

Lower limb nerve blocks

Calum RK Grant

Abstract

The proliferation of ultrasound use is changing the approach to regional anaesthesia of the lower limb. Techniques are being developed that provide high-quality postoperative analgesia while minimizing associated motor block that may impair mobilization. Regional anaesthetic techniques also provide significant opioid-sparing benefits (e.g. less sedation, nausea and urinary retention) that are key principles of current enhanced recovery protocols. Ultrasound-guided nerve localization offers several potential advantages when performing femoral, adductor canal, sciatic and ankle blocks; however, neurostimulation remains a useful and widely used aid to lower limb regional anaesthesia practice.

Keywords Adductor canal; ankle block; femoral; lower limb; nerve block; regional anaesthesia; sciatic; ultrasound

Royal College of Anaesthetists CPD Matrix: 1D02, 2G01, 2G02, 2G03 and 3A09

There has been a resurgence of interest in regional anaesthesia over the past decade, primarily as a result of improved nerve localization available through the use of modern high-resolution ultrasound technology. Recently, the emphasis has shifted toward further refining lower limb blocks to minimize the extent of associated motor block lasting into the postoperative period. These techniques have superseded epidural analgesia as the gold standard following lower limb arthroplasty. Lower limb nerve blocks that provide effective pain relief with a low incidence of systemic side-effects can facilitate rapid functional recovery and rehabilitation after major orthopaedic surgery.¹ The use of continuous peripheral nerve catheter infusions can, if necessary, extend analgesia for several days postoperatively, avoiding the frequently encountered problems of block regression and inadequate analgesia that may occur after a single shot technique. Proximal sciatic and femoral blocks are more suitable for use in an in-patient setting due to motor block that will inevitably limit mobility. Nerve localization is currently achieved using ultrasound guidance or peripheral nerve stimulation and, as a general rule, there is less observed anatomical variation compared to upper limb brachial plexus blocks.

Ultrasound-guided lower limb blocks

B-mode ultrasound allows visualization of peripheral nerves and surrounding structures of interest such as blood vessels, muscles and fascia. It also enables the anaesthetist to visualize, in real-time, the needle tip trajectory and the spread of local anaesthetic when performing a nerve block. Unlike older, blind

Calum RK Grant FRCA is a Consultant Anaesthetist at Ninewells Hospital and Medical School, Dundee, UK. Conflicts of interest: none declared.

Learning objectives

After reading this article, you should understand the:

- indications and potential benefits of lower limb blocks
- indications and potential advantages of ultrasound-guided nerve localization
- principles of specific lower limb nerve block techniques.

percutaneous approaches based on specific vascular or bony landmarks, ultrasound allows the practitioner to block peripheral nerves in the lower limb at almost any point along their course – this is important when considering distal motor-sparing approaches. Ultrasound-guided lower limb blocks are quicker to perform, have a faster onset and are more efficacious when compared to peripheral nerve stimulation.² The femoral, sciatic (distal to the infra-gluteal fold) and popliteal nerves are relatively superficial and can be accurately identified using high frequency (8–18 MHz) ultrasound probes. Deeper structures, such as the lumbar plexus and proximal sciatic nerve, can be imaged using low-frequency probes that provide greater tissue penetration; however, image resolution is compromised at lower ultrasound frequencies due to signal attenuation and, as a result, these blocks can be technically difficult to perform using ultrasound guidance.

Indications

Lower limb arthroplasty

The utility of peripheral nerve blockade after lower limb arthroplasty continues to evolve with a move in some centres towards the use of local infiltration analgesia to avoid motor block that can lead to delayed mobilization, instability and a risk of falling. When planning pain relief following lower limb arthroplasty, however, consideration must be given to the frequent side-effects associated with alternative forms of analgesia (in particular opioid analgesia) and the observation that inadequate analgesia can leave patients unable to comply with initial physiotherapy. Analgesia especially after total knee arthroplasty remains a challenge for anaesthetists and evidence supports the use of peripheral nerve blockade as the most effective method of providing effective analgesia.³ New approaches to femoral nerve block are aimed at avoiding quadriceps weakness by blocking the nerve distal to the femoral triangle, away from the principle quadriceps motor branches. This has led to the development of the sub-sartorial and adductor canal blocks, techniques that have been shown to provide equivalent analgesia to proximal femoral nerve block but with preservation of quadriceps strength.⁴ Avoiding the use of a tourniquet may be of considerable benefit in reducing pain and facilitating early mobilization. The benefit of peripheral nerve blockade after hip arthroplasty is less clear and simpler alternatives such as local anaesthetic infiltration or intrathecal opioid are effective and widely used alternatives.

