

## Common Pediatric Fractures and Trauma

### Objectives:

- At the end of this lecture the students should be able to:
- 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. → **Softer bone**
- 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. → **part cartilage and part bone to allow growth**
- 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. مهمه – وتشرح الصفحة القادمة
- Ligaments in children are functionally stronger than bone Therefore, a higher proportion of injuries that produce sprains in adults result in fractures in children. مهمه

**Ex :** in ankle twist in pediatrecs the bone get affected more than the adults because the bone is weaker than the adult

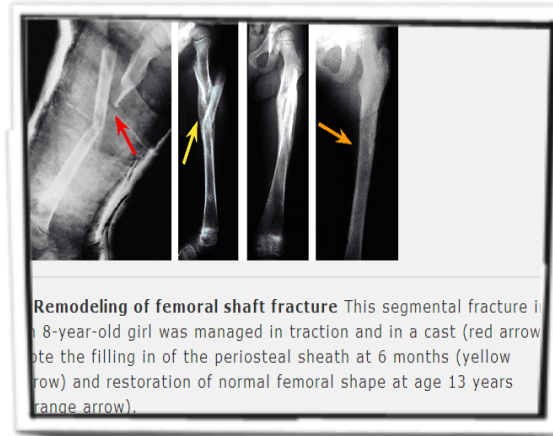
**Other Ex :** the ACL injuries is rare in children because the bone is the weak structure so it get affected more than the ligament and the opposite in the adult

- The Growth Plate Diffuse at the age of 16-18 years old 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.
- NB :
  - Appearance of fractures is different than adults
  - Healing is much faster than adult

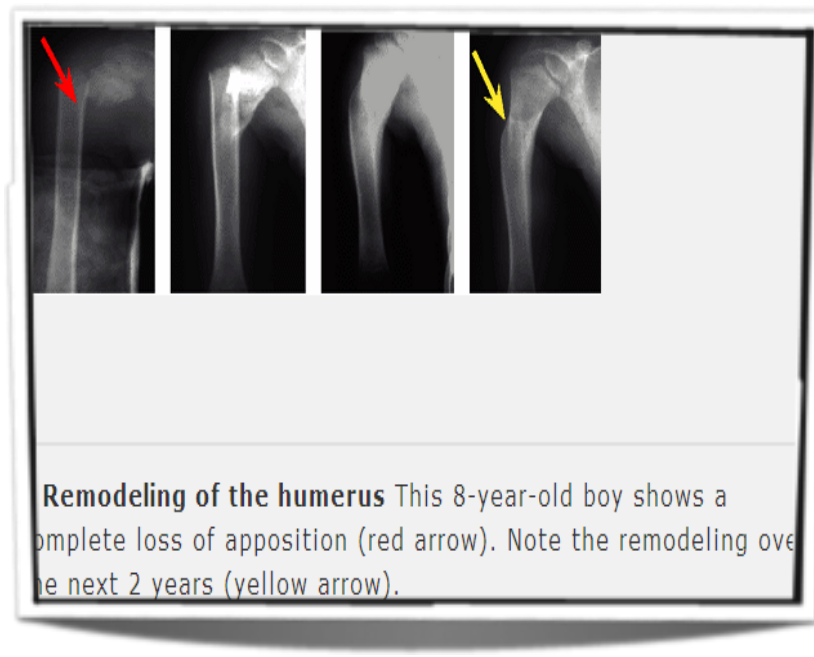
**Growth in children :**

- 1- Longitudinal growth : by Growth plates
- 2- Side growth : by Periosteum

NB : periosteum is wider in children , that's why we have green stick fractures



Because of Periosteum, The Bone will remodel very well! → high remodeling rate اعادة تشكيل



**Common Pediatric Fractures**

◆ **Upper limb:**

- Clavicle.
- Supracondylar Fracture.
- Distal Radius.

◆ **Lower Limbs:**

- Femur fractures.

• **CLAVICLE FRACTURES:**

**Clavicle bone : ( 1<sup>st</sup> bone to form – 1<sup>st</sup> bone to complete – mostcommonly bone to get fractures– faster bone to heal )**

**Epidemiology : MCO حفظ**

- ♦ 8% to 15% of all pediatric fractures.
- ♦ 0.5% of normal deliveries and in 1.6% of breech deliveries. (BirthFracture).
- ♦ 90% of obstetric fractures. (When the Deliver the babe the may press the shoulders which may lead to the 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: Fall onto an outstretched hand. → **MOST COMMON** كلام الدكتور صديقي

Direct: This is the most common mechanism; it carries the highest incidence of injury to the underlying neurovascular and pulmonary structures.

Birth injury. → **in difficult births the most common bone to get affected is the Clavicle**

**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 ( **the mother come complining of mass in her child only → think about fracture** ) , Tenderness, **Decrease Range of Motion (ROM)**, there may be tenting of the skin, crepitus, and ecchymosis.
- What is ecchymosis? **SubcutaneousPurpura larger than 1 centimeter or a Hematoma, commonly called a bruise.**
- Neurovascular status, the brachial plexus and upper extremity vasculature may result. → **very IMP to exam**
- Pulmonary status must be assessed. **Why?** May Penetrate the Lung and Cause Pneumothorax!

**Radiographic Evaluation:**

- a. AP view. ( the Important one that will show you where is the fracture ) The COMMON!
- b. Cephalic tilt view (cephalic tilt of 35 to 40 degrees)
- c. Apical oblique view (injured side rotated 45 degrees toward tube with a cephalic tilt of 20 degrees).

