Elbow Tendinopathy

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KEYWORDS

• Elbow tendinopathy • Tennis elbow • Golfer's elbow • Lateral epicondylitis
• Medial epicondylitis • Elbow overuse injuries

KEY POINTS

- Epicondylitis is thought to be an angiofibroblastic tendinosis and not an inflammatory condition. As such, epicondylosis and tendinosis are more appropriate terms.
- Epicondylosis is a clinical diagnosis and further investigations (radiographs, magnetic resonance images, and nerve conduction tests) are used after a failure of conservative therapy to rule out other clinical entities.
- Most patients improve with time and conservative therapy.
- Corticosteroid injection may reduce pain in the early stages of epicondylosis but has not been shown to be better than placebo for long-term treatment.
- Patients may benefit from a trial of platelet-rich plasma or autologous blood injection prior to consideration of surgical intervention in recalcitrant epicondylosis.

INTRODUCTION

The elbow is a three-joint complex formed by the humerus, radius, and ulna.[1] It allows for flexion and extension of the elbow and flexion, extension, pronation, and supination of the wrist (**Fig. 1**, **Table 1**). The wrist extensors originate from the lateral epicondyle of the humerus, whereas the flexors originate from the medial epicondyle (**Figs. 2–4**, **Tables 2** and **3**). Epicondylar pain is a frequent patient complaint. Commonly referred to as tennis elbow and golfer's elbow, respectively, these overuse injuries are related to sport, recreational, and/or occupational activities.

PREVALENCE

The prevalence of medial and lateral epicondylitis is variable depending on the population. In a Finnish study of 4783 persons, the prevalence of lateral epicondylitis was determined to be 1.3% and the prevalence of medial epicondylitis was determined to

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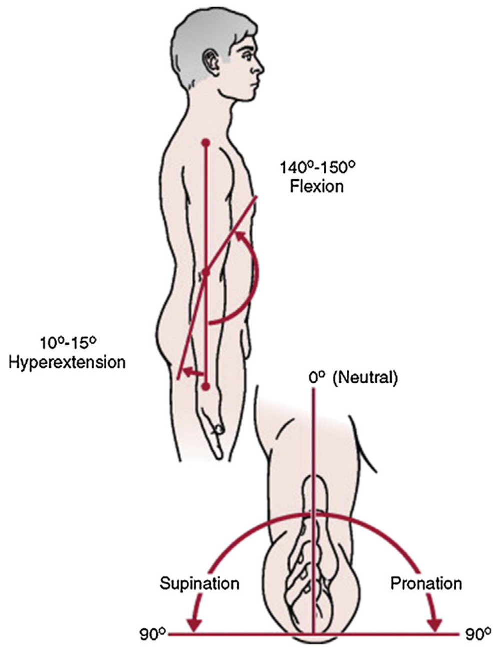

Fig. 1. Elbow range of motion. (*From* Magee DJ, Sueki D. Orthopedic physical assessment. Philadelphia: Elsevier; 2011; with permission.)

be 0.4%.[5] In a recent study of the US military, incident rates for lateral and medial epicondylitis were 2.98 and 0.81 per 1000 person-years.[6] In an occupational health study of 1757 subjects performing repetitive upper extremity movements as part of their occupation, the prevalence of medial epicondylitis was 3.8% (68 of 1757) at the beginning of the study.[7] Three years later this same study found prevalence in the same population to be 5.2% (31 of 598) and calculated the annual incidence of medial epicondylitis in this occupational population to be 1.5%.[7] Lateral epicondylitis has long been associated with racquet sports, and an estimated 10% to 50% of tennis players develop lateral epicondylitis over their careers.[15] Although the incidence of lateral epicondylitis is equal in men and women in the general population, male tennis players are more often affected than female players.[16] Medial epicondylitis predominantly occurs in the fourth and fifth decades with rates in males and females nearly equal, affecting the dominant arm in 75% of patients.[17] Overall, lateral epicondylitis is 7 to 10 times more common than medial epicondylitis.[4]

Table 1
Active movements of elbow complex

Motion	Degrees of Motion
Flexion of elbow	140–150
Extension of elbow	0–10 (hyperextention)
Supination of forearm	90
Pronation of forearm	80–90

From Magee DJ. Elbow. Orthopedic physical assessment. 5th edition. Philadelphia: WB Saunders; 2002. p. 368.

