20 Evaluation of Sports-Related Elbow Instability

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20.1 Introduction

The clinical assessment of the elbow in athletes can be extremely challenging.

An adequate evaluation requires knowledge of the anatomy and biomechanics.

The best approach is a step-by-step one: (1) history, (2) inspection, (3) palpation, (4) passive motion, (5) active motion, (6) active motion against resistance, (7) neurologic examination, and (8) lidocaine test.

These eight steps will allow a clinical diagnosis to be made in most cases of athletes with elbow instability: all maneuvers should be performed on both upper extremities for comparison; ipsilateral shoulder and wrist examination should not be forgotten [1].

Overhead and throwing athletes subject the elbow to significant loads, which can lead to multiple degrees of instability. Elbow injuries in the throwing athlete are most of the time the result of the high valgus and extension forces acting on the elbow during the throwing motion. These forces result in tensile stress on medial structures, compression stress on lateral structures and shear stress posteromedially [2].

The height and weight of the athlete should be noted; a higher incidence of ulnar collateral ligament (UCL) injuries has been found in taller and heavier baseball players. This may be because heavier players may throw harder and taller player has longer extremities, resulting in a longer fulcrum and therefore greater forces on the UCL [3].

Instability in elbows can occur on a frontal plane (valgus–varus), on a longitudinal one (posterolateral–posteromedial), or both.

The center of the elbow varus–valgus axis is along the center of the trochlea, which is located medial to the midline. Therefore, valgus elbow stress with compromised medial structures produces less medial gapping than varus stress when the lateral structures are injured [4].

Here is a list of the most common instability tests, that will be described in detail later in this chapter:

20.2 Instability Tests

Medial instability

- Valgus stress test
- Milking maneuver
- Moving valgus test
- Posteromedial pivot shift

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J. G. Lane et al. (eds.), *The Art of the Musculoskeletal Physical Exam*,
https://doi.org/10.1007/978-3-031-24404-9_20

Lateral instability

- Varus stress test
- Posterolateral pivot shift
- Posterolateral drawer test
- Table-top relocation test
- Stand-up test/chair push-up test
- Push-up test

20.3 Medial Instability

Valgus stability is provided by the osseous anatomy of the olecranon and the humerus, the dynamic muscle forces, and the medial ulnar collateral ligament (M-UCL) complex. The interlocking bony anatomy of the olecranon with the olecranon fossa provides stability from 0 to 20° of flexion. If the elbow is bent more than 20°, the M-UCL is more important, and the majority of stress is placed on its anterior bundle [1].

Lesions of the UCL can be evaluated with the valgus stress test, the moving valgus stress test, and the milking maneuver.

Palpation of the ulnar collateral ligament (UCL) is performed with the elbow in approximately 50°–70° of flexion, allowing the anteposition of the overlying medial muscle mass with respect to the fibers of the UCL. The ligament should be palpated along its entire course, beginning at its origin from the inferior aspect of the medial epicondyle and progressing distally to its insertion onto the sublime tubercle of the proximal medial ulna, searching for tender points that could indicate partial injury. Tenderness over the UCL has an 81–94% sensitivity but only a 22% specificity for UCL tears [5, 6]. When there is an acute UCL injury, ecchymosis may develop along the medial elbow and proximal forearm, reducing even more specificity [4].

The diagnosis of medial epicondylitis must be considered, although the presence of medial epicondylitis does not rule out M-UCL injury because they may coexist. Patients with flexor-pronator epicondylitis have pain with resisted wrist flexion when the elbow is fully extended and localize their pain just anterior and distal to the common flexor muscle origin. In contrast, patients with a M-UCL injury typically have point tenderness about 2 cm distal to their medial epicondyle [4]. **M-**UCL injury may also be differentiated from medial epicondylitis by performing the ***valgus stress test*** with the wrist in passive flexion and pronation to eliminate tension on the flexor-pronator mass [7]. Medial pain with this modification likely indicates UCL injury rather than medial epicondylitis or muscle injury [2].

