Management of Paediatric Elbow Fractures

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Skeletal differences in Adult & children

- Elastic – Torus & Greenstick Fractures
- Thick Periosteum –
  - Periosteal hinge facilitates fracture reduction
  - Aggressive reduction can disrupt it
- Open Physes
  - Good remodelling potential
  - Growth disturbance & angular deformity

Order of Appearance of Ossification Centers of the Elbow on Radiographs

	Age of Appearance in Girls (years)	Age of Appearance in Boys (years)
Capitellum	1	1
Radius (proximal)	4-5	5-6
Medial epicondyle	5-6	7-8
Trochlea	8-9	10-11
Olecranon	9	11
Lateral epicondyle	10	11-12

Anatomic relationships in elbow

- Anterior humeral line bisects capitellum

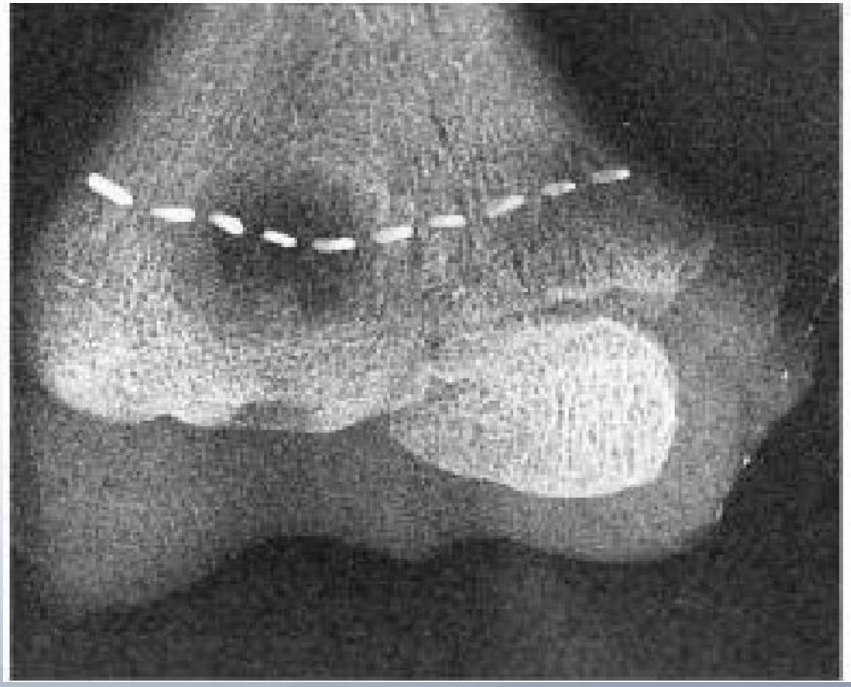
- Baumann Angle: Subtended between lateral physis & line perpendicular to the long axis of humerus
- A change of 5 degrees in Baumann angle corresponds to a change of 2 degrees in carrying angle

Supracondylar fractures

- Transverse fracture crossing the entire width of distal metaphysis without involving the distal humeral physis
- More than half of paediatric

  elbow fractures
- Fall on hyper extended or

  flexed elbow



Physical Examination

- Often difficult
- Anxious parents, unco-operative child (pain, fear)
- Check NV status
- Quick neuro exam & Proper documentation
  - Thumb flexion (AIN median), Extension (PIN radial) & scissoring of fingers (ulnar)
- Radiographs – AP, LAT & Oblique

Fracture Classification

By radiographic appearance + Injury mechanism

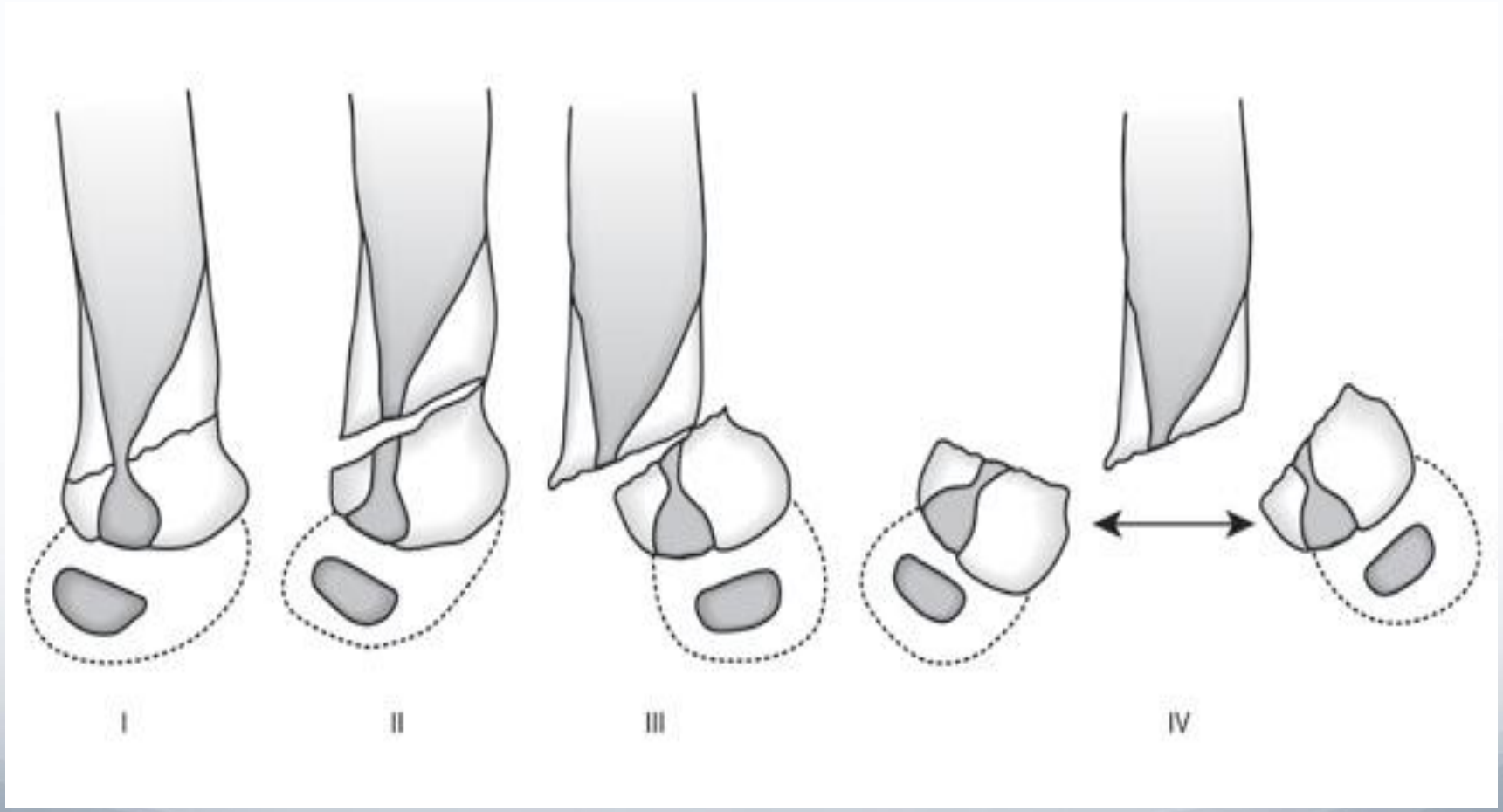
- Flexion type (2%)
  - Usually displaced & not amenable for closed reduction
  - Fracture line extends from proximal anterior to distal posterior
- Extension type (98%)
  - Most common
  - Fall on hyper extended elbow
  - Fracture line traverses from Proximal posterior to distal anterior
  - Gartman's classification

Modified Gartland Classification

Ref: Rockwood & Wilkins: Fracture in Children 7th Edition

		Comments
Type 1	Undisplaced	Fat pad sign present acutely
Type 2	Hinged posteriorly	Anterior humeral line anterior to capitellum
Type 3	Displaced	No meaningful cortical continuity
Type 4	Displaces in to extension & Flexion	Usually diagnosed with manipulation under imaging
Medial comminution (not really a separate type)	Collapse of medial column	Loss of Baumann angle

