Total elbow arthroplasty for acute distal humeral fractures in patients over 65 years old—Results of a multicenter study in 87 patients

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KEYWORDS
Distal humerus fracture; Total elbow arthroplasty; Osteoporosis

Summary
Introduction: Fractures of the distal humerus represent 5% of osteoporosis fragility fractures in subjects over the age of 60. Osteoporosis, comorbidities and intra-articular comminution make management of this entity difficult.

Hypothesis: The hypothesis was that total elbow arthroplasty could be a reliable treatment option in subjects over the age of 65 presenting with a fracture of the distal humerus.

Materials and methods: Eight-seven patients (80 women and 7 men) mean age 79 years old (65–93) underwent total elbow arthroplasty for the treatment of an AO type A fracture in 9 cases, type B in 8 and type C in 70.

Results: After a mean follow-up of 37.5 months (6–106) the Mayo Elbow Performance Score MEPS was 86 ± 14, the quick-DASH score was 24 ± 19 and the Katz score was 5 ± 1.5 points. The MEPS was better in patients with a high preoperative Katz score and a history of inflammatory arthritis who were living at home. Fifty-five patients (63%) presented with a pain-free elbow, and 20 (24%) with slight pain. The flexion-extension range of motion was 97 ± 22° and 48% presented with a flexion-extension arc of at least 100°. Function was normal in 69 patients. Complications were identified in 20 cases (23%) and revision surgery was necessary in 8 (9%). Two arthroplasties had to be changed, one for a fracture of the humeral stem component and the other for loosening. Only one infection occurred in this series.
Introduction

Fractures of the distal humerus are less frequent than fractures of the proximal humerus but represent 2% of all fractures and 5% of osteoporotic stress fractures in subjects over the age of 60. They occur in fairly young men with two peaks of frequency and in elderly women with an incidence that increases over the age of 60 [1]. In the past few years the incidence has seemed to increase and could be multiplied by three by 2030 [2]. Problems exist in the oldest population because of osteoporotic bone, comorbidities, and articular comminution, which make management difficult [3–8]. Total elbow arthroplasty (TEA) for the treatment of fractures of the distal humerus was proposed by Cobb and Morrey in 1997 with immediate satisfactory results [9]. The hypothesis of this study was that TEA could be a reliable therapeutic option in subjects over 65 years old presenting with an articular fracture of the distal humerus.

Materials and methods

Population

This retrospective multicenter study was performed in 18 French Hospitals and one Swiss center. Patients operated on between 2000 and 2010 who were over 65 with an isolated, non-pathological articular or extra-articular fracture of the distal humerus and with at least 6 months follow-up were included in the study. Patients who were younger than 65 with an associated fracture of the upper limb, a pathological fracture and/or follow-up of less than 6 months were excluded.

Eighty-seven patients were included in the study. There were 80 women and 7 men, mean age 79 (65–93). The fracture was on the dominant side in 40 cases (46%). Patients presented with very few comorbidities: 63 were classified as ASA 1 and 2, 23 ASA 3 and one ASA 4 and 5 [10]. Patients were relatively autonomous with a preoperative Katz score of 5.4 points (1.5–6) [11]. Seventy-eight patients lived in their own homes and 9 in a retirement home. Patients’ medical history included underlying inflammatory arthritis in 8 patients, osteoarthritis of the elbow in 5, a history of osteoporotic stress fracture in 10 and a neuropsychiatric disease in 9. Four patients were receiving long-term corticosteroid treatment.

X-rays of the fractures showed [12]: 9 AO type A fractures, 8 type B and 70 type C fractures with 16 C1 fractures, 17 C2 and 37 C3. Osteoporosis was considered to be evident on X-ray in 59 cases (68%). The fracture was closed in 80 cases and open in 7. There was a Gustilo [13] stage 1 fracture in 6 cases and stage 2 in one. There was one immediate neurological complication related to an ulnar nerve injury. There were no vascular injuries in this series.

