Low transcondylar fractures of the distal humerus: results of open reduction and internal fixation

Juan P. Simone, MD, Philipp N. Streubel, MD, Joaquin Sanchez-Sotelo, MD, PhD, Bernard F. Morrey, MD*

Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN, USA

**Background:** This study presents the outcomes of low transcondylar fractures of the distal humerus treated by open reduction and internal fixation.

**Methods:** Between 1996 and 2010, 263 distal humeral fractures were managed at our institution. Patients with a true low transcondylar fracture treated by open reduction and internal fixation were included. Fourteen patients form the basis of this study. Fracture fixation was achieved through a triceps-sparing approach, a triceps tongue, or an olecranon osteotomy. Internal fixation was performed with parallel plates, orthogonal plates, a single lateral plate, or a single medial plate. The clinical outcome was measured with pain levels, range of motion, and the Mayo Elbow Performance Score. Radiographs at latest follow-up were assessed for union, delayed union, nonunion, and hardware failure.

**Results:** At most recent follow-up, 11 patients had no pain, 2 had mild pain, and 1 had moderate pain. The mean Mayo Elbow Performance Score was 85. The mean arch of motion was 95°. Complications included nonunion, delayed union, wound complications, deep infection, and heterotopic ossification.

**Discussion:** Stable internal fixation of low transcondylar fractures is perceived as difficult to achieve because of the very small size of the distal fragment. However, the results of our study indicate that internal fixation of low transcondylar fractures of the distal humerus is associated with a high union rate and satisfactory clinical results. Elbow arthroplasty does not need to be considered for most patients with a low transcondylar distal humeral fracture.

**Level of evidence:** Level IV, Case Series, Treatment Study.

Distal humeral fractures have an incidence of 5.7 per 100,000 persons in the population per year. So-called low transcondylar fractures represent about 9% of these and are considered a distinct pattern among the classical fractures of the distal humerus. These injuries are characterized by a very consistent transverse extra-articular fracture line through or below the lateral epicondyle and at the level of or just above the medial epicondyle. Stable internal fixation may be extremely difficult to achieve because of the very small size of the distal fragment, especially in the presence of poor bone quality and comminution. For these reasons, total elbow arthroplasty may be considered for selected low transcondylar fractures. However, the outcome of internal fixation for this specific type of injury is difficult to understand because most reports on internal fixation of distal humeral fractures group together multiple subtypes.
The purpose of this study is to report on the outcome of a series of patients with a low transcondylar fracture of the distal humerus treated by open reduction and internal fixation.

Materials and methods

This is a retrospective case study of the outcome of a series of patients with low transcondylar fractures of the distal humerus treated by open reduction and internal fixation. Our trauma registry was queried for adult distal humeral fractures that were treated surgically between 1996 and 2010.

To be included in this study, the fracture had to be considered a true low transcondylar fracture. We defined this fracture type as (1) an extra-articular fracture and (2) a fracture with a single transverse fracture line that always exited at the level of or below the lateral epicondyle laterally and at the level of or just above the medial epicondyle. None of the fractures included in the study extended proximal to the roof of the olecranon fossa affecting the columns. There were various amounts of comminution. We excluded patients with less than 6 months of follow-up.

We identified 263 consecutive distal humeral fractures through our registry. Two individuals reviewed all radiographs to determine how many fractures fulfilled the previously mentioned criteria. A low transcondylar fracture treated with internal fixation was found in 20 patients (7.6%). Of the 20 patients identified, 1 patient died within a few days after surgery of causes unrelated to the fracture. Five additional patients were lost to follow-up. The remaining 14 patients form the basis of this study.

The mean age at the time of surgery was 71 years (range, 40-97 years). Three patients were aged between 40 and 60 years, 3 patients were aged between 61 and 70 years, and 8 patients were aged 71 years or older. Of the patients, 9 were women and 5 were men. The left elbow was involved in 6 cases and the right elbow in 8. The mechanism of injury involved a fall from a standing height (9 cases), a fall down the stairs (3 cases), a fall off a ladder (1 case), and a fall off of a stool (1 case). There were no open fractures.

Fracture fixation was achieved through a triceps-sparing approach (8 elbows), a triceps tongue (4 elbows), or an olecranon osteotomy (2 elbows). The ulnar nerve was transposed in 10 elbows. Internal fixation was performed with parallel plates (11 elbows), orthogonal plates (1 elbow), a single lateral plate (1 elbow), or a single medial plate (1 elbow). After closure, the elbow was placed in a bulky non-compressive dressing with an anterior plaster slab to maintain the elbow in extension, and the upper extremity was elevated. Active-assisted and passive motion was encouraged 2 weeks after the surgical procedure. All patients were permitted gentle daily activities and were instructed not to lift anything heavier than a glass of water for the first 6 weeks.

Clinical outcome was assessed based on pain level, range of motion, and the Mayo Elbow Performance Score (MEPS). Pain was described as none, mild, moderate, or severe. Range of motion was measured in degrees for flexion, extension, pronation, and supination. Radiographs obtained at latest follow-up visit were assessed for union, delayed union, nonunion, and hardware failure.

