

ANKLE BLOCK LANDMARK AND ULTRASOUND TECHNIQUE ANAESTHESIA TUTORIAL OF THE WEEK 178

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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.

1. Commencing at a level just proximal to the medial malleolus and moving posteriorly toward the Achilles tendon; What is the correct order of structures?
 - a. tibialis posterior, flexor digitorum longus, posterior tibial artery, tibial nerve, flexor hallucis longus, Achilles tendon
 - b. flexor hallucis longus, tibialis posterior, flexor digitorum longus, tibial nerve, posterior tibial artery, Achilles tendon
 - c. tibial nerve, anterior tibial artery, tibialis posterior, flexor hallucis longus, flexor digitorum longus, Achilles tendon
 - d. tibialis posterior, flexor hallucis longus, posterior tibial artery, tibial nerve, flexor digitorum longus, Achilles tendon

2. Which of the following statements regarding the saphenous nerve are true?
 - a. always supplies sensation over the medial aspect of the foot
 - b. is a branch of the sciatic nerve
 - c. is difficult to visualise with ultrasound at the ankle
 - d. is best to block first, as it is the largest of the nerves supplying the ankle

3. The following statements are true regarding ultrasound guided ankle block...
 - a. is performed more proximally on the leg than the landmark technique
 - b. all the nerves possess helpful vascular landmarks to assist identification
 - c. the tibial nerve should be blocked last because it is the smallest nerve and has the fastest the onset of anaesthesia
 - d. the sural nerve should always be anaesthetised as part of performing an ankle block, irrespective of the site of surgery

INTRODUCTION

In this article we describe a technique for blocking the nerves of the foot and ankle with the assistance of ultrasound. The block techniques for the 5 nerves supplying the foot are described individually and include ultrasound images and photographs of the procedure. For completeness, a landmark ankle block technique is included at the end of the article.

Anatomy – Cutaneous innervation

The foot is supplied by five nerves, tibial, saphenous, superficial and deep peroneal (fibular) and sural. The diagram below represents the cutaneous innervation of each nerve. It is important to note that whilst this represents 'normal' anatomical distribution there is considerable variation and overlap of nerve territories between individuals.

Tibial	Gives off calcaneal, medial and lateral plantar nerves which supply the skin on the sole of the foot and deep structures
Saphenous	Variable, may not contribute to cutaneous innervation or may supply skin on the medial aspect of foot down to great toe
Superficial Peroneal	Skin on the dorsum of the foot
Deep Peroneal	Skin of the 1st web space
Sural	Skin on the lateral aspect of foot

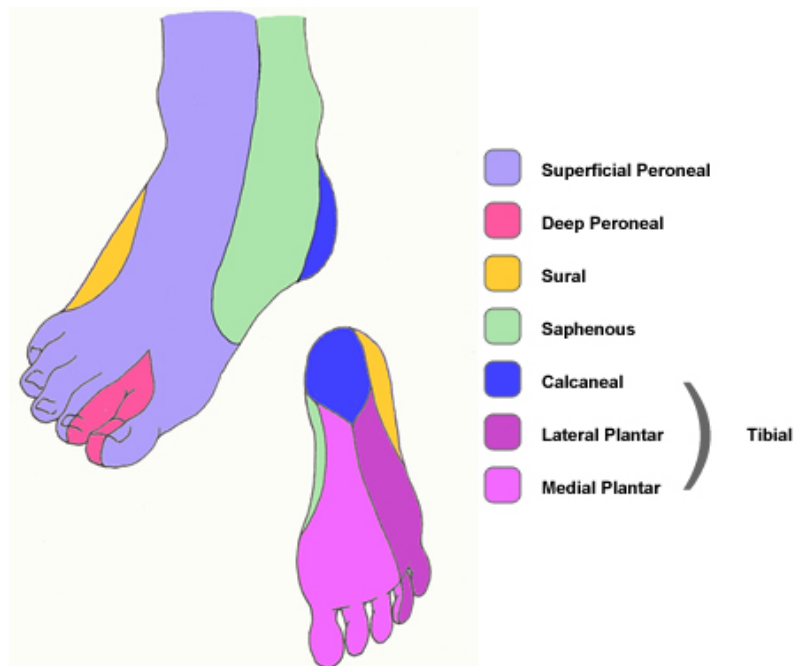


Figure 1. Illustration of the sensory innervation of the foot and ankle (reproduced with permission from Dr. Alice Roberts)

General points

Exactly which nerves need to be blocked will depend on site of surgery. If surgery avoids the 1st and 2nd toes/metatarsals then a block of the saphenous or deep fibular nerve is not required. Likewise, if surgery does not involve 5th metatarsal/toe then blocking the sural nerve may not be necessary. However, its cutaneous innervation can spread more medially to involve 3rd-5th toes and consideration to this should be given when choosing whether to block it or not.

Under ultrasound the nerves are blocked more proximally than using a traditional technique because:

- Bony prominence around ankle makes good skin contact difficult
- Pressure over bone obliterates vascular landmarks
- The achilles tendon is avoided when performing an 'in-plane' approach to tibial nerve

When visualising a static ultrasound image it can be difficult to define the exact margins of these small nerves. If you scan up and down the limb and observe the nerve moving in relation to the other structures it will help you demarcate the nerve boundaries more easily.

Equipment

- Short bevelled block needle (50mm)*
- US machine with high frequency linear probe
- Local anaesthetic
- 2% aqueous chlorhexidine (or equivalent)
- Sterile drapes/gloves/probe cover/ultrasound gel
- Ankle tourniquet[□]

* Once confident with sono-anatomy and needle visualization using a 27 gauge needle attached to an extension avoids having to use local infiltration before needle insertion. It is more comfortable for the patient but may increase the risk of intraneural needle placement as it is more difficult to visualize and will penetrate a nerve more easily than a short beveled needle. In addition the increased resistance to injection from the narrow bore needle may mask an indicator of intraneural injection. This technique should be reserved for those who already have considerable experience with ultrasound guided regional anaesthesia and are familiar with the ankle sonoanatomy.

[□]Remember to use an ankle tourniquet in an awake patient.

General Technique

- If needling with right hand stand, stand on the left-hand side of the patient, all nerves on both legs are accessible from this position so it avoids moving the equipment around the room.
- Position the patient supine with leg to be blocked crossed over the knee in a figure '4' position.
- Aim for the ultrasound machine, probe/needle/patient and operator to be in-line (photo 1).
- All injections are described as an in-plane technique.
- Always start with the tibial nerve, it is the largest nerve and therefore takes the longest for the block to develop (up to 20 minutes).
- Position your needle initially deep to the nerve in the 6 o'clock position, inject, if spread is not circumferential then reposition your needle to the 12 o'clock position.
- Inject up to 2ml of LA around each nerve (except for the tibial nerve where up to 5ml may be required for good perineural spread).



