Original Article

Radial Head Prosthesis in Comminuted Radial Head Fractures: A Surgical Perspective of a time demanding evolution

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Abstract:

Background: Comminuted radial head fractures (Mason type III and IV) are frequently associated with elbow instability and poor outcomes when treated with excision or open reduction and internal fixation. Radial head arthroplasty has emerged as a preferred option for irreparable fractures, aiming to restore elbow stability, motion, and function. **Objective:** To evaluate the clinical, functional, and radiological outcomes of radial head prosthesis in the surgical management of comminuted radial head fractures from a surgical perspective. **Methods:** This prospective observational study was conducted at the Department of Orthopaedics, Comilla Medical College Hospital, from January 2023 to July 2025. Twenty-six adult patients with Mason type III or IV radial head fractures underwent primary radial head arthroplasty and were followed for a minimum of 12 months. Functional outcomes were assessed using the Mayo Elbow Performance Score (MEPS) and Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire. Pain was evaluated using the Visual Analog Scale (VAS), while elbow and forearm range of motion were measured with a goniometer. Radiological assessment focused on prosthesis position, joint congruity, and complications. Data were analysed using SPSS with statistical significance set at $p < 0.05$. **Results:** The mean age was 41.8 ± 11.2 years, with males comprising 69.2% of patients. At 12 months, mean elbow flexion was 130° ± 10°, with a mean flexion–extension arc of 120° ± 12°. Mean VAS scores improved significantly from 7.8 ± 1.0 preoperatively to 1.5 ± 0.9 ($p < 0.001$). The mean MEPS was 88.6 ± 9.1, with 84.6% of patients achieving excellent or good outcomes. The mean DASH score improved to 14.2 ± 7.5 ($p < 0.001$). Radiological outcomes were satisfactory in all cases, with no prosthesis loosening or revision surgery required. **Conclusion:** Radial head arthroplasty provides reliable pain relief, restoration of functional motion, and favourable short-term outcomes in comminuted radial head fractures when performed early and combined with appropriate soft-tissue management and rehabilitation.

Key words: Radial head fracture; Radial head arthroplasty; Elbow instability.

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Introduction:

In 1905, the first description of radial head fractures was published[1]. Two to five percent of all fractures in adults are radial head fractures. They represent 33% of all elbow fractures, making them the most prevalent type[2,3]. A fall onto an outstretched hand with the elbow extended and the forearm pronated frequently causes the mechanism of damage. As a result, the radial head is forced posteriorly while forces are transmitted across the radial head's anterolateral rim, causing an axial load and a valgus strain to the elbow. Treatment will be guided by the fracture's intricacy and potential soft tissue damage, which are linked to

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the fall's intensity[4]. The course of treatment can be either non-operative or operational, depending on the nature of the damage. Radial head excision, radial head arthroplasty, or open reduction and internal fixation are examples of surgical treatment[5]. Mason[3] classified radial head fractures, and Johnston[6] later modified this classification. Mason type I fractures are fissures or marginal sector fractures without displacement, as was formerly stated. A segment of the articular surface is affected or angulated in type II fractures, which are marginal fractures with displacement. Comminuted injuries impacting the entire radial head are known as type III fractures. The Mason-Johnston type IV injury was a subsequent addition to this classification that considers a radial head fracture in conjunction with an ipsilateral ulnohumeral dislocation[6].

Early active range of motion is used as a non-operative treatment for type I fractures. Open reduction and internal fixation or fragment excision are common treatments for type II fractures, which have a mechanical impediment to mobility[7]. Reconstructible fractures of types III and IV with straightforward fracture patterns are surgically treated with internal fixation and open reduction, and the results have been excellent [8]. Unfortunately, as open reduction and internal fixation have led to worse results, such as nonunion, loss of fixation, and unexpected forearm rotation, this cannot be affirmed for comminuted, complex radial head fractures[8],[9]. Since research has shown that radial head excision causes valgus elbow instability, elbow stiffness, decreased grip strength, proximal migration of the radius, and early elbow arthritis due to premature cartilage wear, it is no longer recommended for treating complex radial head fractures[10],[11],[12]. In cases of irreparable radial head fractures accompanied by ligamentous damage or elbow dislocation, radial head arthroplasty is recommended[7],[13],[14],[15].

