Humeral Shaft Fractures – Which Need ORIF?

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Overview:
Fractures of the Humeral Shaft

• Anatomy
• Fracture classification
• Nonoperative management
• Indications for Surgical Treatment
• Methods of Internal Fixation
  – plates
  – rods
• Special Circumstances

Fracture variables

Open injury
  • Gustillo I, II, III
Tscherne
  • soft tissue injury
Periarticular injury
  • glenohumeral
  • elbow

Nerve Injury
  • median, ulnar, radial

Vascular injury
  • artery, vein

Bone Condition
  • pathologic
  • metabolic
  • infectious
Humeral Fractures

- Incidence
  - 2% of all fractures
- Mechanism
  - Young pts: High energy, comminution, neurovascular injury
  - Older pts: Trivial trauma, simple fracture patterns

Mechanism

- Bending: transverse fx
- Torsion: spiral fracture
- Combination
  - oblique fx +/- butterfly fragment

Acceptable reduction criteria:

- 20° anterior angulation
- 30° varus
- 3 cm shortening
- Provides excellent function
- Cosmesis excellent

Klenerman JBJS-B 1966
Classification/Geometry

- Transverse
- Oblique
- Spiral
- Segmental
- Comminuted
- Location in shaft

Treatment Goals

- Maintain acceptable alignment of the fracture
- Provide enough stability to promote healing
- Preserve joint motion

Non-Surgical Treatment

- Generally successful
- Rigid immobilization is not necessary
- Perfect alignment not essential for good result
Acceptable Alignment

- 20° of anterior angulation
- 30° of varus angulation
- 3 cm of shortening

Non-Surgical Treatment

Requirements

- cooperative, upright patient
- absence of major soft tissue injury
- obtain and maintain an adequate reduction

Non-Surgical Treatment

Numerous reports of successful treatment with conservative measures

- Klenerman, JBJS 1966;48B:105
- Mast, CORR 1975;112:254
- Sarmiento, JBJS 1977;59A:596
- Stewart, JBJS 1955;37A:681
- Zagorski, JBJS 1988;70A:607
Non-Surgical Treatment

- Hanging casts
- Coaptation splints
- Functional Braces
  - Warning signs
    - fracture gap and interposition of muscle
    - gross instability
    - neurologic deficit
    - osteoporosis
    - Malposition - obesity

Non-Operative Rx Requirements

- Patient must be:
  - conscious
  - cooperative
  - able to be upright
  - ambulatory
- Allows for gravity to align humerus

Humeral Fractures

Non Operative Treatment of Humeral Shaft Fx:
- Long arm splint - cast bracing
  - 50/51 union (Sarmiento JBJS 1977)
- Hanging casts:
  - distraction increases risk of nonunion (Healy CORR 1987)
Indications for Surgical Treatment

- Articular fx extension
- Pathologic fractures
- Open Fractures
- Multiple Trauma
- Vascular Injury
- Neurologic deficit after penetrating injury
- Bilateral UE Fractures
- Floating Elbow
- Segmental Fractures

My Preference - Plating

<table>
<thead>
<tr>
<th></th>
<th>ORIF w/ Plates</th>
<th>Healed</th>
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<tr>
<td>Bell</td>
<td>34</td>
<td>33</td>
</tr>
<tr>
<td>Foster</td>
<td>45</td>
<td>43</td>
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<td>Vander Griend</td>
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<td>33</td>
</tr>
<tr>
<td>Dabezies</td>
<td>44</td>
<td>43</td>
</tr>
<tr>
<td>Heim</td>
<td>127</td>
<td>120</td>
</tr>
<tr>
<td>Total</td>
<td>284</td>
<td>272(96%)</td>
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Surgical Approaches

- Anterior
- Anterolateral
- Posterior
- Medial
Anterior Approach

• Internervous plane:
  – deltoïd (axillary n.) / pectoralis major (medial & lateral pectoral n.)
  – brachialis (musculocutaneus n.) / brachioradialis (radial n.)

