JOURNAL OF HEALTHCARE SCIENCES
Volume 5 Issue 7 2025, Article ID: JOHS2025001079
http://dx.doi.org/10.52533/JOHS.2025.50713
e-ISSN: 1658-8967

Review

Assessment and Management of Complex Elbow Dislocations

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Received: 14 July 2025, Accepted: 22 July 2025, Published 22 July 2025.

Abstract

Elbow dislocation is one of the most frequent injuries following shoulder dislocation. It is classified into simple and complex dislocation. Simple elbow dislocation involves capsuloligamentous stabilizers disruption without a fracture. Complex elbow dislocations involve an elbow dislocation alongside fractures of one or more critical bony stabilizers. Complex dislocation can lead to various long-term complications, particularly following suboptimal management. Diagnosis of complex elbow dislocation includes history taking, physical examination, and imaging. Classification and assessment of complex elbow dislocation can be confusing due to the separate classification systems. It can be treated by nonoperative treatment and operative treatment based on the severity and direction of dislocation. However, the choice of appropriate treatment plan for complex elbow dislocation and its effectiveness are still debatable. The aim of this review is to explore recent and current advancements in the assessment and management of complex elbow dislocation. The most common complex elbow dislocation is the posterolateral complex dislocation. Posteromedial dislocation and anterior dislocation are other mechanisms of elbow complex dislocation. This type of dislocation can be classified by different classification systems, including Regan-Morrey classification, O'Driscoll classification, and Mason-Johnston classification. The aim of treatment of complex elbow dislocation mainly includes restoring anatomical alignment of the joint, ensuring stability, and enabling early motion. Surgical treatment is considered the cornerstone of most unstable dislocations. A structured, individualized treatment approach, including timely surgical intervention, anatomical reconstruction, and early mobilization, is key to optimizing outcomes and minimizing long-term morbidity.

Keywords*: Elbow Dislocation, Complex Elbow Dislocation, Assessment, Management*

Introduction

Elbow dislocation is the second most common dislocation after shoulder dislocation. The incidence of elbow dislocation is six per 100,000 people (1). Elbow dislocation can be categorized into simple and complex fracture-dislocation (2). In simple elbow dislocation, only capsuloligamentous stabilizers are disrupted (3). Complex elbow dislocations refer to injuries in which an elbow dislocation occurs alongside fractures of one or more critical bony stabilizers, such as the radial head, proximal ulna, or coronoid process (4). It is estimated that one of four elbow dislocations presents with complex elbow dislocations (1).

Complex elbow dislocation is a serious injury and can lead to significant bony and/or soft tissue disruption, which is difficult to manage by orthopedic surgeons (2). Neglect of treatment or suboptimal treatment may result in long-term complications such as stiffness, arthritis, joint instability, and chronic pain (5, 6). There are four recognized patterns for complex elbow dislocation: varus posteromedial rotatory injury, valgus posterolateral rotatory injury (commonly referred to as terrible triad injury), Monteggia/Monteggia-like lesions, and transolecranon fracture dislocations caused by axial loading with a bending moment (1, 5). The transolecranon fracture dislocations can be subclassified into apex-anterior injuries (characterized typically by an intact radial head) and apex-posterior injuries (often involving a radial head fracture) (7).

History, physical examination, and imaging are essential parts of the diagnosis process of complex elbow dislocation. Furthermore, classification and assessment of complex elbow dislocation can be confusing due to the separate classification systems for radial head fractures, coronoid fractures, and olecranon fractures. Examples of these classification systems include Regan-Morrey classification, O'Driscoll classification, Mason-Johnston classification, Wrightington classification, Colton classification, and the AO classification (8, 9). Appropriate diagnosis, assessment, and classification of complex elbow dislocation can guide the treatment plan effectively.

Treatment strategies and outcomes depend on the specific pattern of instability and may range from nonoperative management to fracture fixation, joint replacement, and, in some cases, soft tissue repair (10). The surgical management of complex elbow fracture-dislocations remains challenging and is often linked to considerable long-term complications, including joint stiffness and instability.

This review aims to explore recent and current advancements in the assessment and management of complex elbow dislocation, highlighting risk factors for poor outcomes. The review also investigates the prevalence of this type of injury in pediatric populations.

