Ultrasound-Guided Supraclavicular Brachial Plexus Block

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KEY POINTS

- Ultrasound-guided supraclavicular block is safe and effective for surgery distal to the shoulder.
- The ultrasound probe should be manipulated at different angles to ensure an optimal image of the subclavian artery, brachial plexus, first rib, and pleura.
- Be prepared to abandon this approach for an alternative because of overlying arterial branches.
- The typical local anaesthetic volume required is 20 to 30 mL.
- The intercostobrachial nerve (from T2) is usually not affected but can be blocked by an additional subcutaneous injection.

INTRODUCTION

Brachial plexus blocks are commonly achieved via an interscalene, supraclavicular, infraclavicular, or axillary approach. The supraclavicular level is an ideal site to achieve anaesthesia of the entire upper extremity just distal to the shoulder as the plexus remains relatively tightly packed at this level, resulting in a rapid and high-quality block. For this reason, the supraclavicular block is often called the "spinal of the arm."

Kulenkampf[1] described the first percutaneous supraclavicular block of the brachial plexus in the early 1900s. However, the original technique was associated with a high incidence of pneumothorax. With the increased availability of ultrasound in clinical practice has come the ability to identify and avoid vascular and pleural structures as well as allow real-time visualisation of the needle. The evidence for the use of ultrasound in regional anaesthesia is growing, with a recently updated Cochrane Review suggesting it shortens block performance time, improves sensory and motor block, and reduces the need for block supplementation.[2]

Whilst there is evidence that the use of ultrasound decreases the incidence of pneumothorax and local anaesthetic systemic toxicity, there is no evidence that it reduces the incidence of peripheral nerve injury.[3]

ANATOMY

The brachial plexus is formed by the ventral rami of the lower 4 cervical and first thoracic nerve roots (C5-C8, T1). See Figure 1. These align to create the trunks, divisions, cords, and terminal branches that innervate the whole of the upper limb, except for the territory supplied by the intercostobrachial nerve (from T2), which provides sensory innervation to the medial aspect of the upper arm.

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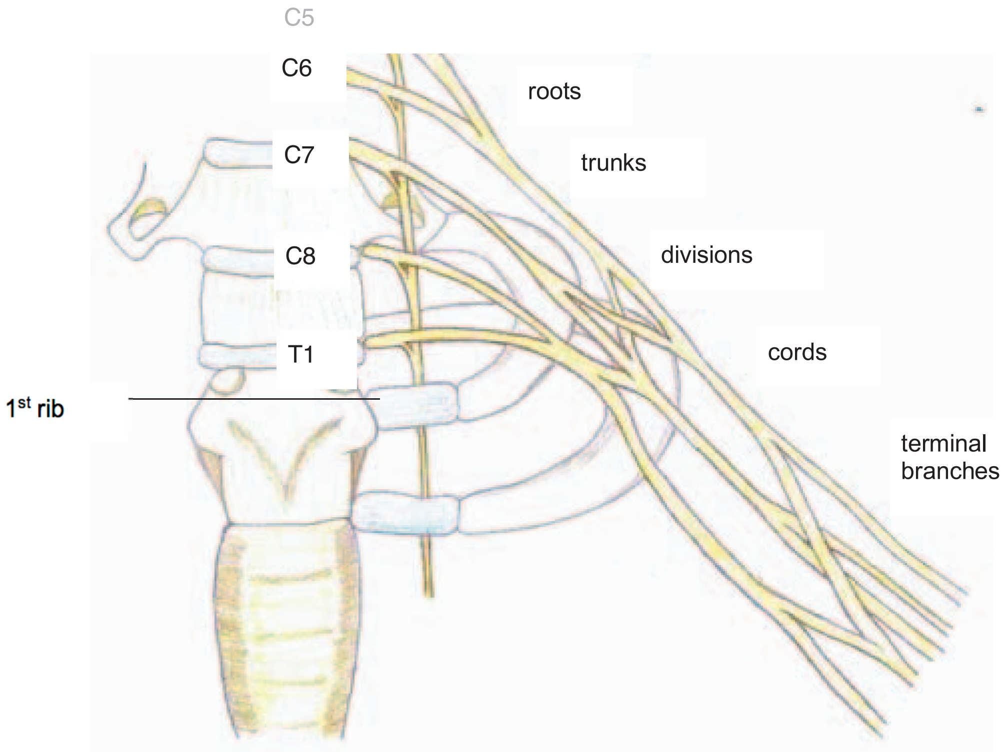

