

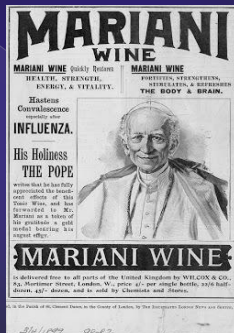
Regional Anesthesia: Upper and Lower Extremity Blocks, Local Anesthetics and Complications

Maria Hirsch, CRNA, DNAP

History- Local Anesthetics

- 1st LA discovered was **cocaine**, an alkaloid from the leaves of *Erythroxylon coca*, found in the highlands of Peru
- 1905- **procaine** synthesized as the first chemical substitute for cocaine
- 1943 **lignocaine** synthesized by Lofgren
- Since then, with the exception of chlorprocaine, all new local anesthetics introduced into clinical practice have been amino-amides

Pope Leo XIII



Local anesthetics

- Amino Amides
Metabolism:
Hepatic and renal
- Amino Esters
Metabolism:
Plasma esterase
- Mechanism of action: prevent transmission of nerve impulses by inhibiting passage of sodium ions through ion-selective sodium channels

Esters

Esters	Potency	Onset	Duration after infiltration (mins)	Max single dose for infiltration (mg)
Procaine *	1	Slow	45-60	500
Chlorprocaine	4	Rapid	30-45	600
Tetracaine *	16	Slow	60-180	100 (topical)

* Not used in PNB

Allergic reactions are more likely to occur with esters because they are metabolized to paraaminobenzoic acid.

Amides

Amides	Potency	Onset	Duration after infiltration (mins)	Max single dose for infiltration (mg)
Lidocaine	1	Rapid	60-120	300 (5-7mg/kg)
Etidocaine	4	Slow	240-280	300
Prilocaine	1	Slow	60-120	400
Mepicacaine	1	Slow	90-180	300 (5-7mg/kg)
Bupivacaine	4	Slow	240-480	175 (2-3mg/kg)
Levobupivacaine	4	Slow	240-480	175
Ropivacaine	4	Slow	240-480	200 (3mg/kg)

Epinephrine



- Duration of LA is proportional to the time the drug is in contact with nerve fibers
- Addition of epinephrine (1:200K or 5 mcg/ml) may be added to help produce vasoconstriction to limit absorption
- 1:400K can also be used effectively and is gaining popularity
- Lidocaine, mepivacaine, and bupivacaine are most affected
- Reduces risk of toxicity

Epinephrine Contraindications

- Epinephrine should **not** be added for peripheral nerve blocks in areas with poor collateral circulation (toes, fingers, ears, etc)
- Patient has of severe HTN, CAD, hyperthyroidism, arrhythmia, utero-placental insufficiency

Sodium Bicarbonate

- Increases the rate of diffusion and speeds the onset of neural blockade
- 1mEq added to each 10ml lidocaine or mepivacaine
- 0.1mEq added to each 10ml bupivacaine or ropivacaine
- Less burning
- Denser motor block
- Can precipitate



Decadron

- Minimal studies in PNBs
- Appears to > duration by up to 6 hours
- 4mg added to LA
- Do not use steroid additives which contain benzyl alcohol (neurolytic)
- Avoid additional decadron intraop

Other Adjuncts

- Toradol
 - > Mixed results in PNBs
 - > Effective when added to IVBs, field blocks, intra-articular
- Clonidine/Dexmedetomidine
 - > α_2 -adrenoreceptor agonist
 - > Prolongs duration of block
 - > 1mcg/kg
 - > Expensive

Exparel (bupivacaine liposome injectable suspension)

- For tissue infiltration
- 266 mg/vial-20ml 1.3%
- Should not administer within 20 mins of lidocaine or other non-bupivacaine locals (may cause immediate release of bupivacaine)
- Do not give other bupivacaine formulations within 96 hrs
- 24 hrs pain control in studies



Table 2: Nerve Fiber Types and Nerve Blocking

Fiber Type	Function	Diameter (microns)	Myelination	Conduction Velocity (m/s)	Sensitivity to Nerve Block
Type A					
Alpha (α)	Proprioception, motor	12-20	Heavy	70-120	+
Beta (β)	Touch, pressure	5-12	Heavy	30-70	++
Gamma (γ)	Muscle spindles	3-6	Heavy	15-30	++
Delta (δ)	Pain, temperature	2-5	Heavy	12-30	+++
Type B					
Postganglionic autonomic		<3	Light	3-15	++++
Type C					
Dorsal root	Pain	0.4-12	None	0.5-2.3	++++
Sympathetic	Postganglionic	0.3-1.3	None	0.7-2.3	++++

