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# Advancing high-resolution musculoskeletal ultrasound: a histology- and anatomy-driven approach for enhanced shoulder imaging. Part 2: Anterior and lateral shoulder

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**Abstract**

Ultrasonography is a reliable imaging technique for the accurate diagnosis and evaluation of musculoskeletal disorders. Recent developments in ultrasound technology have significantly increased image resolution, making it possible to see anatomical features at almost microscopic dimensions. Current standards for standardized shoulder ultrasonography mostly depend on outdated machine types and configurations that may not fully utilize these high-resolution imaging capabilities. In this article, we give a clear and comprehensive introduction to high-resolution shoulder sonography, using histological and anatomical images from cadavers for comparison. Images collected using contemporary technology are shown, and international standard practices are considered. The examination and normal results are presented in a methodical manner, beginning posteriorly, moving frontally, then more anteriorly, and concluding with a lateral and optional axillary examination. This article focuses on the anterior and lateral shoulder.

## Introduction

Ultrasonography is a reliable imaging technique for the accurate diagnosis and evaluation of musculoskeletal problems. Recent developments in ultrasound technology have significantly increased image resolution, making it possible to see anatomical features at almost microscopic resolutions. However, there is as yet no modern atlas comparing ultrasound to microscopic images for proper allocation of ultrasound findings to anatomical structures. Current standards for standardized shoulder ultrasonography depend mostly on outdated machine types and configurations that may not optimally utilize these high-resolution imaging capabilities. In addition to bone and cartilage, musculoskeletal ultrasonography is an accurate diagnostic technique to examine soft tissue structures like tendons and muscles[(1)]. Frequencies most often utilized vary from 5 MHz to 24 MHz, depending on the tissue or joint being studied. Musculoskeletal structures are evaluated statically with the benefit of multiplanar views as well as dynamically in real-time.

## Objective, material, and methods

For information on the objectives, materials, and methods, please refer to the first part of this series of articles[(2)].

## Shoulder examination procedure

With regard to the shoulder examination procedure, please refer to the first part of this series of articles[2].

## Shoulder, ventral/anterior

Standard scans, anterior shoulder (Tab. 1) (Fig. 1)

Anatomical structures, ventral/anterior (Tab. 2)

**Tab. 2.** Anatomical structures, ventral/anterior

- Lesser tuberosity
- Greater tuberosity
- Humeral head/shaft
- Bicipital groove
- Coracoid process, anterior scapula, glenoid
- Glenohumeral joint cavity
- Sternum, clavicle, acromion
- Sternoclavicular joint
- Acromioclavicular joint, anterior part
- Acromioclavicular ligament, anterior part
- Long head of biceps tendon and transverse humeral ligament
- Short head of biceps tendon
- Labrum, anterior part
- Glenohumeral joint capsule
- Middle glenohumeral ligament
- Superior glenohumeral ligament
- Coracoacromial ligament
- Coracohumeral ligament
- Coracoclavicular ligaments (conoid and trapezoid ligaments)
- Coracoglenoid ligament
- Rotator cable
- Subdeltoid bursa (consider hanging drop lateral or medial of bicipital groove), subcoracoid and subacromial part
- Subcoracoid bursa
- Subscapular bursa
- Deltoid muscle, anterior part
- Coracobrachialis muscle and tendon
- Subscapularis muscle and tendon
- Supraspinatus muscle and tendon
- Pectoralis major muscle and tendon
- Pectoralis minor muscle and tendon
- Latissimus dorsi muscle and tendon
- Teres major muscle and tendon

## Ultrasound scanning technique – anterior shoulder

The patient is seated upright on a chair or rotating stool in a relaxed position, with the patient's forearm supinated on their thigh at the

**Tab 1.** Standard scans, anterior shoulder

- Position: neutral position, elbow 90° flexion, hand in supination
- Position: dynamic external rotation (active or passive)
- Position: in slight retroversion with arm hanging down, dynamic internal rotation
- Position: apron or pant pocket position (modified Crass position)

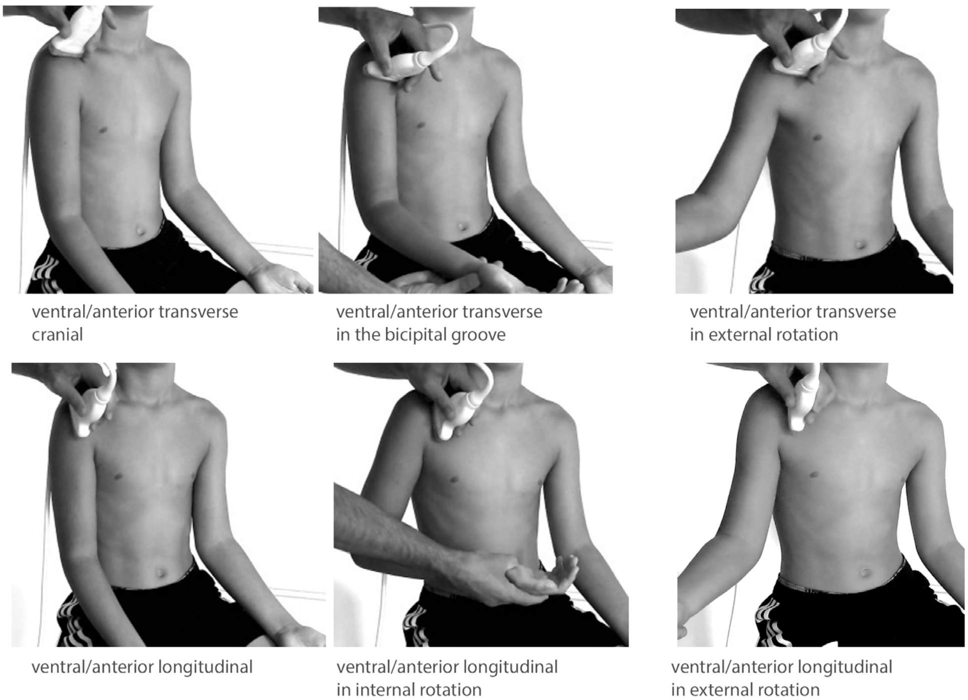


**Fig. 1.** *Probe positions (ventral/anterior) on the model*

beginning of the examination. Starting with a transverse scan, the anterior (ventral) examination begins with inspecting the bicipital groove between the lesser and greater tuberosities (Fig. 2)[3]. These anatomical markers are simple to locate; a useful tip may be to start at the level of the acromioclavicular (AC) joint, then slide the probe caudally and anteriorly, so that it will typically pass exactly over the bicipital groove in an anterior transverse scan. Because of the anisotropy effect, the long head of the biceps tendon (LHBT) is easily located and visualized within the bicipital groove as a hyperechogenic elliptical structure. The transverse humeral ligament is formed by fibers of the subscapularis tendon attaching to the lesser tuberosity and continuing over the bicipital groove. At the level of the tuberosities, the transverse humeral ligament is situated anterior to and above the biceps tendon[4]. The insertion of the pectoralis major tendon, latissimus dorsi tendon, and teres major tendon can be traced distally by following the LHBT to its myotendinous junction, which marks the transition into the biceps muscle (Fig. 3)[5]. In the rotator interval zone, follow the LHBT proximally

