Traumatic Elbow Instability

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Trauma can render the elbow unstable via a combination of bone and ligament injuries. Some of these injuries feature subluxation rather than dislocation of the elbow. Effective treatment centers on restoring enough of the bony and ligamentous structures to keep the elbow in joint so that recovery can proceed as for a simple elbow dislocation. Recognition of distinct patterns of injury can help determine the structures injured and the best methods for repairing them. (J Hand Surg 2010;35A:1220–1225. © 2010 Published by Elsevier Inc. on behalf of the American Society for Surgery of the Hand.)

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Posterolateral Rotatory Instability, posteromedial varus instability, and olecranon fracture dislocations of the elbow are patterns of traumatic elbow instability that present as a continuum of injuries from stable simple elbow dislocations to chronic subluxation or dislocation. Each injury mechanism corresponds to specific injured structures, treatment strategies, pitfalls, and prognosis.

ANATOMY OF ELBOW STABILITY

The elbow is an inherently stable joint. The nearly 180° capture of the trochlea in the trochlear notch is tilted somewhat posterior, thereby increasing the anterior buttress of the coronoid process. The trochlea is wide and has a central groove that interdigitates with a ridge in the center of the trochlear notch. The contacts between (1) the anteromedial coronoid facet and the medial lip of the trochlea, and (2) the radial head and capitellum represent the most important stabilizing columns of the elbow.

This inherent bony stability is reinforced by capsuloligamentous structures. The medial collateral ligament (MCL) has been emphasized as the primary stabilizer of the elbow,1,2 but this is only true for valgus stress, as in throwing athletes.3 The importance of the MCL may be emphasized because its contribution to elbow stability is much easier to isolate in cadavers.2,4 Injury to the lateral collateral ligament (LCL) is a consistent feature of traumatic elbow instability, and problems related the LCL are responsible for a large proportion of residual subluxation or recurrent dislocation.5,6 The LCL and MCL are often referred to as complexes, to emphasize that their contributions to elbow stability are enhanced by adjacent capsuloligamentous, fascial, and musculotendinous structures.4 The anterior capsule also makes a substantial contribution to elbow stability.2 Dynamic forces from the muscles that cross the elbow joint provide an important element of stability when other stabilizing structures have been injured.7,8

SIMPLE POSTERIOR DISLOCATION (NO ASSOCIATED FRACTURES)

Most posterior dislocations occur through a posterolateral rotatory mechanism. In the act of falling onto an outstretched arm, the hand makes contact with the ground, the elbow flexes slightly, and the body rotates...
internally, causing external rotation of the radius and ulna with respect to the distal humerus. A valgus and axial force is produced on a supinated and externally rotated arm, initiating a cascade of soft tissue injury from lateral (avulsion of the origin of the LCL) to medial both anterior and posterior, with the last structure injured being the anterior band of the MCL. The elbow can dislocate with the anterior band of the MCL still intact, but in most injuries a complete capsuloligamentous disruption occurs with a variable degree of injury to the common flexor and extensor muscles crossing the elbow.5,9

Some simple elbow dislocations may occur through a distinct varus posteromedial injury mechanism tearing the soft tissue structures from medial to lateral. A small anteromedial facet coronoid fracture can be a hallmark of this injury mechanism. Based on clinical experience, we speculate that elbow dislocations that occur from medial to lateral may be less stable after manipulative reduction than those that occur from lateral to medial (Fig. 1).

Acute simple elbow dislocations can be reduced under local anesthesia, conscious sedation, or general anesthesia. Manipulative reduction should be accomplished in some flexion because extension risks entrapment of neurovascular structures. Medial or lateral displacement is usually corrected first, and then the elbow is brought forward by pulling the olecranon process toward the trochlea. Varus-valgus stability testing after reduction will not influence management—one expects everything to be torn. The elbow is immobilized as briefly as possible after relocation, definitely no longer than 2 weeks. A slight sagging of the joint (sometimes referred to as the “drop sign”)10 can often be addressed with confident active flexion exercises and avoidance of shoulder abduction (varus stress on the elbow)11 (Fig. 2). If the elbow redislocates after reduction and splint immobilization, nonsurgical treatment is unlikely to succeed.

