Lo SCALPELLO Journal (2022) 36:146-151
doi number: 10.36149/0390-5276-248

Comparison of open reduction and internal fixation and radial head resection for treatment of Mason type 2 and 3 fractures in young and active patients: our experience

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Received: March 20, 2022
Accepted: May 04, 2022

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How to cite this article: Ferrara M, Sangaletti R, Reina M, et al. Comparison of open reduction and internal fixation and radial head resection for treatment of Mason type 2 and 3 fractures in young and active patients: our experience. Lo Scalpello Journal 2022;36:146-151. https://doi.org/10.36149/0390-5276-248

Summary

Objective. The management of Mason type II and III radial head fractures (RHF) is still a debated topic. In the past, the only treatment of choice was radial head resection (RHR) but, as surgical techniques and instrumentation have advanced, internal screw fixation (ORIF) has gained popularity. The aim of this paper is to compare in a retrospective analysis the outcomes of ORIF and RHR in these fracture patterns in young patients.
Methods. A total of 37 patients (age between 20 and 60 years old) affected by Mason type 2 and 3 RHF and surgically treated were collected by means of our electronic hospital database. Sixteen patients underwent RHR, and 21 patients underwent ORIF with mini screws. Functional outcomes and scores as well as the radiographs were recorded during follow-up.
Results. After 22.17 months (range 12-45) of mean follow-up, the mean DASH, UCLA and MEPS scores showed no significant differences between groups (p: 0.26; 0.21; 0.23). The VAS score was unfavorable in the ORIF group compared to the RHR group (p: 0.43) although not statistically significant.
Conclusions. The gold standard in the management of these fractures is not universally recognized. The advantages and complications of both techniques as well as of the RH arthroplasty are abundantly described. Our outcomes support RHR as a possible treatment choice in multi-fragmentary fractures of RH in young patients while minimizing complications.

Key words: radial head fractures, resection, open reduction and internal fixation, outcomes

Introduction

Radial head fractures (RHF) represents about 3% of all fractures and 33% of adult elbow fractures [1].
In 85% of cases RHF occur in active workers between 20 and 60 years of age, and women are more frequently affected than men [2].
The main mechanism of injury for RHF is a direct fall onto the outstretched hand with the elbow extended and the forearm pronated. In about one-third of these patients RHF are associated with other upper limb injuries. RHF are traditionally ranked by the Mason classification. The management depends on the type of fracture, guided by Mason classification, and the associated injuries, even if it is still debated [3]. In general, RHF with a displacement of < 2 mm (Mason 1) can be managed by conservative treatment. Surgical treatment is indicated in fractures (Mason 2 with displacement > 2 mm, Mason 3 and Mason 4). In this group, RHF often have associated injuries that affect choice of treatment. Currently, three are the main surgical techniques for RHF: radial head resection (RHR) [4], open reduction and internal fixation (ORIF) [5] and radial head arthroplasty [6]. In Mason type 2 and 3, surgical treatment is controversial because evidence based medicine supports both RHR and ORIF [7].
For a long time Mason type 2 and 3 were managed conservatively and RHR was performed in case of non-operative treatment failure [8]. The ORIF of RHF has gained popularity in stable fractures due to improvement of surgical techniques and devices, but also in unstable or displaced fractures, becoming preferred to RHR [9].
The gold standard treatment of these types of fractures is still debated and remains a challenge for surgeons, mainly for young and active patients [10-12].
The purpose of this paper is to compare our clinical outcomes after RHR and ORIF in Mason type 2 and 3 RHF.

