Retrospective Study

RADIAL HEAD PROSTHESIS IN THE TREATMENT OF COMPLEX, NON-REDUCIBLE RADIAL HEAD FRACTURES: A RETROSPECTIVE STUDY

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ABSTRACT

Radial head is an important secondary stabilizer of the elbow and it’s essential for the stability in the axial load, valgus and external rotations. Radial head prosthesis is a surgical option that can be used for displaced radial head fractures. This retrospective study evaluated the efficacy of radial head prosthesis in treating complex, non-reducible radial head fractures (Mason III-IV). Twenty-six patients were included. Functional outcomes were assessed using the Mayo Elbow Performance Score (MEPS), Oxford Elbow Score (OES), and Disabilities of the Arm, Shoulder, and Hand (DASH) at 3, 6, and 12-months post-surgery. Results demonstrated a significant improvement in functional scores over time, with a mean MEPS at 12 months of 73.85. Subgroup analysis revealed a correlation between the presence of associated ligamentous injuries and poorer functional outcomes. Radial head prosthesis proved to be an effective treatment, offering good functional recovery. However, the retrospective nature of the study, and limited sample size necessitate further prospective studies.

KEYWORDS: *radial head fracture, radial head prosthesis, Mayo Elbow Performance Score, Oxford Elbow Score, disabilities of the arm, shoulder, hand*

INTRODUCTION

Elbow is a complex articulation composed of three different articulations covered in a single articular capsule: humeroulnar, humeroradial, and proximal radioulnar joint. Radial head is an important secondary stabilizer of the elbow and it’s essential for the stability in the axial load, valgus, and external rotations (1). Radial head and neck fractures are estimated to be one third of all elbow fractures (2). They have an incidence varying between 1.7 and 5% with an average of 2.7% (3). The mechanism of fracture is identified in an indirect trauma to the elbow with the limb in slight flexion and semi-pronation. The capitellum hits against the capitulum humeri causing the fracture. They are often associated with ligamentous injuries and consequent elbow instability. Those fractures have been classified by Mason in IV different types depending on the fracture pattern and the grade of displacement (4). Ligamentous and capsular lesions are estimated to be 4% in Mason I fractures, 21% in Mason II and 85% in Mason III fractures (5).

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Complex, non-reducible and displaced radial head fractures (Mason IV) represent a significant challenge for orthopedic surgeons. Regardless of the fracture, the main goal of every treatment is to restore elbow stability, maintain the right length of the radius and achieve a good range of motion. Traditional treatments, such as open reduction and internal fixation (ORIF), often have limitations in those complex fractures that often have comminution or bone loss. Recently, radial head prosthesis has emerged as a viable alternative in those cases (6). Short- and mid-term follow-up studies have demonstrated the longevity and efficacy of radial head arthroplasty (RHA) (7). They have been developed to decrease complications following a radial head resection surgery.

The main function of the RHA is to simulate the physiological radio capitellar tracking, reproducing the mechanical function of the native radial head (8). This study aims to evaluate the efficacy of RHA in restoring function and improving quality of life in patients with these complex radial head fractures.

MATERIALS AND METHODS

We designed an observational retrospective study conducted on 26 patients who underwent radial head prosthesis between 2019 and 2023 at the Orthopedics and Traumatology Unit of Policlinico Hospital in Bari. Inclusion criteria were age greater than 18 years, comminuted and displaced radial head fractures (Mason III and IV), absence of neurovascular injuries and/or previous elbow traumatic lesions. The exclusion criteria were patients with age >75 years old, Mason type I and II fractures, and arthritic diseases.

Pre-operative elbow X-rays in two projections and CT scans were taken to classify the fracture with the Mason classification and choose the RHA treatment. All patients gave their consent to be included in this study. All procedures were performed in supine position via Kocher approach or via direct posterior approach to the elbow depending on the fracture pattern (Fig. 1).

Fig. 1. *Pre- and post-operative images of a male, 62 years old. Radial head Mason III fracture associated with an olecranon and coronoid fracture. The patient underwent surgery four days after trauma. A direct posterior approach to the elbow was performed. An ORIF of the olecranon and coronoid fracture with two plates was executed first, then a RHA was implanted with a reinsertion of the lateral ulnar collateral ligament with an anchor.*

A radial neck osteotomy was performed, and a straight, unipolar, modular radial head prosthesis was implanted (The Evolve Proline, Wright Medical Technology, Memphis, TN, USA). Patient demographics, fracture characteristics, and associated injuries were recorded. Functional outcomes were assessed using the Mayo Elbow Performance Score (MEPS), OES, and Shoulder and Hand (DASH) scores at regular intervals (three, six- and twelve-month follow-up). Poor functional results are associated with a total MEPS score lower than 60 or between 60 and 74 points.

