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Evaluating Risk Factors for Adverse Nerve Outcomes in Monteggia Fractures: A Narrative review

[1]Akhil Jaiby [2*] Naynesha Barure, [3]Krutika Gohil
[1*,2,3] MBBS,
[1]Grant Government Medical College, Mumbai, India
[2]Grant HinduhrIdaysamrat Balasaheb Thackarey Medical College (HBTMC) and
Dr Rustom Narsi Cooper Municipal General Hospital
Email id of the corresponding author: drnayneshabarure@gmail.com

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Abstract: Monteggia injuries are uncommon but involve severe elbow trauma with various injury patterns. Treatment approaches for these injuries remain contentious and vary significantly. This narrative review focuses on the posterior interosseous nerve in Monteggia injuries, aiming to elucidate the incidence of nerve injuries, assess nerve outcomes, and explore associated complications. We initially reviewed 642 publications and included 20 retrospective studies, which comprised 5 case reports and 15 randomized control trials. Patients were predominantly classified using the Bado classification system, with 83.66% having Bado type I fractures, 9.52% type II fractures, 6.10% type III fractures, and 0.72% type IV fractures. The average age of the patient population was 23 years. Common complications include ulna non-union and limited range of motion, while injuries to the medial nerve and the posterior interosseous nerve are among the most debilitating. Meta-analysis indicates a recovery period of 12-24 weeks following nerve corrective interventions. Further biomechanical and clinical research is needed to better understand the factors influencing nerve and associated recovery.

Keywords- Monteggia-like complex elbow fractures, outcomes, surgical treatment, coronoid fracture, elbow dislocation, elbow trauma, Monteggia injury, olecranon fracture, radial head fracture, suture, ulna non-union, posterior interosseous nerve palsy

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1. INTRODUCTION

Monteggia injury is defined by a combination of radial head dislocation and an ulnar shaft fracture. This injury pattern must be carefully assessed in patients with ulnar fractures, even if the displacement is minimal. The typical initial management strategy involves reducing the ulnar fracture to stabilize the radial head, which is often sufficient to address the injury. Internal fixation of the ulna is frequently recommended to ensure complete stabilization and prevent further complications. Anterolateral fracture-dislocations or fracture-subluxations rarely require open reduction of the radiocapitellar/proximal radioulnar joint [1]. If reduction of the radial head cannot be achieved, open surgical intervention may become necessary. Monteggia like lesions do not allow for mistakes during surgery, as even a minor error could be prove detrimental to performing and completing all surgical steps [2]. Chronic cases of Monteggia injury, which often become irreducible after 2 to 3 weeks, may require more complex surgical procedures such as open reduction and proximal ulnar osteotomy. To address radial head fractures, by the Boyd approach or lateral approach [3]. Without proper treatment, these dislocations can lead to long-term issues such as joint pain, loss of function, and eventually osteoarthritis. Therefore, obtaining and analysing radiographs promptly is crucial for accurate diagnosis and effective management. Monteggia-like lesions are rare and intricate elbow injuries. Giovanni Battista Monteggia first described these injuries in 1814, and they were further classified by Jose Luis Bado insa 1958 into four distinct types [4]. This classification system helps in understanding the varying presentations of these injuries and its variants as described in a report where the proximal radial disruption occurs through a Salter-Harris Type II fracture rather than a radial epiphysis dislocation [5]. The standard treatment approach involves performing open reduction and internal fixation of the ulnar fracture while also addressing the radial head dislocation through closed reduction techniques.

Chronic missed Monteggia fractures are managed by external fixator assisted ulnar osteotomy [6]. If open reduction for the treatment of a missed Monteggia fracture is performed when the patient is less than twelve years of age or within three years after the injury, good long-term clinical and radiographic outcomes can be expected long term [7]. The posterior interosseous nerve, which is a branch of the radial nerve responsible for motor function, travels through the supinator muscle and around the radial head [8]. This nerve is particularly susceptible to traction or compression injuries, especially at the Arcade of Frohse [9] a fibrous or tendinous arch through which the nerve passes. Entrapment of the nerve at this location can result in supinator syndrome, characterized by motor dysfunction and pain. Long-term dislocation of the radial head in Monteggia fractures may cause delayed posterior interosseous nerve palsy.

