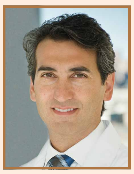
5 Points on
Physical Examination of the Throwing Athlete's Elbow

Lauren H. Redler, MD, Jonathan P. Watling, MD, and Christopher S. Ahmad, MD

Understanding the pathomechanics of throwing and the accompanying elbow injuries is the groundwork for conducting a directed history taking and a physical examination that produce an accurate diagnosis of elbow injuries in throwing athletes. Advances in physical examination techniques have improved our ability to accurately diagnose and treat throwers' athletic elbow disorders.

Throwing imposes an extremely high valgus stress (approaching 60-65 Nm) across the elbow. This high stress occurs during the cocking and acceleration phases of the overhead throwing motion.[1-3] The valgus stress generates tension on the medial elbow, compression on the lateral elbow, and shear on the posterior aspect of the elbow. These forces cause predictable injury patterns in different parts of throwers' elbows. Physical examination performed in a systematic anatomical fashion can enhance predictable and accurate elbow injury diagnosis. In this article, we outline 5 points in a systematic approach to physical examination of a throwing athlete's elbow.





Dr. Redler is Fellow in Sports Medicine, Hospital for Special Surgery, New York, New York. She was Resident, Department of Orthopaedic Surgery, Columbia University Medical Center, New York, New York, at the time the article was written. Dr. Watling is Resident, Center for Shoulder, Elbow, and Sports Medicine, Department of Orthopaedic Surgery, Columbia University Medical Center, New York, New York. Dr. Ahmad is Head Team Physician, New York Yankees; and Chief of Sports Medicine Service, Co-Director of Center for Shoulder, Elbow, and Sports Medicine, Director of Biomechanics Research in Pediatric and Adolescent Sports Medicine, and Professor of Orthopaedic Surgery, Columbia University Medical Center, New York, New York.

Authors' Disclosure Statement: Dr. Ahmad wishes to report that he is a consultant to Acumed and Arthrex and receives research support from Arthrex, Stryker, and Zimmer. The other authors report no actual or potential conflict of interest in relation to this article.

Address correspondence to: Christopher S. Ahmad, MD, Center for Shoulder, Elbow, and Sports Medicine, Department of Orthopaedic Surgery, Columbia University Medical Center, 622 W 168th St, PH-11, New York, NY 10032 (tel, 212-305-5561; e-mail, csa4@columbia.edu).

Am J Orthop. 2015;44(1):13-18.

1 Perform a general upper extremity examination

Cervical spine and shoulder girdle

In the initial examination, the cervical spine and the entire affected upper extremity should be quickly assessed. Assessment of the cervical spine should include palpation, range of motion (ROM), and basic provocative testing, such as the Spurling test, to evaluate for radiculopathy caused by foraminal compression. Posture, asymmetry, atrophy, edema, ecchymosis, and any other deformity should be noted. For example, atrophy of the neck and shoulders suggests underlying neuropathy. In addition, fullness of the supraclavicular region and local tenderness or bruit suggest vasculopathy. Symptomatic compression of the subclavian artery and vein between the anterior and middle scalene muscles may present as weakness, fullness, heaviness, and early fatigue. Physical signs include coolness, pallor, claudication, engorgement, and edema in the arm.[4] Thoracic outlet syndrome can manifest as effort-induced vague pain at the arm and elbow.[5] If this syndrome is suspected, an Adson test should be performed. With the patient's neck extended and rotated away from the affected side, the examiner, standing next to the patient, palpates the radial pulse with the patient's elbow extended (**Figure 1A**). Next, the examiner abducts, extends, and externally rotates the patient's shoulder (**Figure 1B**) while the patient alternates between opening and closing the fist (**Figure 1C**). A decrease or absence in pulse strength from the starting position is a positive test result.

