

# A radial head prosthesis appears to be unnecessary in Mason-IV fracture dislocation

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Submitted 2016-09-27. Accepted 2017-01-16.

**Background and purpose** — Previous reports on elbow injuries with concomitant comminute radial head fracture are difficult to interpret, since they include an array of different soft-tissue and bony injuries around the elbow. We focused on Mason-IV fracture dislocations of the elbow and retrospectively reviewed 2 treatment options: radial head resection or replacement with a radial head arthroplasty, both in combination with lateral ligament repair.

**Patients and methods** — In Linköping, 18 consecutive patients with Mason-IV fracture dislocation and with a median age of 56 (19–79) years were treated with a radial head arthroplasty. In Malmö, 14 consecutive patients with a median age of 50 (29–70) years were treated for the same injury with radial head resection. With a follow-up of at least 2 years (Linköping: median 58 months; Malmö: median 108 months), the outcome was assessed using the Mayo elbow performance score (MEPS), the Disabilities of Arm, Shoulder, and Hand questionnaire (DASH), range of movement, instability, and plain radiographs.

**Results** — There was no statistically significant difference between the groups regarding MEPS, DASH, or range of motion. The rate of additional surgery was higher in patients treated with arthroplasty. Ulno-humeral osteoarthritis was more pronounced in the group treated with radial head resection, but the follow-up time was longer in these patients. Functional results and range of motion tally well with previous reports on similar injuries.

**Interpretation** — Functional results did not improve by using a press-fit radial head arthroplasty in Mason-IV fracture dislocation of the elbow. Secondary osteoarthritis after resection of the radial head is a concern, but it did not affect the functional outcome during the follow-up time.

result in elbow and forearm instability. Treatment options include excision, open reduction with internal fixation, and radial head replacement, with varying results (Broberg and Morrey 1987, Josefsson et al. 1989, Nalbantoglu et al. 2007, Herbertsson et al. 2009). An argument for using a radial head replacement has been to minimize the risk of residual elbow or forearm instability. Previous studies on radial head prostheses have, however, included various types of elbow and forearm injuries with an associated unreconstructable radial head fracture (Grewal et al. 2006, Doornberg et al. 2007), making different treatment options difficult to compare. In our department in Linköping, we have routinely repaired the lateral ligament and used radial head replacement in patients with simultaneous elbow dislocation and an irreparable radial head fracture, the so-called Mason type-IV lesion.

We were made aware of another center in Sweden (Malmö) where simple radial head excision and lateral ligament repair was used as treatment for the same injury during the same time period.

We compared the functional and radiographic outcomes of the 2 different treatment strategies in elbow dislocation with an irreparable radial head fracture.

## Patients and methods

At the Department of Orthopedics in Linköping University Hospital, a consecutive series of 21 patients (group L) had—between January 2002 and December 2011—been treated with radial head arthroplasty and lateral ligament repair because of a dislocation of the elbow with an associated irreparable radial head fracture and no or minimal coronoid fracture (grade 0 or 1 according to the Regan-Morrey classification (Regan and Morrey 1989)). A radiograph of a dislocated elbow or mention in the patient files of a reduction of the elbow by either

A fracture of the radial head in combination with an elbow dislocation is a rare injury with an incidence of 7–8 per 100,000 per year (Kaas et al. 2010, Duckworth et al. 2012), and may

ambulance staff or emergency staff were criteria for eligibility. If the above criteria were fulfilled but additional treatments given, such as fixation of the anterior capsule or a coronoid fragment, the patient was excluded.

In addition, records of pain in the distal forearm and wrist, indicating a longitudinal instability, led to exclusion. The search identified 21 eligible patients. 2 patients were excluded due to having mental impairment and 1 was lost to follow-up, leaving 13 women and 5 men with a median age at the time of surgery of 56 (19–79) years.

At the Department of Orthopedics in Malmö University Hospital, for the same time period, a consecutive series of 19 patients (group M) with the same type of injury was identified. 1 patient had died, 2 no longer resided in Sweden, and 2 were lost to follow-up, leaving 14 patients (12 women and 2 men) with a median age at the time of surgery of 50 (29–70) years. All had been treated with radial head resection, 3 patients with late resection (at 2, 4, and 5 months, respectively), and suture of the lateral collateral ligament complex.

