Peripheral and local anaesthetic techniques for paediatric surgery

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Abstract

Peripheral nerve blocks provide intraoperative 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-based approach and the 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 (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 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).

Contradictions to peripheral nerve blocks

General contraindications

- Lesions (infective) at the site of injection
- History of allergy to LA
- 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

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- 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 (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 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]

Advantages and disadvantes of ultrasound

Advantages

- 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

- 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

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. Tourniquets cause a similar ischaemic pain and yet despite general anaesthesia and peripheral nerve blockade tachycardia and hypertension are observed. Ischaemic and nociceptive pain are transmitted in different nerve fibres. There is no evidence to suggest peripheral nerve blocks increase the risk of ACS or delay its detection.[4] The following recommendations aim to minimize the risk of masking ACS (Box 4).

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 cardiotoxicity and neurotoxicity. 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

Recommendation to minimize risk acute compartment syndrome

- Preoperative discussion with patient, family and surgeon
- Single-shot injection concentration 0.1–0.25% levobupivacaine, bupivacaine or ropivacaine
- Continuous infusion 0.1% levobupivacaine, bupivacaine or ropivacaine
- Caution with use of local anaesthetic adjuncts
- High-risk patients to be followed up by an acute pain service

Box 4

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

therefore toxicity is more likely to present with later signs such as seizures, cardiac arrhythmias or cardiovascular collapse. Test doses are generally not reliable in detecting intravascular injections so meticulous technique, careful aspiration, fractionated dosing and continuous visualization of the target area should be performed to reduce the risk. In those children where the total dose of LA is small, saline may be used initially to confirm the needle/catheter position under US to ensure all the allocated LA is injected into the correct position.

Local anaesthetic adjuncts

Adjuncts are drugs that can be added to local anaesthetic to improve block quality, prolong block duration and avoid the side effects of long-acting local anaesthetics. This must be easily achievable and have a side-effect profile tolerable compared to plain local anaesthetic. The adjunct must be shown to prolong block duration by 50% and have a known mechanism of action.[5]

A wide range of different agents have been used. Epinephrine appears to prolong sensory blockade and delay systemic uptake of LA. Buprenorphine, dexamethasone, clonidine, magnesium and dexmedetomidine show some promising results but caution is recommended due to concerns regarding potential toxicity. Ketamine should be avoided due to adverse effects. There is evidence that intravenous administration of additives (e.g. dexamethasone and clonidine) provide many benefits of perineural administration while reducing the potential for neurotoxicity.[6]

At present, no adjuncts are licensed for use in peripheral regional anaesthesia. A recent meta-analysis demonstrated clonidine to increase duration 20–50% depending on type of block from a single 1–2 μg/kg dose. Other α-2-agonist dexmetatomidine have been shown to prolong block duration, but are not yet available widely in the UK.[7]

Peripheral nerve catheters

Patients undergoing major surgeries may have significant postoperative analgesia requirements and single shot LA techniques have a limited duration. In these circumstances a longer duration of analgesia provided via peripheral nerve catheter LA infusions may facilitate early ambulation and improve rehabilitation. Common continuous peripheral nerve blocks, which should be performed with US guidance in experienced hands, include paravertebral, femoral, sciatic and supraclavicular. Continuous peripheral nerve blocks are safe, effective, with few side effects and are increasingly used in children.[8]

Indications

- Major orthopaedic surgery, e.g. femoral osteotomy, amputation, club foot repair.
- Transplant/reimplantation surgery to improve blood flow to the limb.
- Chronic pain, e.g. CRPS type 1 as part of multimodal rehabilitation.
- Non-surgical pain, e.g. epidermolysis bullosa affecting a limb.

Additional equipment and dose

Continuous nerve blockade requires a standard nerve catheter kit, adhesive plasters, intravenous cannula for tunnelling, tissue glue, and a syringe driver. Most published studies recommend the use of ropivacaine 2 mg/ml or levobupivacaine 2.5 mg/ml at a rate of 0.1–0.2 ml/kg/hour.