Last, the shoulder and scapulae should be assessed, as an affected shoulder or dyskinetic scapula can lead to improper mechanics of the kinetic chain at the elbow. The shoulder should be palpated, and ROM, strength, and stability should be assessed. Glenohumeral internal rotation deficit is associated with medial collateral ligament (MCL) tears; if present, this deficit should be addressed.[6]

Elbow

Inspection should reveal a normal carrying angle of about 11° to 14° of valgus in men and 13° to 16° in women. In

Figure 1. Adson test. With patient's neck extended and rotated away from affected side, change in pulse strength from (A) shoulder neutral and elbow extended to (B) shoulder abducted, extended, and externally rotated with (C) alternating open and closed fist indicates positive test.

immature athletes, increased valgus stresses from repetitive overhead throwing can cause medial epicondylar hypertrophy, and carrying angles of more than 15° are common.[7-9]

Active and passive ROM should be assessed. Normal ROM is about 0° extension and 140° flexion with 80° of supination and pronation. For determination of pathologic differences, ROM should always be compared between the affected and the contralateral sides. Painful loss of motion may be caused by soft-tissue swelling or contracture, effusion, bony impingement, or loose bodies. Crepitus, locking, catching, or another mechanical symptom may indicate loose bodies or chondral injury. Firm, mechanical blocks to ROM during flexion may indicate osteophyte formation in the coronoid fossa, and mechanical blocks to ROM during extension may indicate osteophyte formation in the olecranon fossa. Pain elicited at the end points of motion is caused by osteophytes and impingement, whereas pain elicited during the mid-arc of motion is often caused by osteochondral lesions. Terminal extension, often the first motion lost after injury, may signal intra-articular pathology, if symptomatic. However, throwing athletes may present with developmental flexion contractures of up to 20°.[10]

2 Examine the medial aspect of the elbow

The medial epicondyle, easy to recognize as a bony prominence on the medial side of the distal humerus, serves as an attachment site for the MCL, pronator teres, and the common flexor tendon. In throwers, assessing the MCL is crucial. The MCL should be palpated from its origin on the inferior aspect of the medial epicondyle moving distally to the sublime tubercle of the proximal ulna. Tenderness at any point along the ligament can indicate a range of ligament pathology, from attenuation to complete rupture.

The MCL is further assessed with stress tests, most commonly the valgus stress test, the milking maneuver, and the moving valgus stress test. Of these 3 procedures, the moving valgus stress test is perhaps the most sensitive and specific for MCL injury, and is the test preferred by the authors.[11] This test takes into account shoulder position, simulates the position of throwing, and can account for bony structures that provide stability at more than 120° of flexion. We prefer to position the patient supine on the examining table to help stabilize the shoulder and humerus and to relax the patient. The shoulder is placed in abduction and external rotation while the examiner holds the thumb with one hand and supports the elbow with the other. The elbow is extended (**Figure 2A**) and flexed (**Figure 2B**) while valgus stress is applied. A positive test elicits pain localized to the MCL at the arc of motion between 80° to 120°.[12] Pain at positions near full extension with the moving valgus stress test may also indicate chondral damage at the posteromedial trochlea.[13]

