

# Outcomes Following Open Reduction Internal Fixation of Extra Articular or Simple Articular Distal Humerus Fractures in Patients over 75 Years of Age

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## Abstract

**Introduction:** Treatment of distal humerus fractures in the aged population remains controversial due to concerns for bone quality, healing capacity, and integrity of the surrounding soft tissue envelope. We evaluated outcomes of open reduction internal fixation (ORIF) in patients aged  $\geq 75$  years with extra articular or simple articular distal humerus fractures (AO Type A or B).

**Methods:** Between 2011 to 2016, 13 patients 75 years of age or older identified in the last five years at two tertiary elbow centers as having undergone ORIF for AO Type A or B distal humerus fractures were retrospectively reviewed.

**Results:** The final average Mayo Elbow Performance Scores (MEPS) was 83.1 (range, 50-100). Average range of motion included lack of extension to 15° (range, 0-40°), and an average flexion to 128° (range, 115-140°). Average time to union was 12.2 weeks; however, two patients treated with percutaneous pinning resulted in nonunion. One required conversion to total elbow arthroplasty for pain with osseous collapse. There were no triceps or ulnar nerve issues, and no associated perioperative medical complications.

**Conclusions:** ORIF for AO Type A or B distal humerus fractures in the elderly population provides for immediate/early, functional use of the extremity, predictable union, limited perioperative complications and no long-term weight bearing restrictions. Conversion to total elbow arthroplasty can be utilized as a salvage procedure.

**Level of evidence:** Level IV

**Keywords:** Distal humerus fracture, Elderly, ORIF, Arthroplasty, Fixation, Osteoporosis, Percutaneous pinning, Locked plates

## Introduction

While distal humeral fractures account for only 2% of all fractures, these fractures in patients  $\geq 75$  years of age present a difficult treatment dilemma for elbow surgeons [1]. The incidence of distal humerus fractures in the elderly is predicted to triple by 2030 for patients aged  $>80$  as the population remains active later in life [2]. For younger patients, open reduction and internal fixation (ORIF) remains the preferred treatment method to allow for immediate post-operative motion [3-5]. However, within the aged population, direct fixation of distal humeral fractures can be challenging due to associated poor bone health and diminished surrounding soft tissue envelope that creates concerns for

achieving and maintaining appropriate fixation, obtaining union, and preventing postoperative wound dehiscence and infection [6-8]. Additional complications of ORIF in the elderly include hardware failure (8.6%), heterotopic ossification (7/2%), and olecranon osteotomy nonunion (2.7%) [9]. As a result of these concerns, the consideration to treat these fractures with either nonoperative management or immediate total elbow arthroplasty (TEA) has gained popularity [10-12]. For complex, intraarticular fracture patterns (AO Type C) there appears to be adequate evidence to support TEA as a treatment option in the elderly population [11-16]. However, the ideal treatment algorithm for older patients

with simple fracture patterns (AO Type A or B) is currently unknown as nonoperative management has been associated with pain, stiffness and nonunion, and complication rates following TEA has been reported to be as high as 20-45% and include aseptic loosening, infection, and ulnar nerve dysfunction [7,17]. Additionally, patients undergoing TEA are required to have stringent lifetime weight bearing restrictions which may be an important consideration in patients that require and/or desire weight bearing activities including use of a cane or walker for ambulation and transitions.

The purpose of this study is to analyze the functional outcomes and complications of patients  $\geq 75$  years of age with simple articular

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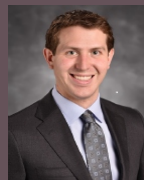
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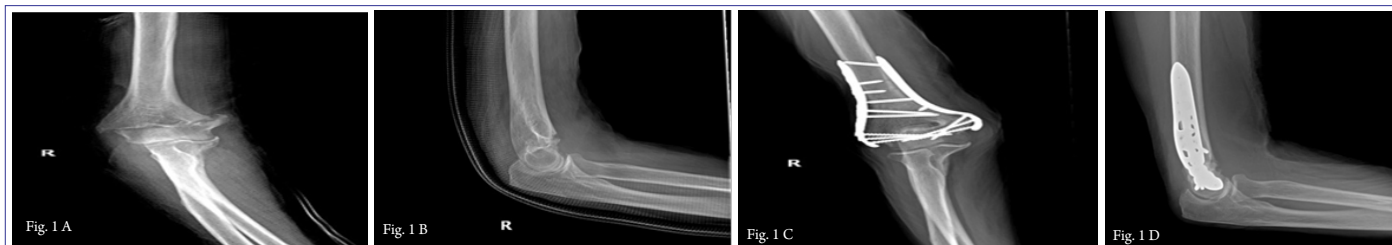
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**Figure 1A,1B,1C,1D:** Eighty-eight year old female who sustained a displaced extra articular distal humerus fracture and underwent open reduction internal fixation with dual locked precontoured distal humerus plates. This patient achieved complete union with no issues.

or extraarticular distal humeral fractures treated with ORIF. Our hypothesis is that management with ORIF will result in acceptable union rate, range of motion, and patient outcome. IRB approval was obtained for this investigation at both tertiary elbow treatment centers prior to gathering patient data.