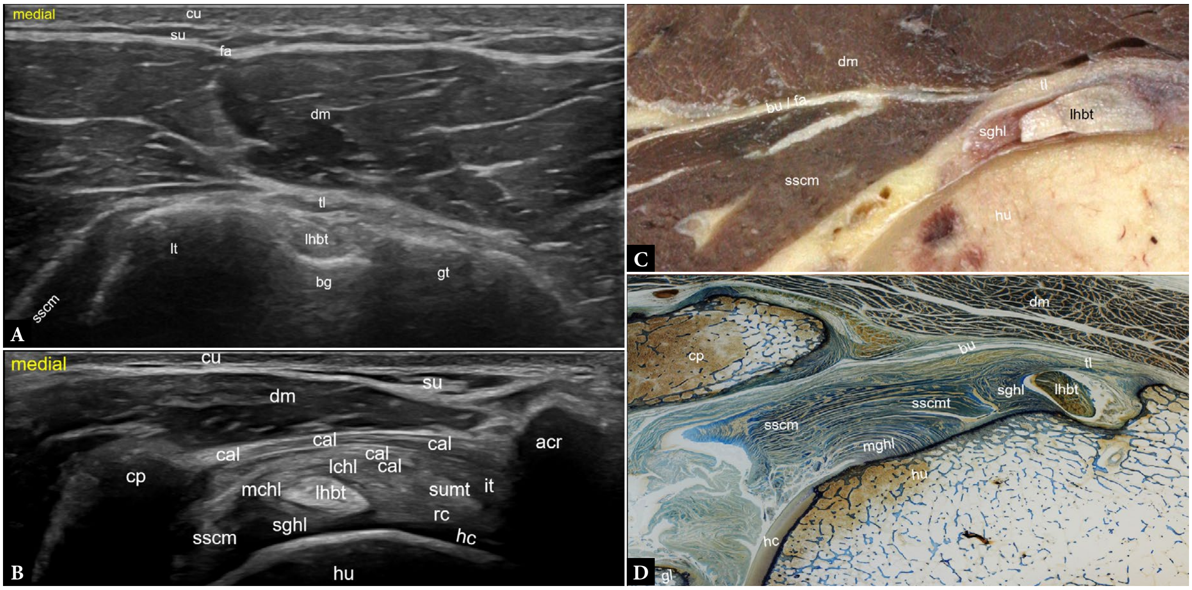


**Fig. 2. A.** *Gray-scale ultrasonography, anterior transverse image.* **B.** *Gray-scale ultrasonography, anterior transverse oblique image.* **C.** *Anatomical image.* **D.** *Histological image. cu – cutis; su – subcutis; fa – fascia; dm – deltoid muscle; lhbt – long head biceps tendon; sscm – subscapularis muscle; bg – bicipital groove; tl – transverse ligament; lt – lesser tuberosity; gt – greater tuberosity; sghl – superior glenohumeral ligament; mchl – medial coracohumeral ligament; lchl – lateral coracohumeral ligament; cal – coracoacromial ligament; sumt – supraspinatus tendon; it – infraspinatus tendon; acr – acromion; rc – rotator cable; hc – hyaline cartilage; hu – humeral head; sscmt – subscapularis tendom; mghl – middle glenohumeral ligament; bu – subdeltoid bursa; gl – glenoid*

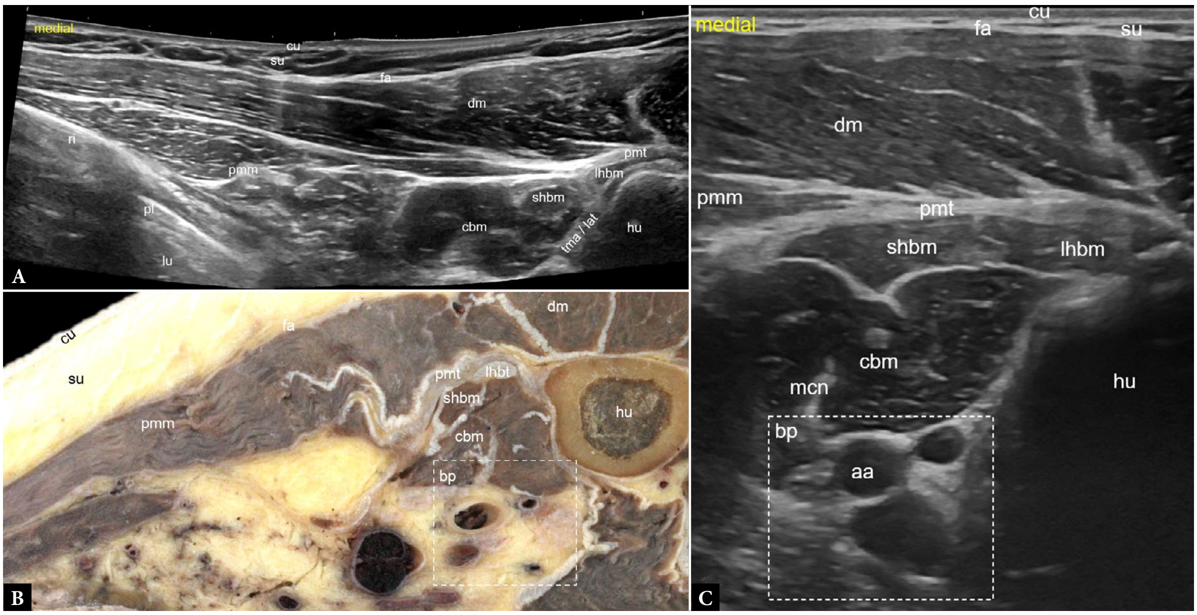


**Fig. 3. A.** *Gray-scale ultrasonography, anterior transverse panoramic image.* **B.** *Anatomical image.* **C.** *Gray-scale ultrasonography, anterior transverse image. cu – cutis; su – subcutis; fa – fascia; dm – deltoid muscle; ri – rib; pl – pleura; lu – lung; pmm – pectoralis major muscle; pmt – pectoralis major tendon; cbm – coracobrachialis muscle; shbm – short head biceps muscle; lhbm – long head biceps muscle; tma / lat – teres major and latissimus dorsi tendons; hu – humerus; bp – brachial plexus; aa – axillary artery; mcn – musculocutaneous nerve*

in its intra-articular portion (Fig. 2, Fig. 4). During dynamic examination, close attention must be paid to any instabilities[6,7]. The supraglenoid tubercle, which is the origin of the LHBT, can be visualized upon forceful internal rotation (Fig. 4)[8]. In the proximal scan, a small amount of hypo-anechoic effusion in the synovial recess surrounding the biceps tendon is a physiological finding. The coracoid process of the scapula is the origin of the short head of the biceps tendon, which can also be traced distally to its myotendinous junction, which lies medial to the one originating from the LHBT (Fig. 5). Examine the coracobrachialis and the short head of the biceps conjoint tendon. The coracobrachialis tendon portion lies anterior to the subscapular muscle, below the short biceps tendon. Evaluate the coracoid process at various levels and locate the pectoralis minor tendon's insertion at the coracoid process's medial portion[9]. Bursitis is a major factor in the development of rotator cuff tear discomfort. It is advisable to evaluate the subdeltoid bursa anteriorly. Note that the development of all of the shoulder bursae of importance occurs simultaneously with the glenohumeral joint cavity development during the third month of fetal life. Here, we mention a selection of common bursae in the shoulder area (Tab. 3) (Fig. 6)[10].

The largest subacromial-subdeltoid bursa comprises three distinct components: the subacromial, subdeltoid, and subcoracoid parts. The bursa receives innervation, in a pattern closely tied to its tripartite components, from three different nerves: the axillary nerve (subdeltoid part), the lateral pectoral nerve (subcoracoid part), and the suprascapular nerve (subacromial part)[11]. Effusion in the subcoracoid space may be related, among others, to the subcoracoid portion of the subdeltoid bursa, to the subcoracoid bursa itself, or to the subscapular recess (a synovial recess of the glenohumeral joint)[6]. The coracohumeral ligament (CHL) and the belly of the infraspinatus muscle generally confine the bursae both anteriorly and posteriorly[12]. The axillary nerve courses around the proximal humerus, consistently passing beneath the most lateral edge of the subacromial-subdeltoid bursa, maintaining an average separation of 1.0 cm between these two structures. Another bursa lies beneath the coracoid process[13], and one beneath the subscapular muscle, which communicates with the anterior recess of the glenohumeral joint[11]. When the arm is rotated externally, the subscapular muscle and tendon are more accessible, and the subscapular tendon can be depicted up to its insertion at the lesser tuberosity[12]. Reducing the transducer frequency allows for evaluation of the middle glenohumeral ligament (MGHL), the glenohumeral joint capsule, the anterior glenohumeral joint recess, the anterior part of the labrum, and the anterior glenoid (Fig. 7). Pay attention to the axillary artery and the brachial plexus and its proximity to the pectoralis minor, coracobrachialis, and subscapularis (Fig. 8). To evaluate the anteromedial impingement of soft tissue, such as that between the coracoid process and the lesser tuberosity, perform dynamic movements like internal and external rotation. There are various key ligaments around the coracoid process. First is the coracoacromial ligament (CAL), a component of the coracoacromial arch that prevents the humeral head from migrating superiorly. Next, the conoid and trapezoid

