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

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ABSTRACT

Background: Displaced radial head and neck fractures can cause elbow instability, pain and restricted movement. Evidence on functional recovery during the first three months after surgical fixation remains limited.

Objective: To assess functional outcomes at six weeks and three months after open reduction and internal fixation (ORIF) of Mason type III and IV radial head and neck fractures.

Materials and Methods: A single-arm, quasi-experimental study was conducted at RYK Hospital and Medical College, Rahim Yar Khan. Ninety-five adults aged 18–75 years with closed fractures sustained within the preceding three weeks were enrolled consecutively. Mayo Elbow Performance Score (MEPS) was recorded at six weeks and three months after ORIF. Paired scores were compared using the Wilcoxon signed-rank test. Mason type III and IV fractures were compared using the Mann–Whitney U and Fisher exact tests.

Results: Among 95 patients, 60 (63.2%) had Mason type III fractures and 35 (36.8%) had type IV fractures. Mean age was 45.53 ± 10.32 years; 62 patients (65.3%) were male. Mean MEPS increased from 70.00 ± 11.76 at six weeks to 83.89 ± 13.05 at three months (mean within-patient increase, 13.89 points; 95% confidence interval [CI], 12.16–15.63; $p < 0.001$). At three months, 50 patients (52.6%; 95% CI, 42.7%–62.4%) had excellent function and 80 (84.2%) had good or excellent function. Median three-month MEPS was 90 in Mason type III fractures and 80 in type IV fractures ($p = 0.020$). Good or excellent outcomes were recorded in 90.0% and 74.3% of these groups, respectively ($p = 0.077$).

Conclusion: MEPS increased between six weeks and three months following ORIF. Patients with Mason type III fractures had higher three-month functional scores than those with type IV fractures. The findings describe early postoperative recovery and do not establish superiority over other treatments.

KEYWORDS: Radial head fracture; Radial neck fracture; Open reduction and internal fixation; Mayo Elbow Performance Score; Functional outcome; Elbow dislocation.

INTRODUCTION

Radial head and neck fractures commonly occur after a fall on the outstretched hand and may cause pain, restricted elbow movement and impaired arm function. The radial head contributes to valgus stability, axial load transmission and forearm rotation. More severe injuries are associated with complex fracture patterns [1]. Capsuloligamentous injury and associated fractures may complicate treatment and recovery [2,3]. Minimally displaced fractures can often be managed without surgery, whereas comminution, mechanical obstruction or instability may require operative treatment. Stiffness, pain and restricted forearm rotation can persist after fracture healing.

Treatment of displaced radial head fractures aims to restore elbow stability and preserve movement. Open reduction and internal fixation (ORIF), radial head arthroplasty and, in selected cases, excision are recognised options. The choice depends on fracture configuration, the possibility of stable reconstruction, bone quality and associated injuries [4,5]. Management of complex fractures continues to vary [6]. ORIF preserves the native radial head when adequate fixation is possible, but severe fragmentation may increase the risk of fixation failure or stiffness. Al-Burdeni et al. reported similar functional results after ORIF and arthroplasty in a small retrospective study [7]. A Cochrane review found insufficient reliable evidence to recommend one surgical technique for all patients [8]. Functional assessment is therefore an important part of postoperative evaluation.

Mason type III fractures involve a comminuted radial head, whereas type IV fractures are associated with elbow dislocation. The Mayo Elbow Performance Score (MEPS) assesses pain, movement, stability and activities of daily living. A recent comparative study reported functional outcomes after surgery for complex radial head fractures, but its

longer follow-up did not describe recovery during the initial three months [9]. Earlier work also found variation in recovery according to injury and patient characteristics [10]. Local data on early function after ORIF for these injuries are limited. This study assessed MEPS at six weeks and three months after ORIF for Mason type III and IV radial head and neck fractures and compared outcomes by fracture type.

MATERIALS AND METHODS

A single-centre, single-arm quasi-experimental study was conducted in the Department of Orthopaedics, RYK hospital and medical college, Rahim Yar Khan, Pakistan, from January to June 2026. Patients were enrolled by non-probability consecutive sampling. The sample size was 95, based on a reported 56% frequency of an excellent MEPS outcome after fixation in an earlier study [11]. A 95% confidence level and 10% absolute precision were used with the single-proportion formula described by Cochran [12]:

$$n = \frac{Z^2_{1-\alpha/2}\,p(1-p)}{d^2} = \frac{(1.96)^2(0.56)(0.44)}{(0.10)^2} = 94.66 \approx 95$$

In this formula, $Z_{1-\alpha/2} = 1.96$ for a 95% confidence level, $p = 0.56$ is the expected proportion based on the cited study, and $d = 0.10$ is the required absolute precision.

