Other Upper Extremity Trauma

Inje University
Sanggye Paik Hospital
Yong-Woon Shin
Forearm Fractures

Forearm fractures

- the most common orthopaedic injuries in children
- 30-50% of all pediatric fractures
  : distal 1/3 (75-84%) > middle 1/3 (15-18%) > proximal 1/3 (<5%)
Distal Radius Fractures

Classification

- Distal physis
- Distal metaphysis
  stability(torus/ greenstick/ complete)
- Galeazzi fracture
  dorsal displaced
  volar displaced
Distal Radius Fractures

Fracture of distal radius metaphysis

- Most common site
- Boy, 11-13 years
- Fall on outstretched hand
- Associated injury: floating elbow, carpal bone, ligament injury (intercarpal, DRUJ)
  - Neurologic insult: median n. by prox. fragment or immobilization position
- Complete fx: unstable – 30% redisplaced (vs. remodel)
  - Risk factor: initial displace, fx obliquity, cast molding

(Alemdaroglu et al. JBJS 2008)
Fracture of distal radius metaphysis

- tremendous remodeling potential: because of proximity to the distal radial physis

<table>
<thead>
<tr>
<th>Age</th>
<th>Sagittal plane</th>
<th>Coronal plane</th>
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<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
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<tr>
<td>4-9</td>
<td>20</td>
<td>15</td>
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<tr>
<td>9-11</td>
<td>15</td>
<td>10</td>
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<tr>
<td>11-13</td>
<td>10</td>
<td>10</td>
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<tr>
<td>&gt;13</td>
<td>5</td>
<td>0</td>
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</tbody>
</table>
Fracture of distal radius metaphysis

Closed reduction / above-the-elbow cast
- apex-volar fx : pronation immobilization
dorsally directed pressure
- apex-dorsal fx : supination immobilization
volarly directed pressure to the fx site
# Fracture of distal radius metaphysis

## Cast indices

![X-ray images of hand](image)

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
<th>Desired Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast index</td>
<td>Inner diameter of cast on lateral (at fracture site)</td>
<td>&lt;0.7</td>
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<tr>
<td></td>
<td>Inner diameter of cast on anteroposterior (at fracture site)</td>
<td></td>
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<tr>
<td>Gap index</td>
<td>Radial gap + ulnar gap at fracture site + dorsal gap + volar gap at fracture site</td>
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<tr>
<td></td>
<td>Inner diameter of cast on anteroposterior</td>
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<tr>
<td></td>
<td>Inner diameter of cast on lateral</td>
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<tr>
<td>Padding index</td>
<td>Dorsal gap on lateral at fracture site</td>
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<tr>
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<td>Maximum interosseous distance on AP</td>
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<tr>
<td>Canterbury index</td>
<td>Cast index + padding index</td>
<td>&lt;1.1</td>
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<tr>
<td>3-point index</td>
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<td>Transverse distance of cortical contact on anteroposterior</td>
<td></td>
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<tr>
<td>3-point index</td>
<td>Distal dorsal gap + volar gap at fracture + proximal dorsal gap</td>
<td>&lt;0.8</td>
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<tr>
<td></td>
<td>Transverse distance of cortical contact on lateral</td>
<td></td>
</tr>
</tbody>
</table>
Fracture of distal radius metaphysis

percutaneous pin fixation

indication
- significant soft tissue swelling
- neurovascular compromise (esp. median n.)
  → not to make compartment syndrome or carpal tunnel syndrome
- initial angulation > 30°, displacement > 50%
- concomitant fx of elbow (floating elbow)

Complication
- pin-track infection
- irritation of the radial sensory nerve
- irritation of an extensor tendon
Fracture of distal radius metaphysis
Fracture of distal radius metaphysis

- open reduction – interposed soft tissue, open fx

*Nonunion as a Complication of an Open Reduction of a Distal Radial Fracture – Song KS, JOT 2003*
Distal Radius Fractures

Fracture of distal radius physis

• Salter-Harris type 2(mc) - dorsal displacement

• Treatment
  - closed reduction and cast immobilization
  - percutaneous pinning: with narrow, smooth pin for unstable fx. or severe swelling
  - open reduction : irreducible/ open/ displaced S-H 3,4
Fracture of distal radius physis

- closed reduction: under sedation or anesthesia
  - pain relief and *atraumatic reduction* (Chinese finger trap)
  - *50% apposition* would be enough to be remodeled

→ Don’t do forceful, repeated maneuver for anatomical reduction, especially beyond *7 days after injury.*
Fracture of distal radius physis

• Complications
  - physeal arrest - 4-5%
    2 factors; amount of initial trauma
    iatrogenic injury (repeated reduction)
    ➔ ulnar impaction syndrome, DRUJ instability
      : physeal bar resection after MRI mapping
      : radial lengthening or ulnar shortening
  - malunion - wait for 6-12months to remodel
    ➔ extension deformity : mid-carpal instability and OA
      : corrective osteotomy
Distal Radius Fractures

Galeazzi fractures

Radius fx with dislocation of distal R-U joint

- Apex-volar fx
  - with volar dislocation of ulna
  - radius metaphysis level
  - supination injury → CR: pronation + wrist flexion

