An Overview about Epicondylitis Pathogenesis and Imaging

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Abstract

The anatomy, pathophysiology, and clinical and imaging manifestations of lateral and medial epicondylitis are reviewed, with emphasis on the appropriate use of MR imaging and US for differential diagnosis and treatment planning. Epicondylitis commonly affects the elbow medially or laterally, typically in the 4th or 5th decade of life and without predilection with regard to sex. Epicondylitis is an inflammatory process that may be more accurately described as tendinosis. In the lateral epicondylar region, this process affects the common extensor tendon; in the medial epicondylar region, the common flexor tendon is affected. The condition is widely believed to originate from repetitive overuse with resultant microtearing and progressive degeneration due to an immature reparative response. Advances in understanding of the anatomy and pathophysiology of epicondylitis have shaped current treatment practices. Conservative measures are undertaken initially, because symptoms in most patients improve with time and rest. Those who fail to respond to conservative therapy are considered for surgical treatment. When surgery is contemplated, magnetic resonance imaging or ultrasonography is useful for evaluating the extent of disease, detecting associated pathologic processes, excluding other primary sources of elbow pain, and planning the surgical approach. Familiarity with the normal anatomy, the pathophysiology of epicondylitis and its mimics, and diagnostic imaging techniques and findings allows more accurate diagnosis and helps establish an appropriate treatment plan.

Keywords: Epicondylitis, Imaging

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Introduction:

Lateral and medial epicondylitis are common disorders affecting the upper extremity. Epicondylitis causes pain and functional impairment and typically results from specific occupational and sports-related activities. Lateral epicondylitis, initially described by Morris as "lawn tennis elbow" in 1882 and now most commonly termed tennis elbow, may occur in patients performing any activity that involves repeated supination and pronation of the forearm with the elbow in extension (1–8). Medial epicondylitis, although commonly termed golfer's elbow, may occur in throwing athletes, tennis players, and bowlers, as well as in workers whose occupations (eg, carpentry) result in similar repetitive motions (7,9). Lateral epicondylitis occurs with a frequency seven to 10 times that of medial epicondylitis (4,9). Both lateral and medial epicondylitis most commonly occur in the 4th and 5th decades of life, without predilection with regard to sex. Epicondylitis represents a degenerative process involving the origin of the extensor tendons at the lateral elbow and the flexor-pronator muscle group at the medial elbow. It is thought that repetitive stress and overuse lead to tendinosis with microtrauma and partial tearing that may progress to a full-thickness tendon tear (1–3). The diagnosis of epicondylitis hinges on a careful history and physical examination. In most patients, the condition is managed conservatively with cessation of the offending activity, applications of ice, administration of a nonsteroidal antiinflammatory drug (NSAID) or a corticosteroid injection, and use of a splint or brace (4,7). These measures are followed by a rehabilitation program aimed at gradually increasing power, flexibility, and endurance with eventual reintroduction into the implicated sport or occupational activity (7). In rehabilitation, it is important to correct any biomechanical abnormalities that may have led to the initial injury. Other treatments include injection of autologous blood or platelet-rich plasma, ultrasonographically guided tenotomy, extracorporeal shock-wave therapy, and iontophoresis and phonophoresis to obtain deep penetration of topical medications into the soft tissues (10). Although conservative treatment is often successful, magnetic resonance (MR) imaging or ultrasonography (US) may be performed to verify the diagnosis in the presence of recalcitrant or confounding symptoms, quantify the degree of tendon injury, identify associated abnormalities, diagnosis for lateral elbow pain includes occult fracture, osteochondritis dissecans of the capitellum, lateral osteoarthrosis, lateral ulnar collateral ligament (LUCL) instability, and radial tunnel syndrome. In cases of suspected medial epicondylitis, it is important to exclude medial osteoarthrosis, medial collateral ligament (MCL) injury, and ulnar neuropathy, any of which may mimic or coexist with medial epicondylitis. Surgery is often performed if there is no clinical response after 3 to 6 months of conservative treatment. Surgical techniques include open and arthroscopic approaches with dissection, release, and débridement of the degenerated tendon (1,4,8). We prefer a mini-open approach that allows a shorter recovery time, and we encourage early postoperative mobilization therapy. The goal in rehabilitation is the eventual reintroduction of the implicated activity with corrected biomechanics. The literature reports a high success rate for surgical procedures, with overall patient satisfaction and full return to preinjury activities (1,8–10). The article reviews the anatomy, pathophysiology, and clinical and imaging manifestations of epicondylitis in the lateral and medial epicondylar regions of the elbow separately. Other common conditions that may mimic or coexist with epicondylitis in these regions are considered, and indications for the use of MR imaging and US in differential diagnosis and treatment planning are described. The implications of the clinical history and imaging findings for the selection of the most appropriate medical or surgical treatment option are discussed in detail.

