Continuous peripheral nerve block (cPNB) refers to the use of a percutaneously inserted catheter with its tip adjacent to a target peripheral nerve or plexus, through which local anaesthetic can be administered to enable a prolonged period of titratable perineural blockade. cPNB has an attractive safety and efficacy profile, and can be extremely useful for managing various types of pain. However, careful consideration should be given to patient and surgical factors, the expertise of the attending anaesthesiologist and systems available for follow-up after initiation of the cPNB.

**Keywords:** continuous peripheral nerve block, percutaneously inserted catheter

**Introduction**

The benefits of regional anaesthesia have been well documented. However, one of the most significant limitations of this technique is the short duration of action compared to the period of clinically significant pain associated with many surgical procedures. Continuous peripheral nerve block (cPNB) refers to the use of a percutaneously inserted catheter with its tip adjacent to a target peripheral nerve or plexus, through which local anaesthetic can be administered to enable a prolonged period of titratable perineural blockade.

**Indications**

cPNB is indicated where peripheral nerve block will be beneficial for a longer duration than what can be covered by a single-shot peripheral nerve block (ssPNB). Although the majority of literature on cPNB refers to perioperative analgesia, this technique has also been used for the management of various chronic pain syndromes, improved range of shoulder motion after manipulation for adhesive capsulitis, orthopaedic trauma, abdominal wall pain in pregnancy, palliative analgesia and to optimise perfusion in free flap surgery. There is also a growing body of evidence for its use in children.

**Benefits of cPNB**

When compared with alternatives, cPNB is an attractive option for postoperative analgesia.

**Comparison with systemic analgesia**

The addition of cPNB to multimodal systemic analgesia decreases surgical stress response, pain scores and opioid-consumption, allows for earlier awakening from general anaesthesia and improves patient satisfaction. Benefits extend into the prolonged postoperative period, with some studies showing significantly decreased pain, opioid requirements and sleep disturbances measurable a week postoperatively. Perineural catheter techniques may decrease the incidence of chronic pain and associated psychological dysfunction up to a year postoperatively. The use of adductor canal cPNB after knee arthroplasty, shortens the time to achieve flexion goals, improves analgesia, lowers supplemental analgesic requirements and can improve joint flexion up to six months postoperatively. There is current interest in the possible role of regional anaesthesia in decreasing cancer recurrence, although robust evidence is still lacking.

**Advantages of cPNB over ssPNB**

Compared with ssPNB, cPNB improves postoperative pain, decreases analgesic requirements, shortens time to discharge-readiness and improves patient satisfaction. However, placing a single perineural catheter for surgical sites innervated by multiple nerves provides less than optimal results unless supplemented by systemic analgesia. The addition of adjuvant drugs such as dexamethasone or dexmedetomidine to ssPNB may increase the duration of analgesia, but still not beyond 24 hours and ongoing concerns regarding neurotoxicity of these drugs have limited their use. In general, the use of liposomal bupivacaine for ssPNB has yielded disappointing results, particularly in view of the cost differential of this formulation. Placement of perineural catheters also gives the flexibility to use different local anaesthetics or different concentrations at various points in the patient’s care based upon differing clinical requirements.

**Comparison with neuraxial techniques**

Compared with epidural analgesia, cPNB provide similar analgesia but with improved haemodynamic stability and avoidance of other severe complications associated with the former. When compared with intrathecal morphine, similar analgesic effects are produced with lower supplemental opioid requirements and reduced incidence of pruritus. However, in certain circumstances, the sympathetic blockade achieved by
neuraxial techniques may be desirable and not accomplished by peripheral blockade.\textsuperscript{14}

**Advantage over intra-articular catheters**

cPNB provides superior analgesia compared with intra-articular catheters for knee and shoulder surgery.\textsuperscript{15,16} In addition, there is a concern regarding local anaesthetic toxicity to chondrocytes with prolonged intra-articular infusion.\textsuperscript{17}

**Comparison with percutaneous peripheral nerve stimulation**

There is growing interest in this modality as an alternative to cPNB for prolonged analgesia, with touted benefits being a decreased risk of peripheral nerve injury and infection, allowing for a potentially prolonged duration of use. Use of this technology is also not associated with motor and sensory deficits and may in the future become a more readily available option for analgesia.\textsuperscript{12}

**Ambulatory perineural infusion**

Outpatient management improves quality of life by enabling convalescence in the comfort of the patient’s own home, a lower risk of nosocomial infection and lower associated hospital costs.\textsuperscript{18} However, pain and postoperative nausea and vomiting remain most common reasons for prolonged hospitalisation or unplanned readmission.\textsuperscript{18} Research involving ambulatory cPNB has been prolific in recent years and emerging evidence suggests that this technique is safe and provides significant cost-saving opportunities in this setting.\textsuperscript{19}

