The Elbow

Iustina Janţă

Anterior Elbow

For the evaluation of the anterior elbow (Illustration 1), the patient is seating facing the examiner, the elbow is extended and resting on the examination table, with the forearm supinated (Fig. 1). In some cases the elbow can be supported by a pillow.

The principal structures that can be evaluated on the anterior elbow are the radial, the coronoid and the annular recesses, the distal biceps brachii tendon and the joint cartilage.

For the evaluation of the anterior elbow, we need a linear probe with a frequency between 10 and 15 MHz.

The evaluation of the anterior elbow starts with the longitudinal view of the radial recess. The starting point is with the probe in longitudinal, just proximal to the capitellum (Fig. 2). Then the probe is swiped from medial to lateral and from proximal to distal to evaluate the radial and the annular recesses. To evaluate the coronoid recess, the probe is swiped from medial to lateral (Figs. 3 and 4). Then the probe is moved to transverse view and swiped from proximal to distal. In this scan, the radial and the coronoid recesses, the annular recess and the joint cartilage are evaluated (Figs. 5 and 6) [4].

For the evaluation of the distal biceps brachii tendon (Illustration 2), there are three approaches suggested, i.e. from anterior aspect, from medial aspect and from posterior aspect. We will discuss each approach on the corresponding aspect of the elbow. From the anterior aspect, the patient's position is the same as for the evaluation of the three anterior recesses. The probe is initially placed in longitudinal, slightly oblique, over the brachialis muscle and the radial tubercle. Slightly more pressure should be put on the distal edge of the probe (Figs. 7 and 8) [4].

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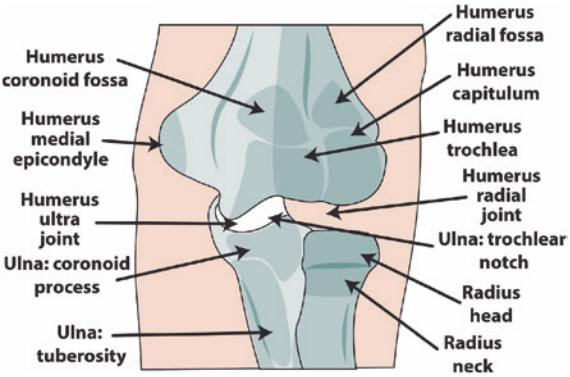

Illustration 1 Anterior elbow. Figure commissioned by Dr Akram and printed with permission from Unzag Designs

Fig. 1 Patient position and probe position (starting point) for the longitudinal evaluation of radial and annular recesses

Other structures that can be evaluated from the anterior part are the median nerve and the radial nerve. The median nerve lies medial to the brachial artery and the radial nerve lies between the brachialis medially and brachioradialis and extensor carpi radials longus laterally.

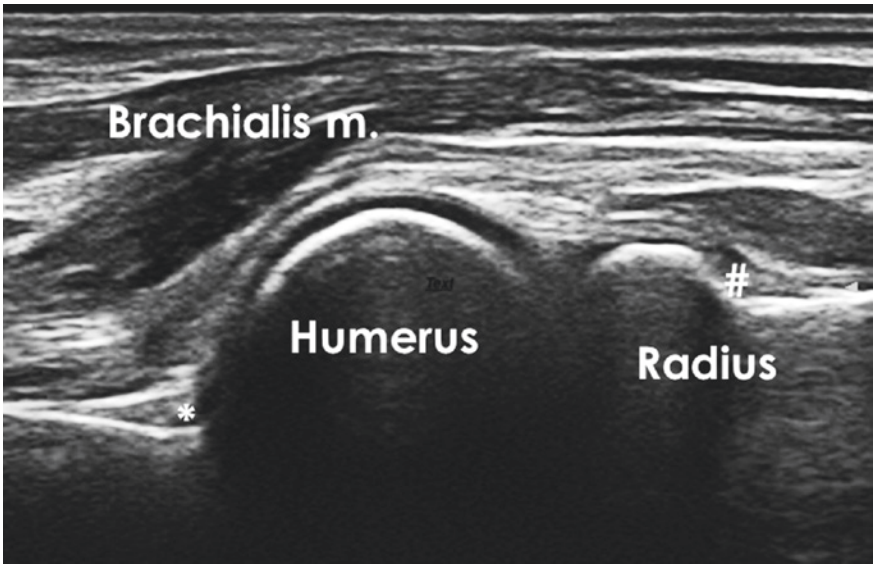

Fig. 2 Longitudinal scan of the anterior elbow. Landmarks: humeral capitellum and radial head and neck. * Radial recess; # annular recess

Fig. 3 Patient position and probe position (starting point) for the longitudinal evaluation of coronoid recess

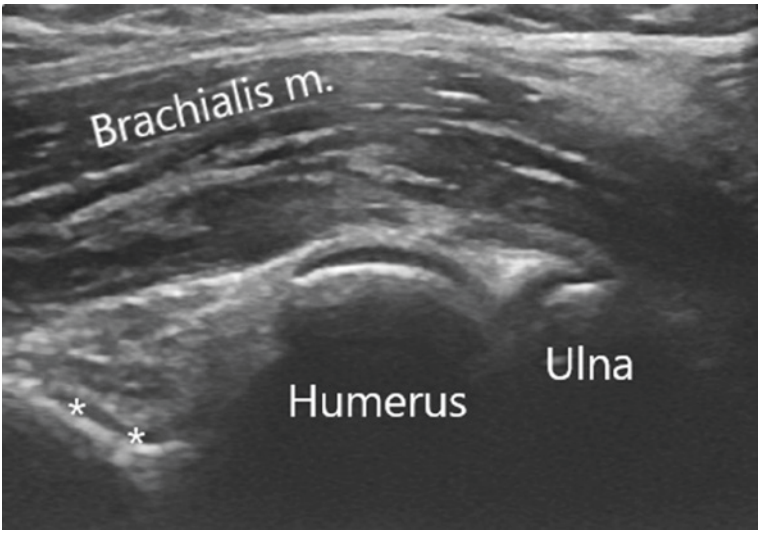

Fig. 4 Longitudinal scan of the anterior elbow. Landmarks: humeral trochlea and coronoid process of the ulna. * Coronoid recess

Fig. 5 Patient position and probe position (starting point) for the transverse evaluation of the anterior elbow

Medial Elbow

For the evaluation of the medial elbow, the patient is seating facing the examiner, the elbow is slightly flexed and resting on the examination table with the arm in external rotation and forearm supinated (Fig. 9) [4].