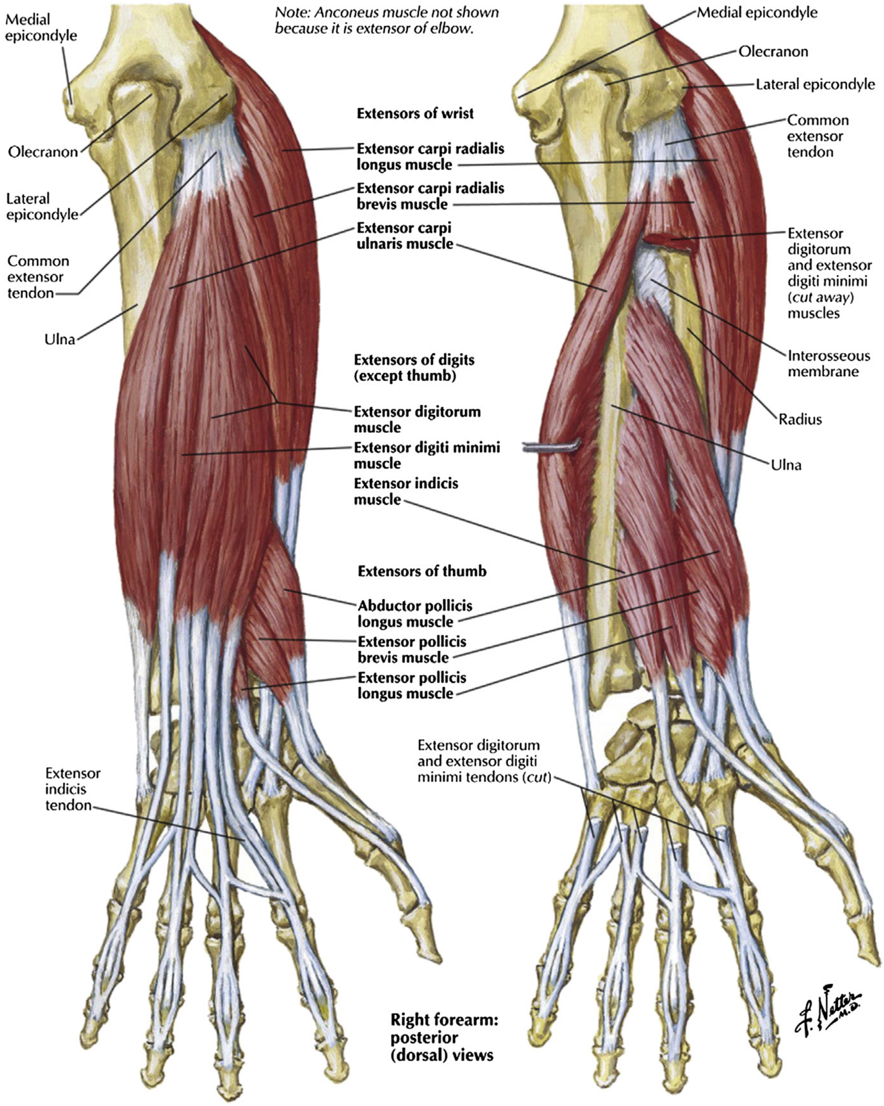

Fig. 2. Muscles that originate from the lateral epicondyle. (*Courtesy of* www.netterimages.com. © Elsevier Inc. All rights reserved.)

MECHANISM OF INJURY

Overuse and repetitive microtrauma of the wrist flexor and extensor tendons is thought to be the mechanism for injury of medial and lateral epicondylitis (**Table 4**). Repetitive movements with eccentric contraction (muscle-tendon unit lengthening while contracting) increase susceptibility to epicondylitis.[10,14,18] This theory was supported by Van Hofwegen who discovered via computer analysis and magnetic resonance imaging that novice tennis players with improper backhand technique underwent eccentric contraction of very lengthened extensor muscles and suggested the microtrauma caused by this technique to be the cause for lateral epicondylitis.[14]