Lateral Epicondylitis Normal Anatomy of the Lateral Elbow The extensor carpi radialis brevis (ECRB), extensor digitorum communis, and extensor carpi ulnaris form a strong, discrete, conjoined tendon that is attached at the anterior aspect of the lateral epicondyle and lateral supracondylar ridge, adjacent to the origins of the brachioradialis and extensor carpi radialis longus (11). The lateral epicondyle is also the site of attachment for the extensor digiti minimi and the supinator, which merge with the ECRB, extensor digitorum communis, and extensor carpi ulnaris to form the common extensor tendon (Fig 1). The ECRB occupies the deep and anterior aspect of this common tendon and inserts at the base of the third metacarpal bone. The undersurface of the ECRB is in contact with the capitellum and slides along its lateral edge during elbow extension and flexion. Repetitive wear and abrasion due to this contact may play a role in the pathophysiology of epicondylitis (12). The essential and universal lesion of lateral epicondylitis involves the ECRB, followed by the extensor digitorum communis and, to a lesser extent, other muscles and tendons of the lateral compartment (1,7,12,13). The sites of origin and insertion and the functions of these muscles and tendons are described in Table 1 (11). Capsular injury as well as thickening and tearing of the lateral ulnar collateral ligament (LUCL) and radial collateral ligament (RCL) have been identified in association with severe lateral epicondylitis (14,15). The lateral collateral ligament complex consists of the RCL, annular ligament, accessory lateral collateral ligament, and LUCL (Fig 2). The RCL originates at the lateral epicondyle anteriorly and blends with the fibers of the annular ligament and fascia of the supinator muscle (11). The annular ligament, the primary stabilizer of the proximal radioulnar joint, tapers distally and surrounds the radial head in a funnel shape. Disruption of this ligament leads to radioulnar instability (11). The accessory lateral collateral ligament helps stabilize the annular ligament but is inconsistently present (11). The fibers of the accessory ligament originate from the annular ligament and insert on the supinator crest, along the lateral aspect of the ulna. The LUCL contributes to ligamentous constraint against varus stress. Originating from the lateral epicondyle as a continuation of the RCL, the LUCL runs along the lateral and posterior aspects of the radius to insert on the tubercle of the supinator crest of the ulna. Disruption of the LUCL results in posterolateral rotatory instability of the elbow (11,14).

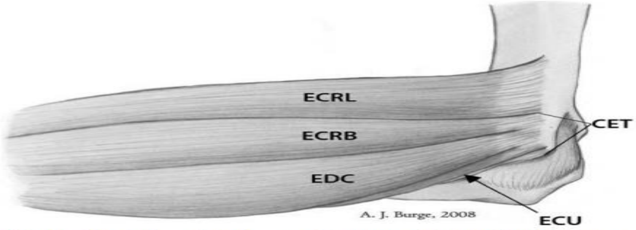


Figure 1. Drawing shows the musculotendinous anatomy of the lateral aspect of the elbow, near the site of the tendon origin on the lateral epicondyle. *CET* = common extensor tendon, *ECRB* = extensor carpi radialis brevis, *ECRL* = extensor carpi radialis longus, *ECU* = extensor carpi ulnaris, *EDC* = extensor digitorum communis.

