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Study of role of prosthetic replacement for comminuted fracture of head of radius

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Abstract
Objective: We had evaluated our experience in the treatment of Morrey Modified Masons type III and IV radial head fractures with radial head prosthesis.
Materials and Methods: From April 2014 to September 2017, modular radial head prostheses were performed in thirty patients. There were twenty female and ten male with mean age of forty years. The follow-up was a mean of 25 months. Fractures of the radial head have been classified by Morrey Modified Masons classification. The indications for a radial head replacement were type III fractures in 24 cases, type IV fractures in 6 cases, and comminuted radial fracture associated with disruption of the medial collateral ligament in 3 cases. Patients were assessed postoperatively and on follow-up based on Mayo Elbow Performance Index (MEPI) Score.
Results: By using the MEPI, out of thirty cases, twenty cases had excellent results, seven cases had good results, two cases had fair results, and one case had poor result. Twenty-eight cases had no complications, one case had infection, and one case had implant failure.
Conclusion: Modular radial head prosthesis can be used successfully for treatment of the Morrey Modified Masons type III and IV radial head fractures.

Keywords: Comminuted radial head fractures, radial head arthroplasty, radial head prosthesis

Introduction
The incidence of radial head fractures has been reported to be between 1.7% and 5.4% of all fractures and represents 33% of all elbow fractures [1-3]. The most common injury mechanism is due to an axial load onto the pronated and extended forearm. The radial head provides stability about the elbow and forearm by acting as a secondary stabilizer to valgus instability of the elbow, with the primary stabilizer being the medial collateral ligament (MCL) and by providing stability to the distal radial ulnar joint to assist the forearm in resisting axial forces and enhancing grip strength [4, 5]. There are several patterns of complex injury that include a fracture of the radial head. Identification of these injury patterns can help guide treatment. These patterns include (i) fracture of radial head associated with rupture of MCL (ii) concomitant fractures of the radial head and capitulum (iii) posterior dislocation of the elbow with fracture of the radial head (iv) posterior dislocation of the elbow with fracture of the radial head and coronoid process (the so-called terrible triad of the elbow) (v) posterior Monteggia fractures including posterior olecranon fracture-dislocations and (vi) Essex–Lopresti lesions and variants [6]. Radial head arthroplasty is indicated in unreconstructable head fractures and in cases of associated elbow instability for which excision of the radial head will likely produce late complications. Speed in 1941 first proposed prosthetic replacement of the radial head using a ferrule cup over the neck of radius [7]. Since then, the use of acrylic, silicone, vitallium, and other metallic radial head prostheses has been reported each with varying results. The purpose of this study was to evaluate our experience in the treatment of Morrey Modified Masons type III and IV radial head fractures with modular radial head prosthesis.

Materials and Methods
The present study consists of 30 patients of Morrey Modified Masons type III and IV radial head fractures treated by modular radial head prosthesis from April 2014 to September 2017.

Inclusion criteria
1. Morrey Modified Masons type III and IV fractures.
2. Closed fractures.
3. Age of patient 20 years and more.
4. Delay at presentation of not more than 2 weeks.

Exclusion criteria
1. Morrey Modified Masons type I and type II fracture.
2. Open fractures.
3. Presence of any infection.
4. Patients with age <20 years.

Preoperative

On admission, a detailed history including the mechanism of injury and the complaints of the patients were noted, along with a thorough clinical examination. Radiographs of affected limb elbow anteroposterior and lateral views were taken [Figure 1] and [Figure 2]. For primary treatment, immobilization was given in the form of a slab. All routine investigations were done prior to anaesthesia fitness.

Fig 1: Patient 1-Preoperative X-ray elbow anteroposterior and lateral views

Fig 2: Patient 2-Preoperative X-ray elbow anteroposterior and lateral views

Operative

Under general or regional anaesthesia, the patient was positioned in the supine position. After routine preparation and draping, Kocher approach was made to expose the radial head. The fractured radial head was excised with great care taken not to leave any fragment in the elbow joint. Copious joint irrigation was performed to remove all loose intraarticular debris. Valgus and axial stress tests were performed using an image intensifier to evaluate the competency of the MCL and interosseous ligament. A modular radial head implant system was used. This device has multiple head diameters and heights and different stem sizes, which allows for a close approximation to normal anatomy. Each head could be mated to any of the stems using a Morse taper resulting in multiple potential combinations of sizes. The different head heights accommodated for the extension of fractures into the proximal neck and also accounted for observed variability in head height. The parts of the broken head were reassembled on the table to ensure that the whole head had been resected to choose the size of the prosthetic head. A minimal amount of radial neck was resected at a right angle to the medullary canal of the radial neck to ensure a smooth surface for load transfer to the implant. The appropriate diameter and height of radial head implant were selected for trial implantation. The medullary canal of the radial neck was gently rasped using the hand reamers. Rasp was used to smooth the neck cut, ensuring that it was at 90° to the neck and the trial head was inserted onto the trial stem. The diameter, height, and congruency of the prosthesis were assessed visually with the aid of an image intensifier. The head had to reach the limit between the trochlear notch and the radial notch of the ulna. The trial components were removed and the definitive implants were inserted with cementing. After radial head replacement, the annular ligament was repaired. The fascial interval between the anconeus and extensor carpi ulnaris was closed. Wound was closed and tourniquet deflated. Associated procedures include MCL repair in three cases. Postoperative X-ray was taken [Figure 3] and [Figure 4].