Evaluation and reporting of our functional, radiological, and quality of life outcomes after primary radial head arthroplasty for displaced, comminuted, and irreconstructable radial head fractures is the aim of this study. The elbow's lateral column, the humeroradial joint, serves as a crucial stabiliser for both axial and valgus stress [16]. Even in the presence of other lesions, such as a medial collateral ligament (MCL) lesion or small coronoid fractures, its integrity guarantees the elbow's strong stability. The MCL is the elbow joint's main stabiliser, with the radial head coming in second in terms of stability under loading and valgus stress, per research from the Mayo Foundation [17]. Thus, from a biomechanical perspective, the radial head is seen as a structure of vital relevance when there is lateral collateral ulnar ligament (LUCL) lesions, coronoid fractures, or MCL injuries[18].

Complex radial head fractures were surgically treated by excision of the radial head. Since worries regarding delayed sequelae surfaced, its popularity has declined. These include ulnohumeral arthritis, wrist pain, elbow valgus instability, and weakness loss[19]. The equipment for arthroplasty and internal fixation has also advanced at the same time. However, even a late salvage radial head excision can result in respectable functional gains [20],[21]. In these challenging situations, radial head arthroplasty offers a good substitute. Arthroplasty avoids the late problems linked to radial head excision and yields consistent results with a shorter learning curve than ORIF.

Since its humble beginnings, when Speed published the first set of ferrule caps for the radius head, radial head arthroplasty has undergone a substantial alteration. The use of metallic caps for acute radial head fractures was then documented by Carr and Howard[22] in 1951. Cherry[23] presented an acrylic prosthetic for radial head fractures two years later. According to outcome studies conducted over the next ten years, radial head arthroplasty was better than radial head excision; nevertheless, during a follow-up period of an average of 3.5 years, 2 out of 14 implants cracked in 1 series[24]. Swanson et al. later introduced the silicone arthroplasty[25]. For a number of years, silicone implants were still popular, but late issues quickly surfaced. These included the development of silicone-based elbow synovitis and fractures of these silicone implants[26],[19]. Numerous businesses were prompted to create the metallic radial head replacements that are currently in demand by these issues as well as biomechanical research demonstrating silicone implants' incapacity to support the radius in a practical manner.

For complex unstable fractures, two recent prospective randomised trials have shown better results with radial head prosthesis compared to osteosynthesis (ORIF). However, ORIF has a higher frequency of

complications, including non-union and premature synthesis failure [27],[28], and one study establishes three fragments as the cut-off number to proceed with prosthesis implant as the preferred treatment[9]. To evaluate the clinical, functional, and radiological outcomes of radial head prosthesis in the management of comminuted radial head fractures (Mason type III and IV) from a surgical perspective.

Methods:

This was a prospective observational study. This was conducted at the Department of Orthopaedics, Comilla Medical College Hospital, Cumilla, from January 2023 to July 2025. Consecutive Sampling was done. All patients who fulfill the inclusion criteria and appear throughout the research period will be included until the target sample size is attained. All patients who satisfy the inclusion criteria and present throughout the trial period

Adult patients aged 18 years or older will be eligible for inclusion. Only individuals with comminuted radial head fractures classified as Mason type III or IV, confirmed by appropriate radiological investigations, will be considered. Participants must have a clear indication for radial head arthroplasty as determined by the treating orthopedic surgeon and must undergo surgical intervention within two weeks of sustaining the injury. Eligible patients should be both willing and able to provide written informed consent and must be available for regular postoperative follow-up for a minimum period of 6 to 12 months.

Patients younger than 18 years will be excluded from the study. Those with radial head fractures managed by open reduction and internal fixation, radial head excision, or conservative treatment will not be included. Individuals presenting with open fractures of Gustilo–Anderson grade II or higher, pathological fractures due to conditions such as metastasis or metabolic bone disease, or associated neurovascular injuries will be excluded. Patients with ipsilateral upper limb fractures that could interfere with outcome assessment, a history of prior trauma or surgery to the same elbow, or systemic conditions known to impair bone healing or function—such as uncontrolled diabetes mellitus or rheumatoid arthritis-will also be excluded. Additionally, patients who are unwilling or unable to adhere to postoperative rehabilitation protocols or scheduled follow-up visits will not be considered for inclusion.