During pitching, the tensile demand on the MCL is re-

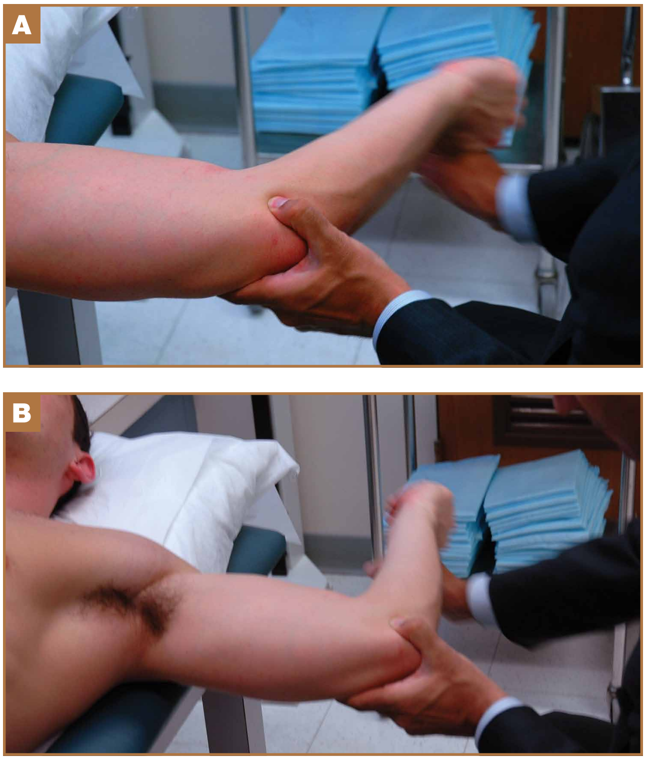


Figure 2. Moving valgus stress test. With patient supine and shoulder abducted and externally rotated, examiner grasps thumb to move elbow from (A) extension to (B) flexion while exerting valgus stress on elbow, using opposite hand to support elbow and palpate medial collateral ligament. Pain at medial collateral ligament in range of 80° to 120° of elbow flexion indicates positive result.

duced by the action of the flexor-pronator mass. It is common to see a flexor-pronator mass injury concurrent with MCL injury.[14] Medial epicondyle tenderness that increases with resisted wrist flexion may signal flexor-pronator injury, though, classically, flexor-pronator muscle strains and tears produce pain anterior and distal to the medial epicondyle.[15]

Traction, compression, and friction at the medial elbow can irritate the ulnar nerve. This nerve should be inspected and palpated along its course at the cubital tunnel to determine its location and stability. Ulnar nerve hypermobility, which has been identified in 37% of elbows, can be determined by having the patient actively flex the elbow with the forearm in supination, placing a finger at the posteromedial aspect of the medial humeral epicondyle, and having the patient actively extend the elbow.[16] The nerve dislocates if trapped anterior to the examiner's finger, perches if under the examiner's finger, or is stable if still palpable in the groove posterior to the medial epicondyle.[16]

The distal band of the medial triceps tendon may also sublux over the medial epicondyle with elbow flexion. This subluxation, also known as *snapping triceps syndrome*, may cause pain or ulnar nerve symptoms.[17] Bringing the elbow from extension to flexion may produce subluxation, first of the ulnar nerve and then of the medial triceps, in 2 separate "snaps." Tenderness can be elicited along the medial triceps muscle.

Ulnar neuritis is caused by traction injury, such as with dynamic pitching, nerve subluxation, or compression at the cubital tunnel. With MCL injury and valgus instability, the ulnar nerve can become irritated as it becomes stretched because of medial elbow laxity.[18] The nerve can also be damaged during flexion as the cubital tunnel retinaculum tightens, decreasing the space available for the nerve.[19] This concept is applied during the elbow flexion compression test. A positive test may elicit tingling radiating toward the small finger or pain at the elbow or medial forearm when manual pressure is directly applied over the ulnar nerve between the posteromedial olecranon and the medial humeral epicondyle as the elbow is maximally flexed.[20]

