

## Case Report

# Comminuted radial head fractures treated by the Acumed anatomic radial head system

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Received January 17, 2015; Accepted March 30, 2015; Epub April 15, 2015; Published April 30, 2015

**Abstract:** Objective: The treatment of comminuted radial head fractures is still challenging. A radial head replacement is more effective in comminuted radial head fractures. The aim of this paper was to present the medium-term results of the Acumed anatomic radial head system (AARHS). Methods: This study was performed on 12 patients with traumatic elbow fracture and instability between 2008 and 2011 of whom 12 were reviewed at a mean follow-up of 60.8 months (19 to 77 months). The evaluation included a record of pain, function, muscle strength, contracture and rotation. The outcome was assessed using the Hospital for Special Surgery total elbow scoring and a modified Disability of Arm Shoulder Hand (DASH) questionnaire. Results: The average flexion and extension arc was 130° (range, 110° to 140°). The mean range of elbow supination was 75° (rang, 60° to 85°) and pronation 80° (range, 65° to 90°). There were no complications such as infection, implant loosening, instability of the elbow, cubitus valgus, osteoporosis of the capitellum, or pain in the forearm and wrist. The mean DASH score was 11.9/100 (0 to 25/100). Conclusion: The radial head replacement with the AARHS can provide effectively stability and good clinic results at the middle term following up. Our experience has encouraged us to continue using the AARHS in comminuted fractures, especially when instability of elbow is a potential problem.

**Keywords:** Comminuted radial head fractures, radial head replacement

### Introduction

The treatment of displaced comminuted radial head fractures is challenging. Conservative treatment in this type of fracture causes poor results. Radial head resection leads to pain in the forearm and wrist, joint instability, decreased strength, osteoarthritis and cubitus valgus [1-5]. Internal fixation is difficult in many cases and sometimes leads to implant failure [6, 7]. On the other hand, comminuted radial head fracture is associated with other injuries such as dislocation of the elbow, the coronoid process fracture, and the collateral ligament disruption. Because the radial head played one critical role in the elbow stability, many orthopedic surgeons suggest preserving the radial head during fracture treatment. King found that the stability and load transfer of the elbow with radial head replacement are equal to those of a native radial head [8, 9]. So in

these cases, radial head replacement should be considered, particularly associated with coronoid process fracture and ligament injuries of the elbow.

Radial head prosthesis design has bipolar and monopolar design concept. And the design changed from nonanatomical implants to anatomic design that attempts to replicate the variable shape of the native radial head. Past designs of radial head prostheses have had a round radial head component. The radial head is clearly not round but has a more ellipsoidal shape [10]. Acumed anatomic radial head system (AARHS Acumed, USA) is a unique implant that closely replicates the natural anatomy of the patient's radial head. The AARHS was first designed in 1988 by Shawn O'Driscoll, Ph.D, M.D. The system provides a comprehensive solution for radial head replacement. Featuring 10 left and right anatomically shaped radial

**Table 1.** Type of radial head fracture with associated injuries recorded for the 12 patients

No.	Sex	Age	Mechanism of Injury	Side	Fracture Type	Associated Injuries
1	F	29	Fall	Left	Mason type III	LCL rupture
2	M	47	Fall	Left	Mason type III	Elbow dislocation, fracture coronoid
3	F	22	Fall	Right	Mason type III	Ulnohumeral dislocation with LCL rupture
4	F	59	Fall	Left	Mason type III	Elbow dislocation with MCL rupture
5	F	32	Fall	Right	Mason type III	Proximal ulnar fracture
6	M	45	Fall	Left	Mason type III	LCL rupture, distal radial fracture
7	M	39	Fall	Right	Mason type III	Undisplaced olecranon fracture and coronoid fracture
8	F	24	Road traffic accident	Right	Mason type III	Ulnohumeral dislocation
9	F	21	Fall	Left	Mason type III	LCL rupture and MCL rupture
10	M	61	Fall	Left	Mason type III	Ulnohumeral dislocation with coronoid fracture
11	F	39	Fall	Right	Mason type III	LCL rupture
12	M	49	Fall	Right	Mason type III	Proximal ulnar fracture

Footnotes: F, Female; M, Male; LCL, Lateral collateral ligament; MCL, Medial collateral ligament.

head implants and 20 stem options, the system provides 200 head/stem combinations to accommodate each patient's anatomy. By providing the patient with an anatomical prosthesis, wear on the capitellum is theoretically reduced due to the improved biomechanics and balancing within the elbow. AARHS was used for replacement of comminuted radial head fractures in selected patients. In this study, we present the results of a small series of 12 patients with ligament repair and fracture fixation to facilitate early mobilization of the elbow.

