The Elbow: Diagnosis and Treatment of Common Injuries
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This article deals with common injuries to the elbow. Elbow anatomy is reviewed. Diagnosis and treatment of pronator syndrome, lateral epicondylitis (tennis elbow), radial tunnel syndrome, posterior interosseous nerve syndrome, medial epicondylitis (golfer’s elbow), ulnar collateral ligament injury, cubital tunnel syndrome, posterolateral rotatory instability, distal biceps injuries, triceps tendon injuries, and posterior elbow impingement are discussed.

Elbow anatomy

Bones

The elbow is a hinge (ginglymus) joint between the distal humerus, the proximal ends of the radius and ulna, and the superior radioulnar joint. The lateral capitellum of the distal humerus articulates with the radial head, enabling flexion and extension as well as pronation and supination. The medial trochlea of the distal humerus articulates with the greater sigmoid fossa (olecranon) of the ulna. The olecranon consists of the coronoid process distally and the olecranon process proximally. The trochlea extends more distal than the capitellum and its articulation produces a 5\degree to 7\degree valgus angle with regard to the long axis of the humerus (carrying angle). On the lateral side of the olecranon is the lesser sigmoid notch, which accommodates the radial head. The radioulnar articulation is designed not to impede pronation and supination [1].
Ligaments

The medial and lateral collateral ligaments provide approximately 50% of elbow stability. The medial collateral ligament complex consists of a strong anterior bundle, a posterior bundle, and a transverse ligament. The anterior bundle originates at the site of the axis of rotation for the elbow, and primarily provides valgus stability. The lateral collateral ligament complex consists of the radial collateral ligament, the annular ligament, the accessory lateral collateral ligament, and the lateral ulnar collateral ligament. The lateral collateral ligament complex provides varus stability, and its humeral origin is in the center of the axis of rotation of the elbow joint. The lateral ulnar collateral ligament is responsible for preventing posterolateral rotatory instability.

Muscles

There are four groups of muscles that cross the elbow joint and accomplish flexion, extension, pronation, and supination. Anteriorly, elbow flexion is produced by the biceps brachii, brachioradialis, and brachialis muscles. Posteriorly, elbow extension is accomplished by the triceps and anconeus muscles. Medially, the flexor-pronator muscles arise from the medial epicondyle of the humerus [1]. They flex the wrist and fingers (flexor carpi radialis, palmaris longus, flexor carpi ulnaris, and flexor digitorum superficialis muscles) and pronate the forearm (pronator teres muscle). Laterally, the extensor-supinator muscles arise from the lateral epicondyle of the humerus. They extend the wrist and fingers (extensor carpi radialis longus, extensor carpi radialis brevis, extensor digitorum, extensor digiti minimi, and extensor carpi ulnaris muscles) and supinate the forearm (supinator muscle).

Nerves

The median, ulnar, and radial nerves are intimately associated with the elbow. The median nerve crosses the elbow anteriorly and is covered by the bicipital aponeurosis in the cubital fossa. It then dives between the two heads of the pronator teres muscle and runs down the forearm underneath the flexor digitorum superficialis muscle. The ulnar nerve passes posterior to the medial epicondyle in the cubital tunnel, where it can be readily palpated. The nerve then passes between the two heads of the flexor carpi ulnaris muscle to enter the anterior compartment. It descends the forearm on the anterior surface of the flexor digitorum profundus. The radial nerve runs anterior to the elbow between the brachialis and the brachioradialis muscles, which signify the beginning of the radial tunnel. In the cubital fossa it divides into the posterior interosseous nerve and the superficial radial nerve. The posterior interosseous nerve passes through the proximal edge of the supinator (arcade of Frohse), and passes between the two heads of the supinator muscle, which mark the
end of the radial tunnel. The superficial radial nerve runs laterally beneath the brachioradialis muscle [1].

**Vessels**

The three major arteries associated with the elbow are the brachial, radial, and ulnar arteries. The brachial artery lies in the cubital fossa, lateral to the median nerve and anterior to the brachialis muscle. In the cubital fossa, the artery divides into its terminal branches, the radial and ulnar arteries. The radial artery lies medial to the biceps tendon and then runs anteriorly to the supinator muscle. It then descends beneath the brachioradialis muscle in the forearm. The ulnar artery leaves the cubital fossa, running deep to the pronator teres [1].

