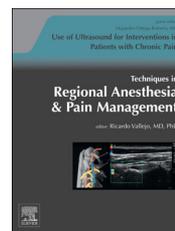


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Ultrasound-guided pain interventions in shoulder region

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ARTICLE INFO

Keywords:

Shoulder injection
Rotator cuff
Glenohumeral joint
Axillary nerve
Suprascapular nerve

ABSTRACT

Shoulder pain is one of the common complaints to physicians in general practice. Among therapeutic measures used to treat this pain, invasive techniques, such as joints and periarticular injection, as well as suprascapular and axillary nerve block, play a crucial role. Ultrasound guidance is a safe alternative to blind techniques, increasing the safety and accuracy of the procedure and reducing complications. A good understanding of the anatomy and sonoanatomy is of paramount importance in performing the ultrasound-guided injections.

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Introduction

Pain in shoulder region can originate from various structures, including the subacromial-subdeltoid bursa, the glenohumeral and acromioclavicular joint, the long head of biceps, and the rotator cuff. Interventional pain procedures are an important modality in multidisciplinary care of patients with musculoskeletal shoulder pain, especially when these patients do not respond to conservative measures. The shoulder is one of the most common regions where ultrasound-guided musculoskeletal injection is applied. Shoulder blocks can be used as a diagnostic tool or as a therapeutic modality for short-term shoulder pain and long-term pain syndromes. This revision article's objective is to describe the anatomy and sonoanatomy of both the shoulder and the surrounding structures and also summarize different infiltration techniques and peripheral nerve blocks.

Shoulder anatomy

Anatomically, the shoulder girdle consists of 3 bones (the scapula, clavicle, and humerus), 3 synovial joints (the

glenohumeral, acromioclavicular, and sternoclavicular), and 2 gliding mechanisms (the scapulothoracic and subacromial) all acting as a single biomechanical unit.

The glenohumeral joint (GHJ) is the joint with the greatest range of mobility. Its articular surfaces are the humeral head and the glenoid fossa. The shallowness and laxity of the fossa surrounding the GHJ and the fact that only a portion of the humeral head is covered by the glenoid fossa makes this a highly mobile but very unstable joint.¹

The muscles comprising the shoulder girdle have 2 planes: a superficial plane that consists of the deltoid muscle and a profound plane comprising the supraspinatus, infraspinatus, subscapularis, and teres minor muscles. The tendons of the muscles in the deep plane are called the rotator cuff, and the function of these tendons is to reinforce the joint fossa and improve its stability. These tendons are the subscapularis in the anterior aspect, supraspinatus in the superior aspect, and infraspinatus and teres minor in the posterior aspect.²

The subscapularis muscle is filling the subscapularis fossa and it is attached to the lesser tubercle of the humerus by means of a strong tendon. The supraspinatus muscle attaches to the medial two-thirds of the supraspinatus fossa

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located in the superior aspect of the scapula, the tendon inserts into the anterior most part of the greater tubercle of the humerus.

The infraspinatus attaches to the medial two-thirds of the infraspinatus fossa and its tendon inserts into the middle portion of the greater tubercle, together with the teres minor it is situated in the posterior aspect of the shoulder joint.

The cuff muscles' combined main action is to stabilize the humeral head into the glenoid fossa's concavity and assist shoulder rotation.

Other periarticular structures include the tendon of the long head of the biceps brachii muscle and the subacromial-subdeltoid bursa. The brachial biceps muscle tendon passes through the bicipital groove of the humerus between the greater and lesser tuberosities, and a synovial sheath surrounds it. It enters the GHJ and inserts on the highest part of the glenoid labrum and the bony edge of the glenoid fossa of the scapula.³ The subacromial-subdeltoid bursa, located under the acromion, the coracoacromial ligament, and the deltoid muscle allows the gliding of the rotator cuff under the deltoid muscle and the acromion during arm movements, and it is in close contact with the supraspinatus tendon (SST) underneath.⁴

Infiltration of shoulder joint and periarticular structures

Infiltration may apply for diseases that do not respond to conservative treatments as in the case of osteoarthritis, synovitis, etc or soft tissue (extra-articular) injections as in

the case of tenosynovitis, entrapment neuropathies, synovial cysts, bursitis, fasciitis, and tender and trigger points.

Generally, most cases of shoulder pain are due to injury of the periarticular structures, with rotator cuff conditions (degeneration-tears) being the most common cause, whereas severe joint disease itself is less common.

The shoulder structures are usually infiltrated including the glenohumeral and acromioclavicular joints, tendons of rotator cuff muscles, biceps brachii tendon and subacromial-subdeltoid bursa.

Rotator cuff tendinitis is the most common shoulder pathology treated by local injection. The SST is the most affected, followed by the infraspinatus tendon and less frequently the subscapularis. The subacromial-subdeltoid bursa is involved in most SST injuries, as well as crystalline diseases.

Infiltrations are conducted for diagnostic purposes, in cases where the pain origin is unknown, for pain relief as an analgesic, and as a support measure in rehabilitation of these patients (shoulder stiffness).

Ultrasound-guided techniques for shoulder injection

Ultrasound has proved to be a useful tool guiding the needle and increasing safety and accuracy of the procedure.^{5,6} The ultrasound approach to these joints and the periarticular structures surrounding them is usually performed with patient in a sitting position using a high-frequency linear probe (7.5-13 MHz).

The following anatomical structures of the shoulder can be visualized via ultrasound: bone structures, such as the

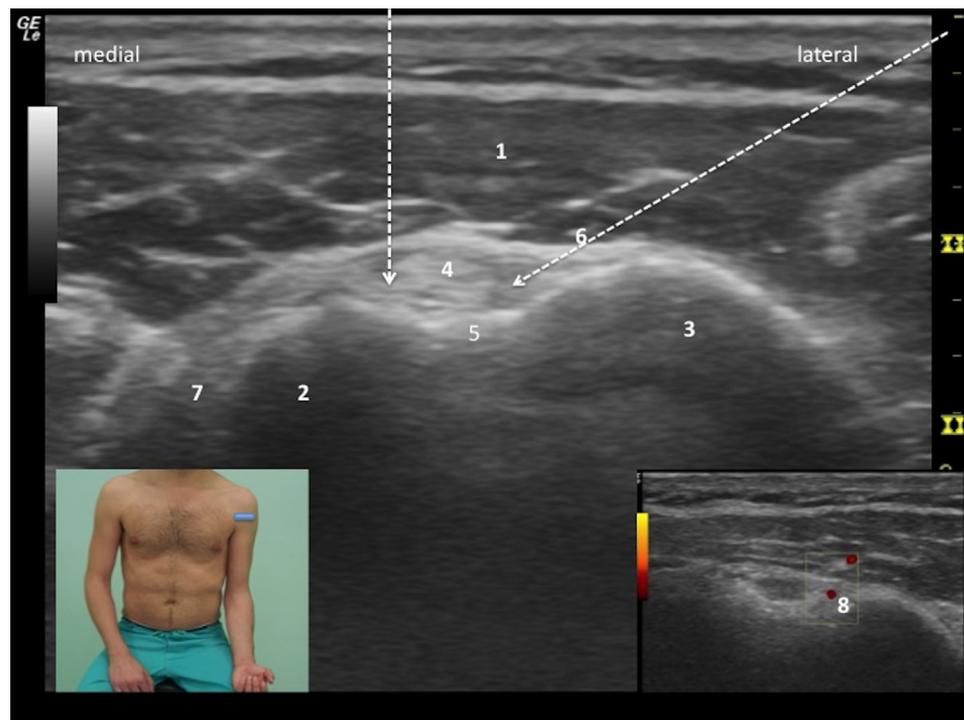


Fig. 1 – Biceps tendon. The inset shows the position of the patient and the linear ultrasound probe: probe transverse across superior aspect of bicipital groove. Arm adducted, hand supinated. Note that the biceps tendon appears hyperechoic. **Landmark:** 1—deltoid muscle; 2—lesser tuberosity; 3—greater tuberosity; 4—biceps tendon; 5—floor of groove; 6—transverse ligament; 7—subscapularis tendon; 8—anterior circumflex artery. (Color version of figure is available online.)

humeral head, coracoid, acromion, and clavicle; muscle structures, such as the deltoid muscle, the muscles of the rotator cuff, and the subdeltoid bursa; and tendon structures, such as the brachial biceps tendon and rotator cuff (supraspinatus, infraspinatus, and subscapularis tendons).