Materials and methods

After institutional review board endorsement, we collected data on adult patients treated surgically for RHF using our hospital electronic database and performed a retrospective analysis. Inclusion criteria were high functional demand based on the University of California Los Angeles(UCLA) score > 7, patients skeletally mature (age between 20 and 60 years old), Mason type 2-3 fracture. Exclusion criteria were polytrauma ipsilateral upper limb fractures or elbow instability, rheumatologic patients, or soft tissue infection at fracture site. Also patients who had already undergone other elbow surgeries were excluded. We identified 60 patients with a close, isolated and displaced radial head fracture who underwent to ORIF or RHR between 2016 and 2020 at our Orthopedics and Traumatology Department. Two independent experts surgeons analyzed pre-operative X-rays and grouped the fractures according to Mason classification [5]. Unfortunately, we had to exclude three patients who were not available for follow-up.
The treatment was performed randomly by 2 senior surgeons with 15 years of traumatology experience. The choice between the two treatments was based on the surgeon's preference and intra-operative evaluation.
Finally, we collected data on 37 patients with RHF Mason type 2 and 3. The surgical approach was the same for all patients: the patient in supine position for lateral elbow access and Kocher approach was applied to expose the radial head through the internervous plane of the anconeus (radial nerve) and the extensor carpi ulnaris (posterior interosseous nerve). The lateral collateral ligament complex was exposed and incised through the annular ligament and capsule. Elbow instability was assessed intra-operatively with varo-valgus stress test.
In ORIF treatment, provisional fixation was obtained with Kirschner wires and bone fragment fixation was performed with Herbert-type screws and anular ligament was repaired using non-absorbable sutures. In RHR treatment, the radial head fragments were carefully removed without damage to the annular ligament and an oscillating saw was used to smooth the radial neck edges. When RHR was performed, radial neck smoothing is planned to allow elbow movement without impingement and to obtain stability of the proximal radioulnar joint [7].
In both groups during the post-operative period, the elbow was immobilized in 90° of flexion and the forearm in neutral position of rotation in a plaster for a few days for pain relief and allow early soft tissue healing. Active assisted motion was encouraged within the first few days including gravity-assisted elbow flexion and extension. Strength and loading of the elbow is prevented for 6-8 weeks.
According to Mason classification for location, comminution and displacement of RHF, there were 5 patients with Mason 2 and 16 patients with Mason III in ORIF group and 16 patients with Mason 3 in RHR group. Muscle power recovery was similar in both groups.
All patients were subjected to clinical assessment by the same author (MF). The elbow range of motion (ROM) in flexion-extension and prono-supination movement, elbow stability in varus-valgus stress and neurological inspection were recorded during follow-up. Patients were seen at regular intervals of time (in the first period at 7 and 15 days) until the fracture had healed and rehabilitation was complete. For all patients we applied internationally approved patient-based tests to evaluate the elbow function: the Disabilities of the Arm, Shoulder and Hand (DASH) Score, UCLA score and the Mayo Elbow Performance (MEPS) Score. A Vidual analogue scale (VAS) was used as a quantitative measure of pain in daily time and during orthopedic follow-up. Furthermore, Medical Research Council (MRC) scale for grading the patient's muscle strength on a 0 to 5 scale was applied during follow-up.
Radiographic examination was performed by two independent investigators to look for signs of arthrosis, heterotopic ossifications, necrosis, osteolysis, displaced fragments and mobilization of screws.

Statistical methods

We conducted exploratory statistical analysis of frequencies and percentages for categorical variables, means and standard deviations for quantitative data. Categorical variables were compared with student's t test. A p-value < 0.05 was accounted statistically significant. All statistics were performed using Excel software (version 2016; Microsoft, Redmond,WA).

Results

The surgery was performed after a mean 7.5 days (range, 1-18) from injury. All 37 patients had a negative post-operative assessment for signs of infection, nerve palsy and loss of motion (pronation/supination). Twenty-one patients underwent fracture ORIF with screws (Fig. 1); 12 patients were women and 9 patients were men, the mean age was of 43.76 years (range, 20-60) at the time of injury. The RHR was performed in 16 patients (Fig. 2), 8 were females and 8 were males, with a mean age of 43.71 years (range 29-59).

