

# Common pediatric Fractures and Trauma

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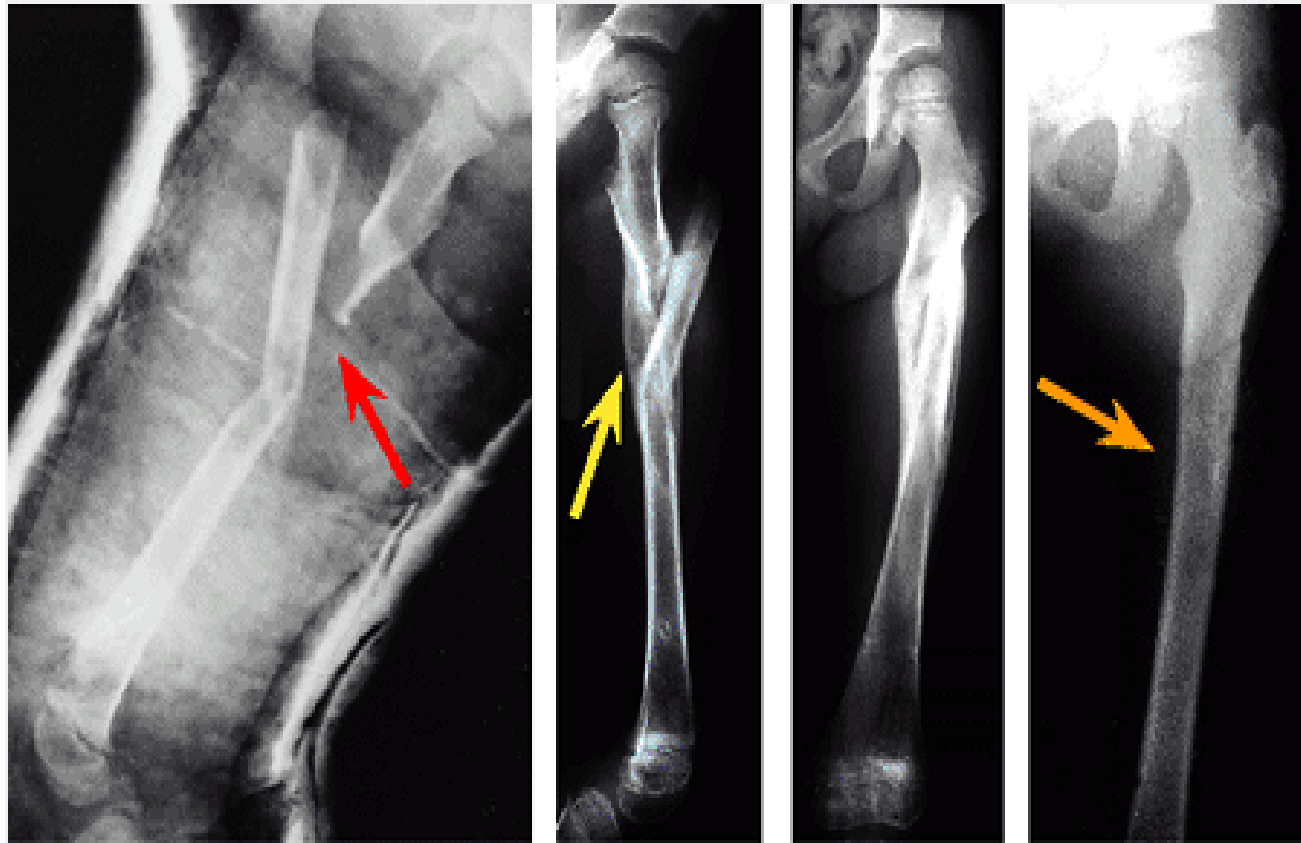
# objectives

- 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.

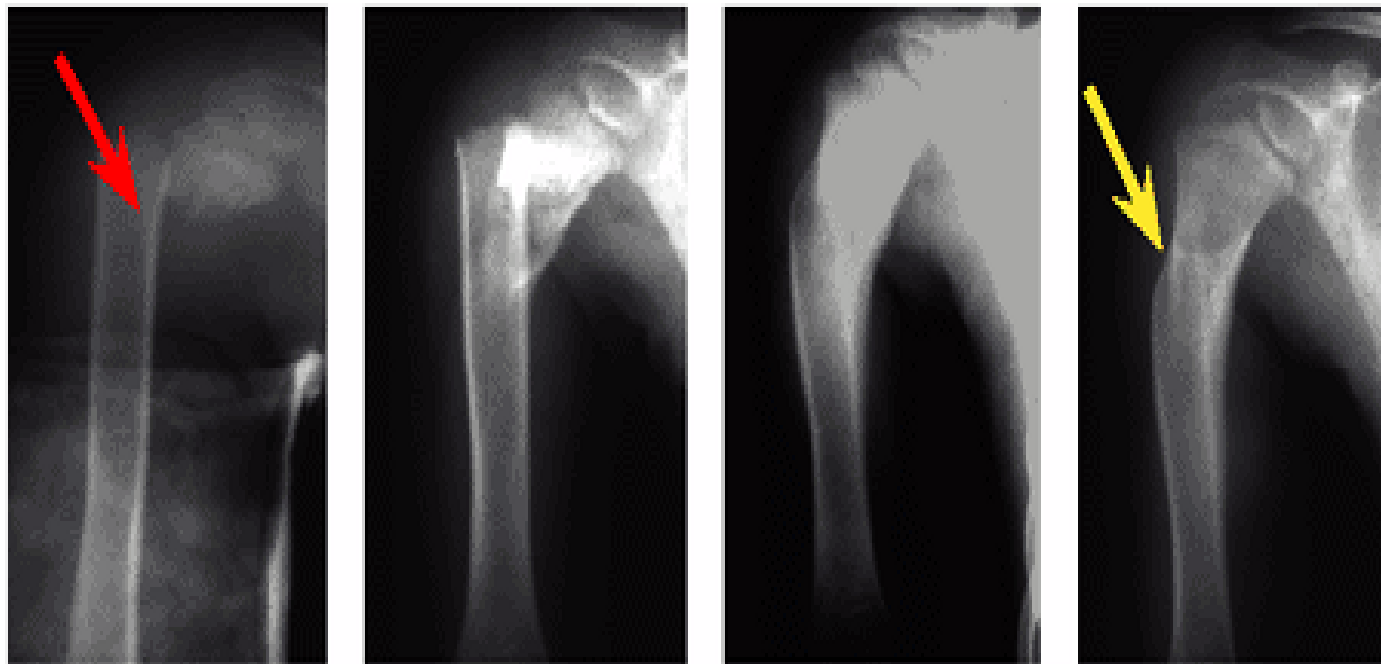
# The different between adult and pediatric bones

