Children Fractures illustrations

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General Principles

- Immature skeleton differs from that of the adult in both the normal and pathological states.
- Capable of plastic deformation before they fail.
- Comminuted fractures are rare.

General Principles

- Failure of union is rare.
- Few fractures require operative treatment.
- Presence of growth plate presents a challenge to the surgeon.
- Special considerations :
  - Pathological fractures
  - Child abuse

Development and Growth

- A fracture in an immature bone can cause growth to speed up or slow down.
- Fractures heal very rapidly.
- Depending on the age of the child and direction of the deformity, can remodel with correction of most angular malunion.
- Most important area of injury is “physis”.

Why are children's fractures different?

Children have different physiology and anatomy

- **Growth plate.**
- **Bone.**
- **Cartilage.**
- **Periosteum.**
- **Ligaments.**
- **Age-related**
- **physiology**

Why are children's fractures different?

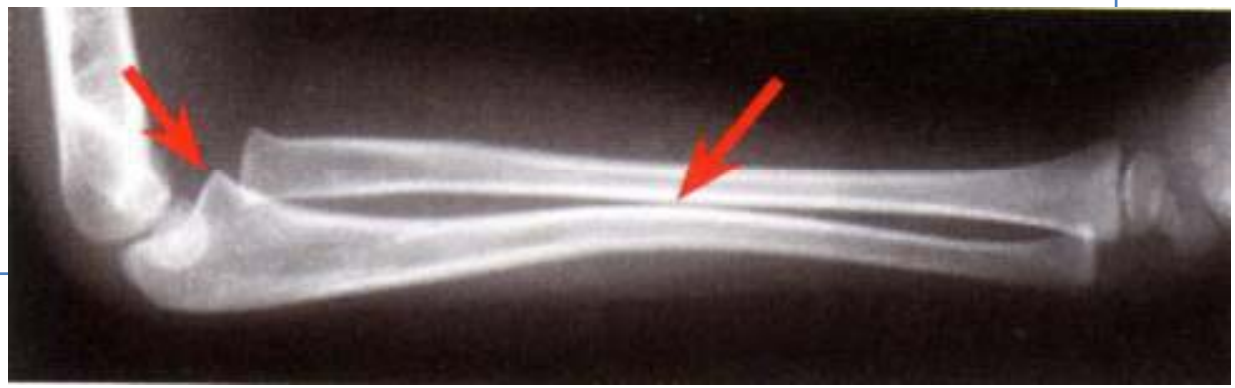
Children have different physiology and anatomy

- Growth plate:
  - In infants, G Plate is stronger than bone
    →**increased diaphyseal fractures**
  - Provides perfect remodeling power.
  - Injury of growth plate causes deformity.
  - A fracture might lead to overgrowth.

Why are children's fractures different?

Children have different physiology and anatomy

- Bone:
  - Increased collagen: bone ratio
    - lowers modulus of elasticity



Children have different physiology and anatomy

- Bone:
  - Increased collagen: bone ratio
    - lowers modulus of elasticity
  - Increased cancellous bone
    - reduces tensile strength
    - reduces tendency of fracture to propagate
      less comminuted fractures
  - Bone fails on both tension and compression
    - commonly seen “buckle” fracture

Children have different physiology and anatomy

- Cartilage:
  - Increased ratio of cartilage to bone
    - better resilience
    - difficult x-ray evaluation
    - size of articular fragment often under-estimated

Children have different physiology and anatomy

- Periosteum:
  - Metabolically active
    - more callus, rapid union, increased remodeling
  - Thickness and strength
    - Intact periosteal hinge affects fracture pattern
    - May aid reduction

Children have different physiology and anatomy

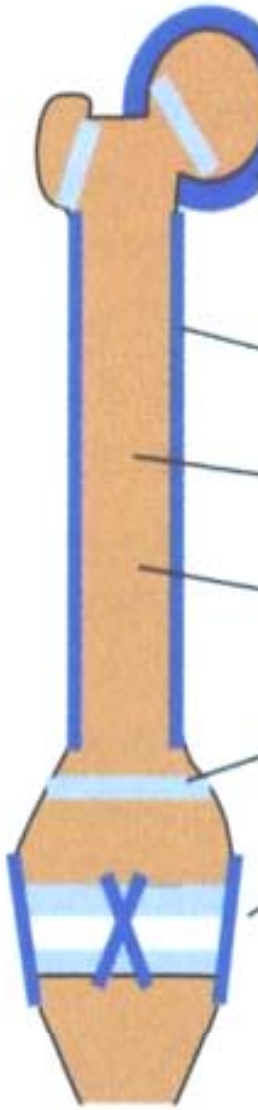
- Age related fracture pattern:
  - Infants: diaphyseal fractures
  - Children: metaphyseal fractures
  - Adolescents: epiphyseal injuries

Children have different physiology and anatomy

- Physiology
  - Better blood supply
  - rare incidence of delayed and non-union

Summary

Children's bones are different



Feature	Management effect
Thick joint cartilage	Not imaged by x-ray
Thick periosteum	Healing rapid
More collagen	Fractures easily
More cancellous bone	Simple fracture patterns
Growth plate	Remodels deformity
Ligaments stronger	Bone fails first

Regulation of Epiphyseal Growth

- Physis is the primary centre for growth in most bones.
- Four functional zones:
  - Growth.
  - Matrix.
  - Transformation.
  - Remodeling.

Regulation of Epiphyseal Growth

- Physis responds to compression as well as distraction.
- Other stimuli to growth are insults from:
  - Implants.
  - Fractures.
  - Infections.
  - Repeated attempts at reduction.

Growth and Remodeling of the Metaphyseal Bone

- Zone of transition between the physis and diaphysis.
- Site of most rapid changes in bone structure.

General Principles

- Skeletal trauma accounts for 10-15 % of all childhood injuries
- Physeal disruptions make about 15 % of all skeletal injuries in children

Incidence of Fracture Type

- Of all physeal injuries, 50% occur in the distal radius.
- Second most commonly injured area is the distal humerus.

Incidence of Fracture Type

- High energy trauma is the most common cause of death in children.
- Musculo-skeletal injuries are second to the CNS as the most frequent traumatic cause of permanent pediatric disability.

Xray Examination of the Injured Child

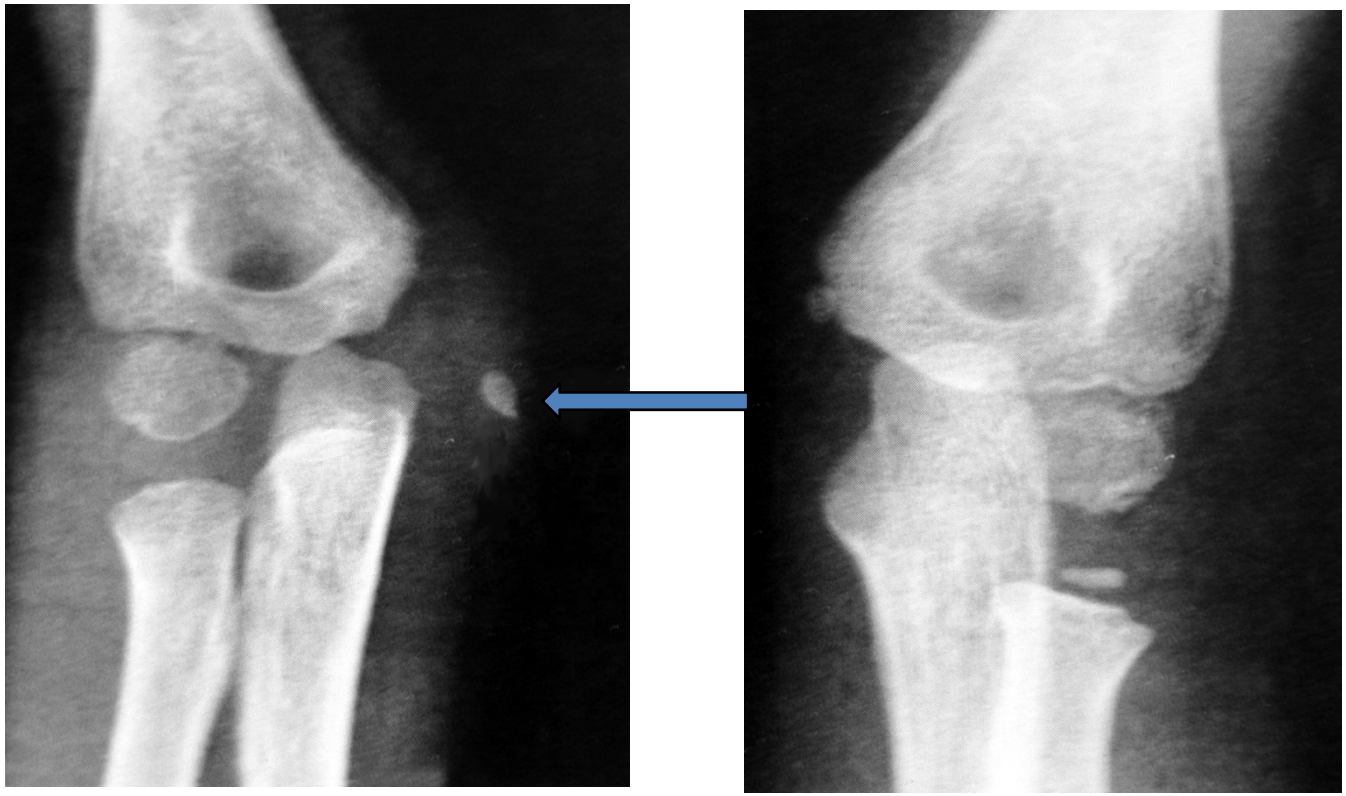
- **Law of Two-s :**
  - Two views
  - Two joints
  - Two limbs
  - Two occasions
  - Two physicians

