

### PAEDIATRIC REGIONAL ANAESTHESIA

Paediatric Regional anaesthesia is often used in combination with general anaesthesia to provide analgesia. It is less commonly used as a sole anaesthetic technique. Its advantages include attenuation of stress response, reduction of opioid requirements ( and its associated side effects) and effective peri-operative analgesia.

Nerve blocks commonly performed include penile nerve blocks, ilioinguinal and iliohypogastric (IG-IH) nerve blocks, femoral and sciatic nerve blocks, caudals, epidurals and spinals.

The regional anaesthetic technique may be continued post-operatively as part of the Acute Pain Service (APS) protocol.

#### Paediatric regional block workflow in our department

1. Most, if not all blocks are done under GA / sedation and appropriate monitoring must be present.
2. Estimated duration and possible side effects of block should have been advised *before* induction, using the “blue” patient information sheet ( found in clear folder at the APS box in MOT recovery).
3. All decisions for regional blocks must be discussed with the anaesthetist-in-charge, and agreeable with surgeon.
4. If a continuous nerve block technique is planned, ensure that the patient returns to a ward with adequate nursing support.
5. Inform the anaesthetic nurse to allow time for preparation of ultrasound machine and nerve block trolley. Additional help must be available if the induction room is set up for induction( ensure availability of anaesthesia machine and monitors) and regional block under GA.
6. **Nerve block ‘time out’** must be performed and documented in the anaesthetic chart, checking for identity of patient, site

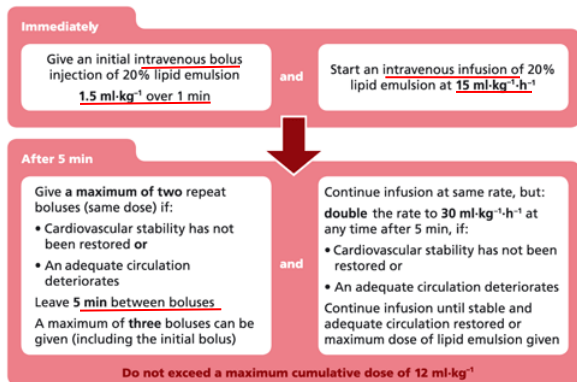
- of surgery, type of block to be given, LA drug (expiry date, dose, and any additive) to be used.
7. Appropriate analgesics must be prescribed in anticipation of *breakthrough pain*, and ideally timed with resolution of block.  
*Eg. PO oxycodone 5 mg 6 hrly strictly x2 / 7 then pm. Serve first dose at 6 pm ( 4 hrs post-block)*
  8. Other **post-block instructions** including pressure care ( of numb limb) and fall precautions can be typed in the post-operative orders on the OT computer, or indicated by selecting the 'post-block tick box' on the OT PACS system.
  9. Review post-block patients in the recovery room (+ ward for inpatients) for pain score and block resolution. Reinforce postoperative care & monitoring of anaesthetized limb to recovery and ward nurses.
  10. In our department, the following patients should be followed up on the **Acute Pain Service** (APS):
    - Continuous centraneuraxial block
      - Eg. Epidural, Caudal epidural
    - Continuous peripheral nerve blockade
    - Post-caudal (single shot) with additives
  11. All post-opt analgesia for patients on APS must be ordered by the anaesthetic team in the CLMM before they return to the ward.
  12. All persistent motor blockade must be reviewed, followed up by the APS/on-call (after office hours) and highlighted to the anaesthetic team who performed the block.

## LA Toxicity

All local anaesthetics given must not exceed the standard toxic limits:

- a) Plain lignocaine: 3 -4 mg / kg
- b) Lignocaine et adrenaline 1: 200 000: 7 mg / kg
- c) Bupivacaine :  
Bolus 2.0 - 2.5 mg / kg in children, 1.5-2.0 mg / kg in neonates
- d) Levo-bupivacaine: 2.0 – 2.5 mg / kg
- e) Ropivacaine: 2.5- 3 mg / kg

