

Peripheral nerve catheter techniques

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Abstract

Peripheral nerve catheters (PNC) or perineural catheters are used synonymously to describe placing a catheter in close proximity to nerve plexuses or individual nerves for the provision of continuous pain relief. The indications of PNCs extend beyond upper and lower extremity orthopaedic surgery to perioperative analgesia in patients undergoing a wide range of surgical procedures (e.g. abdominal, vascular, thoracic, breast and trauma surgeries). PNC use can facilitate early mobilization after surgery by providing high quality analgesia that in turn leads to reduced opioid consumption and associated opioid related side effects. Perioperative PNC analgesia can result in reduced length of in-hospital stay and improved rates of patient satisfaction. Insertion of peripheral nerve catheters can be done by either anaesthetist or surgeon. Long term benefits are still to be ascertained. Risks are similar to peripheral nerve block although catheter dislodgement remains a specific problem.

Keywords Continuous nerve block; peripheral nerve catheter; regional anaesthesia

Royal College of Anaesthetists CPD Matrix: 1D02, 2E01, 2G01, 3A09

Continuous peripheral nerve blocks have been in clinical use since the 1950s to provide prolonged duration block and pain relief far exceeding that of a single-shot technique. They are frequently used to provide continuous analgesia after painful surgical procedures and for the management of severe acute pain that is unresponsive to conventional systemic analgesics. Occasionally they are also used to provide continuous sympathetic block following attempts to revascularize re-implanted digits and limbs. Peripheral nerve catheter (PNC) techniques can be incorporated across a wide range of surgical procedures involving the abdomen and chest wall as well as those that involve either the upper or lower limb.

Technical aspects

PNCs are inserted percutaneously by the anaesthetist using ultrasound guidance or nerve stimulation. The procedure is most frequently performed (after the patient has given informed consent) under light sedation, prior to surgery. Alternatively, in some clinical situations they can be inserted by the surgeon under direct vision, for example, into the sciatic nerve sheath following above knee amputation. Peripheral nerve stimulation is now used less frequently – primarily due to increasing

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Learning objectives

After reading this article, you should understand the:

- technical aspects of PNC techniques
- different types of PNC techniques
- indications, benefits and complications associated with these techniques

expertise among anaesthetists in ultrasound-guided nerve localization; nevertheless, the use of a nerve stimulator can be helpful in confirmation of the position of a nerve or plexus (e.g. femoral nerve and lumbar plexus).

Electrical nerve stimulation implies a motor response to the electrical impulse emitted from the tip of either the needle or catheter. Disappearance of muscle contraction at a stimulating current of less than 0.5 mA is indicative that the needle tip is in an appropriate, extra-neural position. There is poor correlation between catheter position and the current threshold at which disappearance of muscle contraction occurs.² The use of ultrasound has led to the development of new techniques such as rectus sheath, adductor canal and serratus anterior plane blocks – all of which can be prolonged by PNC insertion. These blocks rely local anaesthetic spread within fascial planes or involve sensory nerves – neither of which are suitable for nerve stimulator-guided localization.

When performing ultrasound-guided blocks, a 50- or 100-mm needle can be used depending on the depth of the target. Different types of commercial catheter kits are available – either catheter through needle (CTN) (Figure 1) or catheter over needle

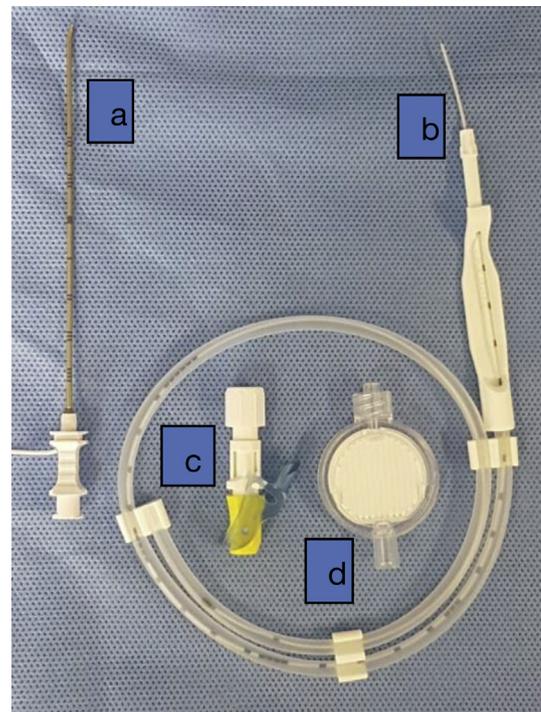


Figure 1 Catheter-through-needle (CTN) kit. (a) Blunt stimulating, echogenic Tuohy needle. (b) echogenic catheter (c) Tuohy-Borst adapter (d) bacterial filter.

(CON) (Figure 2). Insertion is performed using either an in-plane or out-of-plane approach. The in-plane approach allows accurate assessment of needle tip position, although the catheter is inserted across the short axis of the nerve. It is more difficult to locate the needle tip using the out-of-plane approach; however, the catheter can be placed along the long axis of the nerve and therefore is less likely to be dislocated from its desired perineural position. Insertion technique depends on operator experience, nerve location, access and method of catheter fixation.

Catheter-through-needle technique

The PNC block needle is inserted in proximity to the target nerve using ultrasound or neurostimulation combined with injection of small aliquots of local anaesthetic or saline to confirm adequate local anaesthetic spread. A predetermined volume of local anaesthetic is usually injected, in 5-ml increments, to establish a primary block and create space for catheter insertion. The catheter is threaded through the needle, typically between 2 and 5 cm beyond the tip. The needle is subsequently withdrawn, taking care not to dislodge the catheter at this stage. Attempts to advance the catheter should be avoided if resistance is encountered.

