Distal Humerus Fractures: How should they be fixed?

Dr. Emil Schemitsch, MD, FRCS(C)
Richard Ivey Professor and Chairman,
Department of Surgery, Western University
Chief of Surgery
London Health Sciences Centre and St. Joseph’s Health Care
London, Ontario
Questions

1. What is the optimal surgical approach for the fixation of distal humerus fractures?
2. What is the optimal fixation strategy for distal humerus fractures?
3. What is the role of locking plates in the fixation of distal humerus fractures?
4. What is the evidence for transposition of the ulnar nerve?
5. What is the role of acute Total Elbow Arthroplasty?
• Very Few Randomized Trials

• No or insufficient evidence from randomized or quasi-randomized controlled trials to determine whether surgery is appropriate for the management of different types of distal humerus fractures

OR

• which surgical interventions are the most appropriate for the management of different types of distal humerus fractures.

**Approach**

• Posterior approach

• Isolate and protect ulnar nerve

• Extensor mechanism
  – triceps split or peel
  – olecranon osteotomy
  – triceps preserving

**Osteotomy Advantage: Exposure**
Osteotomy - Disadvantages

- Delayed / nonunion
- Compromises TEA
- Painful hardware
- Time-consuming

Triceps Split
Triceps Split vs. Olecranon Osteotomy

Closed fractures
• Extension strength decreased 20-30% in both groups
• No difference b/w groups
• Re-operation higher in osteotomy group

Open fractures
• Better ROM / elbow scores and less pain with triceps split

McKee et al, JBJS(A) 2000
McKee et al, JBJS(B) 2000

Effects of surgical approach on functional outcomes of open reduction and internal fixation of intra-articular distal humeral fractures: a systematic review
Karin L. Ljungquist, MD, Matthew C. Beran, MD, Mitham Awan, MD
Oslo Orthop Trauma, Oslo, Norway

• Systematic review – Only four studies met inclusion criteria
  • Bryan-Morrey, Olecranon osteotomy, Triceps splitting, Paratricipital, Triceps-reflecting anconeus pedicle

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Level of evidence</th>
<th>N</th>
<th>Approaches compared</th>
<th>Study goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen et al</td>
<td>Retrospective, case series</td>
<td>Level 4</td>
<td>32</td>
<td>87</td>
<td>Bryan-Morrey, Olecranon osteotomy</td>
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<td>McKee et al</td>
<td>Retrospective, case series</td>
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<td>Sava et al</td>
<td>Retrospective, case series</td>
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<td>Aitken et al</td>
<td>Retrospective, case series</td>
<td>Level 3</td>
<td>29</td>
<td>29</td>
<td>TRAP, olecranon osteotomy</td>
</tr>
</tbody>
</table>

Ljungquist et al

• No significant difference in outcomes between groups was identified in any study
• Fractures approached by olecranon osteotomy had the highest overall number of complications, as well as the highest number of reoperations.

<table>
<thead>
<tr>
<th>Study</th>
<th>Method</th>
<th>N</th>
<th>Type</th>
<th>IMN</th>
<th>IMN (%)</th>
<th>Complications</th>
<th>Reoperations</th>
<th>Total complications</th>
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</thead>
<tbody>
<tr>
<td>Bryan-Morrey</td>
<td>Split</td>
<td>32</td>
<td>24/32</td>
<td>8.5</td>
<td>1.0</td>
<td>Intra-articular fracture</td>
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<td>0</td>
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<tr>
<td>Paratricipital</td>
<td>Split</td>
<td>32</td>
<td>22/32</td>
<td>8.7</td>
<td>1.0</td>
<td>Intra-articular fracture</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Triceps-reflecting anconeus pedicle</td>
<td>Split</td>
<td>30</td>
<td>23/30</td>
<td>8.3</td>
<td>1.0</td>
<td>Intra-articular fracture</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>
Comparison of outcomes after triceps split versus sparing surgery for extra-articular distal humerus fractures
Emmanuel M. Ikuzit, Dana J. Farrell, Peter A. Siska, Andrew R. Evans, Gary B. Green, Irina S. Tofail
J. Trauma 71 (Suppl 1) S14-3148

- Retrospective review of AO/OTA 13A2 and 13A3 distal humerus fractures
- Compared triceps split (16 patients) and triceps sparing (23 patients)
- Triceps-sparing cohort had greater elbow flexion compared to split (p = 0.03) and less extension contracture (p < 0.0001)
- Triceps strength compared to the uninjured arm also favoured the triceps-sparing cohort
- Both approaches, however, result in reliable union and similar functional outcome according to DASH

Why are there problems with fixation?
- Failure to use plates
- Failure to use a plate on both columns
- Failure to use plates of adequate size and strength
- Putting two weak plates directly posteriorly

Fixation problems occur when:
- Screws don’t pass through plates
- Few screws in distal fragment
- Shorter screws are used
- No fixation between columns
Fixation strategy is critical

- Plates are placed that allow long screws in the distal fragment and intercolumn fixation
- Increased plate options
- Screws interdigitate
- Plates are precontoured
- Intra-op contouring if necessary
- Locking if necessary
Biomechanical studies

Questions?