Photo 1: The relative positioning of the ultrasound machine, probe/needle, patient and operator: ideally all in-line.

To read about the nerve blocks of the ankle individually you use the following links or turn to the page indicated...

Tibial Nerve	page 5
Saphenous Nerve	page 8
Superficial Peroneal Nerve	page 10
Deep Peroneal Nerve	page 14
Sural Nerve	page 18

TIBIAL NERVE

Anatomy & Sono-anatomy

At the level of the medial malleolus several structures lie between the tibia and the Achilles tendon that can be visualized with ultrasound. The order traveling posteriorly from the medial aspect of the tibia is noted below (Figure 2).

- The tibial nerve usually lies immediately behind the posterior tibial vessels (Figures 2 & 3) but occasionally it can lie anterior.
- It lies on and superficial to the belly and tendon of flexor hallucis longus (FHL).

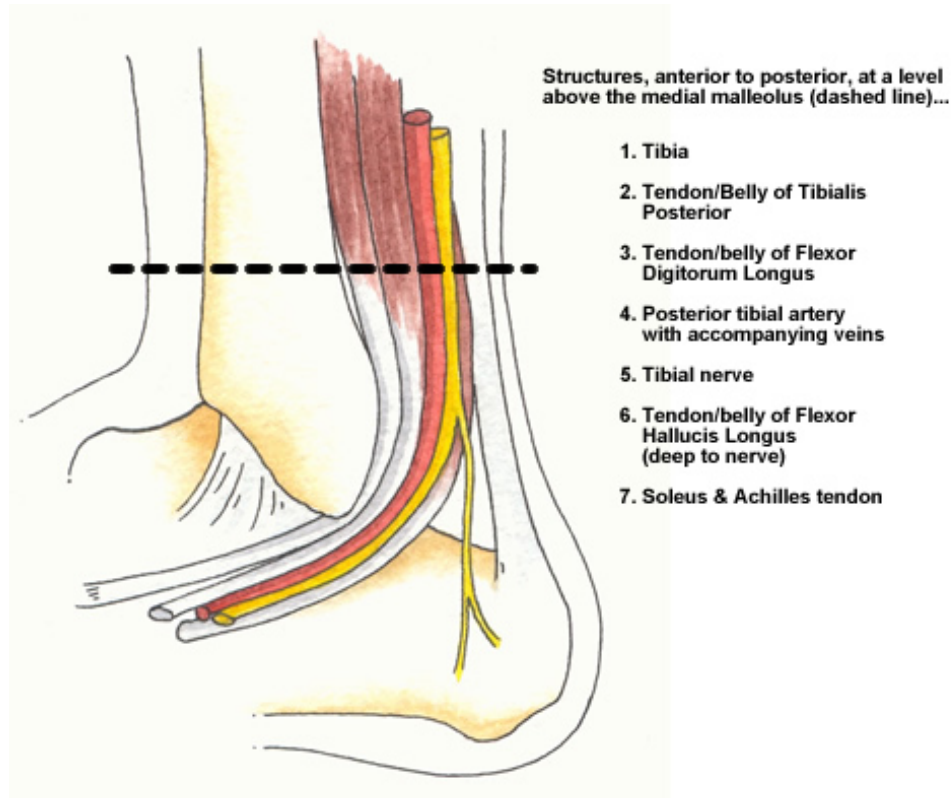


Figure 2: The relationships of the tibial nerve at the ankle (reproduced with permission from Dr. Alice Roberts)

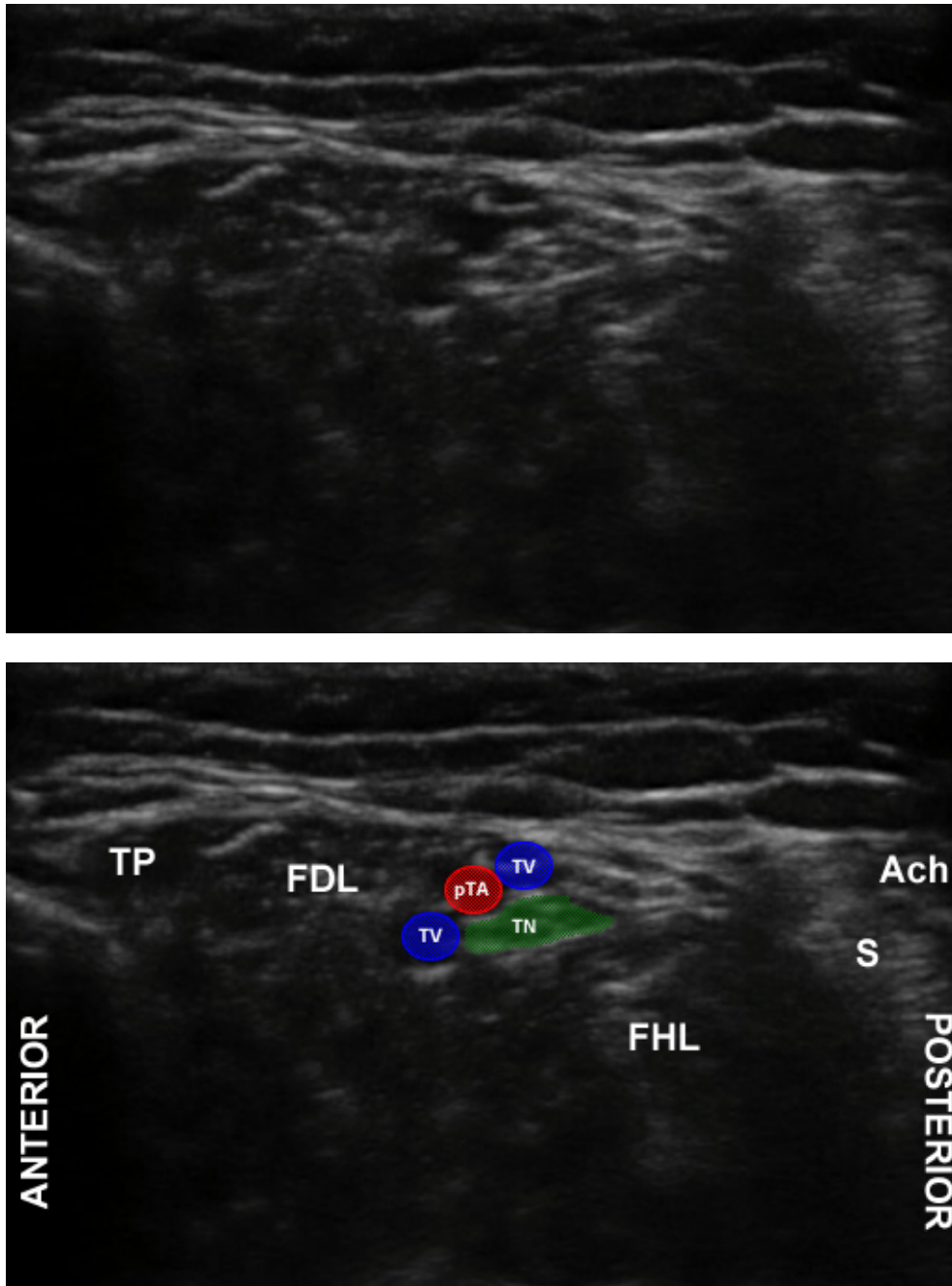


Figure 3: US image illustrating the relationship of the posterior tibial artery (pTA) and veins (TV), flexor hallucis longus (FHL), flexor digitorum longus (FDL), Achilles tendon (Ach), soleus (S) and the tendon of tibialis posterior (TP) to the tibial nerve (TN).