Hip surgery

Analgesia for primary hip arthroplasty or fractured neck of femur surgery can be supplemented by proximal femoral nerve or fascia iliaca block. Revision hip arthroplasty remains an indication for

continuous lumbar plexus block although the side-effect profile of this block must be factored in to any clinical decision making. Complete anaesthesia of the hip joint requires a proximal sciatic block (e.g. Labat's approach) in addition to lumbar plexus block to anaesthetize the posterior aspect of the joint.

Knee surgery

Primary knee arthroplasty is associated with severe acute post-surgical pain. The optimal analgesic technique has still not been unequivocally demonstrated. Distal femoral nerve blocks at a sub-sartorial level or at the level of the adductor canal have been shown to provide equivalent analgesia to femoral nerve block but, importantly, with preservation of quadriceps strength. The sciatic nerve also innervates the knee; however, sciatic nerve block is invariably associated with delayed mobilization and is therefore not recommended in routine practice. A simpler technique for providing analgesia to the posterior aspect of the knee joint can be achieved by intraoperative surgical infiltration to the posterior capsule, thereby sparing hamstring motor function and preventing foot drop.

Ankle and foot surgery

Again, these procedures are frequently associated with significant postoperative analgesic requirements which can be met using peripheral nerve blocks. A combination of popliteal sciatic and saphenous nerve blocks are required to provide analgesia for ankle/hind foot surgeries whereas an ankle block, which is possible to perform using ultrasound guidance, is ideal for most forefoot procedures. Unlike the popliteal sciatic nerve block, ankle block does not result in transient foot-drop, therefore most patients can mobilize heel-walking allowing early postoperative discharge. The use and location of a surgical tourniquet should be considered when selecting the anaesthetic technique, forefoot surgery is possible using an ankle tourniquet which is usually well tolerated for up to 90 minutes. Ankle and knee surgery often require the use of a thigh tourniquet and due to the increased muscle mass and associated discomfort this is usually covered by additional spinal or general anaesthesia.

Other procedures

Peripheral lower limb blocks are frequently used for traumatic lower limb injuries. It is worth noting that nerve blocks should be used with caution, if at all, in cases where there is a risk of compartment syndrome developing, specifically following tibial shaft and some femoral fractures. There is concern that the block will mask pain associated with an evolving compartment syndrome, resulting in delayed diagnosis. Careful patient selection and discussion with surgical colleagues is recommended if there is any uncertainty regarding this risk.

Peripheral nerve blocks are also indicated for anaesthesia and analgesia in lower limb vascular surgical procedures, amputation and for the treatment of uncontrolled ischaemic limb pain. There are often multiple benefits (e.g. cardiovascular stability, decreased opioid requirements) in this high risk group of patients who may also be at risk of developing significant chronic post-surgical pain.

Nerve block techniques

There are many nerve blocks and approaches for the lower limb. An exhaustive list is outside the scope of this article.⁵ The

following techniques are well established and represent a range of options that will effectively cover the vast majority of lower limb surgical procedures.

Femoral nerve block

Femoral nerve block is a commonly used analgesic block for lower limb surgery. It is relatively simple to perform as the nerve is superficial in the proximal thigh, reliably located lateral to the common femoral artery and deep to the fascia iliaca. Ultrasound imaging immediately below the inguinal crease typically reveals an oval or triangular hyperechoic structure situated lateral to the more obvious femoral artery, often on the supero-medial border of the iliopsoas muscle, below the echogenic fascia lata and fascia iliaca (Figure 1). A 50–80 mm regional block needle can be introduced either parallel (in plane) or perpendicular (out of plane) to the ultrasound probe. The sono-image of the nerve is enhanced by deposition of local anaesthetic under and around the nerve, careful hydro-dissection with small increments of local anaesthetic also ensures the correct placement of local anaesthetic.

