The clinical outcome and activity levels of patients under 55 years treated with distal humeral hemiarthroplasty for distal humeral fractures: minimum 2-year follow-up

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Abstract

Background: The aim of the present study was to describe the clinical outcomes and activity levels of young patients after distal humeral hemiarthroplasty (DHH).

Methods: Six patients under 55 years (mean 44 years; range 29 years to 52 years) treated with DHH at a mean postoperative time of 81 months (range 24 months to 133 months) were studied retrospectively. Two other patients had been revised for aseptic loosening and were excluded.

Results: The mean Mayo Elbow Score (MEPS) (88), Subjective Elbow Value (SEV) (89), Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) (12) and American Shoulder and Elbow Surgeons (ASES) elbow pain (6), function (23) and satisfaction scores (9) were satisfactory. The mean University of California, Los Angeles (UCLA) activity score was 7.2.

Conclusions: Although only rarely indicated, DHH has satisfactory clinical outcomes in young patients and allows a higher level of function than is generally advised after total elbow arthroplasty.

Keywords

arthroplasty, elbow, fracture, hemiarthroplasty

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Introduction

Open reduction and internal fixation (ORIF) is the preferred treatment option for displaced distal humeral fractures where preservation of the articular surface is possible.^{1–5} Although this is possible in the vast majority of cases, bone loss, severe comminution or an extremely distal fracture can make fixation impossible or inadequate and likely to result in failure. In the elderly population, total elbow arthroplasty (TEA) is an accepted treatment modality. Patients treated by TEA are usually advised to restrict their activities to avoid polyethylene wear and hence to improve longevity of the prosthesis. As a result, TEA is not a good option in the younger more active population.^{6–20}

Distal humeral hemiarthroplasty (DHH) avoids the concerns associated with TEA but has its own potential

risks of instability, loosening and chondral wear of the ulna. DHH has been increasingly reported in the literature, predominantly in elderly cohorts of patients.^{21–38}

There is little basis for any firm advice on prudent levels of activity after DHH. We now report the clinical outcomes and activity levels of a subgroup of young patients (< 55 years) treated with DHH.

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Materials and Methods

Human Research Ethics Committee approval was sought and attained for one site (11/115) and was not required at the other centre.

Study population

Eight patients under 55 years underwent DHH carried out by two of the authors (JH and RP). There were two male and six female patients. The mean age at the time of surgery was 46 years (range 29 years to 54 years). The mean time postoperatively for assessment was 81 months (range 24 months to 133 months).

DHH was considered for patients either acutely for unreconstructable intraarticular distal humeral fractures or for salvage of a non- or malunion after non-operative or operative treatment where an attempt at fixation was not possible. Further requirements were that elbow stability could be maintained by either intact or repairable epicondyles, coronoid process and radial head, and that prosthesis stability could be provided by either intact or repairable condyles and columns.

The indications for DHH in this series were acute trauma (six patients) and salvage after previous failed fixation (two patients). The mechanism of injury was a fall in six patients and a motor vehicle accident in two patients.

Fractures of those patients treated acutely were classified according to the AO (Arbeitsgemeinschaft für Osteosynthesfragen) system on the basis of plain radiographs and computed tomography. All six were type C3 fractures. In this group, DHH was the initial procedure in five patients. One patient had sustained an open fracture dislocation with coronoid process and radial head fracture in addition to the distal humeral fracture with significant bone loss from the capitellum and trochlea. This patient had also sustained an ipsilateral intraarticular distal radial fracture and a soft tissue injury to the proximal forearm, including a complete posterior interosseous nerve transection that later required tendon transfers. This patient was initially treated by wound debridement, internal fixation of the radial head and joint spanning external fixation in distraction. DHH was then performed as a staged procedure after 3 months. The two patients who underwent DHH for salvage of prior failed surgery included one patient who had the fractures treated by another surgeon with K-wires resulting in inadequate reduction and was converted to DHH at 2 months after injury and one further patient who was initially treated by column plating, which resulted in a non-union that was converted to DHH at 7 months after injury.

Surgical technique

This has been described in detail elsewhere and was the same for both surgeons.³⁰ A posterior approach comprising olecranon osteotomy was performed. An ulnar nerve *in situ* decompression was carried out in all cases and, in two patients, the nerve transposed later in the operation because of metalwork impingement. The osteotomy was fixed with a tension band wire in five cases, cannulated screws and a figure-of-eight wire in two cases and a compression screw in one case. Care was taken to preserve the collateral ligaments and their insertion on the ulna. Column fractures were fixed with either a plate or K-wires and condyles were fixed with either K-wires or a tension band suture. Epicondyle fractures with attached collaterals were repaired with tension band sutures. In this series, two column or condyle fractures and five epicondyle fractures were stabilized. The Sorbie prosthesis (Wright Medical Technology, Arlington, TN, USA) was used from 1999 until mid-2005 ($n=5$); from mid 2005 onwards, the Latitude prosthesis (Tornier, Montbonnot, France) was used ($n=5$).

