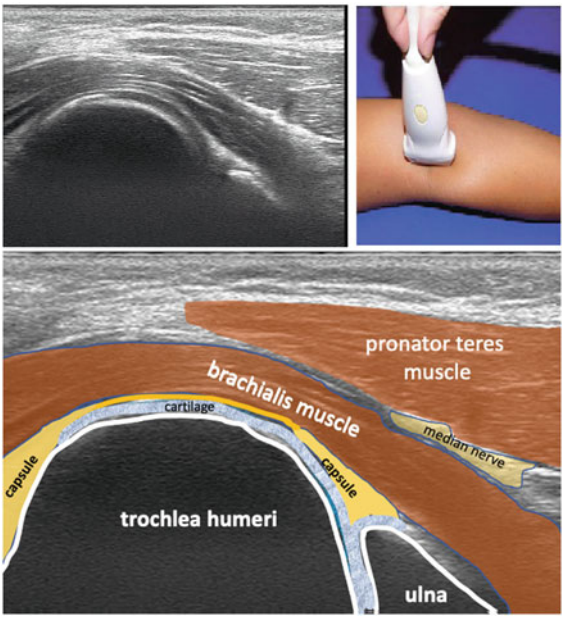
Chapter 6
The Elbow

6.1 Standard Scans of the Elbow

6.1.1 Anterior Longitudinal View of the Humeroulnar Joint (Standard Scan 6-1)

The ultrasound examination of the elbow starts with the longitudinal view of the anterior side of the humeroulnar joint, holding the probe longitudinally to the axis of the arm.



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The patient is sitting on a stool or is supine with the elbow completely extended and supinated.

In the middle of the image, the humeral trochlea is located covered by hyaline cartilage; at the distal pole of the articulation the coronoid process of the ulna is visualized. Cranial to the trochlea, the coronoid fossa containing fat tissue is visible. Anterior to the joint, the brachialis muscle is found. It inserts distally at the ulnar tuberosity.

What is normal?

Normally no fluid is visible in the coronoid fossa. The coronoid fossa contains a fat body.

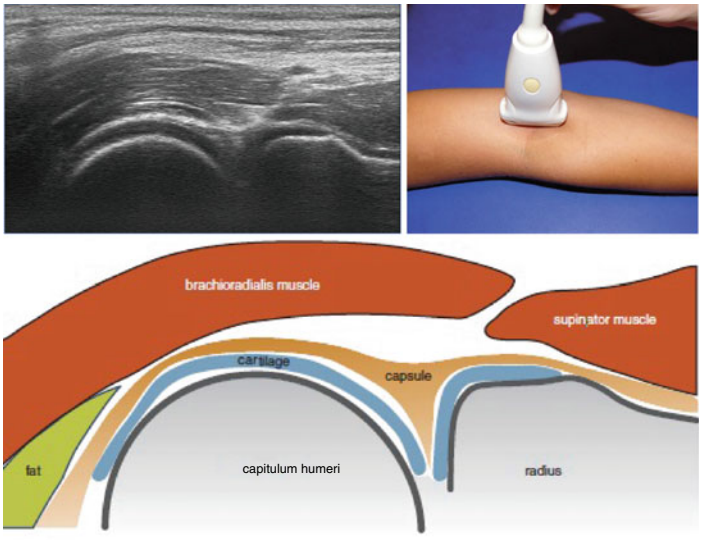
6.1.2 *Anterior Longitudinal View of the Humeroradial Joint (Standard Scan 6-2)*

The probe is continuously shifted radially from Standard Scan 6-1. The patient's and the examiner's position remain the same as with the previous view. The anterior side should be well exposed by full extension of the elbow.

This view shows the capitulum humeri and the head of the radius. The joint capsule extends cranially far along the capitulum humeri into the radial fossa. It can be seen at the very left end of the ultrasound image and the anatomic drawing. The joint capsule attaches distally at the radial head not far from the joint. Between the humerus and the radius, we can detect the capsule, fat tissue and a fibrocartilaginous meniscus-like synovial fold. Anterior to the joint, the brachioradialis muscle is visible. Directly anterior to the radial shaft, the supinator muscle can be visualized.

What is normal?

The hyaline cartilage covering the capitulum can be easily seen. The synovial fold exhibits a V-form. The radial fossa contains fat tissue. Distance between the bone of the radial fossa and the capsule: 1.8 mm (0–3.7 mm).



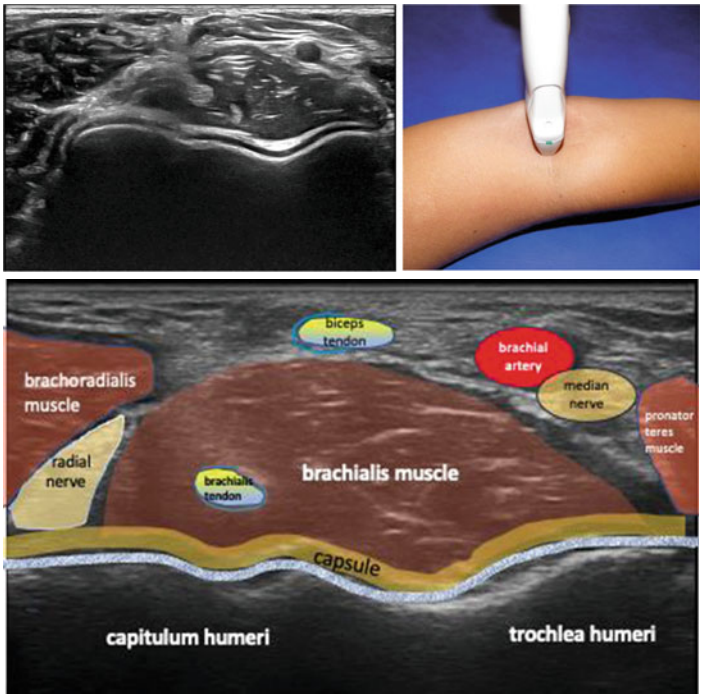
6.1.3 *Anterior Transverse View of the Elbow (Standard Scan 6-3)*

The position of the patient and the examiner remain the same as in Standard Scans 6-1 and 6-2. The probe is rotated by 90°. On the left side of the screen the capitulum humeri is found, while on the right side the trochlea humeri is visible.