Methods

A comprehensive literature search was conducted in Medline (via PubMed), Scopus, and Web of Science databases up to July 7, 2025. Medical Subject Headings (MeSH) and relevant free-text keywords were used to identify synonyms. Boolean operators (AND', OR') were applied to combine search terms in alignment with guidance from the Cochrane Handbook for Systematic Reviews of Interventions. Key search terms included: "Complex Elbow Dislocation" OR "Elbow Dislocation" AND "Assessment" AND "Management". Summaries and duplicates of the found studies were exported and removed by EndNoteX8. Any study that discusses the Assessment and Management of Complex Elbow Dislocations and published in peer-reviewed journals was included. All languages are included. Full-text articles, case series, and abstracts with the related topics are included. Case reports, comments, animal studies and letters were excluded.

Discussion

Anatomy of Elbow Joint

The elbow joint is formed of three parts: the medial ulnohumeral, lateral radiocapitellar, and proximal radioulnar joints, enclosed within a common

http://dx.doi.org/10.52533/JOHS.2025.50713

synovial sheath (2, 8, 11). It is typically stabilized by bony, capsuloligamentous, and muscular components (11). The bony structures include the ulnohumeral joint, which is formed of the articulation between the trochlea and the greater sigmoid notch, formed by the coronoid and olecranon processes (8). The coronoid process consists of anteromedial and anterolateral facets and the sublime tubercle, which is the insertion for the anterior bundle of the ulnar collateral ligament (aUCL). This process is essential for anterior support (2, 12).

The capsuloligamentous system of the elbow involves the medial ulnar collateral ligament (UCL) and the lateral collateral ligament complex (LCL). The UCL comprises anterior (aUCL), posterior (pUCL), and transverse bundles originating from the medial epicondyle. The aUCL inserts into the sublime tubercle and resists valgus stress (2, 11). While the LCL complex comprises the radial collateral ligament (RCL), lateral ulnar collateral ligament (LUCL), and annular ligament (2, 11). The proximal RCL and LUCL originate from the anteroinferior and posteroinferior surfaces of the lateral humeral epicondyle, respectively (11). LCL also stabilizes against varus and posterolateral forces (2, 11).

Furthermore, the elbow joint contains muscular structures such as the triceps, biceps, and brachialis. It also involves common flexor and extensor groups that originate from the humeral epicondyles (2). These muscles act as both static and dynamic stabilizers (13). The elbow joint has primary and secondary static stabilizers. Primary static stabilizers include the aUCL, LCL, and ulnohumeral joints. Secondary static stabilizers comprise the radiocapitellar joint and capsule, with muscles providing additional support (8).

Complex Elbow Dislocation

Complex elbow dislocations can be categorized based on the direction of dislocation and the associated ligamentous or osseous lesion. The most common complex elbow dislocation is the posterolateral complex dislocation. It accounts for 80% of cases and mainly occurs due to a fall on an outstretched hand (14). “Horii circle” is a theory that explains the lateral to medial soft tissue disruptions that usually occur in simple elbow dislocations. It includes three stages: LUCL tear, progressing to anterior/posterior capsular injury, and ultimately medial ligament disruption (14-16). These pathologies were also observed in complex elbow dislocation (14, 16). Additionally, radial head fractures commonly occur in this mechanism of dislocation. These fractures are usually described by the Mason-Johnson classification system (17, 18). The “terrible triad” consists of elbow dislocation, radial head, and coronoid (anterolateral) fractures (14).

The second most common complex elbow dislocation is the posteromedial elbow dislocation, accounting for 10% of cases (19). It usually occurs due to a fall backwards on an outstretched hand with flexion of the elbow and internal rotation of the shoulder, resulting in elbow axial loading with forearm pronation and valgus force. It also involves anteromedial coronoid fractures, LCL disruption, and UCL posterior bundle injury (19, 20).

Anterior elbow dislocation occurs in about 2.6% of cases (21). Complex anterior elbow dislocation occurs typically due to a fall on an outstretched hand associated with a posterior-to-anterior force on the elbow that leads to hyperextension of the joint (22). Furthermore, it always involves olecranon and coronoid fractures with anterior displacement of the distal segment of the ulna (21).