- Pediatric bone has a higher water content and lower mineral content per unit volume than adult bone so less brittle than adult bone.
- 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
- ligaments in children are functionally stronger than boneTherefore, a higher proportion of injuries that 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 .
  - b. Supracondylar Fracture.
  - c. Distal Radius .
- Lower Limbs
  - a. Femur fractures

# 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
- Direct: This is the most common mechanism, it carries the highest incidence of injury to the underlying neurovascular and pulmonary structures
- Birth injury

# Clinical Evaluation

- Birth fractures
  - an asymmetric, palpable mass overlying the fractured clavicle
- typically present with a painful, palpable mass along the clavicle, Tenderness, there may be tenting of the skin, crepitus, and ecchymosis.
- Neurovascular ,the brachial plexus and upper extremity vasculature may 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 calssificatiom

## Type I:

Middle third (most common)

## Type II:

Distal to the  
coracoclavicular ligaments  
(lateral third)

## Type III:

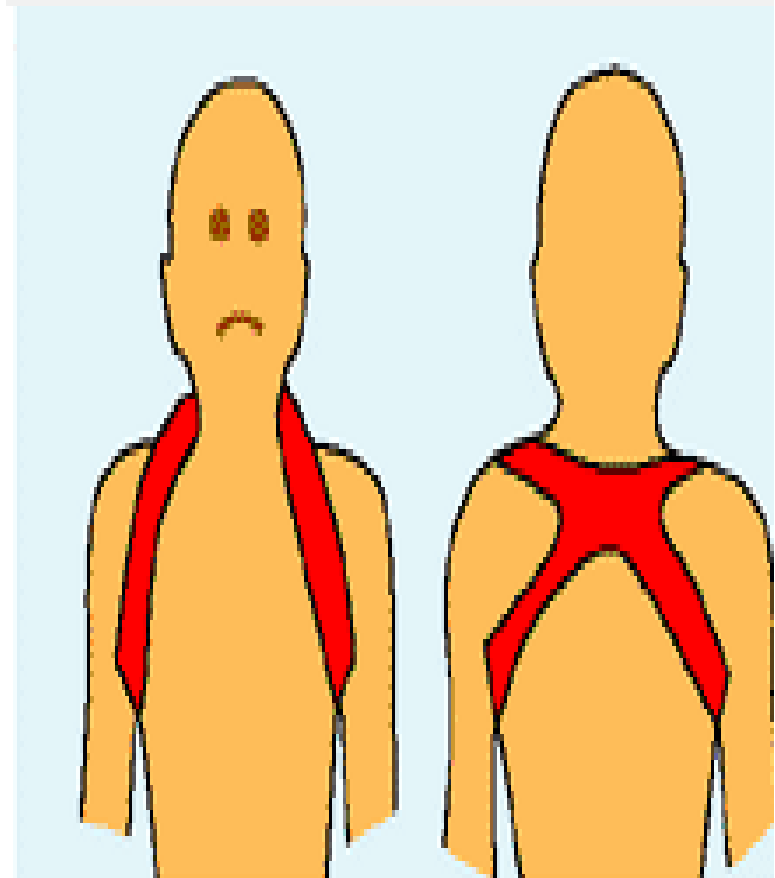
Proximal (medial) third



# 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 or figure-of-eight bandage applied for 2 to 3 weeks



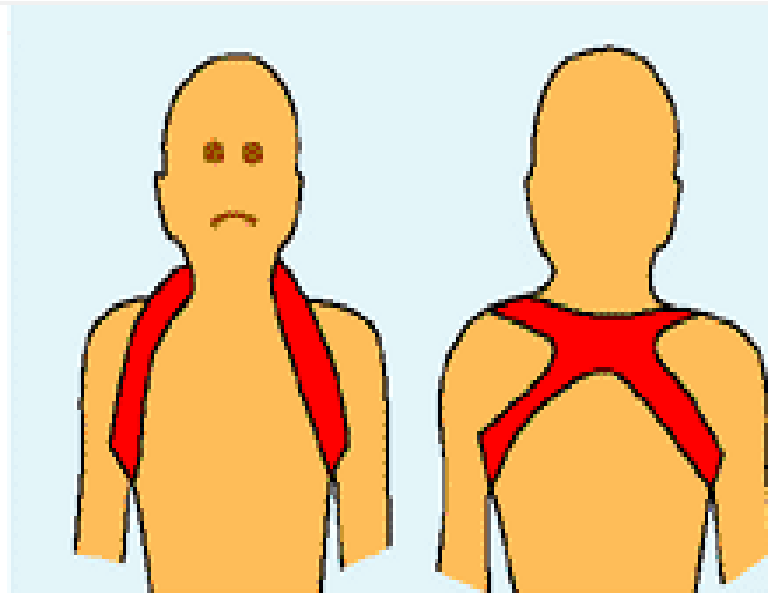