## Patients and methods

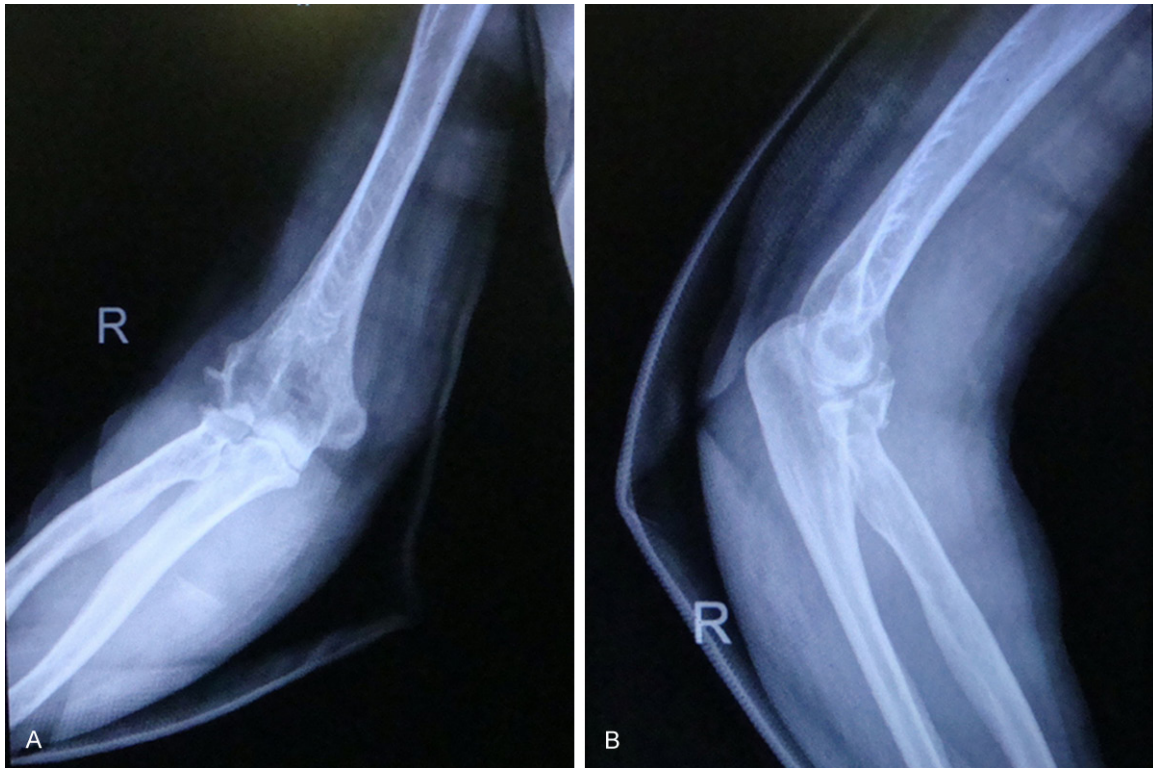
### General data

Between January 2008 and December 2011, 12 patients (six men and six women) (**Table 1**) with radial head comminuted fractures were treated by radial head replacement of the Acumed anatomic radial head prosthesis system. Their mean age at the time of surgery was 40.9 years (22 to 70). The inclusion criteria were all patients with traumatic elbow fracture and instability, where the radial head was comminuted and irreparable at the time of surgery and there was associated valgus laxity of the elbow. The dominant limb was injured in seven patients. Eight fractures were classified as type III and four fractures were classified as type IV with posterior dislocation of the elbow according to the Mason classification system (**Figure 1**). Six patients had an associated elbow ligament injury and three patients had an associated coronoid fracture. The injuries causes were traffic accidents and falling for a height.

