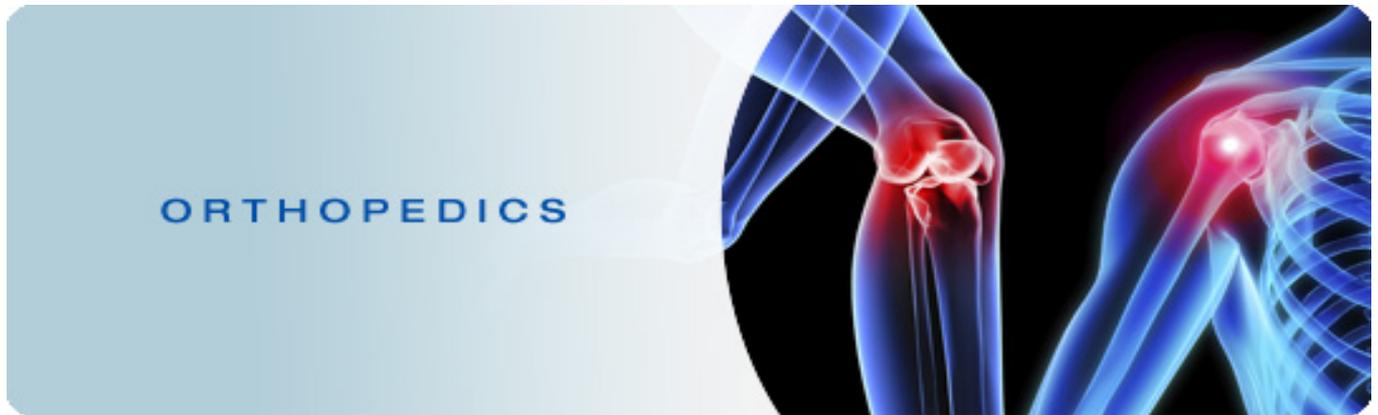


Isn't it funny how someone can say "I believe in Allah " but still follow the Satan who by the way also, " believes " in Allah...

430 ORTHOPEDICS TEAM



Lecture:((Common Pediatric Fractures))

Team Members:

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Hanan Al-Salman.

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Hadeel Al-Ghamdi.

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Nouf Al-Hammad.

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Nour Al-Enezi.

Wejdan Al-Swayyid.

Arwa Abudawood.

Leena Al-Shaman.

Areej Al-Qunaitir.

Team Leader:

Ayedah Al-Ruhaimi.

Special thanks to Norah Al-Turki

-The slides were provided by the doctor .

-Important notes in **Red**.

-Doctor's notes in **green/blue**.

-Copied slides in **Black**.

-MCQ in highlight.

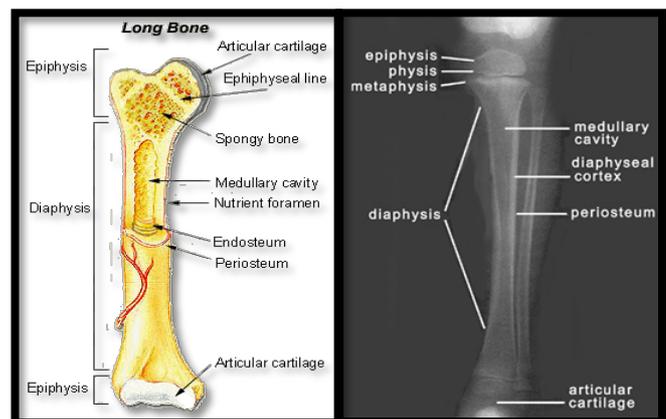
Objectives:

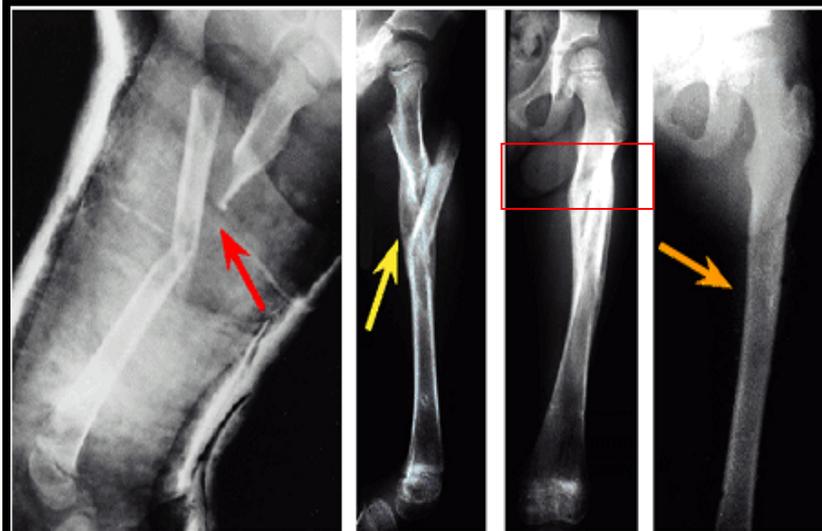
- ✓ know most of the mechanism of injury
- ✓ make the diagnosis of common pediatric fractures
- ✓ request and interpret the appropriate x-rays
- ✓ initiate the proper management of fractures
- ✓ Know which fractures can be treated by conservative or operative methods and the ways of fixation.
- ✓ Know the possible complications of different fractures and how to avoid them.

The different between adult and pediatric bones

- Pediatric bone has a higher water content and lower mineral content per unit volume than adult bone so less brittle than adult bone. (**weak bones**)
- The physis (growth plate) is a unique cartilaginous structure is frequently **weaker than bone** in torsion, shear, and bending, predisposing the child to injury through it. (**That's why the most common pediatric fractures occur in growth plate**).
- The physis is traditionally divided into four zones that the injury through it can cause shortening, angular deformities. (In the Future).
- The periosteum in a child is a thick fibrous structure and Rich in blood supply than adult bone so there is high remodeling rate. (**Thick periosteum → fast remodeling**)
- **Ligaments in children are functionally stronger than bone.** Therefore, a higher proportion of injuries that produce sprains in adults result in fractures in children.
- **The Growth Plate Diffuses at the age of 16-18 years old, it depends mainly at the location of the growth plate.**
- **Twisted injury in adults will give you spiral Fracture but in Pediatric will give you injury to the growth plate.**

Immature bone (Pediatric bone)

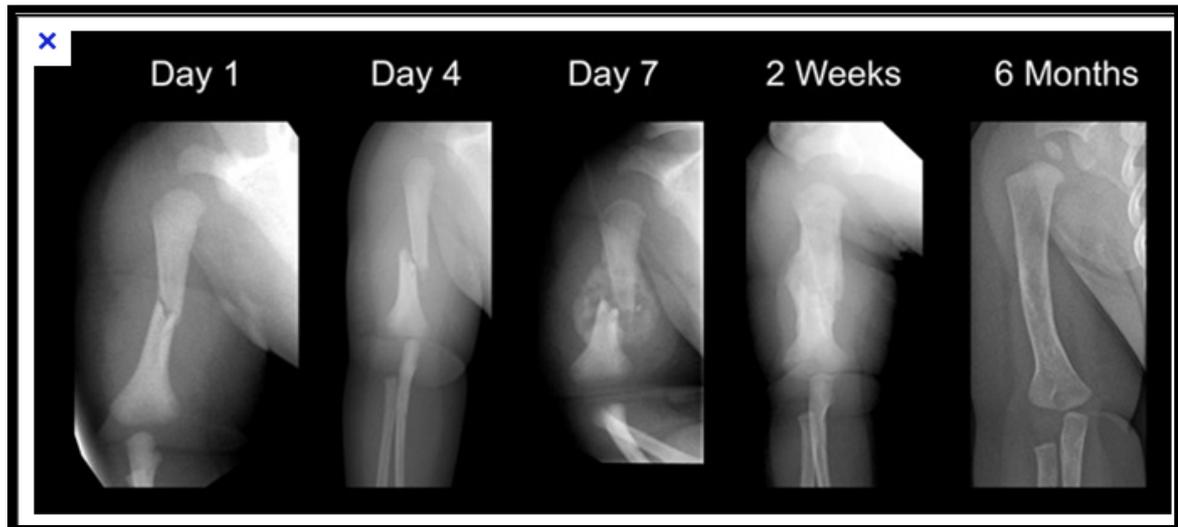




E Remodeling of femoral shaft fracture This segmental fracture in an 8-year-old girl was managed in traction and in a cast (red arrow). Note the filling in of the periosteal sheath at 6 months (yellow arrow) and restoration of normal femoral shape at age 13 years (orange arrow).



F Remodeling of the humerus This 8-year-old boy shows a complete loss of apposition (red arrow). Note the remodeling over the next 2 years (yellow arrow).



Because of Periosteum, the Bone will remodel very well!

Common Pediatric Fractures:

☒ Upper limb:

Clavicle, supracondylar Fracture (**the most common upper limb fracture**) and distal Radius.

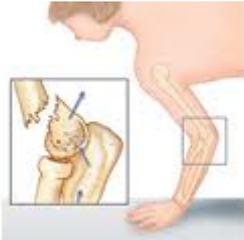
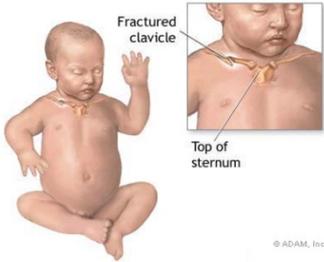
☒ Lower Limbs:

Femur fractures.