Group L was treated using a press-fit radial head prosthesis (Avanta rHeads; Small Bone Innovations, San Diego, CA; or Acumed Anatomical Radial Head; Acumed, Hillsboro, OR) to replace the fractured radial head, along with lateral repair and immobilization in a plaster splint in 90 degrees of flexion with forearm in neutral position, for 2–3 weeks—except for 2 patients who were only immobilized for 1 and 3 days. Time until full activity was allowed varied between 8 and 12 weeks.

Group M was treated with excision of the radial head, repair of the lateral structures, and immobilization—either in a plaster splint with flexion > 90 degrees and the forearm fully pronated (Josefsson et al. 1987, O’Driscoll et al. 1992) or, in 4 cases, with external fixation for 3–4 weeks. After immobilization was over, activity as tolerated was allowed. The median time to follow-up in group L was 58 (26–181) months and in group M it was 108 (47–136) months (Table 1).

At follow-up, the patients were examined regarding range of movement of the elbow and forearm. Questions possibly revealing instability—such as whether there were ulnar nerve symptoms, catching, or giving way—were asked and examination of laxity was done according to the method described by Regan and Morrey (2000), but with the patient seated rather than supine. The patients were asked if there were any complaints regarding wrist pain, and radiographs of both wrists were taken.

Function was assessed using the Mayo elbow performance score (MEPS) (Morrey and An 2000) and DASH score (Gummesson et al. 2003) as patient-related outcome measures. Radiographs were reviewed by an independent radiologist regarding the degree of coronoid involvement (inclusion/exclusion), the degree of osteoarthritis according to Broberg and Morrey (1986), and signs of prosthetic loosening according to the method developed by Popovic et al. (2007) for the proximal radius.

Table 1. Patient demographics

	Age at surgery	F/U	Prosthesis	Comorbidities/Comments
Group L				
1	28	74	AcuMed	
2	61	77	AcuMed	
3	54	73	AcuMed	
4	60	41	Avanta	
5	76	27	Avanta	Ipsilateral distal radius and proximal humerus fracture
6	79	36	Avanta	Previous contralateral Mason-IV fracture
7	41	159	Avanta	
8	64	76	AcuMed	
9	59	41	Avanta	
10	48	30	AcuMed	
11	58	58	Avanta	
12	43	58	Avanta	
13	19	38	AcuMed	Juvenile RA
14	57	181	Avanta	Early dementia
15	56	64	AcuMed	Ipsilateral distal radius fracture
16	62	69	AcuMed	SLE, carpo-metacarpal joint 1 surgery
17	55	33	AcuMed	
18	55	26	AcuMed	
Group M				
1	38	120		Late excision
2	29	115		
3	47	88		
4	58	136		
5	32	133		Late excision
6	70	124		Ipsilateral humeral shaft fracture
7	43	118		
8	37	73		Late excision
9	38	102		
10	54	135		Subacromial decompression, bilateral carpo-metacarpal joint 1 surgery
11	57	76		
12	59	84		
13	69	47		Rotator cuff injury
14	66	54		Ipsilateral distal radius fracture × 2

F/U: follow-up in months; RA: rheumatoid arthritis; SLE: systemic lupus erythematosus.

### Statistics

Data are presented as median (range). When comparing the 2 groups, non-parametric tests were used (Mann-Whitney U-test) with Statistica 12 software. The frequency of osteoarthritis in the 2 groups was compared using the chi-squared test.

### Ethics

Ethical approval was given by the local ethics committees on April 21, 2010 (entry no. 2010/53-31) and April 15, 2013 (entry no. 2013/172-32).

Table 2. Functional outcome and complications

	MEPS	DASH	ROM	Complication	Ulnar nerve affection
Group L					
1	85	4	155		
2	85	7	130		
3	100	0	150		
4	85	43	125	Additional surgery x 3	
5	100	0	135		
6	80	38	125		
7	85	11	135		Intermittent
8	100	24	125		
9	85	4	145	Additional surgery x 2	
10	85	55	110		
11	70	13	130		
12	70	63	110	Synostosis	
13	95	12	100		
14	90	26	125	Additional surgery	
15	100	0	135		
16	85	29	150		
17	100	42	120	CRPS	No sensory, atrophy of intrinsic muscles
18	65	59	95		
Group M					
1	95	2	140		
2	80	37	150		Intermittent
3	100	3	150		
4	100	33	145		
5	100	1	135		
6	100	<sup>a</sup>	115		
7	100	10	105	Radial nerve affection, arthrolysis	
8	55	44	120	Late detected re-dislocation	Constant sensory
9	100	0	150		
10	100	21	135		
11	85	14	120	Arthrolysis	
12	70	38	120		
13	50	<sup>a</sup>	120		Constant sensory
14	100	4	120		

MEPS: Mayo elbow performance score; ROM: range of movement.  
CRPS: Complex regional pain syndrome  
<sup>a</sup> Less than 27 questions answered.