Figure 1. Anatomy of the brachial plexus showing the arrangements of the roots, trunks, divisions, cords, and terminal branches.

- At the periclavicular level, the brachial plexus consists of the superior (C5, 6), middle (C7), and inferior trunks (C8, T1).
- The short, wide trunks soon separate into anterior and posterior divisions.
- A compact fascial sheath encompasses the neurovascular bundle extending from the deep cervical fascia to slightly beyond the borders of the axilla.
- The trunks emerge along the outer border of the first rib and are stacked one on top of the other as they traverse the triangular interscalene groove formed between the anterior scalene and middle scalene muscles.
- Key landmarks from lateral to medial along the first rib are the middle scalene muscle, brachial plexus, subclavian artery, anterior scalene muscle, and subclavian vein. See Figure 2.

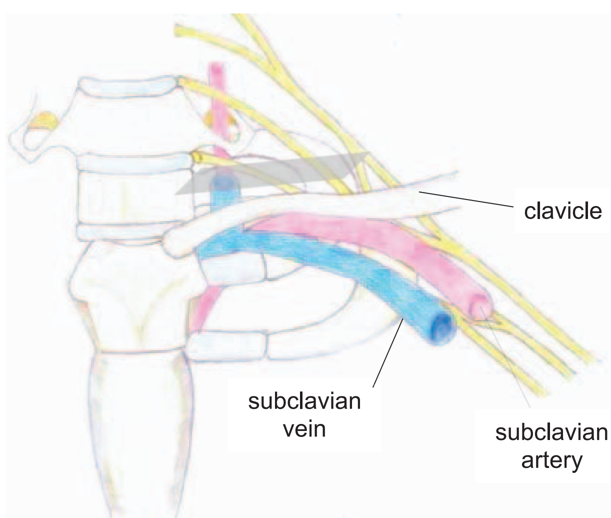

Figure 2. Anatomy of the brachial plexus demonstrating its relationship to the subclavian artery and vein. Note the brachial plexus lies lateral to the subclavian artery, which in turn lies lateral to the subclavian vein. The shaded gray box indicates the position of the ultrasound probe in the supraclavicular fossa.

- The plexus is initially posterosuperior and eventually lateral to the subclavian artery.
- The lower trunk may lie between the subclavian artery and the first rib.
- The first rib curves around the dome of the pleura. Because of this concavity, the dome of the pleura lies medial to the first rib and anterior scalene muscle.
- The phrenic nerve starts on the lateral border of the anterior scalene muscle, becoming more anterior as it moves distally.
- The cervical sympathetic chain runs medial to the anterior scalene muscle within the longus capitus muscle anterior to the transverse process of the cervical vertebra.
- The suprascapular artery or transverse cervical artery and/or vein may be seen traversing the plexus in the supraclavicular region.

CLINICAL APPLICATION

The supraclavicular approach to the brachial plexus provides reliable anaesthesia of the entire arm but only occasionally for the territory of the intercostobrachial nerve. It can be used for orthopaedic procedures below the level of the mid-humerus, including elbow, forearm, and hand surgery, as well as for the creation of arteriovenous fistulas from mid-arm to mid-forearm level.

Exercise caution in patients with significant lung disease because of the potential risk of respiratory compromise secondary to pneumothorax or phrenic nerve block, which can occur in 36% to 67% of patients.[3–5] Similarly, bilateral blocks should not be performed.

