Lower limb nerve blocks

Barry Nicholls is Consultant in Anaesthesia and Pain Management at Musgrove Hospital, Taunton, UK. He qualified from Liverpool University and trained in Newcastle, UK, and Seattle, USA. His interests include intrathecal drug delivery systems, regional anaesthesia training and more recently the use of ultrasound in anaesthesia including peripheral nerve blockade.

Lower limb surgery is mainly orthopaedic but includes vascular and plastic procedures. The most common elective and emergency orthopaedic operations are prosthetic joint replacements (hip and knee) and fractured neck of femur, respectively. Although there is little hard evidence to support the benefits of regional anaesthesia on perioperative morbidity and mortality, there are distinct advantages to using it in the elderly and patients undergoing lower limb surgery. The advantages and disadvantages of using regional anaesthesia in these patients are given in Figure 1.

Advantages and disadvantages of regional anaesthesia

Advantages

- Avoidance of general anaesthesia in high-risk patients
- Stable intraoperative conditions (i.e. cardiovascular)
- Effective perioperative pain control, extending into post-operative period with catheter techniques
- Reduced nausea and vomiting
- Antithrombolytic, therefore reduced risk of deep vein thrombosis
- Avoidance of opioids in the elderly, confused or opioid-sensitive patient
- Preoperative pain control (e.g. pre-amputation ischaemic pain)
- No effect on bowel motility or urinary function (opioids increase constipation, urinary retention)
- Improved early mobilization of major joints

Disadvantages

- Time consuming – most sciatic and femoral blocks take 15–30 min to be effective
- Failure rate about 5% even in the best hands
- Inadequate training of consultants and trainees

Most orthopaedic surgery is performed on extremities (arms and legs), the innervation of which is derived centrally from the spinal nerves. These nerves coalesce into plexuses, and finally divide into terminal nerves supplying the bones and muscles and innervating the skin of the arm and leg. At certain points along their path these nerves can easily be identified and blocked with local anaesthetic, achieving analgesia and anaesthesia.

Much orthopaedic surgery can be carried out using regional anaesthesia and sedation alone. However, because of lack of training of anaesthetists and surgeons, coupled with patients’ poor understanding and acceptance of regional techniques, its use is not as common as one would hope. Many patients have general anaesthesia for procedures that could easily and effectively be carried out using a regional technique.

For the anatomy of the lumbar and sacral plexuses see page 108. The nerves of the leg and foot are described on page 112.

Hip and knee surgery

The hip joint is innervated by the femoral, sciatic and obturator nerves, with the skin and superficial tissues receiving branches from the lower thoracic nerves. Consequently no single peripheral nerve block is sufficient for hip surgery. Generally, spinal, epidural or a mixture of general anaesthesia or sedation with peripheral nerve blocks is used. Techniques commonly used for hip surgery include lumbar plexus blocks (posterior approach and anterior 3:1) and the parasacral approach to the sciatic nerve. The main nerve blocks for hip and knee surgery are listed in Figure 2.
## Major nerve blocks for hip and knee surgery

<table>
<thead>
<tr>
<th>Technique</th>
<th>Nerves blocked</th>
<th>Indications</th>
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<tbody>
<tr>
<td>Parasacral sciatic</td>
<td>Sciatic plus pudendal and other branches of sacral plexus</td>
<td>Analgesia, hip or knee surgery</td>
<td>Urinary retention (occurs in &lt; 5%)</td>
</tr>
<tr>
<td></td>
<td>Posterior cutaneous nerve of thigh</td>
<td>Amputations</td>
<td></td>
</tr>
<tr>
<td>Lumbar plexus block (posterior)</td>
<td>Femoral, Lateral cutaneous nerve of thigh, Obturator</td>
<td>Analgesia, hip or femoral operations including knee</td>
<td>High volume intramuscular injection (when used with sciatic block consider total dose of anaesthetic) Short duration of action</td>
</tr>
<tr>
<td>3:1 Femoral nerve block</td>
<td>Femoral, Lateral cutaneous nerve of thigh, Obturator (4%)</td>
<td>Anterior thigh, femoral and knee surgery</td>
<td>Postoperative pain control for total knee replacement. Single shot is as effective as catheter technique or infusion (first 24 hours). Needed when thigh tourniquet is used</td>
</tr>
<tr>
<td>Sciatic nerve</td>
<td>Sciatic</td>
<td>Knee and lower leg surgery</td>
<td>Catheter technique for amputations</td>
</tr>
<tr>
<td>Posterior (Labat)</td>
<td>Posterior cutaneous nerve of thigh</td>
<td>Ankle and foot surgery</td>
<td>Needed for all surgery on foot and lower leg using thigh tourniquet</td>
</tr>
<tr>
<td>Inferior (Raj)</td>
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For a posterior surgical approach to the hip, additional infiltration over the iliac crest is needed to block cutaneous innervation from the lower intercostal nerves (subcostal nerve). For above and below knee amputation, sciatic and femoral block are needed for surgery, but sciatic nerve block only is crucial for postoperative analgesia.

