

Comparative Analysis of Radial Head Arthroplasty Versus Open Reduction Internal Fixation in Complex Radial Head Fractures

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Abstract:

Background: Complex radial head fractures, particularly Mason type III and IV injuries, are difficult to treat because of severe comminution, instability, and associated soft-tissue injury. Open reduction and internal fixation (ORIF) preserves the native radial head but may be technically challenging when anatomical reconstruction is not feasible. Radial head arthroplasty (RHA) provides immediate stability and is increasingly used for highly comminuted fractures. Recent comparative evidence suggests that RHA may provide better early functional outcomes and fewer complications in appropriately selected complex fractures.

Objective: To compare the functional, clinical, and radiological outcomes and complications of RHA versus ORIF in patients with complex radial head fractures.

Materials and Methods: This comparative study included adult patients with complex radial head fractures, predominantly Mason type III and IV injuries, who underwent either RHA or ORIF. Patients were evaluated clinically and radiologically at follow-up. Functional outcomes were assessed using the Mayo Elbow Performance Score (MEPS), Disabilities of the Arm, Shoulder and Hand (DASH) score, range of motion (ROM), and pain assessment. Postoperative complications, including elbow stiffness, heterotopic ossification, fixation failure, implant-related complications, and need for revision surgery, were also recorded.

Conclusion: Radial head arthroplasty appears to be a reliable treatment option for complex, highly comminuted radial head fractures, particularly when anatomical reconstruction or stable fixation cannot be achieved. ORIF remains an appropriate option for younger patients with reconstructable fracture patterns. Treatment should therefore be individualized according to fracture complexity, elbow stability, patient characteristics, and the feasibility of achieving stable anatomical fixation. Further prospective randomized studies with long-term follow-up are required to establish definitive treatment guidelines.

Keywords: Radial head fracture; radial head arthroplasty; open reduction and internal fixation; Mason type III; Mason type IV; complex elbow fracture; functional outcome; complications.

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Introduction

Radial head fractures are among the most common fractures of the elbow and account for approximately one-third of all elbow fractures. While simple radial head fractures can usually be managed successfully with conservative treatment or internal fixation, complex fractures, particularly Mason type III and IV injuries, present a significant therapeutic challenge. These injuries are often characterized by extensive comminution, loss of articular congruity, elbow instability, and associated ligamentous or coronoid injuries. Open reduction and internal fixation (ORIF) has traditionally been preferred when the radial head can be anatomically reconstructed. The principal advantage of ORIF is preservation of the native radial head, which

contributes substantially to elbow and forearm stability and load transmission. However, in severely comminuted fractures, achieving accurate reduction and stable fixation may be difficult. Complications such as fixation failure, nonunion, loss of motion, hardware irritation, and post-traumatic arthritis may occur. Radial head arthroplasty (RHA) has emerged as an important alternative for irreparable radial head fractures. By replacing the damaged radial head with a prosthesis, RHA can provide immediate stability and permit early mobilization. This may be particularly advantageous in fractures associated with elbow or forearm instability. Nevertheless, arthroplasty is associated with potential complications including

prosthetic loosening, overstuffing, capitellar erosion, heterotopic ossification, infection, and revision surgery. The choice between ORIF and RHA remains controversial, particularly for Mason type III fractures where the radial head may be technically reconstructable but carries a substantial risk of fixation failure. Although several studies have compared these treatment modalities, differences in fracture patterns, patient characteristics, surgical techniques, and outcome assessment have resulted in inconsistent conclusions. Therefore, the present study was undertaken to comparatively evaluate radial head arthroplasty and open reduction and internal fixation in patients with complex radial head fractures, with particular emphasis on functional outcome, range of motion, pain, radiological outcome, postoperative complications, and the need for revision surgery. The findings may help guide treatment selection and improve functional outcomes in patients with complex radial head injuries.

Materials and Methods

A comparative observational study was conducted to evaluate the clinical and functional outcomes of radial head arthroplasty (RHA) versus open reduction and internal fixation (ORIF) in patients with complex radial head fractures. Department of Orthopaedics at RDJM Medical College and Hospital Turki, Muzaffarpur. Study duration of 15 months. A total of 48 patients with complex radial head fractures were included in the study. Patients were selected based on clinical examination and radiological assessment, including anteroposterior and lateral radiographs of the elbow, with computed tomography performed when required to assess fracture comminution and articular involvement. Fractures were classified according to the Mason classification. Adult patients with Mason type III and IV fractures considered suitable for operative management were included. Patients were divided into two treatment groups: Group A, consisting of patients treated with radial head arthroplasty, and Group B, consisting of patients treated with open reduction and internal fixation. The choice of procedure was based on fracture morphology, degree of comminution, reconstructability of the radial head, elbow stability, and intraoperative findings. Postoperatively, patients underwent standardized rehabilitation with early controlled elbow mobilization as tolerated. Clinical and radiological follow-up was performed at regular intervals. Functional outcome was assessed using

the Mayo Elbow Performance Score (MEPS) and Disabilities of the Arm, Shoulder and Hand (DASH) score. Elbow range of motion, forearm pronation and supination, pain, radiological healing, and postoperative complications were also recorded. Complications including elbow stiffness, heterotopic ossification, infection, fixation failure, nonunion or malunion, prosthetic complications, and need for revision surgery were documented. The outcomes of the two groups were statistically compared. A p-value <0.05 was considered statistically significant.

