OUTCOMES OF CEMENTED BIPOLAR RADIAL HEAD ARTHROPLASTY: CASE SERIES OF 7 PATIENTS

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ABSTRACT

Aim of the study This study assesses the effectiveness of radial head prosthesis in patients with radial head fractures, examining how demographics, injury severity, and associated injuries influence recovery and functional outcomes. **Material and methods** A retrospective analysis was performed on patients who underwent radial head arthroplasty. This analysis delved into clinical outcomes such as range of motion, Mayo Elbow Performance score, and Quick Disabilities of the Arm, Shoulder and Hand questionnaire, as well as complications. Data on demographics, Mason classification, and associated injuries were meticulously collected and analysed to determine their impact on recovery and the effectiveness of the prosthesis. **Results** Radial head prosthesis generally led to improved elbow function and reduced disability, with most patients achieving excellent MEPS scores and normal range of motion. However, variability in outcomes was noted, influenced by factors such as age, severity of the initial injury, and associated injuries. Notably, while heterotopic ossifications emerged as a recurrent complication, distal radio-ulnar joint injury was identified in only one patient, suggesting its uncommon occurrence in this patient cohort. **Conclusions** Radial head arthroplasty significantly enhances elbow functionality in patients with severe radial head fractures, though outcomes vary based on individual factors like age and injury severity. This study's insights into the varied implications of radial head prosthesis contribute to optimizing treatment strategies and improving patient outcomes in orthopedic practice.

Key words: radial head, fracture, arthroplasty, Monteggia-like fracture dislocation, bipolar prostheses, heterotopic ossification

INTRODUCTION

Radial head plays a critical role in elbow joint biomechanics, particularly in stabilizing the elbow through the radio-capitellar joint. It provides essential stability under axial load, valgus stress, and external rotation (1). During isometric elbow flexion under resistance, forces as high as four times the body weight can be generated, with the radio-capitellar joint absorbing up to 60% of these loads (2). This highlights the radial head's significance in maintaining forearm stability and managing mechanical loads on the elbow (3).

Radial head fractures constitute 33% of all elbow fractures (4) and approximately 1.7% to 5.4% of fractures overall (5). The incidence has rising trend likely attributed to an aging population and increased participation in high-risk activities (6). Epidemiologically, radial head fractures exhibit a bimodal distribution: younger males

DOI : 10.6261/RJOR.2024.4.16.88

are more likely to sustain complex fractures from high-energy impacts such as sports injuries or falls from heights (7), while older females typically experience simpler fractures from low-energy mechanism, often linked to osteoporosis (8,9). Peak incidence occurs around 37 years of age in men and 52 years in women (10).

Mason classification remains a widely used system for evaluating radial head fractures. This classification guides preoperative planning and prognostic evaluation by categorizing fractures from Type I (non-displaced) to Type IV (radial head fracture associated with elbow dislocation). Treatment options range from non-operative management to open reduction and internal fixation (ORIF), resection or radial head arthroplasty (RHA) for more complex injuries.

RHA has undergone significant advancements, offering a variety of designs to suit different clinical needs. These designs include monopolar or bipolar constructs, as well as modular or monoblock configurations. Stems can be loose-fit or fixed, with fixed stems further categorized into press-fit or cemented options. Additionally, the head design may be anatomic or non-anatomic. The bearing surfaces for radial head replacements are available in materials such as metallic alloys, pyrocarbon, or high-molecular-weight polyethylene.

In recent years, RHA has gained favor for managing complex fractures due to its ability to provide enhanced joint stability, particularly in cases where excision or non-operative approaches may fail to offer adequate support (12). This shift highlights the importance of tailoring treatment plans based on factors such as patient age, the mechanism of injury, and fracture complexity to achieve optimal outcomes.

MATERIAL AND METHODS

We performed a retrospective study on 55 patients with radial head fracture admitted to the Orthopedics-Traumatology Department of the Clinical Emergency Hospital "Sf. Spiridon" Iasi, from 1 January 2022 until 31 December 2023 and focused on patients who underwent RHA.