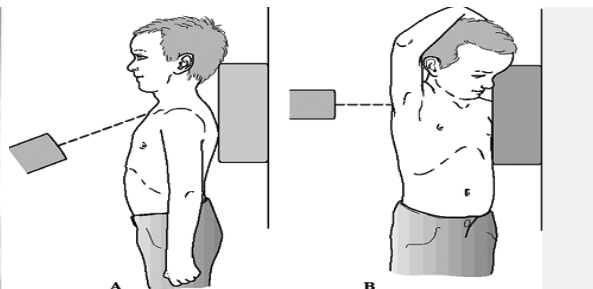


Figure 43.5. (A) Cephalic tilt views. (B) Apical lordotic view.

### **Classification (Descriptive):**

Location → Distal – middle – proximal

Open versus closed

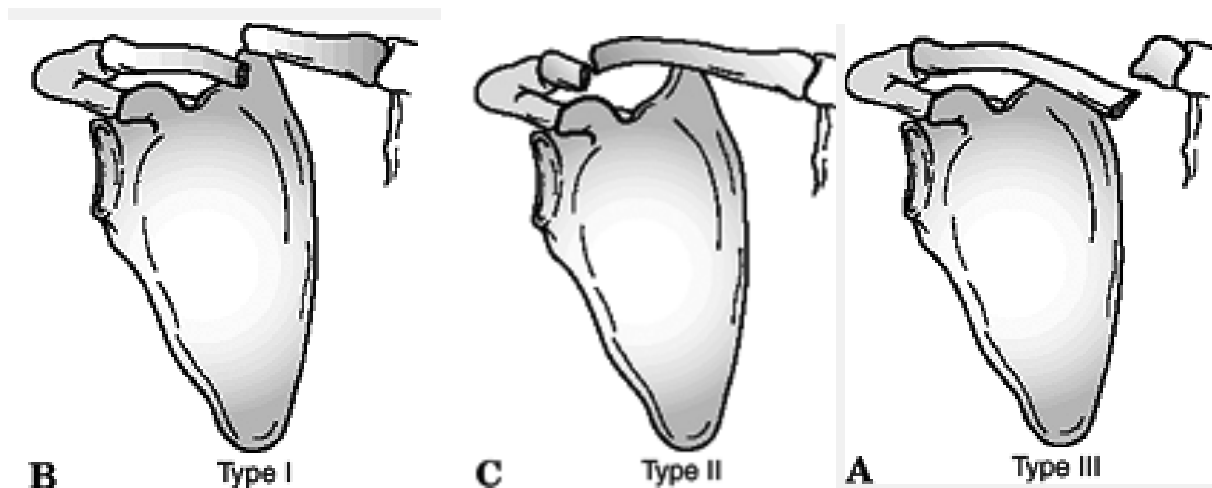
Displacement

Angulation

Fracture type: segmental, comminuted, greenstick

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

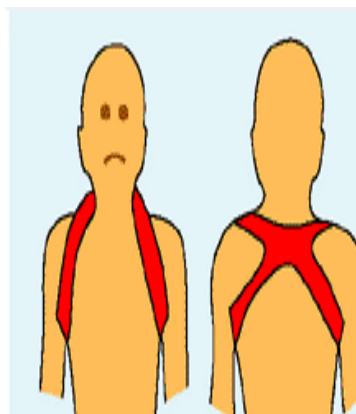
- Type I : Middle third (most common)
- Type II : Distal to the coracoclavicular ligaments (lateral third)
- Type III : Proximal (medial) third



### **Treatment:**

#### ♦ Newborn to Age 2 Years:

- ♦ Clavicle fracture in a newborn will unite in approximately 1 week.
- ♦ Infants may be treated symptomatically with a simple sling ( MCQ ) or (figure-of-eight bandage) applied for 2 to 3 weeks. **No Need For Reduction Due to presence of periosteum and the Same Teqnique May apply To Adults. + analgesia**



**The cullas Formation will be removed from the body After Healing ! So we don't worry about them not like adults**

♦ Age 2 to 12 Years:

A figure-of-eight bandage or sling is indicated for 2 to 4 weeks

**Operative Treatment: Indications**

- ♦ Open fractures.--> Show tenting of the skin شكل خيمه
- ♦ Neurovascular compromise.

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

**X-ray Mid clavicle fracture: Example**

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



**Complications (Rare):**

- a. Neurovascular compromise.
- b. Malunion. → join in wrong anatomical position
- c. Nonunion.
- d. Pulmonary injury.

**B) Supracondylar Fracture فوق الكوع: (The **Commonest** Fracture in Pediatric Age group) → LOTS OF MCQ FROM THIS PART**

- 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.