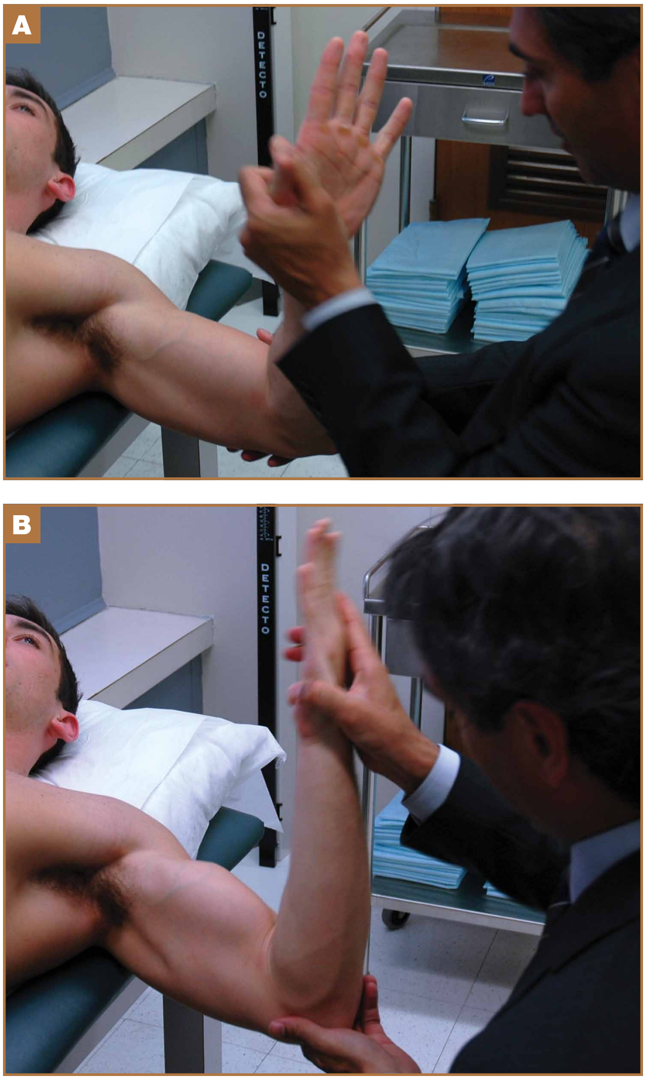


Figure 3. Active radiocapitellar compression test. While applying axial load to elbow in full extension, forearm is actively (A) pronated and (B) supinated. Positive test elicits pain at radiocapitellar joint.

3 Examine the lateral aspect of the elbow

Palpation of the lateral epicondyle, the radial head, and the olecranon tip assists in defining injury to the underlying anatomy. The anconeus "soft spot" (infracondylar recess) within the triangle formed by these 3 bony landmarks should be palpated for fullness, indicating a joint effusion, hemarthrosis, or even a subluxed or dislocated radial head.

While the medial elbow endures a large tensile load, throwing imposes a tremendous compressive force at the lateral elbow, particularly at the radiocapitellar joint. This joint may be tender and produce clicking with pronation and supination in patients with radiocapitellar arthrosis, symptomatic posterolateral synovial plica, or an inflamed radial bursa. Tenderness with crepitus that can be exacerbated with forceful flexion and extension may indicate radiocapitellar overload or loose bodies.

Long-term load transmission and subsequent degeneration of the articular surface may advance to osteochondritis dissecans (OCD). Examination for capitellar OCD reveals tenderness over the radiocapitellar joint and commonly a loss of 15° to 20° of extension. The active radiocapitellar compression test is positive for OCD lesions and elicits pain in the lateral compartment of the elbow when the patient pronates (**Figure 3A**) and supinates (**Figure 3B**) the forearm with the elbow axially loaded in extension.[21]

Microtrauma and inflammation may occur with repetitive eccentric overload. Although rare in throwing athletes, "tennis elbow" causes pain with gripping, and decreased grip strength. Tenderness caused by lateral epicondylitis is just anterior and distal to the epicondyle, at the origin of the extensor carpi radialis brevis. Pain is reproducible with passive wrist flexion and resisted wrist extension with the elbow extended (Cozen test).

Less commonly, athletes may complain of mechanical symptoms, such as snapping or catching with posterolateral elbow pain.[22] These symptoms may be due to thickened or inflamed synovial plica causing impingement. A posterior radiocapitellar plica can be examined by bringing the elbow to full extension while applying valgus stress with the forearm in supination. Conversely, an anterior radiocapitellar plica can be examined with a valgus load on the elbow and passive flexion with the forearm in pronation.[23] A palpable painful snap over the radiocapitellar joint is a positive test.

4 Examine the posterior aspect of the elbow

Posteriorly, palpation is focused on the triceps tendon and the olecranon tip. The elbow should be flexed to 30° to relax the triceps, isolate the olecranon, and allow for palpation of the olecranon fossa on either side of the triceps tendon. Tenderness at the posterolateral or posteromedial aspect of the olecranon should be noted. Warmth, fluctuance, or distension at the elbow may be caused by olecranon bursitis. The 3 heads of the triceps muscle should be palpated where they converge to form an aponeurosis, and tenderness or a palpable gap on any of the heads should be noted.