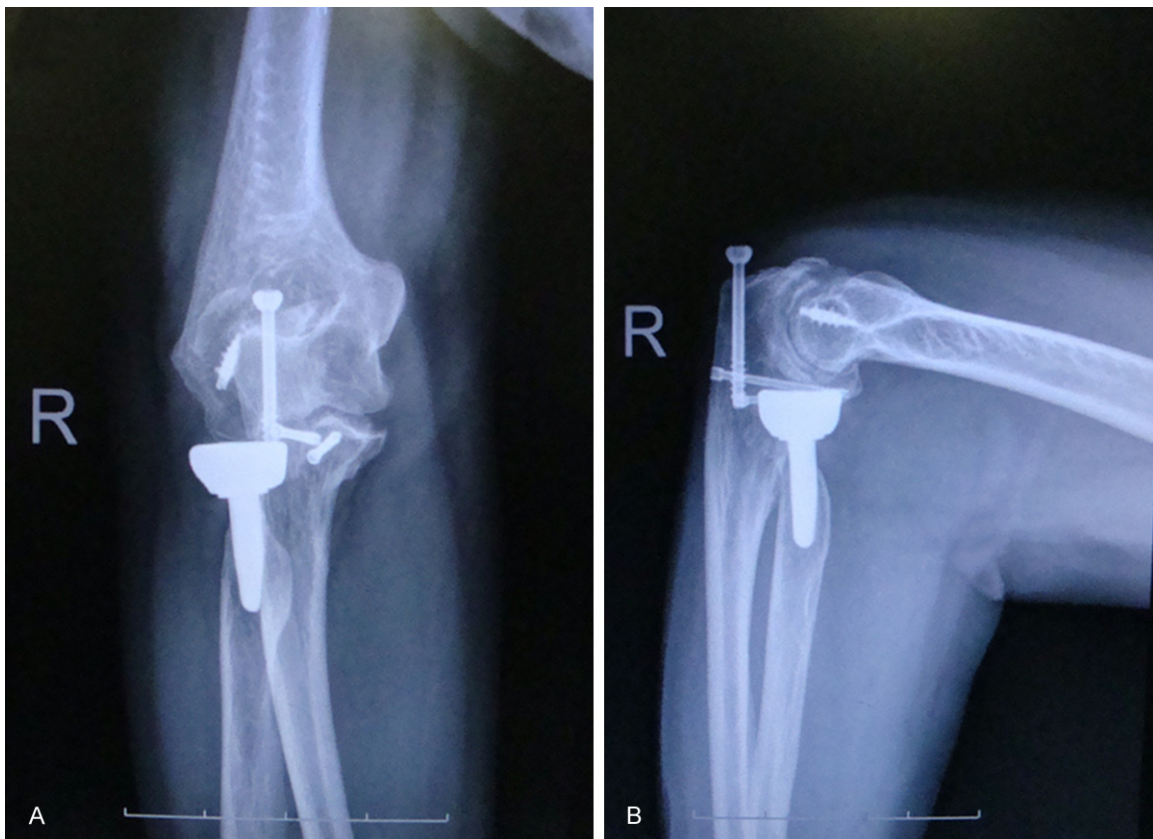
The mechanism of injury was a fall onto the outstretched arm, with the elbow partly flexed. Three patients had their fractures as a result of direct injury to the elbow.

### Radial head replacement

The operations were performed by two surgeons Yan Xiong and Ziming Wang in our department within ten days of injury. According to the Kaplan interval in a line from the lateral epicondyle toward Lister's tubercle, the posterolateral elbow joint curved incision was selected. Resect the radial head with a microsagittal saw as close to the surgical neck as possible. Select the collar reamer that matches the stem diameter determined by the broach. Under power or by hand, ream to create a surface where at least 60% of the radial shaft is in contact with the reamer. Determine head diameter by placing the resected head into the sizing pockets on the impactor base. If between sizes, select the smaller diameter. Insert stem gauge assembly into the bone canal and sequentially increase the height by inserting the end of the gauge under the head of the assembly, until the head reaches the capitellum. It is critical that the coronoid contacts the trochlea during this process. After determining the correct size head and stem, insert the implant into the radius using the impactor and a mallet. Ensure that the laser etched line on the head is aligned with the lateral aspect of the radius when the forearm is in neutral position. Five cases were associated with lateral collateral ligament and one case with medial collateral ligament injuries, which were repaired using the anchor or the Ethibond suture. The coronoid fracture and



**Figure 1.** A 39-year-old man, right elbow; comminuted radial head fractures, undisplaced olecranon fracture and coronoid fracture, (A, Anteroposterior view; B, Lateral view).