Gartland classification



Flexion type fracture

Extension type 1

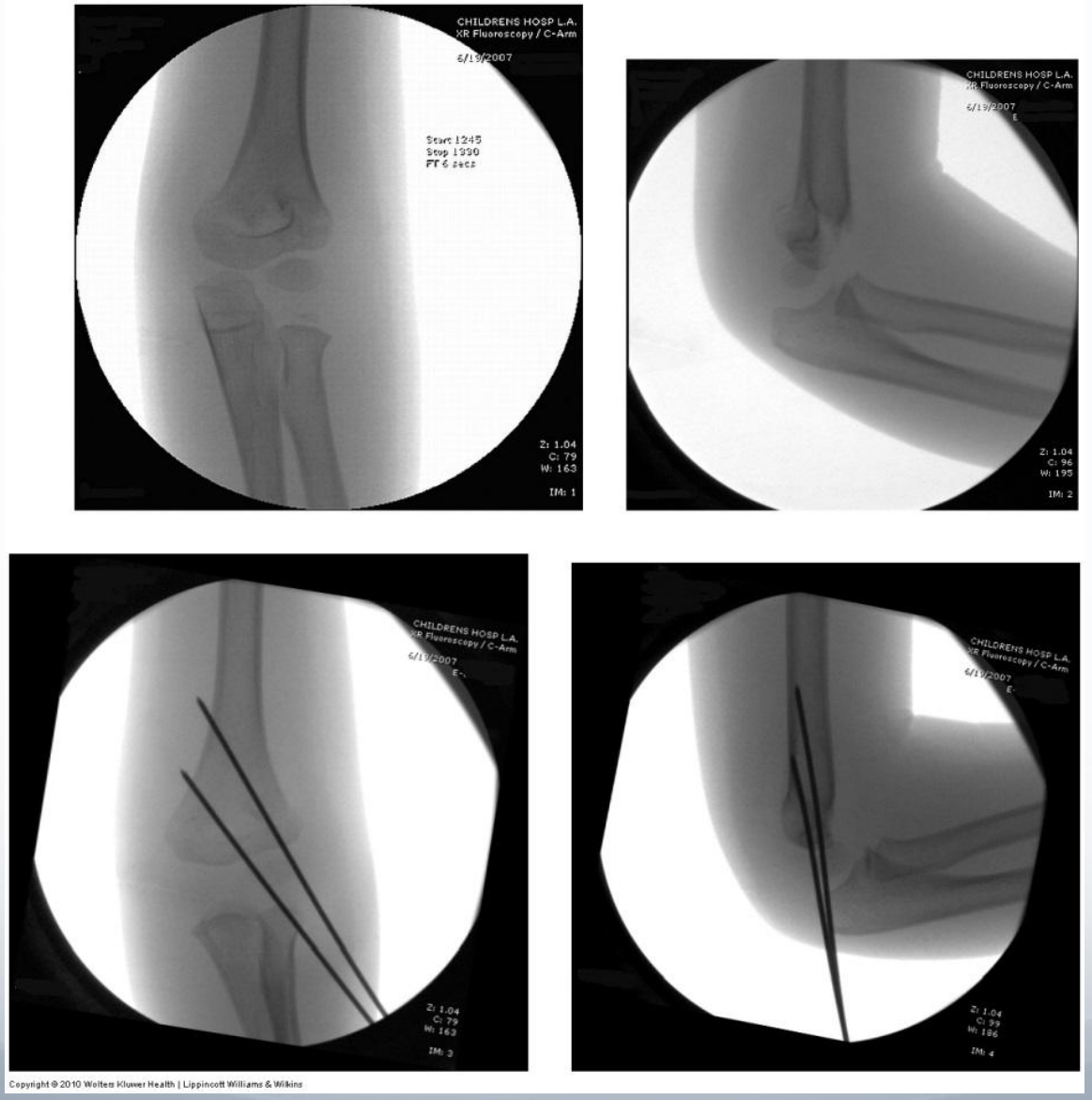
Type 1 - Three weeks later

Gartland Type 2

Acute injury

Four weeks

Type 2 Fractures – Usually fixed



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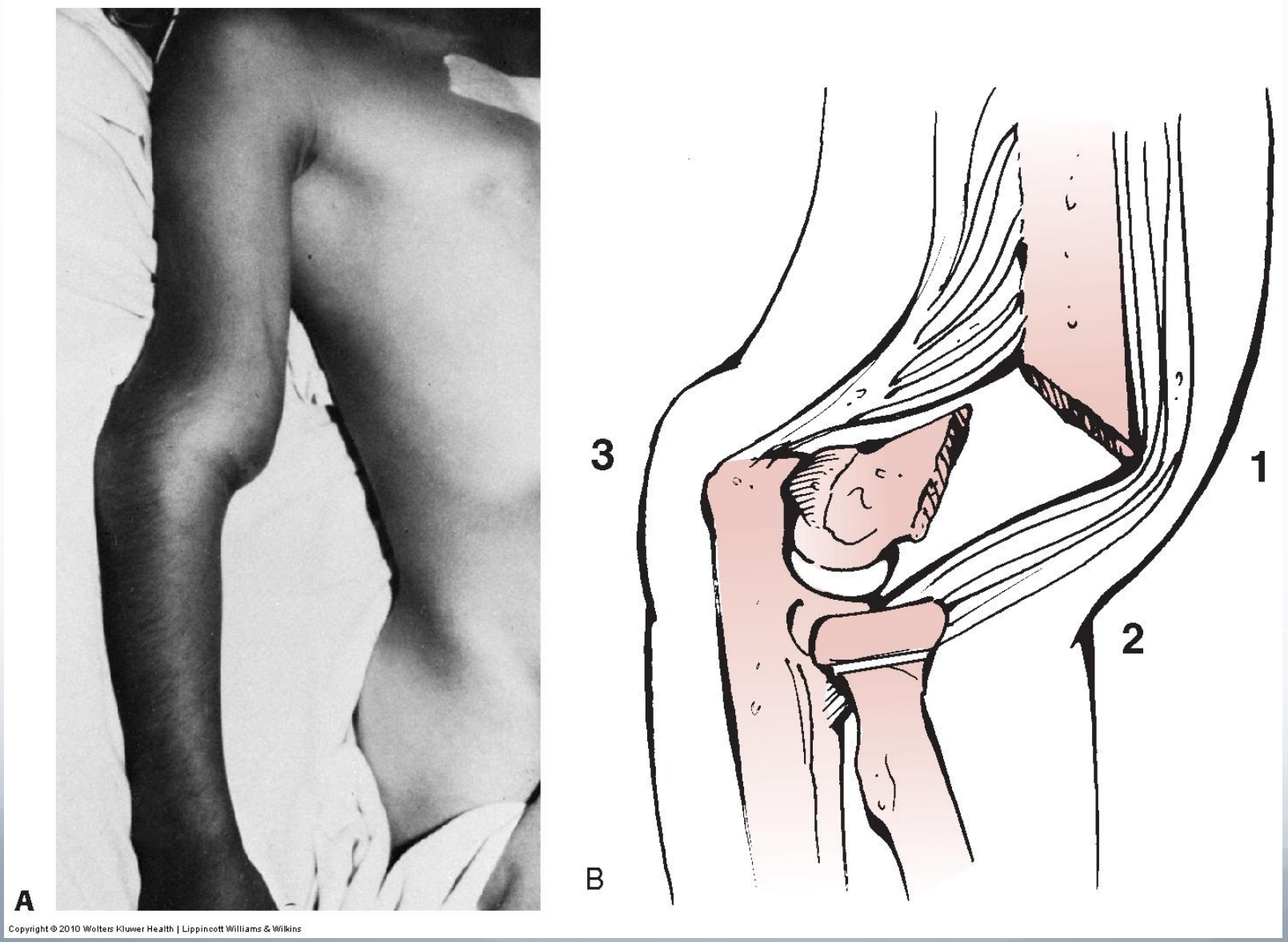
Type 2
Angulated/displaced fracture with intact posterior cortex

- In many cases, the type 2 fractures will be impacted medially
  - Leads to varus angulation
- The varus malposition must be considered when reducing these fractures
  - Apply a valgus force for realignment

Type 3 Fractures



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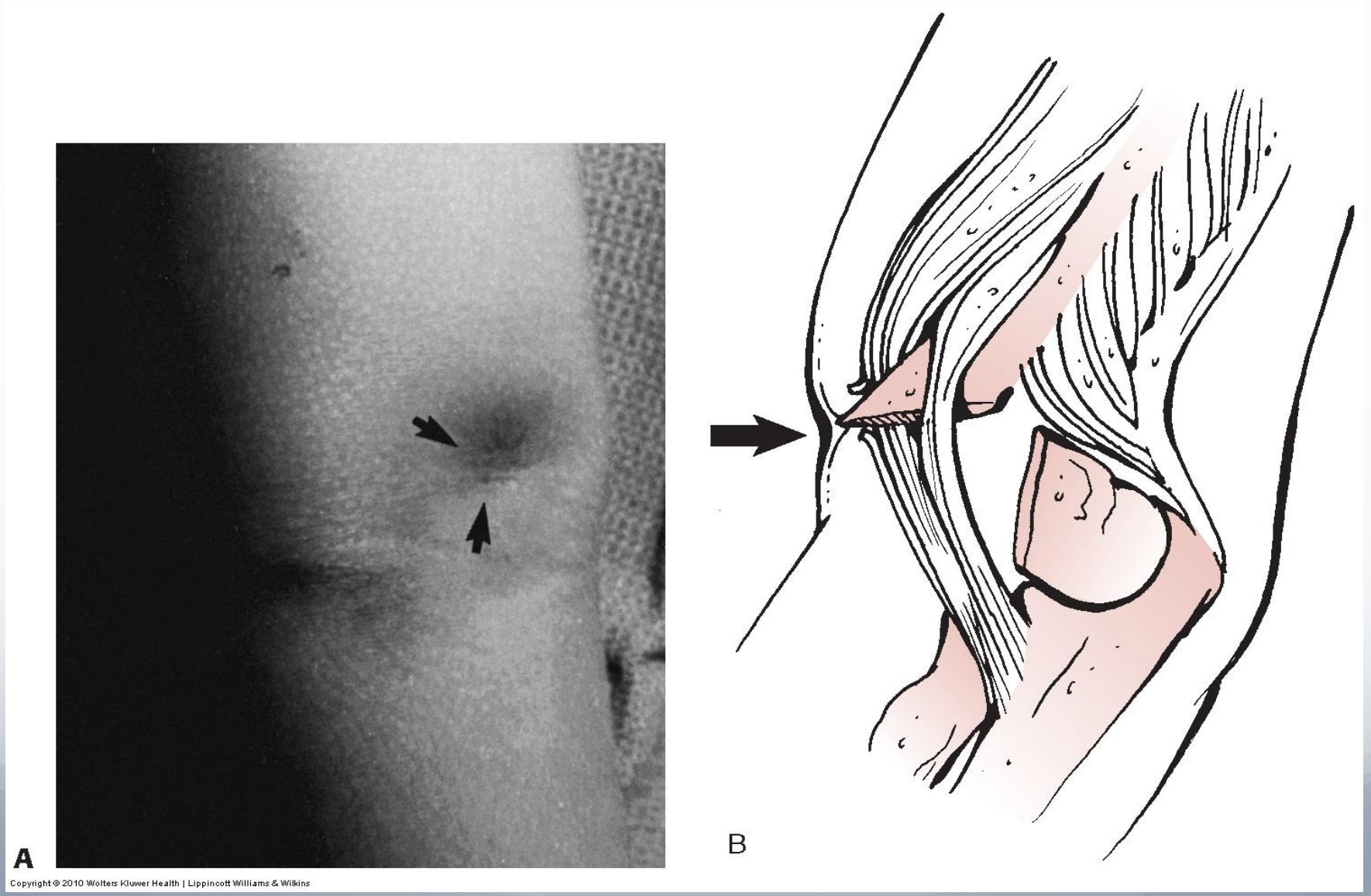
The Pucker sign