# Treatment

Age 2 to 12 Years

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

**Operative** Treatment Indication

- Open fractures
- Neurovascular compromise

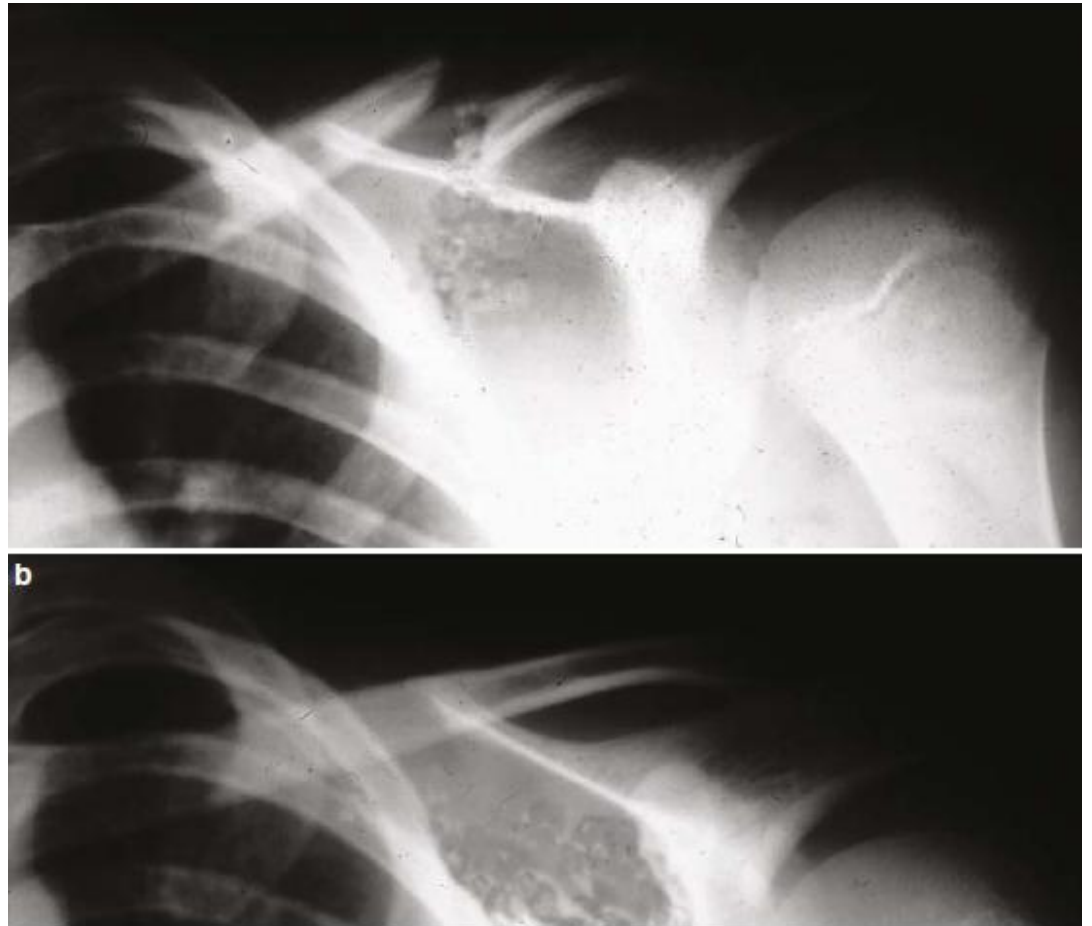


# **X-ray Mid clavicle fracture**

Post conservative treatment

Healed completely

With no complications





# Complications

## Rare

- Neurovascular compromise
- Malunion
- Nonunion
- Pulmonary injury



# Supracondylar Fracture

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

# MECHANISM OF INJURY

- Indirect

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

- Direct

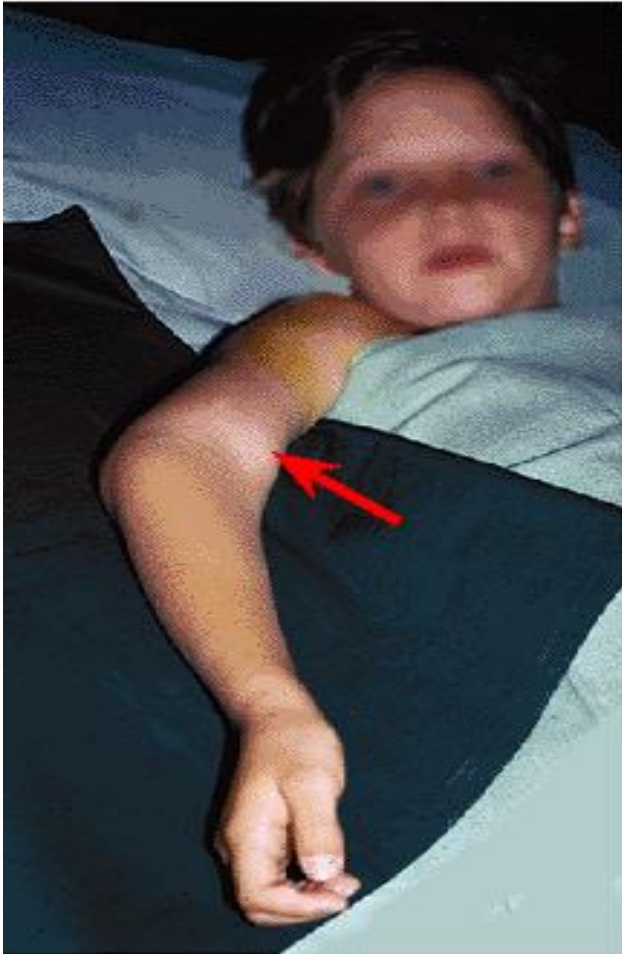
a fall onto a flexed elbow or from an object striking the elbow (e.g., baseball bat, automobile)---(Flexion type < 3%)

# Clinical Evaluation

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



# Clinical



# RADIOGRAPHIC EVALUATION

**AP view elbow**



**lateral x-ray view**



## Lateral elbow x-ray

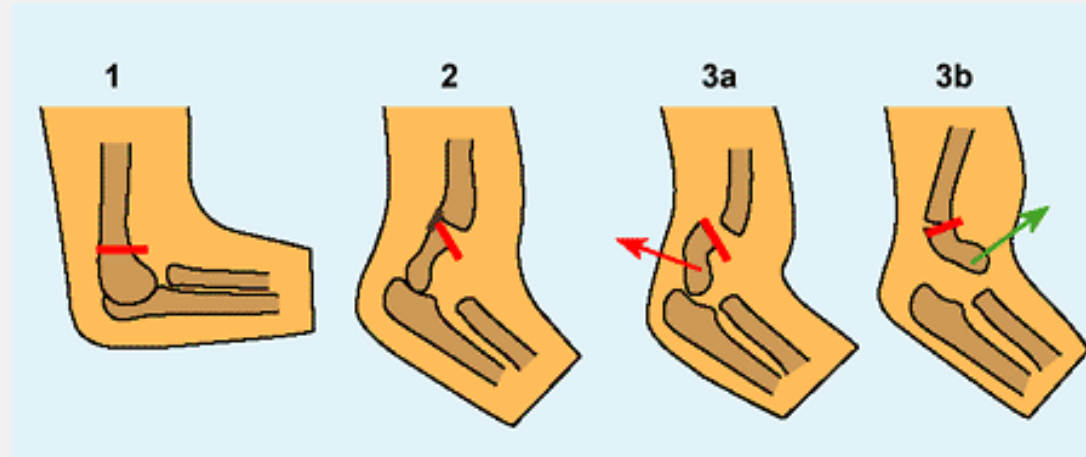


## AP view





# Classification Gartland



**A Classification of supracondylar fractures** Gartland classification includes three basic types. Type 1 is undisplaced. Type 2 has a posterior hinge and includes those with varus or valgus impaction. Type 3 is completely displaced and may show an extension pattern (red arrow) or a flexion pattern (green arrow).

