

# **Peripheral Nerve Blocks Overview and complications**

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# Objectives

- Discuss the advantages and disadvantages of peripheral nerve blocks
- Discuss the physiology and pharmacology of peripheral nerve blocks
- Identify the types of upper and lower extremity peripheral nerve blocks, their effects and uses.
- Discuss common complications of peripheral nerve blocks
- Describe nursing management of the patient undergoing peripheral nerve blockade to include patient education

BILL ABBOTT



“...and this is Ralph, your anesthesiologist.”



# Peripheral Nerve Blocks

- Part of a pre-emptive multimodal analgesic technique providing safe and effective post-operative pain management with minimal side effects.
- Appropriate for both the in-patient and out-patient setting, PNB's afford both anesthesia and extended analgesia for a variety of surgical procedures.
- Afferent nociceptive (pain) stimulus from the injured tissue is prevented from reaching the central nervous system by preinjury neural blockade.
- Pain may be eliminated or minimized.

# Advantages of PNB

- Reduced postoperative pain resulting in greater patient satisfaction with their pain management
- Early ambulation and discharge
- Decreased side effects of nausea and vomiting, drowsiness secondary to less opioid use for pain control.
- Less sedation during surgery allows patients to remain conscious (MAC) thus protecting their airway and avoiding airway manipulation and intubation

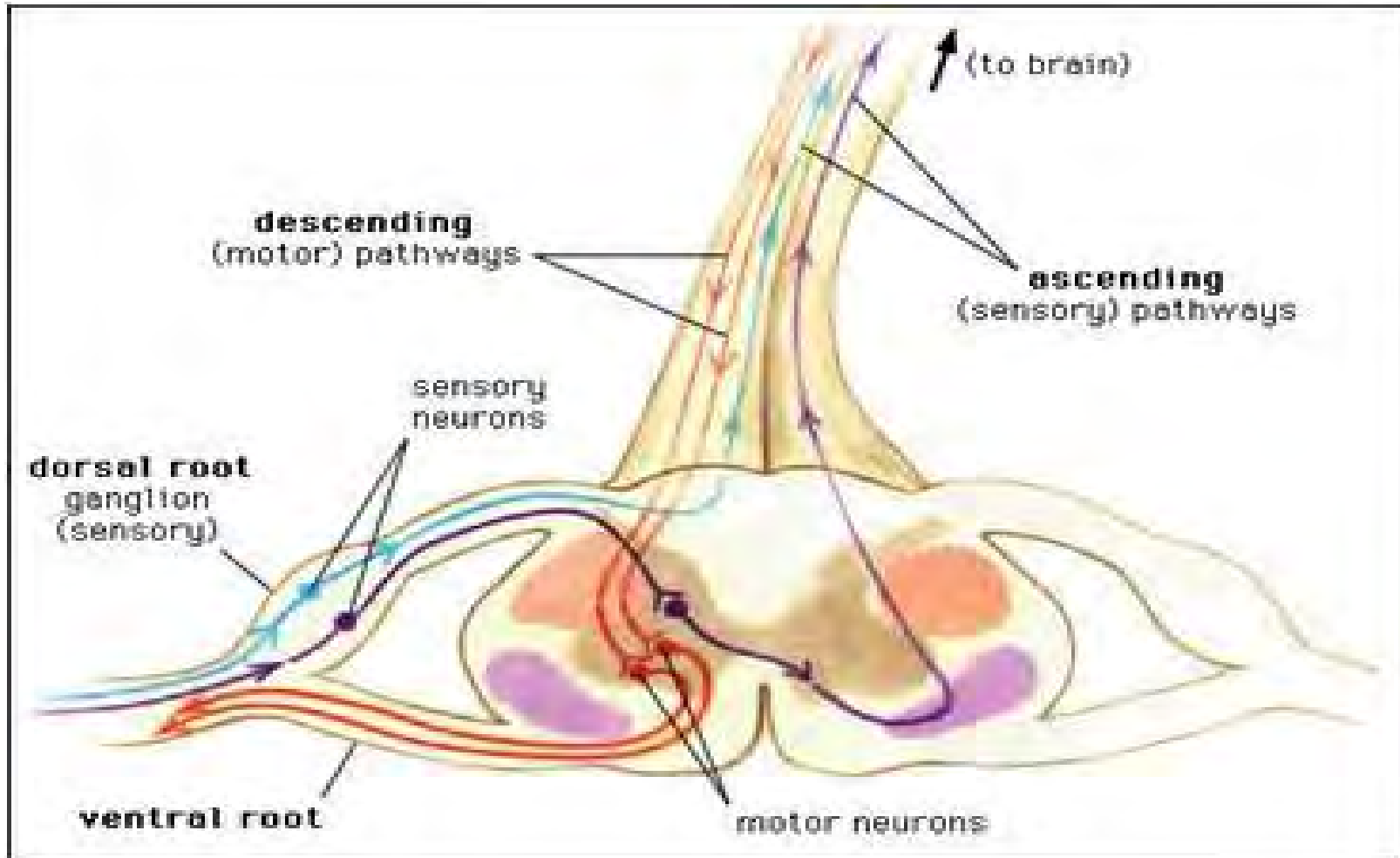
# Disadvantages of PNB

- Requires technical expertise from a variety of medical clinicians
- Time required preoperatively for block placement. This may be offset by decreased anesthesia time in the OR and shorter length of stay in the PACU
- Contraindicated in patients with a history of coagulopathies, preexisting neuropathies, anatomical aberrancy/pathology at injection site, or systemic disease or infection

# Neurophysiology

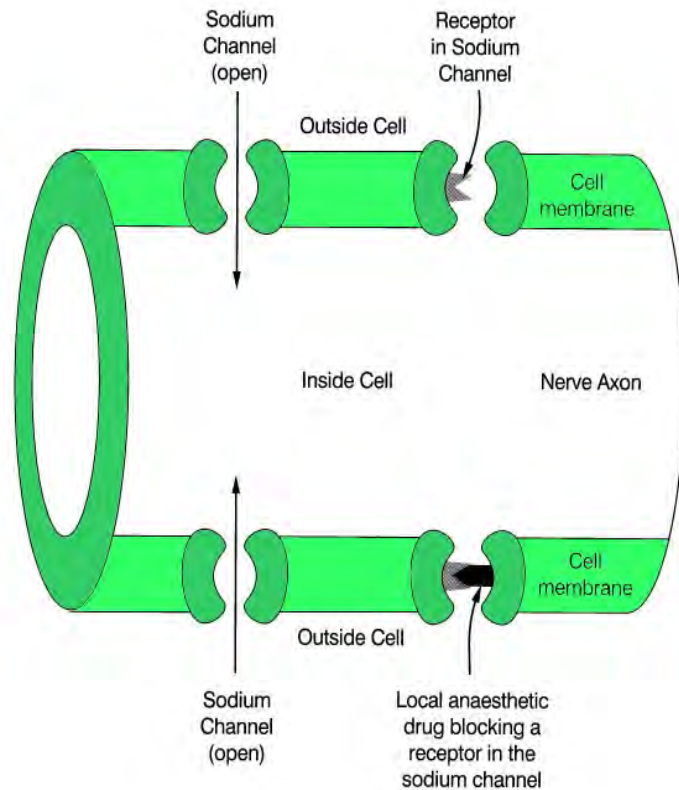
- Local Anesthesia (LA) blocks transmission in ascending and descending nerve pathways. The order of the nerve fibers affected by LA is sensory, motor, and sympathetic.
- Of note, resolution or regression of the block occurs first in motor fibers, then sensory and lastly sympathetic.
- This pattern is important when instructing patients about preemptive pain management and postoperative use of the extremity.

# Neurophysiology





# Neurophysiology



- On a cellular level, it is the influx of sodium into the cell that is responsible for generating an action potential causing depolarization and conduction of the nerve fibers.
- Local Anesthetic (LA) changes the permeability of the cell membrane to sodium interfering with the ability of sodium to enter the cell. This interference with nerve fiber conduction prevents the sensory or motor information from being transmitted to and from the brain. This also applies to cardiac conduction.

# Pharmacology

- Peripheral nerve blocks (PNB) involve injecting a local anesthetic near or around the nerve or nerve plexus that supplies the surgical area.
- The duration of action for each anesthetic medication depends on several factors; injection volume, concentration of the medication, and absorption.
- Single injection commonly 30-40cc
- Percutaneous insertion of a catheter directly near the peripheral nerve supplies the surgical site with a continuous infusion

# Local Anesthetics for Peripheral Nerve Blocks

Drug	Concentration (%)	Onset	Duration (min)	Maximum Single Dose
Lidocaine	1-1.5	Fast	60-180	300 mg
Mepivacaine	1.5-2.0	Fast 3-5min	120-140 Peak 15-45 min	400mg
Bupivacaine	0.25-0.5	Slow 4-10min	240-360+ Peak 30-45min	175mg
Ropivacaine	0.5-1	Slow 10-30 min	300-600+	250mg