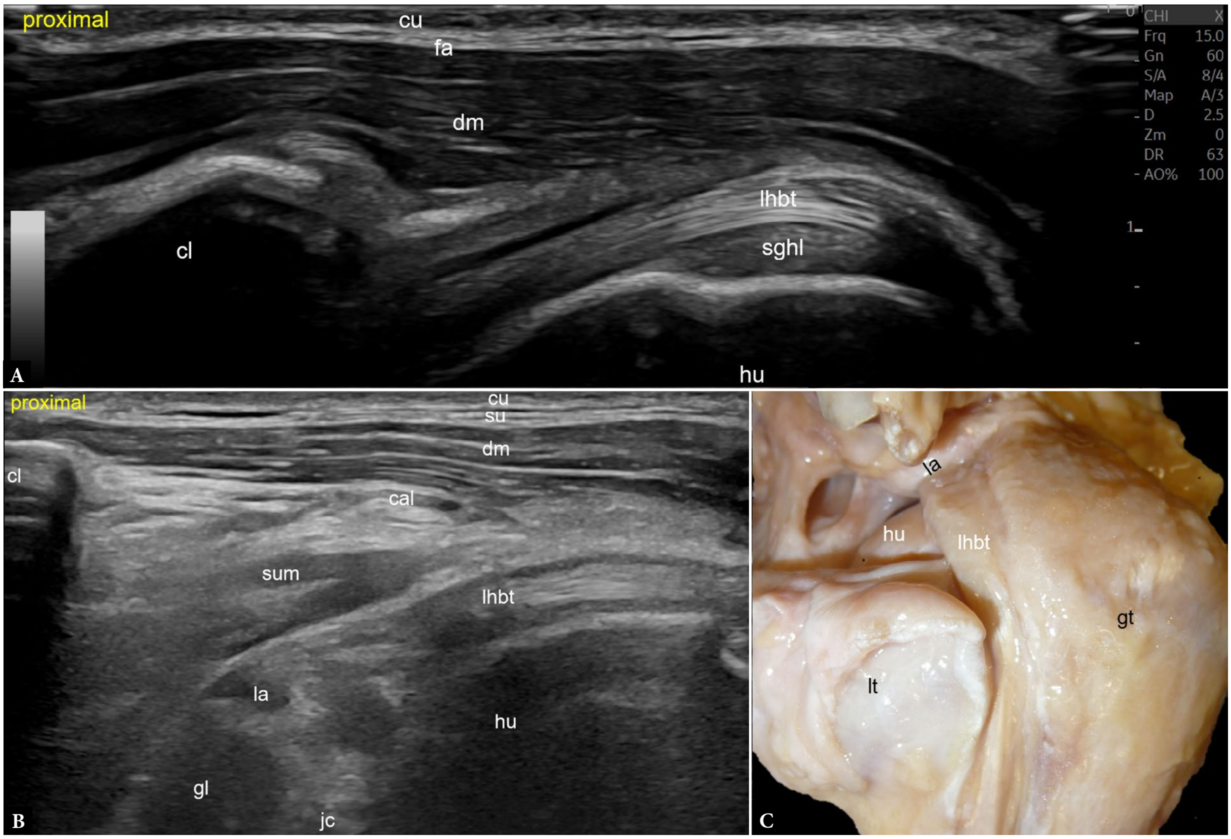


**Fig. 4. A.** *Gray-scale ultrasonography, anterior longitudinal image.* **B.** *Gray-scale ultrasonography, anterior longitudinal image in internal rotation.* **C.** *Anatomical image. cu –cutis; su – subcutis; fa – fascia; dm – deltoid muscle; cl – clavicle; lhbt – long head biceps tendon; hu – humerus; gl – glenoid; sghl – superior glenohumeral ligament; cal – coracoacromial ligament; sum – supraspinatus muscle; la – labrum; jc – glenohumeral joint cavity; lt – lesser tuberosity; gt – greater tuberosity*

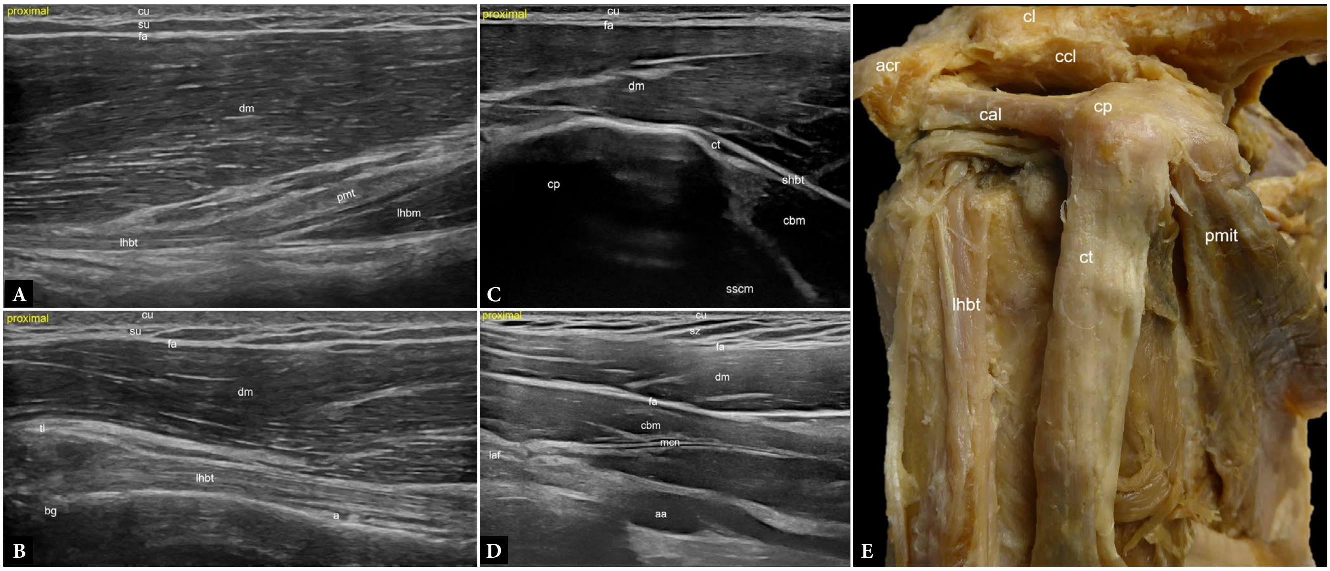


**Fig. 5. A.** *Gray-scale ultrasonography, anterior longitudinal image.* **B.** *Gray-scale ultrasonography, anterior longitudinal image.* **C.** *Gray-scale ultrasonography, anterior longitudinal image.* **D.** *Gray-scale ultrasonography, anterior longitudinal image.* **E.** *Anatomical image. cu – cutis; su – subcutis; fa – fascia; dm – deltoid muscle; pmt – pectoralis major tendon; cbm – coracobrachialis muscle; shbt – short head biceps tendon; lhbt – long head biceps tendon; lhbm – long head biceps muscle; sscm – subscapularis muscle; aa – axillary artery; mcn – musculocutaneous nerve; laf – lateral fascicle; bg – bicipital groove; a – anterior circumflex artery; tl – transverse ligament*