# 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 ,sever 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

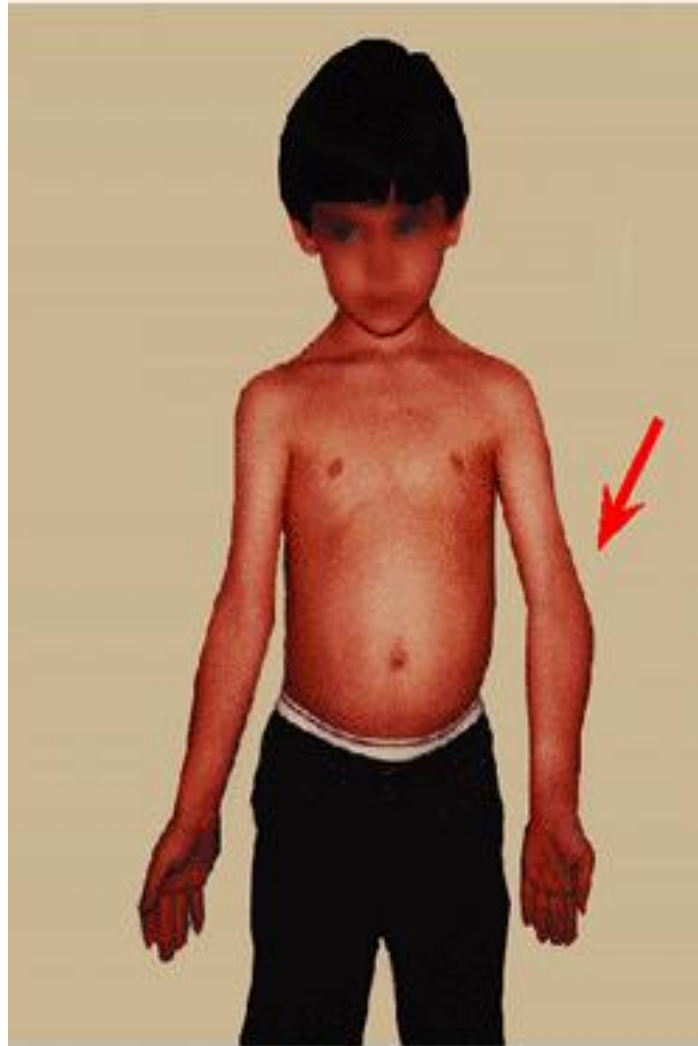
- Neurologic injury(7% to 10%)
  - Most are neurapraxias requiring no treatment
  - Median nerve/anterior interosseous nerve (most common)
- Vascular injury (0.5%)
  - direct injury to the brachial artery ,or secondary to swelling.



- 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

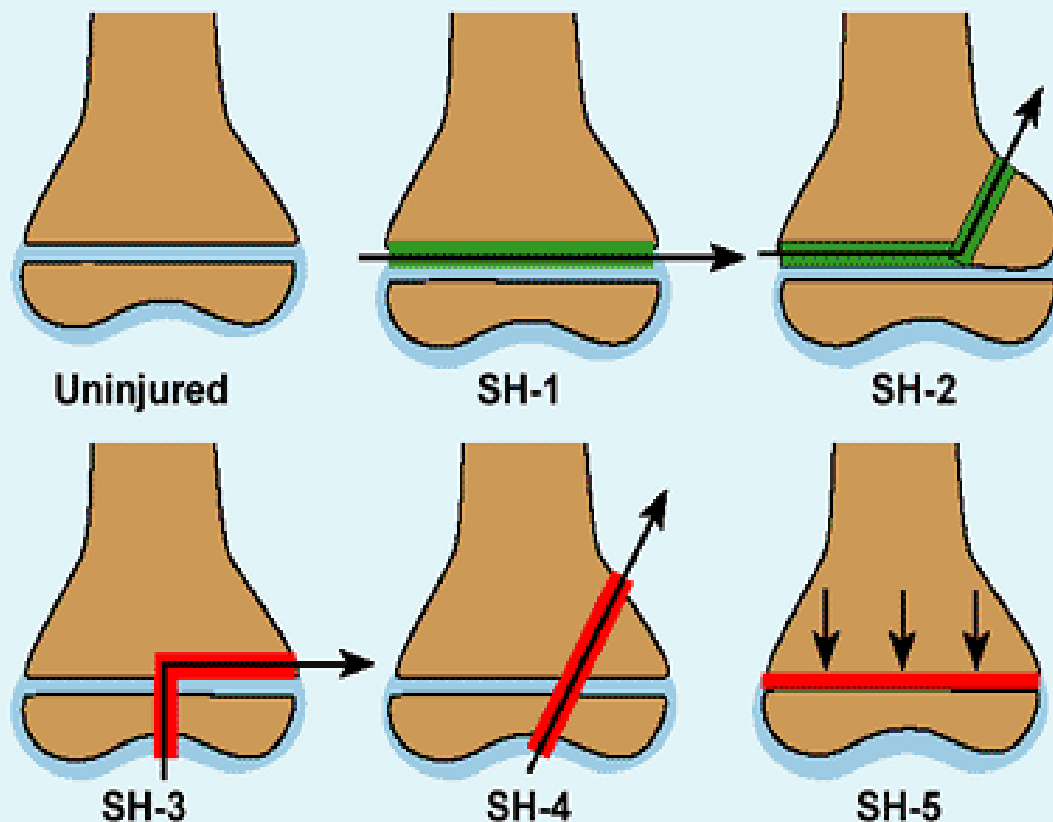




# DISTAL RADIUS FRACTURES

## 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.



**D Salter-Harris (SH) classification of growth plate injuries** These are classified as types 1 through 5 based on the fracture pattern. Types 1 and 2 (green lines) do not traverse the epiphysis and usually do not cause growth problems. Types 3 to 5 (red lines) may cause growth arrest and progressive deformity.

