Regional Anesthesia

Beth Israel Deaconess Medical Center
Harvard Medical School
Contributors

Anasuya Vasudevan, MD  
Instructor in Anesthesia

Robina Matyal, MD  
Assistant Professor of Anesthesia

Marc Shnider, MD  
Director of Regional Anesthesia

Balachandar Subramaniam, MD, MPH  
Associate Professor in Anesthesia

Philip Hess, MD  
Associate Professor in Anesthesia

Vimal Akhouri, MD  
Instructor in Anesthesia

Lisa Kunze, MD  
Assistant Professor in Anesthesia

Allen Pendarvis, MD  
Resident in Anesthesia

Viviane Nasr, MD  
Resident in Anesthesia

Galina Korsunsky, MD  
Resident in Anesthesia

Mario Montealegre, MD  
Research Fellow in Anesthesia

Lu Yang Jiang, MD  
Research Fellow in Anesthesia

Ravi Bhalodia, MD  
Resident in Anesthesia

Joseph Merlone, MD  
Resident in Anesthesia

Robert Cohen, MD  
Attending in Anesthesia

Kathleen Richard, MD  
Resident in Anesthesia

Sheila M. Rajashekar, MD  
Resident in Anesthesia

Alexandra Lewis, MD, MSc  
Resident in Anesthesia

Angela Wang, BA  
Research Assistant in Anesthesia
Regional Anesthesia Complications

Galina Korsunsky, MD
Mark Mecoli, MD
Outline

• Intravascular injection
  – Prevention
  – Recognition
  – Treatment
• Peripheral nerve injury
  – Prevention
  – Recognition and treatment
• Bleeding
• Infection
Intravascular injection and LA systemic toxicity - Prevention

- Use the lowest dose of a LA to achieve a desired effect
- Visualize injectate on ultrasound- stop immediately if injectate is not visualized
- Consider using epinephrine 5mcg/ml of a LA as a pharmacologic marker/and or test dose of an intravascular injection
- Aspirate the syringe prior to each injection, while observing for blood
- Inject slowly and incrementally, looking for signs and symptoms of a LA toxicity between each injection
- Be aware of factors increasing the likelihood of toxicity: eg., site of injection, advanced age, heart failure, liver failure, low concentration of plasma proteins, ischemic heart disease, conduction abnormalities, acid-base disturbances
Intravascular injection and LA systemic toxicity – Recognition

• Be vigilant
• Use standard ASA monitors
• Monitor patients during and after performing a PNB as symptoms may develop up to 30 minutes after the injection
• Consider toxicity in any patient with altered mental status, neurological symptoms and cardiovascular instability after a regional block
• Common symptoms are agitation, confusion, tinnitus, metallic taste, circumoral numbness
• Cardiovascular signs represent severe toxicity: hyperdynamic state, progressive hypotension, dysrhythmias, Torsades de Pointes, ventricular fibrillation
Intravascular injection and LA systemic toxicity - Treatment

• Initial: GET HELP
• Ventilate patient with Fio2 100%
• Use benzodiazepines for **seizure control. AVOID** Propofol if patient is hemodynamically unstable
• Initiate **Lipid emulsion (20%) therapy**: bolus of 1.5 ml/kg lean body mass over 1 minute
• Continuous infusion of 0.25ml/kg/min
• Repeat bolus 1-2 times if persistent cardiovascular collapse
• Double the infusion rate to 0.5ml/kg/min if BP remains low
Intravascular injection and LA systemic toxicity - Treatment

- Continue infusion for 10 more minutes after hemodynamic stability achieved
- Report the event to lipidrescue.org and use of lipid to lipidregistry.org
- Prolonged monitoring after attaining cardiovascular stability is recommended
- Alert a team/facility that can initiate cardiopulmonary bypass if needed
- **ACLS** requires medication adjustment and prolonged effort
- **AVOID** vasopressin, beta blockers, calcium channel blockers, Lidocaine
- Decrease individual epinephrine dose to <1mcg/kg
Peripheral Nerve Injury

- Incidence of mild paresthesias is about 15% with resolution of most symptoms within weeks and 99% by one year. Serious neurological injury occurs in 2.4 per 10,000 of PNB
Peripheral Nerve Injury - Prevention

- Identify patients with risk factors such as preexisting neurologic injury, neurological disease, diabetes mellitus, extremes of body weight, male gender, advanced age. Perform a thorough neurologic exam of the extremity/body part being anesthetized; document findings
- Consider using a less potent LA, less volume of a LA, lower concentration of a LA, avoid use of vasoconstrictive additives
- Be aware of surgical risk factors such as direct trauma, patient positioning, use of tourniquets, perioperative inflammation
- If patient experiences pain on injection, stop the procedure and reposition the needle
- Avoid heavy sedation of a patient prior to/while performing a PNB
- Detailed documentation of a PNB performed
Peripheral Nerve Injury – Recognition and Treatment

- Presenting symptoms, history and physical
- Mild and/or resolving symptoms without evidence of neural injury indicate excellent prognosis and require only patient reassurance
- Severe and/or progressive neural injury require prompt evaluation by a neurologist or peripheral nerve surgeon
- Consider neurophysiologic testing such as nerve conduction studies and EMG
Bleeding

• For patients undergoing deep plexus or peripheral block, ASRA recommends that recommendations regarding neuraxial techniques be similarly applied

• Patients receiving **thrombolytic therapy**: avoid these drugs for 10 days after puncture of noncompressible vessels. Avoid regional anesthesia in patients who have received these drugs. If patients have received these medications around the time of neuraxial anesthesia, consider appropriate neurologic monitoring. For timing of a catheter removal, get fibrinogen level to evaluate for residual thrombolytic effects

• In patients receiving **systemic heparin therapy**, heparin infusion should be stopped 2-4 hrs before removing a catheter. Patients should be monitored up to 12 hours after the removal for neurologic complications
Bleeding (continued)

- In patients receiving subcutaneous heparin twice a day, there is no contraindication to regional anesthesia. Remove neuraxial catheter 2-4 hrs after last heparin dose. Patient may receive SC heparin dose after placement of a neuraxial catheter.

- Patients receiving LMWH as thromboprophylaxis, needle placement can occur 10-12 hrs after the last dose. In patients who receive treatment doses of LMWH, regional anesthesia can be done at least 24 hrs after the last dose.
Bleeding (continued)

- **Postoperative thromboprophylaxis**: for twice a day dosing, LMWH should be started 24 hrs after the surgery. Indwelling catheters should be removed prior to initiation of LMWH. First dose should be delayed 2 hrs after removal of the indwelling catheter. If LMWH thromboprophylaxis is once a day, first dose can be administered 6-8 hrs after the surgery. Indwelling neuraxial catheters can be safely maintained. Catheter should be removed 12-14 hrs after last dose. LMWH should be restarted at least 2 hrs after the catheter removal.
Bleeding (continued)

• In patients receiving oral anticoagulation, therapy must be stopped 4-5 days before planned procedure and INR normalized prior to initiation of neuraxial block. If thromboprophylaxis with Warfarin is initiated when neuraxial anesthesia is in place, remove catheter when INR <1.5.

• Patients on antiplatelet medications: NSAIDs only are not contraindication to neuraxial anesthesia. Patients receiving Clopidogrel should stop it 7 days prior to initiation of neuraxial anesthesia, and patients on Ticlopidine – 14 days. Avoid neuraxial anesthesia in patients receiving platelets GP IIb/IIa inhibitors
Infection

• Incidence of local infection is 0-3.2%, abscess formation 0-0.9%.
• Catheter colonization occurs at higher rate, with femoral and axillary catheters carrying the highest risk.
• Risk factors include admission to an ICU, trauma, immune system compromise, nerve catheter indwelling for more than 48 hrs, male sex.
• Using strict aseptic techniques is the best prevention of infections.
References


Interscalene Brachial Plexus Block

Robert Cohen, M.D.
Ravi Bhalodia, M.D.
Brachial Plexus Anatomy

- Roots originate from ventral rami of C5-T1
- Emerge from intervertebral foramina, traveling through interscalene groove between middle and anterior scalene muscles
- Converge into superior (C5+C6), middle (C7), and inferior (C8+T1) trunks
Interscalene Anatomy

• Brachial plexus aligned vertically in interscalene groove at level of cricoid cartilage (C6)
• Bordered by anterior scalene medially; middle scalene laterally
• Other structures to note:
  – Phrenic nerve immediately anterior to (occasionally within) anterior scalene
  – Carotid artery, internal jugular vein, and vagus nerve
  – Cervical sympathetic chain
  – Vertebral artery
Interscalene Anatomy

- Vagus Nerve
- Phrenic Nerve
- Brachial Plexus
- Sternocleidomastoid Muscle
- Anterior Scalene
- Middle Scalene
- Post Scalene
- Carotid
- Cervical Sympathetic Nerve
- Jugular
Sensory/Motor Distribution