Xray Examination of the Injured Child

Law of Two-s

Xray Examination of the Injured Child

Law of Two-s



Normal

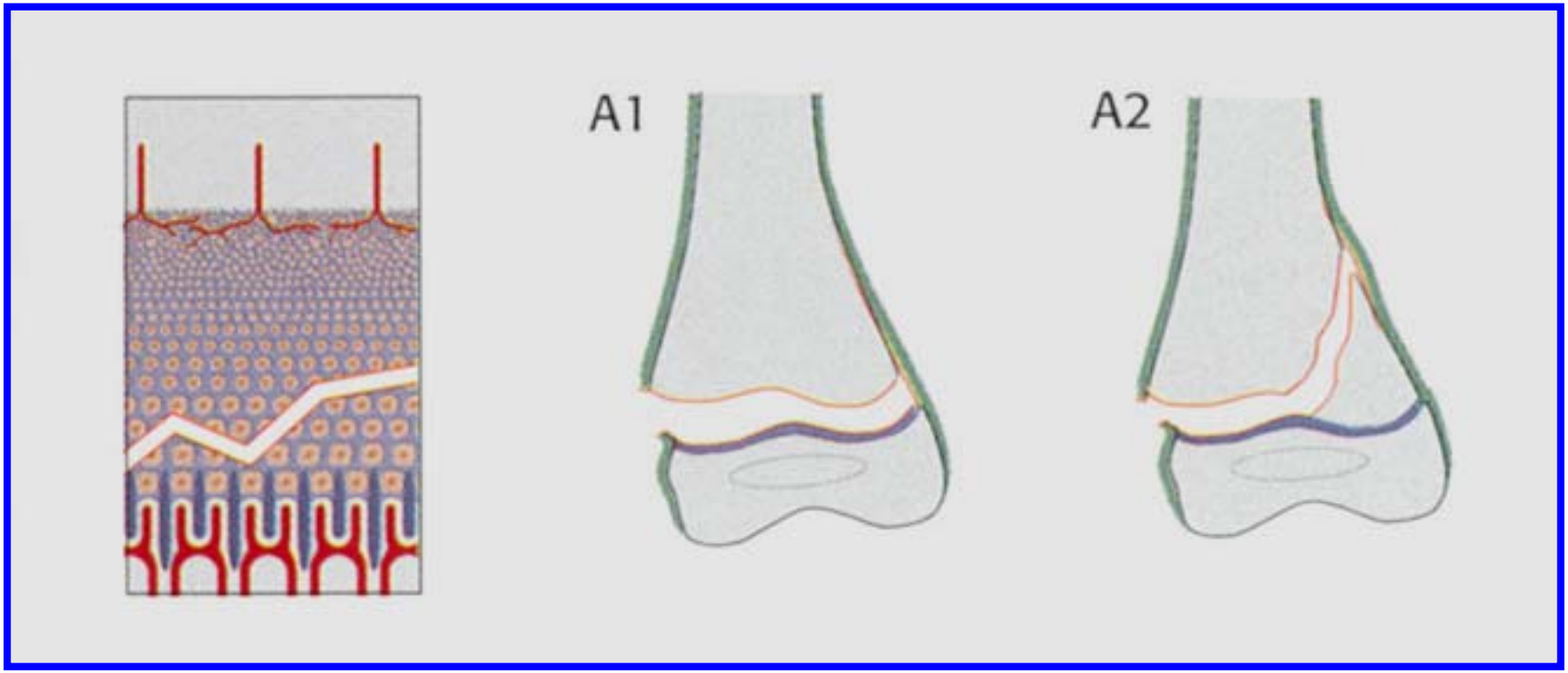
(Epiphyseal Injuries)

General Principles and Classification

- Inevitably involve the growth plate.
- Treatment and prognosis depends upon the pattern of injury.
- Frequently used classification is Salter-Harris.
- Muller proposed classification based upon three subdivisions.

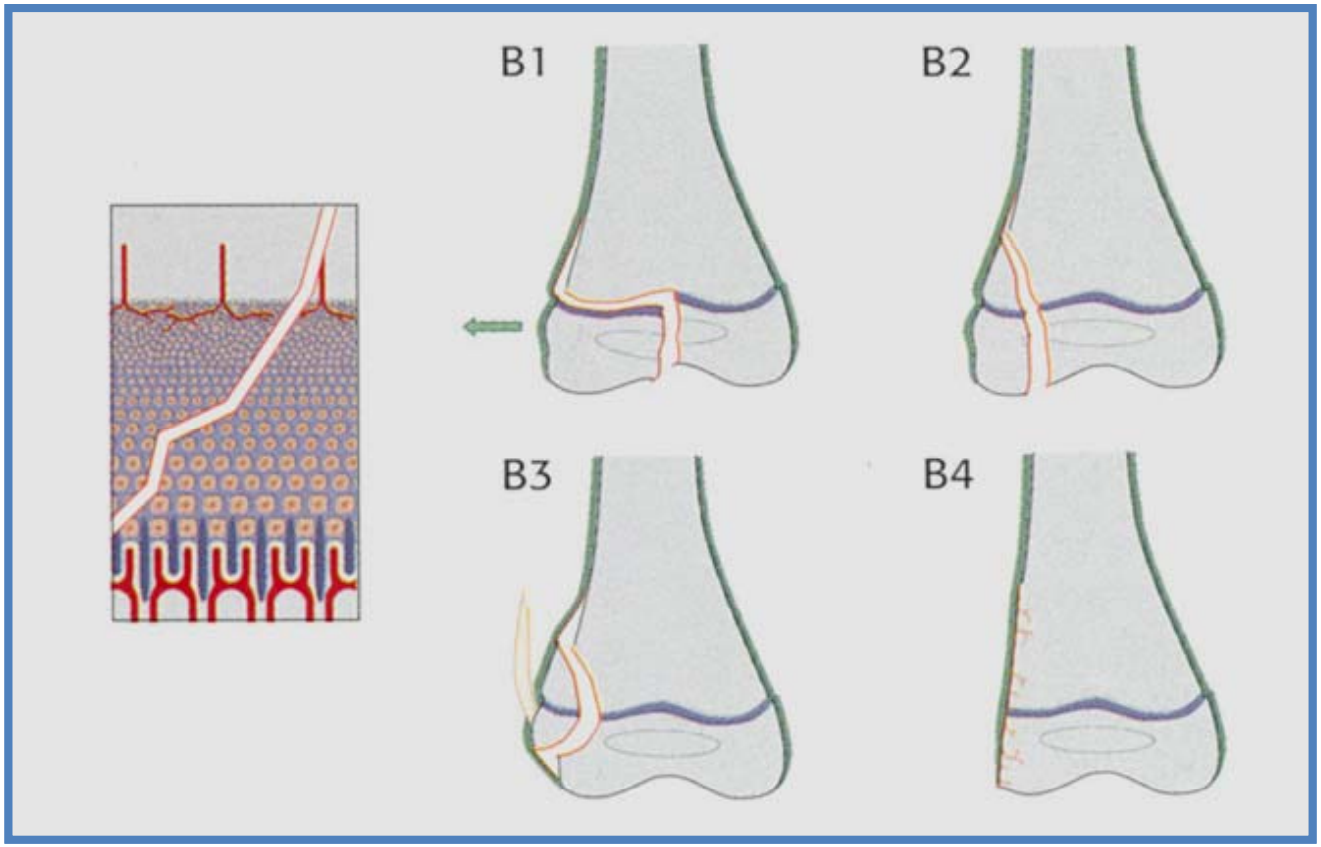
Muller's Classification

Type A (Salter-Harris Types I and II)



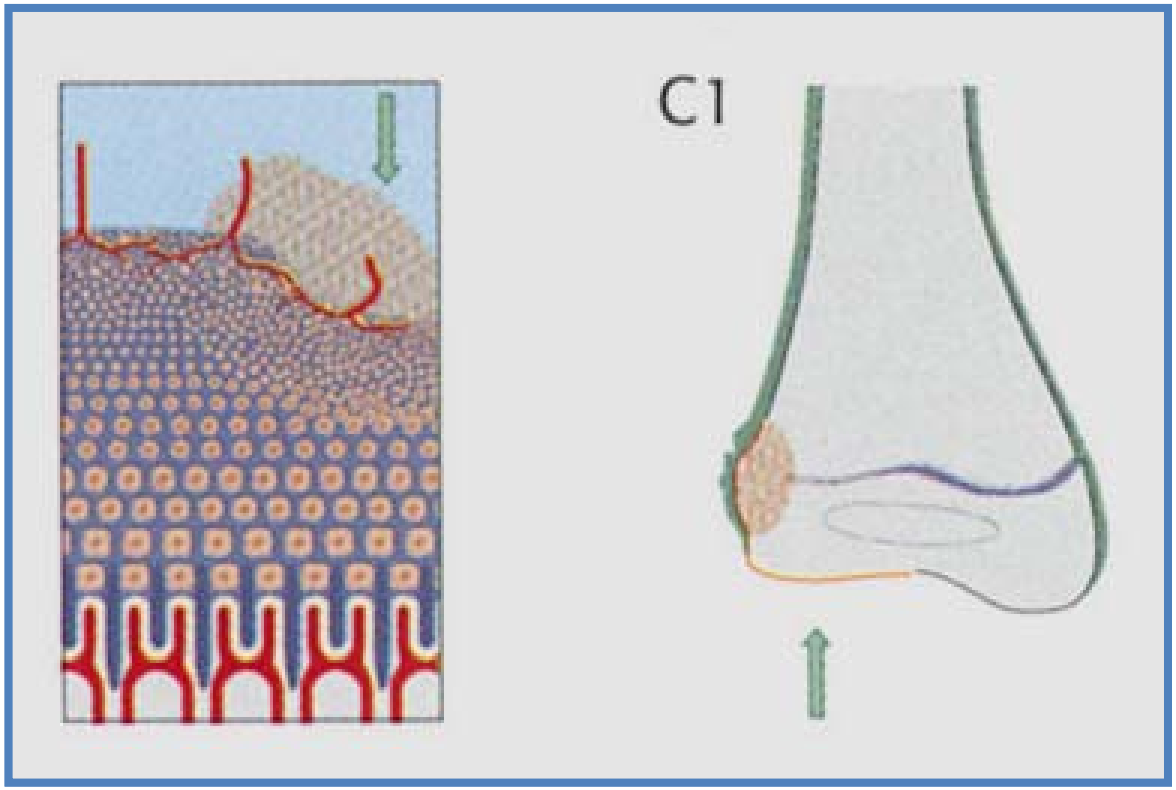
Muller's Classification

Type B (Salter-Harris Types III and IV)

