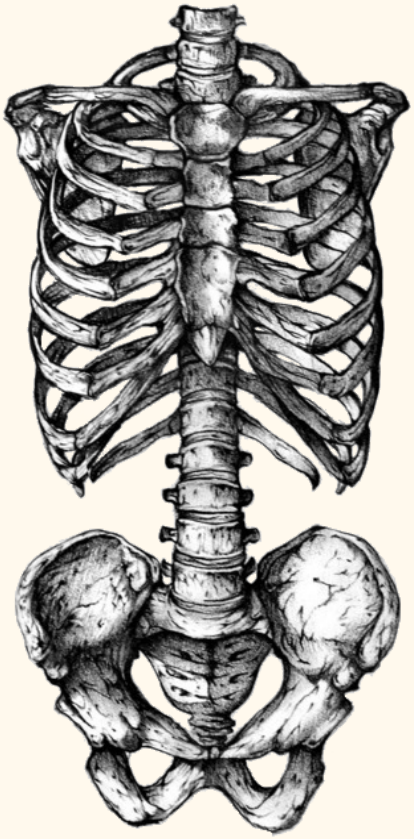
جامعة الملك سعود
King Saud University

434 Orthopedics Team

Lecture 11

Common Pediatric fractures



Objectives

1-Introduction

2-Difference between Pediatrics & adult

3-Physis fractures, Salter-Harris classification

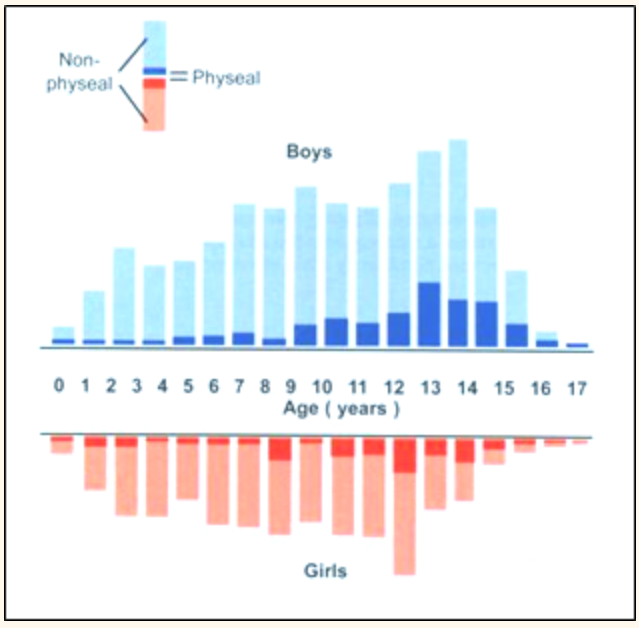
4-Indications of operative treatment

5-Methods of treatment of Pediatrics fractures & trauma

6-Common Pediatrics fractures:
U.L clavicle, humeral supracondylar, distal radius
L.L femur shaft

Introduction

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



Why are Children's Fractures Different ?

Children have different physiology and anatomy.

1. Growth plate:
   -Perfect remodeling power
   -Injury of growth plate may cause:
   Angular deformity Or leg length inequality (L.L.I)
   -A fracture might lead to overgrowth

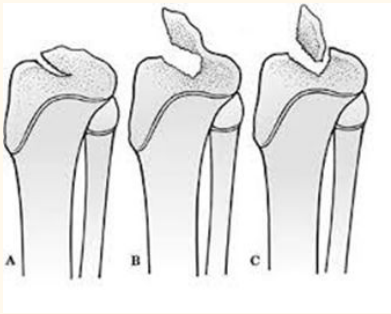
2. Bone:
   -Increased (collagen:bone) ratio

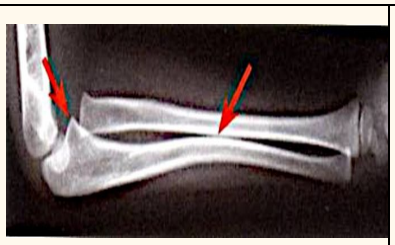
Less brittle
Deformation

3. Cartilage:
   Difficult X-ray evaluation
   Size of articular fragment often under-estimated
4. Periosteum:
   -Metabolically active
   More callus, rapid union, increased remodeling
   -Thickness and strength
   May aid reduction
   Intact periosteal hinge effects fracture pattern
   -We don't see it in adult only pediatric