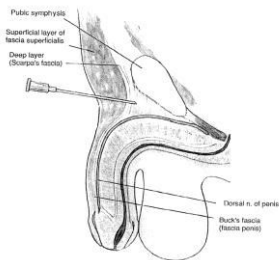
Suggested treatment with 20% lipid emulsion in case of serious systemic toxicity of local anaesthetics according to the Association of Anaesthetists of Great Britain and Ireland (AAGBI) guidelines  
[http://www.aagbi.org/publications/guidelines/docs/la\\_toxicity\\_2010.pdf](http://www.aagbi.org/publications/guidelines/docs/la_toxicity_2010.pdf)



\*In KKH, Lipofundin can be found in the black LAST boxes at MOT recovery and outside DSOT 2. Otherwise call Pharmacy 3086/2464 or IPAS 2209/8474. Pharmacist –on-call 91690643. It should be given as soon as it is available. Normal resuscitative measures should be instituted in the meantime.

## Peripheral Nerve block (PNB) Techniques (Landmark-guided)

### PENILE NERVE BLOCK



The dorsal nerves of the penis are mainly responsible for the sensory innervation of the skin of the penis, with terminal branches to both dorsal and ventral aspects. The dorsal nerves are terminal branches of the pudendal nerves which arise from the sacral plexus (S2, S3, S4). Additional sensory innervation is from the genitofemoral and ilioinguinal nerves and posterior scrotal branches of the perineal nerves that run paraurethrally to the ventral surface of the frenulum.

After emergence from the parent nerve trunk, the dorsal nerves pass under the pubic bone and run within the subpubic space. They then enter the substance of the suspensory ligament where they are accompanied by two dorsal arteries and the dorsal vein of the penis. The suspensory ligament divides the subpubic space into two compartments that may be noncommunicating.

#### **Subpubic approach to dorsal nerves of the penis**

- Safe and reliable technique
- Using a 23 G needle, puncture point approximately 0.5 – 1 cm lateral to midline. Place the needle almost perpendicular to skin with a slight caudal and medial slope
- Enter the subpubic space by piercing Scarpa's fascia

- Place LA ; (plain bupivacaine or levobupivacaine 0.25% ) 0.1ml / kg per side up to maximum of 10mls within space.  
**The use of adrenaline in the LA solution is contraindicated as it can result in spasm of the dorsal arterises and glan necrosis.**

Nerve supply to the **ventral surface** of the penis may also be supplied by the genitofemoral and ilioinguinal nerves. Local infiltration of the frenulum is useful to block sensory fibres from these nerves.

### **Subcutaneous ring block**

Local anesthetic given as a circumferential subcutaneous ring at the base of the penis - **avoid use of adrenaline**. This is often used as a rescue technique.

### **Complications**

Midline puncture with injury of the dorsal artery can lead to a compressive haematoma and glansnecrosis.

## **ILIOINGUINAL AND ILIOHYPOGASTRIC (IG-IH) NERVE BLOCKS**

Iliohypogastric and ilioinguinal nerve blocks provide ipsilateral intra and post-operative analgesia for most operations in the inguinal region.

The iliohypogastric nerve provides sensory innervation to the suprapubic and anterior hip region. The ilioinguinal nerve innervates the inguinal hernia sac, the medial aspect of the thigh and the anterior scrotum or labia.

The two nerves are branches of the primary ventral rami of L1. The L1 primary rami enter the psoas major where it commonly divides into the IG and IH nerves. At the lateral border of quadratus lumborum, the 2 nerves pierce the lumbar fascia and lie between the transversus abdominis and the internal oblique muscles.

The IH nerve continues ventrally between the internal and external oblique. The IG nerve perforates the transversus abdominis at the level of the iliac crest. It continues ventrally and pierces both the internal and external oblique and finally reaches the inguinal canal.

### Performance of block

- G23 needle or short beveled needle
- LA dose: plain bupivacaine / levo-bupivacaine 0.25% 0.25-0.4 ml / kg LA per side.
- Reported incidence of associated femoral nerve block: 3.7 - 10%
- Various landmark approaches have been described taking into consideration the anatomy and course of the nerves.

