Peripheral and local anaesthetic techniques for paediatric surgery

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Abstract

Peripheral nerve blocks provide intra- and postoperative analgesia and are usually used as adjuncts to general anaesthesia in paediatric patients. For children in the UK most of these blocks are performed under general anaesthesia. In older cooperative children, some are performed awake, providing the correct environment and reassurances are available to minimize stress and anxiety. Peripheral nerve blocks provide good-quality analgesia without the adverse effects associated with systemic medications. Good pain management reduces morbidity and aids patient recovery, resulting in better patient and family satisfaction and earlier discharge. These factors are essential for successful and efficient paediatric surgery. Failure to achieve good pain control is obviously unpleasant, but has also been identified in the occurrence of sleep and behavioural disturbances in children following surgery. Delayed recovery and discharge can have significant disruptive and economic effects on the family and hospital. Despite these benefits, peripheral nerve blocks, like all invasive techniques are associated with complications and adverse effects. They should only be performed after careful analysis of the risk:benefit ratio. This article discusses a general approach to peripheral nerve blocks in children, along with the benefits of a predominately ultrasound approach and role of peripheral catheters.

Keywords Children; paediatrics; peripheral nerve blocks; regional anaesthesia

Royal College of Anaesthetists CPD Matrix: 2D02, 2D05, 2G01, 2G02, 2G03, 2G04

Learning objectives

After reading this article, you should be able to:

- recognize the basic knowledge and equipment requirements for regional anaesthesia in children
- describe the indications, anatomy, techniques and complications for the common blocks used in children
- discuss the advantages and disadvantages of ultrasound guidance for regional anaesthesia in children

General approach to performing a peripheral nerve block

The essential requirements for the performance of each nerve block are described below.

- History and clinical examination: including weight (to calculate maximum dose of local anaesthetic), and, where possible, examination of the potential puncture site. For contraindications to peripheral nerve blocks see Box 1.
- Identification of the most suitable block. The most peripheral option should be selected.
- Consent: explain potential advantages, adverse effects, complications (Box 2), alternative methods of pain relief, and analgesia rescue plan if the block fails.
- Resuscitation equipment: oxygen, intubation trolley, resuscitation drugs, including 20% intralipid.
- Full Association of Anaesthetists of Great Britain and Ireland (AAGBI)-recommended monitoring (pulse oximetry, ECG, blood pressure, end tidal CO_2) and intravenous access.
- Trained assistance.
- Equipment: insulated short-bevelled needle with extension tubing, ultrasound machine with high-frequency probe (sterile gel and probe covers), gauze swabs, antiseptic solution, sterile gloves, sterile drapes, syringe, local anaesthetic (LA) and a peripheral nerve stimulator (if required for mixed nerves).
- Absolute sterile technique.
- Non-anaesthetized patients: tetracaine gel (proposed puncture site); however, the skin should always be infiltrated with 1% or 2% lignocaine. Entonox can be used during block insertion.
- Nick the skin with a sharp needle before inserting a short-bevelled needle. This reduces the risk of missing underlying fascia as the short-bevelled needle passes through the skin.
- Perform injection slowly with initial and frequent aspiration to exclude intravascular injection.
- Duration of action is usually limited to 6–12 hours after a single bolus of long-action LA. A peripheral nerve catheter can be used to provide a longer duration of analgesia.
- Postoperative advice: warning of muscle weakness and reduced sensation; and how to protect the anaesthetized area (e.g. sling and mobilization aids).
- Patients should receive simple analgesics in addition to peripheral nerve blocks as blocks can fail, may not cover the entire surgical area and do not address other associated pains such as sore throat and cannula site.