- Ideal for shoulder and upper arm surgery (C5-C7)
- Frequently (~50%) spares ulnar nerve distribution (C8-T1)
  - Less effective for elbow or medial wrist/hand surgery
  - Test by temperature/pinprick sensation
- Anterior shoulder surgery may require supplementation with superficial cervical plexus (C1-C4) block
- Motor supply to deltoid, supraspinatus, infraspinatus, teres major
  - Test by abduction and flexion of arm
Sensory/Motor Distribution

Posterior

Anterior
Contraindications

• Absolute
  – Patient refusal
  – Infection at site of puncture

• Relative
  – Contralateral phrenic n. palsy
  – Contralateral pneumothorax
  – Contralateral pneumonectomy
  – Impaired pulmonary function (e.g. severe COPD), where unilateral partial or complete loss of phrenic n. function interferes with comfortable ventilation
Technique

- Patient positioned supine or semi-sitting with head facing toward contralateral side
- Skin disinfected; ultrasound gel applied to skin
- Probe placed transverse in supraclavicular fossa*
- Brachial plexus visualized superficial and lateral to subclavian a.
- Trunks traced cephalad as they converge into proximal trunks/distal roots
- **Alternate approach**: probe positioned transverse at C6 to visualize carotid a., then moved laterally to visualize brachial plexus
Probe Positioning

Brown, Atlas of Regional Anesthesia
Technique

• Transducer positioned 3-4 cm superior to clavicle, over external jugular v.

• Needle typically inserted in-plane with transducer, in lateral-to-medial direction (posterior approach)
  – Traverses middle scalene muscle before entering sheath surrounding roots of brachial plexus, often felt as a “pop”
Technique

• Local anesthetic injected at single site to envelop the brachial plexus
  – If needed, multiple sites may be injected (posterior, inferior, superior)
  – “Donut sign” indicates hypoechoic anesthetic solution surrounding brachial plexus (hypoechoic nerves encircled by hyperechoic fascial covering)
    • Low volume (5-10 ml): purported to decrease diaphragmatic weakness
    • Standard volume (15-20 ml): unilateral diaphragmatic paralysis common
    • Large volume (30-40 ml): increased risk of bilateral effect (via epidural spread)
Ultrasound

- SCM = Sternocleidomastoid
- AS = Anterior scalene
- MS = Middle scalene
- CA = Carotid artery
- IJ = Internal jugular vein
- BP = Brachial plexus

Image courtesy of Marc Shnider, M.D.
Complications

• Presence of phrenic n. (C3-C5) ventral to anterior scalene muscle results in ~100% incidence of phrenic n. blockade
  – Results in ipsilateral diaphragmatic hemiparesis, which causes ~25% reduction in pulmonary function
• Presence of cervical sympathetic chain medial to anterior scalene muscle creates risk of ipsilateral Horner’s syndrome
  – Results in ptosis, miosis, and anhidrosis
• Proximity of recurrent laryngeal n. creates risk of hoarse voice
• Proximity of vertebral artery and CNS structures medially and dorsally creates risk of vertebral, epidural, or spinal injection
• Unmonitored needle movement may violate dome of lung, leading to pneumothorax
Clinical Pearls

• Superficial block (depth 1-2 cm)
• Always check for heme-negative aspiration prior to injection
• Avoid injection of local anesthetic immediately adjacent to transverse process and/or nerve root emerging from neural foramen
  – May increase risk of epidural or intrathecal injection
• Low-volume injection of local anesthetic may assist in “hydrodissecting” to identify fascial planes
References

Supraclavicular block

Mario Montealegre, MD
Luyang Jiang, MD
Supraclavicular block

• Useful for upper extremity surgery (arm, elbow, forearm, wrist and hand)
• Versatile, high success rates, quick onset of block (referred to as “the spinal of the arm”)
• First block performed by Kulenkampff in 1911 (on himself!)
• Performed on the distal trunks and origins of the divisions, where the brachial plexus occupies the least surface area (explains fast onset)
• Close proximity of the pleural dome and subclavian artery to the needle insertion point decreased popularity of this block. Recently there has been a resurgence due to the advantage of ultrasound guidance
Anatomy

- The three trunks of the brachial plexus carry the entire sensory, motor and sympathetic innervation of the upper extremity, with exception of the uppermost part of the medial side of the arm (T2).
- This block is performed in the distal trunks and proximal divisions where the brachial plexus is most compact.
- The neurovascular bundle passes underneath the middle third of the clavicle.
- The pleura can be punctured accidentally at the pleural dome or through the first intercostal space.
- The brachial plexus at this level is usually located posterolateral to the subclavian artery.
- Results in anesthesia of C5 to T1 dermatomes.
Anatomy
Anatomy
Indications and contraindications

• **Indications**
  - any surgery on the arm, elbow, forearm, wrist, hand

• **Absolute contraindications:**
  – Patient refusal
  – Allergy to local anesthetics
  – Infection or cellulitis at injection site

• **Relative contraindications:**
  – Coagulopathy
  – Respiratory compromise (risk of pneumothorax and phrenic nerve paralysis)
Positioning and Preparation

- Semifowler
- Head rotated away from puncture site
- Wrist supinated
- Arm rested on the side
- Disinfect the site with clorhexidine solution
- 22G, 50mm insulated needle
- High frequency linear probe
Ultrasound Technique

- Patient Position: semi-Sitting or supine, Head turned slightly away from the side of block, arm in neutral position, shoulders relaxed
- Probe Position: Scanning above the clavicle, linear probe placed parallel to the clavicle
- Needle Position: Introduced laterally towards the midline, In-Plane
- Your Position: Next to the patient, close to the shoulder.
Ultrasound Technique
Blocks are performed by imaging the subclavian artery and trunks of the brachial plexus on the short axis at the level of the first rib.
Clinical Pearls

• When needle introduced with live ultrasound Artery Must Be seen all the time.
• Identify the first rib and differentiate it from the pleural surface before needle advancement
• Needle tip should not disappear below the clavicle and should not be advanced medial to the artery.
• Necessary to make small readjustments of needle tip position to ensure local anesthetic spread to the 3 trunks
Block Outcome and Need for Supplementation

• The mean Anesthetic volume used was 20-30 mL for single injection
• Best motor response for nerve stimulation
• Adequate musculocutaneous nerve block
Complications

- Phrenic nerve block
- Horners syndrome
- Recurrent laryngeal nerve paralysis
- Vascular puncture
- Pneumothorax
- Neurological deficits
References


• Atchabahian, A. Ultrasound-guided supraclavicular block. The Journal of the New York School of Regional Anesthesia. 2009; 13:20-26

Infraclavicular Block

Balachandar Subramanium MD, MPH
Sheila Rajashekarara MD
Infraclavicular Block

- Initially introduced in the late 1920s/early 1930s by Balog and Labat
- New technique was described by Raj in the 1970s to decrease the chance of a pneumothorax (1)
- Minimizes sparing of musculocutaneous nerve
- Primarily used for procedures involving the arm, wrist or hand
Anatomy of the Infraclavicular Space

- Four borders of concern (1):
  - **medial**: Ribs 1-4
  - **lateral**: Humerus
  - **superior**: Coracoid process, Clavicle
  - **anterior**: Pectoralis major and minor
  - **posterior**: Subscapularis, Teres major and Latissimus dorsi

- Thin fascial sheath contains subclavian (or axillary) artery and vein

- Note: axillary and musculocutaneous nerve may leave the sheath before the coracoid process (occurs in 50% of patients) (1,2)
Anatomy: Branches of Cords

- Lateral cord: Lateral pectoral nerve, musculo cutaneous nerve and part of median nerve
- Medial cord: part of median nerve, ulnar nerve, median pectoral nerve, medial brachial cutaneous nerve, medial antebrachial cutaneous nerve
- Posterior cord: Axillary nerve, Radial nerve, upper and lower subscapular nerve, thoracodorsal nerve
Positioning and Tools

- **Position**: supine/beach chair head facing away from extremity to be blocked (3,4)
- For new trainees, the arm should optimally be abducted and flexed at the elbow to reduce the depth from the skin to the plexus
- For experienced operators, the arm can be in a neutral position
- **Needle**: 5-10cm, 21-22g short bevel insulated stimulating needle (4)
Parasagittal Ultrasound Approach

- Position transducer in the parasagittal plane, in a cephalad-caudal direction
- Use a 8-13 Mhz linear probe in most patients
- For patients who are obese, a 4-8 mHz curvilinear probe may offer more optimal image clarity
- Axillary artery typically located at a depth of 5-6 cm (4)
- Insert needle in plane at cephalad end of probe, with needle tip just underneath clavicle
Parasagittal Ultrasound Approach