Demographic data are shown in Table I, and no statistical differences were found between groups ($p < 0.05$). After 22.17 months (range 12-45) of mean follow-up, the mean DASH, UCLA and MEPS scores showed no significant differences between groups (p: 0.26; 0.21; 0.23). The VAS score was unfavorable in the ORIF group compared to the RHR group (p: 0.43). Outcomes of clinical scores and elbow functions are reported in Tables II and III. Two patients in ORIF group had a DASH over 10 points and MEPS lower than 70 points. X-Rays highlighted a fracture displacement of more than 1 mm between bone fragments. The first patient, a man of 29 years old with high functional request (UCLA 9) underwent surgery at 17 days after injury for a fracture classified Mason 3. At 35 months of follow-up he showed no elbow instability, and no deficit of ROM and muscle strength. The VAS score was 4 points and 6 points during physical examination. The second patient, a man of 46 years old with high functional request (UCLA 9) underwent surgery at 6 days after injury for a Mason 3 fracture and at 12 months of follow-up showed no elbow instability and no deficit of ROM, but MRC scale of 4/5 grade and daily VAS of 3 points and VAS during physical examination of 7 points.

These patients had good recovery of movement and strength, but more residual pain than other patients in the same group.

Radiographic examination for all patients revealed no cases of arthrosis or heterotopic ossifications, and screw mobilization was highlighted in only 2 patients in ORIF group as mentioned above.

Discussion

RHF are still a challenge for surgeons. The gold standard in the management of these fractures is not universally recognized [13]. Historically the management of Mason type 2 and type 3 fractures was RHR whenever conservative management failed [8].

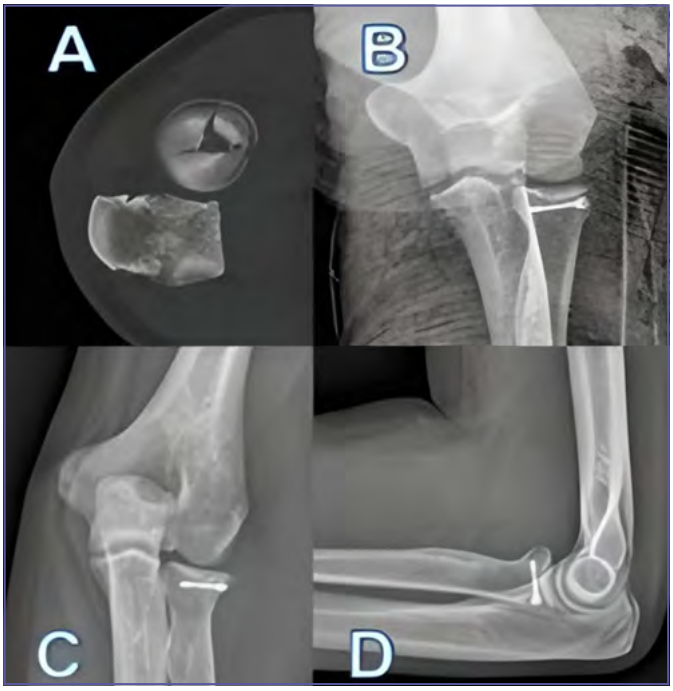

Figure 1. A) 34 years old man affected by RHF underwent to ORIF; B) post-operative X-ray check; C-D) X-ray check after 5 month FU.