A. CLAVICLE FRACTURES

- 8% to 15% of all pediatric fractures.
- 0.5% of normal deliveries and in 1.6% of breech deliveries. (Birth Fracture).
- 90% of obstetric fractures. (During Delivery the baby will get shoulder fracture)
- **80% of clavicle fractures occur in the shaft,(the MIDDLE)**NOT the Proximal or the Distal!
- The periosteal sleeve always remains in the anatomic position. Therefore, remodeling is ensured.

▪ **Mechanism of Injury:**

Indirect	Direct	Birth injury
<p>Fall onto an outstretched hand.</p> 	<p>This is the most common mechanism; it carries the highest incidence of injury to the underlying neurovascular and pulmonary structures.</p>	 <p>Patient will present with pseudo-paralysis of the limbs</p>

▪ **Clinical Evaluation:**

- In Birth fractures: an asymmetric in the Shoulder, palpable mass overlying the fractured clavicle.
- typically present with a **painful (ACUTE) , palpable mass along the clavicle, Tenderness, Decrease Range of Motion (ROM), there may be tenting of the skin, crepitus, and ecchymosis.**
- **Ecchymosis → Subcutaneous Purpura > 1 cm or a Hematoma, commonly called a bruise.**
- Neurovascular status, the brachial plexus and upper extremity vasculature may result.
- Pulmonary status must be assessed. Why? May Penetrate the Lung and Cause Pneumothorax.

▪ **Radiographic Evaluation:**

1. AP view (The most COMMON and important view, it will show the location of the fracture). **No lateral view!**
2. Cephalic tilt view (cephalic tilt of 35 to 40 degrees).
3. Apical oblique view (injured side rotated 45 degrees toward tube with a cephalic tilt of 20 degrees).

AP view

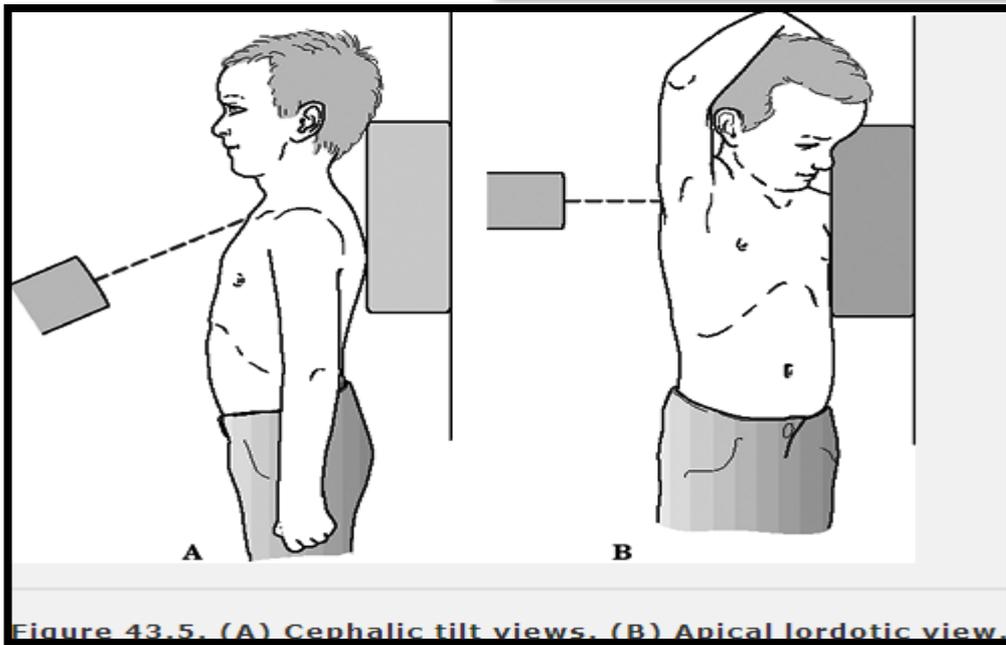
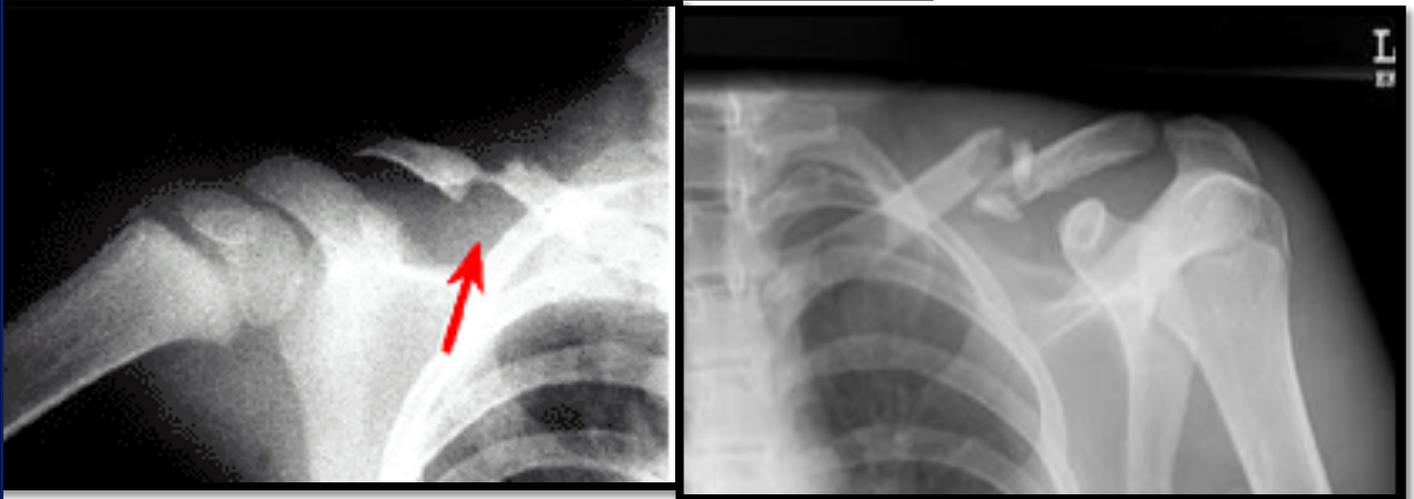


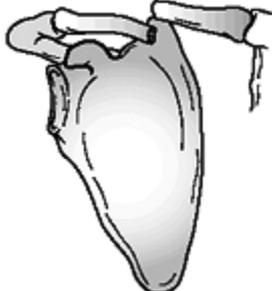
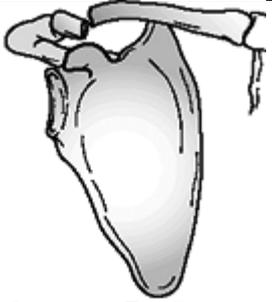
Figure 43.5. (A) Cephalic tilt views. (B) Apical lordotic view.

▪ **Classification (Descriptive):**

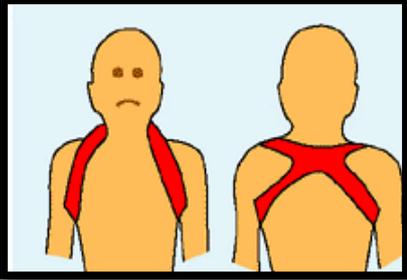
Location, open vs. closed, displacement, and angulation.

Fracture type: segmental, comminuted, greenstick.

▪ **Allman classification: (Another way to Classify):**

Type I	Type II	Type III
<ul style="list-style-type: none"> • Middle third (most common). 	<ul style="list-style-type: none"> • Distal to the coracoclavicular ligaments (lateral third). 	<ul style="list-style-type: none"> • Proximal (medial) third.
 <p style="text-align: center;">B Type I</p>	 <p style="text-align: center;">C Type II</p>	 <p style="text-align: center;">A Type III</p>

▪ **Treatment of clavicle fractures:**

Newborn to Age 2 Years	Age 2 to 12 Years
<p>-Clavicle fracture in a newborn will unite in approximately 1 week.</p> <p>-Infants may be treated symptomatically with a <u>simple sling or (figure-of-eight bandage) applied for 2 to 3 weeks.</u> No Need For Reduction</p> <p>Due to presence of periosteum and the same technique may apply to adults.</p>   <p style="color: green;">The collar Formation will be removed from the body After Healing!</p> <p style="color: green;">So we don't worry about them not like adults.</p>	<p><u>A figure-of-eight bandage or sling is indicated for 2 to 4 weeks.</u></p>  

Indication of operative treatment:

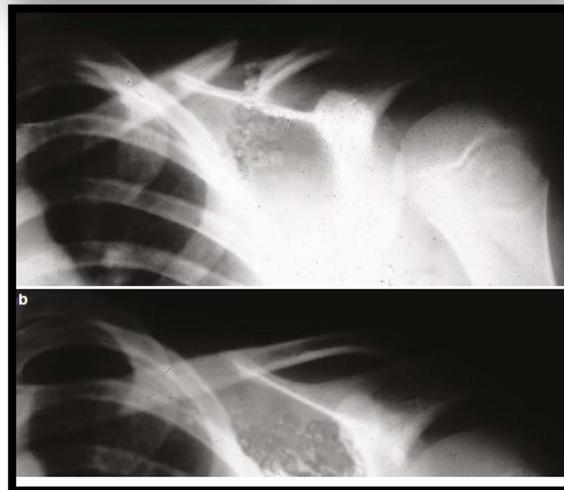
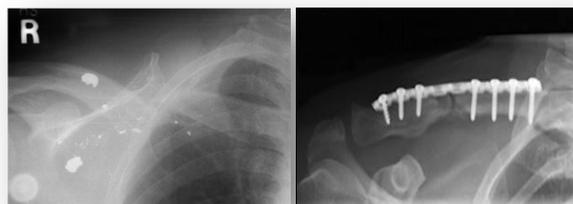
- 1- Open fractures
- 2- Neurovascular compromise

- **99% of The Close Fractures Treated by the closed Method or sling!**

Example of X-ray Mid clavicle fracture: →

- Post conservative treatment
- Healed completely
- With no complications (No Cellus Formation or Angulation)

- **Complications (Rare):**
 - Neurovascular compromise.
 - Malunion.
 - Nonunion.
 - Pulmonary injury.