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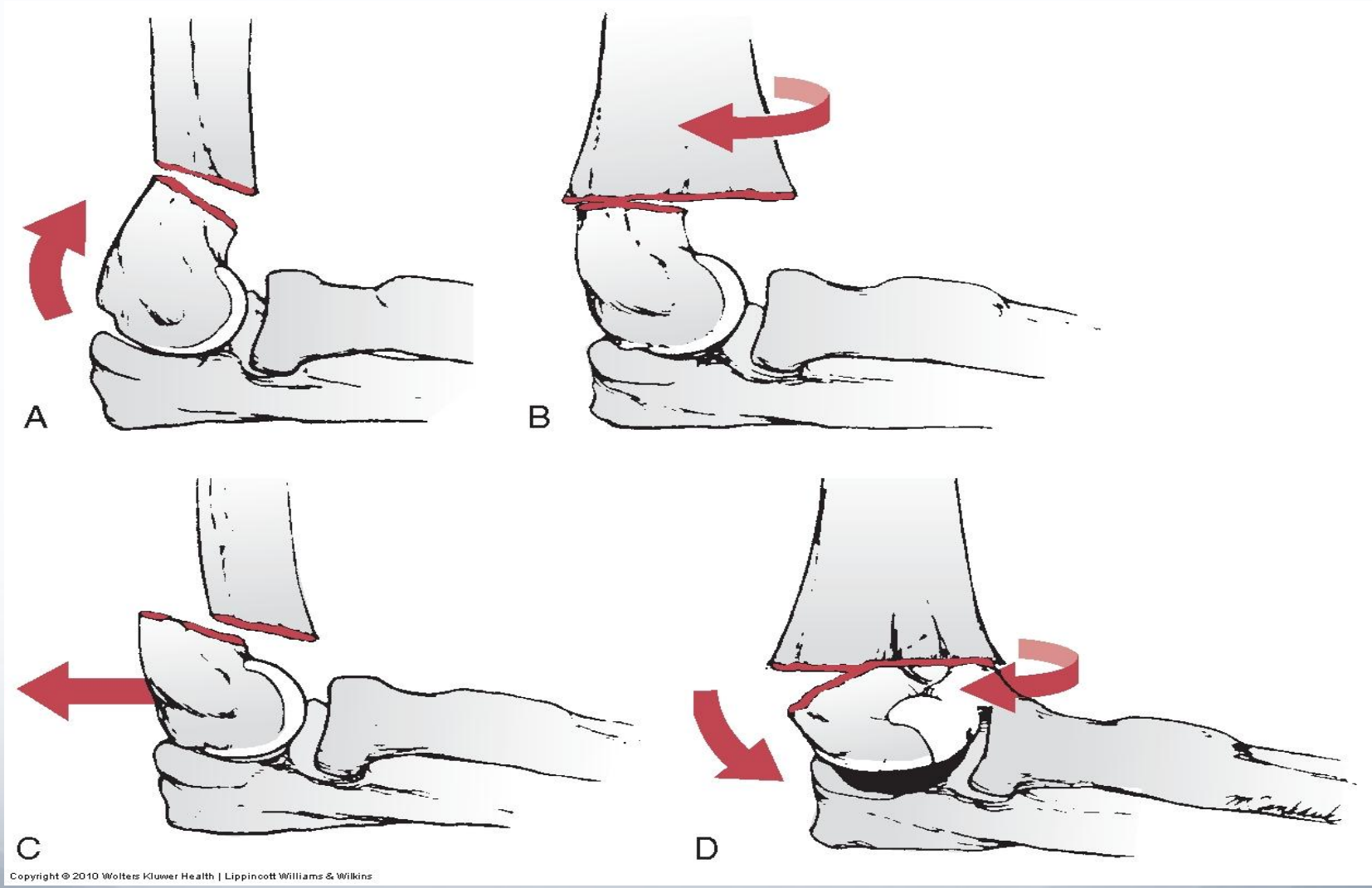
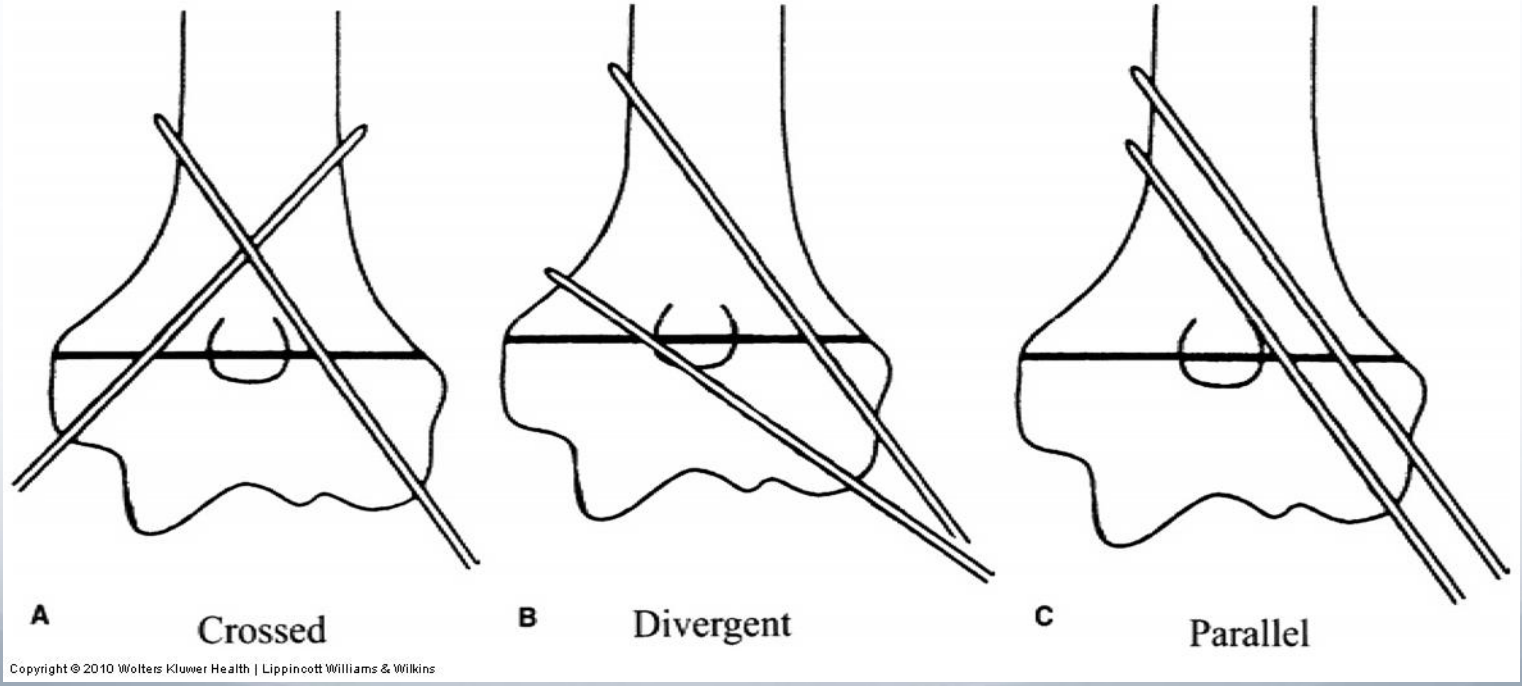
Distal fragment rotation



Management of type 2 & 3

	Laboratory Testing	Clinical stability	Iatrogenic ulnar nerve injury
Crossed Pins	More stable	Comparable	3% - 8%
Lateral entry pins	Less stable	Comparable	0%



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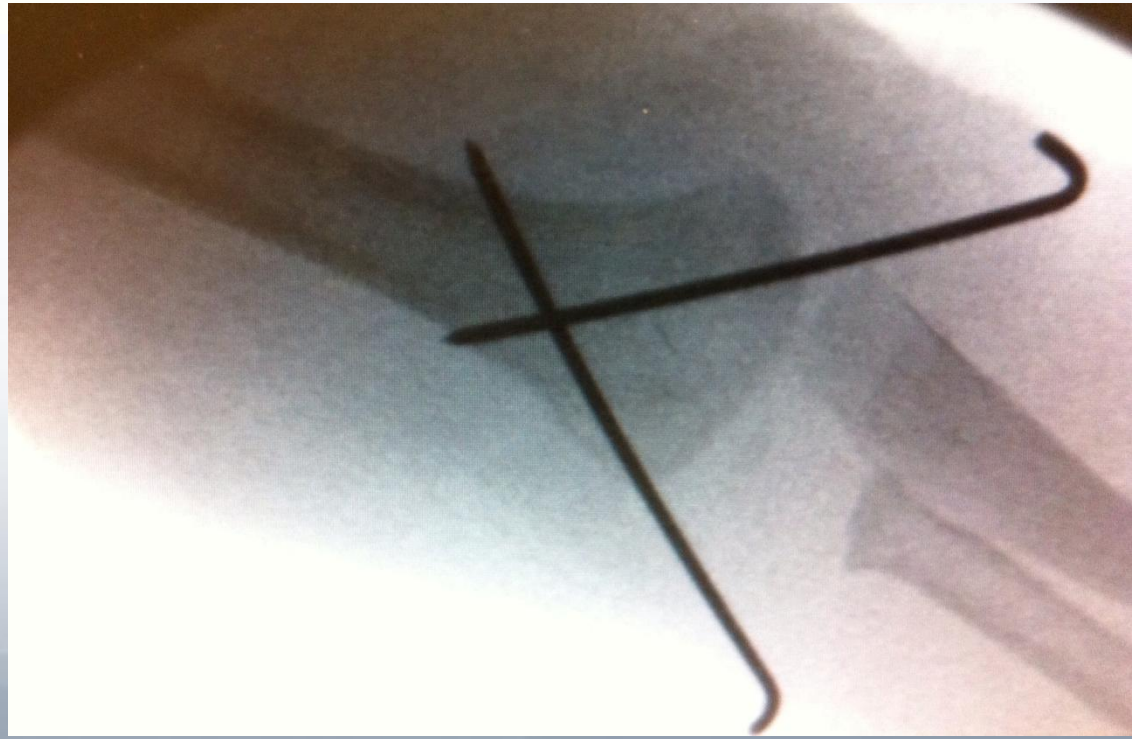
Pin Placement

