Complex distal humerus trauma
Brouwer, K.M.

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CHAPTER 4
Low Extra-Articular (Transcondylar) Fractures of the Distal Humerus
Weening AA, Brouwer KM, Adams M, Ring D
In Review, J Shoulder Elbow Surg
Abstract

*Introduction:* We reviewed our experience with low transcondylar, extra-articular distal humerus fractures to determine the prevalence of extra-articular distal humerus fractures, the percentage that are low transcondylar fractures, and the results of treatment.

*Material and methods:* One hundred seventy-four fractures of the distal humerus in adult patients were identified. Patients with at least 1-year follow-up were evaluated based on the medical record according to the system described by Broberg and Morrey.

*Results:* Twenty-six fractures (15%) were extra-articular (AO Type A), 15 involved both the medial and lateral columns (8.6%), 9 of which were low transcondylar fractures representing 5% of all fractures and 60% of the extra-articular bicolumnar fractures. Among the 9 patients with low transcondylar fractures, 2 had nonunion and 3 died within 3 months of injury. Among the 8 patients with healed fractures after sufficient follow-up, patients with higher extra-articular distal humerus fractures had better motion and function than patients with low transcondylar fractures.

*Discussion and conclusions:* Transcondylar fractures are the most common type of extra-articular bicolumnar fracture and may be more common than previously recognized. Mortality within three months and nonunion seem common with this fracture type.

*Key words:* Distal humerus fracture; transcondylar; open reduction and internal fixation; nonunion

*Type of study/level of evidence:* Therapeutic level IV
Introduction
Most distal humerus fractures involve the articular surface\textsuperscript{1,2}. Extra-articular fractures are less common and are addressed specifically in only few studies\textsuperscript{3-5}. A subset of extra-articular bicolumnar fractures involving both the medial and lateral columns occur very low, at the base of the olecranon fossa, and are often referred to as transcondylar fractures\textsuperscript{3,6}.

Given that low transcondylar fractures of the distal humerus are relatively uncommon, it is remarkable that they seem over represented in many nonunion series\textsuperscript{7-9}. Considering the relative lack of published data available, and our impression that these fractures may be more common than previously recognized, we reviewed the experience of a level 1-trauma center treating extra-articular (AO Type A) fractures of the distal humerus over a period of 6 years\textsuperscript{10}.

The purpose of this investigation was to measure the prevalence of extra-articular distal humerus fractures, the percentage that comprises low transcondylar fractures, and to compare the results of treatment of the low transcondylar fractures with higher extra-articular bicolumnar distal humerus fractures.

FIGURE 1: Breakdown of adult patients with distal humerus fractures treated at our level 1 trauma center between 2002 and 2007

Materials and Methods
Using a trauma database and billing records we identified 174 consecutive acute distal humerus fractures in adult (age 18 or greater) patients treated at a level 1-trauma center between 2002 and 2007. Under a protocol approved by our Human Research Committee we reviewed the medical records and applied the following inclusion criteria: 1) extra-articular fracture; 2) very low fracture at the level of the base of the coronoid and the olecranon fossa (transcondylar fracture). Twenty-six of the 174 fractures (15\%) were extra-articular fractures, of which 11 were single extra-articular epicondyle fractures and 15 were bicolumnar metaphyseal...
fractures of which 9 were low fractures at the level of the base of the olecranon and coronoid fossae (transcondylar fracture) (Fig. 1). We compared the demographics, injury characteristics, and results of treatment for the 9 transcondylar fractures and the 6 higher bicolumnar fractures (Fig. 2).

Transcondylar Fractures
Among the patients with transcondylar fractures there were 5 women and 4 men with an average age of 67 years (range, 41 to 85 years). Two of the four patients under age 60 were very infirm and a third was diagnosed with breast cancer 3 years after fracture and died 8 years after fracture. The fourth patient under age 60 had 10 prior surgeries for lower limb problems. The right elbow was fractured in 5 patients, the left in 4. Limb dominance was not regularly available. At the time of injury, 5 patients defined their occupation as retired, 1 was unemployed, 1 was disabled, 1 was employed at desk-based work, and the occupation was unknown in one patient. The mechanism of injury was a fall from a standing height in all 9 patients. One patient had an ipsilateral distal radius fracture. Two patients had grade 1 open fractures.