**MECHANISM OF INJURY:**

- **Indirect:** Most commonly a result of a fall onto an outstretched (FOOSH) upper extremity. (Extension type >95%). → **NB : this mechanism ( outstretch) may break the Clavicle – supracondyl – ulna – radius )**
- **Direct:** A fall onto a flexed elbow or from an object striking the elbow (e.g., baseball bat, automobile) (Flexion type < 3%). → **RARE**

**Clinical Evaluation:**

- a. A swollen, tender elbow with painful range of motion.
- b. S-shaped angulation at the elbow
- c. Pucker sign (dimpling of the skin anteriorly )
- d. **ALWAYS DO : 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 Type. The Way to assess: Ask the Patient TO Do (OK) sign!**

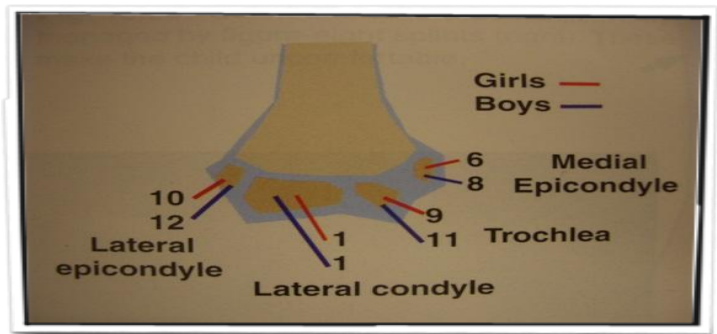
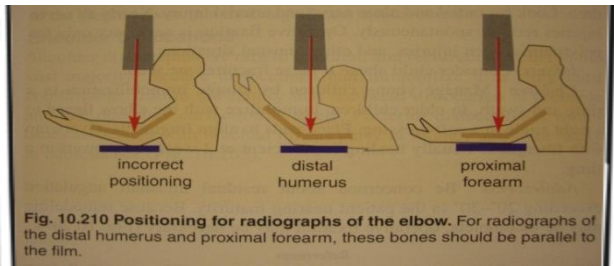
**You are examining Flexor Polices Longs, Flexor digitorum longus!**  
**So Examine Each Nerve by doing its Function!**

**NB : the brachial artery run on the humerus → so in this type of the fracture its injury is common → So ALWAYS check the pulse → if no pulse do Flexion → if no response send to the OR**

**Clinical**



Complete Fracture of Supracondylar

**Radiological Evaluation:****Ways of elbow x-ray**

The Growth Plate in distal humerus usually appears in different locations depending on the age:

CROTOE مهمه: Each one presents a growth plate

C: Cubetulum

R: Radial head

O: Olecranon

T:

O: E: (from the Figure) Not Important!



AP view elbow

lateral x-ray view

الصورة ممكن يجي عليها  
MCQ



Lateral elbow x-ray

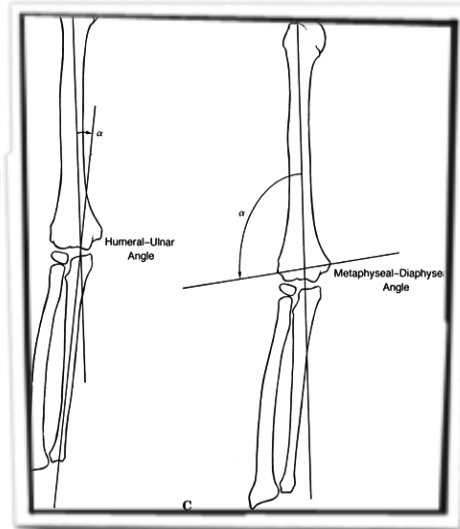
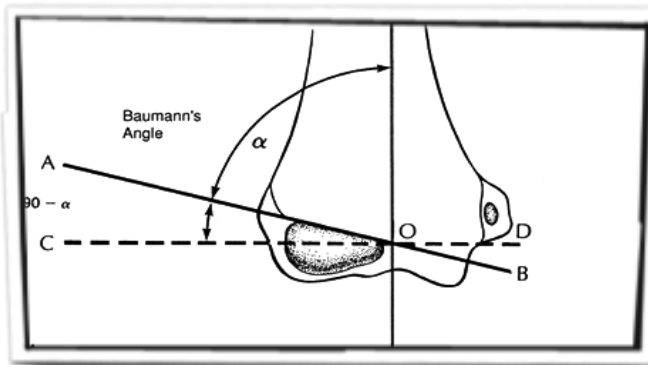
AP view



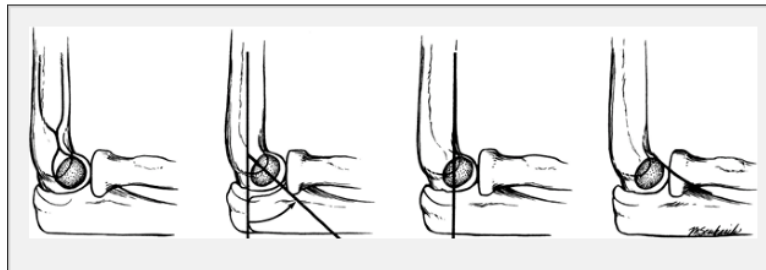
**Anteroposterior (AP) and lateral views:**

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%

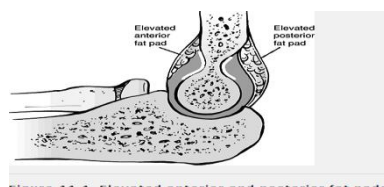
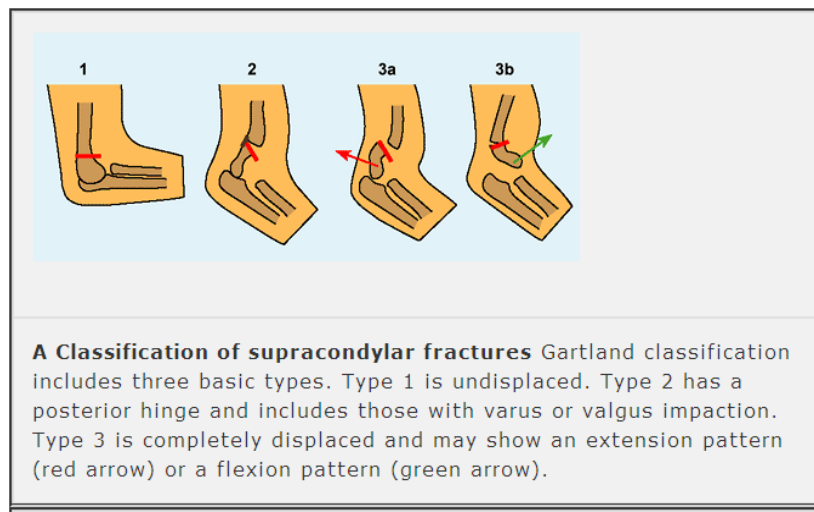


