

Common Pediatric Fractures & Trauma

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Nov 2018

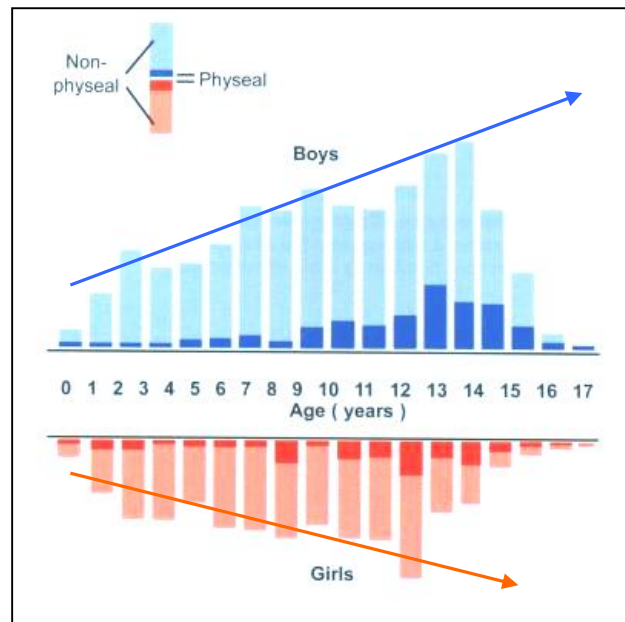
Objectives

- 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

Difference Between A Child & Adult's Fractures

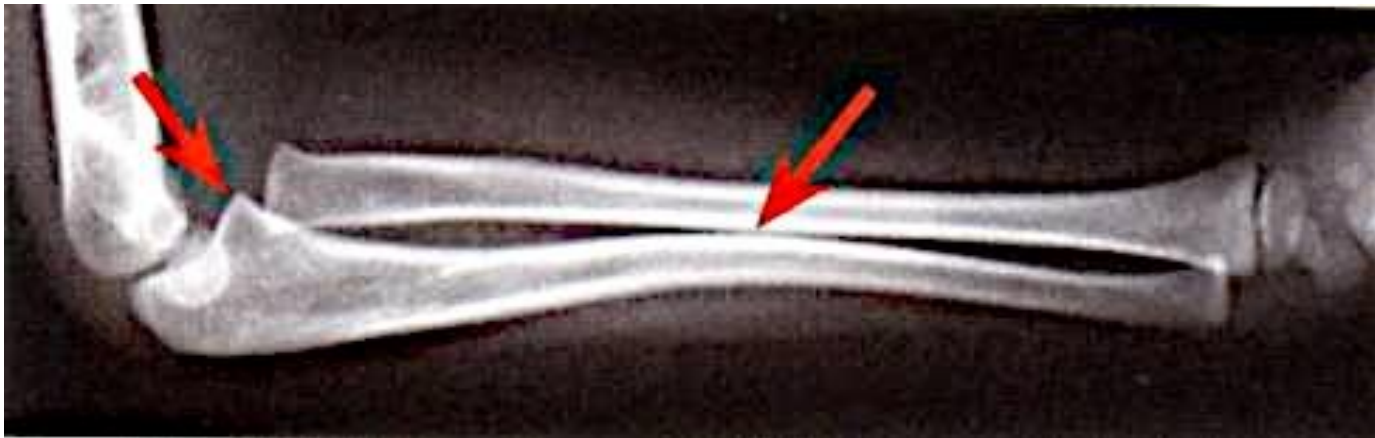
Why are Children's Fractures Different ?

- Growth plate:
 - Perfect remodeling power
 - Injury of growth plate may cause:
 - Angular deformity
 - Or leg length inequality (L.L.I)



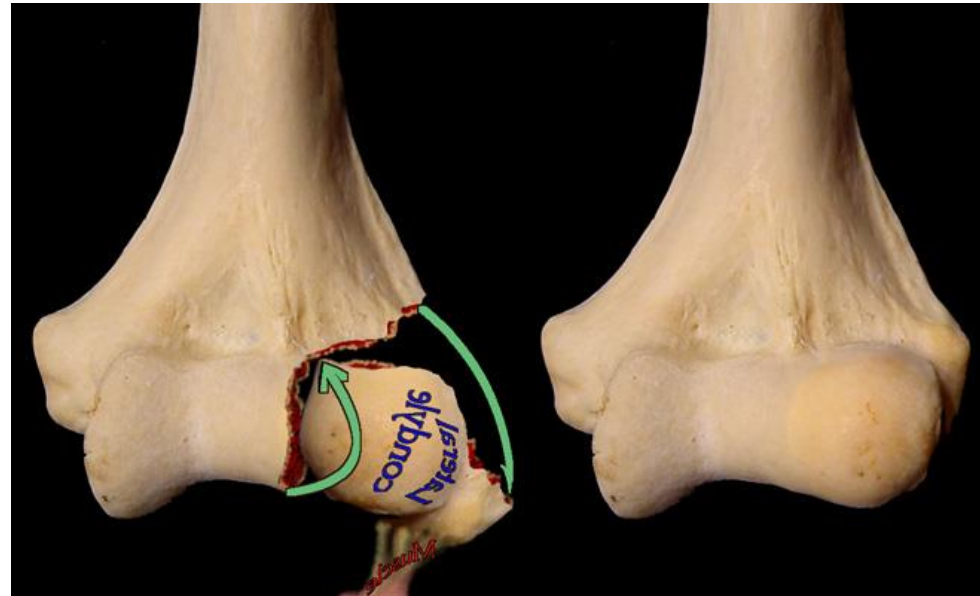
Why are Children's Fractures Different ?

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



Why are Children's Fractures Different ?

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

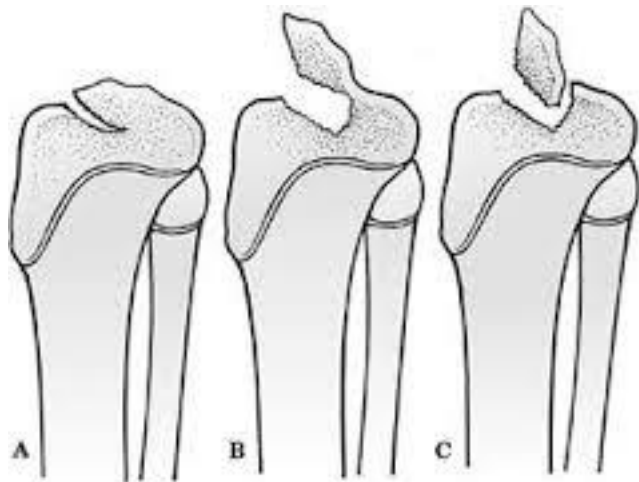


Why are Children's Fractures Different ?

- Periosteum:
 - Metabolically active
 - More callus, rapid union, increased remodeling
 - Thickness and strength
 - May aid reduction

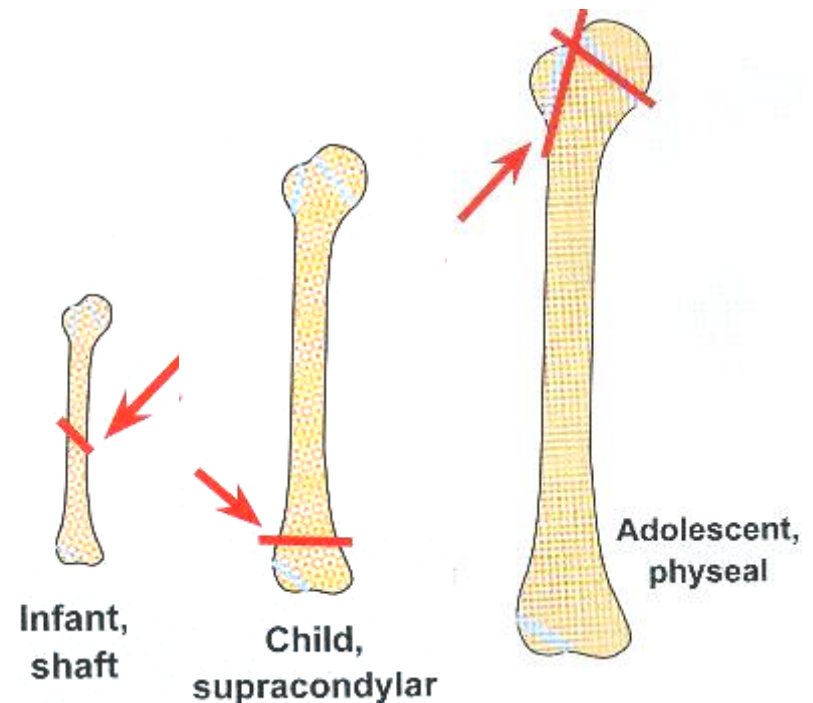
Why are Children's Fractures Different ?

