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Original Article

Evaluation of long-term functional outcome in Monteggia fracture dislocation: A Retrospective Study.

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ABSTRACT

Introduction: Monteggia fracture–dislocation (MFD), defined by proximal ulna fracture with radial head dislocation, is an uncommon injury with potential for persistent pain, stiffness, instability, and loss of forearm rotation when reduction and alignment are suboptimal. Evidence on durability of recovery beyond the early healing phase remains limited. This study evaluated long-term functional outcomes and complications after MFD managed at a tertiary trauma center.

Materials and Methods: A retrospective observational study was conducted using electronic medical records and PACS imaging. Forty consecutive patients with radiologically confirmed MFD and ≥12 months follow-up were included. Injuries were classified by Bado type. Treatment details (operative vs non-operative, ulnar fixation method, need for radial head open reduction, adjunct annular ligament procedures) and complications were recorded. Radiographic union and range of motion were extracted from follow-up documentation. Functional outcome at final follow-up was graded using Anderson et al. criteria (excellent/satisfactory/unsatisfactory/failure) based on union and loss of elbow flexion–extension and forearm rotation. Associations between Bado type and dichotomized outcome were tested (χ^2/Fisher's exact), with $p<0.05$ significant.

Results: The cohort was predominantly male (70%), most commonly aged 31–45 years (40%); road traffic accidents accounted for 60%, and 85% were closed injuries. Bado type I predominated (55%), followed by type II (25%). Operative treatment was performed in 90%; plate osteosynthesis was used in 88.9% of operative cases. The radial head reduced after ulnar alignment in 75%, while 25% required open reduction; annular ligament repair/reconstruction was performed in 15%. Union was achieved in 92.5% (delayed union 5%, nonunion 2.5%); 64.9% united within ≤12 weeks (documented cases). Motion loss persisted: 20% had >20° elbow flexion–extension loss and 20% had >50% forearm rotation loss. Complications occurred in 35%, most commonly stiffness requiring supervised physiotherapy >3 months (15%). Anderson outcomes were excellent in 45% and satisfactory in 35% (combined 80%); unsatisfactory and failure were 15% and 5%, respectively. Bado type was not significantly associated with outcome ($p=0.257$).

Conclusion: Most adult MFDs achieved union and good functional results with operative fixation, especially plate stabilization of the ulna, and radial head reduction was commonly restored by correcting ulnar alignment. However, a substantial minority experienced clinically relevant motion loss and complications, highlighting the need for anatomic reconstruction, verification of radiocapitellar congruity, and structured rehabilitation.

Keywords: Monteggia Fracture, Elbow Joint, Fracture Fixation, Retrospective Studies, Treatment Outcome.

INTRODUCTION

Monteggia fracture-dislocation (MFD)—classically defined as a fracture of the proximal ulna with dislocation of the radial head—is an uncommon but clinically important injury that can lead to substantial long-term functional impairment if not recognized early and treated appropriately.[1] Although Monteggia lesions constitute a small proportion of forearm fractures (commonly cited as <5% of forearm fractures) their impact is disproportionately large. This is because they involve both osseous disruption and loss of congruity at the radiocapitellar and proximal radioulnar joints.[2] This is responsible for compromising elbow stability and forearm rotation. In routine trauma practice, missed radial head dislocation, delayed presentation, inadequate restoration of ulnar alignment and residual instability remain key contributors to persistent pain, stiffness, weakness and loss of pronation–supination. These sequelae affect activities of daily living and work capacity, especially in young and middle-aged adults who form a large proportion of trauma referrals.[3]

The injury pattern was first described by Giovanni Battista Monteggia and subsequently refined conceptually as a "Monteggia lesion," a spectrum characterized by dislocation at the proximal radioulnar articulation associated with ulnar fractures at variable levels, and sometimes associated injuries at the wrist.[4] The widely used Bado classification organizes Monteggia lesions into four types based on the direction of radial head dislocation and the ulnar fracture pattern. Type I (extension type) involves anterior radial head dislocation with anterior angulation of the ulnar fracture, and is commonly reported as the predominant pattern in most clinical series; Type II (flexion type) involves posterior or posterolateral radial head dislocation with posterior angulation of the ulna; Type III involves lateral or anterolateral dislocation with ulnar metaphyseal fracture; and Type IV includes fractures of both radius and ulna at the same level with radial head dislocation.[5] The practical value of this classification is that it frames mechanism, predicts associated soft-tissue injury, and guides surgical strategy for restoring alignment and stability.[6]