**Tab. 3.** Selection of common bursae in the shoulder area

- Bursa ligamenti coracoclavicularis, coracoclavicular or supracoracoid bursa (1) – located between the conoid and trapezoid ligaments (= supraclavicular ligaments).
- Bursa subtendinea musculus coracobrachialis, subtendinous coracobrachialis tendon bursa (2) – situated below the conjoint tendon of the short biceps tendon and the coracobrachialis muscle tendon, and anterior to the subscapularis muscle at the distal tip of the coracoid process lateral to the insertion of the tendon of the pectoralis minor muscle. Note: it is often described in the literature as the subcoracoid bursa, or the coracobrachial (and subcoracoid) bursa and are often mentioned together in the literature. The coracobrachialis bursa can communicate with the subacromial part of the subdeltoid bursa.
- Bursa infracoracoidea, infracoracoid bursa (3) – beginning at the tip of the coracoid process, along the tendon of the bicipitis brachii muscle, caput breve, and the joint capsule.
- Bursa subcoracoidea, subcoracoid bursa (4) – visible posterior to the coracoid process and medial to the insertion of the tendon of the pectoralis major muscle. Note: the bursae 2 and 3 and the cranial part of the bursa 5 are located close to each other in the relatively small area deep under the proximal part of the coracoid process and the acromial part of the coracocromial ligament. Communication with the bursa subtendinea musculus subscapularis is possible.
- Bursa subtendinea musculus subscapularis, subtendinous subscapularis bursa (5) – located between the tendon of the subscapularis muscle and the medial border of the cranial scapula, the bursa runs to the coracoid process, can 'hang' in a 'C-shape' over the upper edge of the tendon of the subscapularis muscle; the bursa is connected to the glenohumeral joint, respectively to the anterior joint capsule via the Weitbrecht foramen. The bursa may also communicate with the subcoracoid bursa.
- Bursa subtendinea musculus infraspinata, subtendinous infraspinatus bursa (6) – situated between the tendon of the infraspinatus muscle at the insertion and the capsule of the glenohumeral joint. Rarely in connection with the joint capsule.
- Bursa subtendinea musculus teretis majoris, subtendinous teres major bursa (7) – lies under the tendon of the teres major muscle near the insertion and the humerus.
- Bursa subcutanea acromialis, subcutaneous acromial bursa (8) – located subcutaneously cranial to the acromioclavicular joint (acromion)
- Bursa subdeltoidea, pars subdeltoidea, subdeltoid bursa (9) – lies deep to the deltoid muscle and superficial to the rotator cuff.
- Bursa subdeltoidea, pars subacromialis, subacromial part of the subdeltoid bursa = subacromial-subdeltoid bursa (10) – lies under the acromion and beneath the coracoacromial ligament.
- Bursa subdeltoidea, pars subcoracoidea, subcoracoidal part of the subdeltoid bursa (11).
- Bursa supraserrata, bursa musculus serratus anterior superior, supraserrata bursa (12) – located at the superior angle of the scapula between the serratus anterior and subscapularis muscles.
- Bursa infraserrata, bursa scapulo-thoracica, bursa musculus serratus anterior inferior, infraserrata bursa (13) – located at the inferior angle of the scapula between the serratus anterior muscle and the ribs (thoracic wall).
- Bursa trapezoidea, trapezius bursa (14) – lies under the trapezius muscle at the level of the superior angle of the scapula.
- Bursa subtendinea musculus pectoralis major, pectoralis major bursa (15) – located between the tendon of the pectoralis major muscle, the long biceps tendon, and the conjoined tendon of the latissimus dorsi and teres major muscles.
- Bursa subtendinea musculus pectoralis minor, pectoralis minor bursa (16) – situated between the subscapularis muscle and the insertion of the pectoralis minor muscle.
- Bursa subtendinea musculus latissimus dorsi, latissimus dorsi bursa (17) – lies between the tendon insertion of the teres major muscle and the latissimus dorsi muscle.
- Bursa costoclavicularis, costoclavicular bursa (not shown) – located between the two parts of the sternoclavicular ligament.

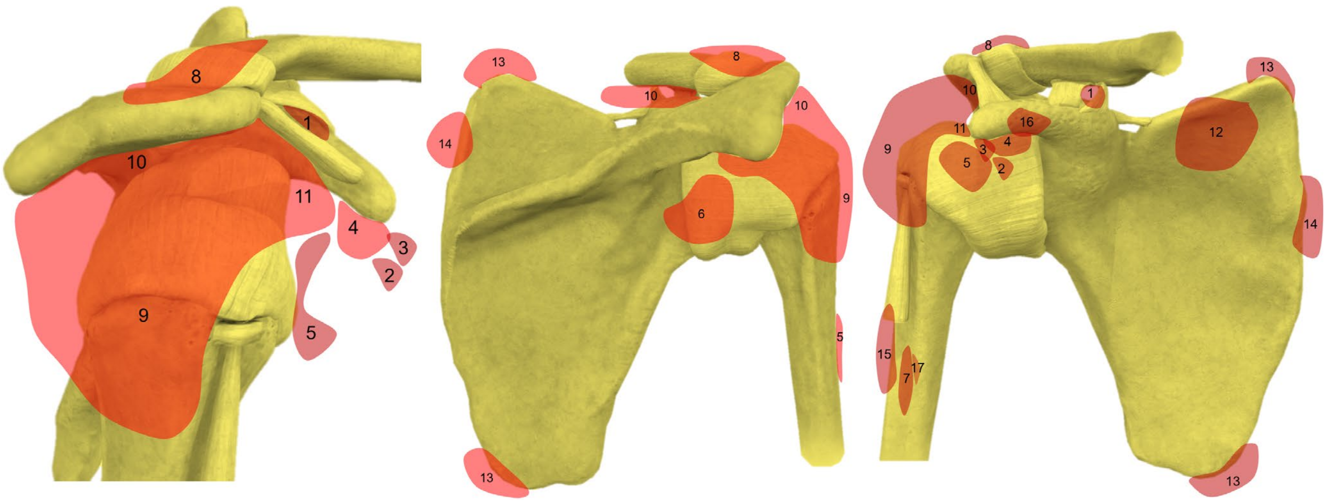

**Fig. 6.** *Schematic drawing of selected common bursae in the shoulder area, Tab 3*

coracoclavicular ligaments support the AC joint (Fig. 9). The CHL extends laterally from its coracoid insertion to form part of the rotator interval, which is discussed in detail in the next paragraph[14]. Finally, the coracoglenoid ligament also stabilizes the LHBT. The origin of the more superficial/anterior CAL and the lower lying CHL may be found at the lateral portion of the coracoid process (Fig. 10). As a triangular, fibrous lamina, the CAL is composed of an inferior and superior surface connected to the deep deltoid muscle[15]. Track the ligaments to their insertions. The lateral pulley and a portion of the rotator cable are formed by the CHL passing over the LHBT and the CHL coursing in the direction of the supraspinatus tendon. The CHL and rotator cable form a unique stabilizing structure with three pillars (anterior, intermediate, and posterior)[16]. Examine the area between the CAL and CHL for a bursa (i.e., subacromial part of the subdeltoid bursa). The acromion, CAL, and coracoid process make up the coracoacromial arch[17], which restricts superior translation of the glenohumeral joint and protects it.

