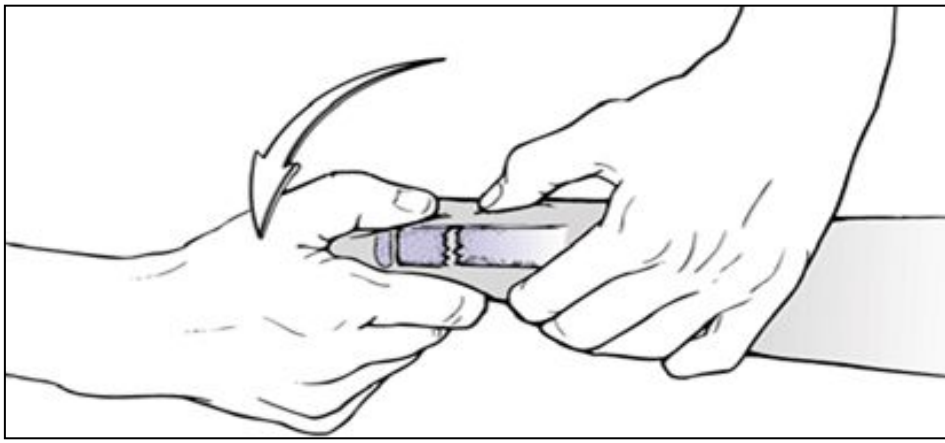
Distal Radius Metaphyseal Injuries

Complete fracture:

- Closed reduction, then well molded above elbow cast for 6-8 w



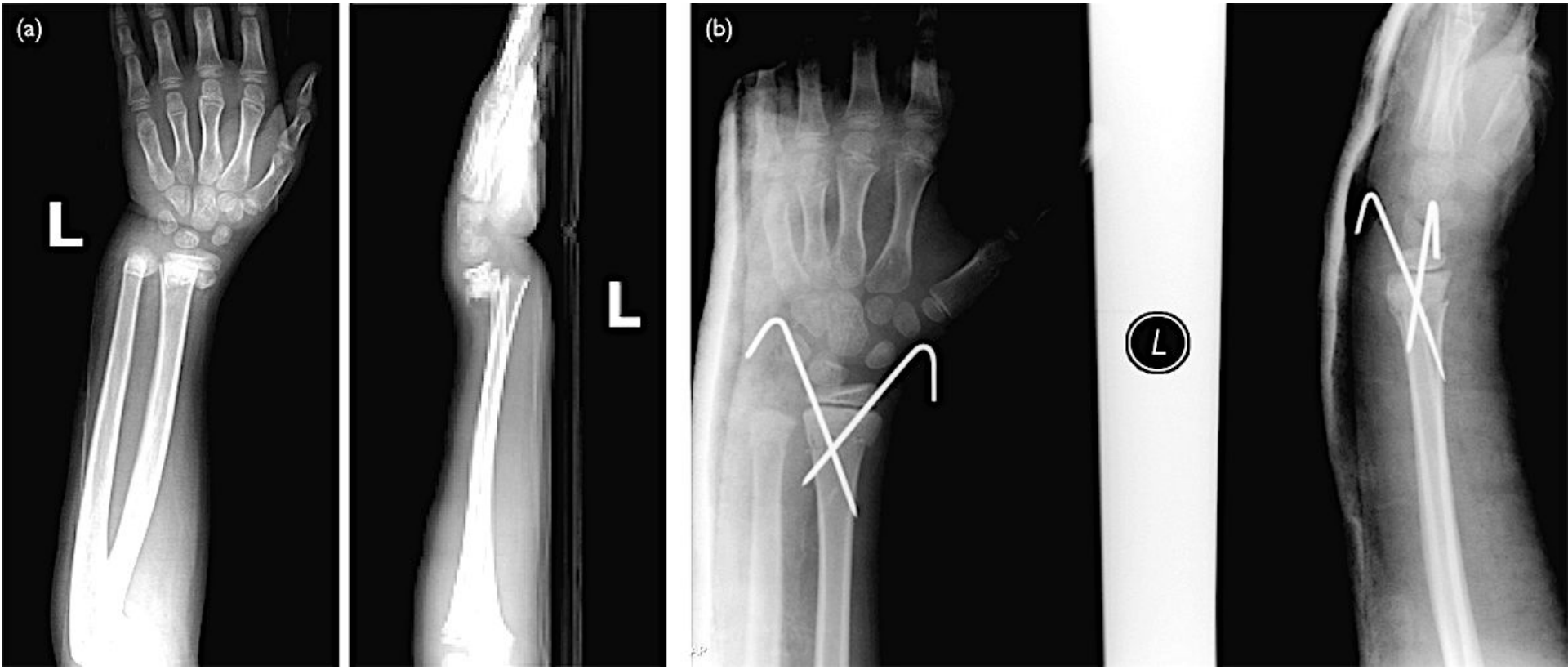




Distal Radius Metaphyseal Injuries

Complete fracture:

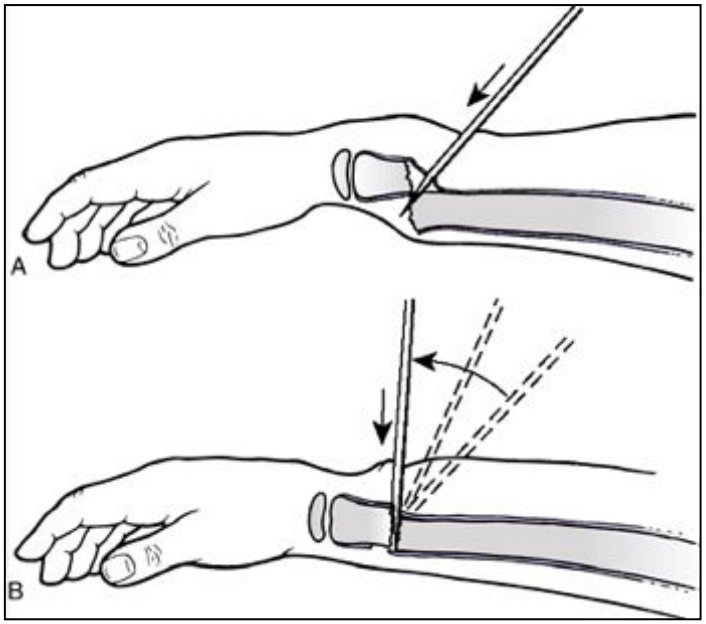
- Or open reduction and fixation (internal or external)



Distal Radius Metaphyseal Injuries

<u>Complete # □ indications for percutaneous pinning without open reduction:</u>

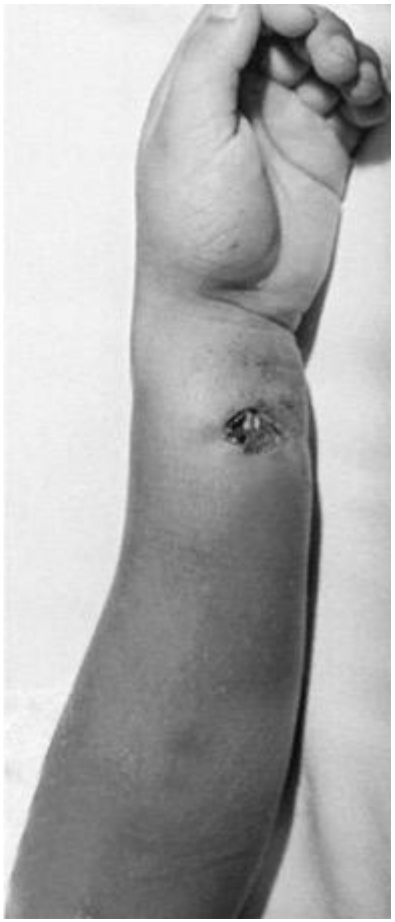
- Loss of reduction
- Excessive swelling
- Floating elbow
- Multiple manipulations



