29 Elbow Instability

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29.1 Introduction

The elbow is a trochleoginglymoid joint [1] consisting of three articulations: the humeroulnar, the humeroradial, and the proximal radioulnar joint.

This configuration makes the elbow a fairly constrained and one of the most congruous and stable joints of the body. The ulna and the radius are connected by the forearm interosseous membrane which highly contributes to the stability of the proximal and distal radioulnar joints.

The normal range of motion of the elbow is approximately 0° of extension and 140° of flexion. A functional range of motion for activities of daily living has been described to be of 30°–130°, and the functional arc of throwing ranges from 20° to 130°. The normal supination and pronation are both of approximately 80° [2].

Although it is not a weight-bearing joint, it can be subjected to high loads when practicing racket or throwing sports or in gymnastics. As a consequence of these continued sport activities, elbow stability, due to static and dynamic constraints, can be compromised.

The elbow is the second most commonly dislocated major joint [3], and 15–35 % of elbow dislocations can have residual instability [4, 5]. Elbow dislocations represent 11–28 % of all elbow injuries, with an annual incidence of 6–8 cases per 100,000 people [6].

The symptoms of the instability in athletes can occur following a single traumatic event or may be due to repetitive stress leading to chronic laxity such as in a throwing athlete.

The focus of this chapter will be on elbow instabilities connected to sport activities. The causes of instabilities can be divided into medial, lateral, and posterolateral rotatory (PLRI).

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29.2 Etiology

The elbow joint is one of the most useful joint of the body. Its stability is due to different structures that can be divided into primary and secondary stabilizers [7].

The elbow is a very congruous joint with two ligamentous complexes: MCL and LCL. They are involved in the pathoanatomy of throwing athletes or in elbow dislocations and instability.

The primary stabilizers are represented by:

- Ulnohumeral joint, a stable articulation in which the humeral trochlea articulates with the ulnar notch (or incisura semilunaris) of the proximal ulna, with greatest stability in full extension and flexion. This stability is augmented by compressive forces of muscles.
- Anterior bundle of medial collateral ligament that is the primary valgus stabilizer among the different components of the medial ligament complex [8–10]. The medial collateral ligament complex (MCL) consists of three bundles with different insertions forming a triangular shape: the anterior, posterior, and transverse. The anterior bundle (or anterior oblique ligament) is the most significant component of the MCL, being the main stabilizer to valgus stress of the elbow [8, 11–13]. The anterior bundle can be further divided into anterior and posterior bands [8, 11, 14]. Some authors have included a third deep middle band [15, 16] (Fig. 29.1).
- Lateral ligament complex, made up of lateral ulnar collateral, radial collateral, annular ligament, and the accessory collateral ligament described by Martin [17]. This complex is the primary restraint to posterolateral rotatory instability and varus forces. To create functional posterolateral instability are necessary combined injuries. In fact isolated lateral ulnar collateral or radial collateral ligament injuries do not result in instability [18, 19].

The secondary stabilizers are represented by:

- Radial head: an important secondary restraint [10] because 60 % of axial loads are imparted through radiocapitellar

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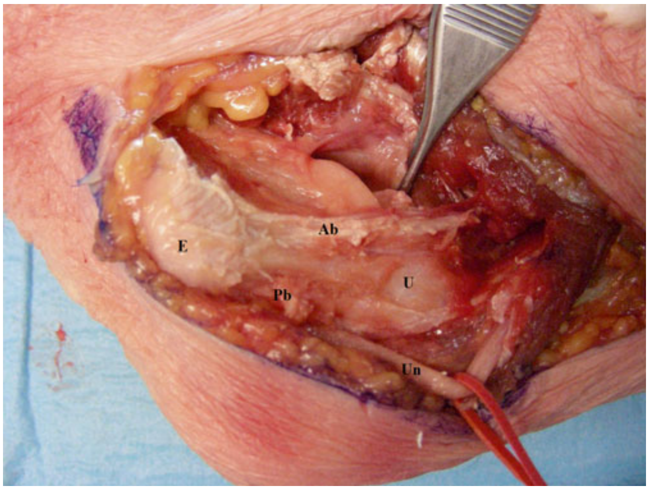

Fig. 29.1 Medial collateral ligament and ulnar nerve. *E* medial epicondyle, *Ab* anterior bundle, *Pb* posterior bundle, *U* ulna, *Un* ulnar nerve

joint [20]. Radial head injuries compromise lateral and medial stability by decreasing tension in the lateral ligament complex and because it is a secondary restraint to valgus load, respectively.

