# Elbow Injuries in the Throwing Athlete

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**KEYWORDS**

• Elbow injuries • Throwing • Athlete • UCL • OCD • Neuritis • VEOS

**KEY POINTS**

- Overhead throwing is associated with elbow angular velocity of greater than 2300° per second and valgus torque of 64 N/m, which results in lateral-sided compression, posterior-sided shear, and medial -sided tension.
- The bony articulations, medial and lateral ligamentous stabilizers, muscle groups, and nervous structures about the elbow can undergo acute and chronic pathologic changes that result in injury.
- A thorough history, physical examination, plain radiographs, and advanced imaging (computed tomography, magnetic resonance imaging, bone scan) with or without a diagnostic arthroscopy can help determine the diagnosis.
- Failure of conservative management may require operative intervention and can lead to successful results, allowing the throwing athlete to return to play.

## BACKGROUND

The elbow experiences significant forces in sports that require repeated gripping and throwing. Stability conferred by the bony articulations, ligamentous stabilizers, and muscles that envelop the elbow helps resist the large valgus forces of throwing. Over time, chronic medial tensile forces, lateral compressive forces, and posterior compressive and shear forces lead to pathologic changes and subsequent injury (**Box 1**). A thorough understanding of anatomy, biomechanics, and pathophysiology will aid in the diagnosis and treatment of elbow injuries sustained in the throwing athlete.

## BIOMECHANICS OF THE THROWING ELBOW

The factors that stabilize the elbow depend on the position of the arm. In full extension, the ulnohumeral articulation, anterior joint capsule, and medial collateral ligament provide equal contributions to valgus stability.[1] As the elbow moves into 90° of flexion, the medial collateral ligament takes on 55% of the burden. Primarily, the ulnohumeral articulation, as well as the anterior joint capsule, resists varus stress. In full extension, the bony articulation provides 55% of the stabilizing force, whereas at 90° of flexion, its relative contribution increases to 75%. The radial collateral ligament provides minimal varus restraint, both in flexion (9%) and extension (14%). In extension, the anterior capsule provides 85% of the resistance to distraction. In flexion, the medial collateral ligament provides nearly 80% of resistance to distraction.

Maximum valgus force across the elbow is generated during late cocking and acceleration.[2] The elbow is flexed to 95° and the elbow is subjected to valgus forces up to 64 Nm. During acceleration, the elbow extends at more than 2300° per second. At the time of ball release, the lateral

Funding Sources: None.
Conflict of Interest: Consultant DePuy Synthes (K.S. Matullo).
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Orthop Clin N Am 45 (2014) 571–585
http://dx.doi.org/10.1016/j.ocl.2014.06.012

**Box 1**
**Elbow injuries in throwing athletes**

Medial
- Ulnar collateral ligament (UCL) injury
- Ulnar neuritis
- Medial epicondylar injury
- Flexor-pronator mass injury

Posterior
- Valgus extension overload syndrome (VEOS)
- Olecranon stress fracture
- Persistent olecranon physis

Lateral
- Capitellar osteochondritis dissecans
- Radiocapitellar plica

Miscellaneous
- Osteophytes and loose bodies

aspect of the elbow is subject to greater than 500 N of force. These extreme medial and lateral forces can cause injuries that can jeopardize the career of the throwing athlete.

## MEDIAL ELBOW PAIN

### *Ulnar Collateral Ligament Injury*

#### *Anatomy*

The ulnar collateral ligament (UCL) is composed of an anterior bundle, a posterior bundle, and a variable transverse oblique bundle, sometimes referred to as the Cooper ligament. The anterior bundle arises from the inferior-most aspect of the medial epicondyle and inserts on the sublime tubercle of the coronoid process of the ulna. The anterior bundle is composed of an anterior and a posterior band, which provide restraint against valgus stress at different degrees of flexion.[3]

The anterior bundle is the primary restraint to valgus stress of the elbow at 30° to 90° of flexion and is a coprimary restraint along with the posterior bundle at 120° of flexion.[3] The anterior band provides restraint to valgus stress from 0° to 85° of flexion, whereas the posterior band provides the most restraint from 85° to 120°. Fifty percent of the valgus torque imparted on the elbow is transmitted to the UCL. The remainder of this stress is taken up by the strong flexor-pronator muscle mass on the medial side of the elbow.[4]

#### *Etiology*

The valgus and extension forces across the elbow during throwing activities often exceed the failure strength of the UCL. Repetitive or excessive stress leads to microtrauma and potentially acute rupture of the ligament. There is a cumulative effect of this microtrauma, and athletes who do not take adequate time to heal are at increased risk for rupture.[5]

UCL injuries are seen in tennis players, football players, wrestlers, javelin throwers, and most commonly, baseball players, especially pitchers. Risk factors for UCL injury in baseball players include high-pitch velocity, inadequate warm-ups, and inadequate rest time.[6] Chronic attenuation of the UCL can lead to further injury in the elbow due to increased bony stress, including radiocapitellar arthritis and posteromedial olecranon arthritis.

#### *History and physical*

Acute injury is typically described with pain or a pop on one throwing motion. The athlete is unable to continue play and may describe a feeling of paresthesias within the ulnar nerve distribution. In contrast, patients with chronic injury to the UCL may report a loss of ball control, loss of velocity, or increased fatigability. Pain is often reported by patients to be associated with the acceleration phase of throwing.[7,8] Patients in the later stages of chronic UCL injury may report pain with terminal extension of the elbow.

Physical examination should begin with assessment of both passive and active range of motion. Any joint effusion or flexion contracture should be documented. The carrying angle of the elbow, normally 11° in men and 13° in women, may be as large as 15° in throwers. This is thought to be the result of adaptive change secondary to the repetitive stress and laxity of the UCL.[9]

The elbow should be palpated to determine sites of abnormal tenderness. Lateral pain with pronation and supination may indicate arthritic change due to overload of the lateral structures, whereas posterior discomfort in full extension suggests posteromedial olecranon arthritic change secondary to repetitive extension overload. Neurologic changes should be assessed, as laxity of the UCL can cause tension on the ulnar nerve, leading to complaints of weakness or paresthesias.

The "milking test" is used to assess for UCL laxity (Fig. 1). The examiner stands behind the patient while the forearm is supinated and the elbow is flexed to 90°. The examiner applies a valgus force to the elbow by pulling on the patient's thumb. Apprehension, pain on the medial side, or instability indicates laxity of the UCL.

The "moving valgus stress test" has been shown to be 100% sensitive and 75% specific for UCL laxity (Fig. 2).[10] The test is performed by maximally