Outcomes

Clinical outcome measures. Patients were invited to attend for clinical and radiological assessment. Patients were excluded from assessment if they had undergone revision of the prosthesis. Clinical review was performed by one of the authors who was not involved in the clinical care of the patient (GS or GB). The American Shoulder and Elbow Surgeons elbow score (ASES), Mayo Elbow Performance score (MEPS), Subjective elbow value (SEV) and Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) score were recorded. Grip strength was measured with a Jamar grip dynamometer (Lafayette Instrument, Lafayette, In)..

A questionnaire was then completed to assess participation in 67 different activities of varying demand, which were stratified into low ($n=6$), moderate ($n=26$) and high demand ($n=35$). This has previously been used to assess activity levels after TEA in the North American population and was modified for use in the Australian population taking into account commonly performed recreational activities.³⁹ Additionally, the questionnaire included the University of California, Los Angeles (UCLA) activity score,⁴⁰ as well as recording occupation, ability to perform duties of the occupation and changes of occupation, sporting or recreational activity as a result of the elbow injury.

Radiological outcomes. Anteroposterior (AP) and lateral radiographs were obtained and assessed for evidence of ulnar wear and loosening by one of the authors (GS).

Radiological evidence of ulnar or radial wear was assessed on the AP radiograph and classified as none (Gd 0), partial-thickness cartilage loss (Gd 1), full-thickness cartilage loss (Gd 2) and bone loss (Gd 3)

Table 1. Clinical outcome measures.

Outcome score	Mean (range)
Mayo Elbow Score	88 (55 to 100)
Subjective Elbow Value	89 (82 to 95)
QuickDASH	12 (2 to 29)
ASES pain	6 (0 to 17)
ASES function	23 (9 to 30)
ASES satisfaction	9 (9 to 10)
Flexion	126 (120 to 140)
Extension	23 (5 to 50)
Flexion extension arc	103 (70 to 120)
Pronation	78 (20 to 90)
Supination	71 (–10 to 90)
Grip strength (kg)	30 (18 to 44)

ASES, American Shoulder and Elbow Surgeons; QuickDASH, Quick Disabilities of the Arm, Shoulder and Hand.

using a previously described method.³⁶ In the assessment of loosening, five zones in each radiographic plane were assessed. Lucencies were classified as nil, <1 mm, 1 mm to 2 mm and >2 mm in width. Progressive lucency, component migration, tilt or fracture of the component or cement mantle was taken as evidence of loosening.

Statistical analysis

Patient-reported activities are summarized descriptively and expressed as a count (percentage) for categorical variables. Continuous variables are expressed as the mean with ranges.

Results

Complications and reoperations

There were three complications that required reoperation: one patient developed postoperative stiffness and was treated by open release. Two patients were revised for primary prosthetic loosening (both with an unflanged component); one in whom avascular necrosis of the lateral column resulted in a progressive loss of support of the humeral stem and was revised to total elbow revision after 18 months; and the other with progressive loosening, which was revised to total elbow revision after 66 months. In both revision cases, tissue samples did not indicate any evidence of infection. In addition, four patients underwent removal of

Table 2. Reported activities stratified by 'demand' placed on elbow.

Low demand activity	Number of patients (%)	Moderate demand activity	Number of patients (%)	High demand activity	Number of patients (%)
Cooking	6 (100)	Gardening	5 (83)	Dirt shovelling	3 (50)
Driving	6 (100)	Carrying Groceries	4 (67)	Road Biking	3 (50)
Pumping petrol	6 (100)	Sexual intercourse	4 (67)	Putting luggage overhead	2 (33)
Stationary bike	6 (100)	Leaf raking	3 (50)	Wheelbarrowing	1 (17)
Lawn bowling	0 (0)	Swimming	3 (50)	Free weights	1 (17)
		Dancing	2 (50)	Canoeing / kayaking	1 (17)
		Lawn mowing	2 (50)	Home renovation	1 (17)
		Hiking	2 (50)	Mountain biking	1 (17)
		Downhill skiing	2 (50)	Rock climbing	1 (17)
		Pilates	2 (50)	Horseback riding	1 (17)

metalwork from fixation of an olecranon osteotomy (three tension band wire; one compression screw). Removal of metalwork was routinely offered to all patients after radiological union of the osteotomy even in the presence of minor symptoms to minimize the complexity of any future revision surgery.

Clinical and radiological assessment

The two patients revised for prosthetic loosening were excluded yielding a study population of six patients (two male; four female). The mean age at the time of surgery of the included patients was 44 years (range 29

years to 52 years). There were two patients under 40 years and four patients over 40 years at the time of surgery.

Clinical outcomes

Clinical outcomes are shown in detail in Table 1

Radiological outcomes

One patient had a lucent line in a single zone on the lateral radiograph (> 2mm) between the bone graft under the anterior flange of a Latitude prosthesis and

Table 3. Individual patients demographics, clinical outcome scores and activity levels.