• Pain practitioners block the nerves transmitting pain impulses (Type A- δ , Type C)
 • Lower concentrations of local anesthetic will only block the small unmyelinated and lightly myelinated (Type C and Type A- δ) fibers
 • Middle-frequency currents (2,000-20,000 Hz) block smaller unmyelinated (Type C) and small myelinated (Type A- δ) fibers
 • Larger fibers (Type A- α , β , γ) require high-amplitude currents and are usually spared in electrical, low-dose chemical (eg, labor epidural) blocks

www.practicalpainmanagement.com

Histology of Peripheral Nerves

Peripheral nerve is fascicles held together by an external connective sheath

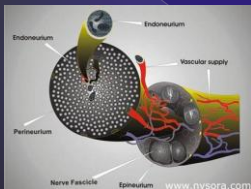
Each fascicle contains nerve fibers, capillaries held together by a loose connective tissue (endoneurium)

Perineurium surrounds fascicles-tough and resistant



Hadzic A., Borgeat A., Deschner S., Complications Of Peripheral Nerve Blocks on NYSORA accessed 1-1-12

Peripheral Nerves, con't.



Peripheral nerves have an extensive blood supply and a "tight junction" with capillaries

Neurovascular bed blood flow is as high as 30-40ml/100g/min

Other substances affect nerve function and are dependent on oxidative metabolism

Mechanism of peripheral nerve injury related to peripheral nerve blocks

Mechanical-acute

Laceration
Stretch
Intra-neural injection

Vascular

Acute ischemia
Hemorrhage

Pressure

Extraneural
Intra-neural
Compartment syndrome

Chemical

Injection of neurotoxic solutions



Example of a mechanical injection injury to a peripheral nerve. From Hadzic A, Borgeat A, Deschner S, NYSORA.com accessed 1-1-12

Classification of Nerve Injuries

Seddon	Sunderland	Structural and functional processes
Neurpraxia	1	Myelin damage, conduction slowing and blocking
Axonotmesis	2	Loss of axonal continuity, endoneurium intact, no conduction
	3	Loss of axonal and endoneurial continuity, perineurium intact, no conduction
Neurotmesis	4	Loss of axonal, endoneurial, and perineurial continuity, epineurium intact no conduction
	5	Entire nerve trunk separated; no conduction

From NYSORA website; Hadzic A, Borgeat A, Deschner S. Complications of Peripheral Nerve Blocks, accessed 1/1/12

Prevention of Nerve Injury



B-Smart™ Nerve Block Pressure Injection Monitor
Macosta Medical USA, LLC

- Avoid using an injection pressure higher than 20 psi
- Avoid forceful, fast injections
- Use one size needle and consistent syringe size, "one hand" technique
- Use short-bevel needles (30 or 45 ° angle)
- Compressed air technique

Ultrasound



- Use of US *most likely* improves safety of PNBs
- Offers the ability to visualize what has previously been performed blindly
 - > Nerves and adjacent structures
 - > Location of needle tip
 - > Spread of local anesthetic



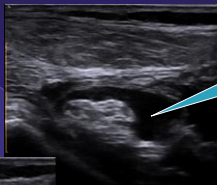
- US imaging can detect subepineural injection at some PNB sites (such as sciatic)
 - > Epineurium is echogenic compared to the hypoechoic image of injected LA



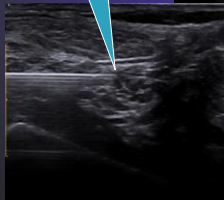
If US is used as a tool for *intentional* intraneural injection resulting in perineural trauma, nerve injury could be increased

The Intraneural Injection

Needle tip entering epineurium



Note "halo"- not full donut



http://www.asra.com/display.spring_2011.php?id=154

Neurotoxicity of Local Anesthetics

- All local anesthetics are potentially neurotoxic
- The greater the LA potency, concentration, and length of exposure to neuronal tissue, the greater the risk of neurotoxicity

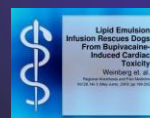


Neurotoxicity of Local Anesthetics

- There are no human data to support the use of one LA or additive over another to reduce neurotoxicity
- Patients with previously injured nerves (DM, severe PVD, chemotherapy) may benefit from lower doses/concentration and avoiding vasoconstrictive additives

Neal JM, Bernards CM, Haddad A, et al. ASRA practice advisory on neurologic complications in regional anesthesia and pain medicine. Reg Anesth Pain Med 2008; 33:404-15

Local Anesthetic Systemic Toxicity (LAST)



- Administration of lipid emulsion causes lipophilic medications to be trapped in an expanded plasma lipid compartment aka. "lipid sink"