Complications: peripheral techniques are considered safer than neuroaxial techniques as complications such as bleeding and infection are less severe. Catheter dislodgement, occlusion and leakage are common if preventative measures are not taken; these include: tunnelling the catheter and applying tissue glue to the puncture site (reducing LA leakage around puncture site which may lift off the dressing). A test dose should be performed after dressing to ensure the catheter is not kinked. A longer duration of catheter placement is associated with a greater incidence of insertion site infection, therefore close follow up and removal of catheters after 3 days is generally recommended.

Peripheral nerve blocks

Upper limb techniques

Brachial plexus anatomy: the brachial plexus is formed from the anterior primary rami of C5, C6, C7, C8 and T1. These nerve roots emerge from the intervertebral foraminae and unite to form the superior, middle and lower trunks. The trunks pass from the interscalene groove over the first rib superoposterior to the subclavian artery. They divide and unite forming cords that are named based on their relation to the axillary artery. These then form the nerves that supply the upper limb:

- lateral cord – lateral root of median nerve, musculocutaneous nerve
- medial cord – medial root of median nerve, ulnar nerve, medial cutaneous nerves of arm and forearm
- posterior cord – axillary and radial nerves.

Supraclavicular blocks: provide the most reliable blockade of the brachial plexus with a rapid onset. The close proximity of the plexus to the subclavian artery and lung, particularly in children, mandates the use of ultrasound by an experienced operator to perform this block.

- Indications – surgery to the arm, forearm and hand.
- Technique – position the patient supine with the head turned to the contralateral side. In infants and small children, a head ring and sand bag behind the shoulders facilitates needle access. The ultrasound probe is placed above and parallel to the clavicle in the supraclavicular fossa. The hypoechoic subclavian artery is visualized above the hyperechoic first rib. At this level the plexus lies above and lateral to the artery and appears as a group

of hypoechoic nodules (Figure 1). Needle insertion is in-plane from lateral to medial. Complete visualization of the needle is essential at all times, generally 0.2–0.5 ml/kg of local anaesthetic will suffice, if complete spread of LA is not observed the needle can be repositioned to encircle all the nerve bundles. It is feasible to place a catheter in proximity to the brachial plexus.

- Complications – intravascular injection, pneumothorax (<1% with ultrasound), Horner's syndrome (1%), phrenic nerve palsy (1%) and epidural/subarachnoid injection.

Axillary nerve block

- Indications – surgery of the elbow, forearm and hand.
- Technique – position the patient supine with the arm abducted 90° and elbow flexed 90°. Place the ultrasound probe transverse (short axis to the arm) and insert the needle in-plane from cephalad to caudal. The round hyperechoic structures of the branches of the brachial plexus usually surround the axillary artery (median (superficial and lateral), ulnar (superficial and medial) and radial (posterior and lateral or medial). The fourth principle nerve, the musculocutaneous nerve, is a hypoechoic flattened oval, with a bright hyperechoic rim found in the fascial layers between the biceps and coracobrachialis muscle. Placing a catheter within the vicinity of the branches of the brachial plexus (within the sheath) enables a continuous LA infusion.
- Complications – haematoma (1.1%) and nerve injury (rare).

Distal upper limb nerve blocks: the radial, median, and ulnar nerve can be blocked under US guidance and are useful for forearm and hand surgery (e.g. syndactyly). More peripheral blocks are advantageous due to the reduced risk and side effects. The radial nerve is generally best visualized above the lateral aspect of the elbow in the groove between biceps brachii and brachioradialis, the median nerve mid-forearm between the flexor digitorum superficialis and flexor digitorum profundus and the ulnar nerve mid-forearm medial to the ulnar artery.

Truncal techniques

Paravertebral nerve block

- Anatomy – the thoracic (T1–T6) and thoracoabdominal (T7–T11) intercostal nerves innervate the chest and abdominal walls. They run between inner most intercostal muscle and internal intercostal muscle in the lower margin of each rib as the most inferior structure in the neurovascular bundle. The paravertebral space (PVS) contains the thoracic spinal nerves as they emerge from the intervertebral foramina. It is bounded by the costotransverse ligament with the parietal pleura anteriorly and transverse processes and ribs posteriorly.
- Indications – thoracotomy, thoracoscopic surgery, Nuss bar, chest drains, rib fractures, upper abdominal surgery, tracheo-oesophageal fistula repair, pyeloplasty, gynaecomastia correction.
- Technique – place the child lateral, with the side to block uppermost. Rest the US probe in a transverse position over the midline to identify the spinous processes. Scan laterally in this plane to identify the pleura, transverse process and the paravertebral space. Angling the probe slightly so parallel with the ribs, insert the needle from lateral to medial. Once the needle tip penetrates the costotransverse ligament the LA can be seen to displace the pleura anteriorly as it is injected (Figure 2).
- Complications – pneumothorax, vascular puncture, epidural and intrathecal spread.