2. Material and Methods

2.1 Search strategy and selection criteria

Two independent reviewers searched databases namely Medline, Embase, Web of Science, and Google Scholar for articles on injury to posterior interosseous nerve in the event of a Monteggia fracture. Out of 642 articles that appeared in the search result for keywords Monteggia and posterior interosseous nerve and a filter to include studies until 10 August 2024, 20 research studies were selected out.

2.2 Ethics Statement

No institutional ethical clearance was sorted since the study is a review of pre-existing research studies in the public domain.

3. Results

Complications associated with Monteggia fractures included pin-related complete palsy [10], Salter-Harris fractures of the radial head [11], trapped nerves in the radiocapitellar joint [12], persistent radial head dislocation, forearm deformity, elbow stiffness, and nerve palsies at the time of presentation. Additionally, there were cases of radiocapitellar joint nerve entrapment [13], forearm deformity, elbow stiffness, and nerve palsies. Other complications noted were radial-ulnar synostosis [14], K-wire breakage [15], complete palsy, changes in ulna length [16], a 21% postoperative complication rate [17], varus angulation of the ulna [18], and loss of joint congruence. Unnoticed complications call for revision surgeries in about 34% of monteggia fractures [19].

Treatment options for Monteggia fractures and their complications include radial head reduction, neurolysis, ulnar length restoration, intramedullary nailing, CORA-based corrective ulnar osteotomy, nonoperative treatment, reduction and casting, closed reduction and internal fixation (CRIF) and opened reduction and internal fixation (ORIF) [20], radial head reconstruction, bell-tawse procedure for chronic cases, and achieving 110-120 degrees of elbow flexion [21]. Both angulation and elongation of the ulna are required to allow for reduction of the radial head. We do not see any indication for procedures directed at the radio-capitellar joint [22]. Recovery from explorative neurolysis typically takes around 14 weeks, and ulnar fractures may require reduction.

To evaluate the injuries and prognosis related to Monteggia fractures, scales such as the Mayo Elbow Performance Score, Bruce’s criteria modified by Letts [20], the Oxford Elbow Score, Shoulder and Hand (QUICK-DASH) score [23], and the Broberg & Morrey Score are commonly used.

The risk of nerve injury is influenced by several factors, starting with the type and severity of the fracture. Severe fractures with significant comminution or displacement are more prone to causing nerve damage, and complex fractures that necessitate invasive surgical interventions further increase this risk. The mechanism of injury also plays a crucial role; high-energy trauma, such as motor vehicle accidents, is associated with a higher incidence of nerve injuries due to the greater forces involved, whereas low-energy injuries generally lead to fewer complications. Timing is another critical factor: delayed diagnosis or treatment of Monteggia fractures can result in poor alignment and healing, thereby increasing the likelihood of nerve entrapment. Early and appropriate intervention is essential for minimizing nerve damage and enhancing recovery. Additionally, surgical technique is vital—poor reduction or fixation during surgery can lead to misalignment and elevated risk of nerve injury, underscoring the importance of the surgeon's skill and precision. Patient-specific factors, including age, overall health, and pre-existing conditions like diabetes or peripheral neuropathy, also affect healing and can exacerbate nerve injuries.