Despite advances in fixation techniques and postoperative rehabilitation protocols, Monteggia injuries remain "problem fractures" because stable, anatomic reconstruction is essential for a good outcome. The forearm functions as a ring: ulnar malalignment can prevent concentric reduction of the radial head or predispose it to recurrent subluxation/dislocation. Furthermore, Monteggia lesions may be accompanied by fractures of the radial head, neck or capitellar chondral injury which may cause compounding instability.[7] Inadequate early management may therefore result in chronic radial head dislocation, restricted elbow motion, valgus instability, degenerative changes, heterotopic ossification and nerve dysfunction. Complications such as delayed union, nonunion, malunion, myositis ossificans, infection, and radial nerve palsy can occur even in treated cases. Poor outcomes are more common when treatment is delayed or when injuries are managed conservatively in adults.[8]

A key clinical determinant of functional recovery is the restoration and maintenance of radiocapitellar congruity, which governs elbow stability and forearm rotation.[9] Surgical principles in acute adult Monteggia injuries typically prioritize anatomic reduction and stable fixation of the ulna (often with plate fixation for diaphyseal patterns, or screws/other constructs for proximal patterns) because accurate ulnar alignment frequently permits spontaneous reduction of the radial head. When radial head stability remains unsatisfactory after ulnar fixation open reduction becomes necessary.[10]

While many reports describe early union rates and short-term range-of-motion restoration, very few studies focus specifically on long-term functional outcome after Monteggia fracture-dislocation. Accordingly, there remains a clinically relevant knowledge gap regarding long-term functional outcomes after Monteggia fracture-dislocation in contemporary practice, especially when assessed beyond the early healing phase and interpreted in relation to injury pattern, treatment modality, and complications. This retrospective study of 40 cases aims to address this gap by evaluating long-term functional outcomes following Monteggia fracture-dislocation, using standardized functional criteria centred on union and forearm range of motion.

MATERIALS AND METHODS

This retrospective observational study was conducted in the Department of Orthopaedics at a tertiary care teaching hospital. Consecutive patients treated for Monteggia fracture-dislocation during the predefined study period were identified through the computerized hospital information system (HIS)/electronic medical records (EMR) and trauma/operation theatre registries. All eligible cases with complete digital documentation were included, yielding a final sample of 40 patients. Eligible patients available within the study window were included in this study on the basis of a predefined inclusion and exclusion criteria.

Data were retrieved primarily from computerized case records. These records included emergency department notes, inpatient (IPD) sheets, operative notes, discharge summaries, physiotherapy documentation and outpatient follow-up entries. Demographic variables (age, sex), injury details (side, mechanism, open/closed status), neurovascular findings, time to definitive management (where recorded) and associated injuries were also analysed. Preoperative and follow-up radiographs available on PACS from radiology department were reviewed to confirm diagnosis and classify injuries using the Bado classification.

Treatment characteristics were abstracted from operative notes and perioperative records, including method of ulnar fixation (plate osteosynthesis/intramedullary fixation/other constructs as applicable), intraoperative assessment of radiocapitellar congruity after restoration of ulnar alignment, requirement for open reduction of the radial head, and adjunct procedures when performed (e.g., annular ligament repair/reconstruction). Post-treatment course was assessed from EMR follow-up notes for immobilization strategy, initiation and progression of rehabilitation, radiographic union, and complications (delayed union, nonunion, malunion, infection, heterotopic ossification, nerve palsy, redislocation/subluxation, and implant-related problems).

Patients were routinely followed up in outpatient services at approximately 2 weeks (wound review/suture removal), 6 weeks, 3 months, 6 months, and 12 months, and thereafter annually when records were available. Only cases with a minimum follow-up of 12 months were included for assessment of long-term functional outcome. Functional outcome at the latest documented follow-up was graded using Anderson et al. criteria, incorporating fracture union and motion loss: Excellent (union with <10° loss of elbow flexion–extension and <25% loss of forearm rotation), Satisfactory (union with <20° loss of elbow flexion–extension and <50% loss of rotation), Unsatisfactory (union with >20° loss of elbow flexion–extension or >50% loss of rotation), and Failure (nonunion or functional failure requiring salvage/major persistent instability). Range of motion values were obtained from standardized clinic and physiotherapy notes.

