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Elbow injuries: Getting kids back in the game

Elbow injuries are increasingly common in children and young adults who participate in team sports nearly year-round. This review—and the tables that accompany it—can help you help them safely return to play.

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PRACTICE RECOMMENDATIONS

› *Administer the valgus stress test, the "milking maneuver," and the moving valgus stress test to athletes suspected of having ulnar collateral ligament injury.* (C)

› *Treat Little League elbow with nonsteroidal anti-inflammatory drugs, ice, brief immobilization, and a 4- to 6-week "break" from throwing.* (A)

› *Advise young baseball players (and their parents) to avoid pitching year-round, and to get 3 months of rest per year.* (A)

Strength of recommendation (SOR)

(A) Good-quality patient-oriented evidence
(B) Inconsistent or limited-quality patient-oriented evidence
(C) Consensus, usual practice, opinion, disease-oriented evidence, case series

The growing popularity of club teams and year-round participation in sports has spawned an epidemic of elbow injuries in primary and secondary school students and young adults alike. The incidence of elbow pain in children engaged in sports that require overhead throwing, such as baseball, football, volleyball, tennis, and javelin, ranges from 45% to 78%.[1]

Fortunately, acute traumatic elbow injury, with pain severe enough to force the athlete to cease participation entirely, is relatively rare, accounting for only 1% to 5% of cases.[1,2] Far more often, elbow pain is associated with overuse, resulting in a gradual onset of medial elbow soreness that does not prevent the athlete from playing.

When an athlete seeks care for elbow pain, there are a number of things to consider, including the patient's age, skeletal maturity, and type and frequency of throwing. Younger "throwers" typically incur injuries related to the physes, while adolescents and adults are more likely to sustain injuries to the ligaments and tendons.[3] In both cases, repetitive valgus stress is the mechanism of injury. This review—of elbow anatomy (see the box on page 588),[4-6] injury, differential diagnosis, and treatment—will make it easier for you to get injured athletes back in the game.

Is it Little League elbow? Start with a targeted history

In skeletally immature athletes, open physes result in the epicondylar apophysis being the weakest structure on the medial aspect of the elbow. Thus, repetitive valgus stress and tension overload often lead to "Little League elbow"—an umbrella term with a differential diagnosis that encompasses medial epicondylar fragmentation, delayed or accelerated growth of

In skeletally immature athletes, the epicondylar apophysis is the weakest structure on the medial aspect of the elbow—and the likely source of injury.

IMAGE © JOE GORMAN. X-RAY COURTESY OF GARY MLADY, MD, UNIVERSITY OF NEW MEXICO.

the medial epicondyle, and delayed closure of its growth plate, among other conditions (**TABLE 1**).[3,7,8]

In more mature athletes, repetitive microtrauma to the ulnar collateral ligament (UCL) leads to its gradual attenuation or complete failure.[7] This increases the stress on the radiocapitellar joint and olecranon, and can lead to edema, scarring, calcification, osteophyte formation, medial epicondylitis, ulnar nerve neurapraxia, or radiocapitellar chondral damage.[9] Extended practices and tournaments, with no substantial rest period throughout the year, put adolescents at increased risk for UCL injuries.[10]

Regardless of age, the medical history of an athlete with elbow pain should elicit information about the mechanism of injury; the location, duration, and quality of the pain; factors that alleviate or exacerbate the pain; the presence of weakness or paresthesias; and the extent to which the pain has affected the patient's ability to throw. Patients with chronic UCL injuries, for example, often report a loss of arm control and decrease in throwing speed. It is also important to address hand dominance, level of participation, the position played, changes in technique or training regimen, prior injuries, and the effects of any previous treatment.[11]

Compare the affected and uninjured extremities

Inspect, palpate, and assess the active and passive range of motion, strength, and neurovascular status of both arms, with the uninjured side serving as a comparison. The scapula, shoulder, and wrist are also involved in throwing, so these joints should be examined along with the elbow.

Measure range of motion. Normal ranges for the flexion-extension arc are 0 to 140°, with 75° of pronation and 82° of supination.[12] Use a goniometer, if available, to ensure accuracy and reproducibility,[1] and pay close attention to the position that elicits pain.