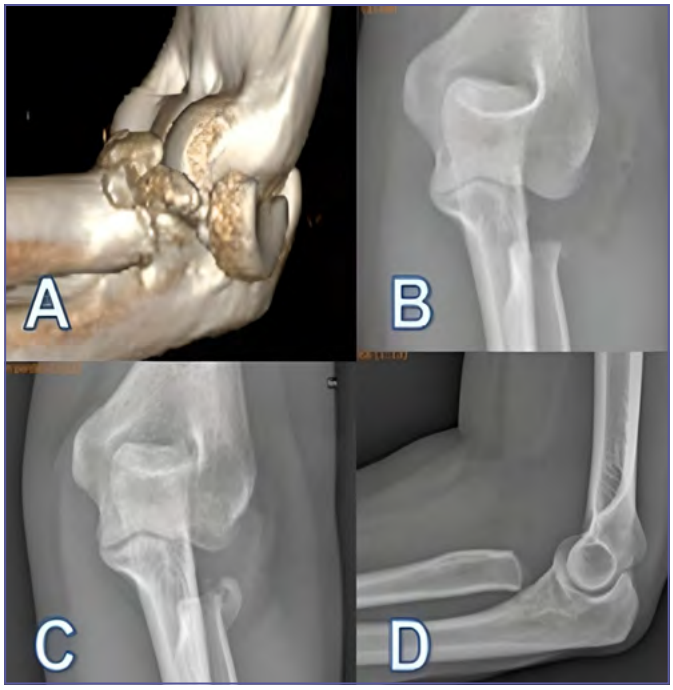

Figure 2. A) 52-years-old woman affected by RHF who underwent RHR; B) post-operative X-ray; C-D) X-ray after 3 months of follow-up.

Table I. Demographic data and statistical analysis.

	Total	ORIF	RHR	P-value
N° of elbows	37	21	16	
Patients mean age	43.74 (10.4)	43.76 (10.66)	43.71 (10.47)	0.99
Male/female	17/20	9/12	8/8	
Patients weight (kg)	75 (14.4)	74.20 (14.97)	76 (15.22)	0.76
Patients BMI	24.46 (3.45)	24.25 (3.95)	24.97 (10.47)	0.60
Time since injury (days)	7.5 (5.8)	5.41 (5.44)	6.36 (9.63)	0.75
Follow-up (months)	22.17	20.88	22.86	0.72

Table II. Outcomes of functional scores and statistical analysis.

	Total	ORIF	RHR	P-value
Mason 2	5	5	0	
Mason 3	32	16	16	
UCLA	7.43 (1.38)	7.80 (1.26)	7.08 (1.56)	0.21
DASH	1.70 (3.95)	2.16 (5.05)	1.55 (2.59)	0.26
MEPS	90.50 (19.67)	91.33 (11.72)	87.08 (28.40)	0.23
VAS	0.62 (1.18)	0.79 (1.31)	0.58 (1.16)	0.43
VAS During physical examination	1 (1.49)	1.47 (1.68)	0.67 (1.23)	0.37

Table III. Clinical outcomes.

Elbow functional outcomes	Total	ORIF	RHR	P-value
Elbow instability (N°)	1	0	1	
Extention lag (degrees)	6.50	6.7	7.9	0.32
Active flection (degrees)	138.8	139.0	136.7	0.42
Passive extention (degrees)	3.97	3.3	5.4	0.36
Passive flection (degrees)	140.67	142.7	136.7	0.37
Active pronation (degrees)	80	80.0	80.0	0.51
Passive pronation (degrees)	80	80.0	80.0	0.45
Active supination (degrees)	79.7	79.3	80.0	0.15
Passive supination (degrees)	80	80.0	80.0	0.61
Muscle strength (MRC scale 0-5 points)	4.75	4.80	4.6	0.23

The risks of RHR are elbow instability, pain, cubitus valgus and limited range of motion [7].

RHR can also results in osteoarthritis, pain with loss of strength and loss of motion in the elbow, along with ulnar nerve symptoms and proximal migration of the radius [7,9].