Data was compiled in a structured database and analyzed using standard statistical software. Continuous variables were summarized as mean ± standard deviation or median (interquartile range) based on distribution; categorical variables were presented as frequencies and percentages. Associations between injury/treatment variables (e.g., Bado type, open injury, requirement for radial head open reduction, complications) and functional outcome categories were explored using Chi-square or Fisher's exact test. Continuous variables compared across outcome groups were analyzed using Student's t-test/ANOVA or Mann–Whitney U/Kruskal–Wallis tests as appropriate. A two-tailed p-value <0.05 was considered statistically significant.

Inclusion criteria

- Radiologically confirmed Monteggia fracture-dislocation
- Treated at the study institution during the study period
- Availability of EMR/HIS records and PACS imaging adequate for classification and extraction of treatment/outcome variables
- Minimum follow-up of 12 months with documented union status and elbow/forearm range of motion

Exclusion criteria

- Incomplete computerized documentation preventing injury classification or functional grading
- Pathological fractures
- Pre-existing ipsilateral elbow/forearm functional limitation documented prior to injury
- Polytrauma cases in which reliable elbow/forearm functional assessment could not be ascertained from records.

RESULTS

The cohort (n=40) was predominantly male (28, 70.0%) with the greatest representation in the 31–45 years age group (16, 40.0%), followed by 18–30 years (14, 35.0%). Injuries were slightly more frequent on the right side (22, 55.0%) compared with the left (18, 45.0%) (Table 1).

Variable	Category	Number (n)	Percentage (%)
Age (years)	18–30	14	35.0
	31–45	16	40.0
	46–60	8	20.0
	>60	2	5.0
Sex	Male	28	70.0
	Female	12	30.0
Side involved	Right	22	55.0
	Left	18	45.0

Table 1. Demographic profile of the study cohort (n = 40)

Road traffic accidents were the leading mechanism of injury (24, 60.0%), and most injuries were closed (34, 85.0%). On radiographic classification, Bado type I injuries were most common (22, 55.0%), followed by type II (10, 25.0%), while type IV injuries were uncommon (2, 5.0%). Associated ipsilateral injuries were documented in a minority, most frequently radial head/neck fractures (6, 15.0%) and coronoid fractures (4, 10.0%) (Table 2. Figure 1-2).

Variable	Category	Number (n)	Percentage (%)
Mechanism of injury	Road traffic accident	24	60.0
	Fall	12	30.0
	Sports/assault/other	4	10.0
Injury type	Closed	34	85.0
	Open	6	15.0
Bado type	Type I	22	55.0
	Type II	10	25.0
	Type III	6	15.0
	Type IV	2	5.0
Associated injuries (same limb)	Radial head/neck fracture	6	15.0
	Coronoid fracture	4	10.0
	Distal radius/ulna fracture	3	7.5
	None documented	27	67.5

Table 2. Injury characteristics and Bado classification (n = 40)

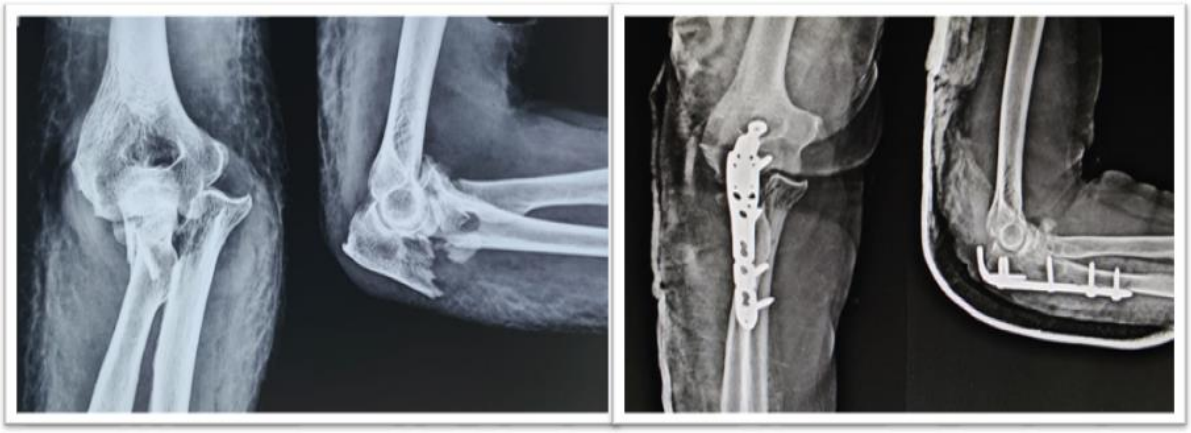

Figure 1:- Preoperative anteroposterior and lateral views showing a proximal ulnar fracture with associated radial head dislocation (Monteggia lesion) (Left). Postoperative radiographs demonstrating anatomical restoration of ulnar alignment with plate osteosynthesis (Right).