Both humerus and joint capsule have a similar hyperechoic appearance as the joint capsule of the elbow is strong and rather thick. The capsule runs directly parallel to the bony contour of the capitulum and the trochlea. The anechoic region between capsule and bone represents cartilage.

If effusion is present, hypoechoic fluid will lift the capsule, particularly in the fossae. This can be seen when the probe is shifted proximally.

Two portions of the distal biceps tendon (in the top center of this transverse anterior view) can also be examined. Both attach further distally at the ulnar aspect of the bicipital tuberosity on the radius. The long head inserts proximally and the short head of the distal biceps tendon more distally at the tuberosity. The third aponeurosis-like portion, which is called the lacertus fibrosus, originates from the distal short head and is usually not visible with ultrasound. The median nerve localizes medially to the brachial artery.



The radial nerve is located between the brachialis and the brachioradialis muscles. Mostly the nerve has already just divided into its superficial branch (lateral) and its posterior interosseous branch (medial) at the level of the elbow. The pronator teres muscle may be seen on the right side of this scan if the probe would be shifted more medially.

What is normal?

The capsule follows the contours of the hyaline cartilage. Bone capsule distance between bone and joint capsule at the ulnar side: 1.0 mm (0.5–1.5 mm). This is usually equivalent to the thickness of the hyaline cartilage.

6.1.4 *Posterior Longitudinal View of the Elbow (Standard Scan 6-4)*

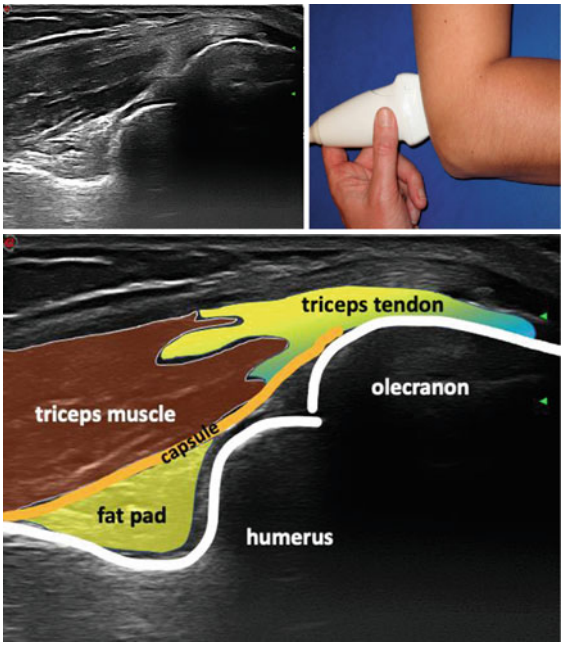
The posterior longitudinal Standard Scan is suitable for examining the three portions of the triceps muscle, their common tendon with its insertion on the olecranon, the olecranon fossa, and the posterior joint space. Musculoskeletal pathology seen on this standard scan includes particularly joint space effusion. The probe may be shifted distally in order to visualize olecranon bursitis or triceps tendon enthesitis.

In order to obtain an optimal exposure of the joint space and the olecranon fossa, the long axis view is done with the elbow flexed by 90°. The hand may rest on the examination couch. The elbow can be flexed and extended in order to detect small amounts of fluid in the joint.

The humerus and the olecranon fossa with its fat pad are visualized. Posterior to the humerus a long axis view of the triceps muscle is obtained, coursing distally towards its insertion on the olecranon. The bony olecranon is easily identified.

What is normal?

With the elbow flexed, ultrasound allows identification of as little as 1–3 ml of fluid posteriorly. The bone-joint capsule distance at the bottom of the olecranon fossa (a): 1.9 mm (0–3.9 mm).



6.1.5 Posterior Transverse View of the Elbow (Standard Scan 6-5)

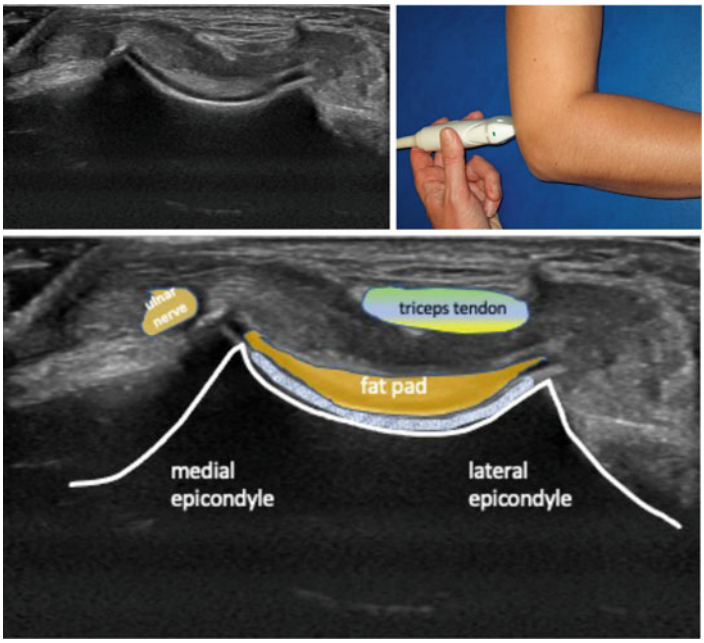
Rotating the probe by 90° yields the short axis posterior view. Patient and the elbow remain in the same as with the longitudinal view.