**Pronator syndrome**

**Definition**

Pronator syndrome is a condition in which the median nerve is compressed or impinged at the point where the nerve passes between the two heads of the pronator teres muscles. The two heads of the muscle are joined by a fibrous band, which is the tendinous arch of the flexor digitorum superficialis (sublimis bridge). An aberrant fibrous band may arise from the ulnar head of the pronator teres and attach to the arch, providing a point of compression. The nerve can also be impinged in the pronator teres muscle due to muscle hypertrophy, or beneath the lacertus fibrosus of the biceps brachii, which crosses the median nerve anterior the elbow [2].

**History**

Patients who have pronator syndrome typically present with anterior elbow pain or proximal volar forearm pain. This pain usually occurs in patients who perform repetitive pronation and gripping activities, such as weight training. Patients have a difficult time characterizing the pain associated with pronator syndrome, and they are often unable to identify inciting events or pinpoint the onset of symptoms. Patients note worsening of symptoms with activity and relief of discomfort with rest. Night pain and hand weakness are rare, unlike with carpal tunnel syndrome. There may be reduced sensibility in the radial three and a half digits of the hand, although absence of this symptom does not rule out the condition [2].

**Physical examination**

On observation of the affected limb, the examiner may note that the ulnar head of the pronator teres is hypertrophied (compressing the nerve between the two heads of the pronator teres). Neurologic examination of the
extremity may reveal a positive Tinel’s sign over the anterior cubital fossa, as well as sensory deficits in the radial three and one half digits of the hand on the affected arm. Resisting pronation of the forearm may reproduce or exacerbate the pain associated with pronator syndrome. Resisted flexion of the superficialis muscle of the middle finger may aggravate symptoms if the site of compression is at the tendinous arch of the flexor digitorum superficialis. Deep palpation over the ulnar head of the pronator teres may also reproduce symptoms [2].

Radiology/electromyography

Radiologic studies are typically unnecessary. Nerve conduction studies are not useful for diagnosis, but they may help to delineate the severity of damage to the median nerve [3]. For example, if axonal loss can be demonstrated, it might be more prudent to refer the patient for surgery, as opposed to continuing conservative therapy.

Treatment

These patients should be initially managed with activity modification, nonsteroidal anti-inflammatory drugs (NSAIDs), and perhaps splinting. Physical therapy can also be initiated for treatment, although published data supporting the efficacy of this regimen are lacking [4]. Indications for surgical referral include symptoms persisting for longer than 6 months, electromyograph (EMG) demonstration of axonal loss, or a significant decrease in function [5]. Prognosis for recovery is good, provided that the injury to the median nerve does not entail a complete disruption of nerve fascicles [6].

Lateral epicondylitis (tennis elbow)

Definition

Lateral epicondylitis is tendinosis (chronic insult with disordered repair) of the origin of the extensor carpi radialis brevis muscle and other extensor tendons on the lateral epicondyle of the humerus.

History

Patients complain of pain over the lateral aspect of the elbow. The pain is described as anything from sharp to achy, and sometimes radiates down the lateral aspect of the forearm. Patients are usually involved in an activity requiring repetitive wrist extension, such as tennis or mechanical work.

Physical examination

The examiner elicits tenderness to palpation over the origin of the extensor carpi radialis brevis tendon immediately anterior, medial, and distal
to the lateral epicondyle. This tenderness is more pronounced with resisted wrist extension while the elbow is in extension or when the forearm is pronated.

Radiology/electromyography

Plain films, CT, and MRI are generally unnecessary. EMG has no role in diagnosis.

Differential diagnosis

Radial tunnel syndrome can present with similar symptoms, and must be considered whenever a presumed diagnosis of lateral epicondylitis does not respond to treatment. Posterior interosseous nerve syndrome can present with lateral elbow pain and arm weakness.