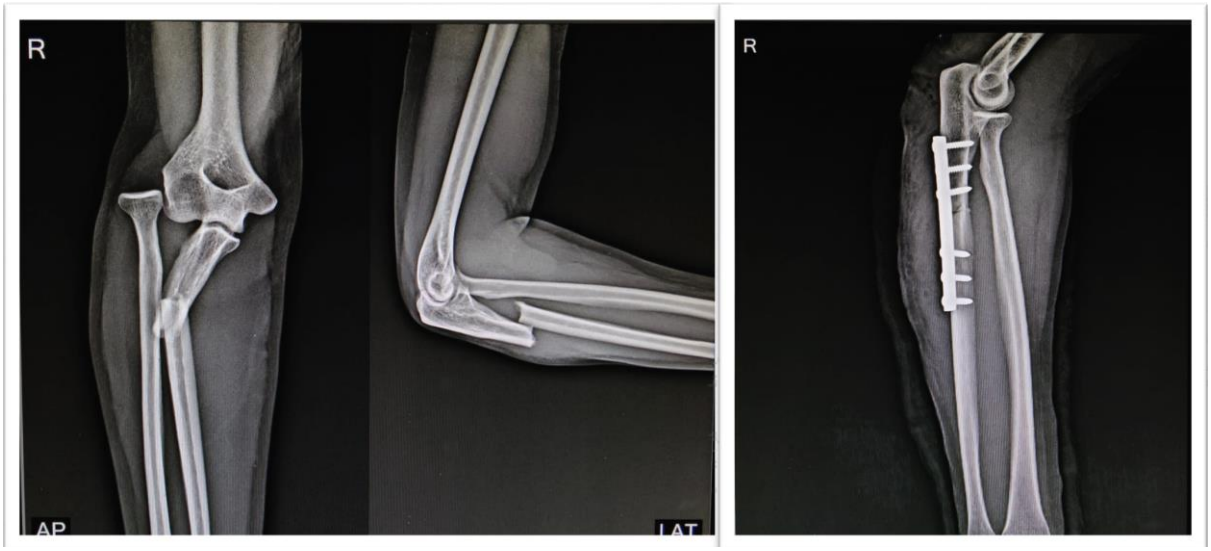

Figure 2. Preoperative anteroposterior and lateral radiographs demonstrating a displaced proximal ulnar fracture with associated radiocapitellar incongruity consistent with a Monteggia lesion(Left). Postoperative radiograph showing stable ulnar fixation with plate osteosynthesis and restoration of radiocapitellar alignment (Right).

Most patients underwent operative management (36, 90.0%). Among operative cases, plate osteosynthesis was the predominant method of ulnar fixation (32/36, 88.9%). In the majority, the radial head reduced following restoration of ulnar alignment (30, 75.0%), whereas open reduction of the radial head was required in 10 (25.0%) cases. Annular ligament repair/reconstruction was performed in selected patients (6, 15.0%) (Table 3).

Variable	Category	Number (n)	Percentage (%)
Primary management	Operative	36	90.0
	Non-operative (closed reduction + immobilization)	4	10.0
Ulnar fixation method (operative cases, n=36)	Plate osteosynthesis	32	88.9
	Intramedullary fixation	4	11.1
Radial head management (all cases, n=40)	Reduced after ulnar alignment (no open reduction)	30	75.0
	Open reduction required	10	25.0
Additional procedures (all cases, n=40)	Annular ligament repair/reconstruction	6	15.0
	External immobilization >3 weeks (splint/cast)	12	30.0

Table 3. Treatment modalities employed (n = 40)

At follow-up, 18 patients (45.0%) were available between 12–18 months, and 8 (20.0%) beyond 24 months. Radiological union was achieved in 37 (92.5%) cases; delayed union occurred in 2 (5.0%), and nonunion in 1 (2.5%). Among cases with documented union time (n=37), union within ≤12 weeks was observed in 24 (64.9%) (Table 4).