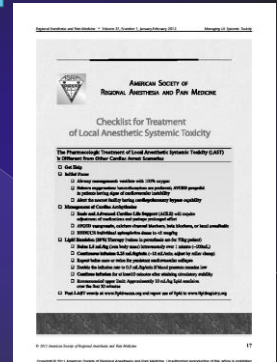
Management of LAST

- 20% lipid emulsion given at 1.5ml/kg (lean body mass) over 1 min; then infusion of 0.25ml/kg/min (max 10ml/kg)
- May be beneficial even after prolonged cardiac arrest
 - Bupivacaine has been shown to delay the onset of myocardial acidosis during no-flow states

American Society of Regional Anesthesia and Pain Medicine, 2010 Practice advisory on local anesthetic systemic toxicity (LAST) accessed online 1/17/12

Management of LAST

- ASRA practice advisory recommends use of a checklist (www.asra.com)
- Should have 20% lipid emulsion available in all sites where LA is used



Management of LAST

- Propofol is **not** a component of lipid rescue
 - Small doses may help control seizure activity
 - As a 10% emulsion, it would require gram quantities to provide enough lipid



Regional Anesthesia in Anesthetized Adults



- Inadequate data to formally evaluate this practice
- Pain or paresthesias with needle/catheter placement or during injection **major known risk factors** cannot be identified

- Patients cannot report early signs of LA toxicity
- Use of a nerve stimulator *does not* protect an anesthetized patient from nerve injury



Preparation for Blocks

- Ultrasound with appropriate transducer(s)
- Sterile towels, sponges, probe cover, gel
- 25 gu 1.5 in needle syringe for skin local
- Appropriate short-bevel block needle
- Extension tubing, stopcock
- Syringes with local anesthetic of choice
- Assistant, monitors, sedation, emergency equipment



Upper Extremity/Brachial Plexus Blockade

• Several Approaches

- > Interscalene
- > Posterior
- > Supraclavicular
- > Infraclavicular
- > Axillary

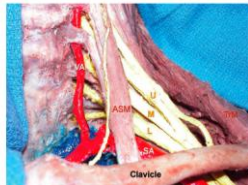
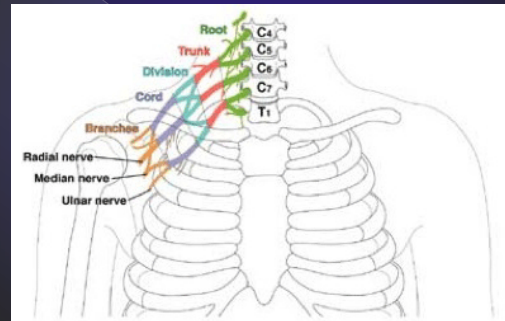
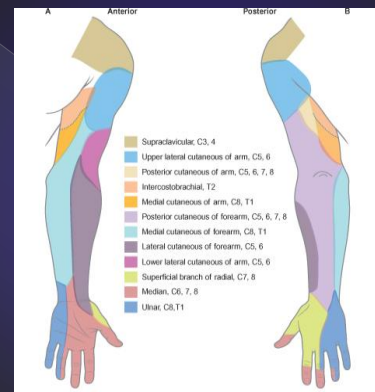
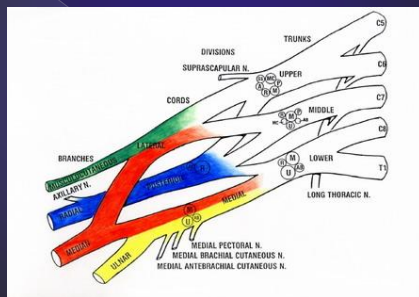


FIGURE 20 Relationship of the arterial vasculature and the brachial plexus at the level above the clavicle.



Brachial Plexus



© Elsevier Ltd 2005. Standing: Gray's Anatomy 39e - www.graysonline.com

Interscalene Approach (root)

• Anatomy

- > Between anterior and middle scalene muscles
- > C6 level

• Indications

- > Surgery to shoulder to mid-forearm
- > Reduction of dislocated shoulder

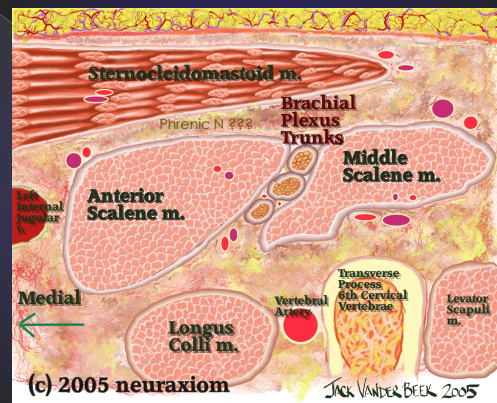
• Supplies

- > 5 cm blunt block needle
- > 20-35 ml local anesthetic



FIGURE 21 C-antibiotic brachial plexus block. Needle is inserted in the interscalene space using an 8-cm needle. Please note that for better demonstration, sterile drapes are not used in the model in this figure.

