

# Comparison of Functional Outcomes of Total Elbow Arthroplasty vs Plate Fixation for Distal Humerus Fractures in Osteoporotic Elbows

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## Abstract

Treating intra-articular fractures about the osteoporotic distal humerus poses a significant challenge. The purpose of this retrospective study was to evaluate functional outcomes for distal humeral fractures treated with total elbow arthroplasty (TEA) or open reduction and internal fixation (ORIF) in a nonarthritic elderly population with osteoporosis.

We reviewed the records of all women older than age 60 who had undergone surgical treatment for intra-articular distal humerus fractures (Orthopaedic Trauma Association types 13B and 13C) by 1 of 2 surgeons. Demographic and operative data were obtained, charts were reviewed, and patients were asked to have their outcomes evaluated with the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and the Mayo Elbow Performance Index (MEPI). Twenty-two patients (23 elbows) were identified, and 2 of these (3 elbows) were excluded. Of the remaining 20 patients, 9 had undergone cemented, semiconstrained TEA as initial treatment, and 11 had undergone ORIF. These 2 groups were compared.

Mean follow-up was 14.8 months (range, 6-38 months). There were no significant differences between the TEA and ORIF groups with respect to demographic factors. Final elbow range of motion was 92° flexion-extension arc (arthroplasty group) and 98° (fixation group). Two patients in the arthroplasty group and 2 in the fixation group died. For the remaining patients, mean DASH scores were 30.2 (arthroplasty) and 32.1 (fixation), and mean MEPI scores were 79 (arthroplasty) and 85 (fixation). These differences were not statistically significant. Four TEAs developed radiographic loosening by a mean of 15 months, and 1 of these underwent revision with good outcome. Ten of the 11 fractures in the fixation group healed radiographically; the 1 nonunion

with collapse continued to be asymptomatic. Two patients in the fixation group underwent contracture release after union for limited elbow range of motion.

Many factors come into play in the treatment of intra-articular distal humerus fractures in patients with osteoporosis. Implant selection must be based on bone quality, expected outcome, and surgeon experience. For these injuries, good outcomes may be obtained with either TEA or ORIF.

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 orthopedic surgeon.<sup>1,2</sup> In the elderly patient population with osteoporosis, treatment of these injuries becomes even more complicated, by poor bone quality and intolerance of joint immobilization.<sup>3,4</sup> Although fractures of the distal humerus are relatively uncommon overall, accounting for approximately 2% to 6% of all fractures in adults, appropriate methods of management remain a source of debate in the orthopedic literature, with there being advocates for either total elbow arthroplasty (TEA) or open reduction and internal fixation (ORIF).<sup>5,6</sup>

Recent epidemiologic studies have indicated that the incidence of distal humerus fractures in the geriatric patient population is rising steadily.<sup>4,7,8</sup> Palvanen and colleagues<sup>7</sup> found an increase in the number of distal humerus fractures among Finnish women older than age 60, from 12 per 100,000 women in 1970 to 28 per 100,000 women in 1995. The authors concluded that, should the trend continue, the number of distal humerus fractures among elderly women would increase three-fold by 2030.

In the treatment of distal humerus fractures, the traditional principles of ORIF continue to receive the most support in the orthopedic literature. In the elderly patient population with osteopenia, however, operative fixation is difficult and prone to failure, with complication rates reaching 30% in some series.<sup>1,3,9-11</sup> In response to these poor outcomes, some authors have advocated TEA as the primary treatment method.<sup>6,12-16</sup>

The purpose of this study was to evaluate functional outcomes for distal humeral fractures treated with

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**Figure 1.** Anteroposterior (A) and lateral (B) radiographs of comminuted distal humerus fracture.

TEA or ORIF in a nonarthritic, non-steroid-dependent elderly female population with osteoporosis.