In the transverse view, the two humeral epicondyles are visible on each side of the screen. In the middle, the olecranon fossa is filled with fat tissue. Posterior to the fossa, the triceps muscle or its tendon is identified. The medial head of the triceps tendon is the deepest part of the triceps muscle, it has a shorter tendon part than the other heads and a further distal insertion on the olecranon.

This standard scan can be extended distally and ulnarly for examining the ulnar nerve, which runs in the ulnar groove next to the medial epicondyle (Standard Scan 6-8). The probe can also be shifted distally over the olecranon for olecranon bursitis and, further distally, rheumatic nodules.

What is normal?

Small amounts of physiological fluid may be present at the bottom of the fossa as mentioned on the previous page.



6.1.6 *Lateral Longitudinal View of the Elbow (Standard Scan 6-6)*

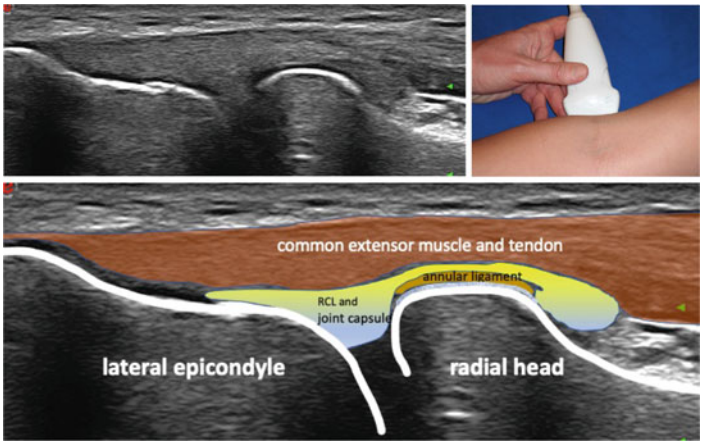
The long-axis view of the lateral aspect, together with standard scan 6-2, is the standard position for the examination of the origin of the common extensor tendon at the lateral epicondyle, the humero-radial joint and the lateral collateral ligament. The patient is seated with the elbow resting on the table. The examination may be easier with varying degrees of flexion of the elbow up to 90°.

The common extensor tendon is composed of different muscle slips, which usually cannot be reliably separated. The common extensor origin is identified as a triangular shaped, slightly hyperechoic structure comprising four superficial extensor muscles, i.e., the extensor carpi ulnaris, the extensor digiti minimi, the extensor digitorum communis, and the extensor carpi radialis brevis. Note that the other extensor tendons, i.e., the extensor radialis longus and the brachioradialis tendon, originate more proximally from a lateral ridge on the humerus. The fibers of the lateral radial collateral ligament (RCL) are coursing deep to the common extensor tendon. This Standard Scan is also suitable to visualize the annular ligament around the radial head.

The extensor tendon insertion may become inflamed both in common overload conditions such as “tennis elbow” and in inflammatory disease, e.g., spondyloarthritis. The hypoechoic origin correlates to edema, and power Doppler shows increased perfusion in enthesitis.

What is normal?

The tendons are homogeneous and slightly hyperechoic. Close to their insertion they may become hypoechoic due to anisotropy. Heel-toe the probe in order to avoid anisotropy. It is important to shift the probe slowly in order to see all parts of the tendons.



6.1.7 *Medial Longitudinal View of the Elbow (Standard Scan 6-7)*

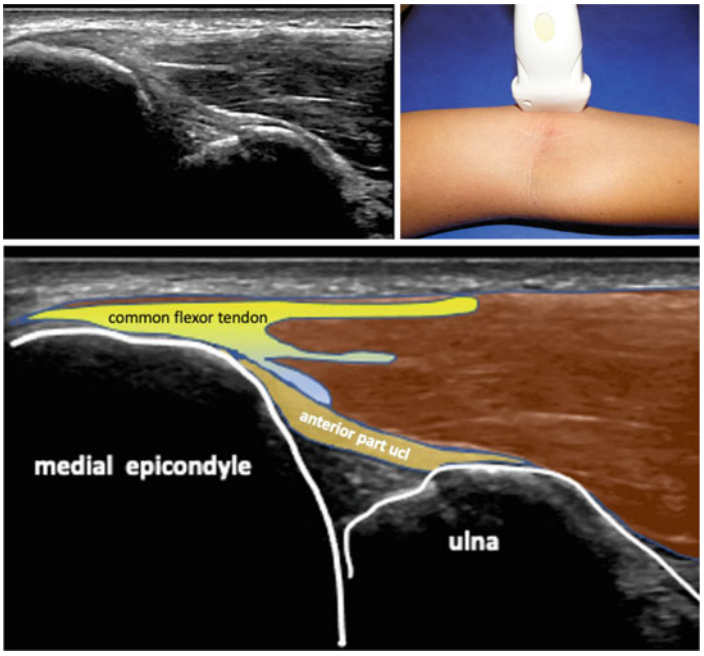
Standard scan 6-7 is the medial mirror image of the Standard Scan 6-6. The position of the patient is different though, as the elbow is now fully extended and the hand supinated. The medial longitudinal view provides information about the medial epicondyle, which is the humeral site where the common flexor tendon originates.

The standard scan also visualizes the anterior portion of the ulnar collateral ligament (ucl). The ulnar collateral ligament is identified as a tight band-like structure that stretches from the medial epicondyle to the tubercular portion of the coronoid process.

The common flexor tendon origin has a slightly hyperechoic appearance similar to its mirror image on the lateral side. The origin is prone to enthesitis, giving rise to what is known as "golfers elbow".