Pectoralis (PECS I) block

- Anatomy – the medial and lateral pectoral nerves originate from the medical (C8, T1) and lateral cords (C5, C6, C7) of the brachial plexus. They travel in the facial plane between pectoralis major and pectoralis minor. The lateral pectoral nerves penetrates clavipectoral fascia to supply pectoralis major directly, with additional supply from the medical pectoral nerve that pierces through pectoralis minor inferiorly. Between the two muscles is the lateral pectoral branch of the thoracoacromial artery. The axillary artery and vein lie deep to pectoralis minor.
- Indications – pacemaker and porta-cath insertion, gynaecomastia surgery.
- Technique – with the patient supine, place a linear US probe parallel below the clavicle. Visualize the muscle layers and the lateral pectoral branch of the thoracoacromial artery (Figure 3). Insert the needle in plane on the lateral side of probe, pierce pectoralis major and use hydro dissection to locate the facial plane between

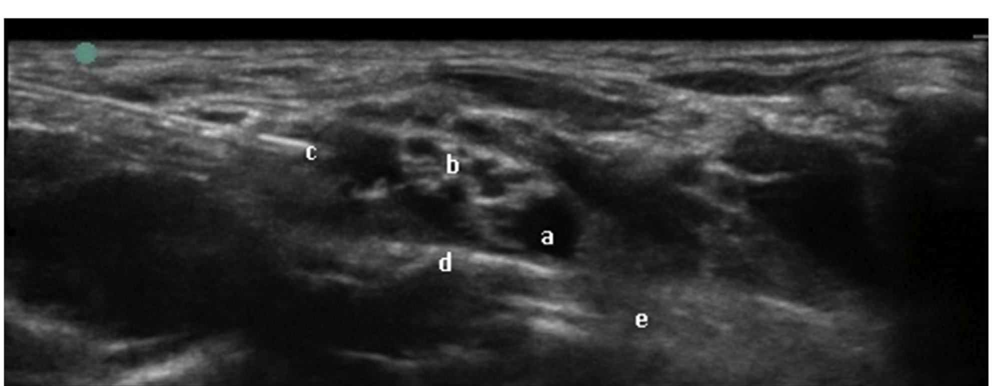

Figure 1 Ultrasound-guided supraclavicular nerve block (depth 1.8 cm). (a) Subclavian artery; (b) brachial plexus; (c) needle tip approaching brachial plexus; (d) rib; (e) pleura.

Figure 2 Ultrasound-guided paravertebral nerve block (depth 4.7 cm). (a) Transverse process; (b) costotransverse ligament; (c) pleura; (d) lung; (e) paravertebral space.

pectoralis major and minor. Current evidence suggests 0.5 ml/kg of local anaesthetic.

- Complications – pneumothorax, brachial plexus injury, vascular puncture.

Transverse abdominal plane block

- Anatomy – the sensory segmental nerves of T9, T10, T11, T12 and L1 pass in the plane between transverse abdominal and the internal oblique abdominal muscle.
- Indications – lower abdominal surgery, e.g. appendicectomy, hernia repair, iliac crest grafts, gynaecological and urological procedures.
- Technique – with the patient in a supine position, place the US probe in the mid-axillary line, between iliac crest and costal margin. The needle tip should be visualized and local anaesthetic injected, as it penetrates the hyperechoic fascial plane between the internal oblique and transversus abdominis (Figure 4). For the block to be successful, a significant volume of the appropriate concentration of LA (i.e. 0.5 ml/kg) is required. Commonly bilateral blocks are required so care should be taken not to exceed recommended safe doses. TAP blocks do not provide visceral analgesia so should be used as part of a multimodal analgesic approach.
- Complications – intraperitoneal injection and visceral damage.