### Lumbar plexus block

**Posterior approach:** a marker pen is used to draw two lines, one parallel to the spinous processes passing through the posterior superior iliac spine, and the other joining the highest points of both iliac crests (L3–4; Tuffier line). The point of needle insertion is at the intersection of these two lines (Figure 3).

![3 Lumbar plexus block. a Tuffier's line, b posterior superior iliac spine. The distance from the midline is 4–6 cm.](image)

A 100–150 mm long insulated needle is inserted in a horizontal plane with the needle tip directed slightly caudal with the aim of contacting the transverse process (5–8 cm) or stimulating the lumbar plexus (quadriceps muscle twitch) (8–12 cm), whichever occurs first. When the transverse process is contacted, the needle is withdrawn and then reinserted with a slight cephalad or caudal orientation to pass above or below the transverse process. Stimulation of the lumbar plexus occurs, causing contraction of the quadriceps femoris muscle. The needle is manipulated until the twitches of the quadriceps muscle are still seen or felt at 0.3–0.5 mA; 20–40 ml (max 0.5 ml/kg) of local anaesthetic is then injected.

**Clinical tips** – if the motor response is hamstrings contraction (L4 component to the sacral plexus) the needle is too medial or caudal. If hip flexion occurs (direct psoas stimulation) the needle is too deep. If there is contraction of the posterior abdominal wall (quadratus lumborum) the needle is too lateral.
Anterior approach (femoral 2:1–3:1): the femoral artery is palpated below the inguinal ligament and a point is marked 1 cm lateral to the artery below the ligament. A 50 mm insulated needle is inserted, directed at 45° cephalad. Two distinct ‘pops’ or ‘clicks’ are felt – the fascia lata and the iliopectineal fascia. The motor response is contraction of the quadriceps (patella twitch). 10–25 ml of local anaesthetic is then injected.

Sciatic nerve block
Para sacral sciatic nerve block (Mansour): the parasacral sciatic nerve block is a paravertebral block at the level of S2–3. It blocks the sacral plexus rather than the sciatic nerve per se. The plexus is found in a fascial plane anterior to piriformis muscle beneath the parietal pelvic fascia. This fascia, on the pelvic surface of piriformis, fuses with the perio steum at the medial margins of the anterior sacral foramina, forming a tough resistant barrier. The sacral anterior primary rami emerging from the foramina lie behind this fascia; the internal iliac vessels, ureter and sigmoid colon are anterior to the fascia. The gluteal vessels accompany the sacral plexus.

Other components of the sacral plexus that are blocked by this approach are the gluteal nerves, the nerves to quadratus femoris (branch to the hip joint) and the nerve to obturator internus. This approach may also block pelvic splanchnic nerves (sacral parasympathetic), perineal nerves and possibly the pudendal nerve, causing urinary retention. Used in conjunction with a lumbar plexus block this approach gives good perioperative and postoperative analgesia for hip, knee or foot surgery.

Technique – the patient lies in the lateral decubitus position. A line is drawn connecting the posterior superior iliac spine and the ischial tuberosity. This approach may also block pelvic splanchnic nerves (sacral parasympathetic), perineal nerves and possibly the pudendal nerve, causing urinary retention. Used in conjunction with a lumbar plexus block this approach gives good perioperative and postoperative analgesia for hip, knee or foot surgery.

