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Original Research Article

PROSPECTIVE COMPARATIVE STUDY OF CLINICAL, FUNCTIONAL AND RADIOLOGICAL OUTCOMES OF RADIAL HEAD EXCISION VERSUS RADIAL HEAD REPLACEMENT IN COMMINUTED RADIAL HEAD FRACTURES

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ABSTRACT

Background: Comminuted radial head fractures (Modified Mason Type III) are challenging injuries requiring a choice between radial head excision and radial head replacement. This study prospectively compared the clinical, functional, and radiological outcomes of both procedures at a tertiary orthopaedic centre.
Materials and Methods: Sixty-two patients with Modified Mason Type III comminuted radial head fractures were enrolled over two years: 31 underwent radial head excision and 31 underwent radial head replacement. The primary outcome was the Mayo Elbow Performance Score (MEPS) at six months. Secondary outcomes included operative parameters, range of motion, complications, radiological fracture healing, patient satisfaction, and functional outcome grading. Continuous variables were compared with the independent samples t-test; categorical variables with the chi-square test. $P < 0.05$ was significant.
Results: Mean MEPS at six months was 85.9 ± 7.2 (excision) and 88.3 ± 6.8 (replacement); the difference was not significant ($t = 1.28$; $p = 0.206$). Replacement required longer surgery (110.6 ± 20.3 vs 90.3 ± 15.4 min) and produced greater intraoperative blood loss. Overall complication rates were identical at 9.7% per group ($p = 1.000$), but differed in type: excision produced instability and proximal radial migration, while replacement produced implant failures. Elbow flexion was marginally better after excision (120.3 ± 10.6° vs 115.4 ± 11.2°). Patient satisfaction was slightly higher after replacement (8.1 ± 0.9 vs 7.8 ± 1.0).
Conclusion: Both procedures produced comparable six-month functional outcomes for Modified Mason Type III comminuted radial head fractures. Radial head replacement offered a marginal functional advantage and fewer instability-related complications, at the cost of greater operative complexity. Longer follow-up in larger cohorts is required to establish whether the functional difference becomes clinically meaningful over time.
Keywords: Radial head fracture; comminuted fracture; radial head excision; radial head replacement; Mayo Elbow Performance Score; Mason classification.

INTRODUCTION

Radial head fractures are among the most common elbow injuries in adults, accounting for approximately 20% of all elbow fractures and nearly one-third of elbow fractures presenting to orthopaedic units. They result primarily from falls onto an outstretched hand, which transmit axial and valgus loads to the radial head and produce fracture patterns ranging from undisplaced cracks to severely comminuted multi-fragment injuries. High-energy trauma from motor vehicle accidents and contact sports accounts for many cases in younger patients, while lower-energy falls predominate in older individuals with reduced bone density. The broad age distribution and the functional demands of the upper limb make management of these fractures a priority in orthopaedic practice.[1]

The radial head occupies a central position in the biomechanics of the elbow. It transmits approximately 60% of the axial load across the elbow joint and acts as the primary buttress against valgus stress. Together with the medial collateral ligament complex, it contributes to elbow stability — particularly during rotational movements and activities that impose valgus loads on the forearm. The radial head also facilitates the full arc of forearm rotation by participating in the proximal radioulnar articulation. Loss of the radial head therefore threatens not only elbow stability but also pronation and supination, functions essential for most daily activities and occupational tasks.[2]

Radial head fractures are classified using the Mason system, subsequently modified by Johnston. Type I fractures are undisplaced or minimally displaced and are managed conservatively. Type II fractures involve a single displaced fragment amenable to open reduction and internal fixation. Type III fractures are comminuted, with multiple fragments that preclude stable internal fixation. Type IV fractures are any type accompanied by elbow dislocation. Type III comminuted fractures present the greatest management challenge, as the degree of fragmentation prevents reliable reconstruction and demands a definitive decision between excision and prosthetic replacement of the radial head.[3]

Radial head excision involves the surgical removal of the fractured radial head. It is technically straightforward, avoids implant-related costs, and has a long historical track record. In simple fractures without associated soft tissue injury, acceptable functional outcomes have been reported. However, loss of the radial head disrupts the biomechanical equilibrium of the elbow: the radius migrates proximally, valgus loads are transferred entirely to the medial collateral ligament, and the risk of late cubitus valgus, elbow instability, and degenerative arthritis increases over time. These long-term consequences are particularly problematic in physically active or younger patients, for whom elbow stability is essential for work and sport.[4]