Operative technique:

All patients were positioned supinely on an arm table with a pneumatic tourniquet applied at the base of the operated limb. Intravenous antibiotic prophylaxis was delivered prior to the tourniquet application. All patients underwent a lateral approach for prosthesis installation. Forearm is fully pronated as a safeguard to protect the injury of the Posterior interosseous nerve. Meticulously dissecting the soft tissue according to the incision plane, the radial neck was excised with an oscillating saw at a distance of 23 mm from the capitulum, employing a specialized template. The medullary canal of the radius was prepared using sequential reamers. Actual head size is measured according to the size of the excised radial head placed in a specialised template. The stem was cemented following the obturation of the centromedullary canal when needed. Usually, a long stem with appropriate diameter is preferred according to the width of the reamed centromedullary canal. The radial head prosthesis is then placed and press fit into the canal. Elbow ROM and Stability is checked and restored before after closer of the incision. A long arm back slab is applied for 3 weeks. Stitches removed on 14th post-operative day. Follow up visits ensued on 4th, 6th and 12th week, 6 months and 12 months.

Data Collection Tools:

Data were collected using an investigator-developed structured proforma specifically designed for this study. This form captured baseline demographic information such as age, sex, occupation, and hand dominance. Relevant clinical details including the mechanism and date of injury, as well as the side involved, were recorded. Fractures were classified according to the Mason system based on radiological confirmation. Detailed treatment-related information were obtained, including the date of surgery, surgical approach, and fixation method. Intraoperative findings and any complications encountered during surgery were systematically noted.

Outcome Measures:

Functional outcomes were assessed using validated scoring systems. The Mayo Elbow Performance Score (MEPS) was used to evaluate pain, range of motion,

joint stability, and functional performance in daily activities, with a total score of 100 points categorised as excellent, good, fair, or poor. Upper limb disability was further assessed using the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, a 30-item patient-reported outcome measure with scores ranging from 0, indicating no disability, to 100, representing severe disability. Objective assessment of elbow and forearm mobility was performed using a standard goniometer. Measurements included elbow flexion and extension, as well as forearm pronation and supination, and were recorded at each follow-up visit. Pain intensity was evaluated using the Visual Analog Scale (VAS), where patients rated their pain on a scale from 0, representing no pain, to 10, indicating the worst pain imaginable. Radiological evaluation was carried out using preoperative and postoperative plain radiographs. These images were reviewed to determine fracture characteristics and healing, assess prosthesis position and alignment, and identify complications such as implant loosening or heterotopic ossification. A predefined radiograph evaluation checklist was used to ensure consistency. Postoperative adverse events were documented using a structured complication checklist. This included the occurrence of surgical site infection, nerve palsy, elbow instability, and prosthesis-related complications.

Follow-Up:

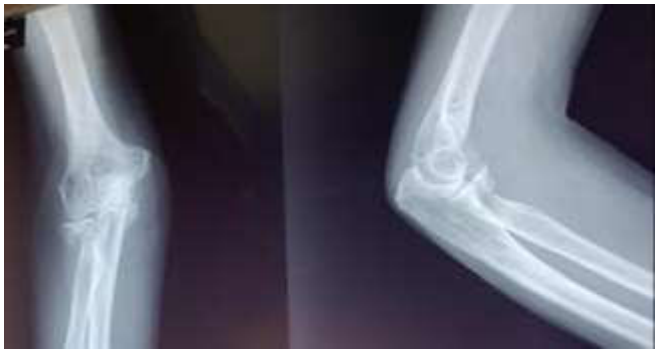
A standardized follow-up log was maintained for all participants at predetermined intervals of 2 weeks, 6 weeks, 3 months, 6 months, and 12 months after surgery. At each visit, functional outcome scores, range of motion measurements, and radiological findings were recorded.

