Pediatric Regional Room Tips

<table>
<thead>
<tr>
<th>Author</th>
<th>Thuy Phan, CRNA</th>
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<tbody>
<tr>
<td>Service</td>
<td>Pediatrics</td>
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This manual was created to guide residents/students in the placement of regional blocks in the pediatric patient at the bedside. Information was taken directly from various websites and compiled as a condensed reference with clinically relevant information to assist in dosing and trouble shooting. It is not intended for publication.

http://www.nysora.com/
http://www.usra.ca/spappugra
http://www.arapmi.org/

Abdominal/Groin Blocks .................................................................................................................. 2
  Pediatric Ilioinguinal/Iliohypogastric Block ............................................................................ 2
  Abdominal Rectus Sheath Block .................................................................................................. 5
  Transversus Abdominis Plane Block (TAP) ................................................................................... 7
  Penile Nerve Block ..................................................................................................................... 11

Neuroaxial Blocks ............................................................................................................................ 13
  Caudal ........................................................................................................................................... 13
  Spinal Anesthesia ........................................................................................................................ 17
  Epidural ......................................................................................................................................... 20

Upper Extremity Blocks ................................................................................................................... 24
  Interscalene ................................................................................................................................. 24
  Supraclavicular ............................................................................................................................ 28
  Infraclavicular Block ................................................................................................................... 35
  Axillary Block .............................................................................................................................. 39

Lower Extremity ................................................................................................................................ 44
  Popliteal Fossa Block .................................................................................................................... 44
  Ultrasound guided needle placement (ursa.com) ......................................................................... 45
  Femoral .......................................................................................................................................... 56
  Ankle ............................................................................................................................................. 61
  Sciatic Block ................................................................................................................................. 68
  Saphenous ....................................................................................................................................... 75
**Abdominal/Groin Blocks**

**Pediatric Ilioinguinal/Iliohypogastric Block**

Unilateral or bilateral block of the skin and muscle of the inguinal canal/groin area

**Indications**
- Inguinal hernia repair
- Orchidopexy
- Hydrocele repair

**Anatomy**

Inguinal region and the upper scrotum is innervated by the **Ilioinguinal** and **iliohypogastric** nerves which both originate from the first lumbar nerve root and the **genitofemoral nerve** which originates from the first and second lumbar nerves. The 12th thoracic and iliohypogastric lies in between the internal and external obliques. The ilioinguinal lies between the transverse abdominis muscle and the internal obliques initially and then the above continue anterior medially and become superficial as it terminates in the skin and muscles of the inguinal region.

**Note:** Genitofemoral nerve follows a different course and often requires supplementation intraoperatively by the surgeon in the region of the inguinal canal and spermatic cord
Techniques
1. Landmark needle Placement
2. Ultrasound guided needle Placement

Equipment
1. Short bevel needle 22 or 25 gauge needle
2. Sterile towels
3. 4"x4" gauze packs
4. Syringe with local anesthetic
5. Sterile gloves
6. Chloraprep swab

Landmarks
Locating a point 1 cm superior and 1 cm medial to the anterior superior iliac spine (ASIS).

Needle Placement
A 22 or 25 gauge blunt-tipped needle is first directed cephalolateral direction to contact the inner aspect of the ileum and then withdrawn slightly. Local anesthetic is then continually injected as the needle is withdrawn through the layers of the abdominal wall. The needle is then reinserted at a steeper angle to make sure it penetrates the three abdominal muscle layers. As the needle is advanced toward the pubic symphysis, a characteristic "pop" is felt as the external oblique muscle is penetrated. Local anesthetic is then injected in a fan-shaped manner into the body of the muscle and surrounding subcutaneous tissue and may be redirected toward the umbilicus, creating a subcutaneous field block.
Ultrasound guided (USRA.CA)

- The II and IH nerves are expected to lie within the fascial plane between the transverse abdominis and internal oblique muscles above the ASIS.
- The two nerves may pierce the internal oblique muscle layer at the ASIS level and travel more superficially between the internal and external oblique muscles.
- Identify the three muscular layers of the abdominal wall: the external oblique (most external), the internal oblique and transverse abdominis muscles. The external oblique muscle may be seen only as a thin layer of aponeurosis.
- Identify the peritoneal cavity and bowel movement deep to the transverse abdominis muscle layer.
- Trace the course of the nerve proximally to the region above ASIS and then distally towards the inguinal region if possible.
- It is common to visualize small vessels adjacent to the II and IH nerves within the same plane.

Choice of Local Anesthetic

0.2-0.4 ml/kg bupivacaine 0.25 or 0.2% ropivacaine not to exceed max 3mg/kg dose

Complications

- Femoral nerve block (high volumes)
- Hematoma in the inguinal in region of cord
- Intestinal perforation
**Abdominal Rectus Sheath Block**

The aim of this block is to deposit local anesthetic solution between the muscle and the posterior aspect of the sheath.

**Indications**
- Umbilical and epigastric hernia repair
- Laparoscopic surgery
- Pyloromyotomy
- Small midline incisions

**Anatomy**

The umbilical area is innervated by the 10th thoraco-abdominal intercostal nerves from the right and the left side. Each nerve then passes behind the costal cartilage and between the transverse abdominus muscle and the internal oblique muscle. The nerve runs between the sheath and the posterior wall of the rectus abdominus muscle and ends as the anterior cutaneous branch supplying the skin of the umbilical area.

**Technique**

1. Landmark placement of needle

**Equipment**

1. Short bevel needle 22 or 25 gauge needle
2. Sterile towels
3. 4"x4" gauze packs
4. Syringe with local anesthetic
5. Sterile gloves
6. Chloraprep swab
Landmarks
1. Linea semilunaris above or below the umbilicus
2. Anterior and posterior rectus sheath
3. Rectus muscle

Needle Placement
With the patient in supine position a 23-G needle is inserted above or below the umbilicus ½ cm medial to the linea semilunaris in a perpendicular plane. The anterior rectus sheath is identified by moving the needle with a back and forth motion until a scratching sensation is felt. Once the sheath is felt, it is entered and local anesthetic solution is deposited posterior to the sheath. The usual depth of needle entry is about 0.5 to 1.5 cm. After aspiration, inject on each side.

Local Anesthetics
Bupivacaine .25-.5% or Ropivicaine 0.2-0.5% at 0.2 mL/kg

Complications
- A lateral approach may not allow appreciation of passage of the needle through the various layers, a superficial injection after passage through the anterior rectus sheath may not allow spread of local anesthetic due to the presence of tendinous bands. Intravascular injection particularly if a large volume is injected directly into the rectus muscle.
- For LA to spread throughout the sheath the needle must be placed in the posterior part of the sheath. The peritoneum is directly beneath and there is a potential for penetration and possible visceral damage.
**Transversus Abdominis Plane Block (TAP)**

Injection of local anesthetic within the TAP can potentially provide unilateral analgesia to the skin, muscles, and parietal peritoneum of the anterior abdominal wall from T7 to L1.

First described by: Rafi (Anaesthesia 2001;56:1024-6)

**Indications**
- Laparotomy
- Appendectomy
- Nissen fundoplication
- Pyloromyotomy
- Major abdominal wall surgery
- Colostomy placement and closures

**Anatomy**

The anterior abdominal wall (skin, muscles, parietal peritoneum) is innervated by the anterior rami of the lower 6 thoracic nerves (T7 to T12) and the first lumbar nerve (L1). Terminal branches of these somatic nerves course through the lateral abdominal wall within a plane between the internal oblique and transversus abdominis muscles. This intermuscular plane is called the transversus abdominis plane (TAP).

1. There is a fascial sheath between the internal oblique and transversus abdominis muscles. The nerves lie deep to this fascia.
2. Nerves of T6-T9 enter the TAP medial to the anterior axillary line. T6 enters the TAP just lateral to the linea alba, and T7-T9 at progressively increasing distances from the linea alba. Nerves running in the TAP lateral to the anterior axillary line originate from segmental nerves T9-L1.
3. There is extensive branching and communication of the segmental nerves in the TAP. In particular the T9-L1 branches form a so-called “TAP plexus” that runs with the deep circumflex iliac artery. This may partly account for the ability of a single injection to cover several segmental levels.

**Techniques**

1. Landmark technique
2. Ultrasound-guided posterior block
3. Ultrasound-guided subcostal block
Equipment
1. Short bevel needle 22 or 25 gauge needle
2. Sterile towels
3. 4"x4" gauze packs
4. Syringe with local anesthetic
5. Sterile gloves
6. Chloraprep swab
7. Ultrasound machine with probe cover

Landmark
Triangle of Petit: This area is bounded by the latissimus dorsi muscle posteriorly, the external oblique muscle anteriorly and the iliac crest inferiorly (the base of the triangle)

1. Internal Oblique
2. External Oblique
3. Aponeurosis
4. Iliac crest
5. Latissmus Dorsi

Needle Placement
The patient in a supine position, a needle is inserted perpendicular to all planes into the triangle of petite, looking for a tactile endpoint of two pops. The first pop indicates penetration of the external oblique fascia and entry into the plane between external and internal oblique muscles; the second pop signifies entry into the TAP plane between internal oblique and transversus abdominis muscles.

Ultrasound-guided posterior block:
1. Using ultrasound probe, identify posterior rectus sheath and rectus abdominis muscle immediately lateral to umbilicus
2. Slide the probe lateral until the three muscle layers…external oblique, internal oblique, transversus abdominis…can be identified. This typically occurs at the anterior- to mid-axillary line.
3. Insert a needle using the in-plane approach (along axis of ultrasound probe) in the fascial layer that separates the internal oblique and transversus abdominis muscles. Aspirate then inject solution. Injectate should be seen spreading in PAT as dark oval shape.

Success is dependent on correctly identifying neuro-fascial plane between internal oblique and transverses abdominis muscles.
- The patient is placed in a supine position and the abdomen is exposed between the costal margin and the iliac crest.
- If there is difficulty in distinguishing the three muscle layers, it is helpful to start the scan in the midline over the rectus abdominis muscle. The rectus abdominis muscle is the only muscular layer in the midline.
- The rectus abdominis muscle tapers laterally to a junction that leads to the three muscle layers of the lateral abdominal wall. The internal oblique, transversus abdominis and intervening TAP are easily identified at this point, and can be traced laterally to the region above the iliac crest where the block is to be performed.

Muscular layers of the anterior abdominal wall beyond the lateral border of rectus abdominis.

**Ultrasound Guided Subcostal TAP block**

The **Subcostal TAP** is a modification of the original technique in which the ultrasound probe is placed just beneath the costal margin and parallel to it. The needle is then introduced from the lateral side of the rectus muscle in plane of the ultrasound beam and 10 ml of local injected into the transversus abdominis plane to extend the analgesia provided by the posterior TAP block above the umbilicus.
Local Anesthetic
1. volume: 0.2 ml/kg with total dose of 20 ml on either side
2. dose: bupivcaine 2 mg/kg in neonate
   bupivcaine 3 mg/kg in children and 4 mg/kg in adolescent

Further pharmacokinetic and pharmacodynamic studies are needed.

Complications
- Interperitoneal injection
- Local anesthetic toxicity

Cadaveric studies on spread:
1. British Journal of Anaesthesia 2009;102:123-7. ultrasound-guided posterior block. 20 ml injectate. Involvement of nerves: T10 50%, T11 100%, T12 100%, and L1 93%.
2. Anaesthesia 2009;64:745-750. ultrasound-guided subcostal block. 20 ml injectate. Involvement of nerves: T9 43%, T10 100%, T11 100%, T12 43%.
Penile Nerve Block

Indications
• Circumcision
• Meatoplasty

Anatomy
Principle innervation of the penis is via the two dorsal penile nerves, which are branches of the pudendal nerves derived from the sacral plexus. The penile nerves travel near the dorsal penile arteries in the vicinity of Buck’s fascia to innervate the glans and the distal two thirds of the body of the penis. The ilioinguinal and genitofemoral nerves supply a small portion of the innervation of the base of the penis and are derived from the lumbar plexus. These nerves need not be blocked for a simple circumcision.

Equipment
1. 25 gauge needle
2. 4”x4” gauze packs
3. Syringe with local anesthetic
4. Sterile gloves

Landmark
The key points are:
1. The triangular space lying deep to the fascia, bounded above by the symphysis pubis and below by the corpora cavernosa.
2. The fact that the fascia splits on its deep surface to form a vertical suspensory ligament of the penis which, in turn, divides to encircle the shaft of the penis.
3. The dorsal nerves and vessels lie deep to the suspensory ligament where it divides on the corpora cavernosa and are therefore in an enclosed space where they could be depressed if a large hematoma developed.
4. There are pear shaped, potential spaces on either side of the suspensory ligament which usually do not communicate directly

Techniques
1. Landmark needle Placement Ring Block
2. Landmark needle Placement Dorsal Penile Block

Ring Block
Perform a circumferential subcutaneous injection at the base of the penile shaft using a 26 or 27 gauge needle. Weight based volume of local should be infiltrated enough to surround the base of the penis from two injection sites one ventrally (A on figure 1a and b) and one dorsally (B on figure 2).
Dorsal Penile Block

**DO NOT USE EPINEPHRINE.** The site of insertion of the needle is shown passing through the membranous layer of the superficial fascia. The bilateral injections into potential spaces shown allow the local anesthetic to diffuse into the space with minimal chance of damage to the dorsal arteries. If an adequate volume of local anesthetic is used the ventral branch which supplies the frenulum should be blocked. If in doubt a subcutaneous ring of local anesthetic may be injected around the ventral side of the shaft of the penis.

