

التيم عبارة عن سلايدات المحاضرات بالإضافة إلى شرح الدكاترة

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لذا إن وجدتم أي خلل أو خطأ فاعذرونا وبلغونا حتى يتم تصحيحه

نتمنى لكم التوفيق و السداد

لا تنسونا من دعواتكم

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# Common pediatric Fractures and Trauma

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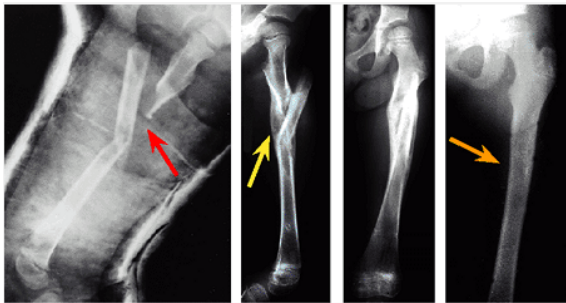
F1 lecture notes added by : Manahel Al-Ansari

Lecture notes are in **ORANGE**

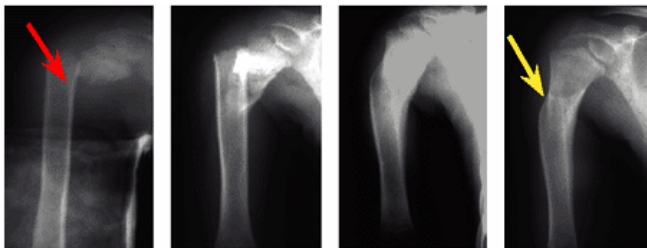
## **The different between adult and pediatric bones**

- Pediatric bone has a higher water content and lower mineral content per unit volume than adult bone so less brittle than adult bone.

- 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.
- The physis is traditionally divided into four zones that the injury through it can cause shortening, angular deformities.
- The periosteum in a child is a thick fibrous structure than adult bone so there is high remodeling rate (a higher degree of angulation is acceptable in kids than in adults because of higher remodelling rates).
- Ligaments in children are functionally stronger than bone. Therefore, injuries which only produce sprains in adults result in fractures in children.



**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).

## Common Pediatric Fractures

### •Upper limb

a. Clavicle Fractures

b. Supracondylar Fractures

c. Distal Radius Fractures

### •Lower Limbs

a. Femur fractures

## I. CLAVICLE FRACTURES

- 8% to 15% of all pediatric fractures
- 0.5% of normal deliveries and in 1.6% of breech deliveries
- 90% of obstetric fractures
- 80% of clavicle fractures occur in the shaft
- The periosteal sleeve always remains in the anatomic position. Therefore, remodeling is ensured.

### Mechanism of Injury

- Indirect: Fall onto an outstretched hand. **Indirect trauma causes 1 clean fracture line.**
- Direct: This is the most common mechanism; it carries the highest incidence of injury to the underlying neurovascular and pulmonary structures. **They are usually comminuted fractures (so check the neurovascular state; in kids, also check pulmonary function).**
- Birth injury

### Clinical Evaluation

- Birth fractures present as an asymmetric, palpable mass overlying the fractured clavicle.
- Typically present with a painful, palpable mass along the clavicle and tenderness. There may be tenting of the skin, crepitus, and ecchymosis.
- Neurovascular: the brachial plexus and upper extremity vasculature may be injured.
- Pulmonary status must be assessed.

## Radiographic Evaluation

a.AP view



## Classification Descriptive

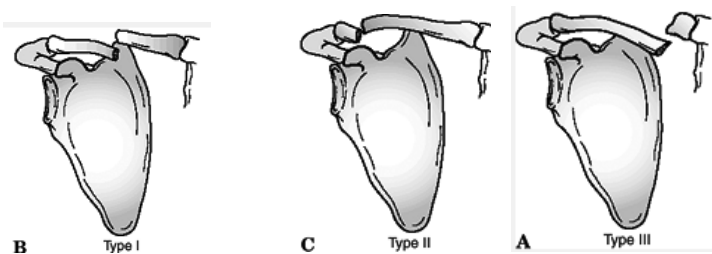
- Location
- Open versus closed
- Displacement
- Angulation
- Fracture type: segmental, comminuted, greenstick

## Allman's Classification

Type I: Middle third (most common)

Type II: Distal to the coraco-clavicular 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 or figure-of-eight bandage applied for 2 to 3 weeks.

