PEDIATRIC UPPER EXTREMITY FRACTURE MANAGEMENT

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SPORTS MEDICINE SYMPOSIUM: THE PEDIATRIC ATHLETE
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DISCLOSURE

• I have nothing to disclose.
OBJECTIVES

Discuss the diagnosis, management, and outcome of common pediatric upper extremity fractures:

- Forearm Fractures
- Supracondylar Fractures
- Medial Epicondyle Fractures
- Lateral Condyle Fractures
- Proximal Humerus Fractures
- Clavicle Fractures
FOREARM FRACTURES

• 1:100 kids each year
• Mechanism usually FOOSH
• Check for neurovascular compromise
• Open vs. closed
• Splint in position of comfort for transport
• Imaging: AP, lateral forearm (includes elbow & wrist)
DISTAL RADIUS BUCKLE FRACTURES

• Pre-formed splint x 3 weeks
• No follow up is necessary (West, 2005)

DISTAL RADIUS FRACTURES

- Most common fracture in pediatrics (28-30%)
- Metaphysis most frequent site
- Most do well with closed reduction if needed
- OR: open, unstable, displaced SH III or IV
- Above elbow cast or GOOD below elbow cast x 4-6 weeks

http://backup.orthobullets.com/pediatrics/4014/distal-radius-fractures--pediatric
BOTH BONE MID-SHAFT FOREARM FRACTURES

• Evaluate x-ray for:
  – Angulation
  – Displacement
  – Bayonet apposition or shortening
  – Rotational deformity
• Make sure to image wrist and elbow

https://www.orthobullets.com/pediatrics/4014/distal-radius-fractures--pediatric;
**WHAT IS ACCEPTABLE ALIGNMENT?**

<table>
<thead>
<tr>
<th>Age</th>
<th>Acceptable Bayonetting</th>
<th>Acceptable Angulations</th>
<th>Malrotation*</th>
<th>Dorsal Angulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 9 yrs</td>
<td>&lt; 1 cm</td>
<td>15-20°</td>
<td>45°</td>
<td>30 degrees</td>
</tr>
<tr>
<td>&gt; 9 yrs</td>
<td>&lt; 1 cm</td>
<td>10°</td>
<td>30°</td>
<td>20 degrees</td>
</tr>
</tbody>
</table>

• More angulation tolerated near physis
• Need ~ 2 years of growth remaining
REDUCTION AND SPLINTING

• Sedation generally required in ED (e.g. ketamine, propofol, nitrous oxide)
• Can consider hematoma block +/- versed
• Bear et al (J. Hand Surg Am. 2015)
  – 52 patients w/ distal radius fractures age 5-16y underwent reduction w/ either procedural sedation or hematoma block
  – Overall satisfaction and satisfaction w/ anesthesia similar with 2.2 hr reduction in ED length of stay for hematoma block group
REDUCTION AND SPLINTING

• Periosteum can facilitate or complicate reduction
• Physis: gentle pushing, minimize attempts to avoid damaging physis
• Mid-shaft fractures:
  – 1\textsuperscript{st}: Recreate deformity to unlock periosteum
  – 2\textsuperscript{nd}: Apply longitudinal traction
  – 3\textsuperscript{rd}: Correct rotational deformity
  – 4\textsuperscript{th}: Reduce angulation
REDUCTION AND SPLINTING

• Consider deforming forces on rotation
  – Proximal radius pulled into supination by biceps & supinator
  – Distal radius pulled into pronation by pronator quadratus & brachioradialis

• Rule of Thumbs: rotate thumb towards apex of fracture
REDUCTION AND SPLINTING

• Sugar tong splint
  – 3-point molding
  – Interosseous molding
  – 90° at elbow
INTEROSSEOUS MOLD

FOREARM FRACTURE FOLLOW-UP

- Total time in cast: ~ 6 weeks
- Weekly x-rays x 2
- At 4 weeks consider moving from AE cast to BE cast
- Straight ulnar border to avoid a “banana” cast

http://raisingsaints.blogspot.com/2012/04/surprising-it-took-this-long-really.html
MONTEGGIA FRACTURES

• Proximal 1/3 ulnar fracture w/ radial head dislocation

https://www.orthobullets.com/trauma/1024/monteggia-fractures
GALEAZZI FRACTURES

- Fracture of distal 1/3 radius with distal ulna dislocation
ELBOW: OSSIFICATION CENTERS

<table>
<thead>
<tr>
<th>Ossification Centre</th>
<th>Age of Ossification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capitellum</td>
<td>1</td>
</tr>
<tr>
<td>Radial Head</td>
<td>3</td>
</tr>
<tr>
<td>Internal (medial) Epicondyle</td>
<td>5</td>
</tr>
<tr>
<td>Trochlea</td>
<td>7</td>
</tr>
<tr>
<td>Olecranon</td>
<td>9</td>
</tr>
<tr>
<td>External (lateral) Epicondyle</td>
<td>11</td>
</tr>
</tbody>
</table>
ELBOW

• Anatomy:
  – Anterior humeral line intersects middle 1/3 of capitellum
  – Long axis of radius aligns w/ capitellum in all views
  – Anterior fat pad can be normal
  – Posterior fat pad never normal
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NORMAL

NOT NORMAL

By James Heilman, MD - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=14633683
SUPRACONDYLAR FRACTURES

• 95-98% extension type
• Usually FOOSH
• Most common age is 5-7 years
• Associated injuries:
  - Radial Nerve Palsy
  - Ulnar Nerve Palsy
  - Anterior Interosseous Nerve Palsy
SUPRACONDYLAR FRACTURE – TYPE I

