The Egyptian Journal of Hospital Medicine (October 2022) Vol. 89 (2), Page 8058- 8064

Open Reduction and Internal Fixation of Radial-Head Fractures Mason Type II

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ABSTRACT

Background: A radial head fracture is the bone injury that occurs to an adult elbow the most frequently. People between the ages of 20 and 60 years are most commonly affected by radial head fractures. Falling on an extended hand when the elbow is partially flexed and the forearm is pronated is the most common mechanism of injury.

Objective: We aimed to evaluate the results of open reduction and internal fixation (ORIF) of type II Redial-Head fractures (Mason type II) in the adults.

Patients & Methods: This prospective quasi-experimental study involved 20 patients with type II fractures of head radius in Department of Orthopedics, Faculty of Medicine, Assiut University through the period from December 2018 till May 2019.

Results: Overall mean age was 31.9 ± 7.58 years old with male had predominance (60%). Up to 90% of patients had mini screws, while 5% had mini screws with mini plate and 5% had mini plate only. The overall mean length of stay was 2.2 ± 1.15 days. Majority of patients did not have post-operative complications (70%), while 25% had delayed rehabilitation and 5% had post interosseous nerve injury. According to Broberg and Morrey criteria, most of patient had excellent evaluation (65%), 30% had good and only 5% had fair evaluation. There was statistical significant difference between grades of evaluation by Broberg and Morrey criteria and post-operative complications (p=0.014) with higher complications among patients with fair/good evaluation (83.3%) versus 16.7% in patients with excellent evaluation.

Conclusion: The most effective methods of therapy for type II fractures appear to be ORIF employing small screws and mini plates. Additionally, ORIF was linked to a greater satisfaction rating and fewer problems.

Keywords: Broberg and Morrey criteria, Radial-Head Fractures, Mason type II.

INTRODUCTION

The most frequent bone injury to an adult elbow is a fracture of the radial head. Most radial head fractures affect people between the ages of 20 and 60 years. The most frequent mechanism of injury includes falling on an extended hand when the elbow is partly flexed and the forearm is pronated [(1)]. The elbow becomes unstable due to the radial head losing its bony integrity and needing extra ligament support after trauma. In addition to shear, articular impaction is a common component in radial head fractures. Failure of a head margin in compression is the most basic pattern of displacement [(2)].

The soft tissues of the elbow and/or forearm frequently fail in conjunction with higher-energy injuries to the radial neck. The "awful trio" of elbow dislocation, coronoid fracture, and fractured radial head injuries is a typical pattern of damage [(3, 4)].

Up to 10% of radial head fractures result in elbow dislocation, while only 5% to 10% of elbow dislocations result in radial head fractures [(5)]. As additional supporting structures are damaged, the radial head's load-bearing role assumes more significance. To regain lateral elbow support and elbow joint stability after an elbow dislocation, fractures involving more than 30% to 40% of the radial head should be treated [(6)].

We aimed to assess the outcomes of open reduction and internal fixation (ORIF) of type II Redial-Head fractures (Mason type II) in adults in the current research.

PATIENTS AND METHODS

Study setting and design

This prospective quasi-experimental study involved 20 patients with type II fractures of head radius in Department of Orthopedics, Faculty of Medicine, Assiut University through the period from December 2018 to May 2019.

Inclusion criteria: Closed injuries**.** Type II fractures.
Exclusion criteria: Unfit patient. Children. Type I, III and IV fractures.

Methodology:

All patients underwent physical examinations, which included tests for stability, varus and valgus stability at the elbow, and instability to assess for mechanical blocks to elbow flexion/extension and rotation.

Anteroposterior (AP) and lateral views of the elbow, radiocapitellar view (oblique lateral), and lateral image of the elbow with tube tilted at 45 degrees toward shoulder are all radiological exams of the elbow joint. If necessary, computed tomography (CT) is added.

1. Pre-operative assessment

Before deciding whether to remove the radial head or repair it, the elbow was thoroughly and methodically evaluated in the operation room. The following procedure was used to assess each elbow. The surgeon stressed the fisted hand to test for axial migration while the elbow was stabilised on the hand table and the forearm was in neutral rotation.

Received: 20/7/2022
Accepted: 22/9/2022

If the radial shaft migrates into the capitellum, proximal migration of the radius was appreciated. Additionally, radial shortening at the DRUJ can be seen on fluoroscopy when the radial shaft is grabbed and dragged proximally with a tenaculum. With the elbow bent to 30 degrees and the forearm in pronation, the medial collateral ligament integrity was assessed.