B. SUPRACONDYLAR FRACTURE

(The Commonest Fracture in Pediatric Age group)

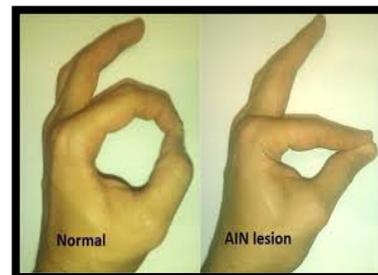
- Comprise 55% to 75% of all elbow fractures.
- The male-to-female ratio is 3:2.
- The peak incidence is from 5 to 8 years, after which dislocations become more frequent.
- The left, or nondominant side, is most frequently injured.
- **Supracondylar fracture is a fracture in the metaphysis.**

▪ **Mechanism of injury:**

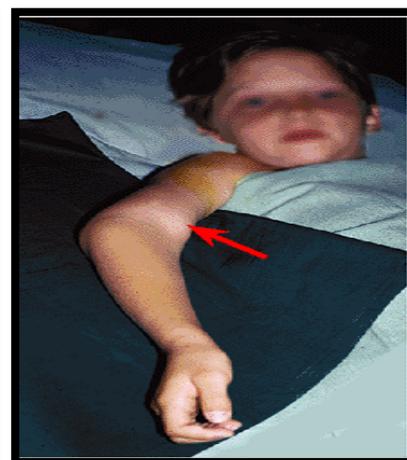
Indirect	Direct
<p>The most common mechanism. Most commonly a result of a <u>fall onto an outstretched (FOOSH)</u> upper extremity. (Extension type >95%).</p> 	<p>A fall onto a flexed elbow or from an object striking the elbow (e.g., baseball bat, automobile). (Flexion type < 3%).</p> 

▪ **Clinical Evaluation:**

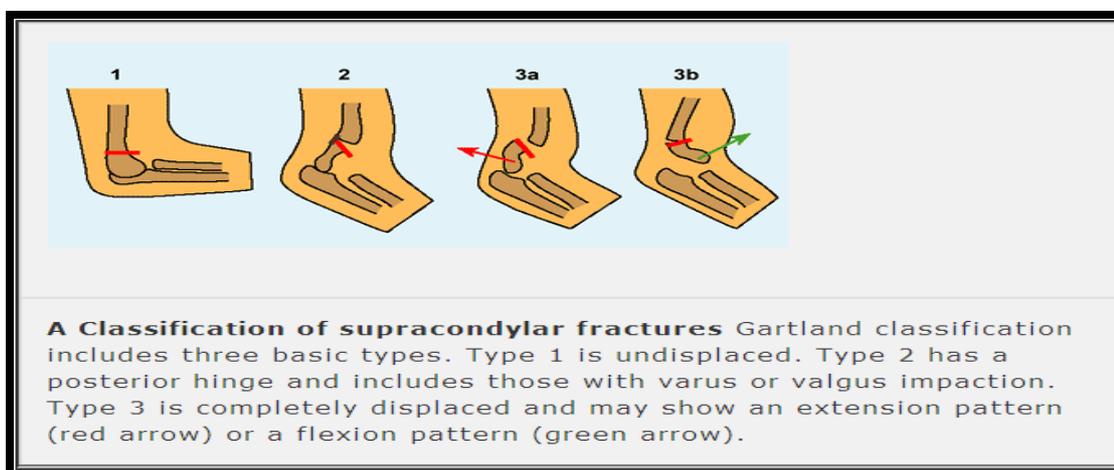
- A swollen, tender elbow with painful range of motion.
- S-shaped angulation at the elbow.
- Pucker sign (dimpling of the skin anteriorly) →
- **Neurovascular examination:** The median, radial, and ulnar nerves as well as their terminal branches. Capillary refill and distal pulses should be documented and the Radial Artery.
- **The commonest Nerve to be injured is: Anterior Interosseous Nerve which is branch from the Median nerve and is associated more with Extension (indirect) Type. The Way to assess: Ask the Patient TO Do (OK) sign (median nerve)!**
- **Muscles involved with median nerve injury → Flexor Polices Longs, Flexor digitorm longs!**
- **E.g. if there is radial nerve injury, there will be wrist drop and loss of sensation in the lateral side.**
- **Ok sign → Median nerve and loss of sensation**
- **Abduction of the thumb → ulnar**
- **You can examine 3 nerves by the thumb!**



Complete Fracture of Supracondylar.



▪ **Gartland Classification:**



X **Supracondylar fractures: Gartland classification**

1. Minimally displaced fracture
2. Displaced distal fragment
 - Intact posterior cortex
3. Complete displacement
 - Posteromedial (75%) posterolateral (25%)

Type 1: Undisplaced - Anterior humeral line pass to Cubetelum, minimally displaced.

Type 1 Diagnosis



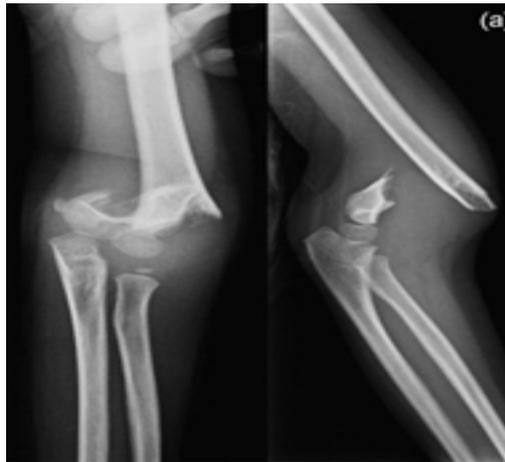
Type 2: Anterior Cortex Disrupted, Posterior cortex intact

Lateral elbow x-ray

AP view



Type 3A: Extension type- posterior medial.



Type 3B: Flexion type -posterior lateral (rare)

AP view elbow



Lateral view

(To differentiate between extension and flexion type)



▪ **Treatment of SUPRACONDYLAR fractures:**

1- Initial approach → in the ER → **ABCDE**

"Close fracture" → apply splint with flexion of 20-30 ° → X-rays → Dx → Tx according to the type. (Apply back-slab if there is swelling, if not → complete cast)

"Open fracture" →

control hemorrhage and correct coagulopathy

- e.g. direct pressure, tourniquets if in extremis
- fluid resuscitation, transfusion of packed cells and other blood products as required

give analgesia and antibiotics early

- e.g. morphine or fentanyl +/- ketamine for analgesia
- see Q10 for antibiotics

Assess the limb and seek/treat complications

- e.g. neurovascular compromise, compartment syndrome, crush injury and rhabdomyolysis