Results

Mean follow-up time was 11 months (range, 6-16 months). Mean time between the injury and surgery was 6 days.
At most recent follow-up, 11 patients had pain, 2 had mild pain, and 1 had moderate pain. Mean arch of motion was 95° (range, 45°-140°). Mean flexion was 117° (range, 85°-140°); extension, 22° (range, 0°-50°); pronation, 81° (range, 60°-81°); and supination, 76° (range, 50°-85°). Mean MEPS was 85 points (range, 35-100 points). On the basis of the MEPS, 9 patients had an excellent score; 3, good; 1, fair; and 1, poor. The 2 patients with a fair or poor result underwent revision to a total elbow arthroplasty because of nonunion and severe heterotopic ossification with post-traumatic arthritis.

When assessed per age group, that is, 40 to 60 years, 61 to 70 years, and 71 years or older, the mean range of motion was 78°, 98°, and 101°, respectively, and the mean MEPS was 70 points, 80 points, and 95 points, respectively.

Of the 14 fractures included in the study, 2 (14%) evolved into a nonunion. One of the patients with a nonunion underwent revision to a total elbow arthroplasty because of nonunion and severe heterotopic ossification with post-traumatic arthritis. The remaining 12 fractures healed. In 2 instances, screw migration was appreciated during the early months after fixation, but the fractures eventually healed without additional surgery. These 2 elbows were considered to have a delayed union.

There were a total of 7 complications (50%): nonunion (2 elbows), delayed union (2 elbows), wound complications (1 elbow), deep infection (1 elbow), and heterotopic ossification limiting motion (1 elbow). In 4 elbows (29%), additional surgery was required: 1 nonunion was converted to a total elbow arthroplasty (case 3); 1 deep infection underwent irrigation, debridement, and a 6-week period of intravenous antibiotic administration (case 12); 1 case of wound dehiscence required a flexor carpi ulnaris muscle flap (case 11); and 1 case underwent removal of heterotopic ossification (case 14) (Table I).

Discussion

The results of our study show a rate of delayed union and nonunion of 29% for this fracture pattern. Stable internal fixation of low transcondylar fractures is perceived as difficult to achieve because of the very small size and fragility of the distal fragment. Some fixation methods allow the placement of more distal screws than other fixation methods. Imatani et al developed a custom AO small T plate for transcondylar fractures. They reported 17 cases (12 of which were AO/ASIF class A2) with complete union and no perioperative complications. Range of motion averaged 20° to 126° at a mean follow-up of 20 months. The same study group later compared 4 fixation techniques in cadavers and tested them for fixation rigidity after creating and fixing low transcondylar fractures. The comparison groups were as follows: (1) a custom plate in the lateral column and a medial 4.5-mm cancellous cannulated screw, (2) 2 conventional low contour plate (LCP) reconstruction 3.5-mm plates, (3) 1 lateral LCP plate combined with a cancellous cannulated 4.5-mm screw, and (4) 2 cancellous 4.5-mm screws placed in a crisscross orientation. Groups 3 and 4 failed at a statistically significantly lower axial load than groups 1 and 2. Group 4 also failed at a statistically significantly lower extension load than
groups 1, 2, and 3. To our knowledge, our study is the only biomechanical study analyzing this specific injury pattern.

Most of the surgical approaches were performed through a triceps-sparing approach because the fracture is an extra-articular fracture. Whether to use a transolecranon osteotomy or inverted V tenotomy depended on the surgeon’s choice to achieve a better view and fixation. Ljungquist et al. in a systematic review, found insufficient data to conclude that one approach is superior to another for fixation of distal humeral fractures. Function will most likely depend on fracture complexity, quality of reduction, implant choice, and early motion.

The first 2 cases in our study group underwent surgery before 2003. The first case was fixed with a lateral 7-hole Dupont J plate (Stryker, Kalamazoo, MI) and a medial 7-hole 3.5-mm pelvic reconstruction plate. The second case was fixed with a medial Zimmer precontoured supracondylar humerus plate system (Zimmer, Warsaw, ID) and 2 lateral 3.5-mm partially threaded cancellous screws. A delayed union and screw migration developed in both cases. From 2003 onward, new plate designs including locking anatomic plates were available. Over the past decade, we have preferred to stabilize distal humeral fractures on the basis of 2 parallel plates fixed to the shaft proximally and locked together distally with as many interdigitingating screws as necessary to stabilize the fracture. The rigidity of this construct seems to allow an early rehabilitation program immediately after surgery.

It has become our preference for distal fractures in which bone quality and quantity are scarce. One of the nonunions in our series was the case of a 59-year-old woman with a comminuted lateral epicondyle. After reduction and plate fixation, a large metaphyseal defect was noted. Demineralized bone was used to graft this defect. Ten months after surgery, with persistent pain and lack of motion, the patient underwent revision to a total elbow arthroplasty (Fig. 1).

Still, healing rates may not only be affected by the instability of the fracture pattern but also by biological factors in an elderly patient population. Our second nonunion case had a stable fixation construct. The construct might have failed to heal because of either lack of bone quality or a biological response to healing (Fig. 2). A vascular watershed area has been described for the distal segment of the humerus involving the olecranon, coronoid, and radial head fossa during investigations of the intrasosseous blood supply to the distal humerus.

