J Shoulder Elbow Surg (2019) 28, 925–930

ELSEVIER

Journal of Shoulder and Elbow Surgery

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# Good outcome after elbow hemiarthroplasty in active patients with an acute intra-articular distal humeral fracture

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**Background:** This study reported the clinical outcomes and complications after elbow hemiarthroplasty (EHA) for acute distal humeral fractures Arbeitsgemeinschaft für Osteosynthesefragen (AO)/Orthopaedic Trauma Association (OTA) type C2 and C3.
**Method:** During a 6-year period, 24 active patients with acute intra-articular and multifragmentary distal humeral fractures were treated with an EHA by 1 of 4 experienced elbow surgeons. Mean age was 65 years (range, 47-80 years). Median follow-up time was 20 months (range, 12-70 months).
**Results:** The median Oxford Elbow Score was 40 points (range, 17-48 points), where 48 points represents a normal elbow. Outcomes were "good to excellent results" in 21 patients, "fair" in 2 patients, and "poor" in 1 patient. The median Mayo Elbow Performance Score was 85 points (range, 50-100 points), where 100 points represents a normal elbow. Outcomes were "good to excellent" in 19 patients, "fair" in 4 patients, and "poor" in 1 patient. The median pain severity score was 2 (range, 0-7) in a scale from 0 to 10 where 0 represents a pain-free elbow. The median flexion/extension and supination/pronation arcs were 110° (range, 60°-140°) and 160° (range, 115°-180°), respectively. Complications were recorded in 7 patients, and 3 of them underwent reoperation because of stiffness, which was treated with open release.
**Conclusions:** EHA provides a good and reliable option in the treatment of an acute intra-articular distal humeral fracture unsuitable for open reduction and internal fixation, especially in active patients.
**Level of evidence:** Level IV; Case Series; Treatment Study


**Keywords:** Elbow; hemiarthroplasty; humerus; fracture; outcome; reoperation; complication

Adult distal humeral fractures comprise 2% to 5% of all fractures and 30% of all elbow fractures.[1,15] Intra-articular and multifragmentary fractures pose a clinical challenge. Open reduction and internal fixation (ORIF) is often preferred, but the outcome varies and, in many cases, is disappointing.[6]

Ethical Committee approval was not required for this study.

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1058-2746/$ - see front matter © 2018 Journal of Shoulder and Elbow Surgery Board of Trustees. All rights reserved.
https://doi.org/10.1016/j.jse.2018.10.018

Total elbow arthroplasty (TEA) is increasingly used in the treatment of fractures that are not amenable to ORIF, but mechanical complications related to the linked articulation and risk of loosening of the ulnar component remain a challenge, especially in active patients.[16] Thus, TEA is mainly suitable for elderly patients who have moderate functional demands[4] and are able to accept lifelong activity restrictions to prevent mechanical complications.

By using elbow hemiarthroplasty (EHA), the mechanical complications related to a linked articulation and loosening of the ulnar component are avoided, and there are no weight-bearing restrictions. The modern EHA has evolved from the early design of an acrylic arthroplasty, which was described by Mellen and Phalen in 1947.[10] EHA is used to treat acute fractures or fracture sequelae, but information about the functional outcome and complications is sparse.[7,11,12,17,18]

This study reports the clinical outcomes and complications after EHA for acute distal humeral fractures Arbeitsgemeinschaft für Osteosynthesefragen (AO)/Orthopaedic Trauma Association (OTA) type C2 and C3.

## Materials and methods

In this retrospective cohort study, we used our institutional database to identify all patients sustaining an acute distal humeral fracture treated surgically during a 6-year period (2011-2016). In that interval, 27 patients were treated with an EHA, 117 with ORIF, and 68 with a TEA. Our department is a referral center receiving complicated cases from an area with 2.5 million inhabitants. Simple fractures are treated in local hospitals. According to our intuitional treatment algorithm, extra-articular and nondisplaced intra-articular fractures (AO/OTA type A, B, and C1) are treated nonoperatively or with ORIF. Arthroplasty is only considered for comminuted intra-articular fractures (AO/OTA type C2 and C3) unsuitable for ORIF.

EHA was preferred in active patients, whereas TEA was preferred in elderly patients who had moderate functional demands and in patients who had significant radiographic signs of osteoarthritis. Conventional radiographs and computed tomography scans were performed for preoperative planning, but the final decision to perform ORIF, EHA, or TEA was made during the operation. All patients were operated on by 1 of 4 experienced elbow surgeons (A.A., A.S., K.H., B.O.). The indication and the type of treatment were always discussed during a conference meeting before surgery.