Recurrent dislocation of the elbow after manipulative reduction can sometimes be treated reattaching the lateral collateral ligament complex, and sometimes both the lateral and medial collateral ligament complexes, but a static or hinged external fixator or even cross-pinning of the joint (particularly in older, infirm patients) can also be effective. The key is to hold the elbow reduced for about 3 weeks while the soft tissues begin to heal.

**DISLOCATION OF THE ELBOW WITH ASSOCIATED FRACTURE**

Fracture-dislocation of the elbow is most commonly defined as a dislocation of the elbow with one or more intra-articular fractures. Typically, this refers to dislocation with fracture of the radial head or with fractures of both the radial head and the coronoid process (the so-called terrible triad), but dislocation with fracture of the capitellum and trochlea and with fracture of the olecranon are also seen. Most anteromedial facet coronoid fractures and complex proximal ulna fractures (olecranon fracture-dislocations) feature subluxation, but not complete dislocation of the elbow, and therefore do not fit this traditional definition of a fracture-dislocation.

Some useful principles can help conceptualize the management of fracture-dislocations: (1) Fracture-dislocations should be converted to simple dislocations by repairing or reconstructing the bony stabilizers of the elbow; (2) the initial treatment is important because it can be difficult to salvage subacute and chronic elbow subluxation with damage to the articular surfaces12; (3) restoration of motion results from restoration of a congruent stable joint.

**ELBOW DISLOCATION WITH FRACTURE OF THE RADIAL HEAD**

The studies of Josefson and colleagues and Broberg and Morrey documented that elbow dislocation with fracture of the radial head is associated with a stable elbow in most patients, even if the radial head is excised or not specifically treated.13,14 Furthermore, patients casted for a month were able to regain functional ulnohumeral motion in most cases, although secondary radial head resection was often needed to restore forearm rotation.

Nonetheless, we usually recommend surgical treatment consisting of repair or replacing the radial head and reattaching the origin of the lateral collateral ligament complex to the lateral epicondyle. Surgical treatment limits later problems related to the radial head.
fracture and restores stability sufficient to avoid a cast and begin active elbow exercises (with avoidance of shoulder abduction/varus stress) within a few days of surgery in most patients.

**ELBOW DISLOCATION WITH FRACTURES OF THE RADIAL HEAD AND CORONOID PROCESS (“TERRIBLE TRIAD”)**

Dislocation of the elbow with fractures of the radial head and coronoid has been referred to as the terrible triad of the elbow, owing to frequent problems with persistent instability, stiffness, and degenerative changes (Fig. 3A). Standard protocol for treatment including repairing or replacing the fractured radial head, open reduction and internal fixation of the coronoid fracture, and reattaching the origin of the lateral collateral ligament complex to the lateral epicondyle has improved the results of treatment. On the basis of biomechanical research and concerns about heterotopic ossification, some surgeons favor selective...
coronoid repair, but our preference is to repair all displaced coronoid fractures in the setting of a terrible triad injury because of the unpredictable nature of the injury, the established potential for postoperative dislocation, and the fact that most heterotopic ossification occurs anterior to the radial neck and not anterior to the coronoid.

One can use either a single posterior longitudinal incision, elevating a lateral skin flap, or smaller individual incisions as needed (usually one lateral and one small dorsal incision to pass sutures through the ulna). In our opinion, the coronoid is best repaired with a suture loop passed through drill holes in the ulna (facilitated by a drill guide from the anterior cruciate ligament reconstruction set) (Fig. 3B). The radial head is repaired if possible, but in many patients some fragments are too small or cannot be located, and the surgeon should be ready to replace the radial head with a prosthesis; this adds a critical element of stability. The origin of the LCL is reattached to the lateral epicondyle using suture anchors or drill holes through bone. If the elbow still subluxates or dislocates in full gravity extension with the forearm in neutral rotation, consideration can be given to reattaching the origin of the MCL to the medial epicondyle, applying a static or hinged external fixator, or cross-pinning the joint (a useful option when more sophisticated techniques are either unavailable or unfamiliar) for a few weeks (Fig. 3C, D).