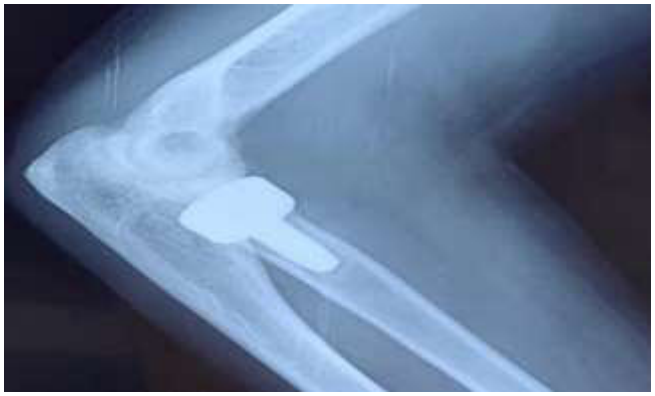
Data Analysis:

Collected data were analysed quantitatively using SPSS software. Appropriate statistical tests, including t-tests and chi-square tests, were applied for intergroup comparisons. Qualitative feedback, where applicable, was analysed thematically. Statistical significance was set at a p-value of less than 0.05.

Results:

A total of 26 patients diagnosed with comminuted radial head fractures classified as Mason type III and IV underwent radial head arthroplasty and were followed for a minimum duration of 12 months. The mean age of the study population was 41.8 ± 11.2 years, with ages ranging from 22 to 65 years. Male patients constituted the majority of cases, accounting for 18 individuals (69.2%), while 8 patients (30.8%) were female.





In terms of laterality, the right elbow was more frequently involved, affecting 17 patients (65.4%), whereas the left elbow was involved in 9 patients (34.6%). The injury occurred on the dominant upper limb in 15 patients (57.7%). Road traffic accidents were the most common mechanism of injury, reported in 15 cases (57.7%), followed by falls on an outstretched hand in 9 patients (34.6%). Other causes, including sports-related injuries and assaults, were responsible for the remaining 2 cases (7.7%).

Regarding fracture severity, Mason type III fractures were observed in 18 patients (69.2%), while Mason type IV fractures were identified in 8 patients (30.8%). Associated ligamentous injuries were also noted, with clinical and/or radiological suspicion or confirmation of collateral ligament involvement present in 10 patients (38.5%).

Table-I: Baseline demographic and injury profile of the patients (n=26)

Variable	Category	n (%)
Age (years), mean ± SD	–	41.8 ± 11.2
Sex	Male	18 (69.2)
	Female	8 (30.8)
Side involved	Right	17 (65.4)
	Left	9 (34.6)
Dominant limb involved	Yes	15 (57.7)
	No	11 (42.3)
Mechanism of injury	RTA	15 (57.7)
	Fall (own height/stairs)	9 (34.6)
	Others	2 (7.7)
Mason classification	Type III	18 (69.2)
	Type IV	8 (30.8)
Associated ligament injury*	Present	10 (38.5)
	Absent	16 (61.5)

Most surgical procedures were performed early after injury, with 19 patients (73.1%) undergoing surgery within 7 days of trauma, while 7 patients (26.9%) received delayed intervention beyond 7 days. The mean operative duration was 82 ± 15 minutes. Overall, the average interval between injury and surgical intervention was 5.1 ± 3.2 days.

Table-II: Implant characteristics and perioperative details (n=26)

Variable	Category	n (%)
Timing of surgery	Early (≤7 days)	19 (73.1)
	Delayed (>7 days)	7 (26.9)
Operative time (min)	Mean ± SD	82 ± 15
Injury-to-surgery interval	Mean ± SD (days)	5.1 ± 3.2

At the 12-month final follow-up, patients demonstrated satisfactory restoration of elbow and forearm mobility in the operated limb. Mean elbow flexion reached 130° ± 10°, with values ranging from 110° to 145°. A residual extension deficit was observed, with a mean extension lag of 10° ± 6° (range: 0°–25°), resulting in an average flexion–extension arc of 120° ± 12°. Forearm rotational movements were also well preserved, with mean pronation of 82° ± 8° and mean supination of 78° ± 9°.