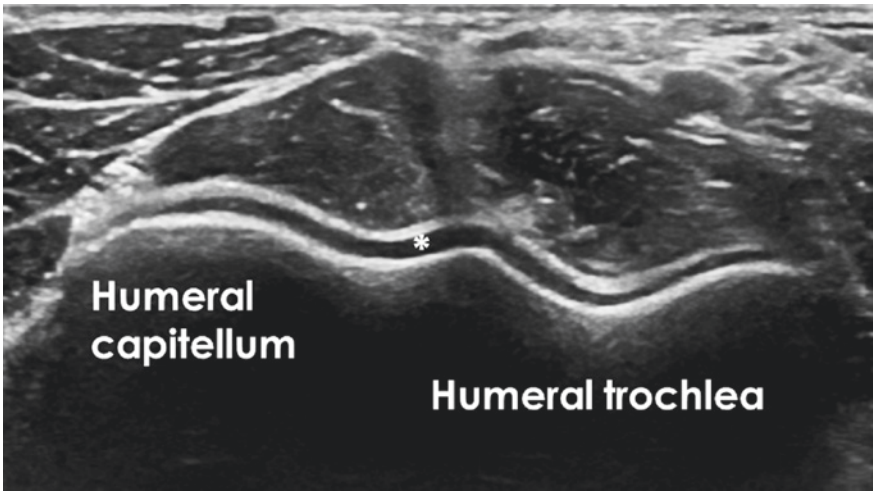

Fig. 6 Transverse scan of the anterior elbow. Landmarks: humeral capitellum and humeral trochlea. * Joint cartilage

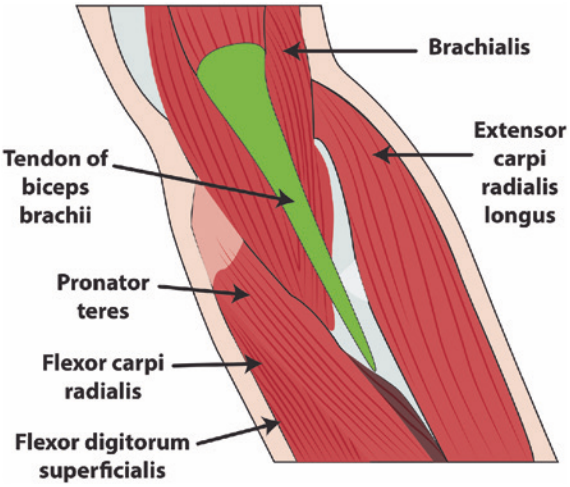

Illustration 2 Anatomical illustration of the anterior elbow including the biceps tendon. Figure commissioned by Dr Akram and printed with permission from Unzag Designs

The principal structures that can be evaluated on the medial elbow are the common flexor tendon and enthesis and the ulnar (medial) collateral ligament (Illustration 3).

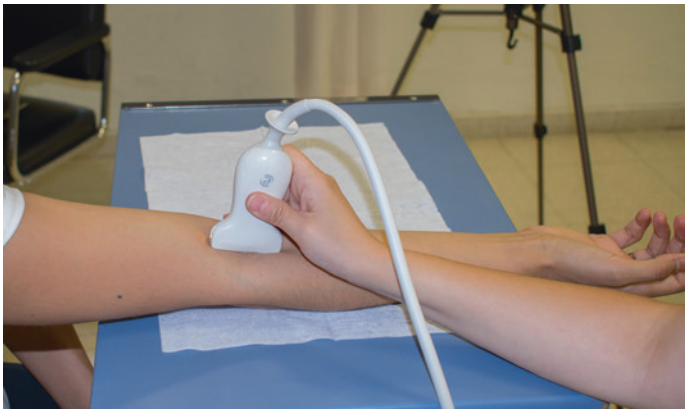

Fig. 7 Patient position and probe position (starting point) for the longitudinal evaluation of the distal biceps brachii tendon, anterior aproach

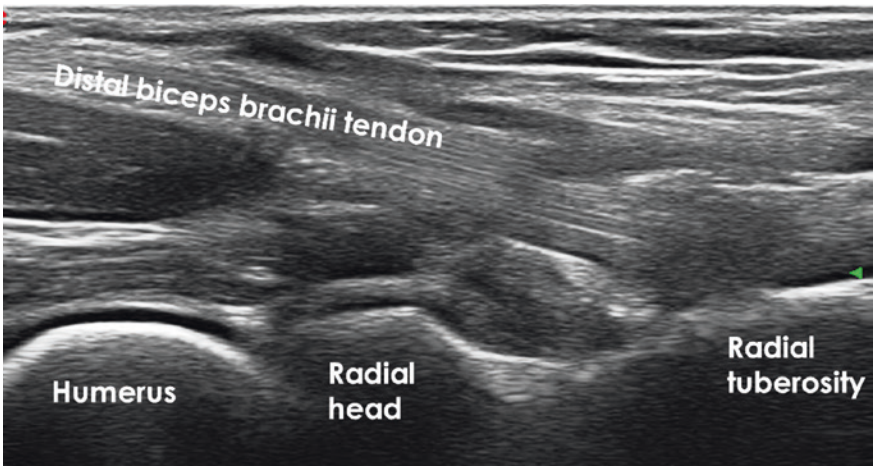

Fig. 8 Longitudinal scan of the anterior approach of the distal biceps brachii tendon. Landmarks: radial tuberosity

For the evaluation of the common flexor tendon, a high frequency, liner probe is needed (e.g. frequency more than 15 MHz).

The evaluation of the medial elbow starts with the longitudinal view of the common flexor tendon. The starting point is with the probe in longitudinal with the proximal part over the medial epicondyle and the distal part over the ulna (Fig. 10) [4]. Then the probe is swiped from medial to lateral to evaluate the entire aspect of the tendon. For the evaluation of the common flexor enthesis the probe should be moved distally, avoiding the anisotropy.

Fig. 9 Patient position and probe position (starting point) for the longitudinal evaluation of the medial elbow

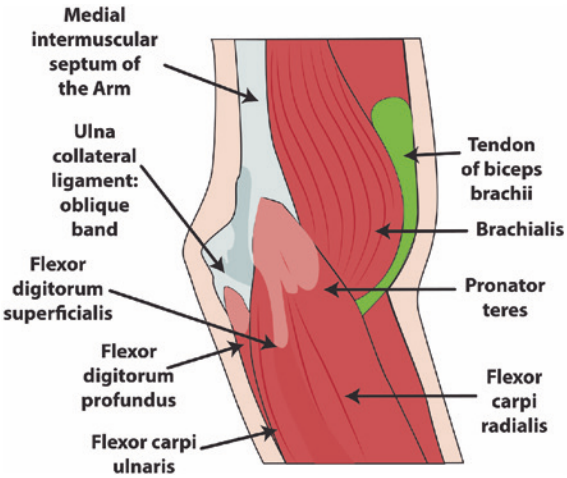

Illustration 3 Anatomical illustration of the medial elbow: common flexors

For the evaluation of biceps tendon from the medial aspect, the patient's position remains the same as for the anterior evaluation, adding that the examiner holds the patient's wrist with her/his free hand in order to perform a slightly forced external rotation (Fig. 11). The starting point is with the probe longitudinally