Good results are associated with a MEPS score between 75-89 points; complete recovery of the elbow is observed for patients who reach a MEPS score higher than 90 points. An OES score of 48 or higher indicates a good clinical and functional post-operative outcome (9).

The DASH questionnaire is a subjective, district-specific assessment tool investigating the persistence or onset of disability related to upper limb function. It consists of approximately 30 questions related to symptoms or signs of disability with a score ranging from 0 (absence of disability) to 100 points.

RESULTS

Twenty-six patients were included in the study, nine men and seventeen women, with a mean age of 56. The fracture involved the dominant limb in 21 patients. 5 were Mason III type, 18 were Mason IV type. Nineteen patients had ligamentous injury associated with the fracture. All patients were treated at our trauma unit by a senior surgeon. The mean DASH, MEPS and OES scores are shown in Tables I, II and III. At the first follow-up 3 months after surgery, the analysis of the questionnaires administered to the patients revealed the following mean scores: mean MEPS 62.12 (between 40 and 75); mean OES 25.88 (between 14 and 35); mean DASH score 66.73 (between 30 and 90).

Table I. *MEPS, OES and DASH scores in patients divided by ligamentous injuries.*

	Media Legamen. SI	Diff. %	Media Legamen. NO	Diff. %	Diff. Legamento Si / No
MEPS 3 mesi	60,26		67,14		-10,25%
MEPS 6 mesi	65,53	8,04%	77,14	12,96%	-15,05%
MEPS 12 mesi	70,79	7,43%	82,14	6,09%	-13,82%
OES 3 mesi	24,74		29		-14,69%
OES 6 mesi	29	14,69%	33,57	13,61%	-13,61%
OES 12 mesi	32,05	9,52%	36,86	8,93%	-13,05%
DASH 3 mesi	70,53		56,43		24,99%
DASH 6 mesi	63,16	-11,67%	44,29	-27,41%	42,61%
DASH 12 mesi	56,84	-11,12%	37,14	-19,25%	53,04%

Table II. *MEPS, OES, and DASH scores in patients are divided by age.*

	Media > 55 anni	Diff. %	Media < 55 anni	Diff. %	Diff. età > o < 55
MEPS 3 mesi	58,33		67,27		-13,29%
MEPS 6 mesi	65,67	11,18%	72,73	7,51%	-9,71%
MEPS 12 mesi	72	8,79%	76,36	4,75%	-5,71%
OES 3 mesi	24,4		27,91		-12,58%
OES 6 mesi	28,4	14,08%	32,73	14,73%	-13,23%
OES 12 mesi	31,47	9,76%	35,91	8,86%	-12,36%
DASH 3 mesi	70,67		61,36		15,17%
DASH 6 mesi	61,33	-15,23%	53,64	-14,39%	14,34%
DASH 12 mesi	53,33	-15,00%	49,09	-9,27%	8,64%

Table III. *MEPS, OES, and DASH scores in patients are divided by dominant limb.*

	Media Arto Dom. SI	Diff. %	Media Arto Dom. NO	Diff. %	Diff. arto dominante Si / No
MEPS 3 mesi	61,19		66		4,81%
MEPS 6 mesi	67,86	9,83%	72	8,33%	4,14%
MEPS 12 mesi	72,86	6,86%	78	7,69%	5,14%
OES 3 mesi	25,57		27,2		1,63%
OES 6 mesi	29,76	14,08%	32,2	15,53%	2,44%
OES 12 mesi	32,86	9,43%	35,4	9,04%	2,54%
DASH 3 mesi	65,95		70		4,05%
DASH 6 mesi	57,38	-14,94%	61	-14,75%	3,62%
DASH 12 mesi	51,9	-10,56%	50	-22,00%	-1,90%

At the second follow-up at six months: mean MEPS 68.65 (between 45 and 90; increase of 9.51%); mean OES 30.23 (between 16 and 40; increase of 14.39%); mean DASH score 58.08 (between 20 and 85; decrease of 14.89%).

Finally, at the last follow-up at one year: mean MEPS 73.85 (between 45 and 95; increase of 7.04%); Average OES 33.35 (between 17 and 45; increase of 9.36%); average DASH score 51.54 (between 20 and 85; decrease of 12.69%).

The patients were divided into two groups based on the presence or absence of ligament lesions (Table I). The mean MEPS recorded at 3, 6 and 12 months in patients with ligament lesions were 60.26, 65.53 and 70.79 respectively. In patients without lesions, the mean MEPS were 67.14, 77.14, and 82.14, respectively. The mean OES in patients with injury at 3, 6, and 12 months was 24.74, 29, 32.05 respectively; in patients without injury, it was 29, 33.57, and 36.86

respectively. The mean DASH score at 3, 6 and 12 in patients with injury was 70.53, 63.16 and 56.84 respectively; while in patients without ligament injury it was 56.43, 44.29 and 37.14 respectively.