## Radial head fractures with Acumed anatomic radial head system

**Figure 2.** A 39-year-old man, right elbow; radiographic result 5 years after olecranon fracture and coronoid fracture fixed with screw and radial head replacement (A, Anteroposterior view; B, Lateral view).



**Figure 3.** A 39-year-old man right elbow; clinical result 5 years after olecranon fracture and coronoid fracture fixed with screw and radial head replacement (A, Extension; B, Flexion; C, Supination; D, Pronation).

the olecranon fracture were fixed with screw (Figure 2).

All patients were immobilized initially in a long arm splint in 90 degrees of flexion with neutral rotation. Motion is initiated within 3 days in all cases. For isolated fractures of the radial head and neck, without ligament injury, postoperative early motion is commenced in flexion and extension as well as pronation and supination. For those with instability noted at surgery requiring ligament repair, elbow flexion and extension began at the fourteenth day. Patients were monitored with serial examinations and radiographs. The unaffected elbow side in each patient was selected as a control group. All the patients were reviewed by the surgeon Zhihang Fan and an evaluation was undertaken using the Hospital for Special Surgery total elbow scoring and a modified Disability of Arm

Shoulder Hand (DASH) questionnaire. The evaluation included a record of pain, function, muscle strength, contracture and rotation. The pain was recorded using a 10-point visual analog scale pain score (0 = no pain; 10 = severe pain). The range of elbow inflexion was recorded and muscle strength was measured with a dynamometer. The standardized elbow radiograph were taken and used to detect the ossification and osteoarthritic change, the prosthesis stability and change of the distal radio-ulnar joint. The lateral and medial ulnohumeral space, proximal radial migration was recorded.

### *Statistical analysis*

The flexion and extension, supination and pronation range of motion, and the lateral and medial ulnohumeral space, proximal radial migration were analyzed and compared. Paired

t test was used to compare between the affected and unaffected elbows in each patient. In all cases, a *P* value of 0.05 was assumed to denote statistical significance.

## Results

All patients treated by the Acumed anatomic radial head system achieved our follow up at a mean follow-up of 60.8 months (19 to 77 months). There were no infection and implant loosening complications. There was no dislocation of the radial prosthetic head. All the elbows were stable with no cubitus valgus or osteoporosis of the capitellum. Most patients got a pain-free elbow and visual analog scale for pain 1.3 (range, 0-3). There was no pain in the forearm or wrist, and there was no complex regional pain syndrome. The average flexion and extension arc was 130 degrees (range, 110° to 140°). In comparison, the unaffected elbow measured an average flexion and the extension arc was 140° (range, 125° to 150°). There was statistically significant difference (*P* = 0.018). Three patients had 10 degrees of average flexion contracture. The mean range of elbow supination was 75° (60° to 85°) and pronation 80° (65° to 90°) (**Figure 3**). The difference in range of motion between the affected and unaffected elbow was statistically significant (*P* = 0.016). The mean grip strength was 95% that of the contralateral side (85% to 110%). Without the specialized rehabilitation, all patients' elbow function had recovered to the level before injury at a mean of 60 days (45 to 90 days). All patients had an excellent or good clinical result. The mean Hospital for Special Surgery total elbow scoring was 97.1/100 (94 to 100). The mean DASH score was 11.9/100 (0 to 25/100).

Radiographic measurement revealed that average lateral ulnohumeral space on the affected side was 2.2 mm (range, 1-5 mm) and lateral ulnohumeral space on the unaffected side was 2.5 mm (range, 1-5 mm). There was no significant difference between the affected and unaffected elbow (*P* = 0.25). The Average medial ulnohumeral space on the affected side was 2.1 mm (range, 1-5 mm) and medial ulnohumeral space on the unaffected side was 2.2 mm (range, 1-4.5 mm). There was no significant difference between the affected and unaffected elbow (*P* = 0.21). The average proximal radial migration on the affected side was 0.25 mm (range, -2 to 3 mm) and the average proximal

radial migration on the unaffected side was 0.22 mm (range, -2.5 to 3 mm). There was no statistically significant (*P* = 0.16). And the radiological review showed no evidence of elbow instability and all patients' radiology had no a peri-prosthetic lucency during the following up. One small heterotopic calcification was found in two elbows, but it did not cause obvious influence. There was humero-ulnar arthritis in one elbow. There were no the distal radio-ulnar degeneration. All patients were satisfied with the clinical results.