The extent of opening, the feeling at the termination point, and the radiographic appearance were all evaluated using this stress approach. Radial head dysfunction was exacerbating the posterior lateral instability, which is measured in elbow supination, valgus, and axial load.

The evaluation of AP stability in progressive extension was the last step. If an elbow's posterior subluxation was seen at an angle of flexion > 30º, the radial head needed to be fixed or replaced. Additionally, if a difficult proximal ulna or coronoid fragment underwent ORIF, restoration of the radial head buttress helped unload the ulna to speed healing.

2. Operative details

Two surgical approaches to the radial head include the conventional posterolateral (Kocher) route between the anconeus and extensor carpi ulnaris (ECU) and a more extendable straight lateral approach. This extensile method begins at the Kocher interval and proceeds distally to separate the extensor muscles and provide access to the radial shaft.

The Kocher procedure started with an oblique incision that proceeded from the lateral epicondyle's posterior surface to a place above the ulna's posterior border, approximately 6 cm distal to the tip of the olecranon, and then downward and distally. A longitudinal incision in the elbow joint capsule at the annular ligament allowed visualisation of the radial head and the underlying capitellum.

Even though it was enough for access to the radial head alone, the exposure was not ideal for exposure to the shaft since it was difficult to extend distally. The extensile lateral approach was employed above the radial head and neck but anterior to the lateral collateral ligament (LCL) complex. The skin incision began distally over the lateral epicondyle, prior to the anconeus, and proceeded over the radial head and neck.

The lateral epicondyle and the posterior portion of the ECU muscle attachment are the two endpoints of the deep muscular interval. The ECU and the extensor digitorum communis were separated at a distance. The muscle fibers were stretched and contracted as they reflected the anterior portion of the extensor mass. At this point, the capitellum serves as a useful landmark; ensure the dissection is anterior to its equator.

The supinator's crossing fibers were next seen when the extensor fibers expanded out. These fibers are angled away from the muscle fibers of the extensor mass by around 45 degrees. The anterior extensor sleeve was removed from the epicondyle and afterwards reconstructed for greater visibility (figure 1).

Figure 1: Anatomic fixation of the radial head fracture may be seen in the lateral (A) and AP postoperative radiographs (B). Two 1.5-mm screws were utilised to support the radial head, while a 2.0-mm screw was used to secure the neck.

Fixation Techniques

The head pieces required to be bonded together before, if necessary, the head was connected to the shaft after the radial head had been sufficiently exposed using one of the aforementioned methods. Numerous fixation techniques were used, ranging from plates and intramedullary implants to Kirschner (K) wires and headless screws. To ensure that rotation was not restricted, all fixation had to remain inside the radius' non-articular "safe zone."

This area, which measured about 100 degrees, was on the dorsal side of the radius, parallel to the wrist's Lister tubercle. The immediate lateral surface of the radial neck served as the safe zone's focal point while the forearm was in neutral rotation. It was possible to employ plates and screws without worrying about inducing impingement of the proximal radioulnar joint if the safe zone's perimeter was not crossed. The articular fragments were temporarily fixed using tiny (0.028- and 0.035-in) K wires (figure 2).

