Supracondylar Humerus Fractures
Two Very Different Fracture Types

- Adult supracondylar (SC) humerus fxs
- Pediatric SC humerus fxs
ADULT FRACTURES
Adult Injuries

• Distal humerus fx (all types) encompass .5-7% of all fxs & 30% of elbow fxs

• Low energy injuries in elderly females w/ elbow struck in flexion or fall onto outstretched hand

• Road accidents & sports more common cause in younger males (higher proportion open)
Classification

• Anatomic location
  – High
  – Low
  – Abduction
  – Adduction

• Relative to condyles
  – supracondylar
  – transccondylar
  – intercondylar
AO/OTA Classification

- **Type A**: extra-articular
  - A1: apophyseal avulsion (epicondyle)
  - A2: simple metaphyseal transcolumn
  - A3: complex multifragmentary metaphyseal transcolumn

- **Type B**: partial articular
  - B1: lateral sagittal
  - B2: medial sagittal
  - B3: frontal

- **Type C**: complex articular (most common)
  - C1: articular & metaphyseal simple
  - C2: articular simple, metaphyseal complex
  - C3: multifragmentary

JAAOS 2010
Jupiter & Mehne Classification

- Based on intra-operative findings
- High T- horizontal transcolumnar fx & vertical fx extending to articular surface
- Low T- transverse component through olecranon fossa
- Y- oblique fx through each column, w/ vertical component through joint
- H- trochlea detached from medial & lateral columns
- Lambda- medial or lateral, based on intact column w/ free trochlear fragment

JAOOS 2010
Semantics

- SC humerus fxs in adults refer to extra-articular fxs above the condyles; this is equivalent to a Type A2 & A3 (transcolumnar)
- For the sake of completeness, I will discuss distal humerus fxs
Challenges

- Unique & complex anatomy of distal humerus, involving ulnohumeral & radiocapitellar joints, makes anatomic reduction difficult & hardware placement challenging
- Osteoporosis in elderly population can lead to severe comminution
Anatomy

• **Ulnohumeral joint**
  – Hinge joint
  – Allows flexion & extension
  – Trochlea forms center of hinge; supported by medial & lateral columns

• **Radiocapitellar joint**—forearm rotation
Distal Humerus Columns

Rockwood & Green 2006
Injury Evaluation

• Signs & symptoms-
  – Pain, swelling, deformity, & sometimes instability
  – Anteromedial ecchymosis about distal brachium assoc. w/ brachial A laceration

• Standard images-
  – AP & lateral radiographs
  – CT scan esp. for intra-articular fxs
Nonsurgical Treatment

• Non-displaced, minimally-displaced, or comminuted fxs in low-demand elderly pts
• Splint for 1-2 wks before beginning ROM
• D/C immobilization at 6 wks if healing evident
• Up to 20% of condylar shaft angle may be acceptable
Surgical Treatment

• For most displaced fxs, open injuries, or vascular injury
• For 20 yrs, studies have demonstrated superior clinical outcomes for displaced intra-articular fxs
• ORIF
• Total Elbow Arthroplasty (TEA)
• Arthrodesis (salvage)
Goals

- Pain-free joint
- 100° flexion/extension (30°-130°)
- 100° arc of forearm rotation (50°-150°)
- Early ROM (immobilization >3 wks leads to less elbow motion)
Surgical Approaches

• Incisions
  – Posterior midline- provides good exposure to both columns
  – Medial or Lateral- for the rare single column injury
  – Some choose to transpose the ulnar N

• Approaches
  – Triceps-sparing- extra-articular or simple intra-articular fxs
  – Triceps-splitting
  – Bryan-Morrey- for TEA
  – Triceps reflecting
  – Olecranon osteotomy- for complex intra-articular fxs
Olecranon Osteotomy

• For complex intra-articular fxs
• According to studies, more of the articular surface can be visualized
• Apex distal chevron osteotomy exiting the non-articular “bare area”
• Repair w/ tension band, plate, or pre-drilled screw
• Complications- non-union (up to 30%), stiffness, prominent hardware (up to 27% req. removal)
ORIF