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Elbow anatomy and biomechanics

The elbow has 3 articulations—ulnohumeral, radiocapitellar, and proximal radioulnar—that provide primary stability to valgus stress. The elbow's soft tissue restraints include 2 ligament complexes (medial and lateral collateral), 4 muscle groups (flexors, extensors, pronators, supinators), and 3 major nerves (radial, median, ulnar) and their branches.

The ulnar collateral ligament (UCL) complex—which consists of the anterior and posterior bundles and the transverse ligament—is the main source of medial elbow stability.[4] Mechanical stability for overhead throwing is provided by both bony and soft tissue restraints. During the pitching motion, the forces generated exceed the UCL's tensile strength, and protective flexor muscles are activated.[5,6]

And the pitch . . . There are 6 stages of throwing: windup, early cocking, late cocking, acceleration, deceleration, and follow-through. Elbow pain is most likely during the late-cocking or early acceleration phase of a throw, the point of ball/javelin release, or the moment the racquet hits the ball.[4]

Tenderness over the ulnar collateral ligament has a sensitivity of 81% to 94% for UCL tears, but a specificity of only 22%.

In medial epicondylitis, the full range of motion should be preserved. Patients experience pain at the medial epicondyle and overlying flexor-pronator mass proximately, and pain or weakness with resisted wrist flexion, and resisted pronation, at full extension.[4,11] Flexor-pronator strain will produce similar findings, but edema or ecchymosis may be present and there may be pain immediately distal to the medial epicondyle.[11]

Pain associated with injury to the UCL—which courses distal and slightly posterior to the medial epicondyle—typically occurs 2 cm distal to the medial epicondyle over the anterior bundle. Tenderness over the UCL has a sensitivity of 81% to 94% for UCL tears, but a specificity of only 22%.[13]

Physical maneuvers can help identify source of elbow pain

A complete UCL tear can cause valgus gapping as small as 3 mm, which makes it difficult to detect on physical exam alone.[4] Orthopedic and sports medicine literature recommend that 3 maneuvers be used to identify UCL pathology:[4,14,15]

The valgus stress test (FIGURE 1) assesses the effects of valgus stress on the UCL. Gapping >3 mm signifies UCL instability. The test has a sensitivity of 66% and a specificity of 60% for detecting a UCL strain or tear.[13,16]

The milking maneuver (FIGURE 2), performed by the patient (or by a clinician if the patient lacks flexibility), reproduces a common pitching exercise. Medial elbow pain or apprehension indicates UCL injury.[13,16]

The moving valgus stress test (FIGURE 3A-C) is done in an effort to recreate the flexion angles of the elbow during the late cocking and early acceleration phases of throwing. Pain anywhere in the arc of motion suggests a UCL injury; pain elicited at 45° of flexion suggests osteochondrosis of the humeral capitellum, while pain closer to full extension suggests osteochondrosis of the trochlea.[13,16]

Does your patient have 2 positive valgus tests and posterior pain?

Valgus extension overload syndrome, which is caused by repetitive stress and results in osteophytes, chondromalacia of the medial olecranon fossa, tension in the UCL, and compression of the radiocapitellar joint, will also produce positive valgus stress and positive moving valgus stress tests. Keep in mind, however, that patients with valgus extension overload often have loss of full extension and posterior elbow pain with forced elbow hyperextension.[17]

Look for ulnar nerve injury

The physical examination should also be used to test for ulnar nerve injury. The elbow flexion test—a provocative maneuver in which the patient flexes the elbow as far as possible and reports any tingling or numbness of the hand—should be included in the work-up. Symptoms that develop in <60 seconds indicate a positive test for ulnar nerve compression, with the pinky and ulnar half of the ring finger most