Clinical tips – bony contact is useful as a depth gauge, but the needle should not be inserted more than 20 mm after bony contact.

Posterior approach (Labat): with the patient in the lateral decubitus position with a slight forward tilt (Sims’ position), operative side up. Ideally, the posterior superior iliac spine, greater trochanter and knee should be in a straight line. A line is drawn connecting the greater trochanter to the posterior superior iliac spine. Halfway along this line a perpendicular line is extended caudal. The insertion point is where the perpendicular line crosses a line connecting the sacral hiatus and the greater trochanter.

A 100 mm insulated needle is inserted perpendicular to all planes. As the needle is inserted through the buttock, twitching of the gluteus muscles is observed, this disappears with further advancement (1–2 cm) of the needle; stimulation of the sciatic nerve is then obtained. In an adult, the sciatic nerve is typically located at a depth of
5–8 cm. Stimulation of the tibial component is sought; observed as plantar flexion of the foot at less than 0.5 mA. 15–20 ml of local anaesthetic is then injected.

**Inferior approach (Raj):** with the patient supine, and their hip and knee flexed to 90°, the greater trochanter and ischial tuberosity are marked. A line is drawn joining these two points and the intermuscular groove between the adductors and the hamstrings marked (Figure 5). At this point, insert a 50–100 mm insulated needle with a slight medial angulation until dorsiflexion of the foot occurs. 15–20 ml of local anaesthetic is then injected.

![Sciatic nerve block (Raj technique) inferior approach. a Greater trochanter, b ischial tuberosity.](image)

**Clinical tips** – the peroneal (fibular) and tibial component may be separate. The peroneal component lies lateral and more superficial than the tibial. Tibial stimulation is desirable because it is associated with improved clinical block (tibial and peroneal). A higher stimulating current may be required in elderly, diabetic, oedematous, hypothermic or hypothyroid patients (currents above 1 mA are seldom required). The use of solutions containing epinephrine should be avoided because animal studies have shown that it reduces sciatic nerve blood flow by up to 40%.

**Popliteal blocks**
The popliteal fossa is a diamond-shaped space behind the knee. It is limited above, medially by the semimembranosus and semitendinosus and laterally by biceps femoris, diverging from the apex. The lower part of the diamond is formed by the heads of gastrocnemius, with the roof of the fossa formed by fascia lata and its floor by the femur superiorly and the knee joint inferiorly. The popliteal artery and vein are anterior and medial to the tibial and peroneal (fibular) nerve as they pass through the fossa. The sciatic nerve normally divides into the tibial and common peroneal (fibular) branches near the apex of the popliteal fossa. In 75% of patients this occurs within 9–10 cm of the popliteal crease (in 95% within 13 cm); in a few patients the nerves remain separate for their entire course throughout the thigh. However, their relationship to each other is always constant with the tibial medial and the peroneal (fibular) lateral.

The tibial nerve runs vertically down between the heads of gastrocnemius. The common peroneal (fibular) nerve runs downwards and laterally, medial to the biceps tendon, disappearing into the substance of peroneus longus.

Popliteal blocks are indicated in all surgery for the ankle and foot, but as the sole anaesthetic only in patients in whom calf or ankle tourniquet can be used. Blockade of the saphenous nerve is advised in most cases because this may reduce the pain caused by a calf tourniquet.

**Lateral approach:** with the patient supine, flex the knee to 30°, palpate the groove between biceps femoris and vastus lateralis and draw a line along it. Palpate the upper border of the patella and draw a line down towards the groove. Where this line crosses the groove, insert a 22 G, 50 mm insulated needle posteriorly 25–30° and slightly caudad (Figure 6). The needle passes through bicep femoris, to enter the popliteal...
The common peroneal nerve is usually easily located and noted by eversion and dorsiflexion of the foot. Using the same needle direction, advance the needle to locate the tibial nerve, causing plantar flexion of the foot. The distance between the two nerves is usually 5–25 mm. 10 ml of local anaesthetic is injected for each nerve.