Treatment

Initial treatment includes activity modification and NSAIDs, which can often achieve pain control in the acute phase [7]. In the case of tennis players, proper technique and racquet choice must be evaluated. Patients who do not respond favorably may be treated with a counterforce brace or splint. The counterforce brace is worn during activities and diminishes muscle force on the lateral epicondyle. Splints should keep the wrist in 30° to 45° of extension to relieve tension on the extensor carpi radialis brevis tendon [8]. Once pain is controlled and inflammation has subsided, initiation of physical therapy is prudent. Physical therapy is most successful when combined with other treatments [9]. In cases of chronic, refractory lateral epicondylitis, steroid injections can be administered. There have been mixed results reported in the literature with this treatment. One study [10] demonstrated that 92% of subjects reported improvement at 4 weeks, whereas another [11] showed that injections had no effect on outcome at 6 months. The majority of those treated with conservative therapy respond, with fewer than 10% of patients exhibiting a recurrence of symptoms [12]. Botulinum toxin injection could be an alternative to surgery in the future, although there is scant literature supporting its use for this condition [13]. Surgical referral should be considered if symptoms are still present after 6 months of conservative treatment.

Radial tunnel syndrome

Definition

Radial tunnel syndrome (RTS) is compression of the radial nerve in the radial tunnel. There are five locations within the radial tunnel that can
compress the nerve, the most common site occurring as the posterior interosseous nerve passes through the arcade of Frohse (proximal edge of the supinator muscle). The syndrome is characterized as forearm pain without weakness.

**History**

Typical patients have a history of performing repetitive forearm pronation with wrist extension, such as in heavy manual labor or athletics. Patients often complain of soreness or an aching over the extensor mass just distal to the lateral epicondyle.

**Physical examination**

The examiner may elicit tenderness to palpation over the extensor mass, approximately 8 cm distal to the lateral epicondyle. Another site of tenderness is at the arcade of Frohse. The examiner may be able to elicit pain by resisting supination with the patient’s elbow in extension [2]. Pain may escalate when this maneuver is repeated with the patient’s wrist in extension. If the patient has lateral epicondylitis, pain is exacerbated with the patient’s wrist in flexion rather than extension [14]. An additional test is performed by resisting extension of the patient’s middle finger with the patient’s elbow in extension. This maneuver, if positive, will reproduce the patient’s symptoms.

**Radiology/electromyography**

Plain films, CT, and MRI are of no utility. Nerve conduction studies are of questionable value.

**Differential diagnosis**

RTS must be distinguished from recalcitrant lateral epicondylitis. RTS is present in approximately 10% of cases of lateral epicondylitis [15]. Posterior interosseous nerve syndrome has a similar presentation, but typically exhibits motor involvement in addition to forearm pain.

**Treatment**

Treatment is primarily conservative. This includes activity modification, NSAIDs, and splinting. Physical therapy is also useful in combination with the other modalities. Particular attention must be paid to the technique that the patient uses in the activities that produce the pain. Surgical referral is indicated if there is no improvement after 6 months of conservative treatment, or if the symptoms are intolerable.
Posterior interosseous nerve syndrome

Definition

Posterior interosseous nerve (PIN) syndrome is compression of the posterior interosseous nerve at the arcade of Frohse. Compression of the PIN nerve at this site typically leads to forearm pain and weakness in the muscles it innervates. These muscles include the digit extensors, thumb extensors, extensor carpi ulnaris, and abductor pollicis longus.

History

The history is the same as RTS. The only additional complaint is forearm or wrist weakness.

Physical examination

The examination is similar to that of RTS. There is pain to palpation distal to the lateral epicondyle and over the arcade of Frohse. Provocative maneuvers include resisted forearm supination and resisted middle finger extension with the elbow in extension. The patient will have weakness or inability to extend the thumb or other digits at the metacarpal-phalangeal joint [2]. The examiner may also note radial deviation of the wrist in extension, due to weakness of the extensor carpi ulnaris muscle.

Radiology/electromyography

Plain films, CT, and MRI are of no utility. Nerve conduction studies are of questionable value.

Differential diagnosis

PIN syndrome can be similar in presentation to lateral epicondylitis and RTS. The provocative maneuvers can distinguish PIN syndrome from lateral epicondylitis. RTS and lateral epicondylitis do not manifest motor weakness.

