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RESEARCH ARTICLE

Prosthetic Replacement of Radial Head in Surgical Management of Fractures Radial Head

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Abstract

Objectives: To show the results of a limited surgical protocol in treating Mason type III radial head fracture isolated or associated with fractures of the proximal ulna or elbow dislocations , especially if the medial collateral ligament is disrupted , including replacement of the unfixable comminuted fractured head of radius and repair of the lateral collateral ligament (LCL) and lateral ulnar collateral ligament (LUCL).
Design: Retrospective study
Setting: Department of Orthopedic, Sohag University Hospital, Egypt
Subjects: Twenty patients with Mason type III radial head fracture or fracture dislocation radial head (Mason type VI) .
Intervention: Surgical protocol of replacement of comminuted unfixable fractured head of radius, repair of LCL, LUCL injuries and short elbow immobilization in a plaster splint followed by physiotherapy .
Main Outcome Measure: Mayo score on four parameters (pain , motion , stability and function) was calculated, and clinical and radiological complications were assessed[1] .
Results: Sixteen patients (80 %) excellent, two good, one fair and one poor . The average cumulative Mayo score was 93.5/100 . No patients developed re-dislocation post-surgically. Radiological results showed no case had secondary post-traumatic osteo-arthrosis or prosthesis breakage or loosening .
Conclusion: Operative management as described above can achieve elbow stability, functional range of motion and minimal complications without the need to repair the the medial collateral ligament (MCL) or to use hinged external fixator or cross- pinning .

INTRODUCTION

Radial head fracture is the most common fracture of the elbow. Although they sometimes occur in isolation, many of these fractures are associated with elbow dislocation and disruption of the medial collateral ligament (MCL), lateral collateral ligament (LCL) and avulsion of the common flexor-pronator origin and common extensor-supinator origin creating very unstable situation at the elbow joint . Significant number of the radial head fractures associated with elbow dislocation are comminuted fractures with fracture fragments more three or four pieces (Fig. 1) they are often associated with fracture of the radial neck making their fixation a very difficult or unattainable task [2-9] .

Numerous biomechanical studies have demonstrated the importance of the radial head as an axial and valgus stabilizer of the forearm and elbow respectively, particularly in the setting of associated ligamentous injuries [10-14].

Excision of the fragments of the head of radius which cannot be fixed in case of associated elbow dislocation will lead to chronic and recurrent elbow instability which will compromise the function of the whole upper limb with chronic elbow pain and development of secondary osteo-arthritis [1, 15-23] .

An efficient management of the elbow fracture dislocation whenever the comminuted fracture of head of radius is unfixable is to maintain and preserve the elbow lateral column stability by replacing the radial head by a prosthesis with ligamentous repair [24-34].

SUBJECTS AND METHODS

From April 2011 to April 2013, we operated upon 20 patients with Mason type III and type IV fractures.

There were 15 male and 5 female patients with male to female ratio 3:1 and the average age at trauma was 35 years (range 20 – 50 years).

The mechanism of injury was a fall from height (high velocity fall) in seven patients, falling from a standing height in five patients, and involvement in road traffic accident (high – energy trauma) in eight patients . The mean time to surgery was two days (range 1 – 4 days) . The mean follow up was for 17 months (range 10 – 24 months).

All patients had Mason type III or type IV with comminuted non fixable fracture of the radial head . The patients who had posterior or postero-lateral elbow dislocation associated with comminuted non-fixable fracture of the radial head, (after clinical and radiological assessment using X-ray), had closed manipulation of their dislocated elbow in the emergency room under sedation and were described to have unstable reduction with redislocation of the elbow joint in more than 30° flexion. These patiens' elbows were further investigated using CT scan and kept immobilized in a plaster of Paris (POP) slab in more than 90° flexion of the elbow .

SURGICAL TECHNIQUE

Preoperative prophylactic antibiotic (one gram of ceftriaxone) was routinely given with induction of anesthesia. All the patients were positioned supine with their elbows supported on a side table with the tourniquet inflated in the upper arm [2].

SURGICAL APPROACH

Dorso-lateral Kocher's approach with radial head access between the anconeus and extensor carpi-ulnaris muscles was used in all cases. Blunt retractors were then used genitally to gain exposure of the radial head and neck. Carefull retraction on the fully pronated forearm preserves the posterior interosseous nerve [2].

The entire radial head fragments were removed .Sixteen patients had four fragments and four patients had five fragments. These fragments were reassembled on table to provide a template for the size of the prosthesis. The intramedullary canal of the radius was shaped to accept the stem of the implant using curette , burr, or small rasp. Bone resection preparation should be as conservative as possible with the best effort to preserve the flare interface between the radial head and neck .