- 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 ?

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



Why are Children's Fractures Different ?

- Physiology

- Better blood supply → rare delayed and non-union

Remodeling

Day 1



Day 4



Day 7



2 Weeks



6 Months







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



Type I



Type II



Type III



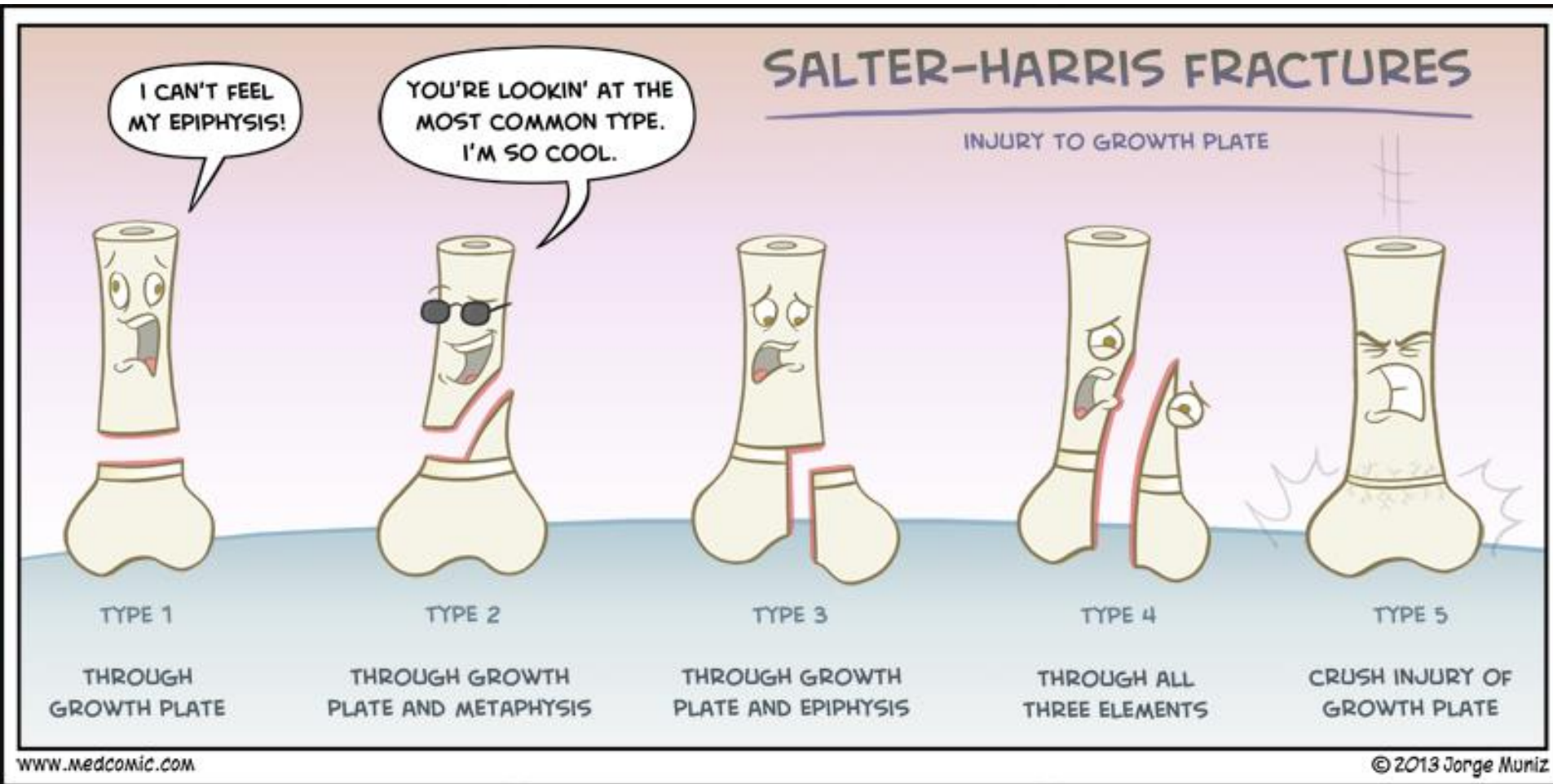
Type IV



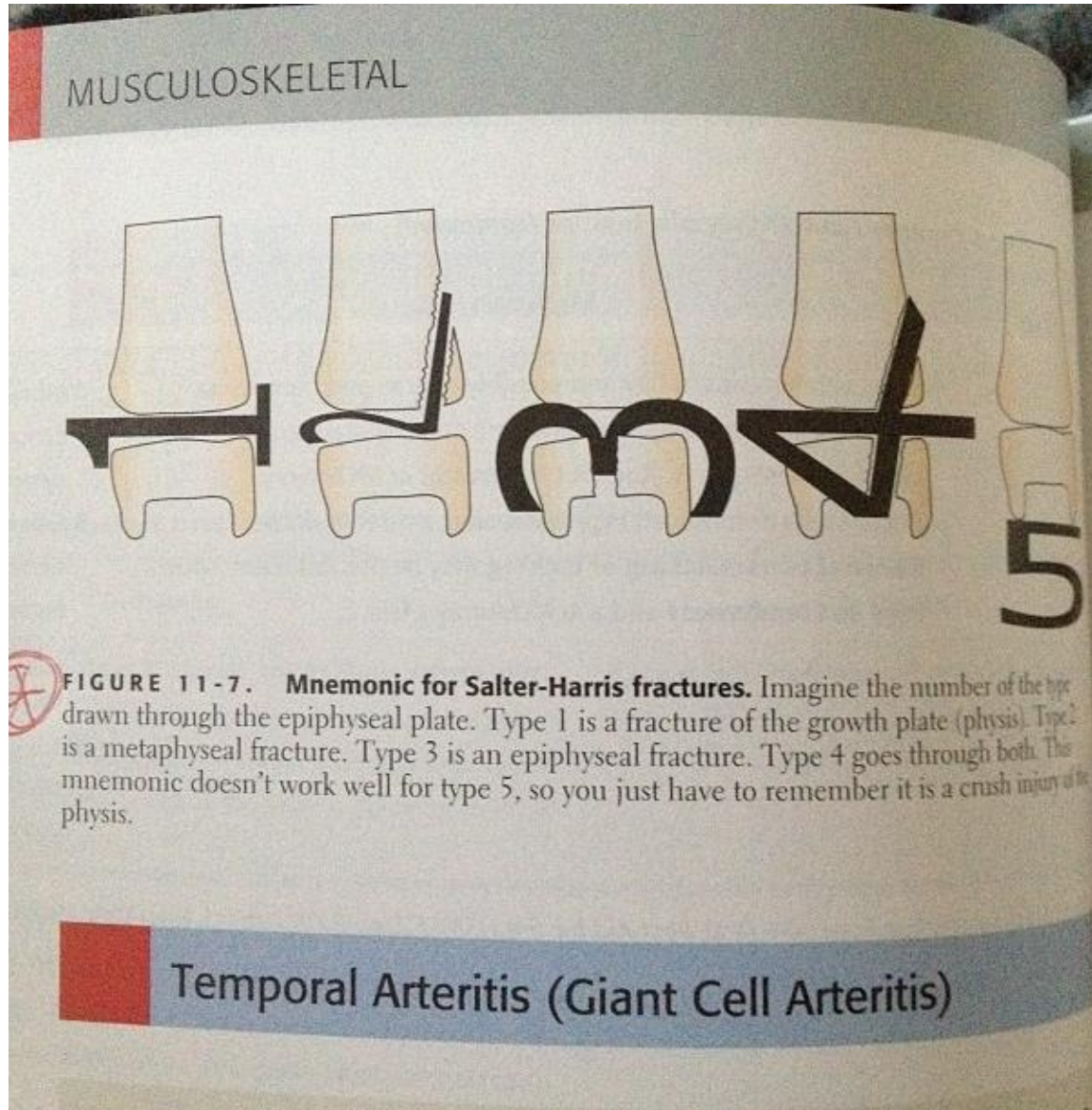
Type V

Salter-Harris

Salter-Harris Classification



Salter-Harris Classification

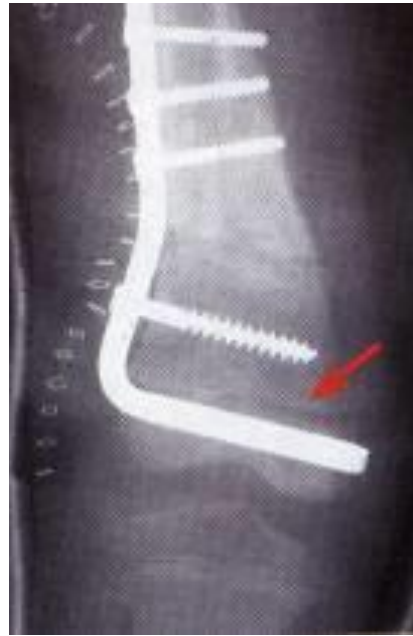


Physis Injuries- Complications

- 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

- 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