Figure 44-4. Elevated anterior and posterior fat pads.



**Classification (Gartland):**

**Type 1:** undisplaced - Anterior humeral line pass to Cubitulum

**Type 2:** → ( Displacement + fracture BUT the cortex to cortex contact is intact posteriorly )

Anterior Cortex Disrupted Posterior NO

**Type 3:** Both Cortex displaced.

A: posterior medial ( extension type ) → common

B: posterolateral (Flexion Type of injury which is rare)

**Treatment of extension type:**

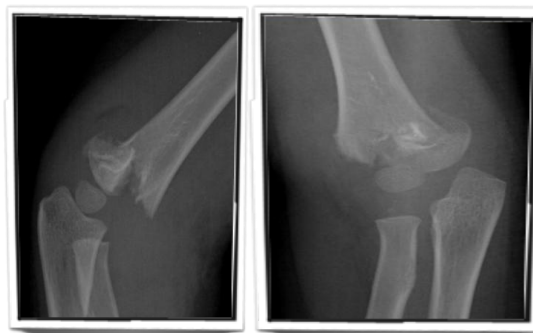
**Type I:** Immobilization in a long arm cast or splint at 60 to 90 degrees of flexion is indicated for 2 to 3 weeks → NB : in this type the pt, will present with tenderness and Hx of trauma but no visible fracture → in this case DO CAST because MANY growth plate in this area and we should be careful → and repeat Xray in one week

**Type II:** Reduce by closed methods followed by casting; it may require pinning (K-wire) if unstable, severe swelling, tilting.

**Type III:** → need surgery

Attempt closed reduction and pinning.

Open reduction and internal fixation( ORIF ) and back slap , may be necessary for rotationally unstable fractures, open fractures, and those with neurovascular injury



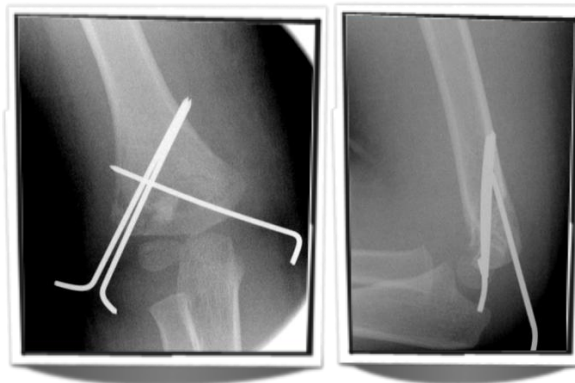
Oblique view elbow

unstable

**Which type? Type 3 A**



**Intra op fluoroscope lateral view AP view**



**AP post CR+ k-wires**

**lateral view**

**Treatment of flexion type: Rare! → ( this type same as extention but it is Displaced anteriorly )**

**Type I:** Immobilization in a long arm cast in near extension is indicated for 2 to 3 weeks.

**Type II:** Closed reduction is followed by percutaneous pinning

**Type III:** Reduction is often difficult; most require open reduction and internal fixation with crossed pins.

### **Complications:**

- Neurologic injury (7% to 10%).
- ◈ Most are neurapraxias requiring no treatment
  - Median nerve/anterior interosseous nerve (most common)** in which type? Flexion
  - Radial nerve
  - Ulnar nerve:
  - This is most common in flexion-type
- Vascular injury (0.5%)
- ◈ Direct injury to the brachial artery, or secondary to swelling.
- Loss of motion

Group A1

- Myositis ossificans مهمه: soft Bone Formation in the Muscle, during manipulation, which will cause decrease ROM.
- Angular deformity ( most common مهمه ) ( Cubitusvarus more frequently than Cubitus valgus) (10% to 20)
- Compartment syndrome (<1%) **Associated with Vascular Injury leads to Volkmann's Ischemic Contracture.**