http://www.amazon.com/Hadzics-Peripheral-Ultrasound-Guided-Regional-Anesthesia/dp/0071549617/ref=sr_1_1?ie=UTF8&qid=1334330534&sr=8-1



(c) 2005 neuraxiom

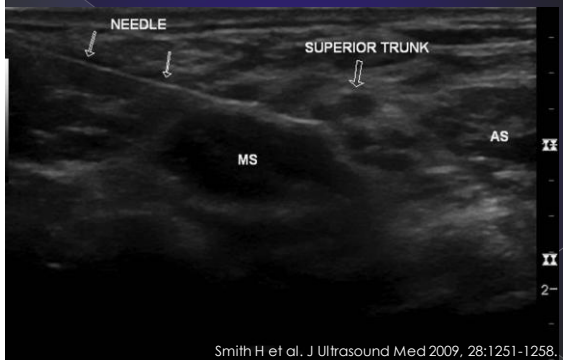
JACK VAN DER BEEK 2005



Interscalene Block- US



Interscalene Block

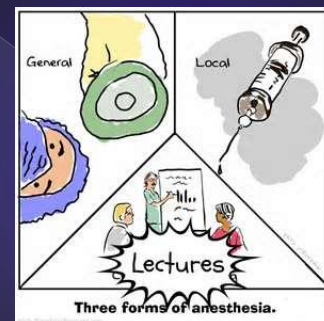
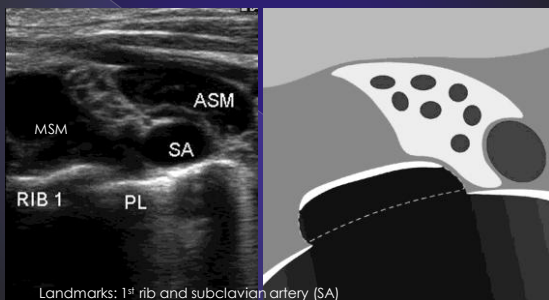


Supraclavicular Approach(trunk)

- Anatomy
 - > Midway between the sternal notch and the acromioclavicular junction
- Indications
 - > Upper arm, forearm and hand surgeries
 - > Decreased risk of phrenic nerve paresis
- Supplies
 - > 5 cm blunt block needle
 - > 15-30 ml local anesthetic



Supraclavicular Approach

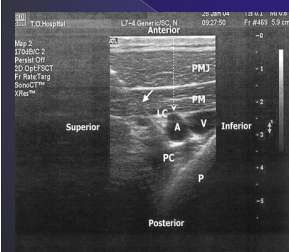


Infraclavicular Block

- Anatomy
 - > Identify coracoid process
 - > 2 cm medial and 2 cm inferior
- Indications
 - > Mid-forearm and hand surgery
- Supplies
 - > 5-8 cm 22 gu blunt block needle
 - > 20-40 ml local anesthetic



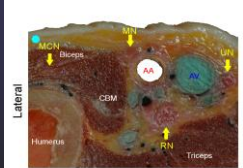
Infraclavicular Block



Inject local at 12' and 6' O'Clock locations around artery

- Short closed arrow identifies needle. Long dashed arrow represents needle trajectory of traditional "blind" coracoid approach.
- A = axillary artery
- LC = lateral cord
- P = pleura
- PC = posterior cord
- PM = pectoralis minor
- PMJ = pectoralis major
- V = axillary vein.

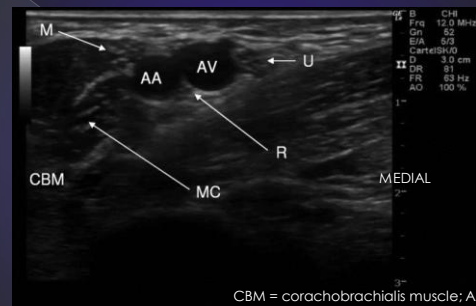
Axillary Approach(branch)



Axillary Brachial Plexus

- Anatomy
 - > Axillary crease
 - > Pulse of the axillary artery
 - > Needle insertion lateral to the pulse
- Indications
 - > Lower arm and hand surgery
- Supplies
 - > 5cm 22gu block needle
 - > 30-40 ml local anesthetic (10-15 per nerve)