What is normal?

The ulnar collateral ligament attaches to the coronoid process; the ligament comprises 3 bands: anterior (the most important), posterior and transverse. The superficial surface of the ligament is outlined as a hyperechoic straight line, prone to anisotropy.



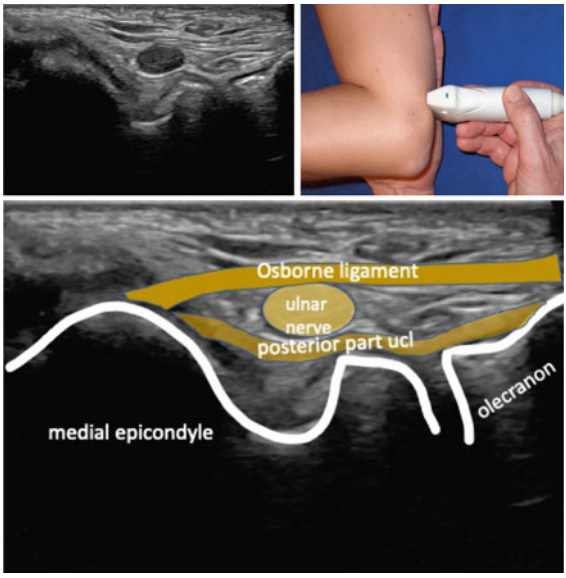
6.1.8 *Transverse View of the Cubital Tunnel of the Elbow (Standard Scan 6-8)*

From the position in Standard Scan 6-5, the probe is shifted more distally and ulnarly so that the distal pole of the probe is seated on the olecranon and the proximal pole on the medial epidcondyle. The ulnar nerve is positioned in the cubital tunnel along the posteromedial aspect of the distal humerus, adjacent to the medial epicondyle. The proximal roof of the cubital tunnel is formed by a thin ligament called Osborne retinaculum. The floor of the tunnel is formed by the posterior part of the ulnar collateral ligament along with the joint capsule of the humeroulnar joint space. In the transverse scan, nerves have a honeycomb-like appearance, with hypoechoic, rounded areas embedded in a hyperechoic background. The hypoechoic structures correspond to the neuronal fascicles that run longitudinally within the nerve, and the hyperechoic background relates to the interfascicular epineurium. The outer boundaries of the ulnar nerve may be poorly demarcated, because of the similar hyperechoic appearance of the superficial epineurium and the surrounding soft tissue and fat tissue.

Testing for ulnar nerve dislocation during flexion can be best performed by putting a wrapped towel beneath the elbow, so that the lower arm can be easily flexed and extended.

What is normal?

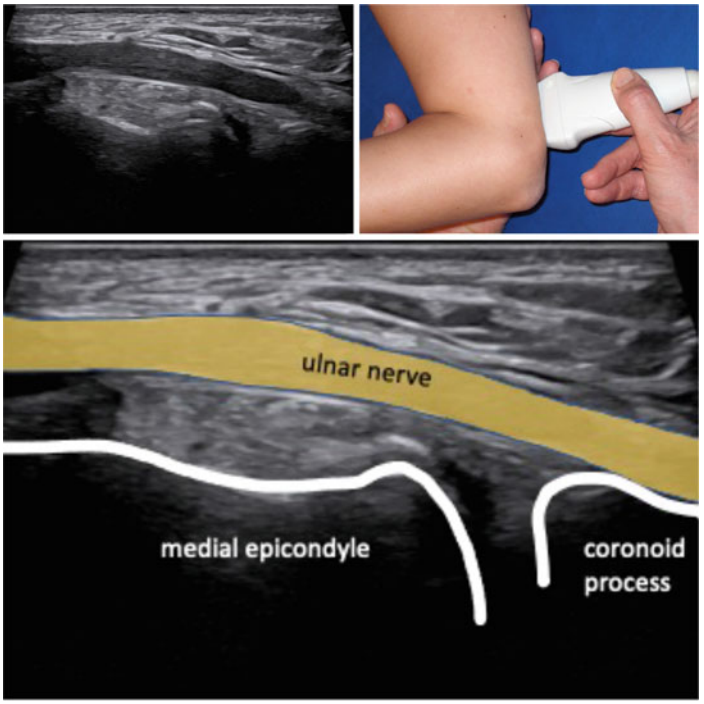
A cross-sectional area of ≤ 7 mm^2 is normal, ≥ 9 mm^2 is pathologic, and 8 mm^2 is borderline. There is no difference between the dominant and non-dominant arm.



6.1.9 *Longitudinal View of the Ulnar Nerve of the Elbow (Standard Scan 6-9)*

The position of the arm is the same as in Standard Scan 6-8. The probe is rotated by 90°. In the longitudinal ultrasound plane, all peripheral nerves show a peculiar arrangement made of multiple hypoechoic parallel linear areas separated by hyperechoic bands. Generally, the hypoechoic lines dominate the ultrasound image.

