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Functional Outcome of Elbow Kinematics in Radial Head Excision Versus Radial Head Replacement: A Comparative Study

Ayush Kumar Singh*, Aswini Jidge, Ujwal Ramteke, Nivedhitha Venkateswaran, Hemlata Rokade, SM Mulje, Sunirmal Mukherjee, Abhinandan Kotian

Wrightington, Wigan and Leigh NHS Foundation Trust, Metropolitan Borough of Wigan, Greater Manchester, United Kingdom

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***Correspondence:** Ayush Kumar Singh. Wrightington, Wigan and Leigh NHS Foundation Trust, Metropolitan Borough of Wigan, Greater Manchester, United Kingdom. E-mail: ayush_kumar_singh@yahoo.co.in

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Abstract

BACKGROUND: Radial head fractures are quite common with incidence 1.5-4% of all adult fractures. The treatment for these fractures depends upon age, type of injury and whether the physics is closed or not.

AIM: Comparison between radial head excision versus radial head replacement based on mayo elbow scoring in comminuted radial head fractures.

MATERIAL AND METHODS: We did a prospective comparative study comprising 32 patients between age 22-60 years with Mason type II/III radial head fractures at Sir J.J Group of Hospitals, Mumbai. The patients were randomised using the admission day of the week placing 17 patients in the arthroplasty group and 15 patients in the excision group. The patients were followed up for 18-24 months (average 20 months) postoperatively. Results were analysed by the Mayo's elbow performance score at 6 months and 18 months and were statistically evaluated by unpaired t-test.

RESULTS: At 6 months, radial head arthroplasty gave excellent results in 2 patients, good in 5 patients and fair in 8 patients. In excision, there were 5 patients with excellent results at 6 months, 7 with good results and 2 with fair results. At 18 months, of the 17 patients who had undergone head arthroplasty, 2 had excellent results, and the same number had poor results. 7 (46.7%) of the 15 cases who had undergone radial head excision had excellent results. Good results were obtained in 7 cases of each. There was 6 cases (35.3%) of radial head arthroplasty which fell into the fair group. As per Mayo's score at 6 months follow up, mean and standard deviation (SD) of the scores in arthroplasty was 68.82 and 18.66 respectively & for excision, it was 85.66 and 10.66. At 18 months follow up, it was 75 and 14.89 for arthroplasty & 90.66 and 7.98 for excision. The difference between the results was statistically significant ($p < 0.01$).

CONCLUSION: Our study shows that long and short-term results of radial head excision are better as compared to arthroplasty in comminuted radial head fractures based on mayo elbow scoring, particularly for dominant upper limbs.

Introduction

Radial head forms one of the restraint to valgus instability of the elbow, the primary being medial collateral ligament. Fracture of the radial head causes instability of the elbow and needs to be replaced, fixed or excised as the situation demands. Multiple studies have shown that the radial head is responsible for approximately 30% of the valgus stability of the elbow. Cutler (1926), in one of the earliest comprehensive reviews, considering that direct trauma was the commonest mechanism of injury to the radial head [1]. Studies of static loading across the elbow have suggested that as much as 60% of the force is transmitted across the radio-capitellar articulation [2], [3]. Radial head excision has been in vogue for comminuted fractures throughout the years. Prosthetic replacement of the radial head was first proposed by Speed in 1941 using a ferrule cup over the neck of the radius. Since that time, the

use of acrylic, silicone, vitallium, and other metallic radial head prostheses has been reported each with varying results.

Comminuted radial head fractures are treated by radial head excision or by radial head arthroplasty. There have been contrasting results of the treatment outcome of both modalities of treatment in the literature. Our study aimed to prospectively compare the results obtained by radial head excision and arthroplasty, in comminuted fractures of the radial head.

Material and Methods

This prospective study comprising 32 patients was conducted at the Department of Orthopaedics, Grant Medical Government College, Mumbai from 2013- 2016. All the patients were between the age group of 22 - 60 years (19 male, 13 female) with an average age of 43 years. The inclusion criteria were as follows: [1] Mason's Type 3 radial head fractures [2] age of patient between 22 -60 years and [3] not more than 2 weeks delayed presentation. Patients with age < 22 years and open fractures were excluded from the study. Thirty-two patients who fitted the criteria were included in the study after obtaining written informed consent. Clinical and radiological evaluation was done in each of them. Following prospective randomisation, 17 patients were included in the excision group and 15 patients in the arthroplasty group.