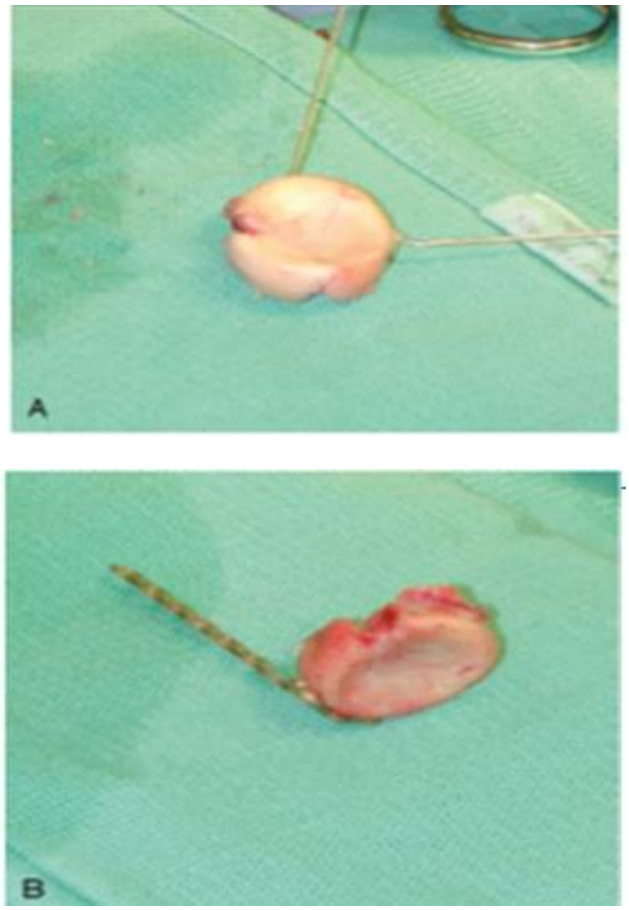


Figure 2: (A) Using K wires and hidden screws, many articular pieces of the radial head were initially temporarily repaired. After that, (B) the completed head is fastened to the proper T plate.

Partial Articular Fragments

After achieving provisional fixation, the pieces were compressed and tightly fixed using screws during final fixation. Screws were either conventionally put in the non-articular area or, if embedded in cartilage, buried well below the surface. If only a part of the head was fractured, in situ fixing was used. These fractures were very simple since a piece of the radial head was still connected to the radial shaft. In most cases, a Kocher technique was sufficient because no distal dissection was necessary.

The radiocapitellar joint's equator should remain anterior to the dissection, and the LCL must still be preserved. In the safe zone, headed screws with a diameter of 1.3 to 2.0 mm can be inserted normally or countersunk if they need to go into an articular area of the radial head.

Combined Radial Head and Neck Fractures.

The entire head was removed and repaired on the back table if there was a total articular fracture. It was difficult to determine the safe zone's location with the head free, but a close examination revealed it by the absence of cartilage. With the help of tiny K wires and headless screws, the skull fragments were put back together. The head-plate construct was then moved into the working area after being attached to the proper plate.

The head was crushed to the shaft through an eccentric hole in the plate and a later interfragmentary screw. The plate will lay obliquely when it is appropriately positioned in addition to the radial head's usual angulations on the shaft. The appropriate soft tissue repair and closure were done once the required reduction and fixation were accomplished. The LCL had either been torn at the site of injury, released during exposure, or weakened by the necessary retraction during fixing.

The LCL was repaired with heavy (no. 2 or no. 5) non-absorbable sutures using either suture anchors or transosseous drill holes. The annular ligament was often not restored separately because the LCL repair tightened it as well. To ensure there was no impingement and that the elbow was stable, the forearm was moved through its full range of motion.

3. Postoperative evaluation

The Broberg and Morrey System [(7)], the industry-standard functional evaluation score for the elbow, served as the foundation for the postoperative clinical examination. The score ranges from 0 to 100 and is based on four variables: range of motion, grip strength, functional stability, and discomfort.

Clinical and radiological assessments (flexion, extension, pronation, supination, and X-ray tests) were finished during the fourth to sixth weeks. The elbow's 90° flexion was utilised to assess pronation and supination, while the neutral position was employed for the flexion-extension tests. Using a tension meter, the force of flexion, extension, pronation, and supination was calculated in relation to the unaffected extremities. A goniometer was used to calculate the elbow's flexion-extension and rotational ranges. X-ray technology was used to monitor the apposition of the joints as well as the healing of the fractures. In the meanwhile, heterotopic ossification was identified.

Some surgical issues that persisted throughout the follow-up included deep wound infection, range of motion deficit >30°, no or slow healing, internal fixation failure, secondary fragment displacement, joint stiffness, and heterotopic ossification. Joint mobility restriction, which is frequently observed following elbow injuries, was categorised as a complication when it exceeded 30 degrees. A damage to the post-interosseous nerve was identified in one case. Five more patients had put off their recovery.

Ethical consideration

The Academic and Ethical Committee of Assiut University approved the study. All participants signed informed permissions after being told about the study's goal. The Declaration of Helsinki, the World Medical Association's code of ethics for studies involving humans, guided the conduction of this work.

Statistical analysis

SPSS was used to analyse the results (ver. 25.0; IBM, Chicago, IL, USA). Quantitative data were presented as mean ± standard deviation (SD).

Frequency and percentage were used to illustrate the qualitative data, and the Chi^2 test was used to compare them. The agreed cutoff for statistical significance was $p \leq 0.05$.