Block Conduct

- Scan between the tibia and Achilles tendon in a proximal direction from just above the medial malleolus.
- All of the structures listed above are visible with ultrasound.
- Try to define each one and scan up and down the leg to get the best view of the nerve.
- Ensure that your probe rests proximally enough to ensure the needle approach will not pierce the Achilles tendon (Photo 2).
- Approach with the needle 'in-plane' with the US probe from posterior aspect of leg.
- Caution must be used when the tibial nerve lies anterior to the vessels as the tendon of FHL then lies posterior to vessels and may easily be mistaken for the nerve.



Photo 2: Alignment of the operator, US probe and US machine during a tibial nerve block; note the posterior, in-plane approach of the needle.

SAPHENOUS NERVE

Anatomy & Sono-anatomy

The saphenous nerve travels down the medial aspect of the leg usually posterior and in close proximity to the great saphenous vein. At the ankle it passes in front of the medial malleolus. It commonly only supplies skin down to the medial malleolus but may go on to supply skin on the medial aspect of the foot. Visualizing this nerve which may either be very small or absent, is challenging.

If the surgical site requires the saphenous nerve to be blocked then performing a peri-venous injection around the great saphenous vein proximal to the ankle will suffice. If the vein has been harvested for coronary grafting a more proximal saphenous block above or below the knee where visual landmarks are maintained may be easier to perform.

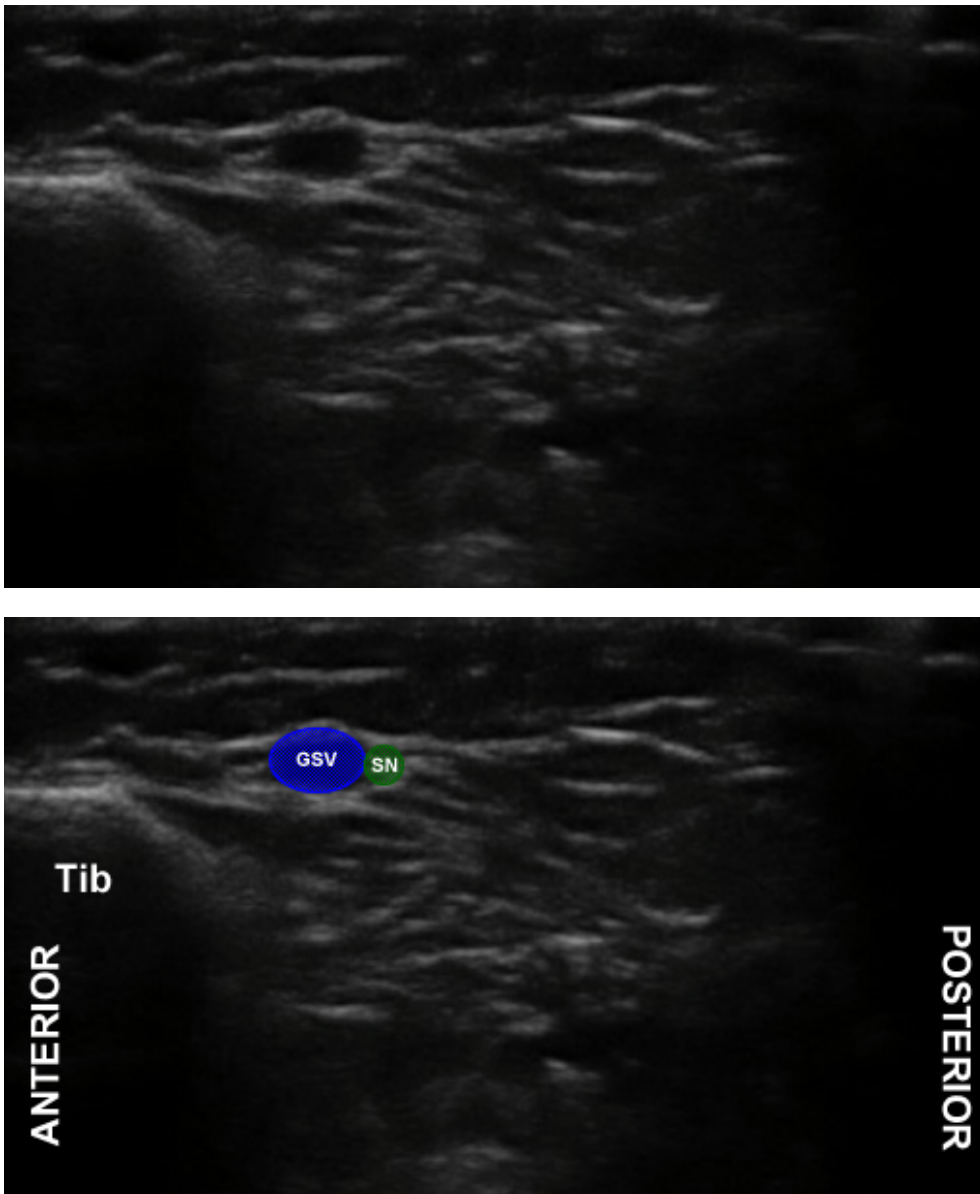


Figure 4: US image illustrating the relationship of the tibia (Tib) to the great saphenous vein (GSV) and the saphenous nerve (SN).

Block Conduct

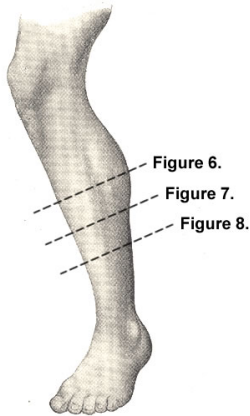
- Place the probe over the antero-medial aspect of the ankle gently so as not to compress the vein.
- Trace the vein proximally up the leg until you are able to maintain good skin contact without obliterating the vessel.
- Approach with your needle in-plane from posterior aspect of the leg and place at 5 o'clock to the vein.



Photo 3: Photo showing the alignment of the operator, US probe and US machine during a saphenous nerve block.