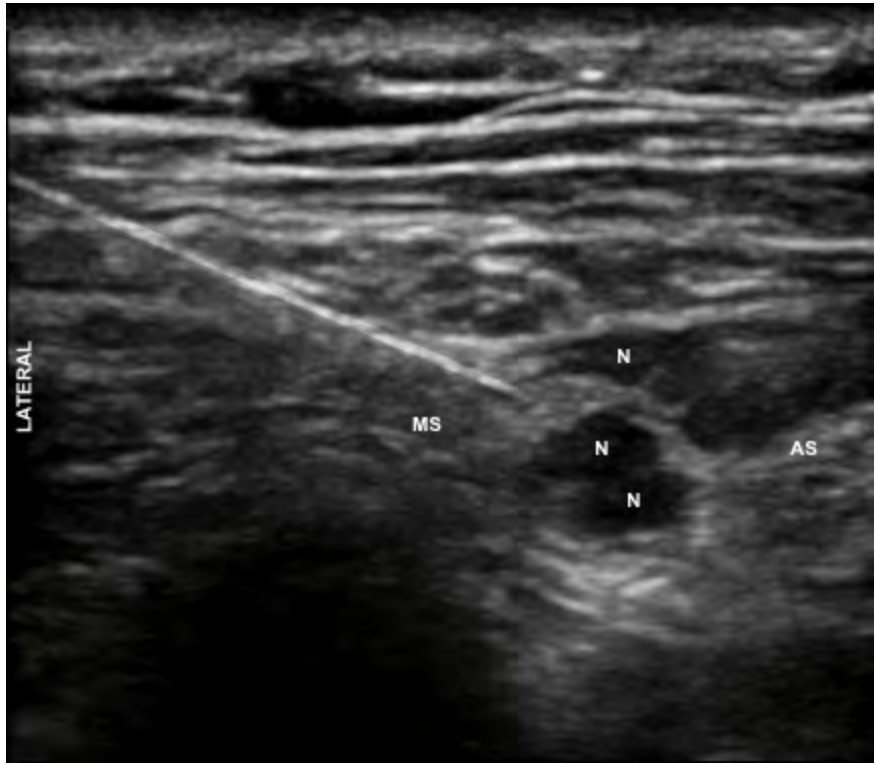
# Injection techniques

- **Aspiration:** occurs before the initial injection of LA to avoid intravascular infusion and after each 5ml of injected Local Anesthetic
- **Injection pressure:** Using one hand and a 20cc syringe, apply slow and deliberate force. If force is too high, nerve damage may occur
- **Resistance:** Discontinue the injection and notify anesthesia if there is high resistance to the injection. Needle needs repositioning.



# Ultrasound Guidance

- Ultrasound guidance enhances visualization of the neural target and its surrounding structures. Able to differentiate between vascular and non-vascular structures with the use of Doppler flow, as well as other structures i.e. lung.
- Unintentional intraneural injection is reduced
- Assessment of the proper needle-tip position occurs in real time
- Visualization of LA spread around the neural target ensures a successful block procedure
- Allows for use of a smaller volume of LA due to the ability to visualize the administration during injection.
- Identification of anomalous anatomy or pathology,