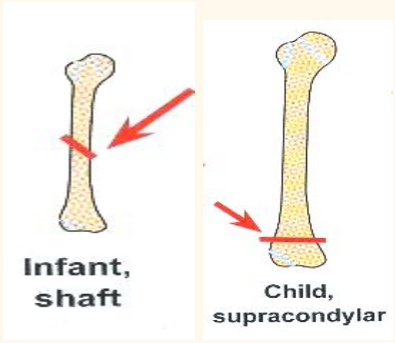
5. Ligaments:
   -Functionally stronger than bone.
   -Higher proportion of injuries that produce sprains in adults result in fractures in children.
   -You'll never hear a child with ACL tear

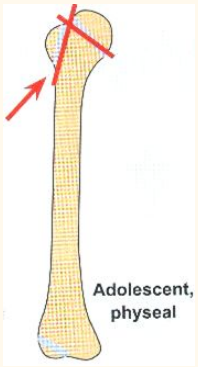
6. Age related fracture pattern:
   Infants ---> diaphyseal
   Children ---> metaphyseal
   Adolescents ---> epiphyseal
7. Physiology:
   Better blood supply
   Rare incidence of delayed and non-union

Growth plate In the picture lateral side is arrested and medialis continue to grow "genu valgus deformity"	Bone • Picture shows the cortex and periosteum are intact, It's not a fracture it's called plastic deformation • The younger the patient the more you will see this.	Ligaments 



Age related fracture pattern





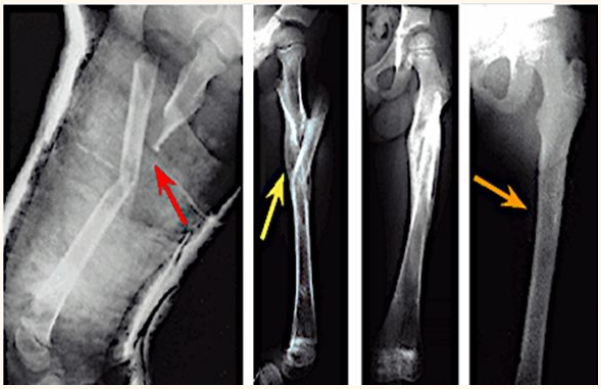
Cartilage

We always operate if it involves the lateral condyle because the size of fracture is underestimated

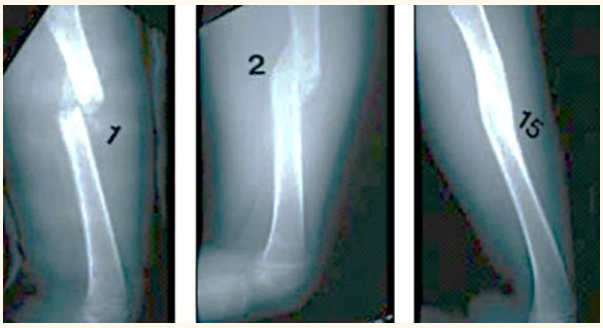
Examples of Remodelling in children

We only realign the bone then apply casting, NO SURGERY.

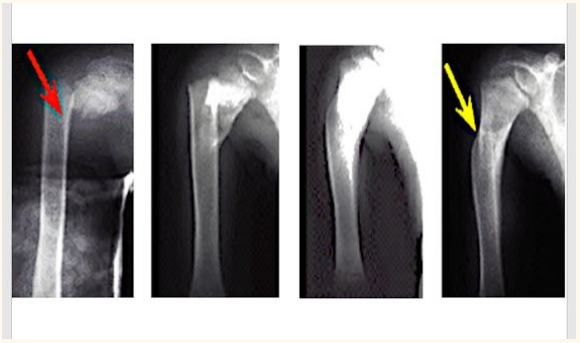
Fracture in the humerus of newborn



Femur fracture Big callus forms Remodelling



Union happened



Fracture in the humerus

*In infants we don't use cast, instead we use tongue depressor.
*Fractures near to a joint that moves everywhere (shoulder) and near to epiphysis ---> Better for remodeling.

Physis injuries

The growth plate, or physis, is the translucent, cartilaginous disc separating the epiphysis from the metaphysis and is responsible for longitudinal growth of long bones.

