



EVALUATION OF FUNCTIONAL OUTCOMES FOLLOWING OPEN REDUCTION AND INTERNAL FIXATION IN RADIAL HEAD AND NECK FRACTURES

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ARTICLE INFO:

Keywords:

Radial head fractures, Open Reduction and Internal Fixation, Mayo Elbow Performance Score, Functional recovery, Orthopaedic surgery

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Article History:

Published on 05 July 2025

ABSTRACT

Objective: This study aimed to evaluate the early functional recovery following Open Reduction and Internal Fixation (ORIF) of radial head and neck fractures using the Mayo Elbow Performance Score (MEPS).

Design: A Quasi-experimental study.

Place and Duration: It was conducted at the Orthopaedic Department, Jinnah Hospital Lahore, from September 2024 to March 2025.

Methodology: Ninety-five patients aged 18–75 years with closed Mason Type III or IV radial head/neck fractures were enrolled. Surgical exposure was achieved via posterolateral(Kocher) or straight lateral approaches, and fixation utilized K-wires, screws, or plates. MEPS was recorded at 6 weeks and 3 months post-operatively. Data analysis was performed using SPSS 24.0, with comparisons made using t-tests, Mann-Whitney U, and Chi-square tests.

Results: Out of 105 initially enrolled patients, data from 95 were analysed. The majority (80%) had Mason Type III fractures; 47.4% had combined radial head and neck fractures. At 6 weeks, 76.84% reported no to mild pain, but only 33.68% regained full range of motion, and 73.68% experienced limitations in daily activities. By 3 months, outcomes significantly improved: 97.89% reported no/mild pain, 77.89% regained full motion, 89.47% had stable elbows, and only 20% had persistent functional limitations.

The mean MEPS score at 6 weeks was 70.99 for Mason Type III and 60.79 for Type IV ($p = 0.030$). At 3 months, Type III patients had a mean score of 94.01, while Type IV had 82.63 ($p < 0.001$), indicating significantly better outcomes in less complex fractures. Gender was significantly associated with better MEPS scores at both follow-ups, favouring males ($p < 0.05$). Other variables, including time to surgery and fracture type, did not show a significant effect on final functional outcomes.

Conclusion: ORIF significantly improves function in radial head/neck fractures, especially Mason Type III. Gender influenced recovery, while early intervention timing showed no statistical impact.

INTRODUCTION

Radial head and neck fractures represent a significant portion of upper extremity injuries, accounting for approximately 33% of all elbow fractures [1]. These fractures present a unique clinical challenge due to their propensity for associated injuries, such as elbow dislocations and ligamentous injuries [2]. Complications following such fractures can be debilitating, thereby necessitating prompt intervention [3].

Various treatment modalities are available for managing radial head and neck fractures. Non-operative treatment with immobilization, for instance, is reserved for non-displaced or minimally displaced fractures [4, 5]. Surgical options include closed reduction and percutaneous pinning, radial head excision, and radial head arthroplasty, among others. However, these approaches come with their own set of complications and limitations, such as inadequate fragment stabilization or the potential for postoperative osteoarthritis [6, 7].

Open Reduction and Internal Fixation (ORIF) has been advocated to anatomically restore the radial head and neck fractures and achieve joint congruity. This procedure is particularly favoured for fractures that are amenable to reconstruction, including isolated fractures with minimal comminution [8]. Despite the frequent application of ORIF in this context, there exists a notable void in literature pertaining to short term functional outcomes post-ORIF [9, 10].

The current research aimed to comprehensively assess the functional outcomes of ORIF in the treatment of radial head and neck fractures employing a validated tool; Mayo Elbow Performance Score (MEPS) to establish evidence-based practice that can guide clinical decision-making, thereby potentially improving patient care.

Materials and Methods

This research was conducted from 16th September 2024 - 16th March 2025 after the approval given by the Ethical Review Board of Allama Iqbal Medical College/ Jinnah Hospital Lahore, as well as the Research Evaluation Unit of the College of Physicians and Surgeons Pakistan.

Data were collected for a Quasi experimental study at the Orthopaedic Department of Jinnah Hospital Lahore. The sample size was calculated using "Open Epi Software" [11] at 95% confidence level with a 5% margin of error keeping the anticipated frequency of excellent Mayo Elbow Performance score 56% after ORIF of radial head and neck fractures [12]. The calculated sample size was 95, and subsequent data was collected using non-probability consecutive sampling technique.