• No or minimal displacement
• No visible fracture line
SUPRACONDYLAR FRACTURE – TYPE I

- Posterior splint w/ elbow at 90° flexion or less x 3-4 weeks
- If you see a fat pad, treat it like a fracture
SUPRACONDYLAR FRACTURE – TYPE II

- Obvious fracture line
- Posterior cortex intact
- Varying amounts of displacement
- Closed reduction with ortho in OR (usually)
SUPRACONDYLAR FRACTURE – TYPE II

- Place immediately in posterior splint with <20° flexion or where patient is comfortable
SUPRACONDYLAR FRACTURE – TYPE III

- Completely displaced
- No intact cortex
- High risk of neurovascular complications
- Place immediately in posterior splint with <20° flexion
- Frequent pulse checks
- Urgent reduction & pinning in OR with ortho
MEDIAL EPICONDYLE FRACTURES

- 5-10% of pediatric elbow fractures (Gottschalk, 2012)
- Peak incidence: age 9-14 years
- Last ossification center to fuse at age 15-20 y (Chessare, 1977)
- Origin of flexor-pronator mass and ulnar collateral ligament (UCL)
- Mechanism: FOOSH w/ valgus stress to elbow, acute avulsion or overuse injury in throwing athletes

https://radiologykey.com/elbow-7/
MEDIAL EPICONDYLE FRACTURES

- Up to 60% associated with elbow dislocation
- 15-20% of elbow dislocations result in incarceration of medial epicondyle fragment (Gottschalk, 2012)

http://www.cmcedmasters.com/ortho-blog/pediatric-elbow-dislocation
MEDIAL EPICONDYLE FRACTURES

• Exam:
  – Pain/swelling over medial epicondyle
  – Consider testing stability with valgus stress

• Imaging:
  – AP, lateral, consider internal obliques to determine anterior displacement
  – Degrees of displacement difficult to measure
MEDIAL EPICONDYLE FRACTURES TREATMENT

• Non-op:
  – < 5 mm displacement
  – Up to 4 weeks immobilization in AE cast flexed to 90°
  – Usually heals w/ fibrous union
• Op: > 15 mm or joint entrapment
• Controversial: 5-15 mm
MEDIAL EPICONDYLE FRACTURES TREATMENT

• Other indications for surgery (Gottschalk, 2012)
  – Gross elbow instability
  – Ulnar nerve damage
  – Overhead athletes or weight-bearing athletes (gymnasts)
  – Fragment in joint

• Surgery had 92.5% bony union vs. 49.2% non-op group (Kamath, 2009)
LATERAL CONDYLE FRACTURES

- #2 pediatric elbow fracture
- High risk of non-union, malunion, AVN
- Mechanism:
  - Avulsion from common extensor complex
  - FOOSH
- Internal oblique views helpful (fracture is posterolateral)
LATERAL CONDYLE FRACTURES TREATMENT

- Non-op if < 2 mm displacement in all views
  - AE cast 4-6 weeks, elbow at 90°
  - Weekly x-rays x 3 weeks
- CRPP vs. ORIF

http://www.orthobullets.com/pediatrics/4009/lateral-condyle-fracture--pediatric?expandLeftMenu=true
PROXIMAL HUMERUS FRACTURES

• < 5% of pediatric fractures
• Mechanism:
  – Blunt trauma
  – Indirect trauma
  – Overuse injury in throwers
• Proximal humerus physis: 80% longitudinal growth in upper arm, so great remodeling potential
• Imaging: AP, lateral, scapular Y or axillary views
PROXIMAL HUMERUS FRACTURES: TREATMENT

• Acceptable alignment
  – < 10 y.o. = any angulation
  – 10-13 y.o. = up to 60º angulation
  – > 13 y.o. = up to 45º angulation & 2/3 displacement

• Immobilize: sling +/- swathe

• Sometimes closed reduction attempted

• Operative for unacceptable angulation or displacement, intra-articular fracture, NV injury, open fracture

http://backup.orthobullets.com/pediatrics/4004/proximal-humerus-fracture--pediatric
LITTLE LEAGUE SHOULDER

- Physis injury of proximal humerus
- Repeated overhead throwing causes microtrauma
- High loads of torque
- May lead to acute SH I fracture
- Rest & refer to PT for guided throwing program
LITTLE LEAGUE ELBOW

• SH I fracture medial epicondyle
• Treatment is a period of rest followed by guided throwing program
• Pitch counts in place to prevent Little League elbow & shoulder

vhttp://www.cincinnatichildrens.org/health/little-league-shoulder
http://orthokids.org/Sports-Injury-Prevention/Throwing-Injuriesr
CLAVICLE FRACTURES

• 8-15% of pediatric fractures
• Mechanism:
  – Direct blow to clavicle
  – FOOSH
  – Impact to lateral shoulder
• Treatment for uncomplicated mid-shaft fractures:
  – Sling for comfort
  – ROM as pain as allows
  – No high risk activities x 2 months

https://eorif.com/pediatric-clavicle-fracture
CLAVICLE FRACTURES

• Hospital for Sick Children in Toronto (Adamich, 2016)
  – 339 skeletally immature patients with mid-shaft clavicle fractures
  – 2 had re-fractures
  – No non-unions
  – No follow up x-rays necessary
  – Majority can be discharged after initial assessment
CLAVICLE FRACTURES

- Surgical indications:
  - Tenting of skin
  - Open fracture
  - NV injury
  - Medial physeal injury

https://aneskey.com/chest-and-abdomen/
https://www.orthobullets.com/pediatrics/4123/medial-clavicle-physeal-fractures
QUESTIONS???

https://puptastic.com/cast-designs/
REFERENCES

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