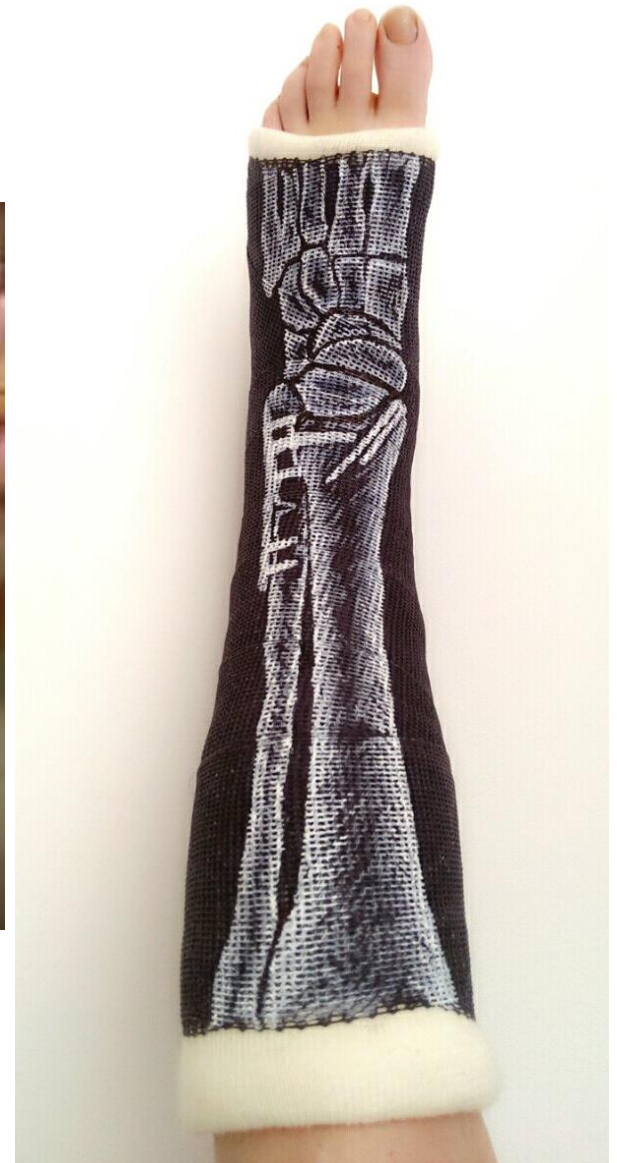
- Open fractures
- Severe soft-tissue injury
- Fractures with vascular injury
- Compartment syndrome
- Multiple injuries
- Displaced intra articular fractures (Salter-Harris III-IV)
- Failure of conservative means (irreducible or unstable #'s)
- Malunion and delayed union
- Adolescence
- Head injury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

Methods of Treatment of Pediatric Fractures & Trauma

1) Casting → still the commonest



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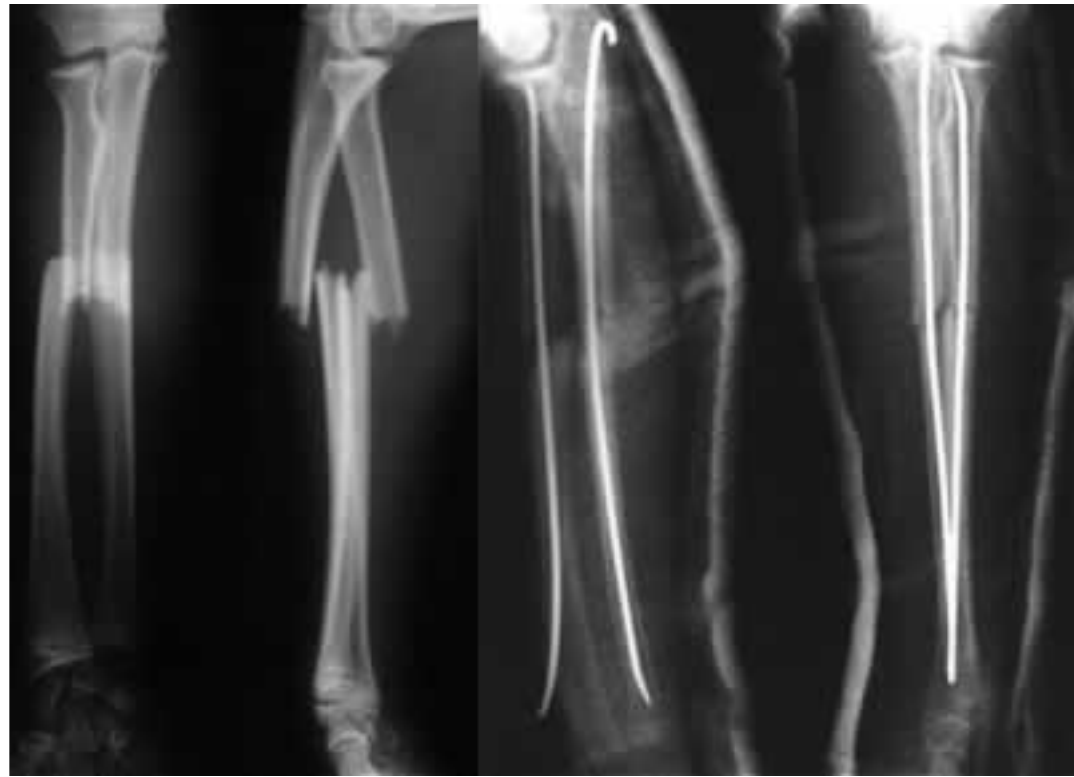


2) K-wires

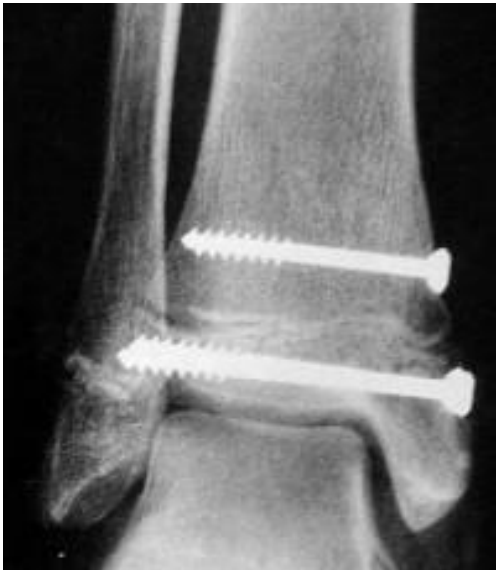
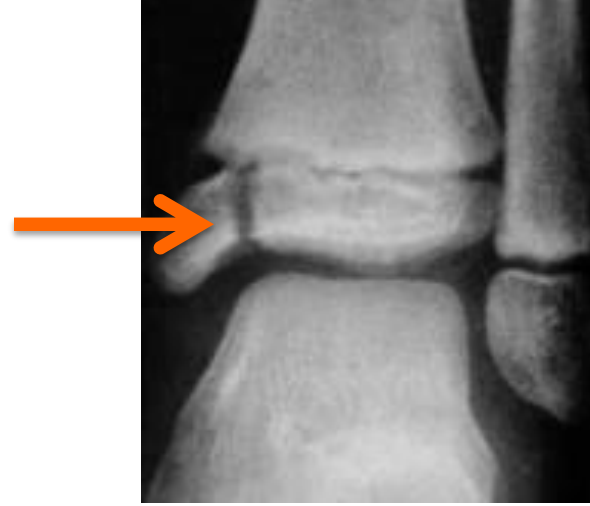
- Most commonly used internal fixation (I.F)
- Usually used in → metaphyseal fractures



