Key Factors: Rehabilitation After Elbow Dislocation

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The elbow is the second most commonly dislocated major joint in adults. Such injuries are termed either simple or complex. A simple dislocation is a capsuloligamentous injury with no associated fractures (Figure 1A). The lateral collateral ligament, medial collateral ligament and anterior joint capsule are usually disrupted with simple dislocations. Complex dislocations have ligamentous disruption with associated fracture of one or more of the major bony stabilizers including the radial head, coronoid or olecranon (Figure 1B).

The initial treatment goal is to obtain a congruent reduction of the articulation, treat any associated injuries as required and ensure that a stable congruent joint can be maintained, allowing for early range of motion (ROM). This article will review key factors that therapists must be aware of when rehabilitating patients following elbow dislocations.

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aware of prior to initiating rehabilitation, appropriate orthotic positioning and outline the rehabilitation process following elbow dislocation.

Brief Anatomy Review

Bony Anatomy
The distal humerus, proximal ulna and the radial head comprise the articulation of the elbow. Together they form three articulations: the ulnohumeral joint, radiocapitellar joint and the proximal radioulnar joint. The radial head is an important valgus stabilizer of the elbow, whereas the coronoid process provides an important varus buttress. Both of these structures act as an anterior buttress to prevent posterior subluxation of the ulnohumeral joint.

Soft Tissue Anatomy
The lateral collateral ligament (LCL) and medial collateral ligament (MCL) complexes in combination with the anterior and posterior capsule provide important static restraints to elbow instability.

Lateral Collateral Ligament Complex
The LCL complex consists of the lateral ulnar collateral ligament (LUCL), annular ligament, and the radial collateral ligament. The LCL complex provides restraint to varus and posterolateral rotatory instability. The LUCL is taut in both elbow flexion and extension as it arises from an isometric point on the lateral epicondyle and inserts onto the proximal ulna. The annular ligament inserts on the anterolateral and posterolateral aspects of the lesser sigmoid notch of the ulna. The radial collateral ligament originates from the lateral epicondyle slightly more anterior than the LUCL and blends with the annular ligaments and surrounds the radial head. Both the annular ligament and radial collateral ligaments are not isometric, thus, become taut in various amounts of flexion and extension.

Medial Collateral Ligament Complex
The MCL provides an important restraint to valgus and posteromedial rotatory instability. The MCL consists of three structures: the anterior, transverse and posterior bundles. The MCL is not an isometric structure as it inserts posterior to the axis of elbow rotation. This results in the MCL becoming taut in specific portions of elbow ROM providing stability to valgus loads. Of the three components of the MCL, the anterior bundle is the primary valgus stabilizer. The anterior bundle arises from the inferior aspect of the medial epicondyle and inserts on the sublime tubercle of the ulna, a structure along the medial aspect of the coronoid. It is taut and strains valgus loads when the elbow is extended. The posterior bundle inserts posterior to the anterior bundle, thus, it is lax in extension and taut in flexion. In elbows lacking flexion, the posterior bundle tends to contract causing a restriction to flexion. The anterior bundle of the MCL is a primary elbow stabilizer. The posterior bundle is a secondary elbow stabilizer, whereas the transverse bundle is of little significance.

Details Therapists Should be Aware of Prior to Implementing Rehabilitation
At our facility we advocate that elbow dislocations be referred to specialized rehabilitation within the first two to five days following open or closed reduction. However, close communication between the surgeon and therapist is necessary in order to optimize outcomes. It is imperative for therapists to be aware of the following details prior to implementing rehabilitation:

• Mechanism of injury and the various structures involved
• Method of Reduction:
  > Closed Reduction: If a closed reduction was performed (most often with simple dislocations) the therapist must be aware of the status of the LCL and MCL complexes and the safe arc of ulnohumeral joint motion. Ideally, this is established by the physician who performs an examination under anesthesia post reduction by gradually extending the elbow with the forearm in supination, pronation, and neutral rotation. The angle at which the joint starts to sublux should be recorded and the therapist notified. If this information is not available elbow extension should be limited to 60 degrees initially, progressively increasing extension by 10 degrees on a weekly basis.
  > Open Reduction: If surgery was performed, the therapist must know the status of the skeletal and ligamentous fixation and whether the fixation was rigid or tenuous.
• Radiographic abnormalities such as the presence of a drop sign. A radiographic drop sign is an objective, measurable increase in ulnohumeral joint distance which is evident on static lateral radiograph (Figure 2). An ulnohumeral joint distance of greater than 4 mm would be considered a positive drop sign. Normal ulnohumeral joint distance in the uninjured elbow is 2-3 mm. A radiographic drop sign can be present after simple or complex dislocation treated with or without surgery and indicates that there is a persistent instability of the elbow joint.
Key Rehabilitation Concepts

The previously-mentioned information will allow therapist to place the elbow and forearm in a ligamentous friendly orthotic position, initiate controlled mobilization of the ulno-humeral joint and appropriately progress rehabilitation based on the stages of tissue healing.