The following demographic and clinical characteristics of the included patients were obtained: age, gender, weight, mechanism of injury, fracture type, presence of associated injuries, period of hospitalization, period of immobilization.

The Chm radial head system was used, a bipolar prosthesis with a cemented stem, made of cobalt alloy, UHMWPE polyethylene. The stem is connected to the head through a socket joint, which enables the head prosthesis to rotate and tilt 15° against the stem axis in both directions (Fig. 1). The head of the prosthesis is available in 9 sizes (3 diameters: 20, 22, 24 mm and 3 heights: 10, 12, 14 mm) and the stem is available in 2 variants (standard or angular) depending on the level of radial head resection.

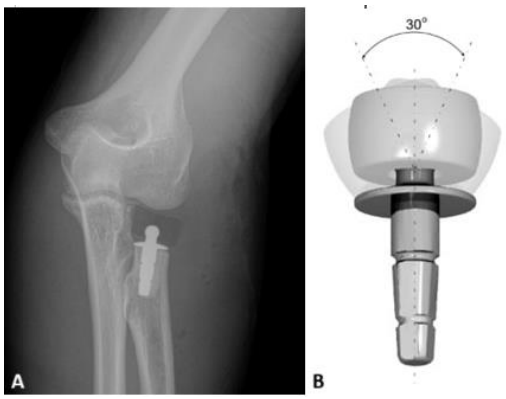

Figure 1. A- Plain radiograph of the elbow highlighting the radiological aspect of the Chm prosthesis; B- Radial head prosthesis with a standard stem.

The head of the prosthesis was measured by comparing both implant and native radial head fragments to avoid overstuffed implants (Fig. 2).

DOI : 10.6261/RJOR.2024.4.16.88

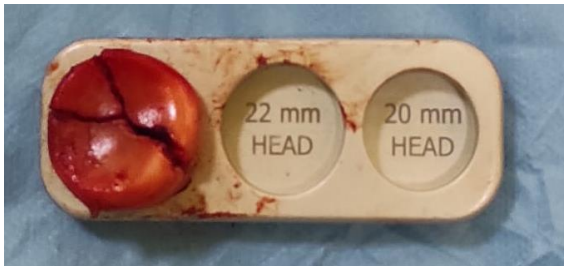

Figure 2. Measurement of the native radial head after resection

Clinical outcomes were evaluated using the Mayo Elbow Performance Score (MEPS), the Quick Disabilities of the Arm, Shoulder, and Hand (Q-DASH) score, active range of motion (ROM) of the elbow joint and specific tests for distal radio-ulnar joint injuries. For all patients, a series of plain radiographs (x-ray) of the elbow and DRUJ —including anteroposterior, and lateral view—were utilized to monitor periprosthetic lucency and heterotopic ossification (HO).

HO was graded according to Hastings and Graham classification (11): type 1 does not cause a functional outcome; type 2 has some functional limitation: 2A represents an elbow flexion contracture of 30° or greater and limited flexion of less than 130°, 2B represents limited forearm rotation of less than 50° pronation or less than 50° supination, and 2C represents heterotopic bone causing limitations in both planes of motion; and type 3 has ankyloses that prevent elbow motion.

DRUJ injury was noted using a novel classification (12): grade 1- normal joint congruency on x-ray, occasional discomfort or mild limitation of wrist movement; grade 2- joint subluxation or incongruity with persistent pain, occasional clicking, mild to moderate limitation of wrist movement; grade 3- severe joint incongruity/ dislocation, with persistent pain, significant functional impairment, instability during daily activities and possible signs of nerve compression or vascular compromise.

RESULTS AND DISCUSSIONS

Between 2022 and 2023, a total of 71 patients with radial head fractures were admitted to our department. Among these, 26 were classified as Mason type III fractures and 9 as Mason type IV. RHA was performed in 7 cases (Fig. 3, Fig. 4) comprising three male and four female patients. The average age for male patients was 34 years, while the average age for females was 52.8 years, highlighting a notable difference in age distribution between genders. Most injuries were low-energy traumas, including five falls from standing height, one fall down the stairs, and one high-energy all-terrain vehicle (ATV) accident. Associated injuries included Monteggia-like fracture-dislocations, coronoid fractures, and olecranon fractures.