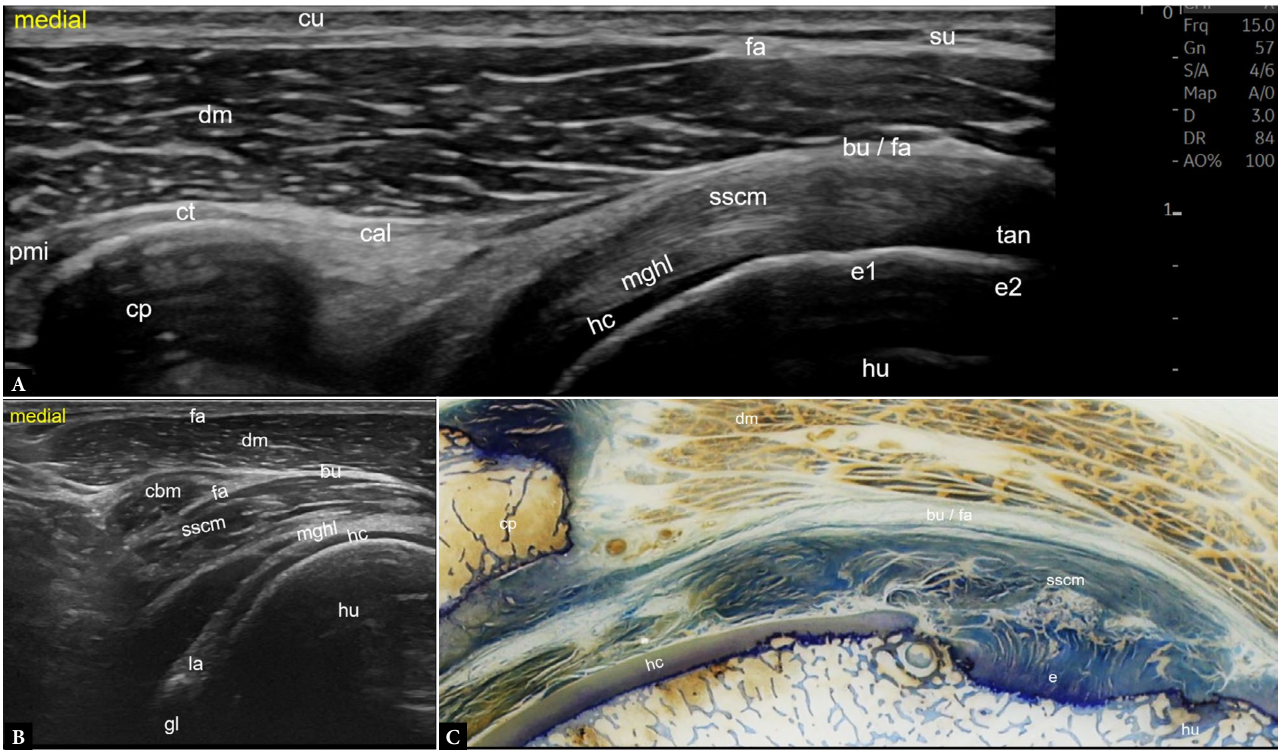


**Fig. 7. A.** *Gray-scale ultrasonography, anterior transverse image in external rotation.* **B.** *Gray-scale ultrasonography, anterior transverse image in external rotation.* **C.** *Histological image. cu – cutis; su – subcutis; fa – fascia; dm – deltoid muscle; pmi – pectoralis minor tendon; ct – conjoint tendon; cp – coracoid process; cal – coracoacromial ligament; sscm – subscapularis; hu – humerus; mghl – middle glenohumeral ligament; la – labrum; gl – glenoid; hc – hyaline cartilage; e1 – enthesis of the joint capsule; e2 – enthesis of the subscapularis tendon; tan – tendon anisotropy; cbm – coracobrachialis muscle index*

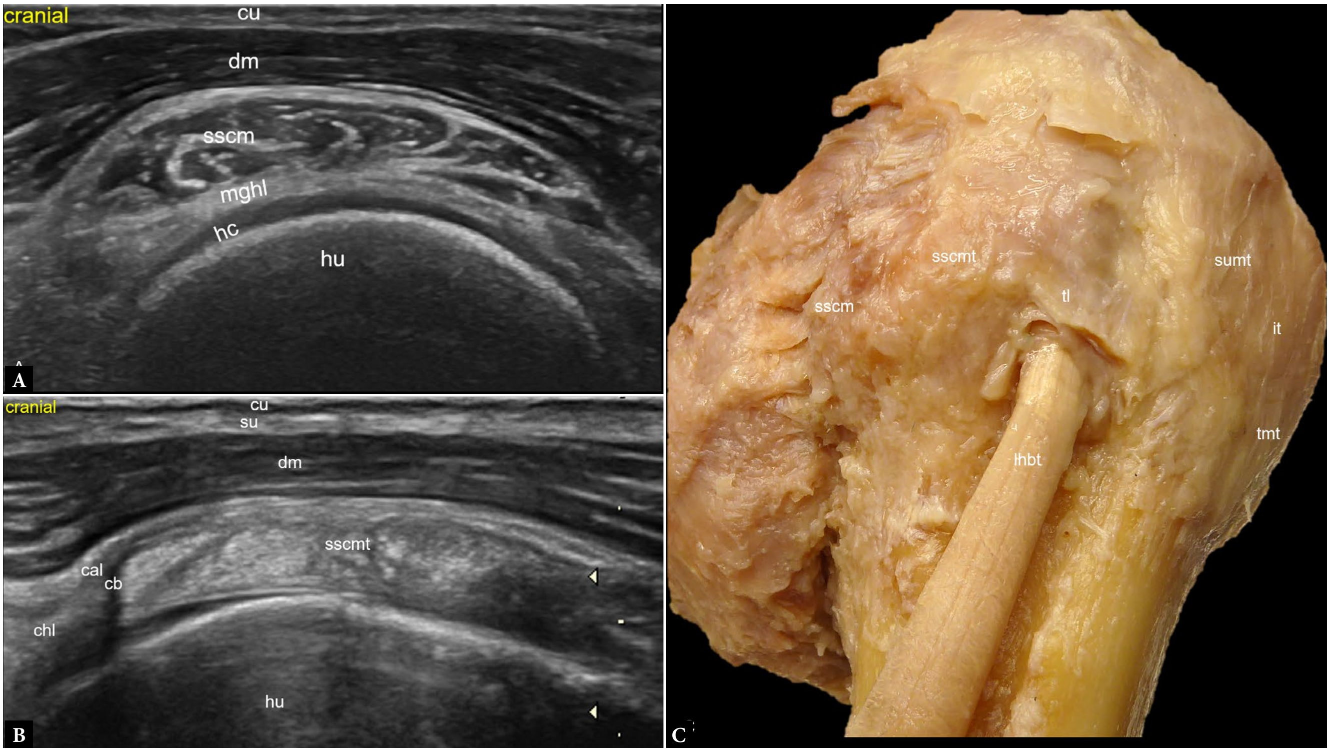


**Fig. 8. A.** *Gray-scale ultrasonography, anterior longitudinal image in external rotation.* **B.** *Gray-scale ultrasonography, anterior longitudinal image in external rotation.* **C.** *Anatomical image. cu – cutis; su – subcutis; fa – fascia; dm – deltoid muscle; cal – coracoacromial ligament; sscm – subscapularis; sscmt – subscapularis tendon; cb – cranial border of the subscapularis tendon; hu – humerus; mghl – middle glenohumeral ligament; hc – hyaline cartilage; sumt – supraspinatus tendon; it – infraspinatus tendon; tmt – teres minor tendon; tl – transverse ligament; lhbt – long head biceps tendon; chl – coracohumeral ligament*

## Shoulder, lateral (and optional axillary recess)

Standard scans, lateral shoulder (Tab. 4.) (Fig. 11)

Anatomical structures, lateral (Tab. 5)

## Ultrasound scanning technique – lateral (and optional axillary recess)

When evaluating the lateral structures, gently rotate the arm internally or, preferably, place the elbow leading towards the back with the hand supported on the lateral pelvis (apron or pant pocket position, known as the modified Crass position)[18]. In fact, an optimal view to assess the ligaments, humeral cartilage, and supraspinatus enthesis (footprint at the greater tuberosity) is provided by the modified Crass position (Fig. 12, Fig. 13)[19]. The longitudinal and transverse views of all structures, particularly the supraspinatus tendon, should be seen from anterior (starting with the subscapularis tendon and LHBT) to posterior (ending with the infraspinatus tendon and teres minor tendon) (Fig. 14). The supraspinatus tendon is first evaluated statically, then dynamically. The patient performs an abduction while rotating the arm slightly, first internally and subsequently externally, during a subacromial impingement test[19]. Similar to the test performed beneath the CAL in the anterior shoulder, the mobility of the supraspinatus tendon and/or the bursa under the acromion is observed during live scanning[20]. Use the superior glenohumeral ligament (SGHL) – which extends laterally to the subscapularis tendon insertion and medially to the