The elbow should be assessed for a fixed flexion and valgus deformity, sometimes seen in older baseball pitchers, which can predispose athletes to ulnar neuritis [8, 9].

When the UCL is injured, the ipsilateral shoulder appears to have increased external rotation on physical examination [10].

A thorough neurovascular examination should follow, with attention to the ulnar nerve distribution. Examination of the shoulder and scapula is critical because altered mechanics can alter throwing mechanics through the kinetic chain. A glenohumeral internal rotation deficit is associated with valgus instability in throwers [11].

The neck should be a potential source of referred pain and needs to be considered.

"Surgery thoughts" should request the evaluation for presence or absence of a palmaris longus (PL) tendon: ask the patient to touch the ipsilateral thumb and small finger and flex the wrist to detect the tendon. It is a potential autograft source for UCL reconstruction but is absent in 1 extremity in 3% and absent in both extremities in 2.5% of white people in North America [12].

The most critical component of the physical examination when UCL injury is suspected is assessment of the UCL functional integrity through various tests subjecting the elbow to a valgus force and assessing for medial joint space opening, the quality of an eventual end point, and medial-sided pain [4].

Valgus stress test is performed to evaluate injury to the anterior bundle of the anterior oblique ligament (AOL) of the M-UCL. Although cadaveric studies have suggested 70°–90° elbow flexion as the optimal position to isolate the contribution of the UCL to valgus stability, it is difficult to control humeral rotation and apply valgus stress at that angle. Therefore, testing is best performed at 20°–30° elbow flexion with the forearm pronated. Valgus stress test may be performed with the patient seated upright, supine, or prone. Norwood and colleagues described valgus stress test of the elbow with the forearm supinated at 15°–20° elbow flexion to unlock the olecranon from the olecranon fossa [13].

It is now recognized that forearm pronation prevents subtle posterolateral instability (pseudo-valgus instability) from mimicking medial laxity [14].

To perform the valgus stress test on the right elbow in the seated or supine position, the examiner stabilizes the humerus with the left hand just above the humeral condyles and applies a valgus moment with the right hand while grasping the patient's pronated forearm (Fig. 20.1). In the prone position, the examiner stabilizes the humerus in 90 shoulder abduction with the right hand above the humeral condyles, flexes the elbow 20°–30°, and applies valgus stress with the left hand on the patient's pronated forearm.

Traditionally, the humerus is stabilized, the forearm pronated and the elbow is subjected to a valgus stress at about 20–30 elbow flexion. In a positive test, there is no firm end point and the articular surfaces of the ulna and medial humeral condyle are felt to move apart and the forearm swings out laterally [13]. About half of patients with a torn M-UCL are painful at the test [5]. This test is 66% sensitive and 60% specific for

Fig. 20.1 The ***valgus stress test*** is performed with the humerus externally rotated, the elbow flexed to 20°–30° and the forearm pronated

detecting abnormalities of the anterior band of the anterior oblique ligament (AOL) [6].

Comparison with the opposite elbow is mandatory.

Detecting significant instability is often very subtle in the throwing athlete because of the relatively small degree of medial opening on examination, even in case of significant ligament injury. The literature shows that a complete sectioning of the anterior bundle of the M-UCL only increases medial opening by 1–2 mm [15, 16]. This fact highlights the importance of comparing findings with the contralateral side. Accordingly, even the most experienced elbow surgeons are only able to detect preoperative valgus laxity on physical examination in between 26 [17] and 82% [5] of patients with operative M-UCL tear.

For pain as an outcome, the test showed 65% sensitivity and 50% specificity. However, by using laxity as outcome, the test had a disappointing sensitivity but perfect specificity of 100% [18].