### Materials and Methods

All patients  $\geq 75$  years and older who underwent ORIF for simple articular or extra articular distal humeral fractures over the past five years at each elbow center by three treating elbow surgeons were retrospectively identified. For this investigation, a simple articular distal humeral fracture was defined according to the AO classification Type B, or as a single fracture line extending into the distal humeral articulation with no associated articular comminution.

All patients underwent surgical stabilization after first obtaining medical clearance. Surgery consisted of either ORIF with specific fracture directed precontoured distal

humeral locking plates or percutaneous fixation with cannulated screws per treating surgeon's discretion. The ulnar nerve was typically identified and addressed in patients who underwent open reduction, which included either transposition or identification within situ release and protection. The postoperative protocol was directed towards early, active motion immediately or after wound healing occurred (typically within 14 days).

Extensive chart analysis was performed to obtain patient characteristics and documented outcomes were identified and evaluated. In this cohort, we retrospectively identified time to union, final ROM, and the Mayo Elbow Performance Score (MEPS) for each patient. In addition, patient charts were assessed for any perioperative complications and reoperations (Table 1).

### Results

Thirteen patients  $\geq 75$  years of age were identified as undergoing ORIF for simple articular or extra articular distal humeral

fractures with an average age of 81.8 years (range, 75-90 years, Figure 1). All patients were followed for at least one year after surgery, although the average period of follow up in clinic for these patients was 5.5 months (range, 3-24 months). Ten of the 13 patients were females, with 9 patients sustaining fractures to the dominant arm and 4 to the non-dominant extremity. Eight patients underwent surgical fixation for an extra-articular distal humerus fracture, and five patients had simple articular fracture extension (Table 1).

The average time to surgery was 7.3 days (range, 0-21 days) with 2 cases occurring the same day and the longest occurring 21 days later. Most surgeries were performed utilizing a posterior midline incision to expose, reduce, and fix the distal humeral fracture without an olecranon osteotomy (although one olecranon osteotomy was performed with no postoperative sequelae). The triceps was left intact on all patients and there were no triceps issues in the postoperative setting. In 6 cases the ulnar nerve was transposed

**Table 1: Patient demographics, type of fixation, functional outcomes (MEPS), final range of motion, time to union, and perioperative complications.**

ID	Age	Sex	Type of Fracture	Type of Fixation	MEPS	Final ROM	Time to Union (weeks)	Perioperative Complications
ML	75	F	Simple articular, complete supracondylar	Parallel plates	95	6-115°	12	None
DL	78	M	Extraarticular supracondylar	Parallel plates	100	20-120°	14	Infected olecranon bursa 1 year post op
JB	75	F	Simple articular, complete supracondylar	Percutaneous cannulated screws	Prior to TEA: 60, After TEA 90	10-130° (after TEA conversion)	Nonunion	Nonunion and failure of fixation, required revision to TEA
LS	88	F	Extraarticular, supracondylar	Parallel plates	95	0-130°	10	None
CF	75	F	Simple articular, complete supracondylar	Parallel plates	90	10-130°	12	Mild CRPS
BB	89	F	Extraarticular, supracondylar	Parallel plates	95	15-135°	12	None
CS	77	F	Supracondylar	Medial and posterior plates	85	5-140°	13.4	None
LW	81	F	Supracondylar, intercondylar	Medial plate	100	5-135°	7.1	Mild weakness
HR	82	F	Simple intraarticular, comminuted supracondylar	Parallel plates	50	40-115°	14.3	Post-traumatic arthritis
JL	88	F	Displaced extraarticular, supracondylar	Percutaneous cannulated screws	85	0-145°	Nonunion	Nonunion and screw loosening; pneumonia post operatively
FI	90	F	Displaced supracondylar	Parallel plates	50	30-120°	14	None
WE		M	Displaced supracondylar	Parallel plates	95	20-115°	12	Suture abscess requiring I&D
BG		M	Supracondylar with lateral condyle extension	Parallel plates	85	35-132°	15	None