Age 2 to 12 Years

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

Operative treatment is indicated if

- Open fractures
- Neurovascular compromise

### **X-ray Mid clavicle fracture**

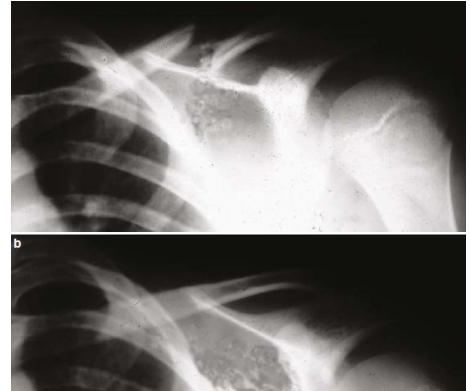
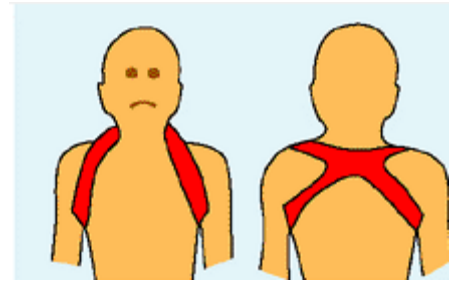
Post conservative treatment

Healed completely

With no complications

### **Complications Rare**

- Neurovascular compromise
- Mal-union
- Non-union
- Pulmonary injury



## **II. Supracondylar Fracture**

- 55% to 75% of all elbow fractures.
- The male-to-female ratio is 3:2.
- Usually 1 kids 5 to 8 years.
- The left, or non-dominant side, is most frequently injured.

It is the most common arm fracture in kids. Why?

- ligament laxity
- potential weak point in the humerus at the olecranon
- there's a wide bony head in the humerus

### **MECHANISM OF INJURY**

- Indirect: most commonly a result of a fall onto an outstretched upper extremity.  
(Extension type >95%)

- Direct: a fall onto a flexed elbow or from an object striking the elbow (e.g., baseball bat, automobile) Flexion type < 3%

### Clinical Evaluation

- A swollen, tender elbow with painful range of motion
- S-shaped angulation of 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.

The median nerve (anterior interocubus branch) is most commonly damaged here, (but remember to check all the nerves!) so check it via the OK sign.

### Clinical



### RADIOGRAPHIC EVALUATION

#### AP view elbow



#### lateral x-ray view



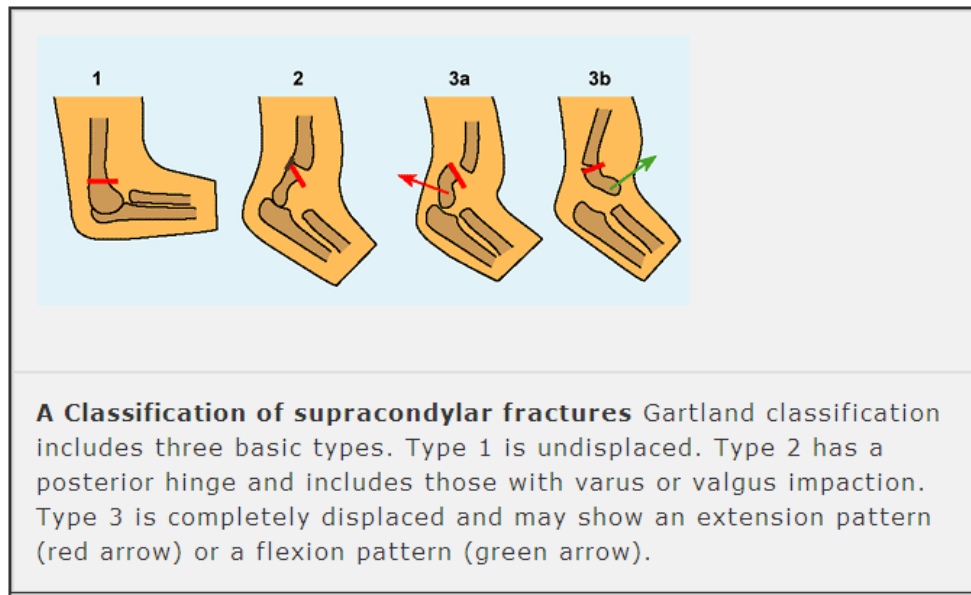
## Lateral elbow x-ray



## AP view



## Classification Gartland



### Gartland's Classification:

Type 1: anterior and posterior periosteum intact

Type 2: posterior periosteum intact (tx: closed reduction & k-wire\*)

