

# Ultrasound Guided Axillary Brachial Plexus Block

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**ANAESTHESIA**  
TUTORIAL OF THE WEEK

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## QUESTIONS

Before continuing, try to answer the following questions. The answers can be found at the end of the article, together with an explanation. **Please answer True or False:**

### 1. Regarding ultrasound guided axillary brachial plexus block:

- A low frequency probe is used
- Arm abduction over 90° may be useful in identifying vascular structures
- The main landmark is the pulsatile, hyperechoic axillary artery which lies in close proximity to the nerves
- The ultrasound probe is placed transversely, approximately at the level at the junction of teres major and biceps brachii
- It can be performed by either an in-plane or out of plane technique

### 2. The following nerves provides cutaneous supply to the lateral forearm:

- Musculocutaneous nerve
- Ulnar nerve
- Radial nerve
- Median nerve
- Axillary nerve

### 3. The following statements are true:

- It is necessary to block the musculocutaneous nerve for elbow surgery
- A separate injection is usually required for the musculocutaneous nerve
- The radial nerve lies deep to the axillary artery
- The ulnar nerve lies lateral to the axillary artery
- It is possible to block the intercostobrachial nerve separately using ultrasound

## Key Points

- Ultrasound guided axillary block is a safe, reliable block of the brachial plexus.
- Place the transducer transversely across the axilla, approximately at the junction of biceps brachii and the pectorialis muscles.
- Use the axillary artery as a landmark: median, ulnar and radial nerves usually lie at 11, 2 and 5-6 o'clock respectively.
- A single injection will not usually block all four nerves, a separate injection is commonly required for the musculocutaneous nerve within the coracobrachialis.

## INTRODUCTION

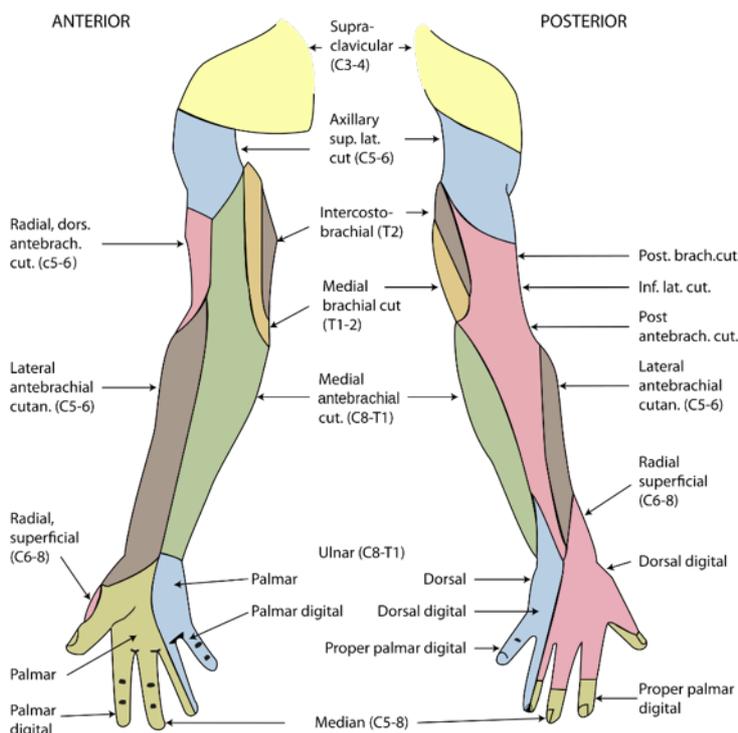
This article will focus on ultrasound guided approach to axillary brachial plexus block which aims to block the following four nerves: musculocutaneous, radial, ulnar and median. It is a popular block for hand and forearm surgery as it is relatively low risk compared with other brachial plexus blocks. The axillary artery is used as a landmark as it is closely associated with the nerves.