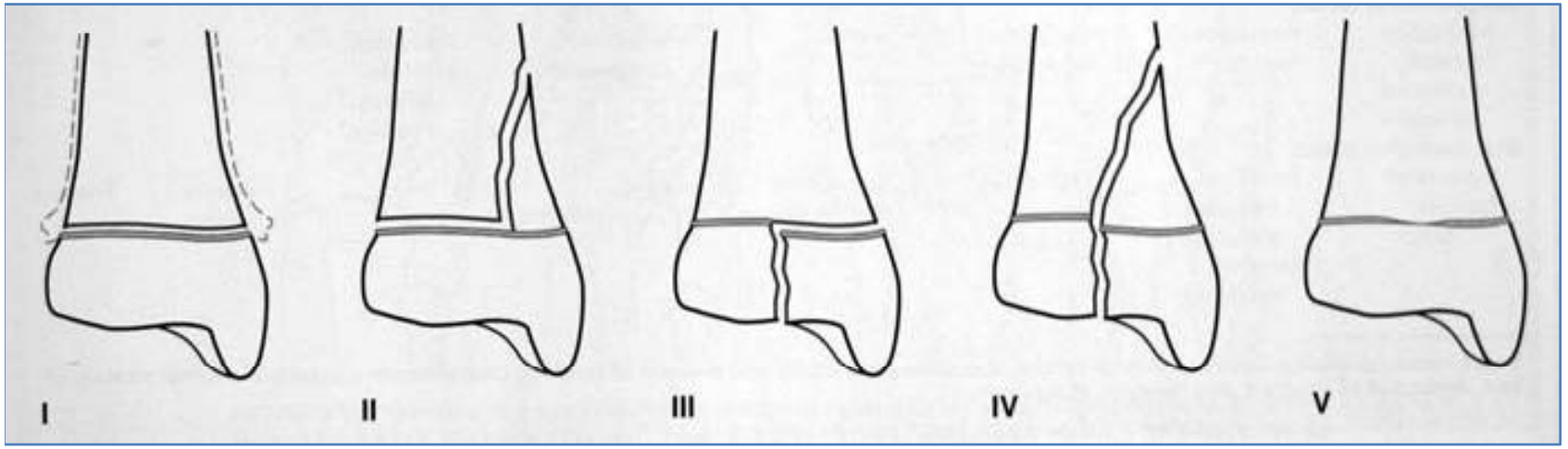


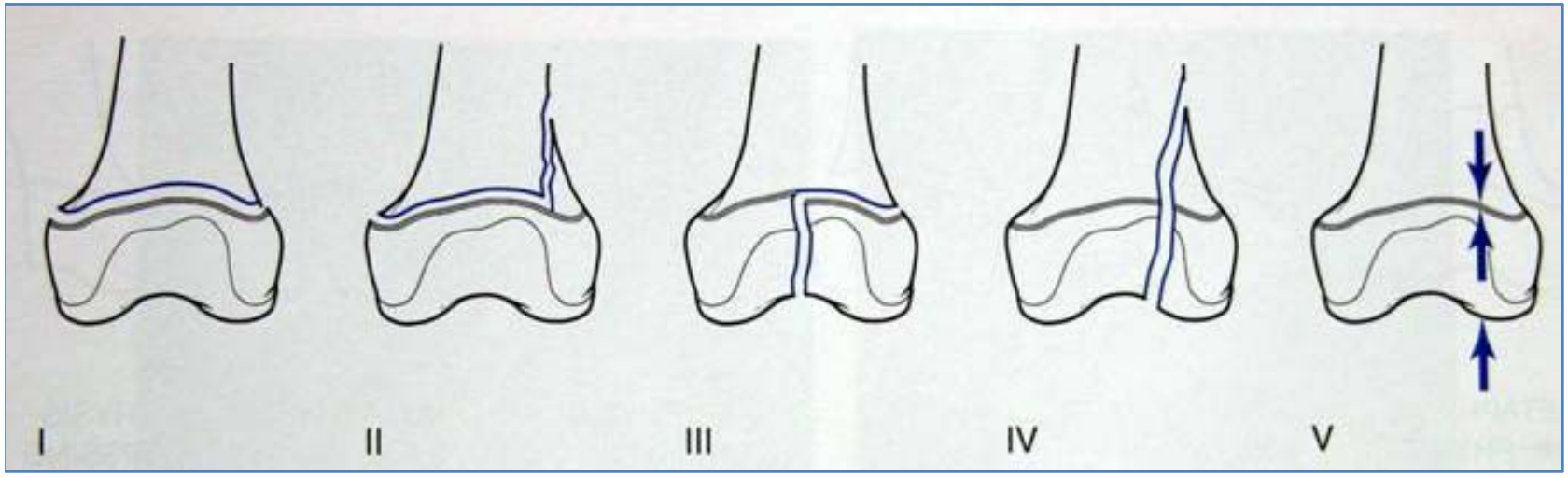
Muller's Classification

Type C (Salter-Harris Type V): •



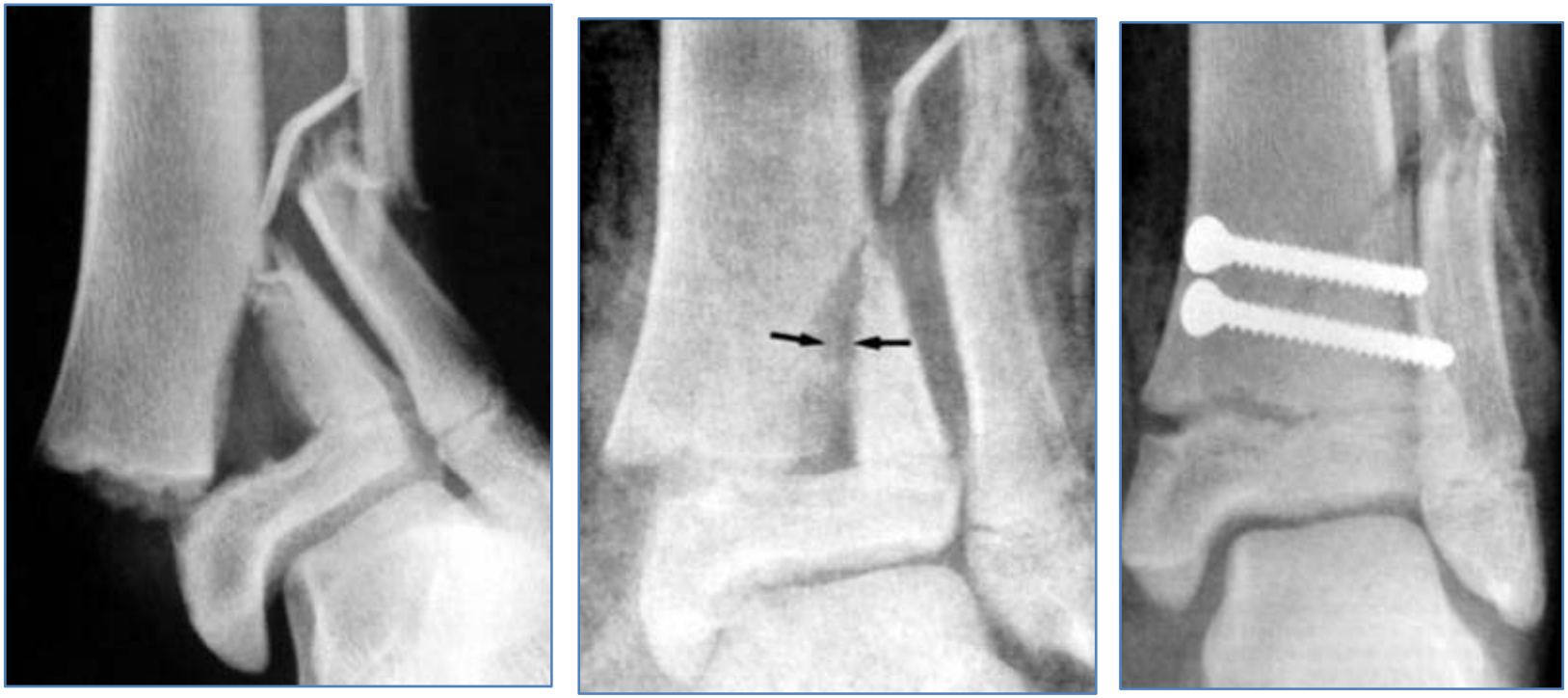
Epiphyseal Injuries



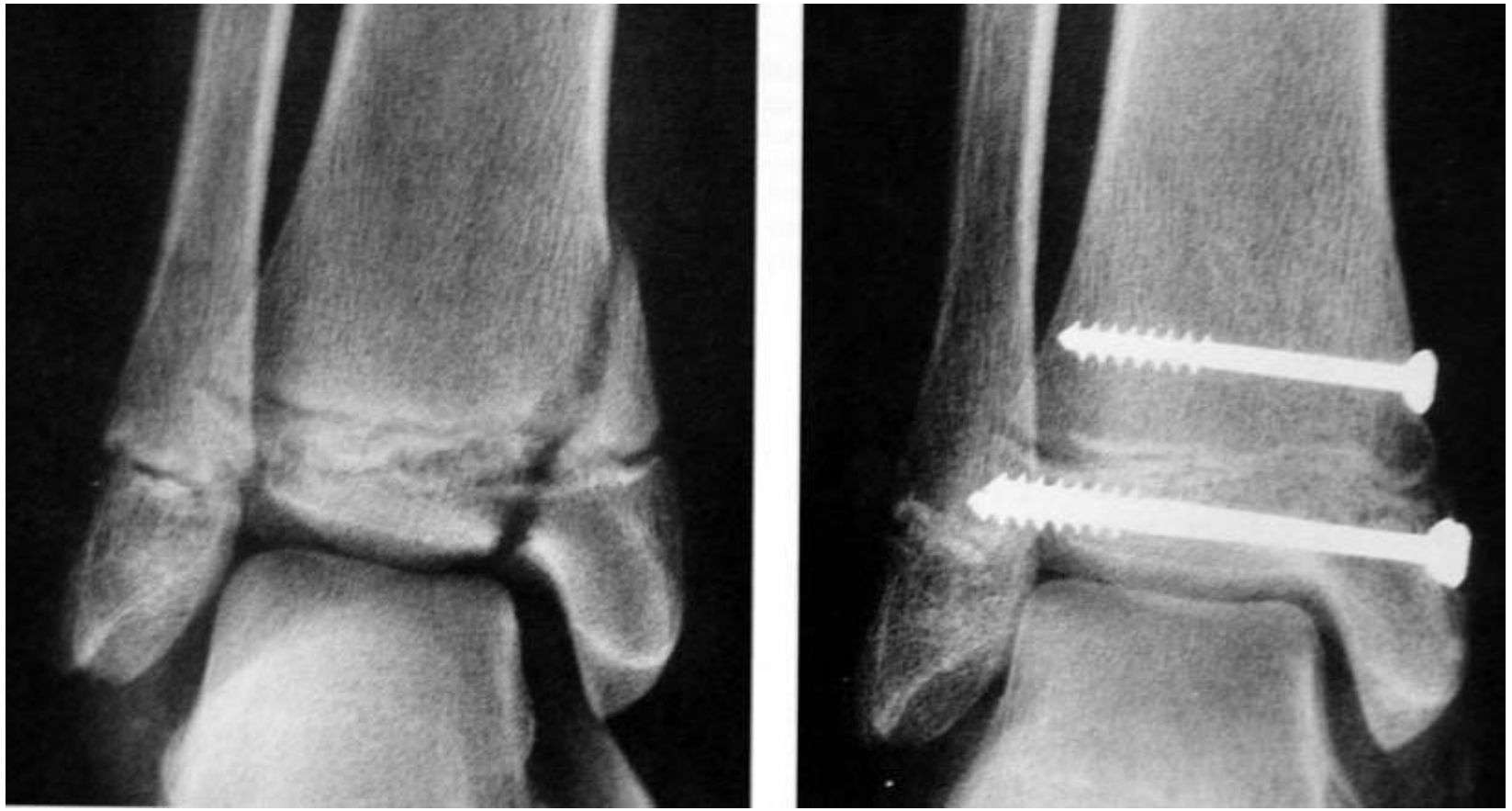


Epiphyseal Injuries

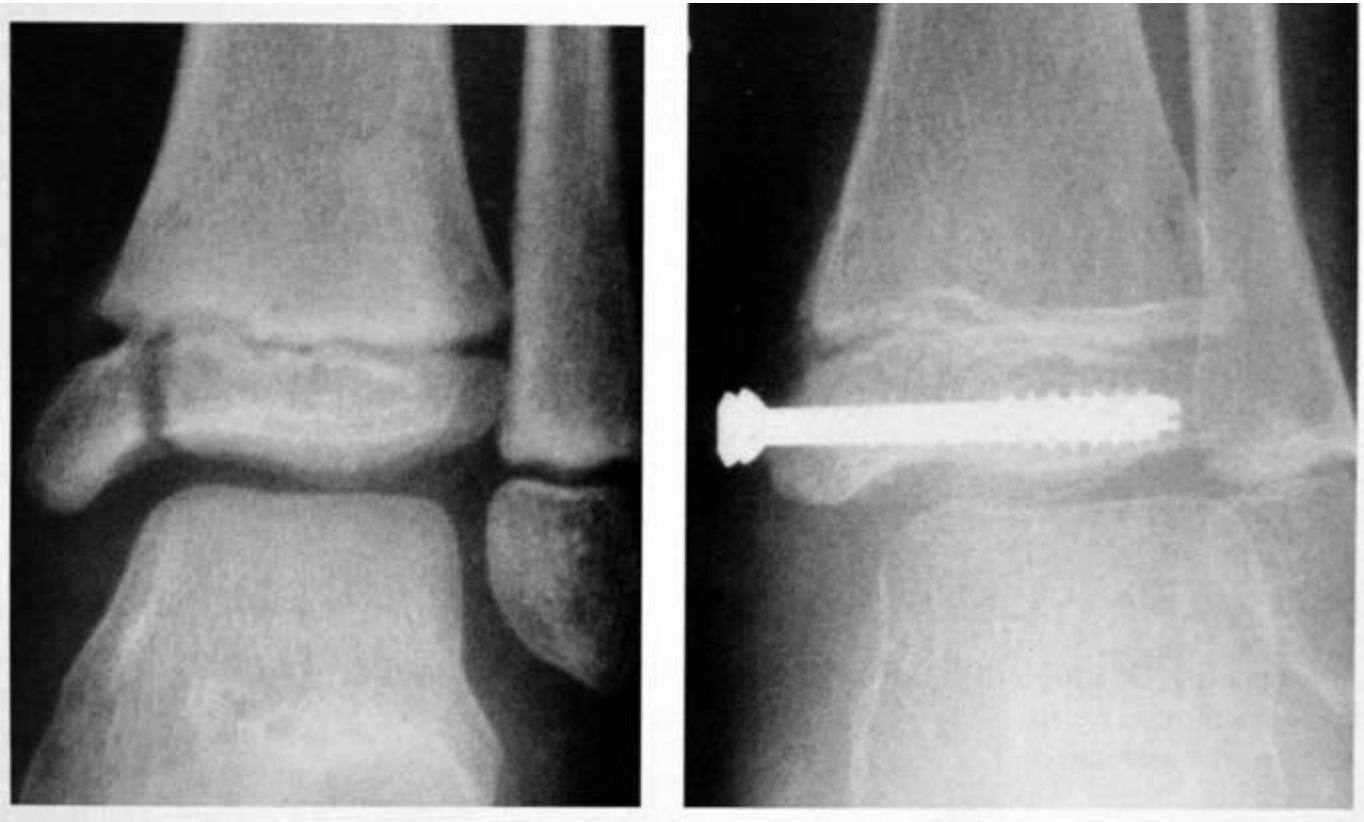
Epiphyseal Injuries



Epiphyseal Injuries



Epiphyseal Injuries