Diagram below is from the NYSROA website:

**Figure 1a.** Cross-sectional view. **Figure 1b.** Anatomical view.

**Figure 1.** Penile nerve block; infrapubic approach. **Figure 18.** Penile block: Subcutaneous ring block.

**Local Anesthesia**

0.25% bupivicaine or 0.25% ropivicaine plain 1-2 ml total volume

**Complications**

- May not adequately block the ventral side and may require additional local anesthetic infiltration by surgeon
- Hematoma
- Intravascular injection
Neuroaxial Blocks

Caudal
Epidural block placed at the level of the sacrum.

Indications
• Surgery below the umbilicus:
  • Hernia repair
  • Lower limb surgery
  • Skin grafting
  • GU procedures
  • Procedures on the anus and rectum
  • Orthopedic surgery on the pelvic girdle

Newborn and premature infants: If used as the sole anesthetic, caudal epidural anesthesia reduces the risk of respiratory depression from residual neuromuscular blockade and inhalation anesthetics.

Neuromuscular disease such as muscular dystrophy. There is a high incidence of postoperative respiratory failure due to a combination of general anesthesia and muscle weakness.

Contraindications
• Coagulation or anticoagulant disorders
• Infection: active cellulitis, pilonidal/peri-rectal abscess, and meningitis.
• Unstable blood pressure and/or heart rate
• Patient or parent refusal
• Congenital anatomic anomalies of the spinal cord or vertebral bodies
  • Cases of Spina Bifida, caudal epidural anesthesia should not be attempted as the spinal cord may be tethered within the spinal canal.
  • Scoliosis is not an absolute contraindication to caudal epidural anesthesia though scoliosis may make caudal epidural anesthesia technically more difficult to achieve.

Anatomy (NYSORA)

Sacral anatomy
• The sacrum is a triangular bone that consists of the five fused sacral vertebrae (S1- S5). It articulates with the fifth lumbar vertebra and the coccyx.
• The caudal epidural space is the lowest portion of the epidural system and is entered through the sacral hiatus.
• The terminal part of the dural sac, ending between S1 and S3.
• The five sacral nerves and coccygeal nerves making
up the cauda equina. The sacral epidural veins generally end at S4, but may extend throughout the canal. They are at risk from catheter or needle puncture.

- The filum terminale - the final part of the spinal cord which does not contain nerves, exits through the sacral hiatus and is attached to the back of the coccyx.
- Epidural fat, the character of which changes from a loose texture in children to a more fibrous close-meshed texture in adults. It is this difference that gives rise to the predictability of caudal local anesthetic spread in children and its unpredictability in adults.

**Pediatric anatomic considerations**

- The sacrum is cartilaginous in infants and children which can allow for inadvertent intra-osseous injection.
- The spinal cord reaches L3-4 in the neonate and the dural sac can be found at S3-4. Adult levels of L1 and S1 are usually reached by 1 year of age.

**Equipment**

1. 22 or 25 gauge needle or angiocath
2. Syringe with local anesthetic
3. Sterile gloves
4. Betadine swab

**Technique**

1. Landmark needle Placement

**Landmarks**

**Equilateral triangle formed by three points:** Two posterior superior iliac spines (PSIS) and the sacral hiatus at the apex.

- The sacral hiatus is bounded by the sacral cornu.
- The sacral cornu are palpable on either side of the midline about 1 cm apart.
- Palpation of the sacral hiatus at the apex of this inverted triangle should identify the puncture site.
- The convexity of the coccyx can also be palpated and then move cephalad to palpate the concave sacral hiatus to identify the puncture site.

**Needle Placement**

The patient is in the lateral decubitus and tucked position. The sacral cornu is palpated and the sacral hiatus is identified by first palpating the coccyx, then the two fingers are placed over the sacral cornu to indicate where to direct needle placement. With the free hand direct placement of the needle. Once correct placement is determined, secure the placement of the needle with one hand to prevent migration of the needle and with the other aspirate the syringe, looking for CSF or blood.
A 22 gauge short beveled cannula or the needle is inserted at a 60-degree angle and the needle is advanced until a "pop" is felt as the sacro-coccygeal ligament is pierced. The needle is then carefully directed in a cephalad direction at an angle approaching the long axis of the spinal canal. Secure needle with one hand and with the other control the syringe for injection. Deliver dose in repeated increments.

Administer the test dose, followed by the injection of a 1ml test dose of local anesthetic, with a hand positioned over the sacrum to detect any tissue swelling resulting from malposition of the needle or catheter either into the sub-periosteal area or along the dorsal surface of the sacrum. If CSF is aspirated or if blood continues to be aspirated after repositioning of the needle or catheter, the block should be abandoned. Catheters are affixed to their connectors and filters and strapped in position.

### Local Anesthetic

<table>
<thead>
<tr>
<th>Local Anesthetic*</th>
<th>Dose (mls)</th>
<th>Estimated Sensory Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 % Lidocaine</td>
<td>0.06 ml/segment</td>
<td>Mid-Thoracic (T8)</td>
</tr>
<tr>
<td>0.25% Bupivacaine</td>
<td>1 ml/kg</td>
<td>Mid-Thoracic (T8)</td>
</tr>
<tr>
<td>0.175% Bupivacaine</td>
<td>1.25 ml/kg</td>
<td>Mid-Thoracic (T8)</td>
</tr>
</tbody>
</table>

* All solutions are containing epinephrine 1:200,000

This table of dosing is applicable for patients less than 20 kg for those greater than 20 kg the height of the block based on the doses above may be variable.

### (NYSORA) Typical Local Anesthetics for Caudal Block in Pediatric Patients (single-shot)

<table>
<thead>
<tr>
<th>Agent</th>
<th>Concentration (%)</th>
<th>Dose (mg/kg)</th>
<th>Onset (min)</th>
<th>Duration of Action (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ropivacaine[50]</td>
<td>0.2</td>
<td>2</td>
<td>9</td>
<td>520</td>
</tr>
<tr>
<td>Bupivacaine[50]</td>
<td>0.25</td>
<td>2</td>
<td>12</td>
<td>2553</td>
</tr>
<tr>
<td>Ropivacaine[51]</td>
<td>0.2</td>
<td>0.7</td>
<td>11.7</td>
<td>491</td>
</tr>
<tr>
<td>Bupivacaine[51]</td>
<td>0.25</td>
<td>0.7</td>
<td>13.1</td>
<td>457</td>
</tr>
<tr>
<td>Ropivacaine[52]</td>
<td>0.2</td>
<td>1</td>
<td>8.4</td>
<td>Not available</td>
</tr>
<tr>
<td>Levobupivacaine[52]</td>
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<td>1</td>
<td>8.8</td>
<td>Not available</td>
</tr>
<tr>
<td>Bupivacaine[52]</td>
<td>0.25</td>
<td>1</td>
<td>8.8</td>
<td>Not available</td>
</tr>
</tbody>
</table>

This table of dosing is applicable for patients less than 20 kg for those greater than 20 kg the height of the block based on the doses above may be variable.
Additives

- **Bupivacaine**: 0.75-1ml/kg of Bupivacaine 0.25% with epinephrine 1:200,000 provides 3-6 hours of anesthesia for all procedures below the umbilicus. In Infants, less than 2.5 kg a more dilute solution is used (0.125% / 0.19 %) and the volume can be increased to remain below the toxic dose range.

- **Adrenaline (epinephrine): 1:200,000**: combined with the local anesthetic solution can be used as a test dose for assessment of intravascular injection, the heart rate should increase more than 10 beats in 10 seconds after injection when epinephrine is added.

- **Opioids**: Epidural opioids should be reserved for surgery in which catheterization is required and all children should be admitted to an area of the hospital where close monitoring and observation will take place. A dose of **30-50mcg/kg of preservative free morphine** can be added to the local anesthetic solution. This will provide 12 to 24 hours of analgesia but can produce urinary retention, nausea, and itching and respiratory depression.

- **Clonidine**: (α2-adrenergic agonist, with spinal analgesic action). A dose of **0.5-1.0 microgram/kg** improves the quality and duration of analgesia lasting for up to 12 hours. Doses greater than 1 microgram/kg are often associated with increased sedation.

- **Ketamine**: In doses of **0.25 - 1.0 mg/kg**, causes significant prolongation of postoperative analgesia, when compared to 0.25 % bupivacaine alone. There is no increase in adverse effects including delayed motor strength, time to micturation, postoperative sedation or postoperative nausea and vomiting. In doses higher than 0.5 mg/kg, the neuroleptic effects of ketamine appear to be more of a problem. Preservative free ketamine should be used at all times if possible.

Complications

- GA suppresses signs of toxicity
- Intravascular or Intrathecal Injection – this may lead to grand mal seizures and/or cardiac arrest. Neonate presents with respiratory distress.

- Dural puncture
- Perforated rectum – contamination of the needle and spread of infection is extremely dangerous
- Sepsis – can be avoided if strict aseptic technique is followed
- Urinary retention – Not uncommon, temporary catheterization may be required
- Subcutaneous injection
- Hematoma
- Absent or patchy block
- Intra-osseous injection
Spinal Anesthesia
Central neuroaxial block

Indications
- Preterm children of less than 60 weeks of age post conception; infants with bronchopulmonary dysplasia, apnea or need for ventilatory support. All of these have a greater risk of apnea and hemodynamic instability when recovering from general anesthesia.
- Children with history of malignant hyperthermia or significant risk of it.
- Children with chronic disease of the airways like asthma or cystic fibrosis.
- Children with acute respiratory conditions.
  - Surgeries with level below T4 and duration less than 90 min
    - Umbilical and inguinal hernia repairs
    - Perineal surgery
    - Lower extremity surgeries
    - Orchidopexy
    - Hypospadius
    - Skin grafts
    - Anal surgery
    - Circumcision/Cystoscopy
    - Imperforated anus/rectal biopsies
  - Exploratory laparotomy
  - Meningomyelocele repair
  - Muscle biopsy
  - Cardiac surgery

Contraindications
1. Presence of a significant spinal defect
2. Infection of the skin or subcutaneous tissue in the puncture area.
3. Coagulation defects
4. Neurological defects in growth, as well as demyelinating disease of the CNS.
5. Refusal of the parents
6. Allergy to local anesthetics
7. Severe hypovolemia
8. Uncontrolled seizures
9. Increase ICP
10. Presence of VP shunt

Anatomy
- Spinal cord terminates at a much more caudad level (S3 compared to S1 in adults)
- Conus medullaris ends at approximately L1 in adults
  - L2 or L3 level in neonates and infants
- Neonates and infants have a proportionately smaller pelvis than adults
- Sacrum is located more cephalad relative to the iliac crests
- Truffier’s line crosses the midline of the vertebral column at the L4-5 or L5-S1 interspace well below the termination of the spinal cord making this landmark applicable in all pediatric patients
- The more caudad termination of the dural sac makes it more likely to have an inadvertent dural puncture during performance of a single-shot caudal block if the caudal needle is advanced too far into the caudal epidural space.
- **Cerebrospinal fluid (CSF) volume is larger on a mL/kg basis in infants and neonates (4mL/kg) compared to their adult counterparts (2mL/kg).** This may account for the higher local anesthetic dose requirements and shorter duration of action of spinal anesthesia in this population.

![Figure 1](image)

**Equipment**
1. Bupivicaine spinal ampule
2. Desired spinal needle
3. Sterile gloves
4. Syringe with pre-calculated additives
5. Band aid

**Needle Placement**
Place the patient in Lateral decubitus with legs tucked to chest, avoid excessive neck flexion can cause airway obstruction in infants. In infants, the L4-5 or L5-S1 interspace should be identified; the L3-4 interspace may be used in older children. The area should be sterile prepped with betadine and draped. Prepare a syringe with appropriate dose of local anesthetic prior to dural puncture. The subarchnoid space is then entered using a short 22- or 25-gauge spinal needle via midline approach traversing the ligamentum flavum. Once clear CSF is seen exiting the needle, the drug(s) should be injected slowly and the needle removed.
Local Anesthetics

- Recommended dosing for **Duramorph 3-5 mcg/kg**

<table>
<thead>
<tr>
<th>AGE</th>
<th>Bupivacaine (mg/kg)</th>
<th>Tetracaine (mg/kg)</th>
<th>Ropivacaine (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants</td>
<td>0.5-1</td>
<td>0.5-1</td>
<td>0.5-1</td>
</tr>
<tr>
<td>1-7 years</td>
<td>0.3-0.5</td>
<td>0.3-0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>&gt;7 years</td>
<td>0.2-0.3</td>
<td>0.3</td>
<td>0.3-0.4</td>
</tr>
</tbody>
</table>

- Tetracaine to increase the duration up to 120 minutes an epinephrine wash (epinephrine aspirated from vial and then fully expelled from the syringe prior to drawing up local anesthetic)

**Clinical Pearls**

- This ligament is very soft in children and a distinctive “pop” may not be perceived when the dura is penetrated.
- The barbotage method is not recommended as this may result in unacceptable high levels of motor blockade and potential for a total spinal blockade.
- The caudal end of the patient should not be elevated for placement of the electro-cautery return electrode as a total spinal can result from spread of local anesthetic solution to a higher spinal level.

**Complications**

- **Vascular puncture**: If blood is obtained from the needle, wait until the fluid clears and then inject the anesthetic. If this does not happen then go to other intervertebral space and repeat the procedure.
- **Inadequate block**: happens with poorly experienced operators and may be due to poor technique or wrong calculation of the dosage.
- **Nausea and vomiting**: can happen in some patients to whom inadequate amounts of fluids have been infused.
- **Headache**: is a complication that is seen more frequently in older children and is related to the caliber of the needles used for the injection. **Dose for blood patch 0.3 ml/kg**
- **Hypotension**: can happen when inadequate volumes of fluids have been infused and when the anesthetic level is high. It is mostly seen in older children (older than 7 years).
- **Local and systemic infection**: can happen if adequate aseptic techniques are not followed.
Epidural

Indications

- Hip and knee surgery. Internal fixation of a fractured hip is associated with less blood loss when central neuraxial block is used.
- Vascular reconstruction of the lower limbs. Epidural anesthesia improves distal blood flow in patients undergoing arterial reconstruction surgery.
- Amputation. Patients given epidural anesthesia 48-72 hours prior to lower limb amputation may have a lower incidence of phantom limb pain following surgery, although this has not been substantiated.
- Obstetrics
  - Low concentration local anesthetics, opioids, or combinations of both are effective in the control of postoperative pain in patients undergoing abdominal and thoracic procedures.