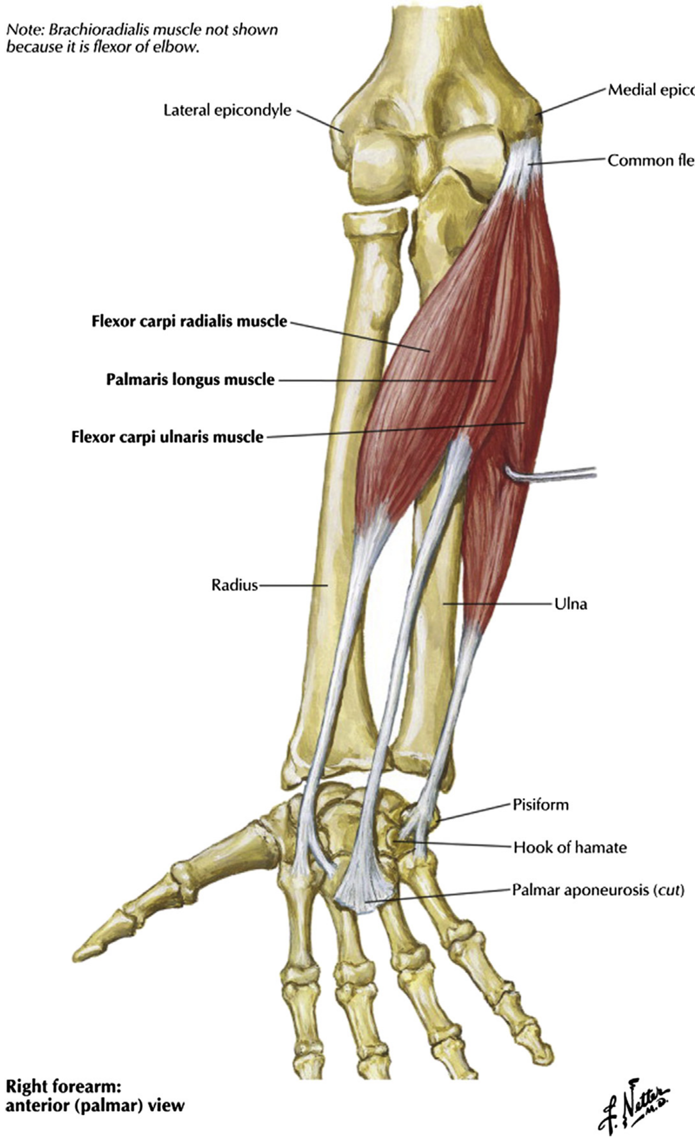

Fig. 3. Muscles that originate from the medial epicondyle (superficial). (*Courtesy of* www.netterimages.com.

Although lateral epicondylitis is associated with sports involving repetitive movements of the upper extremity, it is also recognized as an occupational disorder involving overuse of the hand, wrist, and forearm.[8–10] In a prospective cohort study of 45 auto assembly workers with known lateral epicondylitis, Werner and colleagues[18] found that older workers with jobs requiring more repetition and awkward wrist postures were less likely to have resolution of their elbow tendonitis.

Medial epicondylitis is less common and, as such, fewer investigations into the mechanism of injury have been performed. However, repetitive wrist flexion during