Type 3: anterior periosteum intact (tx: closed reduction and pinning/open)

Type 4: anterior and posterior periosteum NOT intact (tx: open)

### 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



### •Type II:

Reduce by closed methods followed by casting; it may require pinning if unstable, severe swelling, tilting.

### •Type III:

- Attempt closed reduction and pinning
- Open reduction and internal fixation may be necessary for rotationally unstable fractures, open fractures, and those with neurovascular injury

**Oblique view elbow**



**unstable #**



**Intra op fluoroscope lateral view**



**AP view**



**AP post CR+ k-wires**

**lateral view**



## Treatment of flexion type

### •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

The most common complication of supracondylar fractures is cubitus varus.

### •Neurologic injury (7% to 10%)

Most are neurapraxias requiring no treatment

Median nerve/anterior interosseous nerve (most common)

### •Vascular injury (0.5%)

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

### •Loss of motion

### •Myositis ossificans

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

### •Compartment syndrome (<1%)

## Cubitus varus deformity

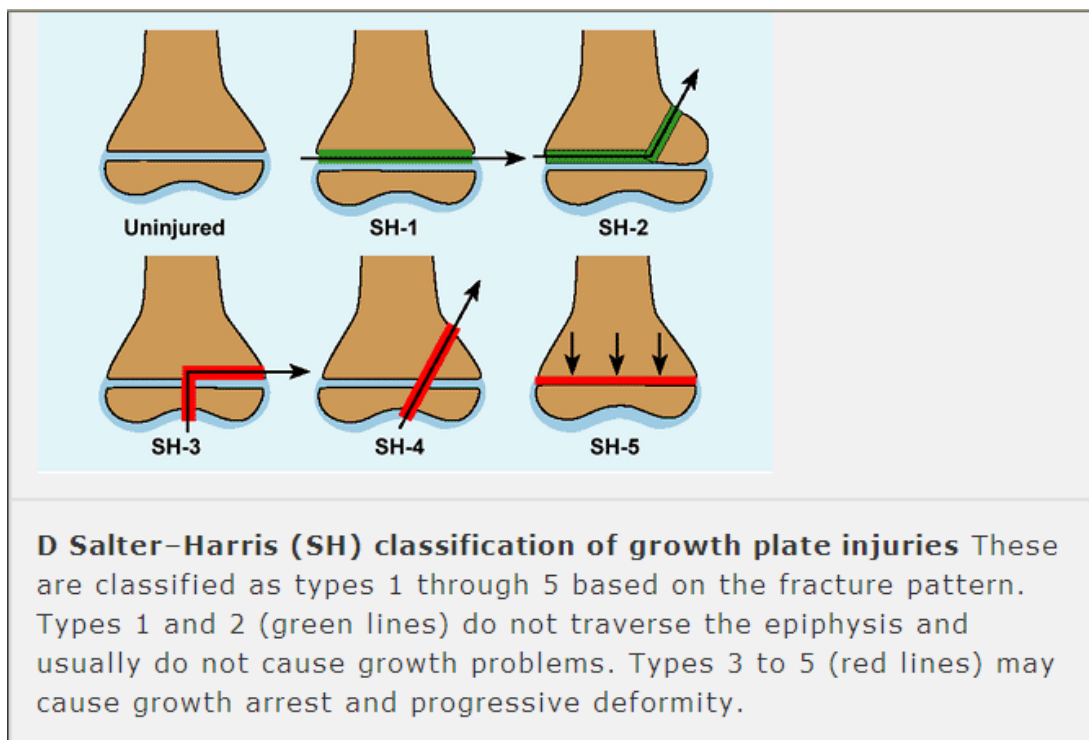
Angular deformity (varus more frequently than valgus) (10% to 20%)

### III. DISTAL RADIUS FRACTURES

#### 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.
- A K-wire is used to treat because it causes less trauma to the growth plate. It doesn't cause compression and only crosses the growth plate at ONE point.
- If not treated, carpal tunnel syndrome (median nerve) occurs.