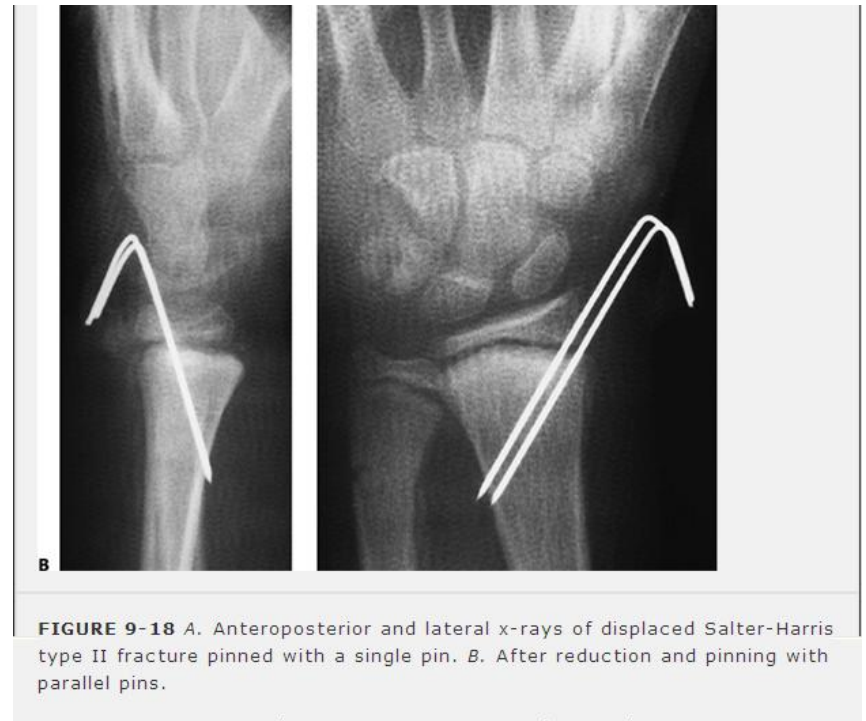




pre op Salter harris 2

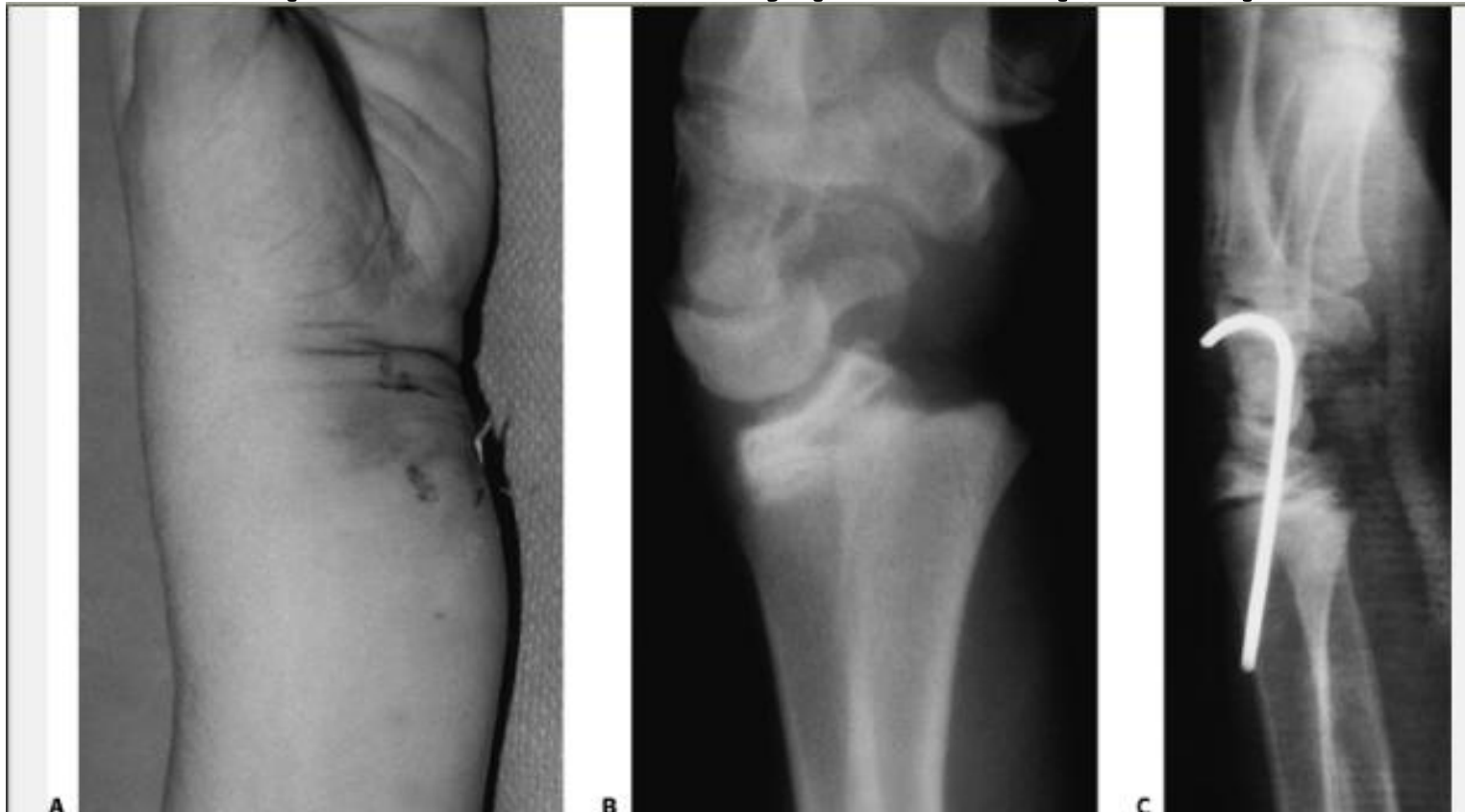


AP and lateral X-ray post OP



**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.

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

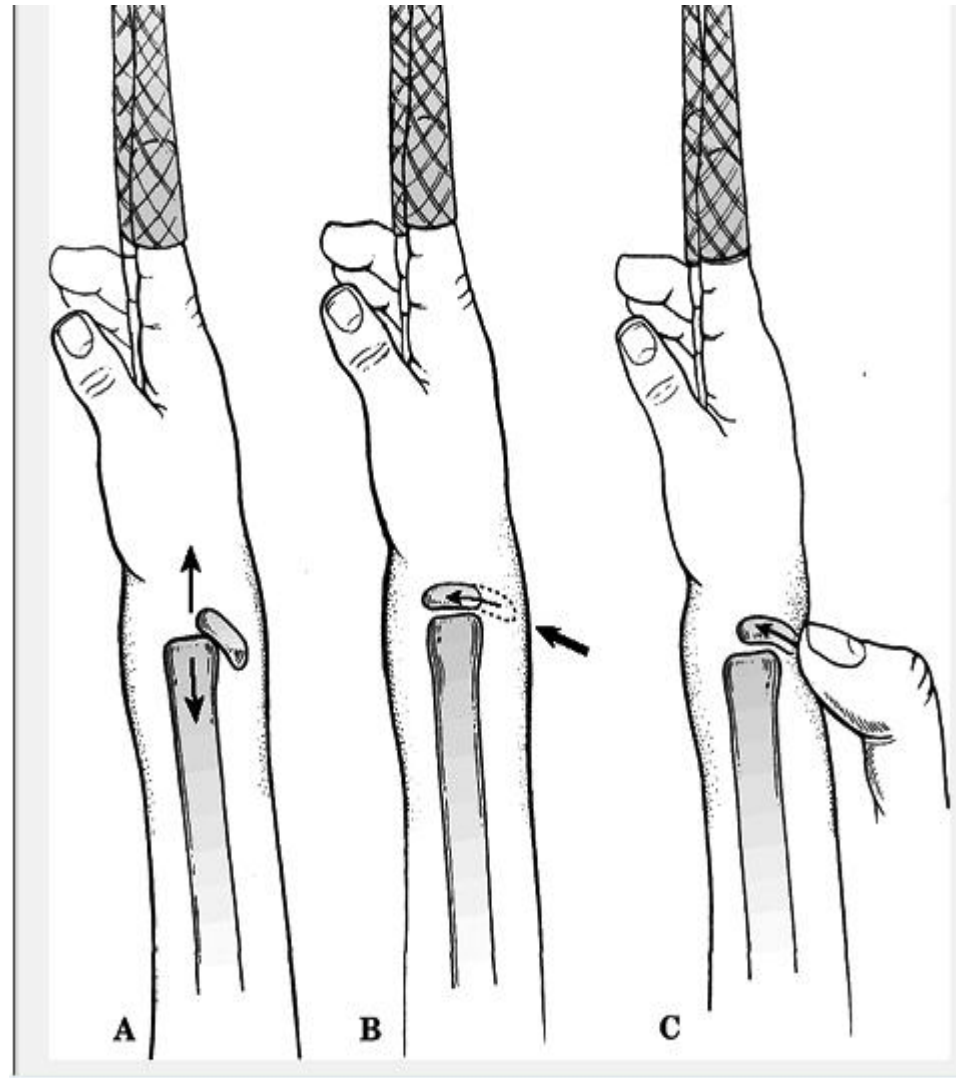


**FIGURE 9-17** A. Clinical photograph of patient with a displaced Salter-Harris type II fracture of the distal radius. The patient has marked swelling volarly with hematoma and fracture displacement. The patient had a median neuropathy upon presentation. B. Lateral x-ray of the displaced fracture. C.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



# Salter-Harris 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.

- Salter-Harris Types IV and V

Rare injuries, need ORIF

# Complications

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