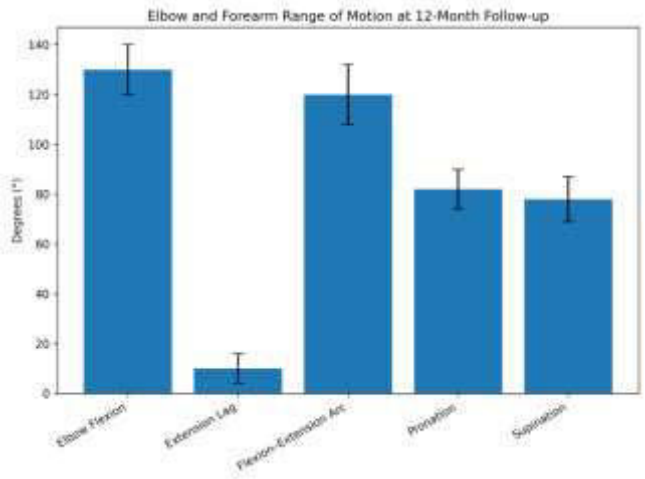


Figure-1: Mean elbow and forearm range of motion at 12-month follow-up. Error bars represent standard deviation. Patients demonstrated satisfactory recovery with preserved flexion–extension arc and forearm rotation, despite a mild residual extension lag.

Pain levels showed marked improvement over the course of follow-up. The mean preoperative Visual Analog Scale (VAS) score was 7.8 ± 1.0, indicating severe pain prior to surgery. At the final assessment, the mean VAS score had decreased substantially to 1.5 ± 0.9. This reduction in pain from the preoperative period to the 12-month follow-up was statistically significant ($p < 0.001$, paired t-test).

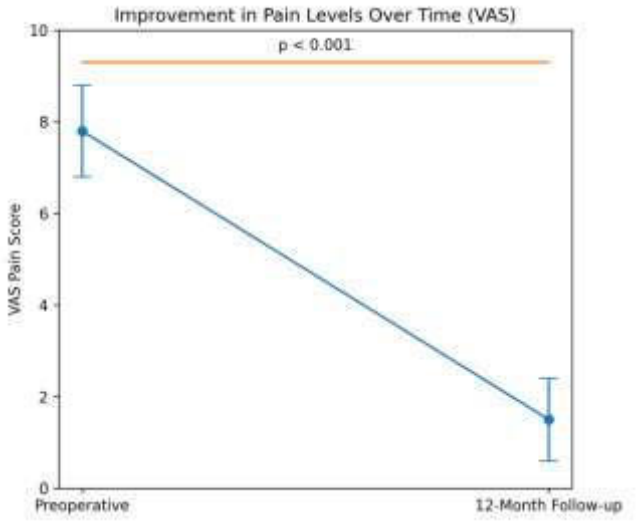


Figure-2: Change in mean Visual Analog Scale (VAS) pain scores from the preoperative period to the 12-month follow-up. Error bars represent standard deviation. A statistically significant reduction in pain was observed at final follow-up compared with baseline (paired *t*-test, $p < 0.001$).

At the 12-month follow-up, functional assessment demonstrated favourable outcomes following radial head arthroplasty. The mean Mayo Elbow Performance Score (MEPS) was 88.6 ± 9.1, with scores ranging from 60 to 100. Based on MEPS categorisation, excellent results were achieved in 14 patients (53.8%), while 8 patients (30.8%) had good outcomes. Fair results were observed in 3 patients (11.5%), and only 1 patient (3.8%) demonstrated a poor outcome.

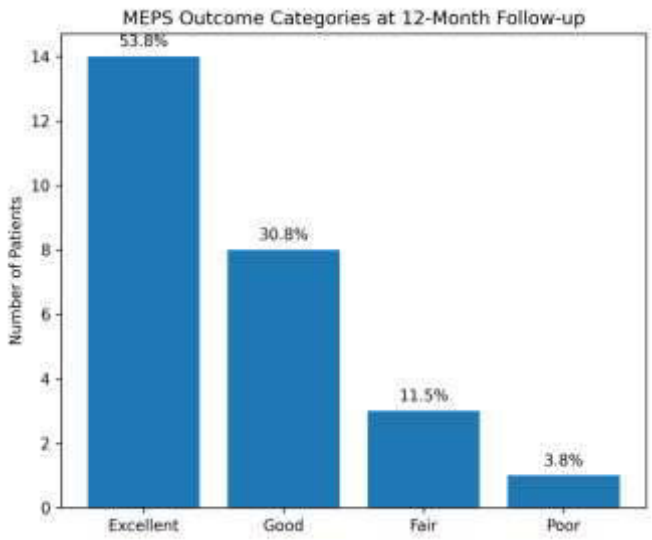


Figure-3: Distribution of Mayo Elbow Performance Score (MEPS) outcome categories at the 12-month follow-up after radial head arthroplasty. Excellent and good outcomes were achieved in the majority of patients, indicating favourable functional recovery.

