History and Physical Exam on the Thrower's Elbow

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Introduction

Overhead athletes frequently sustain injuries to their dominant elbow secondary to the high valgus and extension forces inherent to the throwing motion. The relatively unnatural motion of throwing can produce a myriad of pathological stresses on the structures about the elbow, namely tensile stresses medially, compression stresses laterally, and shear stresses posteromedially. Accurate diagnosis and treatment of elbow pain in the throwing athlete depends upon a detailed history, methodical physical examination, and appropriate ancillary tests when needed, as any of the above mentioned stresses may produce varying types of lesions in the elbow *joint*. The clinician must possess a thorough understanding of the functional anatomy and biomechanical characteristics of the complex elbow articulation to efficiently evaluate and diagnosis such pathologies in the thrower's elbow.

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This chapter reviews the proper components of a thorough history and physical examination on the elbow in the overhead sport athlete.

History

Evaluation of an athlete presenting with elbow pain must begin with a detailed throwing history, including onset and duration of symptoms, anatomical site of injury, temporal assessment of symptoms during the throwing motion, associated symptoms, previous treatment, and competition level/time of season [1].

Symptom Onset and Duration

Elbow pain in throwing athletes can often present as an acute event coinciding with a chronic overuse injury [1]. Pitchers are especially susceptible to acute-on-chronic injuries of the elbow due to the high volume and intensity of the overhead motion associated with pitching. Approximately 60% of throwers with ulnar collateral ligament (UCL) injury present with acute medial pain, frequently accompanied by an audible "pop" [2, 3]. These athletes recall the exact throw when they heard the "pop" and typically experience pain in their elbow immediately following the episode. Subsequently, the athlete will no longer be able to compete due to valgus instability of the elbow during the throwing motion. Hemorrhage and edema in the elbow may cause symptoms of ulnar nerve irritation. If ulnar neuritis is suspected,

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special care must be taken during the ligamentous examination.

Many athletes, with or without the acute "pop," will experience concomitant prior medial elbow pain or treatment for flexor-pronator tendonitis or ulnar nerve neuritis. Incomplete healing of these pathologies may cause a subtle change in pitching mechanics that leads to long-term UCL attenuation. These problems may be viewed on a spectrum of overuse injuries to the elbow and are frequently the principal cause of pathology in the elbow of the overhead athlete. The clinician must be vigilant to assess for whether or not the athlete has had repeated or continuous bouts of medial elbow pain, responsive to conservative interventions. Such athletes often continue to throw with minor to moderate pain, but 50% demonstrate decreased command and velocity [4]. Kvitne and Jobe concluded that these players are typically unable to throw the ball at over 75% of their standard velocity due to pain [5]. Other complaints include early fatigue and inability to throw as many pitches per appearance.

Location of Injury

Injured athletes can often pinpoint the anatomic location of where they subjectively experience pain in the elbow during the overhead throwing cycle. The athlete's description of the location and intensity of pain will facilitate the clinician in formulating an early differential diagnosis that can be confirmed with a systematic physical examination of the injured elbow [6]. Pain on the medial aspect of the elbow can signify a host of different pathologic scenarios, namely, UCL insufficiency or tear, medial epicondylitis, ulnar nerve irritation or instability, flexor-pronator strain or tear, olecranon/ulnar stress fracture, or in the skeletally immature patient, avulsion facture of the medial epicondyle. Medial epicondylitis presents with aching pain over the medial elbow and may chronically lead to subjective grip weakness. Point tenderness over the origin of the flexor mass, at the medial epicondyle, is the hallmark finding of medial epicondylitis. Ulnar nerve neuritis in the overhead athlete will produce similar symptoms to those seen in non-athletes who experience mononeuropathy of the ulnar nerve at the elbow, however they are often exacerbated by or associated with throwing. The ulnar nerve lies in a precarious anatomic position and is very sensitive to traction injury as a result of valgus instability. These symptoms may include medial joint-line pain, clumsiness or heaviness of the hand and fingers, numbness and tingling of the fourth and fifth digits, or medial pain that radiates along the forearm to the hand [6].

Lateral elbow pain, due to throwing, is often associated with radiocapitellar compression and associated chondral wear, lateral epicondylitis, olecranon stress fractures, a plica, or radial nerve entrapment syndrome. Posterior pain is often the direct result of valgus extension overload (VEO), and its differential diagnosis must include olecranon osteophyte formation, triceps tendonitis, or olecranon stress fracture [7]. Loose chondral bodies can lead to pain in medial, lateral, and posterior aspects of the elbow and may manifest as a sensation locking or catching to the athlete. The athlete may also have to manipulate or snap the elbow in order to unlock or free the joint.