### METHODS

We conducted this retrospective study after obtaining internal review board approval at our institution. All patients were contacted in accordance with guidelines set by the institution, and all consented to participate. Inclusion criteria were female sex, skeletal maturity, age over 60 years, unilateral intra-articular distal humerus fracture, willingness to participate, and minimum follow-up of 1 year. Specific exclusion criteria were steroid-dependent arthritic or medical conditions. Over a 5-year period, 63 patients with a displaced intra-articular distal humerus fracture had been treated by Dr. Egol and Dr. Tejwani. We retrospectively reviewed the patient database and extracted the records of all women older than age 60. We obtained demographic and operative data, reviewed charts, and contacted patients for functional data, including scores on the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and the Mayo Elbow Performance Index (MEPI). Twenty-two active elderly patients (23 elbows) fit the inclusion criteria. One patient, whose left-sided fracture had been treated with arthroplasty and whose right-sided fracture had been treated with ORIF, at different times, was excluded because she did not fit into a single group. Another patient was excluded because of loss of fixation resulting in arthroplasty within 2 weeks of initial treatment. The final analysis was of the remaining 20 patients (20 elbows).

Of these 20 patients, 9 had undergone cemented, semiconstrained TEA (Coonrad-Morrey [Zimmer, Warsaw, Indiana] or Solar [Stryker, Mahwah, New Jersey]) as initial treatment, and 11 had undergone ORIF with small fragment plate and screws (Synthes [Paoli, Pennsylvania] or Acumed [Portland, Oregon]). These 2 groups were compared.



**Figure 2.** Postoperative anteroposterior (A) and lateral (B) radiographs of Coonrad-Morrey total elbow arthroplasty (Zimmer, Warsaw, Indiana).

All medical records and charts were reviewed, and demographic data were extracted: age, handedness, mechanism of injury, fracture classification, and medical comorbidities. Operative data extracted included implant type, approach, transposition of ulnar nerve, operative time, and tourniquet time. Postoperative data included development of any in-hospital complications, length of stay, and hospital discharge status.

### Total Elbow Arthroplasty

The 9 patients (mean age, 79 years; range, 71-90 years) in this group had undergone semiconstrained TEA for a displaced, intra-articular fracture of the distal humerus (Figures 1A, 1B, 2A, 2B). All distal humerus fractures were Orthopaedic Trauma Association (OTA) type 13C fractures, deemed unreconstructible at time of surgery. Five of the 9 fractures were on the dominant side. Mode of injury was, almost invariably, a fall on an outstretched hand from a standing height. Mean time from injury to operating room was 3.9 days, and mean operative time was 2 hours 30 minutes (range, 2 hours 15 minutes to 4 hours 40 minutes).

The operative procedure was similar for all 9 patients. It included the Bryan-Morrey approach to the elbow, excision of fracture fragments, and cemented, semiconstrained TEA (4 Coonrad-Morrey, 5 Solar). In all cases, the radial head was intact and did not require repair or replacement. At the discretion of the treating surgeon, a tourniquet was used (3 patients), and anterior transposition of the ulnar nerve was performed (8 patients). Mean follow-up was 15 months.

### Open Reduction and Internal Fixation

The 11 patients (mean age, 76 years; range, 61-89 years) in this group had undergone ORIF of the distal humerus with small fragment plate and screw fixation (Figures 3A,