**A****B**

**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.

# 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.



## 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**

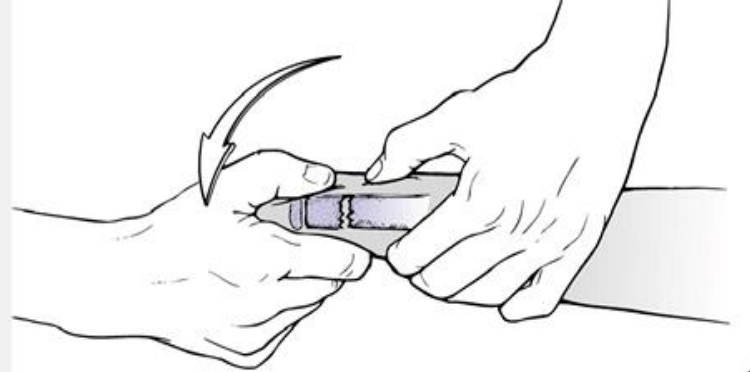
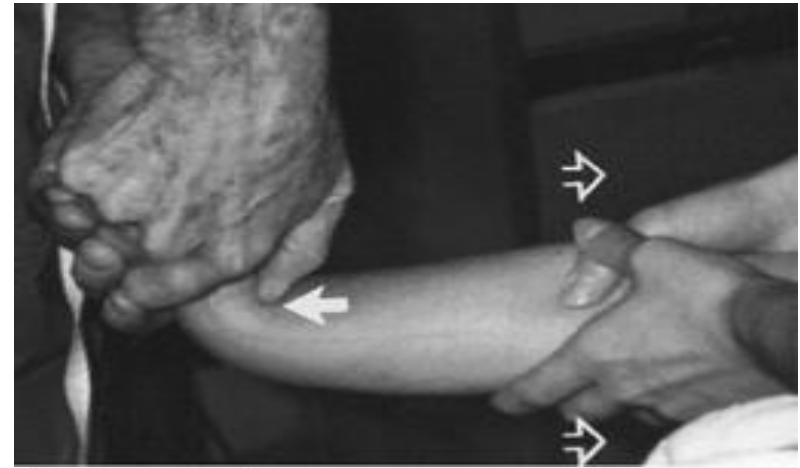
Sagittal Plane			
Age (yr)	Boys	Girls	Frontal Plane
4â€“9	20	15	15
9â€“11	15	10	5
11â€“13	10	10	0
>13	5	0	0

Acceptable residual angulation is that which will result in total radiographic



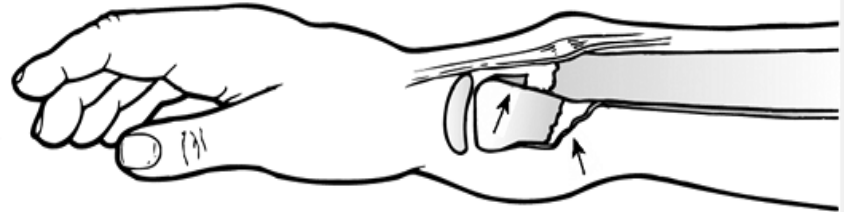
# Complete fracture

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

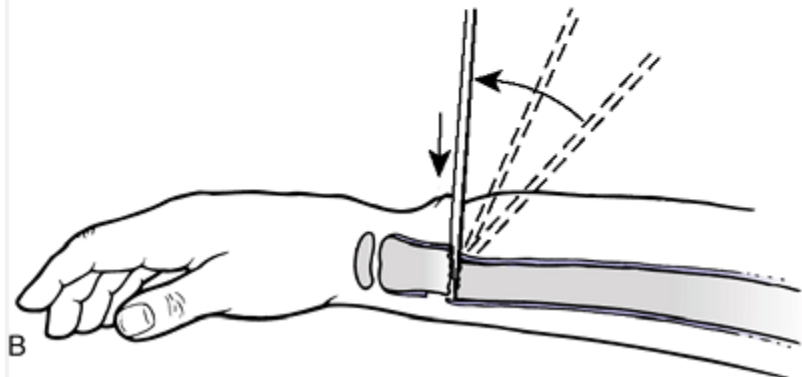
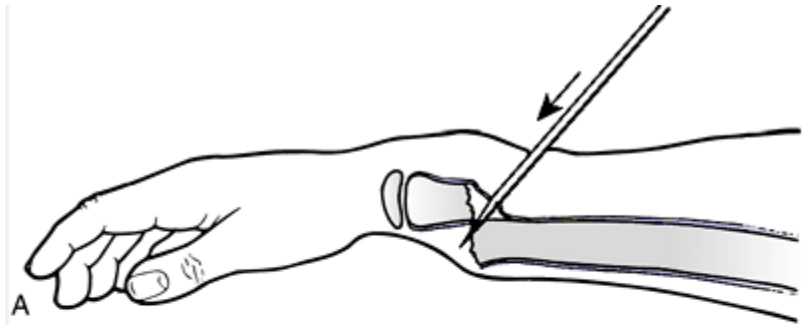


# Indications for percutaneous pinning

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



B



# 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.

# Complete fracture

Indication for open  
Reduction

- irreducible #
- Open fracture
- Fracture with compartment syndrome.