Distal Radius Metaphyseal Injuries

<u>Complete # □ indications for ORIF:</u>

- Irreducible fracture
- Open fracture
- Compartment syndrome



Distal Radius Meta. Injuries- Complications

- Malunion
  Residual angulation may result in loss of forearm rotation
- Nonunion
  Rare
- Refracture
  With early return to activity (before 6 w)
- Growth disturbance
  Overgrowth or undergrowth
- Neurovascular injuries
  With extreme positions of immobilization

Examples
of
Distal Radial Fractures

Distal Radial Fractures
Physeal Injuries

Distal Radial Physeal #-

Distal Radial Physeal #- “S.H” Type I

Distal Radial Physeal #-

Distal Radial Physeal #- “S.H” Type II

Distal Radial Physeal #-

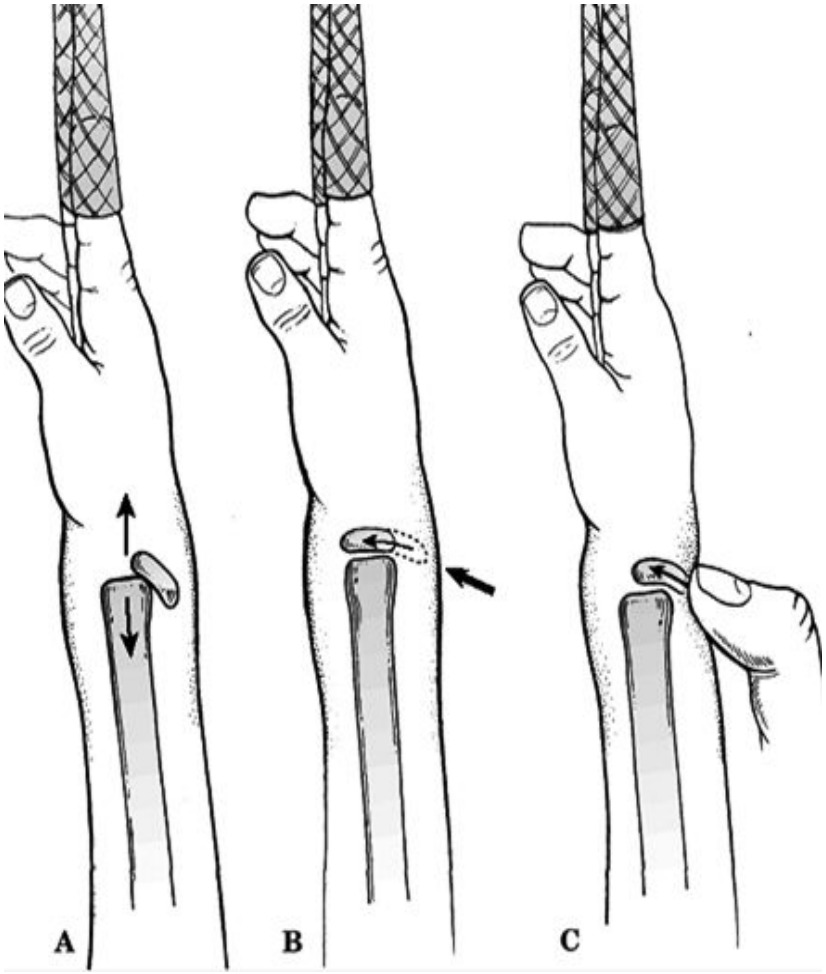
Distal Radial Physeal #- “S.H” Type III

Distal Radial Physeal #- Treatment Types I & II

- Closed reduction followed by above elbow cast, with the forearm pronated
- We can accept deformity:
  - 50% translation
  - With no angulation or rotation
- Growth arrest can occur in 25% with repeated closed reduction manipulations
- Open reduction is indicated in:
  - Irreducible #
  - Open #