RESULTS

Baseline data of the studied patients (table 1):

It was found that most of patients were above 30 years old (55%) with overall mean age of 31.9 ± 7.58 years old. Male had predominance distribution among study patients (60%) more than female (40%). Majority of patients had urban residence (70%) while 30% from rural area. Left side of operation (55%) was higher than right side (45%).

Table (1): Baseline data of the studied patients

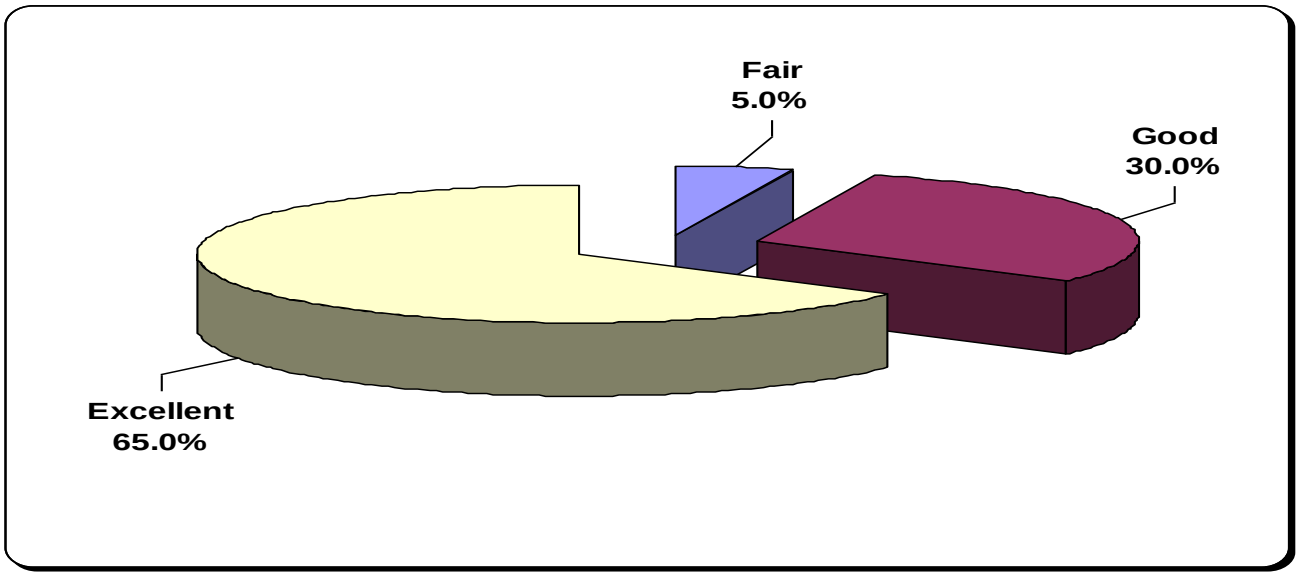
	No. (20)	%
Age		
< 30 years	9	45.0
≥ 30 years	11	55.0
Mean ± SD (Range)	31.90 ± 7.58 (19.0 – 48.0)	
Sex		
Male	12	60.0
Female	8	40.0
Residence		
Rural	6	30.0
Urban	14	70.0
Side of operation		
Right	9	45.0
Left	11	55.0

Methods of ORIF and outcome among the studied patients (table 2, figure 3):

Up to 90% of patients had mini screws, while 5% had mini screws with mini plate and 5% had mini plate only. Most of patients stayed in the hospital after the operation less than 3 days (70%) with overall mean length of stay of 2.2 ± 1.15 days. Majority of patients did not have post-operative complications (70%), while 25% had delayed rehabilitation and 5% had post-interosseous nerve injury. According to Broberg and Morrey criteria, most of patient had excellent evaluation (65%), 30% had good and only 5% had fair evaluation.

Table (2): Methods of ORIF and outcome among the studied patients

	No. (20)	%
Methods of ORIF		
Mini screws + mini plate	1	5.0
Mini plate	1	5.0
Mini screws	18	90.0
Hospital stay		
< 3 days	14	70.0
≥ 3 days	6	30.0
Mean ± SD (Range)	2.20 ± 1.15 (1.0 – 5.0)	
Postoperative complications		
No complication	14	70.0
Delayed rehabilitation	5	25.0
Post interoseus nerve injury	1	5.0
Evaluation by Broberg and Morrey criteria		
Fair	1	5.0
Good	6	30.0
Excellent	13	65.0



ORIF: open reduction and internal fixation

Figure (3): Evaluation by Broberg and Morrey criteria

Evaluation by Broberg and Morrey criteria according patients' characteristics (table 3, figure 4):

There was statistical insignificant difference between grades of evaluation by Broberg and Morrey criteria based on age groups (p=0.0642), sex groups (p=1.000), residence (p=0.152), side of operation, (p=0.540) and post-operative stay in the hospital (p=0.539). At the same time, there was statistical significant difference between grades of evaluation by Broberg and Morrey criteria and post-operative complications (p=0.h014) with higher complications among patients with fair/good evaluation (83.3%) versus 16.7% in patients with excellent evaluation.