## ANATOMY

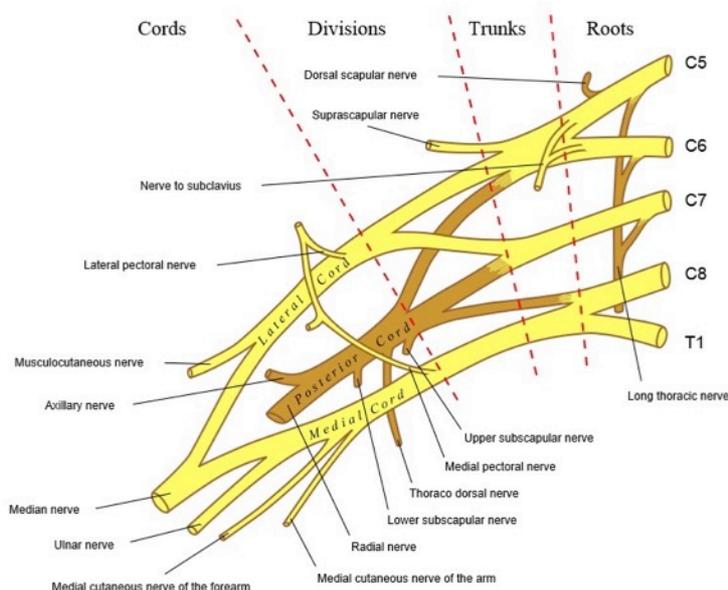
The majority of the upper limb is supplied by the brachial plexus (Figure 1). The plexus is formed from the anterior rami of the cervical spinal nerves C5-8 and the first thoracic spinal nerve T1 (Figure 2). Parts of the arm that do not receive cutaneous innervation from the brachial plexus are the upper medial portion of the arm which is innervated by the intercostobrachial nerve (T1-

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2) and the 'shoulder cape' region which is innervated by the supraclavicular nerve (originates from the cervical plexus). The axillary sheath is formed from the pre-vertebral fascia and envelops the brachial plexus from the cervical vertebrae to the distal axilla.



**Figure 1:** Illustration of the sensory innervation of the upper limb. The areas supplied by branches of the radial nerve are coloured pink. (Adapted from Gray's anatomy, taken from Wikipedia)



**Figure 2.** Illustration of the brachial plexus, right side (Adapted from Gray's Anatomy, taken from Wikipedia)

At the level of the axilla the brachial plexus forms its main terminal branches. The median, radial and ulnar nerves lie in close proximity to the axillary artery within the axillary sheath. The musculocutaneous nerve generally lies outside the sheath, usually within the body of coracobrachialis muscle.

It is important to appreciate the anatomical relationships of the nerves and their adjacent structures as they pass through the axilla. With this knowledge, nerves can be correctly identified under ultrasound guidance before proceeding with the block.

### Median Nerve (MN)

The median nerve enters the arm at the inferior border of teres major. It *descends with the brachial artery* on the medial aspect of the arm between biceps brachii and brachialis. Initially it lies lateral to the artery and then crosses over to lie medial to the artery at the level of the antecubital fossa.

### Ulnar Nerve (UN)

The ulnar nerve runs medial to the axillary artery in the axilla. It then *leaves the artery* to descend in the anterior compartment in the medial aspect of the arm. As it leaves the artery early on, this makes it easy to differentiate it from the median nerve when scanning distally down the arm. The ulnar nerve then pierces the medial intermuscular septum and enters the ulnar groove on the posterior surface of the medial epicondyle.

### Radial Nerve (RN)

As the radial nerve often lies deep to the axillary artery it can be difficult to identify as it may be obscured by acoustic enhancement (post-cystic enhancement). This is an ultrasound artifact that makes the area behind a vessel look artificially brighter (more hyperechoic). See *Anaesthesia Tutorial of the Week 218: The Physics of Ultrasound Part 2*. Scanning down the arm, the radial nerve passes posteriorly between teres major and long head of triceps brachii before entering the spiral groove of the humerus accompanied by the profunda brachii artery. Colour doppler may be useful to identify the artery to aid location of the radial nerve which closely accompanies it.