SUPERFICIAL PERONEAL NERVE

Anatomy & Sono-anatomy



The common peroneal nerve divides into the superficial and deep peroneal nerves within the belly of peroneus longus. The superficial branch then travels down through the leg lying first between peroneus longus and brevis and then in the groove between peroneus brevis and extensor digitorum longus underneath the cover of deep fascia. Distal to this, the nerve penetrates the deep fascia to become superficial and divides into branches that supply the skin of the dorsum of the foot (Figures 6, 7 & 8).

Figure 5: Illustration of the levels at which the ultrasound images in figures 6, 7 & 8 were captured.

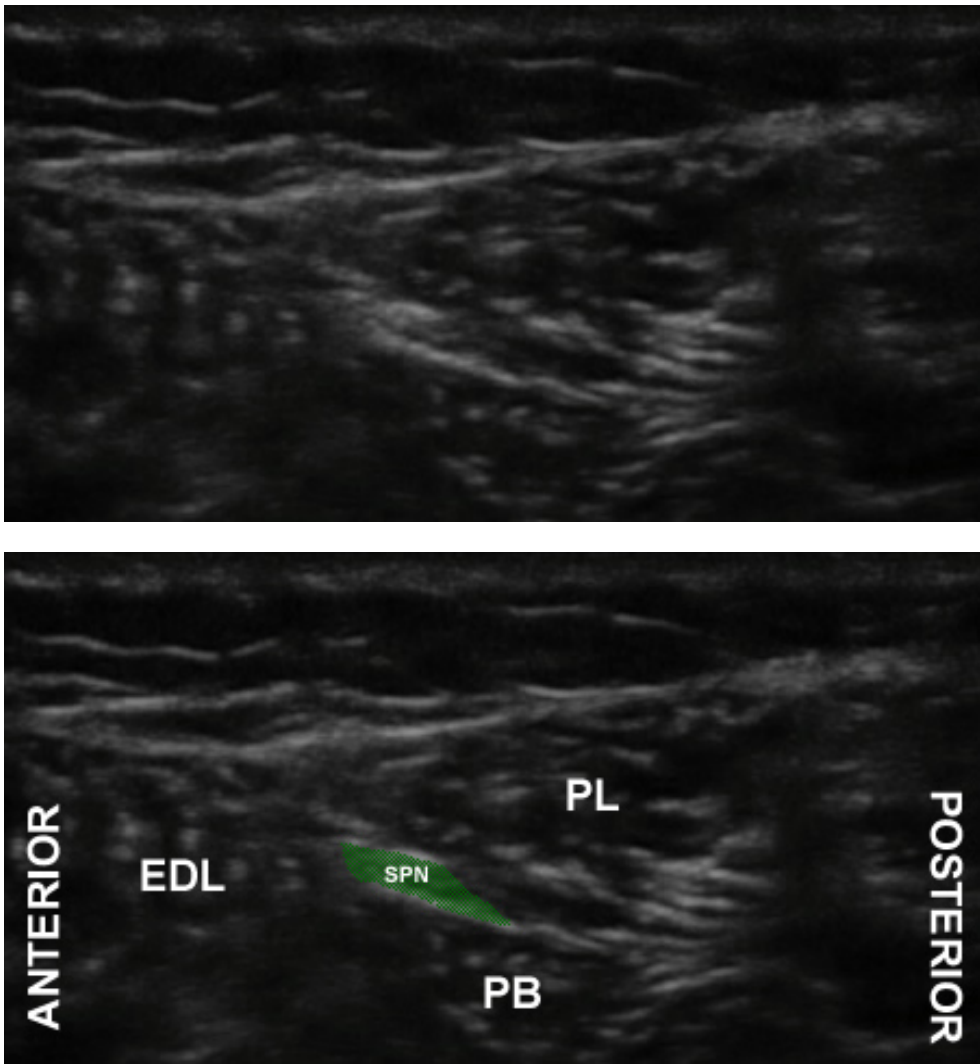


Figure 6: US images illustrating the relationship of the muscles peroneus longus (PL), extensor digitorum longus (EDL) and peroneus brevis (PB) to the superficial peroneal nerve (SPN) in the proximal lower leg.