The technique of Radial Head Excision

For radial head excision, the upper arm was slightly abducted, the elbow extended, and the forearm pronated on a hand table. A short lateral approach beginning at the lateral epicondyle and ending a few centimetres distal to the radial neck was used.

The interval between the anconeus and extensor carpi ulnaris was entered, and the radial collateral ligament complex was exposed [4]. A longitudinal incision was made in the anterior part of the lateral collateral ligament along its fibres extending from the lateral condyle to just distal to the radial neck through the annular ligament and capsule. The fractured radial head was excised with great care taken not to leave any fragment in the elbow joint. The radial head was reconstructed on the operation table to make sure that no fragments were left behind. The wound was closed in layers, and no drain was used.

The technique of Radial Head Arthroplasty

For implant arthroplasty, the prosthesis used was a monoblock radial head implant made of stainless steel 316 XL in four different head sizes with diameters of 14, 16, 18, and 20 mm with a stem size of 5 mm. The radial neck was reamed with reamers starting with size 3 mm with 1 mm increment until size 5 mm. The correct diameter of the radial head prosthesis was selected by comparing the excised radial head fragments and the prosthesis. The height of the prosthesis was best selected to ensure that it would have a normal articulation with the proximal radioulnar joint so that it was at the same height as the trochlear notch [10]. The implants were press-fit into the proximal part of the radius, and no cement was used. Annular ligament repair was not done. The wound was closed in layers and drain was not used routinely.

Medial collateral ligament stability was assessed by placing a valgus force on the elbow with the forearm in pronation and elbow at 30° of flexion and assessing the distance between the radial neck and the capitellum. A change in the distance between the radial neck and capitellum of > 2 mm was taken as an indication for a disruption of the anterior band of the medial collateral ligament. Instability of the elbow in the extended position indicated that the anterior and posterior parts of the capsule were also torn.

Follow Up

Active range-of-motion exercises of the elbow were started immediately after the surgery. Suture removal was done on the 12th postoperative day

The cases were followed up on a fortnightly basis in the first month, after that till the acceptable uncomplicated range of motion was regained. After that, the patient was followed up every 3 months. The results were analysed by the Mayo elbow performance score. Statistical analysis was done using UNPAIRED t TEST utilising the software Epi – Info; Version 3.5.

Biomechanical study shows that activities of daily living can be accomplished without discomfort within a functional arc of motion of elbow flexion-extension of 100°, and forearm rotation of about 100° (pronation 50° to supination 50°). The range of motion of elbow in our two study groups has been charted which shows a better range of motion in a patient with radial head replacement as compared to excision. Patients were evaluated at 6 and 18 months based on the Mayo Elbow Performance Score.

Mayo Elbow Performance Score

Part 1: Pain (VAS)

The therapist asks the patient how severe the pain is and in how frequent the pain appears. Forty-

five points are for patients who do not have pain (1), 30 points are given to patients who have mild pain (2), moderate pain results in 15 points, patients with severe pain get 0 points (3).

Part 2: Arc of motion

Patients start with there elbow completely stretched. The patients try to bend his arm. Twenty points are given when the arm reaches more than 100° flexion (1), when the angle is between 100° and 50° the therapist gives 15 points (2). When the maximum is no more than 50° 5 points are given (3).

Part 3: Stability

When the elbow is considered stable, 10 points are noted (1). A mildly unstable elbow results in 5 points (2). An unstable elbow does not receive points (3). Concerning stability, the involved elbow is evaluated for valgus, varus and posterolateral rotatory instability

Part 4: ADL

Based on 5 ADL's who are each given 5 points an image is sketched how well the patient can participate in daily life. The activities are combing your hair (A), performing personal hygiene (B), eating (C) and putting on the shirt (D)and shoes (E).