- Advance needle until needle tip visualized at posterior aspect of artery - at this point, should be near the posterior cord
- Inject medication - the anesthetic should spread in a horse shoe fashion to cover the lateral, posterior and medial cords
Advantages

1. Can reliably perform block with arm in neutral position
2. Obtain definitive analgesia and anesthesia of the brachial plexus, including the branches that are involved with tourniquet pain- except the intercosto brachial nerve
3. Time to perform block can be relatively short (minutes)
4. Ability to visualize spread of anesthetic surrounding nerve bundle
5. In-plane positioning of needle can aid in avoiding lung and vasculature (2)
Drugs

• Most commonly inject a volume of **15-30cc of local anesthetic** (1,4,5)

• Type of anesthetic used depends on requirements for time of onset and duration of analgesia - medications such as **mepivicaine** have a faster onset time, but a shorter duration of analgesia compared to **bupivicaine**.
Clinical Perals

- Block of the musculocutaneous and intercostobrachial nerves allow for better tolerance of tourniquet during surgery
- If unable to abduct arm, infraclavicular block can be placed with the arm and head in neutral, supine position
- Note, however, that the musculocutaneous and axillary nerves leave the brachial plexus sheath prior to the coracoid process in 50% of patients (1,2)
- Onset of anesthesia in the Median nerve distribution vs. radial nerve suggests an incomplete spread of local anesthetic to posterior and medial cords- may need supplementation/rescue block
References


Axillary Block

Philip Hess, MD
Axillary Block

• First described in 1911 by Hirschel
• Brachial plexus block of the terminal branches at the axillary artery and vein just beyond the pectoralis minor muscle
• Popularized as a distal brachial plexus block
• Is associated with fewer complications
• Useful for surgery of hand, forearm and elbow
Anatomy of Axillary Block

- Brachial plexus nerves course with the axillary artery and vein(s) along the humerus from the apex of the axilla
- Median nerve often superficial & medial to the artery
- Ulnar nerve often superficial & medial to the artery, often near the axillary vein
- Radial nerve typically posterior to the artery
- Musculocutaneous usually found in the coracobrachialis or biceps muscle
Axillary Brachial Plexus
Indications & Contraindications

- **Indications:**
  - Hand surgery
  - Forearm surgery
  - Elbow surgery (especially medial elbow)

- **Absolute contraindications:**
  - Patient refusal
  - Allergy to local anesthetics
  - Infection/cellulitis at injection site

- **Relative contraindications:**
  - Coagulopathy
Positioning & Preparation

- Positioning: supine, arm abducted 90 degrees, care taken not to over abduct arm because may compress the plexus and prevent proximal spread.
- Prep: clean injection site with chlorhexadine or iodine solution
- Typically a 22G 50mm insulated needle is most appropriate
- Use a high-frequency (>10MHz), linear probe
- Begin scanning at most proximal location in the apex of the axilla with the probe positioned in cross-section to the humerus
Positioning & Preparation

Axillary Block

- Median n.
- Ulnar n.
- Radial n.
- Musculocutaneous n.
- Axillary vein
- Axillary artery

Biceps brachii m

Coracobrachialis m

Humerus

Triceps brachii m
Ultrasound Technique

• Locate the axillary artery
• Nerves are hyperechoic round or oval masses and surrounding the artery.
• In-plane approach is easy, with needle inserted from cephalad aspect and directed posteriorly.
• Block posterior radial nerve first: pushes plexus closer, improving imaging for subsequent injections
• Redirect needle superficial to block median nerves, then beyond artery for ulnar nerve
• To block musculocutaneous nerve direct perpendicular to skin to fascia between coracobrachialis and biceps muscles
Ultrasound Technique

Axillary brachial plexus with anatomical structures labeled
Complications & Tips

• **Complications:**
  – Hematoma (may ache for several days if vessels punctured)
  – Neuropathy from intraneural injection or needle puncture
  – Intravascular injection leading to systemic toxicity

• **Tips:**
  – Decreased risk of pneumothorax compared to supraclavicular or infraclavicular block
  – Easily compressible, so lower risk of significant hematoma
  – Significant anatomical variation in location of nerves in relation of axillary artery
Clinical Pearls

• If lateral forearm anesthesia is required, the musculocutaneous nerve must be visualized and blocked.

• Intercostobrachial nerve block is often added to an axillary block for medial elbow or tourniquet pain. Inject ~5cc subcutaneously along the medial upper arm from the biceps to the triceps.

• Perivascular infiltration and transarterial approaches are also options for an axillary block but may be less successful and have longer time to onset.

• Rescue for incomplete block can often be accomplished with terminal nerve blocks further down the forearm.
References


• Barash PG, Cullen BF, Stoelting RK et al: Clinical Anesthesia. 2009. 976-977
Peripheral Nerve Blocks

Philip Hess, MD
Peripheral Nerve Blocks Overview

- Injections directed at individual nerves as they pass through the upper arm
- Can be performed at the elbow or the forearm
- Can be used as rescue block or primary anesthesia
Anatomy Median Nerve

- Travels medial to the biceps muscle in the upper arm, and can be seen medial to the brachial artery and the biceps tendon at the elbow.
- Travels between the superficial and deep compartments of the forearm, where it can be seen between the flexor digitorum superficialis and profundus.
- At the wrist the median nerve lies between the palmaris longus and flexor carpi radialis tendons.
Anatomy Ulnar Nerve

- Travels in the posterior-medial upper arm, and can be seen in the ulnar groove at the elbow.
- Travels superficially to the deep compartment of the forearm, where it can be seen medially to the ulnar artery.
- At the wrist, the nerve lies immediately lateral to the flexor carpi ulnaris and just medial to the ulnar artery.
Anatomy Radial Nerve

- The nerve leaves the axillary sheath in the upper arm, and spirals around the humerus to the lateral aspect of the lower arm. At the elbow it can be seen between the brachialis and brachioradialis muscles, lateral to the biceps tendon.
- Travels superficial to the deep compartment of the forearm, where it can be seen in the fascial plane lateral to the radial artery
- At the wrist the nerve has fanned out and requires a field block
Anatomy Musculocutaneous Nerve

- The musculocutaneous (MCN) supplies the flexors of the arm and elbow. It travels between the biceps and coracobrachialis (CB) muscles, and then travels in the body of the CB to the elbow. It can be seen superficial and lateral to the biceps tendon at the elbow.
- The MCN serves as the sensory lateral cutaneous nerve of the forearm.
Cutaneous Distribution

- Ulnar nerve provides sensation to the medial hand, the fifth and most of the fourth digit.
- Median nerve provides sensation to the anterior hand, the thumb through middle finger, and the posterior tips of these fingers.
- Radial nerve provides sensation to the posterior and lateral aspect of the hand up to the distal IP joint.
- Musculocutaneous nerve provides sensation to the lateral cutaneous nerve of the forearm.
- The intercostal brachial nerve provides sensation to the medial upper arm, and extends to the medial elbow as the medial cutaneous nerve of the arm.
Cutaneous Distribution

- Supraclavicular
- Lateral Cutaneous of Arm
- Intercostobrachial
- Posterior Cutaneous of Arm
- Medial Cutaneous of Arm
- Post Cutaneous of Forearm
- Medial Cutaneous of Forearm
- Lateral Cutaneous of Forearm
- Radial
- Ulnar
- Median
Contraindications

• No contraindications specific to the blocks. Standard contraindications apply:
  – Patient refusal
  – Infection
  – Coagulopathy
  – Allergy to local anesthetics
Antecubital fossa
Ulnar Nerve
Forearm Images

Ulnar nerve & art.