- Capsule: surrounding entirely the joint and gives better contribution in extension.
- Muscular support: anterior and posterior muscles that travel across the elbow and enable flexion and extension mobility. The elbow is also the site of origin for the flexor/pronator and extensor/supinator musculature of the forearm located medially and laterally, respectively. Anconeus muscle is anatomically oriented to provide restraint to posterolateral rotatory instability. The extensor/supinator musculature provides dynamic lateral stability; it is often avulsed with lateral ligaments. The flexor/pronator musculature provides dynamic valgus stability. These musculature groups have compression effect on ulnohumeral joint, augmenting bony stability [21].

29.3 Injury Mechanism

The mechanisms of injury are represented by subluxation and dislocation events.

The instabilities can be divided into simple and complex. The simple elbow instability indicates a dislocation with soft tissue lesions without associated fractures that can compromise joint stability [6, 22]. The most frequent form is a posterior dislocation produced by a posterolateral rotation mechanism (PLRI) as described by O'Driscoll [23].

The term complex elbow instability, which replaces the former "fracture–dislocation" and "transolecranon fracture," means on the other side the association of ligaments and bony lesions.

Simple dislocations without any secondary injuries to the bone occur more often than complex dislocation [6]. The latter account for 15–20 % of all elbow dislocations [24, 25].

Referring to direction and mechanism of dislocation, we can distinguish PLRI and valgus stress (which can be posttraumatic or due to overuse).

So dislocations can be simple (with only soft tissue injuries) and complex (with bone and soft tissue injuries).

Simple dislocations are classified as anterior, posterior (direct posterior, posterolateral, and posteromedial), and divergent (extremely rare in which the humerus is jammed between the radius and ulna and the interosseous membrane is destroyed) [26, 27].

Complex dislocations can be anterior and posterior.

A posterior dislocation is caused by a fall on the wrist while the elbow joint is extended and the wrist is pronated. The impact of the tip of the olecranon on the olecranon fossa has a leverage effect, while the coronoid process slips in a dorsal direction over the trochlea of humerus [23, 28].

A posterior dislocation is also caused by a fall on hand with a flexed elbow joint where the force, acting in a direct axial direction, makes the olecraon slip out [29, 30].

An anterior dislocation occurs through a combination between a flexed elbow and a force acting dorsally.

The most common mechanism is fall on outstretched hand generating axial load through the elbow.

29.3.1 PLRI

In all posterior dislocations, there is a lateral ligament disruption generating the so-called posterolateral rotatory instability (PLRI) [31, 32].

PLRI consist in three stages of instability that correlates with the severity of soft tissue injury:

Stage 1 – injury to lateral ligaments and extensor origin so this causes posterolateral shift of ulnohumeral and radiocapitellar joints.

Stage 2 – injury propagates to the anterior and posterior capsules, so this causes posterolateral subluxation with perching of the coronoid under the trochlea.

Stage 3 – posterolateral dislocation:

- 3a: anterior bundle of MCL is intact, so there is pivoting around intact ligament.
- 3b: anterior bundle of MCL is disrupted with complete dislocation (the most common injury pattern).
- 3c: complete stripping of all soft tissue from the distal humeral. It is grossly unstable unless flexed >90°.

O'Driscoll et al. [23] described a circle strategy for the sequence of injuries to soft tissue regarding to a simple posterior dislocation. The force generated flows from lateral to medial. This leads to rupture of the LCL, then the anterior and posterior capsules, and lastly the MCL.

