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Hemiarthroplasty for the Treatment of Distal Humerus Fractures: Short-term Clinical Results

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Abstract: Total elbow arthroplasty is the current gold standard of treatment for unreconstructable distal humerus fractures; however, longevity of the implant remains a concern in younger, more active patients. Distal humerus hemiarthroplasty offers an alternative and may allow for more durable results. The authors retrospectively evaluated the short-term clinical outcomes of 10 patients who underwent elbow hemiarthroplasty for distal humerus fractures. This short-term review suggests that distal humerus hemiarthroplasty may be an effective treatment for certain distal humerus fractures. Additional studies must be conducted to further define the role of elbow hemiarthroplasty for the treatment of complex fractures of the distal humerus.

Management of distal humerus fractures can be challenging. With the goal of restoring a painless, functional, and stable elbow joint, the gold standard of treatment for distal humeral fractures is open reduction and internal fixation (ORIF).[1-3] Fracture comminution or osteoporosis may compromise the stability of the construct and lead to poor clinical outcomes. In these situations, total elbow arthroplasty may offer a superior option in situations when satisfactory elbow reconstruction is unachievable.[4]

However, total elbow arthroplasty is only recommended in patients older than 70 years due to concerns of aseptic implant loosening.[5] In addition, risks of periprosthetic fracture[6] and the generation of polyethylene wear that occurs with linked implants[7] may compromise sustained clinical success of the total elbow arthroplasty. Patients undergoing total elbow arthroplasty must also maintain an extremity-specific sedentary lifestyle, sacrificing the ability to use their operative extremity for any significant weight-bearing activities. Hemiarthroplasty eliminates the need for an ulnar component and placement of polyethylene and may allow for a more durable treatment option in the younger patient population.

The purpose of the current investigation was to retrospectively evaluate the short-term clinical outcomes of 10 patients who underwent distal humeral hemiarthroplasty for comminuted intra-articular distal humerus fractures. The authors hypothesized that the use of a distal humerus hemiarthroplasty for unreconstructable elbow fractures would allow for excellent clinical outcomes comparable with historic control groups of total elbow arthroplasty for treatment of unreconstructable distal humeral fractures.

Materials and Methods

All research was approved by the institutional review board and performed in accordance with the ethical standards set forth by the university committee on human experimentation. Between August 2008 and February 2012, ten patients underwent distal humerus hemiarthroplasty as a Federal Drug Adminstration off-label use. Inclusion criteria for distal humeral hemiarthroplasty included low distal humeral fractures with comminution and poor bone quality that were deemed unreconstructable by the senior author (J.M.I.). All fractures demonstrated an intact radial head and coronoid process, intact sigmoid notch cartilage, intact or reconstructable medial or lateral columns, intact or repairable collateral ligaments, and an intact elbow extensor

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mechanism. No patients were skeletally immature, had a pathologic fracture, or had multisystem polytrauma requiring additional operative treatment.

Fractures were retrospectively classified on the basis of the Orthopaedic Trauma Association classification system by a radiologist blinded to the eventual treatment choice (Figure 1). The senior author, who is fellowship trained in shoulder and elbow surgery and has advanced training in orthopedic traumatology, performed all hemiarthroplasty surgeries.

A previously described standard technique was used for all elbow hemiarthroplasty surgeries.[8] Hemiarthroplasty was performed using the Tornier Latitude system (Tornier North America, Stafford, Texas) (Figures 2A, B). In brief, with the patient in a supine position, a standard posterior approach to the elbow was used. The ulnar nerve was routinely identified and transposed subcutaneously at the completion of the case. All patients had an olecranon osteotomy created to facilitate exposure of the fracture. Bicolumnar reconstruction was performed when necessary using precontoured anatomic plates (Acumed, LLC, Hillsboro, Oregon) (Figure 2C).

The trochlea was resected, the humeral canal was broached and reamed, chamfer cuts were created in the distal humerus as necessary, and implants were trialed with attention directed toward re-creation of the flexion–extension axis of the elbow joint. Careful attention was also paid to recreate the radiocapitellar relationship. Bone graft harvested from the removed distal humeral bone was placed behind the anterior flange. Once the final implant size was selected, it was then cemented into place using a cement gun with a cement restrictor in the humeral canal.

