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A clinico-radiological study of radial head replacement vs excision in comminuted radial head fractures

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Abstract

Introduction: Treatment options for intra-articulation region dislodgement and angulation that cannot be operated easily have not been well characterized. Similarly, there is no consensus on how to treat fractures of Mason types III and IV.

Material and Methods: SPSS, Microsoft excel and Statkingdom soft wares were used for calculating the p-values and t-values in the experimental analysis.

Theory: More than three pieces have been observed to lead to worse fixation outcomes and an increased risk of complications. Patients with complicated elbow injuries are recommended to have radial head arthroplasty, which aims to recreate the native head.

Results: The p-value and the t-test values of the prosthetic treatment of the radial bone group are more significant than the head excision of the radial bone group.

Conclusion: The patients in the head region radial bone prosthetics replacement group fared better in terms of function after 1, 6, and 12 months after surgery, compared to those in a head excision of radial bone group.

Keywords: Mason-type injury, head excision, excision and elbow injury

Introduction

Only 3% of all broken bones [1, 2] occur at the radial head, but 33% of adult elbow fractures [1]. Women and patients in the middle years of life are disproportionately affected by this damage [3]. Falling onto a pronated hand causes an axial stress over the elbow, which is the common mechanism of damage. Mason first categorized these fractures [1], but Broberg and Morrey updated his system to account for movement and size [4].

Anatomical perspective of the bone injury

The capitellum and the proximal ulna are the two bones with which the radial head makes contact. Anatomical research has shown that the human head is not spherical and has a non-zero offset [5]. The radiocapitellar joint has articular cartilage on its convex radial surface. Thicker hyaline cartilage covers the 280-degree orientation of the outside surface periphery of the skull, which expresses depression in the sigmoidal region, whereas thinner cartilage covers the non-articulating arc [6, 7]. Metalwork may be safely placed without risk of impingement or limitation of forearm rotation if the nonarticular area is properly identified with marking of the middle anterior-posterior region of the radial bone head region while in neutral pose, extension and relaxation of the arm on the upper and lower side. This allows [8] using the styloid protuberance present towards the radial side end of the bone and Lister's tubercle [6] or marking an arc which measures about 110-degree from 65 degrees in the anterior direction to 45 degrees posterolaterally with the arm in unbiased rotation [6, 8, 9] are all described as ways to locate this safe zone. Only one extraosseous vessel supplies the radial head, and this vessel usually enters through the bare area [10].

Different Types of elbow fractures

Radial head fractures may be broken down into a variety of categories. Mason classified fractures as Type I if they were fissures or end surface sector fractures.

It is called as Type II if they ended margination sector fractures with dislocation of the bones, and Type III Mason type fractures if they were comminuted fractures of the whole skull. Any elbow dislocation accompanied by a radial head fracture is now classified as a Type IV injury. The Broberg and the researcher's Morrey refinement of the Mason categorization is the most often used systematization Dislocation in the covering range of 2 mm, and the inclusion of a maximum of thirty per cent of the protuberance of articulating surface characterizes a Type I injury or bone fracture. Displacement exceeding 2 mm and involvement of over thirty per cent of the joint surface characterize a Type II fracture. Comminuted fractures of the third kind. For injuries to the elbow and forearm that occur simultaneously, Van appended a suffix to the original altered Mason classification to account for the Mayo-Mason classification.

Table 1 below shows the different types of the Mason type bone fractures as given below in the table:

Table 1: Mason classification

Mason type	Characteristic attributes of bone fractures
Type I	Fracture of a bone region on the side margins, which is not displaced Displacement of 2 mm inside the joint
Type II	A segmental fracture with dislocation Removal within the joint more than 2 mm or angulation
Type III	Fracture with comminution

Materials and Methods

The randomized controlled study was conducted in the Post Graduate Department of Orthopaedics, Govt. Hospital for Bone and Joint Surgery, an associated hospital of Govt. Medical College Srinagar from June 2020 to Jan 2023, following institutional ethical committee approval. A total of 50 cases of comminuted fractures of the radial head were clinically radiologically evaluated during the study, 25 radial head replacements vs 25 radial head excisions were followed up at one month, six months, and final follow till 12 months.

Inclusion criteria

Skeletally mature patient (Aged 20 years above and below 60 years) with Mason's III type and IV type fractures of the head region of the radial bone, which is Morrey Modified according to the injury or fracture.

Exclusion criteria

- Morrey modified Mason's type-I and Type-II fractures of the radial head.
- Fracture duration of more than four weeks
- Open fractures.
- Pathological Fractures.
- Associated Neurovascular Injury.
- Presence of any infection.
- Previous ipsilateral elbow injuries.