29.3.2 Valgus Injuries

These injuries can be determined by falling with severe valgus moment or combined with direct contact at lateral elbow, often seen in contact athletes.

Repetitive microtraumas represent a common mechanism for valgus injuries in throwers.

Most common clinical pictures are represented by medial ligament injury, avulsion of flexor/pronator mass, and radial head/neck compression fractures.

29.3.3 Varus Injuries: Posteromedial Dislocation

Frequently due to a fall, a lateral ligament injury is often associated with medial facet coronoid fractures.

29.3.4 Complex Injuries

The mechanism of injury is similar to simple dislocation. Loading pattern and arm position determine associated bony lesions.

The timing of the lesions can be acute (post-traumatic) or chronic (post-traumatic or due to overuse).

29.4 Clinical Evaluation

First of all, it is necessary to have a complete medical history of the patient to locate the seat of the pain and the mode of onset, acute or chronic, and the cause, traumatic or not.

The patient may report a lateral elbow pain; a feeling of popping, snapping, or shifting; or recurrent subluxation or dislocations.

Patient may have apprehension while performing activities requiring forced extension of the elbow. The patient who practices sport launch may experience pain in the medial elbow during the acceleration phase.

Atraumatic onset is uncommon with PLRI.

Throwers may have changed their training; they can report loss of velocity and control.

The examiner should assess any predisposing factors such as surgical procedures performed in the lateral region as aggressive tennis elbow release, radial head resection, multiple lateral elbow injection (due to the possible weakening of the ligaments) and prior injury as cubitus varus for pediatric supracondylar humerus fracture malunion.

Anatomical deformity of the profile can hide bone injury or dislocation of the joint.

Before any clinical maneuver, it is important to rule out bony, nervous, and vascular disorders [24].

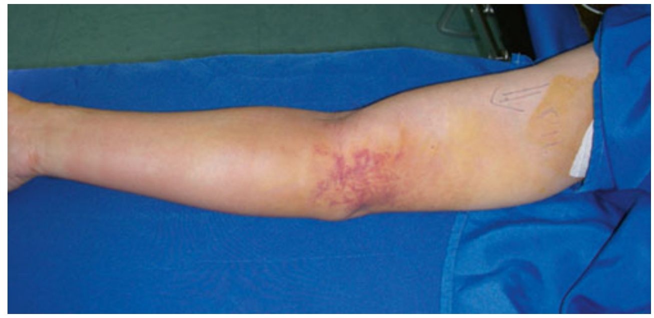

Fig. 29.2 MCL acute tear and elbow bruise

Clinical examination must include an accurate assessment of the ipsilateral shoulder, elbow, and wrist to exclude the presence of previous injuries or pathologies.

An evaluation of the ipsilateral distal radioulnar joint and the interosseous membrane for the presence of an Essex–Lopresti injury would also appear to be important [33, 34].

An injured elbow may be swollen due to the presence of periarticular edema or hematoma (Fig. 29.2). It is important to exclude the presence of a compartmental syndrome which rarely can develop from the beginning of the trauma. Therefore, clinical monitoring during the early hours is necessary [23].

Excluding bone and neurovascular lesions, stability tests must be performed.

Sometimes these maneuvers are performed after sedation (because of the pain) and under radiological control for better assessment.

Some patients arrive in the emergency department with joints which have already been spontaneously reduced.

In such cases, the diagnosis is derived from the case history and any possible instability, which may be present.

Several clinical maneuvers have been described to highlight different types of elbow instability.

29.4.1 Valgus Instability

Patients with this kind of instability usually report medial elbow pain and decreased strength during overhead activity; there may be symptoms of ulnar neuropathy from either acute or chronic UCL injury caused by edema/hemorrhage of the medial elbow or excessive traction on the nerve.