## Results (Table 2)

The median MEPS score in group L with 18 patients was 85 (65–100), with 6 excellent results, 9 good, and 3 fair. Median DASH score was 13 (0–63). In group M with 14 patients, the median MEPS was 100 (50–100), with 9 excellent results, 2 good, 1 fair, and 2 poor. Median DASH score was 12 (0–44, n = 12). There were no statistically significant differences regarding function measured by MEPS or DASH. 2 patients in group M did not answer enough questions for us to be able to calculate a DASH score. No patients with re-dislocation after surgery were recorded in either group.

The median extension deficit in group L was 20° (0–30) and median flexion ability was 145° (125–155), giving a median arc of movement of 130° (95–155). In group M, the corresponding figures (medians) were an extension deficit of 15° (0–45), flexion of 150° (135–155), and arc of movement of 127.5° (105–150).

8 patients in group L had a reduced arc of total forearm rotation (median 30° (10–85)), and 1 patient had developed a proximal forearm synostosis. 2 patients in group M had decreased forearm rotation, 1 by 10° and 1—with previous ipsilateral distal radius fracture—by 45°, both being a supination deficit.

In group L, 1 patient had discrete increased posterolateral laxity on clinical examination and had intermittent ulnar nerve symptoms, but no subjective instability was described. In group M, 2 patients complained of instability, 1 of whom had a clinically subtle posterolateral laxity. The other patient reported intermittent locking and ulnar nerve symptoms, but was stable on examination. Loose bodies could be seen on radiographs and these were later removed, with no further locking but still intermittent sensory ulnar nerve affection. 4 additional patients in group M had subtle valgus laxity, 2 of which had ulnar nerve symptoms, but all 4 were subjectively stable.

In group L, 4 patients had additional surgery, 7 times in total—3 due to aseptic loosening of the prosthesis and 1 because of proximal radio-ulnar synostosis. In addition 1 patient suffered from a regional pain syndrome. 4 other patients had signs of loosening of the prosthesis but did not have symptoms to justify revision. No patients had the prosthesis removed due to attrition of the capitellum.

In group M, 2 patients underwent arthrolysis due to stiffness. 1 patient with multiple injuries, who had the elbow primarily treated with closed reduction and plaster cast immobilization, had persistent dorsal dislocation diagnosed 2 months after the initial trauma, resulting in late surgery with open reduction, resection of the radial head, and external fixation at > 90°. The elbow had not been in flexion for a long time, and on the following day release of the ulnar nerve had to be performed due to severe symptoms. At follow-up, the patient had remaining ulnar nerve dysfunction. 1 patient in group M (with immobilization using external fixation) had a sensory affection of the radial nerve and was weaker in the wrist extensors on examination.

Radiographically, more patients in the resected group (M) had secondary osteoarthritis than in the arthroplasty group (L) (Table 3). Resorption of the proximal radius around the stem was seen in 10 patients.

In 1 patient in group M, the radiographs showed a positive ulnar variance of approximately 2 mm compared to the uninjured side but the patient did not complain of any wrist pain.

## Discussion

Our findings do not support the use of radial head replacement for Mason type-IV fracture dislocation. Neither functional results nor the degree of instability were improved in patients treated with radial head replacement. There were more secondary osteoarthritic changes in the ulno-humeral

Table 3. Radiographic assessment

	Osteo- arthritis	Heterotopic ossification				Zones
		a	b	c	d	
Group L						
1	1	a			d	
2	0				d	
3	0	a				
4	2	a			d	
5	0	–				1–7
6	0	a		c	d	1–7
7	1				d	1–7
8	0	a				
9	1	a			d	
10	0	a		c	d	
11	0	–				
12	0	–				
13	0	–				
14	0	a		c		
15	0	–				
16	0	a				
17	2	a		c	d	
18	0	a				1–7
Group M						
1	1	a	b		d	
2	1	b		c	d	
3	0	a	b			
4	1		b		d	
5	1		b			
6	1	a	b	c	d	
7	1	a	b	c	d	
8	1	a	b		d	
9	1	a	b	c	d	
10	1	a	b	c	d	
11	1	a	b		d	
13	2	a	b		d	
14	1	a	b		d	

a: in or about ligaments or capsule.  
b: end of osteotomized bone.  
c: loose fragments.  
d: in the substance of muscle.