The intercostobrachial nerve (which is derived from T2 and therefore not part of the brachial plexus) is frequently not blocked by the supraclavicular approach to the brachial plexus. It supplies a small strip of skin along the medial aspect of the upper arm. It can be blocked directly by infiltrating approximately 10 milliliters of local anaesthetic is administered subcutaneously from the upper border of the biceps to the lower border of the triceps at the anterior axillary line. It can also be blocked directly using ultrasound guidance. Some authors have commented that this may reduce tourniquet pain during awake surgery under supraclavicular block, but this remains to be proven,[6] as tourniquet pain is probably also mediated by tissue ischaemia and not just local sensation.[7]

PREBLOCK PREPARATION

- Please also see **ATOTW 134 Peripheral nerve blocks getting started.**
- Obtain informed consent from the patient.[4]
- Ensure there are no contraindications to the procedure.
- In the event of inadvertent intravascular injection of local anaesthetic, full resuscitation facilities and Intralipid 20% should be immediately available. The Association of Anaesthetists of Great Britain and Ireland Management of Severe Local Anaesthetic Toxicity Guideline provides a structure for the management of this complication.[8]
- Establish intravenous access and attach appropriate monitoring: electrocardiogram, noninvasive blood pressure monitoring, and pulse oximeter.
- Confirm the correct side of block. An example of an approach to minimise wrong-sided blocks is provided by the "Stop Before You Block" toolkit on the Royal College of Anaesthetists' website.[9]
- Ensure appropriate aseptic precautions. This authors' preference is to prepare the site with chlorhexidine spray (0.5% chlorhexidine gluconate and 70% denatured ethanol) and allow it to dry before proceeding with a "no-touch" needling technique.

Equipment

Use a high-frequency linear probe (10 to 15 MHz).

A 50-mm or 80-mm length, short-bevel, insulated nerve stimulator needle should be used.

Peripheral nerve stimulation (PNS) is an additional way of confirming nerve location. If PNS is used, initial settings should be 0.5 mA current, 2 Hz frequency, and pulse width of 0.1 ms. Studies imply that combining PNS and ultrasound-guided regional anaesthesia (UGRA) techniques does not add value to ultrasound guidance alone. Block success was not improved when a motor response was present rather than unobtainable during needle placement for supraclavicular block.[10]

Patient Positioning

As with any procedure, ergonomics is key. When performing this block, we keep the patient sitting at 30° to 45° head up with the edge of a pillow supporting their head but not obscuring the block site. The head is turned slightly away from the side of the block. The operator should stand on the same side of the patient as the block, with the ultrasound machine on the opposite side. The operator's eyes should be in line with the needle, probe, and ultrasound screen. See Figure 3.

Figure 3. Photo demonstrating patient positioning and location of ultrasound machine for left-sided supraclavicular brachial plexus block.

Local Anaesthetic

Local anaesthetic choice, concentration, and volume should be tailored to the specific goals of surgical anaesthesia, postoperative analgesia, speed of onset, duration of block, and motor sparing effects.

Levobupivacaine (0.25%-0.5%) and bupivacaine (0.25%-0.5%) provide slower onset and long duration blocks and are commonly used in the United Kingdom. An alternative, ropivacaine (0.2%-0.75%), provides a moderately fast onset with long duration of action. For more rapid onset but shorter duration blocks, lidocaine (1%-2%) or prilocaine (1%) can be employed. Lidocaine and prilocaine can be combined with adrenaline to prolong the duration of block as well as to allow usage of larger volumes.

Although 0.2% to 0.5% ropivacaine and 0.25% bupivacaine provide excellent analgesia, neither consistently provides surgical anaesthesia.[2,3] Comparable and adequate surgical anaesthesia was obtained with plain 0.75% ropivacaine or plain 0.5% bupivacaine.[3] Twenty to 30 mL of local anaesthetic will suffice; however, it is possible to use significantly less (10-20 mL) with ultrasound guidance. It is imperative to be aware of, and stay within, the maximum safe doses of the local anaesthetic agents.