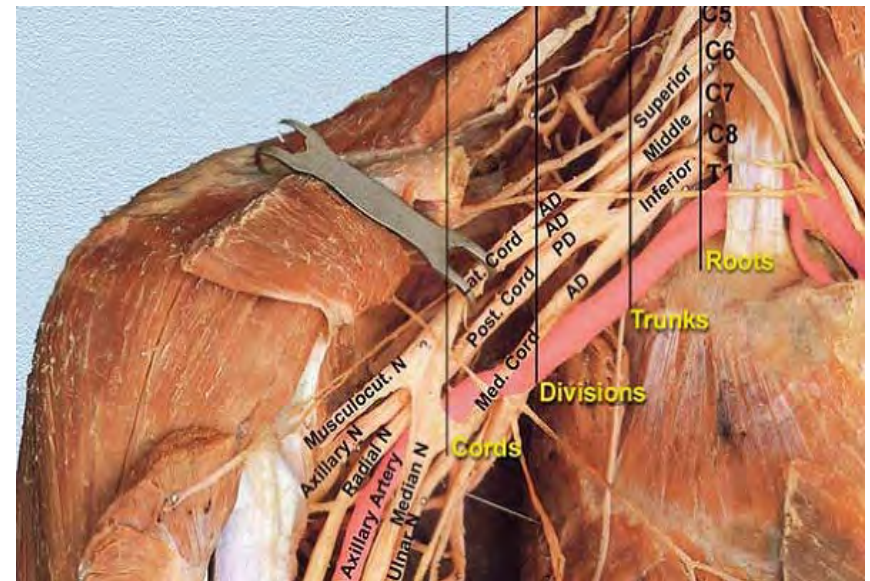


# Upper extremity

Interscalene  
Supraclavicular  
Infraclavicular  
Axillary

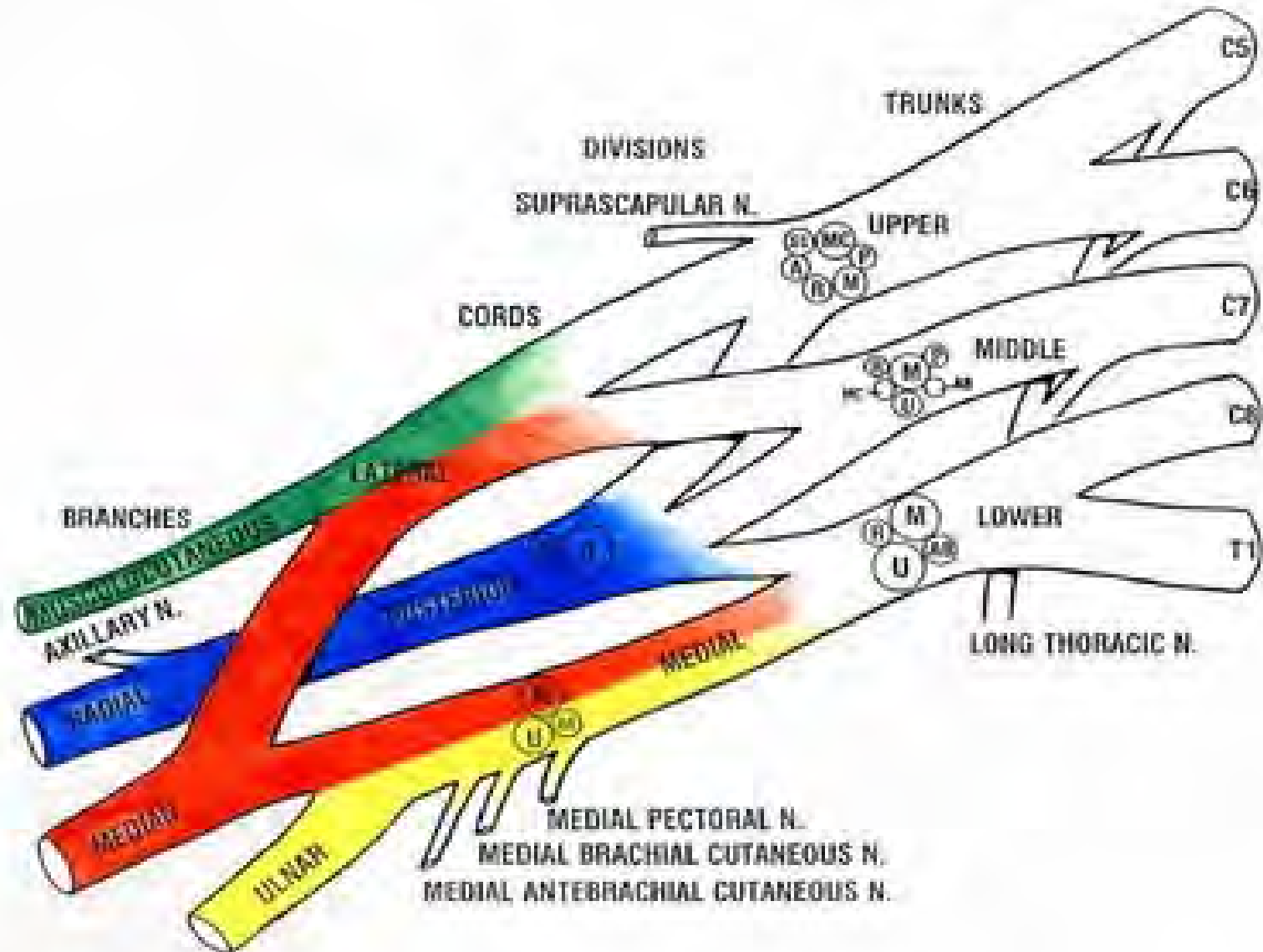
# Brachial plexus anatomy

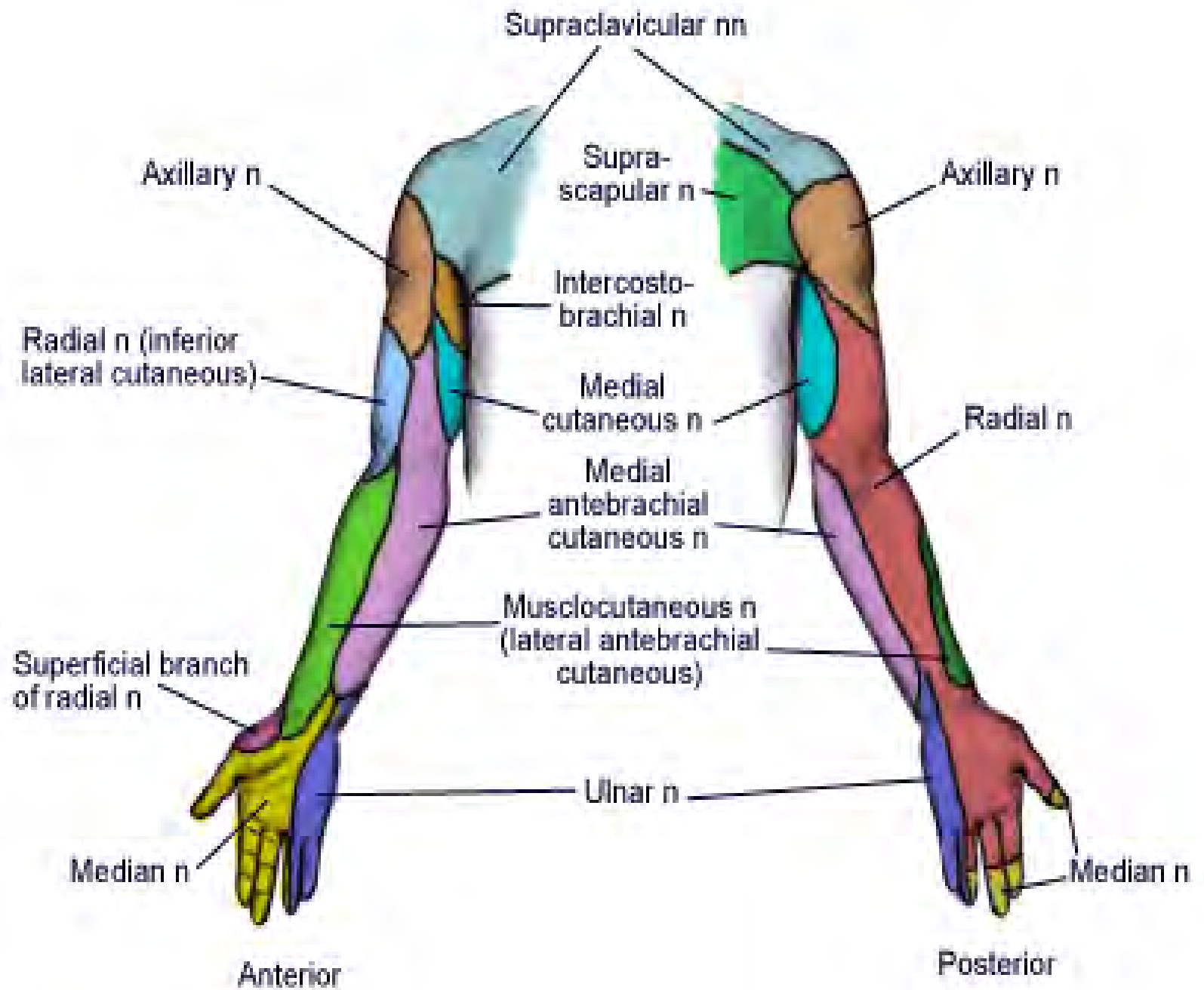
- The brachial plexus extends from C5 to T1; (C5, C6, C7, C8 and T1).
- It innervates the shoulder and arm.
- The brachial plexus begins as spinal nerve roots and continues to the terminal branches that supply the upper extremity.
- Specifically, the anatomy progresses from roots to trunks, trunks to divisions, divisions to cords (lateral, medial and posterior cords) and finally to terminal nerve branches





# Brachial Plexus Nerves





# Interscalene Block (ISB)

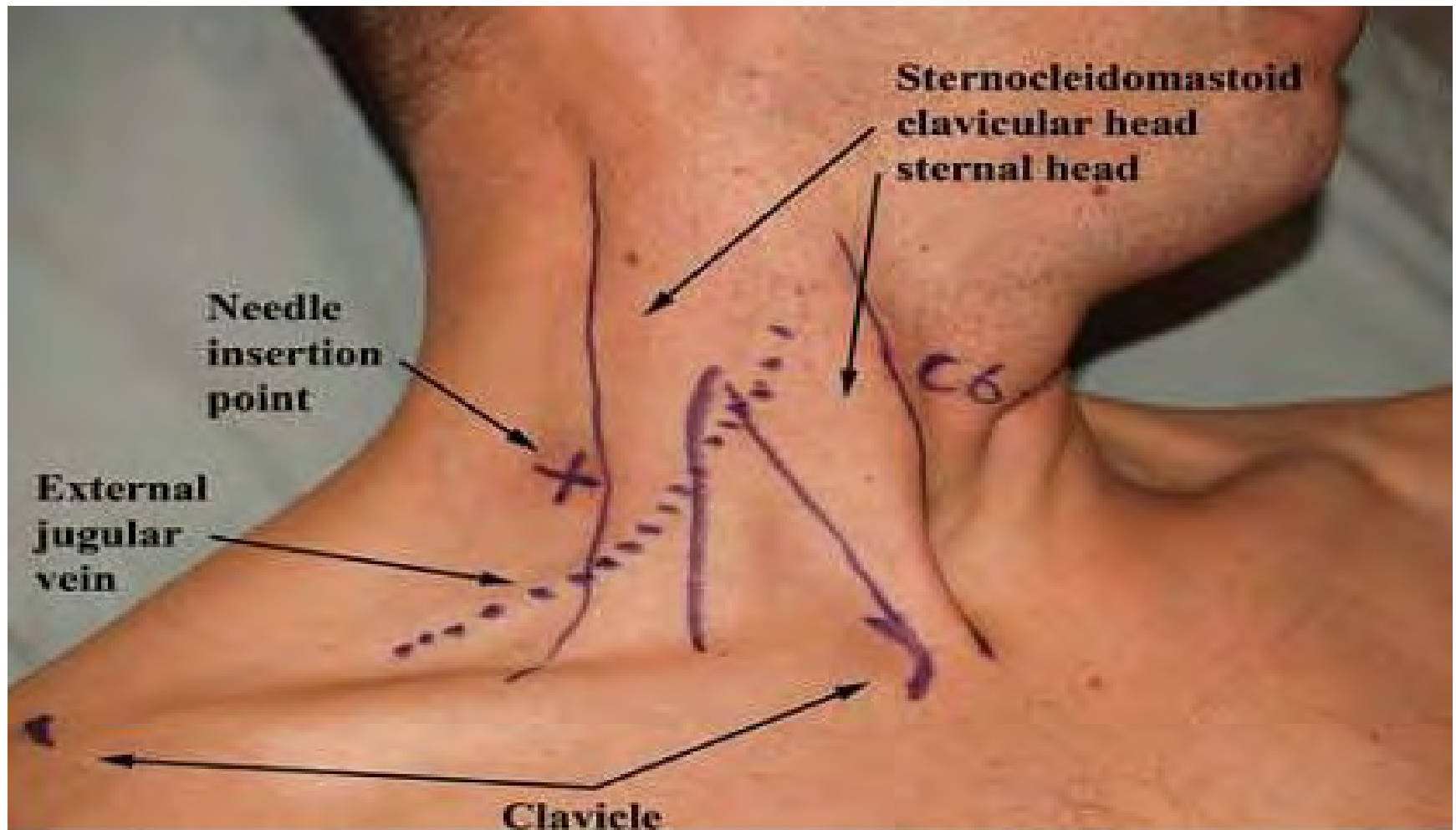
- Suitable for shoulder and upper arm procedures involving the lateral 2/3 of the clavicle, proximal humerus, and the shoulder joint i.e. total or hemiarthroplasty, arthroscopy, subacromial decompression, and procedures for the instability of the shoulder joint, rotator cuff repair and frozen shoulder.
- The block is performed at the level of the distal trunk and the origin of its divisions blocking nerves at C4-C6. It is the most proximal to the brachial plexus so not recommended for hand surgery
- Not recommended for patients with impaired pulmonary function. ISB obstructs the phrenic nerve, resulting in ipsilateral diaphragmatic paralysis