Table 1
Anatomy of the Muscles of the Lateral Compartment of the Elbow

Muscle	Function	Origin	Insertion
Extensor carpi radialis longus	Extends and abducts the wrist	Distal aspect of the lateral supracondylar ridge of the humerus and lateral intermuscular septum	Dorsum of the base of the second metacarpal bone
ECRB	Extends the wrist	Common extensor tendon from the lateral epicondyle of the humerus	Dorsal aspect of the base of the third metacarpal bone
Extensor digitorum communis	Extends the wrist and second through fifth digits at the MCP joints	Common extensor tendon from the lateral epicondyle of the humerus	Dorsum of the second through fifth digits
Extensor carpi ulnaris	Extends and adducts the wrist	Humeral head: common extensor tendon from the lateral epicondyle; ulnar head: dorsal aspect of the mid ulna	Ulnar aspect of the base of the fifth metacarpal bone
Extensor digiti minimi	Extends the proximal phalanx of the fifth digit at the MCP joint and aids in wrist extension	Common extensor tendon from the lateral epicondyle of the humerus	Dorsal expansion of the fifth digit
Anconeus	Tightens the joint capsule and acts as a weak extensor of the elbow	Posterior aspect of the lateral epicondyle of the humerus	Radial aspect of the olecranon and proximal ulna
Supinator	Supinates the forearm	Humeral head: lateral epicondyle; ulnar head: lateral aspect of the olecranon (supinator crest)	Lateral and anterior aspect of the proximal to mid radius

Source.—Adapted from reference 11.
Note.—MCP = metacarpophalangeal.

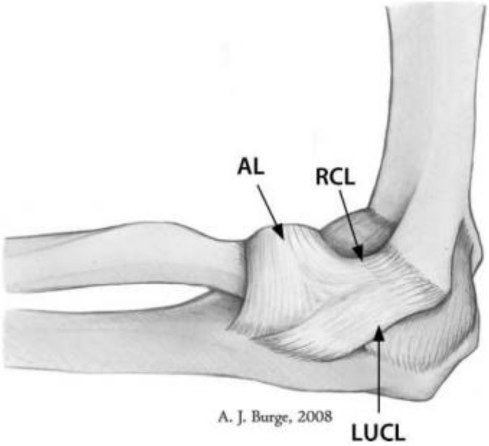


Figure 2. Drawing shows the ligamentous anatomy of the lateral aspect of the elbow. *AL* = annular ligament, *LUCL* = lateral ulnar collateral ligament, *RCL* = radial collateral ligament.

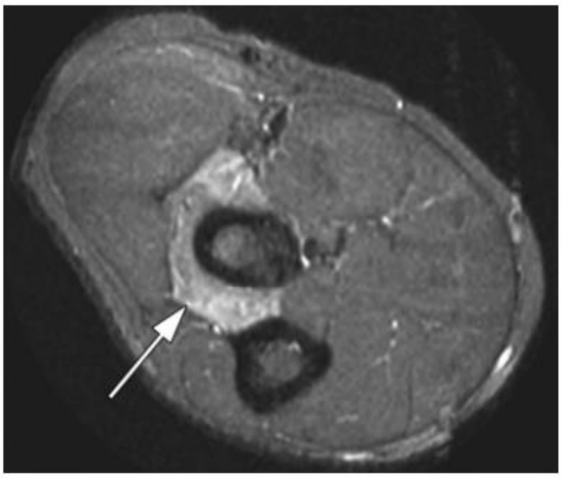


Figure 3. Radial tunnel syndrome. Axial T2-weighted fat-saturated fast SE MR image obtained in a 38-year-old man demonstrates a region of high signal intensity within the supinator muscle, a finding indicative of denervation edema (arrow).

Pathogenesis Lateral epicondylitis is most often the result of repetitive stress injury but may result from direct trauma. The condition is common among tennis players, especially nonprofessionals, in whom poor mechanics may be an instigating factor (7). Lateral epicondylitis is caused by repeated contraction of the forearm extensor muscles, particularly at the origin of the ECRB, which results in microtearing with subsequent degeneration, immature repair, and tendinosis. In addition to the mechanical forces that lead to excessive varus stress on the ECRB, its unique anatomic position against the lateral aspect of the capitellum places the tendon at risk for repeated undersurface abrasion during elbow extension (12). The lack of vascularity at the undersurface of the tendon further contributes to degeneration and tendinosis (12). At gross examination, the affected tendon appears gray and friable (1,7). Epicondylitis was initially believed to originate from an inflammatory process involving the radial humeral bursa, synovium, periosteum, and annular ligament (9). In 1979, Nirschl and Pettrone (1) described their observation of the disorganization of normal collagen architecture by invading fibroblasts in association with an immature vascular reparative response, which they collectively termed “angiofibroblastic hyperplasia.”The same process later was described as “angiofibroblastic tendinosis” because no inflammatory cells were identified (13,16). Because inflammation is not a significant factor in epicondylitis, the term tendinosis is preferred over epicondylitis or tendinitis. Over time, scar tissue forms that is vulnerable to repetitive trauma, which leads to further tearing. Continuation of this cycle of injury and immature repair results in more substantial tears, with consequent alteration and failure of musculotendinous biomechanics and worsening of symptoms (17)