Adults aged 18–75 years with closed, radiographically confirmed Mason type III or IV fractures of the radial head or neck, sustained within the preceding three weeks, were eligible if they could complete functional assessment. Patients were excluded if they had major associated proximal forearm fractures or other skeletal injuries likely to affect outcome assessment, pre-existing elbow arthritis or dysfunction, substantial ipsilateral soft-tissue or nerve injury, or treatment other than ORIF. Elbow dislocation accompanying a Mason type IV fracture was not an exclusion. Age, sex, time since injury, fracture location (head, neck or both) and Mason classification were recorded before surgery. Fractures were assessed on anteroposterior and lateral radiographs; computed tomography was obtained when clinically indicated [4].

Surgical exposure was through a posterolateral Kocher interval or an extended lateral approach, depending on the fracture pattern. Fragments were reduced and fixed with suitable implants, including headless screws, plates, Kirschner wires or intramedullary devices. Implant placement was planned to avoid prominence within the proximal radial safe zone. Postoperative care included analgesia, antimicrobial prophylaxis when indicated and supervised rehabilitation with progressive elbow movement. Mason fracture type was used for subgroup analysis; it did not define a separate treatment group.

Functional assessment was performed at six weeks and three months after surgery. The main outcome was total MEPS, scored from 0 to 100 according to pain (45 points), motion (20 points), stability (10 points) and five activities of daily living (25 points) [13]. Pain was graded clinically; elbow motion was measured with a goniometer; stability was assessed on examination; and daily function was recorded from the patient's ability to perform routine tasks. Outcomes were graded as excellent (90–100), good (75–89), fair (60–74) or poor (<60). The MEPS component scores, changes between visits and results by Mason fracture type were also examined.

Data were analysed using IBM SPSS Statistics, version 26.0. Continuous variables were reported as means with standard deviations; MEPS was also described by median and interquartile range. Categorical variables were reported as frequencies and percentages. The Shapiro–Wilk test assessed normality. As MEPS values were not normally distributed, paired scores were compared using the Wilcoxon signed-rank test and fracture-type groups using the Mann–Whitney U test. Fisher's exact test was applied to the proportion of patients with good or excellent function. Mean within-patient changes were presented with descriptive 95% t-based confidence intervals, and proportions with Wilson 95% confidence intervals. All tests were two-sided, with $p < 0.05$ considered statistically significant.

RESULTS

The study included 95 patients: 60 (63.2%) with Mason type III fractures and 35 (36.8%) with type IV fractures. Mean age was 45.53 ± 10.32 years; 62 patients (65.3%) were male. Mean time since injury was 11.60 ± 6.47 days. Fractures involved the radial head alone in 53 patients (55.8%), the neck alone in 20 (21.1%) and both sites in 22 (23.2%). Baseline characteristics are shown in Table 1.

Table 1. Baseline demographic and fracture characteristics

Characteristic	Overall (n = 95)	Mason III (n = 60)	Mason IV (n = 35)
Age, years, mean ± SD	45.53 ± 10.32	44.77 ± 11.14	46.83 ± 8.74
Male	62 (65.3%)	37 (61.7%)	25 (71.4%)
Female	33 (34.7%)	23 (38.3%)	10 (28.6%)
Time since injury, days, mean ± SD	11.60 ± 6.47	11.48 ± 6.06	11.80 ± 7.20
Less than 1 week	30 (31.6%)	18 (30.0%)	12 (34.3%)
1–2 weeks	30 (31.6%)	22 (36.7%)	8 (22.9%)
2–3 weeks	35 (36.8%)	20 (33.3%)	15 (42.9%)

Radial head involvement	53 (55.8%)	36 (60.0%)	17 (48.6%)
Radial neck involvement	20 (21.1%)	15 (25.0%)	5 (14.3%)
Combined involvement	22 (23.2%)	9 (15.0%)	13 (37.1%)

Values are mean ± SD or n (%). Fracture-location groups describe the recorded anatomical site rather than the number of fragments.

Mean MEPS was 70.00 ± 11.76 at six weeks and 83.89 ± 13.05 at three months. The mean within-patient increase was 13.89 points (95% CI, 12.16–15.63; Wilcoxon signed-rank $p < 0.001$). Scores increased in both Mason groups (Table 2). At three months, median MEPS was 90 (IQR, 80–95) in Mason type III fractures and 80 (IQR, 72.5–90) in type IV fractures (Mann–Whitney U $p = 0.020$). The change between visits did not differ significantly between the two fracture types ($p = 0.352$).