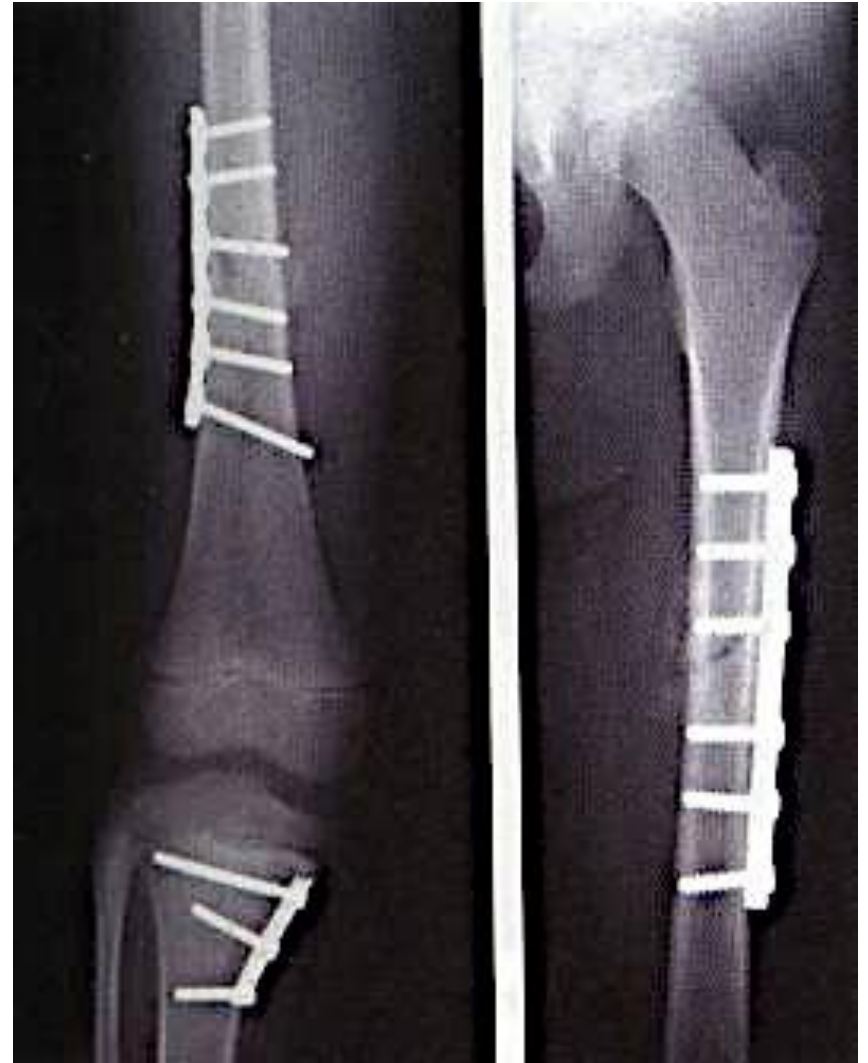
3) Intramedullary wires (Elastic nails)



4) Screws



5) Plates → specially in multiple trauma



6) I.M.N → only in adolescents (>12y)

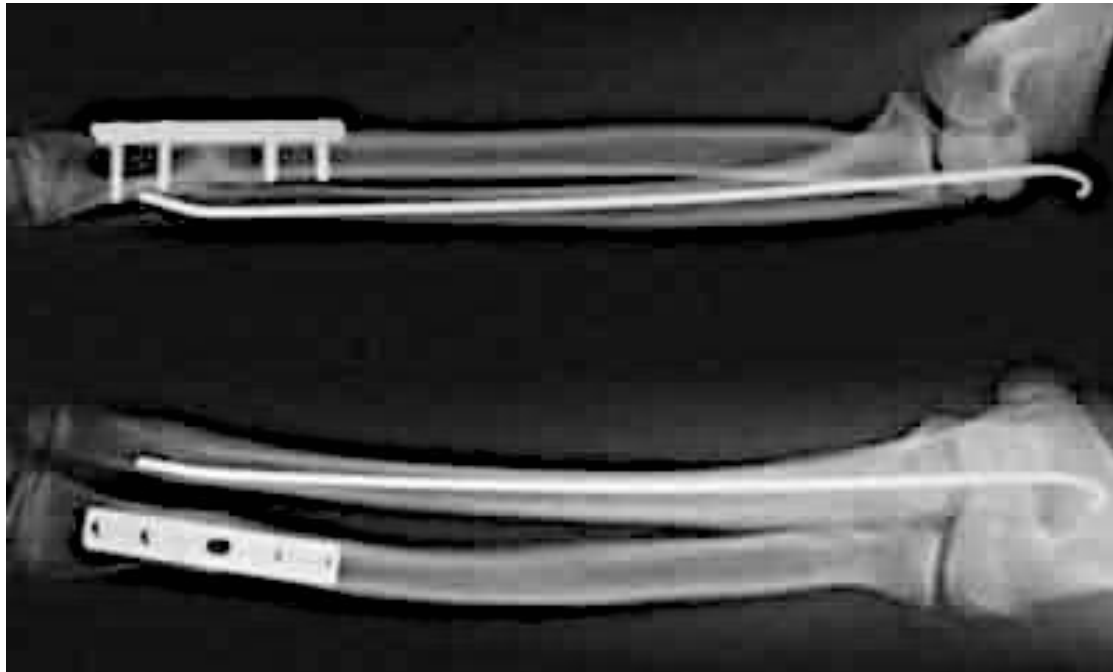


7) Ex-fix → usually in open #



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 # - Incidents

- 8-15% → of all pediatric #
- 0.5% → of normal SVD
- 1.6% → of breech deliveries
- 90% → of obstetric #
- The periosteal sleeve always remains in the anatomic position (remodeling is ensured)



Clavicle # - Mechanism Injury

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

Clavicle # - Examination

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

Clavicle # - Reading XR

- Location:
 - (medial, middle, lateral) $\frac{1}{3}$ → commonest middle $\frac{1}{3}$
 - Commonest # site → middle/lateral $\frac{1}{3}$
- Open or closed →
- Displacement →
- Fracture type

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



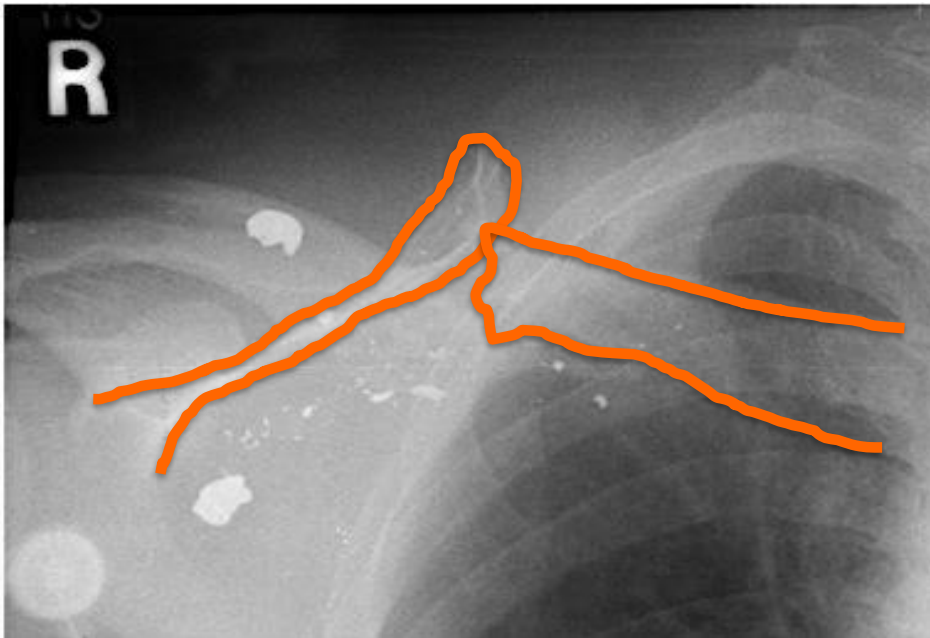
Clavicle # - Remodeling



Clavicle # - Treatment

Indications of operative treatment:

- Open #'s, or
- Neurovascular compromise



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

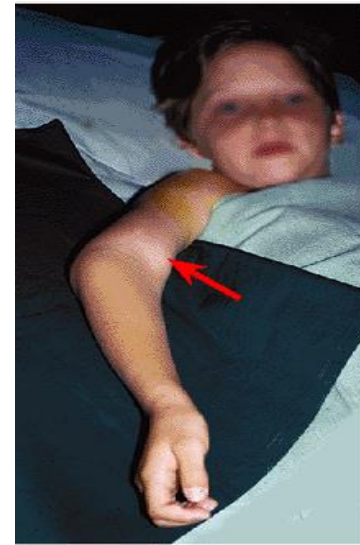
- 55-75% → of all elbow #
- M:F 3:2
- Age → 5 - 8 years
- Left (non-dominant) side → most frequently #

Supracondylar #- Mechanism of Injury

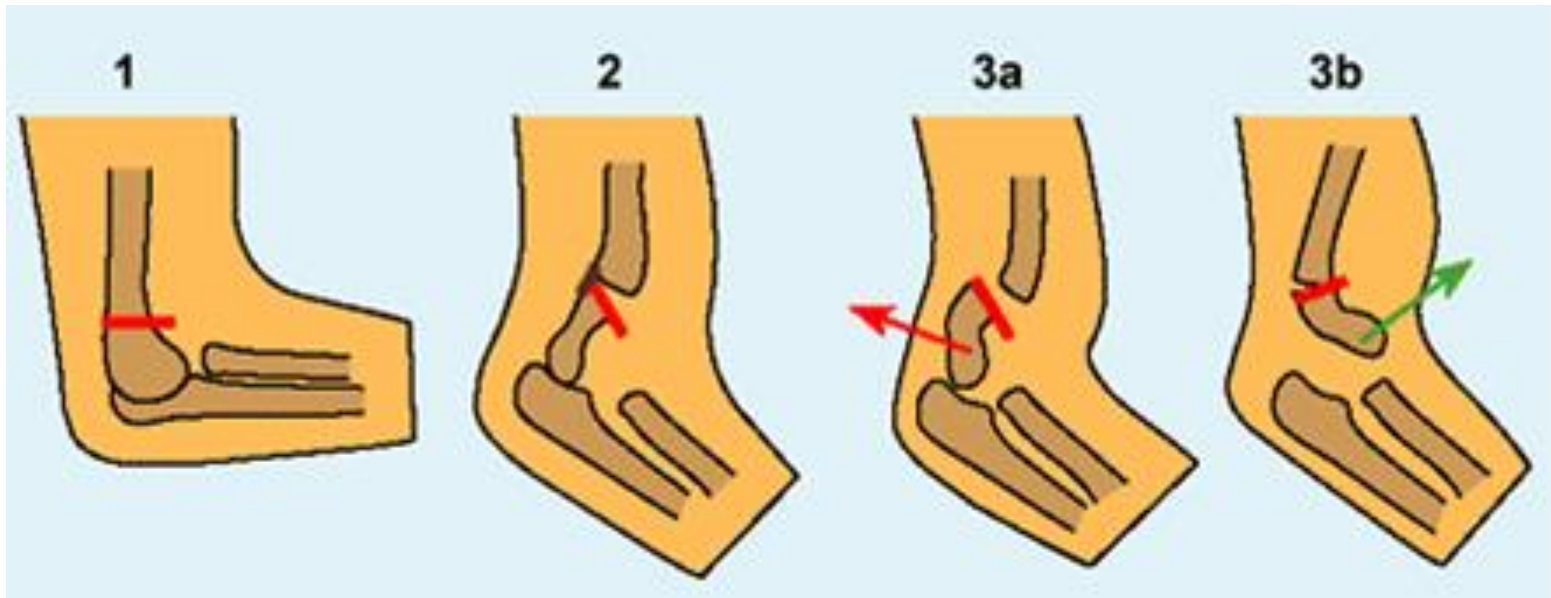
- Indirect:
 - Extension type
 - >95%
- Direct:
 - Flexion type
 - < 3%

Supracondylar #- Clinical Evaluation

- Look:
 - Swollen
 - S-shaped angulation
 - Pucker sign (dimpling of the skin anteriorly)
 - May have bursae
- 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



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Supracondylar #- Gartland Classification

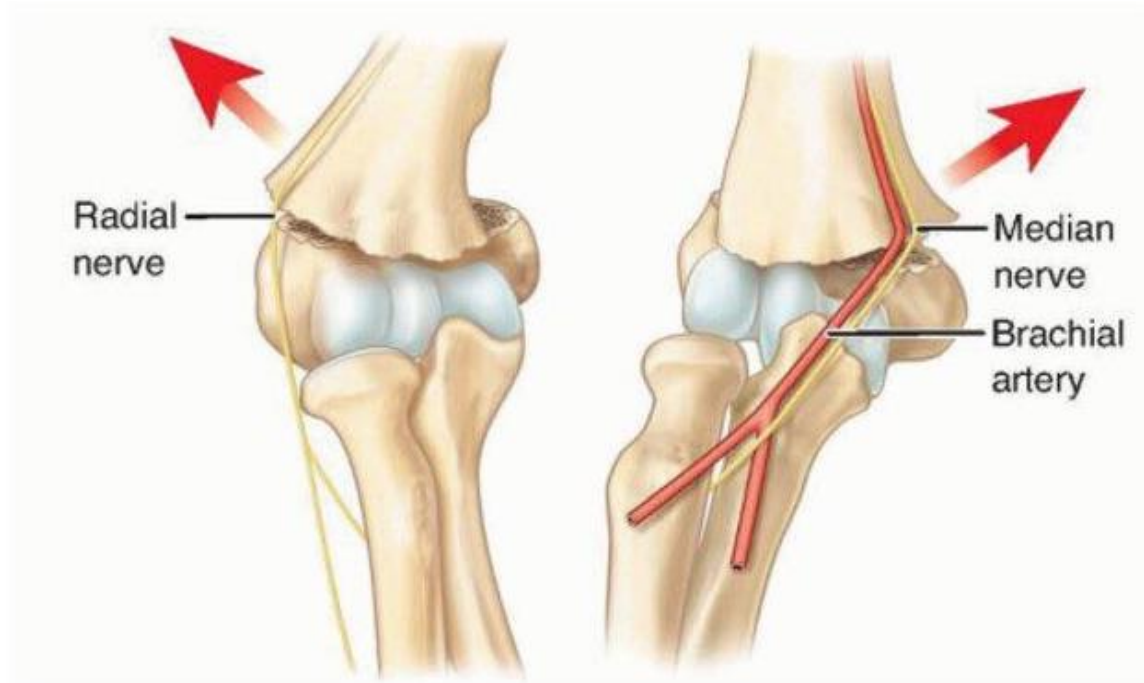
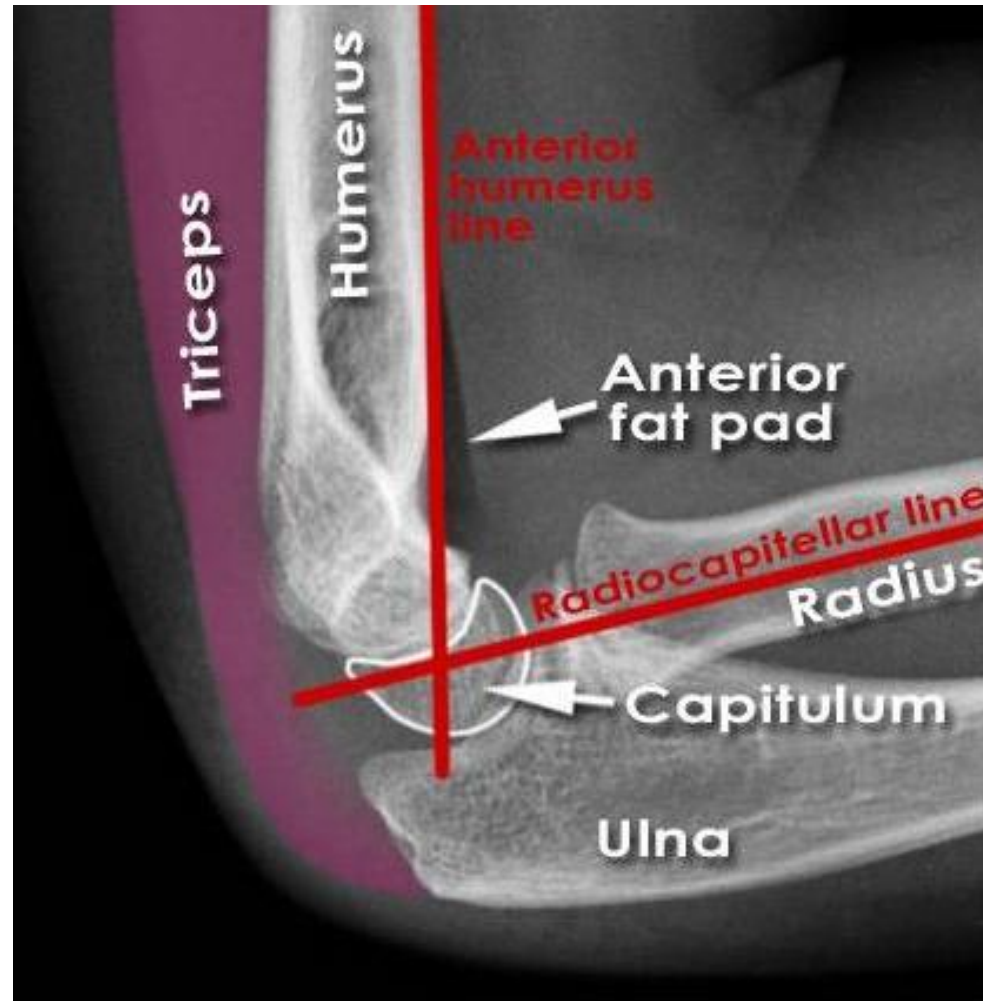