Patients with isolated UCL injury often have point tenderness 2 cm distal to the medial epicondyle, slightly posterior to the common flexor origin. The UCL stability can be assessed with specific physical exam tests. The "milking maneuver" involves having the patient apply a valgus torque to the elbow by pulling down on the thumb of the injured extremity with the contralateral limb providing stability [35]. With the modified milking maneuver, the examiner provides stability to the patient's elbow and pulls the thumb to create a valgus stress on the UCL [36]. These tests result in pain and widening at the medial joint line if the UCL is insufficient. O'Driscoll and coworkers described the moving valgus stress test, in which the valgus torque is maintained constantly to the fully flexed elbow and then quickly extends the elbow [37]. This test is positive if medial elbow pain is elicited and has a 100 % sensitivity and 75 % specificity. The abduction valgus stress test is performed by stabilizing the patient's abducted and externally rotated arm with the examiner's axilla and applying a valgus force to the elbow at 30° of flexion. Testing with the forearm in neutral rotation has been shown to elicit the greatest valgus instability [38]. A positive test results in medial elbow pain and widening along the medial joint line. Even so, valgus laxity can be subtle on physical exam, and the range of preoperative detection is between 26 and 82 % of patients [39, 40]. Furthermore, Timmerman and colleagues found valgus stress testing to be only 66 % sensitive and 60 % specific for detecting abnormality of the anterior bundle of the UCL [41].

29.4.2 PLRI

PLRI is first described in 1991 by O'Driscoll and colleagues in a series of five patients [32].

The clinical mechanism of injury to the lateral stabilizers of the elbow that results in PLRI has been hypothesized to consist of supination of the forearm, combined with a valgus and axial load to the elbow [23]. The presentation is variable and can include lateral elbow pain; mechanical symptoms such as snapping, clicking, catching, or locking; and recurrent episodes of instability. Patients often report their elbow feels loose or like it is sliding out of place, especially when loading it in a slightly flexed position with a supinated forearm, as when pushing off an armrest while standing from a chair.

On physical exam, patients often have normal upper extremity strength and elbow range of motion and minimal to no tenderness around the LCL complex. Several provocative maneuvers have been developed to elicit instability symptoms. The posterolateral rotatory instability test is performed by supinating the forearm and applying valgus and axial forces to the elbow while flexing the elbow from full extension [32]. A positive test is demonstrated by reduction of a subluxated radial head when the patient is under general anesthesia or apprehension during testing when the patient is awake [32]. More recently, Regan and Lapner described two other apprehension tests, the chair sign and push-up sign [42]. The chair sign is performed by having the patient actively push off the armrests of a chair with the forearms supinated and the elbows at 90°. The test is considered positive with reluctance to fully extend the elbow during push off. The push-up sign is conducted by having the patient push off from the ground with the forearms supinated, elbows at 90°, and arms abducted to greater than shoulder width. A positive test results in apprehension and guarding as the elbow is terminally extended. These apprehension tests have been determined to be more sensitive than the posterolateral rotator instability test in awake patients. The table-top relocation test has been recently described by Arvind and Hargreaves [43]. The patient is asked to stand in front of a table. The hand of the symptomatic arm is placed over the lateral edge of the table. The test involves three parts. The patient is initially asked to perform a press-up with the elbow pointing laterally. This maintains the forearm in supination. Pressure is pushed down through the hand onto the table, as the elbow is allowed to flex (bringing the chest toward the table). In the presence of posterolateral rotatory instability (PLRI), positive apprehension and a reproduction of the patient's pain occur as the elbow reaches approximately 40° of flexion. The maneuver is then repeated, using the thumb of the examiner placed over the radial head, giving support and preventing posterior subluxation while the press-up is performed. Patients with posterolateral rotatory instability find that their symptoms of pain and instability are relieved by this second maneuver, which is similar to the relocation test of the shoulder. Finally, removal of the examiner's supporting thumb from the weight-bearing, partially flexed elbow reproduces the pain and apprehension. The relief and recurrence of pain during the second and third maneuvers helps to exclude articular pathology as the cause of pain and reinforces the diagnosis of instability.