Treatment

Conservative methods may be considered in the initial treatment. These include activity modification, NSAIDs, splinting, and physical therapy. Surgical referral is suggested if there is no improvement after 3 months of treatment, or if motor function deteriorates [16].

Medial epicondylitis (golfer's elbow)

Definition

Medial epicondylitis is tendinosis of the flexor/pronator origin on the medial epicondyle of the humerus.
History

Patients complain of pain over the medial epicondyle and the proximal forearm. The pain can be characterized as sharp or achy, and may radiate down the medial aspect of the forearm. Onset is usually insidious, but there may be an inciting event. The patient may also complain of a weak grasp, and pain with repetitive wrist flexion and pronation. Activities associated with this disorder include golf, overhead tennis strokes, and using a screwdriver.

Physical examination

The patient will note tenderness to palpation just anterior to the medial epicondyle. Resisted wrist flexion and forearm pronation while the patient’s elbow is in extension will reproduce symptoms. Grip strength may also be decreased relative to the unaffected limb.

Radiology/electromyography

Radiologic and EMG studies are not indicated.

Differential diagnosis

Medial epicondylitis must be distinguished from ulnar collateral ligament strain or rupture and cubital tunnel syndrome.

Treatment

Conservative methods are recommended for initial treatment. These include activity modification, NSAIDs, and splinting. Splinting has poor patient compliance, but may be considered on occasion. Steroid injection is useful for chronic epicondylitis that has not responded to other treatment methods, although the pain relief may not last long-term [17]. Once acute symptoms are controlled, physical therapy may be considered, keeping in mind that there are no published data proving its efficacy. The therapist may prove useful in modifying the patient’s activity to prevent recurrence of the symptoms.

Ulnar collateral ligament injury

Definition

Ulnar collateral ligament strain is defined as attenuation or disruption of the ulnar collateral ligament secondary to recurrent microtrauma, or macrotrauma resulting in medial elbow pain.
History

Patients who have this injury are typically involved in an overhead throwing sport, such as baseball or javelin. They will usually report a long history of medial-sided elbow pain that has acutely increased (due to ligament rupture) while performing their activity. Pain is worse with throwing and improves with rest.

Physical examination

Valgus stress of the elbow will reproduce the symptoms. With the patient’s hand between the examiner’s arm and chest, the elbow is flexed to 30° and a valgus stress is applied. The forearm must be pronated to prevent subluxation of the radius and ulna if there is concurrent lateral collateral ligament disruption. This provocative test may demonstrate pain or laxity if the medial collateral ligament is disrupted. Comparison with the contralateral elbow is important to determine side-to-side differences. This test may also be performed with the patient in the supine position, with the arm flexed overhead. In this position, the wrist and elbow are grasped as the ankle and knee are held during a knee examination. This position gives the examiner better control over the elbow.

Radiographs/electromyography

Plain films might demonstrate calcification within the ulnar collateral ligament, or osteophytes on the posteromedial olecranon, radiographic findings that may be associated with ligament injury. A valgus stress film can be used to assess medial joint line opening, but it is not very sensitive and it must be performed on the contralateral elbow for comparison. MRI and CT arthrography are both 100% sensitive for diagnosing complete tears. CT arthrography is superior for diagnosing partial tears, with a sensitivity of 71%, versus 14% sensitivity for MRI [18]. EMG is not useful for evaluation of the ligament, but it may be helpful in assessing ulnar nerve function.

Differential diagnosis

Other causes of medial elbow pain are medial epicondylitis and cubital tunnel syndrome.

Treatment

Acute treatment of these injuries includes rest, ice, compression, and NSAIDs. Further treatment depends on the patient. In noncompetitive athletes in whom pain control and stability are the most important goals, a strengthening and stretching program for the flexor pronator group usually suffices [19]. For highly competitive athletes without a complete rupture, conservative therapy followed by a rehabilitation period of 3 to 6 months is
recommended before the patient is referred for surgery [20]. Surgery is indicated for highly competitive overhead throwing athletes who have a complete rupture. Return to professional competition after ulnar collateral ligament reconstruction is difficult for overhead throwing athletes [19].

