Major nerve blocks of the lower limb
MF Al-Haddad MB ChB FRCA
DM Coventry MB ChB FRCA

Until relatively recently, nerve blocks of the lower limb were only practised by regional anaesthesia enthusiasts and rarely by others. Whilst brachial plexus blockade has provided an alternative to general anaesthesia for upper limb surgery, spinal and epidural anaesthesia have offered a safe, reliable and easily performed alternative for most lower limb procedures.

However, interest in lower limb blocks has been increasing as the benefits of prolonged pain control have become increasingly recognised. The aim of this article is to review major lower limb nerve blocks, focusing on their clinical applicability and role in current practice.

Clinical application
Whilst still used as alternatives to general anaesthesia, many anaesthetists now perform lower limb blocks in combination with general or (increasingly) spinal anaesthesia to provide prolonged postoperative pain relief. In this situation, a single nerve block may be employed to cover the majority of pain at the operative site in the early postoperative period. The use of the peripheral nerve stimulator has led to improved success and ease of block performance. Improved designs of needles and equipment are now available which allow more accurate catheter placement for prolonged blockade by either continuous infusion or repeat bolus administration. The significant improvement in analgesia can result in the avoidance or minimal use of opioids in the postoperative period, and may facilitate earlier mobilisation and rehabilitation, usually without the necessity for the high-dependency nursing environment recommended for safe epidural management.

In cases of orthopaedic trauma, where there is risk of a compartment syndrome developing, consultation should take place with the surgeon involved before considering any prolonged neural blockade.

In addition to the benefits of improved pain control, these blocks can provide a useful alternative to general anaesthesia where central neural blockade is either technically difficult or contraindicated (e.g. ankylosing spondylitis, spinal stenosis). They are particularly useful when a widespread sympathectomy is undesirable, as in low cardiac output states or aortic stenosis. Combined femoral and sciatic block provide greater haemodynamic stability than even a carefully performed unilateral spinal anaesthetic. Unlike subarachnoid blocks, these techniques do not interfere with respiratory function, coughing or expectoration and can usually allow the dyspnoeic patient to be positioned upright in the perioperative period with reduced likelihood of postural hypotension and syncope. Lower limb blocks can also be employed in the head-injured trauma patient, thus allowing the monitoring of conscious level during surgery without the risks of acute brain shifts which could accompany dural puncture when intracranial pressure is raised. Peripheral blocks may represent a safer alternative to central blockade in the presence of minor degrees of coagulopathy, although the risks and benefits of regional anaesthesia in this situation must be carefully balanced.

Despite the advantages outlined above, the necessity of performing two major nerve blocks, time constraints on busy operating schedules and often, lack of training, have deterred many anaesthetists from regularly performing these techniques.

Anatomical considerations and choice of block
A working knowledge of the appropriate anatomy is necessary for nerve localisation as
well as for choosing the appropriate block necessary for surgery (Fig. 1). The latter requires knowledge of the cutaneous innervation as well as that of the joints and surrounding tissue. The former requires knowledge of the appropriate anatomical landmarks for block needle insertion and of the muscle innervation to allow interpretation of nerve stimulator findings. If a thigh tourniquet is required, the entire leg will have to be blocked. For surgery on the foot, a below-knee tourniquet can often be used obviating the need for any sensory blockade above the knee. If a below-knee tourniquet is employed, this must be placed at least 10 cm distal to the tibial tuberosity to prevent compression of the peroneal nerve as it courses around the fibular neck.

The nerve supply to the lower limb is derived from the major nerves of the lumbar plexus (L2–4) through the femoral, obturator and lateral cutaneous nerve of thigh, whilst the remainder is largely supplied by the sciatic nerve (L4–5 and S1–3). The innervation of the leg below the knee is predominantly sciatic, with only the medial cutaneous area supplied by the saphenous (femoral) nerve. For this reason, most simple operations on the foot can be performed using sciatic block alone, either with a below-knee tourniquet or without tourniquet for patients with peripheral vascular disease. In approximately 10% of individuals, the saphenous nerve extends distally beyond the hindfoot to supply the medial aspect of the foot as far as the first metatarso–phalangeal joint. Therefore, it may be necessary to block this nerve at the knee or ankle if these individuals are having surgery around the first metatarso–phalangeal joint (e.g. osteotomy or bunionectomy).