**Figure 2A and 2B:** Seventy-five year old patient who underwent percutaneous pinning of a distal humerus fracture with cannulated screws and then went on to painful nonunion. **Figure 2C:** Following revision of this nonunion to total elbow arthroplasty.

anteriorly, in 3 cases it was released in situ, and in 3 others it was left untouched. Eleven fractures were fixed using specific fracture directed precountoured distal humerus locking plates per surgeon discretion. 2 other patients were fixed with percutaneous cannulated screws. Average surgical time was 132 min (range, 67-184 minutes). Post-operative restrictions consisted of either full active range of motion (9 patients), or brief splinting until wound healing occurred (4 patients) which lasted between 7-14 days. However, one patient who underwent percutaneous pinning was splinted for four weeks after surgery before range of motion was initiated due to fixation strength concerns.

Clinical outcome scores were measured utilizing the MEPS, which found 7 patients had 'Excellent' (>89) scores, 3 were 'Good' (75-89), 2 were 'Fair' (60-74), and there was one 'Poor' (<60) score. The average score for the cohort was 83.1 corresponding to a 'Good' designation. Postoperative arc of motion included average lack of extension of 15° (range, 0-40°), and an average flexion to 128° (range, 115-140°). Post-operative pain was assessed subjectively at discharge with 10 patients reporting no pain, 2 reported mild pain that later resolved, and one patient reported major pain which was associated with fracture nonunion. The average time to union was 12.2 weeks (range, 7-15 weeks); however, in two cases union was not visualized at last clinical follow up. Both patients had undergone percutaneous screw fixation. One of the non-union patients reported increased pain and dysfunction and the patient eventually underwent conversion to a TEA, which improved the MEPS score from 60 to 90 (Figure 2). The other patient

who went on to nonunion also required subsequent surgery consisting of implant removal. One patient required a formal irrigation and debridement of a suture abscess in the operating room eight weeks after the index surgery, there were no postoperative sequela from this procedure. Additionally, another patient developed septic olecranon bursitis of the operative elbow well after union of the fracture (two years after ORIF), which required operative irrigation and debridement with no long-term sequelae. There were no ulnar nerve issues or other skin integrity complications in the perioperative setting. Also, there were no perioperative medical complications within the study population.

#### Discussion

Treatment of distal humerus fractures in the aged population remains controversial due to concerns for bone quality, healing capacity, and integrity of the surrounding soft tissue envelope. Several investigations have suggested that immediate conversion to TEA or nonoperative management may be advantageous to avoid these complications; however, these treatments are not without their own disadvantages.

TEA has recently gained popularity for initial treatment of distal humerus fractures in the elderly population as an alternative to ORIF, however may be limited in availability at some medical facilities due to surgical complexity. Elbow arthroplasty does not require bone healing, provides immediate stability to the articulation, and allows for immediate mobilization if the triceps is left intact. Mckee et al. reported on TEA compared to ORIF in Type C distal humerus fractures in elderly patients following a

multicenter, prospective investigation [13]. Results after TEA for comminuted distal humerus fractures in this population were more predictable than those following ORIF, leading the authors to conclude that TEA is a reasonable procedure for elderly patients with complex distal humeral fractures who were not able to achieve stable fixation. Ellewin et al. retrospectively reviewed 29 patients and also concluded that TEA can be recommended for patients older than 60 years of age with comminuted distal humerus fracture [15] Frankle et al. retrospectively reviewed 24 women older than 65 years of age who sustained a Type C distal humerus fracture treated with ORIF or TEA. The authors reported outcomes in patients undergoing TEA were all good or excellent, while in patients undergoing ORIF 33% had poor or fair outcomes and three required eventual conversion to TEA. The authors concluded that TEA ultimately is a viable treatment option for distal intraarticular humerus fractures in women older than age sixty-five [16].

These investigations all report on the benefit of TEA for comminuted distal humerus fractures (Type C) in the aged population; however, data on outcomes for simple fractures of the distal humerus in this population (Type A or B) is limited, despite these fracture accounting for 32-48% of all distal humerus fractures in patients over the age of sixty-four [18]. Mansat et al. recently reported on the results of immediate TEA for distal humerus fracture in 87 patients over the age of sixty-five [12]. In this investigation, 19.5% of patients treated with a TEA had extraarticular or simple articular fracture patterns (AO Type A or Type B). Although a majority of patients reported satisfactory outcome (63%), these authors did report a complication rate of 23% for all patients with a postoperative revision rate of 9%. Additionally, the final range of motion was reported as relatively limited with the mean motion arc of only 22° to 97°. It should be mentioned that the authors did not breakdown outcome or motion based on AO classification of fracture.