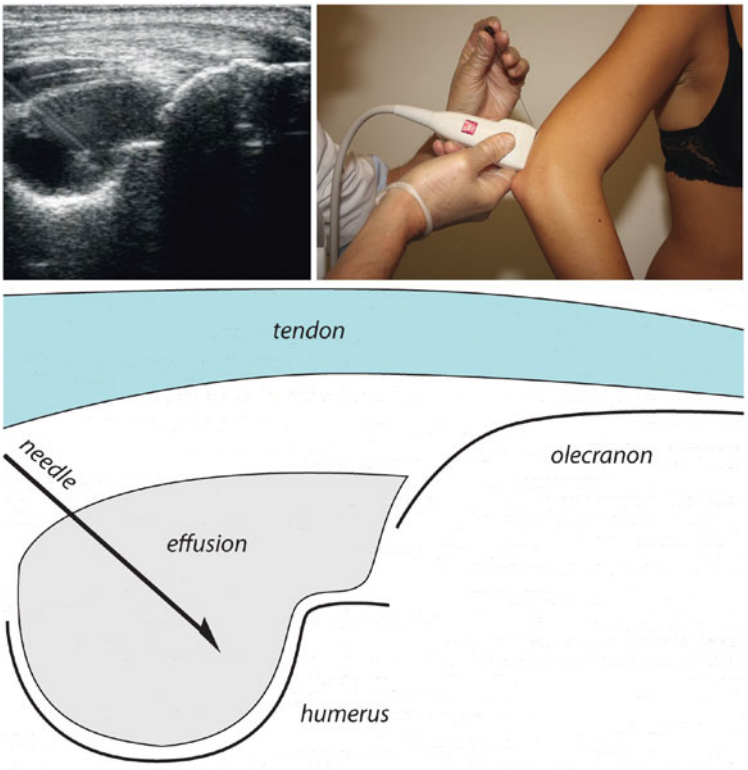
The ulnar nerve passes through the cubital tunnel, which is a bony passage way between the medial epicondyle and the olecranon. The proximal roof of the cubital tunnel is formed by a thin ligament called Osborne's retinaculum. The floor of the tunnel is formed by the posterior part of the ulnar collateral ligament and the joint capsule of the posterior recess. Then, the ulnar nerve curls around the medial humeral condyle at the elbow and courses down the proximal forearm between the two heads of the flexor carpi ulnaris. The distal roof is formed by the thicker arcuate ligament. Then, it descends deep to the muscle of the flexor carpi ulnaris on the surface of the flexor digitorum profundus.



6.1.10 *Ultrasound-Guided Injection of the Elbow*

The longitudinal posterior standard scan is suitable for ultrasound-guided injection of the posterior olecranon fossa as elbow effusions usually extend to this fossa. Alternatively, an effusion can be reached with an anterior approach in the region of the coronoid fossa.

The patient is seated with the elbow flexed by 90° and the hand flat on the examination couch. The probe is aligned with the long axis of the upper arm and the triceps muscle. The prescan should show the triceps muscle and tendon, the fat pad, and the contours of the distal humerus and posterior trochlea, the joint space and the ulnar olecranon. A posterior effusion is clearly visible in the olecranon fossa. After the usual antisepsis, the in-plane introduction of the needle into the posterior joint space under direct visualization is carried out. The needle is introduced posteriorly in the midline at an angle of 45° and directed at the olecranon fossa under direct ultrasound guidance.



6.2 Pathology of the Elbow

6.2.1 Synovitis of the Elbow

Best scans: Standard Scans 6-1 to 6-5.

Figure 6.1 shows a longitudinal ultrasound image at the anterior radial side of the elbow joint. Small amounts of effusion extend from the joint space into the radial fossa (arrow). The capsule is pushed up by the synovitis at the level of the fossa. The sonographer will miss the effusion if the area of the fossa is ignored.

Figure 6.2 shows an effusion of the right elbow joint in the anterior transverse scan. The effusion elevates the joint capsule at the level of the trochlea and the capitulum humeri closely to the joint space. The hyperechoic line anterior to the effusion represents the joint capsule (⇓). The thinner line anterior to the trochlea represents the interface between the synovial fluid and cartilage (⇑). Smaller effusions can be seen only when shifting the probe more proximally to the fossae.

Figure 6.3 is a posterior longitudinal scan showing a large effusion in the olecranon fossa with elevation of the posterior soft tissue. The amount of effusion can be estimated by the amount of fluid in the olecranon fossa. In this case, the fossa is completely filled. Synovial proliferation is present closely to the posterior joint capsule (⇓).

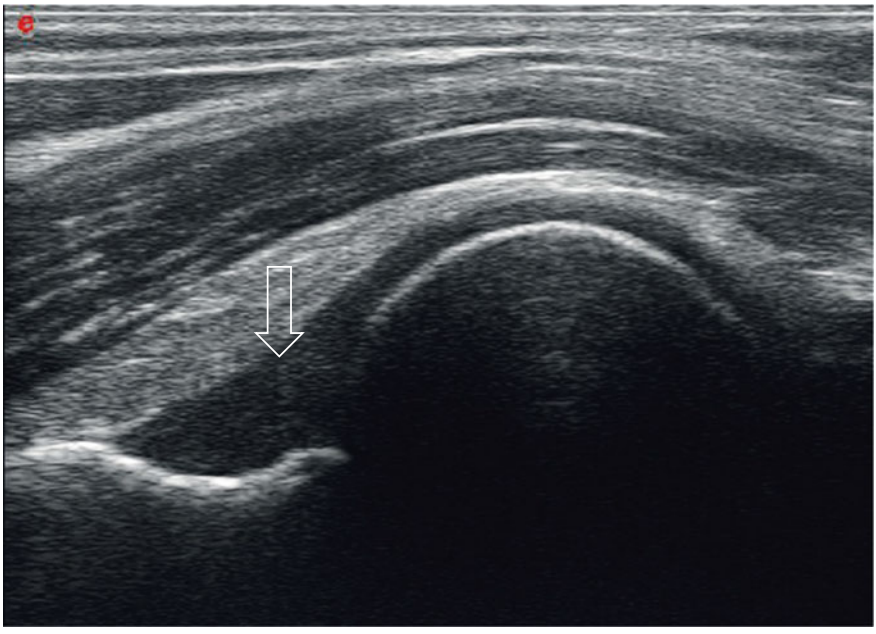


Fig. 6.1 Small effusion in the radial fossa (anterior longitudinal view at the level of the humeroradial joint)