# 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

- 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



# RADIOGRAPHIC EVALUATION

- a. Anteroposterior and lateral views
- b. 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

Age <6 Months

a. Pavlik harness or  
a posterior splint



b. Traction and  
spica casting



# Ages 6 Months to 6 Years

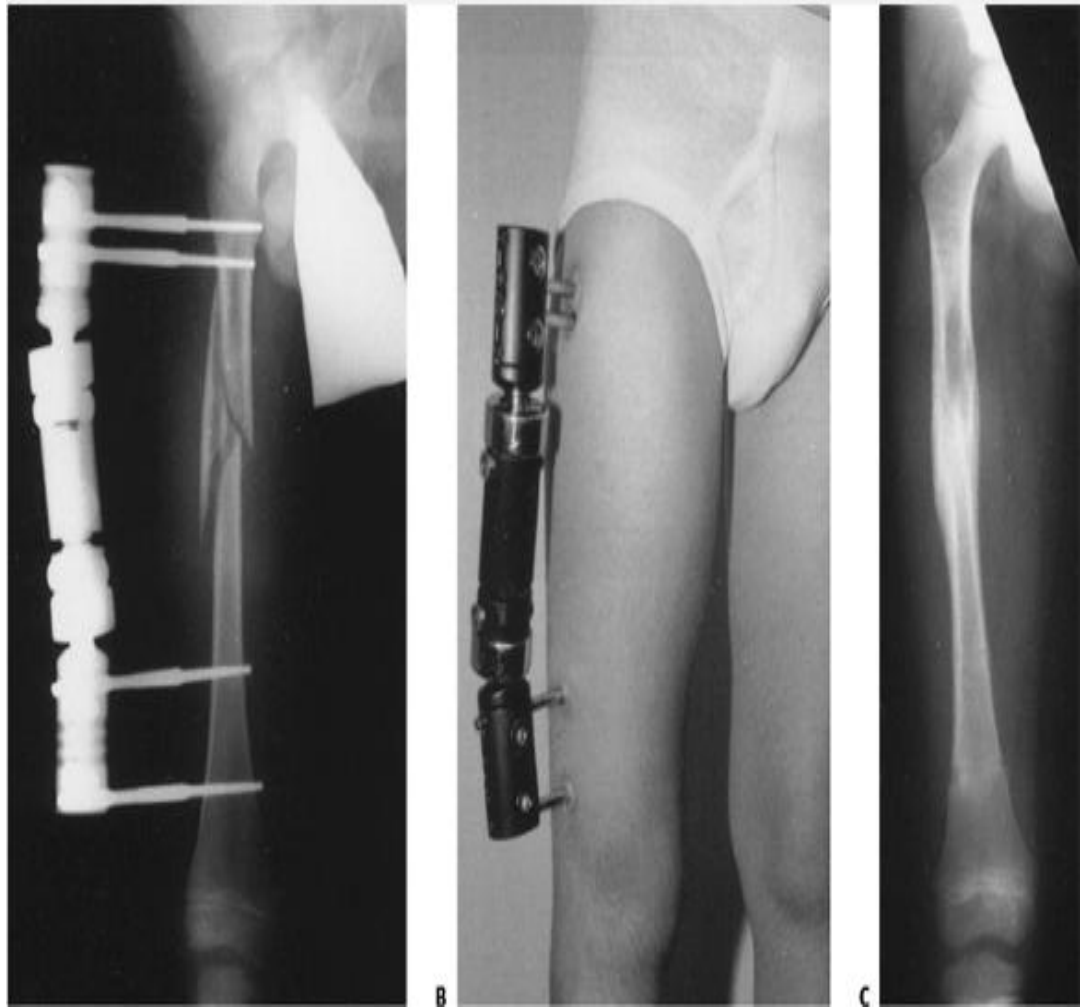
a. Immediate spica casting is the treatment of choice (>95%).

b. Skeletal traction followed by spica casting if there is difficulty to maintain length and acceptable alignment



## c.External fixation

- multiple injuries
- open fracture
- comminuted #
- Unstable patient

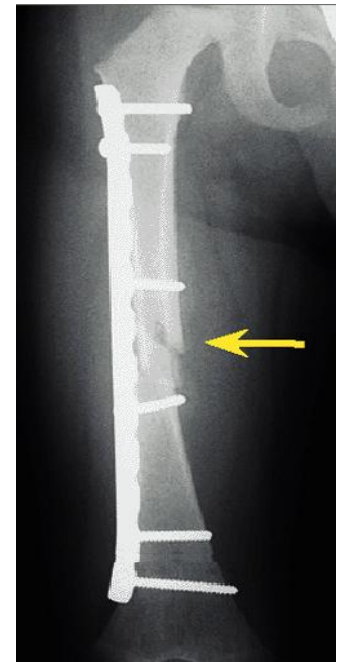
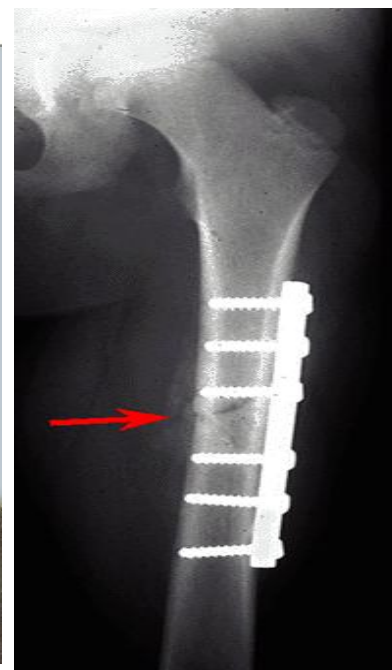
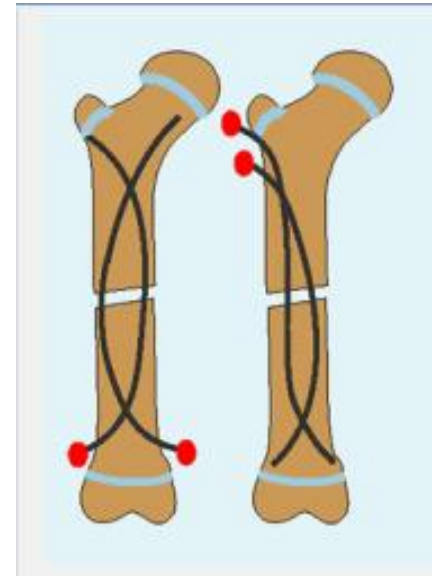