Epiphyseal Injuries

Pathological Fractures

Bone Cyst

Pathological Fractures

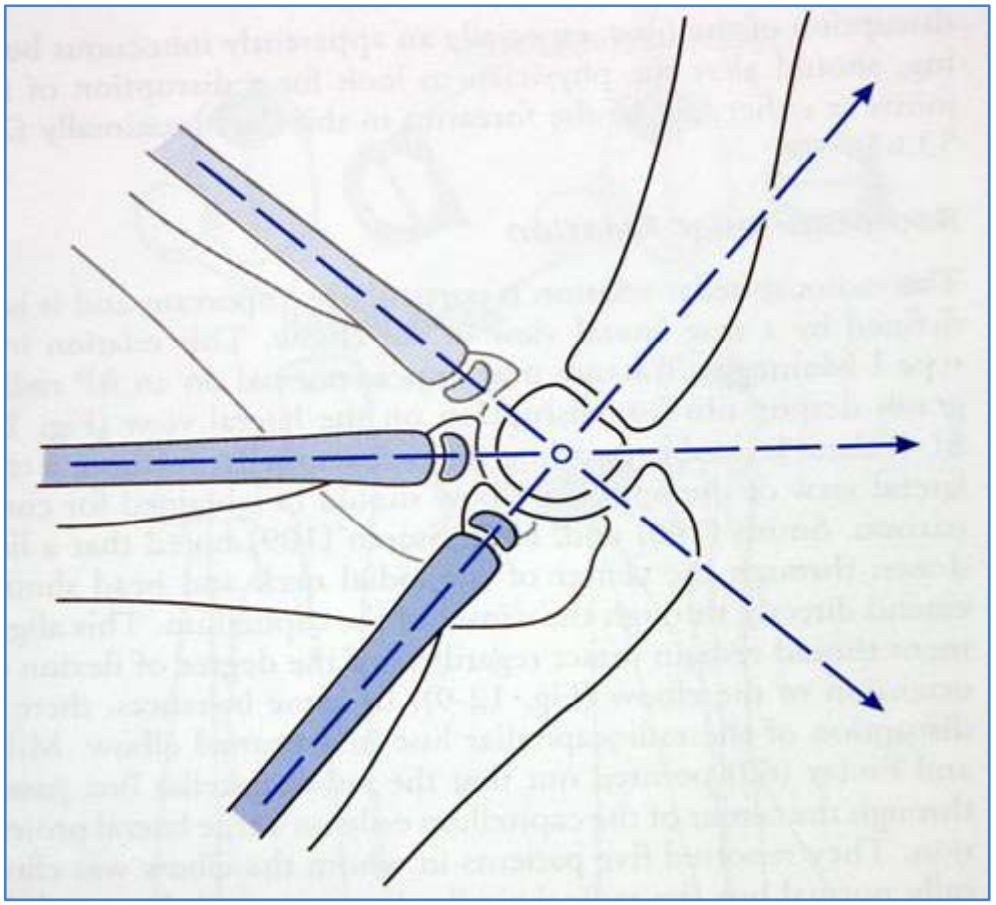
Rickets

Radiological Evaluation of Elbow

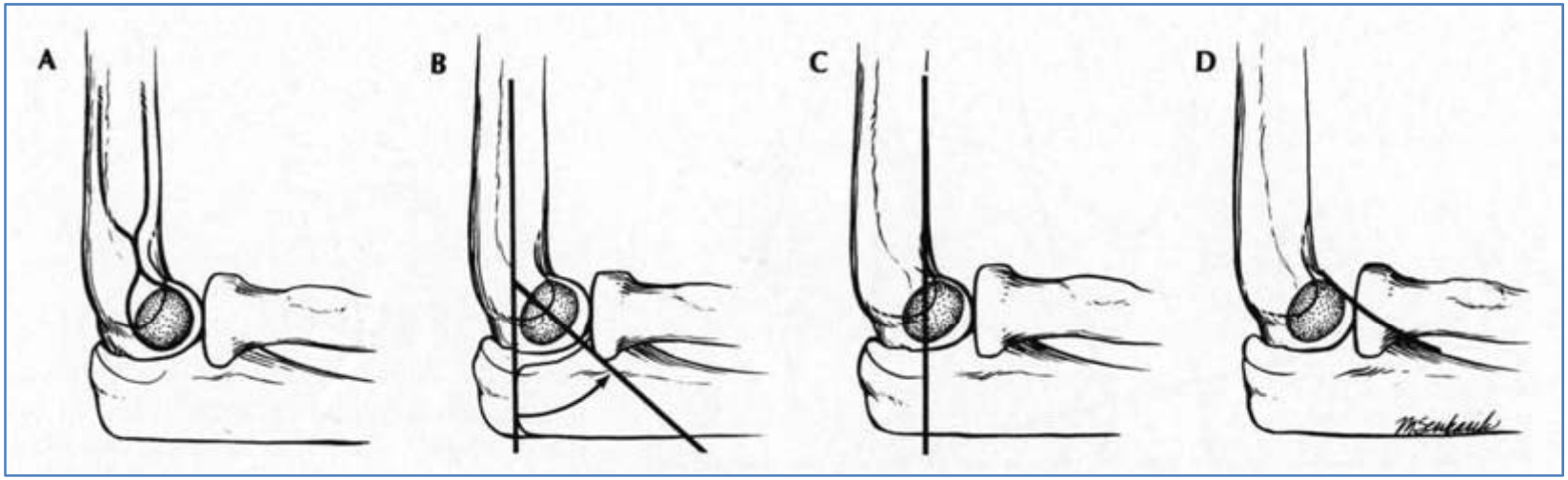
- Ant. fat pad
- Post. Fat pad
- Ant. Humeral line
- Radial head contour
- Radio-capitellar line
- Ossification centers
- Hourglass sign
- Distal humerus
- Ulna / olecranon
- Clinical correlation