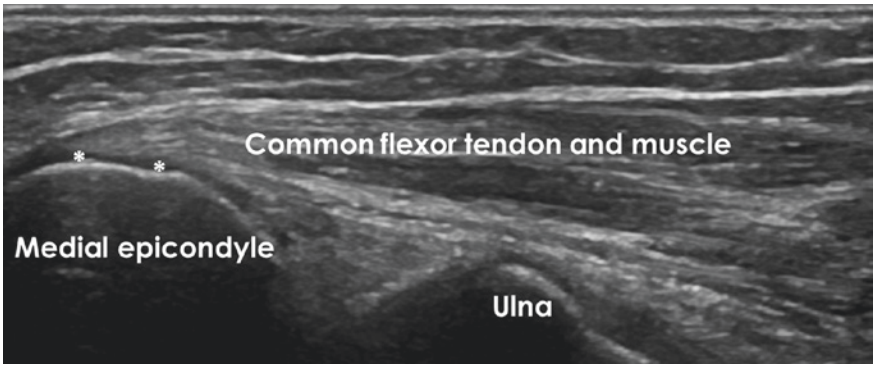

Fig. 10 Longitudinal scan of the common flexor tendon. Landmarks: medial epicondyle, proximal ulna. * Common flexor enthesis

Fig. 11 Patient position and probe position (starting point) for the longitudinal evaluation of the distal biceps brachii tendon, medial aproach

and parallel to the distal humerus, with the proximal aspect of the probe over the medial epicondyle. From this point, the probe is moved distally over the pronator teres muscle, until the radial head and then the radial tuberosity is found.

The ulnar (medial) collateral ligament is a triangular ligament arising from the medial epicondyle of the humerus and inserting on to the coronoid process and olecranon of the ulna. It is formed from three bands, anterior, posterior and oblique, the anterior band being the strongest one (Fig. 12) [4].

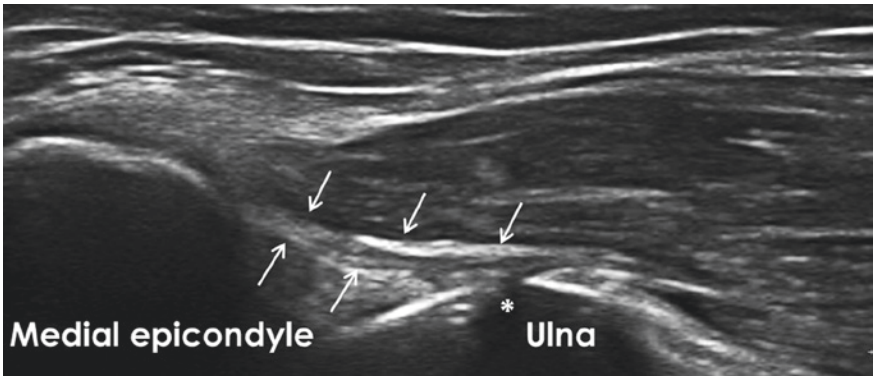

Fig. 12 Longitudinal scan of the ulnar (medial) collateral ligament (anterior band) between arrows. Landmark: medial epicondyle, ulna. * Joint space

Fig. 13 Patient position and probe position (starting point) for the longitudinal evaluation of the lateral elbow

Lateral Elbow

For the evaluation of the lateral elbow, the patient is seating facing the examiner, the elbow is slightly flexed and resting on the examination table with shoulder in internal rotation (Fig. 13) [4].

The principal structures that can be evaluated on the lateral elbow are the common extensor tendon and enthesis and the radial (lateral) collateral ligament (Illustration 4).

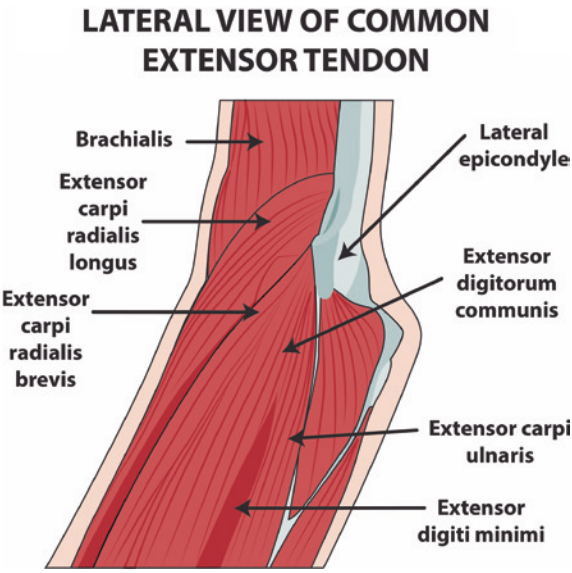

Illustration 4 Anatomical illustration of the lateral elbow: common extensors. Figure commissioned by Dr Akram and printed with permission from Unzag Designs

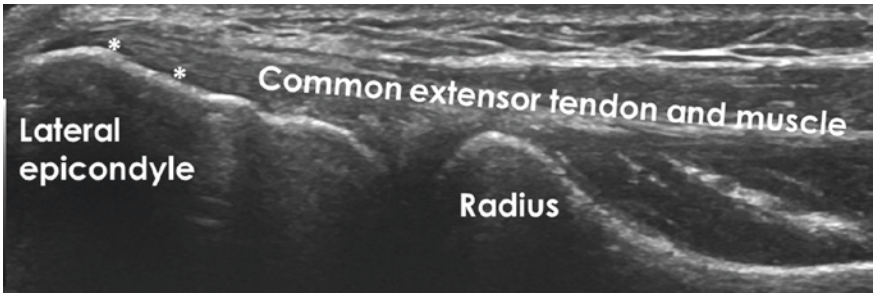

Fig. 14 Longitudinal scan of the common extensor tendon. Landmarks: lateral epicondyle, radius. * Common extensor enthesis

Due to the superficial localization of the extensor tendons, a high frequency, liner probe is needed (e.g. frequency more than 15 MHz).

The evaluation of the lateral elbow starts with the longitudinal view of the common extensor tendon.

The starting point is with the probe in longitudinal with the proximal part over the lateral epicondyle and the distal part over the radius. Then the probe is swiped from medial to lateral to evaluate the entire aspect of the tendon. For the evaluation of the common extensor enthesis, the probe should be moved distally, avoiding the anisotropy (Fig. 14) [4].