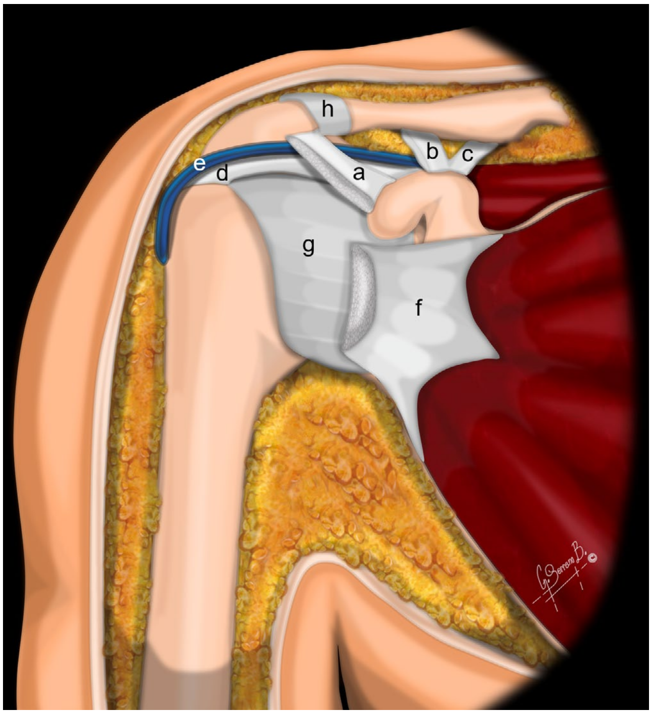


**Fig. 9.** *Illustration of selected anterior shoulder structures. a – coracoacromial ligament; b – trapezoid ligament; c – conoid ligament; d – supraspinatus tendon; e – subdeltoid – subacromial bursa; f – subscapularis tendon (cut); g – glenohumeral joint capsule; h – acromioclavicular joint*

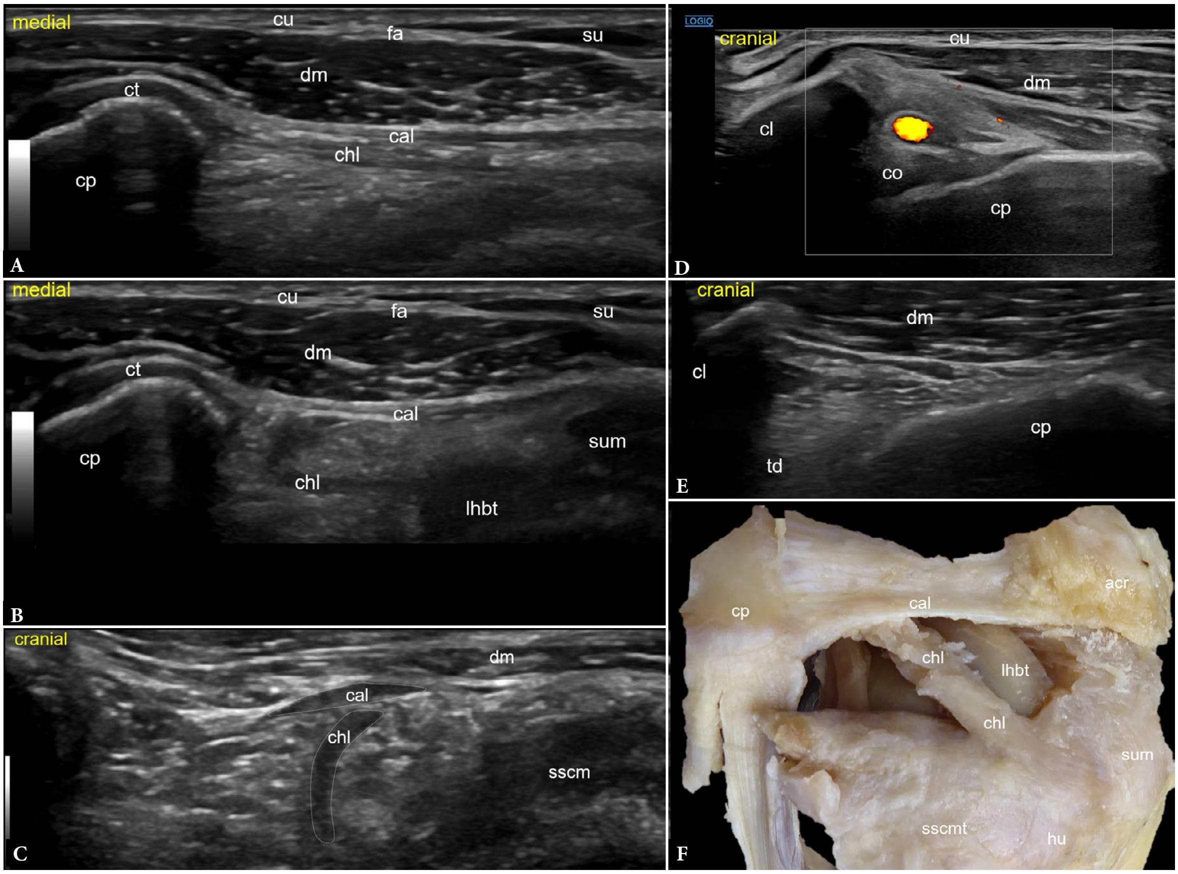


**Fig. 10. A.** *Gray-scale ultrasonography, anterior transverse image in external rotation.* **B.** *Gray-scale ultrasonography, anterior transverse image in internal rotation.* **C.** *Gray-scale ultrasonography, anterior longitudinal image.* **D.** *Power-Doppler ultrasonography, anterior longitudinal image.* **E.** *Gray-scale ultrasonography, anterior longitudinal image in internal rotation.* **F.** *Anatomical image. cu – cutis; su – subcutis; fa – fascia; dm – deltoid muscle; cl – clavicle; ct – conjoint tendon; cp – coracoid process; cal – coracoacromial ligament; chl – coracohumeral ligament; sum – supraspinatus, lhbt – long head biceps tendon; sscm – subscapularis; hu – humerus; co – conoid ligament; td – trapezoid ligament; acr – acromion; sscmt – subscapularis tendom*

**Tab. 4.** Standard scans (lateral shoulder)

- Position: apron or pant pocket position (modified Crass position)
- Position: in slight retroversion with arm hanging down, dynamic internal rotation
- Position: subacromial impingement test, abduction
- Position: arm 90° abduction for the axillar glenohumeral recess

LHBT – as well as the LHBT to assess the rotator cuff interval during a transverse scan (Fig. 15)[21]. In the modified Crass position, assess the structures medial and lateral to the LHBT within the rotator cuff interval. The entire LHBT and its related tissues are first inspected in transverse and longitudinal planes from the rotator interval distal to the superior aspect of the pectoralis major tendon before the rotator interval is addressed. The LHBT serves as a landmark and orientation point: the lesser tuberosity is where the subscapularis tendon insertion is situated medially. The supraspinatus tendon insertion is situated at the greater tuberosity, lateral to the LHBT[22]. The lateral CHL, also known as the lateral pulley, wraps around the supraspinatus tendon through superficial and deep layers; a part of the deep layer is the so-called rotator cable, which is situated beneath the supraspinatus tendon[23,24]. The rotator cable may be seen on its short axis, on long-axis scans of the supraspinatus tendon, appearing as a fibrillar, transversely oriented bundle of fibers that is situated approximately 1–1.5 cm medial to the rotator cuff footprint. It runs deep and perpendicular to the supraspinatus and infraspinatus tendons, superficial to the capsule. To evaluate the entire interval zone, the probe should be moved in a caudal and cranial manner. Moreover, to better examine the rotator interval, a supine position on the examination bed, with the upper extremity to be evaluated hanging off the side, may be useful. This position allows for posterior flexion of the arm, which opens the interval, stretches the LHBT, and tightens the CHL[14]. The superior aspect of the bicipital groove is examined by positioning the probe in the LHBT short axis; the transducer is then slid upward to a location just above the groove's most proximal aspect (and the transverse humeral ligament). The CHL and SGHL form an annular sling around the LHBT as it reaches the glenohumeral joint. This sling is fibrillar, but the contiguous LHBT usually appears more hyperechoic when correctly evaluated, i.e., when the ultrasound beam forms an angle of 90° with respect to tendon fibers. In this orientation, the examiner can take advantage of anisotropy by tilting the transducer to better differentiate the tendon from the CHL and SHGL. As the LHBT and CHL approach the joint, they are followed superiorly. Then, the LHBT turns abruptly and disappears within the joint, returning to its origin on the supraglenoid tubercle[25]. The longitudinal examination of the LHBT up to the origin at the supraglenoid tubercle/labrum can be enhanced by putting the arm in slight to strong internal rotation, depending on the patient's individual anatomy (Fig. 4).