**Table I: Complications of cPNB**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Incidence*</th>
<th>Aetiology/Risk factors</th>
<th>Mitigation of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ectopic tip location\textsuperscript{23}</td>
<td>Case reports</td>
<td>Incorrect initial placement (catheter migration unlikely)</td>
<td>Catheter insertion &lt; 5 cm beyond needle Initiate infusion under monitoring LA test dose via catheter</td>
</tr>
<tr>
<td>LAST\textsuperscript{24-26}</td>
<td>Rare</td>
<td>Intravascular injection LA accumulation with prolonged infusion</td>
<td>US-guided insertion ↓ risk intravascular injection Caution in elderly or patients with comorbidities</td>
</tr>
<tr>
<td>Respiratory distress\textsuperscript{27}</td>
<td>40% phrenic nerve palsy with cISB (0.1% respiratory failure)</td>
<td>Phrenic nerve block with initial block or accumulation of LA with prolonged infusion</td>
<td>Ultrasound-guided regional anaesthesia (UGRA) Phrenic nerve sparing blocks</td>
</tr>
<tr>
<td>Myotoxicity\textsuperscript{28}</td>
<td>↑ risk with ophthalmic blocks and adductor canal catheters</td>
<td>Myotoxicity of LA ↑ risk with ↑ concentrations, prolonged duration and bupivacaine</td>
<td>Limit duration &lt; 3 days Use lowest effective concentration Avoid bupivacaine</td>
</tr>
<tr>
<td>Catheter retention during withdrawal\textsuperscript{a}</td>
<td>Case reports</td>
<td>Most reported with stimulating catheter and insertion depth &gt; 5 cm</td>
<td>Catheter-over-needle Limit insertion depth</td>
</tr>
<tr>
<td>Infection\textsuperscript{4,5,29,30}</td>
<td>Inflammation: 3–4% Bacterial colonisation: 6–57% Clinically significant infection: 1% No reported cases of permanent injury</td>
<td>↑ risk with diabetes, obesity, ICU admission, absence of perioperative antibiotics, male gender ↑ risk with axillary, femoral and cISB ↑ duration of infusion</td>
<td>Strictly sterile insertion technique Limited evidence ↓ risk with subcutaneous tunnelling Limit duration (no maximum duration per se, but most studies suggest &lt; 5 days)</td>
</tr>
<tr>
<td>Postoperative neurological symptoms\textsuperscript{26,25,31}</td>
<td>0–1.4% cISB</td>
<td>Multifactorial (RA is not independent risk factor for PONS) risk with cPNB does not appear to be greater than ssPNB</td>
<td></td>
</tr>
<tr>
<td>Major haematoma\textsuperscript{4}</td>
<td>+++ Rare</td>
<td>Anticoagulation Hepatic/haematological comorbidity</td>
<td></td>
</tr>
<tr>
<td>Fall risk\textsuperscript{4,23,33}</td>
<td>0.3%</td>
<td>Continuous femoral or lumbar plexus block</td>
<td>Adductor canal block preserves quadriceps strength (yet to be shown to decrease fall risk)</td>
</tr>
<tr>
<td>Catheter failure\textsuperscript{4}</td>
<td>0.5–26%</td>
<td>Inaccurate placement or dislodgement</td>
<td>US visualisation of catheter tip Secure catheter with tissue adhesive, adhesive dressings or suture</td>
</tr>
<tr>
<td>Hoarseness\textsuperscript{37}</td>
<td>40% cISB</td>
<td>Recurrent laryngeal nerve palsy</td>
<td>Low volumes, distil blocks</td>
</tr>
<tr>
<td>Leakage at catheter site\textsuperscript{34}</td>
<td>1.8–3.7%</td>
<td>May cause contamination of surgical site</td>
<td>CON system Tissue adhesive</td>
</tr>
<tr>
<td>MRI heating risk</td>
<td>Catheters containing coils to prevent kinking</td>
<td></td>
<td>Check manufacturer specifications prior to MRI</td>
</tr>
<tr>
<td>Patient distress regarding insensate limb</td>
<td></td>
<td></td>
<td>Careful patient counselling and written information sheets</td>
</tr>
</tbody>
</table>

\textsuperscript{LA} – local anaesthetic, US – ultrasound, LAST – local anaesthetic systemic toxicity, CON – catheter-over-needle, cISB – continuous interscalene block

*Wide variation in reported incidence likely due to heterogeneous equipment, techniques, anatomic locations and infusion protocols

\textsuperscript{Intuitively, CON would appear to have lower risk of retention; however, data are lacking.}

\textsuperscript{a}Intuitively, CON would appear to have lower risk of retention; however, data are lacking.
Complications

While a cPNB has definite advantages, it is more difficult to insert than an ssPNB and require more intensive post-procedure follow-up. Current evidence suggests that the use of cPNB does not increase the risk of postoperative complications when compared with ssPNB and large randomised controlled trials have indicated that this technique is safe for use in both inpatient and ambulatory settings, and in the paediatric population. However, as with any technique, meticulous attention to safety is vital in order to mitigate the risk of complications. Table I summarises significant complications of cPNB, which should be discussed with the patient during the pre-anaesthetic consultation.

