Journal of Shoulder and Elbow Arthroplasty
Volume 4: 1–6

DOI: 10.1177/2471549220960052
journals.sagepub.com/home/sea
SAGE

Distal Humerus Fractures Managed With Elbow Hemiarthroplasty

JD Stephens, DO[1], Brandon Kohrs, DO[1], Logan Bushnell, DO[1], Speros Gabriel, BS[1] and H Brent Bamberger, DO[1]

Abstract

Background: Distal humerus fractures not amenable to open reduction internal fixation (ORIF) present a unique dilemma, especially for patients that weight bear through assistive devices. The one accepted operative treatment for irreparable distal humerus fractures is total elbow arthroplasty (TEA). However, TEA commonly requires lifetime weight lifting restrictions and has limited long term results. Elbow hemiarthroplasty (EHA) represents an alternative treatment modality. This study reviews patients treated with EHA permitted to weight bear postoperatively.

Methods: Twelve patients underwent EHA for comminuted distal humerus fractures deemed non-reconstructable by ORIF. Patient survey data was collected retrospectively. All patients were allowed to weight bear as tolerated through the operative extremity. Outcome measures included Patient rated elbow evaluation (PREE), Mayo elbow performance score (MEPS), and whether revision surgery was required.

Results: The average MEPS score was 76.1 indicating fair outcomes and the average PREE score was 41. One patient required revision. Average follow up was 44.1 months. Three patients required an assistive device prior to injury.

Discussion: EHA serves as a viable option for non-reconstructable distal humerus fractures. EHA does not require a weight lifting restriction, which is a benefit over TEA. Overall, patients reported preserved functional capabilities but did report moderate pain. EHA demonstrated durability, although one patient required revision.

Conclusion: With growing interest in use of EHA, further studies are required to evaluate EHA as a superior treatment for patients with nonreconstructable traumatic distal humerus fractures; however, this study does support use in elderly patients with intermediate follow up.

Keywords

Hemiarthroplasty, elbow, immediate weight bearing, non-reconstructable, distal humerus fracture

Date received: 2 April 2020; revised: 26 July 2020; accepted: 25 August 2020

Introduction

Comminuted intraarticular distal humerus fractures present a challenge for management. The standard of care for distal humerus fractures not amenable to open reduction internal fixation (ORIF), has been a total elbow arthroplasty (TEA).[1–3] However, TEA has pitfalls. Linked implants have a theoretical risk of polyethylene wear, aseptic loosening, periprosthetic fracture, etc. Moreover, patients often must obey lifelong weight lifting restrictions postoperatively.[4] It has been proposed that patients undergoing TEA should not lift any more than 2 pounds on a repetitive basis or more than 10 pounds during a single event,[5] which may equate to a fairly sedentary lifestyle. This puts significant limitations on elderly individuals who are more likely to be dependent on assistive devices for ambulation and for weight bearing through the elbow while rising from a seated position. Another issue with the lifelong restrictions of a TEA is that it has done poorly in younger individuals

[1]Department of Orthopedics, Grandview Medical Center, Affiliate of Kettering Health Network and Ohio, University Heritage College of Osteopathic Medicine, Dayton, Ohio

Corresponding Author:
JD Stephens, Grandview Medical Center Library, 405 W. Grand Ave, Dayton, OH 45405, USA.
Email: j.d.stephens@ketteringhealth.com

with up to at least 22% revision rates reported at 7.6 and 10.8 years in individuals less than 40 years old.[6,7]

As a result, there has been a growing interest in elbow hemiarthroplasty (EHA) as an alternative to TEA.[8] EHA has been utilized across the globe, including the U.S. However, in the U.S., the implants are used off-label, as there is no Food and Drug Administration (FDA) approval for EHA. Evidence regarding EHA is limited to few case reports and biomechanical studies with relatively short term follow up but early results have been promising for functional outcomes as compared to previous data on TEA for this specific subset of fractures.[9–12]

Although there has been a recent influx of hemiarthroplasty data, there is limited intermediate to long term data currently that assesses the patient outcomes of EHA and durability of EHA with patients allowed to weight bear as tolerated throughout follow up. One main benefit of EHA is the potential to allow for immediate weight bearing through the upper extremity for elderly individuals who often rely on assistive devices for mobilization. It may also allow increased function in younger individuals who wish to maintain a modest level of activity beyond the two-pound weight limit commonly recommended for TEA.