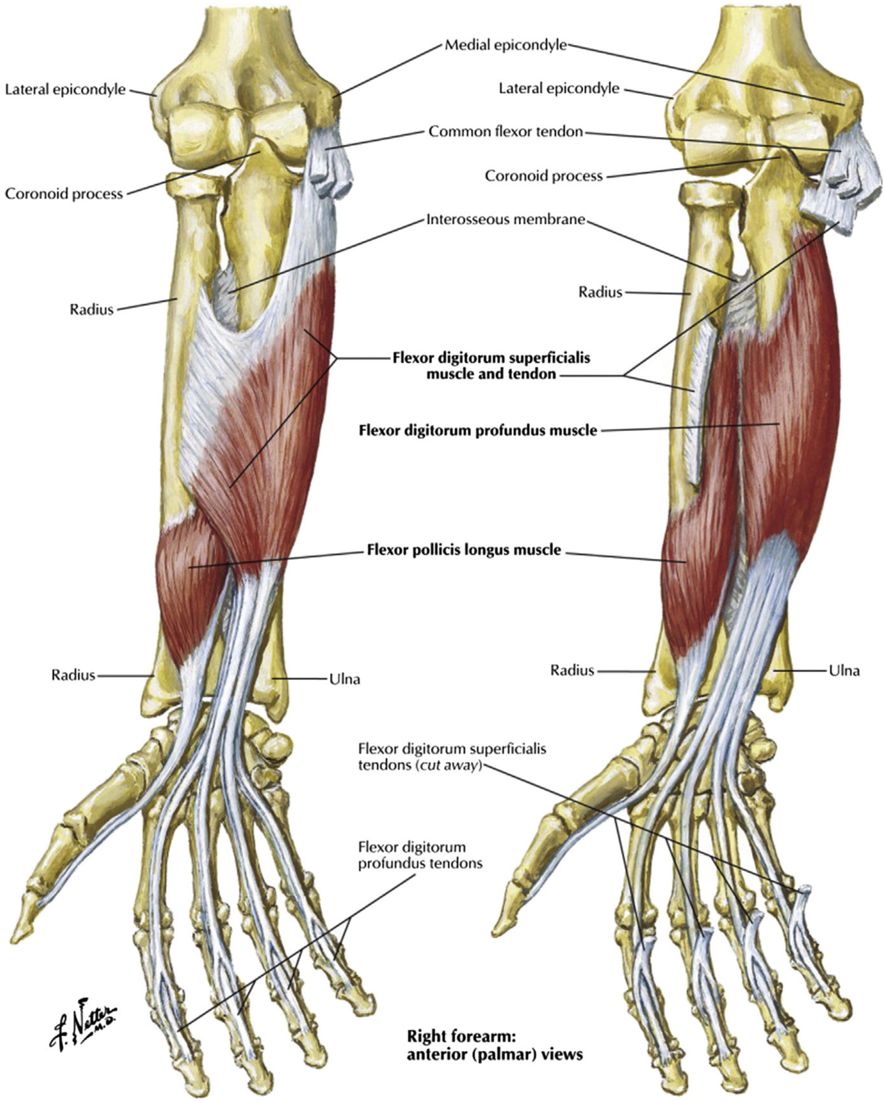

Fig. 4. Muscles that originate from the medial epicondyle (deep). (*Courtesy of* www.netterimages.com. © Elsevier Inc. All rights reserved.)

eccentric contraction is theorized to cause similar tendon injury as has been demonstrated in the common extensor tendon of the lateral elbow.

PATHOPHYSIOLOGY

Despite the suggestive name, epicondylitis is an inflammatory process only in the earliest stage of the disease.[16] Rather, the hallmark of this disease is microvascular damage, degenerative cellular processes, and disorganized healing. For this reason "tendinosis" is considered a more appropriate name for this clinical entity.[19] A microvascular dysregulation and degenerative cause for lateral epicondylitis was first

Table 2
Muscles that originate on the lateral epicondyle of the humerus

Name	Function
Extensor digitorum communis[a]	Wrist and digit extension
Extensor digiti minimi	Wrist and fifth digit extension
Extensor carpi ulnaris	Wrist extension and ulnar deviation of the wrist
Extensor carpi radialis longus	Wrist extension and radial deviation of the wrist
Extensor carpi radialis brevis[a]	Wrist extension and radial deviation of the wrist
Brachioradialis	Elbow flexion
Anconeus	Elbow extension

[a] Injury to the extensor carpi radialis brevis muscle[2] and, less often, the extensor digitorum communis muscle are involved in lateral epicondylitis.[3]

Table 3
Muscles that originate on the medial epicondyle of the humerus

Name	Function
Pronator teres[a]	Elbow flexion and forearm pronation
Flexor carpi radialis[a]	Wrist flexion and radial deviation of the wrist
Palmaris longus	Wrist flexion
Flexor carpi ulnaris	Wrist flexion and ulnar deviation of the wrist
Flexor digitorum superficialis	Digit flexion at the proximal interphalangeal joint (PIP) joint and wrist flexion

[a] Injury to the pronator teres and flexor carpi radialis muscles are commonly involved in medial epicondylitis.[4]

Table 4
Risk factors for lateral and medial epicondylitis

Lateral Epicondylitis	Medial Epicondylitis
Overuse in athletics	Overuse in athletics
Tobacco smoking	Repetitive movement
Obesity	Forceful activity off the upper extremity
Age 45–54 y	White race
Repetitive movement (at least 2 h daily)	Other tendinopathies/tenosynovitis
Oral steroid use	Eccentric contraction
Other tendinopathies/tenosynovitis	
Diabetes	
White race	
Female	
Eccentric contraction	

Data from Refs.[5–14]

supported by reports of pathologic changes in tissue removed at operation in recalcitrant epicondylitis.[20] Very few inflammatory cells were noted in these early tissue samples. Further evidence against an inflammatory cause for epicondylitis came by using microdialysis to study the concentration of substances in the extensor carpi radialis brevis (ECRB) tendon in patients with lateral epicondylitis. Using this technique, Alfredson and colleagues[21] found there were no inflammatory biomarkers in the ECRB of patients with lateral epicondylitis. Moreover, histologic examination of the ECRB in lateral epicondylitis has demonstrated chronic degeneration with few inflammatory cells, many immature fibroblasts, disorganized vascular elements, and disorganized collagen.[19,22] This chronic degeneration and failed healing after microtrauma is thought to be secondary to poor blood supply to the tendons. A 2007 study by Bales and colleagues[23] demonstrated areas of hypovascularity in the lateral elbow and suggested that these areas may lack a blood supply sufficient to generate a normal inflammatory cycle and a robust healing response. Furthermore, in studying lateral epicondylitis from a cellular and molecular perspective, Chen and colleagues[24] found a markedly elevated rate of apoptosis and autophagic cell death in the ECRB tendon in 10 patients with chronic recalcitrant lateral epicondylitis. Overall, based on these vascular, histologic, and cellular findings, epicondylitis is most appropriately termed an angiofibroblastic tendinosis[15] or epicondylosis.