Scoring system interpretation

The manual goniometer was used to measure a range of motion. The grip strength of the participants was measured using a hydraulic hand-jamming dynamometer. Radiographs and physical examinations were used to determine the degree of elbow stability in the joint. The Mayo Elbow Performance Index (MEPI) [16, 17] was used to evaluate the functioning of the elbow. DASH is a questionnaire used to evaluate the condition of an injury to the Arm, Shoulder region, and Hand impairment injury [18, 19].

Results and Analysis

In the current study, various patients were examined in the Government Hospital of Jammu and Kashmir for various types of Mason bone injuries. Further, a study was conducted for 25 radial head replacements vs 25 radial head excisions that were followed up after one month, six months and a final examination after 12 months of surgical procedure. Various patients in the age group of 20 years- 60 years were included in this study. Further, the tabular results were classified according to the Mason injury caused to the patient due to a road accident or due to a fall. Table 1 elaborates the nomenclature system as deciphered by Mason with X-ray images (Figur 1). Table 2 gives the number of patients who suffered from road accident and fall leading to Mason injuries in hand and legs. Table 3 mentions the number of patients suffering from type III and type IV Mason injury.

Further, the hypothesis was tested for the surgery performed by the excision of the head region of the radial bone and by the replacement prosthetic procedure of the head region of the radial bone. The initial hypothesis H_o is that there is no negative outcome between the surgery performed on the two participant groups by the method of surgical radial head excision and radial head replacement by the prosthetic process. The hypothesis H_1 is that there is a negative outcome between the two surgical procedures of excision of the head of the radial bone and prosthetic replacement of the head region of the radial bone. The comparison between the outcome measures for the two groups of the patients on which the surgery was performed with p-value analysis is given in table 4.

Table 2: Distribution of patients on the basis of injury mechanism

Cause of Injury	Number of patients	Percentage
Injury due to fall	15	60
Accident injury on the road	18	72
Total	33	66

Table 3: Distribution of patients on the basis of injury type

Injury type inpatient	Number of patients injured	Percentage
Mason type III	14	42.42
Mason type IV	5	15.15

As indicated in Table 2, 60% of the patients suffered from fall injuries, and 72% of the patients suffered from road injury accidents. As indicated in Table 3, in the current study, about 42.42% of the patients suffered from Mason type III injury, and 15.15% of the patients suffered from Mason type IV injury. The other types of injuries were excluded in this study.