Radial art & nerve

Medial

Median nerve

Lateral
Scanning Technique

- For blocks at the elbow, the patient can be supine or recumbent, with the arm at neutral position or out to the side.
- High frequency probe (>10mHz) is required for accurate identification.
- In-plane or out-of-plane approaches are both acceptable.
Pitfalls / Optimizing scanning

- The nerves are small, hyper-echoic, and are easily misidentified. Follow the course of the nerve to distinguish between tendon and nerve.
- Nerves are hard structures. Gentle pressure with the probe will distort the surrounding tissue, but not the nerve.
- Asking the patient to flex/extend their fingers will distort the muscles, but not distort the nerve. The nerve may move, but will retain its shape.
Clinical Pearls

• The nerves are frequently near blood vessels!
• Unlike other blocks, multiple injections may be required. The precision of distal nerve blocks can be an advantage when performing anesthesia for the dominant hand.
References


Paravertebral Analgesia

Allen Pendarvis, MD
Robina Matyal, MD
Introduction

- First described in 1905 by Hugo Sellheim\textsuperscript{1}
- Used in limited fashion—primarily for abdominal surgery
- Underwent resurgence in 1979, when Wyatt and Eason began using the technique in conjunction with catheter placement\textsuperscript{1}
- Currently increasing in popularity, especially as an alternative to epidural analgesia
Paravertebral Analgesia
Anatomy of the Paravertebral Space

- Wedge-shaped, extending from T1-T12, continuous with the intercostal space
- Medial border: vertebrae/fascia, intervertebral discs
- Posterior border: transverse processes, ribs, and the superior costo-transverse ligament
- Anterolateral border: parietal pleura
- Ipsilateral spinal nerves, white and gray rami communicantes pass through the paravertebral space
- Relatively thin fascial sheath allows easy penetration of local anesthetic
- Also contains intercostal vessels
Anatomy of the Paravertebral Space

- Blockade results in anesthesia in the distribution of the affected spinal nerves.
- Continuity with the intercostal space and epidural space (through intervertebral foraminae) also influence the distribution of block.²
Anatomy of the Paravertebral Space
Technique

Positioning & Prep

- Sitting, lateral decubitus, or prone
- Thoracic kyphosis, to increase the distance between transverse processes
- The site(s) to be blocked are appropriately sanitized with iodine or chlorhexidine solutions
- A 22g (for single-shot) or 18-16g (for catheters) are appropriate selections
Technique

Landmarks

- Identify/mark spinous processes adjacent to block sites
- Paravertebral space typically located ~1.5-2.5cm lateral to midline
- Larger-volume, single site injection or multi-site, smaller volume injections are common, in addition to catheter placement

Site marking in a sitting patient
Indications

High Thoracic Paravertebral
- Lung resection/
  Thoracotomy/VATS
- Breast surgery with node
dissection
- Analgesia for rib fractures /
  trauma
- Nephrectomy
- AAA repair (upper)

Thoraco-Lumbar
Paravertebral (T9-L5)
- Inguinal herniorraphy
- Cystectomy/Prostatectomy
- Hysterectomy
- AAA repair (lower)
Contraindications

**Absolute Contraindications**
- Patient refusal
- Allergy to local anesthetics
- Cellulitis/dermatitis at the skin of injection
- Tumor, vascular abnormality, etc. at the site of blockade
- Sepsis
- Severe hypotension

**Relative Contraindications**
- Coagulopathy
- Inability to tolerate pleural puncture/diaphragmatic weakness
- Inability to tolerate epidural puncture/spread
- Anatomical abnormalities
Sagittal (Classic) Ultrasound Approach

• Position the ultrasound probe longitudinally, and re-identify the spinous processes. Translate the probe laterally to locate the transverse processes.

• The TPs should border the superior costotransverse ligament, the paravertebral space, and the parietal pleura of the lung.

• If the probe is positioned too laterally, the PVS will appear too small or nonexistent. Too medial, and the laminae will obscure the image.

• Advance the needle in-plane with the US probe. Needle visualization can often be difficult with this approach, due to the steeper angles required\(^3\).
Sagittal (Classic) Ultrasound Approach

• Do NOT advance without visualization of the needle tip – the margin for error is very small! A loss of resistance 'pop' is sometimes felt when entering the PVS.

• After achieving the PVS, injection of local anesthetic will depress the bright parietal pleura, validating block location.
Sagittal (Classic) Ultrasound Approach

Paramedian sagittal image, between two transverse processes
Proximal Lateral (Transverse) Ultrasound Approach

- Position the ultrasound probe axially (perpendicular to the orientation of the vertebral column) approximately 1.5-2.5 cm lateral to the spinous processes.

- Adjust the ultrasound probe such that the plane of view is in-between transverse processes, which would otherwise obstruct imaging of the deeper structures.

- Advance the needle in-plane and lateral-to-medial until the tip passes into the PVS.

- As with the previous technique, injection of local anesthetic in the paravertebral space should depress the bright line of the parietal pleura, suggesting appropriate needle tip positioning.

- It is worthy of note that while this technique allows for easier visualization of the needle tip, it is also associated with a greater incidence of epidural spread or intrathecal injection along with a higher failure rate for catheter placement.\(^4\)
Proximal Lateral (Transverse) Ultrasound Approach

Horizontally-oriented image, positioned over a transverse process\textsuperscript{3}
Complications

Complications – relatively low incidence overall, but include:

- Intravascular injection / local anesthetic toxicity
- Epidural injection and/or unintended epidural spread of anesthetic
- Dural puncture/intrathecal injection
- Pleural puncture
- Infection

- Bleeding/Hematoma
- Hypotension
- Pain
- Nausea/vomiting
- Urinary retention
Advantages of PVB

- Non-inferior to epidural analgesia, with fewer absolute contraindications/complications and possibly shorter hospitalization\(^5,6\)
- May be a safer option in anticoagulated patients\(^7\)
- Lesser degree of sympathectomy and subsequent systemic hemodynamic effects vs. epidural anesthesia\(^7\)
- Analgesic superiority to systemic opioid therapy, local anesthetic injection, and continuous wound catheter anesthesia\(^8,9\)
- Efficacy and accurate placement appears reliable with ultrasound guidance\(^10,11\)
Clinical Pearls

- 15cc of local anesthetic as a single-site injection or 3-4cc at 2-3 sites should cover approximately 4-7 dermatomes

- 0.5% bupivacaine should result in 4-6hrs of anesthesia, 12-18hrs of effective analgesia; 7-10cc/hr is a reasonable infusion rate in catheter placement

- Addition of 5mcg/mL epinephrine to injectate will attenuate hemodynamic side effects by reducing systemic absorption

- Effective blockade can be evaluated by testing for loss of pin-prick or temperature sensation in the appropriate dermatomes
Clinical Pearls (continued)

- As epidural, intrathecal, and intravascular injection are all risks in paravertebral block, careful monitoring is still necessary. Airway equipment and intralipid should be readily available.

- Avoid blockade below L2, due to LE muscle weakness.

- Periodic, low-volume injection of local anesthetic when approaching the PVS may aid in localization of the needle tip and reduce the likelihood of pleural puncture.

- Attachment of a saline-filled syringe to the needle tubing may reduce the chance of pneumothorax in the incidence of pleural puncture.
References


Lumbar Plexus Block

Joseph Merlone, MD
Marc Shnider, MD
Overview

• The lumbar plexus blockade also known as psoas compartment block can be an excellent modality for surgical and post-operative pain control of the lower extremity.

• It is not as common as either neuraxial techniques or more peripheral blocks for a variety of reasons:
  - It is an advanced block, with more challenging ultrasound imaging
  - Epidural spread occurs in up to 15% patients so close monitoring is required
  - it is not recommended for ambulatory patients
Anatomy

• Lumbar plexus consists of L1-5 nerve roots
• This block primarily effects L2-4, with small amount of L1 supply
• As nerve roots exit vertebral foramina they embed in psoas muscle, as it is attached to the lateral and transverse process of each lumbar vertebrae
Anatomy
Anatomy Continued

- The major nerves of the plexus anesthetized are: genitofemoral, lateral femoral cutaneous nerve, femoral and obturator nerves.
- The block is performed with direct injection into the psoas muscle with spread proximal to each nerve root.
Sensory/Motor Distribution

- Lateral femoral cutaneous nerve: sensory innervation to lateral aspect of the thigh extending to just below the knee, no motor innervation.
- Genitofemoral nerve: innervates a small region of the anterior thigh just below the ileoinguinal ligament, no motor innervation.
Sensory/Motor Distribution (continued)

- Femoral nerve: innervates the anterior and medial aspects of the thigh to just below the knee, and the saphenous distribution innervates the medial aspect of the leg below the knee extending down to just below the medial malleolus. The motor distribution innervates all divisions of the quadriceps muscle.
Sensory/Motor Distribution (continued)

- Obturator nerve supplies sensory innervation to small region of the inner thigh which is highly variable, and motor fibers to control hip adductors.
- The motor branches of the psoas and iliacus muscles arise from the femoral nerve and are also anesthetized by this block.
Indications

• This technique can be used for a variety of procedures of the lower extremity. It has been described as very effective for femoral shaft or neck fractures, and procedures of the inner thigh. It is infrequently used as the sole anesthetic for procedures of the knee or lower extremity as it does not cover sciatic distribution.
Contraindications

**Absolute:**
- Patient refusal
- Allergy to local anesthetics
- Infection, locally at site or sepsis

**Relative:**
- Pt unable to lie on side; performed in lateral decubitus position
- Hypotension - sympathectomy secondary to epidural spread is common
- Obesity – depth may be prohibitive to obtain adequate ultrasound images
Positioning

- Patient in lateral decubitus position with the operative side up. Midline should be identified (spinous process) in addition to the iliac crest.
- The Ultrasound probe is placed approximately 4cm from the midline in perpendicular line with posterior-superior iliac crest, parallel to long axis of the spine.
Technique

• Site is sterilized with chlorahexadine or iodine solutions
• 22g needle for single shot, or 18g for catheters
• It can be helpful to begin imaging lower and identifying iliac crest, then moving cephalad counting transverse process until optimizing position above L4.
• inferior pole of the kidney should also be identified in addition to the peritoneum to prevent inadvertent injury.
• Needle is inserted at approximately 15-30 degree angle in-plane with ultrasound probe.
Technique

- Needle should be advanced under direct visualization until it is seen within the posterior 1/3 of the psoas muscle.
- When nerve stim is used, the psoas muscle can be seen “dancing” on ultrasound in addition to watching for patellar twitch (0.5-1mA is the ideal stimulating current). 15-20 of local anesthetic is then injected.
Optimization

• Psoas compartment block is most frequently done at depths greater than 6 cm. For this reason a medium to low frequency (4-8 MHZ) is required. Use of a curvilinear probe expands the visual field and makes needle visualization easier.