• Dangers:
  – axillary n. / anterior circumflex vessels
  – radial n.
Brachialis-Brachioradialis Interval

Anterolateral Approach = Muscle split

- **No true internervous plane:**
  - lat. brachialis / brachioradialis (radial n.)

- **Dangers:**
  - radial n.
  - lat. antecubital cutaneous n.
Posterior Approach

- Distal 1/3 fx’s
- Intervals:
  - long head/lateral head triceps (rad. n.)
  - medial head split
- Dangers:
  - radial n./brachial a.
  - ulnar n.
When surgery is indicated, plating is preferred when:

- There is a small medullary canal.
- There is a need for nerve or vessel exploration.
- There is articular involvement.
- IM nailing for the rare segmental injury of entire shaft and the pathologic lesion of metastatic disease

Plates vs. Intramedullary Rods

**Plate advantages**
- anatomic reduction
- ability to explore radial nerve
- minimal morbidity to shoulder joint

**Rod theoretical advantages**
- limited exposure
- more reliable in weight bearing?
- Better in advanced osteopenia
Prospective Randomized Trial: IM Nails vs. Plates

- 89 patients prospectively randomized at Harborview:
  - IM nailing vs. compression plating

- Shoulder pain and decreased shoulder ROM associated in IM nailing

Comparison of locked nail and plate fixation

- 48 antegrade nails compared to a historic control of 25 plates
- Results (nail advantages)
  - Less OR time
  - Fewer transfusions
  - Fewer complications (infection, nonunion)
- Conclusion
  - Nails have more favorable tx results

Lin J Trauma-Infection & Critical Care 1998

Special Circumstances

- Vascular Injury
- Open fractures
- Fractures with Bone Loss
- Fractures with radial nerve injury
- Pathologic Fractures
- Nonunion
### Effect of Immediate Weightbearing

- 83 humerus fractures tx by ORIF (86-95)
- 94% union
- Weight-bearing activity
  - 52% full WB
  - 49% NWB
  - 8% transfer activity
- No difference in healing or increased complications despite immediate loading of construct

Wolinsky OTA

### Radial Nerve Palsy

- Spontaneous recovery in more than 90% of closed fractures
- Recovery time 3-5 months common
- Secondary palsies post manipulation or surgical retraction also usually recover

### Radial Nerve Palsy

- Exploration
  - Only for open injuries, vascular compromise
- Baseline EMG 4-6 weeks
- Follow-up at 3 months
- Consider exploration if no improvement at 5-6 months
Case: 21 y/o RHD F presented to ER, radial nerve out – unable to extend fingers

2 Weeks Later

2 Months
3 Months
- 3 months of functional bracing, radial nerve is still out
- Callus sparse
- Fx still mobile
- Indication for surgery nerve exploration and stabilization of fracture

Post-op: 12 hole 4.5 narrow plate

6 Months Post-Op: Union and full recovery of radial nerve
Case: 50 y/o M auto vs pedestrian sustaining very unstable midshaft humerus fx

Post-Op: Retrograde Humeral IM nail

1 month follow-up
3 month follow-up

6 month follow-up
- Despite prolonged immobilization and electrical bone stimulation, humerus nonunion persist

Revision Surgery
- Management:
  - Removal of IM nail and locking screws
  - Application of 4.5 BC plate and screws
  - Adjuvant cancellous bone cube allograft and hydroxyapatite gel
3 months post-revision

- Persistent nonunion with screw loosening and failure of fixation - Plate too short - inadequate fixation

Post-Op repeat revision surgery (10 months s/p index procedure)

- 10 hole plate with adjuvant cancellous bone allograft

11.5 year follow-up

- DASH = 0.8
- Constant Score = 96 (Excellent)
- ASES Score = 98.3
- Pain VAS = 0
Video

Thank You