Timing During the Throwing Motion (Fig. 6.1)

A complete understanding of the phases that encompass the overhead throwing motion, and subsequent pathologic deviations, will enable the clinician to properly evaluate and diagnosis injuries sustained by the overhead athlete during throwing. The phase at which the athlete experiences pain must be viewed as critical information and will aid during the process of performing a focused physical examination [8]. Three phases are historically connected with elbow pain in the throwing athlete—late cocking, acceleration, and deceleration. Nearly 85% of athletes with medial elbow instability complain of pain during the late cocking and acceleration phases of throwing, while less than 25% complain of pain during the deceleration phase [4]. Large tensile forces are generated on the medial aspect of the elbow which

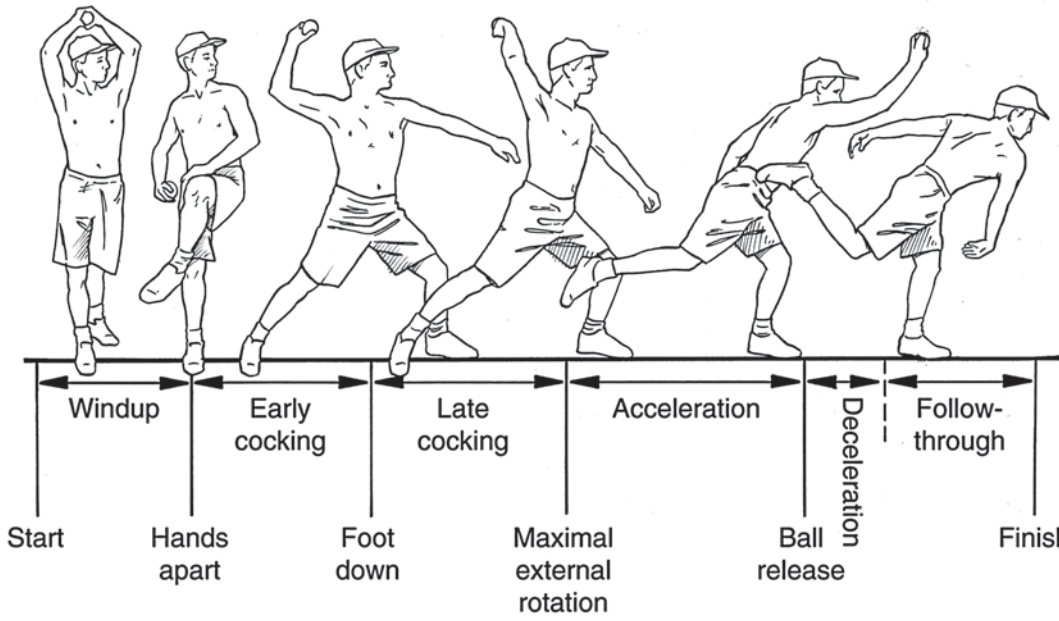

Fig. 6.1 The phases of the baseball pitch. (From [38], reprinted with permission from Elsevier Limited)

can result in pain, and are ultimately the direct result of valgus torque seen during the late cocking and acceleration phases of throwing. When the athlete is experiencing pain during the deceleration phase, posterior pathology is often the culprit and is most often due to the large proximal forces that are generated during the overhead throwing motion (VEO, olecranon osteophyte formation, triceps tendonitis, loose bodies) [9, 10].

Associated Symptoms and Previous Treatment

Related symptoms during or in conjunction with throwing must be documented and further evaluated. Neurological or vascular complaints such as cold intolerance, numbness, or tingling in the hand or fingertips, sharp or shooting sensations radiating down the forearm, and fluctuating grip strength may be early indicators of significant neurovascular pathology [11]. Early fatigue or a chronic dull aching pain can signify early nerve compression, as a result of nerve entrapment or mononeuropathy. Complete motor loss or loss of precision with fine muscle movements of the hand often represents more severe nerve injury and special care must be taken during the physical examination.