• Are two plates at 90˚ to each other (traditional method and thinking) superior to two plates placed directly on the columns medially and laterally directly facing each other (more recent implant design)?

Internal Fixation of the Distal Humerus: A Comprehensive Biomechanical Study Evaluating Current Fixation Techniques

Four Constructs
A. Synthes locking plates (IMP1) (medial and posterolateral with lateral flange)
B. Acumed parallel locking plates (IMP2),
C. Smith & Nephew orthogonal locking plates (IMP3)
D. Synthes orthogonal 3.5-reconstruction plating (IMP4) (1 posterolateral and 1 medial)
Caravaggi et al.

Parallel locking plates showed significantly higher stiffness and medial and posterolateral with lateral flange were significantly the least stiff construct.

Parallel locking plates was the strongest construct showing a mean ultimate strength of 781N ($P<0.001$), whereas Recon plating was significantly the weakest construct with 241N ($P<0.001$).

Lee et al.

Fracture pattern dependent:

- Orthogonal plating method may be preferred for coronal shear fractures
- Parallel plating method may be the preferred technique to maximize strength for fractures occurring at the most distal end of humerus

Lee et al.

A comparison between orthogonal and parallel plating methods for distal humerus fractures: a prospective randomized trial

Sixty-seven patients with a mean age of 55.4 years

Randomly assigned to receive 1 of 2 treatments:
- orthogonal locking compression distal humerus plate (LCDHP)
- parallel plating with pre-contoured anatomical plate

No significant differences were found between the orthogonal and parallel plating methods in terms of clinical outcomes or complication rates.
Evidence summary

Quality of the Evidence
- LEVEL I: No studies
- LEVEL II: 1 study
- LEVEL III: 2 studies
- LEVEL IV: 15 studies

Recommendations
- All both columns #s should be treated with dual plates (either perpendicular or parallel)
- In severely comminuted, very distal or osteoporotic #s, a parallel plate configuration should be considered

Locking and Non-locking Constructs Achieve Similar Radiographic and Clinical Outcomes for Internal Fixation of Intra-articular Distal Humerus Fractures

- 96 patients with surgically treated AO type 13C distal humerus fractures (65 locking, 31 non-locking)
- Three in 96 (3.1%) experienced loss of fixation
  - No difference between the two groups
- No difference between locking and non locking groups:
  - Rate of nonunion
  - Infection,
  - Reoperation at 6 weeks and 6 months
- Locking plate constructs were 348% more expensive

Simple Decompression vs Anterior Transposition of the Ulnar Nerve for Distal Humerus Fractures Treated with Plate Fixation: A Multi Centre Randomized Controlled Trial
Canadian Orthopaedic Trauma Society
OTA 2016
**Nerve Conduction Studies**

<table>
<thead>
<tr>
<th>Nerve conduction test results</th>
<th>All Patients</th>
<th>Decompression</th>
<th>Transposition</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>N %</td>
<td>N</td>
<td>N %</td>
<td>N</td>
</tr>
<tr>
<td>Abnormal results</td>
<td>28</td>
<td>62%</td>
<td>12</td>
<td>55%</td>
</tr>
<tr>
<td>Minor abnormality</td>
<td>15</td>
<td>33%</td>
<td>6</td>
<td>27%</td>
</tr>
<tr>
<td>Severe abnormality</td>
<td>12</td>
<td>27%</td>
<td>6</td>
<td>27%</td>
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<tr>
<td>Sensory only</td>
<td>10</td>
<td>22%</td>
<td>3</td>
<td>14%</td>
</tr>
<tr>
<td>Sensory + Motor</td>
<td>16</td>
<td>36%</td>
<td>8</td>
<td>36%</td>
</tr>
</tbody>
</table>

No difference

**Conclusions**

- Majority of patients have ulnar nerve symptoms post-surgery
- Significant improvement by 1-year post-injury in neurologic symptoms and functional outcomes
- No difference with regards to ulnar nerve symptoms, functional outcomes or complications for patients treated with either simple decompression or anterior transposition
- Either strategy for managing the ulnar nerve is acceptable, and can be used at the discretion of the treating surgeon
TEA versus Fixation?

- Elderly, low demand patients over 65 years of age with comminuted, intra-articular fractures of the distal humerus

Mayo Elbow Performance Score

- Restoration of anatomy with early motion results in best function
- Biomechanics depend on plate configuration
  - 2 column fixation with parallel plates may be best if maximal rigidity required
- No advantage to ulnar nerve transposition
- Consider TEA in the elderly high demand patient
- Consider conservative treatment in the elderly, low demand, medically unwell patient