29.5 Diagnostic Imaging

Conventional plain anteroposterior and lateral radiographs should be taken before any clinical maneuver. Oblique views may be necessary for a better assessment of the coronoid process and the radial head [6, 33]. Depending on the symptoms and pain experienced, radiographs should also be made of the adjacent joints. Similar to medial elbow instability, plain radiographs of the elbow are used to identify an avulsion fragments or associated fractures (e.g., coronoid, radial head) that can contribute to instability. Associated arthritic changes or loose bodies may also be seen. Widening of the ulnohumeral joint space after reduction of an acute dislocation, the so-called drop sign, has been associated with significant ligamentous injury and increased risk of recurrent instability [44].

Stress radiographs can be taken at the point of maximum rotatory subluxation during the pivot-shift test and may show widening of the ulnohumeral joint space on the lateral and anteroposterior views and posterior subluxation of the radial head on the lateral view.

CT scan is mandatory in course of complex dislocations [6, 24, 33].

MRI/arthroMRI is useful in case of chronic instabilities evidencing chondral associated lesions and possibly showing a leakage of contrast fluid in case of lateral or medial collateral lesions [45].

29.6 Treatment Strategy

The goal of the treatment is to achieve stable reduction of the elbow to begin as soon as possible a rehabilitation treatment to void stiffness [6, 46].

In the course of acute trauma with simple dislocation, the reduction maneuver generally does not require general anesthesia and can be performed with intravenous sedation.

Stability tests are carried out after the reduction, and in stable elbows, the rehabilitative protocols are begun in 10 days.

In case of instability, when the elbow joint remains reduced in a range from at least 60° of flexion to full flexion, the patients can start supervised active rehabilitation in stable arc of motion in hinged brace [6].

If there is not a stable arc of motion, open reduction with LCL or MCL repair or reconstruction is necessary.

29.7 Treatment of UCL Lesions

Initial treatment consists of rest, anti-inflammatory medications, icing, and bracing.

Literature reports 42 % success rate in returning to previous sport activities at 6 months' follow-up in conservative treatment [3, 47, 48].

These modest results lead to consider surgical treatment, particularly in high-level athletes as treatment of choice.

UCL repair is considered only in case of avulsion injuries in younger athlete [3, 47], performing surgery soon after injury and having MRI showing complete avulsion from the bone [47].

In adults, also in acute events, it is frequent to find an intrasubstance damage of the UCL, and the reconstruction must be considered.

Autografts or allografts can be used in performing UCL reconstruction.

The palmaris longus, if present, or the hamstring tendons are commonly utilized as graft source.

The original technique was performed in 1986 by Jobe, the "Tommy John procedure," from the name of the pitcher who was operated [49]. Several modifications to the original technique have been described in order to decrease morbidity, avoid ulnar nerve transposition, and obtain a better graft fixation.

A modification involving docking the two ends of the tendon graft into a single blind-ended humeral tunnel and tying the sutures over a humeral bone bridge or fixing graft with interference screws [50] was later described.

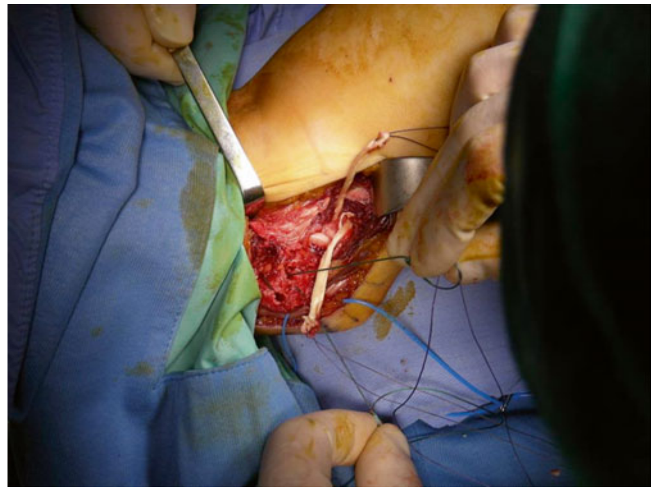

Fig. 29.3 Double-loop graft (semitendinosus) fixation with a 6 mm interference screw in a 7 mm bone tunnel at ulnar level