Figure 3. Anteroposterior x-ray of the left elbow. A- at trauma date, Mason III; B- after surgery

Figure 4. Profile x-ray of the left elbow. A- at trauma date; B- after surgery

Hospital stays ranged from 4 to 10 days,

DOI : 10.6261/RJOR.2024.4.16.88

with an average duration of 7.4 days. Patients with associated injuries, such as Monteggia-like lesions and coronoid fractures, experienced longer hospitalizations. Follow-up periods varied from 16 to 29 months, with an average of 20.7 months across the cohort (Table 1).

Table 1. Demographic and clinical data of patients

Case	Age (yr)	Gender	Mason	Associated injury	Hospitalization	Follow-up (mo)
1	25	F	III	-	6	29
2	28	M	III	Coronoid fracture	10	25
3	61	F	IV	Monteggia-like	9	21
4	53	F	III	Monteggia-like	6	19
5	36	M	IV	-	4	18
6	38	M	III	Coronoid and olecranon fracture	9	17
7	72	F	III	Terrible triad, olecranon fracture	8	16

Functional outcomes, assessed using MEPS and QuickDASH questionnaire, were excellent in most cases, with QuickDASH scores indicating minimal residual disability (Table 2). ROM analysis revealed that three patients achieved full ROM, defined as 140° flexion, 0° extension, and 90° pronation and supination. The remaining patients exhibited deficits in extension and supination, which were more pronounced in those with complex associated injuries (Table 3).

Table 2. Summary of the clinical and radiological outcomes after RHA

Case	Q-DASH	MEPS	HO	DRUJ
1	0	100	0	0
2	0	100	1	1
3	2,3	85	2A	0
4	4,5	80	2A	0
5	0	100	0	0
6	0	100	1	0
7	4,5	85	1	0

Table 2. Active ROM

Case	F	E	Pron	Sup
1	140	0	90	90
2	140	0	90	90
3	125	15	80	70
4	120	20	80	70
5	140	0	90	90
6	140	5	80	90
7	130	0	80	70

One patient demonstrated a Grade 1 DRUJ instability, presenting with occasional discomfort and mild wrist movement limitations without radiological incongruency. This case was managed conservatively, and no surgical intervention was required, the patient was advised to make a career change, being a construction worker. The other six patients exhibited no signs of DRUJ instability.

At two weeks postoperatively, one patient required wound debridement due to difficulties in incision closure, although this intervention had no repercussions on functional outcomes or signs of deep tissue infection. Another patient presented extensive HO detected via x-rays (Fig. 5) and computed tomography approximately six months after surgery. This patient had severely limited

DOI : 10.6261/RJOR.2024.4.16.88

ROM (15–20° flexion-extension arc, 10° pronation and supination), severe pain, and ulnar neuropathy. Surgical exploration revealed HO surrounding the prosthesis, necessitating prosthesis removal. The ulnar nerve was entrapped in fibrous tissue and decompressed, while the lateral collateral ulnar ligament was reconstructed, and the anterior capsule excised to improve extension. Postoperatively, this patient achieved 110° flexion, a 30° extension deficit, and 70° pronation and supination.

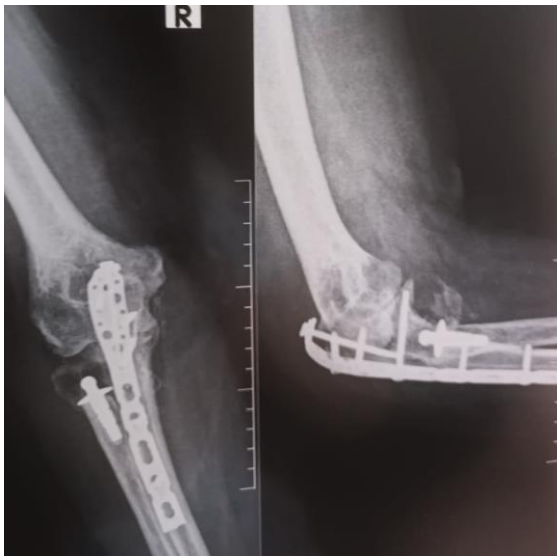

Figure 5. Antero-posterior and lateral x-ray of the wright elbow at 3 months postoperatively showing an extensive mass of heterotopic ossification surrounding the prosthesis.