A combination of valgus force and a rapidly decelerating arm at the follow-through phase of pitching causes a shear force between the medial aspect of the olecranon tip and the olecranon fossa. This shear force can result in chondrolysis, osteophyte formation, and loose bodies, particularly in the posteromedial elbow. This *valgus extension overload* (VEO) *syndrome* often results in loss of full extension and symptoms, which may be attributed to osteophytes or fractured and nonunited fragments in the olecranon fossa or the olecranon tip. Frank crepitus may also be present with extension testing caused by loose bodies or synovial reaction over osteophytes. Assessing for VEO using the extension impingement test, the examiner places continuous valgus stress on the elbow while quickly extending from 20° to 30° of flexion (**Figure 4A**) to terminal extension (**Figure 4B**) repeatedly. The examiner repeats this without valgus load while palpating the posteromedial olecranon for tenderness to differentiate impingement caused by instability from pain over the medial olecranon without instability (**Figure 4C**). Particular attention should be focused posteriorly in athletes with medial instability, as MCL injuries and VEO syndrome often occur in conjunction in the throwing athlete.

Repetitive acceleration and deceleration of the arm can also cause stress fractures. With stress fractures, pain is often noted more distal and lateral on the olecranon, but tenderness may be palpable medially from posteromedial impaction that occurs from the valgus load during the overhead throwing motion. In immature athletes, the repetitive sudden snap of full extension in the deceleration phase of throwing can cause olecranon apophysitis. Frank avulsions can occur as well but are usually preceded by chronic posterior elbow pain with possible loss of full extension.

The late cocking phase of the throwing motion (just before throwing) hyperextends the elbow and places significant strain on the elbow. Repetitive strain can cause painful posterior impingement. The arm bar test is extremely sensitive (**Figure 5**).[13] With the patient's elbow extended, shoulder internally rotated, and hand on the examiner's shoulder, the examiner pulls down on the olecranon to simulate forced extension and reproduces the pain associated with posteromedial impingement.