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

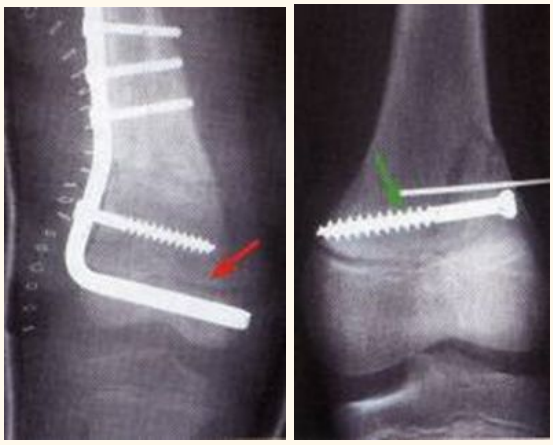
Classification (Salter-Harris)

Type I: Through the growth plate. It doesn't appear on the x-ray, so usually request an x-ray to the other side
Type II: Growth plate with metaphysis
Type III: Growth plate with epiphysis. “Intra-articular”, one of the complication is premature osteoarthritis
Type IV: Growth plate with metaphysis and epiphysis
Type V: Compression

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

Type IV (corrected with K-wires and screws)



Indications of operative treatment

- Open fractures
- Severe soft-tissue injury
- Fractures with vascular injury
- Compartment syndrome “it depends when patient came to hospital(6 gloden hours)”
- Multiple injuries
- Displaced intra articular fractures (Salter-Harris III-IV)
- Failure of conservative means (irreducible or unstable fractures’s)
- Malunion and delayed union
- Adolescence
- Head injury “because they’ll develop a lot of callus”
- Neurological disorder
- Uncooperative patient

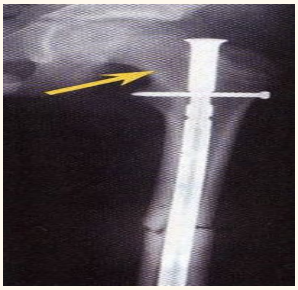
Methods of Treatment of Pediatric Fractures & Trauma

Immobilization and fixation

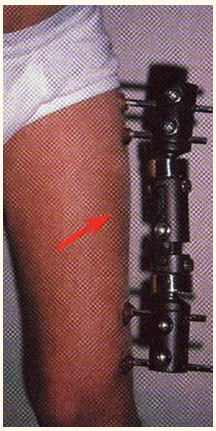
1- casting (the commonest)
2- K-wires :
Most commonly used internal fixation (I.F), Usually used in metaphyseal fractures
*Inserted percutaneously in OP under GA
3- Intramedullary wires (Elastic nails)
4- Screws
5-Plates--->specially in multiple trauma
6- I.M.N--->only in adolescents (>12y)
Above 12 years because the greater trochanter growth plate is near to the entry point of Piriformis fossa. So, the older the child the less chance to have AVN (Avascular necrosis).
7- Ex-fix--->usually in open wounds
8- combination of the above Ex: plates and screws or K-wires and screws

Cast 	K-wires  	Intramedullary wires(Elastic nails) 
Screws Before	Plates	I.M.N (Intramedullary nail)

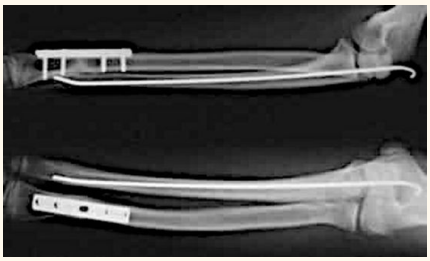
After



Ex-fix



Combination of methods



Common Pediatric fractures

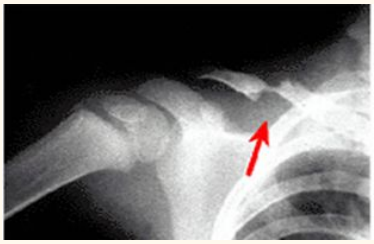
Clavicle fracture

8-15% of all pediatric fractures
0.5% of normal SVD
1.6% of breech deliveries
90% of obstetric fractures
80% occur in the shaft of clavicle
The periosteal sleeve always remains in the anatomic position (remodeling is ensured)
We should check neurovascular and pulmonary function status.
AP view on X-ray is enough