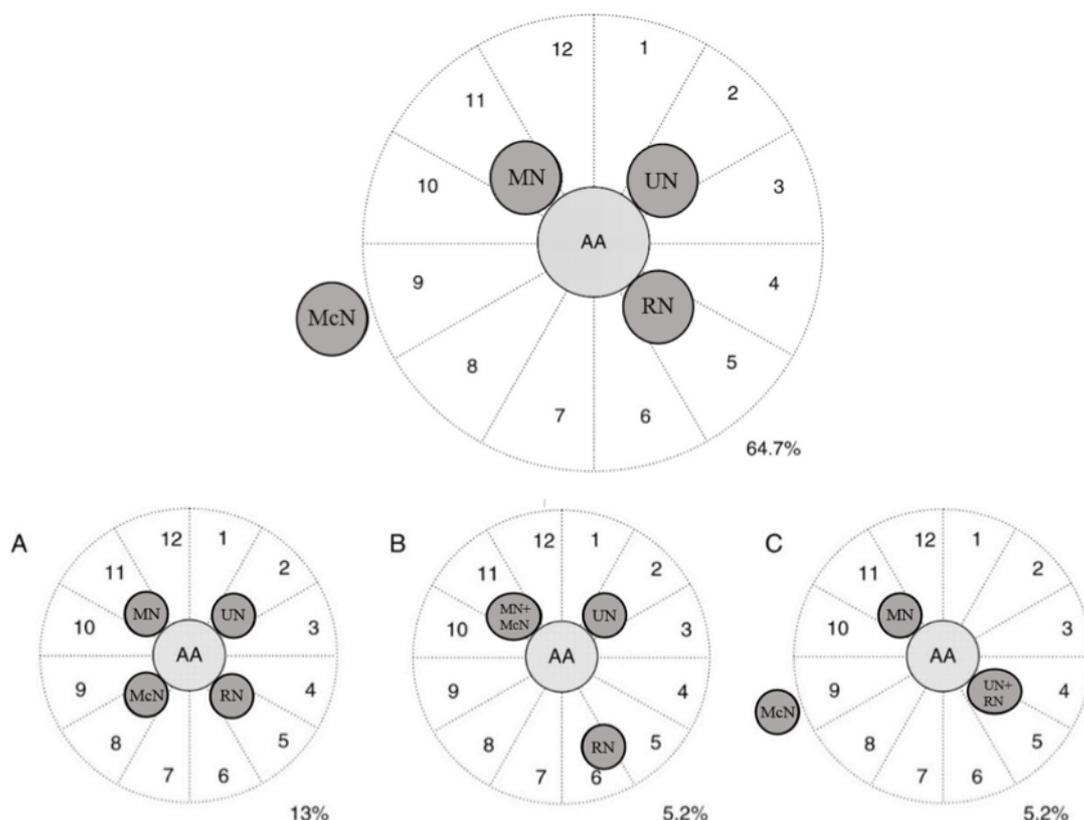
### Musculocutaneous Nerve (McN)

The musculocutaneous nerve penetrates coracobrachialis and lies between biceps brachii and brachialis as it descends obliquely towards the lateral side of the arm. It pierces the deep fascia lateral to the tendon of biceps brachii above the elbow. It enters the forearm to continue as the lateral cutaneous nerve of the forearm (lateral antebrachial cutaneous nerve) to supply skin sensation to the lateral aspect of the forearm. A common anatomical variant includes McN adherent to the MN, rather than within the body of coracobrachialis. This occurs in approximately 18% of patients<sup>1</sup>

## GENERAL POINTS

Nerves can be individually identified with the axillary brachial plexus block. As there is a large degree of anatomical variability (Figure 3), extended scanning up and down the arm is recommended to locate the nerves accurately.

Given the anatomical variability, it is not surprising ultrasound guided axillary blocks lead to a higher success rate compared with landmark techniques<sup>2</sup>. Ultrasound guidance has also been shown to reduce the risk of vascular puncture<sup>3</sup> and reduce block onset time<sup>4</sup> when compared with landmark techniques.



**Figure 3:** . Illustration of anatomical variability of main nerves at the level of the axilla. Left side lateral, right side medial. MN = median nerve UN = ulnar nerve RN = radial nerve McN = musculocutaneous nerve

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The axillary block is an excellent ‘beginners block.’ The most common complication is vascular puncture which can usually be managed simply with pressure over the affected area and there are no other major structures which can potentially be damaged at the site of block such as the pleura or spinal cord.

As with other blocks of the brachial plexus, the axillary block can be combined with peripheral nerve blocks of the forearm. Using a long acting local anaesthetic agent in the peripheral blocks and a short acting local anaesthetic agent for the axillary block, a fast onset reliable dense motor block for awake surgery can be augmented with prolonged analgesia to peripheral nerves covering the site of the surgery. The motor block from the short acting local anaesthetic in the axillary block will wear off more quickly allowing the patient earlier movement while the longer acting local anaesthetic in the peripheral nerve blocks will provide prolonged targeted post-operative analgesia.

The anatomical terms of location are confusing with axillary block as the elbow is flexed and the arm abducted during the procedure. Classically, with the landmark technique there is reference to being “above” and “below” the artery. For simplicity we will refer to structures in the anatomical position. We will refer to lateral as being “above” the artery towards coracobrachialis and the musculocutaneous nerve. Medial is therefore “below” the artery towards the underside of the arm. (Figure 7).