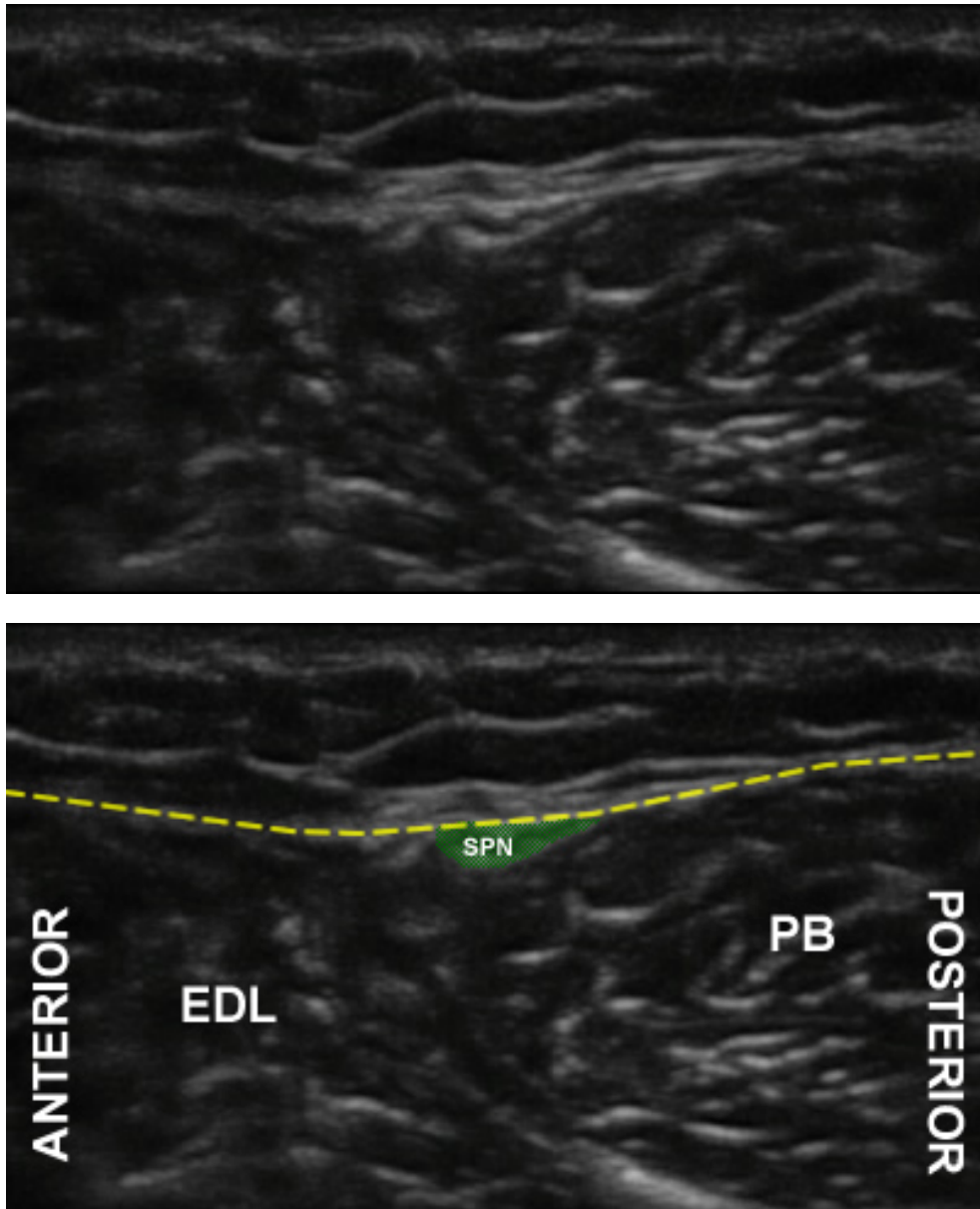


Figure 7: US images illustrating the relationship of the tendon of peroneus longus (PL), and the muscles extensor digitorum longus (EDL) and peroneus brevis (PB) to the superficial peroneal nerve (SPN) in the mid lower leg; note the deep position of the nerve in relation to the deep fascia (yellow-dashed line).

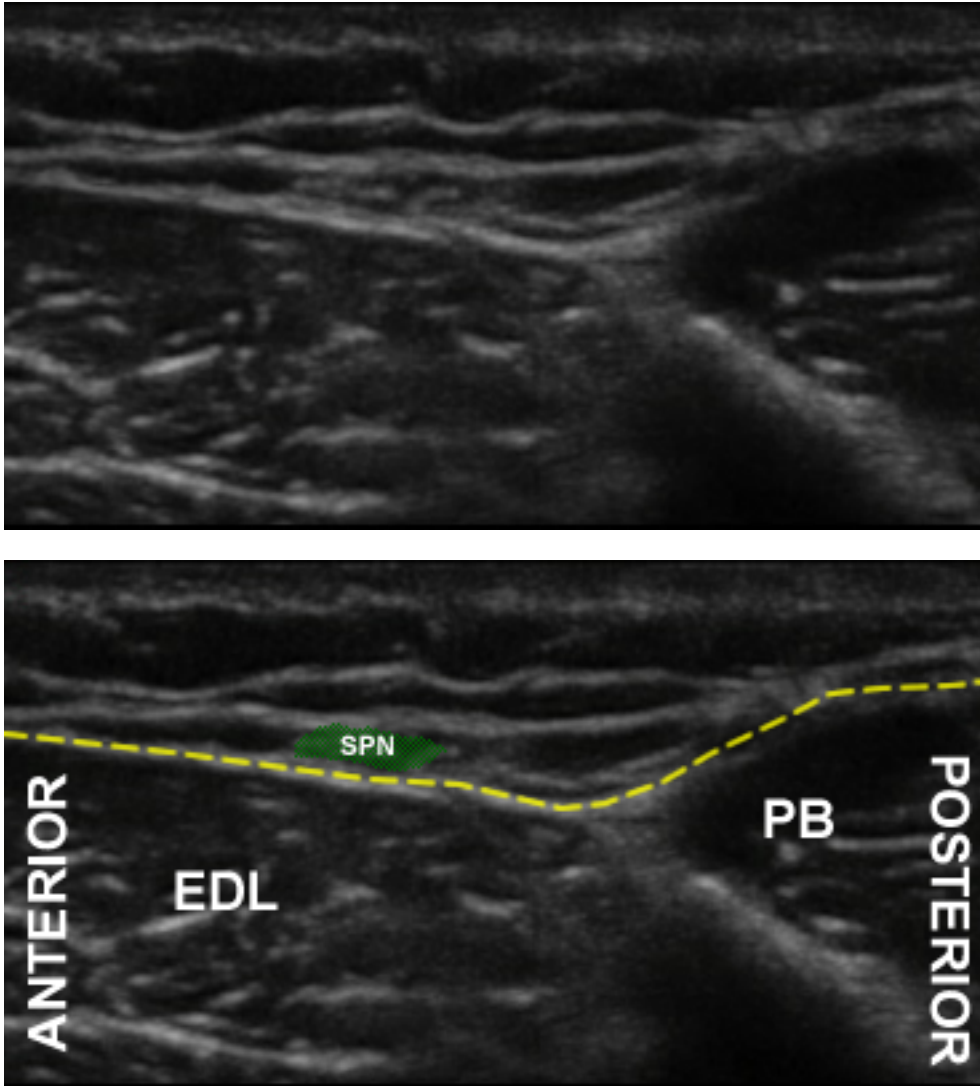


Figure 8: US images illustrating the relationship of extensor digitorum longus (EDL) and peroneus brevis (PB) muscles to the superficial peroneal nerve (SPN) at mid-calf level; note the superficial position of the nerve in relation to the deep fascia (yellow-dashed line).

Block Conduct

Be aware that this is a small nerve and there are no helpful vascular landmarks therefore a good understanding of the muscle sono-anatomy is necessary.

- Place your probe over the lateral malleolus and scan proximally (Photo 4).
- As the fibula dives deep two muscle bellies merge towards each other. The anterior muscle is extensor digitorum longus and posteriorly is peroneus brevis (at this level you can usually see the tendon of peroneus longus lying superficial to it as a thin dark band surrounded by a bright connective tissue).
- As you scan proximally keep the junction of these two muscles in the centre of your screen
- The superficial peroneal nerve can be seen passing posteriorly, superficial to the deep fascia over the belly of EDL, before penetrating fascia to lie in the groove formed between the two muscles.
- It lies within this groove for a variable distance before diving between peroneus brevis and longus.
- Scan the course of the nerve until you are confident of its relationship to the other structures
- Aim to block before it gives off any proximal branches



Photo 4: Photo showing the alignment of the operator, US probe and US machine during a superficial peroneal nerve block.

DEEP PERONEAL NERVE

Anatomy & Sono-anatomy

In the leg the deep peroneal (fibular) nerve descends on the anterior surface of the interosseus membrane before passing medially over the anterolateral surface of the distal tibia. Throughout its course the nerve is associated with the anterior tibial vessels. As it descends, it is commonly described as lying lateral to the vessels then anterior then reverts to lateral. However, the nerve may lie medial to the vessels (Figures 9, 10 & 11).