The goal of the present study is to assess the outcomes of patients with non-reconstructable distal humerus fractures treated with EHA that were permitted to weight bear as tolerated immediately postoperatively. Outcomes were evaluated based on patient satisfaction, functionality and durability with intermediate to long term follow up. We hypothesized that EHA would have low rates of revision surgery while allowing immediate weight bearing.

Methods

All research was approved by the institutional review board and performed in accordance with the ethical standards set forth by the hospital committee on human experimentation. Between March 2011 and August 2017, 12 patients were identified at a single institution that were treated with EHA as a FDA off-label use for acute traumatic distal humerus fractures. All were deemed non-reconstructable by means of ORIF due to the extensive nature of the fracture pattern, comminution, and bone quality. Of these 12 patients, one patient was lost to follow up, one patient had deceased from unrelated causes, and one patient was excluded because EHA was utilized as a salvage procedure. Ultimately, 9 patients were included in this case series. Each patient was retrospectively contacted and a phone interview was conducted to complete a survey. Additionally, patient electronic medical records (EMR) were reviewed to obtain objective data from physical examinations performed in follow up from each patient's last encounter by the operating surgeon. Postoperative range of motion and whether any patients required a revision surgery were also recorded. All patients were evaluated using a calculated Patient Rated Elbow Evaluation (PREE), Mayo Elbow Performance Score (MEPS), subjective pain level and whether or not the patient required a revision operation.

The total PREE score rates pain and disability equally with a higher score indicating more pain and functional disability (i.e., 0 = no disability).

All patients were living independently prior to injury. Inclusion criteria included a non-reconstructable fracture of the distal humerus as deemed by the operating surgeon treated with EHA. All patients were operated on by one of two board-certified orthopedic hand surgeons. All fractures demonstrated an intact radial head and coronoid process, intact or repairable collateral ligaments and intact elbow extensor mechanism. No patients had pathologic fractures. Please refer to Figure 1 for example of fracture patterns treated with EHA and postoperative imaging.

Surgical Technique

A standard posterior approach to the elbow was performed in all cases. Eight of the 9 patients reviewed underwent an olecranon osteotomy to further aid in visualization of the distal humeral articular surface and fracture. The ulnar nerve not routinely transposed unless instability was noted. Four patients required lateral column reconstruction. Implants were cemented. If performed, the olecranon osteotomy was fixed using cannulated screws or an olecranon plate. Surgical technique differed marginally depending on surgeon preference. The Tornier Latitude implant system (Wright Medical Memphis, TN, U.S.A) was utilized in all the patients reviewed. This is more adaptable than prior systems and is an anatomic modular system specifically designed for the stemmed humeral component to be used in isolation as a hemiarthroplasty. However, it may be converted to a linked or unlinked TEA.

Collateral ligaments were preserved and three patients did require reconstruction of one or both collateral ligaments from primary injury or reconstruction of the condyles. Postoperatively, patients were put into a sling for comfort but were allowed immediate weight bearing through their operative extremity. Active assisted range of motion therapy was initiated early in post op care. At 6 weeks postoperatively, elbow-strengthening exercises were initiated.

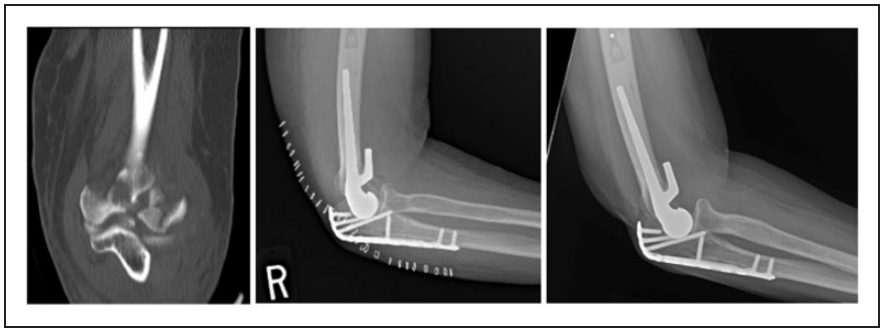

Figure 1. A, Preoperative coronal CT image demonstrating a comminuted distal humerus fracture. B, Two-week postoperative lateral radiograph of EHA and olecranon osteotomy. C, Three year follow up lateral radiograph.

Table 1. Patient Age, Follow Up Time in Months, MEPS, PREE, Revision Requirement, Pain Score and Assistive Device Requirement.