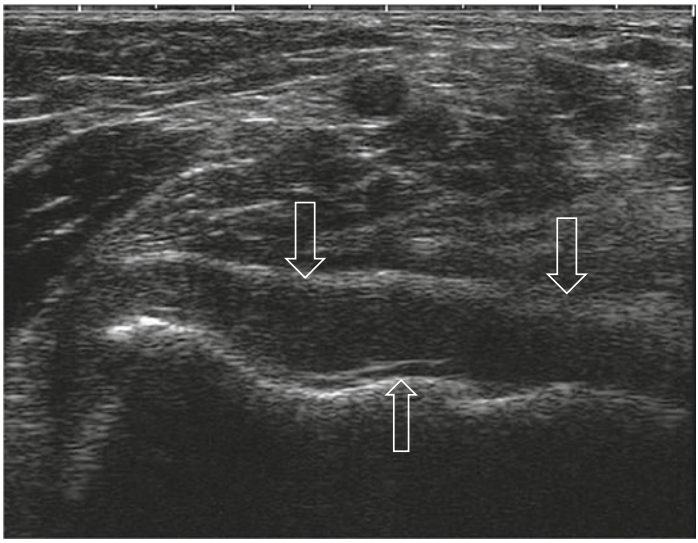


Fig. 6.2 Large effusion of the elbow joint (anterior transverse view)

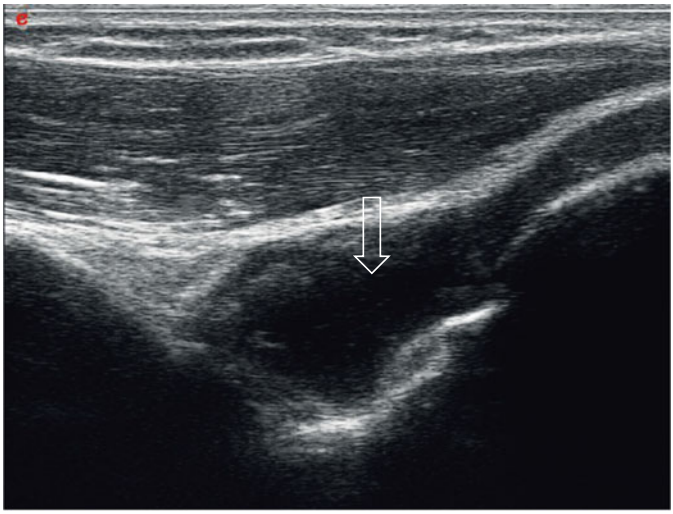


Fig. 6.3 Effusion and synovitis in the olecranon fossa (posterior longitudinal view)

6.2.2 *Enthesitis, Tendinopathy and Bursitis of the Elbow*

Best scans: Standard Scans 6-6 and 6-7.

Figure 6.4 is a longitudinal ultrasound image of the lateral region of the elbow. A calcific deposit localizes within the common extensor tendon close to its insertion (⇓). It is sometimes difficult to distinguish between tendon calcifications, osteophytes, and loose bodies. Osteophytes (enthesophytes) are usually connected to the bone. A loose body is usually intra-articular. Loose bodies and calcifications typically have no connection to the bone. On the other hand, a similar image may be seen if trauma has caused an avulsion of bone at the tendon insertion. Therefore, the image should only be evaluated in conjunction with history and clinical assessment. In lateral epicondylitis, the deep fibers of the common extensor tendon are involved, which belong to the extensor carpi radialis brevis tendon.

Figure 6.5 shows a hypoechoic, dark, inhomogeneous common extensor tendon insertion due to inflammation. Power Doppler ultrasound shows increased blood flow, indicating acute enthesitis.

Figure 6.6 shows a transverse sonogram of the olecranon bursa that is filled with hypoechoic material which may represent cell debris, hematoma, fibrin clots, pus, or other material. There is only a tiny spot of anechoic fluid (⇓) that may be aspirated under ultrasound guidance.

Figure 6.7 shows a longitudinal scan of a hypoechoic thickened triceps tendon, whose echotexture is completely destroyed by deposition of hyperechoic material, consistent with calciumpyrophosphate (CPP) crystals.

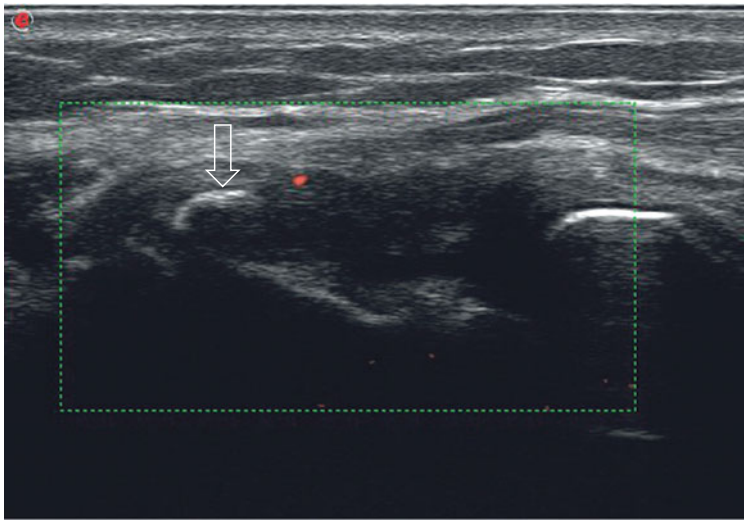


Fig. 6.4 Calcifying enthesopathy at the radial humeral epicondyle (longitudinal lateral view)