Patients aged between 18 and 75, presenting within three weeks of injury with closed fractures of radial head and/or neck (Mason Type 3 and Type 4) were included. This system classifies radial head and neck fractures into four types: Mason Type I: Undisplaced fractures. Mason Type II: Partially displaced fractures involving less

than 30% of the articular surface. Mason Type III: Completely displaced fractures involving more than 30% of the articular surface. Mason Type IV: Fractures associated with elbow dislocation. Patients with concurrent fractures, associated nerve injuries to the ipsilateral limb as well patients with co-morbid bone and joint diseases (like osteoarthritis) were excluded from data collection.

Prior to intervention, written informed consent was taken. Furthermore, a preoperative assessment was conducted, including a medical history related to age, duration of injury, clinical examination, and necessary radiological investigations. Two surgical approaches were used to access the radial head: the posterolateral (Kocher) and the extendable straight lateral approaches. The Kocher method used an oblique incision from the lateral epicondyle toward the ulna, extending 6 cm distally. The straight lateral approach involved a longitudinal incision from 2 cm above the lateral epicondyle to 5 cm below the joint. Muscular intervals and fibrous layers were navigated to reach the radial head. Fixation methods included K wires, headless screws, and plates, all placed within the 100° "safe zone" to prevent joint impingement and ensure rotational freedom. In instances of combined radial head and neck fractures, the complete head was detached, reconstructed on a back table, and then reconnected to the shaft employing various fixation techniques, as deemed appropriate.

Data were collected via a data collection pro-forma at 6 weeks and 3 months post operative interval. Post-operative functional outcomes were assessed by experienced orthopaedic surgeons, and recorded as the Mayo Elbow Performance Score (MEPS), a validated 100-point composite scoring system based on patient pain, range of elbow movements, instability and functionality for activities of daily living (ADL). Scores from each subcategory were summated to form a composite MEPS score which was interpreted as follows: Excellent

(90–100), Good (75–89), Fair (60–74), and Poor (below 60) [13].

Data were analysed using IBM Statistical Package for Social Sciences (SPSS) version 24.0. The categorical data Mason Fracture Types (III, IV), gender, time elapsed since fracture and MEPS scoring category were represented as frequency and percentage. The continuous data: age and MEPS were presented as mean and standard deviation. To assess the normality of data distribution, the Shapiro-Wilk test was employed. Functional outcomes, assessed via MEPS, were compared between Mason Type III and IV fractures using either independent t-tests for normal data or Mann-Whitney U tests for non-normal data. Chi square was used to assess the association of total Mayo Score, with independent variables. A significance threshold of 0.05 was used to determine statistical significance.

RESULTS:

A total of 105 individuals were initially enrolled in the study. This approach ensured that despite anticipated dropouts of 5%, the required sample size was still met. The mean age of the participants was 31.55 years, ranging from 6-61 years with a standard deviation of 13.28. The qualitative baseline characteristics of the study participants are summarized in **Table 1**.

Fracture classification based on the Mason system indicated that 80% of the patients had Mason Type III fractures, while 20% had Mason Type IV fractures. The majority of participants (80%) were treated within 1 week. Radiological findings revealed that 40% of the participants had a radial head fracture, 12.6% had a radial neck fracture, and 47.4% had a combined fracture of the radial head and neck. Children (under the age of 18) accounted for 16.8% (n=16) of the total participants. Although overall, the combined fracture of the radial head and neck was the most commonly observed type of fracture in the total participant group, this was not the case among children. Among them, 7 (43.75%) were diagnosed with a Mason Type IV fracture, and 9 (56.25%) had a Mason Type III fracture. Radial neck

fractures were disproportionately more common in children with 10 out of 16 (62.5%) presenting with radial neck fracture,