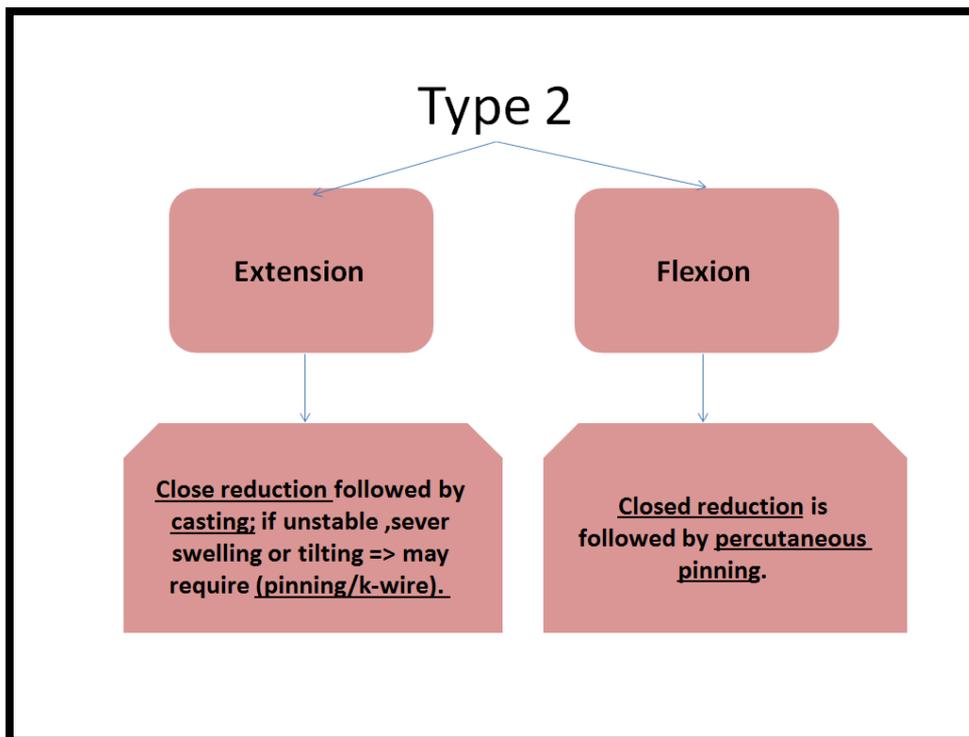
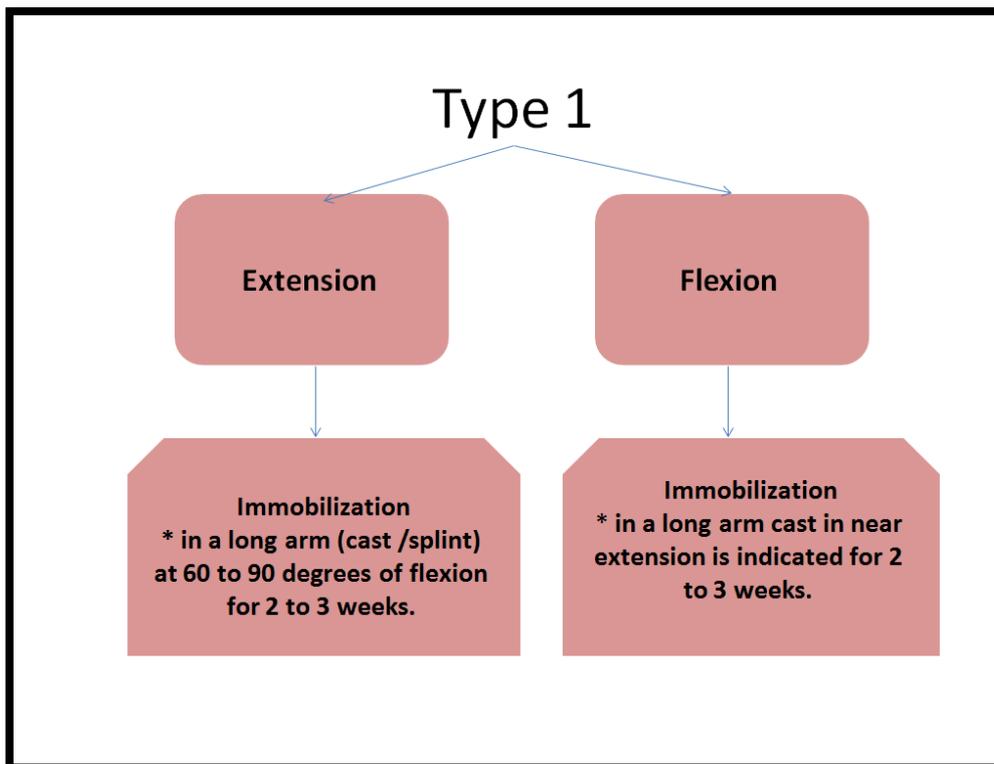
Following the provision of adequate analgesia:

- **remove gross contaminants** from the wound
- if there will be more than a 1 to 2 hour delay in going to the operating theatre for washout and debridement then **clean** by profusely irrigating with saline and **cover** the wound with a sterile dressing (e.g. saline soaked pads).
- **reduce** gross deformities using gentle traction **and splint** the injured limb — this is a top priority if there is neurovascular compromise
- **immobilise** the limb with a POP back-slab **and elevate** the limb
- give **tetanus toxoid/ tetanus immunoglobulin** if indicated

Remember to look at the x-ray and consult orthopedics.

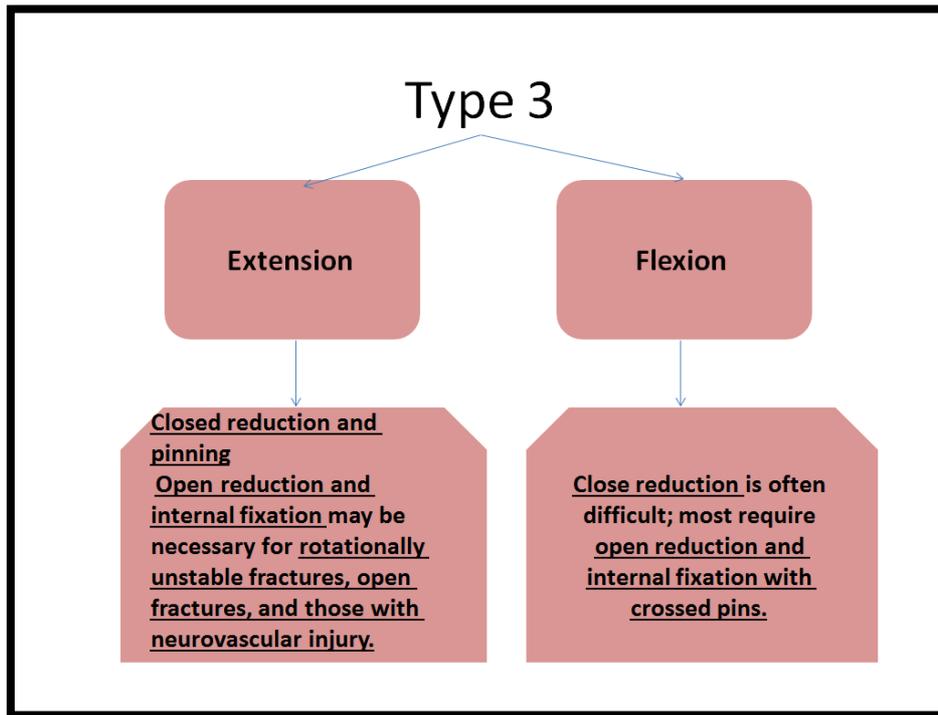
This protocol is applied for any open fracture (pediatric & adults)

2- According to the type (definitive Tx)

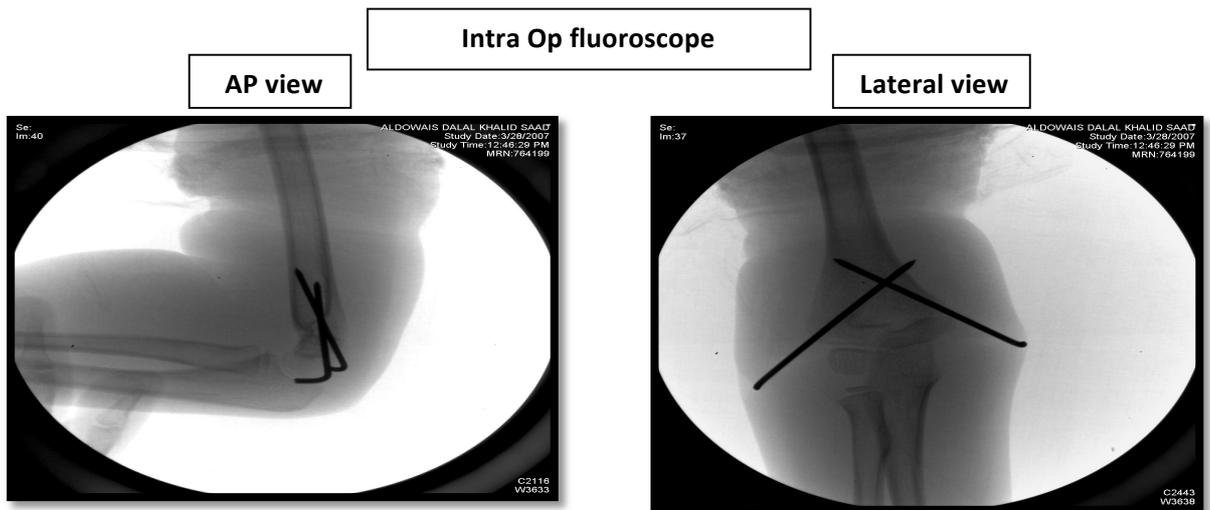


Long arm cast (to mid-shaft of humerus) should be applied after all types of treatment.

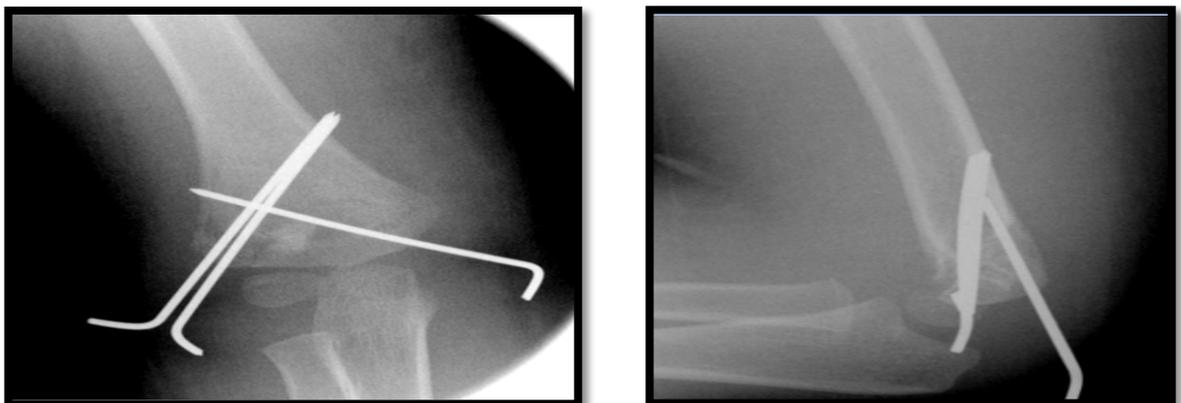
If there is swelling, do back-slab.