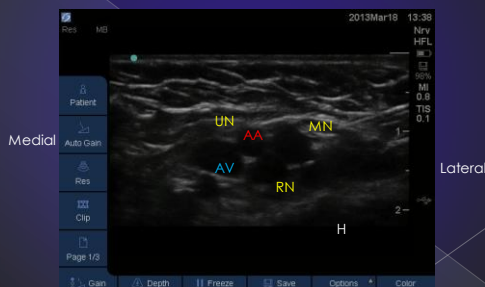
Axillary Block



Dufour E et al. Anesth Analg 2009;108:1981-1993

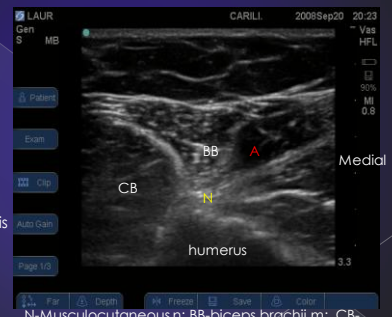
CBM = coracobrachialis muscle; AA = axillary artery; AV = axillary vein; M = median nerve; MC = musculocutaneous nerve; U = ulnar nerve; R = radial nerve.

Axillary Block



Musculocutaneous Nerve

Nerve can lie in many locations; between the coracobrachialis and biceps muscles (most common-seen here), within the coracobrachialis muscle and near the axillary artery



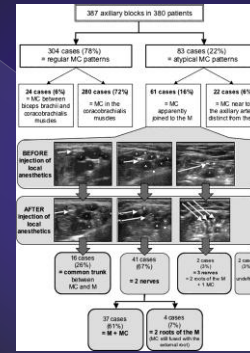
N-Musculocutaneous n; BB-biceps brachii m; CB-coracobrachialis m

Musculocutaneous Nerve



BB-Biceps brachii muscle; CB-coracobrachialis m, MN-musculocutaneous n

Distribution of the main patterns of musculocutaneous nerve localization in 387 axillary blocks using ultrasound guidance before and after injection of local anesthetics.

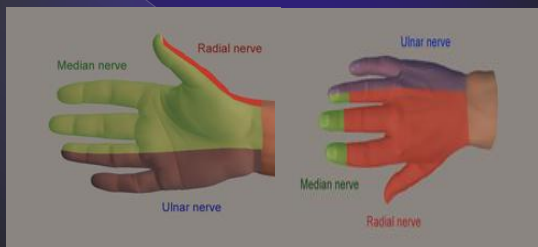


©2010 by Lippincott Williams & Wilkins

Remeraud F et al. Anesth Analg 2010;110:1729-1734

ANESTHESIA & ANALGESIA

Distal Upper Extremity

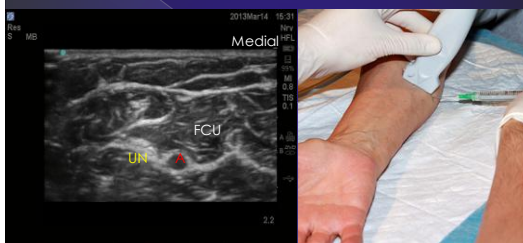


Radial Nerve- mid forearm



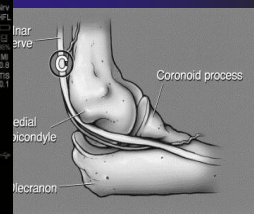
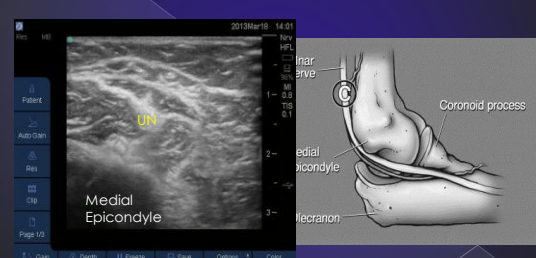
N-radial nerve; BR-brachioradialis muscle

Ulnar Nerve-mid forearm

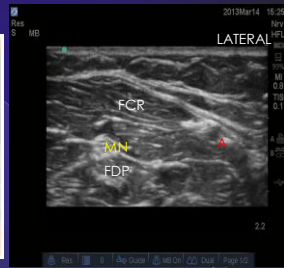


UN-ulnar nerve, A-ulnar artery; FCU flexor carpi ulnaris muscle

Ulnar Nerve Proximal to Elbow

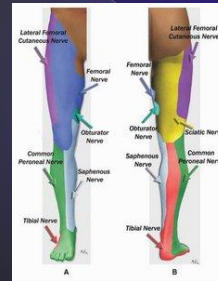


Median Nerve-mid forearm



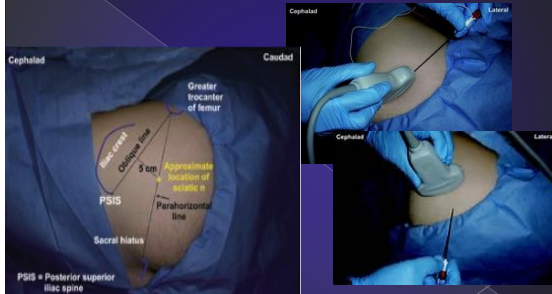
MN-median n; A-radial artery; FCR-flexor carpi radialis muscle; FDP-flexor digitorum profundus muscle