### Schulte - Steinberg technique

Pierce the skin at a point just medial and inferior to the anterior superior iliac spine (ASIS) . The distance is between 5 to 20 mm depending on the age of the patient. The needle is advanced till the external oblique is pierced (loss of resistance). Local anaesthetic is injected between the internal and external oblique.

### Simplified technique after Dalens

Puncture site is at the junction of the lateral one- fourth and medial three- fourths of a line joining the umbilicus and the ASIS. A short beveled needle is introduced at 45 – 60 degrees to the skin until the external oblique aponeurosis is pierced. Local anaesthetic is given in a fan shaped manner.

### Centraneuraxial Block (CNB) Techniques

#### **Contraindications to CNB:**

Sepsis, meningitis, coagulopathy, raised intracranial pressure, anatomic malformations of the spine, infection at the puncture site.

Deep peripheral nerve blocks (PNB) should be avoided in the presence of coagulopathy

#### **Relative contra-indications to CNB:**

Parental objection, Allergy to drugs used, Nursing issues eg. lack of adequate nursing support/ monitoring facilities post-opt.

#### **CAUDAL**

The sacral hiatus, bounded by the sacral cornu, lies at the tip of the equilateral triangle formed by the 2 posterior sacral iliac spines.

Using an aseptic technique, the sacrococcygeal membrane is pierced with 21 to 25 G needle / cannula.

Exercise caution in the presence of a sacral dimple. Check if an ultrasound or MRI has been done to exclude presence of low lying dural sac or tethered cord. Explain adverse effects of hypotension, motor block, urinary retention, intra-vascular injection, inadvertent dural puncture.

#### **Dose**

Volume of Local anaesthetic

0.5 - 0.75 ml / kg for lumbosacral level

1.0 ml / kg for thoracolumbar level (up to T10)

1.25-1.5ml / kg for midthoracic block

Takasaki: 0.06 ml / segment / kg or 0.7 ml / kg

Maximum volume should not exceed 20mls.

If higher level of analgesia needed, consider lumbar epidural.

Concentration: 0.2 - 0.25% bupivacaine generally used but calculate permissible dose to avoid toxicity.

Concentration may need to be decreased if an increase in volume is required to achieve an appropriate level of block.

Suitable as sole anaesthetic technique for ex - premature infants at significant risk of post-operative apnoea.

### **Block Duration**

Duration of single-shot (SS) plain caudal block: 2-3 hr

Caudal blockade can be extended with:

- Additives to SS blocks
  - Ketamine ( preservative free) 0.5-1mg / kg
    - S+ Ketamine is preferred over racemic ketamine, as it is less neurotoxic.
    - Prolongs analgesic effect to 8-12 hours
    - Side effect: psychomimetic, especially for dose  $\geq 1$ mg / kg
    - Avoid ketamine in <1 yr due to risks of neurotoxicity to the developing brain.
- Clonidine 1-2mcg / kg
  - improves analgesic effect & prolongs duration of action to 4-6 hrs.
  - Side effects: hypotension ( if  $>2$  mcg / kg), bradycardia, post-operation sedation, blunts ventilatory response to rising CO<sub>2</sub>
  - Avoid Clonidine in <3 mths due to risk of apnoea.
- Opioids
  - Morphine: 25-30 mcg / kg q12h (5-10 mcg / kg for intra-thecal dose)
  - Fentanyl: 1-2mcg / kg q4h
  - Unsuitable for use in ambulatory setting
  - Side effects: N+V, pruritis, urinary retention, respiratory depression
  - Require close monitoring for 24hrs post-operation
  - No narcotics should be given until at least 6h has elapsed.



- SS caudals with additives must be reviewed by APS the next day.
- Catheter- continuous caudal epidural analgesia
  - Safe and effective in infants
  - Single curve of the back <2yrs=predictable threading
  - Ensure secure dressing with Steristrips® and Tegaderm®, covered with Hypafix® to avoid faecal contamination
  - Epidural bupivacaine or levo-bupivacaine infusion
    - no additives and <48 hr indwelling catheter for neonates
    - Refer to epidural infusion rates in APS guidelines.