Radiological Evaluation of Elbow

Radio-capitellar line

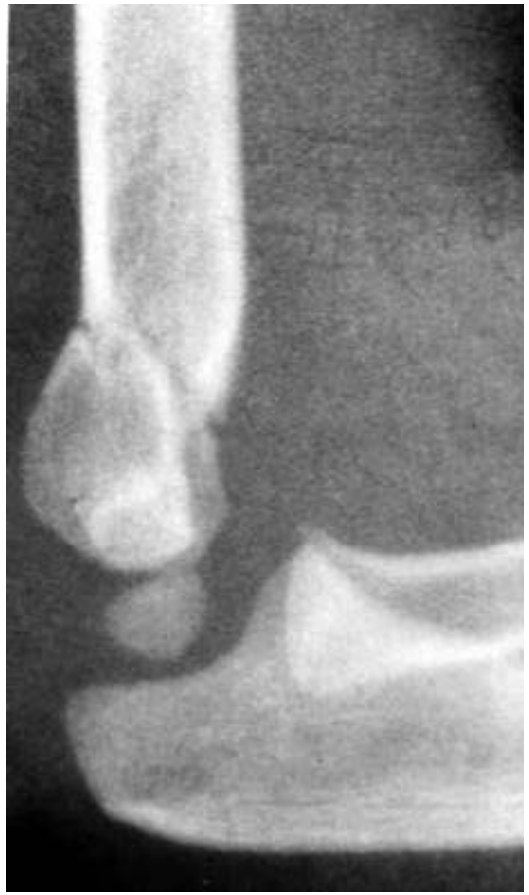


Supracondylar Fracture of Humerus



Supracondylar Fracture of Humerus

Supracondylar Fracture of Humerus
Closed Reduction



Supracondylar Fracture of Humerus Complications

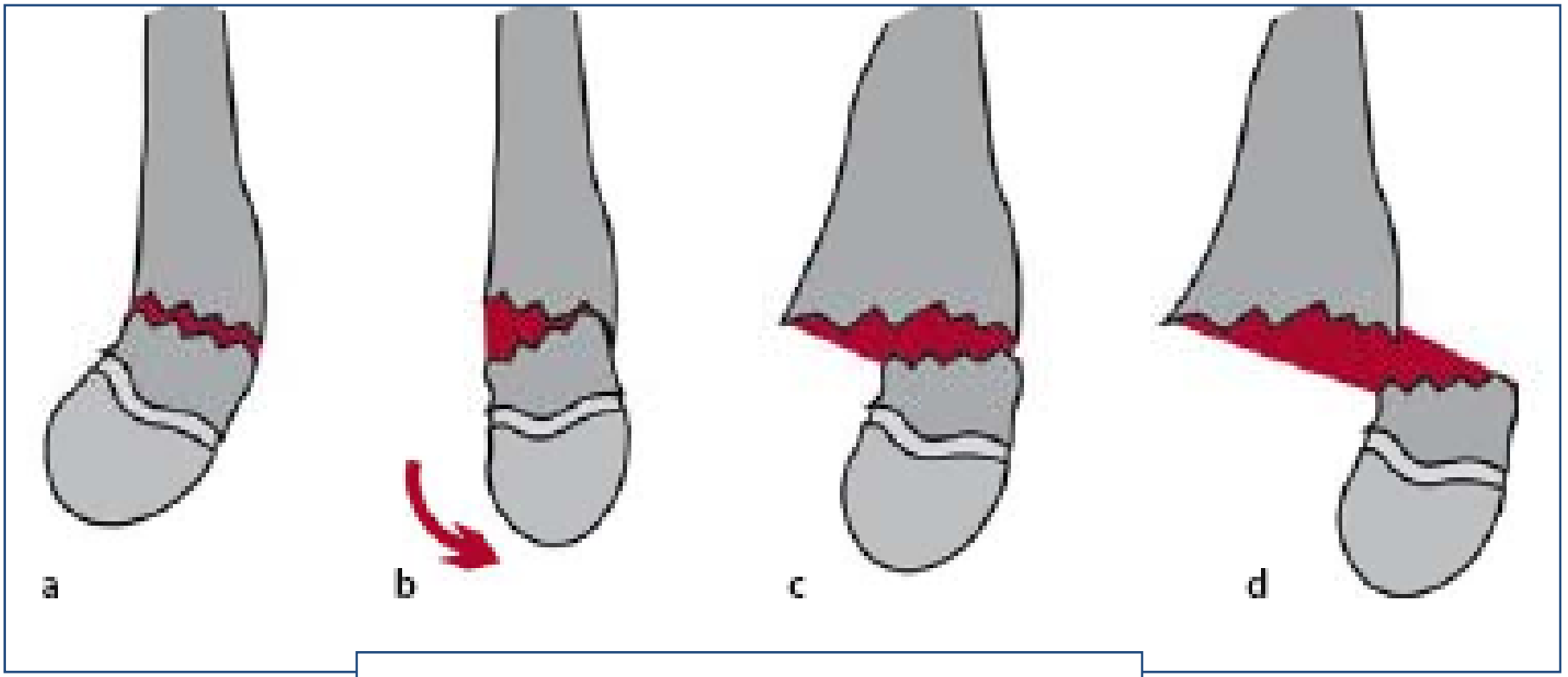


Fig. 3.505a–d. *Classification of supracondylar humeral fractures*: Since the rotational deformity and the resulting instability represent the central problem in these fractures, the only distinction required in such cases is between fractures without (a, b) and fractures with (c, d) rotational deformities

Fixation of supracondylar fracture

Cubitus varus post supracondylar fracture

Fracture of Lateral Humeral Condyle

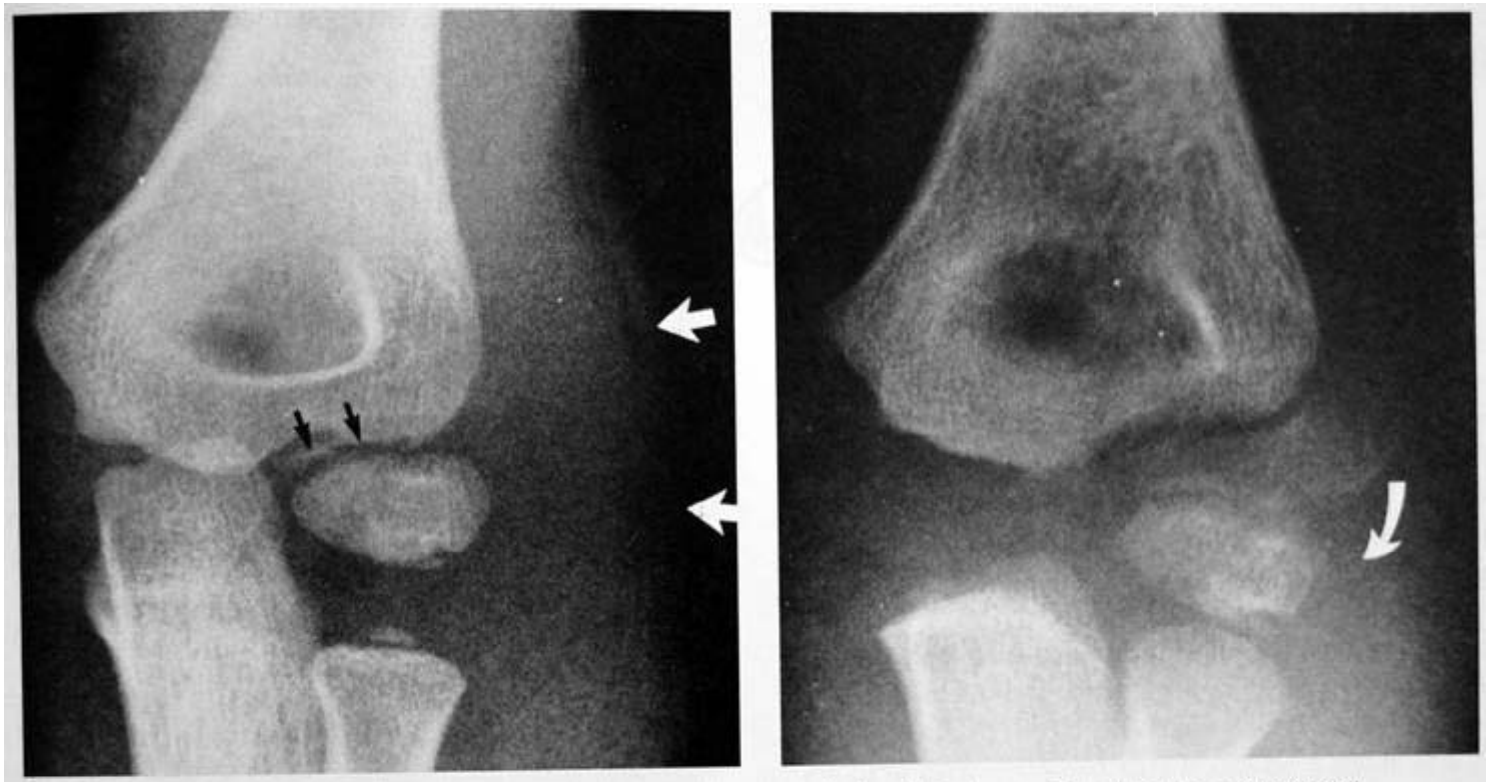
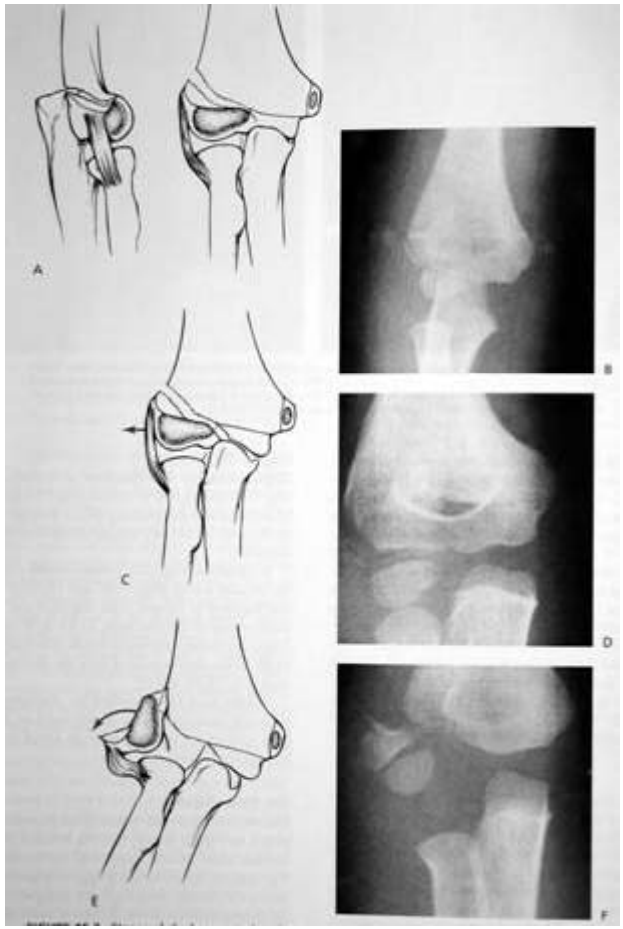