Figure images

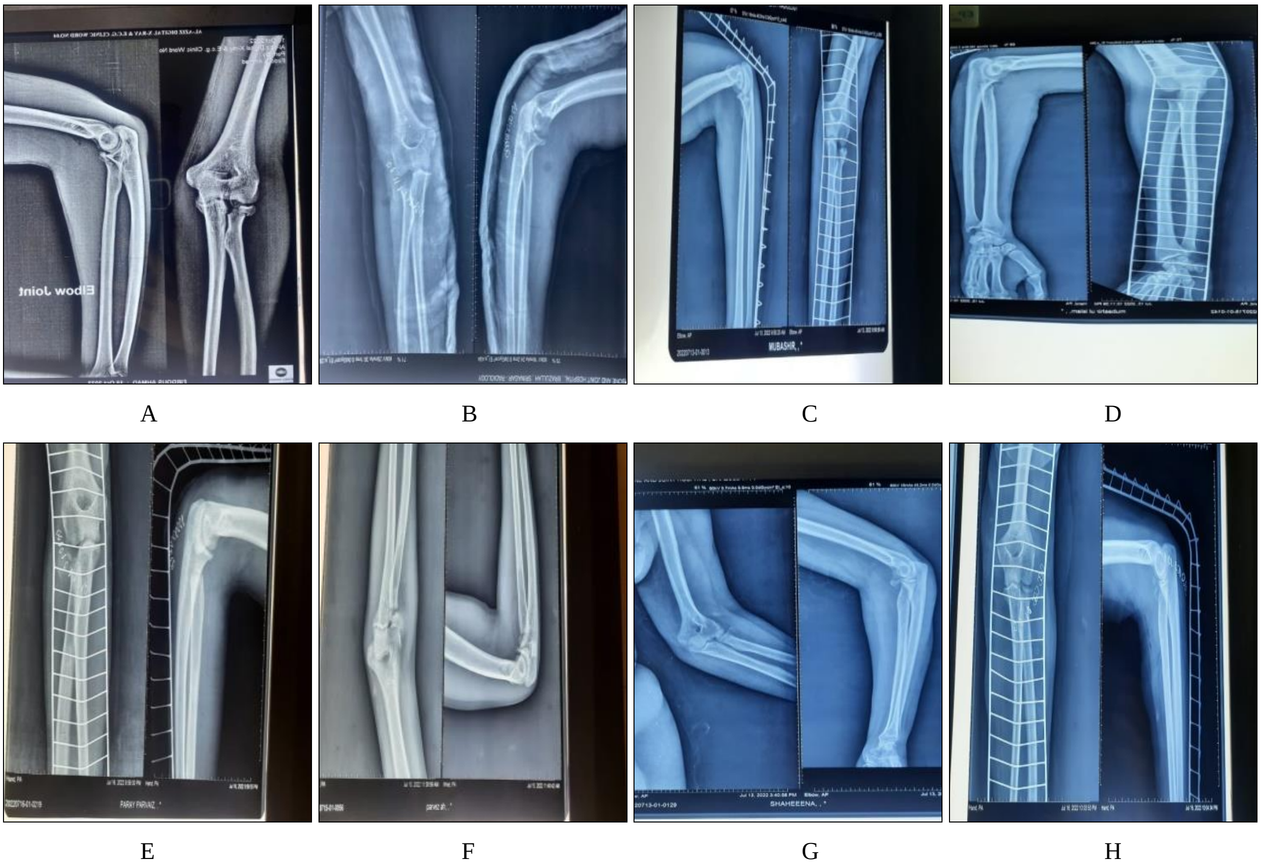

Fig 1: (A) Lateral projection and Anterior-posterior projection of type-III injury, (B) Image projection of Mason III injury, (C) Image projection of Mason's injuury, (D) Hand image projection of Mason III's injury, (E) Projection of Mason's injury during surgery, (F) Projection of bone Mason's injury, (G) View of Mason's injury in the bone of patient and (H) View of Mason injury in patient during surgical treatment

Dash scaling analysis

There are 30 questions on the Disability of the arm, shoulder and hand regions (DASH) questionnaire that assess a patient's capacity to use their arms, shoulders, and hands. Patients may rank the degree of difficulties and interference with their everyday lives using a 5-point Likert scale in this self-reporting survey. As an accurate and trustworthy survey for a range of upper extremity disorders, the DASH has already been translated into a plethora of languages.

Here is the Dash questionnaire that you can fill out

1. Getting a fresh jar open. 2. Putting pen to paper. 3. Activating a switch Cooking four courses 5 Forcefully opening a thick door; DOIng a lot of hard housework; putting something on a shelf over your head; Eighth: Working in a garden or yard Ninth: Setting the table. Ten. Bringing along a briefcase or shopping bag 11. Lifting more than 5 kilogrammes (10.5 pounds) 12. Changing an overhead light bulb 13. Hair care routines with water Easy-peasy leisure activities include 14 washing the back, 15 putting on a pullover jumper, 16 chopping food with a knife and 17 relaxing without much exertion. 18 Leisure pursuits that include absorbing blows to the arm, shoulder, or hand a 19 Free-range arm movements required for recreation 20. Organizing travel (going from point A to point B) 21. Having sexual encounters 22. Recreational pursuits 23. A Day in the Life: Work and Other Routines 24. Pain during engagement in any activity 25. Activity-Related Pain 26. Tingling sensation 27. Weakness, 28.Rigidity 29. Sleep disturbances. 30. Negative effects on self-esteem.

The DASH analysis score value reveals the analysis of the group of participants mental views that whether they agree, partially agree, or do not agree with the questionnaires asked to them based on the scaling system as follows like No difficulty=1, Mild difficulty=2 moderate difficulty=3 Severe difficulty=4. Unable=5 on the intensity scale. The DASH Scoring Formula = ([(sum of n responses)/n] -1) x 25, where n represents the number of completed items. Based on the questionnaire survey amongst the group of patients, a DASH score of 76.7 / 100 was obtained (source: “OrthoToolKit,” orthotoolkit.com. https://orthotoolkit.com/dash/)

Mayo Elbow performance score analysis

The Mayo elbow performance score analysis gives an indication of the intensity of pain exhibited, the amount of movement or the motion range, and the stability of the body mentioned on the MEPS scale:

The Mayo elbow performance score was calculated to be 50/100 amongst the group of patients being examined in the current study.

Table 4: Patients without any negative outcome

Parameters	Number of patients/total patients, percentage	Total patients, total percentage	P-value
Radial head excision process	8/25, 32%	50, 100%	0.002**
Radial head replacement prosthetic process	17/25, 56%		
Group of patients having a negative outcome after surgery	Number of patients/total patients, percentage	Total patients, total percentage	
Radial head excision process	8/25, 50%	50, 20%	
Radial-head replacement prosthetic process	2/25, 12.5%		

** Highly Statistical Significance at P with values lesser than 0.01.

Table 4 results indicate that the p-value is significant, so there is an impact of the negative outcome on the surgical procedures performed. The tabular results indicate that the negative outcome is less in the radial bone head replacement prosthetic surgical procedure than in the radial bone head excision process surgery.