Long head of biceps tendon

The main indication for long head of biceps tendon (LHBT) injections is biceps tendinopathy (from inflammatory tendinitis to degenerative tendinosis).⁷

The biceps tendon should be examined with the forearm in supination and resting on the thigh or with the arm in slight external rotation (Figure 1). This position produces an external rotation of the GHJ, positioning the bicipital groove in the anterior position. The probe is placed transversely (short-axis view) over the anterior aspect of the patient's shoulder between the clavicle and the anterior axillary fold (Figure 1). At this level, the bicipital groove is observed as a depression between the greater and lesser tubercles of the humerus. The ultrasound image of the greater tubercle is larger and more rounded than the lesser tubercle, which is smaller and more tapered. The intertubercular groove runs between the tubercles and houses LHBT (oval hyperechoic structure), and it is covered by the intertubercular ligament (hyperechogenic line) (Figure 1). With tendon pathology or GHJ effusion, the tendon sheath will be filled with synovial fluid. Tilting of the probe is essential at this level because the echogenicity of the tendon of the biceps in short-axis view depends on the angle of the probe position (anisotropy).⁸ A color Doppler scan is used to locate the anterior circumflex artery as small vessel

lateral to the tendon biceps tendon (Figure 1). The tendon is examined in a transverse plane (short axis), where it emerges from under the acromion, to the musculotendinous junction distally. Moving the probe proximally we will be able to observe the intra-articular portion as an oval-shaped hyperechoic structure situated between the subscapularis medially and supraspinatus laterally (Figure 2A). Moving the probe distally along the arm, we can follow the course of the tendon to the myotendinous junction (Figure 2C).

A 90° rotation of the probe permits a longitudinal view of the tendon, showing a fibrillar pattern of hyperechoic and hypoechoic interlaced lines⁹ (Figure 3).

Both the bicipital groove and the LHBT are used as ultrasound landmarks to identify other rotator cuff components.

The LHBT ultrasound approach can be performed either in plane or out of plane. The target is the small space between the tendon and the lesser tubercle of the humerus, just medial to the tendon. The needle should be directed through the transverse humeral ligament and reach the bicipital groove (Figure 1). Injection on the lateral aspect of the groove is equally effective as the medial side, but caution should be taken to avoid the ascending branch of the circumflex humeral artery. The anesthetic solution is injected into the bicipital groove surrounding the tendon, injecting directly over or against the tendon should be avoided. Low volumes (4 mL) are sufficient and injection of steroid directly into the tendon may lead to rupture.

Subscapularis tendon

The patient is seated with elbow flexed to 90°, the arm in external rotation, fixing the elbow on the iliac crest and slight

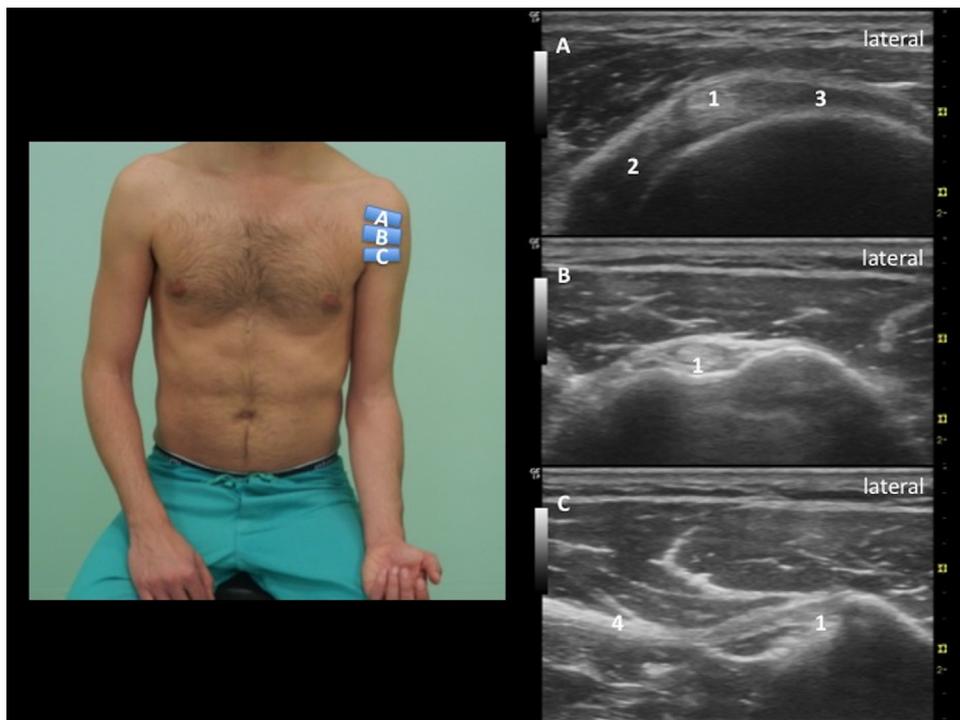


Fig. 2 – Biceps tendon: (A) the intra-articular portion of the biceps tendon appears as an oval-shaped hyperechoic structure located between the subscapularis medially and supraspinatus laterally; (B) the biceps tendon lies in between the greater and lesser tuberosities (bicipital groove); and (C) the biceps tendon at its distal myotendinous junction. *Landmark:* 1—biceps tendon; 2—subscapularis tendon; 3—supraspinatus tendon; 4—pectoralis major muscle. (Color version of figure is available online.)



Fig. 3 – Biceps tendon. Probe longitudinal to long head of biceps tendon. Arm adducted, hand supinated. Landmark: 1—deltoid muscle; 2—biceps tendon; 3—humerus. (Color version of figure is available online.)

supination of the hand (Figure 4). This maneuver stretches the subscapularis tendon (internal rotator) and takes it out from under the coracoid. The coracoid process medially and the lesser tubercle of the humerus laterally are the 2 bony references used for ultrasound identification of the subscapularis tendon. We use a linear probe placed transversally on the anterior aspect of the shoulder at the level of the coracoid process. The ultrasound image provides a longitudinal view of the subscapularis tendon, which has a “beak shape” with a convex surface ending in an acute angle at its insertion into the lesser tubercle¹⁰ (Figure 4). The superficial margin of the tendon is delimited by an echogenic layer, which corresponds to the subdeltoid fat.

To obtain a transversal view, we rotate the probe to 90° and place it along the longitudinal axis of the body (Figure 5). With this view, the tendon has a heterogeneous echotexture with well-defined hyperechoic and slightly hypoechoic areas, representing its wide myotendinous junction¹¹ (Figure 5).

SST and subacromial-subdeltoid bursa

The SST is lateral and posterior to the bicipital groove. It is examined with patient's arm in internal rotation, resting the hand upon the ipsilateral iliac crest or touching the contralateral scapula (Figure 6). This maneuver allows the tendon to be almost completely withdrawn from under the acromion. The SST should be evaluated along its long and short axis. In the short axis (Figure 6), we use the LHBT as the reference as its intra-articular portion is located between the SST laterally and the subscapular tendon medially (Figure 2A). The SST has a convex or “wheellike” shape, with a homogeneous echo structure, more echogenic than the deltoid muscle, which is located above it¹¹ (Figure 6).

In the long axis, the tendon is seen as a convex fibrillar structure located below the deltoid muscle and subacromial bursa, has bird-beak shape attached to the greater tubercle (Figure 7).