TABLE 1

Differential diagnosis of elbow injuries

Location	Differential diagnosis
Medial	Little League elbow - delayed or accelerated apophyseal growth of the medial epicondyle - delayed closure of the medial epicondylar growth plate - medial epicondylar fragmentation and apophysitis - osteochondritis of the radial head - osteochondrosis or osteochondritis dissecans of the humeral capitellum or trochlea Flexor-pronator muscle strain or tear Fracture (olecranon, epicondylar, capitellum) Medial epicondylitis Snapping medial head of triceps Subluxating ulnar nerve Ulnar collateral ligament injury Ulnar neuritis (cubital tunnel syndrome) Valgus extension overload
Anterior	Anterior capsule strain Biceps tendon rupture Biceps tendonitis Dislocation Median nerve compression (pronator) syndrome
Posterior	Olecranon bursitis Olecranon process or tip stress fracture Triceps rupture/olecranon avulsion Triceps tendonitis Trochlear rupture Valgus overload syndrome (posterior olecranon impingement syndrome)
Lateral	Capitellum fracture Lateral epicondylitis Lateral ulnar collateral ligament injury Osteochondritis dissecans Posterior interosseous nerve syndrome Posterolateral rotary instability Radial head fracture Radiocapitellar chondromalacia

Adapted from: McKeag DB, Moeller JL. *ACSM's Primary Care Sports Medicine.* 2nd ed.[3]

likely to have loss of vibration and light touch perception. A positive Tinel's sign over the cubital tunnel is an indication of ulnar neuritis.[18]

If the ulnar nerve moves out of the ulnar groove when the groove is palpated as the elbow is flexed and extended, subluxating ulnar nerve is the likely diagnosis. If 2 structures displace over the medial epicondyle with elbow flexion, the first will be the ulnar nerve and the second will be the medial head

A positive Tinel's sign over the cubital tunnel is an indication of ulnar neuritis.

FIGURE 1

Valgus stress test

PHOTOS from: Benson EC, et al. Clinical assessment of the elbow. In: Stanley D, Trail I, eds. *Operative Elbow Surgery*. Copyright © Elsevier, 2011.

With the injured elbow at 30° of flexion, the shoulder abducted and fully externally rotated, and the patient's wrist under your arm, place one hand laterally over the elbow. Place the other hand under the ulna and the thumb over the ulnar collateral ligament and apply valgus stress. Gapping >3 mm is abnormal.

FIGURE 2

Milking maneuver

The patient grasps the thumb of the affected arm and pulls downward, with the affected elbow positioned as shown, stressing the ulnar collateral ligament (UCL). Elbow pain or apprehension is positive for UCL injury.

of the triceps—an indication of a snapping medial head of triceps.[18]

Imaging studies may require a second look

Imaging studies are sometimes used to further aid in diagnosis of elbow injury. However, standard elbow x-rays, including an anteroposterior view in full extension, an oblique view, and a lateral view at 90° flexion, can be deceiving, as they often appear normal in conditions causing medial elbow pain associated with overhead throwing.

Careful review of the images may be needed to rule out fracture and other conditions, keeping the following factors in mind:

- **A supracondylar fracture** is likely if the anterior humeral line that is drawn along the anterior surface of the humeral cortex (on a lateral view) does not transect the middle third of the midcapitellum.[3,11,18]
- **Dislocation of the radial head** is suggested if the radiocapitellar line (drawn through the center of the radial head and neck) does not transect the midcapitellum on a lateral view.[3,11,18]
- **Intra-articular injury with a joint effusion** is indicated when an enlarged anterior fat pad, which is slightly anterior to the distal humeral diaphysis, is visible (the "sail sign") on a normal elbow radiograph.[3,11,18]
- **A fracture** is likely if a posterior fat pad (which lies in the olecranon fossa and is not usually visible unless an effusion elevates the fat pad away from the cortex) is visible on an elbow x-ray.[3,11,18]
- **A chronic UCL tear** is suggested by heterotropic calcification of the UCL.[19]

It is useful to x-ray both the injured and the unaffected elbows in skeletally immature athletes to compare secondary ossification centers. Little League elbow demonstrates a widening of the medial epicondyle physis, for example, when the x-rays are compared.[3] Secondary ossification centers of the elbow appear first at the capitellum (age 2), followed by the radial head (age 5), medial epicondyle (age 7), trochlea (age 9), and lateral epicondyle (age 11). Most ossification centers fuse between 14 and 17 years of age.[3]

Computed tomography arthrograms, magnetic resonance imaging (MRI), and ultrasonography are also used to identify UCL tears. MRI, which can reveal injuries to cartilage and tendons as well, is the most commonly used imaging technique for musculoskeletal diagnosis of the elbow.[16,20]

FIGURE 3
Moving valgus stress test

With the shoulder in abduction and maximum external rotation (A), place the elbow in maximum flexion and apply valgus force (B), and extend the elbow from full flexion to full extension (C) in an attempt to reproduce the medial pain.