Absolute Contra-indication

- Patient refusal
- Coagulopathy
- Therapeutic anticoagulation.
- Skin infection at injection site
- Raised intracranial pressure
- Hypovolemia

Relative

- Uncooperative patients
- Pre-existing neurological disorders
- Fixed cardiac output states. This includes aortic stenosis, hypertrophic obstructive cardiomyopathy (HOCM), mitral stenosis and complete heart block. Patients with these cardiovascular abnormalities are unable to increase their cardiac output in response to the peripheral vasodilatation caused by epidural blockade, and may develop profound circulatory collapse which is very difficult to treat.
- Anatomical abnormalities of vertebral column
- Prophylactic abnormalities of vertebral column
- Prophylactic low dose heparin

Anatomy

The epidural space is that part of the vertebral canal not occupied by the dura mater and its contents. It is a potential space that lies between the dura and the periosteum lining the inside of the vertebral canal. It extends from the foramen magnum to the sacral hiatus. The anterior and posterior nerve roots in their dural covering pass across this potential space to unite in the intervertebral foramen to form segmental nerves. The anterior border consists of the posterior longitudinal ligament covering the vertebral bodies, and the intervertebral discs. Laterally, the epidural space is bordered by the periosteum of the vertebral pedicles, and the intervertebral foramina. Posteriorly, the bordering structures are the periosteum of the anterior surface of the laminae and articular processes and their connecting ligaments, the periosteum of the root of the spines, and the interlaminar spaces filled by the ligamentum flavum. The space contains venous plexuses and fatty tissue which is continuous with the fat in the paravertebral space.
Equipment
1. Epidural kit
2. Sterile gloves
3. Local anesthetic of choice and dose calculated to weight
4. Opsite and mastisol for taping

Technique
1. Landmark needle placement

Needle Placement
The block can be performed with the patient either in the sitting or lateral decubitus position. The patient should be encouraged to adopt a curled up position, as this tends to open the spaces between the spinous processes and facilitates the identification of the intervertebral spaces.

After the back has been prepared with sterile solution and draped in sterile fashion, the desired level is selected (see below). The epidural space can be entered either the midline or paramedian approach.

- Using local anesthetic raise a subcutaneous wheel at the midpoint between two adjacent vertebrae. Infiltrate deeper in the midline and paraspinoously to numb the posterior structures.
• Insert epidural needle into the skin at this point, and advance through the supraspinous ligament, with the needle pointing in a slightly cephalad direction. Then advance the needle into the interspinous ligament, which is encountered at a depth of 2-3 cm until distinct sensation of increased resistance is felt as the needle passes into the ligamentum flavum.

• At this point, remove the needle stylet and attach the syringe to the hub of the needle.
• Fill the syringe with 5 of normal saline or air. Hold the syringe in the right hand (for a right handed operator) with the thumb on the plunger. The left hand grips the wing of the needle between thumb and forefinger, while the dorsum of the left hand rests against the back. The left hand acts to steady the needle and to serve as a "brake" to prevent the needle from advancing in an uncontrolled way. Using the thumb of the right hand to exert constant pressure on the plunger advance the needle through the interspinous ligament and then into the ligamentum flavum. With continuous pressure on the plunger, advance the needle slowly until its tip exits the ligamentum flavum and the saline is easily injected into the epidural space, and the needle stops advancing.
• Remove the syringe and thread the catheter gently via the needle into the epidural space. The catheter has markings showing the distance from its tip, and should be advanced to 15-18cm at the hub of the needle, to ensure that a sufficient length of catheter has entered the epidural space. Remove the needle carefully, ensuring that the catheter is not drawn back with it. The markings on the needle will show the depth of the needle from the skin to the epidural space, and this distance will help determine the depth to which the catheter should be inserted at the skin. For example, if the needle entered the epidural space at a depth of 5cm, the catheter should be withdrawn so that the 10cm mark is at the skin, thus leaving approximately 5cm of the catheter inside the epidural space, which is an appropriate length.
• Secure the catheter in place. Connect the filter and place the label securely around the filter.

Clinical Pearls
• While the tip of the needle is in the interspinous ligament there may be some loss of saline into the tissues as the tissue is not particularly dense, but there is usually significant resistance to pressure on the plunger. Occasionally, this false loss of resistance may cause some difficulty with placing an epidural. Once the needle enters the ligamentum flavum, there is usually a distinctive sensation of increased resistance, as this is a dense ligament with a leathery consistency
• Bony resistance everywhere - try flexing more or changing position. If still unsuccessful, try paramedian approach (if using midline approach).
• Unable to thread catheter- try rotating the needle slightly so that the bevel changes direction. Most commercial epidural packs contain a catheter stabilizer, which attaches to the hub of the needle and may make feeding the catheter easier. If still unsuccessful, the needle is unlikely to be in the epidural space. Do not pull back the catheter through the needle as the tip may be cut off.
• **Fluid through needle** - if using saline, wait a few seconds to see if it stops flowing. If not, dural puncture is likely. Re-attempt epidural at a different level. If fluid stops flowing, continue as before, but give small doses of local anesthetic incrementally and observe carefully for signs of subarachnoid block.

• **Fluid through catheter** - as above

• **Pain on insertion of the catheter** - a brief sensation of "electric shock" on insertion of the catheter is not unusual, but if it persists, the needle or catheter may be up against a nerve root and should be withdrawn and re-attempted.

• **Blood in catheter.** This indicates that the catheter has entered an epidural vein. Withdraw catheter by 1-2cm provided this will leave at least 2-3cm in the space and flush through with saline. Aspirate again to see if blood is still flowing through catheter. If blood has stopped, the catheter may be used, but with great care, making sure at all times that
  1) catheter is aspirated prior to any subsequent doses of local anesthetic
  2) all doses are given in small increments
  3) the patient is carefully monitored for any early signs of local anesthetic toxicity

• After lumbar injection, analgesia spreads both caudally and, to a greater extent, cranially, with a delay at the L5 and S1 segments, due to the large size of these nerve roots.

• After thoracic injection, analgesia spreads evenly from the site of injection. The upper thoracic and lower cervical roots are resistant to blockade due to their larger size. The epidural space in the thoracic region is usually smaller and a lower volume of local anesthetic is needed.

• Generally the dosing is 1-2ml of local anesthetic is needed per segment to be blocked

**Complications**

Serious complications may occur with epidural anesthesia. Facilities for resuscitation should always be available whenever epidural anesthesia is performed.

• Surface anatomy
  Hypotension
• Inadvertent high epidural block
• Local anesthetic toxicity
• Total spinal
• Accidental dural puncture
Upper Extremity Blocks

**Interscalene**
Brachial Plexus block at the level of the roots.

**Indications**
- Shoulder Arthroscopy
- Rotator cuff repair
- Any Upper arm surgery

**Contraindications**
- Impaired pulmonary function

**Anatomy**
The nerve roots C2 through T1 exit the intervertebral foramina and lie in a fascial plane created by the anterior and medial scalene muscles. Injection of local anesthetic into this plane results in spread within this layer both rostrally towards C2 and caudally toward T1. Interscalene block is typically performed at the midpoint C5-6 so that spread upward involves the upper cervical plexus (C2-4) and downward affects the brachial plexus (C5-T1).

**Landmarks**
1. Cricoid cartilage: level of C6 vertebral body
2. Sternocleidomastoid: interscalene groove is at an oblique angle to the long axis of this muscle
3. Anterior scalene
4. External jugular

**Equipment**
1. Sterile towels
2. Chlorprep swab
3. Marking pen
4. 20-mL syringes with local anesthetic
5. Sterile gloves
6. Surface electrode
7. Insulated stimulating needle
8. Peripheral nerve stimulator
9. Ultrasound machine and sterile cover

**Techniques**
1. Landmark Needle Placement with Nerve stimulation
2. Ultrasound guided needle placement
**Needle Placement**

**Nerve Stimulator**

Patient is in supine position with neck neutral head slightly turned opposite the direction the site to be blocked.

Identify the cricoid cartilage roll the fingers off the sternocleidomastoid muscle onto the belly of the anterior scalene into the interscalene groove. The external jugular often lies above the interscalene groove at the level of C6. The intersection of this groove with a transverse plane at the level of the cricoid cartilage is the point at which the needle should enter the skin and this is about the level of the sixth cervical vertebra (C6). The skin on the side to be blocked is cleaned with an antiseptic and draped. A skin weal is made with lidocaine. A 22 or 23 gauge insulated needle is inserted perpendicularly to the skin with a 45 degree caudal angle (towards the feet) and slightly posterior angle. A “pop” may be noted as the needle passes through the pre-vertebral fascia. This usually occurs at the superficial level.

**Ultrasound Placement as described by NYSORA:**

- Use linear ultrasound probes working at frequencies as high as possible.
- Turn the child’s head to the contra-lateral side.
- The probe should be oriented from the medial to the lateral aspect.
- The medial approach easily helps to identify the thyroid gland and the major vessels in the neck area (carotid artery and internal jugular vein).
- Move the probe along the sternocleidomastoid muscle until its lateral border is reached.
- At the same time, the transducer is descended in a caudal direction such that the posterior scalene gap and the upper anterior roots (C5–7) of the brachial plexus become visible between the anterior and medial scalene muscles.
- Insert needle in a tangential direction relative to the neck above the transducer.
- Turn the nerve stimulator on and monitor the arm movements as the needle tip is inserted guided by the ultrasound imaging.
- The C5 root will be encountered only a few millimeters deep.
- As a rule, the needle should be lateral to the C7 root, which will make sure that the neck vessels remain at an adequate distance.
- Once the local anesthetic is injected, it will invariably spread toward the C5 root, which can be observed in the ultrasound image.
- Depending on the blockade required, the needle can be advanced to a deeper level for injection after the deep roots (C8 and T1) are visualized.
- In the majority of cases, the **local anesthetic will spread medially, even when the needle is in a lateral position**. However, if the local anesthetic fails to spread adequately in a medial direction, the needle is withdrawn to the subcutaneous level and repositioned on the medial side to the posterior scalene gap in the area of the C7 root. The injected...
volume of local anesthetic should be adequate to cover the root surfaces, rather than use of a specific, arbitrary volume.

Local Anesthetics
.25% bupivicaine or .2% ropivicaine 0.15-.25 ml/kg

Complications
- Subarachnoid injection
- Epidural block
- Intravascular Injection in vertebral artery
- Pneumothorax
- Phrenic block
- Horner’s syndrome (drooping eyelid, a pupil that is constricted, enophthalmos, which makes the eye looks as if it sits deeply in the skull or is sunken, and poor sweat production)
  - Horner's syndrome affects only one side of the face, so there is a large difference in appearance between the eyes. The eye on the affected side may have a different color, and may be continually bloodshot. Further, the affected side of the face may flush and appear reddish.

Clinical Pearls
- In children, the interscalene groove is not always located exactly at the lateral border of the sternocleidomastoid muscle; it is often situated away either medially or laterally.
- It is difficult to achieve block of roots C8-T1 due to the tightness of the anatomic structures in the neck area which also increases the risk for inadvertent puncture of vertebral artery or subarachnoid space.
- Ulnar distribution is often spared in this block
- Make sure the entire block-needle system is free of air because any amount of air can cause artifact in ultrasound imaging
Interpreting Responses to Nerve Stimulation (Table obtained from NYSORA website)

Some common responses to nerve stimulation and the course of action to obtain the proper response are shown in table below:

<table>
<thead>
<tr>
<th>Response Obtained</th>
<th>Interpretation</th>
<th>Problem</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local twitch of the neck muscles</td>
<td>Direct stimulation of the anterior scalene or sternocleidomastoid</td>
<td>Needle pass is in the wrong plane; usually anterior and medial to the plexus</td>
<td>Withdraw the needle to the skin level and reinsert 15° posteriorly</td>
</tr>
<tr>
<td>Needle contacts bone at 1-2 cm depth; no twitches are seen</td>
<td>The needle is stopped by the transverse process</td>
<td>The needle is inserted too posteriorly; the needle is contacting the anterior tubercles of the transverse process</td>
<td>Withdraw the needle to the skin level and reinsert 15° anteriorly</td>
</tr>
<tr>
<td>Twitches of the diaphragm</td>
<td>This is the result of stimulation of the phrenic nerve</td>
<td>The needle is inserted too anteriorly</td>
<td>Withdraw the needle and reinsert 15° posteriorly</td>
</tr>
<tr>
<td>Arterial blood noticed in the tubing</td>
<td>Puncture of the carotid artery (most common)</td>
<td>The needle insertion and angulation is too anterior</td>
<td>Withdraw the needle and keep a steady pressure 2-3 minutes; reinsert 1-2 cm posteriorly</td>
</tr>
<tr>
<td>Pectoralis muscle twitch</td>
<td>Brachial plexus stimulation (C4-5)</td>
<td></td>
<td>Accept and inject local anesthetic</td>
</tr>
<tr>
<td>Twitch of the scapula</td>
<td>Twitch of the serratus anterior muscle; stimulation of the thoracodorsal nerve</td>
<td>Needle position is posterior/deep to the brachial plexus</td>
<td>Withdraw the needle to the skin level and reinsert the needle anteriorly</td>
</tr>
<tr>
<td>Trapezius muscle twitches</td>
<td>Accessory nerve stimulation</td>
<td>Needle posterior to the brachial plexus</td>
<td>Withdraw the needle and reinsert</td>
</tr>
<tr>
<td>Twitch of: pectoralis, deltoïd, triceps, biceps, forearm, and hand muscles</td>
<td>Stimulation of the brachial plexus</td>
<td>None</td>
<td>Accept and inject local</td>
</tr>
</tbody>
</table>
**Supraclavicular**
Brachial Plexus Block at the trunk level

**Indications**
- Procedures to upper arm, from midhumeral to hand
- Good choice for patients who cannot abduct their arms for the axillary block

**Contraindications**
Obese patients with poor anatomy

**Anatomy**
Supraclavicular is performed at the trunk level of the brachial plexus.

Primary ventral rami:

1. The C5 and C6 nerve roots join to form the superior trunk
2. The C7 nerve root form the middle trunk and the C8
3. T1 nerve roots join to form the inferior trunk. The C4 and T2 nerve roots also has significant contributions to these trunks.

