

The Lumbar and Sacral Plexus and their Role in Anesthesia

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A Review of the Spine

- The spine is broken down into 5 major sections
 - 7 cervical vertebrae
 - 12 thoracic vertebrae
 - 5 lumbar vertebrae
 - 5 fused sacral vertebrae
 - 4 coccygeal vertebrae (this number can vary)

A Review of the Spinal Nerves

Would it be correct to say that there are 33 vertebrae and that each vertebrae has its own spinal nerve, accounting for the 33 spinal nerves?

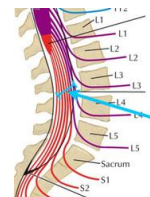
NO!

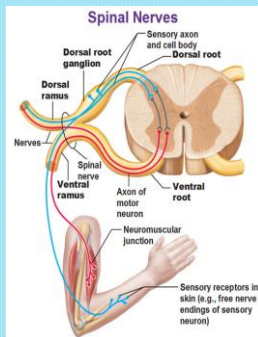
A Review of the Spinal Nerves

- There are 31 spinal nerves
 - 8 cervical spinal nerves
 - C1 emerges between the skull and vertebra C1
 - C2-C7 emerge from the canal above their respective vertebrae
 - C8 between C7 and T1 and the remaining spinal nerves emerge BELOW their respective vertebrae
 - 12 thoracic spinal nerves
 - 5 lumbar spinal nerves
 - 5 sacral spinal nerves
 - 1 coccygeal spinal nerve

A Review of the Spinal Nerves

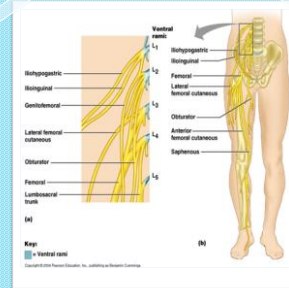
- Where does the spinal cord terminate in the "average" adult?
- Despite the cord's termination, spinal nerves still travel the length of the spinal column
 - Spinal nerves below the spinal cord pass inferiorly to reach exit points and are called the "Cauda Equina"





- **Spinal Segment**
 - Area of the spine that gives rise to anterior and posterior rootlets
 - Rootlets join to form a single pair of spinal nerves
- **Posterior/Dorsal Root**
 - Carries Sensory information
- **Anterior/Ventral Root**
 - Carries Motor Information
- **Posterior/Dorsal Ramus**
 - Innervates only epaxial muscles and the narrow strip of skin on the back
- **Anterior/Ventral Ramus**
 - Innervates most other skeletal muscles (hypaxial) and the remaining area of the skin

A Review of the Spinal Nerves



TAKE HOME POINT:
ALL major somatic plexuses are formed by the Anterior (Ventral) Rami!

Somatic Plexuses

- **Cervical**
 - C2-C4, possible contribution from C1
- **Brachial**
 - C5-T1
- **Lumbar**
 - L1-L3 and most of L4
- **Sacral**
 - S1-S4 and lumbosacral trunk L4-L5
- **Coccygeal**
 - S5 and Coccygeal

LUMBAR PLEXUS

Lumbar Plexus

- As mentioned before, it is formed by the anterior rami of L1-L3 and most of L4
- Six branches
 - Iliohypogastric
 - Ilio-inguinal
 - Genitofemoral
 - Lateral cutaneous nerve of the thigh
 - Obturator
 - Femoral

Iliohypogastric and Ilio-inguinal

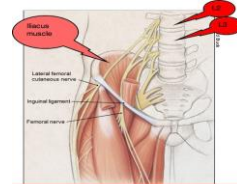
- Both originate from L1
- Iliohypogastric nerve divides into anterior and lateral cutaneous branches
- **Function**
 - **Motor (both)**
 - Internal oblique
 - Transversus abdominis
 - **Sensory**
 - **Iliohypogastric:**
 - Posterolateral gluteal skin and skin in pubic areas
 - **Ilio-inguinal**
 - upper medial thigh skin and skin over the root of penis and anterior scrotum or mons pubis and labium majus

Genitofemoral

- Originates from L1 and L2
- Divides into the genital and femoral branch
- Function
 - Motor is genital branch only
 - Cremasteric muscle
 - Sensory
 - Genital branch supplies skin of anterior scrotum or skin of mons pubis and labium majus
 - Femoral branch supplies skin of upper anterior thigh

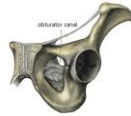
Lateral Cutaneous Nerve of Thigh

- Originates from L2, L3
- Function
 - ALL SENSORY
 - Skin on anterior and lateral thigh to the knee



Obturator

- Originates from L2-L4
- Divides into anterior and posterior branches in the area of the obturator canal
- Function
 - Motor
 - Obturator externus
 - Pectineus
 - Muscles of medial compartment of thigh
 - Sensory
 - Skin on the medial aspect of the thigh