Three non- or minimally displaced transcondylar fractures were treated with cast immobilization. Six patients with displaced fractures were treated with open reduction and fixation, 5 using parallel plates and 1 using a single lateral plate. The ulnar nerve was identified and transposed in 3 patients; released and relocated back in its original position in 1 patient and identified and protected in 2 patients. An olecranon osteotomy was used for exposure in 2 patients and the remainder were treated using a paratricipital approach. The average duration between date of injury and surgery was 3.6 days (range, 1 – 15 days; median, 1.5 days).

Higher Bicolumnar Fractures
The higher bicolumnar fractures occurred in 4 women and 2 men with an average age of 68 years (range, 26 – 85 years). The right elbow was fractured in 3 patients and the left in 3 patients. Five patients were retired and 1 was unemployed. All fractures resulted from a fall from a standing height. One patient had an ipsilateral proximal humerus fracture. No open fractures were seen. All 6 patients had displaced fractures treated with open reduction and fixation, 4 using parallel plates, 1 using a single lateral plate, and 1 using 3 plates. The ulnar nerve was transposed in 5 patients and released and relocated back in its original position in 1 patient. Olecranon osteotomy was used in 1 patient and a paratricipital approach in 5 patients. The average duration between date of injury and surgery was 1.5 days (range, 0 – 3 days; median, 1.5 days).

Evaluation
Three patients with transcondylar fractures died within 3 months of injury, one of whom died in the hospital. Three patients were followed less than one year and either could not be contacted or declined to return for a research specific visit (one transcondylar fracture and 2 higher fractures). The nine patients (5 transcondylar fractures and 4 higher fractures) with at least 1-year follow-up (average 3.0 years, range 1.0 – 6.0 years) were evaluated based on the medical
record according to the system described by Broberg and Morrey\textsuperscript{13}. Nonunion was defined as a persistent fracture line with either instability of the arm in patients treated nonoperatively or loose or broken implants after surgery.

Figure 2A (left): A 79-year-old male sustained a left transcondylar fracture. The anteroposterior radiograph shows the extra-articular fracture line at the level of the base of the olecranon and coronoid fossa.

Figure 2B (right): An 80-year-old male fractured his left distal humerus. The anteroposterior radiograph shows a high extra-articular metaphyseal fracture.
Results

Transcondylar Fractures
Among the 6 operatively treated patients, one died and 4 had a minimal follow-up of 1 year (average 3.8 years, range 2.4 – 6.0 years). The average arc of ulnohumeral motion was 108° (range, 90° - 125°) with an average flexion of 125° (range, 110° - 135°) and an average flexion contracture of 18° (range, 10° - 20°). All patients retained full forearm rotation. According to the Broberg and Morrey system\textsuperscript{13}, the result was rated excellent in 1 patient, good in 2 patients, and fair in 1 patient, with an average score of 89.5 (range, 76 - 98 points) which represents an good score.

One patient developed a postoperative wound infection, nonunion and osteomyelitis. He was treated with multiple debridements and hardware removal to eradicate the infection and gain healing.

Among the 3 patients who were treated nonoperatively, two died and one developed a nonunion, which was treated with open reduction and internal plate and screw fixation without bone grafting. However, the patient did not return for scheduled visits thereafter. When admitted for an ununited left proximal femur, his distal humerus nonunion was unstable with broken hardware. Additional elbow surgery was deemed to risky because of multiple medical co-morbidities. His elbow was rated poor (30 points), according to the Broberg and Morrey System (Table 1).

Higher Bicolumnar Fractures
Four patients were followed for at least one year (average 2.7 years; range, 1.0 – 3.9 years). The average arc of ulnohumeral motion was 128° (range, 105° - 135°) with an average flexion contracture of 8° (range, 0° - 30°). All patients maintained full flexion and forearm rotation. According to the system of Broberg and Morrey 13, the result was rated as excellent in 2 patients and as good in 2 patients, with an average of 95.0 (range, 87 – 100), which represents an average excellent score.