When using a nerve stimulator, the femoral artery is firstly palpated below the inguinal crease, the block needle is then inserted 1–2 cm lateral to the artery. As the needle is advanced, a quadriceps response is elicited, evident by an obvious patellar twitch, at a depth of 1–3 cm. Sartorius contraction may be elicited due to stimulation of a motor branch of the nerve but should not be confused with quadriceps stimulation, as this branch may be out-with the main femoral nerve component, redirecting the needle in a lateral direction usually elicits the correct response. A motor response at a current of less than 0.5 mA implies intraneural needle tip placement and should prompt repositioning prior to injection. A single shot block requires 10–15 ml of local anaesthetic; note that prolonged motor block of up to 24 hours may result from the use of 0.5% Levobupivacane or 0.75% Ropivacaine. Larger volumes of local anaesthetic do not reliably block the lateral femoral cutaneous nerve or obturator nerve in addition to femoral block. Perineural catheters are easily introduced at this level, most frequently for total knee arthroplasty or above knee amputation, and must be



Figure 1 Ultrasound image of the femoral nerve below the inguinal ligament. 1. Femoral nerve. FA - Femoral artery. FV - Femoral vein. IPM - Iliopsoas muscle.

well secured to prevent them being accidentally dislodged or removed.

Fascia iliaca block

This relatively simple procedure can be used to block the femoral and lateral cutaneous nerve of the thigh. It is frequently used for the initial management of pain in patients who present with fractured neck of femur and can be highly effective. It is also useful as an analgesic component of operations involving the hip and femur. It can be performed either as a 'blind' percutaneous procedure or using ultrasound. The former is based on two pops felt as the needle penetrates fascia lata and fascia iliaca, whereas the latter is more accurate in ensuring local anaesthetic is correctly placed in the tissue plane beneath the fascia iliaca. The needle entry point is usually 2 cm distal to the junction of the middle and lateral third of the line joining the anterior superior iliac spine and pubic tubercle, lateral to the femoral vessels. A single-shot block will require local anaesthetic volume of up to 30 ml to achieve compartmental spread. One of the benefits of this particular approach is that the block needle is inserted lateral to the neurovascular bundle, thereby reducing the chances of femoral nerve or vessel injury.

Adductor canal block

Pain control following knee arthroplasty and cruciate ligament repair remains a challenge. Novel strategies have led to the development of blockade of distal femoral nerve branches in an attempt to match the analgesia of femoral block, while sparing quadriceps strength. The saphenous nerve is the terminal sensory branch of the femoral nerve and is located lateral to the superficial femoral artery in the adductor canal at mid-thigh level. Recently it has been demonstrated that a more proximal approach at the distal aspect of the femoral triangle (sub-sartorial block) will also block the nerve to vastus medialis which supplies

genicular branches to the anterior knee joint.⁶ Both adductor canal and sub-sartorial blocks have been shown to provide equivalent analgesia to femoral nerve block with preservation of quadriceps strength. Ultrasound guidance is required for in-plane block performance and small volumes of local anaesthetic, typically 10 ml, are sufficient – larger volumes may lead to proximal spread and femoral block with associated quadriceps weakness, especially if a thigh tourniquet is used (Figure 2).

Sciatic nerve block

The sciatic nerve is the largest mixed peripheral nerve in the body. It supplies the hip joint, hamstrings, knee and the majority of structures below the knee, except the skin on the medial aspect of the lower leg which is supplied by the saphenous nerve.

Proximal sciatic nerve block is useful for hip and knee surgery or when a thigh tourniquet is required. The parasacral approach, described by Mansour, will block the sciatic nerve and the posterior cutaneous nerve of the thigh, a branch of the sacral plexus. Labat's posterior approach is performed with the patient in the lateral position and the hip flexed (Figure 3). A 100 mm block needle is inserted perpendicular to all planes and a distal motor response sought. Plantar flexion or inversion are acceptable motor endpoints and the nerve can be blocked with 15–20 ml of local anaesthetic. Prolonged intraoperative and postoperative supine positioning can lead to pressure ischaemia over the proximal sciatic nerve and for this reason it is recommended that addition of adrenaline to the local anaesthetic should be avoided. Pressure necrosis of the heel is another potential complication that requires appropriate monitoring and pressure care to avoid.

The supine approach can be performed with an assistant holding the leg, the nerve is then located at the mid-point between the ischial tuberosity and the greater trochanter. This approach is flawed due to difficulty in positioning the elevated