Eighty-three patients were treated with primary total elbow arthroplasty, one following failure of conservative treatment and 3 following unsuccessful internal fixation. A Conrrad–Morrey® (Zimmer) prosthesis was used in 85 cases, a Discovery® (Biomet) prosthesis in one case and a Latitude® (Tornier) prosthesis in one case.

Surgical technique

The patient was installed in lateral decubitus position in 37 cases and in dorsal decubitus in 50. The Bryan–Morrey approach was used in 58 cases, the Gschwend approach in 20 cases, the reversed V in 6, the transolecranon in 2, the laterotricipital in 1. The ulnar nerve was identified in 67 cases (77%) but was only transposed in 41 cases (47%). For the Conrrad–Morrey prosthesis, a 10-cm long humeral component was used in 63 cases, a 15-cm in 20 cases, and a 20-cm in 2 cases. In 18 cases the longer flange option was chosen. For the ulnar implant, the standard length was used in all cases. Antibiotic cement was used in 75 cases (86%). A cement restrictor was used in the humerus in 60 cases (69%) and in the ulna in 42 cases (48%). The cement was injected manually in 12 cases, by syringe in 58 and with a specific injection gun in 16. A bone graft was used in 60 cases (69%) beneath the anterior flange of the prosthesis. Prophylactic antibiotics were systematically used. Surgery lasted a mean 104 minutes (45–253). Forty-three patients were immobilized after surgery for a mean 14 days (2–42). Fifty-six patients (64%) received rehabilitation for a mean 2.5 months.

Method of evaluation

At the final clinical follow-up patients were evaluated using the Mayo Elbow Performance Score or MEPS [14] and the quick-Dash score [15]. Range of motion was evaluated by goniometry. Strength was analyzed by flexion and extension counter-resistance testing compared to the opposite side with the elbow in 90° flexion. Patient autonomy was evaluated by the Katz score. X-ray analysis was based on AP and lateral X-rays to determine the position of the implant, whether it was centered or non-centered, the quality of cementing (correct or insufficient), and the presence or not of intraprosthetic radiolucent lines. Radioluencies were considered to be absent, less than 1-mm, 2-mm or more and progressive. The quality of graft integration beneath the anterior flange of the implant was also evaluated. Wear of the polyethylene bushings was judged in relation to the
angle of the ulnar component and the humeral component at the hinge. If the angle was less than 3.5° there was no wear, if the angle was 5° there was partial wear and if the angle was greater than 5° there was complete wear.

Statistical analysis

Univariate analysis was performed with STATA® software version 11.0 (www.stata.com; StataCorpLP, College Station, TX 77845 USA). Preoperative and postoperative data were compared with the Mann–Whitney test. The Chi² test was used to compare categorical values. P < 0.05 was considered to be significant.

Results

Global results

The mean follow-up was 37.5 months (6–106), the MEPS was 86 ± 14 points (45–100) with 48 (56%) excellent results, 34 (30%) satisfactory, 7 (8%) fair 5 (6%) poor. The quick-DASH score reached 24 ± 19 points (0–68), the Katz score was 5 ± 1.5 points (1–6). The MEPS was influenced by where the patient lived, with better results in those located in their own home compared to patients in a retirement home or a nursing home (P < 0.05), by the preoperative Katz score, with better results in those with higher scores (P < 0.01), and by a history of inflammatory arthritis (P < 0.05).

Clinical results

The mean postoperative pain score was 37 ± 10 points. Fifty-five patients (63%) presented with no pain in the elbow and 20 (24%) with minimal pain. The postoperative mobility score was 17 ± 2.5 points. Flexion reached 125 ± 16° (40–170°) with a persistent extension deficit of 29 ± 18° (0–80°). The flexion-extension arc was 97 ± 22° (50–145°). The postoperative stability score was 9.6 ± 1.5 points. Moderate laxity of the elbow was identified in 8 cases. The functional score was 21 ± 5 points. Function was normal in 69 patients (Fig. 1).