A trial implant that best replicates the size of the assembled head was inserted into the prepared canal and joint reduced. Good contact of the trial head with capitellum and smooth movements should be noted on passive flexion of the elbow and rotation on forearm .

The trial implant was then removed and the medullary canal of the proximal radius was thoroughly irrigated with saline solution . The canal gently filled with polymethylmethacrylate (PMMA) bone cement using the finger packing. The implant was inserted into the canal using gentle impaction with a blunt instrument . Excess cement was thoroughly removed. Solar radial head prosthesis (Stryker , Howmedica Osteonics) come in five sizes , but we used medium , 15 mm implant in 17 cases and the medium 12 mm implant in 3 cases .

After intra-operative X-ray confirmation of the position of the radial head prosthesis (Fig. 2), the annular ligament was closed using absorbable sutures .

The (LCL) , the (LUCL) and the common extensor –supinator origin were found avulsed and repaired using NO. 1 absorbable sutures passed through drill holes on the lateral epicondyle in 13 patients and in 7 patients only (LUCL) was found torn and needed a direct suturing repair using 2/0 absorbable sutures .

After release of the tourniquet , hemostasis, and closure of the wound in layers with drain, the stability of the elbow joint was examined. With the elbow in 90 degrees of flexion, a bulky conforming dressing is applied including a posterior plaster splint.

POST-OPERATIVE CARE

After surgery, all patients had a posterior plaster slab for one week. Begin active elbow flexion-extension exercises and forearm rotation after seven days following surgery after removal of posterior plaster slab under supervision of a physiotherapist. Patients are encouraged to maximize elbow extension and flexion at every stage of their recovery to ensure optimal outcome .Non-steroidal anti-inflammatory drugs were provided to ensure the best possible results from physiotherapy.

Mobilization against resistance began six weeks after surgery. Skin clips were removed 10 to 14 days after surgery and arm sling used for one two weeks after removal of the slab .

FOLLOW UP

Each patient was seen two , four and six weeks after surgery and then every three months during the first year and every six months thereafter until the end of the follow-up period . During every follow-up visit , the range of elbow motion and forearm rotation was measured and recorded using a goniometer. Plain radiograph were taken at each review (AP and lateral views) . AP views were performed in pronation and supination. The radial head prosthesis was considered stable when the contact with capitellum was total in all positions . The prosthesis size is satisfactory when the upper level of the implant is at or within one mm from the level of the coronoid process in the X-ray views indicating the absence of impingement of the capitellum by the metal implant.

STATISTICAL ANALYSIS

The differences in the four sections of the Mayo elbow performance index score (pain, motion, stability, function) and also the clinical and radiological complications were analyzed in the view of using post-operative short period of elbow immobilization , with setting the level of significance at $P < 0.05$.

RESULTS

Fig. 2: Post – operative X-ray showing metallic radial head prosthesis.

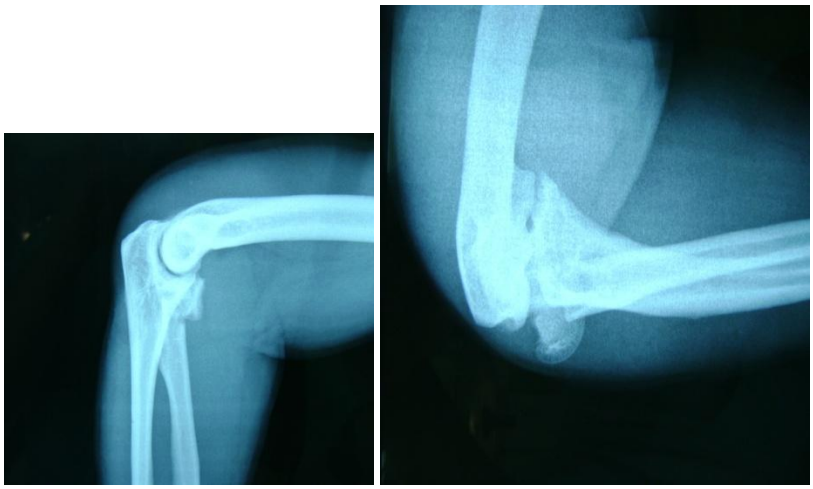

Fig. 1: Pre-operative X-ray: A 38 – years – old male with comminuted fracture of rt. head radius (Mason type III) with lateral column soft tissue injury.