X-rays of extension type:



AP & Lateral views Post close reduction + pinning (k-wire)



▪ **Complications of Supracondylar fracture:**

A. *Neurologic injury (7% to 10%)*

- Most are neurapraxias requiring no treatment
- **Median nerve/anterior interosseous nerve (most common), ulnar and radial nerves.**
- **Extension type is the most common.**



B. *Vascular injury (0.5%)*

- Direct injury to the brachial artery, or secondary to swelling.

C. *Loss of motion.*

D. *Myositis ossificans:* soft Bone Formation in the Muscle, during manipulation, which will cause decrease ROM.

E. *Angular deformity* (Cubitus varus more frequently than Cubitus valgus) (10 to 20 %).*(the most common complication in supracondylar fracture)*

F. *Compartment syndrome* (<1%) Associated with Vascular Injury leads to Volkmann's Ischemic Contracture.

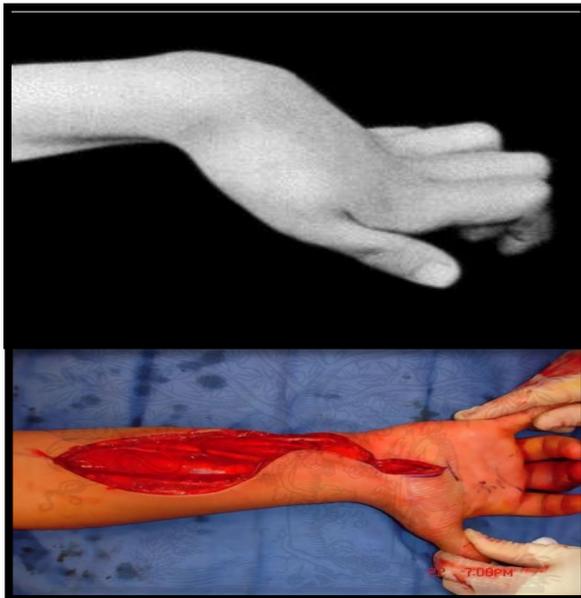
- **Type of Fracture Depends on The Force and The Mechanism! Extension > Flexion.**

Cubitus varus deformity



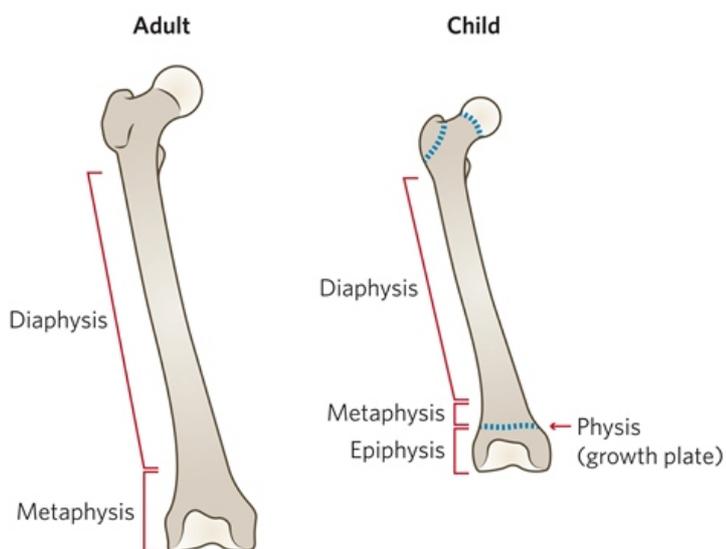
☒ **Compartment syndrome:**

Volkmann's ischemic contracture



C. DISTAL RADIUS FRACTURES

It is important to know the site of fracture, is it in the physis (growth plate) or metaphysis. It differs in prognosis and management.



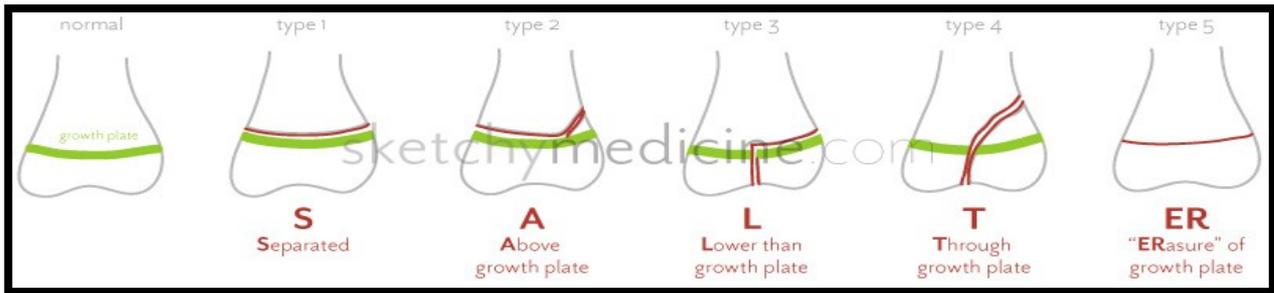
1. Physeal Injuries.

- Salter-Harris Types I and II

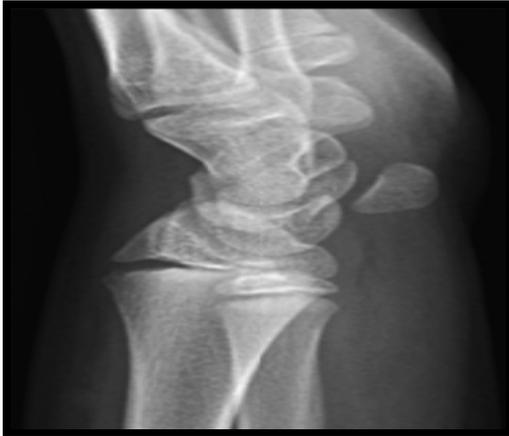
Salter-Harris (SH) Physeal Injury Classification	
Type	Characteristics
I	Separation through the physis, usually through areas of hypertrophic and degenerating cartilage cell columns.
II	Fracture through a portion of the physis that extends through the metaphyses.
III	Fracture through a portion of the physis that extends through the epiphysis and into the joint.
IV	Fracture across the metaphysis, physis and epiphysis.
V	Crush injury to the physis.

The illustrations show five types of physeal injuries from I to V. Type I is a simple separation of the physis. Type II is a fracture through the physis and metaphysis. Type III is a fracture through the physis and epiphysis. Type IV is a fracture through the metaphysis, physis, and epiphysis. Type V is a crush injury to the physis, indicated by blue arrows pointing to the flattened area.

SH Classification from I - V



Type 1 (S= separated)



Type 2 (A=above)



Type 3 (L=lower)

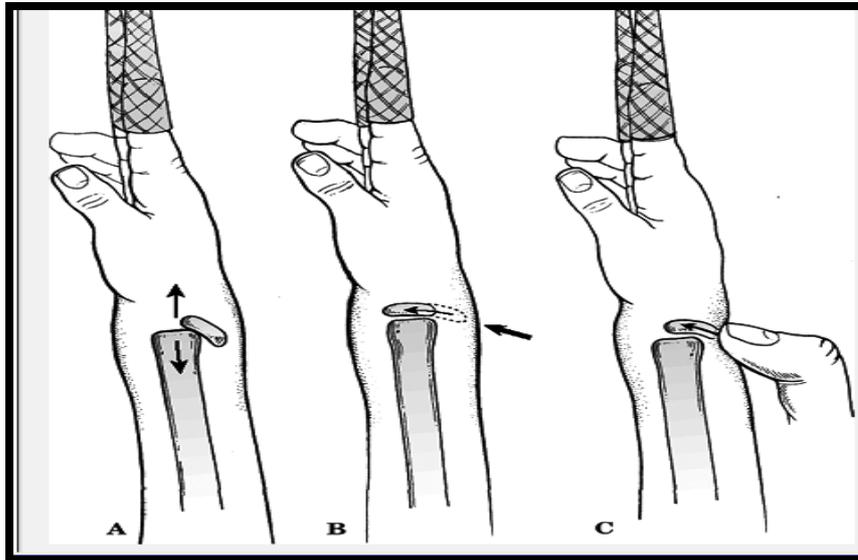


▪ **Treatment of PHYSEAL DISTAL RADIUS fractures:**

Salter harris Types I and II:

- Closed reduction is followed by application of a long arm cast or sugar tong splint with the forearm pronated.
- 50% apposition with no angular or rotational deformity is acceptable. Growth arrest can occur in 25% of patients if two or more manipulations are attempted.

- Open reduction is indicated if the fracture is irreducible or open fracture.



Pre-op Salter harris 2

AP & lateral X-ray Post-op



FIGURE 9-18 A. Anteroposterior and lateral x-rays of displaced Salter-Harris type II fracture pinned with a single pin. B. After reduction and pinning with parallel pins.