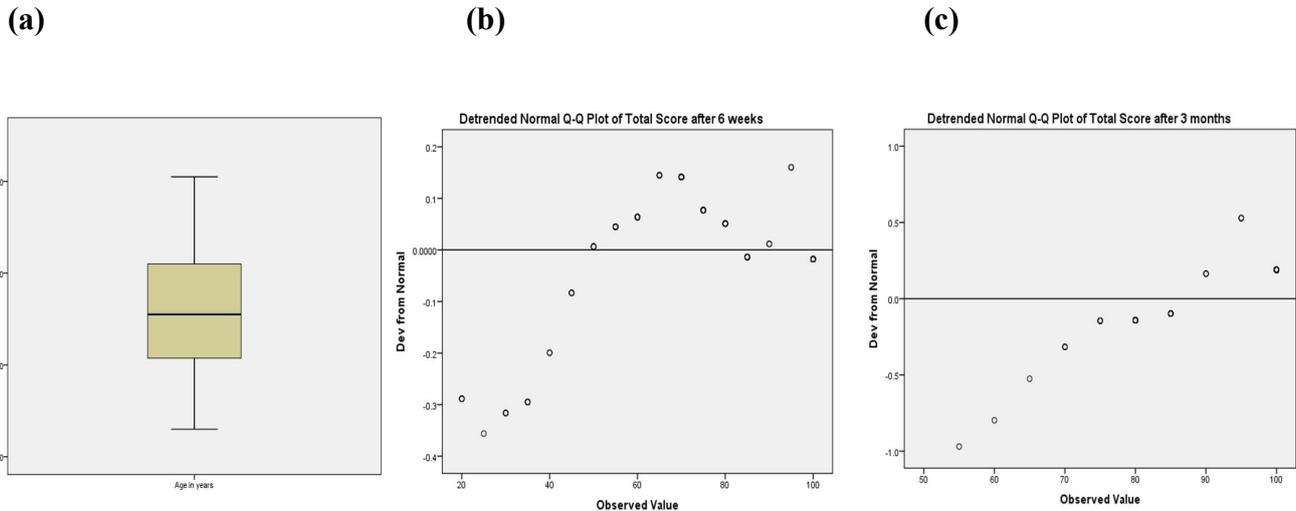
which contrasts with a much lower prevalence of just 12.7% in the total participant pool.

Table-I: Baseline Patient Characteristics

Serial No.	Categorical Variables	Frequency (n= 95)	Percentage (%)	
1.	Gender	Male	31	32.63
		Female	35	36.84
		Prefer not to say	29	30.53
2.	Type of Fracture based on Mason Classification	Mason Type III	76	80.00
		Mason Type IV	19	20.00
3.	Duration between time of fracture and treatment	< 1 week	76	80.00
		1-2 weeks	14	14.74
		>2 weeks	5	5.26
4.	Fracture Site	Radial Head fracture	38	40.00
		Radial Neck Fracture	12	12.63
		Combined Fracture	45	47.37
5.	MEPS after six weeks postop	No to Mild Pain	73	76.84
		Moderate to Severe Pain	22	23.16
		Full Range of Motion	32	33.68
		Limited Range of Motion	63	66.32
		Elbow Stability	79	83.16
		Limited Functionality	70	73.68
6.	MEPS after three months postop	No to Mild Pain	93	97.89
		Moderate to severe pain	2	2.11
		Full Range of Motion	74	77.89
		Limited Range of Motion	21	22.11
		Elbow Stability	85	89.47
		Limited Functionality	19	20

For age in years, tests for normality were conducted using the Shapiro-Wilk test (statistic = 0.979, $p = 0.129$). The boxplot provides a visual representation of the age distribution within the sample [Refer to Figure 1 part (a)]. The de-trended normal Q-Q plot for total MEPS score calculated at 6-week and 3 months follow-up illustrated significant deviations from the horizontal line. The Shapiro-Wilk test for both variables confirmed significant deviations from normality ($p < 0.05$) [Refer to Figure 1 part (b, c)]

Figure I: Shapiro Wilk Normality Test (a) Box Plot for Age in years (b) Detrended Normal Q-Q Plot of Total score at 6 weeks (c) Detrended Normal Q-Q Plot of Total score after 3 months.



The Mayo Elbow Performance Score was assessed in three steps. At six weeks, 76.84% of participants reported experiencing no to mild pain. However, only 33.68% regained full movement. Despite most patients having elbow stability, 73.68% reported inability to perform daily life activities at this early stage of recovery. By the end of the third postoperative month, the outcomes notably improved. Almost all (97.89%) participants experienced no to mild pain. The proportion of participants with full range of motion increased to 77.89%. Moreover, elbow stability improved to 89.47%, and limited functionality dropped significantly to 20%. The scores for the individual components were added together to calculate a total score. At 6 weeks, patients with Mason type III fractures had a mean MEPS score of 70.99, indicating better early recovery compared to Mason type IV fractures, which had a lower mean of 60.79. Furthermore, the variability in outcomes was lower for type III fractures (standard error of 2.419) compared to type IV (standard error of