Sixteen patients (80 %) were excellent , two good (10 %) , one fair (5 %) and one poor (5 %). The one with fair result had flexion deformity and weak grip strength and he was obliged to change his type of work from being heavy manual worker to some kind of lighter job . The one with poor result, the prosthesis was removed in another hospital after 8 months because of disabling reduction of flexion of the elbow. Regarding the range of motion , the average elbow flexion was 130˚ (range , 110 - 140˚). Average extension was 18˚ (range, 0 - 30˚). Average pronation was 70˚ (range, 40 - 80˚). Average supination was 70˚ (range, 50 – 80).

Regarding the stability , nobody had instability or redislocation after the plaster splint was removed after the combined procedure of radial head replacement and lateral soft tissue repair .

The average pain score was 42 / 45. Two patients complained of a mild pain in their elbow on using their upper limbs to carry heavy objects . Therefore, the average cumulative Mayo score [1, 35] was 93.5 / 100 .

The follow up radiographs demonstrated good congruity of both the humero–ulnar and the radiocapitellar joints. The implant was considered stable in pronation and supination X-ray in all cases.

Table 1 : Mayo score [1, 35]

Variable	points	definition	(points)
Pain	45	none	45
		mild	30
		moderate	15
		sever	0
Motion	20	arc > 100˚	20
		arc 50-100˚	15
		arc < 50˚	5
Stability	10	stable	10
		moderate instability	5
		gross instability	0
function	25	Comb hair	5
		feed	5

		hygiene	5
		shirt	5
		shoe	5
Total			100
excellent			> 90
good			75 – 89
fair			60 – 74
poor			< 60

In no patient the radiographs showed the radiological signs of aseptic or septic loosening or capitellar erosion or impingement or subluxation of the implant .

One of our patients developed posterior interosseous nerve palsy for which a dynamic cock – up splint was used by the patient for four months when the nerve recovered with full active extension of his thumb and other fingers . In none of our patients we had deep or superficial wound infections.

All our patients returned to their original work except two patients . The other five patients in our series, who were heavy manual workers also returned to the same kind of heavy physical work.

At the latest follow – up, none of our patients developed post – traumatic secondary osteo – arthritis in their injured elbow joints .

DISCUSSION

Posterior and postero – lateral elbow dislocation usually occurs as a result of a rearward fall on an out – stretched, supinated upper limb. Several lesions can result from this mechanism. In the frontal plane the (MCL) is torn. A radial head fracture can occur either by a sever valgus compression and / or by radio-capitellar abutment during elbow dislocation . In the sagittal plane, the anterior displacement of the trochlea leads to coronoid fractures and / or major capsular detachment . In the transverse plane, tearing of the humero – ulnar part of the (LCL) leads to rotational instability of the humero – ulnar joint . It is the association of frontal, sagittal and transverse lesions that yields major elbow instability, the so called Hotchkiss " terrible triad " [36-41].

Treatment of complex fracture dislocation of the elbow tends to be mostly unstable after closed reduction and even with prolonged immobilization , re-dislocation commonly occur in plaster with poor results of elbow chronic instability and recurrent dislocation especially when the soft tissue injury is sever[1]. Open reduction and rigid fixation of fractured radial head should improve stability and allow early active movements, but unfortunately this can be difficult or impossible to achieve with comminution of the radial head , commonly encountered in elbow complex fracture dislocation. Ring et al showed that results for fixation of radial head fractures with greater than three parts were less predictable. In those patients with Mason type III injuries, 13 of 14 fractures with greater than three parts treated with open reduction and internal fixation had poor or unsatisfactory results. The authors concluded that those with greater than three head fragments should be fractures should be excised and possibly replaced [15].

Partial excision of displaced, unfixable fragments of radial head can be carried out with the remaining intact part retained for stability. However, the elbow will still tend to be unstable and a raw cancellous surface will remain with the probable formation of dense adhesions leading to restriction of forearm rotation. Excision of the intact part of the head will only worsen the instability, but radial head replacement in this situation often restores stability and allows early active motion. Scar tissue cannot adhere to the smooth surface of the radial head implant and restrict movement[15].

Ring et al recently reported on 11 patients with comminuted fracture radial head associated with type II Regan – Morrey coronoid fractures . Seven elbows re – dislocated in a splint after manipulativ reduction. Five, treated with resection of the radial head redislocated after operative treatment . The authors concluded that elbow dislocation associated with unfixable fractures of the radial head and fracture coronoid process are especially prone to recurrent subluxation, instability and post – traumatic arthritis. In this series we have 12 (60 %) patients with associated coronoid fractures with only one case with Regan – Morrey type II fracture which has been fixed with a cannulated screw . We do not believe that Regan – Morrey type I needs any surgical intervention (like Morrey) and are not significant in terms of humero – ulnar instability , and they are usually detached with the capsule and non repairable [42].