6 Popliteal block (lateral approach).

**Posterior approach:** with the patient prone and his foot resting on a pillow, flex the knee and mark the popliteal skin crease. Ask the patient to lift their leg off the table, identify the muscular borders of the popliteal fossa and mark the apex. Draw a line connecting the apex to the mid-point of the popliteal crease and mark a point 1 cm lateral to the midline, 8–10 cm above the skin crease (Figure 7).

7 Popliteal block (posterior approach).

Insert a 100 mm insulated needle at an angle of 45° to the skin advancing in a cephalad direction until the desired motor response is elicited (plantar flexion of the foot). Withdraw and redirect the needle more laterally, identifying the common peroneal nerve by dorsiflexion and eversion of the foot. The nerves lie at a depth of 4–6 cm. For best results both components should be identified and blocked individually with 10 ml of local anaesthesia each. Alternatively, a single injection of 25–40 ml can be used.

**Ankle and foot surgery**

Below the knee, the sciatic nerve supplies all motor and sensory innervation except for a cutaneous strip following the long saphenous vein to the medial border of the foot, which is supplied by the saphenous nerve (L2–4), a branch of the femoral nerve. Most foot surgery can be performed under regional anaesthesia using an ankle tourniquet placed 1–2 cm above the malleoli. Five nerves supply the cutaneous innervation of the foot (Figure 8). These can be blocked at and around the ankle and the forefoot, giving complete analgesia for all foot operations. They are uncomfortable to perform without sedation and the surgeon should be informed that they do not give an immobile foot.
In general, forefoot surgery can be covered by blockade at and around the ankle. Ankle surgery ideally requires blockade at the popliteal level as a minimum, unless a thigh tourniquet is being used, then more proximal blockade is needed. Knee and hip surgery require proximal sciatic and femoral blockade, and/or epidural/spinal for total akinesia of the leg.

Ankle blocks

**Saphenous nerve** – with the patient supine and the leg externally rotated, the tibial tuberosity is identified at the knee and 10 ml of local anaesthetic injected subcutaneously from the tibial tuberosity towards the medial tibial condyle. The saphenous nerve can also be blocked by infiltration on either side of the saphenous vein anterior to the medial malleolus at the ankle.

**Deep peroneal nerve** – 2–3 cm distal to the inter-malleolar line palpate the extensor hallucis longus tendon (dorsiflexion of the big toe); lateral to this is the dorsalis pedis artery. Insert a 23–25 G needle just medial/lateral to the artery until bony contact is made. Withdraw it slightly, injecting 2 ml of local anaesthetic either side of the artery.

**Superficial peroneal nerves** – after blocking the deep peroneal nerve, infiltrate 10 ml of local anaesthetic laterally and/or medially at the plantar junction of the foot to block the medial and lateral divisions (medially for first, second and third toes, laterally for fourth and fifth toes).

**Tibial nerve** – draw a line from the medial malleolus to the posterior inferior calcaneus and palpate the posterior tibial artery. Insert a 22 G 50 mm insulated needle just behind the artery, advancing it until either stimulation or paraesthesia is elicited. If bone is encountered, withdraw slightly, injecting 6–10 ml of local anaesthetic.

**Sural nerve** – using a 23–25 G, 50 mm needle, inject 5 ml of local anaesthetic subcutaneously between the lateral malleolus and the lateral border of the Achilles’ tendon.

**Digital nerves**
- Metatarsal approach: palpate the metatarsophalangeal joint, at a point 2 cm proximal. A 23–25 G needle is inserted either side of the metatarsal advancing to the plantar aspect of the foot. As the needle is withdrawn, 4–6 ml of local anaesthetic is injected on either side.
- Digital approach: a 23–25 G needle is inserted just distal to the metatarsophalangeal joint, advancing to the plantar aspect of the bone. 1–3 ml of local anaesthetic is injected on either side as the needle is withdrawn.
- Web space: a 23 G, 25 mm needle is inserted in the web space to a depth just proximal to the metatarsophalangeal joint. 4–6 ml of local anaesthetic is injected into the web space and the site is massaged to aid spread and effect.

**Catheter techniques**
Perineural catheter techniques are used to extend anaesthesia and analgesia into the postoperative period for 24–72 hours; they are discussed on page 124.
FURTHER READING

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