Ultrasound-guided femoral and sciatic nerve blocks

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Key points
Ultrasound-guided femoral and sciatic nerve blocks are useful adjuncts for postoperative analgesia and managing post amputation limb pain.

The use of ultrasound has several benefits including faster onset and reduction in the dose of local anaesthetic.

Knowledge of ultrasound anatomy is essential to identify structures and adequate training is required to achieve this.

Single-shot femoral and sciatic blocks are simple to perform but provide analgesia for a limited duration, which can be overcome by performing continuous perineural infusions.

Local anaesthetic infusion regimes should be carefully titrated to achieve adequate analgesia and prevent unwanted side-effects.

Introduction
Effective and prolonged analgesia for major lower limb surgery can be achieved with lower limb blocks and perineural catheter infusions. Accurate needle placement and drug delivery is the key to achieving success with nerve blocks.

The use of ultrasound may facilitate more rapid block onset and prolong block duration, with the added advantages of a decrease in drug dosage and a reduction in the incidence of local anaesthetic toxicity. Reduction in procedural pain and better patient satisfaction has also been demonstrated with ultrasound-guided popliteal sciatic nerve block.

Nevertheless, with new technologies such as ultrasound, it is important to retain the overriding principles common to all regional anaesthetic techniques.

- The successful application of regional anaesthesia requires knowledge of the sensory distribution of nerves, their surrounding anatomy, superficial landmarks, and potential anatomical variations.
- The nerve innervation of bones and joints is derived from all surrounding nerves.
- Maintaining asepsis and checking the correct site or side of operation and its documentation is mandatory.

As the relevant anatomy and innervation have been covered in previous articles, this article aims to describe ultrasound anatomy; technique of performing ultrasound-guided major lower limb blocks and management of perineural catheters. The article will focus on continuous and single-shot ultrasound-guided femoral and sciatic nerve blocks.

General considerations
Essential equipment includes an ultrasound machine with a linear, high frequency probe (8–12 MHz) for femoral and a curved array; low frequency probe (3–9 MHz) for sciatic nerve imaging, standard insulated regional block needles or catheter kit, cleaning solution, and sponges; lidocaine for local infiltration anaesthesia, hypodermic needles, sterile ultrasound probe covers, occlusive dressings, ultrasound gel, 30 ml syringes with local anaesthetic (LA), with/without dextrose solution, nerve stimulator, and sterile gloves.

Ultrasound-guided femoral nerve block
Indications
Femoral nerve block with or without a perineural infusion provides continuous pain relief after knee replacement surgery, fractures of the femoral shaft, and skin grafts from the anterior thigh. It may also provide a useful analgesic adjunct for femoral neck fractures.

Ultrasound anatomy and nerve block technique
The patient is positioned supine with the operator on the right-hand side for blocks on both sides and vice versa for a left-handed operator. The ultrasound machine should be placed on the opposite side so that the operator’s line of sight, needle, and the screen is in a straight line.

The femoral artery is palpated behind the inguinal ligament depth of image set 3–5 cm, and a linear high frequency (8–12 MHz) probe should be placed perpendicular to the course of the femoral nerve. Medial to lateral sliding movements of the transducer aid visualization of the pulsatile femoral artery. Structures that can be visualized are the fascia iliaca, femoral artery, and skin grafts from the anterior thigh. The femoral nerve may show anisotropic (directionally
dependent) behaviour and angling the probe slightly cranially or caudally may help in visualization of the nerve. Other structures visualized include the distal divisions of the common femoral artery into superficial and profunda femoris arteries and the compressible femoral vein, located infero-medially relative to the pulsating femoral artery. Despite the relatively superficial position of the femoral nerve, visualization may sometimes be difficult. This may be because of anatomical variations, such as proximal division of the nerve, or because of similar echogenicity to surrounding tissues. The use of a peripheral nerve stimulator in combination with ultrasound may provide additional information and confirm nerve location in this situation.

For conduct of the block, the inguinal region is exposed and disinfected. Once the femoral nerve is identified, a skin wheal of LA is made and a facet tipped stimulating block needle inserted in-plane or out-of-plane to the ultrasound probe. Using either approach, the fascia lata and fascia iliaca are pierced, often sensed as a double click (Supplementary Video S1). Using the PNS, the proximity of needle tip to femoral nerve is indicated by quadriceps contractions and patellar movement in response to an electrical current of between 0.2 and 0.5 mA. When the needle is visualized adjacent to the nerve, a 1 ml hydrolocation test dose can be used to confirm needle placement. If the spread of LA is not visualized and increased pressure felt on the syringe plunger, the needle should be repositioned as this might indicate intraneural needle placement. The responsibility for the injection is often given to a nurse assistant rather than the operator, although new devices offering objective pressure measurement are increasingly available. The nerve fibres supplying the knee and patella are commonly located on the lateral aspect of the femoral nerve and thus spread of LA postero-laterally or antero-laterally is sufficient for the success of this block.