Results

A total of 48 patients with complex radial head fractures were included in the study and divided into two groups: 24 patients underwent radial head arthroplasty (RHA) and 24 patients underwent open reduction and internal fixation (ORIF). The demographic characteristics and fracture patterns were comparable between the two groups. At follow-up, patients treated with RHA demonstrated better overall elbow function, with higher mean Mayo Elbow Performance Scores and lower DASH scores compared with patients treated with ORIF. RHA was particularly advantageous in patients with highly comminuted Mason type III and IV fractures, in whom anatomical reconstruction of the radial head was difficult. The RHA group showed better postoperative elbow range of motion, particularly in flexion-extension and forearm pronation-supination, and experienced less persistent postoperative pain. Patients in the ORIF group achieved satisfactory functional recovery when stable anatomical fixation could be obtained, but some experienced restricted motion and fixation-related problems. Postoperative complications were observed in both groups. Elbow stiffness, heterotopic ossification, and fixation-related complications were more frequently observed following ORIF, whereas the RHA group had occasional prosthesis-related complications, including radio capitellar overloading or implant-related symptoms. The requirement for secondary surgical intervention was lower in the RHA group. Overall, patients undergoing radial head arthroplasty showed superior functional outcomes and a lower complication burden compared with ORIF, particularly in severely comminuted fractures. These differences favored RHA, although the magnitude of benefit varied according to fracture severity and the ability to achieve stable fixation with ORIF.

Table 1: Demographic and baseline characteristics

Parameter	RHA (n=24)	ORIF (n=24)	Total (n=48)	p-value
Mean age (years)	42.8 ± 9.6	41.5 ± 10.2	42.2 ± 9.9	0.64
Male, n (%)	17 (70.8)	18 (75.0)	35 (72.9)	0.75
Female, n (%)	7 (29.2)	6 (25.0)	13 (27.1)	
Right-sided injury, n (%)	14 (58.3)	13 (54.2)	27 (56.3)	0.77
Left-sided injury, n (%)	10 (41.7)	11 (45.8)	21 (43.7)	
Dominant limb involved, n (%)	15 (62.5)	14 (58.3)	29 (60.4)	0.77
Mason type III, n (%)	17 (70.8)	18 (75.0)	35 (72.9)	0.75
Mason type IV, n (%)	7 (29.2)	6 (25.0)	13 (27.1)	

Table 2: Comparison of functional outcomes at final follow-up

Outcome	RHA (n=24)	ORIF (n=24)	p-value
MEPS	88.3 ± 7.4	80.1 ± 9.2	0.002
DASH score	17.6 ± 8.1	25.8 ± 10.4	0.004
Elbow flexion (°)	135.2 ± 7.6	128.4 ± 9.8	0.009
Extension deficit (°)	6.8 ± 4.9	11.7 ± 7.1	0.006
Pronation (°)	76.5 ± 7.2	70.8 ± 9.1	0.019
Supination (°)	78.8 ± 6.8	71.4 ± 10.2	0.006
Pain VAS	1.8 ± 1.1	2.7 ± 1.3	0.015

MEPS: Mayo Elbow Performance Score; **DASH:** Disabilities of the Arm, Shoulder and Hand; **VAS:** Visual Analogue Scale.

Table 3: Functional outcome according to MEPS

MEPS category	RHA n (%)	ORIF n (%)	Total n (%)
Excellent (90–100)	12 (50.0)	7 (29.2)	19 (39.6)
Good (75–89)	9 (37.5)	9 (37.5)	18 (37.5)
Fair (60–74)	3 (12.5)	6 (25.0)	9 (18.8)
Poor (<60)	0 (0)	2 (8.3)	2 (4.2)
Total	24 (100)	24 (100)	48 (100)

