



# Management of distal humeral fractures in the elderly

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Distal humeral fracture, treatment, elderly.

**Summary**<sup>1</sup> Although relatively uncommon, fractures of the distal humerus in the elderly patient population are significant injuries of which optimal management is a subject of debate in orthopaedic literature. The combination of complex anatomy, poor bone quality and extensive comminution often seen with these fractures makes successful treatment difficult. Currently, most surgeons support surgical fixation of distal humeral fractures with the belief that restoration of the patient's native elbow joint provides the best opportunity for a good functional outcome. Others have proposed the use of total elbow arthroplasty as a primary treatment method for geriatric distal humeral fractures based on the difficulties associated with ORIF and the relatively low demands of this patient population. To date, there have been no prospective randomised trials comparing these two treatment alternatives, and a comparison of available outcome data shows good functional outcome for both forms of fracture management. With the aging of the population and an associated increase in the incidence of distal humeral fractures, the debate over the optimal treatment regime will undoubtedly continue.

## Introduction

Fractures of the distal humerus are often comminuted and intra-articular, which in combination with the complex anatomy of the elbow and limited amount of available subchondral bone, adds a level of difficulty to their management by the orthopaedic surgeon [9, 11]. In the elderly patient population, these injuries become even more complicated, with the addition of poor bone quality and an intolerance of joint immobilisation to the treatment picture [17, 36]. Although overall, fractures of the distal humerus are relatively uncommon, accounting for approximately 2–6% of all fractures in adults, appropriate methods of management remain a source of debate in the orthopaedic literature [16, 29].

Recent epidemiological studies have indicated that the incidence of distal humeral fractures in the

geriatric patient population is steadily rising [26, 33, 36]. Palvanen et al demonstrated an increase in the number of distal humeral fractures occurring among Finnish women over 60-years-old from 12 per 100,000 women in 1970 to 28 per 100,000 women in 1995 [26]. The authors concluded that if this trend continues, the number of distal humeral fractures occurring among elderly women will increase 3-fold by 2030.

To date, the traditional principles of open reduction and internal fixation of distal humerus fractures continue to have the most support within the orthopaedic literature. However, in the elderly, osteopenic patient population, surgical fixation is difficult and prone to failure, with complication rates reaching 30% in some series [9, 12, 13, 17, 19, 25]. In response to these poor outcomes, some authors have advocated total elbow arthroplasty as a primary treatment method [5, 14, 15, 22, 23, 29]. This paper reviews the complex issues associated with distal humeral fractures in the elderly and their management.

<sup>1</sup> Abstracts in German, French, Italian, Spanish, Japanese, and Russian are printed at the end of this supplement.

## Nonoperative management

Currently, nonoperative treatment of distal humeral fractures is reserved for stable, non-displaced fractures, patients with previous neurological injury or impairment leading to a non-functional upper extremity and those who are unable to tolerate surgical fixation secondary to medical comorbidities [1]. For a period of time in the middle of the twentieth century, nonoperative treatment in the form of the “bag-of-bones” technique, gained support among orthopaedic surgeons secondary to poor outcomes related to open reduction and internal fixation [2, 32]. This technique entailed treating patients with a short period of immobilisation (cast, or cuff and collar) until the level of pain declined, followed by a period of active mobilisation as tolerated [31, 32]. The results of this conservative management were less than ideal, with patients experiencing either considerable joint stiffness and poor function or significant pain secondary to the development of a pseudarthrosis [2, 8] (Figure 1).