Total Score: < 60 – poor; 60-74 – fair; 75-89 – good; 90-100 – excellent.

The difference between the mean score at 6 months and 18 months between Excision and arthroplasty procedure is statistically significant ($p < 0.01$).

Results

Radial head excision is a better surgical option for radial head fracture management as compared to arthroplasty. The difference between the mean score at 6 months and 18 months between Excision and arthroplasty procedure is statistically significant ($p < 0.01$). The patients ranged from 22 years to 60 years (average 35 years) and the most frequent age group affected was 31-40 years. Twenty-one fractures were on the right side. Out of all the cases, 2 had a medial collateral ligament injury by intraoperative assessment. The mode of injury in all cases is described in the table. The average interval between the injury and surgery was 7 days. Patients were followed up for a period ranging from 18-24 months (average 20 months).

At 6 months, radial head arthroplasty gave excellent results in 2 patients, good in 5 patients and fair in 8 patients. In excision, there were 5 patients with excellent results at 6 months, 7 with good results and 2 with fair results.

Table 1: Mayo Score of Patients

S.no	Age/ Sex	Mode of Trauma	Surgery	Visual Analogue Scale 6 /18 month	Arc of Motion 6 /18 month	Stability 6 /18 month	Activities of Daily Living 6 /18 month	Total score at 6 /18 month
1	23/F	fall	Arthroplasty	1/1	2/1	1/1	ABCDE	95/100
2	45/F	RTA	Arthroplasty	2/2	2 /2	1/1	ABC	70/70
3	34/M	fall	Excision	1/1	1/1	1/1	ABCDE	100/100
4	28/F	fall	Excision	1/1	2/1	1/1	ABD/ABCD	85/95
5	26/M	RTA	Excision	2/2	2/1	2/2	ABDE/ABCDE	70/80
6	52/M	Assault	Excision	2/2	1/1	1/1	BCD/ABCDE	70/80
7	59/F	fall	Excision	2/2	1/1	1/1	BCDE	80/80
8	38/F	Assault	Excision	2/1	1/1	1/1	ABCDE	85/100
9	27/M	Assault	Arthroplasty	3/3	2/2	2/1	BCD	50/55
10	41/M	fall	Arthroplasty	1/1	2/1	1/1	ABCD/ABCDE	90/100
11	65/M	RTA	Arthroplasty	2/2	2/1	1/1	BCDE	75/80
12	28/M	Fall	Arthroplasty	2/2	2/1	1/1	ABCDE	80/85
13	65/M	RTA	Arthroplasty	3/3	3/2	2/2	B/AB	15/45
14	68/F	Assault	Arthroplasty	2/2	1/1	1/1	ABCDE	85/85
15	24/M	Fall	Excision	3/3	2/2	1/1	BD/BDE	50/55
16	29/M	Fall	Arthroplasty	2/1	1/1	2/2	BCD	70/85
17	33/M	Fall	Arthroplasty	2/2	2/1	2/1	ABC/ABCD	65/80
18	35/F	RTA	Excision	1/1	2/1	1/1	ABCDE	95/100
19	49/F	Fall	Arthroplasty	1/1	2/2	2/2	ABCD	85/85
20	54/M	Fall	Arthroplasty	2/2	2/1	3/2	ABC	60/70
21	68/F	RTA	Excision	2/2	1/1	1/1	ABCDE	85/85
22	22/M	Fall	Excision	2/2	1/1	1/1	ABCD/ABCDE	80/85
23	45/M	Assault	Arthroplasty	2/2	2/2	1/1	BCD	70/70
24	70/F	Assault	Excision	1/1	2/2	1/1	ABC	85/85
25	65/M	RTA	Excision	1/1	1/1	1/1	ABCDE	100/100
26	57/M	RTA	Arthroplasty	2/2	2/1	1/1	ABCD/ABCDE	75/85
27	68/F	RTA	Excision	1/1	1/1	2/2	ABCDE	95/95
28	41/M	Fall	Arthroplasty	2/2	2/2	2/2	BCD	70/70
29	34/M	Fall	Excision	1/1	2/2	1/1	BCD	85/85
30	25/M	Fall	Arthroplasty	1/1	3/2	1/1	B/BD	65/70
31	35/F	Fall	Arthroplasty	2/2	2/2	1/1	ACD	70/70
32	36/F	Fall	Excision	1/1	1/1	1/1	ABCDE	100/100

At 18 months, of the 17 patients who had undergone head arthroplasty, 2 had excellent results, and the same number had poor results. Seven (46.7%) of the 15 cases who had undergone radial head excision had excellent results. Good results were obtained in 7 cases of each. There was 6 cases (35.3%) of radial head arthroplasty, which fell into the fair group.