Indications	
<ul style="list-style-type: none"> <li>• Elbow, forearm and hand surgery</li> </ul>	

Contraindications	
<i>Absolute contraindications</i> <ul style="list-style-type: none"> <li>• Patient refusal</li> <li>• Local infection</li> <li>• LA allergy</li> </ul>	<i>Relative contraindications</i> <ul style="list-style-type: none"> <li>• Coagulopathy</li> <li>• Systemic infection</li> </ul>

## EQUIPMENT

- Short beveled regional block needle (50mm)
- US machine with high frequency linear probe
- Local anaesthetic
- 0.5% aqueous chlorhexidine (or equivalent)
- Sterile: gloves/probe cover/ultrasound gel

## GENERAL TECHNIQUE

- Gain IV access and apply monitoring: SpO<sub>2</sub>, ECG, Non-invasive blood pressure. Presence of a trained assistant and full resuscitation equipment availability including intralipid.
- Patient should be positioned supine with the arm abducted, forearm supinated and elbow flexed with the hand either behind or above the head (Figure 4). Do not use excessive arm abduction, it may obscure axillary artery and veins and limit the proximal spread of local anaesthetic.
- The block can be performed awake, under sedation or under general anaesthetic (GA). Extra caution must be taken if performing under GA or excessive sedation as the patient is unable to verbally feedback any pain or paraesthesia on needling or injection. Pain or paraesthesia may be associated with intraneural injection.
- Apply chlorhexidine 0.5% to block site and allow to dry. Apply sterile gel and cover to the ultrasound probe.
- **Ergonomics.** Ensure in-line alignment of patient, operator and ultrasound machine. Avoidance of turning or twisting of the operator’s head when performing the block will make the block more comfortable and easier to perform (Figure 4). It is acceptable to perform the block either from above (head end) or below (facing the patient). Place the transducer transversely across the axilla, approximately at the junction of biceps brachii and the pectorialis muscles.
- Perform a preliminary scan to identify structures – axillary artery, veins, nerves and muscles. Vascular structures will be anechoic (dark). Utilising colour doppler mode will also aid vessel identification. On the lateral side of the axillary artery identify biceps brachii (superficial) and coracobrachialis (deep). McN usually lies in coracobrachialis proximally and pierces through it distally to lie between biceps and coracobrachialis. In approximately 18% of individuals however, the McN lies adjacent to the artery (see Figure 3). Deep to the artery lies teres major and latissimus dorsi. When scanning more distally, triceps will come into view. The RN, MN and UN can be seen as hyperechoic (bright) structures surrounding the artery.

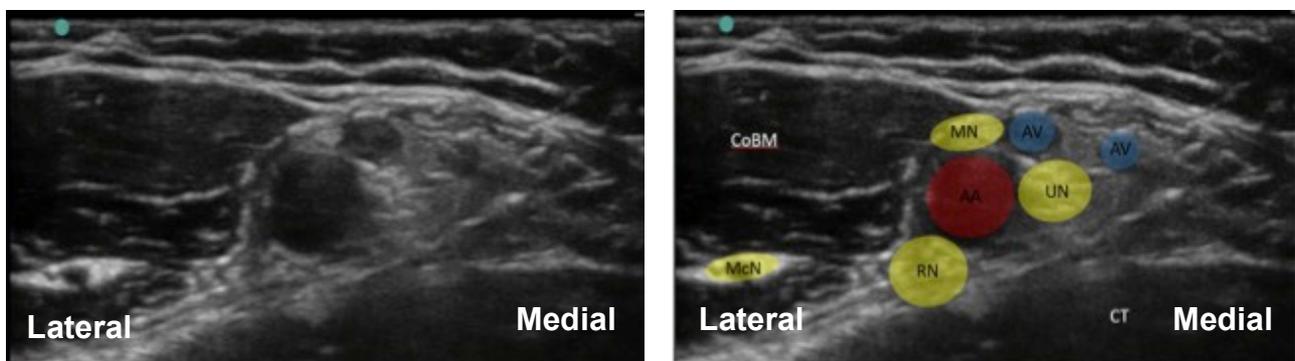


**Figure 4.** Axillary block ergonomic setup

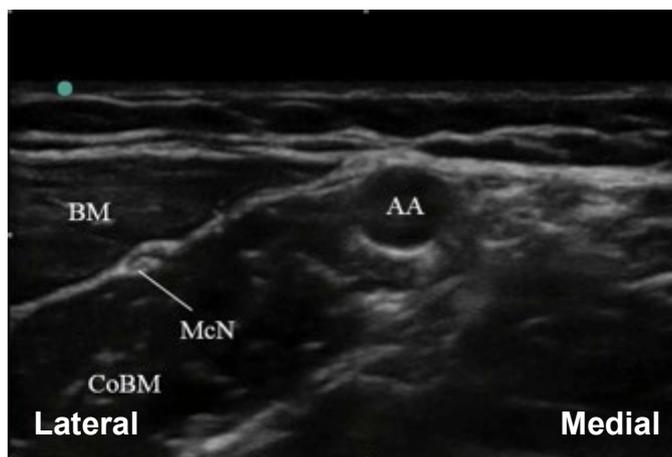
- Different types of local anaesthetic (LA) may be used, commonly long acting agents such as levobupivacaine or ropivacaine. For awake surgery it may be preferable to use LA with a quicker onset time e.g. lignocaine or prilocaine. Volume required is usually from 15-40mls. Be mindful not to exceed recommended LA doses if using larger volumes.
- **Awake surgery:** it is important to block McN (supplies biceps, brachialis and coracobrachialis) to help cover tourniquet pain and prevent arm movement during surgery. It should be noted that innervation of lateral cutaneous nerve of the forearm (terminal branch of McN) may innervate as far distally as the base of the thumb. For any surgery at this site it is important to block the McN.
- **Elbow surgery:** it is important to block McN for complete analgesia as branches from this nerve supply the elbow joint.