Diagnosis and Assessment of Complex Elbow Dislocation

The diagnosis of complex elbow dislocation should start with a thorough history and physical examination (10). Physicians should inquire about the mechanism of injury, additional injuries sustained, previous injuries or dislocations to the affected elbow, weakness, numbness, and tingling, as these symptoms may indicate concomitant neurovascular damage (23). Physical examination includes inspection and evaluation for any deformities, skin changes, open injuries, and abnormal positioning. It should also involve

http://dx.doi.org/10.52533/JOHS.2025.50713

neurovascular, range of motion, and joint stability assessment (10).

Imaging should initially include anteroposterior, oblique, and lateral radiographs of the elbow. Oblique radiographs can detect subtle fractures, such as fractures of the radial head and lateral condyle (24), which cannot be detected in other views. Additionally, radiographs of the ipsilateral wrist, shoulder, and forearm should be done, as 20% of patients with complex elbow dislocations are injured in these areas (25). A CT scan should be obtained as it can assess fracture detail, comminution, and intra-articular extension (25). CT also can decide the appropriate treatment plan. Although MRI can visualize ligamentous injuries, it is considered unnecessary in most acute settings, as significant capsuloligamentous damage is presumed in these high-energy injuries. Its utility for acute surgical planning is debated due to cost and limited added value (25, 26).

The classification of fractures in complex elbow dislocation aids in the assessment of injury and guides treatment. The coronoid fractures can be classified by the Regan-Morrey classification and the O'Driscoll classification. The Regan-Morrey classification is used in cases of coronoid shear fractures. It includes type I involving tip only; type II involving <50% of coronoid height; and type III involving >50% of coronoid height (26). The O'Driscoll classification is based on the anatomic location of the coronoid and includes coronal shear fracture subcategorization and basal fracture subcategorization. The coronal shear fractures subcategorization includes subtype I involving <2 mm, anteromedial facet only; subtype II involving >2 mm, extending to tip; and subtype III involving sublime tubercle ± tip. While basal fracture subcategorization includes subtype I involving the coronoid base and subtype II involving extension into the olecranon (15).

The radial head fractures can be classified by the Mason-Johnston classification into type I, which is nondisplaced or minimally displaced (<2 mm); type II, which is displaced >2 mm; type III, which is displaced and comminuted; and type IV, which is a fracture with associated elbow dislocation (17). Any radial head fracture in a complex dislocation is categorized as type IV. Olecranon fractures can be classified by various classifications. The Mayo, Schatzker, and Colton classifications are limited in guiding treatment during dislocations, as they classify all olecranon dislocations into one group (27-29). Thus, the AO classification is preferred and commonly used in research for its detail: type A, which is extraarticular; type B, which is intraarticular; and type C, which is complex intraarticular involving both the olecranon and radial head (30).

Management of Complex Elbow Dislocation

The aim of treatment of complex elbow dislocation mainly includes restoring anatomical alignment of the joint, ensuring stability, and enabling early motion. In case of a dislocated or grossly deformed elbow joint, closed reduction followed by splinting and post-reduction radiographs could be attempted. However, due to the instability of complex elbow dislocation, the success of maintaining reduction is low without operative intervention. Surgical options include open reduction and internal fixation (ORIF), arthroplasty, and application of hinged or static external fixation (31, 32). Early mobilization is also critical due to the high risk of posttraumatic stiffness, and it typically begins within two weeks of definitive treatment, depending on the injury and fixation type (32, 33).

Complex elbow dislocation can be treated medically when the elbow is stable in varus and valgus stress and stable with extension to at least 30 degrees. Examples of these cases are isolated coronoid fractures (Regan and Morrey types I or II) and isolated radial head fractures (Mason-Johnston type I), as long as the joint is stable on examination (4, 32, 34). A previous study compared the effectiveness of medical treatment with operative treatment in patients with terrible triad injury and found no significant differences (34). Patients in this study met specific criteria, including concentric joint, no mechanical block, small coronoid fracture, and 30° of extension. Notably, one of these patients required operative intervention due to recurrent instability.

http://dx.doi.org/10.52533/JOHS.2025.50713

Patients undergoing closed reduction should receive postreduction radiographs to confirm concentric alignment. If the fracture-dislocation is not open, splinting and delayed evaluation are recommended to allow swelling to subside. Stability is reassessed in follow-up (typically within a week), and if preserved, nonoperative management and early mobilization are initiated (34). Weekly monitoring via radiographs and exams is essential for the first four weeks (34). Surgery is warranted if instability, subluxation, or redislocation is noted (34).