The radial (lateral) collateral ligament is weaker than the ulnar collateral ligament. It arises from the lateral epicondyle of the humerus and inserts on to the

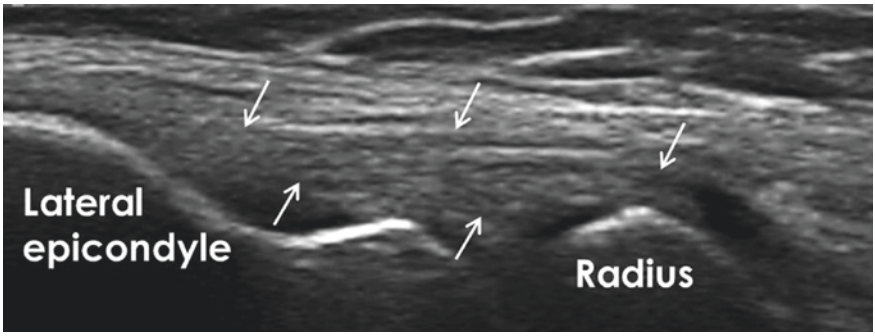

Fig. 15 Longitudinal scan of the radial (lateral) collateral ligament between arrows. Landmarks: lateral epicondyle, radial head

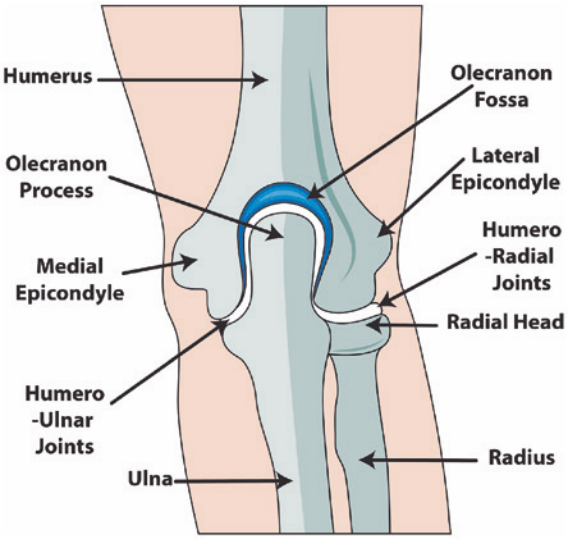

Illustration 5 Anatomical illustration of the posterior elbow. Figure commissioned by Dr Akram and printed with permission from Unzag Designs

radial notch of ulna and annular ligament. For the evaluation of the radial collateral ligament, the probe is placed in the same position as for the evaluation of the extensor tendons and swiped slightly posterior (Fig. 15) [4].

Posterior Elbow

For the evaluation of the posterior elbow, the patient is seating facing the examiner, elbow flexed and arm internally rotated, with forearm and palm resting on the examination table (Fig. 16). An alternative position is with the patient supine and the forearm and palm resting on the patient's chest [4].

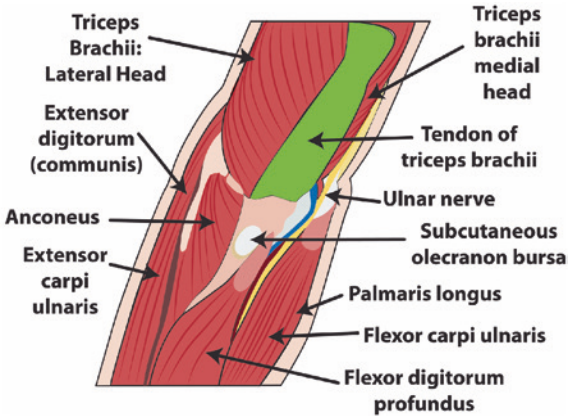

Illustration 6 Anatomical illustration of the posterior elbow including the triceps tendon. Figure commissioned by Dr Akram and printed with permission from Unzag Designs

Fig. 16 Patient position and probe position (starting point) for the longitudinal evaluation of the posterior elbow

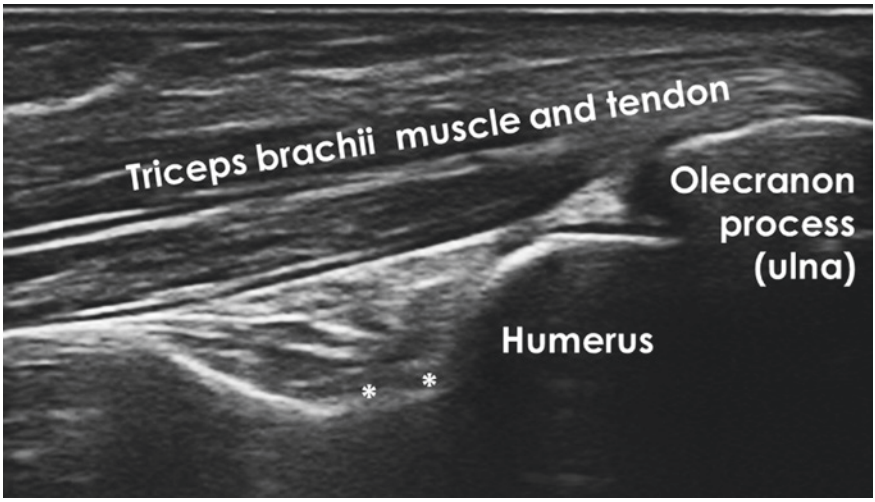

Fig. 17 Longitudinal scan of the posterior recess of the elbow. Landmark: olecranon. * Posterior recess

The principal structures that can be evaluated on the posterior elbow are the posterior joint recess and the triceps brachii tendon and enthesis (Illustrations 5 and 6).

For the evaluation of the triceps enthesis, a high frequency, liner probe is needed (e.g. frequency more than 15 MHz). On the contrary, for the evaluation of the posterior joint recess, a low frequency is needed (e.g. 10 MHz).

The starting point is with the probe placed longitudinal over the midline of the posterior proximal elbow. Then the probe is swiped from medial to lateral and from proximal to distal in order to evaluate the structures on their entire length (Figs. 17 and 18). Then the probe is moved to transverse view and swiped from proximal to distal to evaluate the posterior recess and the triceps tendon (Figs. 19 and 20) [4].

For the posterior approach for the evaluation of the biceps tendon, the patient's position is with the elbow flexed at 90 degrees, resting on the examination table, the forearm is elevated and the hand in neutral position. The starting point is with the probe transverse over the olecranon (Figs. 21 and 22). From this point, the probe is moved distally along the posterior aspect of the forearm. Dynamic manoeuvres of prono-supination are needed in order to identify the distal part of the biceps tendon and its insertion [4].

The annular ligament is the principal stabilizer of the joint and it surrounds the radial head and radial notch of the ulnar. For the evaluation of the annular ligament, the patient's elbow is flexed and resting on the examination table, hand is pronated and palmar flexed (cobra position). The probe is placed transverse to the

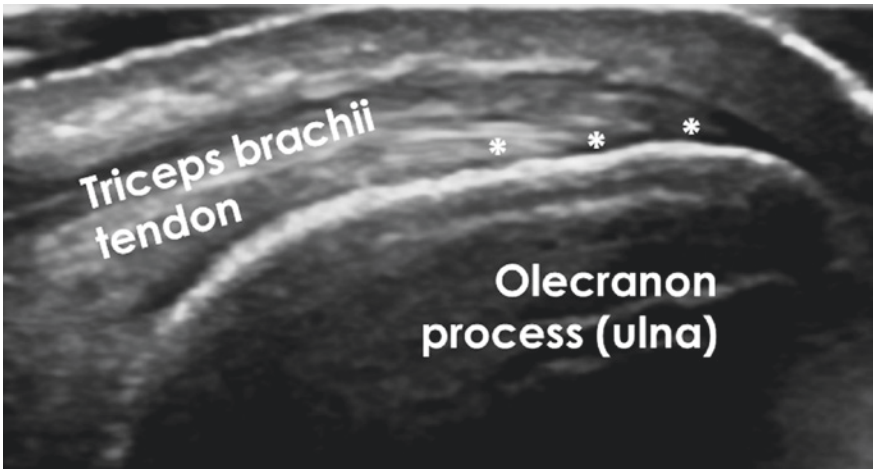

Fig. 18 Longitudinal scan of the triceps brachii tendon and enthesis (*)

radial shaft over the radial head. In this position a longitudinal view of the ligament is obtained (Fig. 23).