### EPIDURAL

- Indications: thoraco-abdominal operations, some laparotomies, major urological procedures, major orthopaedic operations involving hip or knee etc.
- To be performed only under supervision by senior staff.
- IV access must be established.
- Sited under GA with at least ECG, SaO<sub>2</sub> and NIBP monitoring.
- Consider performing the block prior paralysis to allow for detection of total spinal/cord injury.
- Full aseptic technique; scrubbed, gowned and gloved.
- Surface mark spinous processes as landmarks are easily lost under drapes.
- Determine length of catheter in space. Tip should ideally be at midpoint of segmental levels to be blocked.

Paediatric set= 19G Touhy needle: recommended for children <10 kg.  
 Adult set= 18G Touhy needle: recommended for children >10kg.

Catheter gauge depends on brand of Epidural set.

Continuous “loss-of-resistance” technique with saline or air .

Catheter must be labelled and taped securely in place once sited.

Dressing should include a transparent window to allow inspection of the entry site and catheter markings.

Patient's data to be entered in Acute Pain Service File.

## Useful Information

Skin depth to ligamentum flavum: (1x BW in kg) millimeters.

Skin- Epidural distance in children. Bosenberg AT et al. Anaesthesia 1995

Skin- Epidural depth(mm):  $9.0 + 0.62 \times \text{weight(kg)}$

Evaluation of epidural and subarachnoid space distance in young children using magnetic resonance imaging. Franklin AD et al. Reg Anesth Pain Med. 2015.

	Term Neonate	6mo	1 year
Dural Sac	S3	S2	S1
Spinal Cord	L4 / 5	L2 / 3	L1

## b. Dosing (consider dermatomal spread and toxic limits)

- Bolus: concentration - 0.1 - 0.25% bupivacaine
- Volume :load to achieve desired dermatomal coverage  
0.5 – 0.75 ml / kg (max. 1.0 ml / kg)
- Infusion settings ( refer to APS guidelines)
- Standard >1 yr:
  - 0.1-0.125% bupivacaine / levobupivacaine
  - + Fentanyl 2 mcg / kg or Clonidine 1 mcg / ml
  - 0.1-0.4 ml / kg / hr

- 6 mths-1 year:
  - 0.1% bupivacaine / levobupivacaine
  - + / - Fentanyl 1 mcg / kg
  - 0.1-0.3 ml / kg / hr
- < 6 mths:
  - 0.1% bupivacaine / levobupivacaine
  - No additives
  - 0.1-0.2 ml / kg / hr
- Neonates:
  - Infusion not >48 hrs, no additives.
- Morphine 5 mcg / ml may be added to improve spread

### SPINAL

- Suitable as sole anaesthetic technique for ex - premature infants at significant risk of post-operative apnoea.
- Standard monitors in place before starting.
- IV access must be established.
- Full aseptic technique.
- Positioning of patient: lateral or sitting. Avoid extreme neck flexion and potential airway compromise.
- If using the sitting position, back may be flexed but ensure adequate support for the head
- Recommended levels L4 / 5 or L5 / S1. Level should be marked before draping.
- Neonatal Spinal needle: 25G (0.51mm x 2.54cm).
- Dosage: Bupivacaine 0.5% without adrenaline

Weight	Dose	Volume
<2.0 kg	0.6mg / kg	0.12 ml / kg
2-5 kg	0.5mg / kg	0.10 ml / kg
>5 kg	0.4mg / kg	0.08 ml / kg

- Ascertain and record level of block.
- A pacifier with glucose solution can be given to baby.
- Post-operatively, the baby should be monitored for apnoeic spells for 12 - 24 hours.