The olecranon osteotomy was fixed using a 6.5-mm cannulated screw, the O-rod (Acumed, LLC) (Figures 2A, B), or a tension-band wire construct (Figure 2C). Selection was based on surgeon preference and implant availability. The collateral elbow ligaments were maintained, and column reconstruction was performed when necessary. No specific repair or reconstruction of the ligaments was necessary. The ulnar nerve was transposed in the subcutaneous tissue. Layered closure was then performed over suction drains.

Postoperatively, patients were placed in a sling for comfort care. Individuals with operative columnar fixation had additional immobilization for 2 weeks in a splint with the arm flexed at 90°. Active assisted motion was begun immediately in all planes, and passive motion was avoided entirely. At 6 weeks, patients were instructed to begin light elbow strengthening exercises, and no weight limitations were suggested.

Patients were retrospectively contacted and clinically evaluated during routine follow-up. Range of motion was measured using a goniometer, and elbow strength was measured using standard clinical examination. Clinical performance was calculated by using the Disabilities of the Arm, Shoulder, and Hand (DASH) and Mayo scores. Serial anterioposterior and elbow radiographic review was performed to correlate radiographic results with clinical outcome.

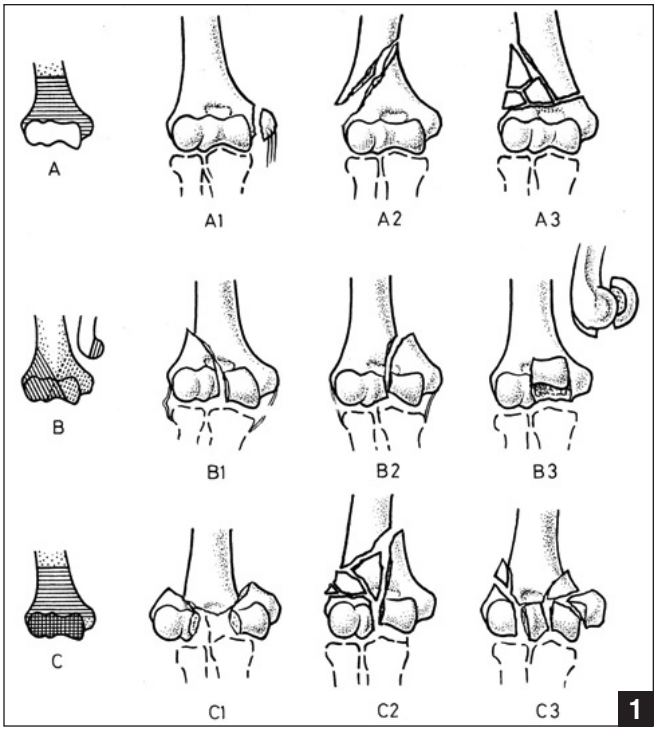

Figure 1: Orthopaedic Trauma Association classification of distal humerus fractures.