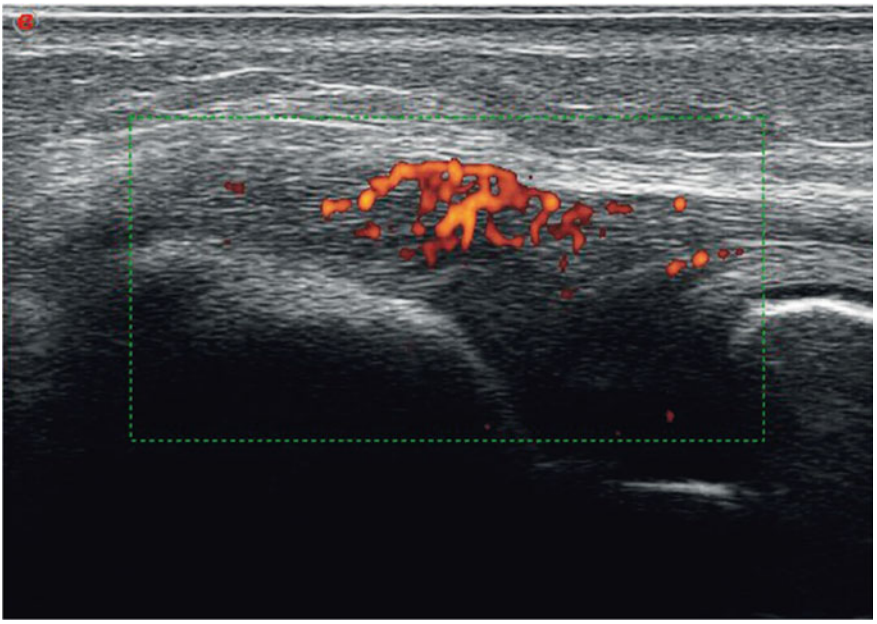


Fig. 6.5 Enthesitis with increased perfusion of the extensor tendons at the radial humeral epicondyle (longitudinal lateral view)

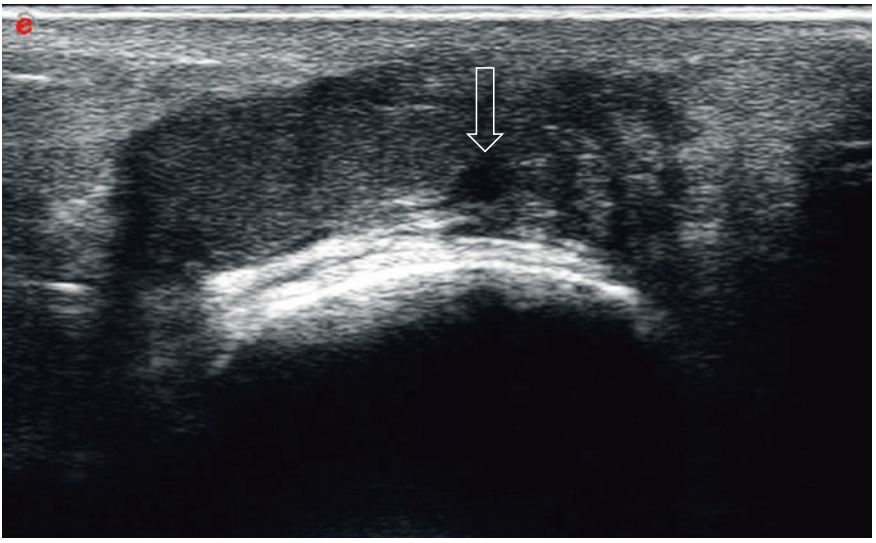


Fig. 6.6 Olecranon bursitis (transverse distal posterior view)

Fig. 6.7 Triceps tendinitis (longitudinal posterior view)

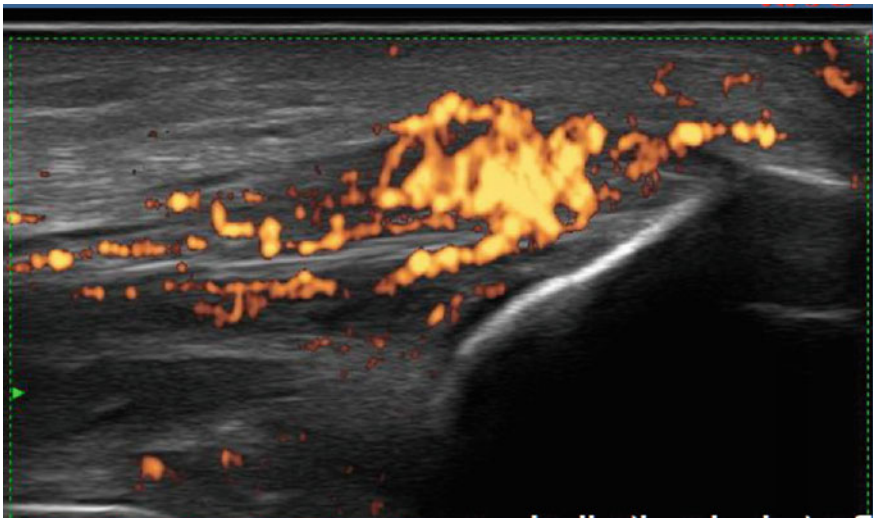


Fig. 6.8 Triceps tendinitis with increased perfusion (longitudinal posterior view)

Characteristic of calcium pyrophosphate deposition disease are the bright, hyperechoic punctate and linear bands with posterior shadowing (⇑⇓).

Figure 6.8 is an example of the strong inflammation caused by the calci-umpyprophosphate crystal deposits in the tendon. Differential diagnosis is with gout, which may result in a similar ultrasound image.

6.2.3 *Cubital Tunnel Syndrome and Rheumatoid Nodules*

Best scans: Standard Scans 6-8 and 6-9.

Figure 6.9 is a longitudinal ultrasound image showing a hypoechoic swollen ulnar nerve in the cubital fossa between the medial epicondyle and the olecranon. The nerve is indicated by the arrows (⇓⇑).

