

RESEARCH ARTICLE

Functional outcomes of patients with comminuted radial head fracture undergoing radial head arthroplasty

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ABSTRACT


Background: The functional stability of the elbow joint can be effectively restored in acute care for comminuted radial head fractures (RHF) complicated with secondary ligamentous or bony injuries through the use of a metallic radial head implant. **Aims and Objectives:** This study aimed to evaluate the efficiency of modular metallic radial head implant EVOLVE® prosthesis in restoring the functional range of motion and elbow joint stability in acute care. **Materials and Methods:** A prospective observational study was conducted in the department of orthopedics at a tertiary-level care hospital in North India from April 2021 till March 2022. All consecutive patients above 18 years of age, with comminuted closed RHF, were included in the study. All underwent modular metallic head radial head implantation. The Mayo Elbow Performance Score (MEPS) was used to measure functional outcomes. **Results:** We observed that MEPS at 1-month follow-up was 81.54 ± 11.18 , which improved significantly at the 3rd-month follow-up to 87.24 ± 12.42 ($P < 0.001$). On the next follow-up at the 6th month, MEPS increased further to 92.14 ± 7.36 , $P < 0.001$. At the final follow-up at the 6th month, MEPS was graded as excellent for 80%, good for 12%, fair for 4%, and poor for 4%. One patient had complex regional pain syndrome and one had joint stiffness. **Conclusion:** The use of a modular radial head prosthesis has shown promise in treating comminuted RHF by re-establishing elbow joint stability in acute setting. This study demonstrated promising short-to-midterm results for the modular radial head arthroplasty.

KEY WORDS: Radial Head Fracture; Radial Head Arthroplasty; Radial Head Prosthesis

INTRODUCTION

Approximately 33% of all elbow joint fractures are radial head fractures (RHF). Among energetic younger patients, the most not unusual reason of this form of trauma is a fall onto an outstretched hand.^[1] Comminuted RHF can present with a complex injury pattern involving multiple movable parts and no soft tissue envelope. Furthermore, they are

often associated with ligamentous and bony injuries of the forearm or elbow. Sometimes, a gross unstable elbow joint is encountered as a result of RHF in combination with collateral ligament damage. In such cases, the radial head (RH) acts as a primary stabilizer.^[2] The management of RH injuries plays a critical role in re-establishing elbow joint stability and facilitating early mobilization. Although conservative treatment may be sufficient for Mason I and Mason II injuries, Mason II injuries may sometimes require open reduction and internal fixation (ORIF) if there is a displacement. However, for Mason III fractures, ORIF or RH prosthesis are the preferred treatment options.^[3] The primary objective of surgical treatment for RHF, whether using ORIF or prosthetic joint implant, is to prevent elbow joint subluxation or dislocation by restoring stability and alignment to the radiohumeral joint. The medial collateral ligament (MCL) is

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a crucial structure that attaches the elbow joint and acts as a primary restraint for valgus stress along with the RH which serves as a secondary stabilizer. Therefore, preserving the RH is vital in re-establishing the elbow joint stability. Resection of the RH is now only suggested for uncomplicated fractures with no ligamentous injury due to the risks of chronic instability and complications such as decreased grip strength, cubitus valgus, and ulnar neuropathy associated with RH resection.^[4] The initiation of early mobilization is pivotal in the prevention of elbow joint stiffness post-surgery. The chief objective of early mobilization is to achieve functional stability of the joint, in order to enable the patient to carry out everyday activities without any impediments. Physiotherapy and rehabilitation are a necessity for recovering the range of motion (ROM) and strength in the affected arm.

In order to preserve the RH, it is mandatory to maintain stability and avert chronic instability in elbow joint fractures that involve the surrounding ligaments and soft tissue.

The supreme method for treating Mason III and IV RHF is a subject of debate among orthopedic surgeons. While some recommend ORIF, others suggest using a RH prosthesis. However, this decision is case dependent and should be based on each individual's circumstances, including the extent of the fracture, related soft tissue injuries, and factors such as patient's age, occupation, and activity level. Although RH arthroplasty is a widely used treatment modality for comminuted RHF, there are reservations regarding the possible complications, including loss of motion, ulnar neuropathy, radiolucency, and periprosthetic osteolysis as these effect the overall function and mobility of the elbow joint.^[5] Therefore, it is important for surgeons to assess the potential benefits and risks of RH arthroplasty carefully and consider individual factors before determining the most suitable treatment. Furthermore, the long-term consequences of RH arthroplasty in young, active patients have not been fully researched or recorded. This is due to the fact that younger patients are more physically active, are putting more strain on the elbow joint, and have a longer lifespan which can lead to a higher degree of prosthesis wear and tear. The RH prosthesis is often considered the treatment of choice for comminuted fractures because these types of fractures often involve associated ligament injuries, which can further compromise stability. In such cases, the RH prosthesis can help restore joint stability and function. However, as with any surgical procedure, there are risks and potential complications that need to be paid attention to, before settling on the most appropriate treatment approach.^[6]

RH arthroplasty is often considered the primary treatment option for Mason type III and IV RHF by many orthopedic surgeons due to its ability to restore joint stability and improve functional outcomes. This prospective study focuses on determining the functional result of local patients who underwent operative treatment for RHF using RH arthroplasty.