Other structures that can be evaluated on the posterior aspect of the elbow are the ulnar nerve and the Osborne's ligament. For the evaluation of the ulnar nerve in transverse view the probe is placed transverse between the olecranon and the medial epicondyle (Figs. 24 and 25). The ulnar nerve passes in a grove, behind the medial epicondyle. The grove is covered by the Osborne ligament, forming the cubital tunnel. For the evaluation of the ulnar nerve subluxation dynamic maneuvers of flexion-extension of the elbow are useful.

Pathology

Ultrasound is useful in detecting several elbow pathologies. The evaluation of the four recesses (i.e. the radial, the coronoid, the annular and the posterior recesses) can detect effusion, synovitis or intraarticular bodies. The evaluation of tendons and ligaments may detect tendinosis, enthesopathy or tears. Nerves can also be assessed by ultrasound for entrapment, subluxation or tumours. An added value of the ultrasound is the possibility of dynamic manoeuvres with a better characterisation of the pathology [5, 6]. If pathological finding, ultrasound has the advantage of guiding invasive procedures.

Fig. 19 Patient position and probe position (starting point) for the transverse evaluation of the posterior elbow

Synovitis is seen as an abnormal hypoechoic intra-articular tissue that is not displaceable and poorly compressible and which can exhibit Doppler sign (Fig. 26, 27, 28, 29, 30, and 31) [7]. It can be observed in several pathological settings, like rheumatoid arthritis, spondilarthropathies, crystal arthropathies and trauma. The posterior recess is the most sensitive area for the assessment of synovitis and/or joint effusion. Pathologies associated with elbow synovitis are

Fig. 20 Transverse scan of the posterior elbow. * Olecranon recess

Fig. 21 Patient position and probe position (starting point) for the longitudinal evaluation of the distal biceps brachii tendon, posterior aproach

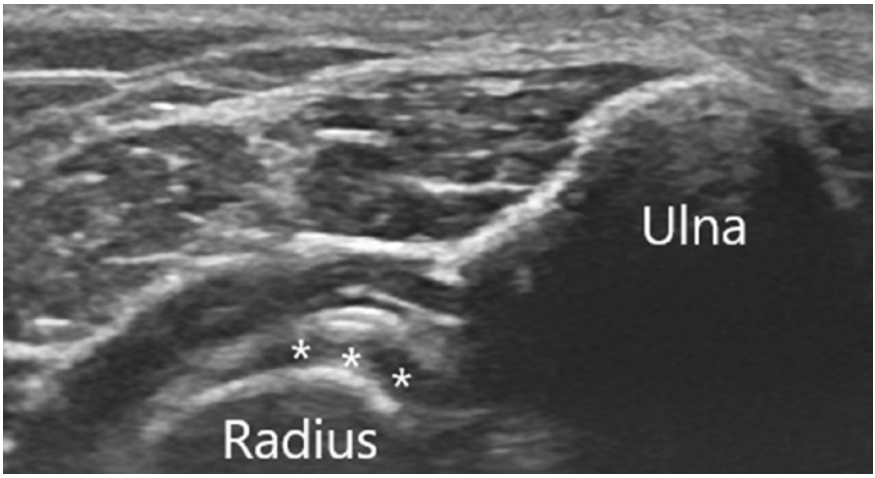

Fig. 22 Longitudinal scan of the posterior approach of the distal biceps brachii tendon. Landmark: radial and ulnar bones

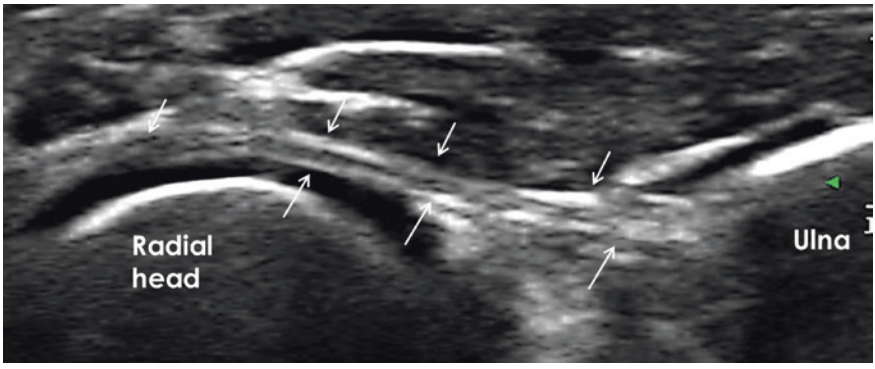

Fig. 23 Longitudinal scan of the annular ligament between arrows. Landmark: radial head

inflammatory arthritis, osteoarthrosis, crystal arthopathies, infections, pigmented villonodular synovitis or osteochrondomatosis.

Epicondylitis is mostly characterised on ultrasound by the presence of tendinopathy and/or enthesopathy. It could be caused by mechanical overuse or trauma, or by persistent inflammation. Tendinopathy appears on ultrasound as focal or generalized hypoechogenicity with or without Doppler sign. In mechanical pathologies, the presence of Doppler sign is due to regenerative tendon response

Fig. 24 Patient position and probe position (starting point) for the transverse evaluation of the ulnar nerve

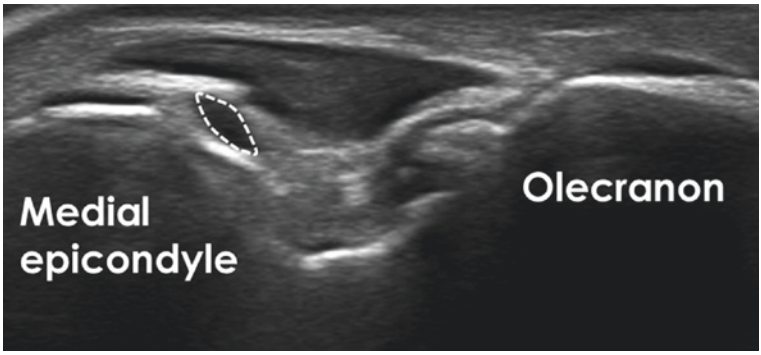

Fig. 25 Transverse scan of the ulnar nerve (dash line). Landmark: medial epicondyle