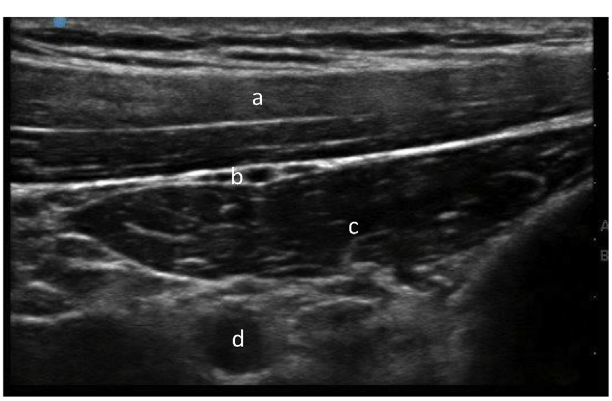

Figure 3 Ultrasound-guided PECS I block (depth 3.3 cm). (a) Pectoralis major; (b) lateral pectoral thoracoacromial artery; (c) pectoralis minor; (d) axillary artery.

Subcostal transverse abdominal plane block

- Anatomy – the sensory segmental nerves of T6, T7, T8 and T9 which pass in the plane between rectus abdominis sheath and the transversus abdominis muscle.
- Indications – open gastrostomy or jejunostomy, umbilical hernia repair, surgery in the supra-umbilical region.
- Technique – with the patient supine, place a linear US probe oblique to the lower border of costal margin. Insert the needle from medial to lateral visualizing the needle tip travelling through rectus abdominis and into the facial plane between the posterior rectus sheath and transversus abdominis. As with the TAP block 0.5 ml/kg volume LA is required for successful block.

Quadratus lumborum block

- Anatomy – the quadratus lumborum (QL) muscle lies medial to the aponeurosis formed from internal oblique and transversus abdominis. Thoracolumbar fascia encases quadratus lumborum, made from three layers, anterior to QL, middle layer between QL and psoas major, and a posterior layer covering the superficial side of the erector spinae muscle. The anterior and lateral cutaneous branches of T4 to L1 travel from the paravertebral space through psoas major before travelling anteriorly between internal oblique and transversus abdominis.
- Indications – lower abdominal surgery, e.g. hernia repair, orchidopexy, gynaecological and urological procedures.
- Technique – with the patient in the lateral position, place a linear ultrasound probe above the iliac crest mid axillary line (Figure 5). For QL1, move the probe posteriorly until the aponeurosis of transversus abdominis forms a hyperechoic line. Pass the needle tip beyond the aponeurosis but superficial to the thoracolumbar fascia. The local anaesthetic will lie anterolateral to the QL muscle. QL2 block, position patient as above, inserting the needle from the lateral edge of US probe travelling towards the posterior edge of the QL muscle, travelling though the latissimus dorsi muscle to reach the lumbar interfascial triangle. The local anaesthetic will spread in the middle thoracolumbar fascial layer. QL3, also known as the transmuscular QL (T-QL) block requires a curved ultrasound probe. Place the probe in the position as above, look for the 'shamrock sign' where the transverse process of L4 is the stem, and the three clovers are formed by the erector spinae muscle anteriorly, QL laterally and erector spinae posteriorly. The needle passes from posterior to anterior using an in plane