MATERIALS AND METHODS

Study Design and Sampling

This prospective study was carried out at a tertiary-level care hospital in its department of orthopedics in North India from April 2021 till March 2022. We included consecutive adult patients over 18 years of age with comminuted closed RHF who could be followed up. The exclusion criteria followed were patients with (1) open fractures, (2) modified Mason type I and II fractures, and (3) active infections. The following formula was used to calculate the sample size: $N = (Z\alpha/2)^2 * (PQ)/E^2$, where N = sample size, $Z\alpha/2$ = Z value at 5% error (1.96), P = taken as 77% (Tarallo *et al.*^[7] reported excellent Mayo Elbow Performance Score [MEPS] in 77% of their patients), Q = 1-P, E = allowable error (taken as 20%), $1/N = (1.96)^2 * (0.77*0.23)/(0.15)^2$, N = 17. Hence, the minimum sample required was 17 patients. However, we included 25 patients in our study. The purpose and rationale of the study and their role as participants were described to all the patients. Written informed consent was obtained from all patients prior to enrolling them. Patient enrollment commenced after obtaining consent from the institutional ethics committee.

Operative Detail

Patients were put in a supine position with afflicted limb in abduction after acquiring surgical fitness and submitting regular laboratory procedures. The Kaplan technique was utilized to find the extensor carpi radialis longus anteriorly, between the extensor digitorum communis and the extensor carpi radialis longus. The annular ligament was left intact so that it may be sutured at the end of the surgery if necessary. If the radial collateral ligament (especially its ulnar section) was not already injured, special attention was paid to save it. The RH was then reached via either a lateral arthrotomy or an olecranon fracture. During the arthrotomy, the capitellar cartilage was examined. Although the state of the capitellar cartilage does not affect the therapeutic circumstances, it is one of the criteria that determine the prognosis. The MCL, LCL, and interosseous ligament were tested for competence after the RH was removed. The resected RH was put on the table, and an acceptable prosthetic size was chosen. A prosthesis with the suitable diameter and height was tested. The proximal medullary canal of the radius was then prepared for the implant using a reamer. The final actual stem was placed after achieving adequate contact between the capitulum and the trial prosthesis. It was made sure that it was suitable for the radial medullary canal and then the final prosthesis was secured. Finally, a bipolar radial articular surface prosthesis with a good fit was implanted. Non-absorbable sutures were used to repair the annular ligament. The joint's stability was assessed, and dressing was applied. The arm pouch was worn throughout the day in between exercises. A physiotherapist introduced immediate passive motion in all patients. On post-operative day 2, continuous passive motion without limitation of movement out of the

cast was started. The cast was removed after 1 week and full ROM was restored. At 6 weeks postoperatively, the patient was allowed to lift weight. For 3 weeks, indomethacin (75 mg/day) was prescribed to prevent heterotopic ossification.

Data Collection and Data Analysis

A pre-designed semi-structured research pro forma was used to gather data. The patients' demographic information, such as age and gender, were recorded. Clinical information such as the method and side of damage were recorded. Patients were asked if they had any major medical or surgical history. A thorough physical examination was performed to look for any connected injuries. Every follow-up appointment included a radiographic evaluation both before and after surgery. Anteroposterior, lateral, and Greenspan RH images of the elbow were obtained. If a wrist injury was suspected, bilateral posterior-anterior wrist stress images were performed. Outcome assessments were done as follows:

1. Each follow-up included a radiological examination. The bridging of the bone on anteroposterior and lateral X-rays was used to define fracture union at the coronoid process.
2. The MEPS,^[8] which comprises dimensions of stability, pain, mobility, and function, was used to measure functional results. An overall score of >90 indicates an exceptional outcome, 75–89 - a good outcome, 60–74 - fair outcome, and 60 indicates a bad outcome. Pre-operative (baseline) and post-operative (months 1, 3, and 6) functional results were evaluated.
3. Clinical examination and assessment of follow-up X-rays were done according to Popovic *et al.*, radiographic indicators of RH prosthesis loosening, namely, osteolysis, radiolucent lines, and proximal RH resorption.^[9]