Radial head replacement was developed to address these limitations by substituting the fractured radial head with a prosthetic implant that restores normal load transmission and joint stability. Modern implant designs include monopolar, bipolar, and anatomically contoured systems, each engineered to approximate the geometry of the native radial head and to minimise stress shielding and periprosthetic bone loss. Radial head replacement is now widely recommended for irreparable Type III and Type IV fractures, particularly when elbow instability is present. It carries its own risks, however, including component loosening, implant overstuffing with secondary stiffness, periprosthetic fracture, and the possibility of revision surgery, making careful patient selection and precise surgical technique essential.[5]

The comparative efficacy of excision and replacement for comminuted radial head fractures remains incompletely resolved. Most published comparisons are retrospective and heterogeneous in design, differing in the outcome measures used, the implant systems assessed, the follow-up intervals, and the criteria for choosing one procedure over the other. Selection bias is a particular concern, as surgeons typically offer replacement to younger, higher-demand patients and excision to older or lower-demand patients, making retrospective comparisons difficult to interpret. Systematic reviews have identified broadly comparable short-term functional results for the two procedures but acknowledge that methodological limitations preclude firm conclusions. Prospective comparative data from well-characterised patient populations with standardised outcome assessment and defined surgical indications are therefore needed to guide clinical decision-making in this common and challenging injury pattern.

This prospective comparative study was designed to evaluate and compare the clinical, functional, and radiological outcomes of radial head excision versus radial head replacement in patients with Modified Mason Type III comminuted radial head fractures at a tertiary care orthopaedic centre in Maharashtra, India. The primary outcome was the Mayo Elbow Performance Score (MEPS) at six months postoperatively, with secondary outcomes encompassing operative parameters, postoperative recovery, elbow range of motion, complication rates, radiological fracture healing time, patient satisfaction, and overall functional outcome grading. The study aimed to provide objective, prospectively collected evidence to assist orthopaedic surgeons in selecting the most appropriate surgical approach for individual patients with this injury.

MATERIALS AND METHODS

This was a prospective comparative study conducted in the Department of Orthopaedics at a tertiary care hospital in Maharashtra, India, over a two-year period. The study was approved by the Institutional

Ethics Committee and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants before enrolment.

Patients aged 18 years and above with closed, acute Modified Mason Type III comminuted radial head fractures presenting within two weeks of injury were included in this study on the basis of a predefined inclusion and exclusion criteria.

Sample size was calculated using the Mayo Elbow Performance Score as the primary outcome variable, based on means and standard deviations reported in prior literature. Using the formula $N = (Z\alpha/2 + Z\beta/2)^2 (SD_1 + SD_2)^2 / (M_1 - M_2)^2$ and accounting for a 10% loss to follow-up, the required sample size was 31 patients per group, giving a total of 62 patients.

Surgical technique and postoperative care

All surgeries were performed under regional or general anaesthesia. Patients in the excision group underwent surgical removal of the comminuted radial head through a lateral Kocher approach. Patients in the replacement group received a metal radial head prosthesis sized to replicate the dimensions of the excised radial head. Postoperatively, wound dressings were changed every alternate day until suture removal. Physiotherapy commenced the day after surgery, emphasising active flexion-extension and forearm rotation exercises. Patients with associated ligamentous injuries were immobilised in a posterior above-elbow slab for three weeks before commencing active exercises.

Patients were assessed clinically and radiologically at one, three, and six months postoperatively. The primary outcome measure was the Mayo Elbow Performance Score (MEPS), a validated scoring system that evaluates pain (45 points), range of motion (20 points), stability (10 points), and daily function (25 points), with a maximum score of 100. Scores of 90–100 are graded excellent, 75–89 good, 60–74 fair, and below 60 poor. Secondary outcomes included operative parameters (surgical duration, intraoperative blood loss, incision length), postoperative recovery parameters (wound healing time, time for swelling to subside), elbow range of motion (flexion and extension in degrees), complication types and rates, radiological fracture healing time, patient satisfaction (numeric rating scale 0–10), and overall functional outcome grading. Data were entered into Microsoft Excel and analysed using SPSS version 23.0. Continuous variables are expressed as mean ± standard deviation. The independent samples t-test was used to compare continuous data between groups. Qualitative variables are presented as frequencies and percentages and were compared using the chi-square test or Fisher's exact test as appropriate. A two-tailed p-value < 0.05 was considered statistically significant.

