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Functional Outcome Analysis In The Management Of Radial Head And Neck Fractures: A Prospective Study.

S Senthil Sailesh[1]*, M Praveen[2], and S Gokulanathan[3].

[1]Assosciate Professor, Department Of Orthopedics, Government Medical College And Hospital, Villupuram, Tamil Nadu, India.
[2]Assistant Professor, Department Of Orthopedics, Srinivasan Medical College And Hospital, Trichy, Tamil Nadu, India.
[3]Assistant Professor, Department Of Orthopedics, Government Medical College And Hospital, The Nilgiris, Udhagamandalam, Tamil Nadu, India.

ABSTRACT

Fractures of the radial head are common injuries, whereas, in the case of displaced fractures, surgical treatment using screw or plate osteosynthesis, excision, or replacement of the radial head is required. However, data about patient-related outcomes (PROM) for different types of radial head fractures is limited in the current literature. Therefore, this study was conducted to evaluate the functional outcome after operatively treated radial head fractures and to further correlate these results with the initial modified Mason classification. This prospective study was conducted in the year 2023 at Department Of Orthopedics, Government Medical College And Hospital, Villupuram, Tamil Nadu, India. The median Quick DASH score was 4.5 (IQR: 4.5-12.5). There were six complications including nonunion (3/18), implant irritation (2/18) and hetero- topic ossification (1/18). There were significantly more nonunion in patients with more than two fracture fragments (P=0.043). Four patients underwent reoperation: three implant removals and one late radial head resection. Multiple classification systems exist to help characterize radial head fractures and their associated injuries, as well as to guide treatment strategies. Depending on the type of fracture, non-operative management may be possible if early range of motion is initiated. Other options include open reduction and internal fixation or excision followed by arthroplasty. A lateral approach is typically used for adequate surgical exposure. Controversy still remains regarding operative management of more severe fractures, but studies have shown good outcomes after radial head replacement for these fractures. We will review the current treatments available for radial head fractures, highlighting gaps in knowledge, as well as providing recommendations for the care of these injuries

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Corresponding author

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INTRODUCTION

Radial head fractures account for one-third of all elbow fractures and often result from a fall onto the outstretched arm in pronation [1]. When other injuries are present, the radial head fracture may be unstable. Reconstruction of the lateral column maintains the normal axis of the elbow and reduces the risk of degenerative arthritis in both the elbow and wrist joints [2]. Surgery is recommended when there is impaired forearm motion, >2 mm fracture displacement, or if >1/3 of the radial head diameter is fractured.2–6 Open Reduction and Internal Fixation (ORIF) should be considered for comminuted fractures of the proximal radius with excellent long-term results [3]. However, overly aggressive use of ORIF places the patient at risk for failure (pseudoarthrosis, mechanical failure, osteonecrosis). In the face of non-reconstructable radial head fractures, the alternatives to ORIF include radial head excision or arthroplasty (RHA) [4]. RHA produces excellent results in 85% of cases but may have higher complication rates. Radial head excision in complex radial head fractures results in inferior outcomes compared to radial head ORIF, and this may be related to osteoarthritic changes following excision [5, 6]. The aim of this study was to evaluate the functional and patient reported outcomes, as well as the complications, of complex radial head fractures treated with screw fixation

MATERIALS AND METHODS

This prospective study was conducted in the year 2023 at Department Of Orthopedics, Government Medical College And Hospital, Villupuram, Tamil Nadu, India. Patients above the age of 18 years were included. Indications for operative treatment were partial articular radial head fractures with displacement >2mm, displaced radial head fractures with greater than one fragment, or restricted supination or pronation. Five patients with isolated radial head fractures were excluded. Com- plex radial head fractures were defined as fractures with accompanying injuries of the elbow. All patients underwent a standard preoperative computed tomography (CT) scan to determine fracture characteristics. All preoperative and postoperative radiographs are accessible through the ICUC iPad application Database along with intraoperative photographs, fluoroscopy images, and photographs of the final range of motion. Eighteen patients were included. There were 8 malesand 10 females with an average age of 48.0±16.4 years (range: 22-71) and median radiographic follow-up of 42weeks (range: 10-125) (Table 1). Using the modified Mason-Johnston classification, there were 7 Mason II fractures, 3 Mason III fractures, and 8 Mason IV fractures. Using the Association for the Study of Internal Fixation Comprehensive Classification of Fractures, 3 fractures were classified as A2, 9 were B2, 1 was C1, 3 were C2 and 2 were C3. All patients had an associated collateral ligament injury and 6 patients had an associated fracture of the ulna, including 3 olecranon fractures, 1 coronoid fracture, 1 diaphyseal and 1 metaphyseal fracture. Eight patients had an elbow dislocation, where 2 had a terrible triad injury of the elbow. There were 2 patients with Monteggia fractures. No patients had an Essex-Lopresti lesion.