A comprehensive illustration in the Table l compares types of injuries to demographic details and nerve outcomes

Table 1. Concise comparison of Nerve Injures, Credentials, Age, Article Type and Mean Age

S.No.	Author	Number of cases (according to Bado)				Mean age in yrs	Nerve Involvement	Type of Report
		I	II	III	IV			
1.	Suarez R [17]	24	12	6	2		4%	Randomised Control Trial
2.	Olney B [18]	102	3	26			11%	Randomised Control Trial
3.	Lercan [24]	2				7		Randomised Control Trial
4.	Li H [13]	8					3/4 of III Bado	Randomised Control Trial
5.	Shim J [25]	9		1			Association with radial dislocation	Randomised Control Trial
6.	Surjit [26]	1				6	Median nerve palsy following intramedullary nailing	Case Report
7.	M Delpont [27]						Pain	Randomised Control Trial
8.	Ruchelsman D [14]	7	38	1	2	52	Ulnar Malunion	Randomised Control Trial
9.	Rahul Anshuman [28]	1				8		Case Report
10.	ElKhouly A [29]	1						Case Report
11.	Osamura N [12]	1				6		Case Report
12.	Bulstra L [16]	12				59		Randomised Control Trial
13.	Mohan [30]	17						Randomised Control Trial
14.	Khan S [21]	20						Randomised Control Trial
15.	Galbraith [31]	21						Randomised Control Trial
16.	Uri [32]	41						Randomised Control Trial
17.	Evan [33]	52						Randomised Control Trial
18.	Čepelík M [25]	111				14		Randomised Control Trial