Inclusion Criteria

- Age 18 years and above
- Closed, acute comminuted fracture of the radial head classified as Modified Mason Type III
- Presentation within two weeks of injury
- Fracture confirmed on plain radiography and classified by the operating surgeon
- Willing to give written informed consent and attend follow-up for six months

Exclusion Criteria

- Compound (open) fractures
- Malunited or neglected fractures presenting beyond two weeks
- Pathological fractures secondary to malignancy
- Periprosthetic fractures
- Fractures associated with polytrauma
- Refusal of consent or inability to comply with the follow-up protocol

RESULTS

All 62 enrolled patients completed six months of follow-up and were included in the final analysis. The two groups were comparable in age, sex, and body mass index at baseline. The data presented in Tables 1–8 are derived directly from patient records.

The majority of patients in both groups were in the 30–49 year age group. Mean age was 45.3 ± 12.1 years in the excision group and 46.8 ± 11.7 years in the replacement group. Males outnumbered females in both groups. [Table 1]

Table 1: Age and gender distribution of the study population (n = 62). RHE = radial head excision; RHR = radial head replacement

Parameter	RHE (n = 31)	RHR (n = 31)	Total (n = 62)
Age range (years)			
18–29	6	5	11
30–39	7	8	15
40–49	8	7	15
50–59	5	6	11
60–69	3	4	7
≥70	2	1	3
Mean age (years), Mean ± SD	45.3 ± 12.1	46.8 ± 11.7	46.1 ± 11.9
Gender			
Male	18 (58.1%)	19 (61.3%)	37 (59.7%)
Female	13 (41.9%)	12 (38.7%)	25 (40.3%)

Falls from height were the most common mechanism of injury in both groups. Road traffic accidents and sports injuries were the next most frequent causes. The distribution of injury mechanisms was similar across the two groups. [Table 2]

Table 2: Mechanism of injury and body mass index in both groups (n = 62). RHE = radial head excision; RHR = radial head replacement

Mechanism of injury	RHE (n = 31)	RHR (n = 31)
Fall from height	12 (38.7%)	13 (41.9%)
Road traffic accident	9 (29.0%)	8 (25.8%)
Sports injury	7 (22.6%)	6 (19.4%)
Direct blow to elbow	3 (9.7%)	4 (12.9%)
BMI (kg/m^2), Mean ± SD	24.8 ± 3.2	25.1 ± 3.1

Ligamentous injuries were the most common associated finding, present in 10 patients in the excision group and 11 in the replacement group. Sixteen patients in each group had no associated injuries. The majority of patients presented within 3–7 days of injury. [Table 3]

Table 3: Associated injuries and time since injury in both groups (n = 62). RHE = radial head excision; RHR = radial head replacement

Parameter	RHE (n = 31)	RHR (n = 31)
Associated injuries		
Ligamentous injury	10 (32.3%)	11 (35.5%)
Other fractures	5 (16.1%)	4 (12.9%)
None	16 (51.6%)	16 (51.6%)
Time since injury (days)		
< 3 days	8 (25.8%)	7 (22.6%)
3–7 days	15 (48.4%)	14 (45.2%)
8–14 days	8 (25.8%)	10 (32.3%)

Radial head replacement required significantly longer operative time and was associated with greater intraoperative blood loss and a longer skin incision compared with excision. Preoperative MEPS was similar in both groups, confirming comparable baseline elbow function. [Table 4].

Table 4: Preoperative MEPS and operative parameters in both groups (n = 62). RHE = radial head excision; RHR = radial head replacement; MEPS = Mayo Elbow Performance Score. Data presented as mean ± SD

Parameter	RHE (n = 31)	RHR (n = 31)
Preoperative MEPS, Mean ± SD	50.6 ± 10.2	51.3 ± 9.8
Operative time (min), Mean ± SD	90.3 ± 15.4	110.6 ± 20.3
Intraoperative blood loss (mL), Mean ± SD	150.8 ± 30.2	180.9 ± 35.1
Incision length (cm), Mean ± SD	8.2 ± 1.1	9.5 ± 1.3

Wound healing and resolution of swelling were slightly faster in the excision group. Elbow flexion was marginally better after excision (120.3 ± 10.6° vs 115.4 ± 11.2°), while extension deficit was similar between the two groups. [Table 5]

Table 5: Postoperative recovery parameters, range of motion, and radiological fracture healing in both groups (n = 62). RHE = radial head excision; RHR = radial head replacement. Data presented as mean ± SD