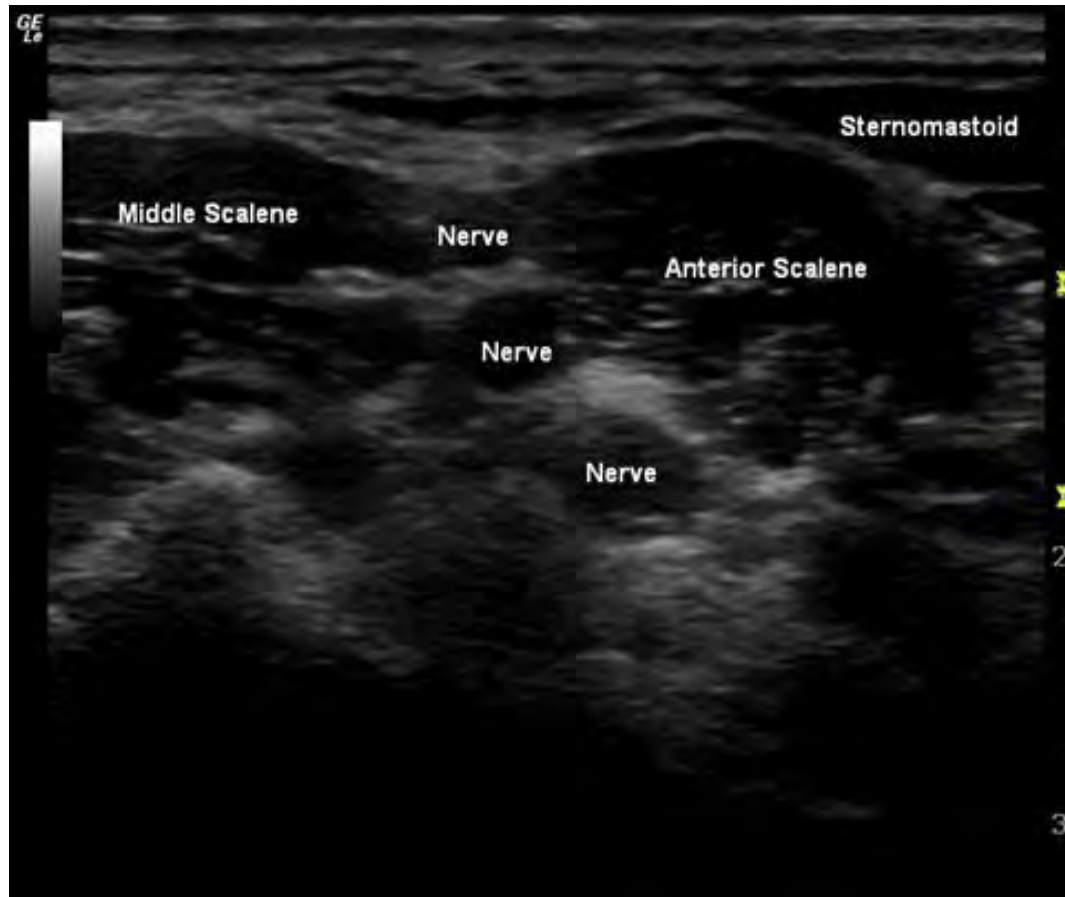
# Interscalene Block

- The approach to the brachial plexus lies in the neck between the interscalene muscle and the clavicle.
- The patient lies supine with the head facing away from the side to be blocked.
- Landmarks include the sternocleidomastoid muscle, external jugular vein, and the cricoid cartilage. The level of the cricoid cartilage corresponds to the C6 vertebral body where the interscalene block is administered.
- The needle is inserted into the interscalene groove in a slightly medial, caudal, and posterior direction to avoid the vertebral column and vascular structures.
- Provides spread to the nonbrachial plexus Supraclavicular nerve which supplies sensory innervation to the cape of the shoulder. May not anesthetize the entire posterior aspect of the shoulder.

# Interscalene landmarks



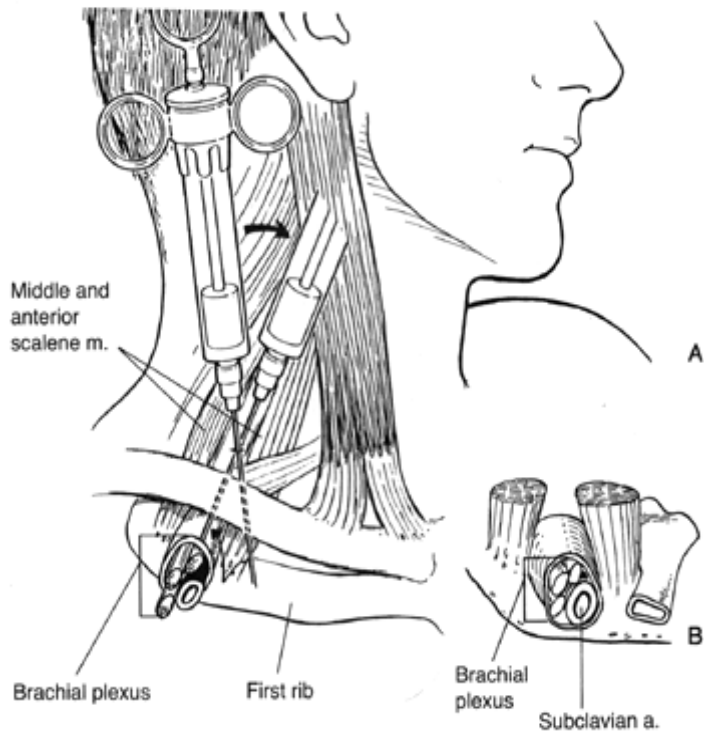
# Ultrasound of Interscalene Anatomy



# Supraclavicular Block (SCB)

- The indication for a Supraclavicular block is surgery of the upper arm, elbow, forearm, wrist, and hand excluding the shoulder area.
- The block is performed at the level of the trunks and divisions of the brachial plexus located lateral to the subclavian artery between the first rib and clavicle.
- The patient lies supine with the head turned away from the side to be blocked.
- Landmarks on the body include the first rib, subclavian artery and the apex of the lung.
- Pneumothorax is a potential complication due to the proximity to the apex of the lung.

# Supraclavicular Block



## Supraclavicular approach



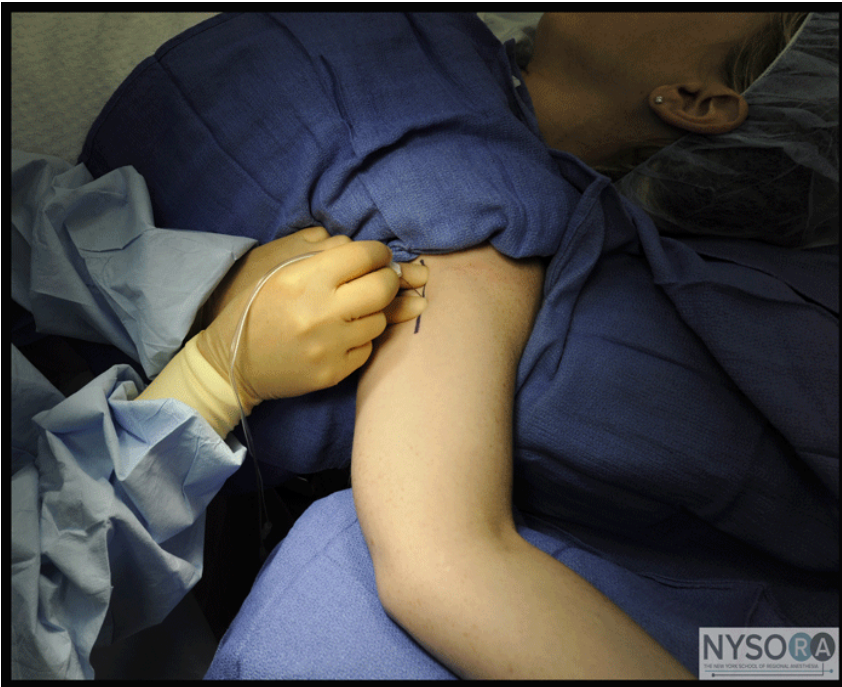


# Infraclavicular Block



- The indication for the Infraclavicular block is surgery of the upper arm, elbow, forearm, wrist, and hand excluding the shoulder area.
- The block is performed at the level of the brachial plexus cords, at the clavicle pectoral triangle lateral to the axillary artery and vein.
- The patient lies supine with the head turned away from the side to be blocked.
- Landmarks on the body to consider are the subclavian artery, the apex of the lung and the pectoralis minor and major muscles.
- Used as a substitute for a Supraclavicular when there is difficult anatomy.

# Axillary Block

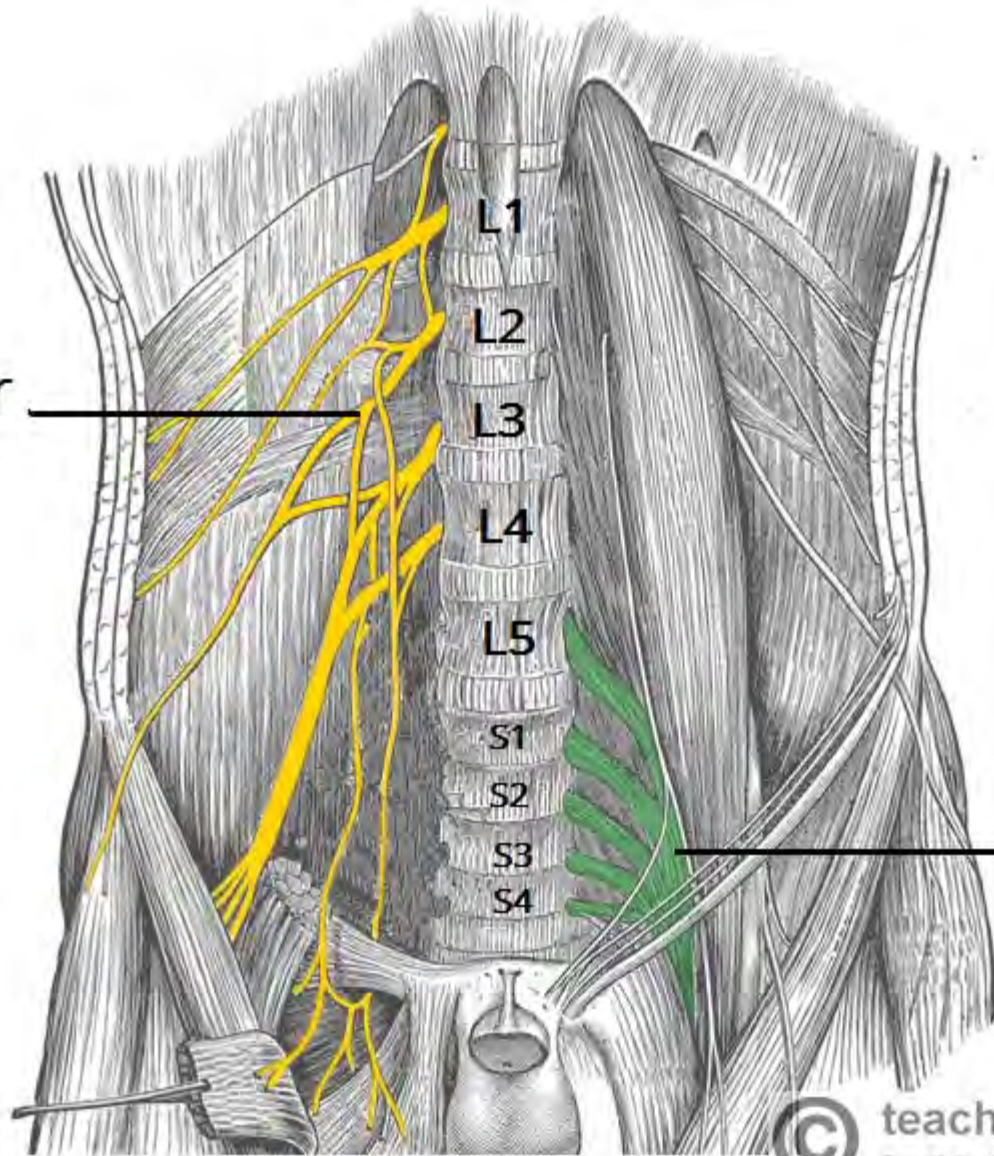


- The indication for an Axillary block is surgery involving the elbow, forearm and hand.
- The block targets three of the four major terminal nerves of the brachial plexus: ulnar, radial, and median nerves. The axillary nerve itself is not blocked.
- Multiple injections are used to target these nerves.
- The patient lies in the supine position with abduction of the arm to be blocked. Excessive abduction is avoided since it stretches the brachial plexus increasing vulnerability to injury.
- Landmarks are the axillary artery, the biceps, coracobrachialis, and triceps muscle.