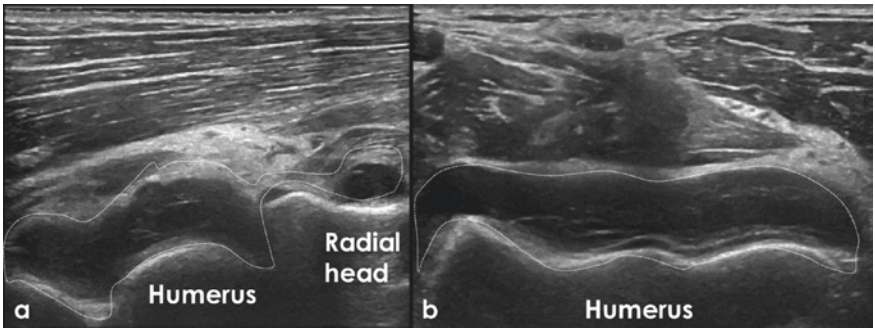

Fig. 26 Longitudinal and transverse view of radial and annular recesses showing synovitis (dash line)

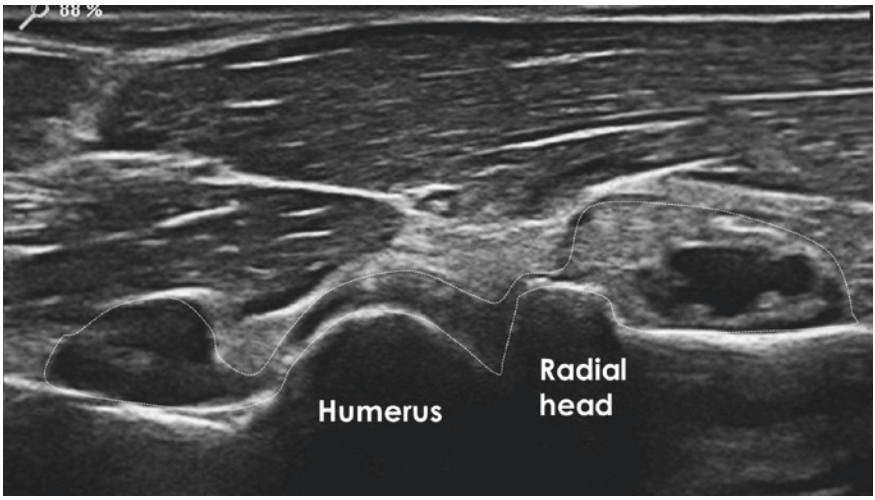

Fig. 27 Longitudinal view of radial and annular recesses showing synovitis (dash line)

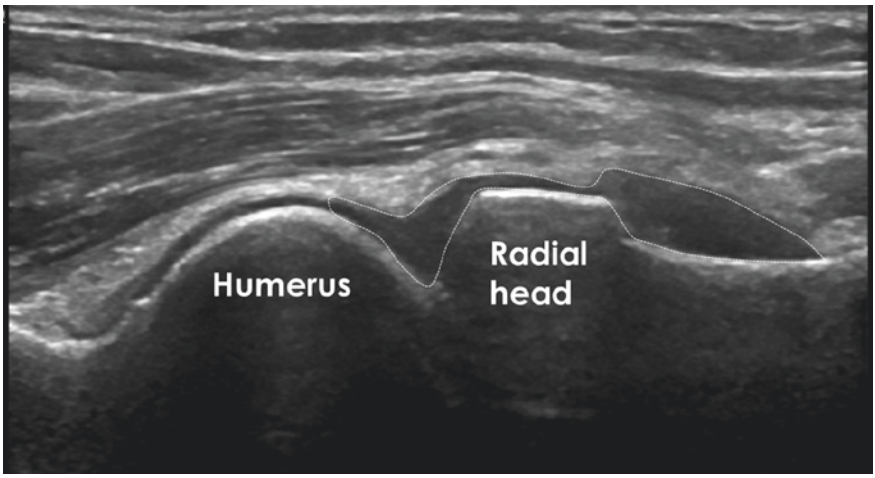

Fig. 28 Longitudinal view of annular recess showing synovitis (dash line)

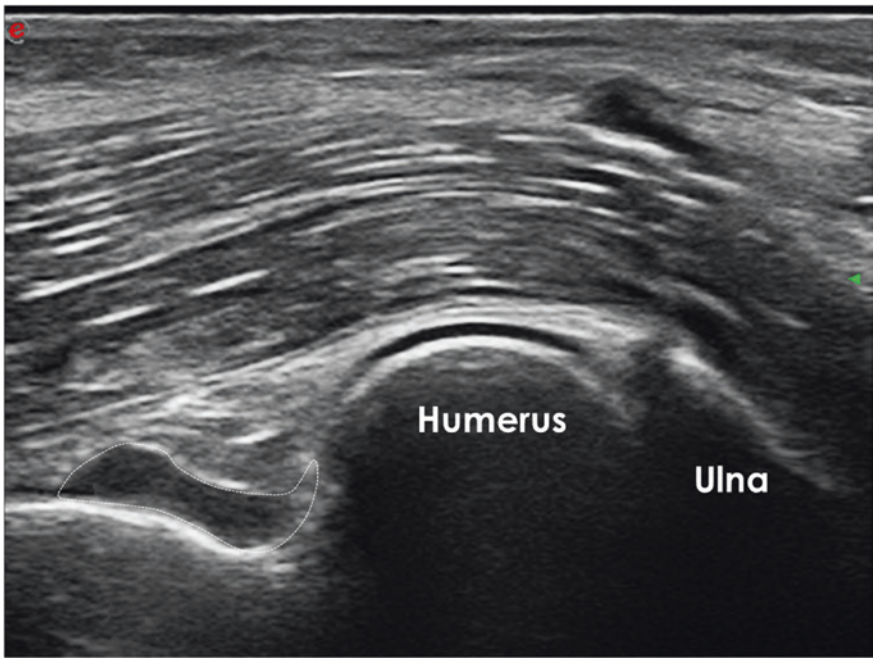

Fig. 29 Longitudinal view of coronoid recess showing synovitis (dash line)

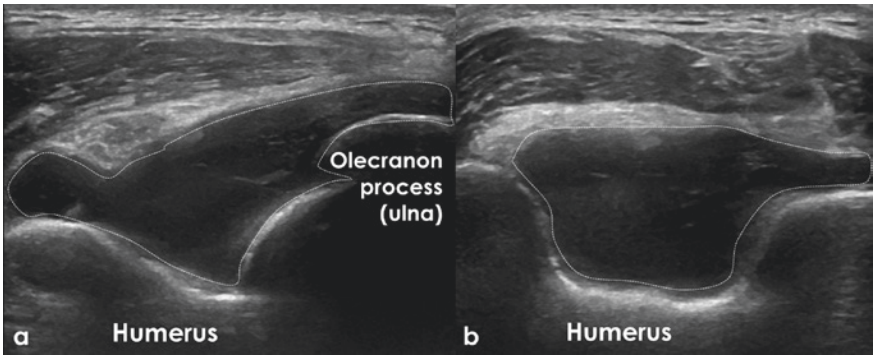

Fig. 30 (**a**, **b**) Longitudinal and transverse view of the posterior recess showing synovitis (dash line)

(Fig. 32a,b). Mechanical tendinopathy is more frequent at the extensor tendons levels, compared to medial flexor tendons.