## BLOCK CONDUCT

- Most commonly relative to the axillary artery the **MN will lie at 11 o' clock, UN at 2 o'clock and RN at 5-6 o'clock** (Figure 5). Identifying the radial nerve may be difficult; it can be obscured by, or mistaken for acoustic artefact beneath the axillary artery
- Seek the classically triangular shaped musculocutaneous nerve within coracobrachialis. It is important to scan up and down the arm to confirm position of McN. Hyperechoic fascial layers that may be mistaken for McN will fade into muscle, McN will not.
- McN is often easier to identify more distally in the upper arm a few cm away from the axilla, here it usually lies between coracobrachialis and biceps brachii (Figure 6).

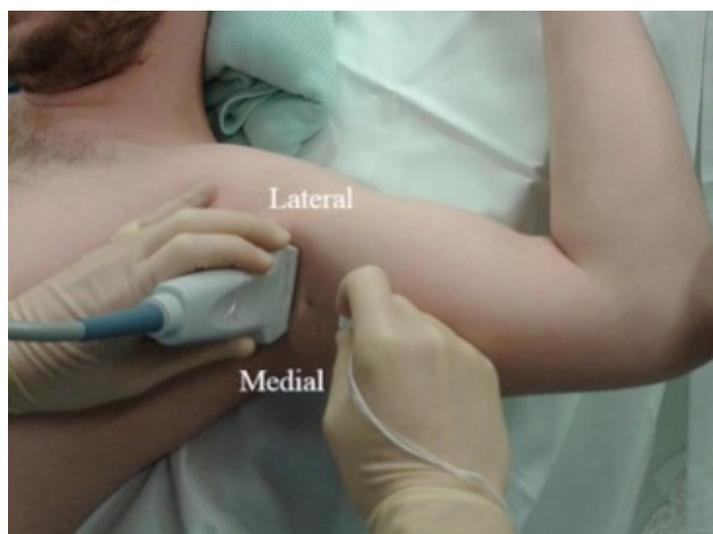


**Figure 5.** Ultrasound view of right axillary brachial plexus AA = axillary artery AV = axillary vein McN = musculocutaneous nerve RN = radial nerve UN = ulnar nerve MN = median nerve CoBM = coracobrachialis muscle CT = conjoint tendon



**Figure 6.** Ultrasound view 7cm distally from junction of biceps brachii and pectorialis muscles on right side. Musculocutaneous nerve is often easier to identify at this point. AA = axillary artery CoBM = coracobrachialis muscle BM = Biceps brachii muscle

- Both in-plane (IP) and out-of-plane (OOP) techniques are commonly used (Figures 7 and 8). OOP has the advantage of having a shorter path to the nerve, making it less painful for the patient. IP has the advantage of better needle visualization and needle accuracy. When performing IP it is preferable to approach from the lateral side of the artery - this avoids needling through veins which usually lie medial to the artery and provides an easier shorter needle path to block the McN.
- **IP approach** – Insert the needle through the skin on the lateral side of the probe at an angle of approximately 30°. Pass the needle in a lateral to medial direction (Figures 9,10 and11).
- **OOP approach** – Insert the needle through the skin on the distal side of the probe (Figure 7) at an angle of approximately 60°. Needle reinsertion may be required to achieve LA placement in the desired locations (Figure 12).
- Having identified all four nerves, using US guidance inject LA around nerves with separate injections. Inject approximately 5 ml of LA around each nerve. Adequate blockade of the McN is achieved with 2-5 ml as this nerve is relatively small.