# Lower extremity

Femoral  
Adductor Canal  
Popliteal  
Ankle  
Sciatic

Lumbar Plexus



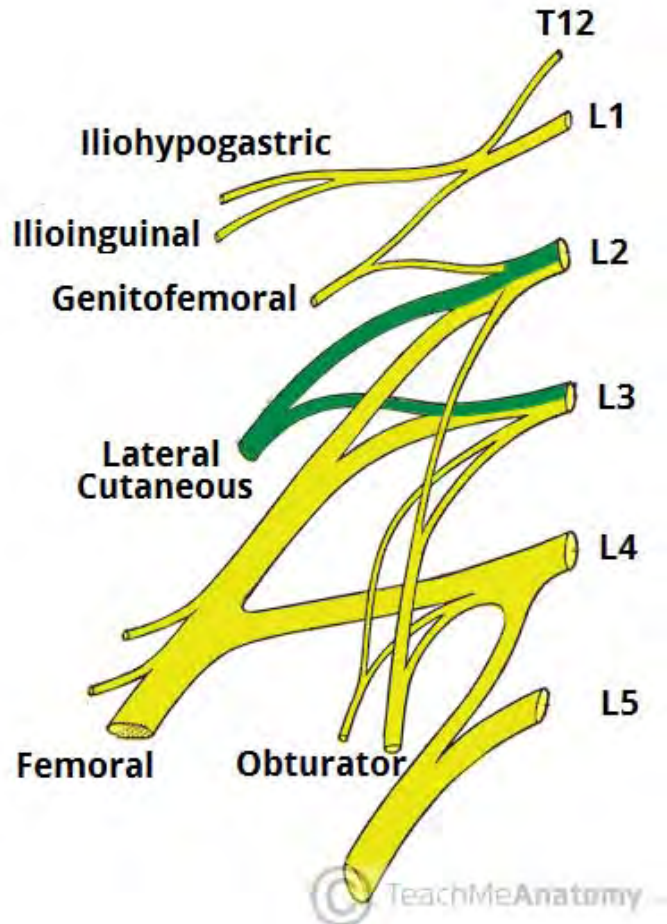
Sacral Plexus



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# Lumbar plexus



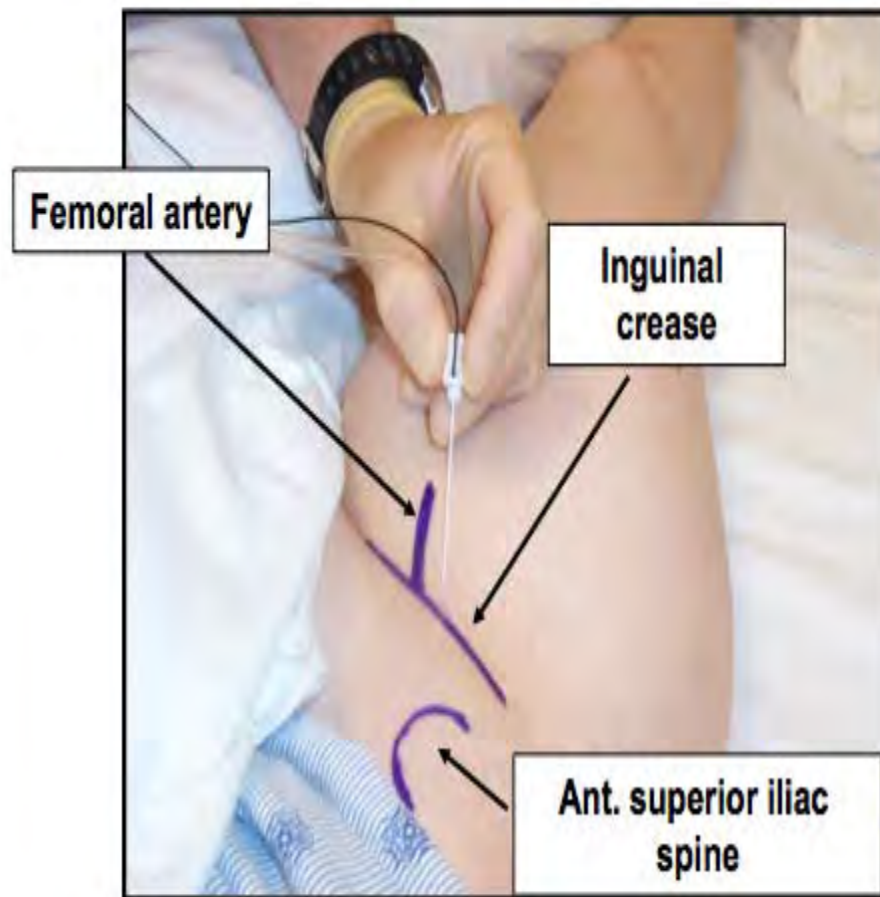
- The lumbar plexus comprises the bundle of nerves which control movement and sensation in the lower extremities.
- The nerve roots exit the spine at L1-5 and S1-2. They further branch to form several nerves that descend from the plexus down the thigh and leg into the foot.
- Only nerves roots and branches, no trunks or cords like the brachial plexus
- The major branches are the lateral femoral cutaneous, femoral, obturator, and sciatic nerves providing sensation to the medial, lateral and anterior aspects of the thigh.

# Femoral Block

- The femoral nerve is the largest branch of the lumbar plexus with origins in L2, L3, and L4
- Provides motor and sensory innervation to the anterior aspect of the thigh, to the knee and to the medial aspects of the calf, ankle, and foot.
- Used for hip fracture repair and mid to distal femur fracture repair. Analgesia is only partial (usually paired with a spinal)
- Indications for single injections are knee arthroscopy, total knee arthroplasty; sometimes paired with a proximal sciatic block, BKA; sometimes paired with a popliteal sciatic block, AKA; paired with a sciatic block, ACL repair; paired with a single shot sciatic block, other hip or knee surgeries.

# Femoral Block

- Patient is positioned in a supine position with the arm on the procedural side stationed out of the sterile field. The injection point is at the intersection of a line drawn from the anterior superior iliac spine to the pubic symphysis and a vertical line just lateral to the femoral artery. The femoral crease and the femoral artery pulse serve as guides.
- If groin accessibility is limited, secondary to obesity, special positioning or taping may be necessary for pannus retraction