• Because of the steep angle of approach, needle visualization may still prove challenging.

• Use of a reflective ultrasound block needle or hydro dissection technique, or both, may be required.

• Proper adjustment of gain and focal depth are extremely important in obtaining a clear picture.
Complications

• As the most common complication with this block is epidural spread, high neuraxial blockade can occur. Patients should be monitored as closely with this block as they would for epidural anesthesia.

• Hypotension is the second most common complication. Unilateral sympathectomty is commonplace, but with epidural spread can cause bilateral blockade.

• Systemic toxicity is higher with this technique than most peripheral blocks. The injectate is deposited in vessel rich muscle rather than epi-neural fascia. However, direct vascular injection is rather low.

• Due to its close proximity to the kidney, there is a real risk for renal injury. Illio-psoas hematoma formation with nerve compression is also a risk.
References

Sciatic Nerve Block

Lisa Kunze MD
Sciatic Nerve Anatomy

• Originates from L4-5, S1,2,3 nerve roots
• Composed of 2 nerves that become:
  – Tibial Nerve
  – Common Peroneal Nerve
  – (separated by Compton-Cruveilhier septum)
• Clear division of nerves in 12% people
• Exits pelvis via greater sciatic foramen below piriformis
• Distal to ischial tuberosity courses deep to gluteus maximus, medial to biceps femoris, and lateral to semitendinosis
Sciatic Nerve Anatomy

- Appears flattened in gluteal area, more rounded distally
- Cutaneous innervation of posterior thigh is from:
  - Posterior Femoral
  Cutaneous Nerve branches off in pelvis and runs superficially on biceps femoris
Dermotomes, Myotomes, Osteotomes

- **Sensory:**
  - Below knee except saphenous distribution
  - Posterior thigh (proximal block)

- **Motor:**
  - Foot
  - Leg – all muscles below knee
  - Hamstring muscles – gluteus (inf. Gluteal N), biceps femoris, semitendinosis, semimembranosus, proximal adductor magnus
Dermotomes, Myotomes, Osteotomes

- **Osteotomes:**
  - Foot
  - Ankle
  - Knee (partial)
  - Tibia (some contributions from femoral nerve in proximal medial aspect)
  - Posterior hip capsule
Equipment and Local Anesthetics

• **Equipment:**
  – 2.5-7 MHz probe (curvalinear)
  – 12 MHz linear probe adequate in small individuals
  – 80-150 mm Needles

• **Positioning:**
  – Lateral decubitus
  – Prone
  – Lithotomy – single leg

• **Local Anesthetic** (single shot):
  – 15-20 cc of 0.25-0.5% Bupivacaine
  – 0.2-0.5% Ropivacaine
  – May be mixed with 1-2% Mepivacaine

• **Nerve Stimulator:**
  – Helpful for deep blocks or when structures difficult to visualize
Ultrasound Techniques: Posterior Approaches

Gluteal
Ultrasound Techniques: Posterior Approaches

Subgluteal
Ultrasound Techniques: Posterior Approaches

- Place probe along line between greater trochanter and ischial tuberosity.
- The nerve should be viewed in axial dimension.
- **Tilt to obtain best image.**
- May move proximally or distally if necessary.
Ultrasound Images

Gluteal (Raj)

Subgluteal


Kunze, 2013
Pearls

- Tilting of probe improves image
- Postion patient to relax the gluteal muscles
- Don’t be fooled by the ligament near the greater trochanter. It appears bright like a nerve.
- The nerve is closer to the ischial tuberosity!
- Use Nerve Stimulation to confirm structure
- May use in-plane or out-of-plane approach
- The nerve is never deeper than the distance between the skin and femur with the subgluteal approach.
Pitfalls

- Obesity
  - Nerve is more superficial with the Subgluteal approach
- Fall Risk
  - Loss of dorsiflexion and knee flexion may put patients at higher risk of fall
- Anisoechoic Nerve
  - Tilt probe
  - Use Nerve stimulation (0.2-0.5 mA)
  - More connective tissue in nerve with aging which can worsen this problem
Pitfalls (continued)

• Failure to block Posterior Cutaneous Nerve
  – Block nerve proximal to ischial tuberosity
  – Not needed for leg and foot procedures
• Anticoagulation
  – This is a deep block — follow ASRA guidelines
• Blood vessels
  – Medial circumflex artery
  – Inferior gluteal artery
References

Femoral Nerve Block

Rikante Kveraga, MD
Galina Korsunsky, MD
ANATOMY

• The femoral nerve is the largest nerve of the lumbar plexus
• It is formed by nerve roots of L2-4
• The femoral n. reaches the thigh by passing underneath the inguinal ligament, just lateral to the femoral artery
• The femoral n. lies deep to the fascia iliaca, on the anterior aspect of the iliopsoas muscle
• The femoral vein is medial to the femoral artery
SENSORY DISTRIBUTION AND MOTOR SUPPLY

• The anterior division of the femoral n. innervates the Pectineus and Sartorius muscles (muscular branches) and skin on the anterior aspect of the thigh (cutaneous branches)

• The posterior division sends muscular branches to the Quadriceps Femoris muscle group and gives rise to its cutaneous division, the saphenous nerve
Indications and Contraindications

Indications
• Fractured neck/shaft of the femur
• Knee joint (ACL repair, TKR)
• Skin graft on anterior aspect of thigh
• Muscle biopsy
• Saphenous nerve block is indicated for surgeries below level of the knee

Contraindications
• None listed
SCANNING TECHNIQUE

• Position the patient supine.
• Expose the inguinal crease.
• Place the ultrasound probe along the inguinal crease.
• If the patient is obese, it may help exposure to: place rolled towel under hip bone or tape pannus back for optimal exposure.
OPTIMUM SCANNING TECHNIQUE

- Orient the probe so that the femoral nerve, artery and vein are in the correct anatomical relationship
- Femoral vein - the most medial structure
- Femoral artery – middle structure
- Femoral nerve – the most lateral structure
OPTIMIZING SCANNING TECHNIQUE

- The nerve is relatively superficial at this level
- Use an ultrasound probe with high frequency (10-12 MHz)
- Adjust the depth to 1-3 cm
- Optimize gain
- The femoral nerve is often found within a triangular hyperechoic region, lateral to the femoral a. and superficial to the iliopsoas muscle
PITFALLS WITH IMAGING

• If two arteries are seen, you need to scan more cephalad to see the femoral artery before it branches to the profunda.

• The femoral nerve is a large structure, but can be difficult to find in the obese patient. If you’re not finding the nerve:
  – Have an assistant hold the pannus back (or tape it)
  – Scan the thigh from very medial to lateral – it can appear to be very medial in obese patients
  – Even though the nerve is generally quite superficial, increase your depth, so you get a “big picture” and that way find the artery
COMPLICATIONS

- Femoral neuropathy/neuritis
- Postoperative falls
- Intravascular injection
- Infection
- Hematoma
CLINICAL PEARLS

- A 5-8 cm 22 G insulated needle (preferably with an echogenic tip design) is inserted to align the needle with the ultrasound beam.
- Guide the needle in the lateral-to-medial direction.
- Ensure you see the needle tip when injecting local anesthetic.
- Inject about 20-30 ml of a LA of your choice to minimize the effective dose.
- Can inject at all 3 points of “triangle” for better spread.
- Observe the expansion of the nerve sheath as the hypoechoic LA spreads around the nerve.
- Scan proximally and distally to assess LA spread.
CLINICAL PEARLS

Femoral n.

Femoral a.

Block needle
CLINICAL PEARLS

- In a larger patient, the nerve might be deeper. A lower frequency probe might be used. Exposing the inguinal crease is important to improve block performance. If a patient has a significant pannus, have another person or other means to retract it.