Correct catheter position can be confirmed by ultrasound visualization of the catheter tip and appropriate spread of local anaesthetic via the catheter. If necessary, the catheter can be withdrawn if it has been inserted too far.

Catheter-over-needle technique

CON is similar to the insertion of a peripheral venous cannula. Once needle tip-to-nerve position is confirmed, the needle is withdrawn leaving the cannula in-situ. A PNC of the same length as the needle is then inserted and secured onto the cannula via a

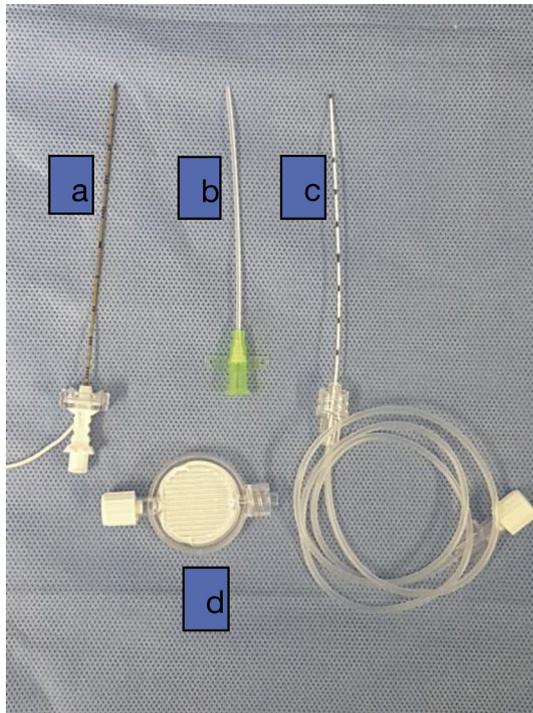


Figure 2 Catheter-over-needle (CON) kit. (a) Blunt stimulating, echogenic needle. (b) echogenic cannula (c) echogenic catheter with integrated Luer lock tubing (d) bacterial filter.

Luer lock, confirmation of catheter placement is as described above.

All PNC insertions should be performed under full asepsis, using 0.5% chlorhexidine skin preparation.³ Catheter fixation is of paramount importance and the use of cyanoacrylate glue and an anchoring dressing are recommended as a minimum. Suturing or tunneling catheters can also be helpful if a prolonged duration of infusion is planned.

Pharmacodynamics

Low concentration local anaesthetic infusions are used to provide analgesia and limit motor block. 0.1% Levobupivacaine or 0.2% ropivacaine at infusion rates of 5–10 ml/h are commonly used in adult practice within the UK.

The optimal perineural concentration and volume of ropivacaine and levobupivacaine is unknown although evidence has shown that the concentration of local anaesthetic required to block nerves is much lower than originally thought.^{4–6} Motor block is generally dependent on the mass of local anaesthetic delivered to the nerve and ropivacaine would appear to have a more favourable sensory: motor block ratio compared to levobupivacaine.

Benefits

The principal benefit of peripheral nerve catheters is the flexibility to extend pain relief after surgical procedures. Motor block frequently occurs after the initial bolus; however, with low concentration local anaesthetic infusions this can be minimized and pain relief maintained allowing patients to engage effectively with their rehabilitation. Other benefits include reduced opioid consumption and related side-effects as well as improved sleeping patterns. There is also a reduction in hospital length of stay leading to early discharge with high scores of patient satisfaction.^{1,7,8} PNC techniques are not associated with systemic side-effects such as hypotension and urinary retention.

Complications

Complications are either immediate and related to the insertion technique or late, most frequently technical problems encountered with catheter dislodgement or pump failure (Table 1). It is important that patients with PNCs are reviewed on a regular basis and cared for in an appropriate clinical area by staff familiar with these techniques.

Complications of peripheral nerve catheter techniques

Immediate

- Nerve injury
- Block specific
- Vascular puncture
- Inability to thread catheter
- Local anaesthetic toxicity

Late

- Dislodged/occluded catheter
- Block regression/pump failure
- Local anaesthetic toxicity
- Infection
- Neuritis
- Retained catheter

Table 1

Delivery systems

Intermittent bolus or electronic/elastomeric infusion pumps can be used for local anaesthetic administration. Infusion pumps offer a fixed or variable rate infusion, with or without patient controlled boluses. Battery powered pumps are available which are programmable and accurate in measuring the amount of local anaesthetic delivered. Elastomeric pumps are relatively inexpensive single use items that offer the advantage of portability and ease of use however, they may be inaccurate in delivering the basal infusion rate if the device is under or re-filled. Infusates must be carefully prepared using aseptic precautions.

Adjuvants

Adjuvant drugs have been added to local anaesthetic solutions to prolong the duration of single shot techniques therefore, the benefit of adding them to PNC infusions is less evident and is not routine practice. A list of perineural adjuvants is outwith the scope of this article; clonidine however, appears to be safe and may be considered for limited use in patients with inadequate analgesia or complex pain problems.

Outcomes

There is evidence to suggest a reduction of persistent and phantom limb pain from nerve catheter infusions of local anaesthetics compared to systemic opioids after lower limb amputation. Rectus sheath catheters have shown analgesic equivalence to epidurals in observational and retrospective studies.^{9,10} Although short term benefits have been established, little evidence exists regarding medium and long term functional outcomes using continuous nerve catheter infusions. ◆

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