RESULTS

Out of the 25 patients included, 44% were female. The mean age of the cohort was 41.23 ± 8.2 years, ranging from 21 to 55 years. The right limb was involved in 52% of patients. Roadside accident was the mode of injury in 56% of cases and the rest 44% had a fall as the mode of injury. We observed that 44% of the patients were operated within 6 days from the day of trauma. We found that 16% had LCL injury, 12% had MCL injury, 12% had elbow dislocation with LCL and MCL injury, and 8% had an olecranon fracture [Table 1]. We observed that MEPS at 1-month follow-up was 81.54 ± 11.18 , which improved significantly at the 3rd-month follow-up to 87.24 ± 12.42 ($P < 0.001$). On the next follow-up at the 6th month, MEPS increased further to 92.14 ± 7.36 with $P < 0.001$ [Table 2]. At the final follow-up at the 6th month, MEPS was graded as excellent for 80% of the patients, good for 12% of patients, and fair and poor for 4% of the patients each. In addition, one patient developed complex regional pain syndrome and one presented with joint stiffness. No post-operative complications were observed in 92% of the patients [Table 3].

Table 1: Characteristics of the patients included in the study

Characteristics	Number	Percentage
Age groups (years)		
25–35	8	32.00
36–45	5	20.00
46–55	12	48.00
Gender		
Male	14	56.00
Female	11	44.00
Side of injury		
Right	13	52.00
Left	12	48.00
Mode of injury		
Road traffic accident	14	56.00
Fall	11	44.00
Time of surgery from the day of trauma		
≤6 days	11	44.00
>6 days	14	56.00
Associated injury		
Lateral collateral ligament injury	4	16.00
Medial collateral ligament injury	3	12.00
Elbow dislocation and LCL injury and MLC injury	3	12.00
Olecranon fracture	2	8.00
No associated injury	13	52.00
Mason fracture type		
Type III	19	76.00
Type IV	6	24.00
Total	25	100.00

Table 2: Change in MEPS at subsequent follow-ups

MEPS	Post-operative follow-up		
	At the 1 st month	At the 3 rd month	At the 6 th month
	Mean (±SD)	Mean (±SD)	Mean (±SD)
	81.54 (±11.18)	87.24 (±12.42)	92.14 (±7.36)

P-value between the 1st and 3rd months was <0.001 and between the 3rd and 6th months was <0.001, both of which were statistically significant.

Table 3: Clinical outcome at final follow-up

MEPS	Number	Percentage
Excellent (>95)	20	80.00
Good (75 to 94)	3	12.00
Fair (60 to 74)	1	4.00
Poor (<60)	1	4.00
Complications		
Complex regional pain syndrome	1	4.00
Joint stiffness	1	4.00
No complications	23	92.00
Total	25	100.00

DISCUSSION

In our retrospective analysis of functional outcome after RH replacement, we found that the MEPS functional score gradually increased over 6 months to become excellent in majority of the cases.

RHF are a frequently encountered type of elbow fractures responsible for approximately 33% of all elbow fractures and present in about one-fifth of the elbow trauma cases.^[10] In case of complex RHF, re-establishment of the radiocapitellar contact is required for maintaining the functional stability of the elbow joint. The decision between RH fixation and replacement is dependent on various factors, including the severity and location of the fracture, the degree of comminution (i.e., fragmentation of the bone), patient's age, and activity level. Nevertheless, excision does have a role in some clinical settings. In our study, both RH replacement and osteosynthesis showed significantly better clinical outcomes compared to excision. However, no definitive difference between the outcomes of the prosthesis and osteosynthesis groups was observed. Another study by Chen *et al.*, comprising 45 patients, showed that the monopolar titanium prosthesis group had significantly better clinical outcomes with an excellent result rate of 91% compared to the ORIF group, which had an excellent result rate of 65.2%.^[11] The post-operative complication rate was also remarkably less in the RH replacement group (13.6%) compared to the ORIF group. In this study, AO steel plates and K-wires were used for ORIF. While the inclusion criteria in the study were similar to ours, there were differences in the operative protocol. Specifically, the study did not mention the reconstruction of coronoid fractures, which is an important aspect of our protocol that emphasizes the restoration of the anterior pillar. This difference in the approach may explain why the results were equivocal and the complication rates were low in both the groups.

In contrast, a different study by Ruan *et al.* made a comparison of 14 patients who received a bipolar prosthesis with 8 patients who underwent osteosynthesis of the RH and at a 14-month follow-up found an excellent outcome rate in 92.2% of the patients in the prosthesis group in comparison to only 12% in the osteosynthesis group.^[12] Our results differ from previous studies because we placed a particular emphasis on collateral reconstruction and coronoid fixation, and we did not use K-wires on the RH. In addition, we utilized standardized operative protocols.