4.430). The Mann Whitney U test statistic came out to be 494.500 with a p value of 0.030 and a negative standardized test statistic (Z) of -2.126. At the 3-month follow-up, patients with type III fractures continued to show significantly better outcomes, with a mean score of 94.01, indicating that many reached maximal elbow function. In contrast, type IV fractures had a mean score of 82.63. Similarly, the U test revealed a marked difference in outcomes between the two groups ($Z=-4.178$, $p<0.001$). Lastly, the total MEPS was grouped into categories (excellent, good, fair, or poor) for assessment of association with independent variables. The chi-square analysis at 6 weeks as well as 3 months revealed that gender was found to be significantly associated with elbow performance scores, with males showing better outcomes ($p<0.05$). In contrast, the type of fracture based on Mason classification, the duration between fracture and treatment, and the type of fracture did not show statistically significant associations with the performance scores.

Table II: Association of Total Mayo Elbow Score at 6 weeks and 3 months with Independent Patient and Fracture characteristics.

Serial No.	Independent Variables		Total Mayo Elbow Performance Score at 6 weeks				P value
			Poor (<60)	Fair (60-74)	Good (75-89)	Excellent (90-100)	
1.	Gender	Male	8	7	14	2	0.005
		Female	14	9	9	3	
		Prefer not to say	4	8	6	11	
2.	Type of fracture based on Mason Classification	Mason Type III	19	18	26	13	0.414
		Mason Type IV	7	6	3	3	
3.	Duration elapsed since fracture treatment	< 1 week	17	22	21	16	0.090
		1-2 weeks	7	1	6	0	
		>2 weeks	2	1	2	0	
4.	Type of Fracture on Radiological investigation	Radial Neck Fracture	5	3	3	1	0.387
		Radial Head Fracture	12	8	14	4	
		Combined Fracture	9	13	12	11	
			Total Mayo Elbow Score at 3 months				
			Poor (<60)	Fair (60-74)	Good (75-89)	Excellent (90-100)	
1.	Gender	Male	0	1	13	17	<0.001
		Female	1	4	16	14	
		Prefer not to say	0	0	1	28	
2.	Type of fracture based on Mason Classification	Mason Type III	1	3	21	51	0.179
		Mason Type IV	0	2	9	8	
3.	Duration elapsed since fracture treatment	<1 week	0	4	21	51	0.124
		1-2 weeks	1	1	7	5	
		>2 weeks	0	0	2	3	
4.	Type of Fracture on Radiological investigation	Radial Neck Fractures	0	1	5	6	0.111
		Radial Head Fractures	1	2	17	18	
		Combined Fracture	0	2	8	35	

DISCUSSION:

Fractures of the radial head and neck vary from un-displaced fractures, to comminuted complex fractures involving dislocation of the elbow joint. While investigators have compared the suitability of different operative techniques for the fixation of these fractures [14], no direct experimental study contrasts the functional outcomes of the open reduction of complex fractures (Mason type III and IV) or the role of patient characteristics on functional outcomes of complex fractures.

Our study demonstrated that the Mason Type III fractures had a much greater incidence than Type IV fractures, while combined fractures of the radial head and neck were more common than isolated fractures of any one component. Similar statistics were reported by a study at a Level 1 trauma centre which showed that Type III fractures were almost 2-3 times more common than the Type IV ones [15]. In the children group however, there was no statistically significant difference between the Mason category which was reflective of results published by Kaas et al. [16].

The Mayo Elbow Performance Score (MEPS) was used to compare functional outcomes of Mason Type III vs Type IV fractures in the post-operative follow-up period. At six weeks, the most common complaint was the limitation of the range of motion experienced by almost 67% of the patients. In contrast to this, Muller et al while comparing Mason type II and III fractures reported 20% patients to have limitation in flexion or extension of the elbow according to the Elbow self-assessment score (ESAS) questionnaire [14]. The difference in results can be due to two reasons, firstly Muller compared Type II fractures which are less complex and involve a smaller portion of the radial head, secondly, patients in Muller's cohort were commenced on physio-therapeutic assistance after early cast removal on the second post-operative day. This is reflective in our results which demonstrate the restoration of full range of motion in up to

80% of patients by 3 months after regular physiotherapy. These results are reflective of a retrospective study by Moghaddam et al who reported that 73% of patients with ORIF for radial head fractures had a disability duration of less than six months [17].