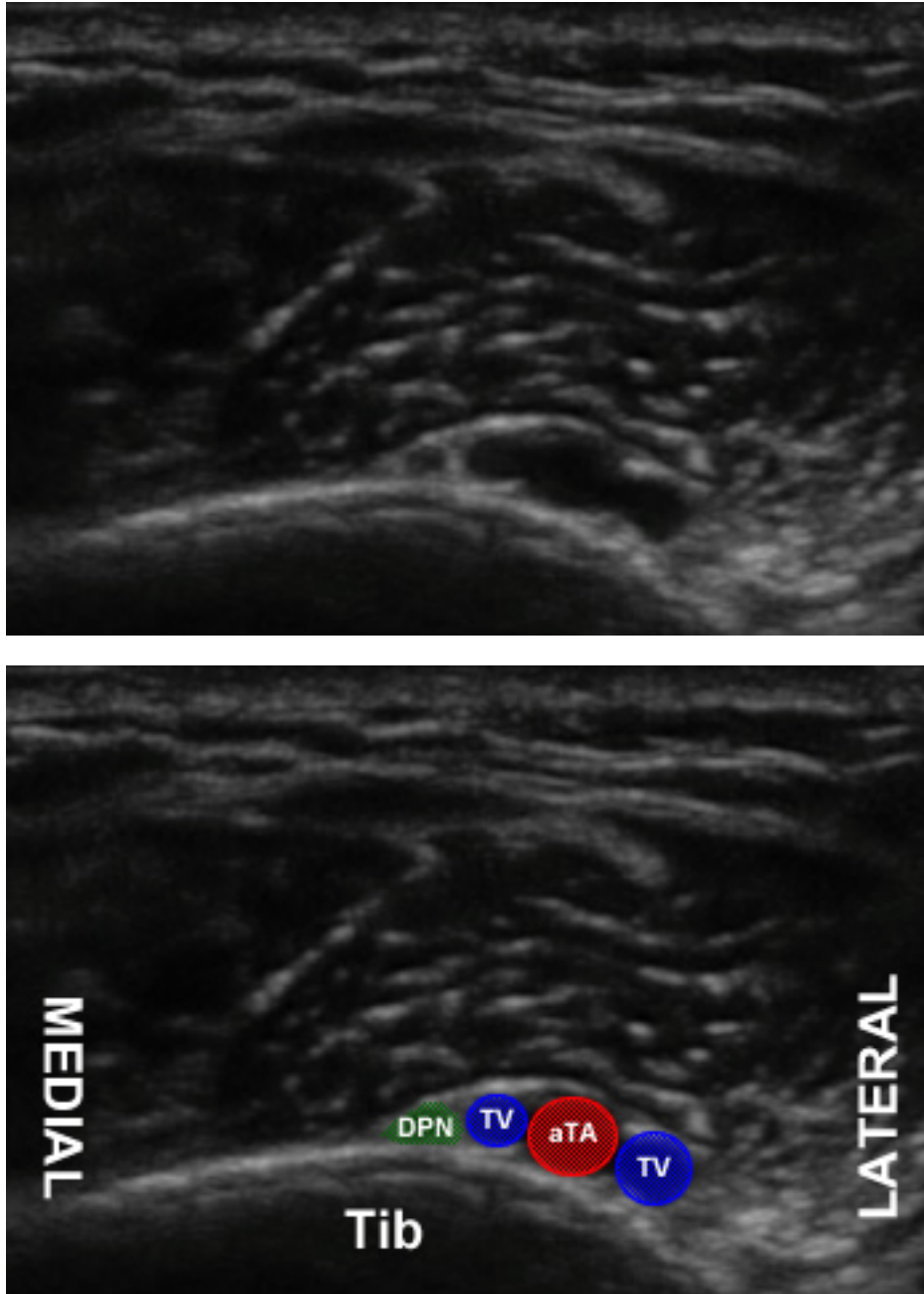


Figure 9: US images illustrating the relationship of the tibia (Tib), anterior tibial artery (aTA) and veins (TV) to the deep peroneal nerve (DPN) at the proximal lower leg.

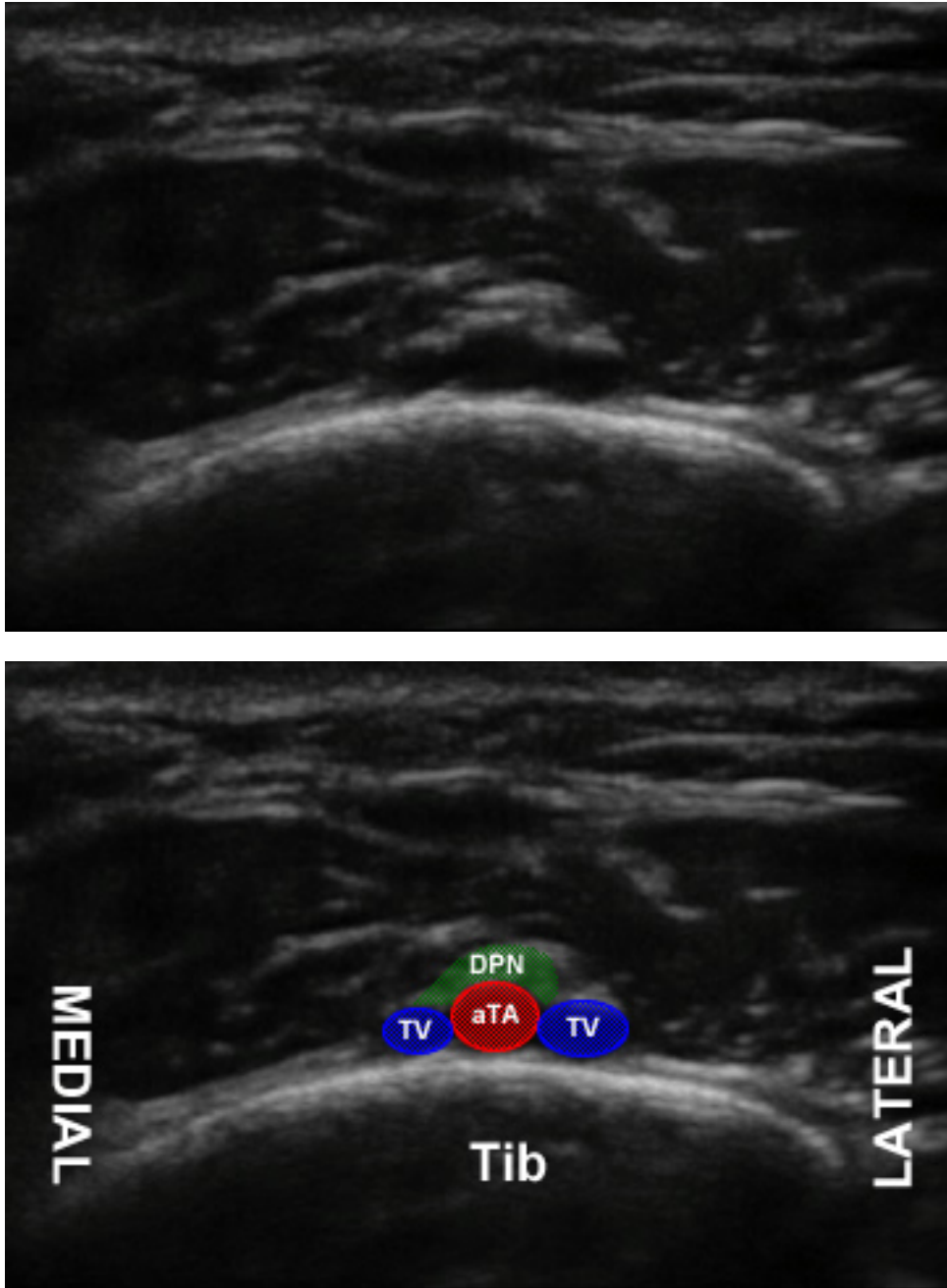


Figure 10: US images illustrating the relationship of the tibia (Tib), anterior tibial artery (aTA) and veins (TV) to the deep peroneal nerve (DPN) at mid-shin level.