Table 2. MEPS at postoperative follow-up and paired change

Population	Six weeks, mean ± SD	Three months, mean ± SD	Mean change (95% CI)	Paired p
Overall (n = 95)	70.00 ± 11.76	83.89 ± 13.05	13.89 (12.16–15.63)	<0.001
Mason III (n = 60)	71.83 ± 11.50	86.33 ± 11.60	14.50 (12.39–16.61)	<0.001
Mason IV (n = 35)	66.86 ± 11.70	79.71 ± 14.45	12.86 (9.73–15.98)	<0.001

Paired p-values were obtained using the Wilcoxon signed-rank test. Between Mason type III and IV fractures, Mann–Whitney U p-values were 0.037 at six weeks, 0.020 at three months and 0.352 for the change between visits. Confidence intervals for mean changes are descriptive and were calculated using the t distribution.

Good or excellent function was recorded in 50 of 95 patients (52.6%) at six weeks and 80 of 95 (84.2%) at three months. The number with excellent function increased from six (6.3%) to 50 (52.6%); the three-month proportion was 52.6% (95% Wilson CI, 42.7%–62.4%). At three months, good or excellent outcomes were recorded in 54 of 60 patients (90.0%) with Mason type III fractures and 26 of 35 (74.3%) with type IV fractures (Fisher exact $p = 0.077$). The distribution of MEPS categories is shown in Table 3.

Table 3. MEPS functional outcome categories at each follow-up

Outcome	Overall (n = 95)	Mason III (n = 60)	Mason IV (n = 35)
Six weeks			
Excellent	6 (6.3%)	5 (8.3%)	1 (2.9%)
Good	44 (46.3%)	31 (51.7%)	13 (37.1%)
Fair	36 (37.9%)	20 (33.3%)	16 (45.7%)
Poor	9 (9.5%)	4 (6.7%)	5 (14.3%)
Good or excellent	50 (52.6%)	36 (60.0%)	14 (40.0%)
Three months			
Excellent	50 (52.6%)	35 (58.3%)	15 (42.9%)
Good	30 (31.6%)	19 (31.7%)	11 (31.4%)
Fair	12 (12.6%)	5 (8.3%)	7 (20.0%)
Poor	3 (3.2%)	1 (1.7%)	2 (5.7%)
Good or excellent	80 (84.2%)	54 (90.0%)	26 (74.3%)

Values are n (%). Fisher exact p-values for good or excellent function by fracture type were 0.088 at six weeks and 0.077 at three months. MEPS categories: excellent, 90–100; good, 75–89; fair, 60–74; poor, <60.

Mean scores increased in all four MEPS components between six weeks and three months: pain from 33.63 to 38.53, motion from 14.42 to 17.26, stability from 8.63 to 9.53, and activities of daily living from 13.32 to 18.58 points (Table 4). Within-patient changes were statistically significant for each component.

Table 4. MEPS component scores at six weeks and three months

MEPS component	Six weeks, mean ± SD	Three months, mean ± SD	Mean increase	Paired p
Pain (maximum 45)	33.63 ± 10.88	38.53 ± 9.45	4.89	<0.001
Motion (maximum 20)	14.42 ± 5.64	17.26 ± 3.98	2.84	<0.001
Stability (maximum 10)	8.63 ± 2.77	9.53 ± 1.47	0.89	0.002
Activities of daily living (maximum 25)	13.32 ± 7.50	18.58 ± 5.86	5.26	<0.001

Paired p-values were calculated using the Wilcoxon signed-rank test. Maximum component scores are 45, 20, 10 and 25 points, respectively. Component means may differ slightly from the total MEPS because of rounding.

DISCUSSION

MEPS increased between six weeks and three months after ORIF, and more than four-fifths of patients had good or excellent function at the later assessment. Three-month scores were higher in Mason type III than type IV fractures. Associated elbow dislocation and soft-tissue injury may contribute to poorer early function in type IV injuries, although these factors were not assessed separately. The relatively small type IV group limits interpretation of subgroup differences.