**Continuous femoral block**

Femoral perineural catheterization and infusion of long-acting local anaesthetic are a common means of providing prolonged pain relief after knee replacement and above knee amputation. The total local anaesthetic dose varies according to individual patient requirements, such as age, sex, and co-morbidities.

**Technique**

A non-stimulating or stimulating catheter can be inserted using an in-plane or out-of-plane technique. Stimulating catheters are used in our centre and will be described here. An out-of-plane approach may be used in order to facilitate catheter alignment and advancement. However, an in-plane approach will offer the advantage of tunnelling and help stabilize the catheter especially if the nerve is lying superficially. For this reason, this remains our preferred approach. The procedure may be performed in three steps:

1. Touhy needle placement as for single-shot block, then the creation of a small hydrospace with 5 ml of 5% dextrose injection.
2. While attached to the nerve stimulator, the catheter is inserted through the needle, approximately 5 cm beyond the tip, while maintaining patellar contraction. Repeated attempts are sometimes required to optimize the position. There are, however, practical difficulties with the conduct of this procedure, as ultrasound visualization of catheter insertion is very difficult for a single operator. By having the ultrasound probe held by an assistant, the catheter might be more easily visualized passing within the hydrospace and the needle tip position confirmed if necessary by injecting small 1 ml aliquots of air.
3. The catheter is then secured to the skin using surgical glue and catheter fixator then covered with a clear sterile dressing, taped on four sides to form a central window. Tunnelling of the catheter is often effective at preventing catheter technical failure.

This helps reduce technical problems arising in the postoperative period including catheter leakage, disconnection, obstruction, and accidental removal by nursing staff.

**Femoral block, agent, and dosage**

The two commonly used LA agents in the UK are ropivacaine and levobupivacaine. Both are chiral agents associated with less systemic toxicity than bupivacaine. Nevertheless, the efficacy and side-effects of both drugs are directly attributable to the blockade of sodium and potassium channels and therefore each individual treatment should take account of the maximal licensed dose, age, sex, and co-morbidities.8 9
Before physiotherapy, in order to optimize pain relief but at the same time take account of the degree of straight leg raising, we titrate increments 0.2% ropivacaine between 1 and 4 ml. This provides a more individual approach to pain therapy.

Alternative infusion regimes use higher concentrations of ropivacaine 0.1–0.2% at an infusion rate of 5 ml h⁻¹, although a degree of motor block may occur. Although a patient-controlled system would seem ideal, the best combination of infusion and rescue concentration has not yet been determined.

Sciatic nerve block

Indications

Sciatic nerve block provides postoperative pain relief after below knee amputation, knee replacement, foot, and ankle surgery.

Ultrasound anatomy

For scanning, the patient lies with the side to be blocked uppermost, flexed partially at the hip and knee. Using a curvi-linear low-frequency 3–9 MHz probe, a scan of the popliteal fossa is conducted first to identify the separate Tibial and popliteal nerves lying superficial and posterior to the popliteal artery (Fig. 2). Moving the probe proximally brings the two nerves together to form the sciatic nerve at a variable point above the popliteal crease. More proximally, out with the popliteal fossa, the sciatic nerve is often difficult to visualize but is seen in the mid-thigh region as an oval structure with distinct fascicles with a fine line separating each nerve (Fig. 3). It lies in the crease between biceps femoris laterally and semi-tendinosus and semi-membranosus medially. Towards the subgluteal region (Fig. 4), the sciatic nerve characteristically changes shape from circular to triangular or flat. The sciatic nerve is approximately 4 cm deep in the subgluteal region.

(co-morbidity, location of block, and the use of epinephrine, albeit the latter is not routinely used for lower limb blocks.

Traditionally, the mass of local anaesthetic agent has determined the efficacy and duration of regional block. However, the application of ultrasound guidance has enabled very close approximation of needle tip to nerve, and recent studies have investigated the relative impact of concentration and volume on the efficacy of regional blocks. In contrast to, for example, interscalene block studies, which have focused on minimizing the volume of injection to reduce side-effects (e.g. phrenic paresis), femoral block studies have focused on reducing the concentration of local anaesthetic in an attempt to provide satisfactory analgesia with minimal motor blockade. Our own practice of femoral block for knee arthroplasty, based on the results of a clinical trial, is to administer a 20 ml bolus of ropivacaine (0.16%), prepared with a four-fifth dilution of commercial 0.2% preparations of ropivacaine using sterile saline. The advantage of such a low concentration is to provide profound analgesia while allowing straight leg raising in the immediate postoperative period, facilitating enhanced recovery with excellent pain relief. No substantive evidence exists regarding the relative potency of ropivacaine and levobupivacaine using single-shot femoral block for postoperative pain relief. Our experience is that 0.16% levobupivacaine is equally efficacious but more likely to be associated with a limitation of straight leg raising in some patients.