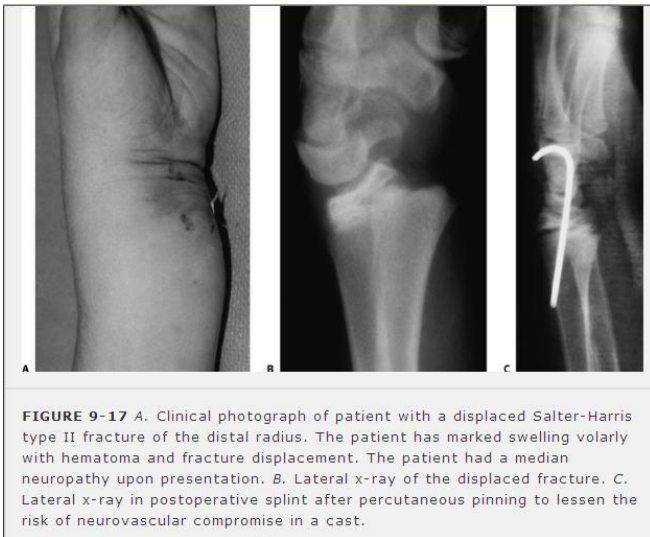
## pre op Salter harris2



## AP and lateral X-ray post OP

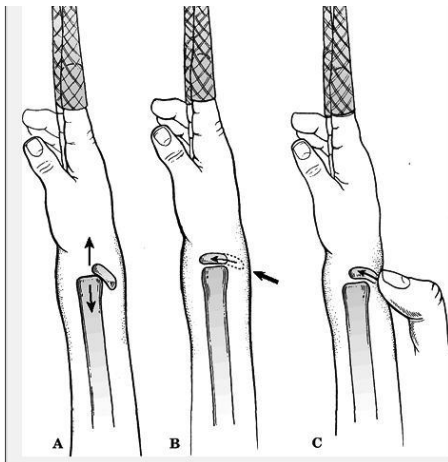


## Clinical picture and X-ray pre and post op



## Salter-Harris Types I and II treatment

Open reduction is indicated if the fracture is irreducible



## 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.

If Salter-Harris Type 3: Pin + K-wire

### Salter-Harris Types IV and V

Rare injuries, need ORIF

If Salter-Harris Type 4: Just K-wire

### Complications

- 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.

## IV. Metaphyseal Injuries

Classification:

- the direction of displacement
- involvement of the ulna
- biomechanical pattern
- torus (only one cortex is involved)
- incomplete (greenstick)
- complete

## Torus fracture

- the injury is stable
- protected immobilization for pain relief
- Bicortical injuries should be treated in a long arm cast.

unilateral= just immobilize for pain relief

bilateral= cast over elbow for pain relief



## 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

Proximal radius= over-elbow cast in supination

Mid radius= over-elbow cast in neutral position

Distal radius= over-elbow cast in the prone position

Why? To relax the muscles.



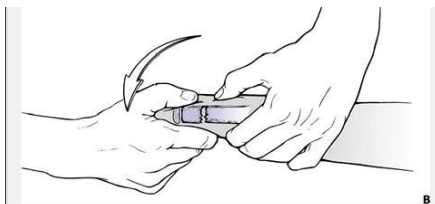
Table 45.1. Acceptable angular corrections in degrees			
Sagittal Plane			
Age (yr)	Boys	Girls	Frontal Plane
4–9	20	15	15
9–11	15	10	5
11–13	10	10	0
>13	5	0	0
Acceptable residual angulation is that which will result in total radiographic			