Operative Treatment

All patients underwent surgery within three days after injury by a single traumatologist. Radial head arthroplasty was not available at the institution because of financial constraints, so the routine practice is radial head fixation. When there was a solitary radial head fracture, a lateral approach was used. The radial head was approached through the Kocher interval (between the extensor carpi ulnar is and anconeus muscles) in 11 patients, through the Kaplan approach (between the extensor digitorum communis and extensor carpi radialis brevis muscles) in 6 patients, and a posterior approach to the elbow in one patient.37,38 To achieve complete visualization of the radial head, the muscles attached to the lateral supracondylar ridge were released. In the presence of lateral collateral ligament injury, this was reattached to the lateral humeral epicondyle using a suture anchor Cortical positioning screws sized 1.5mm to 2.0mm ranging from 18 mm to 34 mm in length (were used, and the number of screws was determined intraoperatively. The screws were placed transversely or obliquely in the area of safety as bicortical positioning screws without compression.39 Most patients (13 of 18) were treated with 2-3 screws, followed by 4-5 screws (4 of 18), and one patient was treated with a single screw. Bone grafting was not performed in any patient. Either a posterior approach, a Kocher approach through the posterior incision, or a combined posterior and lateral approach was used in the presence of a concomitant ulna fracture. Four patients had fixation of the ulna using a Locking Compression Plate (LCP, DePuy Synthes, West Chester, Pennsylvania, USA) and one patient had an olecranon fracture treated with tension band wiring. Eight patients had an accompanying elbow dislocation, and all eight were treated with a static external fixator for three weeks. Postoperatively, the patients who did not have a fixator were im- mobilized for 10-14 days in

an upper arm cast in 90° flexion and neutral supination/pronation followed by gradual, patient-direct- ed mobilization. Active motion began after 5-6 weeks.

Statistical analysis

To evaluate factors influencing range of motion, we used the Fisher's exact test for nominal variables and the student's *t*-test for parametric continuous variables. The Fisher's exact test was also used to test if fracture characteristics influenced the incidence of complications and reoperations. A Mann-Whitney U test was used to assess if fracture characteristics, complications, or decreased range of motion influenced the qDASH score. A significance level was set at 0.05 for all tests.

RESULTS

The average elbow extension was 16.4°±23.8, flexion was 140.8°±9.6, supination was 85.8°±4.6, and pronation was 87.5°±5.2. Compared to the uninjured elbow, the injured elbow had 98.8±2.7% flexion, 96.0±4.8% extension, 98.9±2.7% supination and 99.7±1.2% pronation (Table 2). All patients achieved a satisfactory range of motion of >90% when compared to the uninjured elbow. In eight (44.4%) patients, there was no difference in range of motion between the injured and uninjured elbow. We were able to contact 16 patients to complete the qDASH at least 11 months postoperatively, of which six had a complication. The median postoperative qDASH score was 4.5 (range: 0-61.4). The median qDASH score for patients with reduced range of motion was 18.4 (range: 0-61.4) compared to 4.6 (0-13.6) in those without reduced motion (P=0.62). Patients with complications had a median qDASH of 9.1 (range4.6-61.4) and the qDASH was 4.6 (range: 0-52.3) in those without complications (P=0.17). There were six patients with complications (case 4, 8, 16, 18, 21, 22) including four who underwent reoperation (Tables 3 and 4). Complications occurred in 4 of the 7 fractures with more than two fragments compared to 2 of the 11 fractures with two or less fragments (P=0.14). Non- union only occurred in the fractures with more than two fragments (3 of 7) and did not occur in the fractures with one or two fragments (0 of 11) (P=0.043) (Table 5). The most common complication was nonunion (case 16, 21, 22), followed by implant irritation (case 8 and 18) and heterotopic ossification (case 4). The respective qDASH scores are reported in Table 4. Two patients with nonunion had a reoperation. One (case 16) underwent radial head resection because of an unstable nonunion while the other underwent implant removal because the radial head was found to be a stable, fibrous union intraoperatively after implant removal (case 21). The other patient with nonunion had no pain or functional impairment (case 22). Complete or partial implant.