lateral transverse in modified Crass position | lateral transverse in internal rotation | lateral transverse in internal rotation. 'Lift off test' position | lateral longitudinal in internal rotation

lateral longitudinal in modified Crass position | lateral longitudinal in internal rotation. 'Lift off test' position | axillar recess longitudinal | axillar recess transverse

**Fig. 11.** *Probe positions (lateral) on the model*

**Tab. 5.** Anatomical structures (lateral)

| | |
|---|---|
| • Humeral head, surgical neck<br>• Greater tuberosity<br>• Acromion, lateral part<br>• Deltoid muscle, lateral part<br>• Supra- and infraspinatus muscle and tendon | • Interval of the rotator cuff (subscapular tendon, superior glenohumeral ligament, long head of the biceps tendon, coracohumeral ligament, rotator cable, supraspinatus tendon)<br>• Subacromial-subdeltoid bursa |

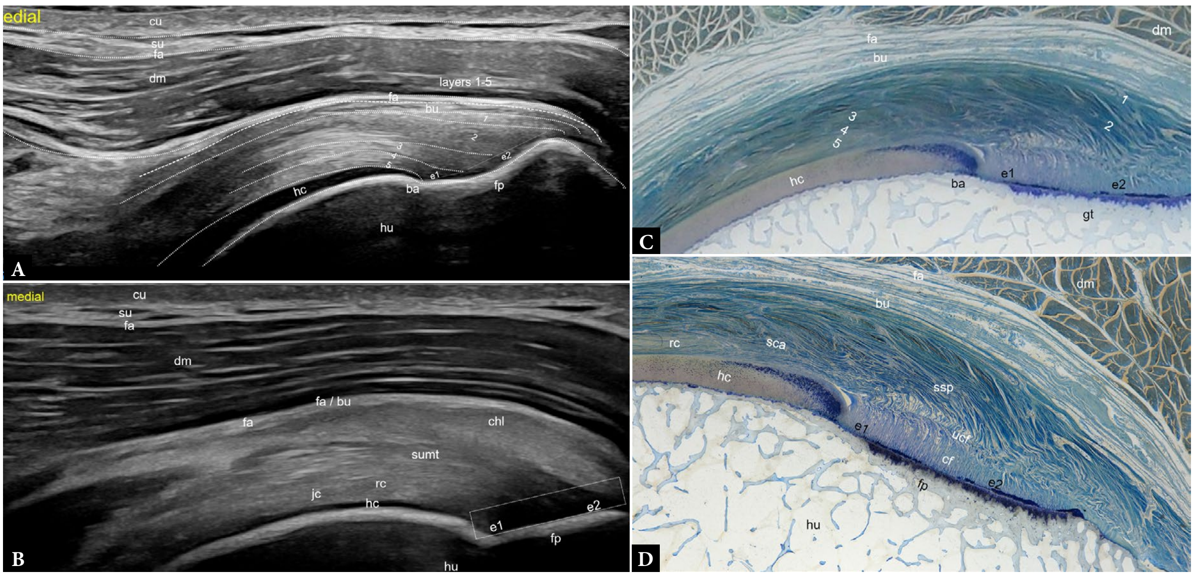


**Fig. 12. A.** *Gray-scale ultrasonography, lateral longitudinal image in modified Crass position.* **B.** *Gray-scale ultrasonography lateral longitudinal image in modified Crass position.* **C.** *Histological image.* **D.** *Histological image. cu – cutis; su – subcutis; fa – fascia; dm – deltoid muscle; sumt – supraspinatus tendon; sum – supraspinatus muscle; hu – humerus; fp – footprint; dotted box – transition zone; jc – joint capsule / ligament; rc – rotator cable; hc – hyaline cartilage; e1 – enthesis of the joint capsule / ligament; e2 – enthesis of the supraspinatus tendon; sca – sesamoid cartilage; cf – calcified fibrocartilage; ucf – uncalcified fibrocartilage. 1 – layer formed by the most superficial part of the posterior component of the coracohumeral ligament, 2 – layer of very closely packed collagen fibers, with long fascicles extending directly from the muscle component to the insertion on the humerus. 3 – tendinous layer less compact than 2 and uniform; 4 – layer formed by deep fibers from the posterior component of the coracohumeral ligament containing thick collagen bands whose fibers are arranged perpendicular to those of the second and third layers, continuing under the infraspinatus tendon (rotator cable); 5 – layer formed by the joint capsule, which has randomly oriented fibers*

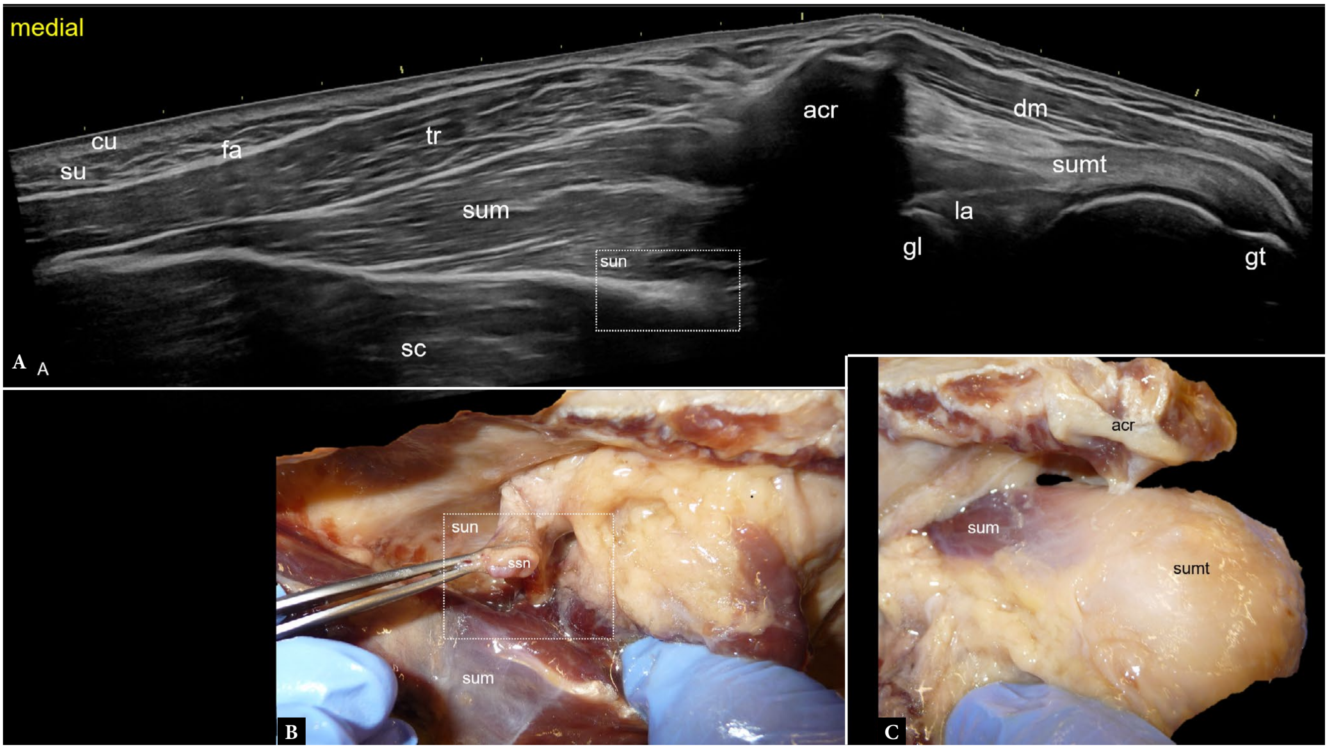


**Fig. 13. A.** *Gray-scale ultrasonography, coronal and lateral longitudinal panoramic image.* **B.** *Anatomical image.* **C.** *Anatomical image. cu – cutis; su – subcutis; fa – fascia; dm – deltoid muscle; tr – trapezius muscle; sun – suprascapular notch; sc – scapula; acr – acromion; gl – glenoid; la – labrum; sumt – supraspinatus tendon; sum – supraspinatus muscle; gt – greater tubercle; ssn – suprascapular nerve and vessels; dotted box*