**“Type of Fracture Depends on The Force and The Mechanism! But Extension here is more common than Flexion “**

**Cubitusvarus deformity:**

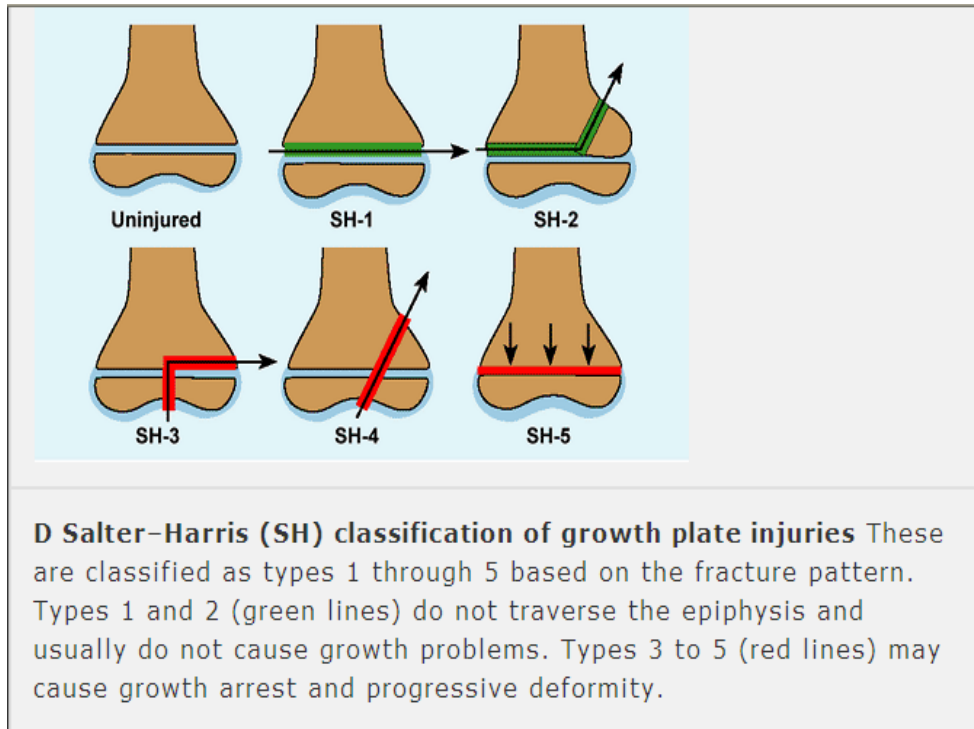
Angular deformity (varus more frequently than valgus) (10% to 20)

**C) DISTAL RADIUS FRACTURES: 2 types :**

- 1- Physeal Injuries.
- 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.