Upper limb function, as assessed by the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, showed minimal residual impairment in most cases. The mean DASH score at final follow-up was 14.2 ± 7.5, with values ranging from 4 to 32, indicating predominantly mild disability. In patients for whom preoperative DASH scores were available, a statistically significant improvement was noted, with mean scores decreasing from 54.6 ± 10.3 preoperatively to 14.2 ± 7.5 at 12 months ($p < 0.001$).

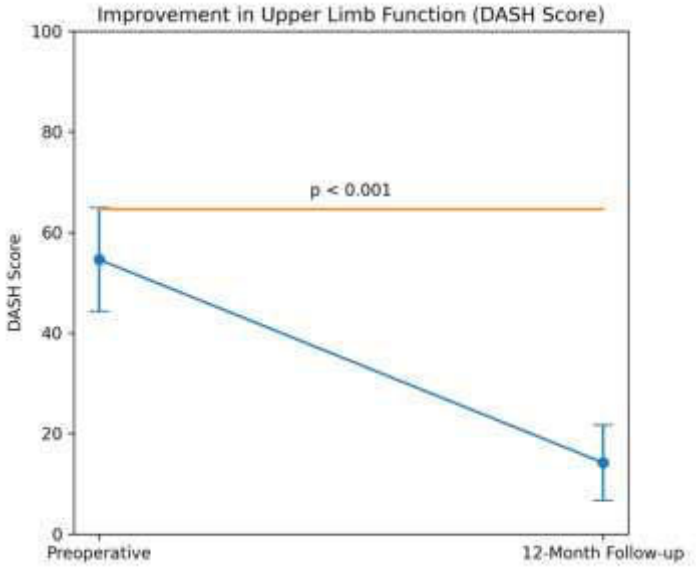


Figure-4: Change in Disabilities of the Arm, Shoulder, and Hand (DASH) scores from the preoperative period to the 12-month follow-up. Mean scores with standard deviation are shown. Upper limb function improved significantly following radial head arthroplasty (paired *t*-test, $p < 0.001$), indicating minimal residual disability at final follow-up.

All fractures showed satisfactory union of associated fractures and stable prosthesis position at last follow-up. No gross radiological loosening of the prosthesis was noted. Heterotopic ossification was observed in 2 patients (7.7%), both Brooker grade I–II, without major functional restriction. Joint congruity of the ulnohumeral and radiocapitellar joints was maintained in all cases.

Complications:

During the follow-up period, 7 patients (26.9%) developed one or more postoperative complications,

the majority of which were minor and self-limiting. Elbow stiffness, defined as a loss of 30° or more in the flexion–extension arc, was the most frequent complication and was observed in 3 patients (11.5%). Heterotopic ossification occurred in 2 patients (7.7%). A superficial surgical site infection was noted in 1 patient (3.8%), which resolved with appropriate antibiotic therapy and regular wound care. Transient neuropraxia involving the radial nerve or posterior interosseous nerve was also observed in 1 patient (3.8%); this deficit resolved completely within three months. Importantly, no cases of deep infection, prosthetic dislocation, implant failure, or requirement for revision surgery were reported throughout the follow-up duration.

Table-III: Postoperative complications (n=26)

Complication	n (%)
Any complication	7 (26.9)
Elbow stiffness (≥30° loss of arc)	3 (11.5)
Heterotopic ossification (Brooker I–II)	2 (7.7)
Superficial wound infection	1 (3.8)
Transient nerve palsy (PIN/radial)	1 (3.8)
Deep infection	0 (0)
Prosthesis loosening	0 (0)
Reoperation/revision	0 (0)

Discussion:

The present study evaluated the clinical, functional, and radiological outcomes of radial head arthroplasty in patients with comminuted radial head fractures (Mason type III and IV) and demonstrated satisfactory pain relief, near-functional range of motion, and predominantly excellent to good functional outcomes at 12 months. These findings are largely consistent with previously published literature on radial head replacement for complex elbow trauma. The mean age of 41.8 years in our cohort aligns closely with prior studies, which have consistently reported that radial head arthroplasty is most commonly performed in active middle-aged adults sustaining high-energy trauma. Abdulla et al. reported a mean age of 47 years[29], while Montbarbon et al. documented a similar demographic distribution with patients predominantly in the fourth to fifth decades of life[30]. The male predominance (69.2%) and frequent involvement of the dominant limb in our series mirror findings across multiple studies, reflecting occupational and road traffic–related injury patterns, particularly in developing regions.