PATIENT HISTORY

Elbow pain is the presenting complaint in patients with epicondylitis. This pain can be acute in onset related to a specific event, injury, or trauma. However, epicondylitis pain is more likely to be gradual and insidious in onset.[16] Initially, the pain is worse with activity and relieved by rest. The pain may or may not radiate down the forearm in the distribution of the wrist flexors or extensors. Patients may experience weakness in the hand or difficulty carrying items.[16] Pain severity can vary with some patients experiencing very mild symptoms and other patients experiencing disabling symptoms. In 1992, Nirschl[15] suggested seven phases of tendinosis pain with the earliest phase being mild pain after activity that resolves within 24 hours and the latest phase having constant rest pain and pain that disturbs sleep.

PHYSICAL EXAMINATION

After a thorough history is taken and the differential diagnosis is narrowed, then a careful physical examination aids in making the correct diagnosis. In considering the differential diagnosis of epicondylitis, a full evaluation of the upper extremity is necessary including cervical spine, shoulder, elbow and wrist. Physical examination of the elbow includes inspection, palpation, range of motion, elbow and wrist strength testing, and ligamentous stability assessment.

Palpation of the lateral aspect of the elbow aids in distinguishing lateral epicondylitis from other pathologies affecting the lateral elbow. Tenderness with palpation of the lateral epicondyle and the origin of the wrist extensor muscles is suggestive of lateral epicondylitis. Care should be taken to determine the distribution of any tenderness because posterior interosseous nerve syndrome may also have tenderness to palpation over the lateral epicondyle that extends into the volar forearm.[25] The radial collateral ligament can be palpated from its origin in the lateral epicondyle to its insertion on the annular ligament and the lateral ulna.

Palpation of the medial aspect of the elbow aids diagnosing medial epicondylitis, an ulnar nerve entrapment or neuritis, an ulnar collateral ligament (UCL) sprain, or a combination of the three entities. Palpation of the medial epicondyle and muscle bellies of the wrist flexor tendons elicits tenderness in a case of medial epicondylitis. The UCL may be palpated from its origin on the medial epicondyle to its insertions on the coronoid process and the olecranon process. Palpation of the cubital tunnel, just posterior to the medial epicondyle, may cause pain or altered sensorium stemming from ulnar nerve pathology.

In examining flexion and extension of the wrist, pain with resisted wrist extension is suggestive of lateral epicondylitis and pain with resisted wrist flexion is suggestive of medial epicondylitis. These findings on physical examination along with the following specialized tests aids in the diagnosis of epicondylitis.

Lateral epicondylitis test, type 1[26]: The patient should be seated with the elbow at approximately 110 degrees, the forearm supinated, and the hand forming a fist. The examiner should stabilize the patient's elbow with the thumb resting against the patient's lateral epicondyle and should place his or her other hand over the patient's fist to resist motion. The patient is then directed to pronate the forearm. While the examiner resists pronation, the patient should radially deviate the fist and extend at the wrist. The test is positive if the patient experiences pain at the location of the lateral epicondyle (**Fig. 5**).

Lateral epicondylitis test, type 2[25]: With the patient seated and the elbow at approximately 90 degrees, the examiner should position a hand over the patient's elbow

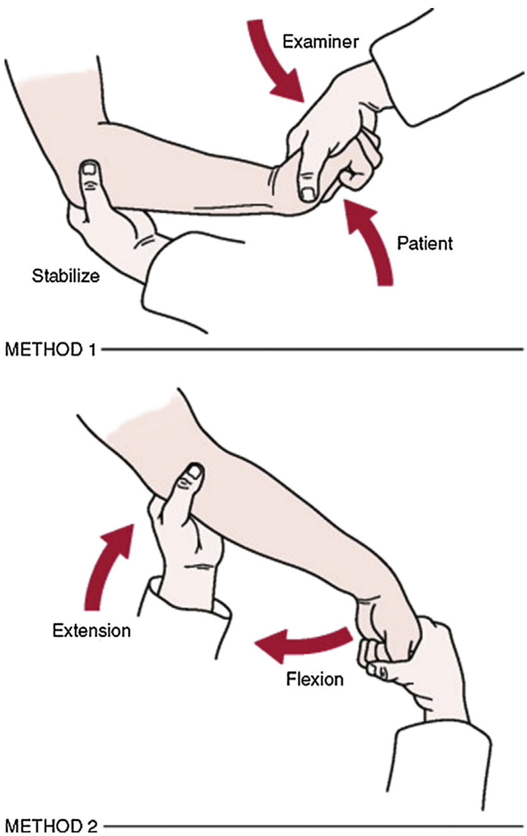

Fig. 5. Tennis elbow tests. (*From* Magee DJ, Sueki D. Orthopedic physical assessment. Philadelphia: Elsevier; 2011; with permission.)

with the thumb resting on the lateral epicondyle. The examiner passively pronates the patient's forearm while the wrist is simultaneously flexed and the elbow is extended. The test is positive if the patient experiences pain at the location of the lateral epicondyle (see **Fig. 5**).