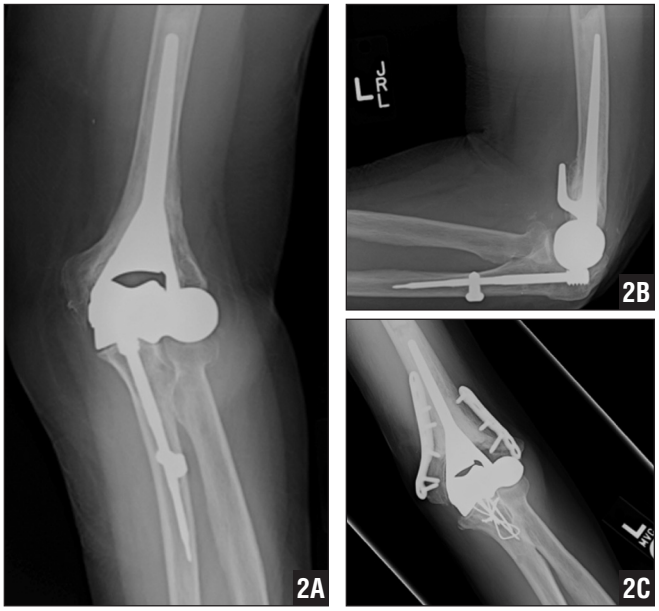

Figure 2: Anteroposterior (A) and lateral (B) radiographs of a distal humerus hemiarthroplasty showing O-rod (Acumed, LLC, Hillsboro, Oregon) olecranon osteotomy fixation. Anteroposterior radiograph showing additional bicolumnar fixation with wire tension-band osteotomy fixation (C).

Table

Patient Motion and Outcome Measures

Patient No.	Age, y	deg					Mayo Score	DASH Score
		Flexion	Extension	ROM	Pronation	Supination		
1	77	130	15	115	70	70	95	6.67
2	56	40	10	60	40	70	N/A	27.5
3	69	130	30	100	70	70	70	35
4	72	145	30	115	70	70	80	55
5	74	130	35	95	60	70	65	55.4
6	72	110	45	65	80	80	95	4.2
7	80	140	30	110	70	70	60	44.2
8	81	130	0	130	60	60	55	62.5
9	80	130	0	130	60	60	100	0.83
10	58	N/A	N/A	N/A	N/A	N/A	75	59.3
Average	71.9	121	21.67	102	64	69	77	35
SD	8.8	32	16	25	11	6	16	24

Abbreviation: DASH, Disabilities of the Arm, Shoulder, and Hand; N/A, not available; ROM, range of motion.

Results

Ten patients (9 women, 1 man; average age, 73.4 years; range [standard deviation], 56-77 [8.8] years) were retrospectively evaluated. All had AO C2 or C3 fracture patterns (Figure 1). Four surgeries were performed on the dominant elbow.

The olecranon osteotomy fixation used included the Acumed O-rod in 4 cases, a wire tension band in 1 case, and a 6.5-mm cannulated screw in the remaining 5 cases. One patient had coexisting upper-extremity injuries (not requiring operative management) in addition to the index distal humerus fracture. This patient had concomitant scaphoid, radial head, and distal radius fractures that were treated nonoperatively.

In addition, 1 patient had previously undergone external fixation at an outside facility for an open distal humerus and lateral condyle fracture. One patient had coexisting medial and lateral epicondyle fractures that were fixed with Acumed plates concomitantly with the hemiarthroplasty procedure. In addition, 1 patient underwent hemiarthroplasty to treat a distal humerus nonunion for a previous unrelated injury that had failed nonoperative treatment.

At an average follow-up of 12 months, all patients regained triceps extension strength subjectively similar to their contralateral extremity, with a score of 5 of 5 in muscle strength. All particpants had an average flexion of 121°±32°, average extension deficit of 22°±16°, average elbow range of motion of 102°±25°, average pronation of 64°±11°, and average supination of 69°±6°. Mean Mayo score at follow up was 77.2±16, and mean DASH score was 35.1±24 (Table).

Complications were uncommon. One patient developed symptomatic olecranon hardware, which was subsequently removed. One patient sustained an olecranon fracture intraoperatively after osteotomy, which was acutely fixed with precontoured Acumed anatomic plate (Acumed, LLC). In addition, 1 patient had new postoperative persistent numbness in the ulnar nerve distribution.

No postoperative elbow subluxation or dislocations were observed. All columnar fractures fixed were considered healed based on clinical examination (lack of tenderness with palpation) and evidence of cortical healing visualized on serial radiographic evaluation. No heterotopic ossification was visualized radiographically, and no superficial or deep infections occurred. In addition, no radiographic lucencies were visible around the humeral components at final follow-up.