Afterwards bone fragment fixation of the radial head gained consensus due to improvement in surgical instrumentation [14]. However, insufficient fixation stability can lead to pain, instability, nonunion and necrosis of the radial head [15]. Nowadays, ORIF is generally preferred to the RHR to treat unstable or displaced fractures [9]. In our retrospective analysis, we wanted to explore whether RHR can still play a role in the treatment of Mason type 2 and 3 fractures in young patients with high functional demands. The topic is still debated. In 2012, Zarattini et al. showed a DASH score of 21.82 point in the RHR group compared to DASH score of 2.81 points in the ORIF group in Mason type 2 fractures, and osteoarthritis was radiographically clear in nine elbows of the RHR group and in two elbows in the ORIF group [16]. The literature suggests that good mid-and-long-term outcomes can still be noted in the treatment of RHR. Antuna et al. analyzed 26 patients RHR-treated for Mason 2 and 3 fracture, younger than 40 years of age, during a 25-year follow-up. They found good clinical outcomes, showing a mean MEPS of 95 and a DASH of 6 [17].

Yalcinkaya et al. found no significant correlation between clinical score outcomes in RHR-treated patients and radiological degenerative changes in the elbow [4]. However, some authors supported an ORIF procedure for Mason type II fractures, showing better outcomes compared to RHR, especially in young and high demand patients [18].

Lindenhovious et al. concluded that an ORIF procedure reduces the risk of subsequent elbow dislocation and protects from post-traumatic osteoarthritis [9]. In Mason type 3 fractures, instead, anatomical reconstruction is difficult and functional outcomes are poor compared to RHR. Recently, Meena PK et al. proposed reconstruction of radial head in Mason type 2 fractures and RHR in Mason type 3 fractures when anatomical and stable fixation is not possible [19].

There are no long-term studies in the literature demonstrating that RHR increases degeneration at the ulno-humeral joint [20]. Nevertheless, ORIF seems to be associated with a higher risk

of complications like pain, stiffness, heterotopic ossification, high rates of early failure, nonunion and poor functional results in displaced whole-head fractures, along with deep wound infection [21,22].

RHR, on the other hand, appears to be associated with fewer post-operative complications such as heterotopic ossification, nerve palsy, elbow instability, pain, cubitus valgus and limited range of motion [23].

The radial head arthroplasty (RHA) seems to solve the problem of which of the two treatments has better outcomes. RHA provides immediate stability without the risk of early collapse and may prevent the risk of radial proximal migration, higher post-operative function outcomes respect to ORIF and RHR. Notwithstanding, at present, there are no long-term result in the literature [21].

Although the use of RHA is progressively increasing , thus representing a solution in complex radial head fractures, it is not free of complications. Among these, the most frequent are overstuffing, prosthetic loosening and rupture of the prosthesis (particularly the silicone component), leading to revision of the prosthesis [24,25].

Chaijenkij et al. [21] suggested that RHA is the treatment of choice in comminuted radius fractures, but that RHR is the safest choice to minimize post-operative complications. Further research with an larger sample size and prospective randomized controlled trial study design are required to more accurately determine which surgical treatment is the best option.

Conclusions

In our small series we found good and similar outcomes with ORIF and RHR with no significant differences between the procedures. The VAS scale of residual pain was slightly higher in ORIF than RHR but not statistically significant.

However, the main limitations of this study are: retrospective evaluation, small sample size and short-term follow-up. In conclusion, despite the limitations of this study, our outcomes support RHR when comminuted RHRs are difficult to treat by internal fixation, gaining satisfactory joint motion, strength and function recovery even in young patients.

Acknowledgements

None.

Conflict of Interest

Each Author declares that he or she has no commercial associations (e.g.consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Funding

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subjects of this article.

Authors' contributions

MF, RS, MR and GN as designers of the study. RS for software and statistical analysis. GN for writing-original draft preparation, writing review and editing. FB and FT as supervisors. All Authors have read and approved the manuscript.

Ethical consideration

No experimental procedures have been conducted. No study design protocol approved by the Institutional Review Board was necessary for this study, as a standard and approved technique was applied and no sensible data are presented.

Consequently for all of them it is not possible to identify any individual patient, according with WMA Declaration of Helsinki. All patients signed an informed consent for the surgical procedure.

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