PRACTICAL CONDUCT OF THE BLOCK

Scanning Technique

Place the ultrasound probe over the supraclavicular fossa (Figure 4), aiming caudad, scanning at different angles to obtain the best image of the subclavian artery, brachial plexus, and first rib. Doppler ultrasound can be applied to further elucidate the position of blood vessels in the area of interest.

Nerve Localisation by Anatomic Correlation

Locate the pulsatile, hypoechoic subclavian artery sitting on the hyperechoic line of the first rib or pleura. Take care not to mistake the carotid artery for the subclavian. Confirm by scanning medially or laterally along the clavicle, as well as cranially up the interscalene groove where you can follow the brachial plexus and associated vessels proximally. The subclavian vein is located medial to the artery (not shown in image). The brachial plexus lies lateral to the subclavian artery and superior to the first rib. The first rib appears hyperechoic with an underlying shadow. Identify the hyperechoic line of the pleura and compare it with the hyperechoic first rib. Note the sliding movement of the pleura during respiration (Figure 5).

Figure 4. Simulated demonstration of ultrasound probe in right supraclavicular fossa.

Needle Insertion

After injecting a small amount of 1% lidocaine to anaesthetise the skin, insert the short bevel needle along the longitudinal axis of the ultrasound probe (in-plane needle approach). Ensure the needle is kept parallel to this axis at all times to improve visualisation of the needle tip.

The in-plane approach is strongly recommended for this block (Figure 6); the needle tip and shaft should be continuously visualised in real time to avoid inadvertent pleural puncture. Insert the needle lateral to the probe aiming medially. Advance the needle toward the junction of the subclavian artery and first rib. This area, which is inferomedial to the plexus, posterolateral to the subclavian artery, and superior to the first rib, is commonly referred to as "the corner pocket." Whilst this method benefits

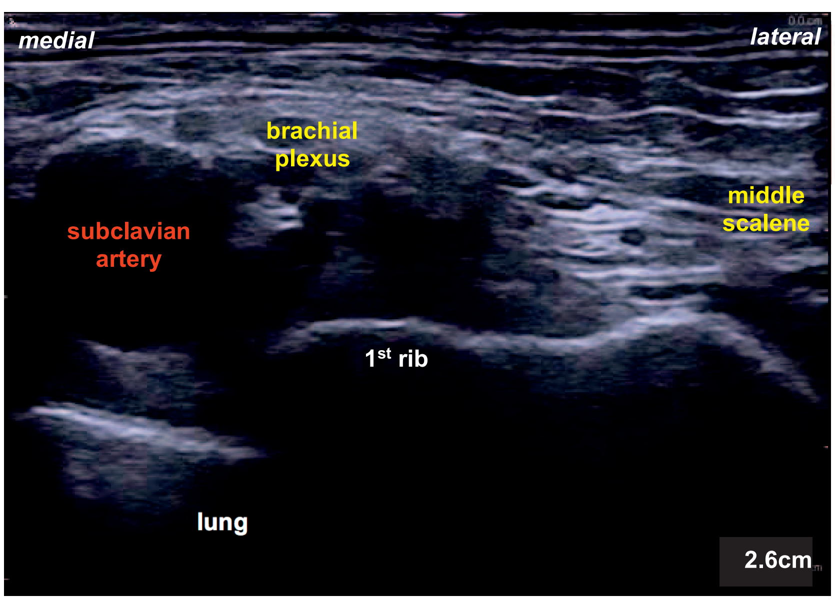

Figure 5. Ultrasound image demonstrating the relationship of the relevant structures in the supraclavicular fossa.