Table 5: Consists of the outcome of the two surgical procedures of radial head excision and radial head replacement during a time interval of 1 month, 6 months and 12 months in a follow-up pattern.

Table 5: First group of participants undergoing the head excision surgery of the radial bone with a follow-up of 1 month, 6 months and 12 months with analysis of Mayo elbow performance score.

Parameters	Max points available	After 1 month of surgery	After 6 months of surgery	After 12 months of surgery
Pain intensity	45	17.86	30.90	36.26
Range of motion or mobility	20	19.24	19.26	19.56
Stabilization	10	8.64	8.54	8.76
Functional Analysis	25	18.34	20.12	22.71
Total point Mayo score	100	64.08	78.82	87.29
Analysis factor		Fair	Good	Excellent

Table 6: Second group of participants undergoing the replacement prosthetic surgery of head region of the radial bone with a follow-up of 1 month, 6 months and 12 months with the calculation of Mayo elbow performance score

Parameters	Max points available	After 1 month of surgery	After 6 months of surgery	After 12 months of surgery
Pain intensity	45	19.56	32.87	41.34
Range of motion or mobility	20	19.98	19.85	19.97
Stabilization	10	9.95	9.87	9.92
Functional Analysis	25	20.13	21.36	25.34
Total point Mayo score	100	69.62	83.95	96.57
Analysis factor		Fair	Good	Excellent

Table 7: Further 2-level t-test was performed for the functional ability of the patients who underwent excision surgery of the head region of radial bone and replacement prosthetic surgery of the head region of radial bone after 1 month, 6 months and 12 months (25 patients in surgical excision group and 25 patients in head replacement surgery group).

Groups		N	Mean calculation value	Standard Deviation calculation value	t-value calculation	p-value calculation value
1 month after surgery	Head surgical excision	25	18.52	4.56	0.176	1.436
	Head replacement surgery	25	20.01	0.01		
6 months after surgery	Head surgical excision	25	20.34	5.53	0.473	0.734
	Head replacement surgery	25	21.23	2.23		
12 months after surgery	Head surgical excision	25	22.87	2.45	2.671	0.014
	Head replacement surgery	25	24.61	1.29		

Significance values based on values lesser than 0.05.

Based on the results given in Table 7, the two-sided t-test is significant for the head replacement group of patients after 6 months of treatment with a p-value of 0.014 in comparison to the head excision group of patients after 6 months of treatment.

Discussion

Because of the head's significance in the radial bone in elbow movement and function, its fixation and repair after injury have garnered a lot of attention [19]. Complicated multiple injuries, involvement of a considerable amount of the surface of the articular cartilage, mechanical obstruction, lack of flexible bodies, and the presence of different types of elbow injuries are some of the identified reasons for surgical intervention. According to previous authors, surgical therapy is likely more crucial for instability than displacement [28]. However, there are risks associated with surgical intervention, including infection, radiocapitellar arthritis, elbow stiffness, and damage to the posterior interosseous nerve (PIN). Both the interval of Kocher and the Kaplan interval are often used to get surgical exposure. Depending on where you rest your arm, the average distance between the radiocapitellar joint for the proximal ulnar nerve (PIN) is anywhere from 40mm to 48mm. Protecting the nerve from damage during surgery is facilitated by keeping the forearm in a pronated position [31].

Fractures to the radial head are rather common, making up between 1.5% and 4% of all breaks [21, 22]. They occur most often around the elbow (33%). Radial head excision was the standard procedure for simultaneously treating Mason type 3 injuries. A substantial complication rate is associated with reconstructing the radial bone's head region utilizing reduction of the fracture and internal fixes [23-26]. Treatment of the head fractures of the radial bone using a prosthetic has grown in favour in recent years. Replacement operation is recommended for individuals with non-constructible radial head fracture and other elbow ligament injuries that need the radial head's secondary stabilizing role [27]. Head excision of the radial bone offers rapid stabilization with promising effects by using metal spacers to restore elbow articulation. Long-term outcomes and durability of prostheses become crucial issues after implantation due to the high incidence of accidents and young age at surgery among the youthful and active population.

Inference

Compared to the radial head excision group, those with radial heads replaced with prosthetics had greater elbow stability, more patient conformity, fewer problems, and faster returns to work.

Conclusion

A number of variables, including the kind of fracture and related injuries, radial head prosthetic substitutes would be preferable to radial head excision because it allows for a faster recovery, greater elbow stability, fewer complications, and greater capacity to perform daily tasks.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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