Three patients declined to participate in the follow-up because of long transportation time. No complications were recorded in those 3 patients according to the last out-patient clinic follow- up. Thus, 24 patients (21 women and 3 men) were eligible for clinical follow-up and radiographic evaluation. The median follow-up time was 20 months (range, 12-70 months). All patients had a minimum follow-up time of 12 months. Mean age was 65 years (range, 47-80 years), with 17 aged younger than 70. At the time of surgery, 6 patients were occupationally active. The fractures patterns were AO/OTA type C2 and C3.

The Oxford Elbow Score (OES) was used as the primary outcome assessment, and the Mayo Elbow Performance Score (MEPS), pain severity score (VAS), and range of motion were used as secondary outcome measures. For the 3 arthroplasties that required reoperation, the outcome scores were collected after the reoperation and at the same time as the other 21 arthroplasties.

The OES is a 12-item patient-administrated questionnaire that measures the quality of life in patients with an elbow disorder. There are 3 unidimensional domains: elbow function, pain, and social and psychological status.[8] Each question is answered on a 5-point scale, with each question contributing equally to the total score. Thus, the total score ranges from 12 to 60, with 60 being the worst. For ease of presentation, the score is converted to a scale from 0 to 48, with 48 being the best. The outcome can be interpreted based on a 48-point scale: 0 to 19, poor; 20 to 29, fair; 30 to 39, good; and 40 to 48, excellent. The Danish version,[13] which was used in this study, has been translated and culturally adapted according to the guidelines by Guillemin, Bombardier, and Beaton.

The MEPS is a surgeon-administrated instrument that evaluates the outcome after elbow surgery. There are 4 domains: pain (0-45 points), range of motion (0-20 points), stability (0-10 points), and difficulties in daily activities (0-25 points).[2,3] The outcome can be interpreted based on a 100-point scale: 0 to 60, poor; 60 to 74, fair; 75 to 89, good; and 90 to 100, excellent.

Radiographic evaluation was performed using anteroposterior and lateral radiographs. There is no specific and validated method to evaluate x-ray images after elbow arthroplasty or to evaluate post-traumatic osteoarthritis of the elbow joint. So, decreased height of the ulnar and radial cartilage, bone healing and joint alignment, arthroplasty loosening, and the presence of heterotopic ossification were analyzed as binary outcomes (yes or no) by the first author (Figs. 1 and 2.

The treatment was standardized. All were placed lateral supine, and a tourniquet was used. A posterior midline approach was used, and the ulnar nerve identified and protected but not transposed. All procedures were performed using a triceps split by a reversed Y-shaped incision. The Latitude anatomic hemiarthroplasty (Wright, Memphis, TN, USA) was used according to the manufacture's manual. A trial component was inserted, and range of motion and stability were evaluated before the component was inserted using standard cementing technique.

A suture passer was used to tunnel a FiberWire suture (Arthrex, Naples, FL, USA) through the arthroplasty (Fig. 3). The medial and lateral epicondyles, with the collateral ligaments attached, were then fixated to the arthroplasty using this FiberWire suture and subsequently to the humerus using additional FiberWire sutures (Figs. 4 and 5). Bone chips were placed between the arthroplasty and the epicondyles to stimulate bony healing. In patients with preserved medial column, the medial ligament was not detached during the procedure. The triceps was sutured side-to-side with FiberWire sutures, and the subcutaneous tissue and skin were closed in layers.

The patients did not receive indomethacin or any other kind of nonsteroidal anti-inflammatory medicine to prevent heterotopic ossification. An extension back splint was used for 3 to 4 days. The patients performed edema prophylactic exercises during the time of immobilization. All patients received standardized physiotherapy. This included active flexion and passive extension of the elbow the first 2 weeks, active flexion and extension without any weight bearing from 3 to 6 weeks, and light weight bearing after 6 weeks. Full weight-bearing exercises were allowed after 3 months.

Functional and patient-reported outcome scores, follow-up time, and length of sick leave did not follow the assumption of normal distribution and are presented as median and range. The analyses were performed using SPSS 21.0 software (IBM, Armonk, NY, USA).


