Diagnosis: ulnar collateral ligament injury. The coronal proton-density (Fig 1A) and T2-weighted (Fig 1B) magnetic resonance images (MRIs) show focal discontinuity (arrows) of the anterior band of the viscer collagen ligament near the ulnar attachment. A small amount of joint fluid has extravasated into the adjacent soft tissue. These findings are diagnostic of ulnar collateral ligament tear.

The repetitive overhand motion used in many sports subjects the medial side of the elbow to strong tensile forces and places the ulnar collateral ligament under high degrees of valgus stress. Consequently, this ligament frequently is injured, especially in athletes.1,5

Abnormal increase in the width of the medial joint space of the elbow is the most common radiographic sign of a tear of the ulnar collateral ligament.6 Several imaging modalities can be used to evaluate the patient, but MRI directly displays the ulnar collateral ligament, and MR arthrography is the most sensitive for detecting tears.

**ANATOMY**

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The elbow is predominantly a ginglymus joint that restricts motion to flexion and extension. The adjacent radioulnar joint, however, allows pronation and supination. The proximity of two joints with such different patterns of motion makes possible complex movements, such as those needed to throw a curve ball, but at the same time increases the risk for several specific injuries.

The proximal articular surface of the ulna articulates with the humeral trochlea, forming a hinge mechanism. The bony contours of these bones do not provide significant stability under valgus/varus stress, but the elbow joint capsule, which contains the radiohumeral, ulnohumeral, and radioulnar articulations, does provide some stability. The dominant stabilizer of the medial joint line, however, is the ulnar collateral ligament.1,2

The ulnar collateral ligament consists of anterior, posterior, and transverse bundles. The anterior bundle extends from the caudal-medial margin of the medial humeral epicondylye to the medial articular margin of the ulna (Fig 2). This bundle is the main stabilizer against valgus stress and frequently is damaged by repetitive activities, which subject the elbow to excessive valgus stress as in throwing athletes. The posterior and transverse bundles are considerably smaller and have not been found to be functionally important in maintaining elbow stability.1,2

**PATHOGENESIS**

Ulnar collateral ligament injuries are most often the result of chronic repetitive stress related to activities that place excessive valgus forces on the medial elbow. The overhead motion used in many sports including pitching in baseball, passing in football, and serving in tennis imparts severe tensile forces on the medial elbow, which is in partial flexion. Baseball pitchers are particularly at risk. Pitching a baseball involves five basic phases of motion: windup, cocking, acceleration, deceleration, and follow-through. The acceleration phase causes the greatest stress on the ulnar collateral ligament, and most injuries are thought to occur during acceleration phase.3

Micro tears initially weaken the anterior bundle of the ulnar collateral ligament. Continued valgus stress can then eventually lead to partial or complete tears of the ulnar collateral ligament. This is usually a chronic process rather than a single episode resulting in a tear.2,4,5

In the skeletally immature patient, avulsion of the medial epicondyle is the equivalent of ulnar collateral ligament
injury in an adult. The physeal plate is weaker than the ligament and therefore more susceptible to injury from the repetitive valgus stress and pronator forces associated with pitching. Osteochondrosis of the medial epicondyloide along with medial epiphyseal stress fractures and avulsions of the medial epicondyloide have collectively been termed "little leaguer’s elbow."

**Clinical Findings**

Patients commonly present with diffuse medial elbow pain, but there may be point tenderness just distal to the medial epicondyloide. The pain is usually chronic. There may be a popping sensation associated with movement. Symptoms are often progressive and associated with decreased throwing ability. Symptoms also can be acute when the ulnar collateral ligament is ruptured by a single episode of trauma such as a fall on an outstretched hand that dislocates the elbow.

In the skeletally immature patient, severe valgus stress, due to a fall or a sudden contraction of the common flexor musculature as in javelin throwing, can result in a fracture through the apophysis and avulsion of the medial epicondyloide. Occasionally, after closed reduction of a dislocated elbow, a displaced epicondylar fragment becomes entrapped in the joint, necessitating open reduction and internal fixation of the fracture fragment. This complication is rare unless there has been a dislocation.

**Imaging**

Radiographs. Plain radiographs are still the initial and primary imaging method for evaluating a patient with elbow pain. When ligamentous injuries are an isolated abnormality, radiographs are usually normal. Infrequently, however, the medial joint space is widened when there is a complete tear of the ulnar collateral liga-

Stress radiographs can demonstrate opening of the medial joint line when routine radiographs are normal. Rijke et al applied force to the lateral elbows (continued on page 822)
Fig 5: Arthrography and CT arthrography profile the undersurface (arrow) of the ulnar collateral ligament. The contour should be smooth. Any contrast extravasation at the medial aspect of the joint is indicative of ulnar collateral ligament tear.