Ultrasound-guided nerve blocks

Ultrasound (US) enables more accurate placement of local anaesthesia by providing non-invasive information regarding the anatomy and needle trajectory, reducing potential damage to adjacent structures. For advantages and disadvantages of US see Box 3. Nerves are non-compressible, showing no flow on Doppler and can appear hyperechoic, hypoechoic or honeycomb. The block can be performed with the needle in-plane, where the

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Contradictions to peripheral nerve blocks

General contraindications

- Lesions (infective) at the site of injection
- History of allergy to local anaesthetic
- Lack of consent

Relative contraindications

- Neuromuscular disorders
- Risk of compartment syndrome (discuss with surgeon)
- Systemic infection (catheter techniques)
- Bleeding disorders (ultrasound can help to avoid inadvertent damage to blood vessels)

Box 1

General adverse effects and complications of peripheral nerve blocks

- Failure of block
- Local anaesthetic toxicity
- Intraneural injection
- Anaphylaxis (rare)
- Infection
- Haematoma

Box 2

Advantages of ultrasound

- No ionizing radiation
- Portability (laptop-sized machines)
- Visualization of the nerve and adjacent structures (vessels, pleura)
- Visualization of the spread of local anaesthetic solution (avoidance of intravascular or intraneural injection)
- Increased efficacy (faster onset, longer duration and increased success rates)
- Decreased incidence of complications
- Lower volumes of local anaesthetic
- Can be performed in presence of muscle relaxants

Disadvantages of ultrasound.

- Cost of equipment
- Operator dependent
- Training (long learning curve with some blocks)
- Obese patients (poor visualization of structures)
- Poor resolution with increasing depth

Box 3

entire needle shaft is viewed or out of plane, where only a cross-section of the needle shaft is viewed. In-plane alignment is generally recommended. US-guided techniques result in higher success rates, reduction in damage to adjacent structures, shorter procedures and onset times and longer block duration.[1]

Local anaesthetic dose

Drug	Single-shot techniques (mg/kg)	Continuous infusions (mg/kg/hour)	Maximum dose per 4-hour period (mg/kg)
Levobupivacaine	2	0.125–0.40	2.0
Ropivacaine	3	0.40	1.6
Lignocaine	3	–	–

Table 1

Peripheral nerve stimulators

When blocking nerves with motor components nerve stimulation (NS) may aid nerve identification and provide additional information to US regarding needle–nerve relationship. The current should initially be set at 2 mA. The needle should then be advanced towards the nerve, seeking out the relevant motor response. With increasing proximity the current is then decreased, aiming to maintain a motor response at 0.5 mA. An initial injection of 1 ml of local anaesthetic abolishes twitch as the nerve is pushed away from the needle tip.[2]
Both US and NS techniques have a good safety record.[3]

Acute compartment syndrome

Acute compartment syndrome (ACS) is caused by an increased pressure in a closed muscle compartment, if severe this may compromise the circulation and function of the tissues leading to motor and sensory impairment, amputation and death. There is a direct relation between the time elapsed and fasciotomy and final functional result. Therefore surgeons are concerned regarding any technique, such as peripheral nerve blocks that may mask early detection. Although controversial it is generally believed that peripheral nerve blocks do not mask the detection of ACS.[4] Tourniquets cause a similar ischaemic pain and yet despite general anaesthesia and peripheral nerve blockade tachycardia and hypertension are usually observed. If there are concerns regarding compartment syndrome then weak LA solutions (0.125% bupivacaine) can be used to prevent extensive motor blockade, compartmental pressures can be monitored, along with maintaining a high index of suspicion and ensuring a senior review if any concerns arise. Failure to consider ACS as a cause of breakthrough pain and focussing on failure of analgesic technique has resulted in delayed diagnoses of ACS.

Local anaesthetic (LA) in neonates and infants

An immature blood–brain barrier, decreased protein binding and immature hepatic clearance makes neonates and infants more prone to LA toxicity. It has been suggested that the dose of LA should be halved in this group. The toxicity is related to both the absolute level of LA and the rate of rise in concentration in plasma. Levobupivacaine remains the drug of choice because of its longer duration of action, and low cardio- and neuro-toxicity. A concentration of 0.125–0.25% is usually used and infusions should be limited to 48 hours (Table 1). Early signs of LA toxicity are less noticeable under general anaesthesia and therefore toxicity is more likely to present with later signs such as seizures, cardiac