Although TEA does not require osseous union in the postoperative setting and provides an immediately well-fixed articulation, there are several important disadvantages associated with its use. The most important being lifelong weight bearing

restrictions required after implantation consisting of no repetitive lifting more than 1.0-2.25 kg, with one-time lift required at under 4.5 kg. Although many patients over 75 years of age are relatively low functioning, these limitations can still profoundly affect certain activities of daily living and diminish independence. In addition, patients that require their upper extremities to assist with ambulation (walker) or transfers can put excessive strain on the implant. The rate of complications following TEA has also been reported as high as 43% including infection, implant loosening, fracture, ulnar nerve injury and heterotopic bone formation [17,19,20]. Complications following TEA can be devastating and extremely challenging to manage, especially in this patient population. For these reasons, total elbow arthroplasty may better serve as a salvage procedure for treatment of simple distal humeral fractures.

Nonoperative management has also been reported as an option for the aged patient with distal humerus fracture. Desloges et al. reported on 19 low functioning, medically unfit, or elderly patients (mean age 77 years) with distal humerus fractures treated nonoperatively [10]. They found 68% of patients reported good to excellent subjective outcomes. Despite immobilization in a cast, these patients were found to have surprisingly good range of motion (mean 22°-128°). However, these authors also reported a nonunion rate of 19% with one patient requiring conversion to TEA. Additionally, these patients were immobilized in a cast and protective splint for up to 8 weeks in the post injury period, effectively limiting functional use of this extremity during the healing period. During the post injury period, these patients required constant soft tissue evaluation and management to protect their fragile soft tissue envelope including regular cast changes and clinical evaluation of their skin which may be burdensome to low functioning patients.

In the current investigation, we studied the

functional outcomes of 13 patients, at an average age of 81.8 years, who underwent ORIF for extra articular or simple articular distal humerus fractures (AO Type A or Type B). The final outcomes reported from our population demonstrated that 77% of patients had excellent or good scores with an average final MEPS of 88.3 and average range of motion of 15° of extension to 128° of flexion. Most of these patients had medical comorbidities that required preoperative evaluation and medical clearance for surgery preoperatively; however, we found no medical complications in the perioperative setting.

Union was achieved in 11/13 (85%) patients, one of these patients requiring a secondary operation of conversion to total elbow arthroplasty. This patient was initially treated with percutaneously placed cannulated screws resulting in a painful nonunion (Figure 2). Another patient treated with percutaneous screw fixation also required postoperative reoperation for removal of implants and progressed to nonunion. Union was achieved in every patient in this study (85%) managed with specific fracture directed precontoured distal humerus locking plates, which improves fixation strength substantially when compared to percutaneously placed cannulated screw and likely was the reason for failure in these patients. Conversion to TEA was performed without incident and with complete resolution of her pain and near full function of the extremity within the confines of the weight bearing restrictions.

This study has several limitations. First, it is a relatively small case series consisting of only 13 patients; however, most similar investigations reported relatively small study patient numbers [10,15,16]. In addition, the study design is retrospective review which has a number of well-known limitations. It is possible that certain patients with simple distal humerus fractures were selected out of undergoing ORIF at the time of their injury for a specific contraindication and were not

captured in our patient search. However, to our best knowledge we effectively identified and analyzed all patients  $\geq 75$  years of age who underwent ORIF for Type A or B distal humerus fractures. Lastly, information on patient bone health was not available for all patients and we cannot comment on severity of osteopenia or osteoporosis. However, this information was not available during preoperative evaluation and would not be used during routine treatment decision making. Prospective, randomized studies are necessary to directly compare ORIF, TEA, and conservative treatment for distal humerus fractures in the aging population.

### Conclusion

Despite concerns for bone integrity, fixation strength, healing capabilities and soft tissue integrity, the findings from this investigation support initial ORIF for elderly patients with extraarticular or simple articular distal humerus fractures (AO Type A or B). These results demonstrate that ORIF offers these patients high rate of union, immediate functional use of the extremity with limited perioperative complications and the benefit of restriction free use of their extremity after union. In this series, two patients were treated with percutaneous pinning and both went on to nonunion. Although this occurred in just a small subset of patients, this indicates that plating with precontoured distal humerus locking plates is likely advantageous for treatment of these fractures in this population. Lastly, for patients who fail ORIF conversion to TEA appears to be an acceptable salvage option.

### Clinical Relevance

This study presents an operative alternative to TEA for extraarticular or simple articular distal humerus fractures. ORIF of these fractures results in normal use of the extremity once union is achieved and leaves the option of TEA for salvage if the ORIF fails.

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