- Apex-dorsal fx
  - with dorsal dislocation of ulna
  - radius meta-diaphysis junction level (more proximal)
  - pronation injury → CR: supination + wrist extension
Galeazzi fractures

“Classic Galeazzi” -- rare
“Galeazzi equivalent” with distal ulnar physeal injury
-- more common: higher growth arrest rate (20-60%)
Galeazzi fractures

Tx

Anatomic reduction of both radius & ulna
→ restore normal function

Greenstick or incomplete fx
→ Closed reduction

Complete fx
* Inability to reduce the ulnar physeal fx
  (extensor or periosteum interposition)
→ ORIF
Forearm both bone fractures

3 categories

- plastic deformation
- greenstick
- complete diaphyseal fractures
considering factors for treatment
- less than 1 yr of skeletal growth remaining (M 15, F 13)
  : limited remodeling potential
    → should be treated as adults (ORIF)
- age factor
  under 8 yr: < 15° / bayonet
  over 8 yr: < 10°
- maximal rotational correction should be obtained.
  (< 30° of rotational malalignment
    - minimal functional loss)
Intramedullary K-wire fixation is a good alternative for children with unstable forearm fractures for whom nonoperative management failed.

-- Shoemaker, JPO 1999
Proximal forearm fractures

- Relatively rare: < 5% of forearm fx
- Rotation limitation: frequent
- <12 years: avoid OR, for fear of proximal radioulnar synostosis
Proximal forearm fractures

Monteggia fractures

a fracture of the ulna
with an associated radiocapitellar dislocation
Monteggia fractures

A line drawn along the axis of the radius through the radial head should bisect the capitellum on every radiographic view.

Radio-capitellar relation

Ulnar bow line
Monteggia fractures

Most can be treated by CR(strong perisoteum)

- **Incomplete** fx or plastic deformation of the ulna
  → closed reduction

- **Complete** ulna fracture → op. to *avoid ulnar shortening*
  - transverse or short oblique → IM fixation
  - long oblique, seg, or comm fx → plate fixation
Monteggia fractures

- open reduction of radial head
  with internal fixation of ulna
  imperfect reduction of ulna,
  infolded annular ligament,
  buttonholing of radial head through joint capsule

- open reduction with recon. of annular ligament
  and/or ulnar corrective osteotomy
  : more than 3-4 weeks after the injury
Proximal forearm fractures

Radial neck fractures

- Classification (Wilkins)
  - Group I: head displacement
    - Valgus injury
      - A: S-H type 1,2
      - B: S-H type 4
      - C: metaphyseal
    - Ass. with elbow D/L
      - D: during reduction (posterior)
      - E: during dislocation (anterior)
  - Group II: neck displacement
  - Group III: stress injury
Radial neck fractures

- angulation $<30^\circ$ and displacement $<40\%$ : cast, in situ
- angulation $30^\circ - 45^\circ$ : CR and cast
- angulation $>45^\circ$ after CR : ORIF – poor result 20%

Complications
- Radial neck fractures
- Loss of motion: cam effect
- Radial head overgrowth
- Premature physeal closure
- AVN
- Cubitus valgus: more 10\°
- Posterior ION injury
- Radioulnar synostosis
- Myositis ossificans
- Malunion: incongruity

Radial recurrent a. $\leftrightarrow$ radial collateral a.

Interosseous recurrent a. $\leftrightarrow$ middle collateral a.

Yamaguchi et al. JBJS Am. 1997
Radial neck fractures

- Closed reduction methods

Patterson

Israeli

Bernstein

Metaizeau
Proximal forearm fractures

Olecranone fractures

• Metaphyseal fx
  - flexion type: immobilization in extension
  - extension type
    - valgus type: with radial neck fx
    - varus type: with Monteggia type 3
Pulled elbow

Supination + flexion  Hyperpronation
Humerus fractures

Humerus shaft fractures

- Neonates – birth trauma
- Neonates to age 3 – consider possible non-accidental trauma (child abuse)
- Age 3-12 – often pathologic fracture through benign bone tumor or cyst
- Older than age 12 – treatment like adults
Humerus shaft fractures

- Tx
  - Usually closed methods
    : Sling and swathe, Coaptation splint, Brace
      * Hanging arm cast
  - Malunion common, but usually little functional loss
    : Remodels well
  - Nonunion uncommon
  - Radial nerve palsy less common, if occurs usually neurapraxia
- ORIF : open fx, multiple trauma or head injury, soft tissue interposition
Proximal humerus fractures

- **Fx pattern**
  - Birth injuries
  - 0-5 years: S-H type I
  - 5-11 years: metaphyseal
  - >11: S-H type II
    *Others rare (III, IV)
Proximal humerus fractures

- Conservative Tx: Wide acceptable range
  - Great remodeling potential
  - Shoulder ROM compensatory
  - Shortening
    - up to 3-4 cm seemingly well tolerated
  - Neurologic and vascular compromise
    - less common than in adults

- Pinning: complications – pin migration, infection
Clavicle fractures

- Common fx in children
- Usually midshaft: 5% lateral, <5% medial
- Almost always heals, usually clinically insignificant malunion
- Complications very uncommon
- Sling, figure of 8 bandage
Clavicle fractures

- Distal clavicle fx
  : do not confuse with A-C dislocation
Thank you for your attention