The ultrasound is unable to differentiate between the supraspinatus and the infraspinatus tendons, as they have a common insertion into the greater tubercle.¹⁰

Between the supraspinatus and the deltoid, the normal subacromial-subdeltoid bursa appears as a thin hypoechoic band. It overlies the superior aspect of the SST. The main role of this largest bursa is to minimize attrition of the cuff against the coracoacromial arch (acromion and coracoacromial ligament) and the deltoid muscle during movements of the arm.

Ultrasound image of the subacromial-subdeltoid bursa looks like a thin hyperechoic structure of approximately 2 mm touching the SST, greater tubercle, and humeral articular cartilage (anechoic line) (Figure 7). With the probe transverse, the bursa is located between the deltoid muscle and the SST on the lateral aspect, and the coracoid process medially (Figure 6). The bursa is surrounded by a thin layer of peribursal fat, and under pathologic conditions it is easily detectable on ultrasound examination.¹⁰ This bursa is involved in most lesions of the SST; its inflammation renders shoulder movements painful. Dynamic assessment of subacromial impingement can be assessed, with the patient abducting the arm while in internal rotation. With this maneuver, the SST can be seen passing deep to the coracoacromial arch. The ultrasound approach to the subacromial-deltoid bursa is usually in plane, from lateral to medial. Solution infiltration (5-10 mL) inside the bursa allows its distension between these muscle masses.

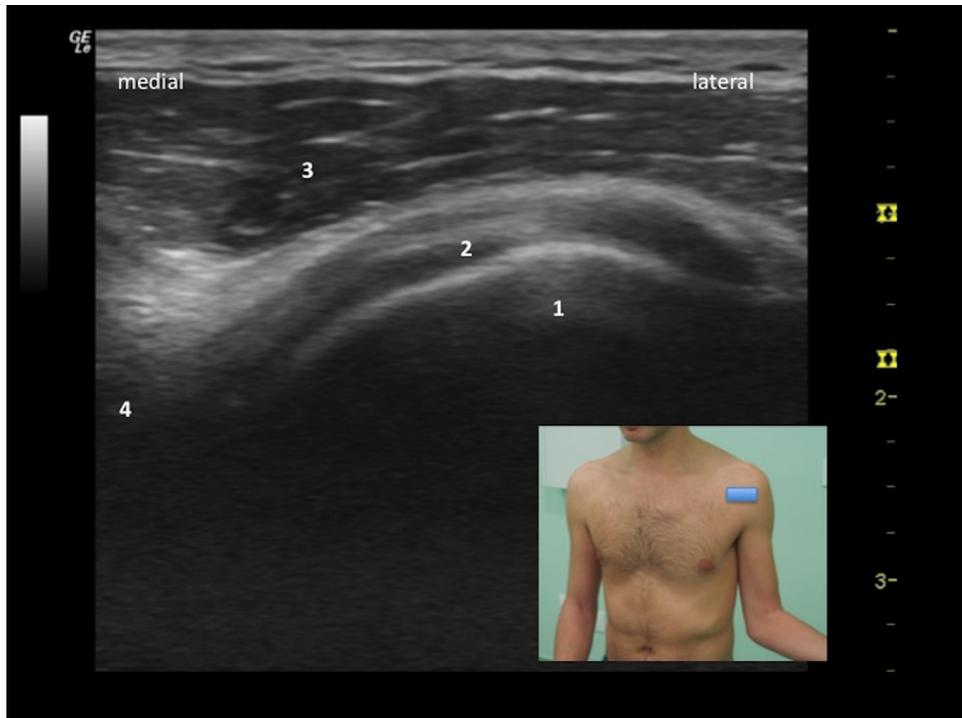


Fig. 4 – Subscapularis tendon. Long axis view. Probe longitudinal to the subscapularis muscle (transverse to anterior shoulder). Shoulder adducted and externally rotated with elbow kept against chest wall. Landmark: 1—lesser tuberosity; 2—subscapularis tendon; 3—deltoid muscle; 4—coracoid process. (Color version of figure is available online.)

Infraspinatus tendon

The infraspinatus tendon is posterior, and it is explored from behind the patient with arm in neutral position or with the patient's hand touching the opposite shoulder. The probe is

placed in the posterior aspect of the scapulohumeral joint. The infraspinatus muscle is seen as an individual structure filling the infraspinous fossa deep to the deltoid muscle¹² (Figure 8).



Fig. 5 – Subscapularis tendon. Short-axis view. Landmark: 1—subscapularis tendon; 2—deltoid muscle; 3—lesser tuberosity. (Color version of figure is available online.)

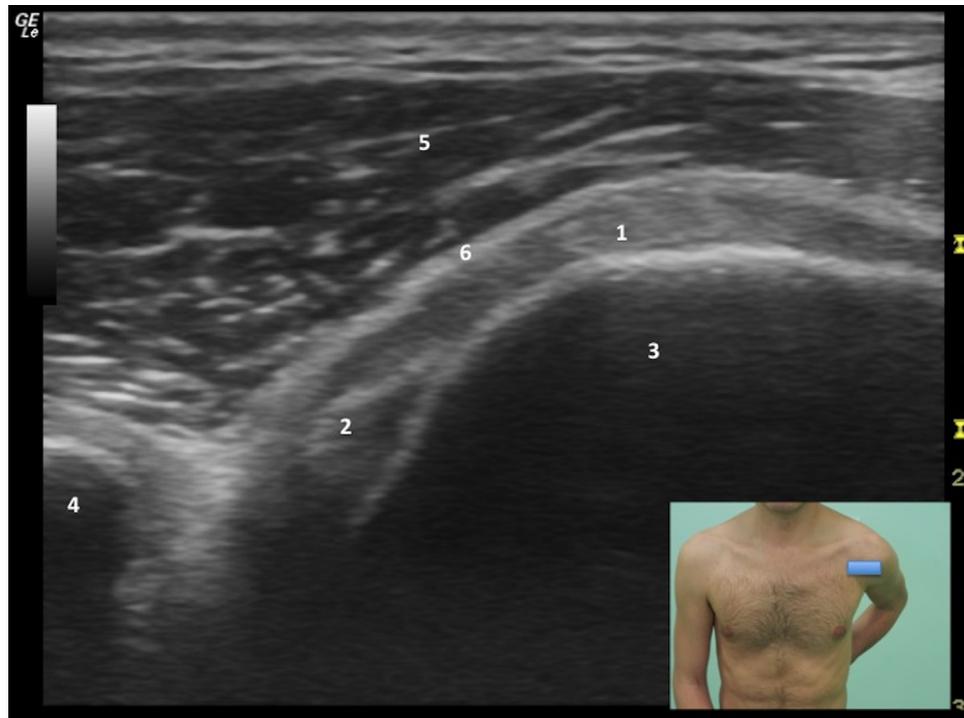


Fig. 6 – *Supraspinatus tendon*. Probe transverse to supraspinatus tendon, with shoulder extended and internally rotated. The tendon passes over the superior aspect of the shoulder joint to insert into the uppermost facet of the greater tuberosity of the humerus. The normal tendon shows a smooth convex superior surface. *Landmark*: 1—supraspinatus tendon; 2—biceps tendon; 3—humeral head; 4—coracoid process; 5—deltoid muscle; 6—subacromial-subdeltoid bursa. (Color version of figure is available online.)