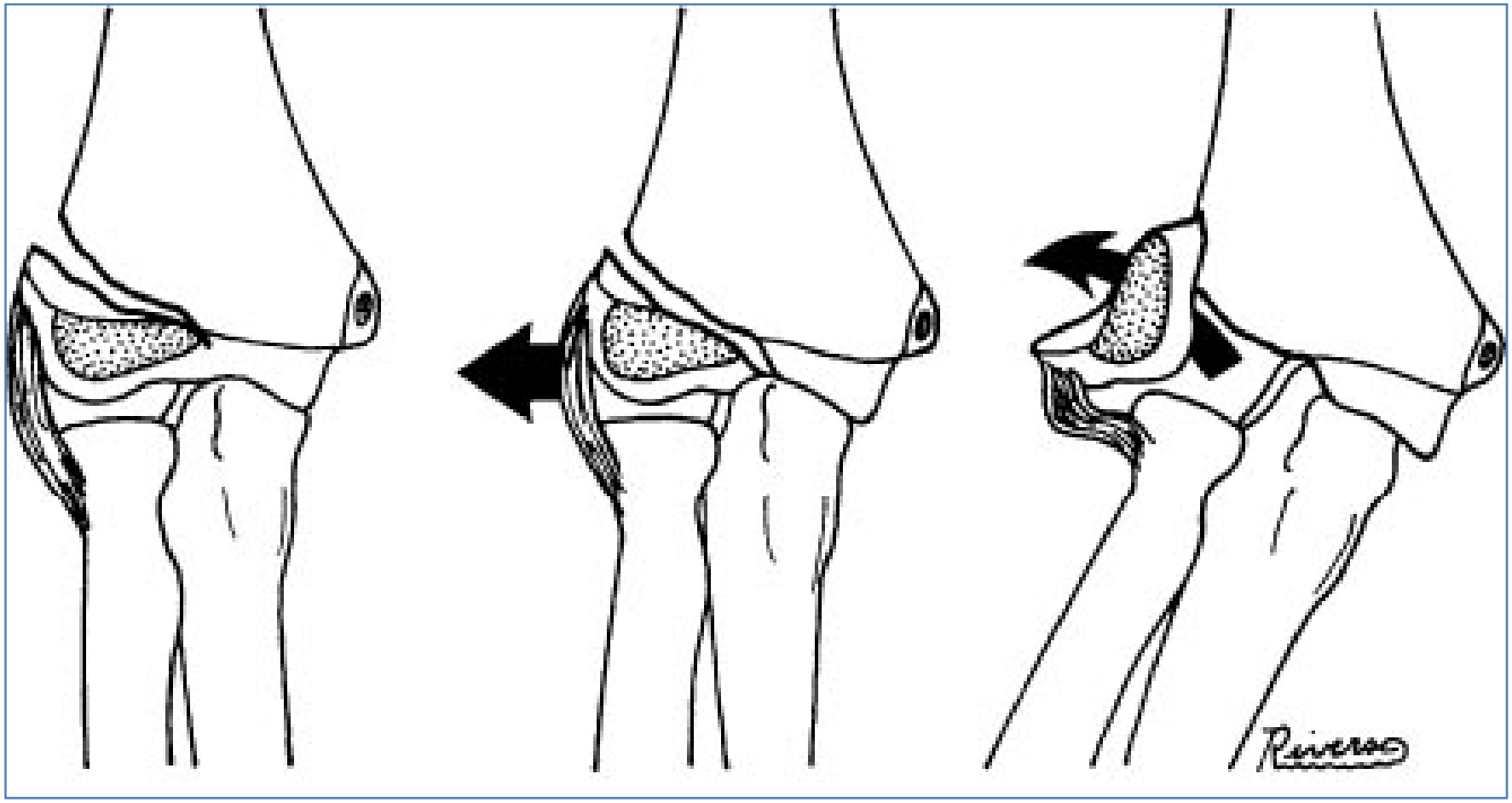
FIGURE 15-1. A: Injury film of a 7-year-old with an undisplaced fracture of the lateral condyle (*small arrows*). Attention was drawn to the location of the fracture because of extensive soft tissue swelling on the lateral aspect (*white arrows*). **B:** Because of the extensive soft tissue injury, there was little intrinsic stability, allowing the fracture to become displaced at 7 days (*arrows*).

Fracture of Lateral Humeral Condyle



Fracture of Lateral Humeral Condyle

Fracture of Medial Humeral Condyle



Lateral condyle fractures

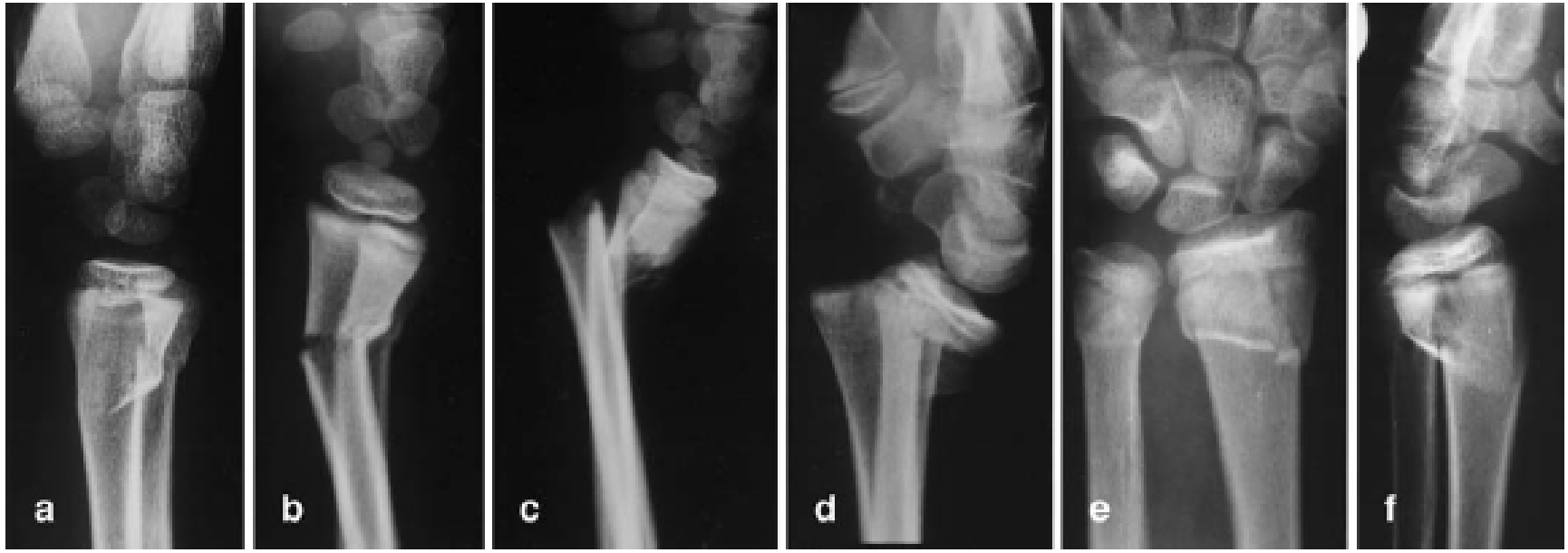
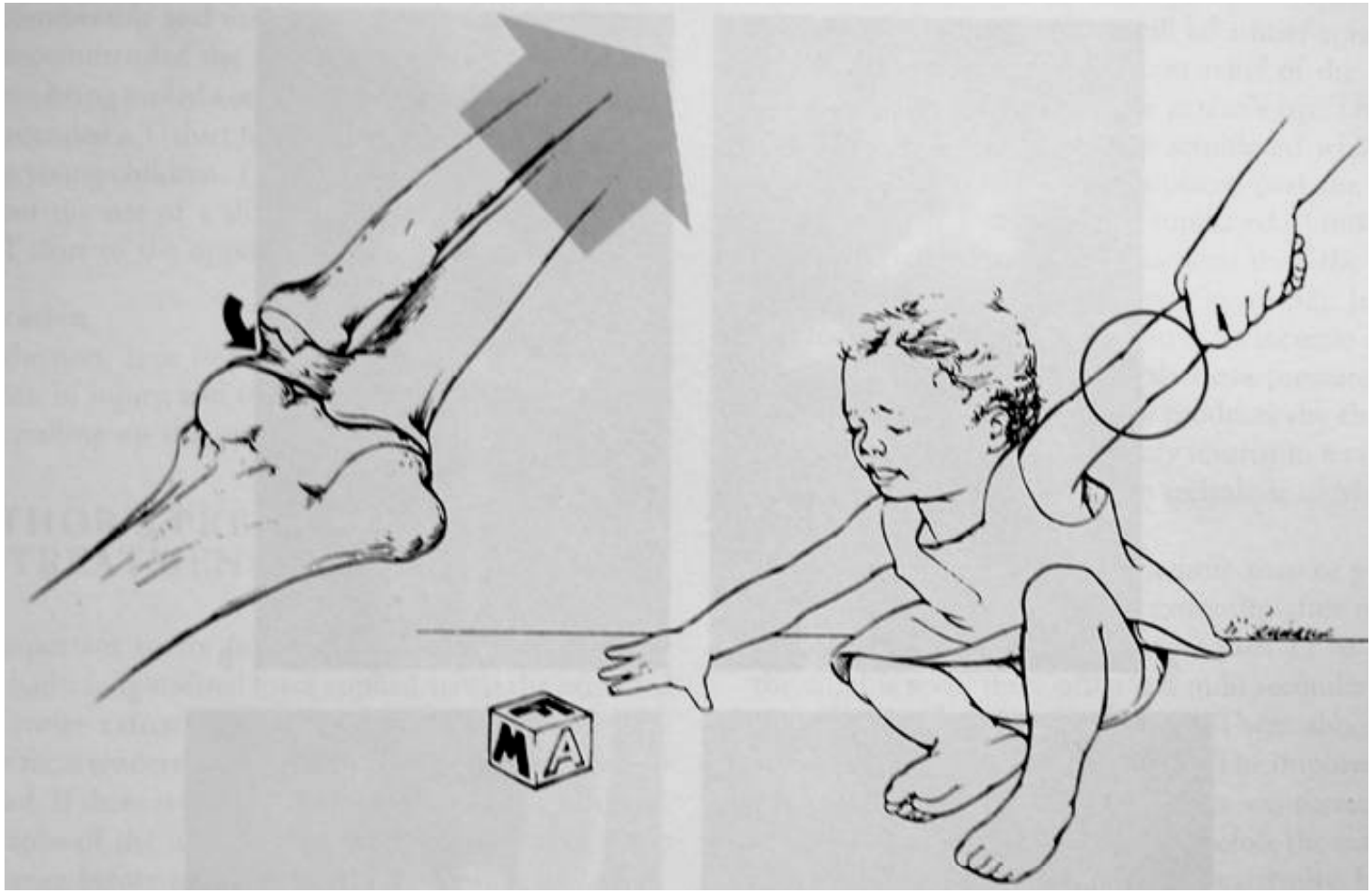