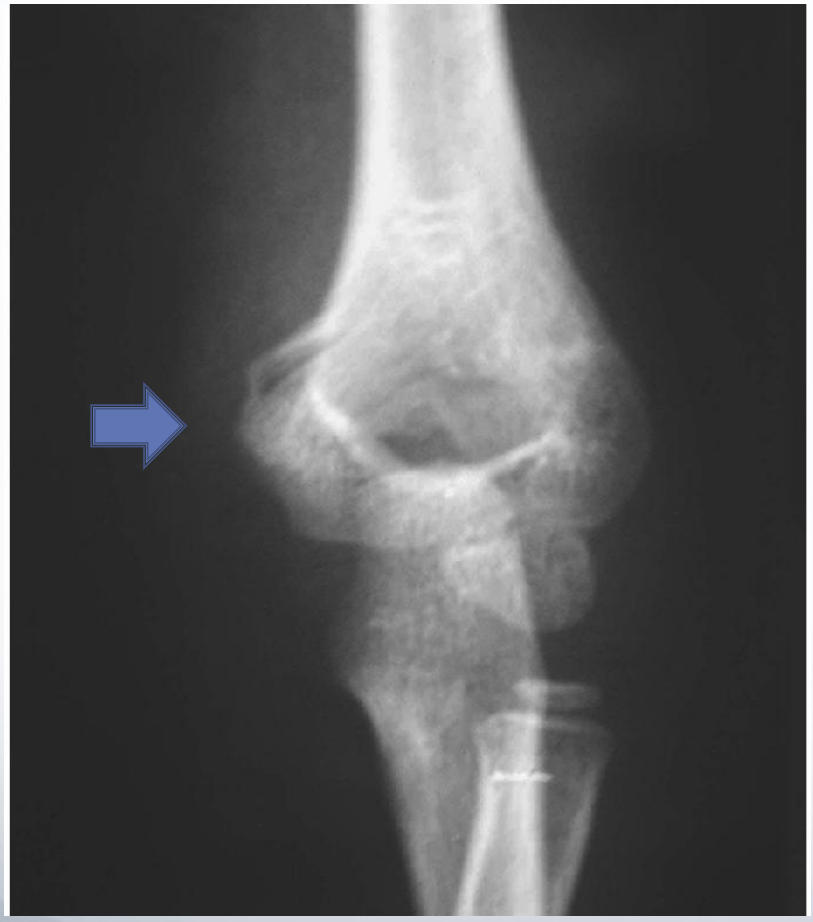
- Insert k-wires as widely as possible near the fracture
- Too close pins – rotational instability
- Baumann angle can be compared with contralateral side
- Pins come out in 3 to 4 weeks

SC fracture with medial comminution.

Reduced and held with crossed pins



Medial comminution



- Subtle radiographic sign
- Unstable variant may collapse to varus if not treated appropriately
- Remodelling potential of the varus / valgus deformity is poor

Neurovascular injuries in SCF

NERVE Injuries

Nerve Injury	Association
Anterior interosseous nerve	Most common in SCF
Median nerve	Posterolateral fracture displacement
Radial nerve	Posteromedial fracture displacement
Ulnar nerve	Rarely traumatic, usually iatrogenic

Vascular injuries & management

Vascular status	Management
Pulse lost after reduction & Pinning	Explore radial artery
Pulseless well perfused hand	Observe 24 – 72 hrs
Pulseless cool hand	Explore brachial artery

Complications

- Compartment syndrome
- Pin Loosening & Loss of reduction
- Volksman Ischemic contracture
  - Due to brachial art compression when immobilised > 90 deg flexion
- Cubitus Varus / Gunstock deformity
  - Very less chances in MUA & K-Wiring
  - Cosmetic deformity + some Functional sequelae
- Recurvatum
  - Common when treated by immobilization of type 2 / type 3 #
  - Poor remodeling potential
- Stiffness
- Myositis Ossificans

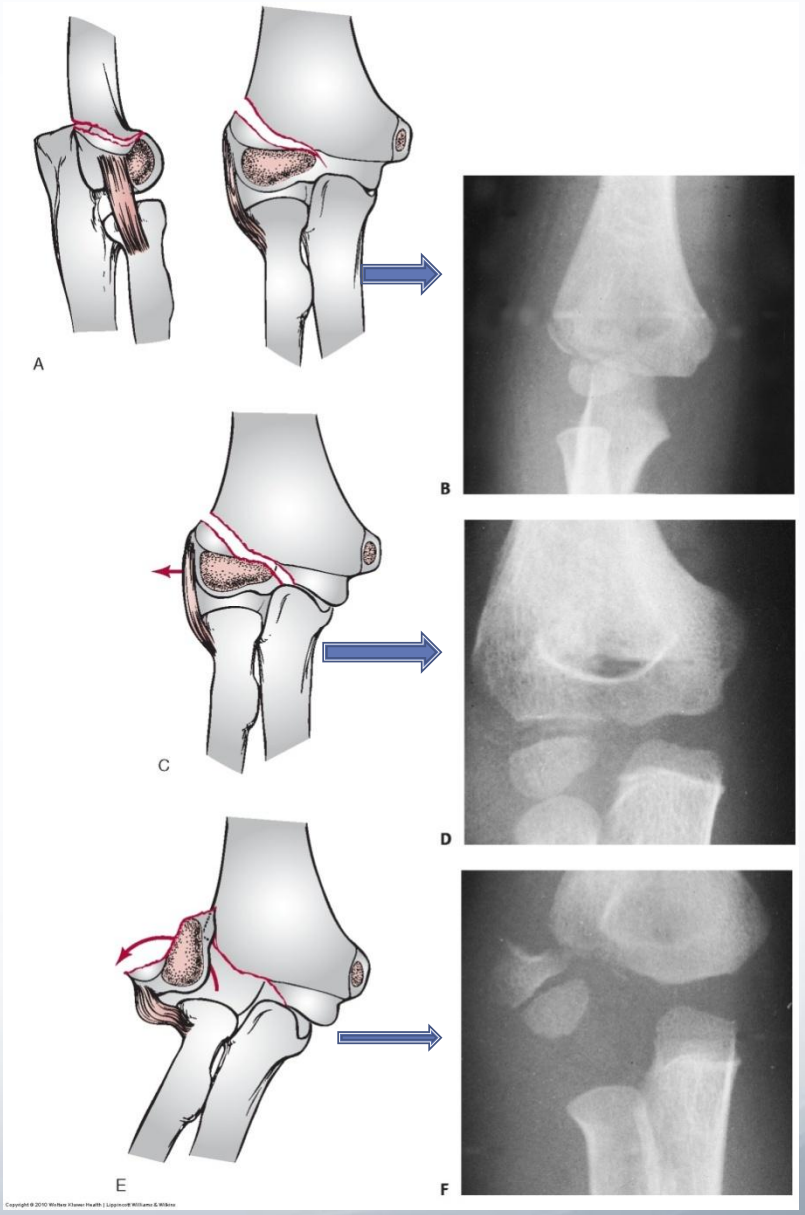
Lateral Condyle Fractures

- 17% of distal humerus # in children approx.
- Peak incidence 6 yrs
- ROM loss can be severe due to intra articular extension
- Very high chance of Growth disturbance

Landin. Elbow fractures in children. An epidemiological analysis of 589 cases. Acta Orthop Scand. 1986;57:309.

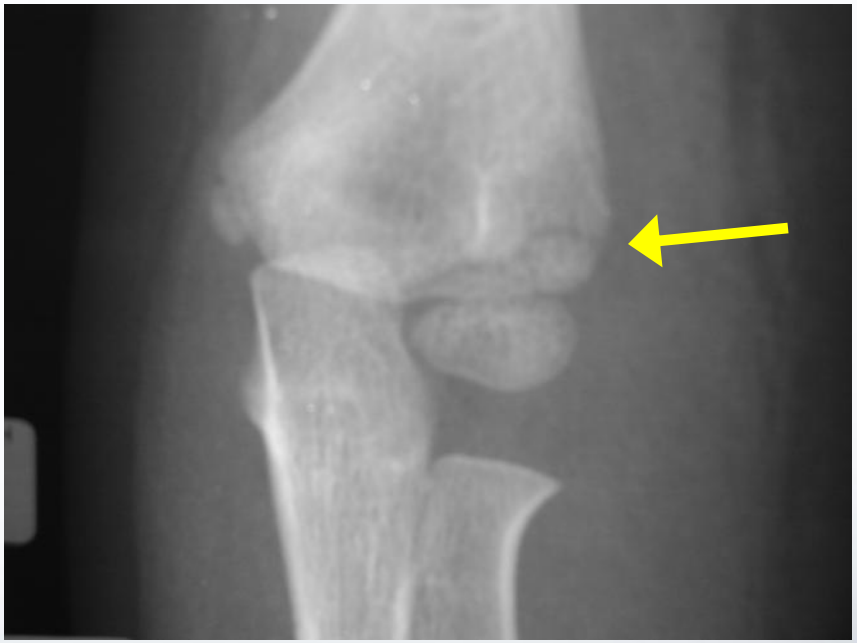
Jakob's Classification

- Type 1
  - Undisplaced (<2mm)
  - Extra articular
- Type 2
  - Minimally displaced (2 – 4mm), Intra articular
  - Capitellum not rotated / significantly displaced
- Type 3
  - Displaced & Intraarticular
  - Capitellum rotated & displaced