## Discussion

For comminuted radial head fractures, satisfactory internal fixation to comminuted radial head is often difficult. The most important cause of failure of internal fixation has been the inability to achieve rigid internal fixation [11]. On the other hand, comminuted radial head fracture is often associated with other injuries such as dislocation of the elbow, the coronoid process, the collateral ligament disruption, interosseous membrane and radio-ulnar instability. Radial head resection has been associated with long-term complications, including wrist and forearm pain, valgus elbow deformity, degenerative osteoarthritis, and decreased strength [4, 5]. Many clinical and biomechanical studies showed that the radial head has been an important stabilizer of the elbow and forearm. Therefore, radial head replacement is indicated if there is a definite evidence of the elbow instability of comminuted radial head fractures.

A variety of implants have been used to replace the radial head. The radial head is made of different materials such as KPS prosthesis, McPyc prosthesis in polycarbon, Bioprofile SA, Monobloc radial head prostheses [12-19]. The radial head of AARHS is made of highly polished cobalt chromehead to maximize articulation. The medial defined ulna articular zone is angled and smooth to improve contact with the radial notch. AARHS can provide the patient with an anatomical prosthesis, and wear on the capitellum is theoretically reduced due to the improved biomechanics and balancing within the elbow. Compared with other radial head prosthesis, AARHS has closely replicated the natural anatomy of the radial head and provided many head/stem combinations to accommodate each patient's anatomy. The designs

have provided enough selections to accommodate the anatomy of the proximal radius. The stem of the AARHS is uncemented and fixed through a tight press fit, so it can reduce the incidence of loosening. This is different from other stem that causes high contact pressure on the opposing articular cartilage or bone cement [9]. The fluted stem of the AARHS can provide rotational stability and grit blasted stem surface promotes bony ongrowth. So there is no prosthesis loosening in our patients. Many radial head designs have been used currently, but little studies showed that one design is better than another. Our study showed that the mid-term results of the clinical and radiological outcome of AARHS are better.

All operations were performed using the Acumed anatomic radial head prosthesis system within ten days of injury. The joint capsule and annular ligament were sutured without special ligament reconstruction. If the radial head fracture associated with coronoid fracture, we used a screw or anchor to fix the coronoid process and strength the elbow stability. At the same time, the coronoid process is one standard to assess the radial head prosthesis size. If the coronoid separated from the trochlea, it is indicated that radial head prosthesis collar is too large. The AARHS can provide many head/stem combinations so that we can select the right size. If the radial head fracture associated with medial or lateral ligament rupture, we used the anchor to reconstruct the stability of the ligament. All patients recovered the functional range of motion of the elbow. None of the elbows had symptoms or signs of instability at the final evaluation. Many medium-term radiological reviews of radial head prosthesis show a high rate of radiolucency around the stem and also osteoporosis of the capitellum, indicating uneven and incongruous loading at the joint [13]. Our radiological review showed no evidence of peri-prosthetic lucency during the following up. There are no major complications such as infection or pain at an average of 60.8 months follow-up. Despite there is a significant difference between the affected and unaffected elbow in range of movements, the patients recovered the functional range of motion of the elbow. All patients had an excellent or good clinical result. Compared with other studies of a similar size, our clinical results with all excellent results at medium-term follow-up is better than

other studies [12-18]. Our experience has encouraged us to continue using the AARHS in comminuted fractures, especially when instability of elbow is a potential problem.

In conclusion, the radial head replacement with the AARHS can provide effectively stability and good clinic results at the middle term following up. Our experience has encouraged us to continue using the AARHS in comminuted fractures, especially when instability of elbow is a potential problem.

## Acknowledgements

The study was partly supported by Medicine and Health Program of Zhejiang Province (2014RCA026) and Medicine and Health Program of Zhejiang Province (2015ZDA028).

## Disclosure of conflict of interest

None.

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