Patient number	1	2	3	4	5	6
Indication	Acute	Salvage	Acute	Acute	Acute	Acute
Age at operation (years)	36	46	52	52	50	29
Time postoperatively (months)	42	127	95	24	133	66
Prosthesis	Latitude	Sorbie	Sorbie	Latitude	Sorbie	Latitude
Complications	Stiffness					
Mayo score	85	85	100	100	100	55
SEV	82.5	85	95	95	95	82
Quikdash	23	7	7.5	2	5	29
ASES pain	6	7	0	0	5	17
ASES function	21	25	23	30	29	9
ASES satisfaction	9	9	9	10	10	9
Flexion	120	140	120	120	135	120
Extension	5	20	20	25	15	50
Pronation	90	90	90	90	85	20
Supination	90	90	90	80	90	−10
Total number recorded activities	14	10	12	4	7	18
Total number moderate and high activities	10	6	8	1	4	15
UCLA activity score	9	6	6	6	6	10
Ulnar wear grade	0	2	1	1	3	2
Job title	Homemaker	High school art teacher	Volunteer worker	School crossing supervisor	Packing line worker	Neuro physiologist

ASES, American Shoulder and Elbow Surgeons; SEV, Subjective Elbow Value; UCLA, University of California, Los Angeles.

the anterior humeral shaft. Radial wear was Grade 0 in all cases. Ulnar wear was classified as Grade 0 in one patient, Grade 1 in two patients, Grade 2 in two patients and Grade 3 in one patient. The patients with Grade 2 and Grade 3 wear demonstrated progressive wear on serial radiographs.

Activity levels

The activities reported are shown in Table 2. All patients performed at least three low demand activities and one moderate demand activity. Some 67% performed at least one high demand activity. The most common moderate demand activities were gardening, carrying groceries and sexual intercourse. The most common high demand activities were dirt shoveling and road biking. The mean UCLA activity score was 7.2 (range 6 to 10). Four patients (67%) were employed on a part time basis, one was employed full-time (17%) and one was a full-time homemaker (17%). Two occupations (33%) involved moderate manual work (one packing line worker and one caregiver who regularly pushed adults in wheelchairs). The patient who worked on a packing line reported difficulties with repetitive lifting of weights > 10 kg. The remaining four patients (67%) all worked in roles that involved a component of light manual work (neurophysiologist, homemaker, school crossing supervisor and high school art teacher). One patient had changed occupation following the injury having previously worked as a chiropractor. Two patients had modified their sporting or recreational activities: one by altering their weight training regime and giving up ice hockey and the

other by modifying the manoeuvres that were performed during regular yoga.

Individual patients demographics, clinical outcome scores and activity levels are documented in Table 3.

AP and lateral radiographs taken at the time of injury of patient 3 are shown in Figs 1 and 2. Immediate postoperative and final follow-up lateral radiographs of patient 5 demonstrating progressive ulnar wear are shown in Figs 3 and 4.

Discussion

Although there have been several recent reports on the outcome of DHH in the short term, this is the first report of outcomes in a younger patient group. Although there is no definition of what may constitute

Figure 2. Lateral radiograph of patient 3 at the time of injury.

Figure 1. AP radiograph of patient 3 at time of injury.

Figure 3. Immediate postoperative lateral radiograph of patient 3.

Figure 4. Final follow-up lateral radiograph of patient 3.

a 'young' patient, an age of less than 55 years has been used to define this population.^{41,42}

The major drawbacks of the present study are its retrospective nature with a small population and no comparative group. However, because this procedure is only performed occasionally and was only undertaken in those patients in whom the distal humerus was deemed unsalvageable, no comparative data are possible, although it would be expected that these patients would have had a poor outcome after attempted ORIF. The procedure is technically demanding and has a significant complication rate. For both patients in this cohort who required revision to TEA for component loosening, this occurred after the use of an unflanged component. We would therefore recommend the use of a component with an anterior flange to diminish stress and strain at the prosthesis–cement interface by transferring load to the distal humerus.

In the included patients, satisfactory physician and patient-reported outcome scores have been achieved. The QuickDASH measure of upper limb function as a whole is similar to the normative value of the Norwegian population of the same age.⁴³ Given the small number of cases, it is not possible to compare outcomes in this young cohort of patients with that reported in other series involving elderly patients.

The number of reported activities performed in this group of patients is higher than that reported after TEA.³⁹ Although there is no consensus about the degree of activity restriction that should be advised after TEA, the high demand activities listed in the questionnaire would all generally be considered ill-advised.

This procedure should only be undertaken for unreconstructable or unsalvageable distal humeral fractures. Postoperatively, the authors recommend prudence in

limiting the severity and frequency of upper limb activity where possible in young patients because ulnar wear will increase over time. All cases in this series were performed using an olecranon osteotomy. This may conceivably alter contact stresses and influence wear rates after DHH. However, it should be noted that, although ulnar wear is of concern and requires further monitoring, no patient has required revision surgery specifically for symptomatic chondral wear.

Declaration of Conflicting Interests

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Ethical Review and Patient Consent

HREC was sought and attained for one site (11/115) and was not required at the other centre.

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