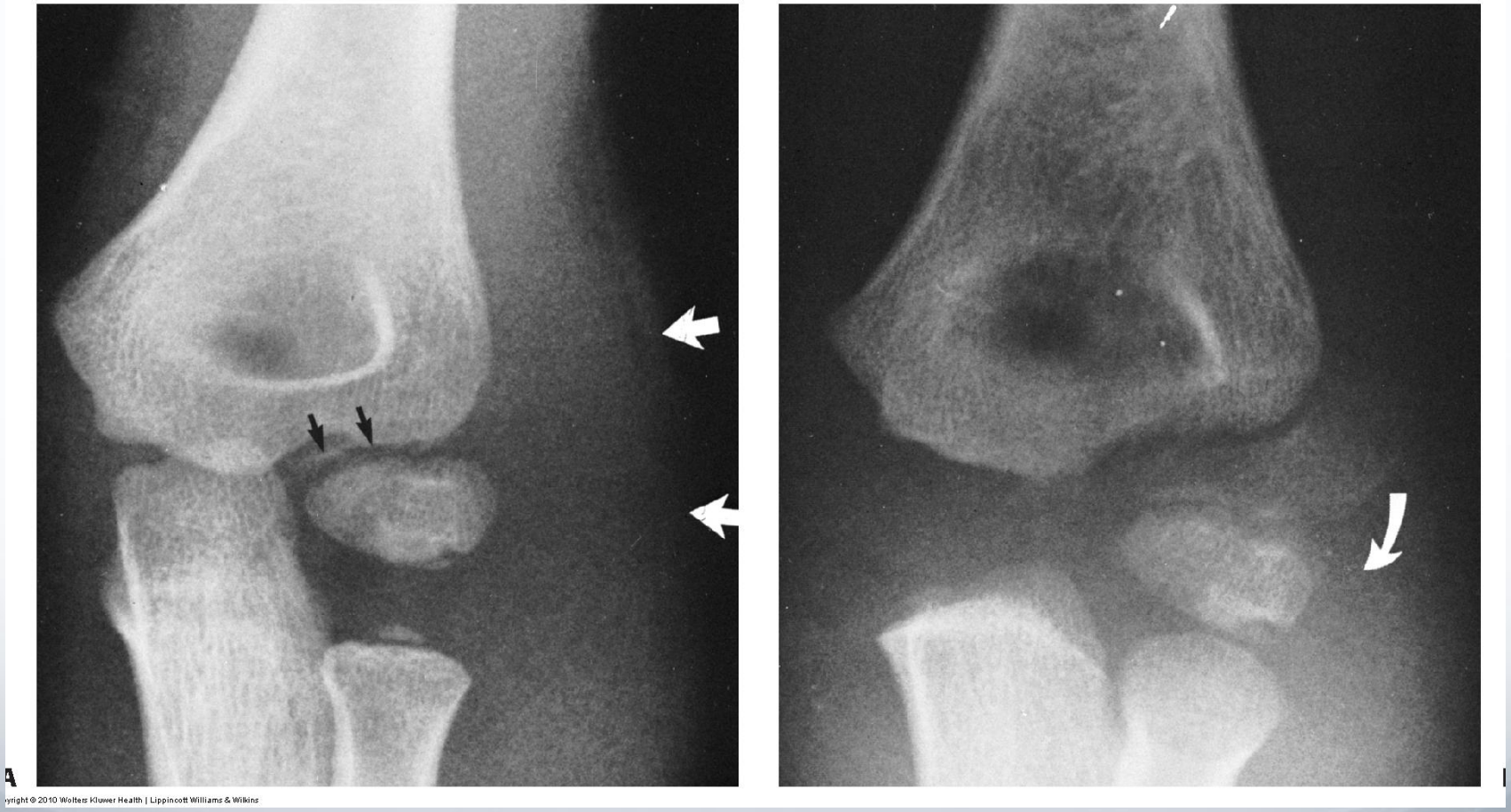


Lateral Condyle Fractures
Jakob Type 1

- Oblique radiographs necessary to confirm fracture position
- Can be managed with cast immobilization
- Needs close monitoring as 2% to 10% tend to displace



Jakob type 1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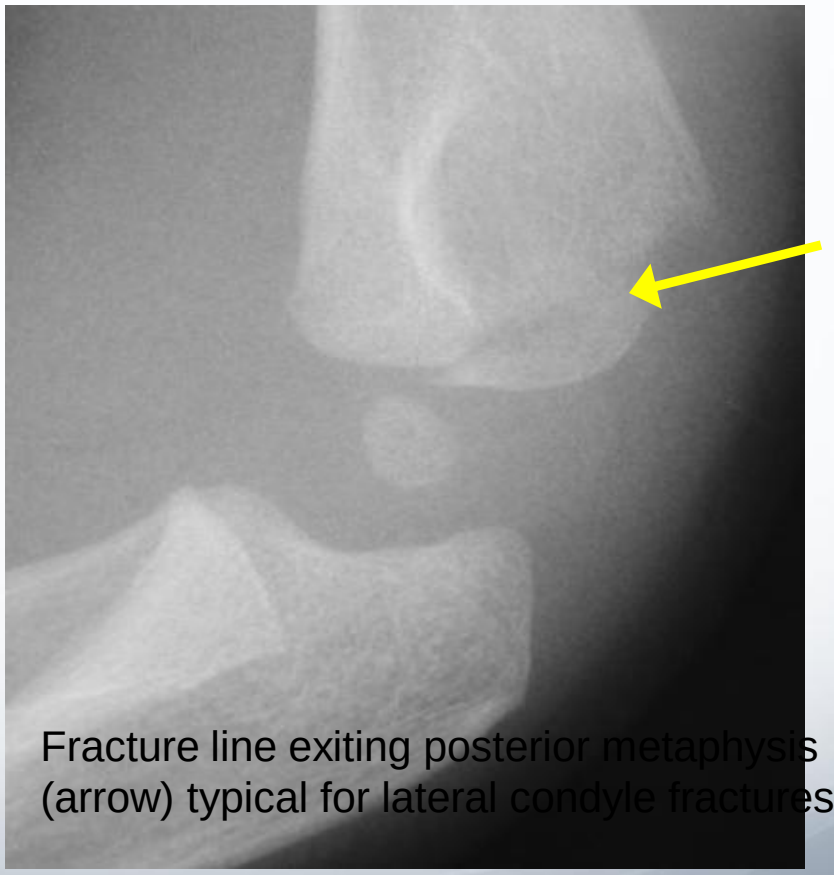
Jakob Type 2

- Displaced more than 2 mm
- Closed reduction & K wiring - articular reduction must be anatomic
- If residual displacement and the articular surface is not congruous
  - Open reduction is necessary



Fracture line exiting posterior metaphysis (arrow) typical for lateral condyle fractures

Flynn. Prevention and treatment of non-union of slightly displaced fractures of the lateral humeral condyle in children. An end-result study. J Bone Joint Surg Am. 1975;57:1087.

Jakob Type 3

- ORIF is *almost always* necessary
- Lateral Kocher approach
- K-wires / screws used
- Preserve soft tissue attachments (and thus blood supply) to the lateral condylar fragment, especially avoiding posterior dissection

-Foster. Lateral humeral condylar fractures in children. J Pediatr Orthop. 1985;5:16.
-Song. Closed reduction and internal fixation of completely displaced and rotated lateral condyle fractures of the humerus in children. J Orthop Trauma. 2010;24:434.

Complications

- AVN (Iatrogenic)
- Cubital valgus due to lateral growth arrest / non union
- Tardy ulnar nerve palsy due to cubitus valgus
- Stiffness