Mechanism of 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

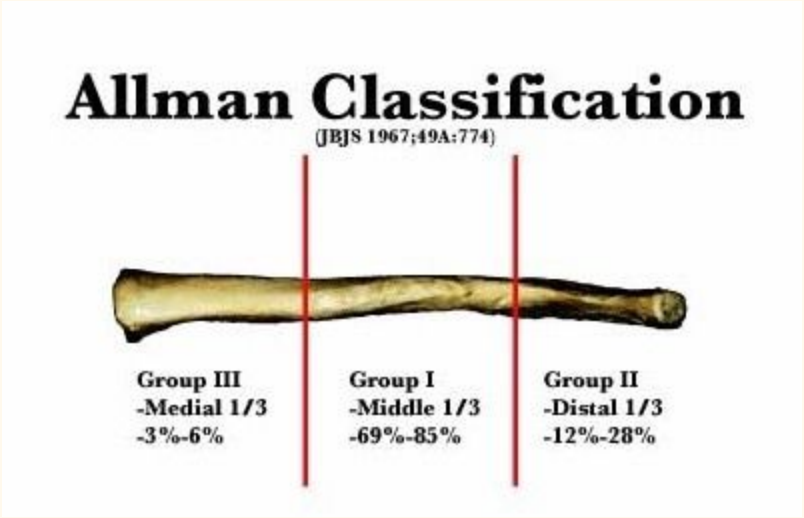
Examination:
Look ---> Ecchymosis, swelling and tinting of skin
Feel:
Tender fracture site
As a palpable mass along the clavicle (as in displaced fracture)
Painful palpable mass along the clavicle, Pain comes from the periosteum
Because it is innervated
Crepitus (when lung is compromised) "We don't do crepitus clinically, it'spainful",
Special tests Must assess for any:
N.V injury, Pulmonary injury

Reading X-ray: AP view

-Location:
(medial, middle, lateral) ⅓ ---> commonest middle ⅓
Commonest fracture site : middle/lateral ⅓
-Open or closed see air on XR
-Displacement %
-Fracture type: segmental, comminuted, greenstick.

Allman classification:
Type I : Middle third (most commonest)
Type II: Lateral third
Type III: Medial third

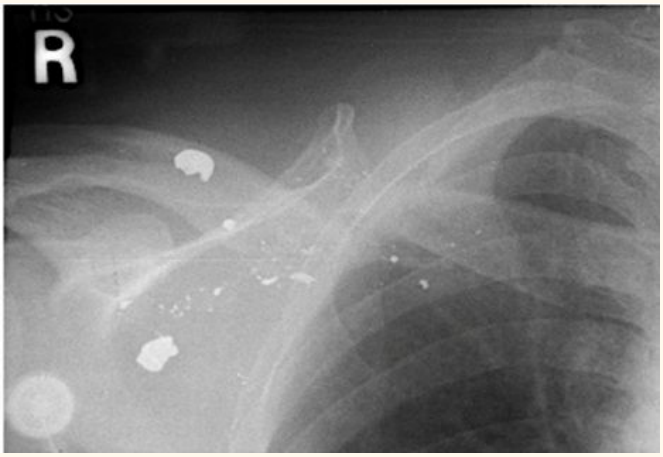


Treatment: (easily treated if there is no N.V or pulmonary injury)
-Newborn (< 28 days):
No orthotics , Unite in 1w
-(1m – 2y):
Figure-of-eight For 2w
-(2 – 12y):
Figure-of-eight or sling For 2-4 weeks



Indications of operative treatment:

Open fractures, or Neurovascular compromise



Complications: (rare)

-From the fracture:

Malunion

Nonunion

Secondary from healing:

Neurovascular compromise
Pulmonary injury
-In the wound:
Bad healed scar
Dehiscence
Infection