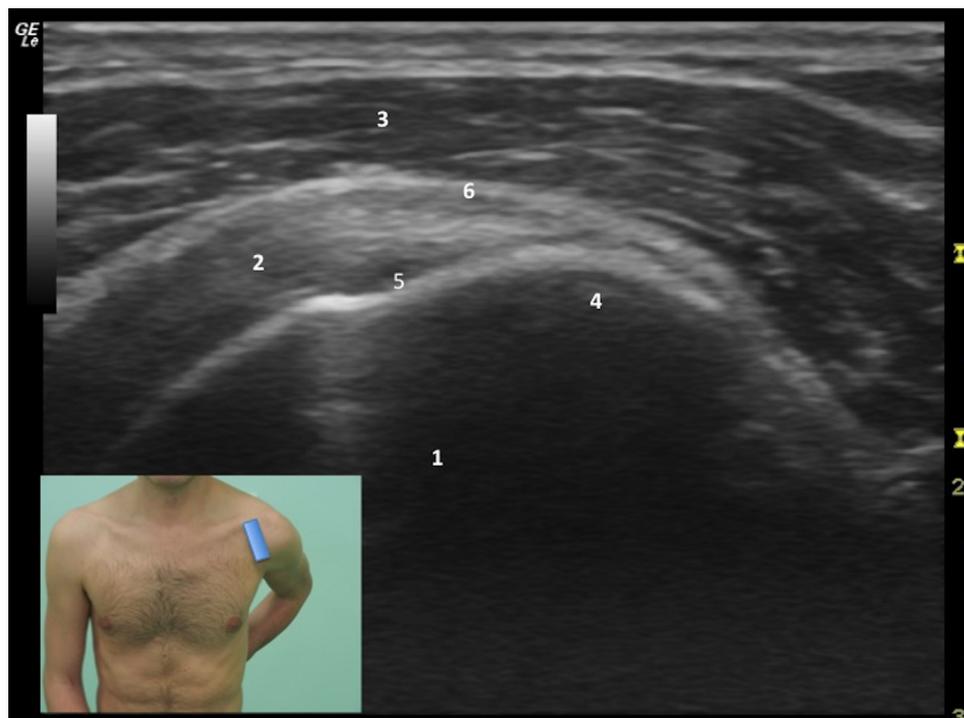


Fig. 7 – *Supraspinatus tendon*. Probe longitudinal to supraspinatus tendon, with shoulder extended and internally rotated. *Landmark*: 1—humerus; 2—supraspinatus tendon (bird-beak shape); 3—deltoid muscle; 4—greater tuberosity; 5—articular cartilage; 6—subacromial-subdeltoid bursa. (Color version of figure is available online.)

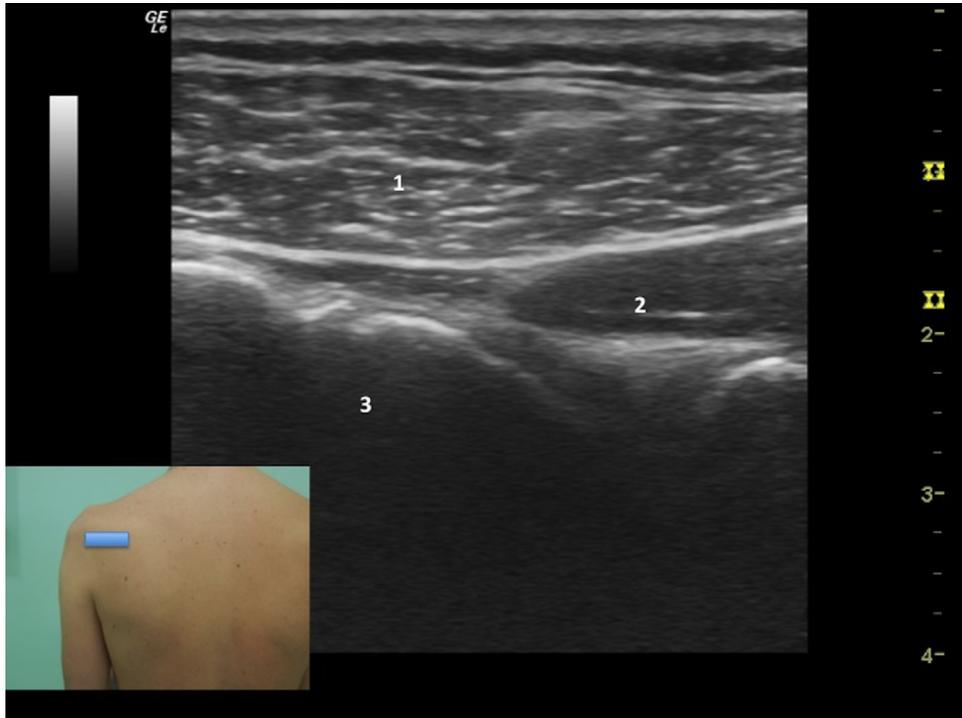


Fig. 8 – Infraspinatus muscle or tendon. Landmark: 1—deltoid muscle; 2—infraspinatus muscle; 3—greater tuberosity. (Color version of figure is available online.)

Acromioclavicular joint injection

The acromioclavicular joint is a small synovial joint between the acromion and the clavicle with its inferior aspect in contact with the subacromial bursa and the rotator cuff.

The patient is seated with arm in neutral position. In this position, the depth of the joint space is wider¹³ (Figure 9). We use a high-frequency linear probe positioned on the superior aspect of the shoulder, along the coronal plane (Figure 9). The probe is moved from the lateral edge of the acromion medially until the acromioclavicular joint is visualized. The ultrasound image over this joint show 2 hyperechoic lines, followed by an acoustic shadow that corresponds to the acromion and the clavicle joined together in the superior aspect with a hyperechoic line corresponding to the joint socket, which is usually in close contact with the periarticular surface of the clavicle⁸ (Figure 9). The cortical surface of the clavicle is usually slightly higher than the acromion. The approach can be performed in plane or out of plane, but as it is a very superficial structure, the out-of-plane approach may be more comfortable for the patient (Figure 9). The joint is often completely distended by a small volume of anesthetic solution (2 mL).⁸ There are no significant vascular or neural structures to consider in this injection, but the skin is often thin and friable over the acromioclavicular joint, so care should be taken not to deposit steroids superficially above the joint.

GHJ injection

The principal indications for GHJ injection are pain relief and helping rehabilitation in patients with osteoarthritis and adhesive capsulitis (frozen shoulder).

Ultrasound GHJ injection can be performed through an anterior or posterior approach or via the rotator cuff interval.¹⁴

The easiest access to the shoulder joint is from the posterior aspect, owing to the lack of vessels, nerves, and major ligament and intra-articular structures along the needle pathway, and there is also lower extravasation of the solution.^{8,15}

Posterior approach to GHJ. The patient is well positioned in lateral decubitus or sitting, with the humerus adducted across the thorax, thus opening the posterior joint space. A high-frequency linear probe is usually used, but for very large shoulders, a convex probe may be necessary.

The probe is placed under the spine of the scapula parallel to its lateral end (Figure 10). At this level, we can see the following structures: the infraspinatus muscle, humeral head, posterior glenoid border, and posterior labrum (Figure 10). The needle is inserted in plane, from lateral to medial, positioning the needle in the space between the glenoid labrum, hyperechoic triangular shape, and humeral head⁸ (Figure 10). It is often necessary to increase the depth of the field of view to avoid loss of view of this area. The introduction of an anesthetic solution displaces the posterior capsule (hyperechoic line) surrounding these structures. If any resistance to the injection is noted, rotate the needle bevel or withdraw the needle a little, as it may have reached the cartilage of the humeral head or the labrum.