Patient	Age at Time of Surgery (yrs)	Follow Up Time (Months)	MEPS	PREE	Revision Required	Pain Score	Assist Device Required Prior to Surgery
#1	58	59	Fair (70)	50.66	No	Moderate	No
#2	63	52	Fair (70)	34.66	No	Moderate	No
#3	84	25	Fair (70)	88	No	Moderate	No
#4	81	36	Fair (70)	36.66	Yes	Moderate	Yes
#5	55	23	Good (85)	30.33	No	Mild	No
#6	83	34	Fair (70)	44	No	Moderate	Yes
#7	68	31	Excellent (95)	4	No	None	No
#8	92	41	Fair (70)	39.66	No	Moderate	Yes
#9	53	96	Good (85)	40.9	No	Mild	No

Results

The average time of follow up was 44.1 months; range 23 to 96 months. The median time to follow up was 36 months. The mean patient age at time of surgery was 71 years of age; range [standard deviation], 55 to 92 [13.7] years. Three patients, or 33%, utilized an assistive device for mobilization prior to injury. The average PREE score and MEPS score for the patients were 41 points and 76.11 points, respectively. The median PREE score was 39.66 points. The median MEPS score was 70 points. Six of the nine patients had fair outcomes, 2 with good outcomes and 1 with excellent outcomes represented by their MEPS scores. Refer to Table 1 for data summary.

One patient required revision surgery. Refer to Figure 2 for injury radiograph and postoperative imaging of patient requiring revision. The patient was 81 years old at the time of EHA and had a history of osteoporosis, coronary artery disease, and atrial fibrillation. The patient had full active range of motion with fair functional status and moderate pain scores in the postoperative period following EHA. An olecranon osteotomy was performed during EHA in this case. The patient was revised from EHA to TEA 36 months following her index EHA. Regarding other complications, one additional patient did undergo additional surgery two weeks following the index procedure for hematoma evacuation and again 3 months later for ulnar nerve transposition. Another patient had a coexisting ipsilateral distal radius fracture treated with ORIF performed subsequently from primary injury. Another patient had a coexisting olecranon fracture treated with ORIF with an olecranon plate (Synthes-West Chester, PA. U.S.A.) concomitantly as hemiarthroplasty. Four patients had coexisting medial or lateral epicondyle fractures requiring fixation. A distal humerus plate (Synthes-West Chester, PA. U.S.A.) was used concomitantly with hemiarthroplasty in those cases. No patients undergoing olecranon osteotomy reported irritation from symptomatic hardware, which is a commonly cited complication in the literature.[12–14] No postoperative infections were noted. The Tornier Latitude system was utilized in all patients. Of the nine patients included in this series, six patients subjectively rated their pain as moderate. One patient rated pain as nonexistent and the remaining two patients rated pain as mild. Two of the patients were former smokers. The remainder had no history of tobacco usage. Three of

Figure 2. A, Preoperative AP radiograph of a traumatic comminuted distal humerus fracture. (B, C) AP and lateral radiographs taken two weeks post op from EHA. (D, E) Lateral and AP radiographs taken 36 months postoperatively demonstrating hardware failure.

the 8 patients carried the established diagnosis of osteoporosis and clinical depression. Additionally, one patient had an established 30-year history of multiple sclerosis with associated baseline upper extremity neuropathy and another with longstanding upper extremity peripheral neuropathy. Both of these patients reported moderate subjective pain levels but also reported moderate pain prior to injury.

Discussion

In this retrospective series review of patients, EHA used as a treatment of non-reconstructable distal humerus fractures allowed for maintained functionality. There were no mandated physical weight lifting restrictions in these patients. With only one patient requiring revision, this suggests that EHA is a durable option in this patient population. An absence of weight lifting restrictions becomes important in patients who rely on weight bearing through assistive devices for mobilization. This case series further supports EHA as a viable option for patients with traumatic distal humerus fractures unable to be managed by ORIF. Patients reported overall preserved functional capabilities signified by a median PREE score of 39.66 points and median MEPS of 70 points. However, most did record their average pain level as moderate. Patients were asked to select a subjective pain score, which was utilized to calculate their MEPS. The majority of patients reported a moderate pain level, however, many of these patients were not requiring use of regular analgesics and therefore the average MEPS may under appreciate the overall outcomes among these patients. Additionally, there was one revision surgery to date demonstrating that the constructs overall have withstood patient activities without a weight bearing restriction.