Surgical intervention is indicated in cases of failed nonoperative treatment or evident instability (23). ORIF is used to address fractures, with repairs typically involving the LCL and LUCL. If instability persists, the medial collateral ligament may also require repair (1, 33). Fixation of radial head fractures restores valgus and posterolateral rotatory stability (25, 33); severely comminuted fractures may necessitate radial head arthroplasty (25). Early mobilization is encouraged regardless of the technique used (25).

If instability persists despite ORIF and ligamentous repair, a hinged external fixator may be employed (4, 33). Iordens et al. showed significant improvement in joint motion with hinged fixators, despite a 37% complication rate, including redislocation and infection (32). Most patients reported excellent functional outcomes (MEPI score of 100 at 1-year).

Hinged fixators are also used as a primary strategy or in combination with ORIF, offering protection while avoiding stiffness from overtightening repairs (31, 32). In contrast, static external fixators are simpler but limit mobilization and are more prone to pin loosening; thus, they are rarely preferred (4, 33). If late instability develops after nonoperative care, delayed surgical reconstruction of the ligaments and re-fixation of healed or displaced fractures may be necessary (15).

Risk Factors for Complex Elbow Dislocation

A recent study investigated the risk factors for poor postoperative outcomes in complex elbow dislocation patients (35). The study found a complication rate of 31.3% and a revision rate of 25.4%, mainly due to elbow stiffness. Severity of initial trauma, surgical injury to soft tissues, heterotopic ossification, degenerative joint changes, and surgeon-related factors all may contribute to elbow stiffness (36, 37). The study found that high BMI was associated with poor outcomes and a higher rate of complications. This may be attributed to altered bone metabolism (↓ osteoblast activity), concomitant diseases, reduced physical activity, higher energy trauma forces, and poor healing potential associated with high BMI.

Furthermore, the study found that older age (>70 y) was associated with poor postoperative outcomes such as reduced range of motion, lower elbow performance scores, and limitations in rehabilitation potential. This may be due to reduced bone quality, pre-existing osteoarthritis, concomitant systemic diseases, and lower motivation/adherence to rehabilitation. Transolecranon dislocation fractures are linked to worse outcomes, especially a higher risk of post-traumatic osteoarthritis. Surgery doesn't impact long-term results, except in open fractures or severe soft tissue injuries where urgent external fixation is needed until specialist surgery.

Complex Elbow Dislocation in Pediatric

Complex elbow dislocation is very rare in children, with a reported incidence of 3% to 6% (38). Only 26 cases were reported in 12 years in literature. The most common mode of injury in children is low-energy fall. Only a few injuries due to secondary high-energy etiologies were observed, unlike adult populations. In adults, the terrible triad includes fractures of the coronoid process and radial head with elbow dislocation, usually accompanied by ligamentous injuries that significantly affect outcomes if not addressed properly (39). However, the most frequent injuries in children involve dislocation with fractures of the radial neck or medial epicondyle, with additional injuries such as olecranon or lateral condyle fractures (40, 41). Unlike adults, pediatric patients rarely exhibit ligament injuries, and soft-tissue repair was not required.

http://dx.doi.org/10.52533/JOHS.2025.50713

Despite generally favorable outcomes in children, with 85% good to excellent results and a low rate of complications, 23% of patients had >10° loss of motion, and 15% had "poor" outcomes based on Flynn criteria. Thus, complex elbow dislocation still carries notable risks in pediatric patients.

Conclusion

Complex elbow fracture-dislocations represent a severe and multifaceted injury that poses significant diagnostic and therapeutic challenges. Accurate classification and thorough assessment are essential to guide appropriate treatment, which varies based on the pattern of instability and extent of bony and soft tissue involvement. While surgical management remains the cornerstone for most unstable injuries, outcomes can be hindered by complications such as stiffness, instability, and the need for revision surgery. Although rare in children, these injuries can also lead to functional deficits despite generally favorable results. A structured, individualized treatment approach, including timely surgical intervention, anatomical reconstruction, and early mobilization, is key to optimizing outcomes and minimizing long-term morbidity.

Disclosures

Author contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Ethics statement

Non-applicable.

Consent for publications

Not applicable.

Data availability

All data is provided within the manuscript.

Conflict of interest

The authors declare no competing interest.

Funding

All authors have declared that no financial support was received from any organization for the submitted work.

Acknowledgements

Not applicable.

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