Lateral epicondylitis test, type 3[25]: The patient should be seated with the elbow flexed and the wrist and fingers extended. In this test, the examiner resists extension of the third digit distal to the proximal interphalangeal joint of the patient. The test is positive if the patient experiences pain at the location of the lateral epicondyle (see **Fig. 5**).

Thomsen maneuver[16]: With the patient seated, the elbow in full extension, and the forearm pronated, the examiner actively resists extension of the patient's wrist. The test is positive if the patient experiences pain at the location of the lateral epicondyle.

Medial epicondylitis test[25]: With the patient seated and the elbow flexed, the examiner applies one hand to the elbow with thumb over the medial epicondyle and then passively supinates the forearm of the patient while extending both the wrist and the elbow. The test is positive if the patient experiences pain at the location of the medial epicondyle (**Fig. 6**).

Milking maneuver[25]: With the patient seated and their shoulder extended, their elbow flexed at 90 degrees, and their forearm supinated, the physician pulls on the patients thumb. The test is positive for damage to the UCL with pain in the medial elbow and a sensation of apprehension and instability with this valgus tension. Further information can be gained about possible damage to the UCL if the milking maneuver is performed dynamically. While grasping the patient's thumb, the examiner provides valgus stress to the forearm while moving the elbow through its full range of motion. With this dynamic examination the examiner is able to identify at what point in the range of motion the stress and pain occurs in the UCL (**Fig. 7**).[27]

Tinel sign at elbow: With the elbow flexed, the examiner taps the ulnar nerve as it lies within the cubital tunnel. It is considered positive if the patient experiences tingling in the distribution of the ulnar nerve with this maneuver. Because medial epicondylitis has been found in 60% of patients with ulnar neuritis, it is

Fig. 6. Medial epicondylitis test. (*From* Howard TM, Shaw JL, Phillips J. Physical examination of the elbow. In: Seidenberg PH, Beutler AI, editors. The sports medicine resource manual. Philadelphia: Saunders-Elsevier; 2008; with permission.)

Fig. 7. Milking maneuver.

important to include evaluation of the ulnar nerve as part of the examination (**Fig. 8**).[13]

Elbow flexion test for ulnar neuritis[17]: With the patient seated, the affected elbow is placed in maximum flexion with pronation of the forearm and wrist extension. This position is held for 30 to 60 seconds. The test is positive if elbow pain is experienced with numbness or tingling in the fourth and fifth digits.

IMAGING AND FURTHER DIAGNOSTIC TESTING

Epicondylitis is a clinical diagnosis and further investigations are used after a failure of conservative therapy to rule out other clinical entities (**Table 5**). Radiographs are recommended if the patient presents with epicondylar pain with a traumatic mechanism of injury instead of the overuse pattern that is typical with epicondylosis. Radiographs with contralateral comparison views should be obtained in the skeletally immature patient even with a history of repetitive motion. In this population, growth plates are more likely to be injured than tendons.

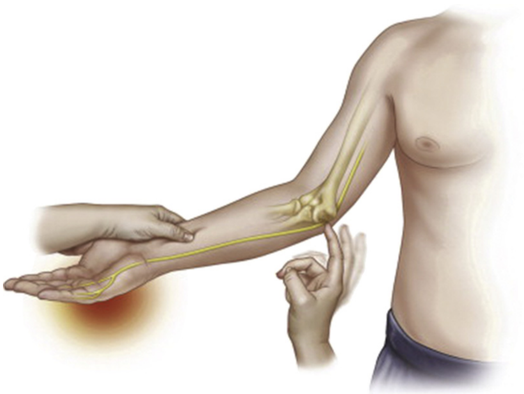

Fig. 8. Tinel sign at elbow. (*From* Waldman SD. Atlas of pain management injection techniques. Philadelphia: Elsevier; 2013.)

Table 5
Differential diagnosis for elbow pain

Lateral Pain	Medial Pain
Epicondylitis	Epicondylitis
Loose bodies	Ulnar nerve entrapment
Posterior interosseous nerve syndrome	Ulnar neuritis
Radiocapitellar osteochondral defect or arthritis	Ulnar collateral ligament sprain
Valgus extension overload	Osteochondritis dissecans
Lateral synovial plica	Little Leaguer's elbow
Cervical radiculopathy	Arthritis
	Cervical radiculopathy

Magnetic resonance imaging is not indicated in the evaluation of epicondylosis. However, in recalcitrant cases, it can be used to rule out loose bodies, osteochondral lesions, and ligamentous injury.