Discussions

Regarding the best time of HO excision, studies show that patients who underwent early excision combined with a rehabilitation program had better restoration of elbow ROM (13); thus, in our case, HO excision was performed when it reached maturity, approximately 6 weeks after the patient started experiencing severe elbow pain and limited ROM, and led to good functional outcomes.

According to Giannicola et al. (14) radial head resection in complex elbow injuries, such as Monteggia-like lesions, may aggravate instability of the forearm and also lead to proximal migration of the radius. As many authors suggest RHA in Mason III/IV associated with Monteggia-like lesion (15,16), our treatment is in accordance with these authors (Fig. 6).

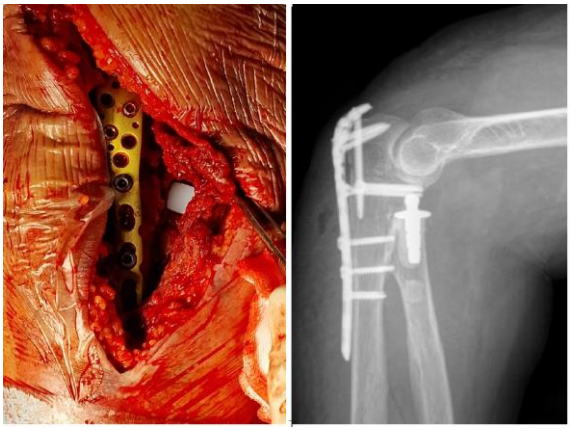

Figure 6. Intraoperative aspects of anatomical locking plate for proximal ulnar fracture and radial head prosthesis, and postoperative profile x-ray of the elbow

Our study revealed favorable outcomes using bipolar prostheses for RHA, with satisfactory ROM and functional scores. While complications like HO were observed, they had minimal impact on most cases. Antoni et al. find no significant differences in clinical outcomes between bipolar and monopolar designs (17). However, bipolar prostheses may provide advantages in capitulum adaptation and reducing stress (18). The smaller sample size in our study highlights the need for further research to confirm these benefits and identify patient populations that may gain the most from bipolar designs.

The integration of the DRUJ classification system into this study highlighted the utility of a standardized approach to identifying and managing associated injuries in radial head fractures. The identification of a Grade 1 DRUJ injury in one patient underscores the

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importance of including a systematic assessment of DRUJ stability during treatment planning, even in cases where instability may be clinically subtle. This framework, coupled with the three-locker system (19), provides a more comprehensive understanding of how injuries to different segments of the forearm impact joint function and recovery. Furthermore, the absence of higher-grade injuries in this cohort suggests that while DRUJ involvement may not be universally present (20), its evaluation remains critical to ensuring optimal outcomes. Future studies should prioritize larger cohorts and standardized assessments to further validate these classification systems in managing complex forearm trauma.

CONCLUSIONS

Our study demonstrates the utility of bipolar cemented radial head arthroplasty in managing complex radial head fractures, with most patients achieving excellent functional outcomes. Incorporating a structured DRUJ classification system and the three-locker framework into the evaluation process enhances the ability to identify and address associated injuries, ensuring comprehensive management. Although complications like heterotopic ossification remain a challenge, individualized treatment strategies and advancements in prosthetic design offer promising solutions.

The main limit of this study is certainly the low number of cases. It is also a retrospective study, with a short follow up and the included cases are not fully homogeneous. Probably because of these reasons we could not find any statistically correlation between classification systems and functional results. Nevertheless, further research with larger cohorts is warranted to validate these findings and refine treatment protocols for complex elbow and forearm trauma.

AKNOLEDGEMENTS AND DISCLOSURES

The authors declare that they have no potential conflicts of interest to disclose.

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DOI : 10.6261/RJOR.2024.4.16.88