In the thigh, the posterior cutaneous nerve is derived from the sacral plexus but the remainder of the sensory innervation is derived from the lumbar plexus. Both hip and knee joints receive innervation from the sciatic and the lumbar plexus nerves. Complete block of the knee for replacement arthroplasty would, therefore, require blockade of sciatic and lumbar plexus (femoral) nerves. However, postoperative analgesia can be provided by femoral nerve block alone. Complete blockade for major hip surgery is somewhat more difficult, with the incisions frequently extending proximally outside lumbar plexus territory. However, lumbar plexus block can be employed alone for dynamic hip screw placement for fractures of the femoral neck or for providing prolonged postoperative analgesia in combination with general or spinal anaesthesia for hip replacement or hip revision surgery. The posterior approach to the lumbar plexus is preferable to the inguinal ‘3-in-1’ approach because it provides a more reliable obturator nerve block which is necessary for analgesia of the hip joint. Femoral nerve block can be used alone for providing analgesia for femoral shaft fractures, osteotomies or for more superficial procedures such as harvesting skin for grafting procedures or for muscle biopsy. Procedures involving groin incisions such as varicose vein surgery or arterial reconstructive procedures require further local infiltration to cover the ilioinguinal, genitofemoral and lower thoracic dermatomes.

Local anaesthetic agents

Because of the significant pain following most lower limb procedures (‘minor’ foot operations or major joint arthroplasty), the most appropriate local anaesthetic agents are usually long acting (e.g. ropivacaine, bupivacaine or levobupivacaine). These agents are normally effective for 14–18 h. Significant amounts of local anaesthetic are required, particularly for combined sciatic-femoral block, because both adequate volume and concentration are necessary for successful major nerve blockade. Care should be taken to remain within recommended limits. Blood concentrations will remain within the safe range when using up to 2 mg kg\(^{-1}\) of each agent. Ropivacaine 0.5% appears equipotent to bupivacaine 0.5% for femoral and sciatic nerve blocks and there appears to
be little advantage in increasing concentration further. If necessary, adequate blockade of one or both nerves can usually be achieved using 0.375% solutions, particularly in the frail, elderly patient. Adequate sciatic block can usually be obtained with volumes of 15–20 ml, with similar volumes being used for femoral block. For ‘3-in-1’ or psoas compartment block, it is best to use at least 20 ml where possible. Ropivacaine and levo-bupivacaine are usually the agents of choice due to their improved safety profile, particularly with respect to cardiovascular toxicity.

The addition of epinephrine 5 µg ml⁻¹ and the slow injection of 5 ml increments with careful aspiration should allow earlier detection of inadvertent intravenous injection and prevent serious adverse effects.

Clonidine 1 µg kg⁻¹ added to a ropivacaine sciatic-femoral block has been shown to increase block duration by 3 h with only a minimal early increase in sedation. There is little evidence to support the addition of opioids in this situation.

**Techniques**

### Sciatic nerve block

The sciatic nerve is the largest peripheral nerve in the body. Because of its deep location and the potential difficulties associated with moving and positioning some patients, it is not surprising that many approaches have been described to facilitate blockade of this nerve. The posterior approach as described by Labat remains one of the most popular and reliable but it requires the patient to be turned to a lateral semiprone position.

The patient is positioned with the limb to be blocked uppermost and flexed at the knee. A line is drawn from the greater trochanter to the posterior superior iliac spine (Fig. 2) and hip flexion adjusted so that the long axis of the femur forms a continuation of this line. At the mid-point, a second, perpendicular line is drawn caudally for 4–5 cm to mark the point of needle insertion. Using an aseptic technique, the skin is infiltrated with local anaesthetic, the nerve stimulator is set at 2 mA and a 100 mm insulated needle is inserted perpendicular to the skin and advanced. Initially, some motor activity is usually provoked in the gluteal region and this should be followed by hamstring contraction as the needle is carefully advanced. The current can then be reduced to 0.5–1.0 mA and further subtle advancement used, ideally, to obtain maximal gastrocnemius contraction at 0.5 mA. If this cannot be achieved, the needle should be withdrawn and redirected medially or laterally and advanced again until plantar flexion is achieved. Dorsiflexion of the foot can also be used as an end-point, although the authors find the former more reliable. After optimising the contractions, 15–20 ml of local anaesthetic is injected in 5 ml aliquots after negative aspiration.

When patient positioning is difficult due to trauma, the leg can either be splinted or an alternative approach selected. Raj described a supine approach but this may also present positioning problems. Beck described an anterior approach which avoids the positioning difficulties but appears somewhat less reliable. Chelly and colleagues have recently simplified the landmarks of the latter approach. Clinical, cadaveric and MRI studies have shown that internal rotation of the limb increases chances of success of the anterior approach by rotating the lesser femoral trochanter out of the way of accurate needle advancement.