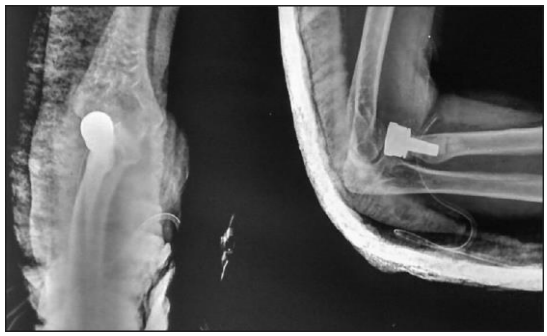

Fig 3: Patient 1-Post-operative X-ray elbow anteroposterior and lateral views

Fig 4: Patient 2- Post-operative X-ray elbow anteroposterior and lateral views

Physiotherapy

Patients with a stable elbow started with active flexion and extension exercises throughout a full arc of motion, 3 days after surgery. A collar and cuff was worn during the day between exercises. In patients with associated ligamentous injuries, a resting splint with the elbow maintained at 90° was used for 4 weeks. Active flexion and extension exercises throughout a full arc of motion were started after 4 weeks.

Follow-up

The patients were followed up in outpatient department fortnightly for a period of 1 month postoperatively. Physiotherapy was continued. At follow-up, patients were examined clinically for a range of movements and then radiologically at the end of 6 weeks, 12 weeks, 6 months, and 1 year. The patients were assessed postoperatively and on follow-up based on Mayo Elbow Performance Index (MEPI) Score [8].

Greater than 90 points = excellent, 75-89 points = good, 60-74 points = fair, and <60 points = poor.

Observation and Results

In our case study of 30 cases, 16 cases were <40 years (53.33%) and 14 cases were more than 40 years, (46.67%) the mean age was 39.8 years, maximum age was 56 years, and minimum age was 30 years [Table 1].

Table 1: Age distribution

Age	Number of patients	Percentage
<40	16	53.33
>40	14	46.67
Total	30	100

Twenty cases (66.67%) were female and 10 cases (33.33%) were male. The mode of injury in 20 cases (66.67%) was due to fall and in 10 cases (33.33%) was due to road traffic accident. Twenty cases (66.67%) involved the right elbow and 10 cases (33.33%) involved the left elbow. Twenty-three cases (76.67%) were right side dominant and 7 cases (23.33%) were left side dominant.

Twenty-four cases (80%) were under Morrey Modified Mason's classification type III and 6 cases (20%) were under Morrey Modified Mason's classification type IV [Table 2].

Table 2: Morrey modified Mason's classification

Morrey modified Mason's classification	Number of patients	Percentage
Type 3	24	80
Type 4	6	20
Total	30	100

Twenty-seven cases (90%) were not associated with any ligamentous injury and 3 cases (10%) were associated with MCL injury. Average follow-up was for 25 months. Range of movement in average flexion was 140 degrees, average extension deficit was 10°, average pronation was 75°, and average supination was 68°.

By using the Mayo Elbow Performance Index, 20 cases (66.67%) had excellent results, 7 cases (23.33%) had good results, 2 cases (6.67%) had fair results, and 1 case (3.33%) had poor result [Table 3].

Table 3: Mayo Elbow Performance Index

Mayo elbow performance index	Number of patients	Percentage
<60 (poor)	1	3.33
60-74 (fair)	2	6.67
75-89 (good)	7	23.33
>90 (excellent)	20	66.67
Total	30	100

In 15 cases (50%), 20 mm implant size was used, in 10 cases (33.33%), 18 mm implant size was used, and in 5 cases (16.67%), 22 mm implant size was used.

Postoperatively, 28 cases (93.33%) had no complications, 1 case had infection (3.33%), and one case had implant failure (3.33%) [Table 4].