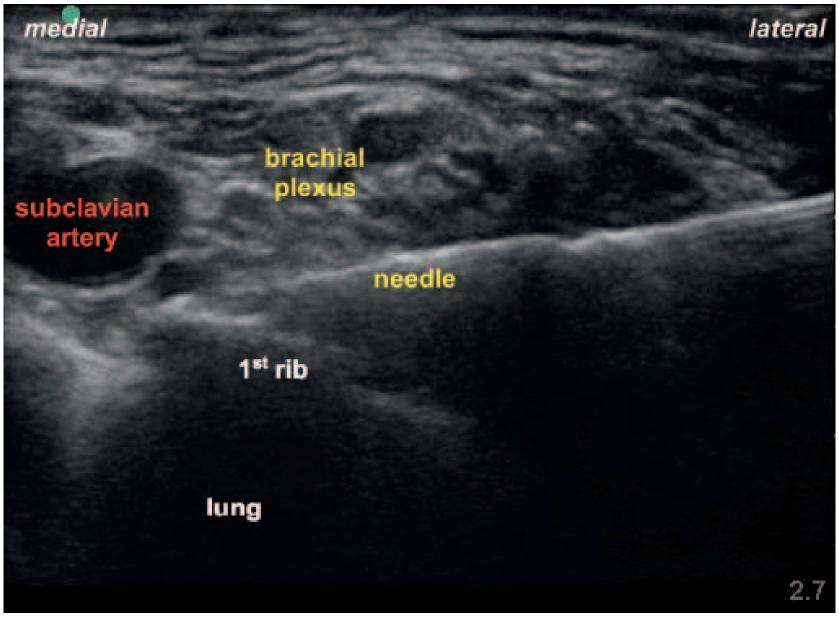

Figure 6. Ultrasound image demonstrating the in-plane needle approach. The needle tip is placed between the subclavian artery and first rib: "the corner pocket."

from a generally unobstructed route straight to the corner pocket, the major disadvantage is that the needle is directed toward the pleura. Directing the needle toward the first rib rather than the pleura can reduce the risk of accidently puncturing the pleura. Some practitioners therefore prefer a medial to lateral approach. This is theoretically safer as the needle movement is away from the lung. However, this approach requires expert manipulation of the needle, as the artery is in the path between the point of needle insertion and the corner pocket. In both techniques, the tip of the needle should be visualized at all times. Never advance the needle deep into the hyperechoic line of the rib/pleura.

Local Anaesthetic Injection

Ideal spread of local anaesthetic is beneath the brachial plexus (see Figure 7) and extending between the plexus and the artery. Half of the local anaesthetic is injected here in small 5-mL aliquots with repeated aspiration to reduce the risk of intravascular