### Complete fracture

- Closed reduction
- a well molded long arm cast for 3 to 4 weeks

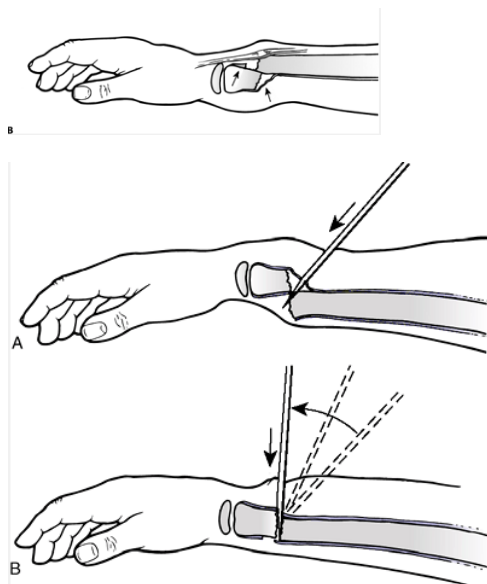
Adults= below elbow cast

Kids= above-elbow cast (to minimize them going crazy)



### Indications for percutaneous pinning

- loss of reduction. excessive local swelling
- floating elbow multiple manipulations



## Complications

- Malunion

Residual malalignment 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.

## Complete fracture

Indication for open

Reduction

- irreducible #

- Open fracture

- Fracture with compartment syndrome.





## V. Pediatric Femoral Shaft

- 1.6% of all fractures in the pediatric population
- Boys are more commonly affected
- 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

### MECHANISM OF INJURY

If the mechanism that the 'guardian' says does not match the fracture, think of child abuse.

- 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

- 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

Check the femoral, common peroneal, and tibial nerves and pulses.

Just look at the quadriceps contraction during the motor exam, because extension of the knee will be too painful due to the fracture.

## RADIOGRAPHIC EVALUATION

- Antero-posterior and lateral views
- X-ray most include hip, knee joints.



## CLASSIFICATION

### •Descriptive

Open versus closed

Level of fracture: proximal, middle, distal third

Fracture pattern: transverse, spiral, oblique, butterfly fragment

Comminution

Displacement

Angulation

### •Anatomic

Subtrochanteric

Shaft

Supracondylar

## TREATMENT

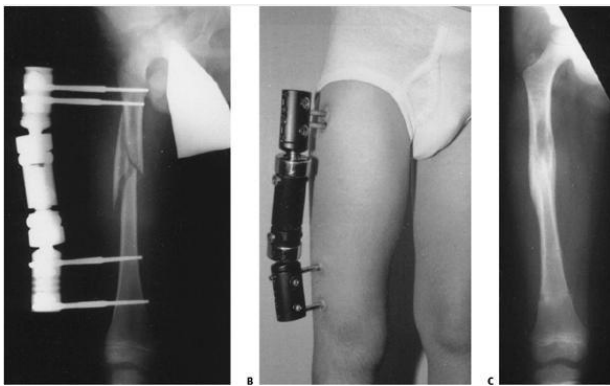
Intramedullary nails are contraindicated in kids <16-18 because it crosses the growth plate (causing osteonecrosis of it's part). Instead, use an elastic nail- this is placed inside the bone by drilling a hole into the bone shaft UNDER the growth plate.