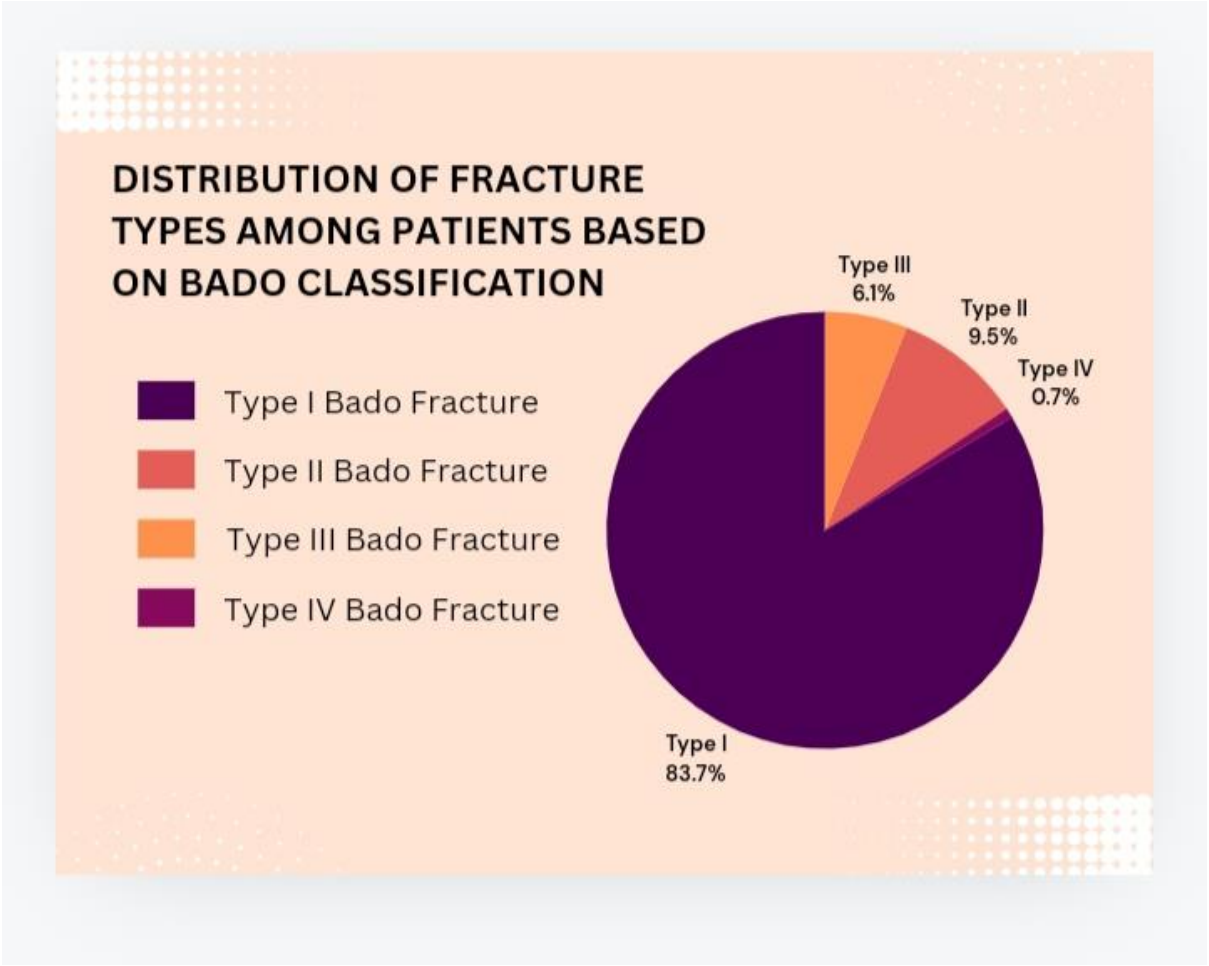

Figure 1.
Distribution of Fracture Types Among Patients Based on Bado Classification

4. Discussion

Elbow fracture dislocations are complex injuries that can provide a challenge for management [1]. Mean revision rate in Monteggia fractures is reported to be around 23%. About 22% are in view of nerve palsies and limited range-of-motion; also the main indication for revision surgery [26]. Spontaneous recovery is also reported in total palsy of the nerve in about 16 weeks following no specific nerve related intervention [27]. Certainly, however chronic and missed diagnoses witness poorer nerve outcomes and enhanced disabilities [28]. Excessive repeated motion with loss of elasticity of surrounding tissues because of long-term dislocation of the radial head may cause delayed posterior interosseous nerve palsy [29]. The lateral and posterior Monteggia injuries are probably variants of dislocation of the elbow and are not caused by rotation violence [30]. Nonoperative management with closed reduction and cast immobilization often prevails in pediatric patients, dictated by the pattern of the ulnar fracture more so than the direction of the radial head dislocation [31]. Persistent subluxation or recurrent dislocation of the radial head reflects malalignment of the ulnar fracture [32]. Determining the key stabilizer to prevent each direction of radial head dislocation and the optimal forearm position to ensure post-reduction stability would provide useful information in the management of patients with radial head dislocation [33]. The complexity of the injury is considerably increased by comminution of the proximal ulna, the degree of radial head fragmentation, the reduction of the radial head, and ulnohumeral instability [34].

Posterior interosseous nerve is at risk with radial dislocations, palsy owing to trauma, rheumatic heart disease [35], fluorosis [36], intravenous cannulation of the forearm [37]. Nerve palsies in traumatic injuries as a neurological diagnosis are almost impossible because of pain [38]. Nerve healing exhibits significant variability among individuals, complicating the attribution of poor outcomes solely to specific risk factors. Recovery can be unpredictable, with some patients achieving significant improvement despite the presence of potential risk factors, thereby challenging the assessment of their impact. Additionally, the scarcity of high-quality, comprehensive studies specifically focused on nerve outcomes in Monteggia fractures limits the ability to draw definitive conclusions. Variations in study design, population, and outcome measures contribute to inconsistent findings. The role of rehabilitation and postoperative care further complicates this issue, as differing protocols and access to quality rehabilitation services can independently affect nerve recovery. Moreover, the natural history of nerve injuries, including their potential for spontaneous recovery, can obscure the true influence of risk factors. Lastly, patient adherence to postoperative instructions and rehabilitation programs plays a crucial role in outcomes, potentially overshadowing the effects of initial risk factors; non-compliance may result in poor outcomes that are not directly related to the fracture or surgical factors.

5. Conflicts of Interest

The authors declare no conflicts of interest.

6. References

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