Anterior approach to GHJ. This is conducted with the patient in sitting or supine position with arm in external rotation. A high-frequency linear probe is used although, like with the posterior approach, if the patient is obese or has very large shoulders, a convex probe may be necessary. The probe is positioned under and parallel to the acromion, on the medial aspect of the acromion above the coracoid (Figure 11). In the

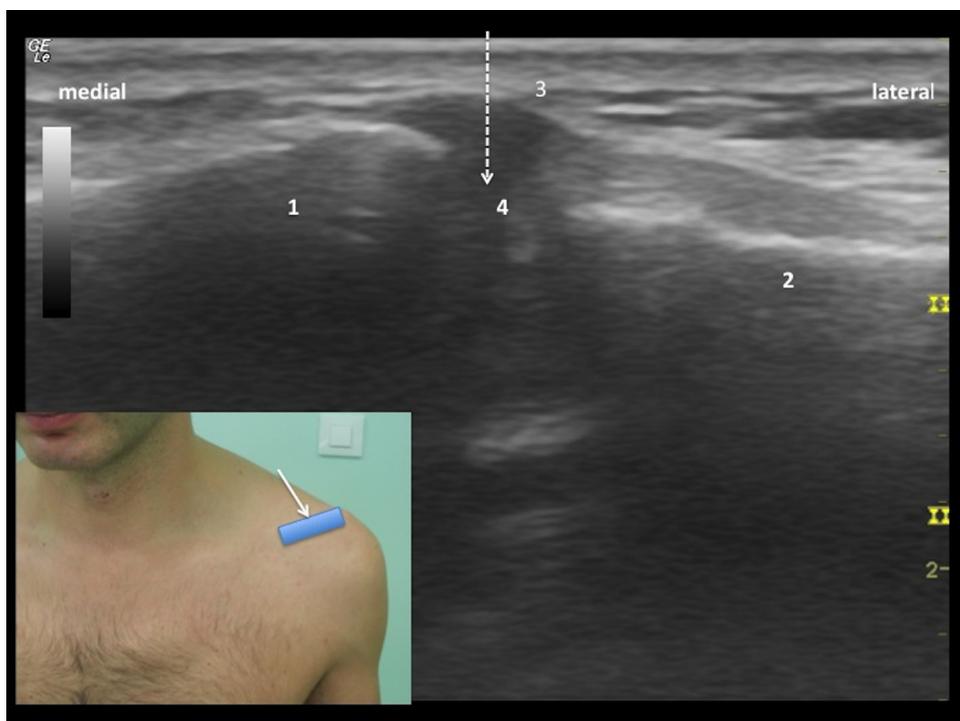


Fig. 9 – Acromioclavicular joint. The inset shows the position of the ultrasound probe (coronal plane adjacent to superior aspect of joint) and the needle with out-of-plane technique. The ultrasound image shows the pathway of the needle (arrow). Landmark: 1—clavicle; 2—acromion; 3—capsule joint or superior acromioclavicular ligament; 4—acromioclavicular joint. (Color version of figure is available online.)



Fig. 10 – Posterior approach to the GHJ. The inset shows the position of the ultrasound probe and the needle with in-plane technique. The ultrasound probe is placed just caudal and parallel to the lateral end of scapular spine. The needle is inserted in plane from the lateral aspect of the shoulder. The ultrasound image is shown with the line representing the needle path, between the free edge of the labrum⁵ and the hypoechoic articular cartilage of the humeral head.⁶ Landmark: 1—humeral head; 2—posterior glenoid rim; 3—infraspinatus muscle; 4—deltoid muscle; 5—labrum. (Color version of figure is available online.)

ultrasound image, we can see the head of the humerus, subscapularis tendon, and coracoid process (Figure 11). This approach is conducted in plane from lateral to medial. The needle passes over the humeral head toward the space between the subscapularis tendon superiorly, the head of the humerus laterally, and the coracoid medially (Figure 11).

Shoulder nerve block

Innervation of the shoulder is complex with involvement of several nerves: the suprascapular, axillary, subscapular, musculocutaneous, and lateral pectoral nerves.

About 70% of shoulder innervation arises from the suprascapular nerve (SSN),¹⁶ and the rest from the axillary nerve with a relatively small contribution from the lateral pectoral, musculocutaneous, and subscapularis nerves.¹⁷

The blocking of the brachial plexus at the interscalene level is considered the most effective analgesic technique for shoulder surgery¹⁸ because it ensures blockage of every branch. However, the interscalene nerve block (ISB) is associated with well-documented adverse effects, including unwelcome arm paralysis and intolerance of hemidiaphragm paralysis.¹⁹ ISB is also associated with more frequent long-term neurologic deficits compared with other nerve blocks²⁰ and must be performed in proximity to important anatomical structures (eg, vertebral artery). An alternative to ISB may be advantageous and has been described, whereby terminal nerves supplying the shoulder joint are blocked rather than the entire brachial plexus.^{21,22}

Combined suprascapular and axillary nerve block (shoulder block) appears to be an effective alternative to ISB for pain relief following shoulder surgery with advantages of minimal side effects,²³ reduced potential for serious complications, and less reported pain during block resolution.²¹ The “shoulder block” attains better results than with single SSN block.^{24,25}

Axillary nerve block

This nerve is blocked together with the SSN as an analgesic alternative to brachial plexus interscalene block.²⁶ However, the clinical role of a specific axillary nerve block remains undetermined.

Anatomy

The axillary nerve is one of the terminal branches of the posterior cord of the brachial plexus, together with the radial nerve. It innervates the deltoid muscle, teres minor muscle, and long head of the triceps brachii muscle. It also provides sensory innervation to the shoulder joint as well as the skin covering the area inferior to the deltoid muscle in the arm.²⁷ The axillary nerve originates at the lateral border of the subscapularis muscle and then advances posteriorly under the shoulder joint toward the surgical neck of the humerus in close proximity to the posterior circumflex humeral artery (PCHA), a branch of the axillary artery. It subsequently divides into 2 branches, one anterior and another posterior.²⁸ The anterior branch innervates the medial and anterior aspect of the deltoid muscle and

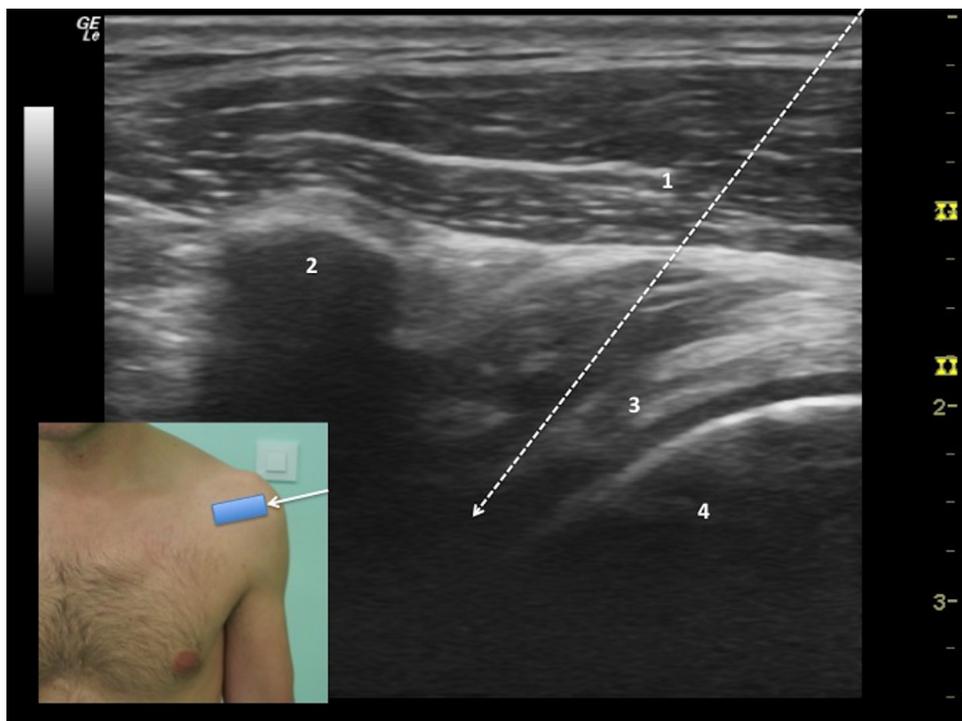


Fig. 11 – Anterior approach to the GHJ. The inset shows the position of the ultrasound probe and the needle in-plane technique. The probe is placed caudal and parallel to the acromion, with the medial part covering the coracoid process. The ultrasound image is shown with the line representing the needle patch. The needle was inserted from the lateral side of the probe aiming at the medial border of the humeral head. *Landmark:* 1—deltoid muscle; 2—coracoid process; 3—subscapularis tendon; 4—humeral head. (Color version of figure is available online.)

branches into the anterior aspect of the joint capsule. The posterior branch innervates the teres minor muscle, posterior aspect of the deltoid muscle and terminates as the superior lateral cutaneous nerve of the arm that runs along the medial border of the deltoid muscle and provides sensory innervation of skin of the inferior aspect of this muscle.²⁹

Sonoanatomy and block technique

The patient is in lateral decubitus position with the arm to be blocked facing up and elbow flexed at about 90° or sitting with the shoulder in neutral position, slight internal rotation of the arm, elbow flexed at 90°, and the hand on the knee.