**Figure 1** Preoperative **(a)** anteroposterior and **(b)** lateral x-ray images.

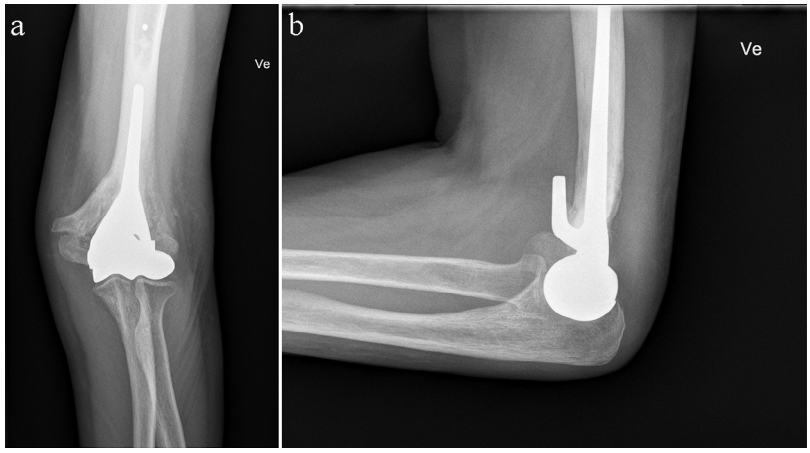


**Figure 2** **(a)** Anteroposterior and **(b)** lateral x-ray images at 5 months after surgery.

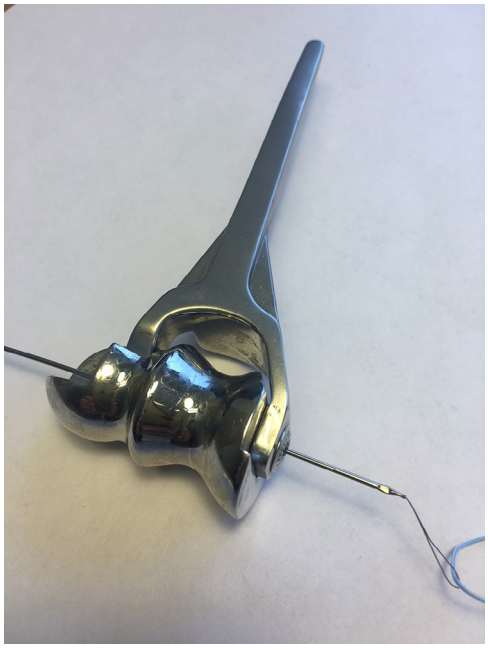

**Figure 3** Prosthesis and the suture passer.

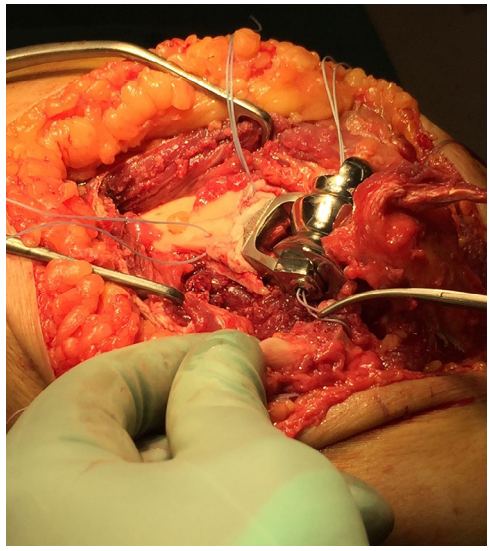

**Figure 4** Perioperative photo before the ligaments and the condyles were sutured.

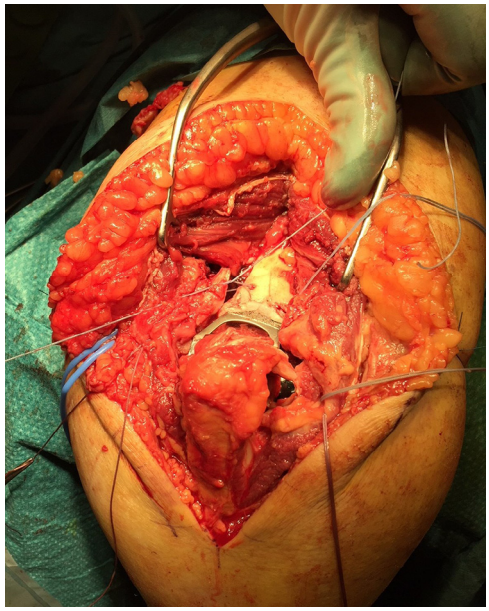

**Figure 5** Perioperative photo after the ligaments and the condyles were sutured.

## Results

The median OES was 40 (range, 17-48). Outcomes were "good to excellent results" in 21 patients, "fair" in 2 patients, and "poor" in 1 patient. The median MEPS was 85 (range, 50-100). Outcomes were "good to excellent" in 19 patients, "fair" in 4 patients, and "poor" in 1 patient. The median pain severity score was 2 (range, 0-7). The median flexion/extension and supination/pronation arcs were 110° (range, 60°-140°) and 160° (range, 115°-180°), respectively (Table I). Six patients were occupationally active at the time of surgery, and they all returned to the same occupation. The median sick leave was 10 weeks (range, 2-20 weeks).