Table 2: Mean Mayo scores of excision and arthroplasty at 6 and 18 months

Months		Excision	Arthroplasty	P Value
6 Months	Mean	68.82	85.66	< 0.01*
	SD	18.66	10.66	
18 Months	Mean	75	90.66	< 0.01*
	SD	14.89	7.98	

Unpaired t-test

Pain, which was moderate to severe, was present in 2 out of 17 cases of radial head Arthroplasty and 1 out of 17 cases of excision. There was no nerve palsy in any of the patients pre-operatively. Posterior interosseous nerve palsy occurred in one patient who had undergone a radial head arthroplasty which recovered after 7 months of follow-up. Elbow stiffness occurred in 2 cases of arthroplasty and none in excision patients. Severe elbow instability resulted in 1 patient of the arthroplasty group at 6 months. None of the patients in the excision group had an ulna plus deformity on follow-up. One out of 32 operated patients had a post-operative infection of the wound which was kept on

daily dressing and under higher antibiotic coverage, which resolved uneventfully in 2 weeks.

Discussion

The management of comminuted Mason type III radial head fractures with associated ligament disruption remains controversial. Several surgical options have been advocated for these complex injuries, including ORIF, excision of the radial head and radial head replacement. Anatomically, the proximal radial epiphysis is contained wholly within the joint capsule. When the skeleton is immature, very few blood vessels cross the physis. The vascular supply to the proximal radial epiphysis is limited to a few small intraarticular vessels coursing along the radial neck and a few intraosseous vessels, resulting in a scanty vascular supply to the radial head. Yamaguchi also observed that the radial head was supplied primarily by intraosseous vessels. One vessel supplies the radial head directly, entering through the nonarticular anterolateral surface.

Consequently, a fracture of the radial head is likely to disrupt its vascular supply. Also, ORIF of a comminuted radial head is often technically difficult. Therefore, ORIF is not reliable for comminuted fractures because of possible osteonecrosis, nonunion, or displaced fragments. According to Ikeda et al., [4], although radial head excision is associated with wrist and forearm pain, and elbow instability, these complications are not considered to be serious if they do not hamper joint mobility. According to Herbertsson et al., [9], radial head excision leads to a good or fair result. Ashwood et al., [5], [6] treated Mason Type 3 radial head fractures using a monoblock titanium prosthesis with satisfactory outcomes. 50% of their patients had an excellent result, and 31% had a good result. Nine of the 25 cases of radial head arthroplasty performed by Moro et al., [7], good or excellent results were obtained in 17 cases [68%]. According to these authors, there is a mild to moderate physical impairment of elbow and wrist in a short-term follow-up after arthroplasty with a metal radial head implant. Josefsson et al., [8] revealed that excision of the radial head might lead to stiffness, weakness and pain. Replacement is also indicated in patients with comminuted radial head fractures that have or are likely to have a disruption of the medial collateral, lateral collateral, or interosseous ligaments. In patients with non-united radial head fractures, articular injury to the capitellum and radial notch of the ulna may occur and lead to elbow arthrosis. Prosthesis replacement can better restore the stability, flexion and extension of the elbow, and the rotational motion of the forearm [9]. In our current experience in this study, we found that radial head excision is preferred method for radial head fracture as it is due to the better functional outcome on long term periods as evident from Mayo Performance Elbow score.

In conclusion, radial head excision is a better surgical option for radial head fracture management as compared to arthroplasty, and in the present Indian scenario, radial head arthroplasty seems difficult due to the unavailability of accurate sized implants and the affordability issues of imported radial head implants available abroad.

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