A high-frequency linear probe is used, which is positioned in the posterior aspect of the arm.

The probe is placed parallel to the long axis of the humerus, about 2–3 cm below the posterolateral aspect of the acromion, on the dorsal side of the arm²⁷ (Figure 12). First, we locate the head of the humerus, and we then move the probe along the surgical neck of the humerus so that the ultrasound image of the cortex of the head continues with that of the surgical neck and the shaft of the humerus. At the neck of the humerus, it is essential to identify the PCHA in the transverse view using a Doppler, as the axillary nerve is localized cranial to this and it is in close contact with it.²⁷ Both structures, the nerve and the artery, are located in a neurovascular space between the teres minor cranially, long head of triceps brachii caudally, the deltoid muscle in the posterior aspect, and the shaft of the humerus in the anterior aspect (Figure 12).

The nerve is visualized as a hyperechoic structure located above the artery, but sometimes it is difficult to identify. The injection of the anesthetic often helps to identify it. The nerve approach has been described in plane from cranial to caudal. The needle tip must be located, below the fascia caudal to the teres minor muscle, and just cranial to the PCHA (Figure 12).

SSN block

The SSN is the main sensory nerve in the shoulder, primarily innervating its posterior and superior aspect.³⁰

This nerve block is indicated for the treatment of short-term and long-term shoulder pain. In short-term shoulder pain, it has been used primarily in the management of postoperative pain following shoulder surgery in cases where the brachial plexus block was contraindicated. In long-term shoulder pain, SSN block has been used as a diagnostic procedure in patients with suspected neuropathy of this nerve and as a therapeutic procedure in cases of oncologic pain, arthritis of the shoulder joint, adhesive capsulitis, and long-term lesions of the rotator cuff.³¹

Anatomy

The SSN is a mixed sensory and motor nerve that originates in the anterior rami of the C5 and C6 spinal nerves.³² It leaves from the lateral aspect of the superior trunk of the brachial plexus, travels through the posterior triangle of the neck, and courses deep to the trapezius muscle and the omohyoid muscle. It enters the supraspinous fossa through the suprascapular notch under the superior transverse ligament of the scapula. The suprascapular artery (subclavian artery branch) and vein pass above this ligament.³³ On its path from the

supraspinous fossa, the nerve together with the suprascapular artery are in direct contact with the bony plane and come out of it through the greater scapular (spinoglenoid) notch and continues in the direction of the infraspinous fossa.³⁴ Shortly after passing through the suprascapular notch, the SSN sends out 2 branches, one is the motor nerve for the supraspinatus muscle³⁵ and the other is known as the superior articular branch. The articular branch is sensory and supplies the coracoclavicular, coracohumeral ligaments, acromioclavicular joint, GHJ (posterior and superior aspects), and subacromial bursa.³⁶

The main trunk of the nerve exits the supraspinous fossa through the lateral border of the spine of the scapula, through a fibro-osseous tunnel (greater scapular or spinoglenoid notch), terminating in motor branches to the infraspinatus muscle.³⁷ This fibro-osseous tunnel is formed by the spine of the scapula and the inferior transverse ligament of the scapula (spinoglenoid ligament).³⁸ The number of motor branches for the infraspinatus muscle varies from 2–4.³⁵ It is important to point out that although sensory branches are issued, there is usually no cutaneous innervation.

Ultrasound-guided SSN block techniques

Various techniques have been described for SSN block: blind techniques with or without neural stimulation, or imaging techniques (fluoroscopy, computed tomography, and ultrasound). In most of these, the nerve is located near the suprascapular notch or in the supraspinous fossa, between the suprascapular notch and spinoglenoid notch³⁹ (Figure 13). Most of the landmark-based and ultrasound-guided approaches are classified as posterior approach when the SSN is targeted along its course between the suprascapular notch and spinoglenoid notch. A new anterior approach is recently described in which the SSN is approached soon after it branches out from the upper trunk.⁴⁰

We describe ultrasound-guided approaches to SSN block, together with some of the advantages and disadvantages.

A suprascapular notch approach. This is an attractive site for SSN blocking, as at this level the nerve has not yet divided into its terminal branches.³⁹

The block is usually performed with patient in supine position, but it can also be performed with the patient in the lateral position with the limb to be blocked facing up. A high-frequency linear probe is used. The basic reference point is the spine of the scapula. Placing the probe above this, toward the middle, and then we let it “fall” toward the supraspinous fossa. The probe should be placed at a slight angle toward the anterior (Figure 14) to visualize the suprascapular notch. Typically, the ultrasound image of the notch is that of a hyperechoic line with slight superior concavity followed by acoustic shadowing, defined in the superior aspect by a hyperechoic line that corresponds to the superficial transverse ligament of the scapula (Figure 14). The nerve, which is often difficult to see, is located at the level of the notch, below the superior transverse ligament of the scapula. Above this ligament and with the help of Doppler, we can visualize the suprascapular artery. The muscle mass we identify at this level is the supraspinatus muscle, and the trapezius muscle at the more superficial level (Figure 14).

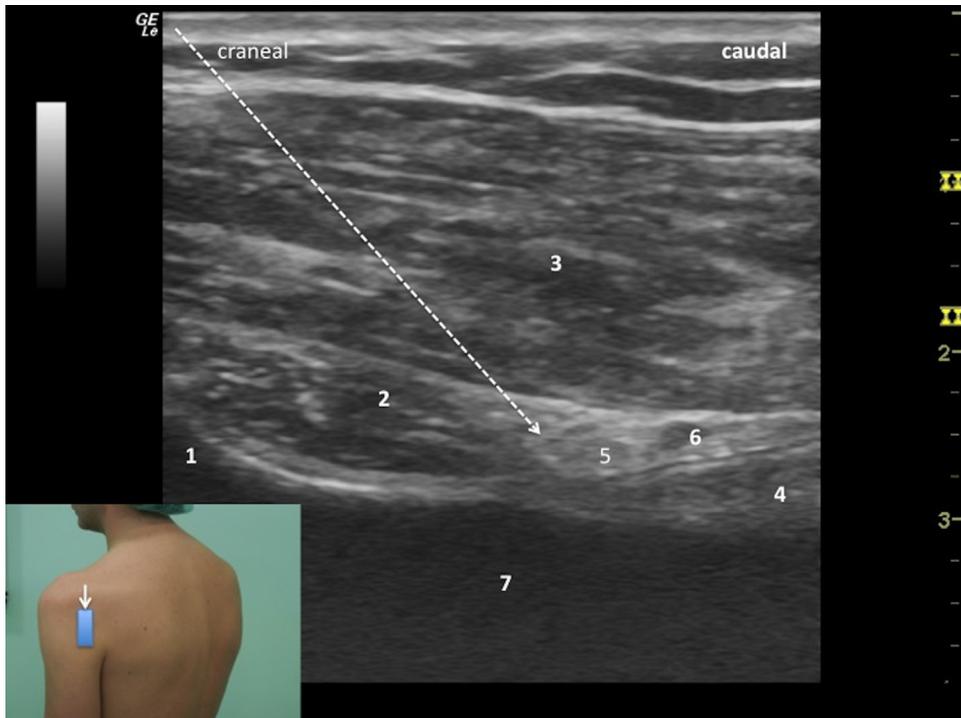


Fig. 12 – Axillary nerve. Lateral view of the shoulder region demonstrating in-line needle (white arrow) insertion. The left side of the image is oriented cranially. *Ultrasonographic landmarks:* 1—head of the humerus; 2—teres minor muscle in transverse section; 3—deltoid muscle in longitudinal section; 4—triceps muscle in longitudinal section; 5—axillary nerve; 6—posterior circumflex humeral artery; 7—humeral shaft. (Color version of figure is available online.)