Entesopathy is defined as an abnormal hyperechoic (loss of normal fibrillary architecture) and/or thickened tendon at its bony attachment. Others findings, like enthesophytes, erosions or calcifications can be observed. Ultrasound enthesitis

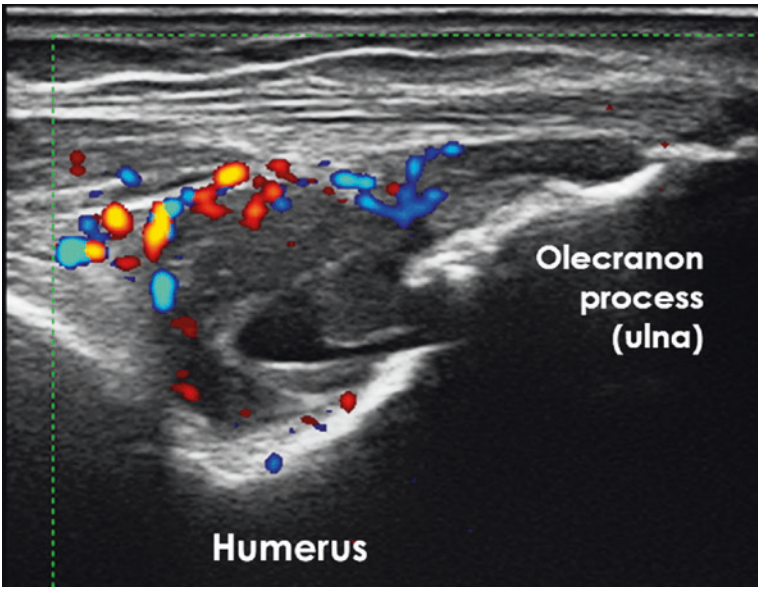

Fig. 31 Longitudinal view of the posterior recess showing synovitis with Doppler sign

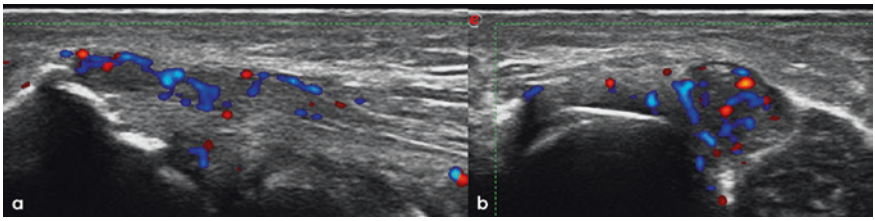

Fig. 32 (a,b). Longitudinal and transverse view of the extensor tendons showing tendinopathy with Doppler sign

is defined by the Outcome Measures in Rheumatology (OMERACT) group as "hypoechoic and/or thickened insertion of the tendon close to the bone (within 2 mm from the bony cortex), which exhibits Doppler signal if active and that may show erosions, enthesophytes/calcifications as a sign of structural damage" (Fig. 33) [8]. According to this definition, the presence of inflammatory signs (i.e. Doppler sign and/or hypoechoic and/or thickened tendon insertion) is mandatory to define enthesitis in spondilarthropathies (i.e. spondyloarthtitis and psoriatic arthritis).

Clinically, it may be difficult to differentiate between tendinopathy/entesopathy and enthesitis. Thus, ultrasound may be used to identify the presence of enthesitis,

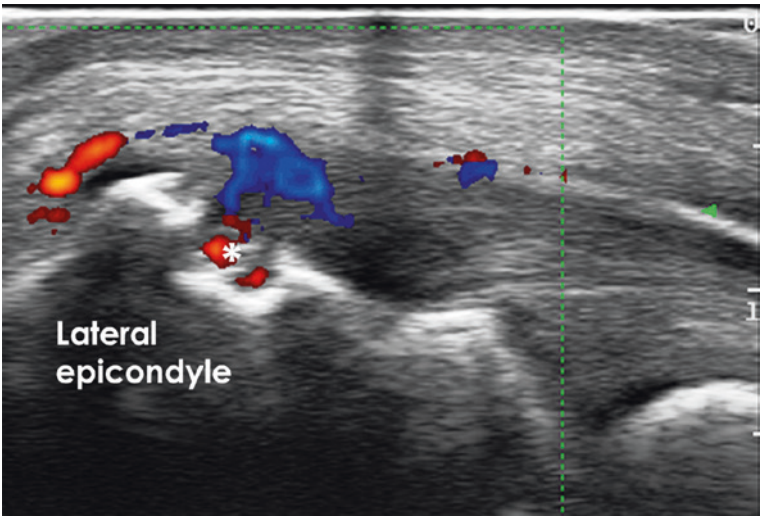

Fig. 33 Longitudinal view of the extensor tendons showing enthesitis with Doppler sign and erosion (*)

features more specific for espondilarthropathy. On the other hand, ultrasound it is also useful to assess the severity and the extent of tendon/enthesis involvement.

At the elbow level, the most frequently involved bursae are the olecranon and bicipital bursae. The normal bursae are not visible, but in some pathological situations, like crystal arthopathies, infections, repetitive trauma or inflammatory arthritis, they are distended and can be easily observed (Fig. 34). For a better visualization of this bursitis, it is important not to put too much pressure on the probe, especially for the olecranon bursitis. The bicipital bursitis is frequently due to chronic mechanical friction and is associated with distal biceps tendinopathy (Figs. 35 and 36a,b).

Although it is not the most symptomatic joint in crystal arthropaties, crystal deposits of uric acid and calcium pyrophosphate can be observed at the elbow joint. For uric acid deposits, the most frequent finding is the presence of tophi at the olecranon burse or within the triceps tendon (Fig. 37); the double contour sign may be also observed. Calcium pyrophosphate deposits may be observed as hyperechoic images within the joint cartilage (Fig. 38).