Table (3): Evaluation by Broberg and Morrey criteria according patients' characteristics

Age (years)	Evaluation by Broberg and Morrey criteria				P-value
	Fair/ Good		Excellent		
	No.	%	No.	%	
Age					
< 30 years	4	44.4	5	55.6	0.642
≥ 30 years	3	27.3	8	72.7	
Sex					
Male	4	33.3	8	66.7	1.000
Female	3	37.5	5	62.5	
Residence					
Rural	4	66.7	2	33.3	0.152
Urban	3	21.4	11	78.6	
Side of operation					
Right	2	22.2	7	77.8	0.540
Left	5	45.5	6	54.5	
Hospital stay					
< 3 days	6	42.9	8	57.1	0.539
≥ 3 days	1	16.7	5	83.3	
Postoperative complications					
Complications	5	83.3	1	16.7	**0.014**
No complications	2	14.3	12	85.7	

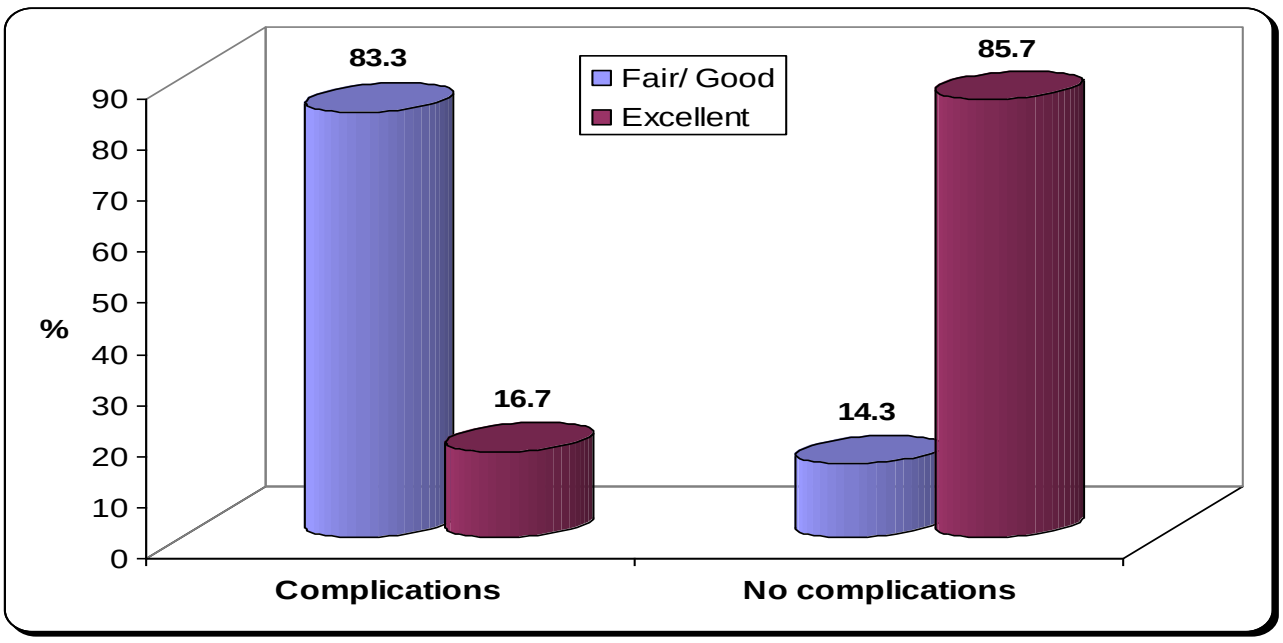


Figure (4): Evaluation by Broberg and Morrey criteria according to post-operative complications

DISCUSSION

There is no consensus on the indications for ORIF in displaced radial head fractures, despite the fact that several alternatives are used in their treatment [8]. In contrast, radial head arthroplasty is becoming more widely accepted as a successful therapeutic option for irreparable fractures. Injuries to the elbow and forearm may also coexist with radial head fractures [9].