Cubital tunnel syndrome

Definition

Cubital tunnel syndrome is entrapment of the ulnar nerve as it passes posterior to the medial epicondyle. Within the cubital tunnel, the nerve is subject to friction, traction, and compressive forces. It is the most common neuropathy of the elbow.

History

Patients typically complain of medial elbow and forearm pain. The pain can be sharp or achy, and may radiate proximally or distally. There may be parasthesias radiating to the ulnar one and a half digits. Patients may complain of weak grip strength, hand fatigue, or clumsiness with objects. Typically the patient is involved in a throwing sport, but it can also be caused by trauma or degenerative changes.

Physical examination

Flexion at the elbow may reproduce or exacerbate symptoms. The examiner may note tenderness to palpation over the ulnar nerve posterior to the medial epicondyle. Tinel’s sign is often positive in this location. The examiner may also note decreased grip strength, decreased index pinch, hypothenar atrophy, or decreased sensation in the ulnar one and a half digits.

Radiology/electromyography

Plain films are useful to identify osteophytes in the cubital tunnel. CT and MRI are of minimal benefit. EMG may help to localize the lesion, but there is a high false-negative rate.

Differential

Other causes of medial elbow pain are medial epicondylitis and ulnar collateral ligament injury.

Treatment

Conservative treatment consists of activity modification, ice, and NSAIDs. Splints can be worn at night with the elbow in 45° of flexion. Steroid injection is contraindicated. If conservative measures fail, the nerve
can be addressed one of four ways: simple decompression, subcutaneous anterior transposition, submuscular anterior transposition, and medial epicondylectomy [21].

**Posterolateral rotatory instability**

*Definition*

Posterolateral rotatory instability is transient rotatory subluxation of the radius and ulna from the distal humerus. This occurs due to injury of the lateral collateral ligament complex, specifically the lateral ulnar collateral ligament.

*History*

Patients typically complain of painful locking and popping of the elbow. There is often a history of trauma or dislocation of the elbow. It can also occur due to iatrogenic injury from a previous elbow surgery.

*Physical examination*

The lateral pivot shift test is used to evaluate the lateral collateral ligament complex. The examiner supinates the forearm with the elbow slightly flexed, and an axial load is applied. A valgus force is exerted throughout the range of motion. As the elbow approaches extension, the patient will experience apprehension, as if the elbow might dislocate. This test may also be performed with the patient in the supine position, and with the arm flexed overhead. In this position, the wrist and elbow are grasped as the ankle and knee are held during a knee examination. This position gives the examiner better control over the elbow. Demonstration of subluxation can usually only be done under anesthesia or sedation.

*Radiology/electromyography*

Plain radiographs are necessary to evaluate for fractures, loose bodies, or osteochondritis dessicans. MRI may be helpful in delineating injury to lateral collateral ligament. EMG is not necessary for diagnosis.

*Differential*

Patients who have this condition must be distinguished from patients who have intra-articular loose bodies, fractures, or osteochondritis dessicans.

*Treatment*

Acutely, hinged elbow bracing may be employed with the forearm in pronation. These patients should be referred for surgery.
Distal biceps injuries

Definition

Injuries to the distal biceps insertion on the radial tuberosity include muscle strain, incomplete tendon tear, or complete tendon tear.

History

The injury typically occurs during maximum muscle contraction, such as lifting a heavy object or an eccentric contraction of the muscle that results in extension of the flexed elbow. Middle-aged men are commonly affected, although the injury occurs in women as well [22]. History usually reveals a single traumatic event that causes sharp pain or a “pop” in the antecubital fossa.

Physical examination

The patient typically has weakness with resisted elbow flexion and forearm supination. Ecchymosis can be present proximal to the elbow, and the biceps may be asymmetric with proximal migration when compared with the contralateral arm. In the case of a complete tear, there is a palpable defect and absence of the distal biceps tendon.

Radiology/electromyography

Radiographs are rarely helpful due to the fact that this is a soft-tissue injury. MRI is very helpful in diagnosing partial or nonretracted tears.

Differential

This injury must be distinguished from medial or lateral collateral ligament tears and elbow fractures.