Parameter	RHE (n = 31)	RHR (n = 31)
Wound healing time (days), Mean ± SD	12.3 ± 2.4	13.7 ± 2.8
Time for swelling to subside (days), Mean ± SD	10.1 ± 1.9	11.4 ± 2.1
Elbow flexion (°), Mean ± SD	120.3 ± 10.6	115.4 ± 11.2
Extension deficit (°), Mean ± SD	5.8 ± 1.2	6.4 ± 1.5
Fracture healing time (months), Mean ± SD	4.8 ± 1.2	5.2 ± 1.4

MEPS improved progressively in both groups over six months. At each time point, the replacement group showed slightly higher mean scores. The difference between groups at six months (88.3 ± 6.8 vs 85.9 ± 7.2) did not reach statistical significance ($t = 1.28$; $p = 0.206$). [Table 6]

Table 6: Mayo Elbow Performance Score (MEPS) at preoperative, 1 month, 3 months, and 6 months postoperatively in both groups (n = 62). RHE = radial head excision; RHR = radial head replacement

Time point	RHE (n = 31)	RHR (n = 31)	p-value
Preoperative	50.6 ± 10.2	51.3 ± 9.8	—
1 month postoperative	65.7 ± 9.4	68.1 ± 8.7	—
3 months postoperative	78.4 ± 8.3	81.6 ± 7.9	—
6 months postoperative	85.9 ± 7.2	88.3 ± 6.8	0.206

The overall complication rate was identical in both groups at 9.7% (3 patients each; $\chi^2 = 0.00$; $p = 1.000$). However, the type of complication differed: the excision group experienced wound infection (n = 2) and proximal migration of the radius (n = 1), while the replacement group had wound infection (n = 1) and implant failure (n = 2). [Table 7]

Table 7: Complications in both groups (n = 62). RHE = radial head excision; RHR = radial head replacement. Data presented as n (%)

Complication	RHE (n = 31)	RHR (n = 31)	p-value
Wound infection	2 (6.5%)	1 (3.2%)	—
Implant failure	0	2 (6.5%)	—
Proximal migration of radius	1 (3.2%)	0	—
Elbow instability	2 (6.5%)	0	—
Overall complication rate	3 (9.7%)	3 (9.7%)	1.000

The overall functional outcome distribution and patient satisfaction scores were similar across both groups [Table 8]. The replacement group had a slightly higher proportion of excellent outcomes (71.0% vs 64.5%) and no patients with poor outcomes. Mean patient satisfaction was marginally higher after replacement (8.1 ± 0.9 vs 7.8 ± 1.0).

Table 8: Overall functional outcome grading and patient satisfaction in both groups (n = 62). Functional outcome based on MEPS: excellent 90–100, good 75–89, fair 60–74, poor < 60. RHE = radial head excision; RHR = radial head replacement

Outcome measure	RHE (n = 31)	RHR (n = 31)
Overall functional outcome (MEPS grade)		
Excellent	20 (64.5%)	22 (71.0%)
Good	7 (22.6%)	6 (19.4%)
Fair	3 (9.7%)	3 (9.7%)
Poor	1 (3.2%)	0 (0.0%)
Patient satisfaction score (0–10), Mean ± SD	7.8 ± 1.0	8.1 ± 0.9

DISCUSSION

This prospective comparative study of 62 patients with Modified Mason Type III comminuted radial head fractures found that both radial head excision and radial head replacement produced satisfactory functional outcomes at six months, with mean MEPS scores of 85.9 ± 7.2 and 88.3 ± 6.8 respectively ($p = 0.206$). Although the replacement group consistently showed higher MEPS scores at each postoperative time point, the difference did not reach statistical significance. Overall complication rates were identical at 9.7%, though the nature of complications differed between the groups. These findings support the view that both procedures are acceptable options for irreparable comminuted radial head fractures, with individual patient factors determining the preferred approach.

Hildebrand et al,[6] conducted a systematic review of 774 patients who underwent radial head excision and reported that acceptable functional recovery was achievable in most patients, particularly those without associated ligamentous injuries. However, they found an increased risk of late elbow instability and degenerative changes in patients with concurrent soft tissue damage. Our excision group showed a similar pattern: instability occurred in two patients and proximal migration of the radius in one, both of which are recognised consequences of excision in mechanically demanding elbows.