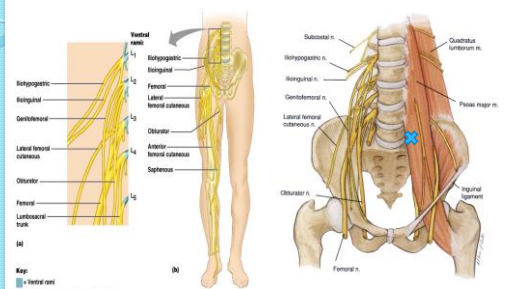
Femoral

- Originates from L2-L4
- Divides into cutaneous, muscular, and articular branches
- Function
 - Motor
 - Iliacus
 - Pectineus
 - Muscles in the anterior compartment of the thigh
 - Sensory
 - Skin on anterior thigh
 - Medial surface of the leg

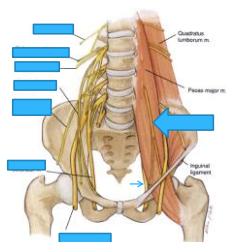
Femoral Nerve

- Muscular branches
 - Anterior and Posterior branches
 - Named according to their relationship with the fascia iliaca
 - Iliacus, pectineus, sartorius, rectus femoris, vastus medialis, vastus intermedius, and vastus lateralis
- Cutaneous branches
 - Medial and intermediate cutaneous nerve supply the skin of the anterior surface of thigh
 - Saphenous nerve, coming off of the posterior branch, supplies medial surface of the leg
- Articular branches
 - Supply hip and knee joints

Anatomy of the Lumbar Plexus

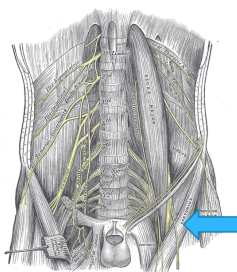


POP QUIZ



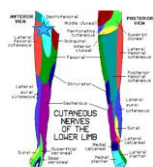
- Based on its relationship with the psoas major muscle, which nerve is indicated by the large arrow?

Pop Quiz



- The lumbar plexus has 6 branches. Which branch innervates the sartorius muscle seen here?

Pop Quiz



- The genitofemoral nerve has two branches, which branch innervates the skin of the upper anterior thigh?

THE LUMBAR PLEXUS BLOCKS

LUMBAR PLEXUS BLOCK

Lumbar Plexus Block

- The highest block completed on the lumbar plexus
- Large volume of LA is needed
 - Epinephrine is routinely added
- Contraindications
 - Absolute
 - Patient refusal
 - Infection at the planned block site
 - Relative
 - Peripheral Neuropathy
 - Bacteremia
 - Previous spine surgery
 - Coagulopathy/medications effecting hemostasis

Lumbar Plexus Block

- Position: lateral decubitus
- Landmarks
 - 1. Spinous processes (midline)
 - 2. Iliac crest
 - Needle Insertion: 4 cm lateral to the intersection of 1 and 2
- First twitches are locally from the paravertebral muscle
 - Quadriceps' twitches are obtained at 6-8 cm



Lumbar Plexus Block

- Blockade success depends on the dispersion of the LA in the fascial plane of the psoas muscle
- Dural sleeves envelope the roots and stimulation at less than 0.5 mA could indicate sleeve injection— NOT A GOAL!
- When placing a catheter for continuous blockade, needle tip should be cephalad
 - Catheter should be placed 8-10 cm deep

Lumbar Plexus Block Troubleshooting

Response Obtained	Interpretation	Problem	Action
Paraspinal muscle twitch	Stimulation of the paraspinal muscles	Too shallow	Advance Needle
Needle contacts bone at 4-6 cm and no twitches	Transverse process has stopped needle progression	Needle is placed properly but needs redirection	Withdraw to the skin and aim 5 degrees caudal or cephalad
Hamstring muscle twitches are seen; needle 6-8 cm	Sciatic Plexus Stimulation	Needle is too far caudal	Withdraw and insert needle 3-5 cm cephalad
Flexion of thigh at depth > 6-8 cm	Direct stimulation of psoas muscle	Too deep-inserting further could go intraperitoneal	Stop advancing and reattempt
Needle is deep (10 cm) but no twitches and no bone contacted	Needle missed transverse process and roots of lumbar plexus	Needle is too lateral	Withdraw needle and angle 5-10 degrees medially

Complications of Lumbar Plexus Block

- Hematoma
 - Antiplatelet therapy is not a contraindication
- Vascular Puncture
 - Avoid deep needle placement (aorta, vena cava)
- Nerve Injury
 - Do not inject if stimulus with mA < 0.5 is noted
- Hemodynamic Consequences
 - 15% of patients may have spread to epidural space

Pop Quiz

- What spinal landmark/level is normally indicated by the iliac crest?
- What is another name for the line made between the two iliac crests?