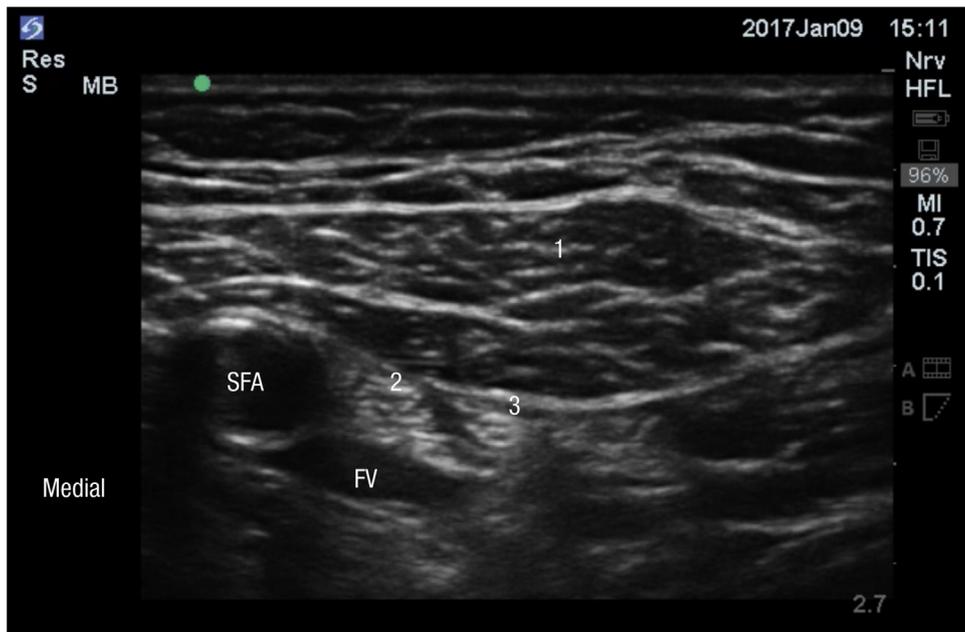


Figure 2 Distal femoral triangle sonoanatomy. 1. Sartorius 2. Saphenous nerve 3. Nerve to vastus medialis. SFA - Superficial femoral artery. FV - Femoral vein. Depth markings 0.5 cm.

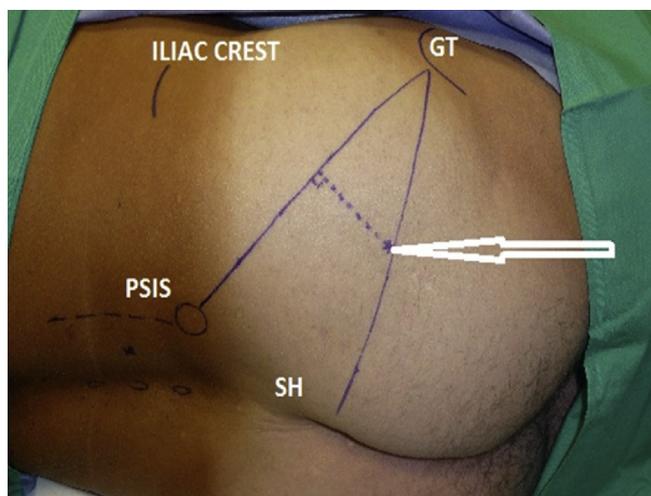


Figure 3 Posterior sciatic nerve block (Labat's approach). A line is drawn from the posterior superior iliac spine (PSIS) to the greater trochanter (GT) of the femur. A second line is drawn from the sacral hiatus (SH) to the GT. The mid-point of the line between PSIS and GT is measured and a third line drawn perpendicular from this point to intersect the line between SH and GT. The point of intersection is the point of needle insertion (marked by white arrow).

leg, limited access to the proximal thigh and the potential for intraneural puncture because of tension applied to the nerve when the hip is flexed to 90°. The anterior approach is potentially useful in patients with traumatic lower limb injuries, although the depth of the sciatic nerve and the proximity of the femoral vessels in the antero-medial thigh limit the usefulness of this block.

The sciatic nerve runs more superficially distal to the infragluteal fold and, utilizing ultrasound, can be visualized and blocked at any point along its course in the posterior thigh. Both in- and out-of-plane needle techniques are possible. Peri-neural catheters can be inserted and are frequently used for pain relief following lower limb amputation. Careful consideration regarding catheter fixation is required to prevent dislodgment when the patient is being moved, tunnelling the catheter subcutaneously is one potential solution.

Popliteal nerve block

This excellent block provides reliable anaesthesia and analgesia for most ankle and hind-foot surgery. It can also be used very effectively to manage severe pain due to critical limb ischaemia. Ultrasound allows accurate identification of the sciatic nerve (Figure 4) and the level at which it bifurcates into the tibial and common peroneal branches proximal to the popliteal crease; thus facilitating selective or complete sciatic nerve block. Circumferential local anaesthetic will ensure rapid and complete block and can be accomplished with 15–25 ml of local anaesthetic. Care should be taken to identify and avoid the popliteal vessels which are situated inferior to the nerve. Supplementation with a saphenous nerve block is required for coverage over the medial ankle and foot and for ankle tourniquet coverage. The saphenous nerve can be blocked in the adductor canal or distally, below the knee, where it lies adjacent to the long saphenous vein. Again, a continuous perineurial technique is indicated for procedures that are likely to be associated with severe postoperative pain.