Practicalities of cPNB

Types of catheters

Many types of perineural catheters (PNC) are available on the market and may be broadly defined as catheter-through-needle (CTN) or catheter-over-needle (CON) devices. When using CTN devices, care should be taken not to advance the catheter tip more than 5 cm beyond the needle, to avoid ectopic catheter placement and entanglement with sensitive structures. Self-coiling catheters curl immediately upon exiting the needle, theoretically decreasing the catheter tip-to-nerve distance. CON devices have the advantage of greater ease of insertion, decreased catheter-site leakage and facilitating catheter-tip visualisation.

Safety measures

While the risk of complications with cPNB is low, meticulous attention should be paid to safety measures. As with any regional anaesthesia, guidelines recommend standard patient monitoring during catheter placement, including electrocardiography, non-invasive blood pressure estimate and pulse oximetry. Proper catheter tip placement should be confirmed by sonographic visualisation, the perineural infusion should be initiated in a monitored care environment such as the postoperative care unit and the patient should be monitored for at least 30 minutes after initiation. Patients and staff should be educated on warning signs of cPNB-related complications and how to manage these. For both inpatient and ambulatory use, written instructions regarding catheter care and infusion management should be given to the patient along with contact details for the responsible anaesthesiologist in case of an emergency.

Ultrasound-guided insertion

As with ssPNB, ongoing evidence suggests widespread benefits of catheter insertion using ultrasound (US) guidance compared with electrical nerve stimulation, including higher success rate, less time required, less procedure-related discomfort and a lower risk of vascular penetration. Presumably, US decreases the risk of inaccurate or difficult catheter placement and allows for confirmation of catheter tip placement.

Infection control measures

While clinically significant infections associated with cPNB are rare, insertion should be performed using a strictly sterile technique, as described in Table II. After insertion, the catheter site should be regularly observed for local signs of infection.

Table II: Recommendations on sterile procedures for insertion of perineural catheters

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove all jewellery</td>
<td></td>
</tr>
<tr>
<td>Wash hands with alcohol-based antiseptic</td>
<td>Required duration and formality of hand wash is currently unknown</td>
</tr>
<tr>
<td>Sterile gloves</td>
<td>Protects patients from cross contamination and HCP from occupational exposure</td>
</tr>
<tr>
<td>Sterile gowns</td>
<td>Currently insufficient evidence; however, advised in local guidelines for cPNB</td>
</tr>
<tr>
<td>Surgical facemask</td>
<td>Reduces likelihood of contamination of procedure site by pathogens from HCP’s upper airway</td>
</tr>
<tr>
<td>Chlorhexidine and alcohol skin preparation</td>
<td>Protects HCP from occupational exposure</td>
</tr>
<tr>
<td>Sterile drapes</td>
<td>Isolate catheter insertion site</td>
</tr>
<tr>
<td>Sterile occlusive dressing over catheter</td>
<td>Ideally chlorhexidine-containing dressing</td>
</tr>
<tr>
<td>Bacterial filters</td>
<td>For long-term catheters</td>
</tr>
<tr>
<td>Clean US machine and probe with 70% isopropyl alcohol</td>
<td></td>
</tr>
<tr>
<td>Sterile US probe cover</td>
<td></td>
</tr>
<tr>
<td>Sterile US gel</td>
<td></td>
</tr>
</tbody>
</table>

Infusion regimens

The optimal protocol of local anaesthetic delivery for cPNB remains unclear. Ropivacaine, bupivacaine and levobupivacaine provide similar analgesia. Prolonged infusion of ropivacaine 2 mg/ml exhibits an extraordinarily low incidence of LAST. However, caution should be exercised when using prolonged infusions in elderly patients or those with comorbidities. While there is currently no evidence-based “ideal” delivery regimen, patient-controlled boluses do decrease local anaesthetic requirement and the use of automatic larger boluses with longer dosing intervals is gaining support.

Post-insertion care

All patients should receive written instructions detailing catheter care, infusion protocol and warning signs of complications. Daily follow-up is mandatory to screen for signs of LAST, respiratory compromise (with proximal brachial plexus blocks), signs of infection, catheter displacement and inadequate analgesia. Follow-up may be in person or telephonic, depending upon local protocols.
cPNB can be extremely useful for managing various types of pain, including postoperative pain for surgical procedures associated with prolonged duration of significant pain. However, careful consideration should be given to patient and surgical factors, the expertise of the attending anaesthesiologist and systems available for follow-up after initiation of cPNB.

Conflict of interest
The author declares no conflicts of interest.

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References