At least three lateral approaches have been described with high reported success rates and few complications, whilst a single or multiple injection technique can be used to block the sciatic nerve at the popliteal fossa. This block is usually described for administration with the patient in the prone position but a lateral approach is possible allowing the patient to remain supine. The popliteal approach provides suitable operating conditions for foot surgery with a below knee tourniquet whilst sparing the hamstrings and facilitating mobilisation.

### Femoral and ‘3-in-1’ blocks

With the patient supine, the femoral artery is palpated just below the inguinal ligament and, after local anaesthetic infiltration, a 50 mm insulated needle is inserted just lateral to the femoral artery pointing cephalad at an angle of 30–45° to the skin. The nerve stimulator is set at 2 mA and the needle is advanced, usually with two fascial ‘pops’, until contraction of the quadriceps and ascension of the patella is elicited. After optimising the contractions with a current of
0.5 mA or less, 15–20 ml of local anaesthetic is injected in 5 ml aliquots after negative aspiration. Using the inguinal ligament, rather than the iliac crest, as the level of needle insertion has been suggested as a way of improving the success rate. The injection of a larger volume of local anaesthetic (30 ml) and the application of digital pressure distal to the injection site when performing a femoral block encourages the proximal spread of the local anaesthetic solution. This produces additional lateral femoral cutaneous block and, sometimes, obturator block (‘3-in-1’ block). However, the latter nerve does appear to be more reliably blocked with a posterior lumbar plexus approach.

Lumbar plexus block

The lumbar plexus can be blocked at the level of L4–5 (psoas compartment block (PCB)) or L2–3. The patient lies either in the lateral decubitus position with the side to be blocked uppermost or adopts a sitting position. The site of needle insertion is either 3 cm caudad and 5 cm lateral to L4 for PCB block or 5 cm lateral to L3 for the higher block. After infiltrating the skin with local anaesthetic, the nerve stimulator is set at 2 mA and a 100 mm insulated needle is inserted perpendicular to the skin until the transverse process of the appropriate vertebra is encountered. The needle is then withdrawn and redirected cephalad to ‘walk off’ the transverse process. It is then advanced further until quadriceps contraction is elicited. After optimising the contractions with a current of 0.5 mA or less, 25–30 ml of local anaesthetic is injected in 5 ml aliquots after negative aspiration. Both approaches will reliably block the femoral, obturator and lateral femoral cutaneous nerves. A recent ultrasound study showed that the skin-to-plexus distance is 5.5 ± 1.4 cm. This distance is directly related to body mass index and not to the level of insertion (L3 to L5).

Epidural spread has been reported and this appears more common in paediatric practice. A renal haematoma has been reported with a block performed at L3 level. Otherwise, complications are rare.

Catheter techniques

Clinical experience and a number of studies have demonstrated the superiority of regional compared with systemic analgesia. In comparison with epidural blocks, using continuous femoral catheters causes fewer side effects such as hypotension and urinary retention. There is also less need for the high dependency care usually recommended for epidural analgesia. A recent study of patients undergoing major knee surgery demonstrated better analgesia, improved early mobility and earlier discharge from the rehabilitation unit for those who had a femoral sheath or epidural catheter compared with intravenous morphine PCA. Singelyn and colleagues, using a femoral sheath catheter following total hip replacement, demonstrated that a regimen of PCA with a 5 ml bolus and a lock-out time of 30 min produced similar pain relief, better patient satisfaction and less local anaesthetic consumption compared with a continuous infusion at 10 ml h⁻¹ using a mixture of bupivacaine 0.125%, clonidine 1 μg ml⁻¹ and sufentanil 0.1 μg ml⁻¹.

Other successful infusion regimens have included continuous infusion of 0.2% ropivacaine at 6–10 ml h⁻¹, patient-controlled ‘top ups’ of 5 ml of the same solution with a lock-out time of 30 min (no background infusion) or a combination of both with a lower background infusion rate of 6 ml h⁻¹, 2 ml bolus top-ups and a lock-out time of 30 min. There does not appear to be an appreciable accumulation of ropivacaine at 24 h when up to 20 mg h⁻¹ of ropivacaine is used. A recent prospective study of 1791 patients who had upper and lower limb blocks with ropivacaine 0.5% who were discharged on the day of surgery, demonstrates the feasibility and safety of these techniques in ambulatory surgery. Disposable infusion devices are being used increasingly used in the UK and in some US ambulatory surgical centres, their use has been continued in the patients’ home for up to 4 postoperative days without adverse events being reported. Two recently published controlled trials demonstrated both the feasibility and high patient satisfaction associated with extended regional blocks using catheter techniques. This was safely achieved by issuing patients with oral and written instructions, observing their ability to follow these instructions whilst in hospital and providing 24-h back-up after discharge.

Key references


See multiple choice questions 72–75.