Variable	Category	Number (n)	Percentage (%)
Follow-up duration	12–18 months	18	45.0
	19–24 months	14	35.0
	>24 months	8	20.0
Union status	Union	37	92.5
	Delayed union	2	5.0
	Nonunion	1	2.5
Time to union (documented, n=37)	≤12 weeks	24	64.9
	13–18 weeks	11	29.7
	>18 weeks	2	5.4

Table 4. Follow-up duration and radiological union (n = 40)

With respect to functional motion at final assessment, loss of elbow flexion–extension <10° was observed in 20 (50.0%), while >20° loss was documented in 8 (20.0%). For forearm rotation, <25% loss was noted in 18 (45.0%), whereas >50% loss was present in 8 (20.0%) (Table 5).

Parameter	Category	Number (n)	Percentage (%)
Elbow flexion–extension loss	<10°	20	50.0
	10–20°	12	30.0
	>20°	8	20.0
Forearm rotation loss (pronation–supination)	<25%	18	45.0
	25–50%	14	35.0
	>50%	8	20.0

Table 5. Range of motion at final follow-up (n = 40)

Overall, at least one complication was recorded in 14 (35.0%) patients. The most frequent functional morbidity was persistent stiffness requiring supervised physiotherapy >3 months (6, 15.0%). Heterotopic ossification/myositis ossificans and transient nerve palsy were each noted in 3 (7.5%), while redislocation/subluxation of the radial head occurred in 2 (5.0%) (Table 6).

Complication	Number (n)	Percentage (%)
Superficial infection	2	5.0
Deep infection	1	2.5
Heterotopic ossification / myositis ossificans	3	7.5
Transient nerve palsy (PIN/radial/ulnar)	3	7.5
Malunion	2	5.0
Redislocation/subluxation of radial head	2	5.0
Stiffness requiring supervised physiotherapy >3 months	6	15.0
Any complication (≥1 of above)	14	35.0

Table 6. Complications observed in studied cases(n = 40)

Functional outcome by Anderson et al. criteria demonstrated excellent results in 18 (45.0%) and satisfactory outcomes in 14 (35.0%), yielding a combined excellent/satisfactory rate of 32 (80.0%). Unsatisfactory outcomes were seen in 6 (15.0%), and failure in 2 (5.0%) (Table 7).

Outcome grade	Number (n)	Percentage (%)
Excellent	18	45.0
Satisfactory	14	35.0
Unsatisfactory	6	15.0
Failure	2	5.0

Table 7. Functional outcome by Anderson et al. criteria at final follow-up (n = 40)

On bivariate analysis, the association between Bado type and dichotomized functional outcome (excellent/satisfactory vs unsatisfactory/failure) was not statistically significant ($\chi^2 = 4.053$, df = 3, p = 0.257), although a trend toward poorer outcomes was observed in higher Bado types, particularly type IV (Table 8). (Table 8)

Bado type	Excellent/Satisfactory n (%)	Unsatisfactory/Failure n (%)	Total (n)	p-value
Type I (n=22)	20 (90.9)	2 (9.1)	22	0.257
Type II (n=10)	7 (70.0)	3 (30.0)	10	
Type III (n=6)	4 (66.7)	2 (33.3)	6	
Type IV (n=2)	1 (50.0)	1 (50.0)	2	

Table 8. Association between Bado type and functional outcome (n = 40).

DISCUSSION

The present series highlights the epidemiologic profile of Monteggia fracture-dislocation (MFD) in a contemporary tertiary trauma setting: predominantly male patients in early-to-mid adulthood, with road traffic accidents as the leading mechanism and Bado type I as the most frequent pattern. This distribution mirrors the high-energy trauma predominance described in adult cohorts, although the "most common" Bado subtype varies across reports depending on referral patterns and inclusion of posterior Monteggia variants. In the landmark JBJS adult series by Ring D et al posterior (Bado type II) lesions constituted the majority, reflecting both the complexity of adult elbow trauma and frequent associated injuries in that subtype.[11] In contrast, the 54-case review by Llusà Perez M et al reported outcomes across a broader adult spectrum and used Anderson-type functional grading, emphasizing that adult Monteggia injuries remain heterogeneous and that institutional case mix can shift the apparent predominance of Bado types.[12] Within this context, our finding of a high proportion of Bado type I injuries may reflect the predominance of extension-type injuries among traffic-related mechanisms at our center and the inclusion of a small non-operative subset, but it remains clinically relevant because even "simpler" patterns can yield motion deficits and complications when soft-tissue disruption or subtle malalignment is present.