Both the brachial plexus and the subclavian artery lie on top of the first rib. The brachial plexus is located lateral and posterior to the subclavian artery. The subclavian vein and anterior scalene muscle are found medial to the subclavian artery. The pleura is usually found within 1-2 cm from the brachial plexus.
### Landmark

1. **First Rib (FR):** Both the brachial plexus and the suclavian artery lie on top of the first rib
2. **Subclavian artery (SA):** The brachial plexus is located lateral and posterior to the suclavian artery
3. **Apex of lung:** The pleura is usually found within 1-2 cm from the brachial plexus
4. **Anterior (1) and middle scalene (2)**

![Image of thoracic anatomy](usra.ca)

### Techniques

1. Landmark Needle Placement with Nerve stimulation
2. Ultrasound guided needle placement

### Equipment

1. Sterile towels
2. Chlorprep swab
3. Marking pen
4. Syringes with local anesthetic
5. Sterile gloves
6. Surface electrode
7. Insulated stimulating needle
8. Peripheral nerve stimulator
9. Ultrasound machine and sterile cover

### Needle Placement

With the head turned toward the non-operative side, palpate the posterior border of the sternocleidomastoid muscle at the C6 level and roll your fingers laterally over the anterior scalene muscle until they lie in the interscalene groove. Move your fingers laterally down the interscalene groove approximately 1 cm from the mid clavicle. This location is the initial insertion site for the needle. Standing at the patient’s head, direct the needle toward the axilla.
Scanning Technique (Obtained directly from the URSA and NYSORA)

Anatomical Correlation

**Arrowheads** = trunks/divisions of the brachial plexus

C = clavicle

FR = first rib

SA = subclavian artery

SAM & SMM = scalenus anterior & medius muscles

SV = subclavian vein

White box = scanned area

Nerve Localization (USRA)

- Perform a systematic anatomical survey from medial to lateral and superficial to deep.
- The brachial plexus (trunks) is generally easy to locate in this region. The subclavian artery serves as an easily identifiable reference point to locate the brachial plexus.
- First locate the subclavian artery.
- The subclavian vein is found more medially.
- The anterior scalene muscle inserts onto the first rib between these 2 vessels.
- Identify the hyperechoic first rib lying deep to the vessels and its bony shadow.
- Identify the pleura and compare it with the hyperechoic first rib. Note air artifact, the “comet tail” sign and pleura sliding movement during respiration.
- Note the skin-to-first rib and skin-to-pleura distance.
- The brachial plexus is consistently found lateral and posterior to the subclavian artery and above the first rib.

In Plane Lateral to Medial Approach (USRA)

- For the IP approach, insert a 5 cm 22G insulated block needle on the outer (lateral) end of the ultrasound transducer after skin local anesthetic infiltration. Advance the needle along the long axis of the transducer in the same plane as the ultrasound beam. In this way, the
needle shaft and tip can be visualized in real time as the needle is advanced towards the target nerves.

- The transducer is placed over the right supraclavicular fossa. The needle is inserted in plane with the ultrasound transducer and beam in a lateral to medial direction.

- Confirm the identity of the nerves by electrical stimulation if desired. Useful stimulation endpoints for surgery proximal to the elbow are biceps and triceps twitches but aim to get hand muscle twitches for surgery distal to the elbow.

- Note that this procedure is unique and is dramatically different from conventional supraclavicular techniques. With one hand holding the transducer and the other holding the needle, the needle is advanced in a lateral to medial direction starting from the outer edge of the transducer.

**Local Anesthetic Injection**

- Observe the pattern of local anesthetic spread around the target nerves in real time during injection (hydro dissection and distention technique). If local anesthetic spread is deemed
inadequate, reposition the needle before administering the remaining local anesthetic dose.

- Aim to deposit most of the local anesthetic bolus immediately above the first rib and next to the subclavian artery to anesthetize the lower trunk if anesthesia is intended for the distal limb.

![Pre-injection Image with Arrowheads and SA annotation]

**Pre-injection**

**Arrowheads** = nerve trunks/divisions  
SA = subclavian artery

![Post-injection Image with Arrowheads and SA annotation]

**Post-injection**

Lateral to medial needle approach  
**Arrowheads** = local anesthetic spread among nerve trunks  
SA = subclavian artery

**Local Anesthetic**

**Clinical Pearls**

**Maximum dose of local anesthetics**

- The maximum dose of bupivacaine is 2.5 mg/kg plain and 3.5 mg/kg with epinephrine. The duration of bupivacaine varies from 2-16 hours, depending on the application.
- The maximum dose of 2-chloroprocaine is 8 mg/kg plain and 10 mg/kg with epinephrine. The duration of chloroprocaine is 1-1.5 hrs.
- The maximum dose of lidocaine is 5 mg/kg plain and 10 mg/kg with epinephrine. The duration of lidocaine is 2-3 hrs.
- Supraclavicular block-0.3ml/kg
- Children younger than five to eight years old can receive 0.5-1 mL/kg of bupivacaine 0.25% or ropivacaine 0.2%. Older children may require larger concentrations such as 0.5-1 mL/kg of bupivacaine 0.5% or ropivacaine 0.5%. Epinephrine 1:200,000 is typically added for detection of inadvertent intravascular injection. If multiple nerve blocks are to be performed, the maximum, allowable dose of local anesthetic should not be exceeded when the amount is calculated for both blocks.

<table>
<thead>
<tr>
<th>(NYSORA)</th>
<th>Onset (min)</th>
<th>Anesthesia (hrs)</th>
<th>Analgesia (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3% 2-Chloroprocaine (+ HCO3)</td>
<td>10-15</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3% 2-Chloroprocaine (+HCO3 + epinephrine)</td>
<td>10-15</td>
<td>1.5-2</td>
<td>2-3</td>
</tr>
<tr>
<td>1.5% Mepivacaine (+ HCO3)</td>
<td>15-20</td>
<td>2-3</td>
<td>3-5</td>
</tr>
<tr>
<td>1.5% Mepivacaine (+ HCO3 + epinephrine)</td>
<td>15-20</td>
<td>2-2</td>
<td>3-8</td>
</tr>
<tr>
<td>2% Lidocaine (+ HCO3 + epinephrine)</td>
<td>10-20</td>
<td>2-5</td>
<td>3-8</td>
</tr>
<tr>
<td>0.5% Ropivacaine</td>
<td>15-30</td>
<td>4-8</td>
<td>5-12</td>
</tr>
<tr>
<td>0.75% Ropivacaine</td>
<td>10-15</td>
<td>5-10</td>
<td>6-24</td>
</tr>
<tr>
<td>0.5 Bupivacaine (or l-bupivacaine)</td>
<td>15-30</td>
<td>5-15</td>
<td>6-30</td>
</tr>
</tbody>
</table>

**Complications**
- Pneumothorax
- Intravascular injection
- Nerve damage
- Horner’s syndrome

**Clinical Pearls**
- Aspiration of bright red blood means the subclavian artery is penetrated and needle is too medial
- Bicep contraction means stimulation of musculocutaneous nerve and needle is too lateral
- Pectoralis muscle stimulation means the needle is anterior.
- Scapular movements means athe needle is posterior to the plexus.
- Phrenic nerve courses through the neck on its way through the thorax on the ventral surface of the anterior scalene muscle and it is often blocked with Interscalene and supraclavicular blocks.
- Block is done at the level of C6 because it is harder to identify the groove below C6 level due to the overlying omohyoid muscle.
- Never direct the needle medially because of the proximity of the lung.
- Four P’s (Brown, 2009): Push, Pull, Pinch, Pinch tools for assesment of Brachial Plexus
<table>
<thead>
<tr>
<th>Four P’s</th>
<th>Patient’s Reaction</th>
<th>Nerve Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push</td>
<td>Extends with triceps</td>
<td>Radial</td>
</tr>
<tr>
<td>Pull</td>
<td>Flex with biceps</td>
<td>Musculocutaneous</td>
</tr>
<tr>
<td>Pinch</td>
<td>Fifth digit</td>
<td>Ulnar</td>
</tr>
<tr>
<td>Pinch</td>
<td>Index finger</td>
<td>Median</td>
</tr>
</tbody>
</table>
**Infraclavicular Block**
Blockade at the level of the cords.

**Indications**
- Surgery of the hands, wrist, forearm, elbow, and distal arm

**Contraindication**

**Anatomy**
From its origin at the intervertebral foramina to the upper arm, the brachial plexus is enclosed by a fascial sheath that is derived from the prevertebral and scalene fascia. This anatomic feature serves as the basis for this block.

The infraclavicular fossa border are defined by:
- The pectoralis minor and major muscles anteriorly
- The ribs medially,
- The clavicle and the coracoid process superiorly
- The humerus laterally

The sheath surrounding the plexus is delicate. It contains the subclavian/axillary artery and vein. The distribution of anesthesia after an infraclavicular brachial plexus block includes the hand, wrist, forearm, elbow, and distal arm. The skin of the axilla and proximal medial arm is not anesthetized (intercosobrachial and medium cutaneous brachii nerves).

Anterior to the brachial plexus are the pectoralis major and minor muscles. Posterior to the brachial plexus in this region is the scapula. The axillary vein is commonly located caudad and medial to the axillary artery.
Surface Landmarks
The following surface anatomy landmarks are useful in identifying the estimated site for an infraclavicular block:

1. Sternoclavicular joint
2. Medial end of the clavicle
3. Coracoid process
4. Acromioclavicular joint
5. Head of the humerus

Anatomic Landmarks
Landmarks for the infraclavicular block include:

1. Coracoid Process
2. Medial clavicular head
3. Midpoint of line connecting 1 and 2 and 3cm caudal

The needle insertion site is marked approximately 3cm caudal to the midpoint of the line connecting points 1 and 2.

Equipment

1. Sterile towels and 4"x4" gauze packs
2. Syringes with local anesthetic with calculate dose
3. Sterile gloves, and surface electrode
4. A short bevel, insulated stimulating needle with appropriate length
5. Peripheral nerve stimulator
6. Chloraprep swab

Techniques

1. Needle placement with nerve stimulator
2. Ultrasound guided needle placement

Needle Placement
With the child in the supine position, the upper arm should remain next to the trunk and the elbow flexed 90 degrees so that the forearm is on the abdomen. Palpate the coracoid process and insert a 1 inch 24 gauge insulated needle 0.5 cm distal to the coracoid process in a perpendicular or vertical direction while continuously aspirating for blood and/or air. Once appropriate stimulation has been determined and continuous aspiration for blood and/or air has been negative, local anesthetic solution is then injected.
**Ultrasound Guided Needle Placement**

1. Place patient in supine with the arms by the side. The position of the patient is often optimized by the use of a head ring and a small roll between the scapula. Interestingly, in adults abduction of the arm with external rotation of the shoulder brings the brachial plexus more superficial and thus distant from the pleura.

2. When performing a left-sided block, a right-handed operator stands at the head of the patient with the ultrasound machine at the ipsilateral side of the patient, the position of operator and US machine are reversed for a right-sided block.

3. A linear probe is held in a para-sagittal plane just beneath the coracoids process and is then moved medial and lateral beneath the clavicle to form the initial mapping scan.

4. The operator should first identify the pectoral muscles, and then locate the subclavian artery. The subclavian vein is compressible and positioned caudad to the artery.

5. Finally, before locating the plexus the pleura must be identified and when performing the puncture it should be kept in view at all times.

6. The plexus itself lies cephalad to the artery, as it travels laterally the cords take up their medial (between artery and vein), lateral (cephalad) and posterior positions.

7. The probe should be moved along the clavicle until the best view of the cords, vessels and pleura is obtained.

8. The needle is introduced from the medial aspect of the probe using a cross-sectional technique towards the lateral or medial cord.

9. Extreme care is required with this approach as the needle tip is difficult to image and an infant’s plexus, vessels and pleura can be very close to one another; therefore, the operator should only insert the needle when they are confident of needle tip position. A test injection of saline (this is used in infants where the amount of LA available is limited) or LA is used to ensure the needle has passed through all the appropriate layers, if the injectate begins to encircle the artery the position is held and 0.5 ml/kg of LA injected.

---

**PM**=Pectoralis Major  
**Pm**=Pectoralis Minor  
**Pl**=Pleura  
**A**= Artery  
**m**=medial cord  
**l**=lateral cord  
**p**=posterior cord
Local Anesthetics (NYSORA)

- Infraclavicular block 0.15mL/kg – 0.33 mL/kg
- Local anesthetic dosing for upper extremity peripheral nerve blockade is based on weight. Children younger than five to eight years old should receive 0.3-0.5 milliliters per kilogram (mL/kg) of bupivacaine 0.25% or ropivacaine 0.2%. Older children may require larger concentrations such as 0.3-0.5 mL/kg of bupivacaine 0.5% or ropivacaine 0.5%. Epinephrine 1:200,000 should be added for detection of inadvertent intravascular injection.