Distal Radial Physeal #- Treatment Types I & II

- Closed reduction,
- Followed by long arm cast,
- With the forearm pronated



Distal Radial Physeal #- Treatment Types II

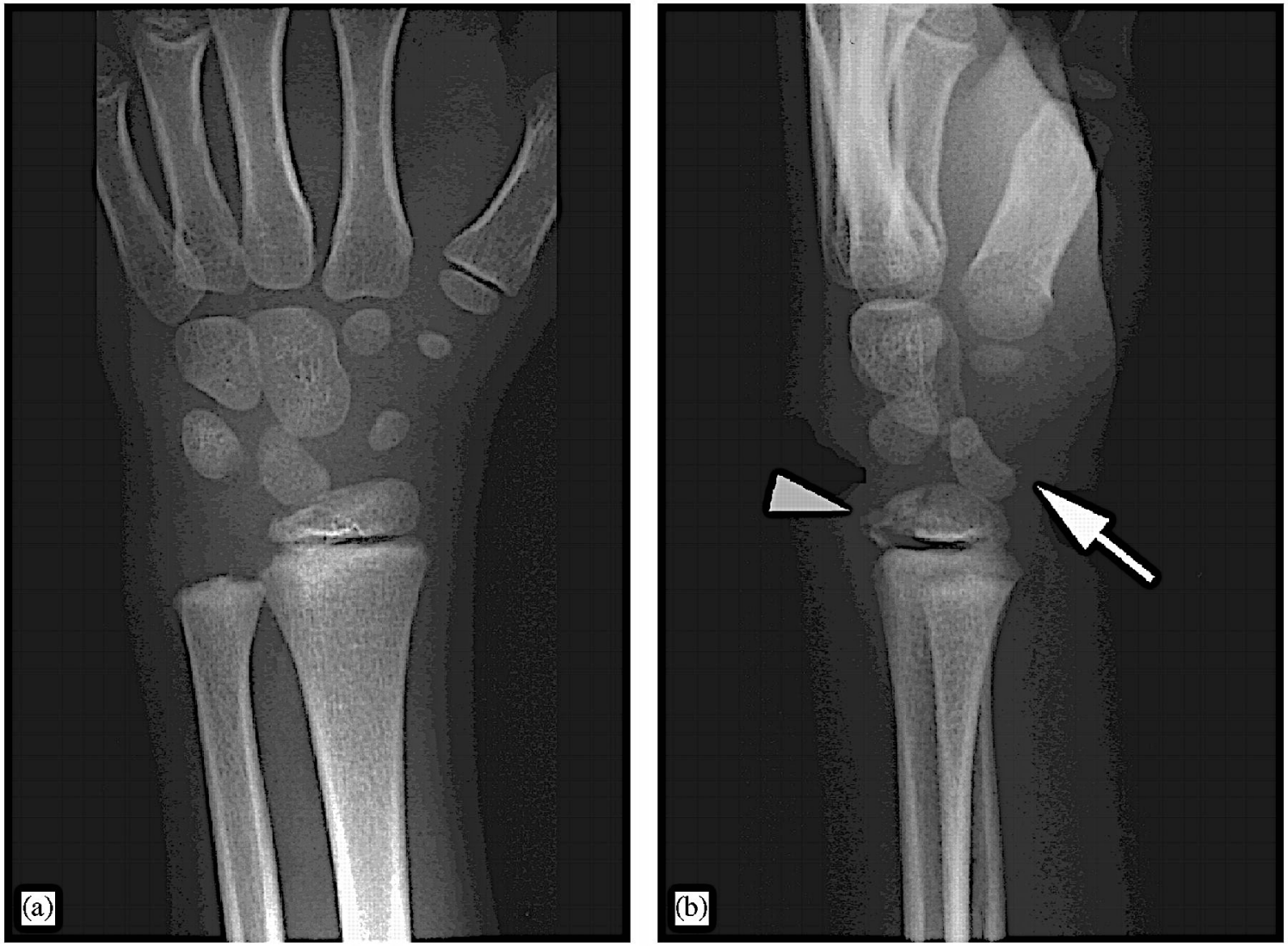
AP

Lat

Distal Radial Physeal #- Treatment Types II

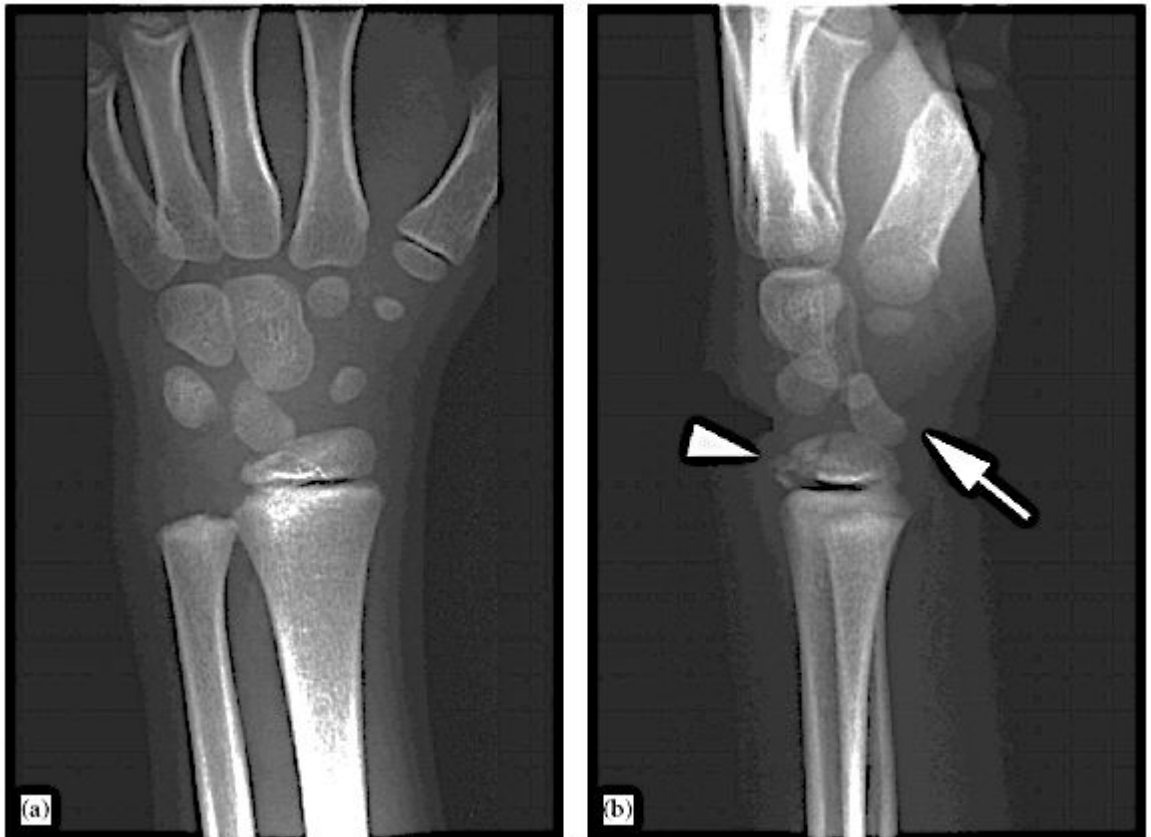
Distal Radial Physeal #- Types III

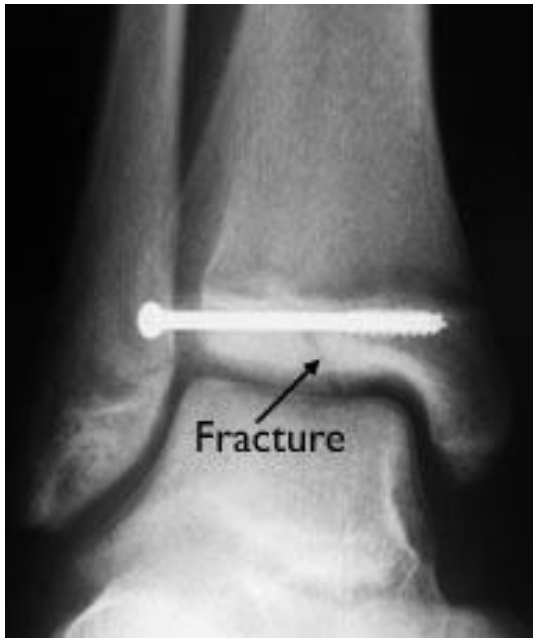
Distal Radial Physeal #- Types III



Distal Radial Physeal #- Treatment Types III

- Anatomic reduction necessary intra-articular