**Figure 7.** Out of plane technique for left sided axillary brachial plexus block



**Figure 8.** In-plane technique with lateral to medial approach for right sided brachial plexus block

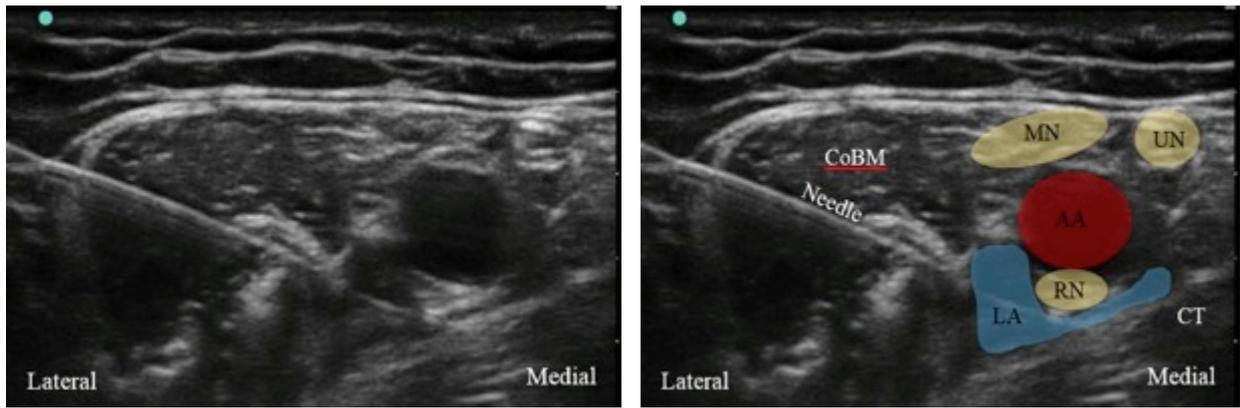


Figure 9: Blocking radial nerve (right arm) with in-plane approach

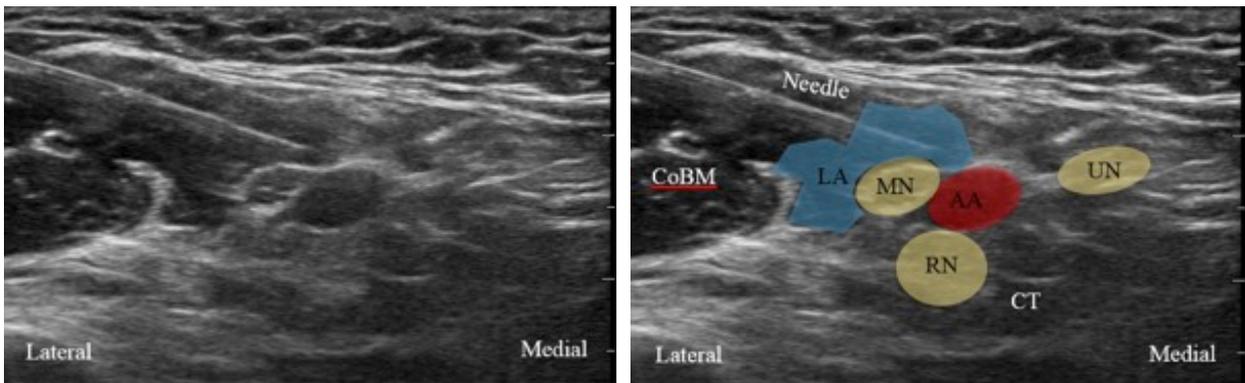


Figure 10: Blocking median nerve (right arm) with in-plane approach

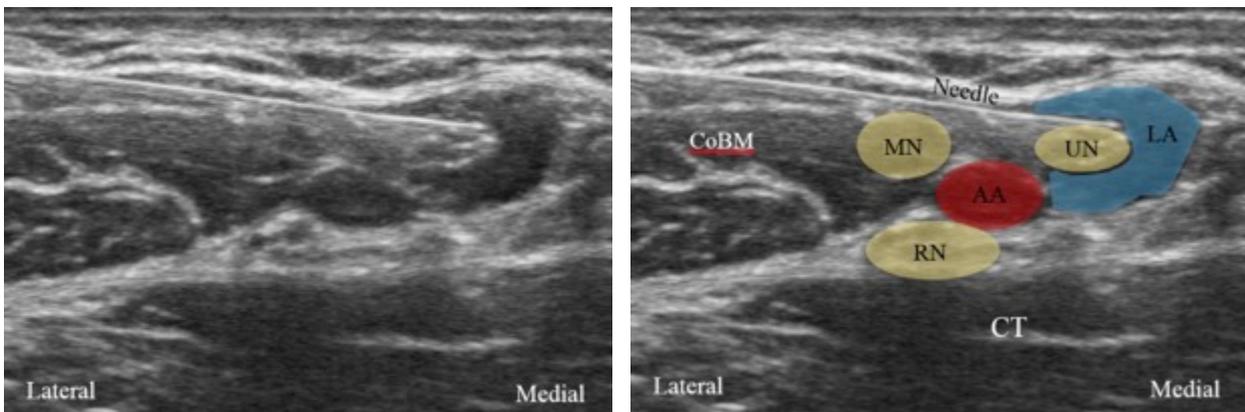


Figure 11: Blocking ulnar nerve (right arm) with in-plane approach

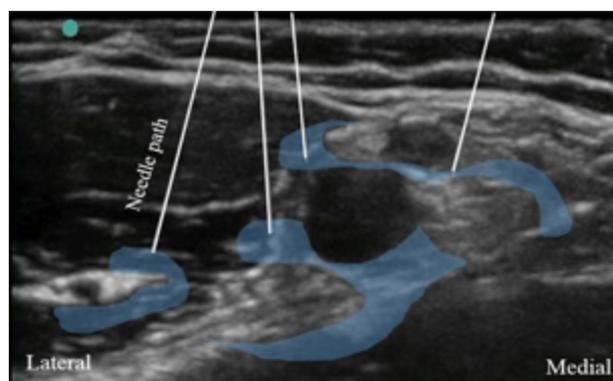


Figure 12: Ultrasound view with artificial overlay demonstrating ideal needle paths and LA spread with 4 injection technique out-of-plane right sided axillary brachial plexus block

- Use hydrodissection to aid nerve identification and move nerves away from vessels. Be aware multiple needle passes may increase the risk of nerve injury and vascular puncture
- Pay attention to LA spread under US and endeavor to get good coverage around each nerve. It is preferable to block nerves innervating the site of surgery first, reducing time to surgical anaesthesia. When anaesthesia of all four nerves are of equal importance, block the RN first. The RN is the largest of the nerves and onset of anesthesia takes longer compared with the other nerves in the axilla.
- As a point of interest, O'Donnell et al. showed a volume as little as 1 ml of LA injected separately for each nerve was sufficient to provide anaesthesia for awake surgery with average block duration of 3 hours<sup>5</sup>.
- It is important to appreciate that fascial layers can impede LA spread affecting the onset time and efficacy of the block. Dissection studies show that these layers inhibit spread of injectate. Leakage between fascial layers can occur with higher injectate volumes<sup>6</sup>. Larger volumes may be more desirable in awake surgery to reduce block failure<sup>7</sup>.

