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

<table>
<thead>
<tr>
<th>Ossification Center</th>
<th>Age of Appearance in Girls (years)</th>
<th>Age of Appearance in Boys (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capitellum</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Radius (proximal)</td>
<td>4-5</td>
<td>5-6</td>
</tr>
<tr>
<td>Medial epicondyle</td>
<td>5-6</td>
<td>7-8</td>
</tr>
<tr>
<td>Trochlea</td>
<td>8-9</td>
<td>10-11</td>
</tr>
<tr>
<td>Olecranon</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Lateral epicondyle</td>
<td>10</td>
<td>11-12</td>
</tr>
</tbody>
</table>
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
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Undisplaced</td>
<td>Fat pad sign present acutely</td>
</tr>
<tr>
<td>Type 2</td>
<td>Hinged posteriorly</td>
<td>Anterior humeral line anterior to capitellum</td>
</tr>
<tr>
<td>Type 3</td>
<td>Displaced</td>
<td>No meaningful cortical continuity</td>
</tr>
<tr>
<td>Type 4</td>
<td>Displaces in to extension &amp; Flexion</td>
<td>Usually diagnosed with manipulation under imaging</td>
</tr>
<tr>
<td>Medial comminution (not really a separate type)</td>
<td>Collapse of medial column</td>
<td>Loss of Baumann angle</td>
</tr>
</tbody>
</table>
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
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
The Pucker sign
Distal fragment rotation
Management of type 2 & 3

<table>
<thead>
<tr>
<th></th>
<th>Laboratory Testing</th>
<th>Clinical stability</th>
<th>Iatrogenic ulnar nerve injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossed Pins</td>
<td>More stable</td>
<td>Comparable</td>
<td>3% - 8%</td>
</tr>
<tr>
<td>Lateral entry pins</td>
<td>Less stable</td>
<td>Comparable</td>
<td>0%</td>
</tr>
</tbody>
</table>

Crossed Pins - More stable
Lateral entry pins - Less stable

A. Crossed
B. Divergent
C. Parallel
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

<table>
<thead>
<tr>
<th>Nerve Injury</th>
<th>Association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior interosseous nerve</td>
<td>Most common in SCF</td>
</tr>
<tr>
<td>Median nerve</td>
<td>Posterolateral fracture displacement</td>
</tr>
<tr>
<td>Radial nerve</td>
<td>Posteromedial fracture displacement</td>
</tr>
<tr>
<td>Ulnar nerve</td>
<td>Rarely traumatic, usually iatrogenic</td>
</tr>
</tbody>
</table>

## Vascular injuries & management

<table>
<thead>
<tr>
<th>Vascular status</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse lost after reduction &amp; Pinning</td>
<td>Explore radial artery</td>
</tr>
<tr>
<td>Pulseless well perfused hand</td>
<td>Observe 24 – 72 hrs</td>
</tr>
<tr>
<td>Pulseless cool hand</td>
<td>Explore brachial artery</td>
</tr>
</tbody>
</table>
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

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
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

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

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 x-rays
- 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 #
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

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 degenerative 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

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)

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

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

Proximal Radius Fractures Treatment

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

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

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

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

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

Missed Monteggia Lesion

Healed prox ulna fx with anterior bow

Anterior radial head dislocation and heterotopic ossification
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

Missed Monteggia Lesions
Treatment Options

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

Missed Monteggia Lesions
Ulnar Osteotomy and Radiocapitellar Pin
Thank You