- 90-90 (medial & posterolateral)-good for coronal fxes involving capitellum
- Bicolumnar/Parallel- (medial & lateral)
- No clear biomechanical advantage between plate configurations; place the plates appropriately for the fx pattern
Total Elbow Arthroplasty (TEA)

- Elderly patient w/ severe comminution & osteoporotic bone
- Failed ORIF
- Good for pre-existing inflammatory degeneration
- Disadvantages- lifting restrictions, prosthetic loosening, PE wear, periprosthetic fx & infxn

JAAOS 2010
Key Surgical Concepts

• Anatomic & stable reconstruction of articular surface
• Stable reconstruction of both columns using 2 orthogonal plates
• Early post-op ROM to reduce elbow stiffness
• Can use lag screws, mini-frag screws, variable pitch countersunk screws, & bioabsorbable implants
Key Surgical Concepts

- Fixation usually occurs in a distal to proximal fashion
- Utilize K-wires for provisional fixation
- Attach articular fragment to a column
- Utilize fluoroscopy

Synthes
Technical Pearls for Surgical Fixation of Distal Humerus Fractures

Every screw in the distal fragments should pass through a plate
Engage a fragment on the opposite side that is also fixed to a plate
As many screws as possible should be placed in the distal fragments
Each screw should be as long as possible
Each screw should engage as many articular fragments as possible
The screws in the distal fragments should lock together by interdigitation, creating a fixed-angle structure
Plates should be applied such that compression is achieved at the supracondylar level for both columns
The plates must be strong enough and stiff enough to resist breaking or bending before union occurs at the supracondylar level

Complications

• Loss of terminal extension
• Elbow stiffness (articular incongruity, adhesions, capsular contractures, loose bodies, HO (3-30%), prominent hardware)
• Post-traumatic OA- long-term sequela of articular incongruity
• Fixation failure
• Nerve injury (Ulnar N 7-15%)
• Delayed or nonunion (2-10%)
• Infection
Outcomes

• Huang et al. (2005) reported the results of 19 elderly pts treated w/ plate osteosynthesis
• According to Mayo elbow performance score, 79% had excellent results & 21% hand good fxn
PEDIATRIC FRACTURES
Pediatric

- 6-8 yrs old
- Most occur on non-dominant side
- M=F
- Fall on outstretched hand w/ elbow in full extension
- Most common type of pediatric elbow fx
- 3% of all pediatric fxs
Relevant Anatomy

Anterior Humeral Line - line along anterior cortex of humerus that should bisect capitellum

Bauman Angle - line perpendicular to long axis of humerus & line along the lateral condyle physis

JAAOS 2012, AAOS COR 2009
Radiographic Evaluation

• AP & lateral radiographs centered at elbow
• Posterior fat pad- lucency along distal humerus & olecranon fossa suggestive of occult elbow fx
• Skaggs & Mirzayan JBJS 1999: 76% of children w/ neg. original XRs w/ posterior fat pad showed evidence of fx several wks later)
Gartland Classification

• Extension (98%)
  – I: non-displaced
  – II: displaced (posterior cortex intact)
    • IIA: no rotational abnormality; IIB: rotationally unstable
  – III: displaced (posterior periosteal hinge intact)
  – IV: displaced (posterior periosteal hinge disrupted)
    • Unstable to flexion & extension

• Flexion (distal fragment anterior)
Nonsurgical Treatment

- Non-displaced (Type I)- immobilize long-arm cast in 90° flexion in neutral rotation
- Closed tx for Type II if:
  - No significant swelling exists
  - Anterior humeral line intersects capitellum
  - No medial cortical impaction of distal humerus
- If tx’ed non-op monitor Type II fxs closely
- Cast removed after fx healing at 3 wks
Factors Determining Emergent Management