Table 1: Patient Characteristics

Variable	All patients (n=18)	Decreased ROM (n=10)	P value
Age, mean (SD), years	48.0 (16.4)	48.2 (16.0)	0.97[1]
Male, n (%)	8 (44.4)	5 (50.0)	0.99*
Right, n (%)	11 (61)	7 (63.6)	0.63*
AO classification, n (%)			>0.99*
A2	3 (16.7)	1 (33.3)	
B2	9 (50)	5 (55.6)	
C1	1 (5.6)	1 (100)	
C2	3 (16.7)	2 (66.7)	
C3	2 (11.1)	1 (50)	
Mason classification, n (%)			0.17*
II	7 (38.9)	5 (71.4)	
III	3 (16.7)	0 (0)	
IV	8 (44.4)	5 (62.5)	
Elbow dislocation, n (%)	8 (44.4)	6 (62.5)	0.66*
Fragments, n (%)			>0.99*
≤2	11 (61.1)	6 (54.6)	
>2	7 (38.9)	5 (57.1)	
Articular surface fractured, n (%)			0.81*
<30	4 (22.2)	2 (50.0)	

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30-60	3 (16.7)	1 (33.3)	
>60	11 (61.1)	7 (63.6)	
Fracture displacement, n (%)			>0.99*
2-3mm	3 (16.7)	2 (66.7)	
3-4mm	1 (5.6)	1 (100)	
>4mm	14 (77.8)	7 (50.0)	
Neck fracture, n (%)	5 (27.8)	2 (40)	0.61*
Concomitant osseous injury, n (%)	6 (33.3)	4 (66.7)	0.64*
N° of Screws for fixation, n (%)			>0.99*
1	1 (5.6)	1 (100)	
2-3	13 (72.2)	7 (53.9)	
4-5	4 (22.2)	2 (50.0)	
Ancillary fixation, n (%)	5 (27.8)	3 (60.0)	>0.99*
[1] Using Student's t-test; * Using Fisher's exact test; ROM: Range of motion			

Table 2: Postoperative Outcomes

Variable	Injured elbow	% of uninjured elbow mean (SD), %
Range of motion, mean (SD), º		
Elbow Extension	16.4 (23.8)	96.0 (4.8)
Elbow Flexion	140.8 (9.6)	98.8 (2.7)
Supination	85.8 (4.6)	98.9 (2.7)
Pronation	87.5 (5.2)	99.7 (1.2)
Patient reported outcomes		
Quick-DASH, median (IQR)	4.5 (4.5-12.5)	-

Table 3: Postoperative Complications

Complication, n (%)	(n=6)
Nonunion	3 (16.7)
Heterotopic ossification	1 (5.6)
Implant irritation	2 (11.1)
Infection	0
Ulnar neuritis	0
Posterior interosseous nerve injury	0
Reoperation, n (%)	**(n=4)**
Implant removal	3 (16.7)
Radial head resection	1 (5.6)

Table 4: Cases with Postoperative Complications

Cases	Treatment		Complication	Re-operation	Classification		Fragments	Elbow dislocation	Articular surface displacement >1/3	Fracture displacement (mm)	Concomitant injury	Quick DASH	
	Screw Fixation	Externa Fixation	Heterotopic Ossification	No	II	B2	2	Yes	Yes	>4	No	Yes	9.1
4	Yes	Yes											
8	Yes	Yes	Implant Irritation	Yes	IV	B2	2	Yes	Yes	3-4	No	Yes	25
16	Yes	Yes	Nonunion	Yes	IV	C2	3	Yes	Yes	>4	Yes	Yes	9.1
18	Yes	No	Implant Irritation	Yes	II	C3	3	No	Yes	2-3	Yes	Yes	61.4
21	Yes	No	Nonunion	Yes	III	B2	3	No	Yes	>4	No	Yes	4.6
22	Yes	No	Nonunion	No	III	C3	4	No	Yes	>4	Yes	Yes	4.6

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Table 5: Bivariate Analysis Complications

	Complications (n=6)	Nonunion (n=3)	Reoperation (n=4)
Mason classification, n (%)			
II	2 (28.6)	0	1 (14.3)
III-IV	4 (36.4)	3 (27.3)	3 (27.3)
P value*	>0.99*	0.25*	>0.99*
Fragments, n (%)			
≤2	2 (18.2)	0	1 (9.1)
>2	4 (57.1)	3 (42.9)	3 (42.9)
P value*	0.14*	**0.043***	0.25*
Fracture displacement, n (%)			
≤3mm	1 (33.3)	0	1 (33.3)
>3mm	5 (33.3)	3 (20)	3 (20.0)
P value*	0.99*	>0.99*	>0.99*
* Using Fisher's exact test			

Figure 1:Exposure of Radial head

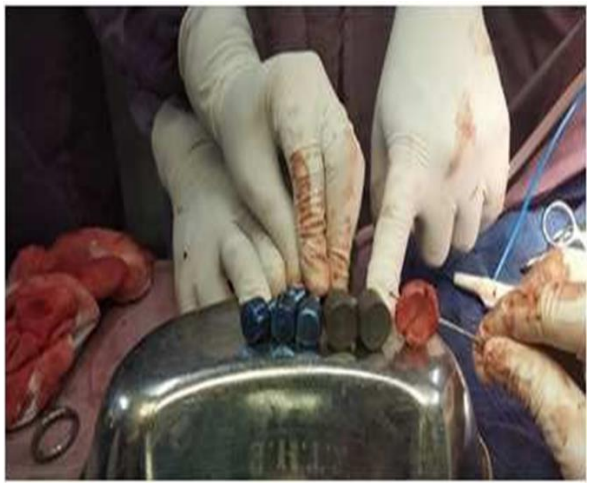

Figure 2: Image shows intraoperative sizing of the radial head.