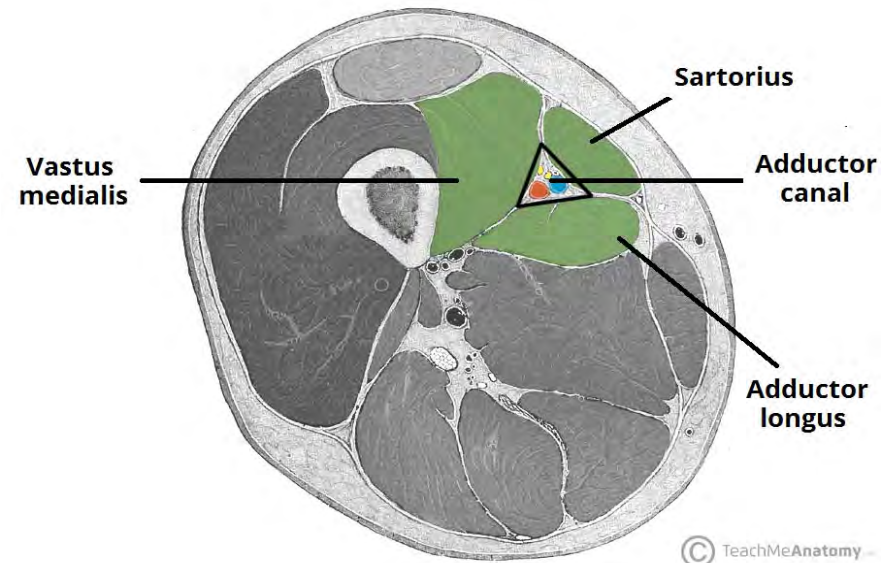
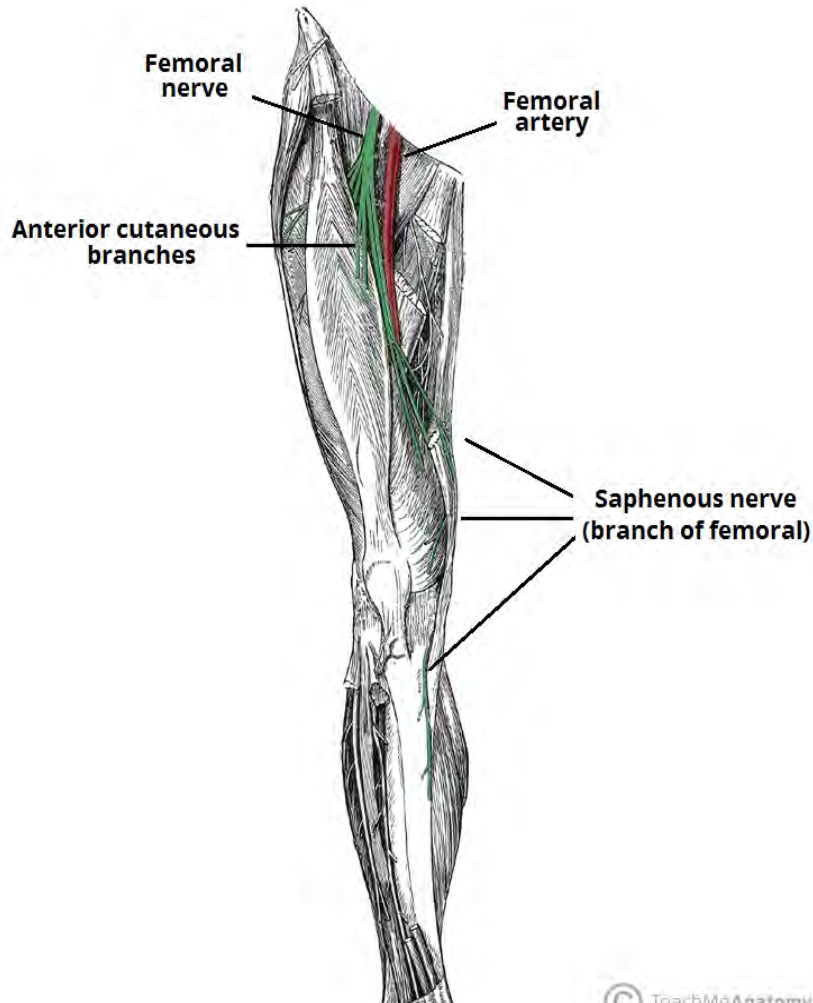
# Adductor Canal



- Serves as a passageway for the saphenous nerve, the vastus medialis, medial femoral cutaneous, articular branches from the obturator nerve and the medial retinacular nerve as well as the femoral artery and femoral vein
- Sensory changes of the Adductor Canal block involve the saphenous nerve including the medial and anterior aspect of the knee from the superior pole of the patella to the proximal tibia.
- Adductor canal block generally spares the quadriceps muscles so pt. able to flex hip with comparable pain control.
- Placement is mid-thigh around the femoral nerve before it exits the adductor canal
- Effective alternative to the FNB for patients undergoing TKA or surgery involving the distal thigh and femur, knee and lower leg on the medial side.



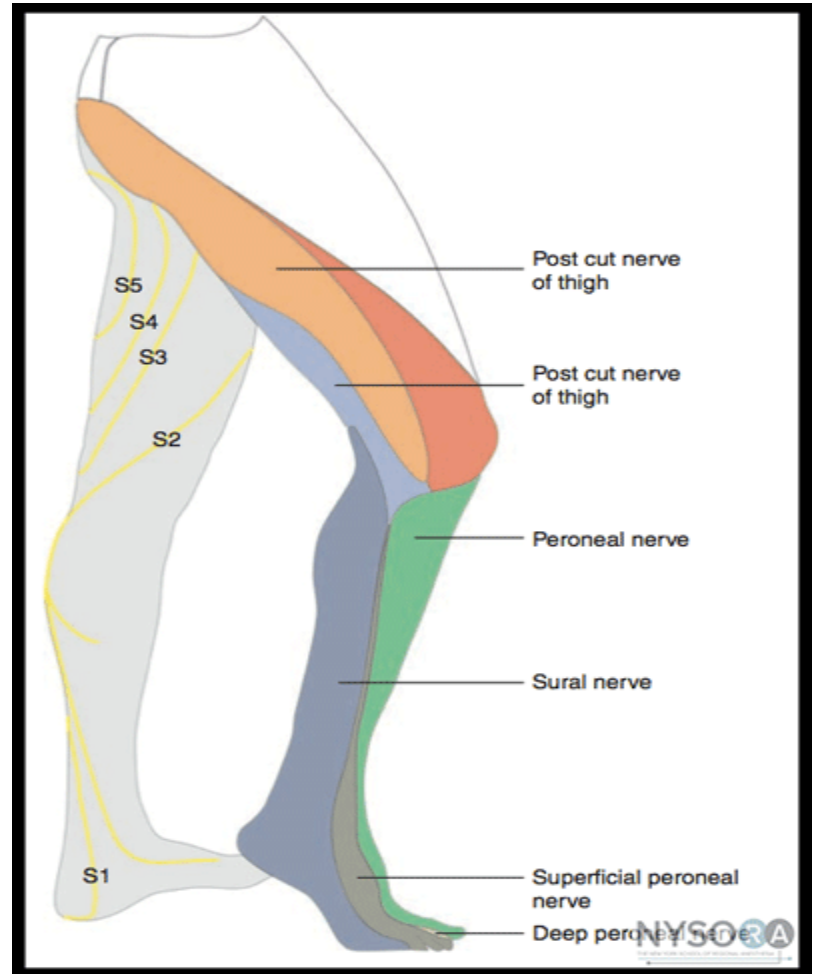
# Femoral/Adductor Anatomy



# Sciatic Block

- The sacral plexus provides motor and sensory innervation to the entire lower extremity including hip, ankle and knee. Important components are the sciatic and posterior cutaneous nerves
- Landmarks are the greater trochanter, the posterior superior iliac spine, and the sacral hiatus.
- Twitch monitors may be used with the goal of visible or palpable twitches of the hamstrings, calf muscles, foot or toes.
- The patient needs adequate sedation; commonly painful. Onset of block usually occurs in 10-25 minutes.
- It provides for complete anesthesia of the leg except for the medial strip of skin innervated by the saphenous nerve. Combined with a femoral block, complete anesthesia of the leg may be achieved.
- More discreet posterior blocks are generally used

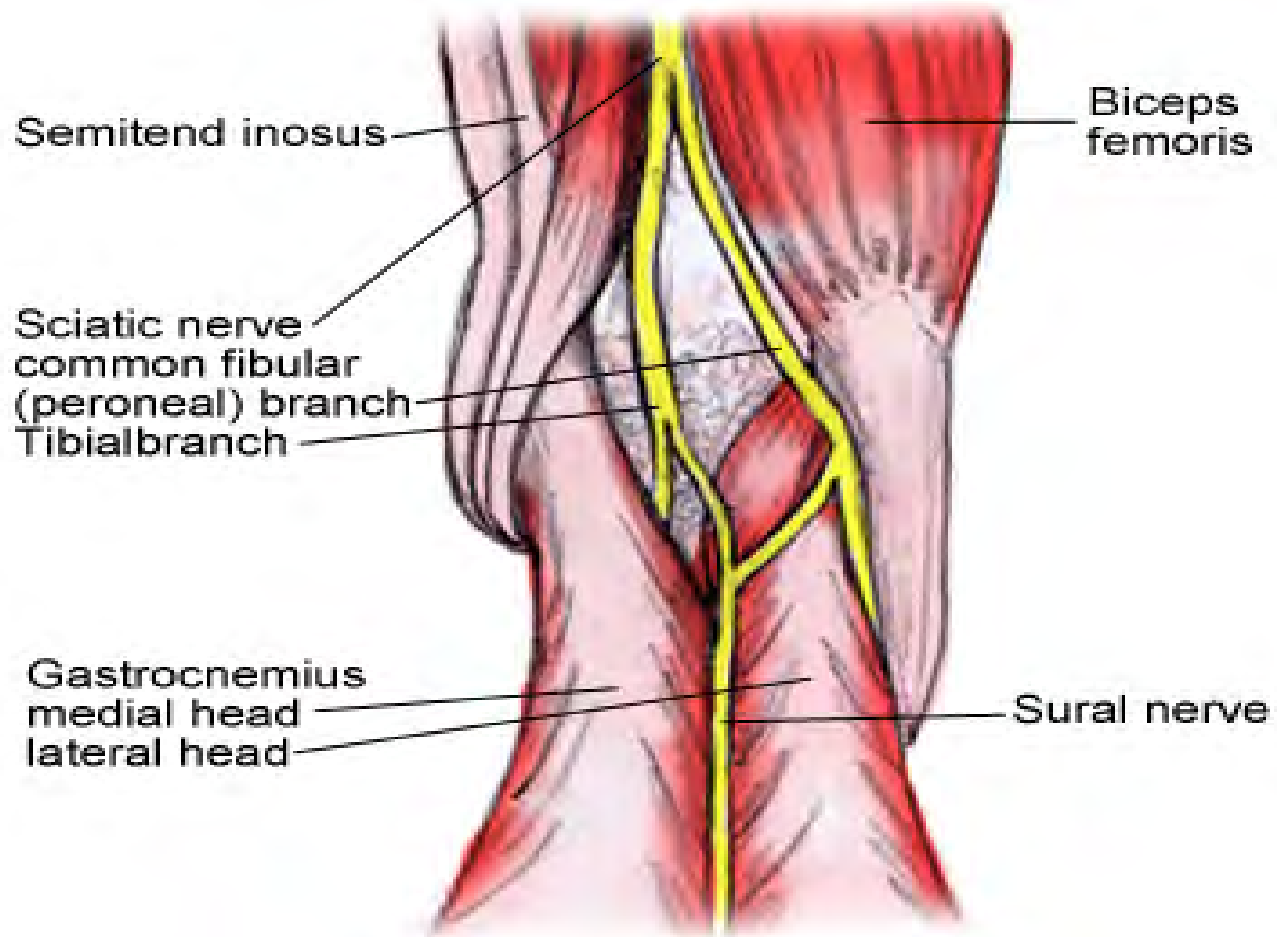
# Sciatic Nerve Block



# Popliteal Sciatic Block

- Anesthetizes the entire leg below the tibial plateau except the skin of the medial aspect of the calf and foot (saphenous nerve distribution)
- The popliteal block is performed on the sciatic nerve proximal to this bifurcation; about 10 cm from the popliteal crease.
- Landmarks include the popliteal crease, tendons of the biceps femoris and the semitendinosus muscles
- Used for minor surgeries of the distal lower leg, foot or ankle