One drawback of this approach is that the shape of the suprascapular notch varies from person to person, which can make identification difficult. Up to 6 different anatomical

types of suprascapular notches have been described.⁴¹ The most common anatomical types are the semicircular and the “U” shape.⁴² In 15% of cases, the notch may be absent or have

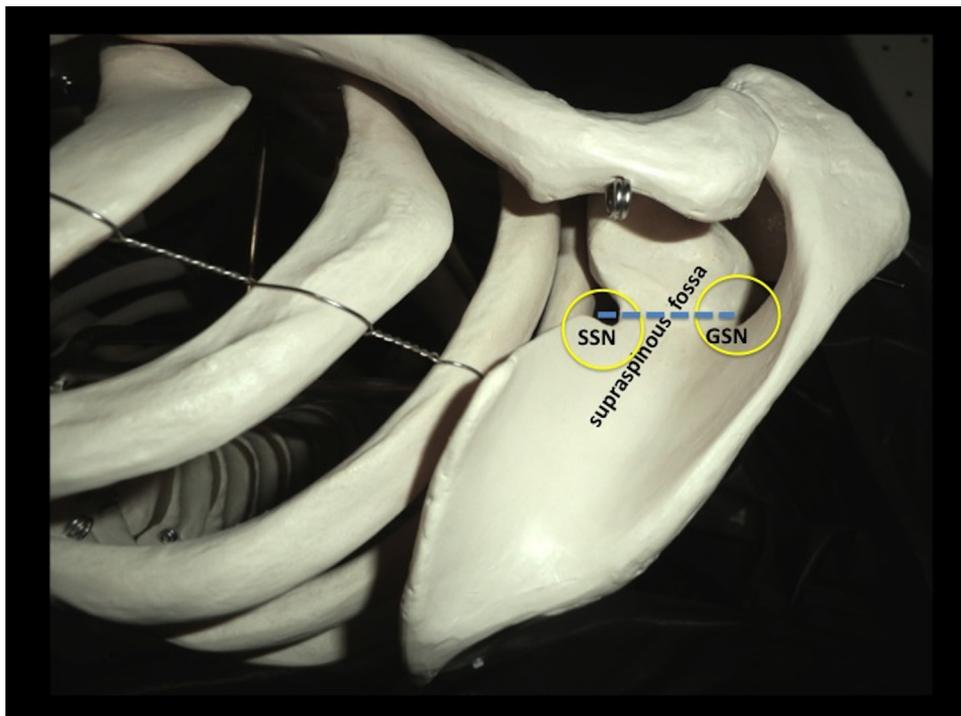


Fig. 13 – Superior view of the suprascapular fossa. The suprascapular nerve (blue line) enters the groove at the suprascapular notch (SSN) and winds laterally around the greater scapular notch (spinoglenoid notch) (GSN). (Color version of figure is available online.)

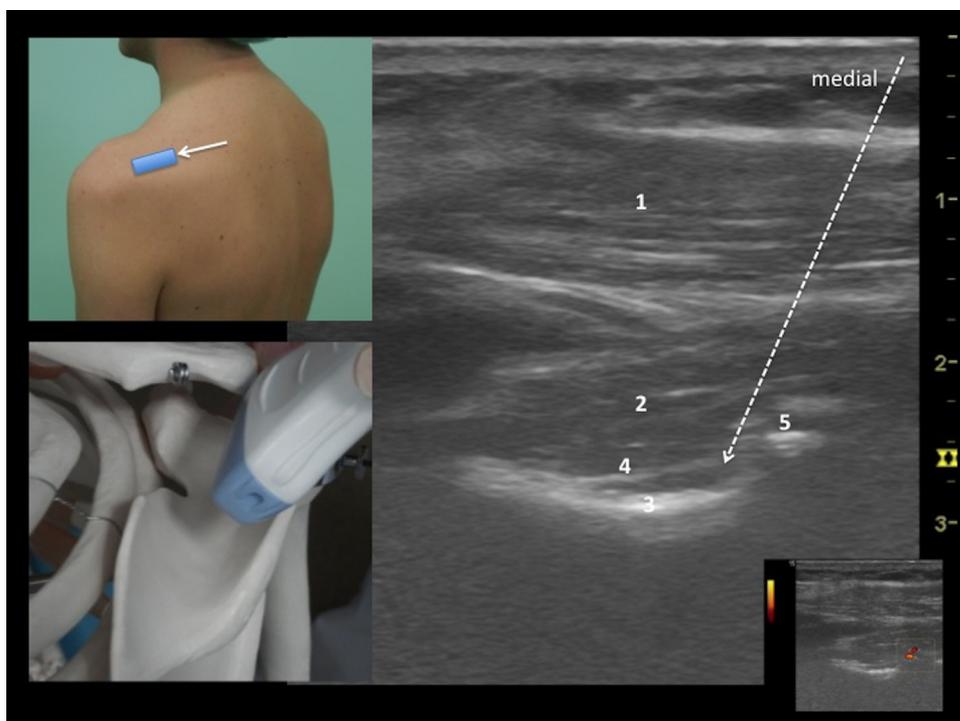


Fig. 14 – Blockade of suprascapular nerve in the suprascapular notch. The arrow represents the pathway of the needle. Landmarks: 1—trapezius muscle; 2—supraspinatus muscle; 3—suprascapular nerve; 4—superior transverse suprascapular ligament; 5—suprascapular artery. (Color version of figure is available online.)

been converted into a hole owing to the ossification of the superior transverse scapular ligament.⁴¹

The main complication with this approach, and basically with blind techniques, is pneumothorax, in cases where the needle pathway is directed toward the chest cavity.³⁹

A supraspinous fossa nerve block approach. Some authors consider this as the ideal site for ultrasound-guided SSN block.^{43,44}

The supraspinous fossa is concave with a smooth surface and broader and less profound medially than laterally, located above the spine of the scapula between the suprascapular notch and spinoglenoid notch (Figure 13). Its medial three-quarters give origin to the supraspinatus muscle. The SSN together with the suprascapular artery passes deeply along the floor of the fossa below the supraspinatus muscles and covered by the inferior fascia of this muscle, in a natural compartment (Figure 15).

Nerve block is performed with patient in lateral decubitus or sitting position (Figure 15). A high-frequency linear probe is used but sometimes a profound block is needed, so use of a low-frequency probe may be necessary.

The reference image is a hyperechoic line followed by an acoustic shadow, which corresponds to the floor of the supraspinous fossa. Identifying the suprascapular vessels helps with the identification. The needle is inserted in plane with the probe, from medial to lateral (Figure 15). If the neurovascular bundle is not visible, which can occur in 5%-10% of cases,⁴⁵ we direct the needle toward the lateral aspect of the supraspinous fossa. Injecting 10-15 mL of local anesthetic under the supraspinatus muscle will produce SSN block. The

supraspinatus fossa is a strictly bordered compartment, occupied (filled) by the supraspinatus muscle. The fibers of this muscle originate from the bony wall of this fossa (medial three-quarters) and from the supraspinatus fascia, which is thick and strong medially, and thin laterally, or may even be absent. At this level, the SSN runs along a natural compartment that would contain the diffusion of the local anesthetic injected, would also favor the extension of the injection toward the lateral of the fossa, and prevent its diffusion medially owing to its higher resistance, so that small volumes (5 mL) would be sufficient to ensure the successful blocking.⁴⁶

The supraspinous fossa could be confused with spinoglenoid notch, particularly in cases where the probe is located very perpendicular to the supraspinatus fossa and close to the lateral portion of the spine of the scapula (Figure 13).