Tendon and ligament tears may be observed as an anechoic or hypoechoic discontinuity of the fibrillary pattern with or without retraction and, in recent cases, with surrounding hypoechoic fluid. The most frequent tendon tears at the elbow

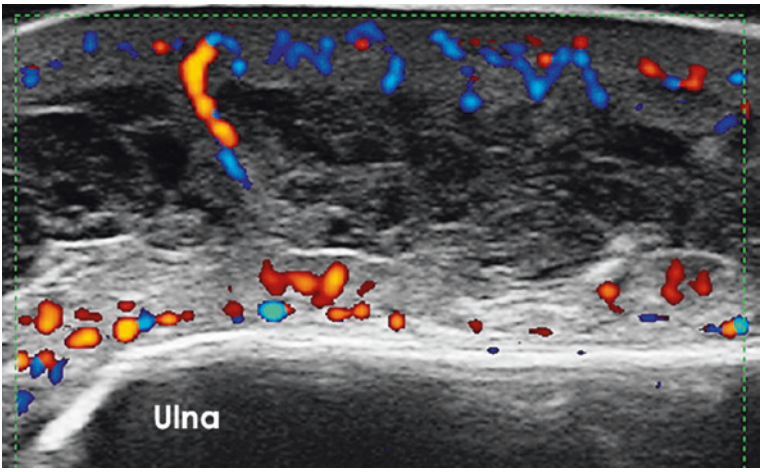

Fig. 34 Longitudinal view over the proximal ulna showing olecranon bursitis

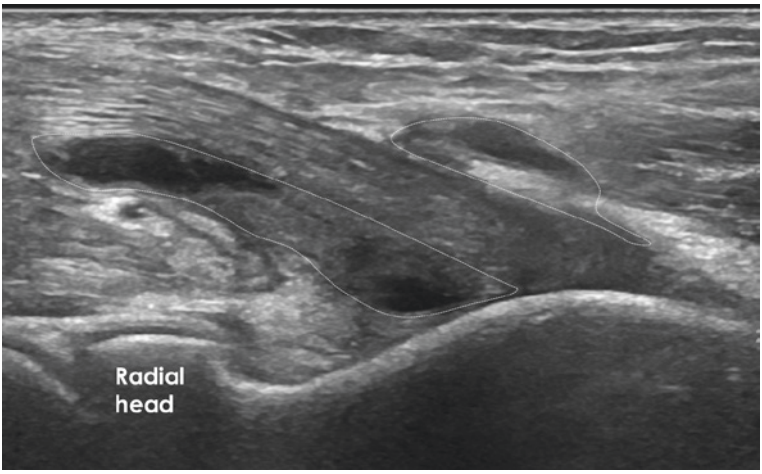

Fig. 35 Longitudinal view of the distal brachii tendon showing bicipital bursitis (dash line)

level are those involving the distal biceps brachii tendon, although, these tears are much less common than the proximal biceps brachii tears. Regarding the elbow ligaments, the ulnar collateral ligament is most frequently involved.

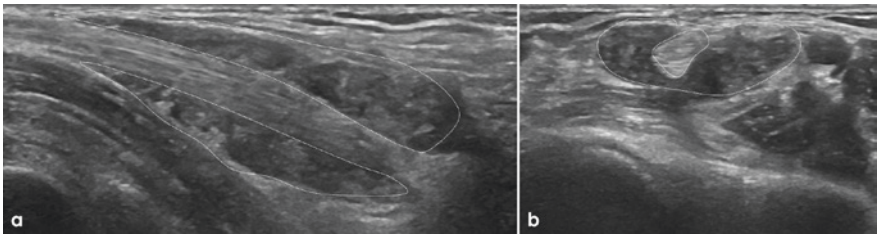

Fig. 36 (**a**, **b**) Longitudinal and transverse view of the distal brachii tendon showing bicipital bursitis

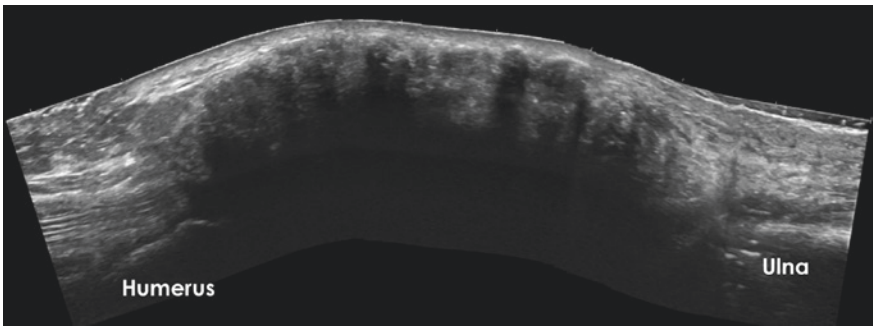

Fig. 37 Extended longitudinal view of the posterior elbow showing a hyperechoic image with acoustic shadow (tophi)

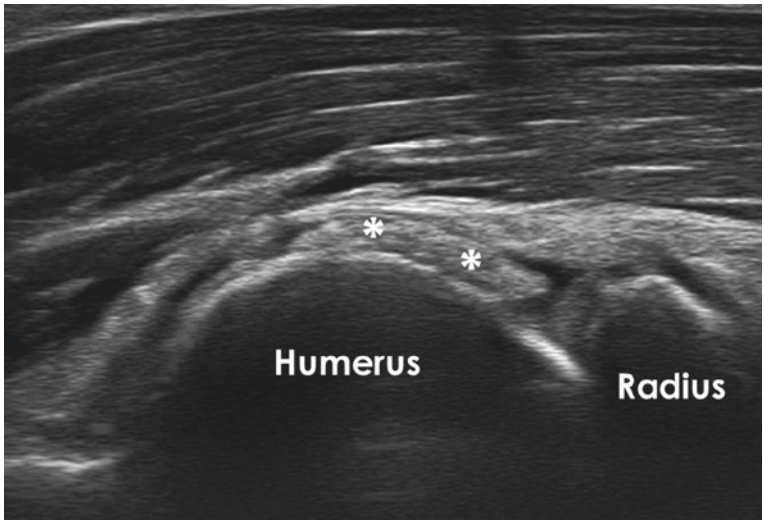

Fig. 38 Longitudinal view of the radial recess showing hyperechoic images within the joint cartilage (*)

References

1. Elbow and forearm. Susan Standring MBE. In: Gray's anatomy, Chapter 49. p. 837–61.e3.
2. Hansen JT. Upper limb. In: Netter's clinical anatomy, Chapter 7. p. 367–435.
3. Paulsen F. Upper extremity. In: Sobotta atlas of human anatomy, vol. 1, no. 3. p. 127–242.
4. Moller I, Janta I, Backhaus M, et al. The 2017 EULAR standardized procedures for ultrasound imaging in rheumatology. Ann Rheum Dis. 2017;76(12):1974–9.
5. Draghi F, et al. Ultrasound of the elbow: examination techniques and US appearance of the normal and pathologic joint. J Ultrasound. 2007;10:76–84.
6. Konin GP, Nazarian LN, Walz DM. US of the elbow: indications, technique, normal anatomy, and pathologic conditions. Radiographics. 2013;33(4):E125–47.
7. Wakefield RJ, Balint PV, Szkudlarek M et al. OMERACT 7 Special Interest Group. Musculoskeletal ultrasound including definitions for ultrasonographic pathology. J Rheumatol. 2005;32(12):2485–87.
8. Terslev L, Naredo E, Iagnocco A, et al. Defining enthesitis in spondyloarthritis by ultrasound: results of a Delphi process and of a reliability reading exercise, Outcome Measures in Rheumatology Ultrasound Task Force. Arthritis Care Res. 2004;66:741–8.