Figure 1: Distal humerus fracture in a 69-year-old male managed with the conservative “bag of bones” technique. The clinical photos demonstrate significant loss of elbow extension. (Case courtesy of Kenneth Faber MD, FRCS)

## Open reduction and internal fixation

A number of constructs have been recommended for fixation for distal humeral fractures, including the use of two plates oriented at  $90^\circ$  to each other (Figure 2) or two plates oriented  $180^\circ$  to one another [10, 34, 35]. What is clear is that at least one plate in the fixation construct should be placed at  $90^\circ$  to the flexion-extension plane. Access to the fracture site is often attained through a posterior surgical exposure utilising an olecranon osteotomy, a triceps-reflecting approach, or a triceps-preserving approach in which the distal humerus is exposed from both the medial and lateral sides of an intact triceps [3, 28, 30, 32]. Typically, once the fracture site has been adequately exposed and debrided, and each of the fracture fragments has been identified, the articular fragments are reduced and fixed first, often using a lag screw technique to provide inter-fragmentary compression. In the presence of poor bone quality or extensive comminution, care must be taken to prevent narrowing of the trochlear notch with over-compression. Next, the reduced articular fragments are secured to the medial and lateral columns using the two perpendicularly oriented, contoured reconstruction plates [1, 32]. However, in the elderly patient population, where poor bone



Figure 2: 83-year-old female with an OTA 13-B fracture of her right distal humerus managed surgically with two reconstruction plates oriented  $90^\circ$  to each other. Fixation was chosen secondary to the nature of the fracture type (simple fracture type with minimal comminution) and the quality of the bone stock.

quality and extensive fracture site comminution are often present, this traditional treatment method may require modification for improved outcomes.

Recent clinical evaluations have assessed outcomes following open reduction and internal fixation of geriatric distal humerus fractures (Table 1). In a retrospective review of twelve patients aged 63 to 85 years with surgically managed displaced distal humerus fractures, Pereles et al demonstrated good to excellent results in 100% of cases [27]. The authors reported two cases of hardware failure (one of which required revision), no infections and no cases with postoperative ulnar nerve symptoms; all patients achieved bony union at a mean of 16 weeks. At a mean follow up of 1 year, patients in this series had a mean elbow flexion of 130° (range 105–145°) and a mean elbow extension of -18° (range 0 to -37°). Similar successful outcomes after surgical fixation of geriatric distal humerus fractures were reported by Huang et al in their retrospective review of 19 patients with a mean age of 72 years [11]. The authors reported a 100% rate of fracture healing, with a mean union time of 14.6 weeks. Significant pain relief was achieved in approximately 80% of patients and, at a mean follow up of 97 months, the average range of motion was 17–128°. Evaluation of functional

outcomes in this cohort based on the Mayo elbow performance score, demonstrated 15 patients with excellent results (79%) and four patients with good results (21%). Based on these findings, the authors concluded that open reduction and internal fixation treats displaced distal humeral fractures in elderly patients effectively. Surgical complications reported in this study included one case of superficial infection and one case of iatrogenic ulnar nerve injury, with no cases of nonunion or hardware failure.

Other clinical studies have reported less success with regard to surgical intervention for the geriatric distal humeral fracture. Srinivasan et al evaluated the results of 29 fractures occurring in a cohort of patients with a mean age of 85 years, comparing surgical management (21 fractures) with conservative treatment (8 fractures) [36]. Although the authors found that at a mean follow-up of 42 months, patients treated surgically had improved outcomes compared to those managed nonoperatively, with better range-of-motion and extent of pain relief, only 57% of cases were judged to have good to excellent outcomes. Furthermore, there were significantly more complications associated with surgical management, with a 7% incidence of nonunion, 10% incidence of infection and a 3% incidence of

Authors (Year)	Number of patients (mean patient age)	Number of good-to-excellent results	Mean post-operative flexion-extension	Number of complications	Number of revision surgeries required
John et al (1994)	49 patients (80 years)	31/39 available for complete follow-up (79%)	85% of cases with at least 30°–120°	10 (20%): 1 wound infection, 1 nonunion, 2 broken plates, 6 patients with ulnar nerve neuropraxia (all resolved)	2: 1 debridement for a wound infection, 1 removal of broken hardware
Pereles et al (1997)	18 patients (71 years)	18 (100%)	18°–130°	2 cases of hardware loosening (11%)	1 revision secondary to hardware loosening
Huang et al (2005)	19 patients (72 years)	19 (100%)	17°–128°	2 (10.5%): 1 superficial wound infection, 1 ulnar nerve injury	None
Srinivasan et al (2005)	28 patients – 21 fractures treated operatively (85 years)	12 (57%)	22°–100°	7 (25%): 4 wound infections, 2 nonunions, 1 case of heterotopic ossification	1 removal of hardware secondary to infection
Korner et al (2005)	45 patients (73 years)	58%	median arc of motion of 100°	13 (29%): 12 cases of implant failure/ distal screw loosening, 1 case of persistent ulnar nerve symptoms	7 revisions secondary to implant failure/ screw loosening