The high proportion of Mason type III fractures (69.2%) and associated ligament injuries (38.5%) further supports the concept that comminuted radial head fractures are often part of a complex instability pattern, as emphasized by Bain et al., who described these injuries as components of global elbow instability rather than isolated bony lesions[31]. In the current study, most procedures were performed early, with 73.1% of patients undergoing surgery within 7 days of injury. Early intervention has been repeatedly highlighted as a key determinant of favorable outcomes. Bain et al. observed inferior functional scores and increased stiffness in patients undergoing delayed surgery, particularly beyond 2–3 weeks, attributing this to capsular contracture and difficulty in restoring elbow biomechanics[31] .

Our mean injury-to-surgery interval of 5.1 days and mean operative time of 82 minutes are comparable to reported operative parameters in modern arthroplasty series, suggesting reproducibility of the procedure in routine clinical practice[27]. At final follow-up, patients in our study achieved a mean flexion–extension arc of 120°, pronation of 82°, and supination of 78°, values that are within or slightly better than those reported in large series and long-term follow-up studies. Montbarbon et al. reported mean flexion of 132° with an extension deficit of 14.5°[30], while Abdulla et al. documented persistent flexion contractures averaging 17.5° despite acceptable function[29]. These comparisons suggest that early surgery and structured rehabilitation in our cohort may have contributed to relatively preserved motion.[32] The marked reduction in pain observed in this study (VAS improvement from 7.8 to 1.5) is consistent with previously published outcomes. Carità et al. reported mean postoperative VAS scores between 1.5 and 2.0 following radial head prosthesis implantation, supporting the analgesic effectiveness of the procedure.

Functionally, the mean MEPS of 88.6 in our cohort compares favorably with scores reported by Abdulla et al. (mean MEPS 86.4)[29] and by Bain et al., where excellent and good outcomes accounted for the majority of patients[31]. Similarly, the mean DASH score of 14.2 indicates only mild residual disability and is comparable to DASH values reported in both

pyrocarbon and metallic prosthesis series, as well as pooled estimates from systematic reviews. Radiologically, all patients in the present study demonstrated stable prosthesis positioning without gross loosening, and heterotopic ossification. This rate is notably lower than that reported in long-term series, where heterotopic ossification rates have ranged from 25% to 75%, particularly with bipolar designs[33] .The absence of radiological loosening or capitellar erosion at one year supports the short-term biomechanical reliability of contemporary prosthetic designs when appropriately sized and positioned.

The overall complication rate of 26.9% in our cohort, predominantly minor and transient, is comparable to or lower than rates reported in meta-analyses and long-term observational studies. Dou et al. demonstrated that prosthesis replacement is associated with significantly fewer complications than ORIF in Mason type III fractures, reinforcing the rationale for arthroplasty in unreconstructible injuries [34]. Importantly, no patient in our study required revision surgery, prosthesis removal, or treatment for deep infection—outcomes that remain a concern in longer-term follow-up studies but are less frequent with modern implants and refined surgical technique.

Conclusion:

Taken together, the findings of this study corroborate existing evidence that radial head arthroplasty is an effective and reliable treatment option for comminuted radial head fractures associated with instability. When performed early and combined with appropriate soft tissue management and rehabilitation, the procedure provides predictable pain relief, restoration of functional range of motion, stable radiological outcomes, and an acceptable complication profile.

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Conflicts of Interest: We do not have any conflict of interest.

Ethical issues: The protocol for this study was approved by the Institutional Review Board of Comilla Medical College, Cumilla, Bangladesh.

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Data availability statement: The authors confirm that the data supporting this manuscript's findings will be shared upon reasonable request.

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