### References:

1. Regional Anesthesia in Infants, Children and Adolescents. Dalens B. Ed. 1<sup>st</sup> Edition. 1993, William & Wilkins.
2. Pediatric Regional Anesthesia, Polaner D, Suresh S, Cote CJ *in* A Practice of Anesthesia for Infants and Children. Cote CJ, Todres ID, Goudsouzian NG, Ryan JF. 3<sup>rd</sup> Edition, 2000, WB Saunders Co.
3. Armitage EN. Regional anaesthesia in Paediatrics. Clinics in Anaesthesiology 1985; 3: 553.
4. Lönnqvist, P.-A. (2012), Toxicity of local anesthetic drugs: a pediatric perspective. Pediatric Anesthesia, 22: 39–43
5. Jean-Xavier Mazoit. Local anaesthetics and their adjuncts. Pediatric Anesthesia 2012; 22: 31-38.
6. Giorgio Ivani, Santhanam Suresh, Claude Ecoffey et al. The European Society of Regional Anaesthesia and Pain Therapy and the American Society of Regional Anesthesia and Pain Medicine Joint Committee Practice Advisory on Controversial Topics in Pediatric Regional Anesthesia. Reg Anesth Pain Med 2015;40: 00–00.

## CURRENT TRENDS

- Complications in Paediatric RA (ADARPEF Study in 1996, 2010)
  - Overall RA complication rate in children is low at 0.09-0.12%.
  - Complications are more frequent in children <6 mths
  - CNB has higher (6X) complications than PNB
- Trends in Paediatric RA
  - There is a move from CNB to PNB (40%→66% in ADARPEF's study)
  - Caudals still account for most (80%) of CNB
  - PNB catheter techniques are popularized.
  - PNB offers the advantage of providing target-controlled area of localized anaesthesia / analgesia, reducing the amount of LA used, thus systemic absorption is smaller. It is most useful in cases where CNB is contraindicated Eg. Truncal PNB may substitute CNB for laparotomy
- Technique evolution
  - Timeline
    - 1962- nerve stimulator
    - 1994- ultrasound
    - 2003- ultrasound in paediatric RA
  - Ultrasound vs nerve stimulator
    - Shorter block performance time

- Higher success rate
  - Longer block duration
  - Less volume of LA
  - Visibility of neuraxial structures esp in infants < 3 months old
  - Useful in paralysed patients or those with neuropathy
- Multi-modal-guidance technique may be feasible (start with 0.5mA, 0.5msec, 2 Hz)
  - See NYSORA  
[http://www.nysora.com/peripheral\\_nerve\\_blocks/3347-our-contributors.html](http://www.nysora.com/peripheral_nerve_blocks/3347-our-contributors.html)

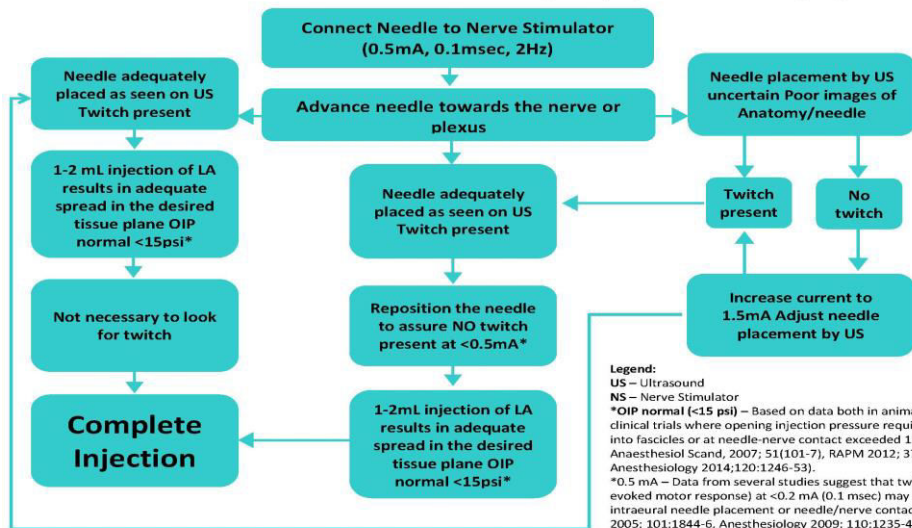
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2. Rubin K, Sullivan D, Sadhasivam S. Are peripheral and neuraxial blocks with ultrasound guidance more effective and safe in children? *Pediatr Anesth* 2009; 19: 92–96
3. Marhofer, P., Ivani, G., Suresh, S., Melman, E., Zaragoza, G., Bosenberg, A. (2012), Everyday regional anesthesia in children. *Pediatric Anesthesia*, 22: 995–1001
4. The ASRA Evidence Based Medicine Assessment of the UGRA and pain medicine. *Reg. Anesth and Pain Medicine* 2010; 35;S1-9
5. Expert panel assessed Evidence basis of UGRA from past 20 yrs