- Inguinal lymph nodes also appear hyperechoic and may be mistaken for the nerve in the short axis view. A nerve is a continuous structure that can be traced (by scanning proximally and distally) while a lymph node is not and can be seen only in a discrete location.

- If the image shows more than one artery, the probe is positioned too distal. Scan more cephalad until only one artery is visualized (femoral artery) before profunda femoris artery branches off.
CLINICAL PEARLS

• If patient complains of pain postop - assess location of pain. Innervation of knee can vary and pain may be from sciatic component. Assuming LA toxicity not a problem, it’s reasonable to place another femoral block.
REFERENCES

• http://www.nerveblock.ca/page19/files/BIGstacks_image_679_1.jpg
Popliteal Fossa & Saphenous Nerve Blocks

Anasuya Vasudevan, MD
Kathleen Richard, MD
Popliteal Fossa Block Overview

• Originally described by Labat in 1923.
• Provides surgical anesthesia and/or post-operative analgesia to the area below the knee making it an ideal block for the majority of foot, ankle, and achilles tendon procedures.
• Does not block the cutaneous sensation contribution of the saphenous nerve.
• Lasts 8-20 hours depending on the local anesthetic chosen.
• No loss of motor function in the hamstrings and posterior adductor muscles allowing for early post-op crutch training.
• Alternate Names: “popliteal sciatic” or “pop-sciatic” block, “tibial-peroneal block”
Popliteal Fossa Anatomy

• The Sciatic Nerve (SN) passes into the thigh anterior to the hamstrings and posterior-lateral to the popliteal artery & vein.
• The SN divides into the medial Tibial Nerve (TN) and lateral Common Peroneal Nerve (CP) components in the popliteal fossa.
• This division commonly occurs 5-10cm SUPERIOR to the popliteal crease. At this point, the nerve(s) lies 2-4 cm below the skin surface.
• The SN can be blocked anywhere along its course through the proximal thigh to the popliteal fossa.
Poipleal Fossa Anatomy

• Blocking the nerve before it divides into the TN and CP components simplifies the technique.
• Popliteal fossa is most widely chosen site to block the sciatic nerve.
Poqliteal Fossa Anatomy

Base: Popliteal Crease

Medial Border: Tendons of Semimembranosus and Semitendinosus

Lateral Border: Biceps Femoris
Popliteal Fossa Anatomy

With the long axis of the linear probe parallel to the popliteal crease, trace tibial component of the sciatic nerve cranially and identify the point of division of the sciatic into the common peroneal and tibial nerves.
Popliteal Fossa Short Axis Anatomy
Sciatic Nerve (SN)

- The lumbosacral plexus (L4-L5/S1-S3) forms the SN.
- The SN branches, just proximal to the popliteal fossa, giving rise to the common peroneal (fibular) and tibial nerves.
- The common peroneal nerve provides sensory innervation to the posterolateral lower leg and dorsum of the foot.
- The common peroneal nerve branches into the deep fibular and superficial fibular nerves.
- The superficial fibular provides sensation to the dorsum of the foot except for the region between the 1st and 2nd digits which is provided by the deep fibular nerve.
Sciatic Nerve (SN)

- The tibial nerve provides sensory innervation to the heel and sole of the foot.
- The sural nerve (S1-S2) provides sensation for the posterolateral lower leg including the lateral margin of the foot to the 5th digit.
Drugs

- **Chloroprocaine 2%** for peripheral nerve block, maximum dose 800mg or 1000mg with epinephrine. Duration is < or equal to 1 hour plain or up to 1.5 hours with epinephrine.

- **Mepivacaine 1-1.5%** for peripheral nerve block, maximum dosage 400mg plain, 500mg with epinephrine. Duration is 1-4 hours plain, with epinephrine 2-5 hours.

- **Ropivacaine 0.5-1%** for peripheral nerve block, maximum dosage 250mg. Duration 2-8 hours
Drugs (continued)

- **Lidocaine 1-1.5%** for peripheral nerve block, maximum dosage 300mg plain, 500mg with epinephrine. Duration is 1-1.5 hours plain, and 2-3 hours with epinephrine.
- **Bupivacaine 0.25-0.5%** for peripheral nerve block, maximum dosage 175mg plain, 225mg with epinephrine. Duration is 3-6 hours plain and 5-8 hours with epinephrine.
- All agents expected onset within 15-20 minutes
Technique: Popliteal Fossa Lateral Approach

• **Supine** - with feet elevated - useful in patients with painful fractures/external-fixators

• **Lateral Approach** – plane between Vastus lateralis and Biceps femoris

![Diagram of the popliteal fossa lateral approach]
Position and Prep

• Prone, lateral decubitus, supine with leg elevated on support
• Foot should be hanging off support to ensure free ROM
• Prep area above and below popliteal crease with iodine or chlorhexidine solutions
• A 22g block needle or 18 g (for catheters) 50mm or 80mm needles (based on the depth of structures)
Ultra Sound Guided Popliteal Fossa Block – Patient in Prone Position

- Position the probe horizontally at the popliteal crease
- Probe setting: 10-15 MHz in thin individuals
- May require a 4-7MHz probe in the obese, especially if the sciatic nerve divides higher up in the thigh
- Identify the popliteal artery pulsation
Popliteal Fossa Block – Prone Position (continued)

- Ease pressure- the popliteal vein will appear as a dark pool immediately anterior to the artery
- The tibial nerve (bright structure) is plastered to the posterior wall of the poplitical vein
- Trace the bright structure toward the head
- Tilt/angle probe slightly towards feet for better visualization of the nerve
- Common peroneal nerve will appear lateral to the tibial nerve, along the medial border of biceps femoris
- The tibial nerve and common peroneal nerve appear to fuse – i.e., the point where sciatic nerve divides into tibial and common peroneal nerves
Popliteal Fossa Block – Prone Position
Sciatic nerve at popliteal fossa surrounded by local anesthetic solution

- **Local anesthetic choice**: Bupivacaine or ropivacaine
- **Volume**: 15-20 mls depending on the spread and accuracy of needle placement
Selective tibial nerve block

• **Advantage**
  – Sensory block to sciatic distribution of knee joint without causing foot drop
  – Performed closer to the popliteal crease where nerve is very superficial

• **Muscular branches:**
  – Gastronemius
    • Popliteus
    • Tibialis posterior

• **Branches to knee joint:**
  – Superior tibio fibular joint
  – Tibia
  – Interosseus membrane
  – Inferior tibio fibular joint
  Terminates as Sural Nerve – sensory to lateral border of foot
Pearls

• Assess efficacy of block by:
  – ask patient to wiggle toes (motor)
  – ask patient to move ankle (motor)
  – pinch postero-lateral lower leg (sensory)

• In a small subset of patients, the sciatic nerve will divide at the level of the piriformis. In such cases, the sciatic nerve is split into its component peroneal and tibial nerves throughout much of the thigh. If this is the case, direct local anesthetic spread around each individual nerve under ultrasound guidance.

• Beware of the compressed popliteal vein that may be very close to the anterior border of the tibial nerve and accidental intravascular injections
Sub-sartorial Saphenous Nerve block - transverse section - middle of right thigh

- Saphenous nerve is a branch of the posterior division of the femoral nerve
- Adductor canal/sub-sartorial canal/Hunter’s canal
- Floor/posterior wall: adductor longus and adductor magnus
- Anterior wall: Vastus medialis
- Roof: Fibrous membrane and sartorius
Sub-sartorial Saphenous Nerve block - transverse section - middle of right thigh

**Contents:** Femoral artery, Femoral vein, Saphenous nerve, Nerve to vastus medialis, and subsartorial plexus (anterior division of obturator nerve, branches from saphenous nerve and medial cutaneous nerve of thigh)
Sub-sartorial Saphenous Nerve block - transverse section - middle of right thigh

- Supine position
- Abduction at hip joint, Knee slightly bent
- High frequency US probe
- Track lateral to medial aspect- middle third of thigh
- Identify femur- Vastus medialis-Sartorius
- Even in muscular/large BMI population, femoral artery pulsation can be identified
- Saphenous nerve may be hard to visualize
- Injection of local anesthetic solution anterior to the pulsation ( subsartorial injection) provides reliable conduction block
Sub-sartorial Saphenous Nerve block - transverse section - middle of right thigh

Supine Right Leg –
Abducted at hip and mild flexion at the knee
Indications and Contraindications

• **Indications**
  – Surgical procedures below the knee
  – Foot and ankle surgery
  – Sural nerve biopsy
  – Short saphenous vein stripping

• **Absolute Contraindications**
  – Patient refusal
  – Coagulopathy
  – Allergy to local anesthetics
  – Local infection
  – Tumor, vascular anomaly etc. at the site of needle entry

• **Relative Contraindications**
  – Neuropathy, pre-existing nerve injury/neurological disease
  – Hardware/implants
References

• [http://www.pitt.edu/~regional/Popliteal%20Block/Popliteal%20Block.htm](http://www.pitt.edu/~regional/Popliteal%20Block/Popliteal%20Block.htm)
• [www.nysora.com](http://www.nysora.com)
• Hadzic, A., Vloka, J. A comparison of the posterior versus lateral approaches to the block of the sciatic nerve in the popliteal fossa. Anesthesiology 1998;88:1480-6
Ilioinguinal Nerve Block

Alexandra Lewis, MD
Vimal Akhouri, MD
Ilioinguinal Nerve Block

• The ilioinguinal nerve block is traditionally performed to manage pain from lower abdominal incision and surgeries that involve the groin and genital region (fig. 1).
• Use in inguinal hernia repairs is common.
• In the pediatric population, this block can be used for orchidopexy or hydrocele repairs.
Ilioinguinal Nerve Block

Figure 1: Distribution of nerves supplying lower abdomen and genital region. [1]
Anatomy

• The primary nerve root supplying the ilioinguinal nerve originates from L1.