Fig. 1a-f Fracture classification: torus fracture of the radius (a), greenstick fracture of the radius and ulna (b), completely dislocated fractures of radius and ulna (c), Salter/Harris type II, separation of the epiphyseal plate with a 'Thurston Holland sign' (d), Peterson type I lesion (e) + (f)

Table 1 Fracture distribution in the radius and ulna

	Radius	Ulna
Salter/Harris I/II	20%	4%
Salter/Harris III/IV	0%	0%
Peterson I	5%	0%

Pulled Elbow



Differential diagnosis: The infant fails to move an arm

- Clavicular fracture
- Epiphyseal separation of the proximal or distal humerus
- Humeral shaft fracture
- Plexus palsy
- Purulent arthritis, osteomyelitis
- Hemiplegia
- Child abuse

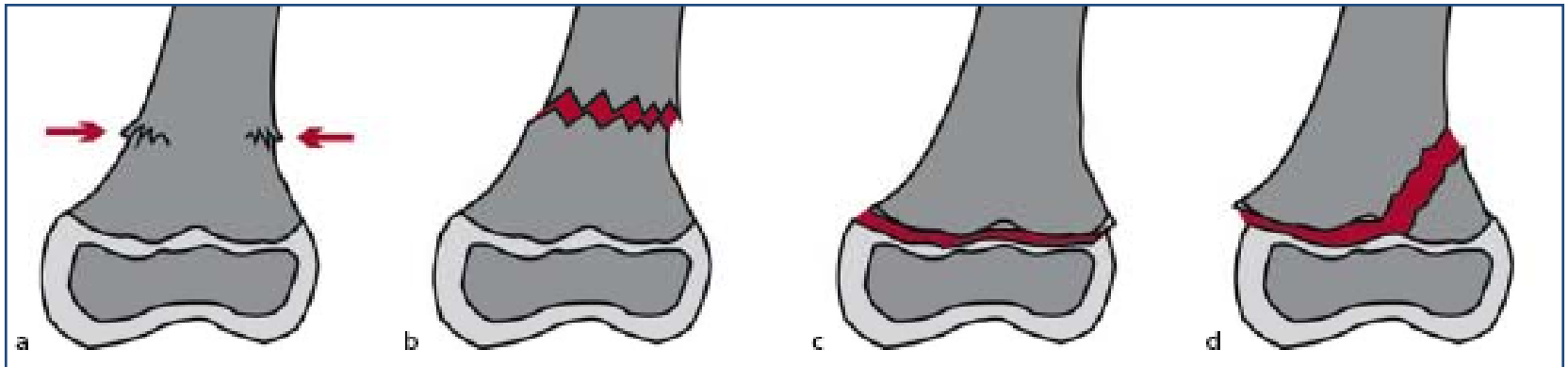


Fig. 3.314a–d. *Metaphyseal fractures of the distal femur*: Metaphyseal compression fractures (a), complete metaphyseal fracture (b), epiphyseal separations without (Salter I; c) and with (d) metaphyseal wedge (Salter II)

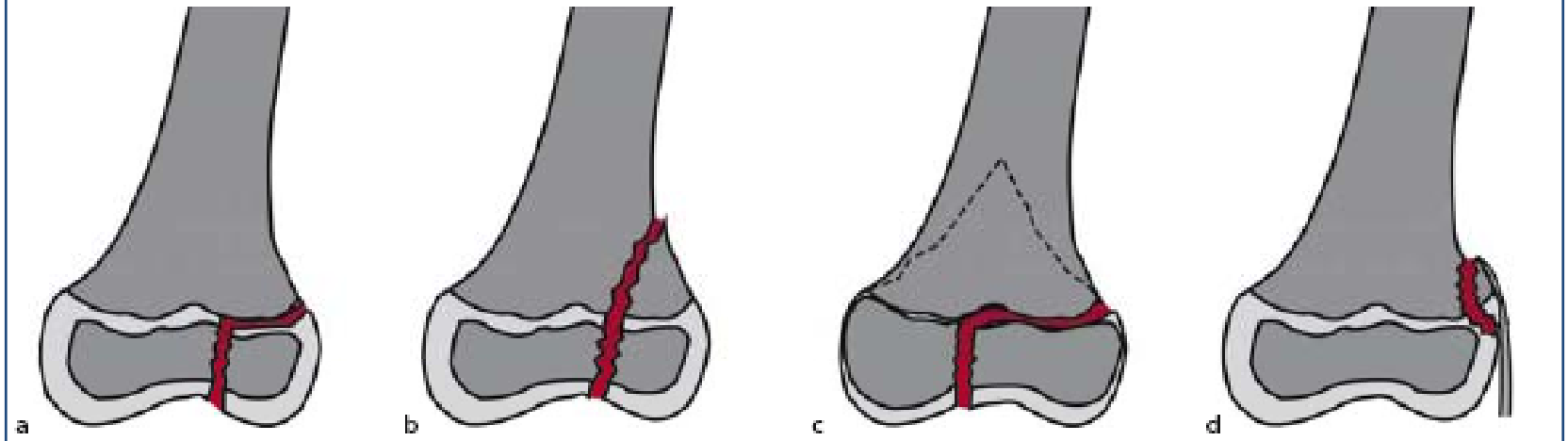
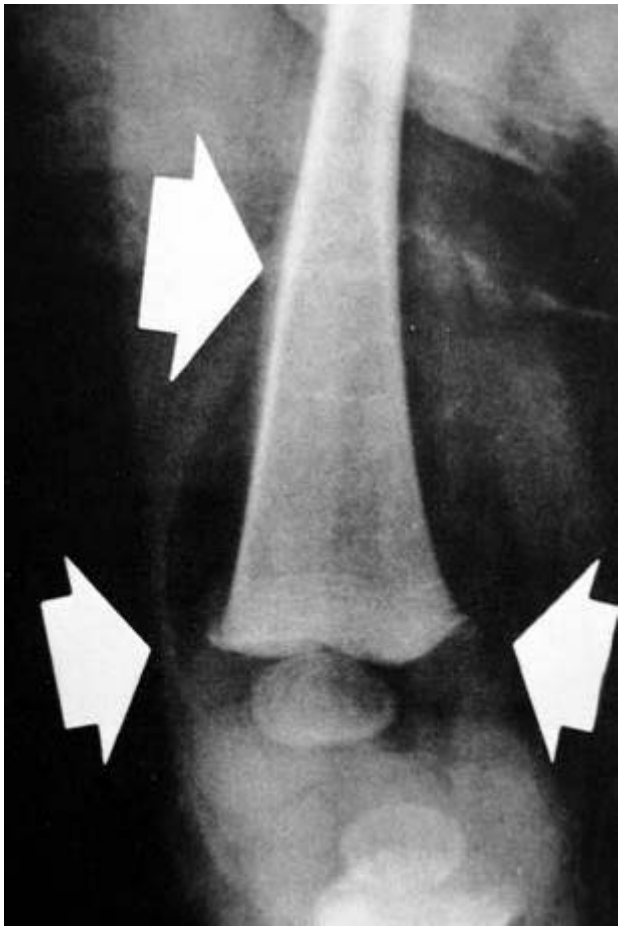


Fig. 3.315a–d. *Epiphyseal fractures of the distal femur*: Epiphyseal fracture without (Salter III; a) and with metaphyseal wedge (Salter IV; b), Transitional fracture (»triplane fracture«; c) and bony avulsion of the collateral ligament (d)