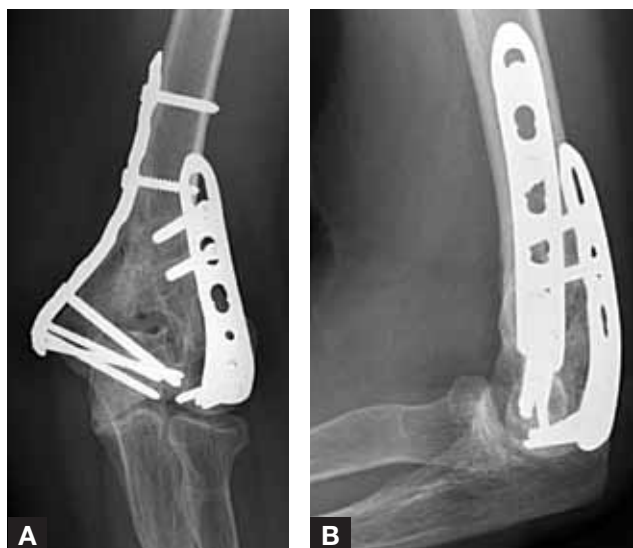


**Figure 3.** Anteroposterior (A) and lateral (B) radiographs of comminuted distal humerus fracture.

3B, 4A, 4B). One patient had sustained an open fracture and underwent incision and débridement and then plating. Four injuries were on the dominant side; the mechanism was predominantly a fall on an outstretched hand from a standing height. The injury pattern was mixed: 3 OTA type 13B fractures and 8 type 13C fractures. Mean time from injury to operating room was 4.4 days, and mean operative time was 3 hours (range, 1 hour 38 minutes to 4 hours 15 minutes). At the discretion of the treating surgeon, anterior transposition of the ulnar nerve was performed (9 patients). All fractures were operated on through a posterior approach to the distal humerus. Fixation involved a mix of parallel and right-angle plates, determined by the surgeon; with our limited numbers, there appeared to be no obvious difference between these fixation methods. Five patients underwent olecranon osteotomy; the other 6 underwent a triceps-sparing approach. At the discretion of the treating surgeon, a tourniquet was used (4 patients). The postoperative protocol was similar to that used for the TEA group. Mean follow-up was 13 months.

#### Both Groups

All patients were splinted for 1 week after surgery and then allowed active assisted elbow range of motion (ROM). At 6 weeks, active ROM was allowed. Patients were not routinely given radiation therapy for heterotopic ossification prophylaxis and were discharged as medical conditions allowed. They were followed up in the outpatient setting at routine intervals when possible (2, 6, 12, 26, 52 weeks). At each visit, the treating surgeon conducted a clinical examination, and elbow ROM in flexion, extension, pronation, and supination was recorded, along with elbow stability. Any postoperative complications were noted, and a radiographic elbow series, including anteroposterior (AP) and lateral radiographs of the elbow, was



**Figure 4.** Postoperative anteroposterior (A) and lateral (B) radiographs of open reduction and internal fixation using distal humerus locking plates (Synthes, Paoli, Pennsylvania).

obtained. A trained interviewer administered 2 validated functional outcome measures (DASH, MEPI) for evaluation of upper extremity function<sup>12,17</sup> at the latest visit or at a minimum of 1 year.

## RESULTS

Mean follow-up was 14.8 months (range, 6-38 months). There were no significant differences between the arthroplasty and fixation groups with respect to demographic factors—age, number of medical comorbidities, American Society of Anesthesiologists classification, and smoking status. Final elbow ROM was 92° arc of flexion/extension and 169° pronation/supination in the arthroplasty group and 98° and 169°, respectively, in the fixation group. Two patients each in the arthroplasty and fixation groups died, and 1 patient in the fixation group could not be contacted for completion of the final functional questionnaire. For the remaining patients, mean MEPI scores were 79 (arthroplasty) and 85 (fixation), and mean DASH scores were 30.2 and 32.1, respectively. These differences were not statistically significant.

#### Total Elbow Arthroplasty

Mean follow-up was 15 months (range, 6-38 months). Mean elbow ROM at final follow-up was 24° to 116° in flexion-extension (92° arc of motion; range, 0°-140°) and 85°/84° of pronation/supination. Two patients had died before final functional evaluation. Mean MEPI score, 79, revealed excellent (3 patients), good (1), fair (2), and poor (1) results. At a mean of 15.3 months, there was evidence of radiographic loosening in 4 TEAs, 1 of which became infected and underwent multiple irrigation and débridement procedures before the patient's demise secondary to comorbid medical conditions, likely exacerbated by the chronic infection of the prosthesis and the treatments addressing it. Thirteen months after the index procedure,

1 patient with radiographic loosening returned for revision surgery, with excellent result. Mean DASH score for this group was 30.2. One patient had an iatrogenic ulnar motor neuropathy, which resolved by 6 weeks (the nerve had been transposed anteriorly).