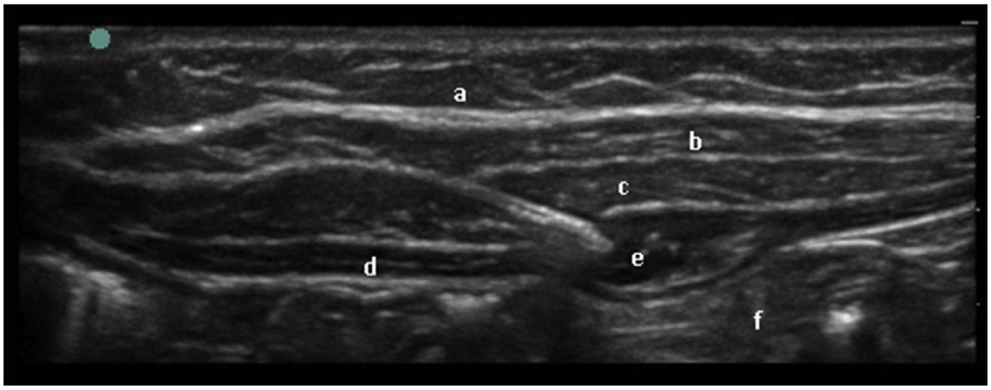

Figure 4 Ultrasound-guided transverse abdominal plane block (depth 1.8 cm). (a) Subcutaneous tissue; (b) external oblique muscle; (c) internal oblique muscle; (d) transversus abdominis muscle; (e) transversus abdominis plane (needle tip and LA injection visible on image); (f) peritoneal cavity.

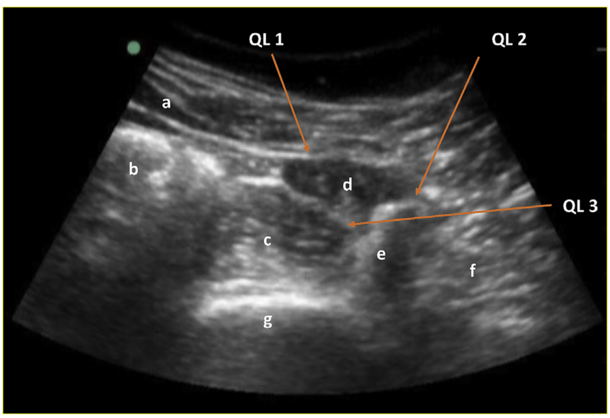

Figure 5 Ultrasound-guided quadratus lumborum block (7.8 cm). (a) Internal oblique; (b) perinephric fat overlying kidney; (c) psoas major; (d) quadratus lumborum; (e) transverse process; (f) erector spinae; (g) vertebral body.

technique, placing the needle tip in the fascial layer between QL and psoas major. This allows local anaesthetic to spread paravertebrally thus providing visceral and somatic analgesia from T4–L1.

- Complications – vascular puncture, visceral damage, intraperitoneal injection.

Rectus sheath block

- Anatomy – the sensory nerves that innervate the paraumbilical skin arise from T10 intercostal nerves, initially traveling between the internal oblique and transversus abdominis muscles and then anteriorly through the rectus muscle. The rectus muscle sheath is formed from the aponeuroses of the three lateral abdominal muscles. It adheres tightly to the muscle anteriorly but loosely posteriorly, creating a potential space. In neonates the rectus muscle can be a thin as 1–2 mm,
- Indications – periumbilical surgery, e.g. umbilical hernia repair, pyloromyotomy.
- Technique – with the patient supine place the US probe transverse on the abdomen, immediately above the umbilicus, then move laterally watching the three muscle layers come together (Figure 6). In older children the epigastric vessels can be located using Doppler. Insert the needle laterally in-plane, allowing for a shallow trajectory due to the close proximity of the viscera below. Stop the needle just in front of the first hyperechoic line (posterior sheath), a give may be felt as the needle exits the muscle into the potential space. Aspirate and inject 0.5 ml or less to test the bevel has entered the correct space. The fasciae are often tougher than you expect. LA (0.1–0.2 ml/kg/side) should spread as an ellipse between the rectus