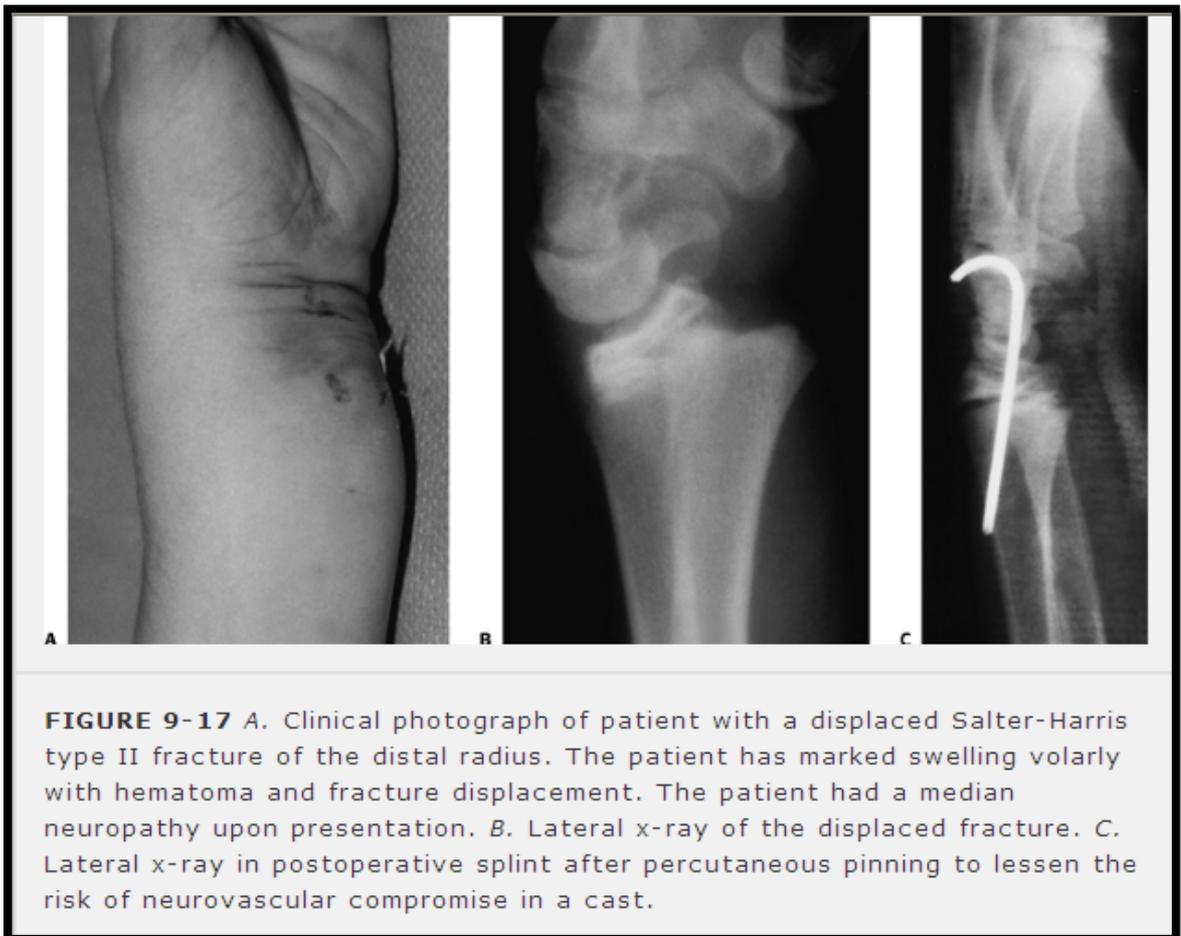


FIGURE 9-17 A. Clinical photograph of patient with a displaced Salter-Harris type II fracture of the distal radius. The patient has marked swelling volarly with hematoma and fracture displacement. The patient had a median neuropathy upon presentation. B. Lateral x-ray of the displaced fracture. C. Lateral x-ray in postoperative splint after percutaneous pinning to lessen the risk of neurovascular compromise in a cast.

Salter-Harris Type III:

- Anatomic reduction is necessary
- Open reduction and internal fixation with smooth pins or screws parallel to the physis is recommended if the fracture is inadequately reduced.

Salter-Harris Types IV and V:

- (Rare) need ORIF.

▪ **Complications of Physeal Injuries:**

- Physeal arrest → lead to shortening, an angular deformity.
- Ulnar styloid nonunion.
- Carpal tunnel syndrome.

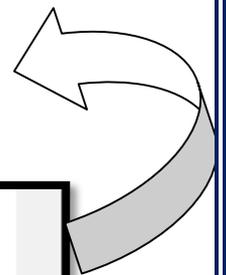


FIGURE 9-25 A. Anteroposterior x-ray of radial growth arrest and ulnar overgrowth after physeal fracture. Patient complained of ulnar-sided wrist pain and clicking. B. Clinical photograph of ulnar overgrowth and radial deviation deformity.

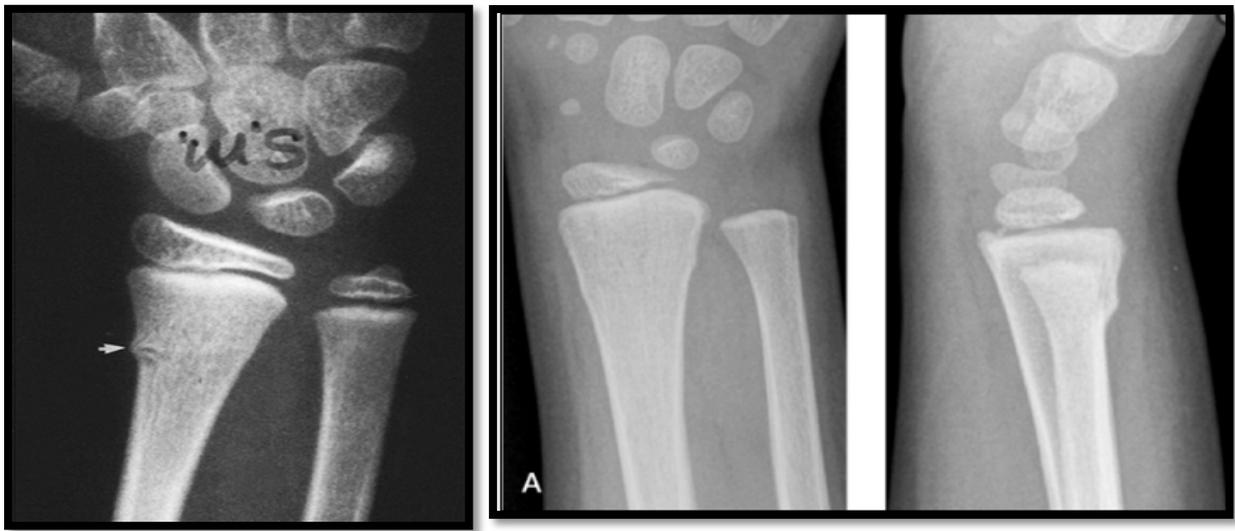
2. Metaphyseal Injuries:

Classification :

- The direction of displacement.(Medial or lateral)
- Involvement of the ulna.
- Biomechanical pattern.

A. Torus (only one cortex is involved):

- The injury is stable.
- Protected immobilization for pain relief.
- Bicortical injuries should be treated in a long arm cast. (To prevent supination and pronation movements)



B. Incomplete (greenstick):

- These have a greater ability to remodel in the sagittal plane than in the frontal plane
- Closed reduction and above elbow cast with supination forearm to relax the brachioradialis muscle.



Table 45.1. Acceptable angular corrections in degrees

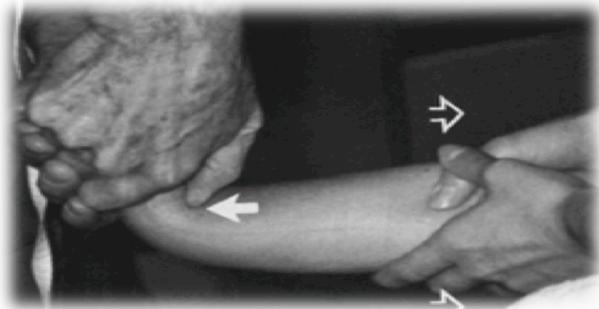
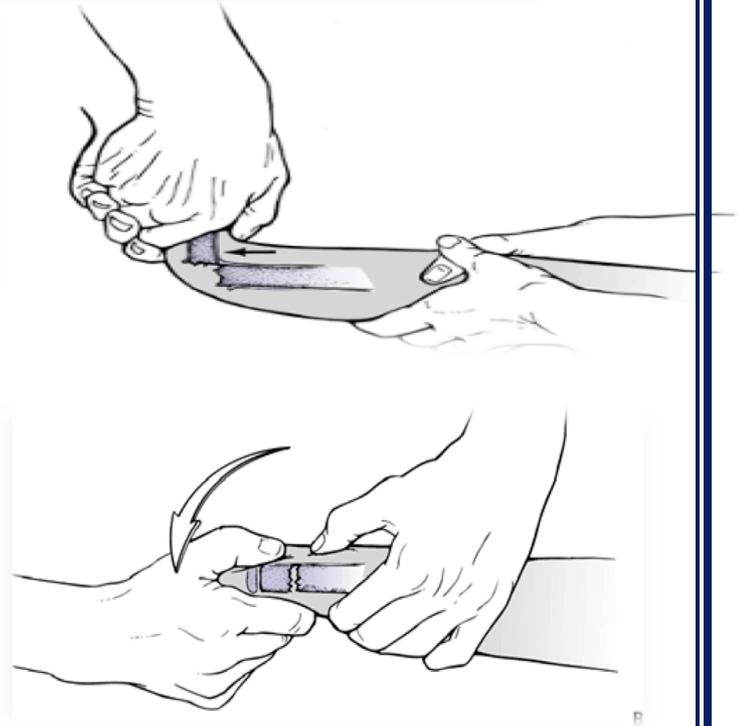
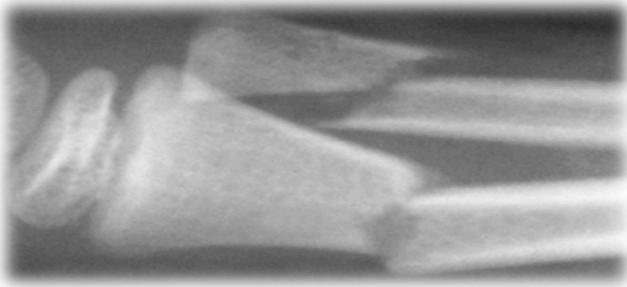
Age (yr)	Sagittal Plane		Frontal Plane
	Boys	Girls	
4-9	20	15	15
9-11	15	10	5
11-13	10	10	0
>13	5	0	0