A consistent and clinically important observation from our study is the high rate of operative management (90%), with plate osteosynthesis as the principal ulnar fixation method (nearly 90% of operated cases), and the frequent spontaneous reduction of the radial head after restoration of ulnar length and alignment (75%). These findings support the long-established principle that anatomic ulnar reconstruction is the keystone for restoring radiocapitellar congruity. In Reckling's classic JBJS analysis, Reckling FW et al emphasized that the best adult outcomes for type I lesions followed open anatomic ulnar reduction/stabilization combined with successful reduction of the radial head, whereas poor results clustered around failure to achieve/maintain ulnar anatomy, heterotopic ossification/synostosis, and recurrent/persistent radial head dislocation. [13] Similarly, the critical adult-focused analysis by Körner J et al underscored that adult Monteggia injuries are "fraught with complications" even when most patients achieve broadly acceptable functional results, and it stressed the practical need for meticulous execution and patient counselling regarding residual deficits and potential reoperations.[14] Our requirement for open reduction of the radial head in 25% of cases aligns with these mechanistic concepts: when radial head stability is not achieved after ulnar fixation, interposed soft tissue, annular ligament disruption, or complex associated fractures may necessitate direct reduction and selective soft-tissue procedures.

Radiological union in our cohort was achieved in 92.5%, with delayed union in 5% and nonunion in 2.5%, outcomes that are broadly consistent with adult operative series while still underscoring the "problem fracture" reputation of Monteggia injuries. In the long-term JBJS (British) study by Konrad GG et al adult Monteggia fractures treated operatively demonstrated that classification systems (Bado/Jupiter) and injury complexity correlate with outcome, but durable functional recovery still depends on maintaining stable alignment and addressing associated lesions; importantly, their follow-up (mean >8 years) illustrates that late sequelae and residual impairment can persist despite union.[15] While our follow-up window was shorter (minimum 12 months, with a subset beyond 24 months), our complication profile (35% with ≥1 complication) reflects the same overarching theme: union is necessary but not sufficient for full functional

restoration. Similarly, Anderson LD et al also demonstrated high union rates and excellent functional restoration after compression plating in diaphyseal forearm fractures.[16]

Functionally, 80% of our patients achieved excellent/satisfactory results by Anderson criteria, yet meaningful motion loss persisted: 20% had >20° loss of elbow flexion–extension and 20% had >50% loss of forearm rotation. These findings reinforce that elbow and forearm rotation deficits are common even after radiographic healing and that outcome instruments anchored only to union can underestimate patient-perceived disability. The patient-reported outcome analysis by Tille E et al suggested that fracture localization and intra-articular involvement—particularly coronoid-related patterns—can worsen prognosis, and it highlights that Monteggia(-like) injuries may yield substantial PROM impairment even when radiographs appear satisfactory. [17] Likewise, in the posterior Monteggia variant series by Colliton E satisfactory mid-term outcomes and union were achievable through comprehensive fixation (often including coronoid and radial head management), but reoperations remained frequent and functional recovery depended on addressing all injured components and enabling rehabilitation. [18] In our cohort, associated radial head/neck fractures (15%) and coronoid fractures (10%) likely contributed disproportionately to rotation loss and stiffness, consistent with the concept that "associated injuries," rather than the ulnar fracture alone, drive residual impairment in complex Monteggia patterns.

Finally, our observed complications (stiffness (15%), heterotopic ossification/myositis ossificans (7.5%), transient nerve palsy (7.5%) and radial head redislocation/subluxation (5%) have direct implications for management pathways. Persistent stiffness is likely multifactorial and our finding that 30% underwent external immobilization beyond 3 weeks supports the importance of balancing stability with early motion as and when fixation permits. Similar complication rates were also reported by the authors such as Canton G et al[19] and Stein F et al.[20]

CONCLUSION

This retrospective study demonstrates that adult Monteggia fracture-dislocations, predominantly Bado type I and commonly caused by road traffic accidents, achieve high union rates with operative management, particularly plate fixation of the ulna. Most radial heads reduce after restoration of ulnar alignment; however, a meaningful minority require open reduction and selective ligament procedures. Despite an 80% excellent/satisfactory functional rate, stiffness, heterotopic ossification, and occasional redislocation persisted in studied cases. These findings strongly suggest that there is need for proper anatomic fixation and structured rehabilitation in cases of Monteggia fractures.

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