Group A1

التصنيف مهم جدا - وعليه سؤال بالاختبار



Common in lower limb,



Type 1



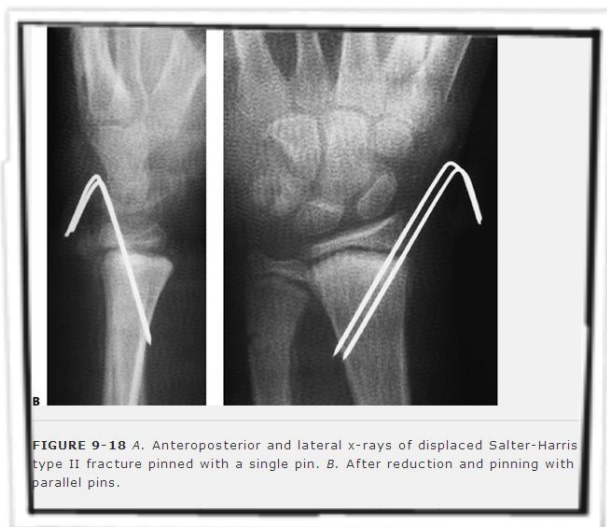
Type2



Type3

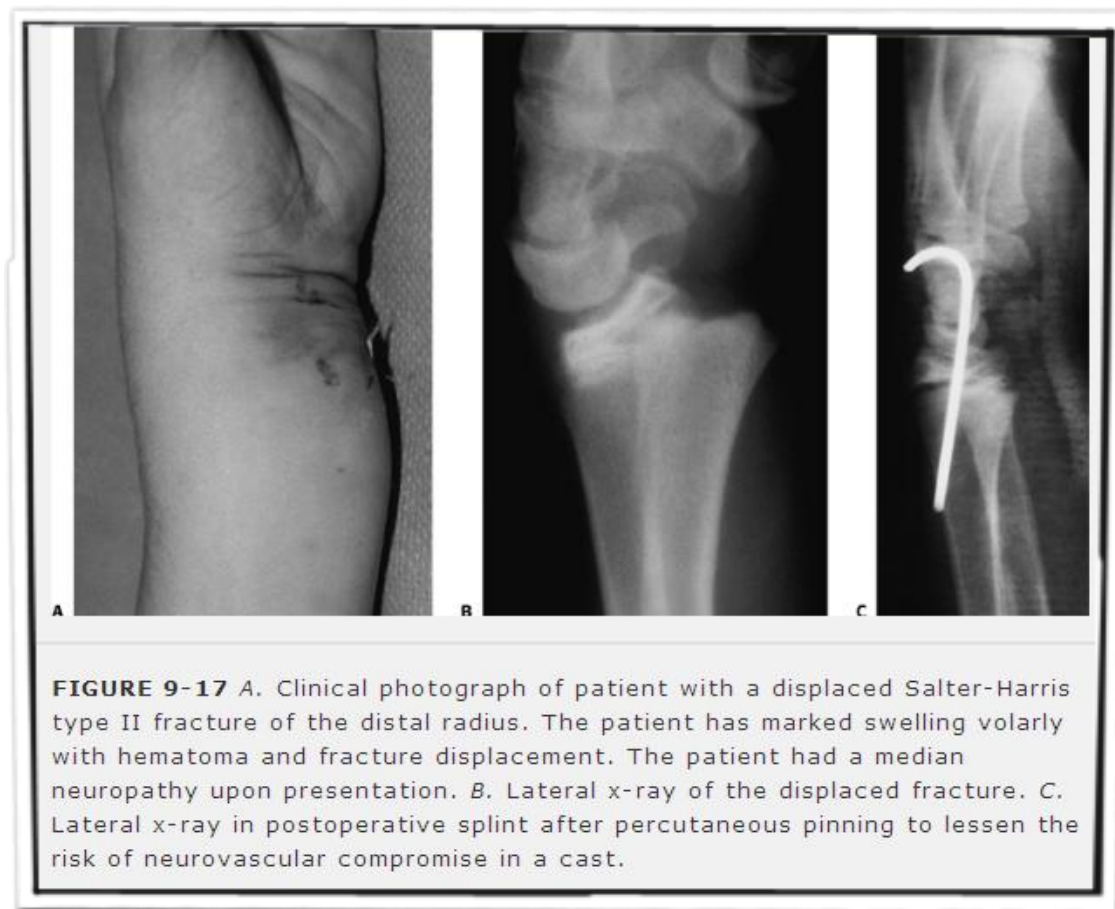


Pre op Salter Harris 2



AP and lateral X-ray post OP

**Clinical picture and X-ray pre and post op**

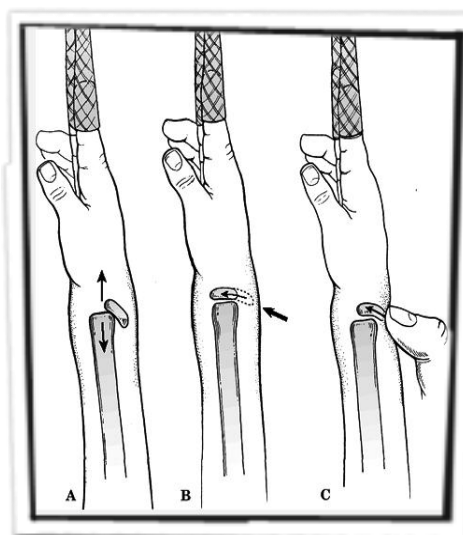


**Treatment**

**Salter-Harris Types I and II Treatment:**

**Conservative treatment**

Open reduction is indicated if the fracture is irreducible (Called: Chinese Method)



### **Salter-Harris Type III:**

Anatomic reduction is necessary → **should be 100 %** مهمة

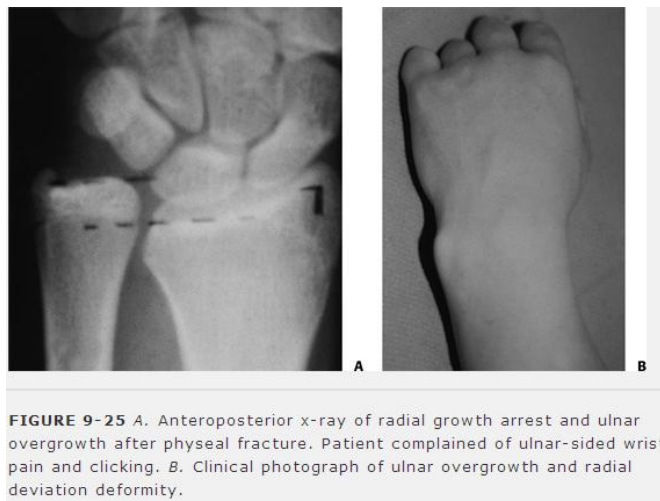
Open reduction and internal fixation (ORIF) with smooth pins (K-wire) or screws parallel to the physis is recommended if the fracture is inadequately reduced to close the Gap. → 1<sup>st</sup> choice

### **Salter-Harris Types IV and V:**

Rare injuries need ORIF.

### **Complications:**

- ♦ Physeal arrest may occur from original injury which will lead to angular Deformity.
- ♦ Ulnar styloid nonunion is often indicative of a TFCC tear.
- ♦ Carpal tunnel syndrome by pressing on the median Nerve.



## **2- Metaphyseal Injuries:**

Classified by:

- The direction of displacement.
- Involvement of the ulna.
- Biomechanical pattern:
  - a. **torus** (only one cortex is involved),
  - b. **incomplete** (greenstick),
  - c. **Complete**.



**1- Torus fracture:** الاندماج على بعض

- The injury is stable.
- Treatment : Protected immobilization for pain relief.
- Bicortical injuries should be treated in a long arm cast.

It heals very fast

**2-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.



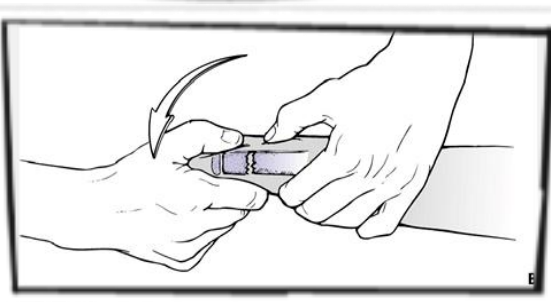
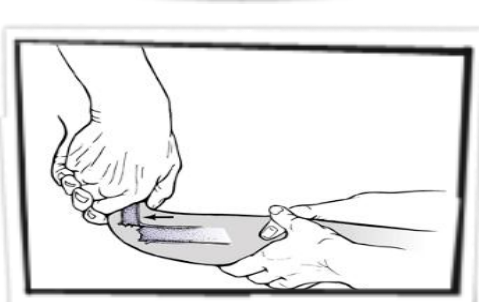
**Table 45.1. Acceptable angular corrections in degrees**

Sagittal Plane			
Age (yr)	Boys	Girls	Frontal Plane
4â€"9	20	15	15
9â€"11	15	10	5
11â€"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.**