The physician should ask the athlete about any prior injuries or treatment to the throwing extremity. Previous treatment or surgery to the elbow or shoulder may give valuable information when determining the etiology of the athlete's current symptoms. It is not uncommon for the overhead athlete to develop elbow pain after a defined treatment period for shoulder pathology, and likewise those recovering from elbow pain may develop ipsilateral symptoms in the shoulder. The significance of the kinetic chain, and its importance to injury prevention is well documented [12, 13]. Previous treatment for flexor tendinitis or ulnar nerve neuritis that continues to hinder the pitcher's performance may lead the physician to consider UCL attenuation as the origin of the pain generator [1].

All portions of the kinetic chain, which include the shoulder, back, hip, knee, and ankle, can subsequently produce undue kinematic effects in the elbow, and injuries that lead to deviations of successful execution of the kinetic chain in throwing must be closely evaluated [14]. Detailed analysis

of the throwing motion has shown proximal-to-distal muscle activation, peak torque development, and force development radiation from the trunk to the elbow [15]. Proximal body segments provide dynamic mechanisms by which the forces generated by the overhead motion can be regulated to allow for minimal injury risk to the throwing elbow [14]. A more proximal injury could result in a functional change that leads to abnormal elbow kinematics and injury at the distal end of the kinetic chain. Glenohumeral internal rotation deficiency (GIRD) has also been linked with acute and chronic elbow problems in the throwing athlete. Morgan and colleagues analyzed the elbows of 20 symptomatic professional pitchers who presented with GIRD, defined as a loss of internal rotation greater than 25° compared to the contralateral shoulder, and determined therapeutic correction of the arc of motion deficits can decrease subjective complaints of elbow pain in pitchers [16].

Level of Competition and Timing of Play

The athlete's level of competition and the temporal aspect of the athletic season are important considerations when discussing treatment options. Recreational athletes will not require the same aggressive treatment plan as high-level professional athletes, while younger athlete's (the skeletally immature athlete) may consider less invasive treatment alternatives. Pitchers with improper mechanics or training regimens can present with medial elbow pain attributable to flexor-pronator tendinitis during preseason or spring training, whereas frank UCL injuries often occur in the middle or end of the season [3].

Excessive pitch counts, increased work-load, insufficient rest between appearances, changing of arm slot, and the delivery of a large percentage of breaking balls are important factors when discussing modifiable elements that may prevent medial elbow injuries in the throwing athlete. In addition, catchers who throw back to the pitcher from their knees are not utilizing their kinetic chain properly and also may sustain injuries to their dominant elbow [17].

Physical Examination

It is important to perform a comprehensive and reproducible physical examination on overhead athletes who are experiencing elbow pain during throwing. A thorough exam can often allow the surgeon to properly diagnose the pathology without the necessity of further ancillary tests. The exam should be conducted methodically and include observation/inspection, palpation, neurovascular, and range of motion testing, digressions from normal will then permit a more focused set of special tests to establish a conclusive diagnosis.

Observation/Inspection

It is imperative that all diagnostic maneuvers, throughout the entirety of the physical examination, be performed on both the affected and nonaffected upper extremity, thus allowing for meaningful comparison of what should be considered a normal finding, an adaptive change, or overtly pathologic. A complete inspection of the elbow includes kinematic assessment of the ipsilateral shoulder and scapula [6]. The physician should note any subtle pathologic changes to the upper extremity and should recognize normal adaptive muscular hypertrophy in the throwing arm [18, 19]. Increased shoulder external rotation arc with a concomitant decrease in internal rotation, in comparison to the unaffected extremity, is not uncommon in the healthy throwers' arm. However, pathologic GIRD is associated with UCL insufficiency [13].

The carrying angle, defined as the angle between the long axis of the humerus and the long axis of the forearm in the coronal plane, should be measured and recorded. Normative values are typically reported as 11 and 13° of the valgus in males and females, respectively [20]. Many high-level athletes have carrying angles greater than 15° and in the pitcher's arm this angle may be 10–15° greater when compared the nonthrowing extremity [19]. This phenomenon is likely due to the previous injury or developmental abnormalities from the repetitive stress put upon the elbow during throwing.

The soft tissues must always be evaluated for swelling or ecchymosis, which can indicate the acuity of any injuries to the structures of the elbow. Ecchymosis often develops in 24–72 h after sustaining an acute UCL injury. Bruising will occur along the medial elbow and proximal forearm in this setting. Significant swelling can also be seen in patients who rupture their flexor-pronator mass in conjunction with UCL tears. Chronic overuse UCL pathology will often exhibit a relatively normal soft tissue envelope, and the clinician should more closely rely on manual maneuvers for an accurate diagnosis. Documentation of surgical scars, blanching due to vascular insufficiency, and olecranon swelling should be noted as well [21].

