

Peripheral regional techniques for acute pain treatment

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Abstract

Regional anaesthesia has many advantages over systemic analgesia alone for postoperative pain and rehabilitation. Advances in continuous peripheral nerve block techniques enable the benefits of single injection blockade to be extended, providing prolonged, site-specific analgesia. A wide range of equipment, local anaesthetic solutions and adjuvants can be used to provide peripheral nerve blockade. In this article we review equipment, drugs, techniques, indications, benefits and potential complications of peripheral nerve blockade, focussing on continuous perineural catheter techniques.

Keywords Acute pain; adjuvants; complications; indications; infusion pumps; local anaesthetics; nerve block; perineural catheters

Acute pain can have considerable impact on patient morbidity.¹ Compared to systemic analgesia alone regional anaesthesia provides improved postoperative analgesia, reduced pain intensity, less nausea and vomiting, improved patient satisfaction and reduced anxiety.² Ineffective control of acute pain may increase the risk of central sensitization and progression to chronic pain syndromes. Injecting the operative site with local anaesthetic (LA) is a simple way to enhance pain control. More specifically LA can be injected around targeted peripheral nerves or plexuses, into fascial planes, the paravertebral space or joints. In this respect peripheral regional techniques can be used to provide analgesia for head, neck, upper and lower limb, thoracic and abdominal acute pain. Single injection peripheral nerve blocks with long acting LAs can provide excellent analgesia, but the benefit is usually limited to a maximum of 24 hours. Thereafter, patients may have to be supplemented with opioid analgesia, encountering unwanted side effects. Increasing interest has focussed on continuous peripheral nerve blockade (CPNB), the percutaneous insertion of a catheter and continuous infusion of LA adjacent to the peripheral nerve of interest, to provide prolonged, site-specific analgesia.

Regional anaesthesia is an important component of good acute pain management. In addition to providing postoperative

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Learning objectives

After reading this article you should be able to:

- name the indications for and benefits of peripheral nerve blockade
- describe the equipment used to provide continuous peripheral nerve block
- compare adjuvant drugs commonly used with local anaesthetics in peripheral nerve blockade.

analgesia, regional techniques can be used for trauma patients, both prior to surgery and for conservative management, (e.g. intercostal or paravertebral blocks for rib fractures and fascia iliaca blocks for hip fractures).

Peripheral regional techniques

Usually the surgical procedure will determine the peripheral regional block technique for postoperative analgesia. To extend the duration of regional analgesia a catheter can be additionally inserted enabling LA to be continually infused over a number of days. The indications for CPNB include major surgical procedures on the extremities, painful physical therapy, prolonged requirements for postoperative analgesia and where opioid avoidance is preferable. The use of CPNB in ambulatory patients has developed over the past few years, pushing boundaries to achieve day-case hospital stay in procedures once originally performed only on an inpatient basis. Important criteria in the ambulatory setting include patient acceptance and immediate support from the acute pain service after discharge.

Equipment

There are a number of different regional anaesthetic needles available on the market. A typical needle is 22-gauge (G), insulated, attaches to a nerve stimulator and has an extension port for injection. Larger gauge, stimulating needles (typically 18 or 19G) are required for catheter (20 or 21G) insertion. There are three different catheter set designs: catheter-through-needle, cannula-over-needle and stimulating catheter systems. Once the catheter has been inserted it needs to be securely fixed and again there are different methods. As yet there is no evidence to support one type of catheter set or fixation method. The steps to performing regional anaesthetic techniques are listed in Table 1.

Infusion pumps

Ideally pumps for CPNBs should:

- be light weight to permit early mobilization
- permit a wide range of infusion rates
- include patient-controlled analgesia
- have safety features: infusion should stop if pump is opened or if a high infusion pressure is encountered.

There are two types of ambulatory pumps, electronic and elastomeric. If various rates of infusion, bolus volumes and lockout periods are required then an electronic pump is preferred. A temperature-sensitive device regulates the infusion rate of most elastomeric pumps but provides no warning of pump

Steps for performing a regional block

- 1 Explain procedure to patient, describing side effects and risks
- 2 Obtain consent
- 3 Consider risk/benefit of performing block awake or asleep
- 4 Have the aid of a trained assistant
- 5 Be aware of the location of intralipid emulsion in department
- 6 Choose regional anaesthetic needle or catheter set you are familiar with
- 7 Check the working function of nerve stimulator and/or ultrasound machine
- 8 Obtain intravenous access
- 9 Patient monitoring
- 10 Position patient optimally
- 11 Sterile preparation
- 12 Calculate appropriate local anaesthetic dose
- 13 Identify anatomy and location of target nerve/plexus (using nerve stimulator, ultrasound or both)
- 14 Inject LA slowly after initial aspiration. Keep verbal communication with patient throughout (if awake) and watch ECG monitor. Aspirate again after every 5 ml injected. Stop injection if painful.
- 15 Catheter insertion is usually performed after injection of LA to avoid trauma. Thread the catheter through the needle (similar to epidural technique) and then remove the needle. Pull the catheter back to where the needle tip was initially at optimum position or guide pull back using ultrasound.
- 16 Catheter fixation is critical to maximize the success rate and prevent postoperative displacement.

Table 1

malfunction or catheter occlusion. Advantages of elastomeric pumps include portability, ease of use and fewer technical problems.