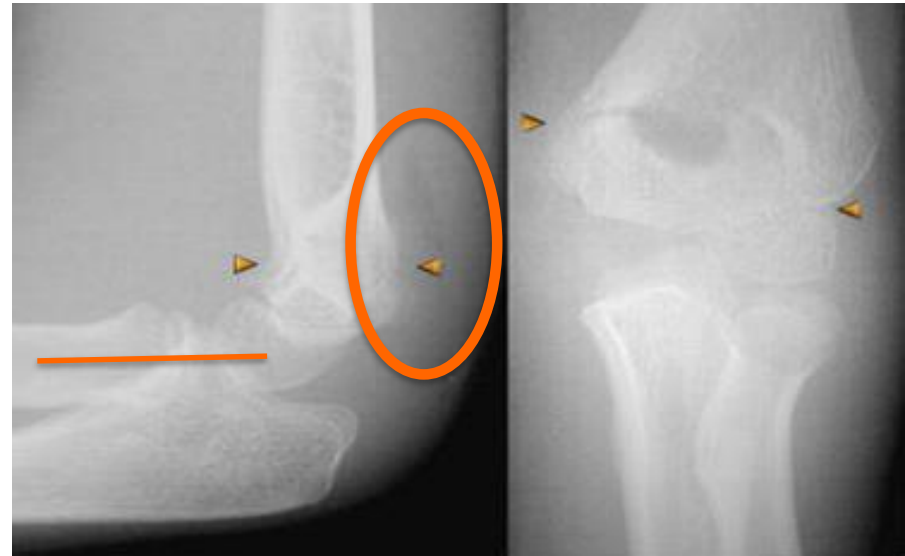
FIG 2 • Relationship to neurovascular structures. The proximal metaphyseal spike penetrates laterally with posteromedially displaced fractures and places the radial nerve at risk. With posterolaterally displaced fractures, the spike penetrates medially and places the median nerve and brachial artery 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)
 - 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 & pinning (ORIF)
 - For 4-6 weeks
 - Direct ORIF if → open #

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 #-



Distal Radial Fractures (Metaphysis)

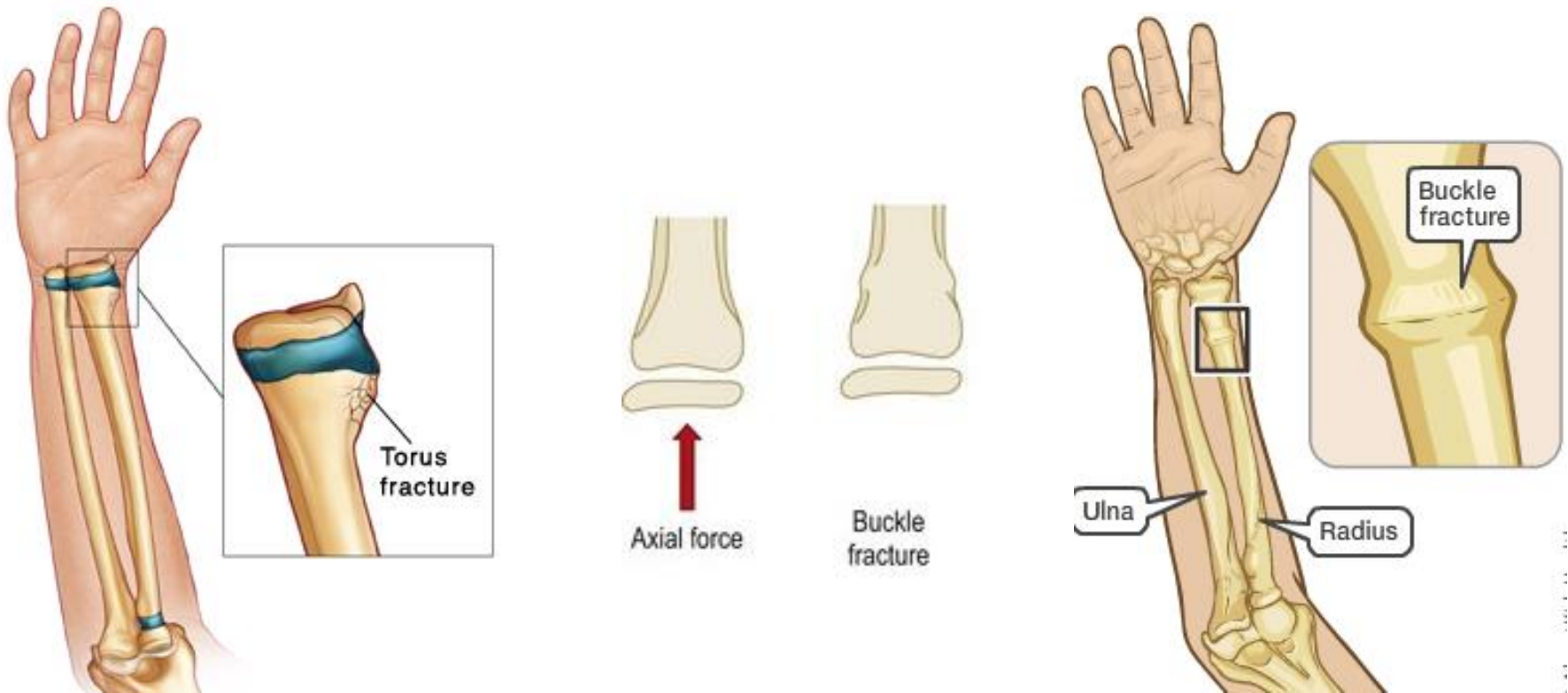
Classification

- 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

Incomplete (greenstick):