If UCL reconstruction is a possibility, the physician should also determine if the athlete has a palmaris longus tendon in the throwing or non-throwing extremity. This is the most common tendon graft for UCL reconstruction and is found in 80% of throwing athletes [3]. If the palmaris longus is not found in either forearm, the gracilis or plantaris tendons can function as viable options for autograft reconstruction alternatives.

Palpation

Palpation of the thrower's elbow should be conducted with a stepwise routine to discover the site of pain and rule out other pathologic conditions associated with throwing. The physician should palpate the injured elbow on the soft spot at the junction of the olecranon, capitellum, and radial head and compare it to the contralateral arm to assess for any joint effusion. The presence or absence of loose bodies must also be documented, as their significance can be quite dramatic, in terms of mechanical symptoms associated with the thrower's elbow.

With the elbow in approximately 50–70° flexion, palpation of the UCL should be performed. This flexion range moves the overlying flexor-pronator muscle mass anterior to the fibers of the UCL, giving the surgeon direct access to the ligament proper. Palpation should occur along the entire course of the UCL, moving proximal to distal from its origin at the inferior aspect of the medial epicondyle to its insertion onto the sublime tubercle of the proximal medial ulna. Athletes with UCL injury most often present with point tenderness about 2 cm distal to the medial epicondyle. Tenderness over the UCL may indicate ligament attenuation, however it must be noted that pain over the UCL has an 81–94% sensitivity but only a 22% specificity for UCL tears [22].

The flexor-pronator muscle mass can be palpated to assess for medial epicondylitis by moving distal and slightly anterior to the medial epicondyle. Athletes most often feel pain associated with the pronator teres (PT) and flexor carpi radialis (FCR) tendons, which are located directly anterior to the course of the UCL [1]. Often it can be difficult for the clinician to differentiate between medial epicondylitis and UCL tear or avulsion due to their intimate anatomic relationship in the medial elbow. Resisted wrist flexion and forearm pronation may elicit greater pain in an athlete complaining of medial epicondylitis, compared to UCL injury [23]. More specific tests for the competency of the UCL, such as the valgus stress test, can help differentiate between these separate and often associated pathological conditions.

Neurovascular

The orthopedist must closely evaluate all neurovascular structure about the affected extremity, especially in athletes who complain of numbness or tingling. Gentle palpation of the ulnar nerve does not cause pain in the healthy elbow, but often causes discomfort in athletes with ulnar neuritis. The ulnar nerve must be evaluated throughout its entire course in the elbow startling just proximal to the medial epicondyle, through the cubital tunnel, and distally into the flexor carpi ulnaris muscle mass. Stability of the ulnar nerve must also be judged with gentle pressure applied on the nerve above the medial epicondyle, as the elbow is taken through a flexion-extension arc. Frank subluxation can often cause significant discomfort during hyperflexion and must be respected

during the remainder of the exam. In some cases, the ulnar nerve dislocates anteriorly to the medial epicondyle while the elbow is moved from extension to flexion and this signifies moderate to severe ulnar nerve instability [24, 25].

Range of Motion

In normal controls, the range of motion (ROM) of the elbow is from 0° of extension to 140–150° of flexion, with 85° pronation and 90° supination [26, 27]. Both active and passive ROM should be determined and intervals of pain during the arc of motion should be documented and further evaluated. Passive movement of the throwing arm should be checked for blockage or limitation of motion and compared to the contralateral arm [28, 29]. It is common for throwing athletes to demonstrate loss of elbow extension in the dominant extremity, which can either be an adaptive condition or an overt pathologic loss of motion. A flexion contracture of up to 20° may develop in a pitcher's throwing arm as well, but is traditionally only considered pathologic if painful [1].

The physician should identify abnormalities in the attitude of the elbow joint at the end ranges of motion. At full extension, a bony stop occurs when the olecranon strikes the olecranon fossa, whereas terminal elbow flexion creates tissue approximation as the biceps brachia and wrist flexors approach one another [28, 30]. Pronation and supination should elicit a capsular end feel. The throwing arm should be compared to the nonthrowing arm as anything that varies from the contralateral side may indicate pathology. Osteophytic changes to either the proximal olecranon or coronoid tip can often produce asymmetric endpoints in extension and flexion arcs of the elbow, respectively.