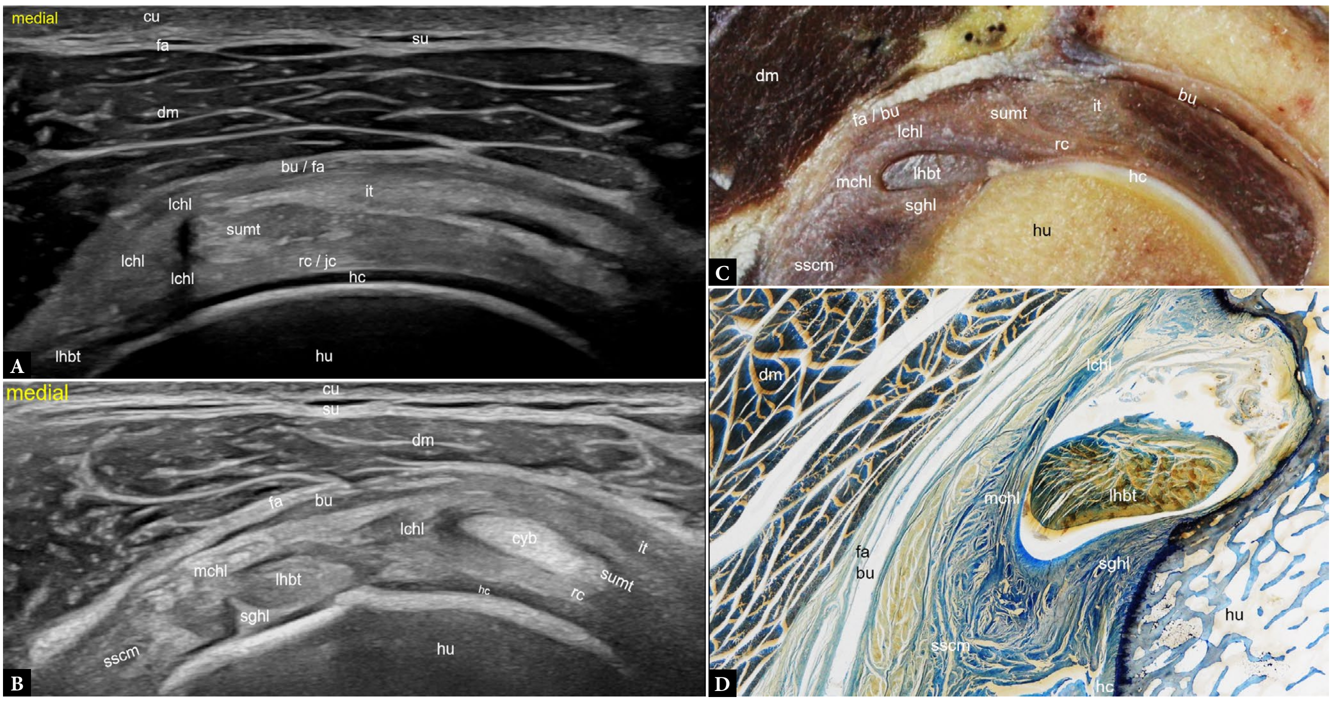


**Fig. 14. A.** *Gray-scale ultrasonography, lateral transverse image in modified Crass position.* **B.** *Gray-scale ultrasonography lateral transverse image in modified Crass position.* **C.** *Anatomical image.* **D.** *Histological image. cu – cutis; su – subcutis; fa – fascia; dm – deltoid muscle; sumt – supraspinatus tendon; it – infraspinatus tendon; hu – humerus; lchl – lateral coracohumeral ligament; mchl – medial coracohumeral ligament; jc – joint capsule/ligament; rc – rotator cable; hc – hyaline cartilage; hu – humerus; lhbt – long head biceps tendon; sghl – superior glenohumeral ligament; cyb – cylindric bundle of the supraspinatus tendon*

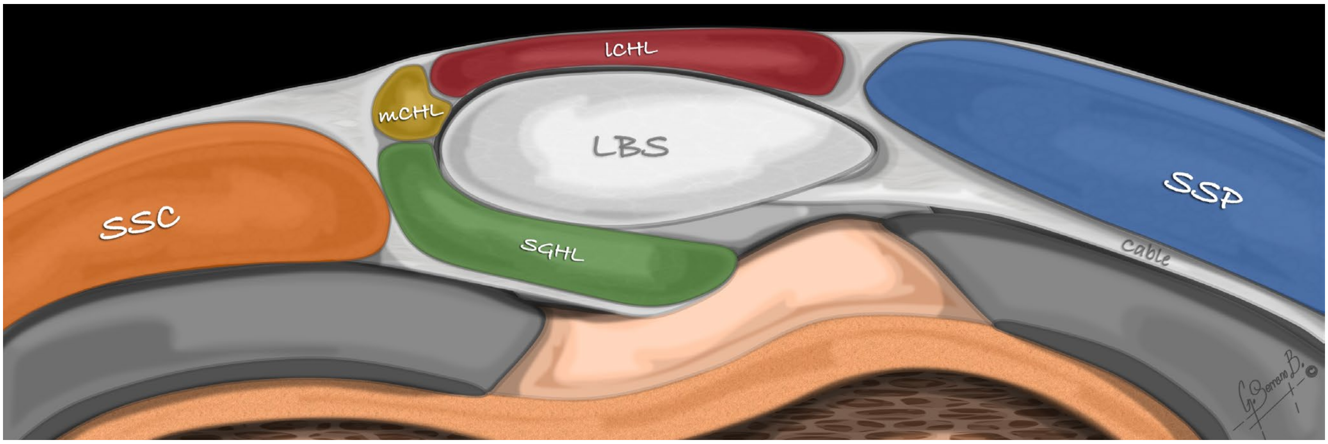


**Fig. 15.** *Illustration of the rotator interval. ssp – supraspinatus tendon; lchl – lateral coracohumeral ligament; mchl – medial coracohumeral ligament; cable – rotator cable; lbs – long head biceps tendon; sghl – superior glenohumeral ligament*

The longitudinal assessment of the proximal portion of the LHBT (intra-capsular portion) is very important because tendinosis or tears can be selectively located at this level, defining a pathological condition with a clinical scenario very similar to adhesive capsulitis, i.e., the hourglass biceps[26]. Over the humeral head's most distal cartilaginous surface, the LHBT/CHL can be visualized. It is important to trace the path taken by the CHL fibers, which start at the base of the lateral coracoid process, as described in the previous paragraph[27]. In external rotation, the SGHL and the subscapularis tendon medial to the proximal part of the bicipital groove can be recognized. The deep layer of the supraspinatus tendon, the joint capsule, and the rotator cable are all components of the superior complex layer[4]. With the arm is behind the head, look optionally inside the axillary recess. As an alternative, evaluate the recess with the patient in a supine position.

## Conclusion

The foundational elements of the assessment of shoulder disorders include the clinical examination and a precise clinical history. Because there is little osseous material covering the joint, the shoulder is especially accessible for ultrasonic imaging. High-resolution musculoskeletal ultrasonography of the shoulder provides an accurate structural evaluation, which requires an in-depth knowledge of sonoanatomy. In optimal conditions, modern high-resolution musculoskeletal ultrasound can improve shoulder imaging by correlating structures to cross-sectional anatomy and detailed histology. This atlas provides an overview of normal sonographic findings.

### Conflict of interest

*The authors do not report any financial or personal connections with other persons or organizations which might negatively affect the contents of this publication and/or claim authorship rights to this publication.*

### Author contributions

*Original concept of study: GT, RM, MMG, FM. Writing of manuscript: GT, RM, FM. Analysis and interpretation of data: GT, RM, VR, MB, MGP, FM. Final acceptance of manuscript: GT, RM, VR, MB, MGP, ASBG, MMG, FM. Collection, recording and/or compilation of data: GT, RM, FM. Critical review of manuscript: GT, RM, VR, MB, MGP, ASBG, MMG, FM.*

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