Clinical Pearls

Maximum dose of local anesthetics

- The maximum dose of bupivacaine is 2.5 mg/kg plain and 3.5 mg/kg with epinephrine. The duration of bupivacaine varies from 2-16 hours, depending on the application.
- The maximum dose of 2-chloroprocaine is 8 mg/kg plain and 10 mg/kg with epinephrine. The duration of chloroprocaine is 1-1.5 hrs.
- The maximum dose of lidocaine is 5 mg/kg plain and 10 mg/kg with epinephrine. The duration of lidocaine is 2-3 hrs.

Complications

- Intravascular injection
- Local anesthetic toxicity
- Pneumothorax
- Nerve damage

Clinical Pearls

Axillary and musculocutaneous nerves leave the sheath at or before the coracoid process in 50% of patients. Consequently, the deltoid and biceps twitches should not be accepted as reliable signs of brachial plexus identification.

<table>
<thead>
<tr>
<th>Stimulation</th>
<th>Motor Response</th>
<th>Explanation</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pectoralis muscle - direct muscle stimulation</td>
<td>Arm adduction</td>
<td>Too shallow a placement of the needle</td>
<td>Continue advancing the needle</td>
</tr>
<tr>
<td>Latissimus dorsi</td>
<td>Arm adduction</td>
<td>Too deep a placement of the needle</td>
<td>Withdraw the needle to skin level and reinsert in another direction (superior/inferior)</td>
</tr>
<tr>
<td>Axillary nerve</td>
<td>Deltoid muscle</td>
<td>Needle placed too inferiorly</td>
<td>Withdraw the needle to skin level and reinsert with a superior orientation</td>
</tr>
<tr>
<td>Musculocutaneous nerve</td>
<td>Biceps twitch</td>
<td>Needle placed too superiorly</td>
<td>Withdraw the needle to skin level and reinsert with a light caudal orientation</td>
</tr>
</tbody>
</table>
**Axillary Block**
Injection of local anesthetics at the terminal branches of the brachial plexus at the axilla.

**Indications**
- Forearm surgery
- Hand surgery

**Contraindications**
1. Patient refusal
2. Inability to position the arm properly
3. Local anesthetic allergy
4. Bleeding disorders or therapeutic anticoagulation
5. Infection in the axilla

**Anatomy**
The axillary block is the most distal block done on the brachial plexus. At this level the plexus is divided into the terminal nerve branches. Two nerves originate from each cord. The lateral cord divides into the musculocutaneous and the lateral portion of the median nerve. The medial cord divides into the ulnar and the median portion of the median nerve, the posterior cord divides into the radial and axillary nerve. Three of these nerves, the median, ulnar, and radial nerves are located, along with the axillary artery, in the axillary sheath. The musculocutaneous nerve is separate from the sheath and runs along the coracobrachialis muscle. For this reason care must be taken to block the musculocutaneous nerve separately.

**Distribution of Anesthesia: From www.nysora.com**
An axillary brachial plexus block (including musculocutaneous nerve block) provides anesthesia to the arm, elbow, forearm, and hand. It should be noted that the unshaded areas are not covered by the axillary brachial plexus block.
Landmark
1. Axilla crease
2. Axillary artery

Equipment
1. Sterile towels
2. Chlorprep swab
3. Marking pen
4. Syringes with local anesthetic
5. Sterile gloves
6. Surface electrode
7. Insulated stimulating needle
8. Peripheral nerve stimulator
9. Ultrasound machine and sterile cover

Technique
1. Landmark needle placement with nerve stimulator
2. Ultrasound guided needle placement with nerve stimulator

Multiple approaches are possible: paresthesia, nerve stimulating, ultrasound, perivascular and transarterial techniques. The block is most effective if each individual nerve is identified and injected. This because of the location of the musculocutaneous is outside of the sheath and the sheath may not be a well formed structure; it may be more a loose collection of connective tissue surrounding the nerves. The benefit of this block is lower risk of pulmonary complications.

Needle Placement
Nerve Stimulation
The patient should be positioned supine with the operative arm abducted and at a roughly 90 degree angle at the elbow. The head should be turned toward the non-operative side. Find the axillary artery high in the axilla. Insert needle 30-45 degrees adjacent and superior to the artery directing the needle toward the midpoint of the clavicle. Refer to the picture (Ross et al, 2006). When using nerve stimulation movement in the hand should be observed. The local anesthetic should then be injected in a fanned out area. Once this part of the block is done the arm should be adducted to aid the distribution of local in this space. The musculocutaneus is blocked
by finding the belly of the coracobrachialis muscle while watching for twitching of the bicep muscle. The axillary brachial plexus requires a relatively large volume of local anesthetic to achieve a complete block. This area is highly vascular with potential for intravascular injection needle should be aspirated frequently and local injected slowly.

**Ultrasound Technique**

Position of the arm same. A linear probe is applied lightly and transversely in the upper axilla being careful not to compress or displace the vessels. After identifying the vein and artery the four nerves should be visualized. Median nerve is close to the artery and lateral. The ulnar is superior and medial to the artery. The radial is found posterior to the artery. Blockage of these nerves usually progresses from deep (radial) to most superficial (median) to prevent distortion of the more superficial nerves. The musculocutaneous is close to the median nerve and then runs between the bicep and the coracobrachialis muscles.

**Local Anesthesia**

**Volume of local anesthetic for common blocks**

- Axillary block – 0.2-0.6 mL/kg
- Local anesthetic dosing for upper extremity peripheral nerve blockade is based on weight. Children younger than five to eight years old should receive 0.3-0.5 milliliters per kilogram (mL/kg) of bupivacaine 0.25% or ropivacaine 0.2%. Older children may require larger concentrations such as 0.3-0.5 mL/kg of bupivacaine 0.5% or ropivacaine 0.5%. Epinephrine 1:200,000 should be added for detection of inadvertent intravascular injection.

**Clinical Pearls**

**Maximum dose of local anesthetics**

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- The maximum dose of lidocaine is 5 mg/kg plain and 10 mg/kg with epinephrine. The duration of lidocaine is 2-3 hrs.
Complications
- Intravascular injection
- Nerve damage
- Hematoma

Clinical Pearls

Rescue Blocks of the Upper Extremity

Distal blocks in the wrist area are challenging because the targeted nerves are located very close to the surface and are firmly embedded in surrounding structures including tendons, muscles, and connective tissue. There is a theoretic risk of nerve damage due to the pressure increase caused by injection of the local anesthetic. It is advisable to avoid nerve block injections in anatomic locations with limited space for the nerves to escape the increase in the compartmental pressure. For the same reasons, punctures should not be placed in the vicinity of bone structures or the ulnar nerve sulcus.

All three nerve blocks discussed require a high-frequency probe (at least 10-MHz). They also require insertion of the needle along the short axis with a 40-mm facet needle. The amount of local anesthetic should be minimized such that the nerve is only covered by thin film of the injected substance.

Radial Nerve
As described by NYSORA

The radial nerve starts at the posterior fascicle and is located along the cubital fossa between the biceps tendon and the brachioradial muscle. In most cases, the superficial and deep segments are already distinguishable in this area, although both rami are still embedded in the same fascial sheath. Therefore, both nerves can be blocked from the same needle position at the same time. In the majority of cases, the needle can be placed successfully between the two rami of the radial nerve, such that both are reached by the local anesthetic.

Ulnar Nerve
As described by NYSORA:

The ulnar nerve can be blocked either above or below ulnar nerve sulcus. The level selected will depend mainly on the quality of visualization in the ultrasound image. The ulnar nerve is formed from the medial fascicle and remains at a very superficial level as it proceeds from the axillary
region in a distal direction. In the area of the ulnar nerve sulcus, its visualization is impeded by bone artifacts. Farther distally, it comes close to the ulnar artery. Figure 19 illustrates the ulnar nerve distal to the ulnar nerve sulcus. Sometimes, it is helpful to use the ulnar artery as reference, which is located more distally. Subsequently, the nerve can be tracked back in a proximal direction to the selected puncture site. Figure 20 shows the position of the ultrasound probe relative to the needle; the puncture site is located distal to the ulnar nerve sulcus.

![Figure 19](image1.jpg)  ![Figure 20](image2.jpg)

**Median Nerve**

As Described by NYSORA

The median nerve is formed from both the lateral and medial fascicles and is located between the axillary and cubital areas. There is, invariably, a close anatomic relationship to the axillary/brachial artery. As a general rule, it is located ventral to the artery in the axillary area and medial (hence, ulnar) to the artery in the cubital area. Its level in the cubital area is very superficial, and sometimes it is larger than the artery in diameter (Figure 21). The position of the probe relative to the needle is shown in Figure 22. For nerve blockade, the needle is first advanced to a point ulnar to the nerve. If the local anesthetic fails to spread in an adequate manner, the needle is repositioned between the artery and the nerve, making sure that these structures are not damaged in the process. With superficial blocks, a skin-nick can facilitate insertion of the short-bevel needle.

![Figure 21](image3.jpg)  ![Figure 22](image4.jpg)
Lower Extremity

Popliteal Fossa Block
Blocking of the tibial and common peroneal nerves high in the popliteal fossa.

Indication
• Foot and ankle surgery

Contraindications
• Rare

Anatomy
The sciatic nerve is a combination of two nerve trunks. The first is the tibial nerve derived from the anterior branches of the ventral rami of the 4th and 5th lumbar nerves and the 1st, 2nd and 3rd sacral nerves. The second is the peroneal nerve derived from the dorsal branches of the ventral rami of the same five nerves. The sciatic nerve pass through the upper leg and divide in the popital fossa into their terminal branches the tibial and common peroneal.

Landmark
Surface Landmarks
1. Popliteal fossa crease
2. Tendon of bicep femoris (laterally)
3. Tedons of semitendinosus and semimembranosus muscles (medially).

The area of interest is the cepholateral quadrant created by the upper border of the semimembranosus muscle and the bicep femoris muscle. It is here both tibial and common peroneal nerve block is possible. The tibial nerve seperates from the common peroneal nerve at the upper limit of the popliteal fossa and sometimes higher.

Equipment
1. Syringes filled with desired amount of local anesthetics
2. Stopcock system for multiple syringe injections
3. Steril gloves, marking pen, and surface electrode
4. Short beveled insulated stimulating needle with desired length based on patient size
5. Nerve stimulator
6. Chloraprep swab

Techniques
1. Intertendinosus approach with nerve stimulator prone position
2. Ultrasound guided needle placement prone position
3. Ultrasound guided needle placement Lateral approach
Needle Placement (Intertendinosus Approach)
The patient is in the prone position with foot slightly off the bed. Insert the needle 45 degrees to the skin in cephalad direction and just lateral to the midline of the popliteal triangle. The distance from the popliteal fold to needle insertion is estimated based on weight. If the weight is < 10 kg, the distance is 1 cm; if the weight is 10 to 20 kg, the distance is 2 cm (Konrad and Johr, 1998). Each 10 kg of body weight should move the needle cephalad in the triangle approximately 1 cm.

Ultrasound guided needle placement (ursa.com)

Scanning Technique
- Position the patient prone and keep the toes off the bed if electrical stimulation will be used to evoke foot movement.

BF=Biceps Femoris, ST=semitendinosus, SM= semimembranosus

- Scan the region proximally and distally to assess nerve anatomy and the point at which the sciatic nerve branches into its tibial and peroneal components.
- Aim to block the sciatic nerve before it divides.
- The sciatic nerve is commonly hyperechoic in this region and is found lateral to the popliteal artery. It is often necessary to angle the transducer caudally to enhance nerve visibility.

Nerve Localization (directly from usra.ca)
- Perform a systematic anatomical survey of structures from superficial (skin) to deep and from medial to lateral.
- First identify the femur which is deep and casts a bony shadow.
- Next, identify the pulsatile popliteal artery that is superficial to the femur. If it is not visible, scan distally towards the popliteal crease where the popliteal artery is more superficial.
- The popliteal vein may or may not be visible (collapsed by transducer pressure).
- Note the muscle groups medially (semitendinosus and semimembranosus muscles) and laterally (biceps femoris muscle).
- The hyperechoic sciatic nerve in this location is always **superficial to the femur and lateral to the popliteal artery.**
If the sciatic nerve is not easily visible, angle the transducer and aim the beam caudally towards the foot. This will bring the nerve into view once the angle of incidence is approximately 90 degrees to the nerve.

Scan the region proximally and distally to assess nerve anatomy. Mark the point at which the sciatic nerve branches into its tibial and peroneal components. Position the transducer in a location where the sciatic nerve is clearly visualized as a single nerve before its bifurcation.

Nerve visualization is significantly improved once local anesthetic is injected due to enhanced contrast between the hyperechoic nerve and the hypoechoic fluid collection.

**Out of Plane Needle Insertion Approach**

- With the patient lying prone, insert a 5-8 cm 22 G insulated needle perpendicular to the ultrasound transducer as seen in figure below.
- **Aim to block the sciatic nerve before it divides.** Scan proximally towards the apex of the popliteal triangle and follow the course of the nerve before needle insertion.
- As the block needle traverses perpendicular to the ultrasound beam, the monitor only shows tissue movement along the needle path and possibly the transverse view of the needle as a “white” dot.
• Advance the needle until there is needle to nerve contact as indicated by nerve movement.
• Aim to place the needle on either side of the nerve rather than contacting the nerve head on.
• Electrical stimulation of the sciatic nerve before local anesthetic injection is optional (operator preference).