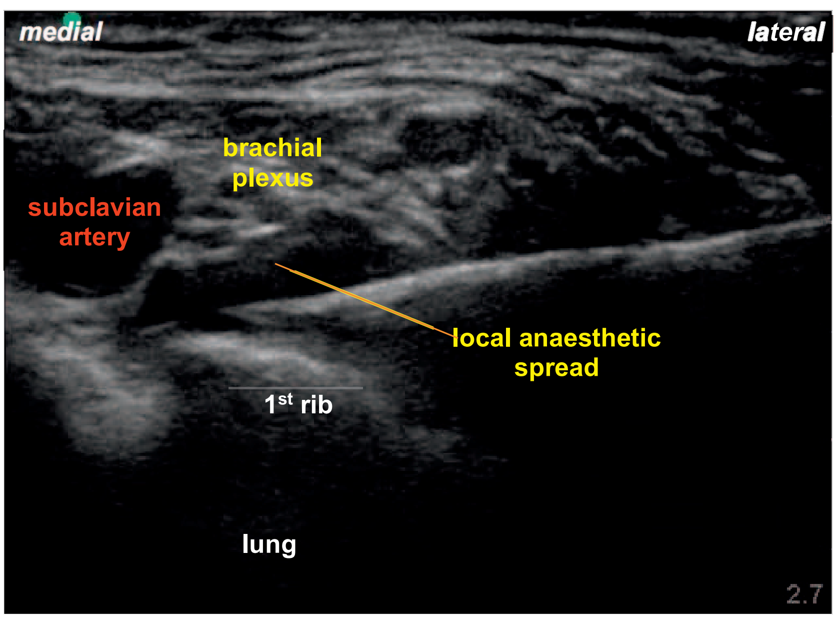

Figure 7. Ultrasound image demonstrating needle tip in "corner pocket." Note the brachial plexus has been lifted up by the injection of local anaesthetic and has become easier to visualise.

injection. The local anaesthetic hydrodissection "floats" the plexus superficially. The needle is then redirected toward the superficial aspect of the plexus or middle of the cluster (see Figure 8), and the remaining local anaesthetic is injected there.

The objective is to have the plexus surrounded by local anaesthetic (Figure 9). Injection pressure monitoring may be a useful safety monitor.[10] High injection pressures may indicate intraneural needle placement, so avoid injecting if there is high resistance, and readjust the needle position.

SIDE EFFECTS AND COMPLICATIONS

In experienced hands, ultrasound enables practitioners to visualise the nerves and adjacent structures as well as allow real-time visualisation of the needle tip and spread of local anaesthetic. This reduces the risk of complications such as pneumothorax and vascular puncture. See Table 1.

Side Effect or Complication	Further Information
Phrenic nerve block	Side effect (common)/complication (rare) Results in diaphragmatic paralysis, which may rarely cause respiratory compromise Incidence is lower (67% vs 92%) than with interscalene brachial plexus block
Horner's syndrome	Side effect (rare) Rare (approximately 1%) May result from proximal local anaesthetic spread and blockage of sympathetic afferents Causes meiosis, partial ptosis, and anhydrosis on the ipsilateral side
Recurrent laryngeal nerve block	Side effect (rare) Causes hoarse voice
Inadvertent arterial puncture	Complication Transverse cervical and dorsal scapular vessels can be seen in the vicinity of the brachial plexus; colour Doppler can help identify these vessels
Nerve injury	Complication (rare) Can present as transient residual paraesthesia or hypoesthesia (approximately 1 in 10) or rarely as permanent paresis (approximately 1 in 700 to 1 in 5000)
Pneumothorax	Complication (rare) Due to close proximity of pleura but incidence is $<$1:1000 and may be reduced using ultrasound
Local anaesthetic systemic toxicity (LAST)	Complication (rare) Can range from mild systemic symptoms to life-threatening central nervous and cardiovascular collapse In circulatory arrest, start cardiopulmonary resuscitation using standard protocols and administer lipid emulsion Refer to Association of Anaesthetists of Great Britain and Ireland safety guideline for an example of such a protocol[10]
Infections	Complication (rare) This is extremely rare if appropriate aseptic precautions are taken (skin antiseptic spray, sterile gloves, "no-touch" needle technique)
Haematoma	Complication (rare) Slightly more common with continuous catheters vs single-shot techniques

Table 1. Side Effects and Complications of Ultrasound-Guided Supraclavicular Brachial Plexus Block

SUMMARY

- The supraclavicular block results in anaesthesia of the upper arm distal to the shoulder.
- Care should be taken when performing this block in patients with underlying respiratory disease because of the high incidence of phrenic nerve block.
- PNS in addition to UGRA appears to do little to improve block success when compared with UGRA alone.
- Asfor any procedure, ergonomics is key: the operator should stand on the side of the block with the ultrasound screen opposite, as shown in Figure 3.
- Real-timevisualization of the needle tip using an in-plane approach is recommended.