Table 2
Differential Diagnosis of Lateral Elbow Pain

Occult fracture
Osteochondritis dissecans of the capitellum
Osteoarthrosis
Posterolateral rotatory instability, LUCL injury
Lateral synovial plica
Synovitis of the radiohumeral joint
Radial tunnel syndrome

Clinical Manifestations and Diagnosis Patients present with lateral elbow pain, which is frequently exacerbated when they grasp objects during wrist extension with resistance. A history of tennis playing or similar racket sports is some times elicited, but the condition often results from other athletic or occupational activities or from an unknown cause. In racket sports, the backhand swing most commonly instigates symptoms (7). With palpation during physical examination, focal tenderness is present at the origin of the ECRB, about 1 cm distal to the midportion of the epicondyle (7). Reduced strength with resisted gripping and with supination and extension of the wrist also are commonly seen. Maneuvers such as the “chair test” (in which the patient is asked to lift a chair with a pronated hand) and the “coffee cup test” (in which the patient picks up a full cup of coffee) evoke focal pain at the lateral epicondyle (7). The diagnosis of lateral epicondylitis is clinically based in most cases.

Table 3
Protocol for MR Imaging of the Elbow with a 1.0-T Extremity Magnet

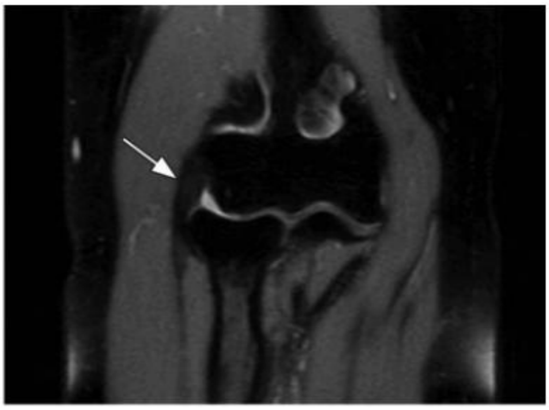
Plane	Sequence	TE (msec)	TR (msec)	ETL	Matrix	BW (Hz)	FOV (mm)	Section Thickness (mm)	Gap (mm)
Coronal	2D GRE*	18	510	1	300 × 192	30	123	2.5	0.3
Coronal	PD FS fast SE	15	3100	10	288 × 192	40	140	2.5	1.0
Coronal	STIR fast SE	15	3700	8	288 × 192	35	150	3.0	0.5
Axial	T1 fast SE	16	800	2	288 × 224	40	120	3.0	1.0
Axial	T2 fast SE	80	3500	10	260 × 240	35	120	3.0	1.0
Sagittal	T1 fast SE	15	650	2	288 × 192	35	150	4.0	0.5
Sagittal	STIR fast SE	15	4100	10	260 × 192	35	150	4.0	0.5

Note.—BW = bandwidth, ETL = echo train length, FOV = field of view, FS = fat saturated, PD = proton density–weighted, TE = echo time, T1 = T1-weighted, TR = repetition time, T2 = T2-weighted, 2D = two-dimensional.
*Flip angle for the GRE pulse sequence is 25°.