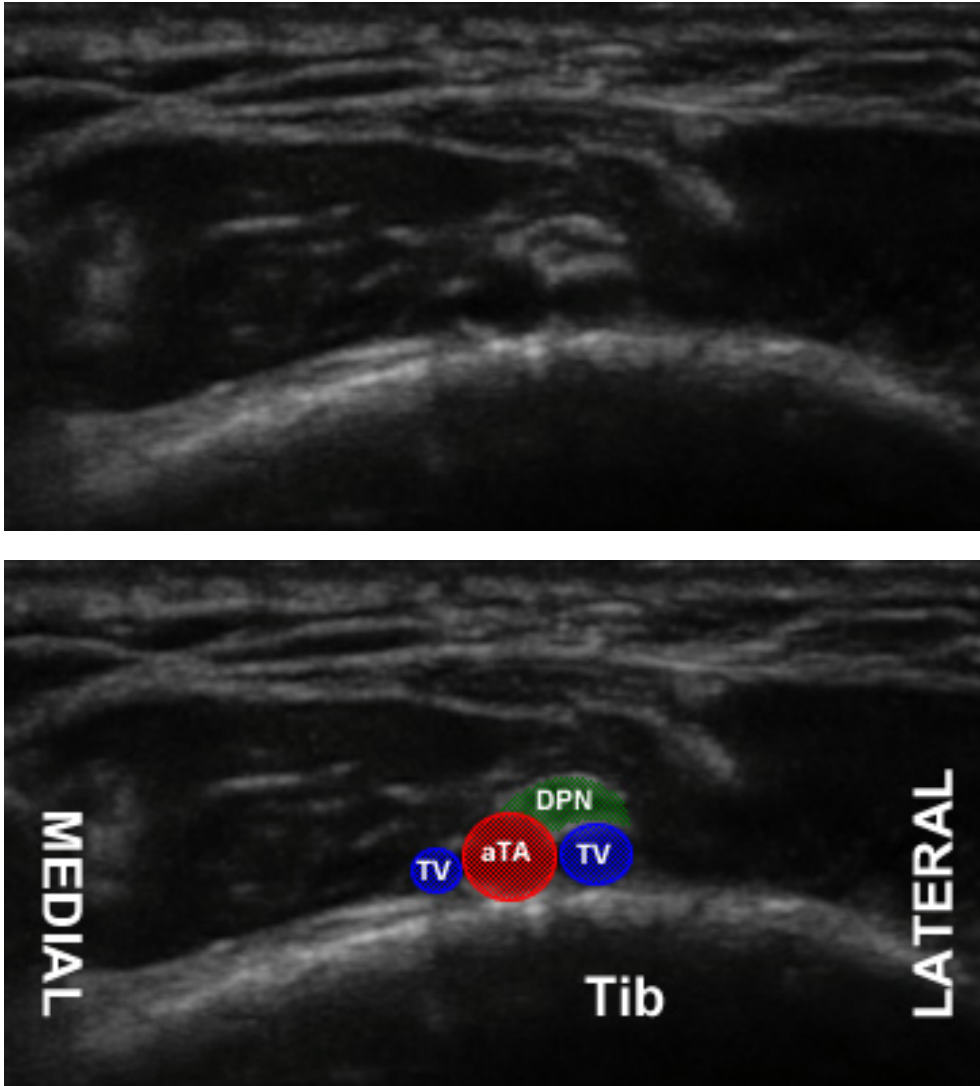


Figure 11: US images illustrating the relationship of the tibia (Tib), anterior tibial artery (aTA) and veins (TV) to the deep peroneal nerve (DPN) at the level of the ankle.

Block Conduct

- Place the probe over the anterior aspect of the tibia just proximal to the ankle joint (Photo 5).
- Locate the anterior tibial artery (it is often accompanied by two veins).
- As you scan up and down the distal portion of the leg the deep peroneal nerve can either be seen lying lateral, medial or rolling over the top of the artery from medial to lateral.



Photo 5: Photo showing the alignment of the operator, US probe and US machine during a deep peroneal nerve block.

SURAL NERVE

Anatomy & Sono-anatomy

The sural nerve is a branch of the tibial nerve in the popliteal fossa and receives a communicating branch from the common peroneal nerve. It descends superficially down the posterior aspect of the leg and behind the lateral malleolus to supply the lateral side of the foot.

The sural nerve maintains a close relationship with the short saphenous vein. Just proximal to the lateral malleolus the sural nerve can be easily visualized as it lies either anterior or posterior to the short saphenous vein in a fascial plane between peroneus brevis anteriorly and the Achilles tendon posteriorly. If followed proximally it can be seen coursing posteriorly over the Achilles tendon with the vein.