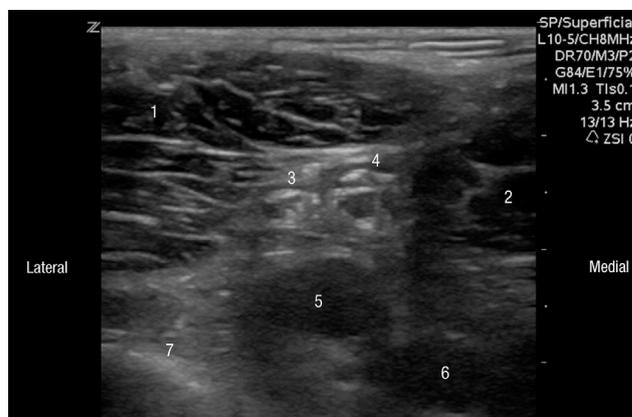


Figure 4 Popliteal fossa sonoanatomy at level of bifurcation of sciatic nerve 1. Biceps femoris (Note 2 'heads' evident) 2. Semimembranosus 3. Common peroneal nerve 4. Tibial nerve 5. Popliteal vein 6. Popliteal artery 7. Lateral femoral condyle. Depth markings are 0.5cm.

Ankle block

Ankle block can be performed using anatomical landmarks and neurostimulation however, best results are achieved using ultrasound.⁷ High-frequency ultrasound probes allow direct visualization of the tibial (Figure 5), saphenous, sural, superficial and deep peroneal nerves; all of which can be blocked using smaller volumes of local anaesthetic (15–20 ml in total) than would be required for landmark/neurostimulation techniques. It is possible to perform most forefoot surgical procedures solely under ankle block if an ankle tourniquet is used, obviating the need for general or spinal anaesthesia. Postoperatively, there is little impairment from motor block so patients can mobilize quickly, nevertheless, significant proprioceptive deficit or instability should be excluded prior to discharge and, as with other regional blocks, patients should be advised to adequately protect the blocked area and to plan analgesia for block regression. A key limitation is that these blocks are technically challenging and therefore unsuitable for the novice regional anaesthetist. With



Figure 5 Ultrasound image above the medial malleolus. 1. Tibialis posterior. 2. Flexor digitorum longus. 3. Tibial nerve. 4. Posterior tibial artery (and veins). 5. Flexor hallucis longus. 6. Soleus. 7. Medial border of tibia.

practice, the block can be performed using a fine 40 mm 27 g needle in order to minimize procedural discomfort from five separate injections. ◆

REFERENCES

- 1 Hebl JR, Dilger JA, Byer DE, et al. A pre-emptive multi-modal pathway featuring peripheral nerve block improves perioperative outcomes after major orthopaedic surgery. *Reg Anesth Pain Med* 2008; **33**: 510–7.
- 2 Munirama S, McLeod G. A systematic review and meta-analysis of ultrasound versus electrical stimulation for peripheral nerve location and blockade. *Anaesthesia* 2015; **70**: 1084–91.
- 3 Chan E, Fransen M, Parker DA, Assam PN, Chua N. Femoral nerve blocks for acute postoperative pain after knee replacement surgery. *Cochrane Database Syst Rev* 2014; <https://doi.org/10.1002/14651858.CD009941.pub2>. Issue 5. Art. No.: CD009941.
- 4 Kwofie MK, Shastri UD, Gadsden JC, et al. The effects of ultrasound-guided adductor canal block versus femoral nerve block on quadriceps strength and fall risk: a blinded, randomized trial of volunteers. *Reg Anesth Pain Med* 2013; **38**: 321–5.
- 5 Enneking FK, Chan V, Greger J, Hadzic A, Lang SA, Horlocker TT. Lower extremity peripheral nerve blockade: essentials of our current understanding. *Reg Anesth Pain Med* 2005; **30**: 4–35.
- 6 Bendtsen TF, Moriggl B, Chan V, Borglum J. The optimal analgesic block for total knee arthroplasty. *Reg Anesth Pain Med* 2016; **41**: 711–9.
- 7 Purushothaman Lakshmiopathy, Allan Anthony GL. Nigel Bedforth; ultrasound-guided ankle block. *Cont Educ Anaesth Crit Care Pain* 1 October 2013; **13**: 174–8.