Ligamentous Friendly Orthotic Positioning

Early referral allows for patients to be placed in a protective orthosis, which will provide comfort, stability and reduce force transmission across the various healing structures around the elbow. The orthosis should position the elbow in 80-90 degrees of flexion with the wrist positioned in slight extension to relax the proximal wrist musculature attachments, enhancing patient comfort. The position of the forearm will be dependent on the injury pattern to provide optimal ligament protection.

- Forearm Pronated: In the presence of an LCL deficiency following close reduction or in operative cases in which the LCL was repaired with an intact MCL (did not require repair and was stable with intra-operative stress testing) the forearm should be positioned in pronation.15–18 This position will pivot the forearm around the medial structures of the elbow tensioning the extensor/supinator group of muscles which will enhance lateral sided stability.

- Forearm Supinated: If MCL deficiency is noted following close reduction, or in operative cases in which the LCL repair was stable and robust but the integrity of the MCL is in question (such as it was left unrepaired or demonstrated instability intra-operatively), positioning the patient in full supination should be considered. This will protect the weak or deficient MCL by pivoting the forearm around the lateral structures tensioning the flexor/pronator group, which contributes to medial-sided stability.19

- Forearm Neutral: If the LCL repair was not robust and the MCL is deficient the patient should be positioned in neutral rotation to protect both the MCL and LCL complexes.

In the setting of simple dislocations the ligament injuries on the lateral side are typically more severe than medially so it is common that forearm pronation is the preferred position. At times a simple collar and cuff can be used, however, this should be discussed with the referring surgeon as this does not provide as much protection as an orthosis (Figure 3).
Early Controlled Mobilization
The optimal implementation of ROM after elbow dislocations is unknown. We recommend that active and active assisted elbow ROM begin on the first therapy visit. Early motion nourishes cartilage and enhances healing of the soft tissues. The position of the elbow during ROM exercises, however, is dependent on joint stability and the presence of a radiographic drop sign.

In the presence of a simple dislocation that did not require operative management patients will be instructed in immediate controlled active elbow extension and flexion exercises. The amount of extension permitted should be based on the findings of the post-reduction examination under anesthesia. If this information is not available, then elbow extension is limited to 60 degrees initially increasing extension by 10 degrees per week. If the status of the collateral ligamentous structures are not known, the patient should perform elbow motion with the forearm positioned in neutral rotation to prevent stress to both the healing LCL and MCL complexes. Forearm rotation is instructed to be performed with the elbow in 90 degrees of flexion or greater to prevent excessive tension to the collateral ligaments.

In operative cases patients will be instructed as follows:
• In the presence of a LCL repair with an intact MCL (i.e., did not require repair and was stable on stress testing), active elbow extension and flexion will be performed with the forearm in full pronation exclusively until six weeks post repair to ensure adequate soft tissue healing has occurred.
• If the LCL repair is not robust and the MCL is deficient (i.e., instability post-repair or not repaired), the patient should be positioned in neutral rotation to protect both the MCL and LCL. Elbow flexion and extension exercises are performed with the forearm in the neutral position exclusively. Initially, terminal

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elbow extension is limited to 30-45 degrees and advanced by 10-degree increments on a weekly basis.

• Patients are also instructed in forearm rotation to be performed actively with the ulnohumeral joint in 90 degrees of flexion or greater.

If a drop sign is present, the patient is instructed in a specific exercise regime to reduce the gravitational forces distracting the ulnohumeral joint. In the presence of a drop sign patients are instructed in the following:

• Isometric exercise of the triceps, biceps and brachialis while in the resting orthosis. Isometric exercises should be performed at regular intervals throughout the day holding the contraction for 10-25 seconds. Isometric exercise enhances compressive joint forces across the ulnohumeral joint, producing superior translation of the ulna reducing ulnohumeral sagging.20

• Elbow and forearm active ROM exercises in an overhead manner. Overhead ROM is performed while supine with the shoulder flexed to 90 degrees (Figure 4A and 4B). Overhead exercise reduces the gravitational forces distracting the ulnohumeral joint and enhances ulnohumeral joint tracking during flexion and extension exercises. This minimizes ulnohumeral joint sagging, joint hinging and impingement during early ROM exercises.21

• Caution when implementing passive ROM to the ulnohumeral joint. This caution is essential in preventing anterior and posterior hinging of the articular structures causing further joint damage, pain and inflammation. This is especially critical with combined fractures of the coronoid, as passive ROM will place undue stress to the healing coronoid, which may disrupt fracture healing or cause displacement.