This study aimed to evaluate the results of fixation of type II fractures of radius head in the adults. This quasi-experimental study included twenty patients with type II fractures of head radius in Department of Orthopedics, Faculty of Medicine, Assiut University.

As regards demographic characteristics, most of patients were above 30 years old (55%) with overall mean age of 31.9 ± 7.58 years old. Males had predominance distribution among study patients (60%) more than female (40%). Most of patients had urban residence (70%) while 30% from rural area.

Left side of operation (55%) was higher than right side (45%). 90% of patients had mini screws, while 5% had mini screws with mini plate and 5% had mini plate only. Most of patients stayed in the hospital after the operation less than 3 days (70%) with overall mean length of stay of 2.2 ± 1.15 days.

The age of patients suffering this fracture has gone upward, with a mean age of 45 years, and in our experience, the gender ratio was roughly 1:1. This is in partial agreement with a demographic study about Associated Injuries Complicating Radial Head Fractures [10].

In this group of patients with radial head fractures who had ORIF, (70%) showed no post-operative sequelae, 25% experienced delayed rehabilitation, and 5% had post-interosseous nerve damage. This is consistent with the findings of **Pike *et al.*** [9]. Despite significant rates of serious problems in both the simple group (13%) and the complicated group (25%), including collapse with conspicuous hardware, incapacitating elbow stiffness, subluxation, minimal pain and disability were seen. Other study have demonstrated positive effects using ORIF, with worse outcomes seen with more severe injuries as well [11].

Another study reported that complications from a total of 23 patients, one case failed to unite, three instances experienced internal fixation failure and secondary fragment displacement within an average of six months, and four cases experienced successful second-stage radial head replacement. Two years after surgery, X-rays were re-examined in two patients, and heterotopic ossification was discovered in both. 19 out of 23 patients had their internal fixation removed within eight to 10 months [12].

According to **Broberg and Morrey** [7] criteria, most of this study patients had excellent evaluation (65%), 30% had good and only 5% had fair evaluation with statistical significant with post-operative complications (p=0.014) as higher complications rate among patients with fair/good evaluation (83.3%) versus 16.7% in patients with excellent evaluation. This is consistent with another research that had 22 instances and a two-year follow-up. **Cai *et al.*** [13] ratings revealed that 81% of the findings were excellent or good. According to Broberg and Morrey ratings, in a different research, an outcome was deemed acceptable if it was good or exceptional and unsatisfactory if it was fair or bad. 65.2% of patients in the ORIF group reported being satisfied with the outcome. Statistically significant differences were seen with the post-operative complications [12].

The repair of broken radial head and neck using AO mini-screws and mini-plates from Synthes in Paoli, Pennsylvania, Herbert screws from Zimmer in Warsaw, Indiana, and biodegradable (polylactide) pins has made internal fixation popular in recent years [14]. An overall success rate of 98% was found in a systematic review that highlighted the positive results following ORIF with screws and biodegradable (polylactide) pins for type II radial head and neck fractures [15].

According to **Lindenhovius *et al.*** [16]**,** ORIF may only be justified when a fracture fragment prevents forearm rotation due to a stable, displaced partial articular fracture of the radial head that is not connected to additional fractures or dislocations of the proximal radius and ulna. The painful hemarthrosis associated with the fracture is a common cause of the apparent limitation of forearm mobility, therefore this diagnosis should be made with caution.

Aspirating the hemarthrosis and administering a local anaesthetic might be helpful when discomfort is preventing a thorough physical examination. As an alternative, re-examination few days later usually results in enough pain alleviation to make examination possible. A real mechanical obstruction to mobility is unusual in our experience [16].

There were a few restrictions on this study. The main drawback is the lack of a comparison cohort, more particularly, a cohort treated with radial head arthroplasty and a cohort treated non-operatively throughout the same time period. Due to the lack of radial head-specific outcome evaluation techniques, only the entire impact of the injury, including any accompanying fractures and ligamentous injuries, can be shown.

CONCLUSION

For type II fractures, the best treatment options seem to be ORIF using mini screws and mini plates. Moreover, ORIF was associated with lower complications and higher satisfaction rate. Further studies including a comparative group, with comparison with another options of treatment are warranted**.** Also, further studies with use of more specific tool for outcome measurement should be encouraged.

Financial support and sponsorship: Nil.

Conflict of interest: Nil.

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