## PERIVASCULAR TECHNIQUE

- The LA injection technique described above targets individual nerves (*perineural technique*) and is the authors' technique of choice. For completeness we describe an alternative injection technique where LA is injected around points relative to the axillary artery: the *perivascular technique*.
- Injections are made adjacent to the axillary artery at 11 o' clock, 2 o'clock and 6 o' clock, ensuring coverage of the MN, UN and RN. Usually McN requires a separate perineural injection. There are therefore a total of 4 separate injections. Inject 5-10 ml of LA in each perivascular position, 2-5 ml is sufficient for McN. The separate injection for the McN may not be required if it lies in close proximity to the axillary artery, resulting in 3 injections (see Figure 3, example A).
- Although 3 perivascular injections will adequately cover MN, UN, and RN, studies have shown 3 injections may not be necessary. Using a high-volume (35ml) single injection at 6 o' clock blocking RN, MN and UN may be as effective as 3 separate perivascular injections in terms of total anesthesia-related time, success rate and block-related pain scores.<sup>8,9</sup>
- It is still important to visualise the nerves so direct nerve puncture is avoided during needling.

## INTERCOSTOBRACHIAL NERVE BLOCK

If an arm tourniquet is required, tourniquet pain may be better tolerated with an intercostobrachial nerve (IcBN) block. IcBN is the lateral branch of the anterior ramus of T2 and provides cutaneous innervation to the upper medial and posterior part of the arm. It can be blocked by subcutaneous infiltration along the medial aspect of the arm from the anterior axillary line to the border of triceps. Using a landmark technique 5 – 10 ml of local anaesthetic is required (Figure 13). Ultrasound guided block of IcBN can be challenging as the nerve is small and difficult to identify; it is superficial to the deep fascia in the subcutaneous tissue, medial to the axillary artery. To block this nerve using ultrasound 1 – 3 ml of local anaesthetic is usually sufficient (Figure 14).