Flexion strength was normal in 46 cases (53%), moderately reduced in 36 cases (41%) and severely reduced in 5 cases (6%). Extension strength was normal in 36 cases (41%), moderately reduced in 39 cases (45%), and severely reduced in 12 cases (14%). The surgical approach did not influence flexion (P = 0.749) or extension (P = 0.404) strength.

X-ray results

The humeral component was centered on the AP X-ray in 80 cases (92%) and on lateral X-ray in 72 cases (83%). The ulnar component was centered on the AP X-ray in 81 cases (93%) and on lateral X-ray in 80 cases (92%). The anterior graft was incorporated behind the anterior flap of the implant in 27 cases, was absent in 57 cases, and had migrated in 2 cases. Radiolucenties were identified around the humeral component in 21 cases, including 2 that seemed to be progressive. Radiolucenties were also present around the ulnar component in 22 cases with one that was progressive. There was loosening of one humeral component, as well as of one ulnar component in another patient. The technique of cement injection did not influence the development of radiolucenties in the humerus (P = 0.929) or the ulna (P = 0.750). The polyethylene bushings of the hinge mechanism were considered to be moderately worn in 15 cases and severely worn in 2 cases. The presence of wear was correlated to the length of follow-up (P = 0.0153). There were periprosthetic ossifications in 26 cases (30%), which did not influence the MEPS (Fig. 1).

Complications/revisions

Complications occurred in 20 cases (23%) and surgical revision was necessary in 8 cases (9%). A hematoma was identified in 5 cases, complex regional pain syndrome in 2 cases and preolecranon skin necrosis in one case requiring a local skin flap. Neurological injury was identified in 7 cases (8%) including 6 of the ulnar nerve, one of the radial nerve, and one of the median nerve. In one case neurolysis was necessary to release the ulnar nerve. One deep infection was identified and treated by simple debridement.

The humeral stem had to be changed because of fracture with a humerotomy and placement of a longer stem to bridge the area of humerotomy. Two prostheses were shown to be loosened on X-ray, and one was replaced. Two elbows releases were performed to treat persistent stiffness of the operated elbow. A fracture of the humeral diaphysis occurred distal from the stem component requiring plate fixation.

Discussion

The use of a total elbow arthroplasty to treat fractures of the distal humerus in elderly subjects was first proposed by Cobb et Morrey in 1997 [9]. This study was then updated by Kamineni et al. [16]. Forty-nine distal fractures of the humerus in 48 patients, mean age 69, were treated by total elbow arthroplasty and evaluated after a mean follow-up of 7 years. Arc of flexion was 24–131° with a MEPS of 93 points. Complications occurred in 14 elbows (29%). Additional surgical was necessary in 10 cases, including 5 revisions. Five cases involved a complication in the soft tissues and the 5 other cases involved bone or the implant. Five other studies confirmed these preliminary results [17–21] (Table 1). The Conrood–Morrey prosthesis was used in all cases. Patients were a mean 70 years old with mostly AO type C fractures. The MEPS was more than 90 points with recovery of the functional arc of motion. After a mean follow-up of 2 years there were 6 complications: 2 superficial infections, one triceps insufficiency, one heterotopic ossification, one complex regional pain syndrome and one aseptic loosening of the ulnar component. In 2004, the SOFCOT performed a multicenter study evaluating the results of TEA in traumatic fractures. Thirty-one elbows were evaluated after a mean follow-up of 17.4 months. Complications occurred in 16% with a rate of revision of 10%, but no implant revisions [22]. Another multicentre study was performed by the SOO in 2007 [23] in 36 patients, mean age 80 years old. After a mean follow-up of 24 months the MEPS was 84 points and the DASH score was 25 points. There were 5 complications
(14%) requiring revision surgery in 2 cases (5%). These studies showed that TEA for traumatic distal fractures of the humerus provide reliable results in elderly patients with a stable, pain-free elbow and recovery of functional range of motion. Complications occurred in approximately 20% requiring revision surgery in 10%. The study presented during the SOFCOT 2012 symposium is the largest in the literature. The results support those already published. Complications were frequent with 20 complications (23%) requiring revision surgery in 8 cases (9%).