However, the differential diagnosis of lateral elbow pain is broad (Table 2), and imaging often is necessary when refractory or confounding symptoms are present. It has been reported that 5% of those with an initial diagnosis of lateral epicondylitis have radial tunnel syndrome (18). Radial tunnel syndrome involves entrapment of the posterior interosseous nerve (a deep branch of the radial nerve) within the radial tunnel. The radial tunnel is bounded medially by the brachialis muscle and anterolaterally by the brachioradialis, extensor carpi radialis longus, and ECRB. Posteriorly, the radial tunnel is delineated at its proximal end by the capitellum and at its distal end by the distal aspect of the supinator muscle. Patients present with insidious pain along the proximal radial aspect of the forearm, without motor deficit, and, typically, without localizability to a specific nerve distribution. Many patients with this condition report a history of activity involving repetitive forearm supination and pronation. Physical examination with palpation at the radial tunnel or resisted supination of the forearm and extension of the middle finger produces pain. The most common MR imaging finding of radial tunnel syndrome is denervation edema or atrophy within the muscles innervated by the posterior interosseous nerve (Fig 3) (18). Role of Diagnostic Imaging Imaging is not routinely indicated for the diagnosis of lateral epicondylitis but typically is performed in recalcitrant or complicated cases to allow evaluation of the extent of disease and exclusion of other pathologic processes that cause lateral elbow pain. Imaging also plays an important role in preoperative planning. MR imaging is the most widely used modality, although US also may be performed. In a study by Miller et al (19), the sensitivity of US for the detection of both lateral and medial epicondylitis ranged from 64% to 82%, whereas that of MR imaging ranged from 90% to 100%. Elbow radiography often is negative but may show calcium deposition adjacent to the lateral epicondyle and may help exclude other pathologic processes (20).

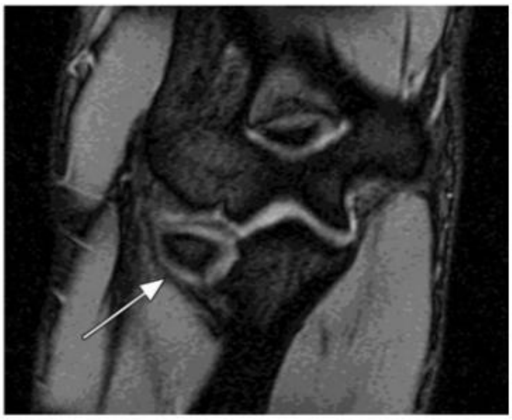
MR Imaging Technique and Findings.—Proper patient positioning and sequence selection are essential for accurate MR imaging of the elbow. We perform all elbow MR imaging examinations by using a 1.0-T extremity magnet (ONI Medical Systems, Wilmington, Mass) with the following sequences: coronal two-dimensional gradientrecalled echo (GRE), coronal proton density–weighted fat-saturated fast spin echo (SE), coronal short inversion time inversion-recovery (STIR) fast SE, axial T1-weighted fast SE, axial T2- weighted fast SE, sagittal T1-weighted fast SE, and sagittal STIR fast SE (Table 3). The patient is imaged while reclining with the arm abducted, elbow extended, and wrist supinated.

Figures 4, 5. **(4)** Normal lateral elbow. Coronal proton density–weighted fat-saturated MR image obtained in a 30-year-old woman shows a normal appearance of the common extensor tendon at the site of its attachment to the lateral epicondyle (arrow). **(5)** Normal LUCL and RCL. Coronal GRE MR images obtained in a 30-year-old man show a normal RCL coursing from the radial head to insert on the lateral epicondyle (arrow in **a**) and an intact LUCL posterior to the radial head (arrow in **b**).



4.

5a.



5b.