Songy et al,[7] evaluated 114 patients who underwent radial head replacement for acute fractures using three implant designs and reported a mean MEPS of 88, closely matching the mean of 88.3 ± 6.8 observed in our replacement group at six months. They also reported a 12% revision rate, which was higher than the 9.7% overall complication rate in our series. The two implant failures in our replacement group (6.5%) are consistent with early technical complications described in similarly sized prospective series.

Kastenberger et al,[8] studied patients with Mason-Johnston Types III and IV fractures managed by on-table reconstruction and reported a mean Mayo Elbow Performance Index of 87, which aligns with the functional outcomes observed in both groups of our study. Their radiological healing criteria were comparable to those applied in this series, and fracture healing times in their cohort were broadly consistent with our results of 4.8 and 5.2 months for excision and replacement respectively.

Vannabouathong et al,[9] performed a network meta-analysis of randomised trials comparing interventions for displaced radial head fractures and concluded that replacement was associated with better overall functional scores compared with excision, particularly in fractures involving associated ligamentous injury. The trend towards higher MEPS in our replacement group is consistent with their pooled findings, even though it did not reach significance in our series — likely due to the relatively short follow-up and modest sample size.

Agyeman et al,[10] reviewed the influence of implant fixation technique on functional outcomes after radial head arthroplasty and found that fixation method affected results primarily in patients with reduced bone quality. In our replacement group, the two implant failures may reflect cases where fixation was suboptimal, highlighting that prosthetic replacement demands precise intraoperative technique in addition to correct sizing.

Scoscina et al,[11] compared ORIF, resection, and prosthetic replacement for Mason Type III fractures and concluded that prosthetic replacement offered the most consistent pain relief and functional recovery, while resection carried a higher incidence of late instability. Our data support this pattern: no instability was recorded in the replacement group, whereas two patients in the excision group developed elbow instability requiring physiotherapy-based management.

Davey et al,[12] analysed the long-term outcomes of radial head arthroplasty in a systematic review at minimum eight-year follow-up and found sustained good-to-excellent outcomes, supporting the durability of prosthetic replacement. Our follow-up of six months captures the early postoperative trajectory but cannot assess late outcomes such as implant loosening, degenerative arthritis after excision, or asymmetric elbow loading, all of which may widen the functional gap between the two procedures over time.

Kachooei et al,[13] performed a systematic review and meta-analysis of prosthesis removal and revision rates after radial head replacement and reported aggregate revision rates in the range of 5–7% at medium-term follow-up. The implant failure rate of 6.5% in our replacement group falls within this expected range and underscores the need for thorough preoperative counselling regarding the possibility of revision surgery with this procedure.

Sershon et al,[14] reported outcomes at a mean ten-year follow-up in patients who received a bipolar radial head replacement and found maintained MEPS scores and satisfactory radiological appearances, with a low rate of component loosening. The comparable six-month MEPS scores in our two groups suggest that long-term data will be necessary to reveal whether the prosthetic approach confers a lasting functional advantage.

Tarallo et al,[15] evaluated anatomic radial head arthroplasty for Mason Type III fractures and found it to be a safe procedure with good functional outcomes and a low complication rate. Patient satisfaction was slightly higher in our replacement group (8.1 ± 0.9 vs 7.8 ± 1.0), consistent with the marginal functional advantage seen at each postoperative time point. The higher operative complexity of replacement — reflected in the longer surgical duration (110.6 vs 90.3 min) and greater blood loss (180.9 vs 150.8 mL) — must be weighed against this modest benefit when deciding between the two procedures in individual patients.

This study has several limitations. The follow-up period of six months may be insufficient to capture long-term sequelae such as implant loosening, progressive degenerative arthritis after excision, or valgus instability. The sample size of 31 patients per group limits statistical power to detect small but clinically meaningful differences. The non-randomised allocation of patients introduces the possibility of selection bias, and the single-centre design limits generalisability. A multicentre randomised controlled trial with longer follow-up would provide more definitive guidance.

CONCLUSION

Both radial head excision and radial head replacement produced comparable functional outcomes at six months in patients with Modified Mason Type III comminuted radial head fractures. Radial head replacement showed marginally higher MEPS scores, fewer instability-related complications, and slightly higher patient satisfaction, though none of these differences reached statistical significance. The excision group showed faster wound healing and shorter operative time. Longer follow-up in larger, ideally randomised cohorts is required to determine whether the functional advantage of replacement becomes more pronounced over time.

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