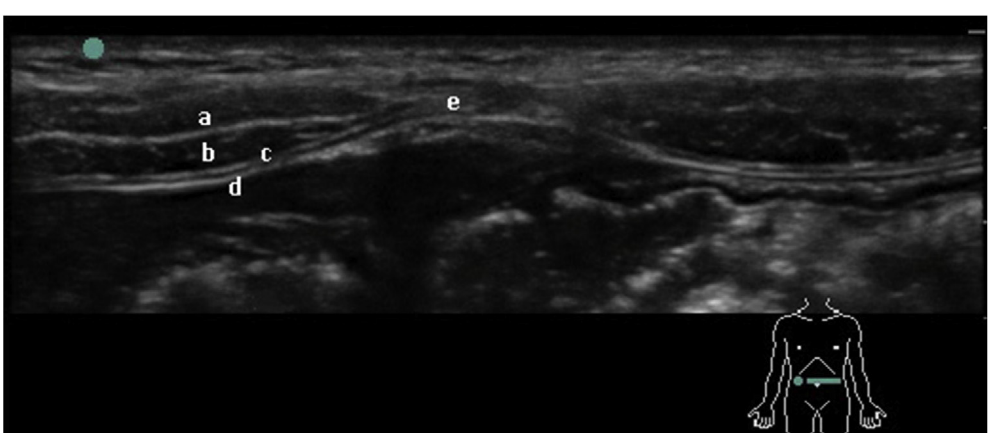

Figure 6 Ultrasound-guided rectus sheath block (depth 1.5 cm). (a) Anterior rectus sheath; (b) rectus muscle; (c) posterior rectus sheath; (d) peritoneum; (e) linea alba.

muscle and the posterior rectus sheath. The procedure can be repeated on the contralateral side. Using the 'zoom' function on the US machine can provide a better image in neonates. A paramedian longitudinal US probe position allows the assessment of LA spread cephalad and caudal.
- Complications – intraperitoneal injection, visceral damage, haematoma.

Ilioinguinal and iliohypogastric nerve block
- Anatomy – the ilioinguinal (L1) and iliohypogastric (T12, L1) nerves are terminal branches of the lumbar plexus. The iliohypogastric nerve pierces the internal oblique and runs under the external oblique superior to the inguinal canal. The ilioinguinal nerve continues in the inguinal canal. In infants, the average nerve –peritoneum distance is 3.3 mm.
- Indications – inguinal hernia repair, orchidopexy, hydrocele and varicocele.
- Technique – the point of injection is 0.25–0.50 cm medial to the anterior superior iliac spine (ASIS) along a line connecting the ASIS and umbilicus. Nick the skin with a sharp needle before inserting a short-bevelled needle because this makes it easier to appreciate the fascia planes beneath. A short-bevelled needle is then inserted perpendicular to the skin and after the first 'pop' 0.3 ml/kg of 0.25% levobupivacaine is deposited. Balance the US probe on the ASIS oriented towards the umbilicus. The ilioinguinal and iliohypogastric nerves are seen as two hypoechoic structures between the internal oblique and transversus abdominis muscles. The disadvantage of the block is that it does not abolish visceral pain due to traction of the spermatic cord.
- Complications – visceral perforation and femoral nerve blockade (up to 11%).

Penile block
- Anatomy – the dorsal nerves of the penis are branches of the pudendal nerve, which lies deep to Scarpa's fascia in the suprapubic space. This space is divided into two by the suspensory ligament.
- Indications – circumcision and distal hypospadias repair.
- Technique – the penis should be pulled gently caudad to make the skin taut over the subpubic space. A short-bevelled needle is inserted perpendicular to the skin just below the pubic ramus 0.25–0.5 cm from the midline. An initial 'pop' is felt as the superficial fascia is passed and a second 'pop' is felt when it pierces Scarpa's fascia. 0.1 ml/kg 0.5% levobupivacaine (maximum 5 ml per side) is deposited and the block is repeated on the other side. Adrenaline is contraindicated. The ventral aspect of the base of the penis should also be infiltrated to block the scrotal branches of the pudendal nerve. Ultrasound seems to confer no advantages and cannot be recommended.
- Complications – vascular compromise and haematoma.

Lower limb techniques

Femoral nerve/fascia iliaca block
- Anatomy – the anterior rami of the first four lumber nerves form the femoral, lateral cutaneous nerve of thigh and the obturator nerves. Sensory innervation is provided by femoral nerve to the anterior and medial aspects of the thigh; lateral cutaneous nerve to the lateral aspect of the thigh; and by the obturator nerve to the medial aspect of thigh, and knee joint. The femoral nerve lies in the femoral triangle lateral to the femoral artery. The fascia lata covers the femoral nerve and the vessels, while the fascia iliaca separates the nerve from the artery.
- Indication – patella lengthening, ACL repair, femoral osteotomy, analgesia for fractured femur, and operations on the anterior and lateral thigh.
- Technique – the nerve is triangular or elliptical in shape and may be difficult to visualize by US due to the adjacent fat. The femoral vessels act as a reliable guide as do the hyperechoic fascia lata and fascia iliaca. Doppler should be employed in particular to identify the external circumflex vessels that cross anterior to the femoral nerve. The needle is inserted lateral to medial in-plane and LA (0.2 ml/kg maximum of 20 ml) is deposited just lateral to the nerve below the fascia iliaca, observing spread of LA around the nerve.
- Complications – vascular injection, haematoma and incomplete blockade.