The advantages of this approach include ease of access, reference of suprascapular notch not required, and the extremely low risk of pneumothorax.⁴⁷

Supraclavicular approach to the SSN. SSN crosses supraclavicular region behind the omohyoid muscle, before leaving the posterior cervical triangle and passing toward the suprascapular notch of the scapula.⁴⁰ Patient in supine position with head slightly rotated toward the side opposite to that being blocked. A high-frequency linear probe is used that is placed along the short axis of the neck (Figure 16). The reference points are the omohyoid muscle and the root of C5. To find the root of C5, we identify the transverse process of C7 that is easily recognized as it lacks the anterior tubercle, and we ascend to identify the transverse processes of the cervical vertebrae C6 and C5. Between these vertebrae, we

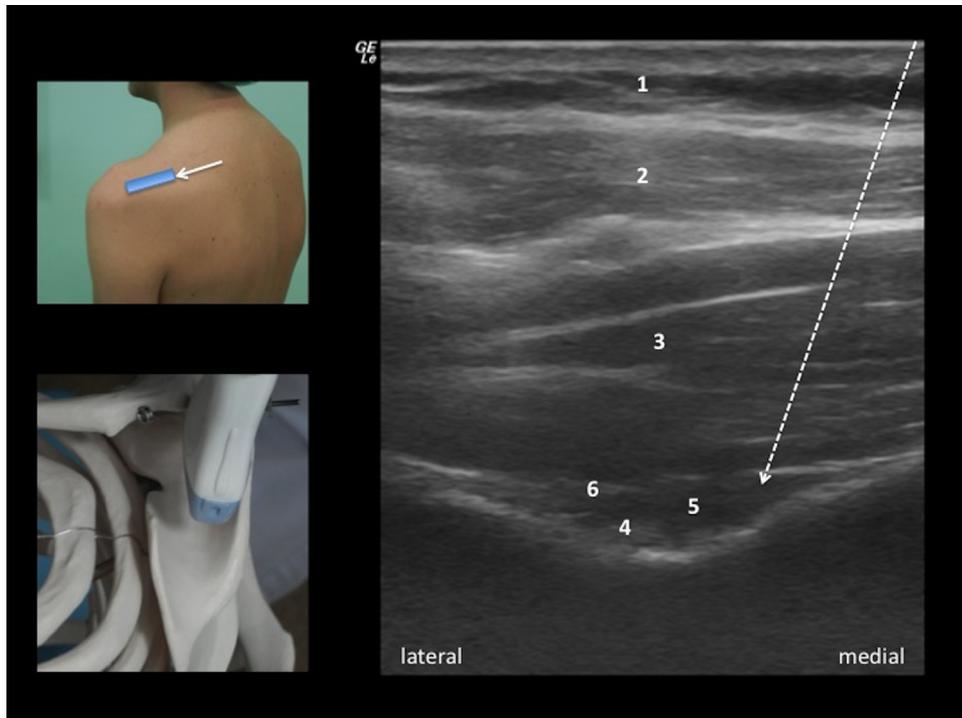


Fig. 15 – Blockade of suprascapular nerve in the supraspinous fossa. The arrow represents the pathway of the needle. Landmarks: 1—subcutaneous cellular tissue; 2—trapezius muscle; 3—supraspinatus muscle; 4—suprascapular nerve; 5—suprascapular artery; 6—inferior fascia of the supraspinatus muscle. (Color version of figure is available online.)

visualize the root of C5 as a rounded anechoic structure, and following this, we can identify the superior trunk of the brachial plexus (Figure 16).

The SSN comes out of the lateral wall of the superior trunk and its ultrasound image is that of a small, rounded, anechoic-hypoechoic structure that follows a lateral and

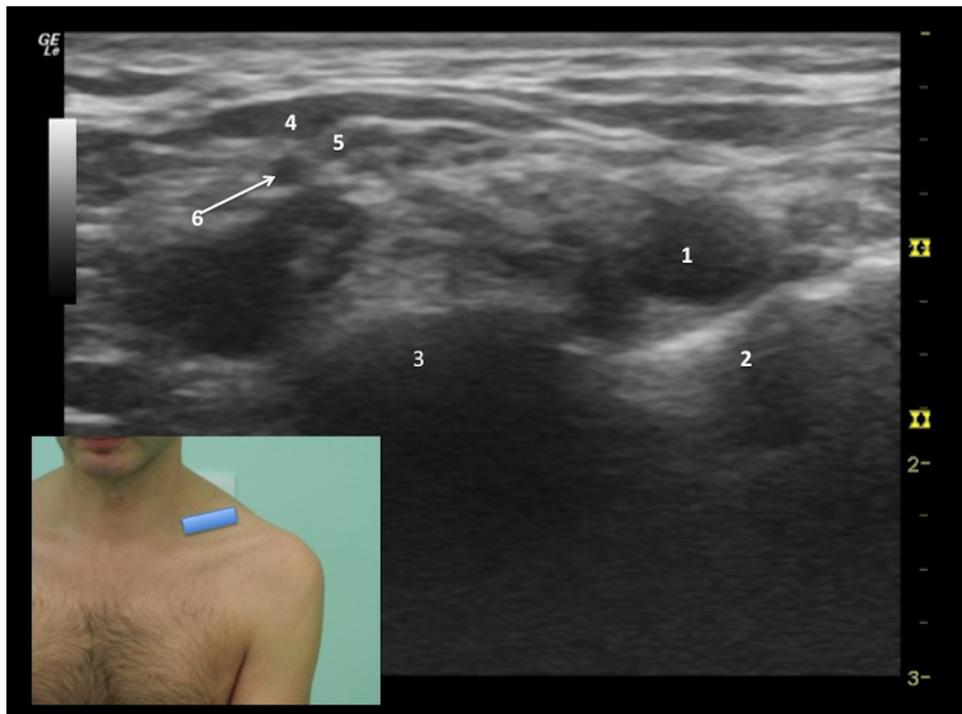


Fig. 16 – Blockade of the suprascapular nerve in the supraclavicular region. Landmarks: 1—subclavian artery; 2—pleura; 3—first rib; 4—omohyoid muscle; 5—the upper trunk of brachial plexus; 6—suprascapular nerve (white solid arrow). (Color version of figure is available online.)

posterior direction and crosses behind and below the omohyoid muscle (Figure 16).

Comparing this approach with classic approaches (suprascapular fossa), the nerve is more superficial, 8 vs 35 mm, and it is easily identified in a greater percentage of patients.⁴⁰ Another advantage is that the patient is in supine position, which increases patient comfort as well as being more convenient for the anesthesiologist.

The disadvantages arise mainly from the proximity of the SSN to the brachial plexus and to the pleura. The distance between the SSN and brachial plexus is very small, about 6 mm. Therefore, the local anesthetic, even with low volumes, can spread to other compartments of the plexus, causing unwanted blockage of these. This proximity should also be taken into account when conducting neurodestructive procedures (radiofrequency or cryotherapy) of the SSN.

Other complications include neurologic injury and intravascular injection as the nerve runs alongside the suprascapular vessels, piercing these while inserting the needle may produce systemic toxicity following the administration of a local anesthetic. Careful aspiration before injection of local anesthetic may help prevent this complication.

The ideal ultrasound technique used to locate the SSN will depend on the indication.⁴⁴ If postoperative analgesia or diagnostic block with local anesthetic is required, then locating and blocking the SSN in the lateral suprascapular fossa is efficient, safe, and effective. If radiofrequency ablation is required, then perhaps locating the SSN more proximally will allow isolation of the nerve in a more superficial location.

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