Acceptable residual angulation is that which will result in total radiographic

The younger the patient the more amount of angulation you can accept!
The Younger the Patient The more Remodeling.

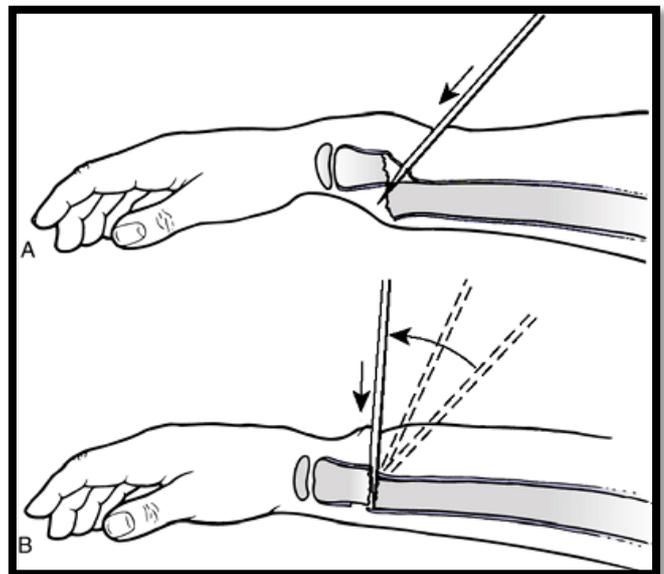
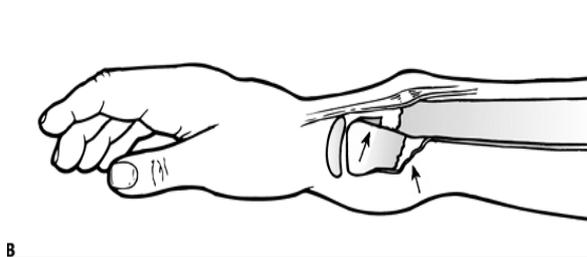
C. Complete :

- Closed reduction (by increase the deformity first, then after Reduction use the cast).
- A well molded long arm cast for 3 to 4 weeks.



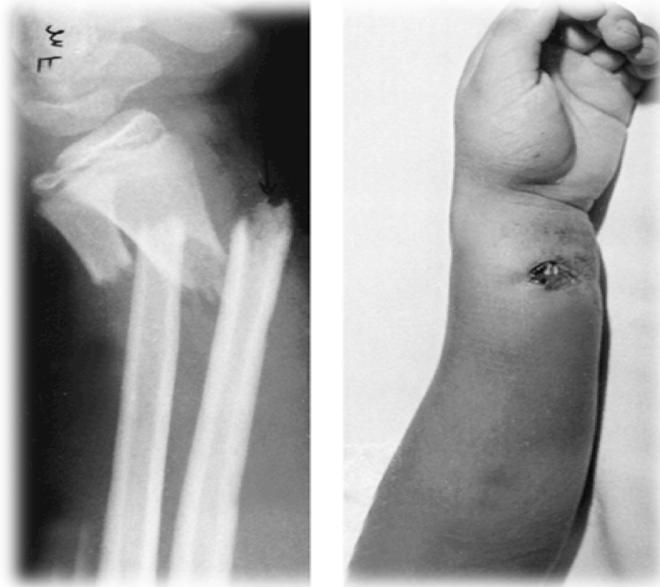
❖ **Indications for percutaneous pinning without open reduction**

- Loss of reduction, excessive local swelling, floating elbow and multiple manipulations.



❖ **Indication for ORIF**

- Irreducible, open fracture and fracture with compartment syndrome.



▪ **Complications :**

- **Malunion** → Residual malangulation of more than 20% may result in loss of forearm rotation.
- **Nonunion** – rare
- **Refracture** → An early return to activity (before 6 weeks).
- **Growth disturbance** → (overgrowth or undergrowth) 3mm/9-12Y
- **Neurovascular injuries** → avoid extreme positions of immobilization.

D. FEMORAL SHAFT FRACTURES

- 1.6% of all pediatric fractures.
- Boys > girls
- Bimodal distribution of incidence 2 to 4 years of age, mid-adolescence.
- In children younger than walking age, 80% of these injuries are caused by child abuse; this decreases to 30% in toddlers.
- **In adolescence, >90% due to RTA (most common)**
- **Mechanism of injury:**
 - **Direct trauma:** Motor vehicle accident, pedestrian injury, fall, and child abuse
 - **Indirect trauma:** Rotational injury
 - **Pathologic fractures:** osteogenesis imperfecta, nonossifying fibroma, bone cysts, and tumors.
- **How to know if it's direct or indirect injury from the x-ray?**
 - Transverse and comminuted fractures are direct
 - The spiral is indirect
- **Clinical evaluation:**
 - A history of high-energy injury should undergo full trauma evaluation as indicated.
 - An inability to ambulate, with extreme pain, variable swelling, and variable gross deformity.
 - A careful neurovascular examination is essential.
 - A careful examination of the overlying soft tissues to rule out the possibility of an open fracture.
- **Radiographic evaluation:**
 - Anteroposterior and lateral views
 - X-ray most includes hip, knee joints.

A mass is showing in the x-ray
→ consider OPEN fracture.



▪ **Classification**

a) **Descriptive:**

- Open versus closed
- Level of fracture: proximal, middle, distal third
- Fracture pattern: transverse, spiral, oblique, butterfly fragment
- Comminution
- Displacement
- Angulation

b) **Anatomical:**

- Subtrochanteric.
- Shaft.
- Supracondylar.



▪ **Treatment:**

❖ **Age <6 Months**

- Pavlic harness or a posterior splint.
- Traction and spica casting.



❖ **Ages 6 Months to 6 Years**

- Immediate spica casting is the treatment of choice (>95%).
- Skeletal traction followed by spica casting if there is difficulty to maintain length and acceptable alignment.

❖ **Ages 6 to 12 Years**

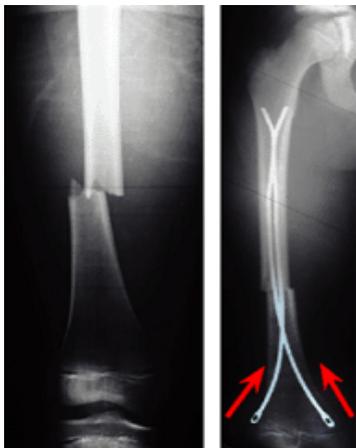
- a) Flexible intramedullary nails

It is contraindicated to put nails in children less than 16 years old, use elastic

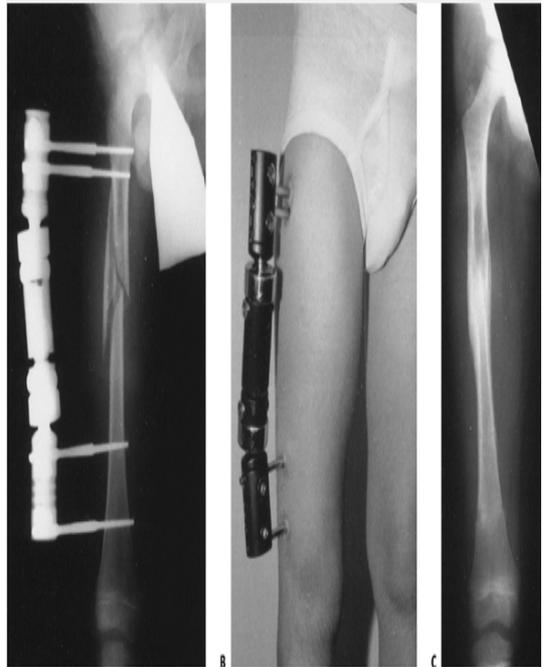
- b) Bridge plating
- c) External fixation: When?
- ✓ multiple injuries
 - ✓ open fracture
 - ✓ comminuted
 - ✓ Unstable patient