Lower Extremity Blocks



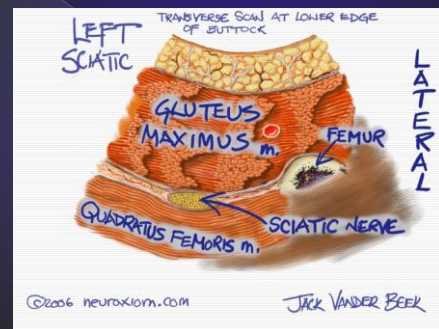
- Gluteal (Labat) Sciatic Nerve Block
- Subgluteal Sciatic Nerve Block
- Femoral Nerve Block
- Popliteal Block

Gluteal Sciatic Nerve Block

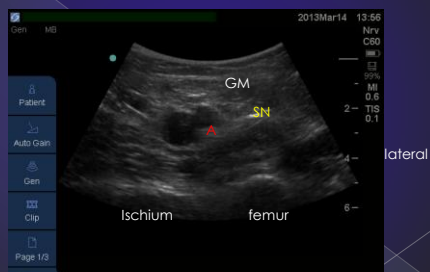


Tsui B., Atlas of ultrasound and nerve stimulation-guided regional anesthesia (2007) Springer publishing.

Gluteal Sciatic Nerve Block



Sciatic Nerve-Gluteal

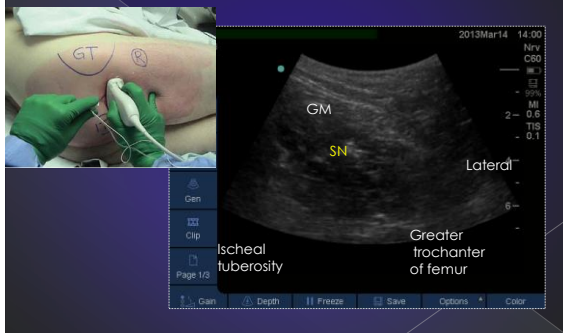


GM-gluteus maximus muscle; SN-sciatic nerve; A- int pudendal artery vs. int gluteal artery

Sciatic Nerve- Gluteal



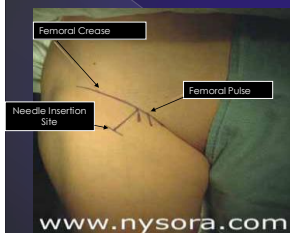
Sciatic Nerve-Subgluteal



Sciatic Nerve- Subgluteal

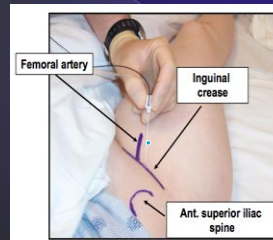


Anterior Approach to the Sciatic Nerve



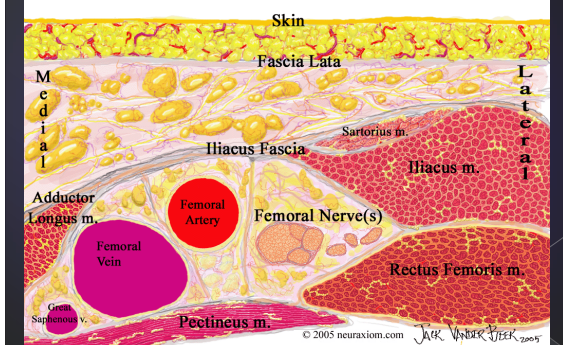
- Landmarks
 - Femoral crease
 - Femoral artery pulse
 - Needle insertion point marked 4-5 cm distally on the line passing through the pulse of the femoral artery and perpendicular to the femoral crease.

Femoral Nerve Block

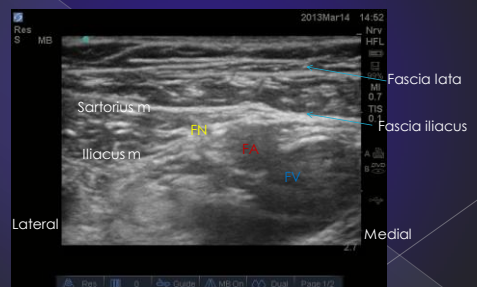


- Anatomy
 - Femoral crease
 - Femoral artery pulse
 - Needle entry lateral to pulse
- Indications
 - Surgery on anterior thigh, knee, quadriceps tendon repair
- Supplies
 - 5-8 cm block needle
 - 20-30 ml local anesthetic