- ORIF with smooth pins or screws



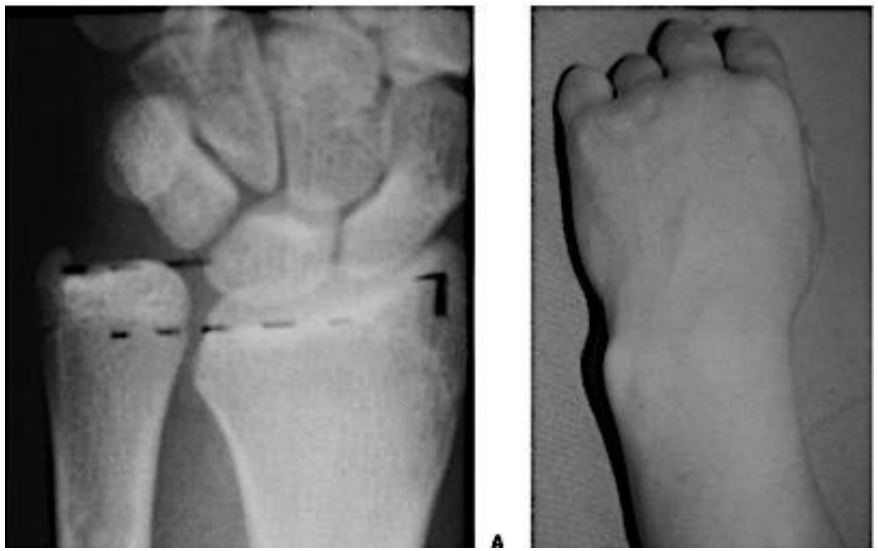


Distal Radial Physeal #- Treatment Types IV & V

- Rare injuries
- Need ORIF

Distal Radial Physeal #- Complications

- Physeal arrest
  - Shortening
  - Angular deformity
- Ulnar styloid nonunion
- Carpal tunnel syndrome



Femoral Shaft Fractures

Femoral Shaft

- 1.6% of all pediatric #
- M > F
- Age:
  - (2 – 4) years old
  - Mid-adolescence
- If in a child <1y old 80% will be ”Child Abuse”
- Adolescence >90% due to RTA

Femoral Shaft #- Mechanism of Injury

- Direct trauma:
  - RTA,
  - Fall,
  - Child abuse
- Indirect trauma:
  - Rotational injury
- Pathologic #:
  - Osteogenesis imperfecta
  - Nonossifying fibroma
  - Bone cysts
  - Tumors

Femoral Shaft #- Clinical Evaluation

- Look:
  - Pain,
  - Swelling of the thigh,
  - Inability to ambulate, and
  - Variable gross deformity
  - Careful O/E of the overlying soft tissues to rule out the possibility of an open fracture (puncture wound)
- Feel:
  - Tender # site
- Careful neurovascular examination is essential