Table 4: Postoperative complication

Postoperative complication	Number of patients	Percentage
No complication	28	93.33
Infection	1	3.33
Implant failure	1	3.33
Total	30	100

Discussion

In 1954, Mason classified radial head fractures into three types. Type 1 - undisplaced segmental or marginal fractures, Type 2 - displaced fractures involving part of the head, and Type 3 - comminuted fractures of the entire head [9]. In 1985, Morrey Modified Mason's classification to include radial head fractures associated with posterior dislocation of the elbow as suggested by Johnston as a Mason Type 4 fracture [10]. In discussing the treatment of severely comminuted radial head fractures, most authors until the 1950s considered excision as the only modality of treatment. But after radial head excision, local formation of new bone and proximal displacement of the radial shaft were the two factors, which would impair the function of the elbow and also cause persistent pain of elbow and wrist [9-11]. Speed in 1941 first proposed prosthetic replacement of the radial head [7]. Acrylic radial head prostheses were introduced but were discarded due to fractures of the prosthesis itself. Silastic prosthesis was introduced in the 1970s. It acted as a spacer only without giving any biomechanical advantage in weight transmission and also caused synovitis [12-16] The search for a stiffer material for prosthesis manufacture resulted in the use of various metals such as vitallium, stainless steel, and most recently titanium. Literature supports metallic radial head replacement as it restores the axial stiffness of the forearm to normal whereas excision allows abnormal proximal migration, especially under load [17, 18]. The complications with arthroplasty are subluxation or dislocation, painful loosening, implant impingement, and fracture of the prosthesis [19, 20]. Van Riet *et al*. [21] have showed capitellar erosion caused by metal radial head prosthesis. Van Glabbeek *et al*. [22] suggests that accurate restoration of radial length is important and that axial understuffing or overstuffing of the radio humeral joint by more than 2.5 mm alters both elbow kinematics and radio capitellar pressure.

The incidence of capitellar chondral injury is 20% in Mason types II and III according to one study [23]. There are few articles with long-term outcomes following capitellar cartilage injury. In our study, we did not have any case with capitellar chondral injury. The Essex–Lopresti lesion is an axial instability of the forearm due to the distal radioulnar joint dislocation with rupture of the interosseous ligament in association with a radial head fracture [24]. In our study, we did not have any case with Essex–Lopresti lesion.

Chen *et al*. [25] conducted a prospective randomized trial on radial head prosthesis versus open reduction and internal fixation in 45 patients with Mason type III radial head fractures between January 2004 and June 2007. The satisfaction levels according to the Broberg and Morrey

Rating Index were higher in the replacement group. The postoperative complication rate was lower in the replacement group (P<0.01).

Smets *et al*. [26] reported results from their multicenter trial using a bipolar prosthesis (Tornier Inc., Montbonnot-Saint-Martin, France) after 25.2 months of average follow-up. In this study, 13 Mason type III fractures were managed by radial head replacements. The average age was 46 years. Moro *et al*. [27] completed a retrospective study of 10 patients with Mason type III fractures treated with radial head replacements (Smith and Nephew Richards, Memphis, TN, USA) over an average of 2 years. The average age was 47 years. In our case study of 30 patients using bipolar radial head prosthesis, 24 cases were type III and 6 cases were type IV. There were 20 female and 10 male with mean age of 40 years. The follow-up was a mean age of 25 months.

Smets *et al*. [26] reported active flexion averaged 135.5°, extension deficit averaged 16.3°, active pronation averaged 79.3°, and active supination averaged 83°. Moro *et al*. [27] reported both assessments comparing the function of the injured arm with the contralateral arm. Average pronation was 78° compared to 79°, supination 69° compared to 77°, elbow flexion 140° compared to 143°, and elbow extension deficit was 8° compared to full extension on the uninjured side (P<0.05). In our study, average flexion was 140°, average extension deficit was 10°, average pronation was 75°, and average supination was 68°.

In Smets *et al*. [26] study according to MEPI Score seven had excellent, three had good, one had fair and two had poor outcomes. One patient with a poor outcome required removal of prosthesis. According Moro *et al*. [27] study six patients suffered complications, including elbow stiffness, ulnar nerve dysesthesia, varying levels of heterotopic ossification, one superficial infection and one patient developed a regional sympathetic -mediated pain syndrome. Accordingly the MEPI three patients had poor outcomes. In our study, according to MEPI score, 20 cases had excellent results, 7 cases good results, 2 cases fair results and 1 case had poor result. 28 cases had no complications, 1 case had infection and 1 case had implant failure.

Our short term results mean follow-up of 25 months looks good, but we will continue our follow-up to look for long-term results.

Conclusion

Modular radial head prosthesis can be used successfully for treatment of the Morrey Modified Masons type III and IV radial head fractures.

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