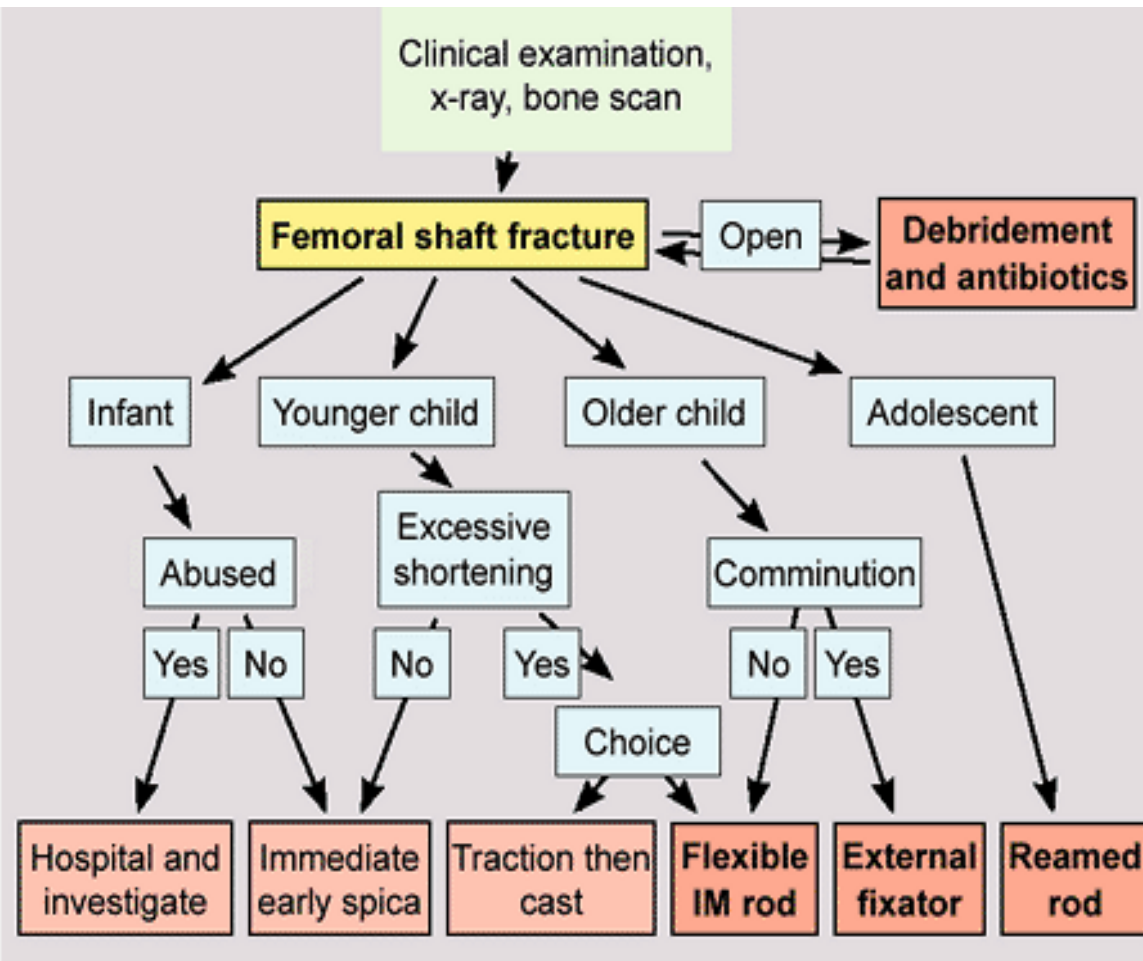
# Ages 6 to 12 Years

a. Flexible  
intramedullary  
nails

b. External fixation

c. Bridge plating

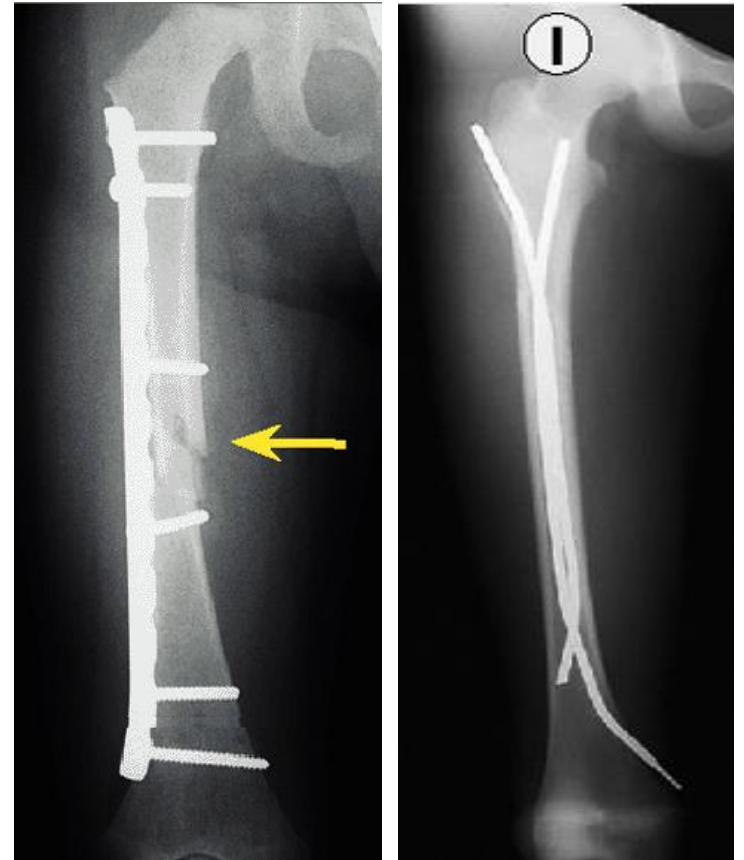




**A Management of femoral shaft fractures** Tailor management to the age of the child, type of injury, and risks inherent in the procedure.

# 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 habitus not amenable to spica casting

**Table 48.1. Acceptable angulation**

<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

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

- Osteonecrosis with antegrade IM nail <16year.