Femoral Shaft #- Radiographic Evaluation

- AP and lateral views
- Must include hip & knee joints

Femoral Shaft #- Classification

Descriptive

- Open or closed
- Fracture pattern:

  transverse, spiral, oblique, butterfly fragment
- Comminution
- Displacement

Anatomic

- Subtrochanteric
- Shaft
- Supracondylar

Femoral Shaft #- Treatment

<u>< 6m:</u>

- Pavlik Harness
- Or closed reduction & immediate hip spica casting
- Or traction 1-2w, then hip spica casting

Femoral Shaft #- Treatment

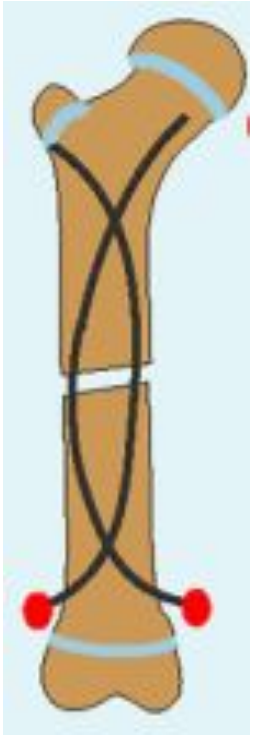
<u>6m – 6y:</u>

- Closed reduction & immediate hip spica casting (>95%)
- Or traction 1-2w, then hip spica casting (if there is difficulty to maintain length and acceptable alignment)

Femoral Shaft #- Treatment

<u>6 – 12y:</u>

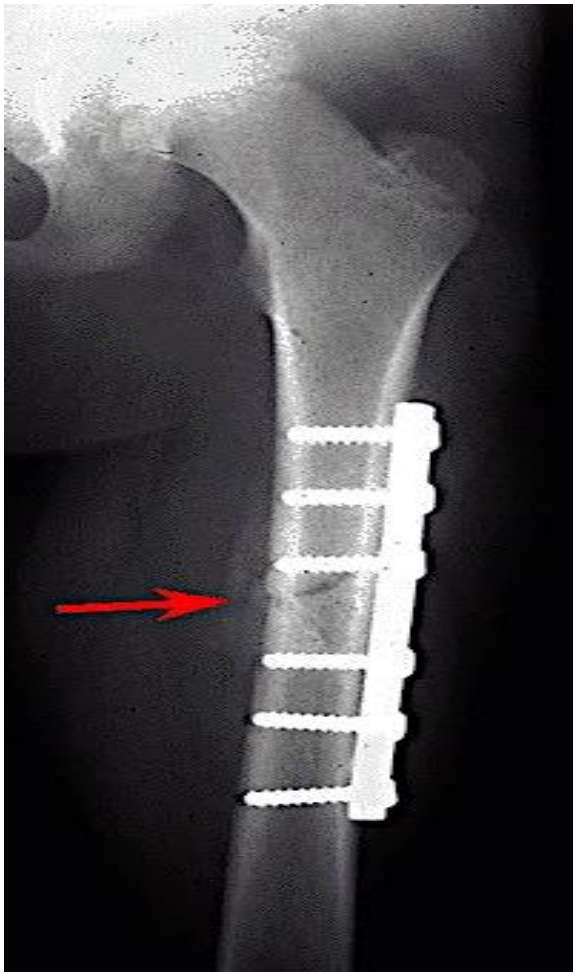
- Flexible I.M.N
- Bridge Plating
- External Fixation