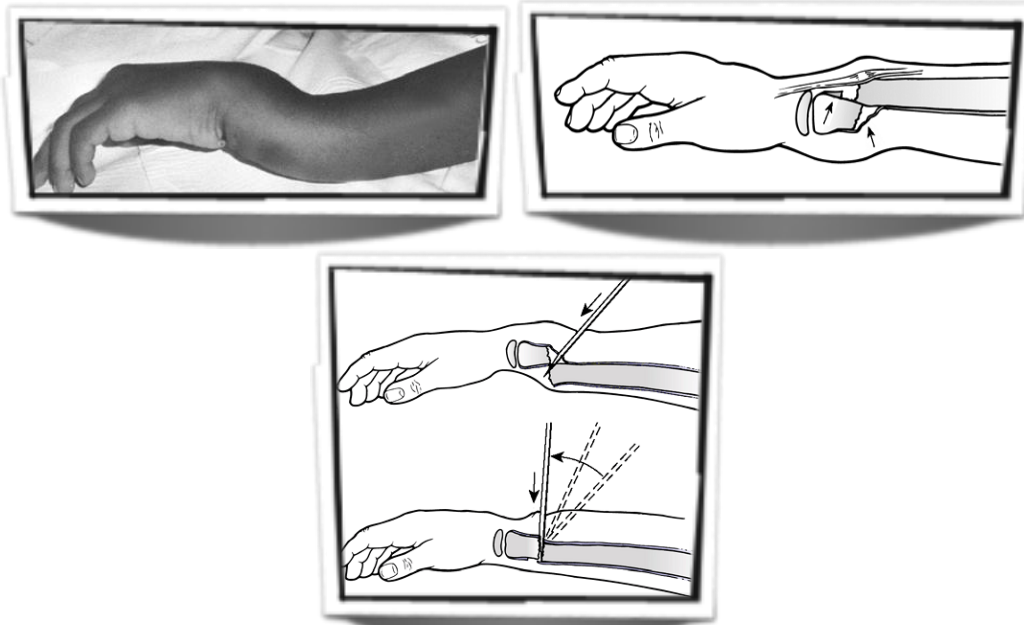
### 3-Complete fracture:

- Closed reduction. **By increase the deformity first, then after Reduction use the cast.**
- a well molded long arm cast for 3 to 4 weeks



Group A1**Indications for percutaneous pinning: (K-wire)**

- Loss of reduction. excessive local swelling ( Soft tissue )
- Floating elbow multiple manipulations.

**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) removing the cast earlier.
- Growth disturbance: (overgrowth or undergrowth) **3mm/ common from 9-12Y/O**
- Neurovascular injuries: Avoid extreme positions of immobilization.

**Complete fracture:**

Indication for open Reduction:

- Irreducible.
- Open fracture
- Fracture with compartment syndrome.



Open fracture with Deformity

**D- Pediatric Femoral Shaft: → IMP because it is wg, bearing bone**

- 1.6% of all fractures in the pediatric population
- Boys are more commonly affected (because they are more active NOTHING ELSE!)
- Bimodal distribution of incidence: (Peak) 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.

**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.



## CLASSIFICATION

### a. Descriptive:

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

### 2. Anatomical:

- ◆ Subtrochanteric
- ◆ Shaft
- ◆ Supracondylar

## TREATMENT: MCQ مقاومة

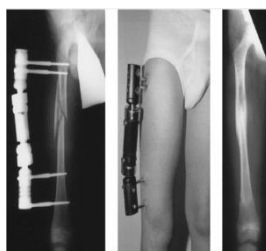
### Age <6 Months

- a. Pavlic harness or a posterior splint MCQ
- b. Traction and Hip spica casting MCQ → most commonly used