Table 1: Clinical outcomes after open reduction and internal fixation of distal humerus fractures in the elderly.

heterotopic ossification (HO). Similarly, Korner et al demonstrated a postoperative complication rate of 29% (13 cases) in their retrospective evaluation of 45 distal humeral fractures occurring in patients over 60-years-old [17]. The majority of the complications (12 cases), were related to implant failure or distal screw loosening, with seven cases requiring revision surgery. Three out of eight patients where a one-third tubular plate was used for fixation of the medial column experienced plate breakage. Even with the relatively high number of postoperative complications, the functional outcome according to the Mayo elbow score was good to excellent in 26 patients (58%) with a median arc of motion of 100° (range 55–135°), leading the authors to conclude that preservation of the elbow joint by open reduction and internal fixation of fractures should be the main goal of managing these cases.

In response to the difficulties in achieving adequate fixation in the osteopenic elderly distal humerus fracture patient, certain authors have advocated adjustments to the traditional method of surgical management, including the use of a third reconstruction plate, augmentation with K-wires or using locked-plate technology [16, 21, 31]. Molloy et al evaluated the biomechanical stability of K-wire augmentation of distal humerus fracture fixation in a cadaveric model using specimens obtained from elderly donors (age range 75–87 years) [21]. In their model, two 2 mm K-wires were inserted into the medial and lateral columns of the specimens, before applying two perpendicular 3.5 mm reconstruction plates. The authors found that K-wire augmentation significantly improved cyclic loading survival compared to controls, likely secondary to the ability of the K-wires to improve screw purchase within the osteopenic distal humerus. Korner et al performed a biomechanical evaluation assessing the value of locked compression plates compared to standard reconstruction plates in the fixation of distal humerus fractures [16]. Although overall there was no significant difference with re-

spect to stiffness and strength between the two plate types, locked compression plates oriented at 90° to each other provided superior stiffness in bending and torsion compared to dorsally applied plates. In addition, the perpendicular locked-plate construct preserved the bone-implant interface during failure testing, whereas the standard reconstruction plates failed primarily by implant loosening and fracture of the bone.

### Total elbow arthroplasty

Although the current literature supports open reduction and internal fixation as the first line treatment following distal humerus fractures in the elderly, the use of total elbow arthroplasty as a primary management tool is gaining support among some authors (Figure 3). These surgeons cite the complexity associated with fracture fixation in this patient population, characterised by poor bone quality and a propensity towards extensively comminuted fractures, variable outcomes associated with ORIF and improved implants, techniques and results seen with total elbow replacement as reasons behind this change in management philosophy [4, 5, 8, 14, 23].

Early clinical experiences with elbow arthroplasty yielded variable results, showing higher rates of unsatisfactory outcomes (loosening, lack of stability) in patients with unconstrained implants secondary to posttraumatic arthritis [20]. Previous studies with semi-constrained implants used for fracture management also yielded poor results, such as reduced implant survival time and high revision rates [18]. However, recent advances in implant technology (such as the introduction of the Coonrad-Morrey prosthesis) and surgical technique have led to improved outcomes.