Sciatic nerve block/popliteal nerve block
- Anatomy – the sciatic nerve (L4–S3) provides sensory and motor innervation to the lower extremity. It exits the pelvis through the greater sciatic foramen, traversing the buttock deep to gluteus maximus then passing down the midline of the posterior thigh and branching into the tibial and common peroneal nerves near the popliteal fossa.
- Indications – all operations on or below the knee when combined with femoral or saphenous nerve blocks.
- Technique – positioning the patient lateral with operative side uppermost provides the best needle access. Place the US probe transversely on the popliteal cease and identify the vessels, the artery lies deep with the vein on top of it. The tibial nerve is located close to the popliteal artery above both popliteal vessels. The common peroneal nerve can be found by tracking cephalad and identifying it as it joins the tibial nerve from a lateral and more superficial position. Dorsi/plantar flexion of the ankle may aid identification by illustrating the nerve moving within the muscular plane. (This See-Saw sign may be absent in cerebral palsy children with marked fibrosis). Approximately 0.5–1.0 ml/kg of LA should be injected at the most distal location to perform the block appropriate for the surgery. A weaker concentration, e.g. 0.125% Levobupivacaine may be appropriate if there are concerns regarding postoperative ACS or a stronger solution e.g. 0.5% Levobupivacaine where postoperative muscle spasms are a major issue (e.g. tendon transfers).
- Complications – injury to popliteal vessels.

Ankle block
- Indications – operations on the foot or toes e.g. syndactyly, bunionectomy.
- Technique – the foot is supplied by five nerves, which can be blocked at the ankle.

- The **tibial nerve** runs deep to the flexor retinaculum behind the medial malleolus. It innervates the heel and sole of the foot. With the probe transversely placed at the level of the medial malleolus it is seen posterior to the posterior tibial artery.
- The **sural nerve** passes inferoposteriorly to the lateral malleolus. It innervates the lateral margin of the foot and ankle and is visualized as a small hyperechoic structure close to the short saphenous vein. It may be difficult to identify.
- The **superficial peroneal nerve** innervates the dorsum of the foot. It is easier to identify more proximally in the lower leg, lying in a prominent groove between extensor digitorum longus and peroneus longus muscles on the anterolateral surface of the lower leg.
- The **saphenous nerve** innervates the medial malleolus and medial aspect of the lower leg. The nerve appears as a small hyperechoic structure proximal to the medial malleolus alongside the saphenous vein.
- The **deep peroneal nerve** innervates the web space between the first and second toes. Place the US probe transverse at the level of extensor retinaculum and blocked immediately lateral to the pulsations of the anterior tibial artery.

Head and neck blocks

There are a wide range of head and neck nerve blocks, most are easy to perform with a basic understanding of the anatomy and have very few adverse effects.

Superficial cervical plexus block

- Indications – superficial neck surgery, e.g. branchial cyst/fistula, thyroidectomy, tracheostomy, tunnelled central venous cannulation.
- Technique – The superficial cervical plexus (C2–C4) appears as a collection of hypoechoic nodules deep and lateral to the posterior border of the sternocleidomastoid muscle. Place the US probe in a transverse position on the neck with the head turned away from the block side. Approach from a lateral to medial direction in-plane and aim to place the LA in the plane immediately deep to the sternocleidomastoid (SCM) adjacent to the superficial cervical plexus.
- Complications – intravascular injection, pneumothorax, phrenic nerve palsy, subarachnoid/epidural injection.

Greater auricular nerve (GAN) block

- Indications – tympanoplasty/mastoidectomy.
- Technique – Arising from C3, it provides sensory innervation for both surfaces of the eternal ear, skin over the mastoid process, small areas behind and above auricle and most skin covering the parotid gland. Place the US probe in the transverse plane above the SCM at the level of the cricoid cartilage with the child supine and head turned away. GAN, single hypoechoic round structure, lies deep to the posterior border of the SCM. ◆

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