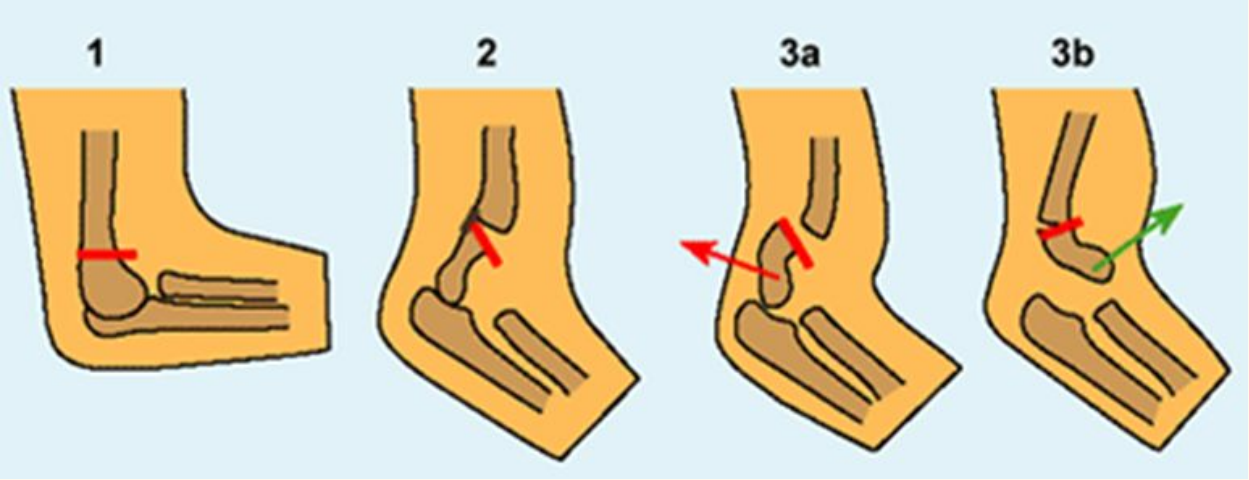
Humeral supracondylar fracture

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

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

Examination:
-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:
Nerves: Median, radial, and ulnar nerves as well as their terminal
branches.
o The commonest nerve to be injured is:
1- Anterior interosseous nerve, which is branch from the median nerve and it is associated more with extension.
2-The way to assess: ask the patient to do (ok)sign.
Vascular: Brachial. Capillary refill and distal pulses should be documented.

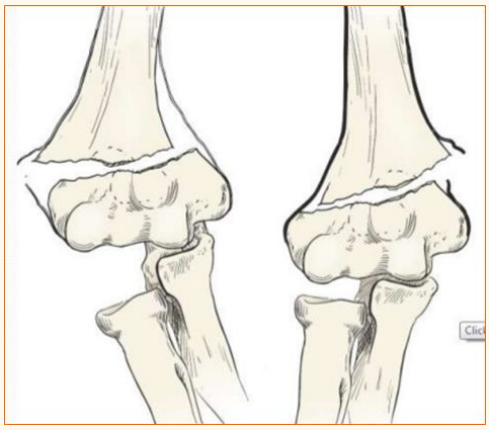
Gartland classification: (Radiological classification)



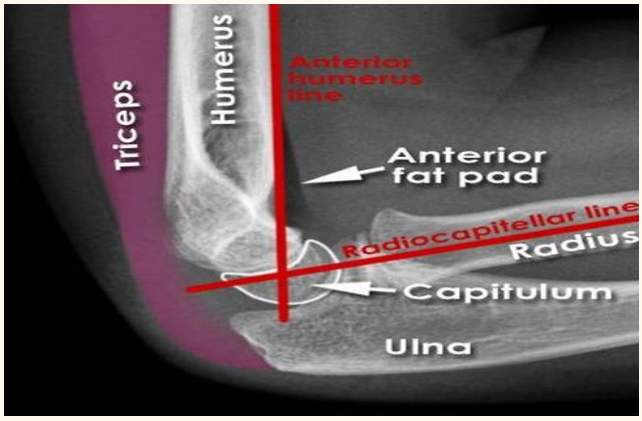
Type 1:No displacement.

Type 2: Minimal displacement.

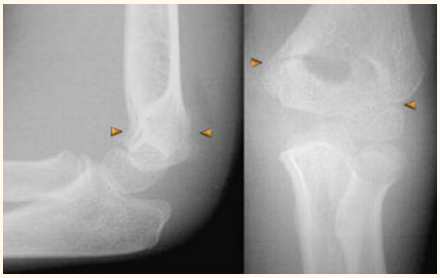
Type 3: Complete displacement, if it's going backward (3a):Extension fracture "indirect Trauma"... Forward (3b): Flexion fracture "direct trauma". may be: Posteromedial (75%), or Posterolateral (25%)



Normal X-ray:



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

Type 1	Type 2
 	

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<tr><td>Type 3 (Extension)
 
</td><td>Type 3 (flexion)
 
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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 fracture

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)

-Loss of motion (stiffness)

-Myositis ossificans "Ossification that occurs in muscles. Bone in muscles ---> Complete stiffness"

-Angular deformity (cubitus varus)

-Compartment syndrome

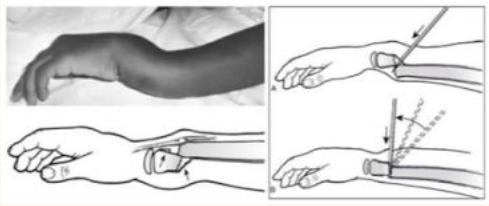
Volkmann's contracture is a permanent flexion contracture of the hand at the wrist, resulting in a claw-like deformity of the hand and fingers. Passive extension of fingers is restricted and painful.

Distal radial fracture (Metaphysis)

• We accept more angulation in pediatrics, the younger the child the more angulation we accept.
• Direction of displacement.
• Involvement of the ulna.

Types according to pattern

1- Torus (buckle) only one cortex is involved while periosteum is intact
Are stable, Immobilized for pain relief in below elbow cast, 2-3 weeks
Bicortical injuries should be treated in long arm cast.
2- Incomplete (greenstick)
Greater ability to remodel (why ?), Closed reduction and above elbow cast with supinated forearm "Anatomical position" to relax the brachioradialis muscle.
3- Complete
Closed reduction, then well molded above elbow cast for 6-8 weeks, Or open reduction and fixation (internal or external)
Indications for percutaneous pinning without open reduction:
• Loss of reduction.
• Excessive swelling.
•Floating elbow. "Fractured radial, ulnar and humerus"
• Multiple manipulations.



Indications for ORIF:
•Irreducible fracture
•Open fracture
•Compartment syndrome

Buckle	Greenstick	Complete



Complications of distal radius fractures :

- Malunion :Residual angulation (more than 20%) may result in loss of forearm rotation
- Nonunion (Rare)
- Refracture: With early return to activity (before 6 weeks) “needs surgery”
- Growth disturbance : Overgrowth or undergrowth (3mm/9-12yrs)
- Neurovascular injuries: With extreme positions of immobilization

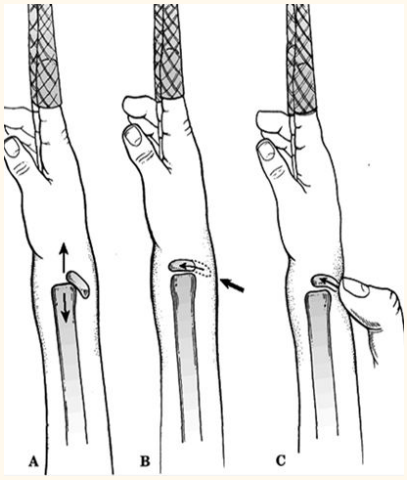
Distal Radial Physeal fractures

Type 1	Type 2	Type 3
 		

Treatment for Distal Radial Physeal fractures

- For Type 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 fracture or Open fracture