Femoral Shaft #- Treatment

<u>6 – 12y:</u>

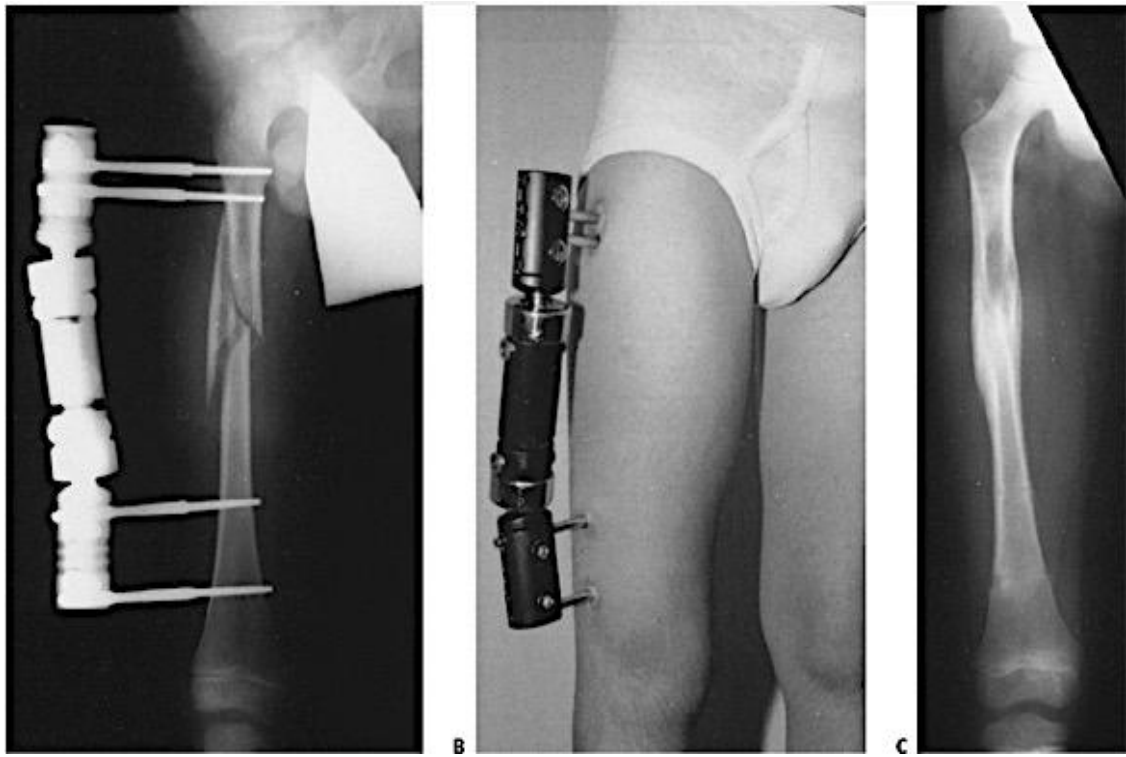
- Flexible IMN
- Bridge Plating
- External Fixation



Femoral Shaft #- Treatment

<u>6 – 12y:</u>

- Flexible IMN
- Bridge Plating
- External Fixation:
  - Multiple injuries
  - Open fracture
  - Comminuted #
  - Unstable patient



Femoral Shaft #- Treatment

<u>12y to skeletal maturity:</u>

- Intramedullary fixation with either:
  - Flexible nails, or
  - Locked I.M nail

Femoral Shaft #- Treatment

<u>Operative Indications:</u>

- Multiple trauma, including head injury
- Open fracture
- Vascular injury
- Pathologic fracture
- Uncooperative patient

Femoral Shaft #- Complications

- Malunion
  - Remodeling will not correct rotational deformities
- Leg length discrepancy
  - Secondary to shortening or overgrowth
  - Overgrowth of (1.5-2)cm is common in 2-10 year of age
- Muscle weakness
- Nonunion (rare)
- Osteonecrosis (AVN) of femoral head with antegrade IMN <12 year

Any Questions?

Remember …

Remember

- Pediatric fractures have great remodeling potentials
- The importance of growth plates & periosteum in remodeling
- A good number of cases can be treated conservatively
- Operative fixations aids in avoiding complications

Objectives

- Difference between adult & pediatric #
- Growth plate # □ Salter-Harris classification, treatments, & complications
- Methods of treatment of pediatric # & there indications
- Know the common pediatric #: mechanism of injury, evaluations (clinical & radiological), treatments, and complications