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CASE 1 –MASON TYPE 1 – CONSERVATIVE MANAGEMENT
FOLLOW UP AT 6 MONTHS – GOOD.

PRE OPERATIVE X-RAY

FOLLOW UP AT 6 MONTHS

RANGE OF MOVEMENTS

FLEXION

PRONATION

EXTENSION

SUPINATION

CASE 2 – MASON TYPE 2 – RADIAL HEAD FIXATION
FOLLOW UP AT 6 MONTHS – GOOD

PRE OPERATIVE X-RAY

FOOLOW UP AT 6 MONTHS

RANGE OF MOVEMENTS

FLEXION

SUPINATION

EXTENSION

PRONATION

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CASE 3 – MASON TYPE-III – RADIAL HEAD EXCISION
FOLLOW UP AT 6 MONTHS – GOOD

PRE OPERATIVE X-RAY

6MONTHS

INTRA OPERATIVE IMAGES

RADIAL HEAD EXPOSURE

EXCISED RADIAL HEAD

RANGE OF MOVEMENTS

FLEXION

EXTENSION

SUPINATION

PRONATION

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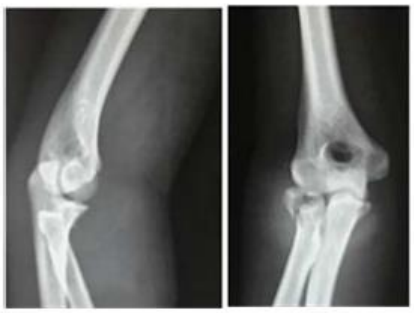
CASE 4 – MASON TYPE III - RADIAL HEAD PROSTHESIS
FOLLOW UP AT 6 MONTHS - EXCELLENT

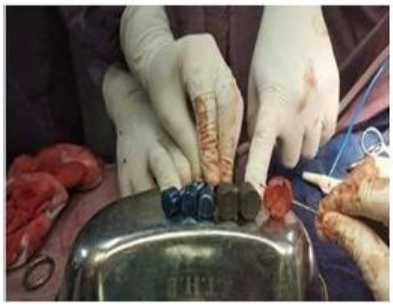
PRE OPERATIVE X-RAY



FOLLOW UP AT 6 MONTHS

INTRA OPERATIVE IMAGES

INTRA OPERATIVE SIZING



IMPLANTATION OF PROSTHESIS

RANGE OF MOVEMENTS

FLEXION

EXTENSION

SUPINATION

PRONATION

DISCUSSION

The treatment of simple radial fractures in isolation or complex radius fracture with or without instability (ligamentous injury) is still under debate. David et al in his study concluded that type I Mason can be managed conservatively and type II Mason can be managed with fixation shows a better functional outcome in his study, similar to our study with a mayo elbow score of more than 75 showing a good result. In the case of type III Mason, there is still an ongoing debate between excision, fixation & replacement [6, 9, 13]. The type III Mason is usually a multifragmentry with intraarticular extension the management is usually difficult. In our study, we compared the functional outcome between excision and replacement based. The choice of selection of patients is based on the surgeon's choice & patient willingness. Leppilahti et al concluded that the resection of the radial head will lead to proximal migration of radius, new bone formation at the resected site, chronic wrist pain & cubitus valgus instability, so excision of the radial head cannot be considered an ideal treatment for isolated radius fracture, the radial head should be preserved whenever technically possible and replaced when necessary. Mehmet et al in their study concluded that the replacement shows a better functional outcome with improved hand grip and less postoperative elbow pain thus in comparison with our study. In our study, we found that as the degree of severity of injury increases the management option shifts from conservative to surgical. The conservative management showed good results at 6 months for type I Mason. As with type II Mason, the fixation showed good results at 6 months with fewer postoperative complications. In the case of type III Mason resection and replacement had good results initially but at the end of 6 months replacement was found to be better for maintaining radio capitellar congruency and grip strength Thus replacement is excellent for type III Mason in comparison with resection [8-21].

Limitation of the study

The study is prospective type conducted without randomization had a small volume and had a short follow up period.

CONCLUSION

From our study, we concluded that though radial head and neck fracture is one of the commonly occurring elbow injuries, each Mason type presents a different clinical scenario. The management option should be decided based on the injury severity with Replacement showing good results in Type III Mason, fixation in Type II Mason, conservative in Type I.

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