**FRACUTURE-SUBLUXATIONS**

**Anteromedial facet coronoid fractures**

Varus posteromedial instability is a recently recognized pattern of elbow injury, the hallmark feature of which is an anteromedial facet coronoid fracture. The most common form of this injury has an associated avulsion of the origin of the lateral collateral ligament complex from the lateral epicondyle, and presents as subluxation rather than dislocation of the ulnohumeral joint. The lesion can be subtle, but when not treated appropriately, the instability and malalignment result in arthrosis. As an alternative, the olecranon may fracture. The lateral collateral ligament or olecranon fracture should be repaired and the anteromedial facet of the coronoid should be repaired with a medial buttress plate applied through the split in the flexor carpi ulnaris (Fig. 4). 

A limited subset of patients with small coronoid fractures and no ulnohumeral subluxation on computed tomography can be treated nonsurgically.
with active motion and avoidance of varus stress for one month.

**Olecranon fracture-dislocations**

Anterior or posterior olecranon fracture-dislocations typically feature disruption or subluxation of the ulnohumeral joint, but complete dislocation with loss of articular surface apposition is uncommon. In anterior olecranon fracture-dislocations, the radial head usually is not fractured, the collateral ligaments remains intact, and the coronoid fracture is a simple large fragment.

Posterior olecranon fracture-dislocations usually feature a coronoid fracture at the base that is comminuted about half the time, a radial head fracture consistently, and avulsion of the lateral collateral ligament from the lateral epicondyle in about half of patients.\(^{21-23}\)

Whether the fracture of the proximal ulna is apex posterior or apex-anterior, the key to optimal treatment is stable fixation with restoration of the contour and dimensions of the trochlear notch (Fig. 5). In our opinion, posterior olecranon fracture-dislocations also benefit from repairing or replacing the radial head and reattaching the lateral collateral ligament origin to the lateral epicondyle with either suture anchors or sutures placed in drill holes through the bone.
SUBACUTE AND CHRONIC POSTTRAUMATIC INSTABILITY

When subluxation or dislocation of the elbow persists after more than 2 weeks, repair of the osseous and ligamentous contributions to stability may be insufficient and temporary static or hinged external fixation may be necessary. When this is not available, it is reasonable to cross-pin the joint because a stiff located joint is easier to salvage than a damaged articular surface.

When part of the radial head is missing, a prosthetic radial head should be used. If the coronoid is insufficient, reconstruction with a fragment of radial head or the tip of the olecranon might help, although for large coronoid fragments this is not always enough to prevent subluxation of the elbow.

The origins of the lateral collateral ligament and the common extensors are released for exposure and then securely reattached at the end of the case. Reattachment of the MCL is optional, as for acute injuries.

Recurrent simple dislocation of the elbow is usually due to chronic posterolateral rotatory instability, which is usually encountered after dislocation in adolescents, but can also be encountered as an iatrogenic complication of the treatment of lateral epicondylitis or other elbow conditions. More subtle degrees of posterolateral rotatory instability associated with pain or clicking in the absence of recurrent elbow dislocation are less understood and more open to debate.

Chronic valgus laxity was noted in only one study of traumatic elbow dislocation. It either occurs rarely or does not present much of a functional problem. Chronic valgus laxity is a problem restricted almost entirely to throwing athletes, with a few iatrogenic cases. Patients who are willing to give up or modify their throwing activities do not need treatment. Reconstruction of the medial collateral ligament with a tendon graft provides an opportunity to continue to throw at a high performance level.

Understanding the patterns of traumatic elbow instability helps the surgeon counsel and manage patients with these injuries. This is an area that is rapidly evolving, and there are several areas of debate. Key principles include the fact that the collateral ligaments usually heal if the elbow is kept reduced; the importance of restoring radiocapitellar contact; the key role of the coronoid process, no matter the size of the fracture fragment; and the priority of stability/alignment over motion.

REFERENCES