Complications, defined as any unexpected adverse effect or event, were recorded in 7 patients. According to OES, 5 of them nevertheless achieved "good to excellent results," 1 a "fair" outcome, and 1 a "poor" outcome (Table II). Three patients underwent reoperation because of stiffness and were treated with open release at 6, 7, and 17 months after the index procedure (Table II). The ulnar nerve was affected in 3 patients. One had almost complete remission after 2 years, 1 had persistent sensory affection in fourth and fifth finger, and 1 had residual sensory and motor affection with deceased finger movement and atrophy of small muscles. Radiographic ulnar wear with heterotopic ossification was observed in 1 patient

**Table I** Patient data

| Patient | Age (yr) | Sex | Follow-up (mo) | OES | MEPS | Flexion/extension arc (°) | Pronation/supination arc (°) | Pain score |
|---|---|---|---|---|---|---|---|---|
| 1 | 66 | F | 70 | 39 | 65 | 75 | 130 | 6 |
| 2 | 61 | F | 64 | 42 | 100 | 110 | 170 | 0 |
| 3 | 53 | F | 53 | 39 | 85 | 120 | 160 | 2 |
| 4 | 66 | F | 67 | 46 | 100 | 105 | 170 | 0 |
| 5 | 70 | F | 25 | 46 | 85 | 115 | 160 | 0 |
| 6 | 59 | F | 23 | 40 | 100 | 85 | 115 | 0 |
| 7 | 62 | F | 22 | 42 | 85 | 130 | 180 | 1 |
| 8 | 56 | M | 20 | 40 | 85 | 105 | 140 | 2 |
| 9 | 73 | F | 14 | 17 | 65 | 115 | 160 | 7 |
| 10 | 71 | F | 15 | 34 | 85 | 130 | 160 | 0 |
| 11 | 67 | F | 20 | 44 | 85 | 110 | 140 | 2 |
| 12 | 64 | F | 19 | 23 | 50 | 65 | 150 | 7 |
| 13 | 62 | F | 13 | 37 | 75 | 90 | 160 | 2 |
| 14 | 56 | F | 14 | 42 | 100 | 115 | 160 | 1 |
| 15 | 70 | F | 12 | 43 | 80 | 90 | 150 | 4 |
| 16 | 47 | F | 12 | 32 | 80 | 60 | 140 | 4 |
| 17 | 68 | F | 12 | 42 | 100 | 135 | 160 | 2 |
| 18 | 70 | F | 20 | 43 | 85 | 140 | 160 | 1 |
| 19 | 68 | M | 20 | 48 | 95 | 85 | 160 | 0 |
| 20 | 65 | F | 15 | 35 | 85 | 135 | 150 | 2 |
| 21 | 70 | M | 14 | 35 | 85 | 125 | 150 | 5 |
| 22 | 66 | F | 14 | 23 | 70 | 105 | 150 | 6 |
| 23 | 80 | F | 12 | 31 | 65 | 120 | 160 | 6 |
| 24 | 62 | F | 30 | 44 | 80 | 85 | 140 | 2 |

*OES*, Oxford Elbow Score; *MEPS*, Mayo Elbow Performance Score; *F*, female; *M*, male.

**Table II** Complications

| Patient | Complication | OES | MEPS | Flex/ext arc (°) | Pro/sup arc (°) | Pain score |
|---|---|---|---|---|---|---|
| 12 | Stiffness (open release) | 23 | 50 | 65 | 150 | 7 |
| 13 | Stiffness (open release) | 37 | 75 | 90 | 160 | 2 |
| 24 | Stiffness (open release) | 44 | 80 | 85 | 140 | 2 |
| 2 | Ulnar nerve | 42 | 100 | 110 | 170 | 0 |
| 9 | Ulnar nerve | 17 | 65 | 115 | 160 | 7 |
| 19 | Ulnar nerve | 48 | 95 | 85 | 160 | 0 |
| 1 | Ulnar wear/heterotopic ossification | 39 | 65 | 75 | 130 | 6 |

*OES*, Oxford Elbow Score; *MEPS*, Mayo Elbow Performance Score; *Flex/ext*, flexion/extension; *Pro/sup*, pronation/supination.

who did not require revision. No aseptic loosening was recorded.

## Discussion

We found that EHA can be a good and reliable option in the treatment of an acute intra-articular and multifragmentary distal humeral fracture in active patients. The median OES was 40, and the median MEPS was 85. The median flexion/extension and supination/pronation arcs were 110° and 160°, respectively. The reason for the impaired range of motion cannot be deducted from the present study but may be related to scar tissue formation and stiffness of the joint capsule, which is why we recommend early mobilization.