Treatment gets most athletes back on track

Most medial elbow injuries respond to conservative treatment—typically, with some combination of activity modification, nonsteroidal anti-inflammatory drugs (NSAIDs), icing, physical therapy aimed at flexor-pronator strengthening, and counterforce bracing.[11] Medial epicondylosis and flexor-pronator strain injuries have an excellent prognosis, with more than 90% of patients back to their previous level of activity at 1 year. Initial treatment consists of a 2- to 3-week rest period, followed by a 6- to 12-week rehabilitation protocol.[11]

Randomized controlled trials have found limited evidence of short-term improvement in symptoms with corticosteroid injections compared with placebo or no treatment, local anesthetic, orthosis, physical therapy, and NSAIDs. However, corticosteroids were less effective than physiotherapy or oral NSAIDs in improving long-term outcomes.[21] Despite a paucity of well-designed studies to prove their use, autologous blood, platelet-rich plasma, and botulinum toxin are sometimes used for refractory elbow pain.[21]

Treatment of Little League elbow consists of cessation of throwing for at least 4 to 6 weeks, with a gradual return to throwing and emphasis on proper throwing mechanics after the pain resolves. Most throwers are out of competition for 2 to 3 months, but fully recover with nonoperative management.[21]

UCL injuries, too, are initially treated with rest, NSAIDs, icing, bracing, and physical therapy, typically with 2 to 3 months of no throwing. Some patients also use a splint at 90° flexion at night and as needed for pain during the day. Patients whose symptoms last more than a year despite treatment may be candidates for arthroscopic debridement.[11]

Consider reconstruction when nonsurgical management fails

UCL reconstruction was introduced in 1974, when reconstruction was performed on professional pitcher Tommy John, who went on to win 164 games.[4,9] The procedure has since undergone numerous modifications. Surgery is indicated for acute rupture, significant chronic instability, insufficient UCL tissue after debridement, or recurrent pain and valgus instability with throwing after rehabilitation.[2,4,6,9]

Reconstruction generally entails fixing a tendon graft through bone tunnels in the medial epicondyle of the humerus and sublime tubercle of the ulna to reestablish valgus stability. A recent systematic review of reconstruction methods found a 76% to 95% rate of excellent results, with patients returned to their prior level of activity at a mean follow-up of 1 year.[22] Rehabilitation typically begins 7 days postop; throwing (without windup) may begin in 4 to 5 months, with a gradual increase in speed and force and a return to the game at 12 months.

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Medial epicondylosis and flexor-pronator strain injuries have an excellent prognosis, with more than 90% of patients back to their previous level of activity at 1 year.

TABLE 2

Keeping young pitchers injury-free[1,10,23-25]

Recommendations for coaches and parents
Record the number of pitches thrown at each outing/sports event for all young pitchers
Avoid allowing young athletes to pitch competitively >8 months per year
Limit the number of pitches to ≤2500 per year and 10 x the pitcher's age per week, or 90 per outing
Ensure that young pitchers are instructed in proper pitching mechanics
Restrict throwing breaking ball pitches* prior to puberty
Ensure that young pitchers get 3 months of rest per year.

*A pitch that changes direction either sideways or downwards as it approaches the batter, eg, a slider or curve ball.

A stepped-up focus on prevention

The increase in UCL injuries in adolescents highlights the need for greater emphasis on prevention.[10] Several governing bodies, including USA Baseball and the American Academy of Pediatrics, have developed research-based guidelines for young athletes (**TABLE 2**).[1,10,23-25]

One of the easiest to follow is to limit an athlete's weekly pitch count to 10 times his age. Thus, a 10 year old should pitch no more than 100 pitches in a given 7-day period. Another important measure—in addition to ensuring that young athletes receive instruction in proper pitching mechanics (see http://www.littleleague.org/Little_League_Online.htm)—is to urge coaches and parents to require players to get at least 3 months of rest after each season and to stop throwing if they have pain or fatigue.[24] **JFP**

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