One patient developed a postoperative infection and underwent irrigation, debridement and implant removal, after which fracture healing was obtained. Another patient had a postoperative ulnar neuropathy (Table 2).
<table>
<thead>
<tr>
<th>Case</th>
<th>Sex, Age</th>
<th>Fracture</th>
<th>Mechanism</th>
<th>Treatment</th>
<th>Complications</th>
<th>Additional surgery</th>
<th>Follow-up (days)</th>
<th>Flexion/Extension</th>
<th>Broberg and Morrey score, rating</th>
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</thead>
<tbody>
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<td>fall</td>
<td>ORIF</td>
<td></td>
<td></td>
<td>867</td>
<td>110/-20</td>
<td>91, Good</td>
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<td>fall</td>
<td>ORIF</td>
<td></td>
<td></td>
<td>908</td>
<td>135/-20</td>
<td>76, Fair</td>
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<tr>
<td>3</td>
<td>M, 49</td>
<td>Transcondylar</td>
<td>fall</td>
<td>ORIF</td>
<td>Infection, nonunion, osteomyelitis</td>
<td>Multiple</td>
<td>1576</td>
<td>120/-20</td>
<td>93, Good</td>
</tr>
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<td>fall</td>
<td>ORIF</td>
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<td></td>
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<td>135/-10</td>
<td>98, Excellent</td>
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<tr>
<td>5</td>
<td>M, 55</td>
<td>Transcondylar</td>
<td>fall</td>
<td>Cast</td>
<td>Nonunion</td>
<td>ORIF</td>
<td>421</td>
<td>110/-30</td>
<td>30, Poor</td>
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<td>6</td>
<td>F, 76</td>
<td>Transcondylar</td>
<td>fall</td>
<td>ORIF</td>
<td></td>
<td></td>
<td>153</td>
<td>135/-10</td>
<td>na *</td>
</tr>
<tr>
<td>7</td>
<td>F, 85</td>
<td>Transcondylar</td>
<td>fall</td>
<td>ORIF</td>
<td></td>
<td></td>
<td>49</td>
<td>120/-20</td>
<td>na †</td>
</tr>
<tr>
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<td>F, 84</td>
<td>Transcondylar</td>
<td>fall</td>
<td>Cast</td>
<td></td>
<td></td>
<td>59</td>
<td>80/-50</td>
<td>na †</td>
</tr>
<tr>
<td>9</td>
<td>M, 78</td>
<td>Transcondylar</td>
<td>fall</td>
<td>Cast</td>
<td></td>
<td></td>
<td>71</td>
<td>110/-40</td>
<td>na †</td>
</tr>
</tbody>
</table>

† Died within 3 months after injury  
* Untraceable / Opt Out  
ORIF = open reduction and internal fixation  
na = not available
### TABLE II. High Bi-Columnar Extra-Articular Fractures

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex, Age</th>
<th>Fracture Mechanism</th>
<th>Treatment</th>
<th>Complications</th>
<th>Additional surgery</th>
<th>Follow-up (days)</th>
<th>Flexion/Extension</th>
<th>Broberg and Morrey score, rating</th>
</tr>
</thead>
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<td>1</td>
<td>F, 68</td>
<td>High metaphyseal into lateral epicondyle</td>
<td>fall</td>
<td>ORIF</td>
<td>Ulnar neuropathy</td>
<td>367</td>
<td>135/0</td>
<td>93, Good</td>
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<td>High metaphyseal</td>
<td>fall</td>
<td>ORIF</td>
<td></td>
<td>943</td>
<td>135/0</td>
<td>100, Excellent</td>
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<td>F, 71</td>
<td>High metaphyseal</td>
<td>fall</td>
<td>ORIF</td>
<td>Infection</td>
<td>1162</td>
<td>135/-30</td>
<td>87, Good</td>
</tr>
<tr>
<td>4</td>
<td>F, 85</td>
<td>High metaphyseal</td>
<td>fall</td>
<td>ORIF</td>
<td></td>
<td>1398</td>
<td>135/0</td>
<td>100, Excellent</td>
</tr>
<tr>
<td>5</td>
<td>F, 77</td>
<td>High metaphyseal</td>
<td>fall</td>
<td>ORIF</td>
<td></td>
<td>166</td>
<td>120/-20</td>
<td>na *</td>
</tr>
<tr>
<td>6</td>
<td>M, 26</td>
<td>High metaphyseal</td>
<td>fall</td>
<td>ORIF</td>
<td></td>
<td>11</td>
<td>85/-30</td>
<td>na *</td>
</tr>
</tbody>
</table>