**Local Anesthetic Injection**
• Once satisfied with nerve stimulation and motor response, injection of local anesthetic under ultrasound observation.
• Observe the spread of local anesthetic in real time to judge adequacy of spread. Aim to see circumferential spread of hypoechoic local anesthetic solution around the nerve (“donut sign”).
• Circumferential spread usually results in a complete block.
• If local anesthetic spread is deemed suboptimal, reposition the needle to place local anesthetic around the region that is spared.
• Scan along the nerve proximally and distally to check longitudinal local anesthetic spread.

**Clinical Pearls**
• **Transducer Angle Towards the Foot (Caudad)**
  If the sciatic nerve is not readily visible, angle the transducer and aim the beam caudally towards the foot. The sciatic nerve courses more superficially when it is in the distal popliteal region. Angling the transducer towards the foot will align the beam 90 degrees to the nerve thus bringing the nerve into view.
• **Visualization of the Popliteal Vein**
  Identification of the popliteal vein and its location is important to prevent accidental intravascular injection, achieved by reducing the transducer pressure.
• **See Saw Sign**
  If nerve visualization is difficult, ask the patient to plantar flex and dorsiflex the foot. One may see the “seesaw” sign as the tibial and peroneal components slide up and down during foot movement (Schafhalter-Zopfpoth I, Anesthesiology 2004; 101: 808-9).

A. The sciatic nerve is not well visualized when the transducer is pointing perpendicular to the skin due to a poor angle of incidence.
**B.** The sciatic nerve (arrowheads) is now clearly visualized when the transducer is pointing caudad. This brings the angle of incidence to approximately 90 degrees to the nerve.

**Arrowheads** = sciatic nerve

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**Alternate Body Positions during Needle Insertion**
The supine position is suitable for the in plane (IP) needle approach
The lateral decubitus position is good for both in plane and out of plane needle placement

**Local Anesthetic**
- A total volume of 0.5mL/kg is injected with a maximum volume of 20mL of 1% lidocaine, 1% mepivicaine, 0.25%-0.5% bupivicaine, 0.2%-0.5% ropivicaine.

<table>
<thead>
<tr>
<th>(NYSORA)</th>
<th>Onset (min)</th>
<th>Anesthesia (hrs)</th>
<th>Analgesia (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3% 2-Chloroprocaine (+ HCO3)</td>
<td>10-15</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3% 2-Chloroprocaine (+HCO3 + epinephrine)</td>
<td>10-15</td>
<td>1.5-2</td>
<td>2-3</td>
</tr>
<tr>
<td>1.5% Mepivacaine (+ HCO3)</td>
<td>15-20</td>
<td>2-3</td>
<td>3-5</td>
</tr>
<tr>
<td>1.5% Mepivacaine (+ HCO3 + epinephrine)</td>
<td>15-20</td>
<td>2-2</td>
<td>3-8</td>
</tr>
<tr>
<td>2% Lidocaine (+ HCO3 + epinephrine)</td>
<td>10-20</td>
<td>2-5</td>
<td>3-8</td>
</tr>
<tr>
<td>0.5% Ropivacaine</td>
<td>15-30</td>
<td>4-8</td>
<td>5-12</td>
</tr>
<tr>
<td>0.75% Ropivacaine</td>
<td>10-15</td>
<td>5-10</td>
<td>6-24</td>
</tr>
<tr>
<td>0.5 Bupivacaine (or l-bupivacaine)</td>
<td>15-30</td>
<td>5-15</td>
<td>6-30</td>
</tr>
</tbody>
</table>

**Troubleshooting (NYSORA)**

<table>
<thead>
<tr>
<th>Response Obtained</th>
<th>Interpretation</th>
<th>Problem</th>
<th>Action</th>
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<tbody>
<tr>
<td>Local twitch of the biceps muscle</td>
<td>Direct stimulation of the biceps femoris muscle</td>
<td>Too shallow a placement of the needle</td>
<td>Advance the needle deeper</td>
</tr>
<tr>
<td>Local twitch of the vastus lateralis muscle</td>
<td>Direct stimulation of the vastus lateralis muscles</td>
<td>Too anterior a placement of the needle</td>
<td>Withdraw the needle and reinsert posteriorly</td>
</tr>
<tr>
<td>Twitch of the calf muscles without the foot or toe movement</td>
<td>Stimulation of the muscular branches of the sciatic nerve</td>
<td>These small branches are often outside the sciatic sheath</td>
<td>Disregard and continue advancing the needle until foot/toes twitches are obtained</td>
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<td>Blood in the syringe mostly commonly indicates placement into the popliteal artery or vein</td>
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<td>Withdraw and redirect laterally</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Twitches of the foot or toes</td>
<td>Stimulation of the sciatic nerve</td>
<td>None</td>
<td>Accept and inject local anesthetic</td>
</tr>
</tbody>
</table>
Lateral Approach to Popliteal Block Ultrasound Guided Needle Placement (NYSORA and)

Surface Landmarks
The following surface anatomy landmarks are used to determine the insertion point for the needle:
1. Vastus lateralis muscle
2. Biceps femoris muscle
3. Patella
4. Popliteal fossa crease

Anatomic Landmarks
Landmarks for the lateral approach to popliteal block include:

1. Popliteal fossa crease
2. Vastus lateralis muscle
3. Biceps femoris muscle

The needle insertion site is marked in the groove between the vastus lateralis and biceps femoris muscle. Note that the lateral femoral epicondyle is another landmark that can be used in this technique. It is easily palpated on the lateral aspect of the knee. This landmark is positioned 1 cm cephalad to the popliteal fossa crease. (arapmi.org)

Equipment
1. Sterile towels and 4"x4" gauze packs
2. Syringes with local anesthetic
3. Sterile gloves, marking pen, and surface electrode
4. One 1", 25-gauge needle for skin infiltration
5. A short bevel, insulated stimulating needle with appropriate length
6. Peripheral nerve stimulator
7. Chloraprep swab

Needle Placement

The biceps femoris tendon is identified and the needle is placed between the vastus lateralis and the biceps femoris tendon at an angle of about 30 degrees about 5 to 6 cm above the popliteal crease. If the femur is encountered without a twitch response, the needle is pulled back to the skin and inserted at a caudal angle to pass behind the shaft of the femur. A response to nerve stimulation at 0.4mA, usually plantar or dorsiflexion and eversion or inversion confirms the position of the needle and its proximity to the sciatic nerve. Since at this spot the needle is expected to be above the point where the sciatic nerve bifurcates into the common peroneal and tibial nerve, response of either tibial or common peroneal nerve is adequate. After aspiration to rule out intravascular placement, local anesthetic solution is injected once visible is obtained or palpable twitches of the foot or toes at a current of 0.2-0.5 mA.

Local Anesthetic

A total volume of 0.5mL/kg is injected with a maximum volume of 20mL of 1% lidocaine, 1% mepivacaine, 0.25%-0.5% bupivacaine, 0.2%-0.5% ropivacaine

Figure 8. Popliteal sciatic block - landmarks for the lateral approach (NYSORA).

Figure 9. Popliteal sciatic block; lateral approach: Needle insertion (NYSORA).
The type and concentration of local anesthetics as well as the choice of additives to local anesthetic influence the onset and particularly duration of the blockade.

(NYSORA) | Onset (min) | Anesthesia (hrs) | Analgesia (hrs)
---|---|---|---
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0.75% Ropivacaine | 10-15 | 5-10 | 6-24
0.5 Bupivacaine (or l-bupivacaine) | 15-30 | 5-15 | 6-30

**Ultrasound Guided Needle Placement (NYSORA, USRA)**

Place patient in supine position with foot and ankle resting on a stack of blankets; this will allow enough room to place the probe directly beneath the leg. Place the probe approximated 8 cm proximal and parallel to the popliteal crease, scan in a cephalad and caudad direction until the sciatic nerve is identified. Often, the popliteal artery is identified and can be used as a landmark for sciatic location—it is lateral to the artery. The sciatic nerve is a round hyperechoic structure. If two smaller, round hyperechoic structures are viewed, the probe is distal to the split of the tibial and peroneal nerve compartments and must be moved to a more proximal location on the leg. Insert 21 gauge needle at the lateral aspect of the ultrasound probe, allowing visibility of the entire needle. (arapmi.org)
Begin with probe placement just above the popliteal crease. Often, the tibial and peroneal components can be viewed as two hyperechoic round structures. Continue sliding the probe in the cephalad direction and the two smaller structures will merge into the single structure of the sciatic nerve. This technique ensures that the probe placement is proximal to the split of the nerve.

As explained by NYSORA, a high-frequency probe should be used for popliteal access to the sciatic nerve in order to accurately identify the point at which the nerve furcates into its two branches, Figure 33 illustrates the sciatic nerve proximal to this furcation site. More distally, the peroneal nerve divides at a very superficial level, while the tibial nerve courses distally and deeper. The lateral approach to popliteal block is particularly suitable (Figure 34) because the child may remain in a supine position during the blockade, similarly to the technique in adult patients. The exact puncture site is selected based on the depth of the nerve visualized in the ultrasound image. The needle tip is first positioned above and then below the sciatic nerve, which will ensure an optimal distribution pattern of the local anesthetic. Naturally, the advantage of not transversing the muscle is lost with this technique. Therefore, a distinction must be made between the lateral (in-line) and dorsal (cross-sectional) techniques (NYSORA).
Complications

- Hematoma
- Infection
- Intravascular injection
- Local anesthetic toxicity
- Nerve injury

Clinical Pearls

- The **tibial nerve results in plantar flexion and inversion**. Common peroneal nerve elicits eversion and dorsiflexion of foot.
- The **posterior fossa has a large fat deposition** and often the onset of the block is variable requires a high volume of local anesthetics and the duration of block is variable
- Provides anesthesia to the entire **distal 2/3 rd of the lower extremity**, with the exception to the lower medial aspect supplied by the saphenous nerve
- Place fingers on the biceps femoris muscle or semitendinosus muscle for assessment of needle placement
  - Local stimulation of the biceps femoris muscle under the fingers the needle should be redirected medially
  - Semitendinosus muscle indicates a too medial withdraw needle to surface and reinsert laterally
  - Do not accept stimulation of calf muscle indicate stimulation outside of sheath

Troubleshooting (NYSORA)

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**Femoral**

**Indications**
- Anterior thigh
- Knee surgery
- Quadricep repair
- Post-op pain management after femur or knee surgery

**Contraindications**
- Rare

**Anatomy**
Largest nerve branch of lumbar plexus (arises from the 2nd, 3rd, and 4th lumbar nerves) courses through the psoas muscle at the lower lateral border and descends caudally in the groove between the psoas and the iliacus muscles passing under the inguinal ligament before entering the femoral triangle of the upper thigh. Femoral nerve breaks into branches supplying the muscles and skin of the anterior thigh, knee and hip joints.

The femoral nerve divides into anterior and posterior branches located lateral and posterior to the femoral artery.

**Anterior Branch:** Motor to the sartorius and pectineous muscle and sensory to the skin of the anterior and medial aspect of the thigh

**Posterior Branch:** Motor to quadriceps (retus femoris, vastus intermedus, vastus lateralis and vastus medialis) sensory to medial aspect of lower leg via the saphenous

At femoral crease nerve is covered by fascia iliaca and separated from the femoral artery and vein by a portion of the psoas muscle and ligamentum ileopectineum. It is the physical separation of this nerve from the vascular fascia that causes the lack of spread of a blind paravascular injection of local towards the femoral nerve.
Landmark
A line is marked from the anteriosuperior iliac spine and the pubic tubercle. This line is the inguinal ligament. The femoral artery is palpated on this line. The femoral nerve passes through the center of the ligament immediately lateral to the artery.

Equipment
1. Sterile towels and 4"x4" gauze packs
2. Syringes with local anesthetic
3. Sterile gloves, marking pen, and surface electrode
4. One 1", 25-gauge needle for skin infiltration
5. A short bevel, insulated stimulating needle with appropriate length
6. Peripheral nerve stimulator
7. Chloraprep swab

Techniques
1. Landmark needle placement with nerve stimulation
2. Needle placement Ultrasound guided

Needle Placement
The patient is placed in supine position. Palpate the femoral artery and insert needle right next to the artery in a perpendicular fashion, displace the needle laterally about 1-1.5 cm from the artery in the inguinal crease. The nerve stimulator is initially set at 1-1.5 mA, the needle is directed cephalad at 30-40 degree angle. A brisk “patellar snap” with the current at 0.5mA or less is indicative of successful localization of the needle near the femoral nerve. The nerve is usually superficial and is rarely beyond 3 cm from the skin.

Local Anesthetic

- A femoral block can be accomplished with as little as 10 mL of local anesthetic. However, larger volumes of local anesthetic (e.g., 20-25 mL) is often used, because the local anesthetic often disperses underneath fascia iliaca laterally and results also in block of the lateral femoral cutaneous nerve of thigh. The block of lateral cutaneous nerve of the thigh, in return, confers anesthesia to the lateral aspect of the thigh, which nicely complements the femoral nerve block.
- A total volume of 0.5mL/kg is injected with a maximum volume of 20 ml of 1% lidocaine, 1% mepivacaine, 0.25%-0.5% bupivacaine, 0.2%-0.5% ropivacaine.