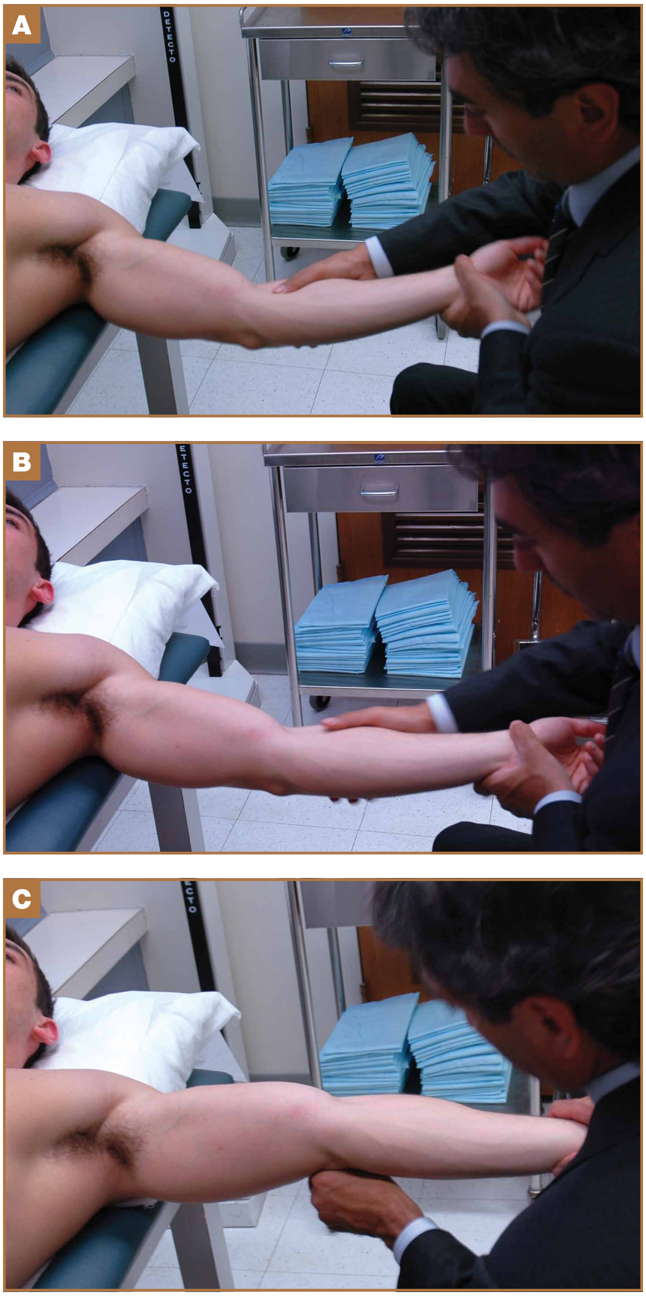


Figure 4. Extension impingement test. Place continuous valgus stress on elbow and quickly extend from (A) 20° to 30° of flexion to (B) terminal extension repeatedly. (C) Maneuver is then repeated without valgus stress, and posteromedial olecranon is palpated for tenderness. This test is used to identify painful impingement caused by subtle instability.

Figure 5. Arm bar test. Patient's elbow is extended, shoulder is internally rotated, and hand is placed on examiner's shoulder. Positive test for posteromedial impingement elicits pain when examiner pulls down on olecranon to simulate forced extension.

Figure 6. Hook test. Shoulder is abducted, and elbow flexed to 90°. With patient actively supinating forearm, examiner attempts to hook index finger under patient's biceps tendon, from lateral to medial. Test is negative if examiner's finger can be inserted 1 cm under tendon, or positive if no cordlike structure can be hooked.

Last, though triceps tendon injuries are rare, ruptures most often occur at the origin of the lateral head of the triceps. As the initial swelling and ecchymosis subside, a palpable gap is pathognomonic for rupture. Extensor weakness can often be observed, but extension may still be possible from anconeus triceps expansion with the aid of gravity. With the elbow overhead, the athlete must extend the elbow against gravity and will exhibit weakness against resistance.

5 Examine the anterior aspect of the elbow

Anteriorly, the bulk of the flexor-pronator group restricts the extent of joint palpation, and the soft tissues are usually injured. The antecubital fossa is a triangular area on the anterior aspect of the elbow that is bounded superiorly by a horizontal line connecting the medial epicondyle to the lateral epicondyle of the humerus, medially by the lateral border of the pronator teres muscle and laterally by the medial border of the brachioradialis muscle. From lateral to medial, the antecubital fossa contains the radial nerve, the biceps brachii tendon, the brachial artery, and the median nerve. Evaluating this area is important because a visible defect, change in muscle contour, or proximal retraction of a muscle belly can indicate a muscular rupture. In particular, a distal biceps rupture (rare) may be accompanied by weakness and pain in supination and, to a lesser degree, in flexion. It is important to note that, in the case of a partial biceps rupture, ecchymosis may not appear, as the hematoma is confined by the intact lacertus fibrosis.[24] The hook test can be used to evaluate for the presence of an intact distal biceps tendon (**Figure 6**).[25] The patient abducts the shoulder, flexes the elbow to 90°, and actively supinates the forearm while the examiner attempts to hook an index finger laterally under the tendon. The test is negative if the finger can be inserted 1 cm under the tendon and positive if no cordlike structure can be hooked. Partial biceps tendon ruptures or tendinitis may exhibit tenderness of the distal biceps tendon and pain on resisted supination with a negative hook test. Often, resisted elbow flexion with the elbow at maximal extension elicits pain at the biceps insertion. Clicking with forearm rotation near the insertion of the tendon, which may be caused by an inflamed radial bursa between the distal biceps tendon and the radial tuberosity, may be associated with impending rupture.

Conclusion

Physical examination combined with thorough history taking usually provides a solid basis for a diagnosis, which in turn makes the value of surgical treatment more assured.

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This paper will be judged for the Resident Writer's Award.