### Open Reduction and Internal Fixation

Mean follow-up was 13 months (range, 6-37 months). Of these 11 fractures, 10 healed radiographically, and 1 experienced nonunion with collapse. There were no nonunions of the olecranon osteotomy site. In 2 patients, posttraumatic joint contractures developed and required release, with subsequent ROM of 90° and 100°. Mean elbow ROM at final follow-up was 20° to 118° in flexion-extension (98° arc of motion; range, 0°-140°) and 85°/84° of pronation/supination. Two patients had died before latest follow-up, leaving 9 patients in the final cohort. Mean MEPI score was 85 (6 excellent results, 3 poor results), and mean DASH score was 32.1.

As mentioned, 1 fracture experienced radiographic nonunion with collapse. The patient had good functional scores and no physical limitations 4 years after surgery. Two patients had postoperative ulnar nerve symptoms with sensory paresthesias. Of the 2 patients with ulnar neuritis, 1 had died before functional outcome evaluation, and the other had an excellent result with complete resolution of symptoms by 3 months. As already stated, 1 patient's ORIF was revised to TEA at 2 weeks, and this patient was not included in this follow-up. There were no infections in this group.

## DISCUSSION

Although the current literature supports ORIF as first-line treatment for distal humerus fractures in elderly patients, TEA as a primary management tool is gaining support among some authors. These authors have cited the complexity of fracture fixation in this population, which is characterized by poor bone quality and propensity toward extensively comminuted fractures, variable outcomes associated with ORIF. They also have cited improved implants, techniques, and results with TEA as reasons behind this change in management philosophy.<sup>13,14,16,18,19</sup> In our experience, elderly women treated with TEA and those treated with ORIF have comparable results with respect to ROM and functional status.

Early clinical experiences with elbow arthroplasty yielded variable results, such as higher rates of unsatisfactory outcomes (loosening, instability) in patients with unconstrained implants secondary to posttraumatic arthritis.<sup>20</sup> In previous studies, use of semiconstrained implants for fracture management also yielded poor results, such as reduced implant survival time and high revision rates.<sup>21</sup> However, recent advances in implant technology (eg, Coonrad-Morrey TEA) and surgical technique have led to improved outcomes.

Indications for TEA are stringent. They include highly comminuted fractures not amenable to ORIF (secondary

to significant bone loss, osteopenia, or osteoporosis) in patients older than age 65 and preexisting elbow arthrosis. Contraindications include active infection, contaminated open fractures, and associated neurologic injuries.<sup>15</sup>

Clinical assessments of the value of TEA as a primary treatment method for distal humerus fractures in elderly patients have demonstrated good results. In a retrospective analysis of 20 cases managed with semiconstrained elbow arthroplasty, Cobb and Morrey<sup>13</sup> reported that, at a mean follow-up of 3 years, 100% of patients were subjectively satisfied, and 75% had an excellent MEPI score; the other 25% had a good score (there were no fair or poor scores). Mean flexion-extension arc was 25° to 130°. In a later study, Kaminen and Morrey<sup>14</sup> followed up 43 TEAs for a mean of 7 years and reported that 80% did well and required no further intervention. Similar successful outcomes were reported in a recent retrospective study, by Garcia and colleagues,<sup>19</sup> of 19 patients treated with Coonrad-Morrey TEA. At a mean follow-up of 3 years, mean MEPI score was 93 (excellent). The only perioperative complication reported was a superficial wound infection, which responded to oral antibiotics.