- Greater ability to remodel (why ?)
- Closed reduction and above elbow cast



Distal Radius Metaphyseal Injuries

Complete fracture:

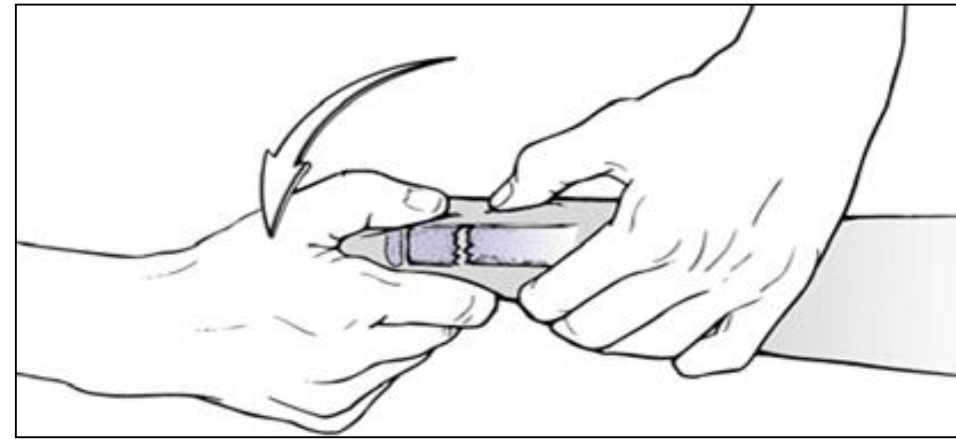
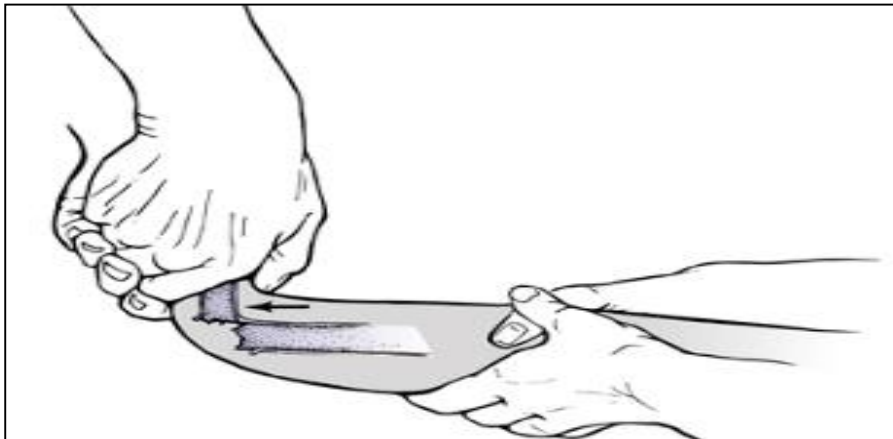
- Closed reduction, then well molded above elbow cast for 6-8 w
- Or open reduction and fixation (internal or external)



Distal Radius Metaphyseal Injuries

Complete fracture:

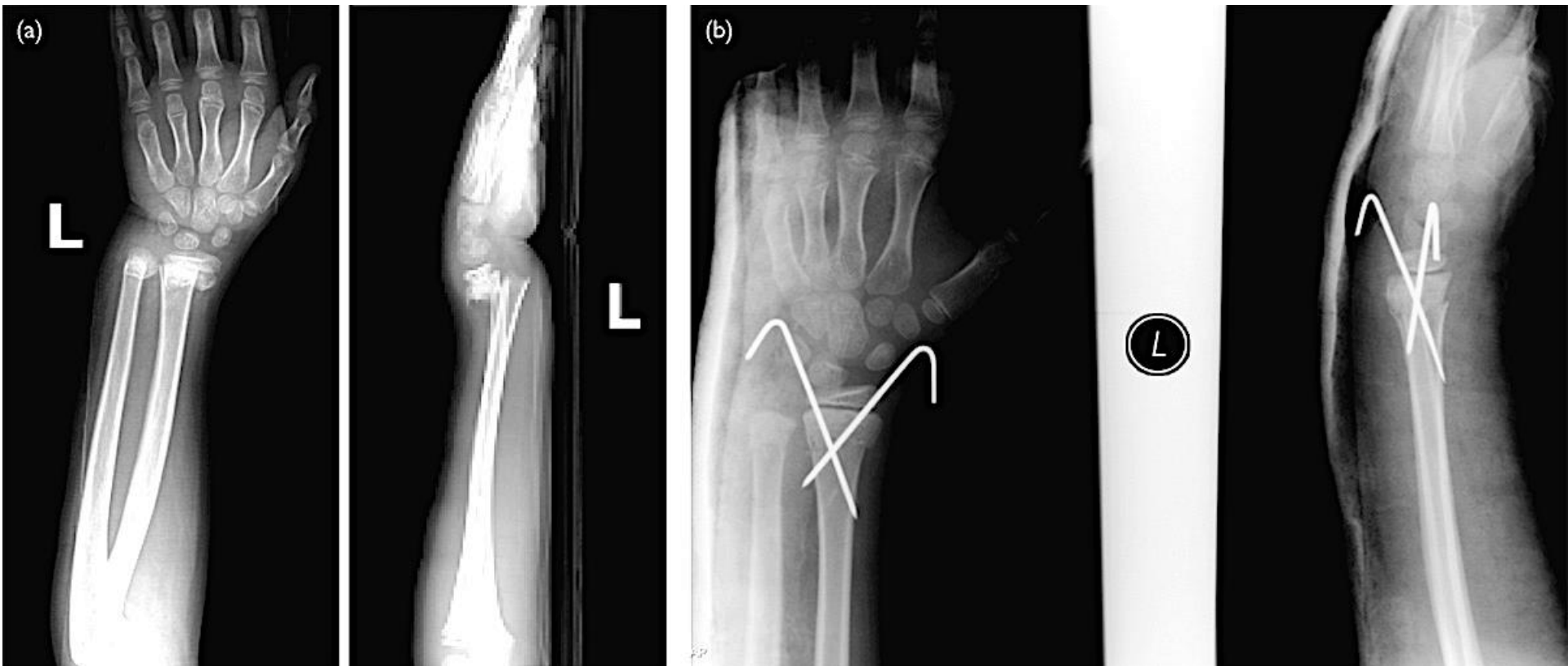
- Closed reduction, then well molded above elbow cast for 6-8 w



Distal Radius Metaphyseal Injuries

Complete fracture:

- Or open reduction and fixation (internal or external)

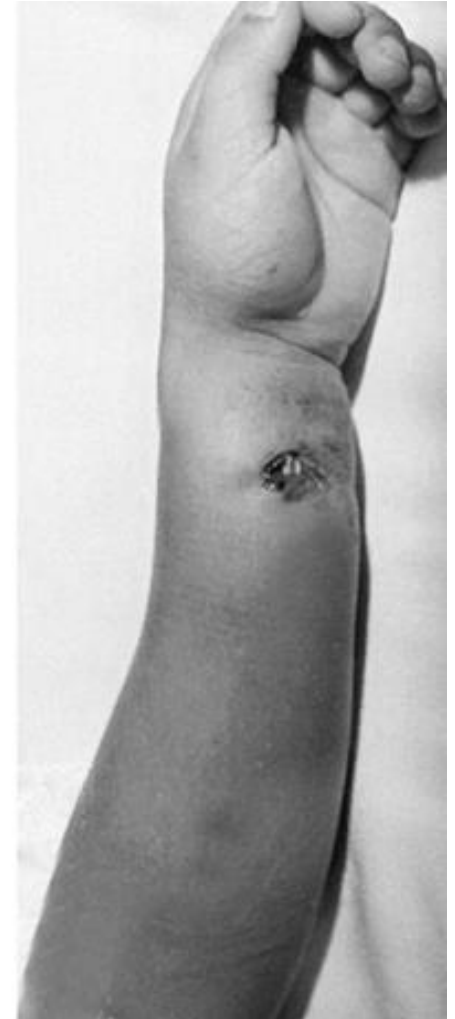


Distal Radius Metaphyseal Injuries

Complete fracture:

Indications for ORIF:

- 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 #-



Distal Radial Physeal #-



Distal Radial Physeal #- Treatment Types I & II

- Closed reduction followed by above elbow cast
- 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 II



AP

Lat

Distal Radial Physeal #- Treatment Types II

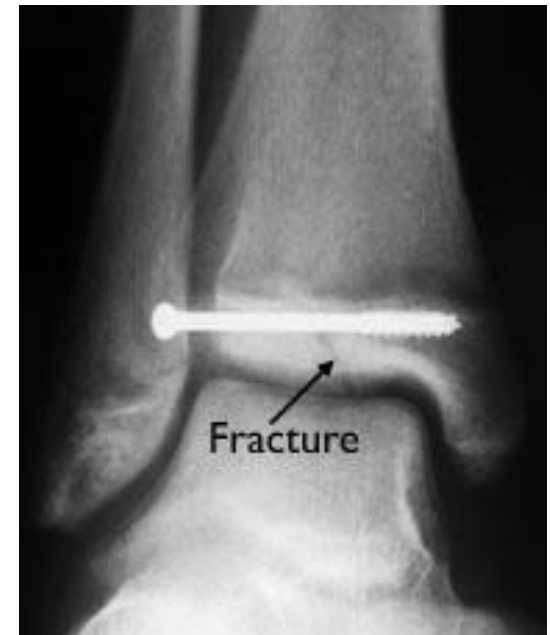


Distal Radial Physeal #- Types III



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

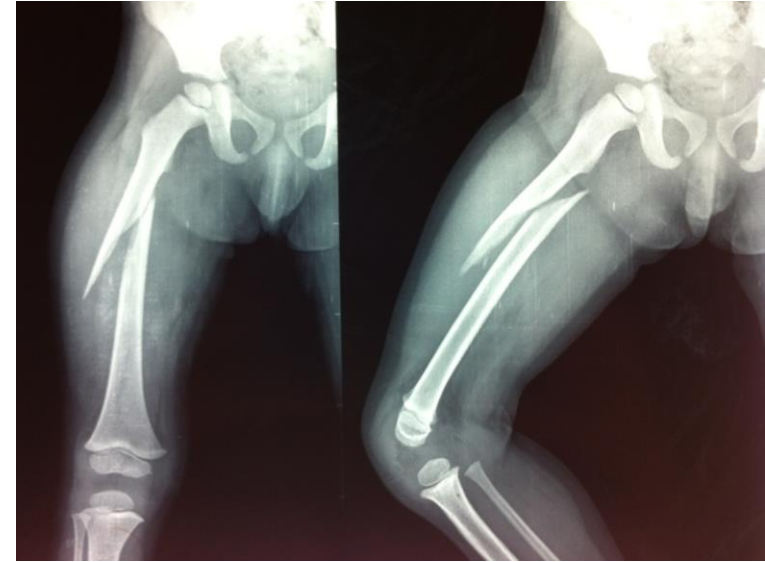
- 1.6% → of all pediatric #
- M > F
- Age:
 - (2 – 4) years years old
 - Mid-adolescence
- Adolescence → >90% due to RTA

Femoral Shaft #- Mechanism of Injury

- Direct trauma:
 - RTA,
 - Fall, or
- 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 #- Treatment

< 6m:

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



Femoral Shaft #- Treatment

6m – 6y:

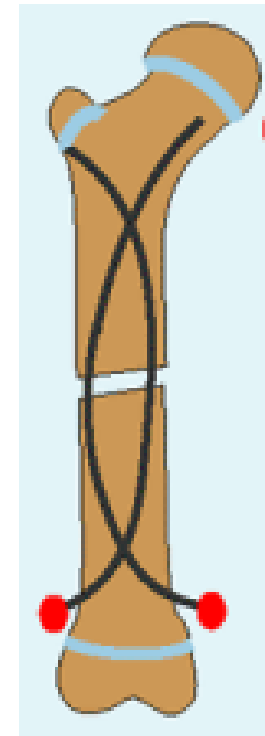
- Closed reduction & immediate hip spica casting (>95%)
- Or traction 1-2w, then hip spica casting



Femoral Shaft #- Treatment

6 – 12y:

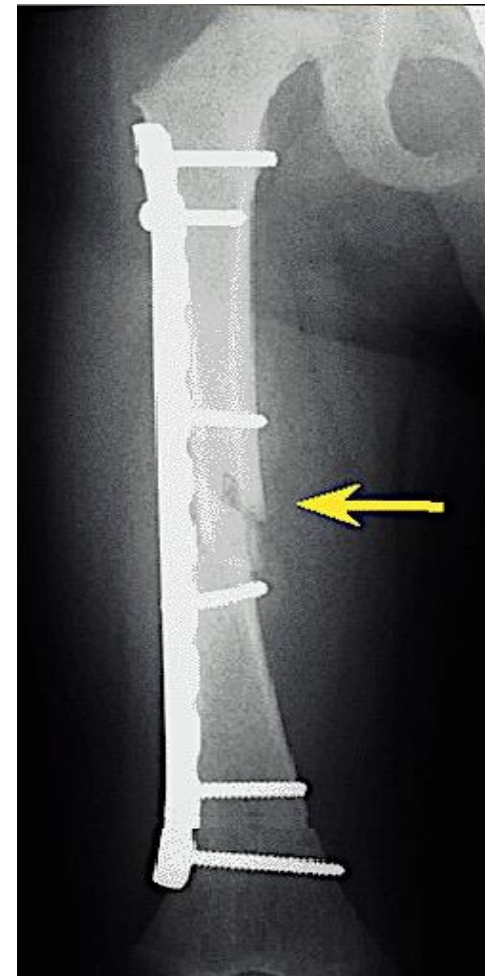
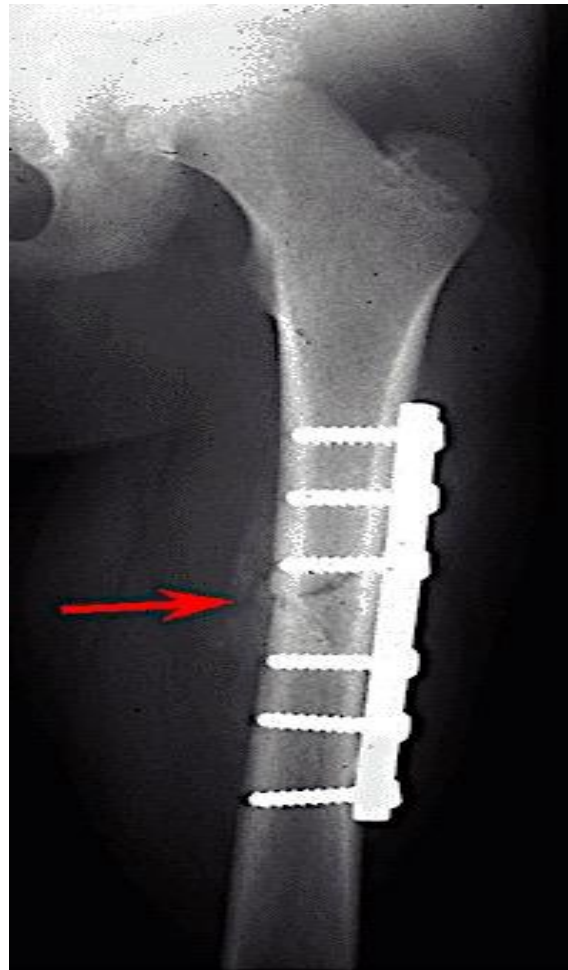
- Flexible I.M.N
- Bridge Plating
- External Fixation



Femoral Shaft #- Treatment

6 – 12y:

- Flexible IMN
- Bridge Plating
- External Fixation



Femoral Shaft #- Treatment

6 – 12y:

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



Femoral Shaft #- Treatment

12y to skeletal maturity:

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



Femoral Shaft #- Treatment

Operative Indications:

- 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
- Muscle weakness
- Nonunion (rare)

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