Indications for total elbow replacement are stringent, including highly comminuted fractures in

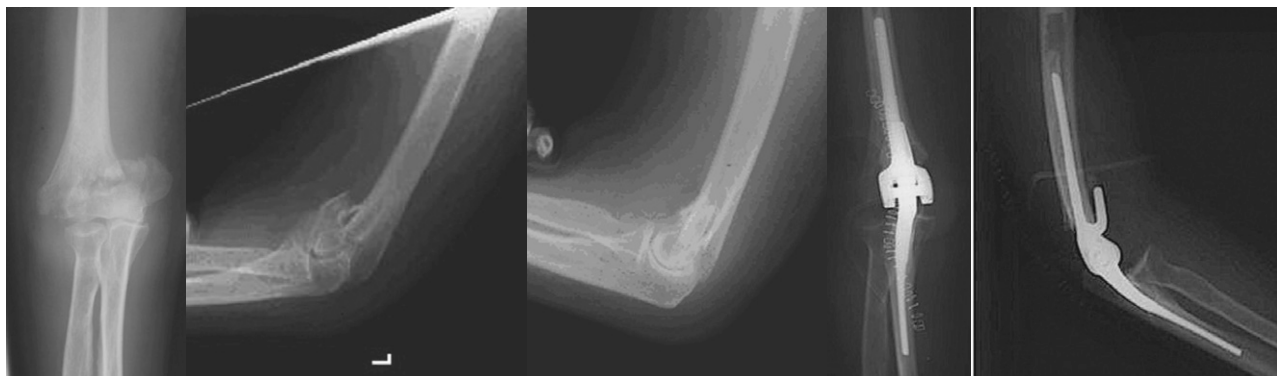


Figure 3: 71-year-old female with an OTA type 13-C distal humerus fracture managed with a primary total elbow arthroplasty.

patients older than 65 years not amenable to ORIF (secondary to significant bone loss or osteopenia/osteoporosis), or in any patient with pre-existing elbow arthrosis. Contraindications to the procedure include active infection, contaminated open fractures, and associated neurological injuries [15].

Clinical assessments of the value of total elbow arthroplasty as a primary treatment method for distal humerus fractures in the elderly have demonstrated good results. In a retrospective analysis of 20 cases (of which nine patients had rheumatoid arthritis) managed with a semi-constrained elbow arthroplasty, Cobb and Morrey reported that at an average of 3 years of follow up, 100% of the patients were subjectively satisfied and 75% achieved a score of "excellent" on the Mayo elbow performance scale [5]. The remainder of the patients scored "good", with no "fair" or "poor" results and overall, the mean flexion-extension arc was 25–130° (Table 2). Similar successful outcomes were reported in a recent retrospective study by Garcia et al [8]. In 19 patients treated with a Coonrad-Morrey total elbow prosthesis, at a mean follow up of 3 years, the mean Mayo elbow performance score was 93, falling into

the excellent outcome category. The only perioperative complication reported was a superficial wound infection, which responded to oral antibiotics.

In two relatively small series, Ray et al and Gambirasio et al both reported excellent functional outcomes with the use of a semi-constrained prosthesis as a primary method of treatment for geriatric distal humerus fractures [7, 29]. Mean Mayo scores were 92 and 94 with mean ranges of motion reported as 20–130° and 23.5–125°, respectively. Complications reported in both studies were limited, with one patient out of ten developing HO and two patients with radiographic evidence of lucent lines around the stem of the humeral component without associated clinical instability in Gambirasio's series.

Kamineni and Morrey reviewed the results of 49 cases in a cohort of patients with a mean age of 67 years, once again demonstrating high functional outcome scores (mean Mayo score of 93), but a relatively higher rate of postoperative complications than seen in the other studies [15]. The authors noted that they obtained an intraoperative flexion-extension arc of 5–138°, which regressed to an average of 24–131° at two years of follow-up, demonstrating that patients

Authors (year)	Number of patients (mean patient age)	Number of good-to-excellent results; mean Mayo elbow score	Mean post-operative flexion-extension	Number of complications	Number of revision surgeries required
Cobb and Morrey (1997)	20 patients (72 years)	20 (100%); 95	25°–130°	5 (25%): 1 fracture of the ulnar component, 3 cases of ulnar nerve neuropraxia, 1 case of reflex sympathetic dystrophy	1 revision secondary to ulnar component fracture
Ray et al (2000)	7 patients (82 years)	7 (100%); 92	20°–130°	1 superficial wound infection (14%)	None
Gambirasio et al (2001)	10 patients (85 years)	10 (100%); 94	23.5°–125°	1 case of heterotopic ossification (10%), 2 cases of radiolucent lines around the humeral component (both clinically stable and asymptomatic)	None
Garcia et al (2002)	19 patients (73 years)	16/16 available for follow-up evaluation (100%); 93	24°–125°	1 superficial wound infection (5%)	None
Kamineni and Morrey (2004)	49 v (67 years)	40/43 available for follow-up evaluation (93%); 93	24°–131°	17 cases with at least 1 complication (35%): 11 wound infections, 3 cases with neurological symptoms, 3 periprosthetic fractures, 3 cases of hardware loosening	10 reoperations: 5 wound debridements, 2 revisions for periprosthetic fracture, 3 revisions for loose components