### Ages 6 Months to 6 Years

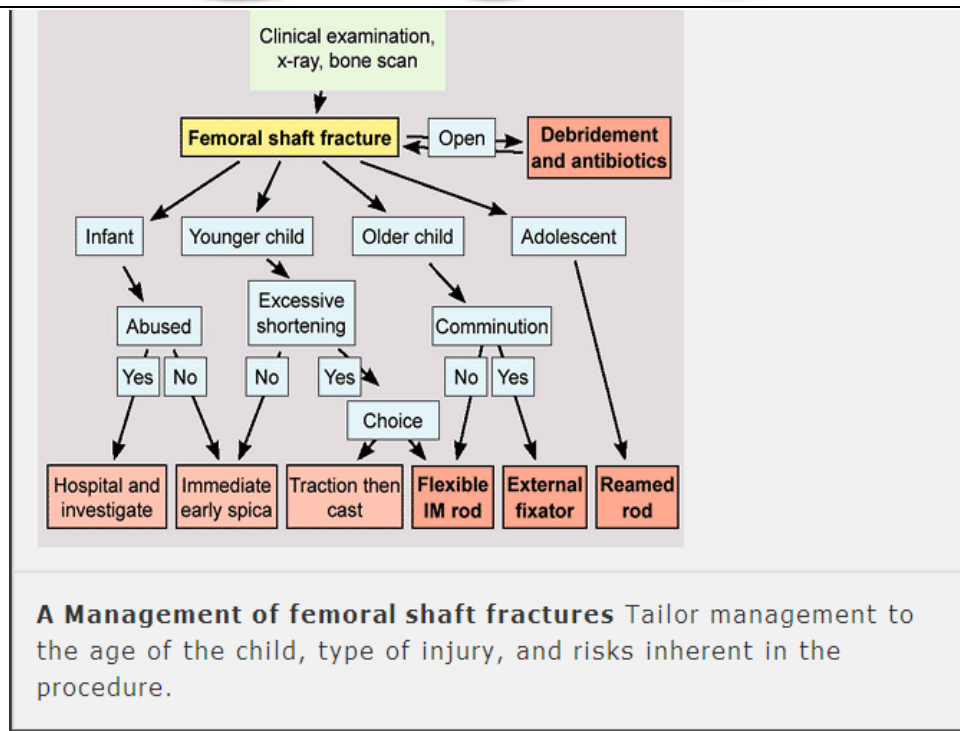
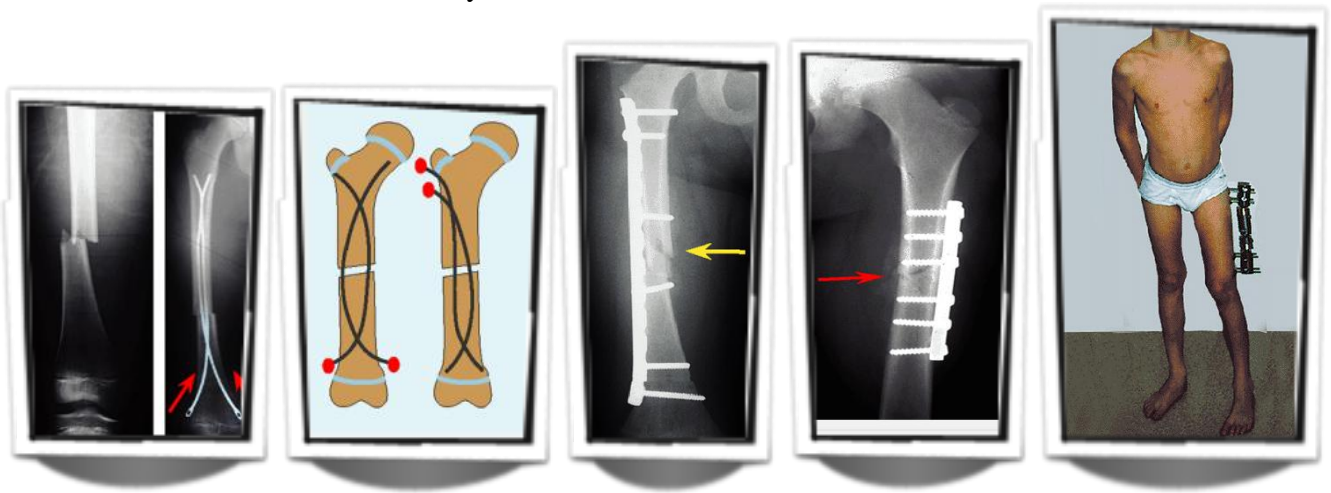
- a. Immediate spica casting is the treatment of choice (>95%).
  - b. Skeletal traction قنالات followed by spica casting if there is difficulty to maintain length and acceptable alignment. MCQ
3. External fixation: When?
- ◆ multiple injuries
  - open fracture
  - comminuted
  - Unstable patient



### Ages 6 to 12 Years

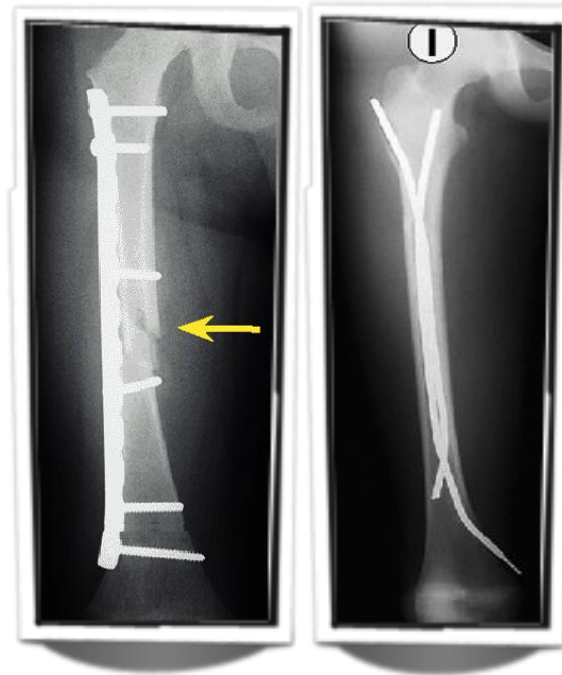
- Flexible intramedullary nails. ( elastic nails ) MCQ مهمه جدا
- External fixation.
- Bridge plating. → should removed in 8 to 12 week to prevent the plate from coming inside the bone

Remember : the intramedullary nails used in adults ONLY مهمه



### Ages 12 to Maturity

- Intramedullary fixation with either flexible or interlocked nails (age>16y → MCQ ) is the treatment of choice. Or if < 16 it will cause Growth Arrest!



### Operative Indications

- Multiple traumas, including head trauma.
- Open fracture.
- Vascular injury.
- Pathologic fracture.
- Uncooperative patient.
- Body habitus (**OBESEPATIENT**) 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:**

- a. Malunion: Remodeling will not correct rotational deformities

(The **Important Thing to restore is The ALIGNMENT**)

- b. Nonunion –rare.
- c. Muscle weakness.
- d. 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.
- e. Osteonecrosis with antegrade IM nail<16year. ( So Try to avoid Intramedullary Nail <16 )

DONE !