Robinson et al. reported a greater risk of union complications in low configurations of distal humeral fractures (odds ratio, 7.5; 95% confidence interval, 2.3-24.7) as compared with higher fractures. In their series, 37.5% of fractures with a “low” configuration subsequently had a delayed union or nonunion.

Distal humeral fractures have a bimodal distribution in terms of age and gender, affecting more male patients in a younger population and more female patients in an elderly population. Our study group was inclined more toward the latter, as was the case in the 2 previously published articles on this fracture pattern. As life expectancy and surgical outcome expectations increase, different treatment modalities are expanding. Fifty-seven percent of the patients in our series were aged older than 70 years. Despite this fact, they had overall better range of motion and a higher MEPS than patients aged 70 years or younger. This finding may be biased because in the group aged 70 years or younger, 1 patient had a symptomatic nonunion and another case had a fair MEPS with symptomatic heterotopic ossification. With a
larger series of cases, stronger conclusions may be drawn as to whether age influences outcomes for this specific fracture pattern. Recent publications report good to excellent results in elderly patients with fractures treated with elbow arthroplasty. In 2009, McKee et al reported better outcomes after total elbow arthroplasty compared with internal fixation in elderly patients with class 13C (OTA/AO) fractures in a randomized prospective trial. Although the results seem to be promising, total elbow arthroplasty yields a fair amount of complications. A recent systematic review has shown that primary total elbow arthroplasty for acute trauma has an associated complication rate of 21.5% ± 9.2%. This includes loosening, instability, deep infection, and ulnar nerve complications among others. Although our series of patients showed a complication rate of 50% (reoperation rate of 29%), these included 4 excellent results, 1 good result, 1 fair result, and 1 poor result. Prasad and Dent compared primary total elbow replacement for distal humeral fractures in the elderly with delayed total elbow replacement and found no statistically significant difference in the functional outcome or complication rates. If primary fixation fails, an elbow replacement is a good option.

Patient selection is crucial to predict better outcomes with a primary elbow arthroplasty rather than open reduction and internal fixation for distal humeral fractures. An elbow arthroplasty should be considered in a physiologically elderly patient with low demands, severe osteopenia or a comminuted fracture that will provide unreliable fixation, and previously symptomatic or end-stage arthritis.

An infection occurred in 2 patients in our series (14%). One was a deep infection, and the other was a skin infection involving a wound complication. Our infection rate is markedly higher than the infection rates reported for open reduction and internal fixation of the distal humerus in several other series with different fracture patterns (0%-6.7%). This may be because of under-reported superficial skin infections because deep infections are substantially more serious. The likely causes of increased infection rates are an older population, soft tissue damage with the original injury, and a superficial joint prone to this complication.

In 1 patient (7%), an additional surgery was performed for heterotopic ossification and loss of motion (Fig. 3). This is not uncommon after elbow injuries, and our result is within the range of incidences reported for distal humeral fractures treated with internal fixation (0%-16%). How to predict the likelihood of heterotopic bone formation is still undetermined, but there has been a reported association with delayed treatment and a prolonged immobilization period.

Our results showed a mean range of motion of 22° of extension to 117° of flexion. Despite the extra-articular fracture pattern of these fractures, they are low enough to break through the capsule and act as intra-articular lesions in nature. That is probably why range of motion is not any better than that reported for complex intra-articular fractures. When one is analyzing extra-articular fractures of the distal humerus, it is important to distinguish whether they are high (extracapsular) or low (intracapsular) because the results will vary.

The weaknesses of our study are the low number of cases and our retrospective analysis of the data. The overall follow-up time may be considered short-term, but 6 months is a clear cutoff point at which to determine whether a fracture has healed. For the specific treatment and fracture pattern studied, it is rather unlikely that a surgical complication would arise or outcomes would significantly change after a 6-month period. It seems that parallel plate fixation with locking distal screws and a stable construct with early motion yields better outcomes. However, because this specific fracture pattern is uncommon, the low number of cases in our study does not allow us to prove statistically that the patient’s age, dominant arm, gender, surgical exposures, and type of internal fixation will guarantee better results because we had mixed results.

Our main strength was the ability to exclude any other fracture pattern and include only a true low transcondylar fracture pattern as previously defined.

**Conclusion**

Low transcondylar fractures of the distal humerus are distinct lesions that involve an older population with rather low-energy trauma. Several important observations may be made: (1) Although open reduction–internal fixation is challenging, our results show that 86% of fractures heal with good to excellent outcome.
scores and no pain. (2) Despite the good overall outcome, the complication rate is surprisingly high, with 29% of patients requiring additional surgery. (3) A stable rigid fixation construct should be achieved to improve healing expectations, although biological factors might play a significant role as well. (4) The alternative treatment of elbow arthroplasty should be considered in a primary setting for cases of marked osteopenia or a severely comminuted fracture in which stable fixation would not seem able to be achieved in a low-demand elderly patient or in a patient with previous elbow arthritis.

Disclaimer

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References