Recent clinical evaluations have assessed outcomes of ORIF of geriatric distal humerus fractures. In a retrospective review of 12 patients (age, 63-85 years) with operatively managed displaced distal humerus fractures, Pereles and colleagues<sup>22</sup> found good to excellent results in 100% of cases. They reported 2 cases of hardware failure (1 required revision), no infections, no cases of postoperative ulnar nerve symptoms, and bony union in all patients at a mean of 16 weeks. At a mean follow-up of 1 year, patients in this series had mean elbow flexion of 130° (range, 105°-145°) and mean elbow extension of -18° (range, 0° to -37°). Similar successful outcomes of operative fixation of geriatric distal humerus fractures were reported by Huang and colleagues<sup>2</sup> in their retrospective review of 19 patients (mean age, 72 years). The authors reported a 100% rate of fracture healing and mean union time of 14.6 weeks. Significant pain relief was achieved in approximately 80% of patients. At a mean follow-up of 97 months, mean ROM was 17° to 128°. Of these 19 patients, 15 (79%) had excellent functional outcomes based on MEPI scores, and 4 (21%) had good outcomes. The authors concluded that ORIF is effective in the treatment of displaced distal humerus fractures in elderly patients. Reported surgical complications were 1 superficial infection and 1 iatrogenic ulnar nerve injury (there were no nonunions or hardware failures).

Other clinical studies have found less success for surgical intervention for geriatric distal humerus fractures. Srinivasan and colleagues<sup>4</sup> evaluated the results of 29 fractures (mean age of patients, 85 years) and compared operative management (21 fractures) with conservative treatment (8 fractures). Although they found that, at a mean follow-up of 42 months, ROM and pain relief were better for patients treated operatively than for those treated nonoperatively, only 57% of cases were judged as having good to excellent outcomes. In addi-

tion, there were significantly more complications associated with operative management, with 7% incidence of nonunion, 10% incidence of infection, and 3% incidence of heterotopic ossification.

Similarly, Korner and colleagues,<sup>3</sup> in a retrospective evaluation of 45 distal humerus fractures in patients older than age 60, found a 29% postoperative complication rate (13 cases). Most complications (12) were related to implant failure or distal screw loosening; of these, 7 required revision surgery. Three of 8 patients in whom 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, functional outcomes according to MEPI scores were good to excellent in 26 patients (58%), with a median arc of motion of 100° (range, 55°-135°), which led the authors to conclude that preservation of the elbow joint by ORIF of fractures should be the main goal of management in these cases. They believed that distal implant fixation was a problem, likely because of age-dependent bony demineralization.

Frankle and colleagues<sup>23</sup> compared TEA and ORIF outcomes. Unlike our findings, 90% of their TEA outcomes and 33% of their ORIF outcomes were excellent. As there were 1 fair and 3 poor results in the ORIF group and no poor and no fair results in the TEA group, they were led to recommend arthroplasty for patients older than age 65.

In our series, newer locking implants potentially could have reduced the number of hardware-failure complications in the elderly, osteoporotic bone. In a multicenter prospective randomized trial, McKee and colleagues<sup>24</sup> compared TEA and ORIF results (mean patient age, 77 years) and found earlier improvement and a lower reoperation rate in the TEA group. The difference in outcome scores evened out by 1-year follow-up.

Both Frankle and colleagues<sup>23</sup> and McKee and colleagues<sup>24</sup> found better outcomes for TEA at least at early follow-up; in our study, TEA and ORIF groups showed no difference in outcomes.

Limitations of our study include the retrospective nature of patient selection and the inherent biases of the 2 treating physicians. In addition, this study had only a small number of patients, and outcome differences may have been significant with a larger cohort. Furthermore, follow-up was a mean of only 14.8 months; in the future, particularly with TEA, longer follow-up may change the outcomes and results. Nevertheless, we believe that this study contributes to the research that has compared TEA and ORIF outcomes in an injury pattern that is becoming more common.

In conclusion, when deciding which surgical option to use to treat an intra-articular distal humerus fracture in a patient with osteoporosis, the surgeon must consider multiple factors. Implant selection must be based on bone quality, expected outcome, and surgeon experience. We have found that both TEA and ORIF provide

good results in the treatment of this injury in the elderly osteoporotic elbow.

## AUTHORS' DISCLOSURE STATEMENT

Dr. Egol notes that he serves on the advisory board for Surgix, is an unpaid consultant for Exactech, and receives research support from Stryker, Synthes, and Biomet. Dr. Tejwani notes that he serves on the speakers' bureau for Zimmer, is a consultant to Stryker, and receives royalties from Biomet. Dr. Tsai and Dr. Vazquez report no actual or potential conflict of interest in relation to this article.

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