• Forearm rotation to be performed actively with the ulnohumeral joint in 90 degrees of flexion or greater. However, these exercises do not need to be performed in the overhead position since no ulnohumeral joint motion occurs with this exercise.

• Active wrist and digital motion. These exercises will also provide a compressive force to the ulnohumeral joint as the wrist, and digital flexors and extensors cross the elbow joint. However, as no ulnohumeral joint motion occurs with these exercises they do not need to be performed in an overhead fashion.
Progression of ROM Exercise and Strengthening

We typically prefer that patients perform 10-15 repetitions of active ROM exercises every 2-3 hours initially. The frequency and repetitions of exercises is progressed to 15 to 20 repetitions hourly. Passive ROM exercise of a graded nature is introduced during the early fibroblastic phase of healing and continues into the remodeling phase. Early PROM should place emphasis on elbow flexion as the loss of flexion is more functionally limiting than loss of extension. Also, the elbow is inherently stable in flexion, and early gentle passive elbow flexion exercises are well tolerated. Overzealous passive elbow extension may place undue stress to healing bony as well as ligamentous structures, placing the elbow in a compromised position, risking recurrent posterior dislocation. The patient should be able to demonstrate proper execution of passive ROM exercises before inclusion into the home program.

Upon confirmation of joint stability from the surgeon, active and passive ROM in all directions can be instituted. This typically begins at six weeks post reduction during the remodeling phase of healing, thus, soft tissue structures have likely attained sufficient tensile strength. At eight weeks postoperative, gentle strengthening exercises for the elbow flexors, extensors, forearm rotators and the shoulder are instituted.

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> Figures 4A and 4B: Figures A and B demonstrate overhead active flexion and extension exercises performed in supine with the forearm position in pronation. The forearm position during this exercise is dependent on ligamentous stability.
Orthotic Considerations

Early Extension Orthosis: It is the practice of these authors to prescribe a progressive static extension orthosis (also referred to as serial static extension orthosis) for nighttime usage (Figure 5). This is not begun until 3-6 weeks postoperatively to ensure that sufficient healing of the bony and ligament repairs has occurred. Progressive static orthotics do not apply overpressure, allowing the patient to maintain any extension achievements made during the day with ROM exercises. If a firm flexion contracture is developing, the progressive static orthosis can be worn intermittently throughout the day to provide a low-load, long-duration stretch. The patient is advised to be sedentary during this time to avoid varus/valgus loads placed on the elbow. This technique is reserved for the reliable patient population. Implementation of progressive static extension orthotic application during the early remodeling phase of healing typically allows the therapist to avoid having to later apply a mobilization orthosis to enhance extension.

Mobilization Orthotic Application & Drop Sign Considerations: Despite best efforts by surgeons and therapists, rehabilitation after elbow dislocation can be challenging and may require the need for mobilization orthotic applications to enhance ulnohumeral joint and/or forearm rotation. Several orthotic designs have been described in the literature, however, they should not be implemented until sufficient osseous and soft-tissue healing has been confirmed. In the presence of a radiographic drop sign that does not spontaneously reduce within the first six weeks following reduction, mobilization orthotic application must be used with caution. Static-progressive extension orthosis application should be used with caution with elbow flexion contractures of 30 degrees or less as ulnohumeral joint hinging may be profound in such instances. Static-progressive and dynamic elbow flexion orthotic application maybe contra-indicated in patients who can achieve 130 degrees of flexion as profound hinging may occur between the coronoid and coronoid fossa. However, this can be used with caused in patients who cannot achieve 130 degrees of flexion. Forearm rotation mobilization orthotic application can be used to regain rotation in the presence of an unresolved drop sign as this motion occurs at the proximal and distal radioulnar joints which should be in proper alignment.

Conclusion
Close communication between surgeon and therapist as well as early referral to rehabilitation is imperative to enhance outcomes after elbow dislocation. The concepts reviewed in this article should be considered to allow for an individualized rehabilitation program to be implemented. An understanding of elbow anatomy, biomechanics, and the details of the surgical details and their implications to rehabilitation are the keys to optimized rehabilitation.
References