Manipulative Tests

Assessing for the functional integrity of the UCL is a key to the diagnosis and is the most important component of the physical examination. The difference between pathologic and healthy ligaments can be difficult to discern and therefore the clinician should always compare to the contralateral normal extremity.

Fig. 6.2 Demonstrates the valgus stress test. Note the maintenance of pronation and the valgus pressure applied just above humeral condyles

The valgus stress (Fig. 6.2) test can be used to assess for injury to the anterior bundle of the UCL. With the elbow flexed to 30°, the physician stabilizes the athlete's humerus just above the humeral condyles and applies a valgus movement while grasping the athlete's pronated forearm [6]. UCL laxity in injured athletes is subtle and has been shown by Field and colleagues to only increase medial opening by 1–2 mm compared to the contralateral arm [31, 32]. Failure to maintain forearm pronation during the valgus pressure may cause subtle posterolateral instability that can resemble medial laxity.

The milking maneuver (Fig. 6.3) can also be used to evaluate valgus stability while the joint is in flexion. Theoretically the test, as originally described by Stephen O'Brien MD, isolates the posterior band of the anterior bundle of the UCL. The athlete flexes the throwing elbow beyond 90° and with the other arm reaches under the humerus and grabs the ipsilateral thumb, which exerts a valgus stress on the affected elbow [33]. The physician should then palpate along the course of the UCL to assess for tenderness and joint space opening.

It must be noted that modifications to the milking maneuver have also been described. At an angle greater than 120° flexion, the

Fig. 6.3 Demonstrates the "milking maneuver." The examiner must palpate the medial portion of the ulnohumeral joint to discern the maximum point tenderness and whether there is medial opening

contribution of the bony anatomy makes evaluation of the ligament less sensitive, consequently Safran and colleagues have described a variation that places the contralateral arm under the elbow being examined, eliminating the confounding factors associated with the osseous architecture that occurs during hyperflexion [6]. This position adducts the shoulder with maximal external rotation, which can be a problem with the original maneuver. The examiner then holds the throwing elbow at 70° flexion, which is the position of the greatest potential valgus laxity, as demonstrated in cadaveric studies [34–36]. Next, the examiners pulls down on the thumb with one arm and puts valgus stress on the elbow with the other, and with the hand imparting the valgus stress, the physician can still palpate the medial aspect with his thumb and assess for gapping or an increase joint space.

The moving valgus stress test (Fig. 6.4), described by O'Driscoll and Lawton, can also aid in the detection of UCL insufficiency [37]. The throwing shoulder is placed in an abducted and externally rotated position, while the physician takes the elbow through its flexion-extension

Fig. 6.4 Shows the moving valgus stress test as described by O'Driscoll and colleagues. It is important for the examiner to note where, during the arc of flexion, the test elicits pain

limits under valgus pressure. In many athletes with UCL injury, pain is often felt at a specific point within the flexion arc of 80–120° and this test aims to reproduce that pain because the shearing force applied to the ligament is similar to that applied during the late cocking/early acceleration phases of actual throwing [6]. It is important to note that while the authors documented 100 % specificity during their initial study; in our experience, a positive result in the setting of UCL insufficiency, at times, depends on when the patient last threw. If athletes with UCL injury have not thrown a ball for weeks prior to their examination, they may not have pain with the moving valgus stress test.

If the athlete complains of posterior elbow pain, the VEO test may detect the presence of a posteromedial olecranon osteophyte or olecranon fossa overgrowth [1]. The examiner stabilizes the athlete's humerus with one hand, and pronates the forearm and applies a valgus force while quickly maximally extending the elbow with the other hand. The athlete may then experience pain in the posteromedial compartment of the elbow, as the olecranon tip osteophyte engages into the olecranon fossa.

Conclusion

Elbow injuries can be difficult to differentially diagnose in the overhead throwing athlete. The clinician must possess a comprehensive understanding of elbow anatomy and kinematics, along with the various stress demands applied to the elbow during the throwing motion. A detailed history and a thorough physical examination are essential in order to obtain an accurate diagnosis

for the thrower that presents with elbow pain. Furthermore, an appropriate treatment plan will be multifaceted and involve the athlete's specific level of play and timing of the season. The role of imaging will be discussed in the subsequent chapter.

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