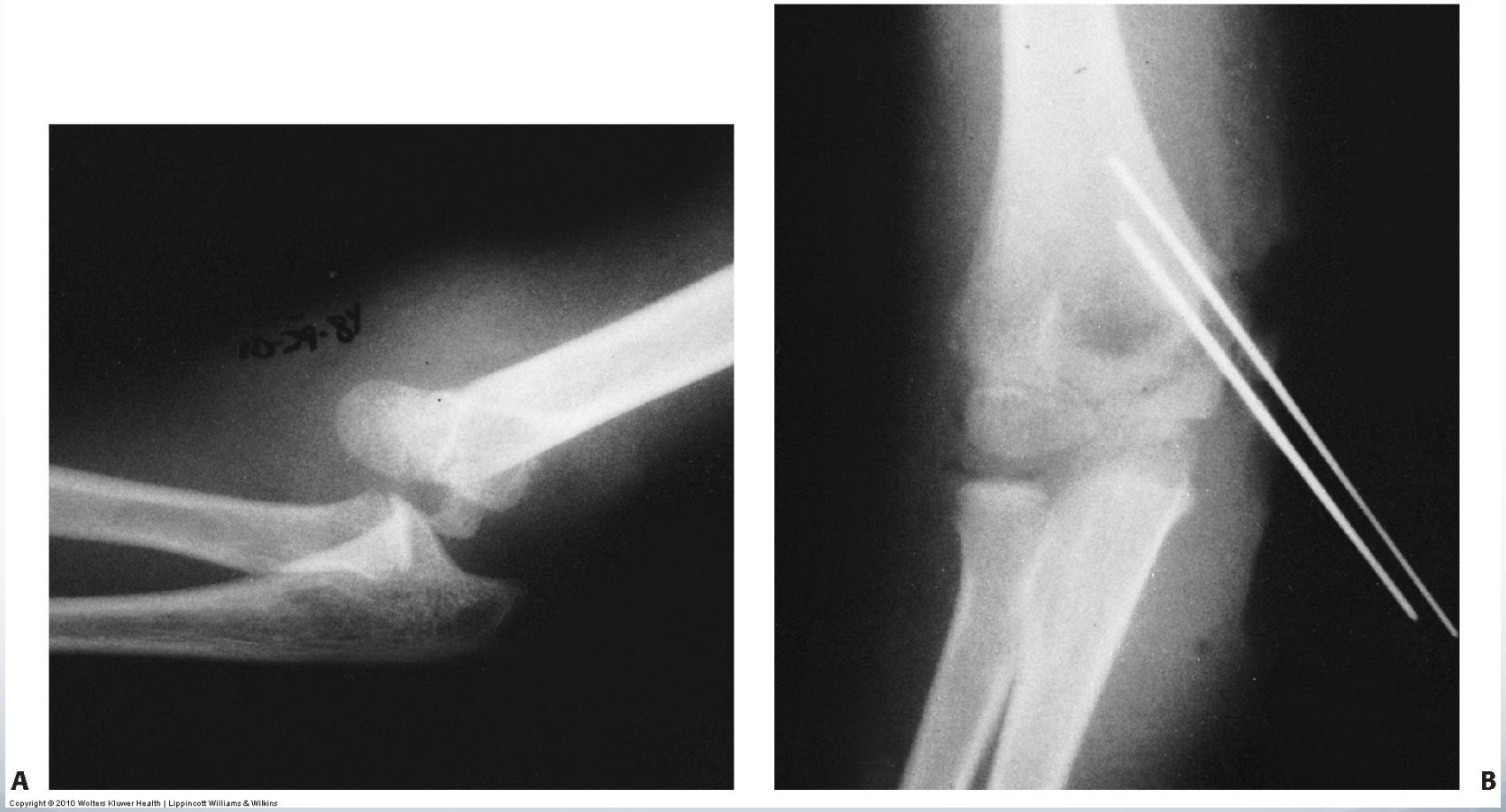
Medial Epicondyle Fractures

- 5% to 10% of paediatric elbow fractures
- >50% associated with elbow dislocations
- Traction injury causing avulsion of apophysis by MCL
- Contraction of flexor supinator mass can cause avulsion

Diagnosis

- AP, lateral & oblique xrays
- If apophysis missing in AP, carefully look for incarceration in oblique & lateral view
- Classification:
  - Based on the amount of displacement whether it is incarcerated in the joint
  - No proper classification

Medial epicondylar



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Management

- Conservative management – mainstay
- Early mobilisation (in 5 days) to avoid stiffness
- Surgery
  - Absolute indication: intra articular entrapment of medial epicondyle
  - Relative: Dominant arm in an athlete, ulnar nerve dysfunction
- Technique
  - Screws in older & k wires in young children
  - Remember Medial epicondyle relatively posterior to humerus

Medial Epicondyle Fracture

Example of Nonoperative Treatment

- 12 year old female UE weight bearing athlete
- Treated nonoperatively
- Full motion, no valgus instability at 6 weeks
- Returned to competition at 8 weeks

Medial Epicondyle Fracture &

Elbow dislocation with Medial Epicondyle Avulsion

Medial Epicondyle Avulsion

After attempted elbow reduction, medial epicondyle avulsion fragment is obvious

Complications

- Stiffness : Usually resolves with mobilisation
- Ulnar nerve neuropraxia
- Chronic instability – rare
- Failure to recognise the incarceration – stiffness & early degenertive changes

Rare Distal Humeral Fractures

- Lateral Epicondyle
  - Rare
  - Usually represent a small avulsion fracture
  - Treated with early mobilization
- T-Condylar fractures
  - Occur in patients that are almost skeletally mature
  - Treatment similar to adult intra-articular elbow fractures
- Medial Condyle
  - Rare
  - Treated with ORIF if displaced

Beaty JH. Elbow fractures in children and adolescents. Instr Course Lect. 2003;52:661–665.

Proximal Radius Fractures

- 1% of children's fractures
- 90% involve physis or neck
- Normally some angulation of head to radial shaft (0-15 degrees)
- No ligaments attach to head or neck
- Much of radial neck extraarticular (no effusion with fracture)

Vocke. Displaced fractures of the radial neck in children: long-term results and prognosis of conservative treatment. J Pediatr Orthop B. 1998;7:217.

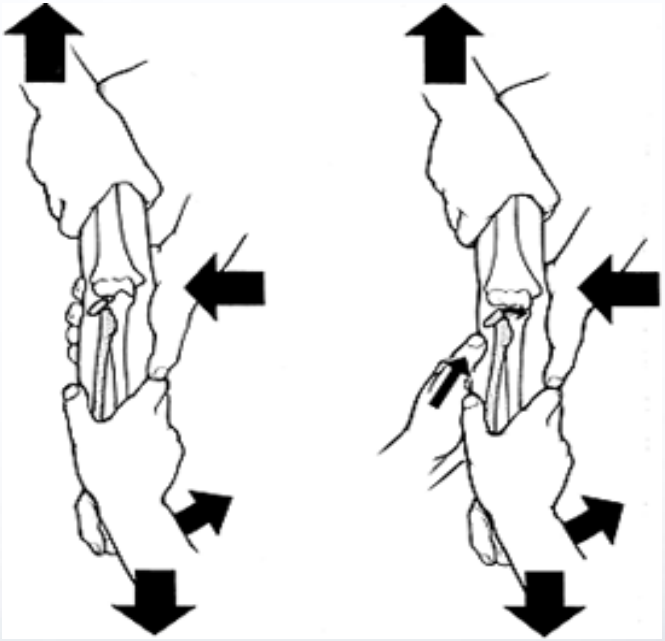
Proximal Radius Fractures Types

- Valgus fractures
  - Salter I or II
  - Intra-articular fractures rare
- Metaphyseal fractures
- Associated with elbow dislocations or proximal ulna fractures
- Can be completely displaced, rotated

Vocke. Displaced fractures of the radial neck in children: long-term results and prognosis of conservative treatment. J Pediatr Orthop B. 1998;7:217.

Proximal Radius Fractures Treatment

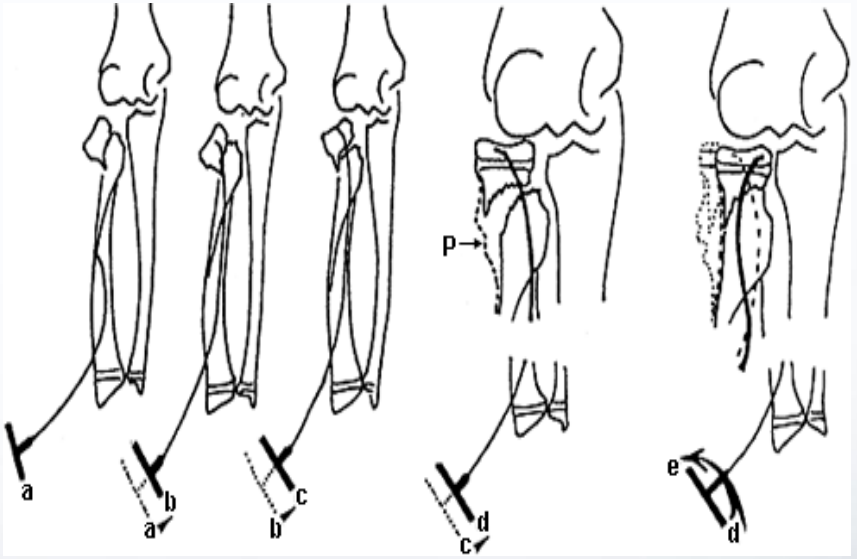
- Greater than 30° angulation
  - Attempt manipulation
  - Usually can obtain acceptable reduction in fractures with less than 60° angulation
  - Traction, varus force in supination & extension, flex and pronate
  - Ace wrap or Esmarch reduction



Evans. Radial neck fractures in children: a management algorithm. J Pediatr Orthop B. 1999;8:93.

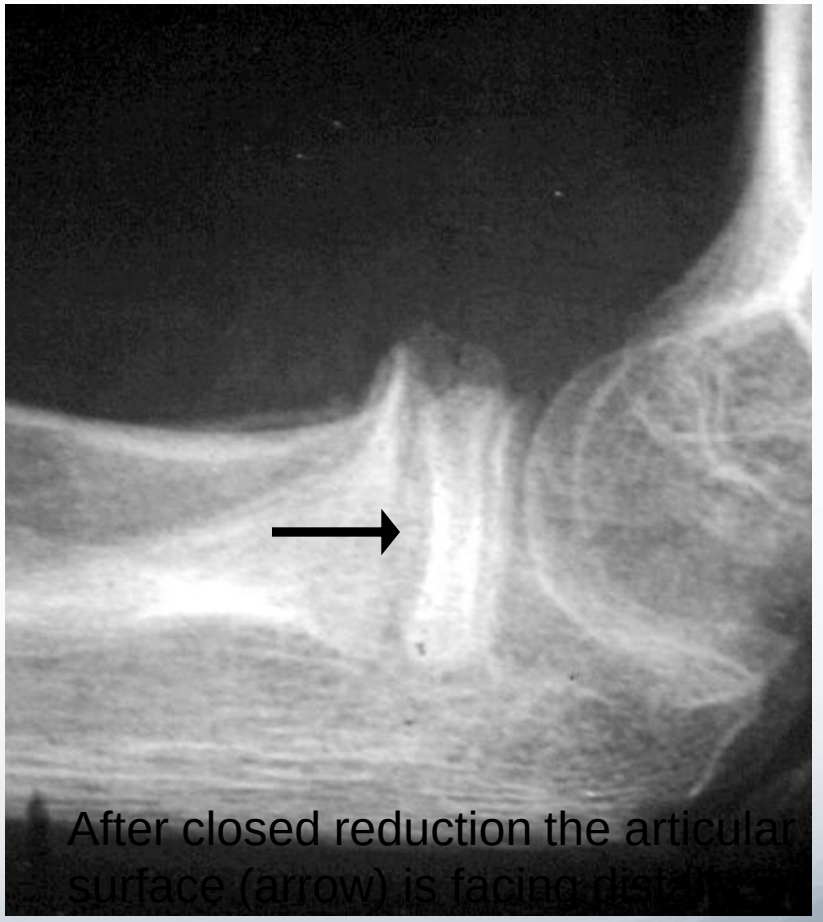
Proximal Radius Fractures Treatment

- Unable to reduce closed
  - Percutaneous pin reduction
  - Intramedullary pin reduction
  - Open reduction via lateral approach