* Untraceable / Opt Out

ORIF = open reduction and internal fixation

na = not available
Discussion

AO Type A, extra-articular fractures comprised 15 percent of the distal humerus fractures seen at our institution. Fifteen of 174 (8.6%) were bicolumnar extra-articular fractures and 9 of 174 fractures (5%) were low transcondylar fractures. Low transcondylar fractures were the predominant type of bicolumnar extra-articular fractures (60% of the total compared to 39% reported by Robinson et al\textsuperscript{14}).

Consistent with Robinson et al, low transcondylar fractures comprised 5% of all distal humerus fractures and resulted largely from falls from a standing height in older patients. The average age in their series was 59.6, but they included children (range, 12 – 99 years). Our average age of 67 years may be more representative of transcondylar fractures in adults.

Three of nine (33%) patients with transcondylar fractures in our series died within 3 months of injury. These patients had an average age of 82 years old and all had medical co-morbidities. Four patients with transcondylar fractures were younger than 65 years; 2 of which had substantial co-morbidity and 1 was physically impaired by chronic knee pain after multiple knee surgeries. The low transcondylar fracture may be similar to a femoral neck fracture in being associated with infirmity and a high risk of mortality\textsuperscript{15, 16}. At our institution, we now mention both total elbow and “bag of bones” nonoperative treatment as options for infirm older patients with this fracture.

We had adequate follow-up in only 9 of 15 (60%) patients and cannot judge statistical significance in terms of functional outcome, but the finding that patients with higher extra-articular fractures gained more motion than patients with transcondylar fractures merits additional study.

Many authors describe transcondylar fractures as problematic. Bryan reported on 2 transcondylar fractures. Both were initially treated with closed reduction and cast immobilization. One patient lost fracture alignment and underwent a secondary closed reduction and percutaneous pinning\textsuperscript{6}. Robinson et al reported a greater risk of delayed or nonunion for ‘low’ extra-articular fractures compared to ‘high’ extra-articular fractures although no specific numbers are provided. Considered together 8 of 54 (15%) bicolumnar extra-articular fractures in their study went on to delayed or nonunion\textsuperscript{14}. Indeed, among 3 large series of patients treated for nonunion of the distal humerus\textsuperscript{7-9}, 63% of the nonunions followed initially extra-articular fractures, which is far greater than the prevalence of extra-articular fractures among all distal humerus fractures. Two of the nine patients (22%) with at least 1 year of evaluation in our series developed nonunions, one in conjunction with post-operative infection, and one following open reduction and internal fixation.

On the other hand, some authors describe good results. Imatami et al treated 12 AO type A2 fractures with a custom AO small T plate and described excellent results with a union rate of 100%\textsuperscript{4}. Likewise, Perry et al described good results for operative treatment of 2 displaced fractures and for nonoperative treatment of 3 non-displaced transcondylar fractures\textsuperscript{3}.
Conclusions
In summary, we believe that transcondylar fractures are more common than previously assumed and are the predominant bicolumnar distal humerus fracture pattern; however, a larger study population is needed to confirm this. Transcondylar fractures seem to have a relatively high risk of nonunion and are also associated with a substantial rate of co-morbidity and post-injury mortality. Operative treatment of a displaced fracture is challenging because of the small, largely articular distal fragment, complex elbow anatomy, and osteoporosis. Unfortunately, the results of nonoperative treatment, even for non- or minimally displaced fractures seem unpredictable.
References