• Similar to the transversus abdominis block, the ilioinguinal nerve courses in the plane between the transversus abdominis and internal oblique muscles (fig 2.).

• The nerve courses medially and inferiorly towards the groin and terminates in the upper scrotum in men and the mons pubis and lateral labia in women. (2)
Anatomy
Indications and Contraindications

• **Surgeries:**
  - Inguinal Herniorrhaphy
  - Orchidopexy
  - Hydrocele repair

• **Absolute Contraindications:**
  - Patient refusal
  - Allergy to local anesthetics
  - Cellulitis/dermatitis at the skin of injection

• **Relative Contraindications:**
  - Coagulopathy
  - Anatomical abnormalities
Preparation for Ilioinguinal block

- **Equipment:**
  - 1 24 gauge short-beveled 50 mm needle
  - 1-2 cc of 1% lidocaine in an insulin syringe
  - 1 20cc syringe w/ choice of local anesthetic (Ropivicaine, Bupivicaine).
    - If bilateral block performed, injection of 20ccs 0.25% ropivacaine or 0.25% bupivacaine on each side is appropriate for prolonged postoperative pain control.
    - If a unilateral block is performed, injection of 20ccs of 5% ropivacaine or .375% bupivacaine can be used to achieve an effective block.

- **Preparation:**
  - Position: Supine
Landmark-Based Approach

- In the blind technique, the anterior iliac spine is palpated. The skin is cleaned with aseptic technique. Approximately, 3 cm medial to the anterior iliac spine and ~3 cm caudad, a 24 short-beveled needle is inserted perpendicular to the skin. (fig. 3). (4)
- The needle is advanced until two fascial pops are appreciated from penetration of the external and internal oblique muscles.
- Local anesthetic is injected after negative aspiration.
- Ultrasound guidance is our preferred technique.
Ultrasound-guided Technique

• A linear ultrasound probe is applied in the transverse position slightly lateral to ASIS (fig. 4).

• Fine movements of the probe should bring transversus muscle and the internal oblique muscle into view.

• Once the desired image is obtained, a 24 gauge needle is inserted from the lateral position in line with the probe.

Figure 4: Position of linear probe for ilioinguinal nerve block [5]
Ultrasound-guided Technique

The ilioinguinal nerve often appears hyperechoic under ultrasound. (fig. 5). After negative aspiration, a small aliquot of local anesthetic is injected to lift the internal oblique muscle from the tranversus abdominis muscle easily without resistance. The remainder of local anesthetic can be injected if no resistance is encountered.

Figure 5. Ultrasound guided approach to ilioinguinal nerve block [6]
Complications

• If the needle is inserted too deep into the muscles, there is risk of perforation of the peritoneum. Sequelae from unrecognized colonic perforation include abscess and fistula formation.

• Other risks include: intravascular injection, allergic reactions to local anesthetics and hematoma formation.
References

Fascia Iliaca Block

Viviane G. Nasr, MD
Robina Matyal, MD
Fascia Iliaca Block Overview

- **Indications** - Analgesia for:
  - Fractured neck or shaft of the femur
  - Hip surgery depending on the surgical approach
  - Above knee amputation
  - Knee surgery (in combination with sciatic nerve block)
  - Lower leg tourniquet pain during awake surgery

- **Contraindications:**
  - Patient refusal
  - Anticoagulation (relative contraindication)
  - Inflammation or infection over injection site
  - Allergy to local anesthetics
Fascia Iliaca Anatomy

- **Muscle:** The iliacus and the psoas major form the Iliopsoas. The fascia covering the iliopsoas is thin superiorly and thickens as it gets closer to the inguinal ligament.
- The Fascia Iliaca Attaches To:
  - *lateral:* thoracolumbar fascia, iliac crest, anterior superior iliac spine, sartorius fascia.
  - *medial:* vertebral column, pelvic brim, pectineal fascia.
  - *anterior:* posterior part of inguinal ligament, fascia lata.
- **Nerve:** The lumbar plexus made of T12 to L5 form the femoral nerve, the lateral femoral cutaneous nerves as well as the obturator nerve, all crossing deep under the fascia iliaca. (The sciatic nerve is not covered by this block).
Cross Section & Ultrasound

- Fascia iliaca
- Iliacus Muscle
- Ilium
Simplified Cross Section

- Lateral Femoral Cutaneous Nerve
- Femoral Branch of Genitofemoral Nerve
- Femoral Nerve
- Fascia Lata
- Adductor Longus
- Sartorius Muscle
- Iliacus Muscle
- Psoas Muscle
- Pectineus Muscle
- Adductor Brevis
- Adductor Magnus
Block With Ultrasound Guidance

• Equipments
  – Ultrasound machine: A linear array ultrasound probe usually in the mid to high frequency range (e.g.-8-10 MHz) is needed.
  – Blunted or short-beveled needle (Tuohy or nerve block needle)
  – Skin antiseptic solution

• Medications
  – 1-2 ml of Lidocaine 1% for skin infiltration in the awake patient
  – The Fascia Iliaca block is a compartment block and therefore large amount of local anesthetics is used. The volume is 30-40 ml of long-acting local anesthetic:
    – Bupivacaine 0.25-0.375%
    – Ropivacaine 0.2-0.5%
Positioning

- The patient is placed in supine position with the person performing the block standing along-side the operative hip or thigh. The ultrasound video screen should be on the opposite position for easy viewing.
- The non-dominant hand should hold the ultrasound probe while the dominant hand holds the needle.
- If the patient has a pannus, this should be retracted by assistant or held up using adhesive tape.
Block Placement

• Palpate for the anterior superior iliac spine (ASIS) and then move the probe over it and visualize it on ultrasound.

• Now move the probe 2 – 3 cms medially and inferiorly to see the edge of the ilium.

• Look for the muscle covering the ilium and descending into the pelvis with it. This muscle is the iliacus muscle. The bright band covering the iliacus is the fascia iliaca.
**In-Plane approach:** Stabilize the hand holding the ultrasound probe to minimize movement. Perform a skin wheal at the inferior edge of the ultrasound probe and insert the block needle at the site of the skin wheal.
Complications

- Intravascular injection
- Local anesthetic toxicity
- Temporary or permanent nerve damage
- Infection
- Block failure
- Allergy to any of the medications used
Rectus Sheath Block

Alexandra Lewis, MD
Vimal Akhouri, MD
Introduction

• First described in 1899 by Schleich.(1)
• A simple block traditionally used to manage pain from midline or paramedian abdominal incisions above the umbilicus.
• The advantage of the block is the avascular region, thus intravascular injection of local anesthetic is low.
• By reviewing the anatomy, it is clear that the rectus sheath block is simple and easy to perform.
Anatomy

- The rectus muscle is located in the midline adjacent to the umbilicus (fig. 1). The terminal branches from T9 to T11 penetrate the belly of the rectus muscle and these nerves are the target of the rectus sheath block.
Anatomy

• The rectus sheath block is performed above the arcuate line, a horizontal line that demarcates the lower limit of the posterior layer of the rectus sheath. In a majority of people, the arcuate line occurs about 1/3 of the distance between the umbilicus to the pubic crest.

• Below the arcuate line, the aponeurosis of the internal and external oblique muscles converge anterior to the rectus sheath muscle (fig.2).