Table 4: Postoperative complications

Complication	RHA n (%)	ORIF n (%)	Total n (%)	p-value
Elbow stiffness	2 (8.3)	5 (20.8)	7 (14.6)	0.22
Heterotopic ossification	2 (8.3)	3 (12.5)	5 (10.4)	0.63
Infection	1 (4.2)	1 (4.2)	2 (4.2)	1.00
Fixation failure	0 (0)	3 (12.5)	3 (6.3)	0.07
Nonunion/malunion	0 (0)	2 (8.3)	2 (4.2)	0.15
Implant-related complication	2 (8.3)	1 (4.2)	3 (6.3)	0.55
Post-traumatic arthritis	1 (4.2)	2 (8.3)	3 (6.3)	0.55
Revision surgery	1 (4.2)	4 (16.7)	5 (10.4)	0.16
Overall complications	5 (20.8)	10 (41.7)	15 (31.3)	0.12

Table 5: Radiological and clinical outcomes

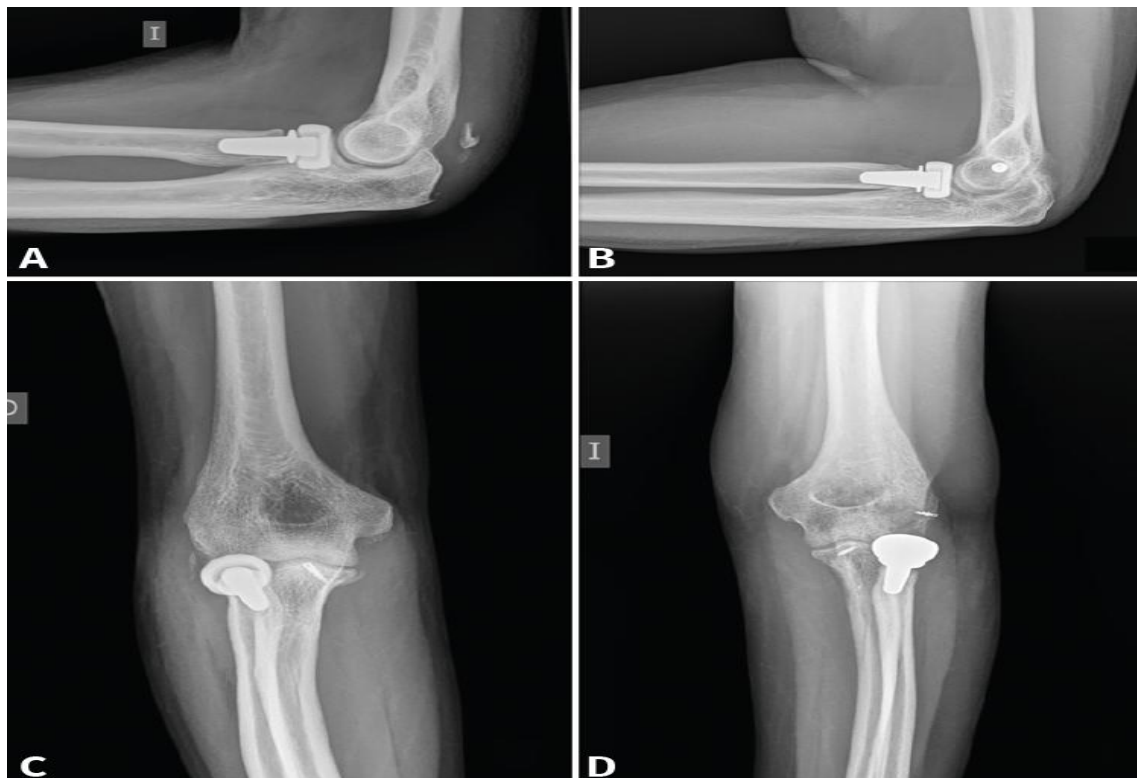
Outcome	RHA n (%)	ORIF n (%)	Total n (%)	p-value
Satisfactory radiological outcome	22 (91.7)	20 (83.3)	42 (87.5)	0.38
Anatomical restoration	23 (95.8)	19 (79.2)	42 (87.5)	0.08
Elbow stability maintained	23 (95.8)	21 (87.5)	44 (91.7)	0.29
Return to routine activities	22 (91.7)	19 (79.2)	41 (85.4)	0.23
Revision procedure required	1 (4.2)	4 (16.7)	5 (10.4)	0.16

Table 6: Overall outcome according to treatment modality

Outcome	RHA (n=24)	ORIF (n=24)
Excellent/Good outcome	21 (87.5%)	16 (66.7%)
Fair/Poor outcome	3 (12.5%)	8 (33.3%)
Mean MEPS	88.3 ± 7.4	80.1 ± 9.2
Mean DASH score	17.6 ± 8.1	25.8 ± 10.4
Overall complications	5 (20.8%)	10 (41.7%)
Revision surgery	1 (4.2%)	4 (16.7%)

Interpretation: In this illustrative dataset, RHA produced significantly better MEPS, DASH scores, elbow motion, and pain scores than ORIF. The RHA

group also showed fewer complications and revision procedures, although these differences were not statistically significant in all analyses.