# Popliteal fossa



# Popliteal Sciatic Block

- Pt. is positioned in the prone position or in a modified exaggerated lateral position with the leg to be blocked uppermost and flexed at the knee touching the bed and the underlying leg straight.
- Advantages are improved calf tourniquet tolerance and an immobile foot.
- Complications may be persistent foot drop with potential pressure necrosis

# Popliteal-sciatic block: two approaches

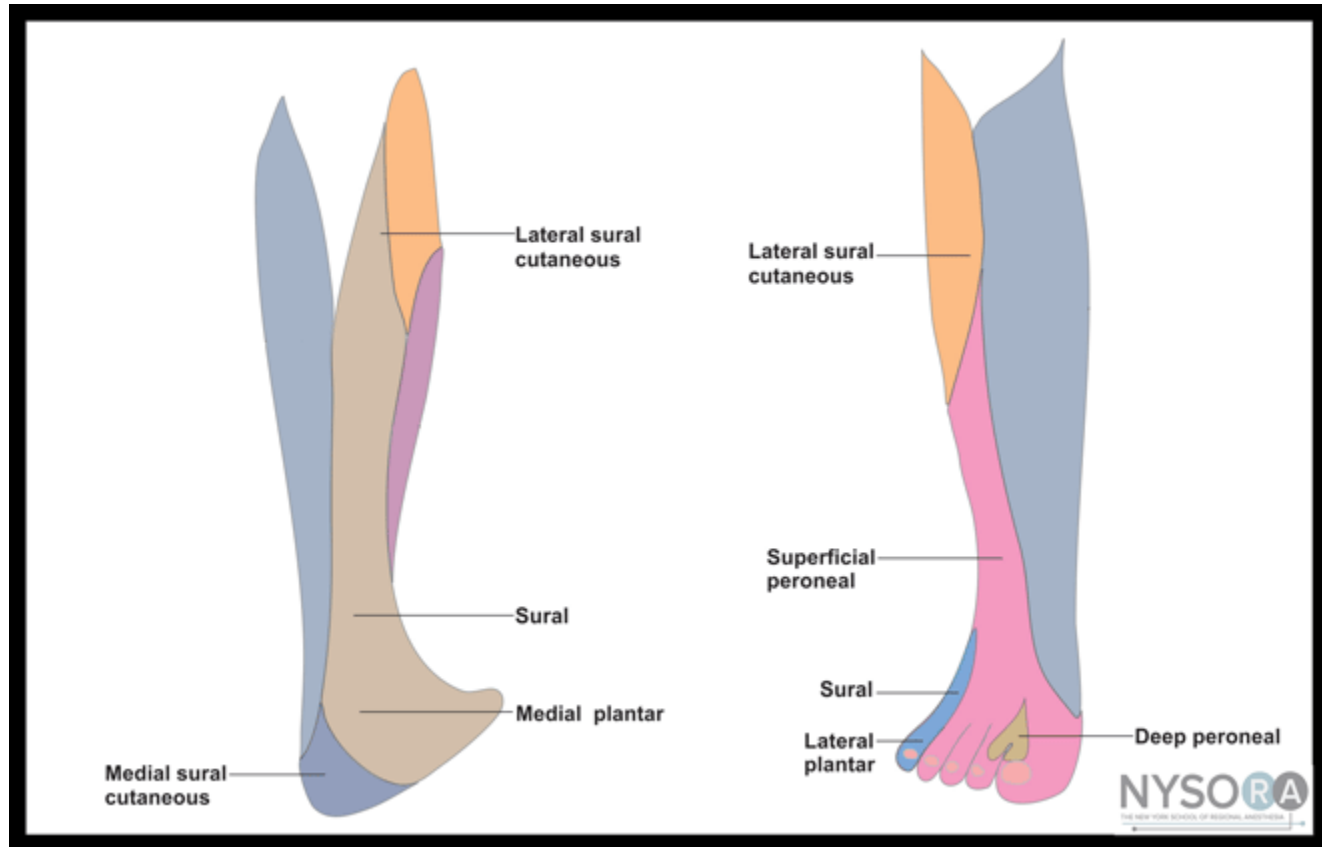


Prone



Supine

# Sensory distribution of block except blue area





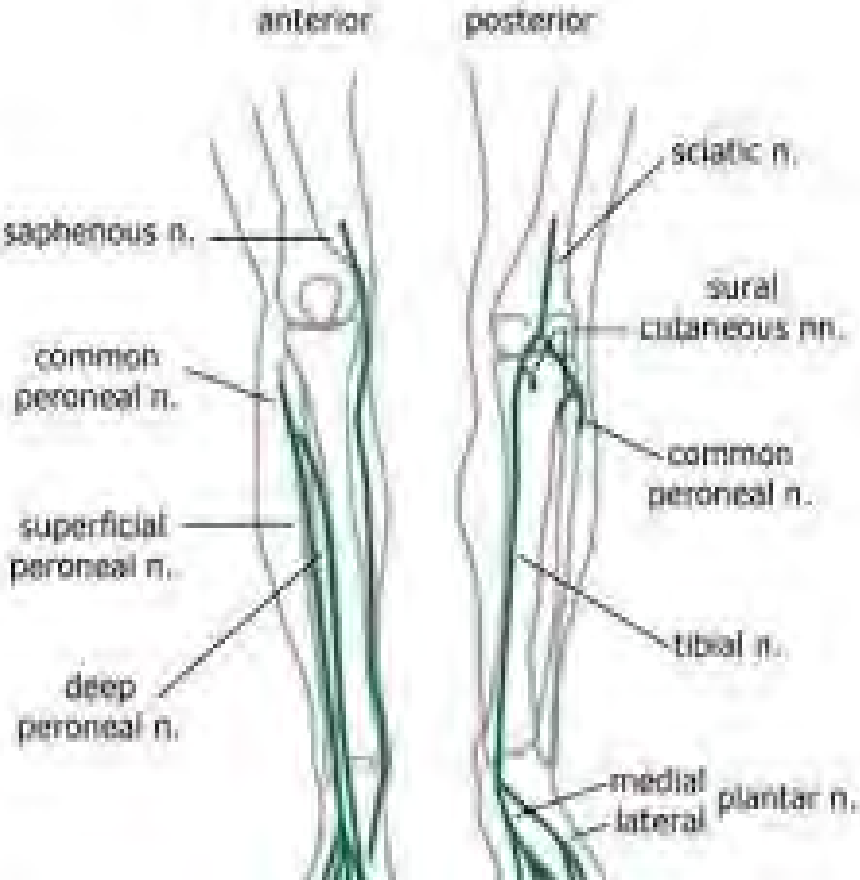
# Ankle block

- The ankle block is performed at the tibial nerve and the deep and superficial aspects of the peroneal nerve. The peripheral nerves at the ankle and metatarsal level are the terminal branches of the sciatic (posterior tibial, superficial peroneal, deep peroneal, sural) and femoral saphenous nerves.
- Indicated for surgery of the foot.
- The pertinent landmarks are the posterior tibial and dorsalis pedis arteries, tendon of the hallucis longus and medial malleolus

# Ankle Block

- Patient is positioned in a supine position. Elevation of the patients calf permits the various insertion sites (ring-like) to be more easily accessed.
- An uncomfortable block requiring 5 different injections
- Epinephrine is contraindicated. Potential arterial vasoconstriction may lead to foot and/or toe ischemia secondary to the lack of collateral circulation at that location.