One limitation of an extremity magnet system is the slightly smaller field of view, which may make it difficult to simultaneously show the bicipital tuberosity and elbow joint line. In whole-body MR imaging systems, image acquisition is ideally performed by using surface- or surround-type quadrature (knee) coils with the patient supine, the arm by the side, and the forearm in supination. Alternatively, the patient can be placed in the "Superman" position (ie, prone with the arm extended over the head, elbow extended, and wrist in neutral position) so that the elbow is closer to the isocenter of the magnetic field. Use of a 3.0-T magnet and a surface coil allows greatly improved image quality. However, patient comfort and satisfaction are limiting factors, especially when the Superman position is used. In our experience, use of a high-field-strength extremity magnet maximizes patient comfort and eliminates motion without any loss in image quality from that provided by a 1.5- or 3.0-T whole-body MR imaging system. Plane selection is important when evaluating the common flexor and extensor tendons and requires proper training of MR imaging technologists. Axial images are obtained perpendicular to the long axis of the humerus at the elbow. The prescribed coronal plane is oriented parallel to a line drawn along the anterior surface of the condyles in the axial plane, and the sagittal plane is perpendicular to that coronal plane. The normal MR imaging appearance of the common extensor tendon is that of a vertically oriented structure that originates from the lateral epicondyle. The tendon should show uniform low signal intensity, regardless of the imaging sequence used (Fig 4). The ECRB is the deepest and most anterior component of the common extensor tendon. Tendon morphology is best assessed on coronal and axial images. Like the common extensor tendon, the lateral ligaments exhibit uniform low signal intensity with all sequences. The LUCL is seen as a low-signal-intensity band medial to the common extensor tendon. It originates from the lateral epicondyle and, after coursing posterior to the radial head, inserts on the tubercle of the supinator crest of the ulna. The RCL, which is located immediately anterior to the LUCL, also originates from the lateral epicondyle (Fig 5). The fibers of the RCL course distally along the long axis of the radial head to blend with the fibers of the annular ligament. A small region with the signal intensity of fluid is often seen partially undercutting the RCL at its radial head attachment and is considered normal. The same feature, if located under the MCL in the medial epicondylar region, is considered abnormal (21,22).

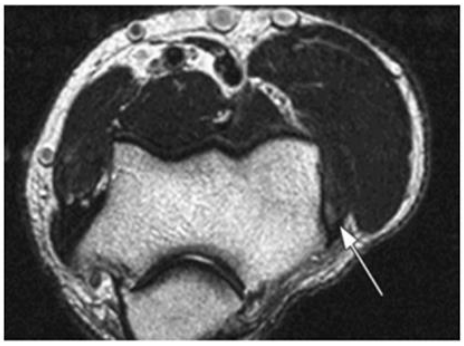
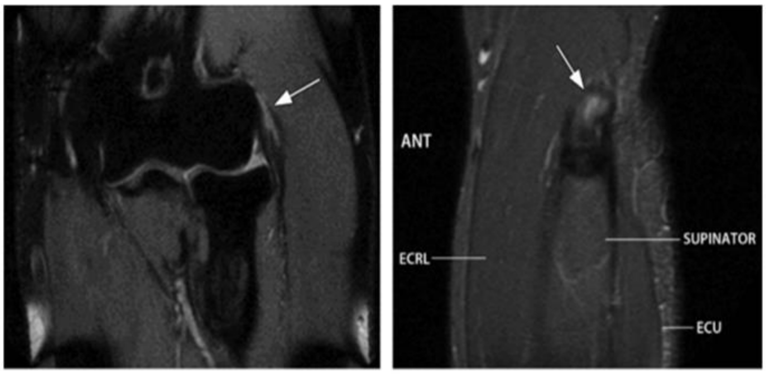
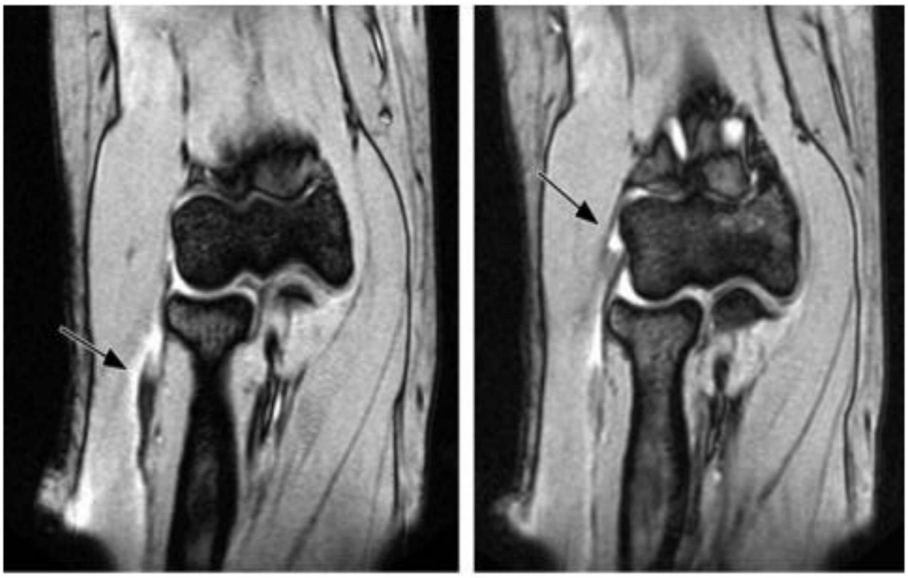