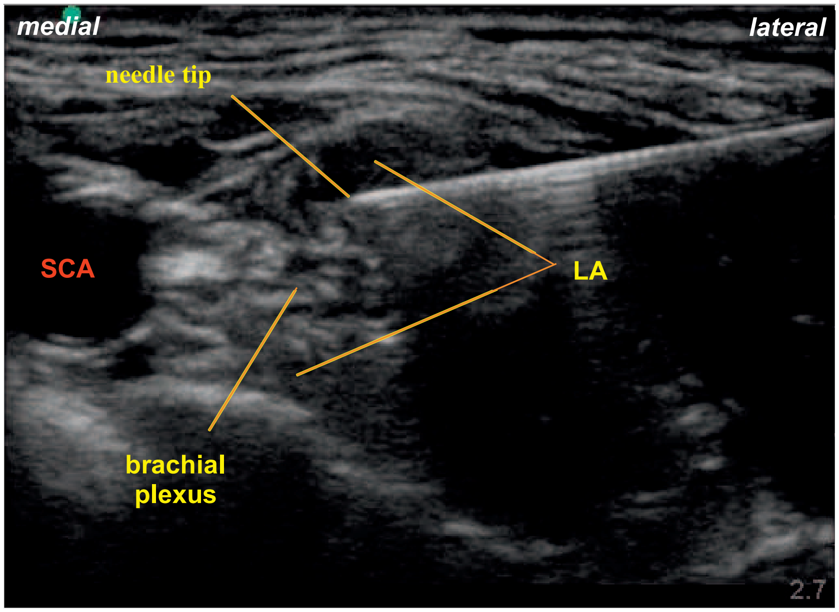

Figure 8. In-plane ultrasound image demonstrating the needle redirected to the superficial aspect of the plexus and the brachial plexus surrounded by local anaesthetic.

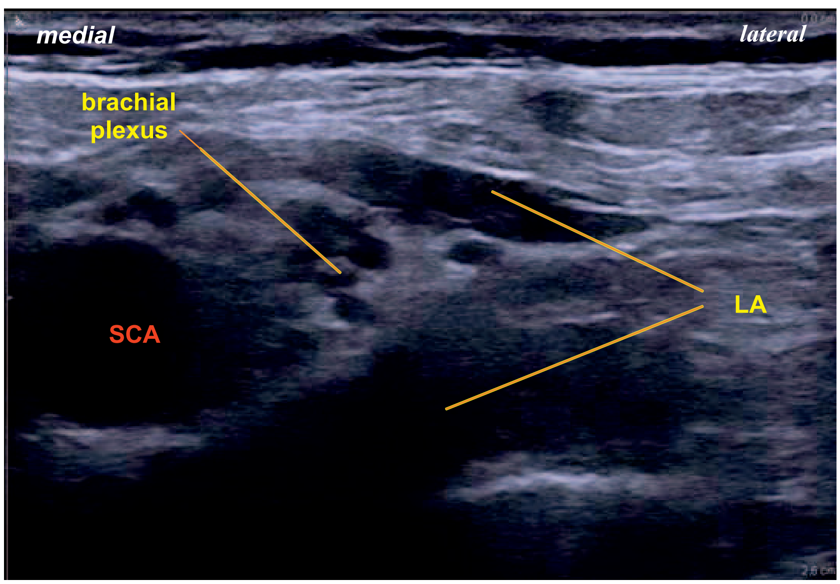

Figure 9. Ultrasound image demonstrating the brachial plexus surrounded by local anaesthetic.

ACKNOWLEDGEMENTS

Dr David Conn (1959-2015)

Dr David Conn passed away on 15 December 2015 (see *BMJ* obituary, *BMJ*. 2016;353:i1962). He worked at the Royal Devon & Exeter Hospital for nearly 20 years developing the pain service and becoming an expert practitioner in regional anaesthesia and a highly respected trainer of junior anaesthetists. He taught, published, and lectured widely on the subject, and the authors would like to take this opportunity to acknowledge his expert guidance and contribution to this tutorial.

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