Unlinked prostheses have been proposed by certain authors for the treatment of these fractures. In 2001,

<table>
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<tr>
<th>Authors</th>
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<th>Age</th>
<th>Fracture by AO</th>
<th>Follow-up</th>
<th>MEPS</th>
<th>Range of motion</th>
<th>Complications rate</th>
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<td>Cobb et al. [9]</td>
<td>21</td>
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Ikävalko and Letho [24] reported their experience with the Souter® (Howmedica) prosthesis for the treatment of fractures of the distal humerus in patients with rheumatoid arthritis. The difficulties reported by the authors involved the need for internal fixation of the columns to obtain a stable humeral component in these patients. Union was only obtained in 20 out of 32 fractures. Additional surgery was necessary in 12 patients to stabilize the TEA. Six patients presented with late complications including 3 with radiographic loosening of the implant. In 2008, Kalogrianitis et al. [25] reported their experience with the iBP® (Biomet) implant for this same indication. The elbow was stable in all patients at the final follow-up and they could perform normal daily activities. The MEPS was 95 points (65–100). The authors concluded that the iBP® implant could be used following traumatic fracture as long as at least one distal humeral column was preserved.

Frankle et al. [26] were the first to report better results with total elbow arthroplasty than with internal fixation (Table 2). The SOO in 2007 confirmed these results with better MEPS and DASH scores. The rate of complications was 14% in the arthroplasty group and 26% in the internal fixation group. McKee et al. [27] performed a randomized prospective study comparing the results of these 2 therapeutic options. Fifteen patients were treated with internal fixation and 25 with arthroplasty. The MEPS score was better in patients treated with arthroplasty at 3 months (83 vs. 65), 6 months (86 vs. 68), 12 months (88 vs. 72) and 2 years (86 vs. 73) compared to patients treated with internal fixation. The DASH score was better in patients treated with arthroplasty at 6 weeks (43 vs. 77) and 6 months (31 vs. 50), but not at 12 months (32 vs. 47) or 2 years (34 vs. 38). The range of motion was 107° in the arthroplasty group and 95° in the internal fixation group. The rate of revision was 12% (3/25) in the arthroplasty group vs. 27% (4/15) in the internal fixation group. The authors concluded that the results of arthroplasty for the treatment of comminutive fractures of the distal humerus in subjects over the age of 65 were more reliable than with internal fixation. A retrospective multicenter study for SOFCOT 2012 compared 181 patients who were treated by internal fixation to 70 who underwent TEA for AO type C fractures. The populations and the follow-up were similar. Only the patient characteristics differed because there were fewer patients with osteoporosis in the internal fixation group (40%) than in the arthroplasty group (60%). Although the clinical results were quite similar with no significant differences 95.7% of the patients who underwent arthroplasty had no complications, while the rate was 80.5% in the internal fixation group. Arthroplasty provides results that are more reliable than internal fixation in older subjects with osteoporosis and comminutive fractures. There are fewer complications even if the consequences are more serious than those that occur following internal fixation.

Although hemi-arthroplasty was recently proposed, only short series have been published on this topic with limited follow-up (10 months) [28–30]. Hemi-arthroplasty should be anatomical. This implant can only be indicated if the columns are preserved to ensure stability or if they can be fixed. The surgical approach is usually transolecranon. Although short term results seem to be good, complications have been observed such as olecranon wear across from the humeral component, nonunion of the olecranon, impingement with internal fixation material to fix the columns or prosthetic instability. This option must still be validated.

**Conclusion**

In this study, semiconstrained arthroplasty of the elbow and in particular Coonrad–Morrey arthroplasties provided highly satisfactory immediate results with a pain-free functioning elbow. These results seem to be reproducible and durable. The rate of complications was fairly high with surgical revision in 10%. The ideal patient for good results after total elbow arthroplasty is 80 years old without any comorbidities who lives at home, with a history of inflammatory arthritis and osteoporosis, presenting with a comminutive fracture of the distal humerus.

**Disclosure of interest**

The authors declare that they have no conflicts of interest concerning this article.

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