Treatment

Incomplete tears may be initially managed nonoperatively, with posterior elbow splinting for a week, followed by physical therapy to maintain range of motion and restore strength; however, these partial tears may continue to cause pain in the antecubital fossa and limit elbow function.

Painful partial tears and complete rupture of the distal biceps tendon are best managed with surgical reapproximation of the biceps tendon to the radial tuberosity. Timing of the surgery should be within 2 weeks of the injury to ensure adequate mobilization of the biceps tendon.
Triceps tendon injuries

Definition

The triceps tendon can be damaged at the tendon insertion site on the olecranon process of the ulna. These injuries include partial or complete rupture and tendonitis.

History

Triceps tendon tendonitis occurs with repetitive extension of the elbow against a force. Triceps tendon rupture most commonly results from a fall on the outstretched hand that places an eccentric force against the triceps muscle. Generally there are no prodromal symptoms, but rather a sharp acute pain posteriorly with a “pop” that is either felt or heard by the patient. Athletes at risk include weight lifters, body builders, martial artists, and overhead athletes.

Physical examination

Triceps tendonitis is diagnosed by eliciting pain while palpating the triceps insertion against resisted elbow extension. Triceps rupture or partial tear is associated with significant weakness or inability to actively extend the elbow against gravity. There may also be a visual or palpable defect in the triceps insertion on the olecranon.

Radiology/electromyography

Radiographs of the elbow may reveal a small bony avulsion from the olecranon, corresponding to the retracted triceps tendon insertion. MRI is useful in diagnosing partial ruptures of the tendon.

Treatment

Triceps tendonitis is managed with activity modification and NSAIDs. A brief period of splinting (7–10 days) followed by physical therapy is suggested in recalcitrant cases.

Triceps tendon ruptures must be repaired in all but the most debilitated of patients. Significant functional loss results if left untreated. Partial ruptures with elbow extension weakness should also be repaired surgically [23]. Optimal surgical results are obtained within 14 days of the injury.

Posterior elbow impingement

Definition

Posterior elbow impingement results from mechanical abutment of bone and soft tissues in the posterior compartment of the elbow.
History

This injury most commonly occurs in overhead throwing athletes such a baseball pitchers, although it can occur in contact athletes, especially football linemen. The mechanism of injury is referred to as valgus extension overload syndrome. During the throwing cycle, valgus force on the elbow can bring into contact the medial tip of the olecranon process and the posteromedial tip of the olecranon fossa [24]. Concurrent ulnar collateral ligament instability may accentuate the condition. The athlete will feel pain with elbow extension in the posteromedial aspect of the elbow. Presentation is usually insidious, and is accompanied with a loss of performance while throwing. Elbow crepitation and locking may also be present in some patients.

Physical examination

The patient will often present with a loss of terminal extension of the elbow. Attempted further extension by the examiner may elicit posterior elbow pain. Crepitus or locking may occur with passive elbow range of motion. Palpation of the posteromedial olecranon tip may recreate the pain experienced while throwing.

Valgus stress of the elbow in extension will also reproduce the symptoms. With the patient’s hand between the examiner’s arm and chest, the elbow is extended and a valgus stress is applied. The forearm must be pronated to prevent subluxation of the radius and ulna if there is concurrent lateral collateral ligament disruption. This provocative test may demonstrate pain in the posteromedial aspect of the elbow if impingement is present.

Radiology/electromyography

A complete set of radiographs is necessary, including anteroposterior (AP), lateral, oblique, and olecranon axial views. A CT scan of the elbow is useful to identify loose bodies or osteophytes on the olecranon. A bone scan may be necessary to rule out a stress fracture of the olecranon tip.

Differential

Posterior elbow impingement is often associated with ulnar collateral ligament instability; therefore the integrity of the ligament must be carefully evaluated.

Treatment

Treatment includes rest, NSAIDs, and a rehabilitation program aimed at increasing the strength of the flexor muscle groups of the elbow and
restoring elbow range of motion. Operative management is indicated if conservative measures are not successful and there is the presence of olecranon tip osteophytes or intra-articular loose bodies.

References