## Suggested Standard Monitoring For Nerve Blocks

Ultrasound + Nerve Stimulation + Opening Injection Pressure (OIP)





## ULTRASOUND-GUIDED PAEDIATRIC RA

### **Sonoanatomy differences in children**

- The size, position, US reflective properties of muscles, nerves, vessels changes with growth.
- Differences are more marked in the younger patients.
  - Nerve structures are smaller and more superficial
  - Poorly mineralized bone have increased US transparency in infants, allowing better neuraxial imaging
    - Spinal canal contents can be well-visualised in <6 mths, 'intermittently' seen in inter-spinous spaces by 1 yr, and poorly seen in >30 mths
    - Nerves are poorly echogenic in a fatty and more hydrated environment
    - Aponeuroses are more echogenic.
    - Plane / compartment blocks are easier
    - Lower arterial and venous pressures makes vessels easily compressible
  - High frequency probe >10 MHz, with smaller surface area proportionate to the size of the child should be used. (US beam will be narrower and less penetrating as a result)

#### **Remember:**

High frequency= high resolution, poor penetration

Low frequency= low resolution, great penetration

Epi / perineurium is hyperechoic ( white)

Nerve tissue is hypoechoic (black)

### Why US in kids?

- Warning signs of intra-vascular and intra-neural injection may be masked as the child is under GA.
- Less margin for error as the smaller nerves are closer to structures such as the pleura
- Variable landmarks with age
- US may be clearer as structures are more superficial and bones less ossified.
- Congenital abnormalities can lead to misleading landmarks
- Less LA volume used makes it safer for neonates / infants with lower LA toxicity threshold and for multiple / repeat blocks to be performed

### EQUIPMENT

- An ultrasound machine eg. Sonosite M-turbo, that is properly configured. ( depth, gain and focus adjusted)
- High frequency hockey stick or linear probes, as neural structures are more superficial
- Short bevel needles with flexible injection tubing( Pajunk or Bbraun available), well-flushed with saline / LA to avoid air artefacts on US image
- Other consumables found on the 'Nerve block trolley' include sterile swabsticks for skin prep, sterile gel, drape, probe disinfectant, sterile 'probe covers', LA drug, syringes, drawing needles

## DRUGS

### LA

Racemic bupivacaine, levobupivacaine, ropivacaine and lignocaine are available.

The concentration used should be adjusted to the toxic limit of the LA for a given volume used.

Usual LA concentrations used are 0.2-0.25%.

Local anesthetic volume with ultrasound guidance vs landmark technique		
Technique	Ultrasound guidance dosages ( $\text{ml} \cdot \text{kg}^{-1}$ )	Landmarks dosages ( $\text{ml} \cdot \text{kg}^{-1}$ )
Supraclavicular block	0.3	0.5
Infraclavicular block	0.2	0.5
Sciatic block	0.2	0.3
Femoral block	0.15-0.2	0.3
Rectus sheath block	0.1 (each side)	0.3
Thoracic PVB	Up to 0.5 (each side)	NA
TAP block	Up to 0.5 (each side)	NA
Ilio-inguinal block	0.1 (each side)	0.4

There is little evidence for the use of LA Adjuvants in PNB, except for clonidine. It appears to prolong block duration by 20-50%.

References:

Anesth Analg 2007; 104:532-537.