<table>
<thead>
<tr>
<th>(NYSORA)</th>
<th>Onset (min)</th>
<th>Anesthesia (hrs)</th>
<th>Analgesia (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3% 2-chloroprocaine (+ HCO3)</td>
<td>10-15</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
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<td>15-20</td>
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<td>2% lidocaine (+ HCO3 + epi)</td>
<td>10-20</td>
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<td>3-8</td>
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<tr>
<td>0.5% ropivacaine</td>
<td>15-30</td>
<td>4-8</td>
<td>5-12</td>
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<tr>
<td>0.75% ropivacaine</td>
<td>10-15</td>
<td>5-10</td>
<td>6-24</td>
</tr>
<tr>
<td>0.5 Bupivacaine (or l-bupivacaine)</td>
<td>15-30</td>
<td>5-15</td>
<td>6-30</td>
</tr>
</tbody>
</table>


Complications
- Intravascular injection
- Hematoma
- Infection

Clinical Pearls

Table (Obtained From NYSORA) Troubleshooting

<table>
<thead>
<tr>
<th>Response Obtained</th>
<th>Interpretation</th>
<th>Problem</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No response</td>
<td>The needle is inserted either too medially or too laterally</td>
<td>Femoral artery not properly localized or the palpating hand moved during the procedure</td>
<td>Follow the systematic lateral angulation and reinsertion of the needle as described in the technique</td>
</tr>
<tr>
<td>Bone contact</td>
<td>The needle contacts hip or superior ramus of the pubic bone</td>
<td>The needle is inserted too deep</td>
<td>Withdraw to the level of the skin and reinsert in another direction</td>
</tr>
<tr>
<td>Local twitch</td>
<td>Direct stimulation of the iliopsoas or pectineus muscle</td>
<td>Too deep insertion</td>
<td>Withdraw to the level of the skin and reinsert in another direction</td>
</tr>
<tr>
<td>Twitch of the sartorius muscle</td>
<td>Sartorius muscle twitch</td>
<td>The needle tip is slightly anterior and medial to the main trunk of the femoral nerve</td>
<td>Redirect the needle laterally and advance deeper 1-3 mm</td>
</tr>
<tr>
<td>Vascular puncture</td>
<td>Blood in the syringe invariably indicates placement into the femoral artery</td>
<td>Too medial needle placement</td>
<td>Withdraw and reinsert laterally 1 cm</td>
</tr>
<tr>
<td>Patella twitch</td>
<td>Stimulation of the main trunk of the femoral nerve</td>
<td>None</td>
<td>Accept and inject local anesthetic</td>
</tr>
</tbody>
</table>

Ultrasound Guided

In Plane Needle Insertion Approach (usra.ca)
- The in plane approach is also commonly used for femoral nerve block by aligning the block needle with the ultrasound beam.
- With this approach, the needle shaft and tip can be visualized distinctly but it may take a longer time to align the needle with the beam compared to the out of plane approach.
Insertion of a block needle over the left inguinal region using the in plane approach

In plane needle approach showing needle in contact with the femoral nerve

**Arrows** = block needle

**FA** = femoral artery

**FV** = femoral vein

In plane needle approach showing needle in contact with the femoral nerve

**Arrowhead** = femoral nerve

**FA** = femoral artery

**FV** = femoral vein

**LA** = local anesthetic

Out of Plane Needle Injection and Injection Technique (pictures from the pitt.edu)
Modified Femoral Block the “3 and 1” Block
The 3 in 1 block aims to block three nerves with one injection: The femoral nerve, Lateral cutaneous nerve and the obturator nerve.

Procedure
Same as the femoral block with one notable difference, the thumb is placed firmly below the injection site to prevent distal spread of the local. An assistant is required to perform the injection. After an aspiration test to rule out intravascular annulations, local anesthetic is injected.
Ankle
Blocking of the five nerves that supply sensation to the foot.

Indication
• Foot surgery

Contraindications
• Rare

Anatomy
The peripheral nerves innervating the foot are derived from the sciatic nerve with the exception of the cutaneous branch of the femoral nerve (saphenous nerve). The terminal branches of the sciatic nerve comprises of two deep nerves (posterior tibial and deep peroneal) and two superficial nerves (superficial peroneal and sural). This concept is crucial during needle placement because the two deep nerves are anesthetized by inject beneath the superficial fascia while the three superficial nerves are anesthesized by simple subcutaneous infiltration.

Five nerves supply sensations to the foot:

1. **Superficial Peroneal Nerve** – Cutaneous sensation to the anteromedial foot.
2. **Deep Peroneal Nerve** – Supplies medial half of the dorsal foot.
3. **Saphenous Nerve** – Superficial sensation to the anteromedial foot.
4. **Tibial Nerve** – Sensation to the heel, medial, and part of the lateral sole.
5. **Sural Nerve** – Sensation to the lateral foot.
**Landmark**
The five nerves are blocked by injections that form a ring of infiltration around the ankle at the level of the malleoli. Landmarks are the dorsalis pedis, posterior tibial artery, and medial malleolus. (Diagrams and description below from www.pit.edu)

**Equipment**
1. 22-25 gauge 1.5 inch length
2. Syringe filled with dose calculated local anesthetic with **NO EPINEPHRINE**
3. Chloroprep swap
4. Sterile Gloves

**Techniques**
1. Anatomic needle placement
2. Ultrasound guided needle placement

**Needle Placement**
The patient in supine position, foot area washed with chrolaprep swab.

1. Identify the anatomical landmarks (medial and lateral malleoli, dorsalis pedal artery). Inject local anesthetic (LA) 1 cm anterior to the medial malleolous to achieve **saphenous nerve** blockade.

2. Insert needle posterior to the medial malleolous and posterior tibial artery. Make contact with the bone and withdraw the needle 1 mm. Inject LA to achieve **tibial nerve** blockade.

3. Insert the needle between the dorsalis pedis pulse and the extensor hallucis longus tendon. Advance 1 cm and inject LA. This will block the **deep peroneal** nerve.

4. Withdraw the needle to just below the surface of the skin, re-direct toward the lateral malleolous, and deposit of LA into the subcutaneous tissue. This will achieve blockade to the **superficial peroneal** nerve.

5. Blockade of the **sural nerve** can be achieved as demonstrated at left. Insert the needle along the line between the lateral malleolous and Achilles tendon. Inject the LA with a deep subcutaneous fan.
Assessment of Block Efficacy: The patient should experience profound loss of sensation with preserved motor function. Apply deep pain to the digits to assess sensory blockade.

Scanning Technique (NYSORA)
- Position the patient supine and bolster the foot with a pillow to expose the anterior and medial portion of the lower leg and foot.
- After skin and transducer preparation, place a 10-15 MHz transducer immediately above the medial malleolus to locate the tibial nerve in the transverse (short axis) view.
- It is also easy to visualize this nerve longitudinally (long axis).
- Optimize machine imaging capability. Select the appropriate depth of field (usually within 1-2 cm), focus range (usually within 1-2 cm) and gain.

A 12 MHz hockey stick transducer over the left medial malleolus

Transverse View of the Tibial Nerve at the Ankle

Arrowhead = tibial nerve
FDL = flexor digitorum longus tendon
FHL = flexor hallucis longus muscle
MM = medial malleolus
PTA = posterior tibial artery
TP = tibialis posterior tendon

Nerve Localization (ursa)

Tibial Nerve
- Perform a systematic anatomical survey in the medial aspect of the ankle.
- The bony medial malleolus is easily identified (bony shadow).
- Move the transducer slightly posteriorly to identify the tibialis posterior and flexor digitorum longus tendons. Both tendons are found within the flexor retinaculum of the ankle. They display a sliding movement with ankle flexion and are often hyperechoic.
- Then identify the pulsatile posterior tibial artery (Doppler use is optional).
- The tibial nerve at the ankle is often round to oval with a honeycomb appearance. It is expected to lie posterior to the posterior tibial artery.
- Trace the tibial nerve proximally. The nerve is larger and is easier to identify more cephalad in the leg. It is also easy to image the nerve longitudinally by rotating the transducer 90 degrees.
Needle Insertion Approach

- Ultrasound guided ankle block is considered a BASIC skill level block because this is a superficial block.
- Both In Plane (IP) and Out of Plane (OOP) approaches can be used. The IP approach is commonly used for single shot injection.

In Plane Needle Insertion Approach

- With the patient lying supine and the leg bolstered by a pillow, insert a 4-5 cm 22-25 G needle inline with the ultrasound transducer as seen in picture below.

  Aim to place the needle tip on each side of the tibial nerve without puncturing the posterior tibial artery.

- Nerve stimulation is usually not necessary.
Local Anesthetic Injection

- Once satisfied with the needle position, inject 5-8 mL of local anesthetic.
- Observe local anesthetic injection in real time to judge adequacy of spread. Aim to see circumferential spread of hypoechoic local anesthetic solution around the nerve “donut sign”.
- Circumferential spread usually results in a complete block.
- If local anesthetic spread is deemed suboptimal, move the needle to either side of the nerve before completing the second half of the injection.
- Scan the nerve in the transverse and longitudinal planes proximally and distally to check the extent of local anesthetic spread.

The deep peroneal nerve is a superficial branch that is located adjacent to the dorsalis pedis artery at the ankle region.

After skin and transducer preparation, place a 10-15 MHz transducer on the dorsum of the foot along the intermalleolar line to locate the dorsalis pedis artery in the transverse (short axis) view.
Aim to find the predominantly hypoechoic deep peroneal nerve lateral to the dorsalis pedis artery and the extensor hallucis longus tendon. This nerve is small thus visualization can be difficult.

- A 25 G 2.5 mm needle can be inserted using the out of plane approach.
- If the deep peroneal nerve is clearly visualized, inject 2-3 mL of local anesthetic on each side of the nerve.
- If the nerve is not clearly visualized, inject 2-3 mL of local anesthetic on each side of the artery in the subcutaneous plane.
- Observe local anesthetic spread around the nerve circumferentially in the subcutaneous plane above bone and at approximately the same level as the artery.

**Local Anesthetics**
This is a volume based block, weight based maximum dose of the chosen local anesthetics should be predetermined prior to initiating this block. NEVER use EPINEPHRINE.

(NYSORA)

<table>
<thead>
<tr>
<th>Onset (min)</th>
<th>Anesthesia (hrs)</th>
<th>Analgesia (hrs)</th>
</tr>
</thead>
</table>

66
<table>
<thead>
<tr>
<th>Anesthetic Solution</th>
<th>Concentration</th>
<th>Onset (min)</th>
<th>Peak (h)</th>
<th>Duration (h)</th>
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<tr>
<td>3% 2-Chloroprocaine (+ HCO3)</td>
<td>10-15</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3% 2-Chloroprocaine (+ HCO3 + epinephrine)</td>
<td>10-15</td>
<td>1.5-2</td>
<td>2-3</td>
<td></td>
</tr>
<tr>
<td>1.5% Mepivacaine (+ HCO3)</td>
<td>15-20</td>
<td>2-3</td>
<td>3-5</td>
<td></td>
</tr>
<tr>
<td>1.5% Mepivacain (+ HCO3 + epinephrine)</td>
<td>15-20</td>
<td>2-2</td>
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<td></td>
</tr>
<tr>
<td>2% Lidocaine (+ HCO3 + epinephrine)</td>
<td>10-20</td>
<td>2-5</td>
<td>3-8</td>
<td></td>
</tr>
<tr>
<td>0.5% Ropivacaine</td>
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<td>5-12</td>
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**Complications**

- Intravascular injection
- Large volume injections may result in damage to small nerves secondary to hydrostatic changes
- Rare but self limiting neuropath may also develop. But usually resolves in three to four weeks
- Compartment syndrome

**Clinical Pearls**

1. Primarily a “volume” block
2. The sural nerve is more superficial position relative to the malleolus than the tibial nerve.
3. Beware of possible compartment syndrome
Sciatic Block

**Indication**
Only an Analgesic block and is often combined with femoral, lateral femoral cutaneous, and or obturator blocks to provide surgical anesthesia of the lower leg. Provide effective analgesia of the lower leg and may provide pain relief from ankle fractures or tibial fractures prior to operative intervention.

**Anatomy**
The sciatic nerve is derived from the ventral rami of L4-S3 and is the largest nerve in the body. It emerges through the greater sciatic foramen to run between the greater trochanter of the femur and the ischial tuberosity prior to taking its position in the thigh posterior to the quadriceps femoris. If the sciatic nerve is blocked in its proximal position, this will also anesthetize the posterior femoral cutaneous nerve (a branch of ventral rami of S1-S3). This nerve innervates the posterior thigh above the knee and the hamstring muscles. The sciatic nerve primarily consists of two nerves, the tibial and common peroneal nerves, which travel in a common sheath in the posterior upper portion of the leg. These nerves divide near the popliteal fossa and innervate the leg below the knee.

**Landmark**
1. Posterior superior iliac spine
2. Ischial tuberosity
3. Greater trochanter
4. Piriformis muscle

**Techniques**
1. Needle placement with nerve stimulator
2. Ultrasound guided needle placement

**Equipment**
1. Sterile towels and 4"x4" gauze packs
2. Syringes with local anesthetic with calculated dose based on weight
3. Sterile gloves, and surface electrode
4. A short bevel, insulated stimulating needle with appropriate length
5. Peripheral nerve stimulator
6. Chloraprep swab

**Needle Placement**
The patient is in the lateral decubitus position with a slight forward tilt. The foot on the side to be blocked should be positioned over the dependent leg so that twitches of the foot or toes can be
observed. Palpate for the greater trochanter and the superior iliac spine, with a marking pen draw a line connecting the two points.

**Surface Anatomy**

1. Greater trochanter
2. Posterior-superior iliac spine
3. Needle insertion point 4-cm distal to the midpoint between landmarks 1 and 2

- The needle is introduced at a perpendicular angle to the spherical skin plane. The nerve stimulator should be initially set to deliver 1.5 mA current (2 Hz, 100μsec) to allow detection of twitches of the gluteal muscles and stimulation of the sciatic nerve.
- As the needle is advanced, twitches of the gluteal muscles are observed first. These twitches merely indicate that the needle position is still too shallow. Once the gluteal twitches disappear, brisk response of the sciatic nerve to stimulation is observed (hamstrings, calf, foot, or toe twitches). After the initial stimulation of the sciatic nerve is obtained, the stimulating current is gradually decreased until twitches are still seen or felt at 0.2 - 0.5 mA. This typically occurs at a depth of 5-8 cm.
- After negative aspiration for blood, local anesthetic is slowly injected. Any resistance to the injection of local anesthetic should prompt needle withdrawal by 1mm. The injection is then reattempted. Persistent resistance to injections should prompt complete needle withdrawal and flushing to assure its patency before the needle is reintroduced.