Table 2: Clinical outcomes after total elbow arthroplasty as the primary treatment of distal humerus fractures in the elderly.

undergoing total elbow arthroplasty may develop postoperative joint contracture secondary to the soft tissue insult associated with the procedure. 17 elbows in this series (35%) experienced at least one postoperative complication, including wound infections (11 cases), neurological symptoms (three cases), periprosthetic fractures after falls (three cases) and component loosening (three cases). These complications required ten reoperations ranging from soft-tissue procedures to complete revisions due to implant loosening. However, even with this complication rate, the authors felt that their outcome data supported the use of total elbow arthroplasty as a primary treatment method for appropriately indicated distal humerus fractures.

To date, there have been no randomised clinical trials comparing the results of total elbow arthroplasty with open reduction and internal fixation for distal humerus fractures in the elderly patient population. Obremesky et al performed an evidence-based evaluation of the two treatment alternatives and found that evidence from relatively small case series suggested equivalent functional outcome with either method [24]. The authors concluded that at the present time there is no strong evidence supporting one treatment option over the other and that surgeons' experience and judgment are the best guides until larger comparative studies become available. A recent retrospective evaluation by Frankle et al compared the results of open reduction and internal fixation with total elbow arthroplasty in 24 elderly women with intra-articular distal humerus fractures [6]. The authors found a greater number of excellent results according to the Mayo elbow performance score for the 12 patients treated with total elbow arthroplasty (11 excellent outcomes) compared to the 12 patients treated with ORIF (four excellent outcomes).

## Postoperative rehabilitation

Following open reduction and internal fixation patients are typically splinted in extension for the first 2–3 days postoperatively. Once the splint is removed, the patient is allowed to participate in gravity-assisted active mobilisation of the elbow with a physiotherapist, advancing as tolerated. Based on the clinical picture, patients after ORIF are allowed to resume normal activities of daily living once there is radiographic evidence of healing present on the postoperative follow-up x-rays.

Rehabilitation after a total elbow replacement similarly begins with range-of-motion exercises 24–48 hours postoperatively with the assistance of a physiotherapist. Active-assisted flexion and extension (if a triceps sparing approach is used) are often incorpo-

rated into the therapy sessions. For the first 6 weeks postoperatively, some authors suggest keeping the patients in a resting daytime splint with the elbow in 90° of flexion and a night-time extension splint. Typically, elbow replacement patients are restricted from lifting objects heavier than 10 pounds with the treated upper extremity and from participating in any upper extremity impact sports (eg, tennis, golf).

## Conclusion

Although relatively uncommon, fractures of the distal humerus in the elderly patient population are significant injuries whose optimal management is a subject of debate in the orthopaedic literature. The combination of complex anatomy, poor bone quality and extensive comminution often seen with these fractures makes successful treatment difficult. Currently, most surgeons support surgical fixation of distal humeral fractures with the belief that restoration of the patient's native elbow joint provides the best opportunity for a good functional outcome. Others have proposed the use of total elbow arthroplasty as a primary treatment method for geriatric distal humeral fractures based on the difficulties associated with ORIF and the relatively low demands of this patient population. To date there have been no prospective randomised trials comparing these two treatment alternatives, and a comparison of available outcome data shows good functional outcome for both forms of fracture management. With the aging of the population and an associated increase in the incidence of distal humeral fractures, the debate over the optimal treatment regime will undoubtedly continue.

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