Techniques for local anaesthetic delivery

There are three approaches to delivering LA for CPNB following insertion of a percutaneous catheter:

- clinician-led boluses of LA at fixed times
- continuous perineural LA infusion at a predetermined rate
- patient-controlled perineural LA boluses (predetermined lockout period) with a basal rate infusion.

Local anaesthetics

Factors to be considered in the choice of LA for PNBs include: speed of onset, duration of action, ability to produce a differential sensory-motor block and toxicity. A number of LA solutions are available and can be classified into short (chloroprocaine), intermediate (lidocaine, mepivacaine) and long-acting agents (ropivacaine, bupivacaine). There is no evidence to support the superiority of one LA over another when used for continuous techniques.³

Adjuvants

Adjuncts may be used to enhance the efficiency of perineural blocks through an increase in depth and duration of the sensory block induced by LA. These include epinephrine, bicarbonate, clonidine, opioids, midazolam, magnesium, steroids and hyaluronidase.⁴ Studies involving other peripheral nerve blockade adjuncts such as neostigmine, ketamine and tramadol have not been convincing.⁴ Suggested infusion regimes are given in Table 2.

Epinephrine: induces vasoconstriction, reducing LA clearance from site of action thus prolonging duration of action. Solutions such as 1:200000 or 1:400000 are commonly used. Since the

microcirculation of peripheral nerves is under adrenergic control adding epinephrine has the potential to cause neuronal ischaemia.

Bicarbonate: the addition of bicarbonate raises the pH of LA solution thereby increasing the proportion of unionized LA available to cross the neuronal phospholipid membrane, increasing speed of onset. The recommended dose is 1 ml of 8.4% of sodium bicarbonate per 10 ml of LA. The stability of LAs with added bicarbonate is not well studied and such mixtures cannot be recommended for continuous perineural infusions.

Clonidine: is an alpha-2 receptor agonist whose effect may be mediated by inhibiting action potentials.⁵ Its effect is dose dependent, increasing the duration of anaesthesia and analgesia when used with intermediate acting LAs. A dose of 0.5–1.0 µg/ml is

Concentrations and infusion rates suggested for continuous peripheral nerve blocks

Local anaesthetic	Concentration (%)	Infusion rate (ml/hour)	Additives
Lidocaine	1	5–10	Clonidine (1 µg/ml)
Bupivacaine	0.125–0.25	5–10	Fentanyl (1–2 µg/ml)
Ropivacaine	0.2–0.3	5–10	Sufentanil* (0.1 µg/ml)
Levobupivacaine	0.125–0.25	5–10	Morphine sulphate (0.03 mg/ml)

Putzu M, Casati A. Local anaesthetic solutions for continuous nerve blocks. In: Hadzic A, ed. Textbook of regional anesthesia and acute pain management, 1st edn. New York: McGraw Hill, 2007.

*Not yet available in the UK.

Table 2

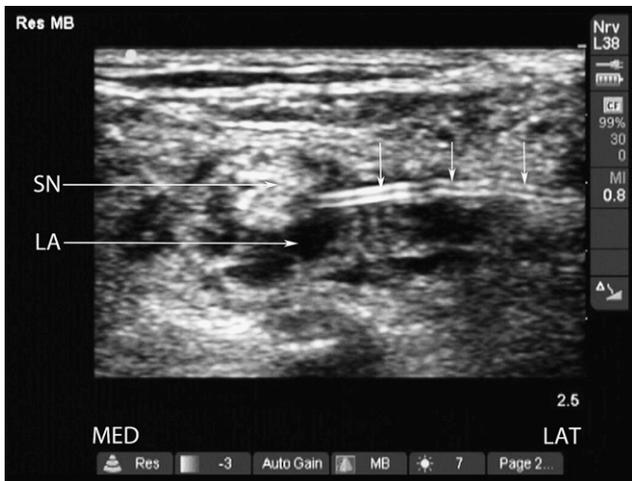


Figure 1 Ultrasound-guided lateral popliteal-sciatic catheter. The small unlabelled arrows indicate the continuous perineural catheter. (SN: sciatic nerve; LA: local anaesthetic; LAT: lateral; MED: medial).

recommended to limit systemic side effects.⁶ There is conflicting evidence to support its use.

Opioids: various studies have supported the existence and functional significance of opioid receptors on primary afferent neurons.⁷ The benefit of adding opioid agonists to LAs for PNBs is unclear.

Safety and complications

The frequency of significant adverse complications for single shot and continuous PNB is low. Common complications of peripheral nerve block include failed or partial block (requiring supplementation), vascular puncture and transient neuropathy (3:100).⁸ Block-specific complications are well recognized, for example pneumothorax following interscalene blockade. Very few cases of LA toxicity have been reported in cases of CPNB, most likely because low concentrations are used and the infusion rate rarely exceeds 10 ml/hour. Catheter insertion increases the risk of localized haematoma formation, infection (3:100) and nerve injury (3:2000) although all risks remain extremely small.⁹ Other potential complications include catheter kinking and dislodgement (up to 5.5% risk), leaking at the catheter insertion site (<10%), pump failure and disconnection.¹⁰

Future directions

Ultrasound guidance for regional anaesthesia has rapidly developed over the past 10 years and may permit more accurate placement of peripheral regional blocks and placement of

peripheral perineural catheters [Figure 1]. Recent research into liposomal delivery systems may transform regional anaesthesia, by providing a vehicle to slowly release LA at the site of injection. This prolonged analgesia may remove the need for adjuncts and catheters in the future. ◆

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