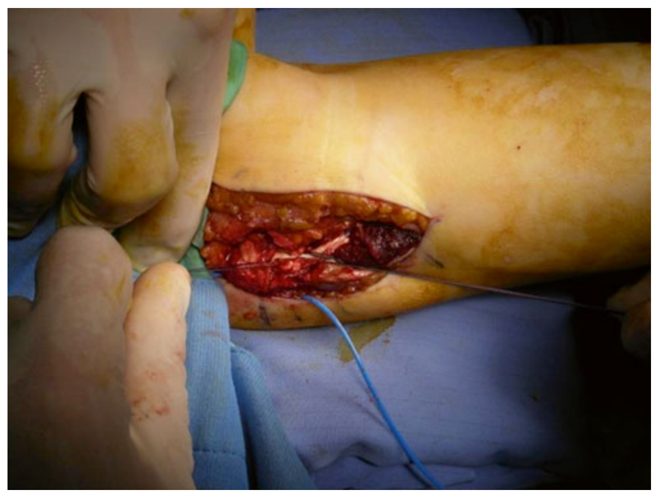

Fig. 29.4 Double-loop graft passed in the 7 mm humeral tunnel and in the 4.5 mm convergent tunnel and then sutured on itself

More recently, we presented a new double-bundle technique [51] in which, using gracilis from homolateral knee, we fix the distal insertion of the UCL using a bioabsorbable screw and the proximal insertion in a 7 mm (diameter) blinded tunnel connected to two 4.5 mm (diameter) divergent tunnels in which every single bundle is passed through (Fig. 29.3). The residual part of the tendon is sutured over itself at different degrees of flexion: anterior bundle at 30° and posterior bundle at 70° (Fig. 29.4).

This technique allows to reconstruct a new ligament tensed in all arc of motion and thick enough to reproduce the original UCL.

Postoperatively, the elbow is positioned in brace for 6 weeks, and rehabilitative protocols start in 2 weeks.

Sport activity progression is initiated at 3–4 months, and return to sport is allowed at 6–8 months post-op.

Reported outcomes of UCL surgery are generally favorable, and in the largest study to date, 83 % of 743 athletes were able to return to a previous or higher level of competition [52]. The most common complications are (often temporary) ulnar or medial antebrachial nerve dysfunction, stiffness, medial epicondyle fracture, and nonspecific elbow pain.

29.8 Treatment of LCL Lesions

After a simple elbow dislocation, most LCL injuries do not require surgical treatment. They are managed initially by splinting with the forearm in pronation to maximize stability. Graduated range of motion exercises are introduced over the first 6 weeks, and in most cases, the torn LUCL will heal and stability will be restored.

Recurrent PLRI after physiotherapy and bracing can require surgical reconstruction using autografts or allograft tendons.

Nestor et al. [53] described in 1992 LUCL reconstruction.

The LUCL is fixed at the origin of the LCL near the tip of the lateral epicondyle and attached to the supinator crest of the ulna.

Many methods of fixation have been described involving multiple osseous tunnels in the humerus and ulna. The grafts are tensioned with the forearm pronated at 30/40° of flexion.

Anterior and posterior lateral capsules can also be imbricated if further stability is required.

Savoie et al. have also described an arthroscopic plication of the posterolateral ligamentous complex with good results [54].

Postoperatively, protocols are based on brace, avoiding terminal 30° of extension for the first 6 weeks.

Sport activity is allowed 6 months after surgery [55].

A largest series of patients reported by Sanchez-Sotelo J et al. [56] showed 86 % of 44 patients had a satisfactory outcome after LUCL reconstruction or repair.

Better results were seen in patients with reconstruction using a tendon graft rather than repair.

Conclusions

Elbow instabilities in athletes comprise a large of spectrum pathologies from medial instabilities in throwing athlete to traumatic posterolateral rotatory instability.

A better comprehension of biomechanical factors and the development of radiological studies allow authors to increase the quality of the diagnosis and the result of surgical treatments.

The poor result of the conservative treatment indicates surgical approach as the treatment of choice in UCL and LCL lesions in athletes.

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