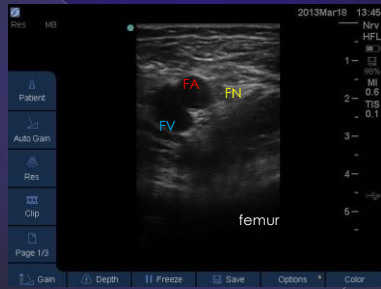
Structures Seen on Ultrasound in Left Femoral Space (viewed from foot)



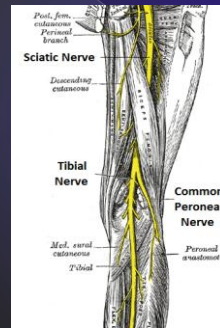
Femoral Nerve



Femoral Nerve



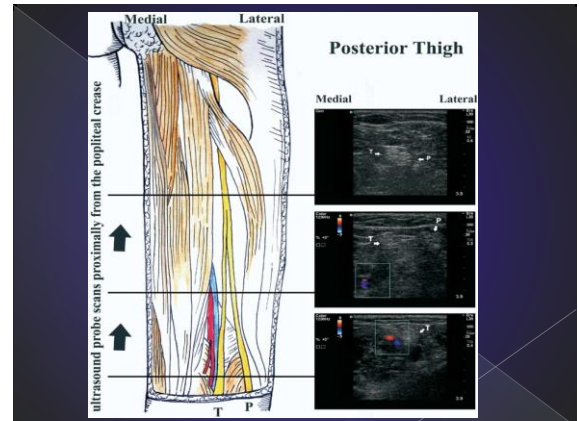
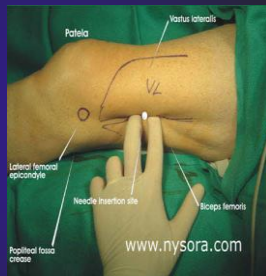
Sciatic Nerve-Popliteal Block



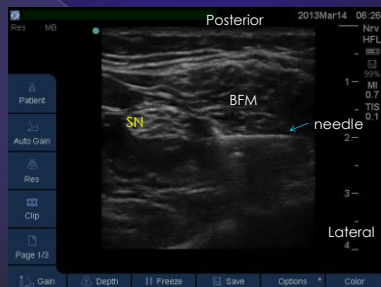
- Anatomy:
 - > In the popliteal fossa, the sciatic nerve lies posterior and lateral to the popliteal artery and vein, bordered medially by the semitendinous and semimembranous muscles and laterally by the biceps femoris muscle.
- Indications:
 - > Calf, ankle and foot surgery
- Supplies:
 - > 20-45 mL local anesthetic
 - > 5-8cm block needle

Popliteal Block: Lateral Approach

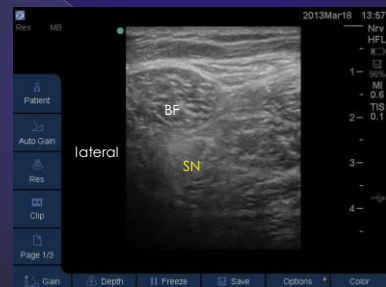
- Anatomic Landmarks:
 - > Popliteal fossa crease
 - > 8-10 cm above the popliteal fossa crease in the groove between the vastus lateralis muscle and biceps femoris
 - > Have patient lift leg to identify landmark (groove between vastus lateralis and biceps femoris)



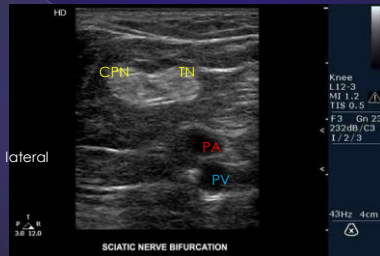
Popliteal block- Sciatic Nerve



Popliteal Block-Sciatic Nerve



Bifurcation Sciatic Nerve



CPN –common peroneal nerve; TN-tibial nerve

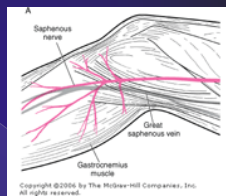
Popliteal Block of the Sciatic Nerve: Posterior (Intertendinous) Approach

- Anatomy
 - > Popliteal fossa crease
 - > Tendon of biceps femoris (laterally)
 - > Tendons of semitendinosus and semimembranosus (medially)
- Indications
 - > Ankle and foot surgery