Musculoskeletal ultrasound is gaining popularity in the evaluation of medial and lateral elbow pain. Tendinosis is seen as a loss of the tendon's normal fibrillar pattern with neovascularization visualized with the use of power Doppler. Dynamic examination can be used to evaluate muscle or tendon tears, subluxation of the ulnar nerve, and tears of the UCL.[28] Diagnostic musculoskeletal ultrasound should be reserved for patients with atypical presentations or inadequate response to conservative measures.

Radial nerve entrapment presents as lateral elbow pain that is often confused for lateral epicondylosis. Nerve conduction and electromyography studies are used to help clarify the diagnosis.[29]

TREATMENT

The cornerstone of treatment of epicondylosis is summarized in the pneumonic PRICEMM (*P*rotection, *R*est, *I*ce, *C*ompression, *E*levation, *M*edication, *M*odalities). Protection signifies that the patient should avoid the offending overuse activity that resulted in tendon injury so as to prevent further damage. Rest is better termed relative rest, because therapeutic exercise can help heal the damaged tendon. Ice, especially ice massage, can assist in pain control. A counterforce elbow strap can be used for compression. Placed approximately 2 cm below the painful epicondyle, this can help offload the proximal tendon during wrist extension or flexion.[30,31] In addition, a nighttime volar wrist splint can prevent excessive epicondylar stress caused by sleep position.[32]

Medications are used for pain control. Tylenol is first line. Nonsteroidal anti-inflammatory drugs are often preferred by patients but there is debate as to whether anti-inflammatories actually inhibit tendon healing. A short-term course may be indicated to increase comfort so that patients can tolerate therapy exercise. Topical anti-inflammatory drugs are also used but there is scant research on their efficacy in elbow tendinopathy. Topical nitroglycerin therapy has shown some promise but studies have shown mixed results.[33–35] Oral corticosteroids are not indicated in the treatment of medial or lateral epicondylosis.

Physical therapy modalities, such as electrical stimulation, phonophoresis, and iontophoresis, are effective in assisting in pain control but are unable to correct the underlying tendinosis. To accomplish this, exercises are performed on the flexor-pronator group or the extensor-supinator group in medial and lateral epicondylosis, respectively. This includes tendon stretching and strengthening exercises. Progression to eccentric exercises is the goal, because this is thought to reestablish normal tendon architecture.[36]

Use of corticosteroid injections is considered by many practitioners to be safe for trial in refractory cases of epicondylitis. Although epicondylosis is not considered to be an inflammatory disease, increased levels of neurogenic pain markers have been documented in lateral epicondylosis and corticosteroids have been shown to relieve pain of neurogenic origin.[37] A 2009 meta-analysis by Gaujoux-Viala colleagues[38] found evidence supporting short-term pain benefits from injection of glucocorticoids for epicondylitis (up to 8 weeks). Later, a 2013 meta-analysis agreed that corticosteroid injections are successful in providing short-term pain relief that is better than naproxen, placebo, physical therapy, or a wait-and-see approach.[39–41] However, the same meta-analysis found that long-term benefits of glucocorticoid injection were not better than placebo in the treatment of lateral epicondylitis.[41] Moreover, there is concern that the temporary pain relief by corticosteroid injections might weaken the wrist flexor or extensor tendons or allow patients to further aggravate their tendinosis. This was supported by Smidt's study, which discovered worse outcomes at 1 year of follow-up with corticosteroid injections for epicondylitis compared with no intervention or physiotherapy.[40] Overall, glucocorticoid injections are reasonable for use in severe epicondylitis pain, but the natural course of epicondylar disease may be unaltered or potentially worsened by this intervention.