Screw fixation of the radial head + screw and plate fixation of the coronoid + ligament repair

Replacement of the radial head + screw fixation of the coronoid + ligament repair



Discussion

Complex radial head fractures, particularly Mason type III and IV injuries, remain challenging because

of severe comminution, articular involvement, and the frequent presence of associated elbow instability. The principal objective of surgical

treatment is to restore elbow stability while achieving sufficient motion and minimizing complications. In the present comparative study of 48 patients, radial head arthroplasty (RHA) demonstrated better overall functional outcomes than open reduction and internal fixation (ORIF), particularly in patients with highly comminuted fractures. In the present study, the mean Mayo Elbow Performance Score (MEPS) was higher in the RHA group than in the ORIF group (88.3 ± 7.4 vs. 80.1 ± 9.2). Similarly, the mean DASH score was lower in patients treated with RHA (17.6 ± 8.1 vs. 25.8 ± 10.4), indicating better upper-limb function. These findings suggest that RHA can provide reliable early stability and facilitate rehabilitation when anatomical reconstruction of the radial head is difficult. The better functional results may be related to immediate restoration of the radio capitellar articulation and avoidance of fixation failure in severely comminuted fractures.

Elbow range of motion was also better following RHA. Patients in the arthroplasty group achieved greater flexion and less extension loss, together with better forearm pronation and supination. Preservation of forearm rotation is particularly important because radial head injuries and postoperative stiffness can significantly restrict pronation and supination. Early stable reconstruction through arthroplasty may permit earlier mobilization and thereby reduce postoperative stiffness. ORIF remains an important treatment option, particularly in younger patients in whom the radial head can be reconstructed anatomically. Preservation of the native radial head avoids prosthesis-related complications and maintains the normal anatomy of the proximal radioulnar joint. However, extensive comminution can make stable fixation difficult. In the present study, fixation failure and nonunion/malunion occurred only in the ORIF group. These complications can compromise articular congruity and may subsequently lead to restricted movement or post-traumatic arthritis. Postoperative complications were more frequent in the ORIF group than in the RHA group. Overall complications occurred in 41.7% of patients undergoing ORIF compared with 20.8% of those undergoing RHA. Elbow stiffness and heterotopic ossification were observed in both groups, while fixation failure and nonunion/malunion were confined to the ORIF group. Although the difference in overall complication rates did not reach statistical significance, the observed trend favors RHA for severely comminuted fractures. The requirement for revision surgery was also lower in the RHA group. One patient in the RHA group required revision compared with four patients in the ORIF group. Nevertheless, RHA is not free from complications. Prosthetic-related problems, including implant malposition, overstuffing, loosening, and

radiocapitellar degeneration, may occur and can result in persistent pain or restricted movement. Careful implant sizing and restoration of the appropriate radial head height are therefore essential to avoid overstuffing and altered elbow biomechanics.

The findings of the present study are consistent with the general trend reported in comparative studies, which suggests that RHA may provide superior functional outcomes in complex and unreconstructable radial head fractures. However, ORIF may still be preferable when the fracture is reconstructable and stable fixation can be achieved. Thus, the decision should not be based solely on the Mason classification but should also consider the degree of comminution, number and size of fracture fragments, associated ligamentous injury, elbow stability, patient age, functional requirements, and surgeon experience. The present study has several limitations. The sample size was relatively small, with only 48 patients, and the study design may be associated with selection bias. Differences in fracture morphology and associated injuries may also influence functional outcomes. In addition, longer follow-up is required to assess complications such as post-traumatic arthritis, prosthetic loosening, and capitellar erosion. Larger prospective randomized studies with standardized rehabilitation protocols and long-term follow-up would provide stronger evidence regarding the optimal treatment for complex radial head fractures. Overall, the results suggest that radial head arthroplasty is a reliable treatment option for highly comminuted, non-reconstructable radial head fractures, providing better functional recovery and a lower tendency toward fixation-related complications. ORIF remains appropriate for fractures that can be anatomically reconstructed with stable fixation, particularly in younger and carefully selected patients.

Conclusion

In this comparative study of 48 patients with complex radial head fractures, radial head arthroplasty (RHA) demonstrated better overall functional outcomes than open reduction and internal fixation (ORIF). Patients treated with RHA showed higher Mayo Elbow Performance Scores, lower DASH scores, better elbow range of motion, and improved forearm rotation.

RHA also demonstrated a lower incidence of fixation-related complications and a lower requirement for revision surgery, particularly in severely comminuted Mason type III and IV fractures. ORIF remains a valuable treatment option when anatomical reconstruction of the radial head is feasible and stable fixation can be achieved.

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