Veltri and colleagues described the ***"milking maneuver"*** to evaluate valgus stability [19]. While the valgus stress tests the anterior band of the AOL, the milking maneuver tests the posterior band of the AOL. Patients with a UCL injury may report a feeling of apprehension, instability, and medial joint pain [20].

With the patient seated, the examiner grasps the thrower's thumb with the arm in the cocked position (90° shoulder abduction and maximum external rotation, removing shoulder external rotation as a confounding variable, and 90° elbow flexion, with forearm supinated) and applies valgus stress by pulling down on the thumb with one hand. The examiner's hand that is being used to hold the elbow is also used to palpate the medial joint line to feel for joint space opening and an end point (Fig. 20.2). This position is felt to be similar to pulling down on the teats when milking a cow, hence the name [1, 4].

In literature the ***milking manoeuvre*** was described, but no evidence on diagnostic accuracy has been found [21, 22].

The "moving valgus stress test" (Fig. 20.3) is a variation and is performed with the examiner beginning in the position of the standard milking

Fig. 20.2 The ***milking maneuver*** and the ***moving valgus stress test*** can be performed with the patient supine and the arm can be supported against applied valgus by the examiner hand

Fig. 20.3 The ***milking maneuver*** and the ***moving valgus stress test*** can also be performed with the patient in the sitting position; and the arm can be supported against applied valgus by the patient hand, in this way the examiners second hand is free to palpate the medial side of the elbow

maneuver and extending the elbow from 120° flexion to 20°–30° flexion while applying valgus stress (pulling the thumb toward the floor).

This alternative way of testing the M-UCL, as described by O'Driscoll and colleagues [23] is performed with the patient in an upright position and the shoulder abducted 90°. Starting with the elbow maximally flexed, a modest valgus torque is applied to the elbow until the shoulder reaches its limit of external rotation. While a constant valgus torque is maintained, the elbow is quickly extended to about 20°–30°. The test is positive when the pain generated by the maneuver reproduces exactly the medial elbow pain at the M-UCL that the patient has with activities. Second, although the patient may experience pain throughout the range, the pain should be maximal between the position of late cocking (120°) and early acceleration (70°) as the elbow is extended (Fig. 20.3).

With the ***moving valgus stress test*** sensitivity for an M-UCL insufficiency is reported at 75% and specificity 100% [18].

There is 100% sensitivity and 75% specificity using arthroscopic valgus stress testing and surgical exploration of the M-UCL as the gold standard [23].

20.4 Lateral Instability

Varus stability is provided by the osseous anatomy of the olecranon and the humerus, the dynamic muscle forces and the lateral collateral ligament (LCL) complex. Varus instability is less common, because a direct impact on the medial side causing varus of the elbow is difficult as the body protects the medial side most of the time [1].

Although lateral instability is uncommon in the throwing athlete, other athletes may present with chronic elbow instability after a traumatic elbow dislocation. Several tests have been described to evaluate the LCL complex [14, 24].

During the ***varus stress test***, the patient's arm is stabilized with one of the examiners hands at the medial distal humerus, and the other hand is placed above the patient's lateral distal radius with the elbow flexed around 20°–30°. An adduction or varus force is applied at the distal forearm by the examiner to test the radial collateral ligament. Varus stress is better applied with the humerus in full internal rotation (Fig. 20.4).

Fig. 20.4 ***Lateral pivot-shift stress test*** by O'Driscoll

Fig. 20.5 The ***chair push-up test***; the test is considered positive if there is a reluctance to extend the elbow fully as the patient raises his body up from a chair using exclusively upper extremity force with forearm supinated

20.5 Rotatory Instability

A combination of instability on both frontal and longitudinal axis can occur. Posterolateral instability is more common than posteromedial instability.

The most common test for **posterolateral instability** is the ***lateral pivot-shift test*** described by O'Driscoll et al. [14]. During this test, the patient is supine with the affected limb overhead. With the forearm supinated, valgus and axial loading is applied, and the elbow is flexed from full extension (Fig. 20.5).