## Technical details

### **'SCANNING'**

#### S: Supplies

- Equipment and drugs as above

#### C: Comfort

- Position yourself to the patient, and machine in an ergonomic way

#### A: Ambience

- Adjust room light settings if you need

#### N: Name of patient, procedure and site 'Time-out'

#### N: Nominate

- Choose your needle, transducer, helper
- Flush out all air from needle and injectate. For children <10 kg, it may be prudent to start off with saline in your syringe, using LA only after you have confirmed the position of the needle tip.
- Choose the right size probe
  - 25 mm footprint for <15 kg

#### I: Infection control:

- Disinfection of skin with swab sticks (chlorhexidine with alcohol)
- Disinfection of probe with alcohol wipes,
  - 'no-touch' or 'sterile tegaderm for SS
  - Full probe sheath for catheters
- Sterile gel to provide air-free interface

#### N: Note the machine settings

- Machine set to 'small parts' or 'nerve' and high resolution (unless target is >4 cm deep)
- Ensure 'multibeam' is activated

#### G: Gain and depth

- Adjust 'near' and 'far' gain
- Focus on the target by placing it in the center of the image and adjusting the depth.

#### G: Go!

- Probe in non-dominant hand
- Check probe orientation
- Steady scanning hand on patient to improve proprioception and better probe fixation when needling
- If you lose your needle image, first check you hands, not the machine.
- Avoid vessels by applying Color Doppler to check for vessels in all scans

### Approach:

- In-plane (IP)
- Out-of-plane (OOP)
- If using PNS: aim for 'no twitch' at  $<0.5\text{mA}$ , with injection pressure  $< 15\text{ PSI}$
- Aspirate before injection, assess for LA spread on US

### ☹ Pitfalls

- Advancing the needle without visualizing its tip ( most common mistake!)
- Poor choice of needle entry point
- Failure to correlate sidedness of the image with regards to patient
- Failure to recognize intra-muscular injection
- Anistropy and artefacts ( enhancement, reverberation etc)

### 😊 Tips

- Start with easier blocks first ( femoral before PVBs)
- Catheters are generally difficult to identify, their position can be confirmed by gentle pulling (looking for tissue movement) and by injecting down them whilst scanning for the spread of injectate
- Machine can fail, anatomy is still important

Common US-guided blocks done in our department

US-guided block	Anatomy	Indications	Side effects	Tips
<b>Truncal</b>				
TAP	Deposit LA between the internal oblique and transversus abdominis muscles, where the ant rami of T1-T6, L1 lie.	Useful for unilateral abdo surgeries ( below the umbilicus) eg. open appendicectomy, inguinal hernia repair, iliac crest bone graft.  Performed bilaterally for laparoscopic procedures  Subcostal approach covers surgeries above the umbilicus eg. cholecystectomy	Intra-peritoneal injection  Bowel perforation  Visceral injury	Does not provide visceral analgesia  Probe is placed transversely between the iliac crest and the costal margin  Insert needle IP in anterior-posterior direction to reach the plane posterior to the mid-axillary line. ( to block the lateral branches)
Rectus sheath	LA is injected between the rectus muscle and posterior sheath  The rectus muscle is adherent to the anterior sheath between the xiphisternum and umbilicus  The posterior sheath is not adherent and allows spread up and down	Pyloromyotomy  Umbilical hernia  Duodenal atresia  Laparoscopic procedures	Intra-peritoneal injection	Probe transversely above umbilicus  Careful of epigastric vessels within rectus muscle  IP approach is safer  Advance needle until a 'give' is felt. Avoid intramuscular injection

Ilioinguinal/iliohypogastric nerve block	The nerves are seen as small hypoechoic ellipses between the 2 innermost muscles	Inguinal hernia repair  Hydrocele  Orchidopexy (scrotal incision not covered)	Femoral nerve block ( up to 10% in landmark technique)	Place one end of the probe on the ASIS  Scan for the 3 muscle layers, with the external oblique muscle thinning out to form its aponeurosis.  Both IP or OOP approach may be used.
Thoracic Paravertebral blocks	LA is deposited in the wedge-shaped space bounded by the vertebral column, parietal pleura, and the superior costotransverse ligament.	Useful for unilateral thoracotomies ( T5) and upper abdominal surgeries (T10), renal surgeries ( T12)  May be done bilaterally for sternotomies.	Avoid in empyema and tumour extending into the paravertebral space  Pneumothorax, epidural spread, dural tap	Probe in transverse paramedian position  IP approach allows good needle visualization.
<b>Limb blocks</b>				
Sciatic nerve block	Enters the gluteal region from the pelvis through the greater sciatic foramen. Passes between the ischial tuberosity and greater trochanter down the leg Often accompanied by the posterior cutaneous nerve medially Usually divides	Ankle and foot surgeries  Combined with saphenous or femoral nerve block for all surgeries below the knee	Intra-vascular injection  LA toxicity	Lateral IP popliteal approach is commonly used.  Place probe transversely on the popliteal crease, with patient in a lateral position, operative side up.  Color Doppler to identify popliteal vessels  Trace the nerve distally to visualize it dividing  Flex the ankle to visualize nerves rocking