-Vocke. Displaced fractures of the radial neck in children: long-term results and prognosis of conservative treatment. J Pediatr Orthop B. 1998;7:217.
-Metaizeau. Reduction et fixation des fractures et decollements épiphyssaires de la tête radial par broche centromedullaire. *Rev Chir Ortop 1980;66:47-9.*
-González-Herranz. Displaced radial neck fractures in children treated by closed intramedullary pinning (Metaizeau technique). J Pediatr Orthop. 1997;17:325.

Completely Displaced, Malrotated Radial Neck Fracture



After closed reduction the articular surface (arrow) is facing distally

180 degrees malrotated

Proximal Radial Fractures Complications

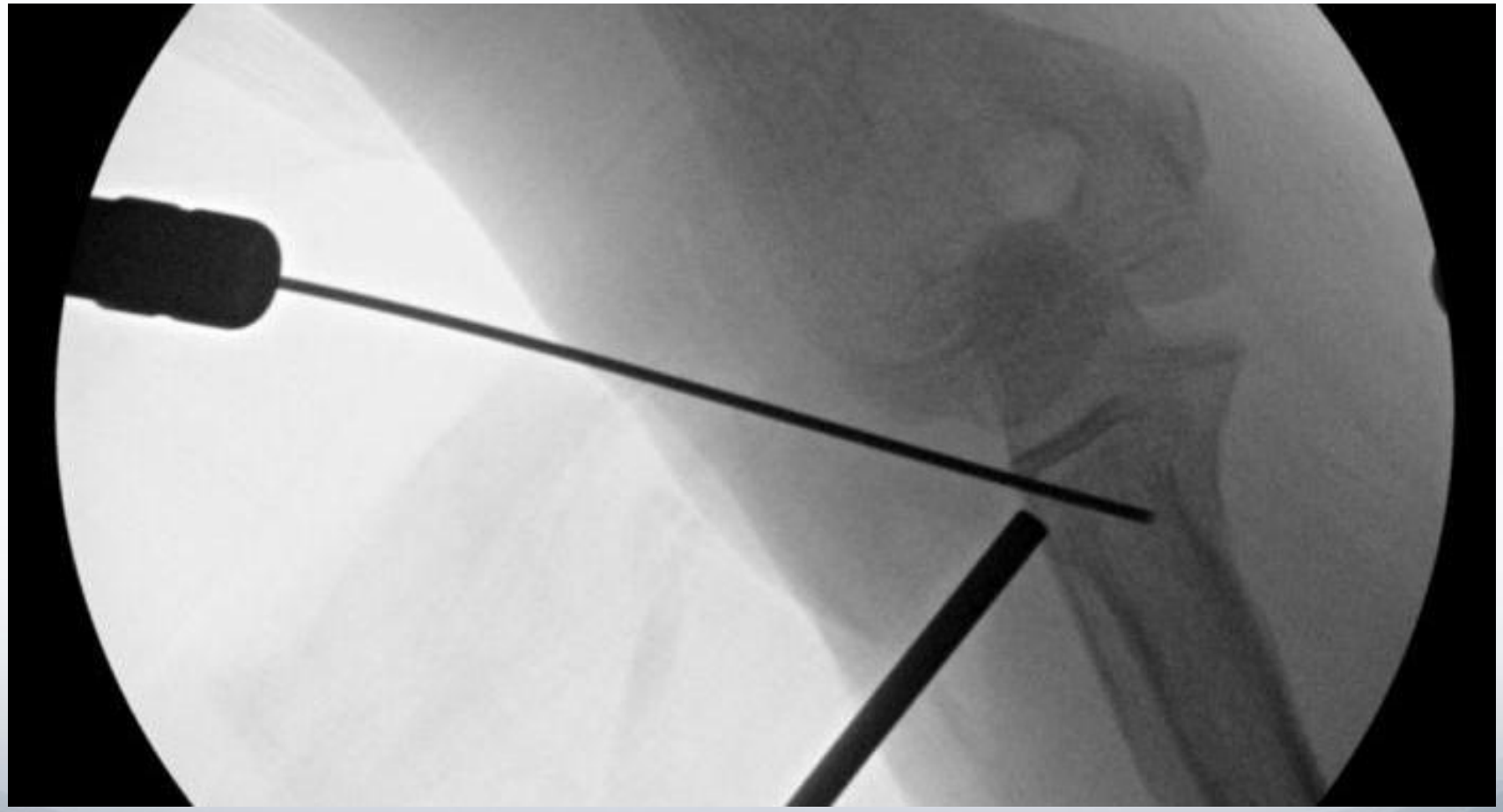
- Loss of forearm rotation
- Radial head overgrowth
- Premature physeal closure – valgus
- Nonunion of radial neck rare
- AVN
- Proximal synostosis

Vocke. Displaced fractures of the radial neck in children: long-term results and prognosis of conservative treatment. J Pediatr Orthop B. 1998;7:217.

100% Displaced
Failed Closed Reduction

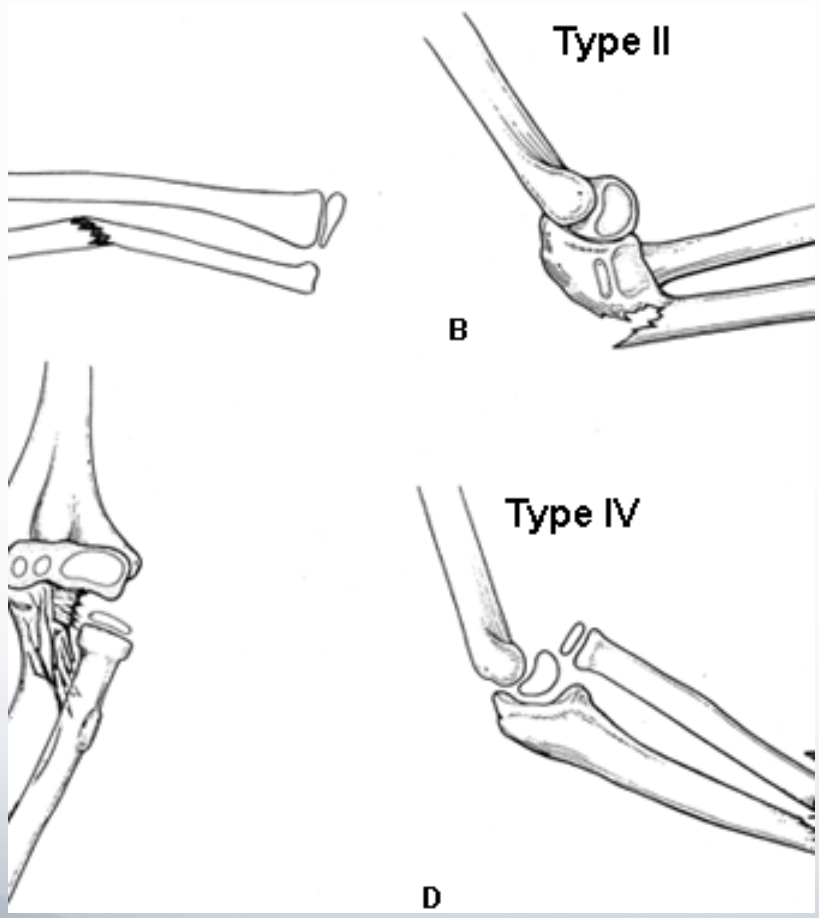
Open “closed” reduction

Blunt pin to push radial head back onto neck



Pin fixation augmented by cast for 3 weeks

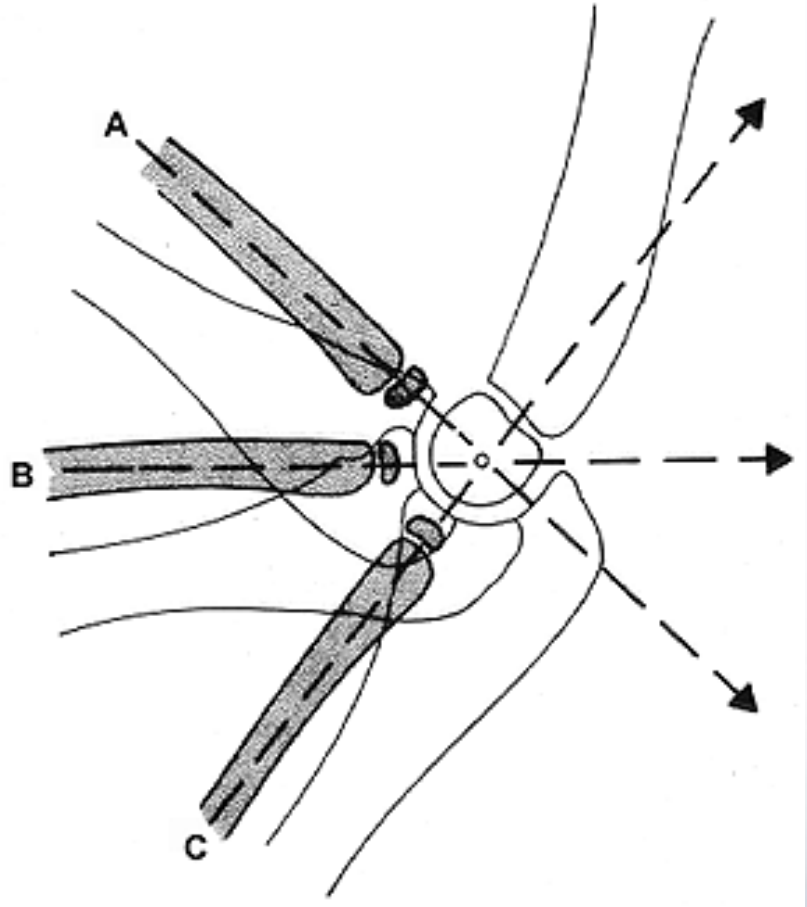
Monteggia Lesions
Ulnar Fracture-Radial Head Dislocation
Bado Classification