Duckworth et al. reported good or excellent Mayo Elbow Scores in 187 of 201 patients (93%) after radial head and neck fractures, with many patients recovering function within six weeks [10]. Their study included less severe fractures and cannot be compared directly with a series limited to surgically treated Mason type III and IV injuries. Mannan et al. reported excellent 12-month outcomes in 55.6% of Mason type II fractures and 58.8% of type III fractures in a retrospective series of 44 patients treated with ORIF [14]. The present three-month proportion was similar in size, but follow-up duration and fracture types differed. Lindenhovius et al. reported nine excellent and four good outcomes among 16 patients (81.3% combined) at a mean follow-up of 22 years after ORIF for stable Mason type II fractures [11]. The proportion with excellent function in that series was used for the sample-size calculation, despite its different injury severity and follow-up duration.

ORIF preserves the native radial head and may maintain forearm load transmission and elbow stability when secure fixation is possible. Kusnezov et al. reported that 90% of a young, active military population returned to active service after operative treatment, although complications and further surgery remained concerns [15]. Al-Burdeni et al. compared 19 patients treated with ORIF and 17 treated with radial head arthroplasty for modified Mason type III or IV fractures. Differences in QuickDASH score ($p = 0.58$), functional motion ($p = 0.13$) and complications ($p = 0.57$) were not statistically significant [7]. These findings indicate that fixation can be used in selected complex fractures but do not establish that it is preferable for all such injuries.

Some comparative studies have reported better results after radial head replacement in severely comminuted fractures. Chen et al. found mean Broberg–Morrey scores of 72.4 after ORIF and 92.1 after replacement in 45 patients with unstable multifragmentary fractures [16]. These results were measured later than the present study and used a different functional scale. De Mauro et al. reported more complications after ORIF in a meta-analysis of prospective studies of Mason type III fractures, although few studies were available [17]. Conversely, Jakobi et al. compared 84 matched patients with Mason type III fractures and found higher mean MEPS after ORIF than arthroplasty (90.1 ± 13.6 versus 78.0 ± 20.5; $p = 0.004$) at a mean follow-up of 4.1 years [9]. Differences in fracture reconstruction and patient selection may contribute to these varying findings.

Kıratlıoğlu et al. reported a mean MEPS of 83.0 ± 8.9 in patients with Mason type III and IV fractures treated by plate and screw fixation at approximately 29 months [18]. Although this value is close to the present three-month mean, the follow-up periods differ substantially. In another long-term study, Ly et al. reported similar functional outcomes after ORIF and arthroplasty for isolated Mason type III fractures, but heterotopic ossification occurred more often after fixation (42.8% versus 15.8%; $p = 0.03$) [19].

A Cochrane review of three randomised trials involving 251 patients found insufficient high-quality evidence to determine the best operation for radial head fractures [8]. A later review of eight observational studies involving 457 patients found that arthroplasty may offer better outcomes in selected severely comminuted and Mason type IV fractures, while ORIF remained suitable for some reconstructable injuries [20]. Sun et al. also found higher pooled elbow scores after replacement in a meta-analysis of 319 patients, although the underlying studies had methodological limitations [21]. The present study had no arthroplasty group and therefore cannot establish a difference between ORIF and replacement.

The changes in total MEPS reflected higher scores for pain, movement, stability and daily activities at three months. Rehabilitation and restoration of joint stability may influence recovery, but their individual contributions were not measured. Jordan et al. reviewed seven small series using intramedullary fixation and reported mean MEPS values from 81.8 to 97.9, with considerable variation in surgical technique [22]. Zarifian et al. reported greater elbow stability after ORIF than excision in a small Mason type III comparison (10/10 versus 5/10; $p = 0.01$) [23]. Li and Chen, however, found satisfactory outcomes in 51.6% after ORIF and 91.7% after replacement across two small comparative studies [24]. Such differences reinforce the need to consider injury severity and the suitability of reconstruction when interpreting results.

This study had several limitations. There was no comparison group, so improvement between postoperative visits cannot be attributed solely to ORIF. Follow-up ended at three months, and the sample was too small to assess uncommon complications or provide reliable subgroup estimates. Surgical techniques and rehabilitation may have varied. Radiographic union, implant-related complications and associated ligament injuries were not reported as separate outcomes. MEPS also includes clinician-assessed and patient-reported measures and may have a ceiling effect. Studies with longer follow-up and appropriate comparison groups are needed.

CONCLUSION

MEPS increased between six weeks and three months after ORIF for Mason type III and IV radial head and neck fractures. Most patients had good or excellent function at three months. Patients with Mason type III fractures had higher three-month MEPS than those with type IV fractures, but the proportions with good or excellent outcomes did not differ significantly. The findings are limited to early postoperative recovery.

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