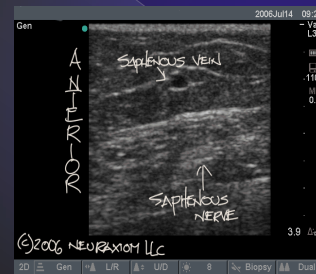


Saphenous Nerve Block

- Anatomy:
 - > The main landmark for this block is the tibial tuberosity
- Indications:
 - > Anesthesia to lower medial leg
- Supplies
 - > 23-25 gu needle
 - > 3-5ml local anesthesia



Saphenous Nerve



- Purely sensory nerve
- Lies posterior to Saphenous vein, which is easily compressible
- Usually shallow unless pt has a lot of sub Q fat (2-4cms)

Saphenous Nerve



- Can reduce gain until the saphenous nerve is last thing visible to help locate
- May need a tourniquet around thigh to help locate saphenous vein

Ankle Block

Volar Foot:

- Posterior tibial nerve
- Sural nerve

Dorsal Foot:

- Saphenous nerve
- Anterior tibial nerve (deep peroneal nerve)
- Superficial peroneal nerve

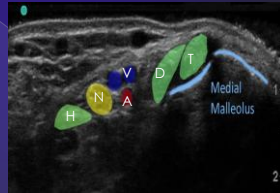


Posterior Tibial Nerve Block



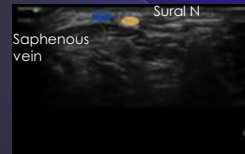
Provides anesthesia to most of the Bottom of the foot

From anterior to posterior, the order of structures is:
 T = tibialis posterior tendon
 D = flexor digitorum tendon
 A = posterior tibial artery
 V = posterior tibial veins (usually more than one)
 N = tibial nerve
 H = flexor hallucis longus tendon



22-25 gu needle, 5-8 ml local anes

Sural Nerve Block



Saphenous vein



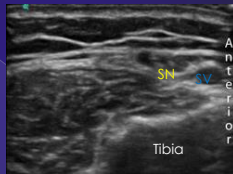
25 gu needle; 3-5 ml local anesthetic

Sural nerve is a sensory nerve that provides cutaneous innervation to the posterior calf, lateral ankle, lateral heel, and foot

Saphenous Nerve Block at Ankle



25 gu needle, 3-5ml local anesthetic



The saphenous nerve is a sensory nerve. Blockade of the nerve at the ankle provides anesthesia to a small medial portion of the ankle and foot.

www.sonoguide.com

Anterior Tibial Nerve Block (Deep Peroneal)



25 gu needle, 5-8 ml local anesthetic



Anterior tibial nerve supplies sensation to the medial half of the dorsal foot; in particular the first and second digits.

www.vaulttrasound.com

Superficial Peroneal Nerve

- The superficial peroneal nerve is almost impossible to visualize with ultrasound
- It is most commonly blocked by infiltrating local anesthetic at the malleolar level along the lateral aspect of the foot (3-5 ml local)

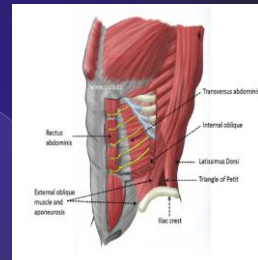


The yellow arrows indicate the superficial peroneal nerve. Note its course anterior to the lateral malleolus.

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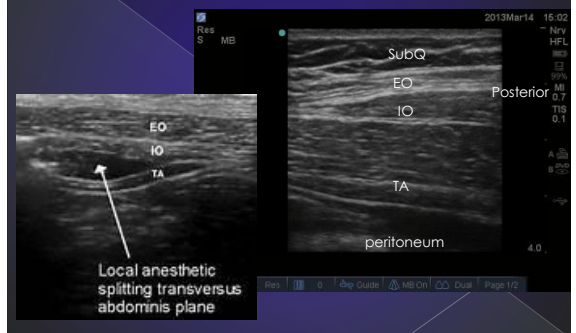
Transverse abdominus plane (TAP) block

- Anatomy landmarks
 - > Borders of the Triangle of Petit: iliac crest inferiorly, external oblique m. anteriorly, latissimus dorsi m. posteriorly
- Indications
 - > Surgery involving lower abdominal wall
- Supplies
 - > 22-17gu Touhy or B-bevel block needle
 - > 20ml local anesthesia per side

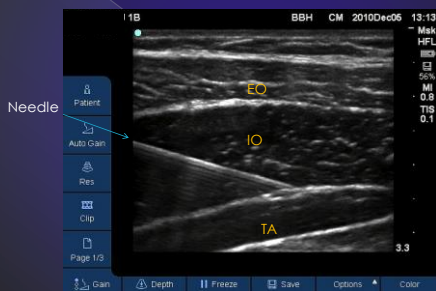




TAP Block



TAP Block



Internet Resources

- www.neuraxiom.com
- www.vaulttrasound.com
- www.sonoguide.com