- Open fx
- Dysvascular limb
- Skin puckering
- Floating elbow
- Median N palsy
- Evolving compartment syndrome
- Young age
- Cognitive disability
Timing of Surgical Intervention

• Traditionally, Type III fxs tx’ed as an emergent procedure w/in several hrs of admission
• Concerns of increased swelling, development of compartment syndrome, increased difficulty achieving adequate closed reduction
• Several studies show no difference in regards to complication rate w/in 12 hrs
Surgical Treatment

• Displaced (most Type II, all Type III & IV)
  – reduce
  – CRPP (.062 K-wires); remove K-wires in 3-4 wks
  – ORIF (consider anterior approach to expose NV structures & soft-tissue obstacles)
Pin Configuration

• Crossed pins
  – More biomechanically stable
  – Medial pin results in 3-8% risk of iatrogenic ulnar N injury esp. when elbow hyperflexed

• Lateral entry
  – Should be separated sufficiently to engage both medial & lateral columns at level of fx
  – Have comparable success in maintaining reduction when inserted w/ appropriate technique
  – No iatrogenic ulnar N injury

AAOS COR 2009
Technical Errors

Illustrations demonstrating potential technical errors in closed reduction and percutaneous pinning of supracondylar humerus fractures in children. In each panel, the left image is an AP view and the right image is a lateral view.

Lateral-Only Pinning

Figure 3

Fluoroscopic images of a pediatric patient managed with lateral-only percutaneous pinning for a type III supracondylar humerus fracture. A, Preoperative lateral view demonstrating complete displacement. B, AP view following pin placement demonstrating the spread of the pins through the medial and lateral columns. C, Lateral view demonstrating the spread of the pins in the AP plane.
Complications

• Overall rate (4.2%)
• Nerve injuries (11.3%)
• Vascular injury (1%)
• Pin migration (1.8%)
• Infections (1%)
• Decreased ROM
• Heterotopic ossification
• Cubitus varus (5-10%)
• Ipsilateral fxs (distal radius)
• Malunion (decreased extension)
• Stiffness (rare w/ cast removal <3 wks)
## Treatment For Vascular Injuries

<table>
<thead>
<tr>
<th>Vascular Status</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>Pulse lost after reduction &amp; pinning</td>
<td>Explore brachial A &amp; tx</td>
</tr>
<tr>
<td>Pulseless, well-perfused hand</td>
<td>Observe for 24-72 hrs</td>
</tr>
<tr>
<td>Pulseless, cool hand</td>
<td>Explore brachial A &amp; tx</td>
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# Nerve Injuries

<table>
<thead>
<tr>
<th>Nerve Injury</th>
<th>Association</th>
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<tbody>
<tr>
<td>Anterior interosseous N</td>
<td>Most common N injury w/ SC humerus fxs</td>
</tr>
<tr>
<td>Median N</td>
<td>Associated w/ posterolateral fx displacement</td>
</tr>
<tr>
<td>Radial N</td>
<td>Seen w/ posteromedial fx displacement</td>
</tr>
<tr>
<td>Ulnar N</td>
<td>Rare traumatic injury; cause is almost always iatrogenic (due to medial pin) Most common in flexion-type</td>
</tr>
</tbody>
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Compartment Syndrome

- Increased need for narcotic medication to control pain is the best indicator
- Vascular injuries- even after repair have an increased incidence of compartment syndrome
- Measure compartment pressure if concerned
- Excellent results occur in 90% if decompression performed w/in a mean of 30.5 hrs s/p dx
Volkmann Ischemic Contracture

- The most disastrous result
- More commonly due to compression of brachial A w/ casting in >90° of flexion than due to arterial injury

Trialx.com
Cubitus Varus

- Gunstock deformity
- Cosmetic deformity w/ few functional sequelae
- Lower risk w/ reduction & pinning than closed reduction & casting
- O’Driscoll et al. identified “tardy posterolateral elbow instability” as a functional deficit of this deformity- consider correctional osteotomy