Autologous blood injections and platelet-rich plasma (PRP) injections have been used to treat epicondylitis, and the results are promising but inconsistent.[42–46] These injections may be performed with or without ultrasound guidance. The success of these treatments couples well with a hypovascular and noninflammatory cause to epicondylitis. Both autologous blood injections and PRP injections are thought to use platelet-derived growth factors and angiogenic mediators to aid in the healing response by recruiting vascularity to the damage tissue.[23] Historically, forcefully releasing the tendinous insertion at the lateral epicondyle[47] and percutaneous release of the ECRB tendon[48] improved outcomes in cases of refractory epicondylitis, and now these practices are thought to have been successful because of the degree of bleeding in the affected areas and the mitomorphogenic properties of blood.[43] In a study of 28 patients who failed prolonged conservative treatment, 79% had complete relief of lateral epicondylitis pain after autologous blood injection therapy. The average time to maximal benefit was 3 weeks, which is consistent with a healing process, but some patients required up to 8 weeks to achieve maximal benefit from a single injection.[43] In a 2006 study by Suresh and colleagues,[44] 20 patients with refractory medial epicondylitis with symptom duration of 12 months underwent rigorous dry needling to fenestrate the tendon causing local bleeding and fibril disruption before autologous blood injection. Overall, this study showed a significant improvement in pain scores and reported only treatment failure in three patients.[44] In another small study that compared PRP injections with bupivacaine injections, after 8 weeks 60% of patients treated with PRP injection had improvements in pain scores compared with only 16% of the patients treated with bupivacaine. More impressively, at 6 months there was an 81% improvement in pain scores in the PRP-treated group and a 93% improvement in pain scores at final follow-up.[45] The results of this study and other autologous blood and PRP studies show promise in the treatment of epicondylosis. However, a recent meta-analysis found the studies on PRP and autologous blood injections to likely be highly biased toward favoring the procedure.[41] For this reason and because of the inconsistent response to autologous blood injections and PRP in prior studies, more work is needed to determine the true benefit of this intervention in epicondylosis.

Botulinum toxin has been studied as a treatment of epicondylosis. The rationale for its use comes from the reversible inhibition of muscle contraction by blocking the neuromuscular end plates and prevention of repetitive microtrauma.[49] Botulinum toxin A may also have direct analgesic properties.[50] Injection of botulinum toxin A into the origin of the forearm extensor muscles in the treatment of lateral epicondylosis was first reported in a trial of 14 patients in 1997.[51] In this study, there was a significant reduction in pain from lateral epicondylosis; however, side effects of weakness in the extensors of the third and fourth digits were also noted. Several studies have shown pain reduction with this treatment method.[49,52,53] The evidence of using botulinum toxin A in the treatment of epicondylosis remains controversial because other studies have not shown long-term improvement in pain, grip strength, or quality of life.[54] Kalichman and colleagues[55] reviewed 10 studies on the use of botulinum toxin A injections for treatment of chronic lateral epicondylosis through November 2009 and found a moderate benefit to this treatment. A later meta-analysis suggested that the noted benefits from botulinum toxin A should be viewed cautiously. The analysis determined the results to be unreliable and reported lacking data on maximum grip strength, pain during maximum grip, and on function and quality of life.[41]

Extracorporeal shock wave therapy (ECSWT) has been used in the treatment of lateral epicondylosis that is refractory to conservative treatment. The procedure uses acoustic waves to treat tendinosis. The exact mechanism of action for ECSWT is unknown but is thought to be caused by the activation of the inflammatory cycle, release of local growth factors, and the recruitment of appropriate stem cells to the affected area.[56] A 2005 randomized, double-blind, placebo-controlled study of 114 patients found a 50% pain reduction in most patients in the active treatment group at 12 weeks of follow-up.[57] The authors of this study concluded that ECSWT can significantly improve pain scores, functional scores, and a patient's subjective impression of epicondylosis.[57] Similarly, a study in 2005 concluded that ECSWT reduced pain and functional impairment, and increased pain-free grip strength in lateral epicondylitis.[58] However, other studies have not found benefit of ECSWT over placebo.[59,60] A recent systematic review of ECSWT concluded that there was little to no benefit from this procedure in the treatment of lateral elbow pain.[61]

Prolotherapy is a complementary therapy that involves the injection of a local irritant into ligamentous or tendinous attachments in peppering fashion to elicit an inflammatory response and lead to induction of tissue growth factors.[62] It has been used in common chronic musculoskeletal conditions including tendinopathy, knee osteoarthritis, and low back pain.[63] The most common injectant is dextrose 15%.[63] There are few trials of prolotherapy as an intervention in epicondylosis, but in a study of 24 adults with at least 6 months of refractory lateral epicondylosis, prolotherapy with 50% dextrose and 5% sodium morrhuate had a significant improvement in pain scores compared with baseline and compared with a control group at 16 weeks postinjection. In addition, clinical improvement in the prolotherapy subjects was maintained at 52 weeks follow-up.[64,65] Further work is needed to determine the value of prolotherapy in epicondylosis.

ECSWT, autologous blood injections, prolotherapy, and PRP treatments are less invasive interventions than surgery and are extensions of more conservative therapies. Surgical interventions can be considered if these therapies fail. Open, arthroscopic, and percutaneous release are all surgical options in recalcitrant cases of lateral epicondylosis.

Patients with epicondylosis who have failed the above mentioned conservative therapies warrant further evaluation with the previously mentioned diagnostic studies. If the diagnosis is confirmed as tendinosis, the patient may benefit from surgical debridement of the diseased tendons.

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