One of the advantages of EHA is that elbow stability is preserved by repairing the collateral ligaments. The medial and lateral epicondyles with the inserted collateral ligaments were fixed to the implant. Furthermore, the mechanical complications associated with polyethylene wear debris and loosening of the ulnar component are avoided. Therefore, EHA may not require the rigid restrictions for weight bearing that are mandatory for TEA.

Welsink et al,[20] in their recent systematic review of 9379 TEAs, 9% because of acute distal humeral fractures, found that the range of motion after TEA was good overall, with a mean flexion-extension arc of 99°. The complication rates ranged from 11% to 38%, with clinical loosening being the most frequently reported complication (7%). Little et al,[9] in their systemic review of 6 studies including 79 TEAs for acute distal humeral fractures, found that 3% were revised and that 99% of the patients had good to excellent outcome. Plaschke et al[14] found in their retrospective study (n = 167) that patients with TEA for acute distal humeral fracture (n = 67) had poorer results than rheumatoid arthritis patients.

Fevang et al[5] included 526 TEAs from the Norwegian Arthroplasty Register. They reported overall 5-year and 10-year failure rates of 8% and 15%, respectively. Only minor differences were found between the different implants. Patients who developed traumatic arthritis after fracture had the worst prognosis compared with inflammatory arthritis. The authors were unable to draw any conclusions about TEA for acute distal humeral fractures because only 12 arthroplasties were recorded.

Soerensen et al[19] concluded in their study of 20 patients that TEA in complex fractures of the distal humerus in elderly patients can result in acceptable short-term to medium-term outcomes. Mean follow-up was 21 months (range, 4-54 months). Mean MEPS was 94 (range, 65-100). Mean flexion-extension arc and supination-pronation arc were 114° and 165°, respectively. According to MEPS, there were 15 excellent, 4 good, and 1 fair result.

The numbers of publications on EHA for acute distal humeral fracture is limited. Nestorson et al[11] included 42 EHAs for acute distal humeral fractures with a mean follow-up 34 months (range, 24-61 months). The mean flexion/extension arc was 105° (range, 60°-145°), and the mean MEPS was 90 (range, 50-100). One arthroplasty was revised due to loosening and a further 7 complications were recorded: 4 patients had additional surgery for limited range of movement and 1 for instability, and 2 patients had sensory ulnar nerve symptoms.

Schultzel et al[9] included 10 patients who underwent EHA for a distal humeral fracture with an average follow-up of 73 months (range, 36-96 months). The mean MEPS was 89 (range, 75-100), the average flexion-extension arc was 101°, and the supination-pronation arc was 152°. They concluded that EHA may be an effective treatment for certain distal humeral fractures.

Smith et al[18] reported a satisfactory outcome in 6 patients who were younger than 55 years. The mean follow-up time was 81 months (range, 24-133 months), and the mean MEPS was 88 (range, 55-100). Another study[7] of 6 patients operated on with EHA because of distal humeral fracture found that 4 patients were satisfied with the final result. Mean follow-up was 54 months (range, 21-76), and the average flexion-extension arc was 95° (range, 70°-115°), and the pronation-supination arc was 165° (range, 150°-180°).

Phadnis et al[12] included 16 patients who were treated with EHA for acute distal humeral fracture. The mean flexion-extension and pronation-supination arcs were 116° and 172°, respectively, and the mean follow-up was 35 months (range,

24-79 months). The mean MEPS and OES were 89 (range, 85-100) and 43 (range, 42-46), respectively.

Our results are similar with the results of previously published studies regarding the outcome of EHA for distal humeral fractures. However, the long-term outcome is unknown, and ulnar wear may affect the results in the coming years. A study with a long follow-up time is needed to fully understand the benefits of EHA compared with TEA.

The limitation of this study is its retrospective nature, the small size series (24 arthroplasties), and the short-term follow-up. Larger prospective series with systemic data collection and a long follow-up time are needed for safer effect estimate, and we therefore suggest a multicenter prospective randomized study be conducted.

## Conclusion

EHA provides a good and reliable treatment option for acute intraarticular and multifragmentary distal humeral fractures with good short-term results in active patients where primary osteosynthesis cannot be obtained. We observed 7 complications and no revisions. The development of elbow joint arthritis could be a risk and could affect the long-term results.

## Disclaimer

Bo S. Olsen has the following disclosures: Biomet, paid speaker; DePuy, a Johnson & Johnson Company, research support and unpaid consultant. The other authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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