Treatment of a dislocation of elbow with an associated fracture of the radial head is much more challenging than treatment of simple dislocation. Not only was there probably more energy involved in the

traumatic event but also failure to restore the contact compression of the radial head against the capitellum. This may severely compromise the ability of the lateral and medial collateral ligament complexes to heal with proper physiological tension. Treatment of fracture – dislocation of the elbow with excision of the radial head without prosthetic replacement can lead to these problems[42].

Josefesson et al reviewed the results of treatment of twenty – three patients who had a combined fracture of the radial head and dislocation of the ulno–humeral joint. By an average of fourteen years postoperatively, severe arthrosis had developed in twelve out of nineteen patients who had excision of the radial head without replacement. Broberg and Morrey noted arthrosis in twenty – two (92 %) of twenty – four patients an average of ten years after fracture –dislocation of the elbow treated without repair or replacement of the radial head. Although only seven patients had moderate or severe arthrosis, more sever radiographic changes were associated with longer duration of follow – up. Four patients in the series Jossefsson et al and two patients in the series of Broberg and Morrey had a re – dislocation within the first two months after the injury , even though many patients in both series had been managed with immobilization in a cast or splint. The re – dislocation was associated with concomitant fracture of the coronoid process in all of the patients in the series by Jossefsson et al. Persistent instability, loss of motion, heterotopic ossification and post – traumatic arthrosis have been well documented, following fractures of the radial head associated with dislocation. Data from Beingessner et al suggests that radial head replacement is insufficient to restore postero – lateral stability in the setting of an (LUCL) injury and the (LUCL) must be repaired . In all the patients from this series we found that the (LUCL) was torn and repaired and in 14 cases the entire (LCL) with (LUCL) component were found avulsed and torn and were associated with avulsion of the common extensor muscle origin and repaired by suturing through drill holes in the epicondyle. According to Beingessner and others if the elbow is still unstable after radial head replacement, coronoid fracture fixation and repair of the (LUCL) ,the (MCL) should be explored and repaired or a dynamic hinge external fixator should be placed across the elbow joint or even to transfix the humero – ulnar joint by cross – pins for short periods of 7 – 14 days to provide stability as the soft tissue injuries heal[7].

According to the results of our study we believe that the radial head replacement with repair of the (LCL) and (LUCL) achieve stability in Mason type III and IV with unfixable fractures radial head. There is also no indication to use hinged external fixator which is difficult to apply and always cumbersome to the patient or to transfix the elbow by pins which may injure the articular joint and increase the rate of post – surgery elbow stiffness . All what is needed as our results indicated is to immobilize the elbow in 90˚ or more flexion in plaster splint for short time of one or two weeks after which the rehabilitation program of active elbow exercise can start without a single case of redislocation or chronic instability during the entire follow – up ($P < 0.05$).

Silicon rubber implants have fallen out of favor since the late 1980's. They have shown the inability to restore lateral compartment stability, cause sever synovitis and implant breakage (fragmentation) and frequently needs to be removed. Metallic implant have shown good long – term results in terms of elbow stability but some authors have shown that the use of metallic implant may result in capitellar erosion due to overstuffing of the joint (Ober et al). In a recent retrospective study, they have compared the results of radial head replacement with silicone rubber and metallic implants and concluded that the metallic implants appeared to be superior to silicon rubber implants[43].

In our series , there was no joint overstuffing by the metallic prosthesis that we used and none of our patients developed capitellar erosion. At latest follow – up none of our patients showed signs of elbow synovitis or breakage of metallic prosthesis.

CONCLUSION

In our study , despite is short comings , (being a retrospective series of a small number of patients rather than a prospective randomized and controlled one) , clearly show that we can rely on the early operative repair of fracture – dislocation elbow cases with a limited standard protocol to achieve stability , satisfactory functional range of motion and minimal complications . We recommend according to the results of this study a limited standard surgical protocol to treat these complex difficult injuries which compromise of radial head replacement for comminuted non – fixable fractures , repair of (LCL) , (LUCL) and common extensor origin avulsion . Also we need to immobilize the elbow in a reduced position for short time of one to two weeks to allow soft tissue injuries to heal after which rehabilitation program can be started promptly without complications of chronic instability or joint stiffness .

We also conclude that the medium – term results of replacement of the comminuted and non – repairable fractured head radius using a metal prosthesis are satisfactory and without complications of synovitis , instability , capitellar erosion , breakage or loosening of the prosthesis .

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