# Lower extremity nerve anatomy



# Ankle Block





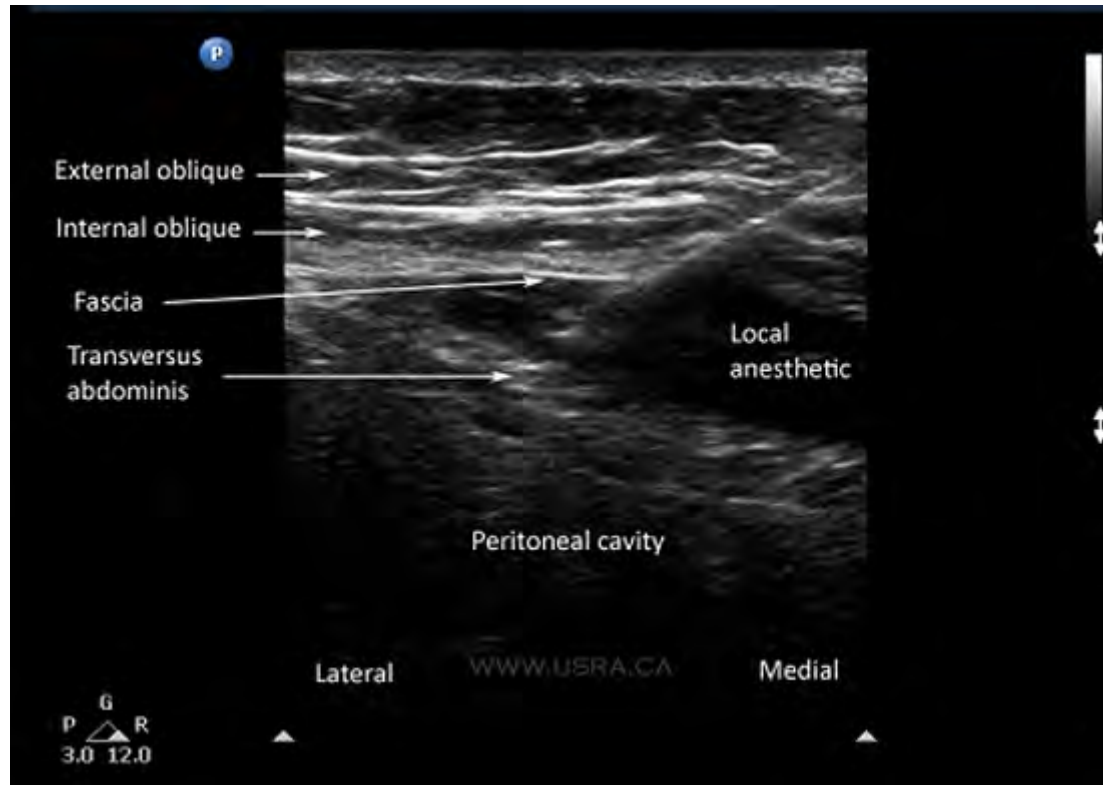
# Transversus Abdominis Plane (TAP) Block

- Provides analgesia to the skin and muscles of the antero-lateral abdominal wall and parietal peritoneum. Does not block visceral pain.
- Goal of the block is to place LA between the internal oblique and transversus abdominis muscle layers resulting in the interruption to the innervation of the abdominal skin, muscles and parietal peritoneum.
- Administered by landmark, ultrasound guided by anesthesia or direct visualization by the surgeon
- Single injection vs. catheter bolus. Bupivacaine, Ropivacaine, and Levobupivacaine commonly used.
- Used for patients undergoing lower abdominal surgery; appendectomy, c-sect, hernia repair, abdominal hysterectomy and prostatectomy.

# Transversus Abdominis Plane (TAP) Block



- Triangle of Petit: bounded by the latissimus dorsi posteriorly, the external oblique anteriorly and the iliac crest inferiorly.
- Needle is inserted perpendicular to all planes looking for the tactile sensation of 2 pops. First indicates penetration of the external oblique fascia into the plane between external and oblique muscles. Second pop signifies entry into the plane between internal oblique and transversus abdominis muscles.



# Complications



# Peripheral Nerve Injury

- May be associated with needle trauma, inadvertent injection of the nerve, or high injection pressures
- Intraneural injection may be identified during block administration by the patient complaining of a sharp pain. The injection is stopped immediately.
- Surgical trauma may also cause nerve damage
- May not manifest until 7-14 days post-op.
- Symptoms: persistent c/o paresthesia, aching or sensory or motor deficits
- Treatment is prevention

# Pneumothorax

- Associated with Supraclavicular blocks
- Causes pts to present with anxiety, tachycardia, tachypnea, chest pain, sub-q emphysema, and diminished breath sounds.
- Pts. may not develop symptoms for 6-12 hours
- Pneumothorax requires a chest tube.
- Ultrasound guidance reduces the incidence since the pleura and first rib is easily visualized.

# Horner's syndrome

- Ipsilateral sympathetic blockade which includes nasal congestion, ptosis of one eyelid, miosis, and conjunctive hyperemia.
- Hoarseness occurs in approximately 10% of patients and is the result of laryngeal nerve block. More prevalent with right sided blocks



# Hemidiaphragmatic paralysis

- The proximity of the phrenic nerve and its originating cervical roots to the brachial plexus often leads to unintended local anesthetic blockade and diaphragmatic dysfunction.
- The incidence is 100% after interscalene block
- Some patients will report mild shortness of breath or altered respiratory sensations and may experience 25-32% reduction in spirometric measures of pulmonary function
- Supraclavicular blocks have a lower incidence.

# Local Anesthetic Systemic Toxicity or LAST

- A complication caused by the inadvertent injection of LA into the vascular system or the rapid absorption from the tissue into the vascular system.
- Studies suggest a more forceful, rapid injection carries a much higher risk than a slow, gentle injection.
- Prevention must include prudent selection of LA concentration and volume, slow, gentle injection, frequent aspiration, and vigilant monitoring of vital signs
- Injection into the vein is more serious than into an artery. Arterial allows for dilution and redistribution of the anesthetic into the tissue before it reaches the systemic circulation. Injection into the vein carries the LA directly to the heart and brain.

# LAST

## A RARE EVENT BUT LETHAL

- Early studies (1992-2002) in France of the incidence of LAST had a range of 7.5 -20/ 10,000 cases of Peripheral Nerve Blocks.
- Study by Sites of an 8 years period 2003-2011 the incidence was 1/12,668. Decrease attributed to Ultrasound guidance.
- Study by DeGregorio (1979-2009) of 93 cases of LAST
- Epidural 33%, Axillary Block 17%, Interscalene Block 13%
- (77) Single injection, (14) Continuous infusion
- (52) or 55% Bupivacaine, (28) or 30% Ropivacaine, (4) or 4% Levobupivacaine, (9) or 11% Other
- Certain characteristics may increase incidence: Age: children or elderly, high output cardiac states which increases vascular absorption, Co-morbidities: cardiac disease, pregnancy, hepatic dysfunction, metabolic syndromes.

# LAST

- Symptoms: ringing in the ears, metallic taste in the mouth, numbness of the lips, twitching of the eyes and lips leading to seizures.
- Most serious; cardiovascular arrest, respiratory, and central nervous system depression (LOC)

# LAST

- Immediate treatment: provide adequate ventilation, oxygenation, and circulation (CPR)
- **Infusion of Intralipid**
- Adult Bolus 1-1.5 ml/kg over 1-2 minutes.
- Pediatric Bolus 1ml/kg.
- Repeat dosing every 3-5 minutes up to max dose of 3ml/kg.
- Provide maintenance infusion 0.25-0.5ml/kg/min



# **Nursing Responsibilities**

# Preoperative

- Assess the patient for physical (neuropathy, coagulopathies, infection) and psychosocial conditions that may influence PNB, baseline VS
- Assess respiratory status for pathophysiology to rule out COPD and other lung diseases, liver disorders
- Inability to tolerate the position required for administration of the nerve block
- Allergies
- Present identified risk factors to the Anesthesia team



*"You might feel a little prick."*

# Block Procedure

- Educate the patient and family about the block procedure and advantages
- Attach monitors; BP, EKG. SO<sub>2</sub>, nasal O<sub>2</sub>, 5 minute interval assessment
- Participate in Time Out procedure
- Assist with procedure as needed, PNS adjustment, Ultrasound picture
- Monitor patient post-procedure VS and progression of block
- Monitor for side effects and/or complications
- Protect anesthetized limb in anatomical alignment.

# Postoperative

- Assess neurovascular status of limb for color, temperature and capillary refill.
- Protect the limb from injury by appropriate positioning
- Repeatedly assess the patient's level of sensory and motor function and analgesia.
- Assess the dressing or cast
- Place limb in neutral alignment and provide support. For upper extremity nerve blocks, place pillow under the patients elbow to prevent stretching of the brachial plexus and pressure on the ulnar nerve. For lower limb, use pillows to support the entire leg and prevent heel pressure.
- Movement or sensation especially pain suggests the need for supplemental analgesia
- Continuous infusion requires checking the catheter placement and the insertion site as well as the delivery device, correct medication and dose.

# Pain management

- Review the pain management prescription
- Need to take pain medication before the block wears off emphasizing the time frame for taking the medications
- Resolution of block is unpredictable so start on a specific schedule
- When a block begins to wear off, anesthetic effects may be gone within 60 minutes.
- Generally begins with ability to move limb, followed by numbness, tingling and heaviness. May vary.
- If experiencing continued side effects that are block related; longer than 48 hours, call doctor.

# Instructions for Upper Extremity Blocks

- Wear the arm brace or sling at all times until the block has worn off and as prescribed by the physician.
- Helpful to sleep in a recliner chair with pillow under the arm or in bed with head elevated and arm supported by pillows in anatomically appropriate position.

# Instructions for Lower extremity blocks

- Do not bear weight on the affected leg until the block wears off. Exception is with the use of a long leg brace and crutches if prescribed by physician
- Use caution and assistance when standing or trying to move or walk to reduce the risk of falling
- Crutch walking instructions and demonstration



# Patient Education

- Discuss prevention of injury to the anesthetized limb.
  - Absence of protective pain reflexes and reduced proprioception
  - The ability of the patient to move the limb before the ability to sense can lead to injury.
- Protection of the affected limb, immobilization
- Correct positioning of the limb to avoid prolonged pressure
- Check the color of fingers or toes with tight dressing or cast.
- Call MD if dusky or darkened, excessive swelling
- Discuss common side effects: Horner's syndrome, pneumothorax

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"FIRST, LET ME GIVE YOU SOMETHING  
FOR THE PAIN."