Child Abuse

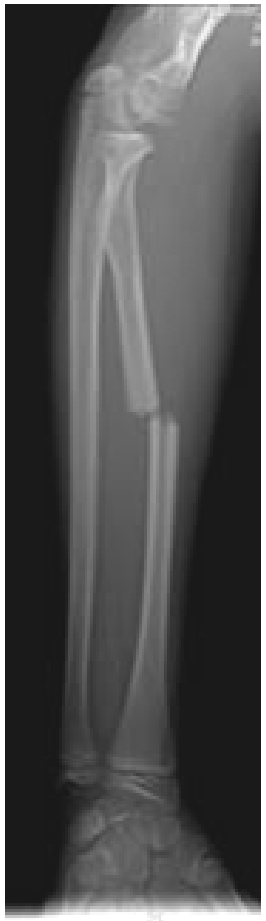
Special Considerations



Torus Fracture

Forearm Fractures

Forearm Fractures

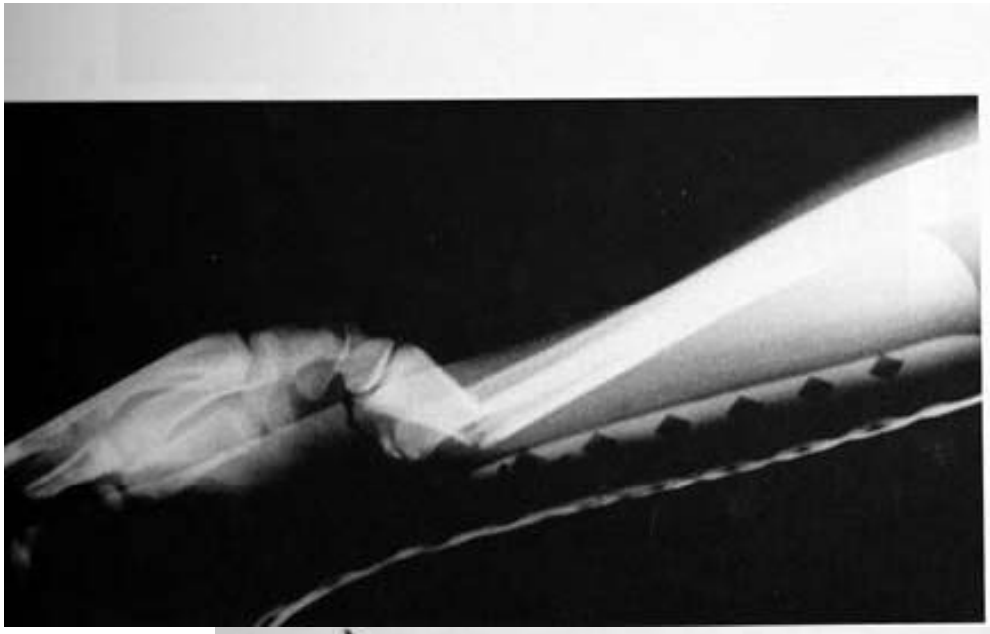


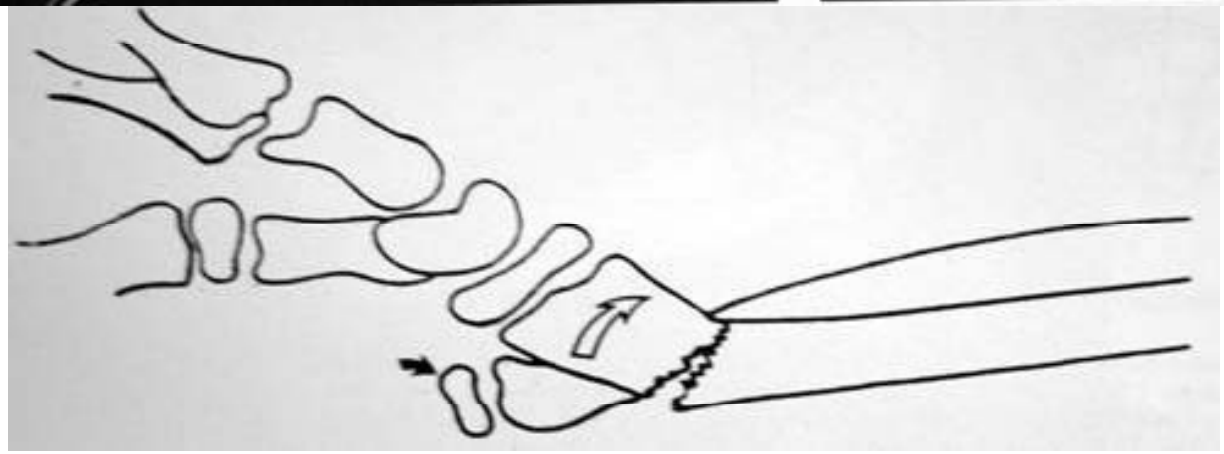
Unstable Forearm Fractures

Monteggia

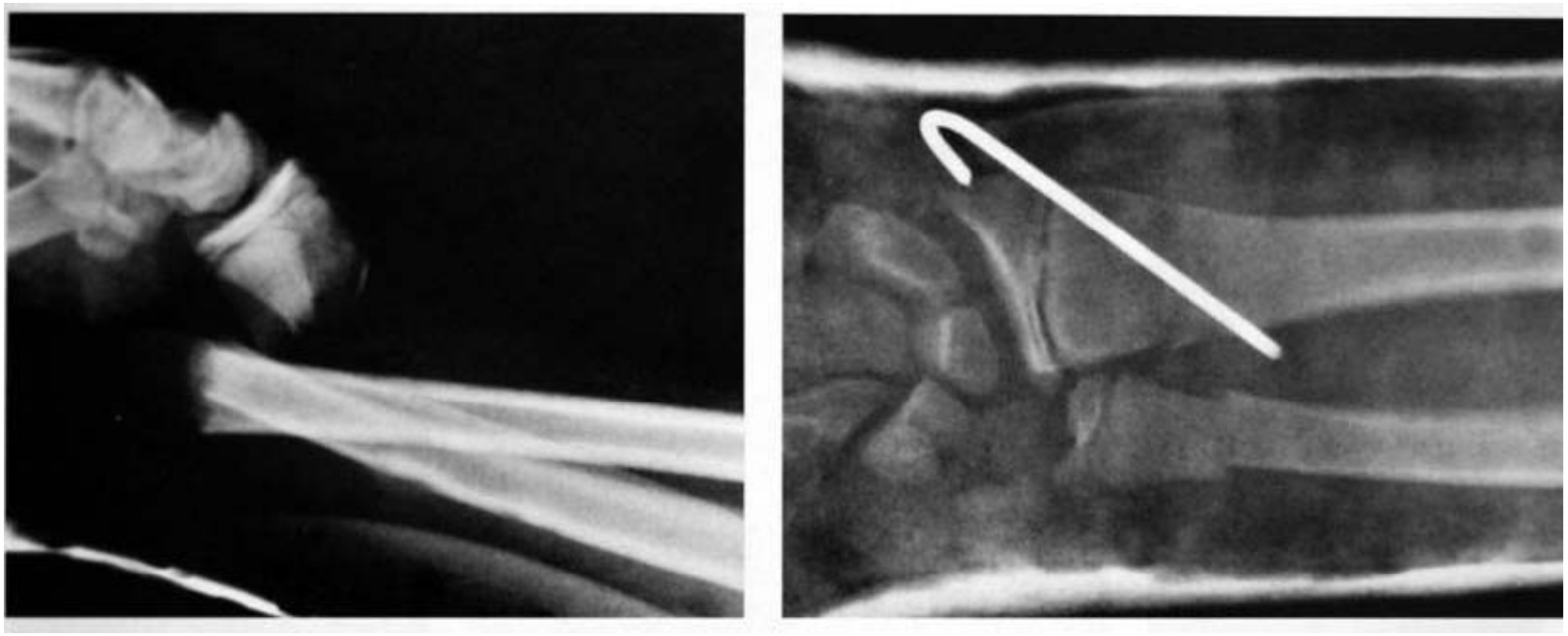
Monteggia

Galleazzi

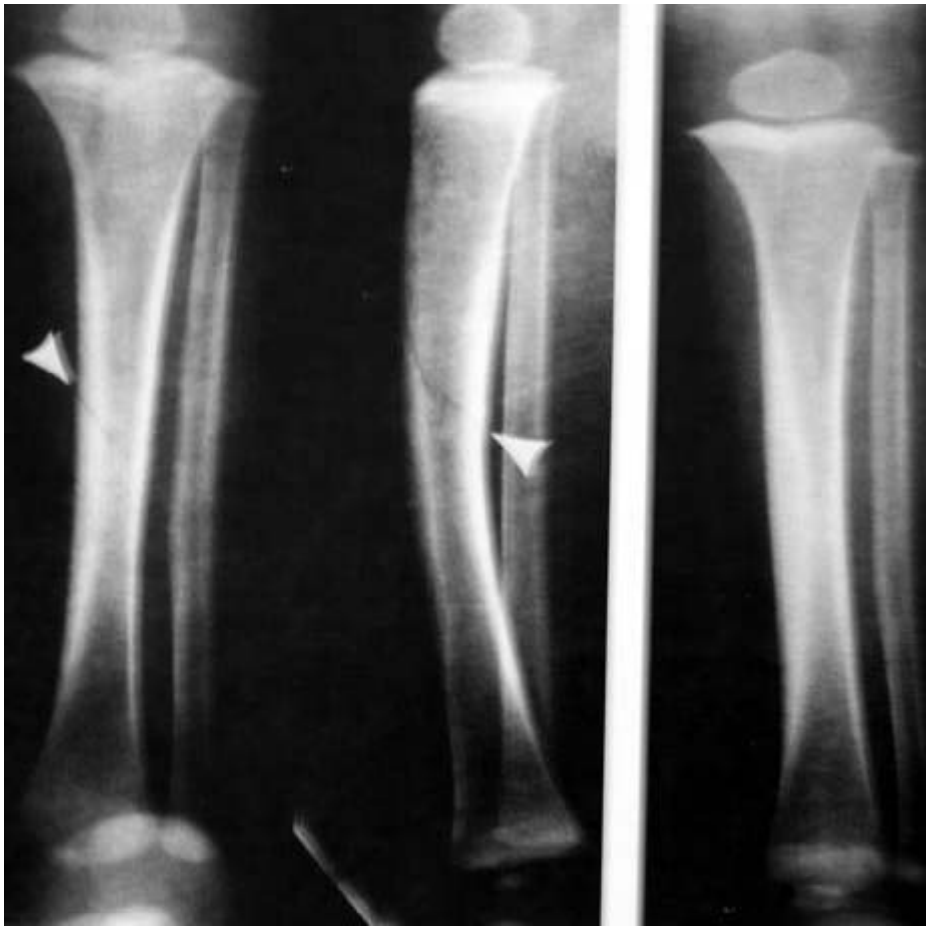




Unstable Reduction



Toddler’s Fracture



Complications

- Ma-lunion is not usually a problem

  (except cubitus varus)
- Non-union is hardly seen

  (except in the lateral condyle)
- Growth disturbance – epiphyseal damage
- Vascular – volkmann's ischemia
- Infection - rare

Complications