Discussion

Treatment of unreconstructable distal humerus fractures with elbow hemiarthroplasty may confer certain advantages not achievable with standard total elbow arthroplasty. Elbow stability is maintained by avoiding collateral ligament sacrifice needed during standard surgical approaches for total elbow replacement. In addition, hemiarthroplasty may not require the rigid physical restrictions for weight bearing that are mandatory for total elbow arthroplasty. Elbow hemiarthroplasty avoids all complications associated with polyethylene wear debris and loosening of the ulnar-sided implant.

Although elbow hemiarthroplasty was first implemented with acrylic implants in 1947,[9] a paucity of data currently exists examining modern hemiarthroplasty implants for the treatment of elbow fractures. The most commonly studied implant, the Kudo elbow hemiarthroplasty system (Biomet, Inc, Warsaw, Indiana), is an anatomic monoblock implant with 1 stem length and no flange. This implant can only be converted to an unconstrained total elbow arthroplasty.

The Kudo prosthesis has shown good short-term clinical success. Adolfsson and Hammer[10] and Adolfsson and Nestorson[11] reviewed this im-

plant in 2 separate investigations. Adolfsson and Hammer[10] retrospectively reviewed 4 distal humerus hemiarthroplasties; with an average follow-up of 10 months, average extension was 20°, average flexion was 126°, and average pronation and supination were each 78°. Using their Mayo scores, 3 patients were deemed to have an excellent outcome and 1 patient had a good outcome.

This trend was mirrored in the study by Adolfsson and Nestorson,[11] where at 4.5 years, 8 patients who underwent distal humerus hemiarthroplasty demonstrated mean elbow motion arcs from 31° to 126°. Of this group, 5 patients had an excellent outcome and 3 patients had a good outcome.

Unlike the Kudo system, the Tornier Latitude system is more versatile. This anatomic modular hemiarthroplasty system has several stem lengths, a flange, and, perhaps most importantly, is convertible to a linked or unlinked total elbow arthroplasty. In 2011, Burkhart et al[8] evaluated 10 patients (mean age, 75.2 years) who were treated with this system for osteoporotic, comminuted distal humerus fractures (n=8) or failed osteosynthesis (n=2). At a mean follow-up of 12.1 months, mean Mayo score was 91.3, mean DASH score was 11.5 points, mean extension deficit was 17.5°, mean elbow flexion was 124.5°, mean pronation was 80.5°, and mean supination was 79.5°. Per the Mayo performance score, 9 patients were considered to have good to excellent results and 1 patient had a fair clinical outcome. These patients were instructed to lift nothing more than 5 kg in a single event or more than 1 kg for repetitive actions.

The current short-term retrospective review demonstrates comparably similar outcomes for distal humeral hemiarthroplasty as prior studies.[8-11] Patient age and range of motion found in the current study were nearly identical to those in all prior studies.[8,10,11] Interestingly, Burkhart et al[8] achieved DASH scores approximately 20 points higher than the current results. It has been suggested that a difference of 17 points may be reflective of significant clinical outcomes for elbow surgery,[12] and it is unclear why these authors demonstrated different results. Obvious differences between the studies include the olecranon osteotomy and the different postoperative rehabilitation protocol in the current study. It is conceivable these discrepancies contributed to DASH score differences.

Interestingly, unlike other prior investigations, the current authors found no heterotopic ossification or progression of clinical or radiographic osteoarthritis.[8] Regardless, compared with historical studies, patients undergoing treatment for unreconstructable elbow fracture with distal humeral hemiarthroplasty demonstrated clinical function similarly achieved with other forms of fixation.[4,13]

However, limitations to the current study exist. All of the weaknesses inherent with a retrospective review of a single-surgeon series should be considered. No control group existed and, accordingly, clinical comparisons to more traditional options of treatment for distal humeral fracture cannot directly be made. In addition, mid- to long-term clinical outcomes cannot be extrapolated from the current report.

The literature is sparse regarding use of hemiarthroplasty for distal humerus fractures. The current investigation provides additional outcome data for distal humerus hemiarthroplasty used for the treatment of unreconstructable distal humerus fractures. However, more long-term prospective comparative research contrasting total elbow arthroplasty must be performed to confirm clinical outcomes and to define the role of elbow hemiarthroplasty in elbow fracture management.

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