Doornberg *et al.* supported our surgical protocol in their assessment of the role of RH arthroplasty in acute traumatic instability of the elbow. Their study included 27 patients who received a modular metal spacer prosthesis.^[13] They reported satisfactory results with only a few complications when using a modular metal RH prosthesis that is intentionally placed in a loose manner to restore stability. It is noteworthy that a large

prosthesis can result in complications, but a deliberately loose prosthesis did not appear to present any issues. However, out of the 27 patients included in their study, 7 patients needed further procedures, including the need for prosthesis removal in two of them.

In a retrospective study by Duckworth *et al.*, they identified younger age and the use of silastic prosthesis as risk variables for higher rates of further surgeries' requirement and prosthesis loosening within 1 year of the primary surgery.^[14]

CONCLUSION

RHFs frequently occur in complex elbow fracture-dislocations. When considering ligamentous injuries and coronoid or olecranon fractures, RH osteosynthesis can result in better outcomes in comparison to arthroplasty. However, the difference is statistically insignificant. Furthermore, despite RH excision having justifiable outcomes, it leads to a statistically significant loss of ROM, particularly in flexion-extension. Management of such injuries carries the potential drawbacks of complications and the requirement of further surgical procedures. Therefore, it is essential to explain the realistic goals of sustainable ROM to patients with comminuted RHF before any treatment is undertaken.

REFERENCES

1. King GJ, Green DP, Hotchkiss RN, Pederson WC, Wolfe SW. Green's Operative Hand Surgery. London: Churchill Livingstone; 2005.
2. Johnson JA, Beingessner DM, Gordon KD, Dunning CE, Stacpoole RA, King GJ. Kinematics and stability of the fractured and implant-reconstructed radial head. *J Shoulder Elbow Surg* 2005;14:195S-201S.
3. Meyer-Marcotty MV, Lahoda LU, Hahn MP, Muhr G. Differential therapy of radial head fracture: A critical analysis based on outcome of 53 patients. *Unfallchirurg* 2002;105:532-9.
4. Charalambous CP, Stanley JK, Siddique I, Powell E, Ramamurthy C, Gagey O. Radial head fracture in the medial collateral ligament deficient elbow; biomechanical comparison of fixation, replacement and excision in human cadavers. *Injury* 2006;37:849-53.
5. Lapner M, King GJ. Radial head fractures. *J Bone Joint Surg Am* 2013;95:1136-43.
6. Ricón FJ, Sánchez P, Lajara F, Galán A, Lozano JA, Guaredo E. Result of a pyrocarbon prosthesis after comminuted and unreconstructable radial head fractures. *J Shoulder Elbow Surg* 2012;21:82-91.
7. Tarallo L, Mugnai R, Rocchi M, Capra F, Catani F, Mason Type III radial head fractures treated by anatomic radial head arthroplasty: Is this a safe treatment option? *Orthop Traumatol Surg Res* 2017;103:183-9.
8. Morrey BF. Radial head fracture. In: Morrey BF, editor. *The Elbow and its Disorders*. 3rd ed. Philadelphia, PA: WB Saunders; 2000. p. 341-64.

9. Popovic N, Lemaire R, Georis P, Gillet P. Midterm results with a bipolar radial head prosthesis: Radiographic evidence of loosening at the bone-cement interface. *J Bone Joint Surg Am* 2007;89:2469-76.
10. Gebauer M, Barvencik F, Rucker AH, Rueger JM. Operative therapie der dislozierten radiusköpfchenfraktur. *Der Unfallchirurg* 2005;108:669-71.
11. Chen X, Wang SC, Cao LH, Yang GQ, Li M, Su JC. Comparison between radial head replacement and open reduction and internal fixation in clinical treatment of unstable, multi-fragmented radial head fractures. *Int Orthop* 2011;35:1071-6.
12. Ruan HJ, Fan CY, Liu JJ, Zeng BF. A comparative study of internal fixation and prosthesis replacement for radial head fractures of Mason Type III. *Int Orthop* 2009;33:249-53.
13. Doornberg JN, Parisien R, van Duijn PJ, Ring D. Radial head arthroplasty with a modular metal spacer to treat acute traumatic elbow instability. *J Bone Joint Surg Am* 2007;89:1075-80.
14. Duckworth AD, Wickramasinghe NR, Clement ND, Court-Brown CM, McQueen MM. Radial head replacement for acute complex fractures: What are the rate and risks factors for revision or removal? *Clin Orthop Relat Res* 2014;472:2136-43.

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