Figure 6. Mild lateral epicondylitis. Axial T2-weighted fast SE MR image obtained in a 44-year-old man demonstrates a focal region of intermediate signal intensity within the common extensor tendon origin (arrow).



a. **b.**

Figure 7. Moderate lateral epicondylitis. **(a)** Proton density–weighted fat-saturated MR image obtained in a 60-year-old man depicts a region of slightly increased signal intensity due to fluid accumulation within the superficial fibers of the common extensor tendon, a finding suggestive of a small partial-thickness tear (arrow). **(b)** Sagittal STIR MR image shows a central region with the signal intensity of fluid in the proximal common extensor fibers, with a surrounding rim of intermediate signal intensity (arrow), findings consistent with a partial-thickness tear and tendinosis. *ANT* = anterior, *ECRL* = extensor carpi radialis longus, *ECU* = extensor carpi ulnaris.



a. b.

Figure 8. Severe lateral epicondylitis. **(a)** Coronal GRE MR image obtained in a 40-year-old woman demonstrates a full-thickness tear and retraction of the ECRB with adjacent edema (arrow). **(b)** Coronal GRE MR image at the level of the lateral epicondyle shows a fluid-filled gap (arrow) at the site of the expected ECRB tendon origin.

Figure 9. Severe lateral epicondylitis. Coronal STIR MR image obtained in a 40-year-old woman depicts intramuscular edema as a focus of high signal intensity within the extensor carpi radialis longus (arrow), a finding consistent with muscular strain and associated with lateral epicondylitis. Another high-signal-intensity focus is seen at the site of the ECRB origin on the lateral epicondyle (arrowhead).

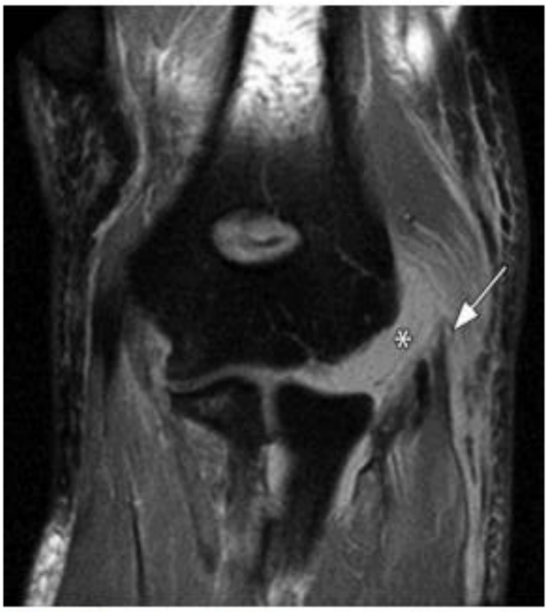


Figure 10. Traumatic injury to the lateral elbow. Proton density–weighted fat-saturated MR image obtained in a 57-year-old man demonstrates avulsion of the common extensor tendon, RCL, and LUCL (arrow), with high signal intensity indicative of fluid in the gap between these structures and the lateral epicondyle (*).

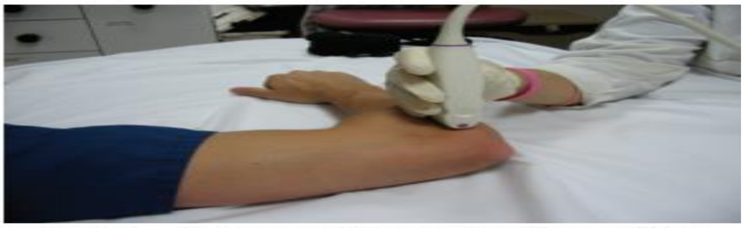


Figure 11. Photograph shows appropriate positioning of the elbow and transducer for US evaluation of lateral epicondylitis.