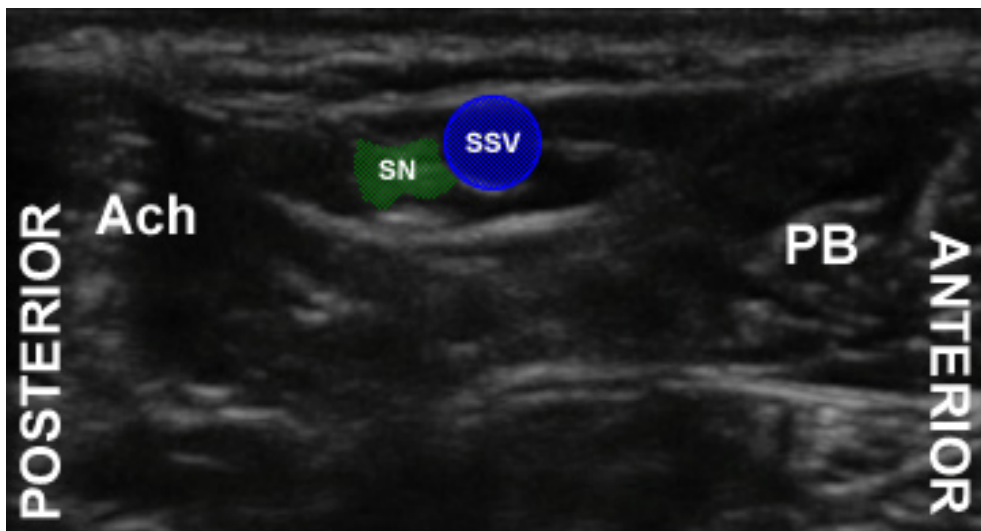
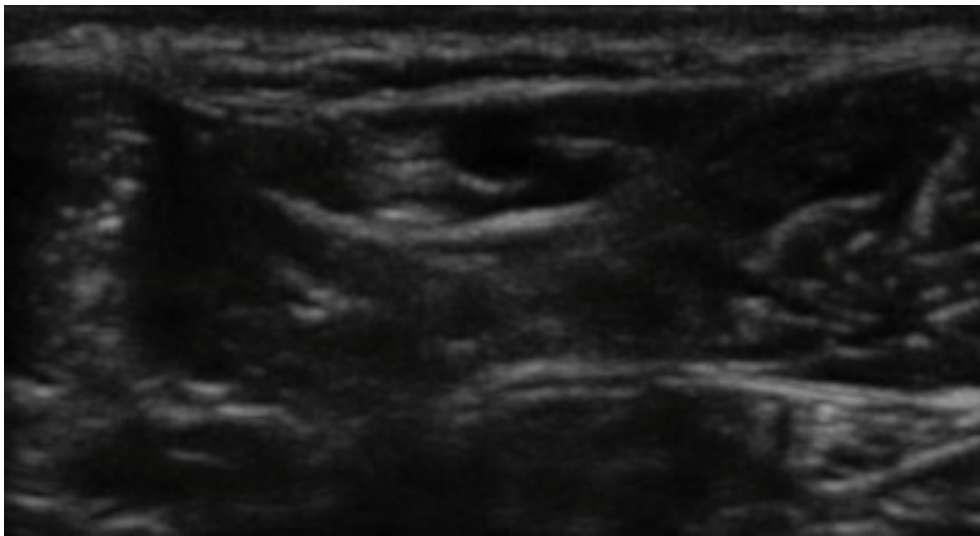


Figure 12: US images illustrating the relationship of the short saphenous vein (SSV), peroneus brevis muscle (PB) and the Achilles tendon (Ach) to the sural nerve (SN).

Block conduct

- Place the probe over the lateral aspect of the leg just proximal to the lateral malleolus.
- Scan posteriorly so that the belly of peroneus brevis lies anteriorly and the Achilles tendon posteriorly (you can see the tendon of peroneus brevis as a dark oval superficial and lying over the belly of peroneus brevis)
- The nerve lies between PB and the Achilles in close relation to the vein.
- Practice following the nerve proximally as it passes posteriorly over the Achilles tendon and observe its relationship to the vein.
- Aim to direct your needle with an anterior in-plane approach taking care to avoid the tendon of peroneus longus.



Photo 6: Photo showing the alignment of the operator, US probe and US machine during a sural nerve block.

ANKLE BLOCK - LANDMARK TECHNIQUE

In contrast to the ultrasound guided technique, the traditional ankle block is performed more distally. Key to this technique is to identify the correct bone and tendon landmarks.

General Points

Identify the medial and lateral malleoli. The block is essentially the local anaesthetic infiltration of a coronal section through the inter-malleolar line. Cleanse the foot with 2% chlorhexidine solution (or appropriate alternative) and drape the leg.

Tibial nerve

The tibial nerve is anaesthetised by injecting local anesthetic just behind the medial malleolus. The needle insertion point is identified as the mid-point between medial malleolus and tip of the calcaneum. The needle is introduced in the groove behind the medial malleolus and posterior to the pulsation of the posterior tibial artery. It is the only nerve at the ankle that you can use a nerve stimulator to aid location, look for plantar flexion of the toes. Inject 5 ml of local anesthetic.

Deep Peroneal nerve

Locate the groove lateral to extensor hallucis longus at a point 2-3cm distal to the inter-malleolar line. This can be made more pronounced by requesting the patient to dorsiflex their foot. Advance the needle until contact is made with bone, withdraw slightly, aspirate and inject. The needle should be re-directed laterally and medially to achieve a 'fan' distribution of the local anaesthetic. Alternatively, if you can feel the pulsation of the dorsalis pedis artery, introduce your needle either side of the vessel down to bone and inject.

Saphenous nerve

The saphenous nerve can be blocked with a 5ml subcutaneous injection of local anesthetic immediately above the medial malleolus. Alternatively, if you can see or palpate the great saphenous vein introduce the needle immediately posterior to it and inject.

Sural nerve

The sural nerve runs subcutaneously through the mid-point between the lateral malleolus and the Achilles tendon. The needle is directed to the lateral malleolus at this level and 5ml of local anesthetic is injected.

Superficial Peroneal nerve

The superficial peroneal nerve is blocked with the subcutaneous injection of local anaesthetic along the inter-malleolar line. The aim should be to raise a subcutaneous wheal using 5ml of local anaesthetic.

IMPORTANT POINTS

- A good knowledge of the surgical procedure and nerve distribution is essential in choosing the appropriate nerves to be blocked.
- Ultrasound guided ankle blocks work well for forefoot and midfoot surgery in awake patients whilst using an ankle tourniquet.
- This technique provides reliable anaesthesia, prolonged postoperative analgesia and allows early mobilisation even for bilateral procedures.
- Block the tibial nerve first, it is the largest nerve and therefore takes has the longest onset time.

ANSWERS TO QUESTIONS

1. a is correct
2. Regarding the saphenous nerve
 - a. False - the innervation on the foot by the saphenous nerve is very variable and may extend distally down the medial aspect to the hallux or terminate around the medial malleolus
 - b. False - it is the terminal cutaneous branch of the posterior division on the femoral nerve.
 - c. True – it is difficult to see reliably as by this stage as it will be very small or absent
 - d. False – it can be blocked in any order, as it is a very small nerve.
3. Regarding ultrasound guided ankle blocks
 - a. True – the bony prominence around the ankle makes good probe/skin contact difficult
 - b. False – the superficial peroneal nerve has no reliable vascular markings, instead knowledge of the surrounding anatomy is necessary to find the structure under ultrasound.
 - c. False – it should be blocked first as it is the largest nerve and has the longest onset time.
 - d. False – blocking the sural nerve is not necessary unless surgery is in the territory of the 5th metacarpal though its innervation may spread medially. In an awake patient it is prudent to block it if surgery involves the 3rd-5th toes.

Acknowledgements

The image in figure 5 is a reproduction of a lithograph plate from the 20th U.S. edition of Gray's Anatomy of the Human Body, originally published in 1918.

Our thanks go to:

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