There is a growing interest in use of EHA for management of non-reconstructable distal humerus fractures. In a more recent study, midterm data, up to 72 months, has shown maintained range of motion, good Disabilities of the Arm, Shoulder, and Hand (DASH) scores, good Mayo Elbow Performance Score (MEPS), and hardware without revision.[15] Additionally, a systematic review by Dunn et al. in 2014 that looked at 129 patients over 17 different studies and found at an average of 42 months follow up there was 76% good to

excellent outcomes based on functional outcomes scores in non-fractures and 67% good to excellent outcomes in patients with distal humerus fractures.[12] The most commonly published complication for EHA includes hardware irritation from olecranon osteotomy ORIF.[12–14] With use of the "triceps on approach," this complication was eliminated in further studies.[16] Interestingly, none of the patients reviewed in the current study developed hardware irritation from an olecranon osteotomy requiring hardware removal. However in the case that required revision, an olecranon osteotomy was performed during the index EHA. Hardware failure was noted radiographically at 36 months follow up from EHA. The patient did have advanced age and multiple comorbidities including osteoporosis. Upon further evaluation of the postoperative radiographs, it appears the hardware of the olecranon osteotomy became loose and created significant osteolysis. Work up for infection was negative. Radiographically and intraoperatively, the humeral component remained well fixated. The hardware from the olecranon osteotomy was removed and the ulnar component of the Tornier system was added to convert to a TEA. Although this patient required revision surgery, the olecranon osteotomy hardware appears to be the underlying issue, and revision may have been avoided had an alternative surgical technique been used. Although an olecranon osteotomy was commonly used in the current study, the advantages of a triceps-sparing approach are noted and would prevent issues with hardware irritation in the future.

In 2019, Al-Hamdani et al. published their results for 24 active patients with acute intraarticular and comminuted distal humerus fractures treated with EHA. Their study included median follow up time of 20 months (range, 12–70 months) and mean patient age of 65 years (range, 47–80 years). They reported overall good outcomes with median MEPS scores of 85 points (range, 50-100 points) and a median Oxford Elbow Score of 40 points (range, 17–48 points). They cited a median flexion/extension range of motion arc of 110 degrees and subjective median pain severity score of 2 on a scale from 0 to 10 (where 0 represents a pain-free elbow). They concluded that EHA provided a good option for the management of non-reconstructable acute distal humerus fractures, especially in active patients.[17] In the current series, the patient population was older on average at the time of surgery. However, their results are favorable and add support for the utility of EHA. An older patient population may be more likely to require assistive devices for mobilization. The advantage of no weight lifting restrictions may be very appealing for a more active elderly patient or a patient reliant on weight bearing through an assist device for ambulation.

In 2012, Argintar et al. evaluated 10 patients having undergone EHA for distal humerus fractures also using the Tornier Latitude system. In their review, they cited infrequent complications and average MEPS and DASH scores, 77.2 points and 35.1 points, respectively.[18] Their MEPS scores are comparable to those of our study. Argintar et al. reported all patients had an elbow extension deficit of 22 degrees, similar to the ones exhibited in the current series, however all of our patients had an overall range of motion arc greater than 100 degrees. Their series comprised follow up of just 12 months, but their outcome scores indicated good clinical outcomes pertaining to functionality. This is similar to the findings of the current series with a median PREE score of 39.66 points.[18] PREE scores rate pain and disability equally, and in our series patients reported good functional capabilities with activities of daily living and hobbies but did report a moderate baseline level of pain. In the current series, patients were allowed to immediately weight bear potentially giving them a benefit. Even while allowing immediate weight bearing, there has been one revision to date. Without comparing TEA and EHA directly, it is difficult to predict which patients report more pain, as pain is commonly cited in TEA patients as well. This series further provides evidence that EHA will endure the physical demands of elderly patients at intermediate follow up.

The limitations of this study include a limited number of patients. Additionally, this was a retrospective series of two surgeons' cases. Two patients were unable to be contacted for follow up and one was excluded due to revision. Patients were permitted to weight bear as tolerated throughout follow up but the amount of weight bearing each patient actually performed was not quantified. The average follow up in this study was 44.1 months, which provides an intermediate benchmark but cannot be extrapolated for longer-term outcomes. One patient had a particularly long follow up, which increased the average. There was no control group. No comparisons to other treatment modalities for management of distal humerus fractures were studied.