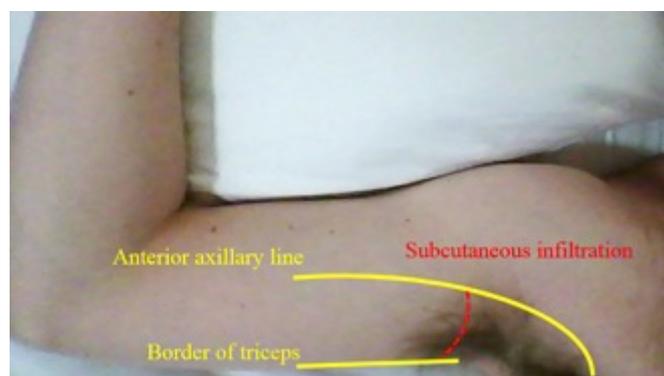
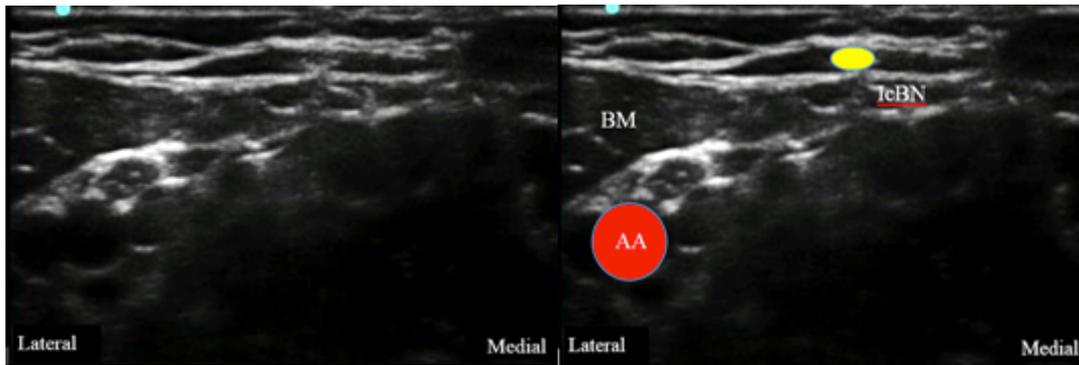


Figure 13: Surface anatomy for intercostobrachial nerve block, landmark technique



**Figure 14:** Ultrasound view of right intercostobrachial nerve. AA = axillary artery BM = biceps brachii muscle IcBN = intercostobrachial nerve

## AXILLARY BLOCK- LANDMARK TECHNIQUE

Please see axillary brachial plexus block landmark technique, Anaesthetic Tutorial of the Week 165 (11th January 2010, Dr Z Harclerode, Dr S Michael)

## ANSWERS TO QUESTIONS

1.
  - a. **False.** A high frequency probe is used.
  - b. **False.** Excessive arm abduction may obscure axillary artery & veins and limit proximal spread of local anaesthetic.
  - c. **False.** Blood vessels are anechoic.
  - d. **True.** A high frequency probe is placed proximally at the level of the junction between teres major and biceps brachii. At this level the radial nerve is more reliably identified.
  - e. **True.** Either an in plane or out of plane technique can be used.
  
2.
  - a. **True.** Lateral antebrachial cutaneous nerve is a branch of the musculocutaneous nerve and supplies sensation to the lateral forearm.
  - b. **False.** Ulnar nerve supplies cutaneous innervation to both surfaces of the medial 1 ½ fingers
  - c. **False.** Radial nerve and its branches supply cutaneous innervation to the posterior aspect of the arm and forearm. Distally the superficial branch of the radial nerve supplies the dorsum of the hand (lateral 3 ½ fingers except finger tips).
  - d. **False.** Median nerve supplies cutaneous innervation to the lateral aspect of the palm, palmar surface of first 3 ½ digits and dorsal aspect of their tips.
  - e. **False.** Axillary nerve supplies sensation to a small area on the lateral proximal aspect of the upper arm.
  
3.
  - a. **True.** Branches of the musculocutaneous nerve supply the elbow joint.
  - b. **True.** A separate injection is required for musculocutaneous nerve in most individuals as it lies outside the axillary sheath.
  - c. **True.** The radial nerve usually lies deep to the axillary artery at the 5-6 o'clock position.
  - d. **False.** The ulnar nerve is the terminal branch of the medial cord and located medial to the axillary artery.
  - e. **True.** It can be located with ultrasound lying superficial to the deep fascia in the subcutaneous tissue, medial to the axillary artery

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## Sources of Images:

Fig 1: Adapted picture from Gray's anatomy <http://commons.wikimedia.org/wiki/File:Gray812and814.svg> public domain

Fig 2 : Adapted picture form Gray's anatomy [http://en.wikipedia.org/wiki/File:Brachial\\_plexus\\_2.svg](http://en.wikipedia.org/wiki/File:Brachial_plexus_2.svg) public domain

Fig 3: Christophe J-L, Berthier F, Boillot A, Tatu A, Viennet A, Boichut N and Samain E Assessment of topographic brachial plexus nerves variations at the axilla using ultrasonography Br. J. Anaesth. 2009 103 (4): 606-612

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