C

A

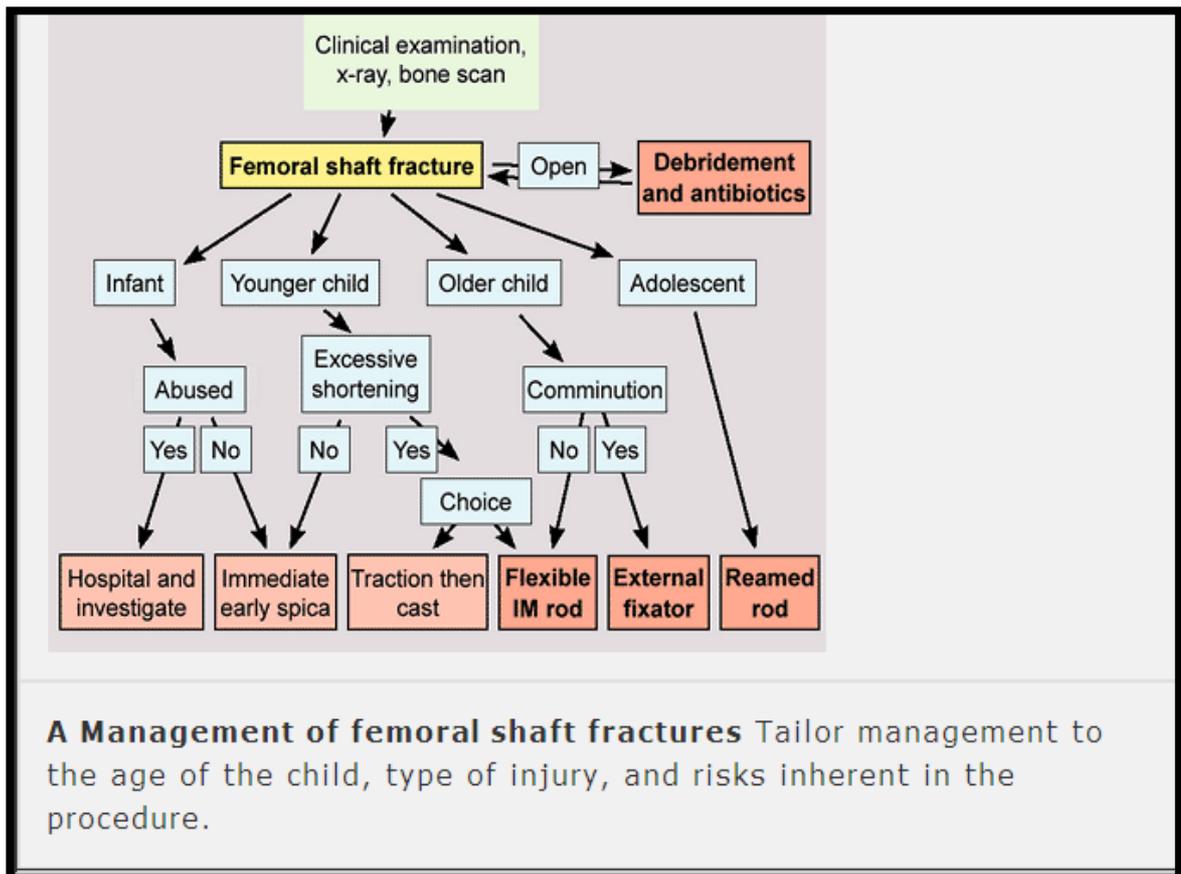
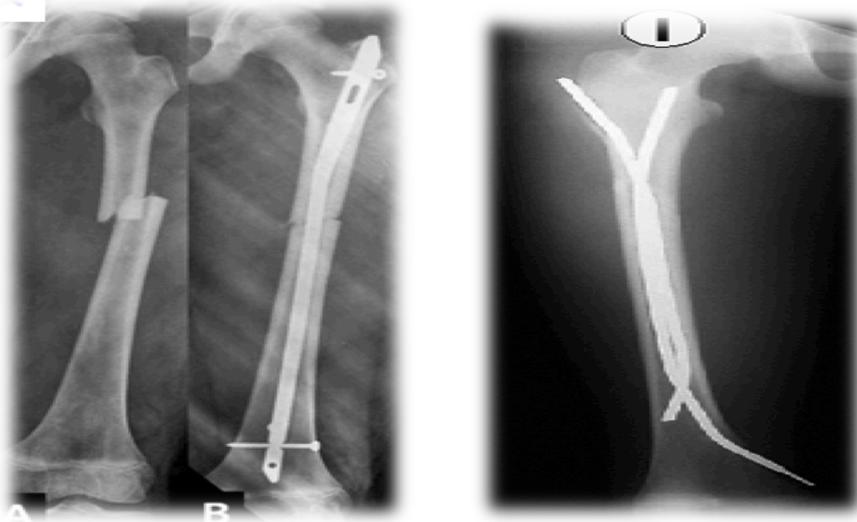


B



❖ **Ages 12 to Maturity**

- Intramedullary fixation with either flexible or interlocked nails (age > 16y) is the treatment of choice.



▪ **Operative Indications**

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

(Body habitus "OBESE PATIENT" not amenable to spica casting)

Table 48.1. Acceptable angulation

Age	Varus/Valgus (degrees)	Anterior/Posterior (degrees)	Shortening (mm)
Birth to 2 y	30	30	15
2â€"5 y	15	20	20
6â€"10 y	10	15	15
11 y to maturity	5	10	10

▪ **Complications:**

1. Malunion: Remodeling will not correct rotational deformities (**The Important Thing is to restore the ALIGNMENT**)
2. Nonunion –rare.
3. Muscle weakness.
4. Leg length discrepancy: Secondary to shortening or overgrowth, Overgrowth of 1.5 to 2.0 cm is common in the 2- to 10-year age.
5. Osteonecrosis with antegrade IM nail<16year. (**So try to avoid Intramedullary Nail <16**).

✚ Some extra information regarding X-ray reading.

- *Anteroposterior (AP) and lateral views:*

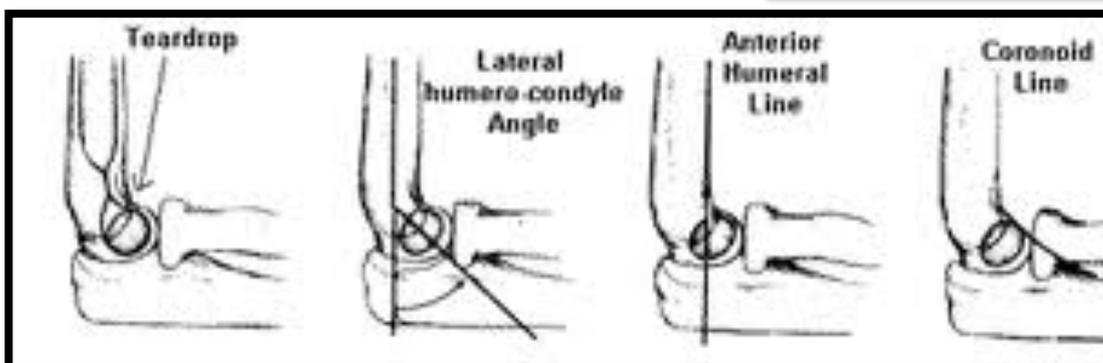
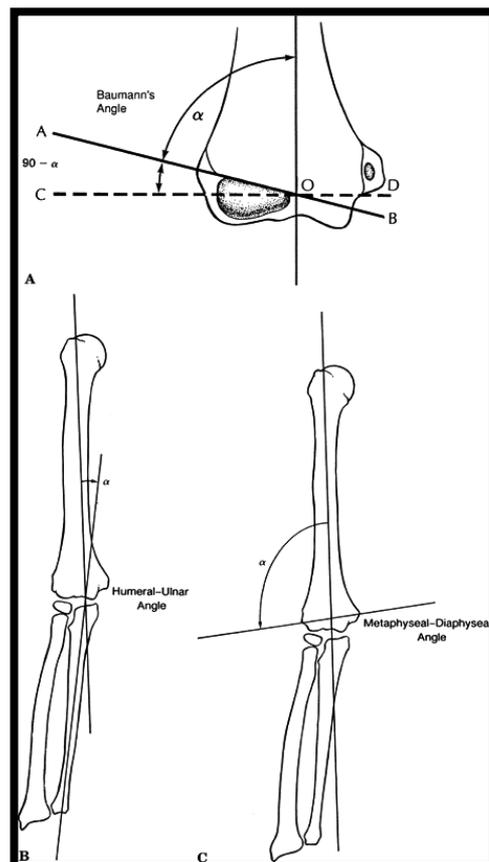
The following angular relationships may be determined:

- Baumann angle:** 15 to 20 degrees
- Humeral-ulnar angle:** reflects the true carrying angle (M=7.f=15)
- Metaphyseal-diaphyseal angle:** reverse of Baumann Angle!

- **True lateral radiograph of the elbow flexed to 90 degrees: (If any of them disrupted - Fracture!)**

- Teardrop.
- Diaphyseal-condylar angle: (30 to 45 degrees anteriorly)
- Anterior humeral line.
- Coronoid line.

The contralateral elbow should be obtained for comparison as well as identification of ossification centers



- **Lateral X-ray:**

- Fat pad signs, black Presentation in front -- usually Fracture in X-ray!
- Anterior (coronoid) fat pad---joint effusion
- Posterior (The deep olecranon fossa) the deep olecranon fossa normally completely contains the posterior fat pad. large effusions cause posterior displacement fracture, it is present >70% .



The End ☺