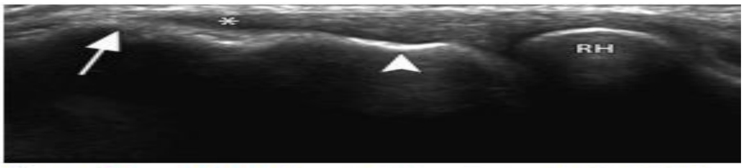


Figure 12. Normal lateral elbow. Longitudinal US image obtained in a 72-year-old man demonstrates a normal appearance of the common extensor tendon (*) at the site of its origin on the lateral epicondyle (arrow). The arrowhead indicates the capitellum. *RH* = radial head.

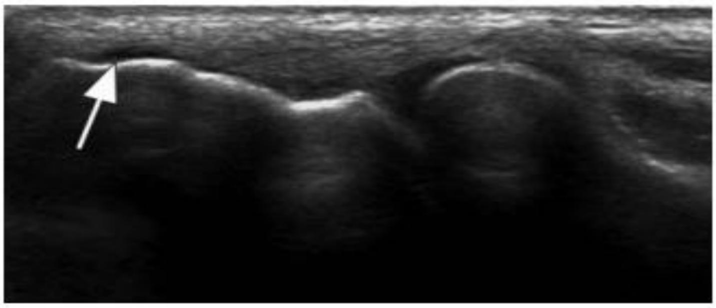


Figure 13. Mild epicondylitis. Longitudinal US view of the common extensor tendon origin in a 59-year-old man shows a small linear hypoechoic region at the origin of the ECRB (arrow), a finding indicative of a small partial-thickness tear.

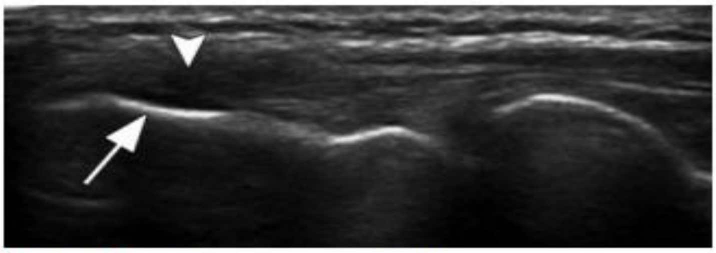


Figure 14. Moderate epicondylitis. Longitudinal US image of the common extensor tendon origin in a 49-year-old woman depicts a linear hypoechoic region indicative of a partial-thickness tear at the undersurface of the ECRB (arrowhead), with surrounding heterogeneous echogenicity indicative of associated tendinosis (arrow).

US Technique and Findings.—US is an excellent option for diagnostic imaging evaluation of lateral epicondylitis, with a reported sensitivity of approximately 80% and specificity of approximately 50% (17,19,24). The lateral region of the elbow is best scanned in both transverse and longitudinal planes with a variable-high-frequency linear-array transducer (5–12-MHz or higher) and with the elbow flexed (Fig 11). US allows visualization of the entirety of the common extensor tendon, from the musculotendinous junction to the site of origin on the lateral epicondyle. The common extensor tendon origin is seen as a continuous band of longitudinally oriented fibers (Fig 12). The ECRB constitutes the most anterior aspect of the common extensor tendon and the major portion of its attaching surface (11,14). Fibers from the RCL and LUCL, located deep to the common extensor tendon, also can be evaluated with US. Tendinosis appears as tendon enlargement and heterogeneity, and tendon tears are depicted as hypoechoic regions with adjacent tendon discontinuity. Surrounding fluid and calcification also may be seen. Levin et al (17) found a statistically significant relationship between clinical symptoms of lateral epicondylitis and US findings of intratendinous calcification, tendon thickening, bone irregularity, focal hypoechogenicity, and diffuse heterogeneity. However, given its high false-positive rate, real-time US may be most useful for determining the extent of tendon damage in patients who are symptomatic (17). We use the same system at US as at MR imaging to grade lateral epicondylitis as mild, moderate, or severe (Figs 13–14).

This work is quoted from review paper of Walz et al (26).

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