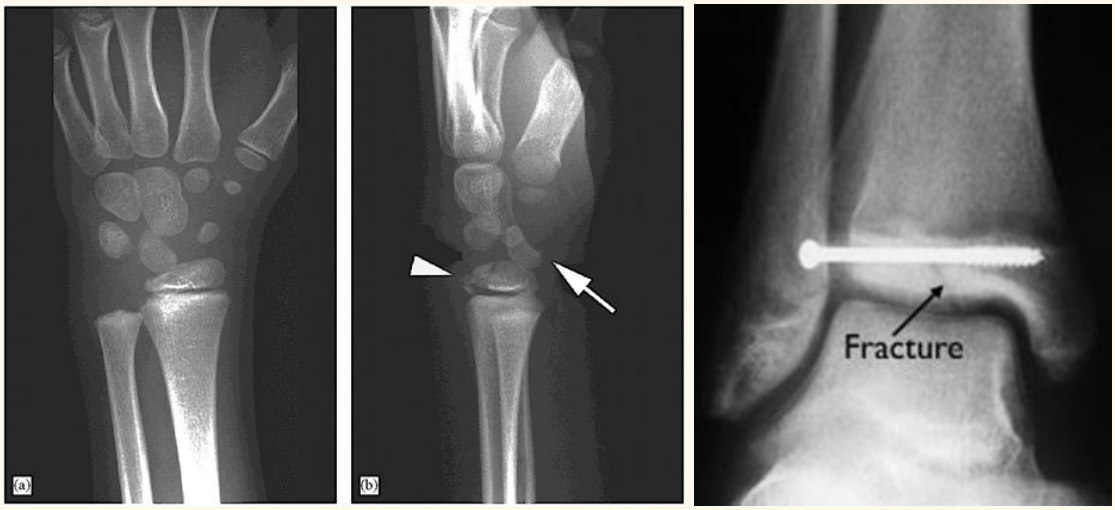






- For Type III

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



- For Type IV & V

Rare injuries

Need ORIF

Complication of distal radial <u>physeal</u> fracture:

- Physeal arrest
- Shortening
- Angular deformity (MRI to assess)
- Ulnar styloid nonunion
- Carpal tunnel syndrome

Femoral shaft fracture

1.6% of all pediatric fractures
M > F
Age: (2 – 4) years years old , Mid-adolescence
Adolescence >90% due to RTA
In children younger than walking age, 80% of these injuries are caused
By child abuse ;this decreases to 30% in toddlers.

Mechanism of injury:
-Direct trauma: RTA, Fall, or child abuse
-Indirect trauma: Rotational injury
-Pathologic fractures:
Osteogenesis imperfecta
Nonossifying fibroma
Bone cysts
Tumors
How to know if it's direct or indirect from x-ray? Transverse and Comminuted fractures are direct; the spiral is indirect.

Examination:
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 fracture site
Careful neurovascular examination is essential

Radiological examination:
AP and lateral view, must include Hip and knee joint

Classification:

• Descriptive:

o Openversus closed.

o Levelof fracture: proximal, middle, distal third.

o Fracture pattern: transverse, spiral, oblique, butterfly fragment.

o Comminution.

o Displacement.

o Angulation.

• Anatomic:

o Subtrochanteric Shaft.

o Supracondylar.

Treatment:

- < 6m:
  Pavlik Harness
  Closed reduction & immediate hip spica casting
  Or traction 1-2w, then hip spica casting



- 6m – 6y:
  Closed reduction & immediate hip spica casting (>95%)
  Or traction 1-2w, then hip spica casting

- 6 – 12y:
  -Flexible IMN

-Bridge Plating
-External Fixation:
Multiple injuries
Open fracture
Comminuted fractures
Unstable patient

- 12y to skeletal maturity:
  Intramedullary fixation with either:
  Flexible nails, or Locked I.M nail

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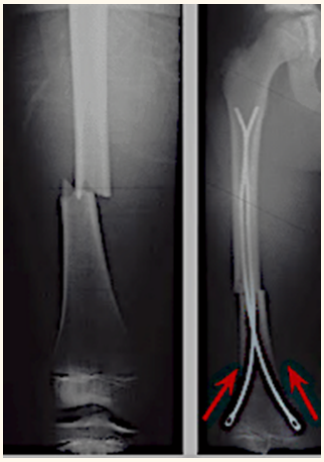
<tr><td>  </td><td>Bridge plating
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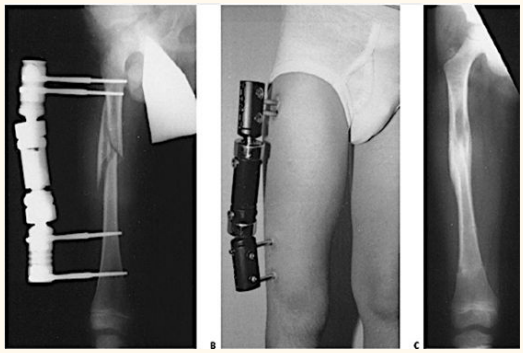

Operative Indications:
Multiple trauma, including head injury
Open fracture
Vascular injury
Pathologic fracture
Uncooperative patient

Complications:
Malunion
Remodeling will not correct rotational deformities
Leg length discrepancy: Secondary to shortening or Overgrowth of 1.5 to 2.0 cm is common in 2-10year of age.
Muscle weakness
Nonunion (rare)
Osteonecrosis with antegrade ” it means from knee and above” IMN <16 year.

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