joint in patients with a resected radial head. The radiographic findings may have been due to a difference in follow-up time, but an increase in osteoarthritic changes in elbows with radial head deficiency has previously been reported (Broberg and Morrey 1986, Herbertsson et al. 2009, Antuna et al. 2010). The radiographic changes were, however, not reflected in any of the functional measures. Dotzis et al. (2006) found no osteoarthritic changes after a mean interval of 5 years in 12 patients (8 of whom had radial head fractures with posterior dislocation) using the Judet prosthesis (Tornier SAS, Saint-Ismier, France), but other reports have described osteoarthritic changes in the ulno-humeral joint using different types of radial head arthroplasties with 2–12 years of follow-up (Harrington et al. 2001, Moro et al. 2001, Grewal et al. 2006, Doornberg et al. 2007, Burkhart et al. 2010, Marsh et al. 2016). It is therefore not possible to conclude that radial head arthroplasty protects against secondary osteoarthritis in the ulno-humeral joint.

The functional outcome in both groups measured with MEPS and DASH corresponds well with previous studies on radial head fractures treated with resection or arthroplasty (Dotzis et al. 2006, Grewal et al. 2006, Doornberg et al. 2007, Flinkkila et al. 2012), with the exception of the study by Antuna et al. (2010), which had slightly better results after a mean time of follow-up of 25 years after resection.

Previous reports on the treatment of irreparable radial head fractures have included many different types of associated injuries, making comparisons difficult. In the present study, we strictly defined the injury as Mason type-IV fracture with an irreparable radial head, and compared 2 different treatment strategies.

One of the main goals when treating elbow dislocations is to restore elbow stability and prevent re-dislocation. No re-dislocations occurred after surgery in our study, irrespective of which treatment method was used. The lateral ligament was repaired in both groups, and this may be the most important injury to address in order to restore ulno-humeral stability. The medial ligament probably heals if the elbow is kept congruent initially, but over time some elongation appears to occur when the bony lateral support is missing. We lack a common definition of instability, but with anamnestic questions used (ulnar nerve symptoms, catching, or giving way) and the physical examination used, we could not find any difference between the groups regarding instability. Previous studies have supported the finding that instability is not a major concern after radial head excision (Herbertsson et al. 2009, Antuna et al. 2010). Proximal migration of the radius after resection of the head has been described (Antuna et al. 2010, Yalcinkaya et al. 2013). In the present study, we tried to exclude patients with acute clinical signs of forearm instability; and since none of the patients complained about wrist pain around the ulnar head, the likelihood of an axial instability appeared to be small and was not investigated further.

Ulnar nerve symptoms were present in both groups. In the medical records, we could not find that any of the patients had ulnar nerve symptoms before surgery. Discrete instability may be a cause, since 3 of 5 patients with ulnar nerve symptoms had signs of increased laxity during valgus stress, but it might also be due to secondary articular changes with medial osteophytes—or any injury sustained by the nerve at the time of dislocation of the elbow. The patient with dorsal dislocation diagnosed after 2 months had persistent ulnar nerve symptoms at follow-up.

In the arthroplasty group, 3 patients had had additional surgery due to loosening and another 4 patients had signs of loosening. This is comparable to a previous report using press-fit stem and modular head and neck (Flinkkila et al. 2012). Zones around cemented stems have also been reported (Popovic et al. 2007), but the clinical relevance in the long term is uncertain.

Radiographic lucencies around smooth-stemmed implants have been reported as being a frequent finding, but is considered to be part of the design, and the failure rates were

reportedly low in a 3 (2–5) year follow-up by Doornberg et al. (2007) and in an 8 (5–14) year follow-up by Marsh et al. (2016).

Resorption of the proximal radius around the prosthetic stem was also seen in our patients, and similar findings have been reported previously (Flinkkila et al. 2012). The clinical relevance of this is unclear.

In summary, we found similar function after radial head resection or arthroplasty despite there being more osteoarthritic changes in patients who had been treated with resection.

JN and POJ: collection of data and preparation of manuscript. LA: design of study and preparation of manuscript

No competing interests declared.

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