Further dividing the patients into two groups based on age (15 patients >55 years and 11 patients <55 years) (Table II), an average MEPS at 3, 6 and 12 months in patients >55 years of 58.33, 65.67 and 72 can be recorded, respectively; while in patients <55 years of 67.27, 72.73 and 76.36 respectively. The average OES in patients >55 years of age at 3, 6, and 12 months was 24.4, 28.4, 31.47, respectively; while in patients <55 years of age was 27.91, 32.73, and 35.91, respectively. Average DASH score at 3, 6, and 12 in patients >55 years of age was 70.67, 61.33, and 53.33 respectively; while in patients <55 years of age was 61.36, 53.64, and 49.09 respectively. The results demonstrated a significant improvement in functional outcomes over time, with patients experiencing a mean recovery of over 70% at 12 months based on the MEPS. Subgroup analysis revealed that patients with associated ligamentous injuries had poorer functional outcomes.

Lastly, Table III divides patients into two groups based on whether the dominant limb was affected or not (21 patients with fracture had the dominant limb involved and 5 patients had the non-dominant limb involved): an average MEPS at 3, 6 and 12 months can be recorded in patients with injury to the dominant limb of 61.19, 67.86 and 72.86 respectively; while in patients without injury to the dominant limb it is 66, 72 and 78 respectively. The average OES is found to be 25.57, 29.76, 32.86 in patients with fracture of the dominant limb at 3, 6, and 12 months, respectively; while in patients with a lesion in the non-dominant limb, respectively, 27.2, 32.2, and 35.4. Mean DASH score at 3, 6 and 12 in patients with a fracture of the dominant limb, respectively, 65.95, 57.38 and 51.9; while in patients with a lesion in the non-dominant limb, respectively, 70, 61 and 50.

DISCUSSION

Our study highlighted an average MEPS score of 73.8% at one year, an OES of 33.35 and a DASH score of 51.54. Those findings align with previous research, supporting the efficacy of radial head prosthesis in treating complex, non-reducible fractures. The procedure offers a reliable solution for restoring joint stability and function.

Findings indicated successful healing, demonstrating favorable mid-term survival rates upon radiological evaluation and functional scoring. According to Ring et al., radial fractures with more than three fragments need a treatment with radial prosthesis or excision (10). Their studies demonstrated that a radial synthesis led to unsatisfactory outcomes in 54% of patients. A recent meta-analysis confirms that RHA has superior results compared to ORIF for Mason type III and IV fractures (11). 12. Flinkkilä et al. analyzed outcomes of 45 patients operated on radial head prosthesis following complex elbow trauma in their clinic. Over thirteen years, the final follow-up reported a mean MEPS score of 92.6 ± 10. The authors conclude that prosthetic replacement was an excellent choice for functional results for complex fractures that cannot be treated with ORIF (12).

Beingessner et al. concluded that RHA for comminuted fractures is not repairable with the traditional ORIF technique, which has provided excellent functional results over time (13). Moreover, from a vascular point of view, the radial head is contained inside the articular capsule. The vascularization depends on a series of intraosseous vessels that run vertically from the neck of the radius (14). Consequently, Mason type III and IV fractures, even a successful osteosynthesis can result in complications such as osteonecrosis of the fragments, pseudoarthrosis, mobilization or failure of the hardware generating a stiff, unstable, or painful elbow.

The presence of associated ligamentous injuries can negatively impact outcomes of radial head replacement, highlighting the importance of a comprehensive preoperative assessment and individualized treatment plans. Furthermore, RHA can be challenging and must be performed by a dedicated specialized team. Selecting the correct length and head diameter can be difficult for the surgeon without experience or practice in this field (15).

The presented paper has some limitations: firstly, it is a study with a retrospective design, and secondly, we have a relatively small sample size; furthermore, there is no comparative group with patients treated with open reduction and internal fixation of the radial head. Therefore, future prospective studies with larger cohorts are needed to confirm these findings further.

It would be interesting to evaluate the activity of alkaline and acid phosphatases around fractures, as already demonstrated around titanium implants. Previous studies have highlighted that alkaline phosphatase (ALP) plays a crucial role in the bone mineralization process, while acid phosphatase (ACP) is involved in bone resorption (16, 17). A histochemical analysis of ALP and ACP activities could provide valuable insights into the bone healing and remodeling processes at fracture sites.

CONCLUSIONS

In conclusion, treating radial head fractures continues to spread debate among orthopedic surgeons. Based on the results reported in this paper, we believe that radial head prosthesis is a valuable treatment option for complex, non-reducible radial head fractures. It offers patients a good chance of recovering function and improving their quality of life. However, surgeons should be aware of the potential impact of associated ligamentous injuries on outcomes.

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