In posterolateral rotatory instability, as the elbow is flexed, the radial head dislocates: this appears as an osseous prominence posterolaterally. With flexion beyond 40°, the radial head suddenly reduces with a palpable and visible clunk. The test may also be done starting with the elbow flexed and then extending, reversing the sequence.

Although the lateral pivot shift test and posterolateral rotatory drawer test are sensitive for detecting lateral instability, they often require general anesthesia to reproduce the radial head subluxation and subsequent reduction.

In addition to passive tests, there are also active tests to evaluate posterolateral instability. The first is the ***table top relocation test***, an active apprehension sign [25]. The upper extremities are positioned on a table with the elbow at 90° flexion, forearms supinated and arms abducted. The test is considered positive if apprehension occurs as the affected elbow is fully extended from a flexed position together with voluntary and involuntary guarding (Fig. 20.5).

A second active apprehension sign is the ***stand up/chair push up test*** [25]: the patient is seated with the elbows flexed 90°, the forearms supinated and the arms abducted. The test is considered positive if the patient is reluctant to fully extend the elbow while raising his body up from a chair using exclusively upper extremity force as a result of apprehension or elbow dislocation.

A third test is ***the push up test***: the patient lays with chest on the floor, elbows flexed at 90°, shoulders abducted, forearm supinated and then performs a push-up. The test is positive with apprehension or radial head subluxation, but this test is much more uncomfortable for the patient than the other two.

Regan et al. described that these tests are more sensitive than the pivot-shift test in the awake patient and may be easily performed in the clinic environment [25].

Specifically, the ***table-top relocation test***, ***stand-up/chair push-up test*** and ***push-up test*** show similar capacities for a positive finding with sensitivity from 88 to 100%.

The ***pivot shift test*** shows sensitivity of only 38% in the awake patient, but 100% sensitivity if performed under anaesthesia [25, 26].

In **posteromedial instability**, theoretically, a subluxation can be obtained applying varus and axial loading with the forearm pronated (***medial pivot-shift test***). This occurs only in the case of a coronoid fracture or deficit. This test cannot be performed in an awake patient [1].

The ***valgus extension overload test*** is performed to detect the presence of a posteromedial olecranon osteophyte or olecranon fossa overgrowth. The examiner stabilizes the humerus with one hand, and with the opposite hand, pronates the forearm and applies a valgus force while quickly maximally extending the elbow. A positive test causes posteromedial pain as the olecranon tip osteophyte engages into the olecranon fossa [1, 2].

20.6 Micro-instability

Recalcitrant lateral elbow pain is supposed to be related to minor lateral instability of the elbow. Recently two new clinical tests have been described to evaluate this condition:

- ***Supination and Antero- Lateral pain Test (SALT).***
- ***Posterior Elbow Pain by Palpation-Extension of the Radiocapitellar joint (PEPPER).***

In the SALT test we suppose that the examiner's thumb, while gliding along the anterolateral surface of the radial head, can selectively compress the anterior capsule and the synovial tissue lying underneath it. In case of synovial hypertrophy and inflammation, the supination movement pushes this synovial tissue in the sigmoid notch. Compression of the inflamed synovial tissue causes pain.

In the PEPPER test, the examiner's thumb is placed on the surface of the radial head with the elbow in 90° flexion. With extension of the radiocapitellar joint, pressure on the thumb and, indirectly, on the radial head is increased. Compression of a chondropathic radial head might be the main source of pain when performing this test.

SALT has a high sensitivity but a low specificity and is accurate in detecting the presence of intra-articular synovitis. PEPPER test is sensible, specific and accurate in the detection of radial head chondropathy.

Positive findings may be indicative of a minor instability of the lateral elbow in most cases of recalcitrant lateral elbow pain, with at least one test positive in 90% of patients affected by this condition [27, 28].

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