Although, published literature on the comparison of Mason type II and III fractures and their outcomes is abundant, few researchers have compared the functional outcomes of Mason type IV fractures. Duckworth compared the optimal treatment for radial head fractures, but no definite conclusion about Type IV fractures could be deduced due to the small number of cases. Duckworth assessed 201 patients with radial head and neck fractures, categorized into Mason types (103 type-I, 82 type-II, 11 type-III, 5 type-IV). Functional outcomes, as evaluated by the MEPS, revealed that 93% achieved excellent or good results by the end of 36 weeks. The median time for return to full work was reported to be 4 weeks (range, 0 – 36 weeks) [18]. Adm et al. and Lindenhovius et al. reported favourable outcomes, with most patients achieving good to excellent elbow function post-fixation[19, 8]. Another study by Deshmukh et al. analysed data of 70 patients with either Mason type III or IV fractures retrospectively. Patients underwent radial head prosthesis surgery. By six weeks, 67% of the patients demonstrated an "excellent" MEPS score, while 22% of the cases had a score between 75 and 89, indicating good results [20]. Similarly, a retrospective study analysed data from the Birmingham Heartlands Hospital. 17 patients with Mason type III fractures undergoing ORIF showed a mean MEPS of 64.59 at six months follow up, with 94% of the patients having excellent or good outcomes [21]. These results were similar to our cohort in which 62.1% of patients achieved an "Excellent" MEPS score after ORIF of radial fractures after three months of surgery.

In our study, patients with Mason type III fractures had a mean MEPS score of 70.99

at 6 weeks, compared to Mason type IV fractures, which had a lower mean of 60.79. Furthermore, the variability in outcomes was lower for type III fractures (standard error of 2.419) compared to type IV (standard error of 4.430), suggesting more consistent recovery for type III fractures. Similarly, the U test revealed a standardized test statistic (Z) of -4.178. This large negative Z score indicates that the ranks for Mason type IV fractures are significantly lower than those for Mason type III fractures, with a p value of <0.001 showing a marked difference in outcomes between the two groups [Refer to Supplementary Table 1 and supplementary Figure 1]. Similar results have been reported in the Journal of Orthopaedic Surgery and Research where Mason Type IV fractures showed frequent elbow dislocation, associated with greater surgical challenges and more variable outcomes [22].

Interestingly, the duration between fracture occurrence and surgical intervention did not significantly impact functional outcomes in this study. This observation is consistent with findings from other studies, which indicate that while timely surgical management is ideal, short delays do not necessarily compromise long-term function, provided that proper surgical techniques and postoperative care are employed [23].

This quasi-experimental study has several strengths. Firstly, the study achieved an adequate sample size accounting for potential loss to follow-up and a robust completion rate of over 90%. This high retention supports the reliability of the outcome data. Secondly, the use of MEPS, a validated and widely accepted functional assessment tool, ensured that patient outcomes were measured consistently and objectively across multiple dimensions. Another strength was the detailed subgroup analysis and appropriate use of statistical methods, including normality testing and non-parametric testing. These analyses provide deeper insight into the differential recovery trajectories, especially the

consistently better outcomes observed in Mason Type III fractures.

Despite its strengths, the study also had limitations that should be acknowledged. The non-randomized design inherent to quasi-experimental studies may introduce selection bias. Furthermore, the absence of a control group receiving conservative treatment or an alternative surgical approach limits comparative assessment and generalization. Lastly, some MEPS components rely on patient self-reporting, which may be influenced by subjective interpretation or recall bias.

CONCLUSION:

The functional outcomes of ORIF for radial fractures assessed with the Mayo Elbow Performance Score at six weeks and three months post-operatively in this study showed significant improvements in pain, range of motion, and stability. Mason Type III fractures consistently showed better outcomes than Type IV. Gender influenced recovery, while treatment timing did not affect final scores.

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Supplementary Table I: Statistical Analysis of Continuous Variables

Quantitative Variables	Shapiro-Wilk Test		Mann Whitney U Test			
	Statistic	Sig.	Median (IQ Range)	Statistic	Sig.	Z Score
Age in years	0.979	0.129	31.00 (21)	-	-	-
Total Score after 6 weeks	0.953	0.002	70.00 (30)	494.500	0.033	-2.126
Total Score after 3 months	0.746	<0.001	100.00 (20)	320.000	<0.001	-4.178

Supplementary Figure I: Independent Sample Mann Whitney U Test