Figure 6.10 shows a transverse scan with a hypoechoic swollen ulnar nerve (⇒). The cross-sectional area is 10 mm^2 (7 mm^2 on the healthy side). The ulnar nerve in this patient is entrapped due to large synovitis of the elbow with effusion that extends to the medial posterior areas of the joint (⇐).

Cubital tunnel syndrome is the result of inflammation of the ulnar nerve manifested by an enlarged, hypoechoic appearance on ultrasound due to edema. Dynamic imaging during flexion of the elbow may reveal medial subluxation of the ulnar nerve in some individuals, but without signs of ulnar neuropathy. Repeated periods of subluxation may cause neuritis.

Figure 6.11 Rheumatoid nodules (arrows) are a classic extra-articular feature of rheumatoid arthritis overlying the posterior aspects of proximal ulna and other pressure locations such as the occiput, sacrum, knee, or the Achilles tendon. Sonographically, rheumatoid nodules appear as hypoechoic oval structures, with clear demarcation from the surrounding tissue. Power Doppler usually reveals no or minor blood flow.

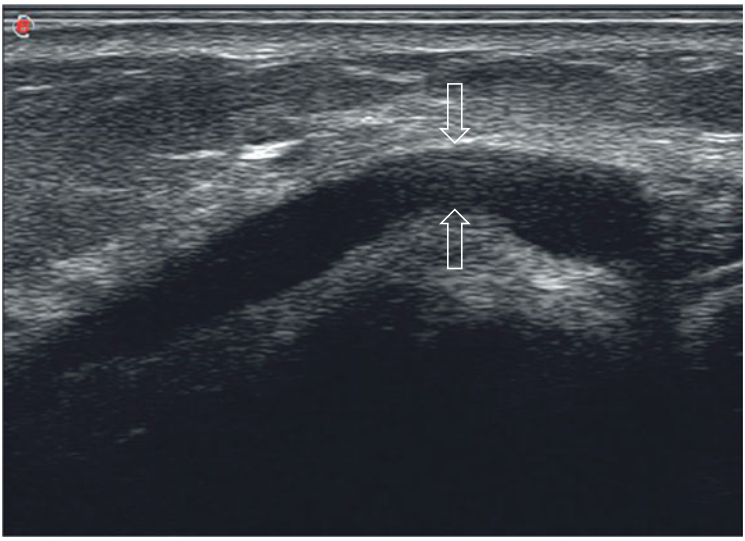


Fig. 6.9 Hypoechoic swelling of the ulnar nerve in primary cubital tunnel syndrome (longitudinal view of the ulnar nerve)

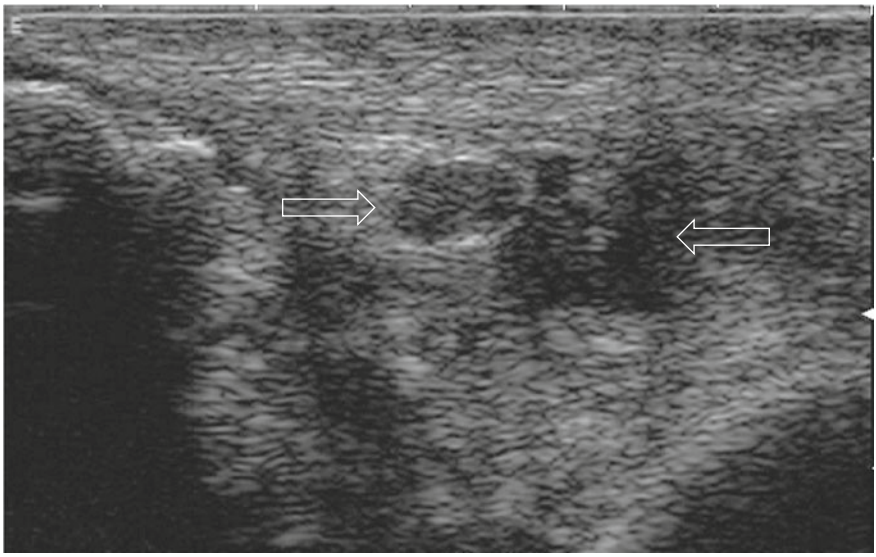


Fig. 6.10 Hypoechoic swelling of the ulnar nerve in cubital tunnel syndrome due to synovitis of the elbow (transverse view of the ulnar nerve)

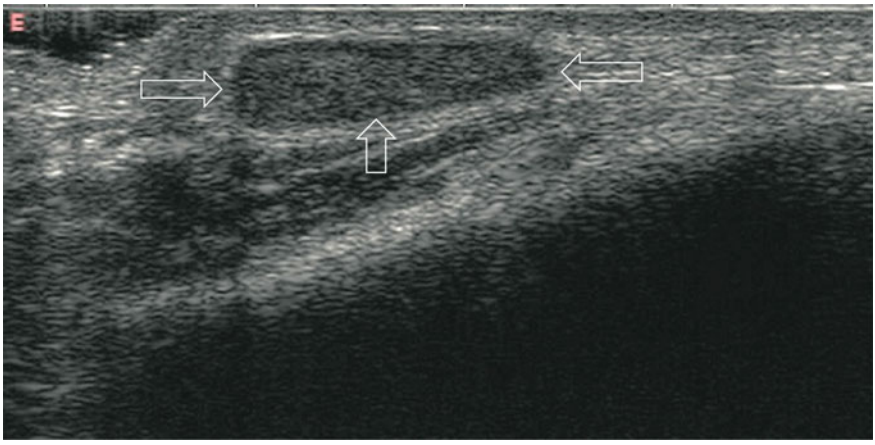


Fig. 6.11 Rheumatic nodule localized typically at the proximal posterior aspect of the ulna (longitudinal distal dorsal view)