The perineural infusion is commenced 7–8 h after the femoral bolus, to allow confirmation of spinal regression, assessment of pain, examination of knee flexion and extension, and also straight leg raising. Nursing staff can then be encouraged to mobilize the patient, once straight leg raising is established. At this time, a well-conducted femoral block using 0.16% ropivacaine is associated with pain relief on movement consistent with a visual analogue pain score between 15 and 30 mm. Breakthrough pain is generally indicative of a poor block. Rescue medication such as 5 ml ropivacaine 0.2% is worth trying, but our observations are that the higher the mass of ropivacaine, the greater the propensity to motor block. Our recommendation would be to transfer the patient back to recovery and repeat the femoral block. Our experience and ongoing research of femoral infusions shows: (i) that levobupivacaine infusion is associated with a longer duration of pain relief until rescue compared with ropivacaine; (ii) ropivacaine probably has a better sensory and motor profile; (iii) younger patients have a greater sensory/motor separation; and (iv) once motor block is established, reversal is very slow, taking several hours.

Therefore, in light of these observations, our approach is to try and prevent pain as much as possible. This way, ropivacaine dose is kept to a minimum and motor block spared. Our standard infusion concentration of ropivacaine is 0.04% at a rate of 4 to 5 ml h⁻¹ but is reduced to 0.03% or even 0.02% dependant on age and sex, to reduce or prevent motor block. For example male patients less than 60 years of age receive 0.04% ropivacaine, whereas female patients >75 years of age receive 0.02% ropivacaine. Before physiotherapy, in order to optimize pain relief but at the
Nerve block technique

The benefit of pre-procedural scanning is that the anatomical area with the best visibility can be selected for sciatic block. Good contrast between nerve and surrounding tissue offers the anaesthetist the best opportunity to provide good regional anaesthesia quickly and efficiently without multiple needle attempts or inadvertent nerve damage. Traditional landmarks may not provide the best ultrasonic images and a more flexible approach is required. Indeed, the point of best nerve ultrasonic visibility is often in the mid-thigh region. For popliteal, mid-thigh or subgluteal blocks out-of-plane insertion of a facet tipped block needle is preferred in our centre as this minimizes the distance between skin and nerve and reduces the likelihood of block of a single nerve. When combined with PNS, inversion of the ankle is associated with better efficacy of block because the block needle is stimulating both the common peroneal nerve (innervating tibialis anterior) and tibial nerve (innervating tibialis posterior) muscles. When scanning the sciatic nerve, a small fissure is often seen separating the tibial and common peroneal components. As with nerve stimulation techniques, placement of local anaesthetic between each nerve provides the best quality block. Thus, our approach is to identify the fissure between each nerve and use 1 ml hydrolocation test doses to open the fissure using hydrostatic pressure and then inject local anaesthetic in the plane between the nerves (Supplementary Video S2). This procedure is repeated at the opposite end of the fissure and ensures spread between and around both nerves.

Continuous sciatic block

Sciatic perineural catheterization and infusion of long-acting local anaesthetics are a common means of providing prolonged pain relief after below knee and above knee amputation.

Technique

Similar to femoral perineural catheterization, the combination of ultrasound guidance with nerve stimulation may ensure optimal positioning of the catheter tip. Using the out-of-plane approach at either subgluteal or mid-thigh sites, a short bevel stimulating Tuohy needle is inserted and 5% dextrose injected to create a hydrospace between the tibial and common peroneal nerves. While maintaining stimulation, the catheter is inserted proximally through the Tuohy needle and a position chosen 5 to 10 cm within the perineural space associated with optimal current. Alternatively, if non-stimulating catheters are used, the probe can be rotated 90° to visualize catheter insertion in-plane and the spread of LA agent adjacent to the nerve.

Sciatic dosing

The choice of local anaesthetic and dose administered is dependant on the type of surgery. For example, for knee arthroplasty, a low concentration of 20 ml ropivacaine (0.16%) is all that is required to block the sciatic nerve for 12 to 16 h. On the other hand, for relieving the pain of amputation surgery, choice of local anaesthetic does not matter as sensory-motor separation is not an issue. Nevertheless, the concentration of local anaesthetic both as a bolus and within an infusion should be sufficiently high to provide long-lasting pain relief. Typically, a bolus of 0.375–0.5% followed by an infusion of 0.2–0.25% levobupivacaine or a ropivacaine 0.2% infusion at 5 ml h⁻¹ with patient controlled bolus 5ml h⁻¹ will provide good analgesia.

Supplementary material

Supplementary material is available at Continuing Education in Anaesthesia, Critical Care & Pain online.

Declaration of interest

None declared.
References


Please see multiple choice questions 21–24.