Age <6 Months

- a. Pavlik harness or a posterior splint
- b. Traction and spicacasting

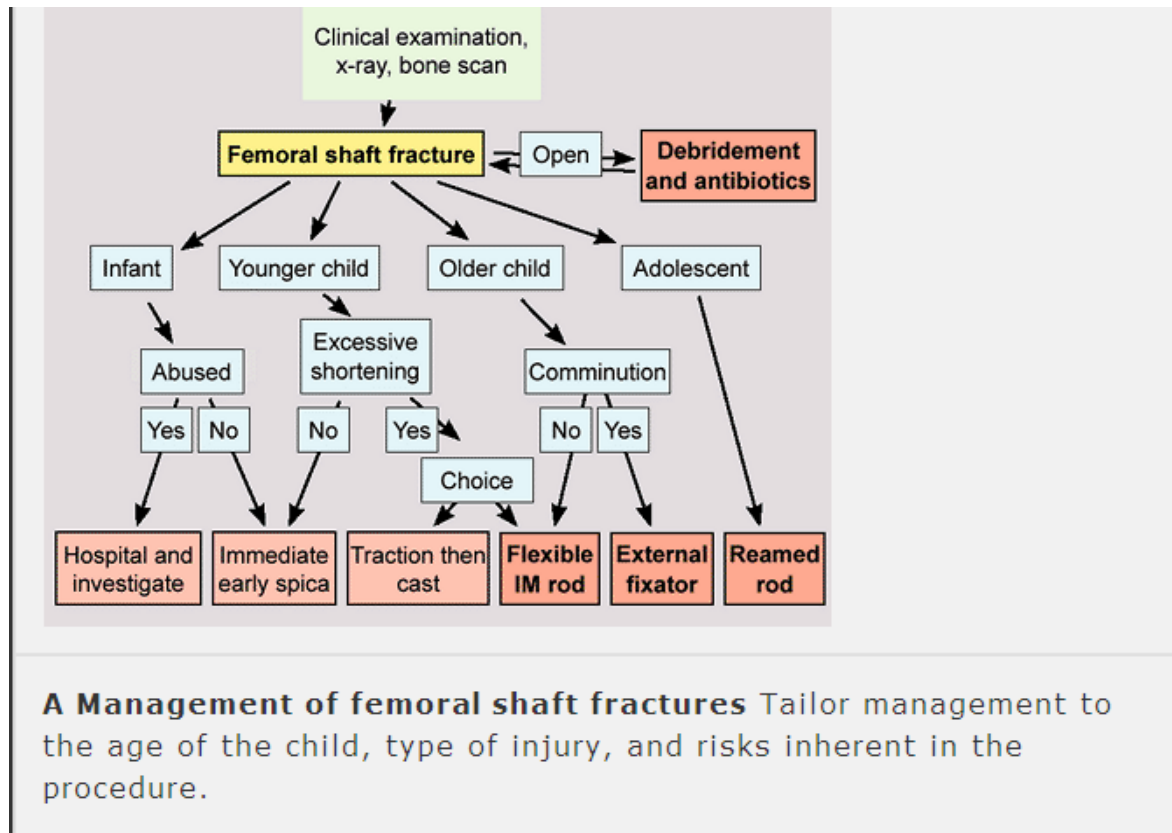
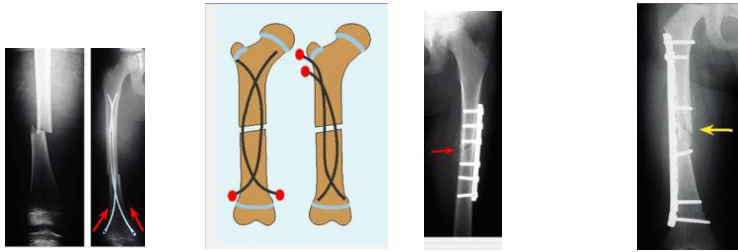
### Ages 6 Months to 6 Years

- a- Immediate spica casting is the treatment of choice (>95%).
- b- Skeletal traction followed by spicacasting if there is difficulty to maintain length and acceptable alignment
- c- External fixation
  - multiple injuries
  - open fracture
  - comminuted #
  - Unstable patient



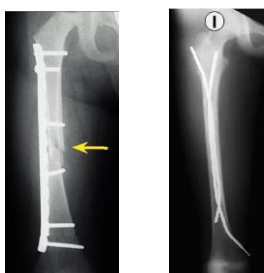
### Ages 6 to 12 Years

- a. Flexible intramedullary nails
- b. External fixation
- c. Bridge plating



## Ages 12 to Maturity

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



## Operative Indications

- Multiple trauma, including head trauma
- Open fracture

- Vascular injury
- Pathologic fracture
- Uncooperative patient
- Body habitusnot amenable to spicacasting

<b>Table 48.1. Acceptable angulation</b>			
<b>Age</b>	<b>Varus/Valgus (degrees)</b>	<b>Anterior/Posterior (degrees)</b>	<b>Shortening (mm)</b>
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

- Malunion

Remodeling will not correct rotational deformities

- Nonunion –rare
- Muscle weakness
- Leg length discrepancy Secondary to shortening or overgrowth

1.5 to 2.0 cm is common in the 2-to 10-year age

- Osteonecrosiswith antegradelM nail<16year

The younger the child, the greater the angulation that will occur. Internal rotation won't reduce it because of the thick periosteum if kids. So there will be quick (and alot) of remodelling.

If there's tissue infection, you use an external fixator instead of an internal fixator because it can easily be removed.

\*When putting in a K-wire, always put a cast because it's not 100% stabilizing.