• The fascia of the posterior rectus sheath is less defined below the arcuate line and there is a higher risk of perforation of peritoneum if the rectus sheath block is performed below this level.
Anatomy

Above the Arcuate Line

Below the Arcuate Line
Indications and Contraindications

• **Abdominal Surgeries:**
  – Midline Laparotomy
  – Open Umbilical Hernia Repair

• **Absolute Contraindications**
  – Patient refusal
  – Allergy to local anesthetics
  – Cellulitis/dermatitis at the skin of injection

• **Relative Contraindications**
  – Coagulopathy
  – Anatomical abnormalities
Preparation for Rectus Sheath block

• **Equipment:**
  – 1 24 gauge short-beveled 50 mm needle
  – 1-2 cc of 1% lidocaine in an insulin syringe
  – 1 20cc syringe w/ choice of local anesthetic (Ropivicaine, Bupivicaine).
    • If bilateral block performed, injection of 20ccs 0.25% ropivacaine or 0.25% bupivacaine on each side is appropriate for prolonged postoperative pain control.
    • If a unilateral block is performed, injection of 20ccs of .5% ropivacaine or .375% bupivacaine can be used to achieve an effective block.

• **Preparation:**
  – Position: Supine
**Landmark-Based Approach**

- In the blind technique, the skin is cleaned with an aseptic technique and a 24 short-beveled needle is inserted perpendicular to the skin, ~ 2–3 cm from midline and slightly cephalad to the umbilicus at the apex of bulge of the rectus abdominis muscle (fig. 3). [4]

- The needle is advanced until the fascial pop from the penetration of the anterior sheath is appreciated.

- The needle is then advanced until resistance is felt. This resistance represents the posterior wall of the posterior sheath of the rectus muscle. Local anesthetic is injected after negative aspiration.

- The preferred technique is with ultrasound guidance.
Landmark-Based Approach

Figure 3: Blind technique approach to rectus sheath block [5]
Ultrasound-guided Technique

• The challenge with a blind technique is the inability to assess appropriate depth for size and weight of patient.
• With ultrasound, a 24 gauge needle is inserted ~3-5 cm lateral to the umbilicus.
• A linear probe is placed in a transverse orientation. Lateral movement of the probe brings the lateral border of the rectus sheath muscle into view (fig. 4).
Ultrasound-guided Technique

**Figure 4:** Ultrasound imaging of rectus sheath muscle. Rectus sheath (RS) and rectus abdominis muscle (RA) are indicated.[6,7]
Ultrasound-guided Technique

If the U/S probe is positioned in a longitudinal orientation (fig. 6a), a catheter can easily be threaded and used for intermittent infusion. Regardless of approach, the operator should obtain a negative aspiration prior to injection of local anesthetic. If the needle is in the correct position, the rectus sheath muscle should be easily lifted from the posterior sheath (fig. 6b).
**Figure 6**: Fig. 6a featured on the right represents needle placement in relation to the posterior rectus sheath (PRS) with a longitudinal approach. Fig. 6b illustrates infiltration of local anesthetic. [7]
Complications

- Intravascular injection of the superior and inferior epigastric vessels
- Allergic reactions to local anesthetics
- Perforation of peritoneum
- Hematoma formation
Clinical Pearls

• A distended or obese abdomen may distort the appearance of the rectus muscle under ultrasound guidance. Rectus sheath block is a challenge in elderly patients and patients with poor muscle tone.

• Superficial injection of local anesthetics often produce a bulge in the abdominal wall and indicates inappropriate depth of the needle.

• Injection of small aliquot of local anesthetic under ultrasound guidance can indicate whether the needle is at an appropriate depth and plane.

• Avoid performance of block near the xiphoid or pubis symphysis -> higher risk of perforation of the peritoneum.
TAP vs. Rectal Sheath Block?

• A rectus sheath block is an appropriate block for midline incisions above the umbilicus. This block provides minimal analgesia for incisions extending to lateral abdominal wall.

• Compared to the rectus sheath block, the standard TAP block captures the lateral cutaneous nerves and is more suitable for transverse or midline incisions BELOW the umbilicus.

• For transverse incisions ABOVE the umbilicus, an oblique subcostal TAP block can be performed. This block is a slight modification of the TAP block and needle insertion occurs directly below the costal margin.

• Both blocks can be undertaken, but extreme caution is warranted with the volume and concentration of local anesthetic infiltrated.
References

• Webster, K. Ultrasound guided rectus sheath block – analgesia for abdominal surgery. Update in Anaesthesia.
• Webster, K. Ultrasound guided rectus sheath block – analgesia for abdominal surgery. Update in Anaesthesia.
Transversus Abdominis Plane Block

Alexandra Lewis, MD
Vimal Akhouri, MD
Tranversus Abdominis Plane Block

• Relatively new regional anesthetic technique described in 2001 by Dr. Rafi. (1)
• Demonstrated increasing analgesic utility in patients undergoing prostatectomy, cesarean section, cholecystectomy, large and small bowel surgeries.
• Significant reduction in systemic opioid use when TAP block is performed in conjunction with alternative analgesics.
Anatomy

• The first step in performing an effective transversus abdominis plane block is to gain an understanding of the surface anatomy.
• Three layers of muscles compose the abdominal wall: external oblique, internal oblique, and the transversus abdominis muscles (fig.1).
• The abdominal wall is innervated by T7 to L1. Branches of these nerves course through a plane between the internal oblique muscle and the transversus abdominis. These nerves are the target of the TAP block.
Anatomy

Figure 1: Transverse section of the abdominal wall with relevant muscular structures and course of nerves within the TAP block.
Preparation for TAP block

• **Equipment:**
  – 1 24 gauge short-beveled 50mm needle
  – 1-2 cc of 1% lidocaine in an insulin syringe
  – 1 20cc syringe w/ choice of local anesthetic (Lidocaine, Ropivacaine).
    • For rapid onset, 20ccs of 1% lidocaine is recommended. Otherwise, 20ccs 0.2% -0.5% ropivacaine or 0.25% bupivacaine is appropriate for prolonged postoperative pain control.

• **Preparation:**
  – Position: Supine
Landmark-Based Approach

- Prior to the introduction of ultrasound-guided technique, a blind technique was traditionally used. In this approach, the borders of the lumbar triangle of Petit were identified (fig. 2).

**Figure 2:** Boundaries of the triangle of Petit illustrated.
Landmark-Based Approach

- The inferior aspect of the triangle is the iliac spine.
- The anterior aspect of the triangle runs parallel to the external oblique muscle.
- The posterior aspect of the triangle reflects the border of the latissimus dorsi muscle, which is often delineated by a line connecting the iliac spine to the costal margin.
- Once the triangle of Petit is identified, the patient is prepped and draped in a sterile fashion in the supine position. After 1% lidocaine is infiltrated, a 24 gauge needle is inserted perpendicular to the skin.
Landmark-based Approach

• In the classic approach, a single fascial ‘pop’ indicated an appropriate depth for infiltration of local anesthetic.(4)  
• O’Donnell et al. (2006) later modified this technique by inserting the needle slightly above the iliac crest.(5) Two distinct pops are appreciated with this technique.  
• The initial pop represents penetration through the fascia of the external oblique muscle and the second pop represents penetration through the fascia of the internal oblique muscle.  
• Ultrasound guided approach is the preferred method. The Landmark based approach is listed here for a better understanding of the surrounding anatomy.
Ultrasound-guided Technique

- By understanding the blind technique, it facilitates the identification of relevant structures with ultrasound.
- A linear ultrasound probe is selected and provides superficial and high resolution of muscle layers.
- The probe is applied in the transverse position over the triangle of Petit (fig. 3).

Figure 3: Position of ultrasound probe for placement of transverse abdominis block. [6]
Ultrasound-guided Technique

• Use the probe to scan and identify the external oblique, internal oblique, transversus abdominus muscles and peritoneum. (fig. 4)
• Once the desired image is obtained, a 24 gauge short-beveled needle is inserted in line with the probe and can be inserted medial to the probe (fig. 3).

Figure 4. Ultrasound imaging of external oblique, internal oblique and transversus abdominis muscles. [7]
Ultrasound-guided Technique

• When the needle lies in the plane between the internal oblique and transversus abdominis, the operator should obtain a negative aspiration prior to injection of local anesthetic.

• If the needle is in the correct position, the internal oblique and transversus abdominis muscle should separate easily without resistance (Fig. 5).

Figure 5: Ultrasound image illustrating infiltration of local anesthetic between the internal oblique (IO) and transversus abdominis (TrA) muscle. [8]
Complications

• If the needle is inserted too deep into the muscles, there is risk of perforation of the peritoneum.
• With any regional block, intravascular injection and allergic reactions to local anesthetics are potential risks.
Clinical Pearls

• A distended or obese abdomen may distort the appearance of the muscle layers under ultrasound guidance.
• Injection of small aliquot of local anesthetic under ultrasound guidance can indicate whether the needle is at an appropriate depth and plane.
• For high abdominal incisions, a modification in technique was described by Hebbard et al in 2008 as the oblique subcostal transversus abdominis block.(9) The block is modified to insert the needle below the costal margin with a medial approach adjacent to the rectus abdominis muscle.
• Caution is warranted in upper quadrant regions due to risk of perforation of solid organs.
References