**Local Anesthetic Choice**

- A total volume of 0.5mL/kg is injected with a maximum volume of 20 ml of 1% lidocaine, 1% mepivicaine, 0.25%-0.5% bupivacaine, 0.2%-0.5% ropivacaine.

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<td>2-5</td>
<td>3-8</td>
</tr>
<tr>
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<td>10-20</td>
<td>2-5</td>
<td>3-8</td>
</tr>
<tr>
<td>0.5% ropivacaine</td>
<td>15-30</td>
<td>4-8</td>
<td>5-12</td>
</tr>
<tr>
<td>0.75% ropivacaine</td>
<td>10-15</td>
<td>5-10</td>
<td>6-24</td>
</tr>
<tr>
<td>0.5 Bupivacaine (or l-bupivacaine)</td>
<td>15-30</td>
<td>5-15</td>
<td>6-30</td>
</tr>
</tbody>
</table>

**TIP:** Avoid the use of epinephrine during sciatic nerve blockade because of the peculiar blood supply to the sciatic nerve, the possibility of additional ischemia due to stretching or sitting on the anesthetized nerve, and the long duration.
Sciatic Block for the Pediatric (PedAnesthesia.org/meetings, Allison Ross, 2006)

The child is placed in the lateral position with the side to be blocked uppermost and the upper leg flexed at both the hip and knee. Insert the needle at the midpoint of the line that extends from the tip of the coccyx to the greater trochanter of the femur, perpendicular to the skin with slight angulation towards the lateral ischial tuberosity.

The Raj block was developed in 1975 and is similar to the posterior approach (Raj and others, 1975). This block is performed in the supine child with the leg to be blocked lifted and flexed at the hip and knee. Insert the needle at the midpoint between ischial tuberosity and greater trochanter in the sciatic groove. By flexing the hip, the Raj technique brings the sciatic nerve closer to the skin. This improves the likelihood of a successful block, especially in obese children and adolescents.

Ultrasound Approach – Midgluteal Approach (NYSORA)

The sciatic nerve is located close to the surface in the immediate subgluteal area, requiring the use of a high-frequency linear ultrasound probe. This figure illustrates the position of the sciatic nerve between the glutaeus maximus and quadratus femoralis muscles (lateral) on the one hand and the biceps femoris muscles (medial) on the other. The posterior cutaneous femoral nerve usually can be visualized medial and slightly more superficial to the sciatic nerve. In association with a thigh tourniquet, this
nerve should also be blocked. Therefore, indications for this approach include not only situations in which good ultrasound visibility is required but also the use of a tourniquet.

**Figure 30** illustrates the needle position relative to the ultrasound transducer, the child being in a supine position with the hip and knee flexed. After the needle has been placed medial to the sciatic nerve, the local anesthetic usually spreads to the posterior cutaneous femoral nerve. If the initial injection fails to reach the nerve, the needle is repositioned more medial to the posterior cutaneous femoral nerve to optimize the distribution of local anesthetic. As a rule, however, a single shot will suffice.

**Midfemoral Approach**

The midfemoral approach to the sciatic nerve is usually selected only if a subgluteal or popliteal approach is not possible, usually because some segments of the sciatic nerve are not accessible to ultrasonography. A clear-cut distinction between the midfemoral and popliteal approach cannot always be made.

The same needle position is selected as with the subgluteal approach (**Figure 31**). The in-line technique is a viable option for this type of puncture. With increasing displacement of the transducer in a distal (popliteal) direction, practical considerations will dictate that the needle insertion be parallel to the long axis of the transducer.

**Figure 31**

It is essential to track the route of the sciatic nerve in a distal direction, thereby visualizing its separation into the tibial and peroneal nerves. The level at which this separation takes place varies widely. Therefore, if complete blockade of the sciatic nerve is required, the needle insertion site should be proximal to this point of separation. Again, this requirement can only be accurately met through direct sonographic visualization.

**Figure 32** illustrates anatomic conditions in the midfemoral access area proximal to the bifurcation site of the sciatic nerve as visualized by ultrasound. The puncture itself is carried out in the same way as the subgluteal puncture. It should be placed between the biceps femoris and semimembranosus muscles. Puncturing the muscles should be avoided to reduce the risk of hematoma during blockade. Depending on how deep the nerve is located, the use of a longer needle (70 mm) may be indicated. In the overwhelming majority of cases, the needle has to be repositioned several times to optimize the distribution of the local anesthetic.
Complications
- Intravascular injection
- Incomplete block due to anatomic variations of where nerves branch
- Nerve damage

Clinical Pearls

Interpreting Responses to Nerve Stimulation (NYSORA)

<table>
<thead>
<tr>
<th>Response Obtained</th>
<th>Interpretation</th>
<th>Problem</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local twitch of the gluteus muscle</td>
<td>Direct stimulation of the gluteus muscle</td>
<td>Too shallow (superficial) placement of the needle</td>
<td>Continue advancing the needle</td>
</tr>
<tr>
<td>Needle contacts bone but local twitch of the gluteus muscle is not elicited</td>
<td>The needle is inserted close to the attachment of the gluteus muscle to the iliac bone</td>
<td>Too superior needle insertion</td>
<td>Stop the procedure, check the patient’s position, and reassess the landmarks</td>
</tr>
<tr>
<td>Needle encounters bone; sciatic twitches were elicited</td>
<td>The needle missed the plane of the sciatic nerve and is stopped by the hip joint or ischial bone</td>
<td>The needle is inserted to laterally (hip joint) or medially (ischial bone)</td>
<td>Withdraw the needle and redirect slightly medially or laterally (5-10°)</td>
</tr>
<tr>
<td>Hamstrings twitch</td>
<td>Stimulation of the main trunk of the sciatic nerve</td>
<td>None. These branches are within the sciatic nerve sheath at this level</td>
<td>Accept and inject local anesthetic</td>
</tr>
<tr>
<td>The needle is placed deep (10cm) but twitches were not elicited and bone is not contacted</td>
<td>The needle has passed through the sciatic notch</td>
<td>Too inferior needle placement</td>
<td>Withdraw and redirect the needle slightly medially, laterally, or superiorly</td>
</tr>
</tbody>
</table>

72
Fascia Iliaca

Indication
- Above the knee lower extremity surgeries

Contraindications
- Rare

Anatomy
The femoral, lateral femoral cutaneous and obturator nerves emerge from the psoas muscle and run along the inner surface of the fascia iliaca. A fascia iliaca compartment block delivers local anesthetic between the fascia iliaca and iliacus muscle where it spreads to bathe the three lumbar plexus nerves.

Equipment
1. Short bevel insulated nerve stimulator needle
2. Sterile towels
3. 4"x4" gauze packs
4. Syringe with local anesthetic
5. Sterile gloves
6. Chloraprep swab

Landmarks

Anatomic Landmarks
1. Inguinal ligament
2. Pubic Tubercle
3. Anterior superior iliac spine
4. Fascia lata
5. Fascia Iliacus

Techniques
1. Landmark needle placement
2. Ultrasound guided needle placement

Needle Insertion
With the child in the supine position, the inguinal ligament is located by drawing a line from pubic tubercle to anterior superior iliac spine. Divide the inguinal ligament into thirds. At the junction of the lateral 1/3 and medial 2/3 of the inguinal ligament, drop a line inferiorly 0.5 to 2 cm and perpendicular to the ligament. This is the point of needle insertion. A blunt needle is used and is inserted perpendicular to the skin. Two pops are felt as the needle first pierces the fascia
lata, then the fascia iliaca. If light pressure is held upon the plunger of the syringe, a loss of resistance is felt as the fascia iliaca is pierced.

Digital pressure is exerted distally to the site during the injection and for a short time afterwards, and the swelling produced in the groin by the volume of local anesthetic is massaged to promote proximal flow of the drug. A **volume of 0.3-0.5 ml/kg is sufficient** in most cases.

**Local Anesthetic Choice**

<table>
<thead>
<tr>
<th>Anesthetic Choice</th>
<th>Onset (min)</th>
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**Complications**: Due to the larger volume that is required to provide an adequate block, care has to be taken to not exceed the maximum dosage of the local anesthetic. Intravascular injection may be avoided with incremental injection with frequent withdrawal.
Saphenous
The saphenous nerve is a purely sensory nerve, arising as a branch of the femoral nerve in the groin.

Indication
• Tourniquet pain

Contraindications
• Rare

Anatomy
The saphenous nerve is the largest cutaneous branch of the femoral nerve. In the proximal thigh, the saphenous nerve often lies anterior to the femoral artery as this vessel passes beneath the sartorius muscle, and posterior to the aponeurotic covering of the adductor canal. The saphenous nerve descends along the medial side of the knee posterior to the sartorius muscle. In the distal thigh, the saphenous nerve pierces the fascia lata between the tendons of the sartorius and gracilis muscles (see picture), and then becomes a subcutaneous nerve. The saphenous nerve may also surface between the sartorius and vastus medialis muscles. Below the knee, the nerve passes along the tibial side of the leg, adjacent to the great saphenous vein subcutaneously. At the ankle, one branch of the nerve is located on the medial side next to the subcutaneous saphenous vein. (Illustration of knee from arapmi.org)

Landmark
The saphenous nerve can be located more distally and subcutaneously in the following locations:
1. between the sartorius and gracilis muscles in the thigh immediately above the knee
2. in the medial side of the leg just below the knee at the level of the tibial tubercle where the saphenous nerve lies next to the saphenous vein subcutaneously
3. in the middle half of the leg where the nerve is adjacent to the subcutaneous saphenous vein
4. at the level of the ankle where the nerve is next to the subcutaneous saphenous vein

• It can be challenging to identify the saphenous nerve below the knee since it is small and located in subcutaneous tissue. In this case, it may be useful to place a tourniquet around
the leg so that the subcutaneous saphenous vein becomes distended and easily visible. The saphenous nerve often lies immediately adjacent to the vein.

**Equipment**
1. Sterile towels and 4"x4" gauze packs
2. Syringes with local anesthetic with calculated dose based on weight
3. Sterile gloves, and surface electrode
4. A short bevel, insulated stimulating needle with appropriate length
5. Peripheral nerve stimulator
6. Chloraprep swab

**Techniques**
1. Landmark needle placement
2. Ultrasound-guided saphenous block

**Needle Placement**
1. **Transsatorial Approach** where the nerve is located behind the sactorius muscle
2. **Paravenous Approach** where the nerve is next to the saphenous vein
3. **Simple Field Block** subcutaneous infiltration on the medial aspect of the tibia

**Transsatorial approach:**
With the patient in the supine position and the leg extended and actively elevated 2 inches above the bed, the Sartorius muscle is easily identified on the medial aspect of the leg, just above the knee. Insert the needle 1 to 2 cm above the patella, slightly posterior and caudad to the coronal plane, and pass it through the body of the sartorius muscle. Once a loss of resistance is appreciated (subsartorial adipose), perform gentle aspiration, and deposit local anesthetic. The distance from skin to loss of resistance is typically 1.5 to 3.0 cm.

**Paravenous Approach.** At the level of the tibial tuberosity, the saphenous nerve lies medial and posterior to the vein. Place a tourniquet around the leg based on this anatomic relationship, and then place the leg over the side of the bed for 1 minute to allow time for the saphenous vein to become identifiable. Once the vein is either viewed or palpated along the medial aspect of the leg, deposit local anesthetic in the subcutaneous tissue on either side of the vein, just below the patella.

**Below-Knee Field Block Approach.** This approach is similar to the paravenous approach but encompasses a wider area. With the patient in the supine position, identify and palpate the tibial tuberosity (a bony prominence several centimeters distal to the patella). Inject local anesthetic into the subcutaneous tissue, beginning at the medial aspect of the tibial tuberosity and ending at the medial aspect of the calf (gastrocnemius muscle).
• **Ankle block** for surgery on the foot, the saphenous nerve is best blocked just above the medial malleolus, like in the ankle block technique. Using a 1" 25 gauge needle, local anesthetic is injected subcutaneously immediately above the medial malleolus in a ring-like fashion. The most commonly reported complication of this block is a painless hematoma of the saphenous vein at the injection site.

**TIP:** The most effective method of blocking the saphenous nerve is a low-volume femoral nerve block. Injection of mere 10 ml of local anesthetic upon obtaining twitches of the patella or vastus medialis muscle results in nearly 100% success rate.

**Ultrasound guided Nerve Localization**

**1. Out of Plane (OOP) Needle Insertion**

The saphenous nerve is best located with a high-resolution ultrasound probe at the **distal-medial thigh level** in the transition zone between the sartorius/gracilis muscles and their attachment of their respective tendons. The puncture should be conducted transversally from the proximal aspect toward the transducer or using the in-line technique. Only small amounts of local anesthetic are required for blockade. In addition, smaller volumes are advisable because larger volume of local anesthetic may cause excessive pressure in this tissue compartment and, consequently, increase the risk of nerve injury.

The OOP approach is also commonly used for saphenous nerve block. The needle tip is more difficult to visualize but the needle to nerve distance is shortest using this approach.

Saphenous Nerve in the Distal Thigh
2. Saphenous Nerve in the Ankle Region

**Pre-injection**

The saphenous nerve (arrowheads) is next to the saphenous vein (V). Both structures are superficial in the subcutaneous plane.
Post-injection
A wall of local anesthetic (LA) is visualized in the subcutaneous tissue superficial to the saphenous nerve and vein (V).

Arrowheads = saphenous nerve

Local Anesthetic Choice
(NYSORA)

<table>
<thead>
<tr>
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Complications
- Intravascular injection
- Compartment syndrome