- Type I – anterior radial head dislocation
- Type II – posterior radial head dislocation
- Type III – lateral radial head dislocation
- Type IV – associated fracture of radius

Bado JL. The Monteggia lesion. Clin Orthop Relat Res. 1967;50:71–86.
Wilkins. Changes in the management of monteggia fractures. J Pediatr Orthop. 2002;22:548.

Monteggia Lesions



- Most important is to make the diagnosis initially
- Radiocapitellar line critical
- A commonly missed diagnosis
- Every ulna fracture should have good elbow joint radiographs to avoid missing Monteggia lesion

Monteggia Lesions

- Be wary of plastic deformation of ulna or minimally displaced ulna fracture with radial head dislocation
- On lateral radiograph the ulna should be straight

Note anterior bow of ulnar shaft, and anterior radial head dislocation

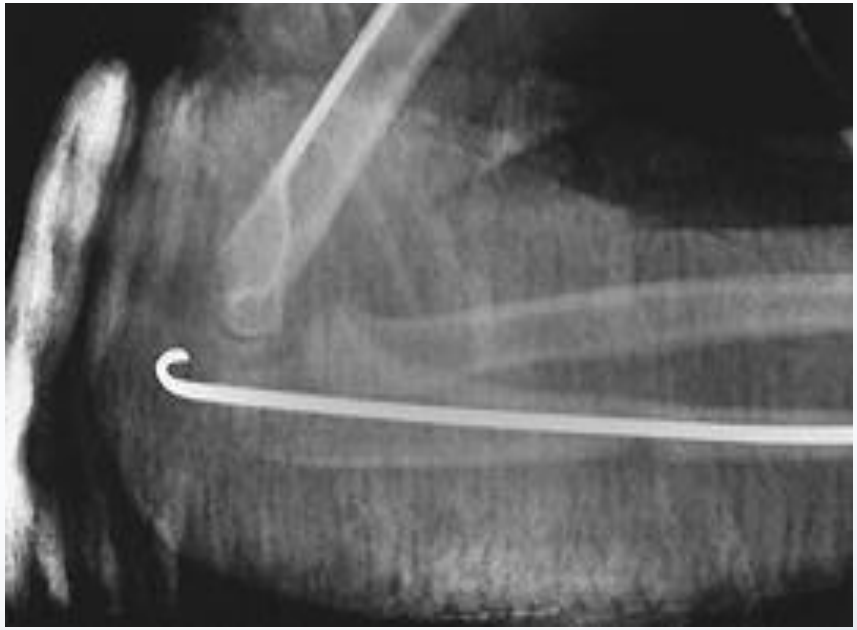
Monteggia Lesions
Initial Treatment

- Closed reduction of ulnar angulation
- Direct pressure over radial head
- Usually will reduce with palpable clunk
- Immobilize in reduced position
- Supinate forearm for anterior dislocations
- Frequent radiographic follow-up to document maintenance of reduction

Wilkins. Changes in the management of monteggia fractures. J Pediatr Orthop. 2002;22:548.

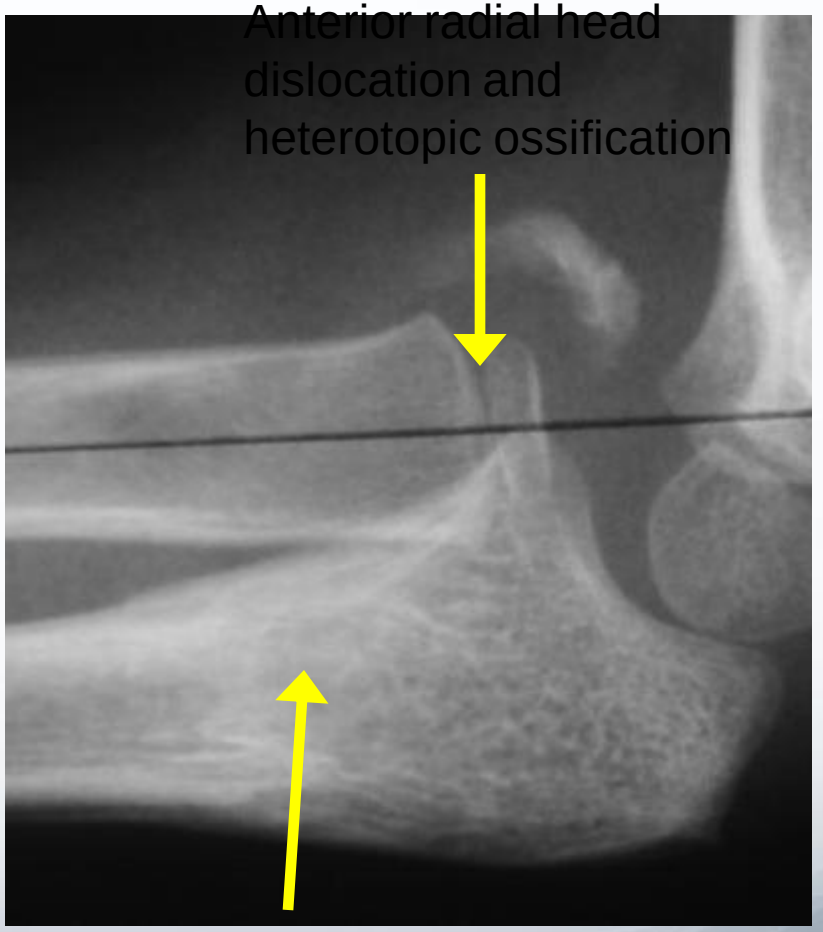
Monteggia Lesions

- If unable to obtain or maintain reduction of radial head
  - Operative stabilization of ulnar fracture to correct angulation
  - Oblique fractures may need plate fixation
  - Assess radial head stability
  - Flexion may help for anterior dislocation



Wilkins. Changes in the management of monteggia fractures. J Pediatr Orthop. 2002;22:548.

Missed Monteggia Lesion



Healed prox ulna fx with anterior bow

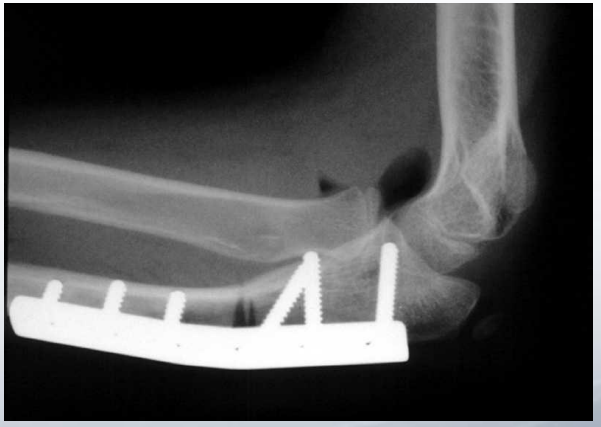
Missed Monteggia Lesions
Possible Long Term Sequelae

- Progressive valgus
- Proximal radial migration with disruption of normal forearm and distal radioulnar joint mechanics
- Posterior interosseous nerve traction palsy
- Collateral ligament instability

Nakamura. Long-term clinical and radiographic outcomes after open reduction for missed Monteggia fracture-dislocations in children. J Bone Joint Surg. 2009;91:1394.

Missed Monteggia Lesions Treatment Options

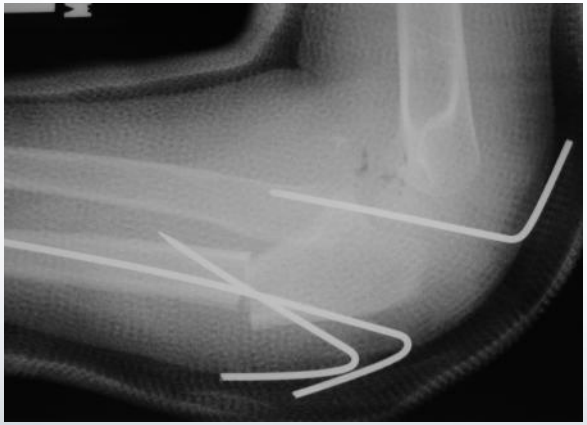
- Annular ligament reconstructions
  - Bell-Tawse
  - Fascia lata
  - Peterson
- Ulnar osteotomy
- Combination
- Transcapitellar pinning
- Be wary of possible pin breakage



-Nakamura. Long-term clinical and radiographic outcomes after open reduction for missed Monteggia fracture-dislocations in children. J Bone Joint Surg. 2009;91:1394.
-Wilkins. Changes in the management of monteggia fractures. J Pediatr Orthop. 2002;22:548.

Missed Monteggia Lesions

Ulnar Osteotomy and Radiocapitellar Pin



Thank You