Conclusion

With growing interest in the use of EHA, further studies are required to evaluate EHA as a superior treatment for patients with non-reconstructable traumatic distal humerus fractures; however, this study does support use in elderly patients with intermediate follow up.

Acknowledgements

Heritage College of Osteopathic Medicine, Ohio University.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

JD Stephens https://orcid.org/0000-0003-1087-5137
Speros Gabriel https://orcid.org/0000-0002-7548-018X
H Brent Bamberger https://orcid.org/0000-0003-3019-0936

References

1. Frankle MA, Herscovici D, DiPasquale TG, Vasey MB, Sanders RW. A comparison of open reduction and internal fixation and primary elbow arthroplasty in the treatment of intraarticular distal humerus fractures in women older than age 66. *J Orthop Trauma*. 2003;17:473–480.
2. Garcia JA, Mykula R, Stanley D. Complex fractures of the distal humerus in the elderly. The role of total elbow replacement as a primary treatment. *J Bone Joint Surg (Br)*. 2002;84(6):812–816.
3. Kamieni S, Morrey BF. Distal humeral fractures treated with noncustom total elbow replacement. *J Bone Joint Surg (Am)*. 2004;86:940–947.
4. Ducrot G, Ehlinger M, Adam P, Di Marco A, Clavert P, Bonnomet F. Complex fractures of the distal humerus in the elderly: is primary total elbow arthroplasty a valid treatment alternative? A series of 20 cases. *Orthopaed Traumatol Surg Res*. 2013;99:10–20.
5. Sanchez-Sotelo J. Total elbow arthroplasty. *Open Orthopaed J*. 2011;5:115–123.
6. Park JG, Cho NS, Song JH, Lee DS, Rhee YG. Clinical outcomes of semiconstrained total elbow arthroplasty in patients who were forty years of age or younger. *J Bone Joint Surg Am*. 2015;97(21):1781–1791.
7. Celli A, Morrey BF. Total elbow arthroplasty in patients forty years of age or less. *J Bone Joint Surg Am*. 2009;91(6):1414–1418.
8. Papandrea RF. Hemiarthroplasty of the distal humerus. *Oper Tech Shoulder Elbow Surg*. 2011;1:747–763.
9. Nestorson J, Ekholm C, Etzner M, Adolfsson L. Hemiarthroplasty for irreparable distal humeral fractures: medium-term follow-up of 42 patients. *Bone Joint J 97B* 2015;10:1377–1384.
10. Desai SJ, Lalone E, Athwal GS, Ferreira LM, Johnson JA, King GJW. Hemiarthroplasty of the elbow: the effect of implant size on joint congruency. *J Shoulder Elbow Surg* 2016;25:297–303.
11. Heijink A, Wagener ML, de Vos MJ, Eygendaal D. Distal humerus prosthetic hemiarthroplasty: midterm results. *Strateg Trauma Limb Reconstruct* 2015;10:101–108.
12. Dunn J, Kusnezov N, Pirela-Cruz M. Distal humeral hemiarthroplasty: indications, results, and complications. A systematic review. *HAND* 2014;9:406–412.
13. Parsons M, O'Brien R, Hughes J. Elbow hemiarthroplasty for acute and salvage reconstruction of intra-articular distal humerus fractures. *Tech Hand Upper Extrem Surg* 2005;6(2):87–97.
14. Rangarajan R, Rick P. Distal humeral hemiarthroplasty versus total elbow arthroplasty for acute distal humeral fractures. *Orthopedics* 2017;40:13–23.
15. Mark S, Karl S, Klein Christopher C, Narvy Steven J, Lee Brian K, Itamura John M. Hemiarthroplasty for the treatment of distal humerus fractures:midterm clinical results. *J Shoulder Elbow Surg*. 2017;26:389–393.
16. Phadnis J, Banerjee S, Watts AC. Elbow hemiarthroplasty using a 'triceps-on' approach for the management of acute distal humeral fractures. *J Shoulder Elbow Surg* 2015;24:1178–1186.
17. Al-Hamdani A, Rasmussen JV, Sorensen AKB, et al. Good outcome after elbow hemiarthroplasty in active patients with an acute intra-articular distal humeral fracture. *J Shoulder Elbow Surg*. 2019;28:925–930.
18. Argintar E, Berry M, Narvy SJ, Kramer J, Omid R, Itamura J. Hemiarthroplasty for the treatment of distal humerus fractures: short-term clinical results. *Orthopedics*. 2012;35(12):1042–1045.