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	into the tibial and peroneal components at the apex of the popliteal fossa.			in its fascial plane ('see-saw sign')
Femoral nerve block	<p>At the level of the inguinal ligament, it lies deep to the fascia lata and iliaca, lateral to the femoral vessels, which lie in a separate fascia compartment.</p> <p>LA is deposited after 2 'pops' ( fascia lata, followed by fascia iliaca), above the iliacus muscle.</p>	<p>Fractures of the femur</p> <p>Analgesia for knee surgeries</p> <p>Combined with sciatic nerve for all surgeries below the knee</p>	Vessel puncture leading to haematoma	Use color Doppler to identify the femoral vessels and superficial circumflex iliac artery, which pass directly over the femoral nerve. The nerve is found lateral to the artery in a triangular hyperechoic area.
Adductor canal ( Subsartorial canal block)	The saphenous nerve (the largest sensory nerve branch of the femoral nerve ) may be blocked at the adductor canal, where it crosses the femoral artery from lateral to medial, beneath the sartorius along the medial side of the knee.	Saphenous nerve block when combined with sciatic block provides opioid-sparing analgesia for knee surgeries, with the theoretical advantage of avoiding quadriceps weakness.		<p>Place the probe on the medial aspect of the mid-thigh.</p> <p>Trace the femoral artery to the point just before it dives posteriorly to form the popliteal artery. The LA is deposited at the adductor hiatus at this point</p>
Supraclavicular brachial plexus block	The 'bunch of grapes' ( cluster of	For upper limb surgeries, excluding the	Pneumothorax, phrenic	Probe is placed parallel to and just behind the clavicle, pointing into the



	hypoechoic nodules) appearance of the plexus is found posterolateral to the subclavian artery, which lies on or just anterior to the first rib. The cervical pleura at both sides of the rib 'slides' with respiration	shoulder	nerve palsy, Homer's syndrome, vascular injury	thorax.  Color Doppler must be used to check for vessels.  IP lateral to medial approach, injecting LA as you go, aiming to reach the ulnar portion of the plexus, next to the subclavian artery.
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## References

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2. Alderhey Children's Hospital Sonosite course resource
3. Ecoffey, C. (2012), Safety in pediatric regional anesthesia. *Pediatric Anesthesia*, 22: 25–30
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### Continuous peripheral nerve block

PNB catheters may be considered for surgeries associated with

- Major unilateral orthopaedic surgery with intense post-operative pain (eg. Congenital foot / hand reconstruction, traction of a femoral shaft fracture, osteotomies, club foot repair, amputations, osteosynthesis and exostosis),
- painful post-operative physical therapy (eg. Arthrolysis, ligament repair)
- chronic pain conditions (eg. CRPS 1, epidermolysis bullosa.)
- Insertion should be performed fully scrubbed, gowned and gloved. A full-length sterile ultrasound probe sheath should be used for ultrasound-guided technique

Continuous PNB infusion: Bupivacaine / levobupivacaine 0.125% at 0.1-0.3ml / kg / hr.

### Compartment Syndrome (CS)

- Opinions differ regarding the potential for analgesia to mask the symptoms of CS thus delaying its diagnosis.
- SS blocks will wear off. When indicated, continuous blocks may be performed with close monitoring, after discussion with surgeon.
- Low concentrations LA (0.1-0.125% for infusion) are unlikely to block ischaemic pain
- Increasing pain, distal motor weakness are warning signs
- Careful examination, compartment pressure monitoring (<30 mmHg)