(Radiologic Case Study continued) of both healthy and injured athletes. They found that a 0.5-mm or greater increase in the joint space between the medial epicondyle and coronoid process of an injured elbow compared with the opposite elbow was accurate in identifying a complete or large partial ulnar collateral ligament tear.

Prior to physeal closure, avulsion of the medial epicondyle is usually clearly visible (Fig 3). When the avulsed fragment is not displaced, diagnosis is more difficult, but regional soft-tissue swelling suggests the diagnosis and subtle widening of the physis may be visible. Comparison radiographs can be useful in these cases. When avulsion of the medial epicondyle is associated with dislocation of the elbow, the avulsed epicondyle may migrate distally and can become entrapped in the joint.

Following closed reduction of an elbow dislocation, radiographs should be scrutinized to make certain that an avulsed ossific epicondyle is not entrapped in the joint line (Fig 4). In children younger than age 7, this center is not yet ossified so that the only radiographic clue to entrapment is widening of the medial joint line.

Fig 6: MR allows direct visualization of the ulnar collateral ligament. Imaging is designed to optimally demonstrate the functionally important anterior band. Coronal T2-weighted (left) and proton-density weighted (right) images show the ulnar collateral ligament (arrows) optimally.

Arthrography/Computed Tomographic (CT) Arthrography. Arthrography and CT arthrography both profile the undersurface of the ligaments and thus provide indirect evaluation of ligamentous integrity. Following intra-articular injection of contrast material and air, the normal medial joint capsule profile is well-defined and has no significant convoluted (Fig 5). Any extravasation of contrast material is evidence for ligamentous discontinuity.

Timmerman et al reported that CT arthrography was accurate for diagnosing complete ulnar collateral ligament tears but less sensitive when tears were incomplete. A “T sign” of contrast material has been described in patients with tears of the ulnar collateral ligament. This sign refers to the shape of contrast material extravasating through a ligamentous tear at the ulnar attachment where the horizontal part of the “T” is formed by contrast contained by the superficial layer of the ulnar collateral ligament, which blends with the joint capsule. Arthrography and CT arthrography are technically less demanding and less expensive than MRI, and both offer a fairly effective means of diagnosing complete and partial ligamentous disruption.

Magnetic Resonance Imaging/MR Arthrography. Magnetic resonance has the advantage of directly imaging the ligaments of the elbow. The anterior band of the ulnar collateral ligament is optimally examined by a small field of view in the coronal plane with the elbow flexed 20° to 30°. The transverse and posterior bands can be demonstrated by using other anatomic planes, but imaging protocols emphasize demonstration of the functionally important anterior band.

The normal ulnar collateral ligament is a continuous, linear, low-signal band on all pulse sequences (Fig 6). Normally, there can be minimal intermediate signal at the attachment of the ligament to the epicondyle as seen on T1-weighted and proton density-weighted sequences, but there should be no high signal at this site on T2-weighted spin-echo sequences. If there is sufficient joint fluid, extravasation of fluid though a ulnar collateral ligament defect is well shown on T2-weighted spin-echo sequences. Joint fluid also facilitates the identification of irregular contours and margination of ligaments, indicating partial thickness tears.

Magnetic resonance arthrography (Fig 7) has been shown to be more sensitive than routine MR for detecting ulnar collateral ligament tears. Schwartz et al imaged following the intra-articular injection of saline and reported sen-
sivities of 86% for showing partial tears and 95% for showing complete tears. Routine MR imaging, reported by Timmerman et al., resulted in much lower sensitivities of 14% and 71%, respectively, for partial and complete tears of the ulnar collateral ligament.

TREATMENT

The functional demands of the patient play a key role in determining management. Even minor limitations of movement and stability can be incapacitating to an elite athlete. Initially, most ulnar collateral ligament tears are treated conservatively with rest, anti-inflammatory medication, and physical therapy. If conservative therapy fails or if the patient is a high-performance athlete, surgery may be elected. Surgical procedures include direct ligamentous repair and reconstruction using a tendon graft.

In children with avulsion of the medial epicondyle, fracture fragment displacement and joint line stability guide management decisions. If there is little or no displacement of the fragment and the joint is stable, treatment is nonoperative with brief immobilization followed by physical rehabilitation. If a fragment is entrapped, closed reduction may be attempted, but open reduction is usually required.

The indications for operative intervention when a fragment is displaced but not entrapped are controversial. Even nonunion of a significantly displaced fragment can still result in a functionally intact elbow. Relative indications for operative intervention include complete ulnar nerve dysfunction and joint line instability, especially in a high-demand athlete.

REFERENCES


Section Editor: Terrence C. Demos, MD
This 22-year-old semi-pro, right-handed baseball pitcher (Fig 1) has had persistent elbow pain distal to the humeral epicondyle since pitching for seven innings 2 weeks ago. Your diagnosis?

(See page 819 for answer.)