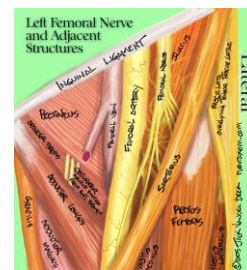
FEMORAL NERVE BLOCK

Femoral Nerve Block

- Used for surgeries on the anterior leg or in combo with a sciatic nerve block for the entire leg
 - Can be a single dose or continuous catheter
- Contraindications (relative)
 - Previous ilioinguinal surgery
 - femoral vascular graft, kidney transplant
 - Large inguinal lymph nodes or tumor, local infection, peritoneal infection, and preexisting femoral neuropathy

Femoral Nerve Block Procedure

- Position: supine with ipsilateral extremity abducted 10-20 degrees
- Landmarks
 - 1. Inguinal ligament
 - 2. Inguinal crease
 - 3. Femoral artery
- Needle insertion: below the inguinal crease (at the femoral crease) & 1-2 cm lateral to the femoral pulse



Ultrasound Procedure

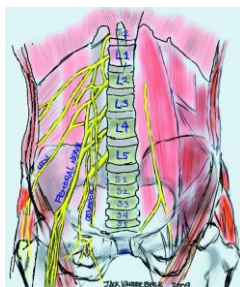
THREE-IN-ONE BLOCK

Three-in-One Block

- Single perivascular injection slightly distal to the inguinal ligament
 - LA will spread medially and laterally
- Blocks the lateral femoral cutaneous, femoral & obturator nerves
 - Sometimes called the 2 ½ in One block because it does not always successfully block the obturator
- Contraindications
 - Infection at needle site, severe blood coagulopathy
 - Femoral-popliteal bypass graft (relative)
 - Can be performed w/US guided technique

Drawbacks of the 3-in-1 Block

- Anterior Obturator Nerve innervation is inconsistent
- NEVER anesthetized by 3-in-1 block
 - Posterior Obturator Nerve innervates a sensory area at the popliteal fold
 - Proximal parts of the thigh are sensory innervated by nerves from the abdominal wall



Performing a 3-in-1 Block

- Position: supine with leg to be blocked 15-30 degrees laterally rotated
- Landmarks
 - 1. Anterior superior iliac spine
 - 2. Inguinal ligament
- Needle Insertion: 1-2cm distal to inguinal ligament and lateral to the femoral artery
- A 2-fold resistance loss may be felt as needle pierces fascia lata and fascia iliaca
 - Nerve depth usually 12 +/- 4mm

Femoral & 3-in-1 Block Troubleshooting

Response Obtained	Interpretation	Problem	Action
No Response	Needle is either too medially or too laterally	Femoral artery not properly localized	Follow systematic lateral angulation & reinsertion of the needle
Bone contact	Needle contacts hip or superior ramus of pubic bone	Needle is too deep	Withdraw to level of skin & reinsert in another direction
Local twitch	Direct stimulation of the iliopsoas or pectineus muscle	Too deep	Withdraw to level of skin & reinsert in another direction
Twitch of the sartorius muscle	Sartorius muscle twitch	Needle tip is slightly anterior & medial to main trunk of femoral nerve	Redirect needle laterally & advance deeper 1-3 mm
Vascular puncture	Blood return	Too medial needle	Withdraw & reinsert laterally 1 cm
Patella twitch	Stimulation of the main trunk of the femoral nerve	None	Accept & inject LA

Femoral and 3-in-1 Nerve Block Complications

- **Hematoma**
 - Stop and apply pressure for 2-3min
- **Vascular puncture**
 - Insert needle just lateral & parallel to pulse
 - Never direct needle medially
- **Catheter infection**
 - Remove catheter after 48-72hours
- **Fall risk**
 - Educate on inability to bear weight
 - Avoid long acting LAs for outpatient surgery

Femoral vs. 3-in-1 Block

- 1. Volume of local anesthetic
 - Femoral: 20 ml or less
 - 3-in-1 nerve: 25-30 ml
 - This allows for the spread to the obturator and lateral femoral cutaneous nerves
- 2. Slight alteration in technique
 - For the 3-in-1 block, pressure should be applied 2-4 cm below the injection site to help spread the local anesthetic to the obturator and lateral femoral cutaneous nerve

FASCIA ILIACA COMPARTMENT BLOCK

Fascia Iliaca Compartment Block

- A block for post-operative pain relief for hip, anterior thigh, and knee procedures
- Compartment block where VOLUME is the key
 - The goal is for the LA to spread cephalad and bathe the lumbar plexus nerves
- Similar distribution as the previously discussed 3-in-1 block
 - Many believe this block is more successful

Fascia Iliaca Compartment Block

- Landmarks
 - 1. Iliacus muscle
 - 2. Iliopsoas
 - 3. Fascia covering of the iliopsoas
- The fascial covering of the iliopsoas becomes thicker as it reaches the inguinal ligament
 - Provides a "pop" with needle penetration



SAPHENOUS NERVE BLOCK

LATERAL

TRACING THE SAPHENOUS NERVE

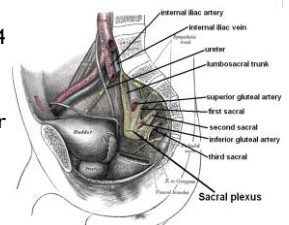
DEBILITATING

SAPHENOUS NERVE

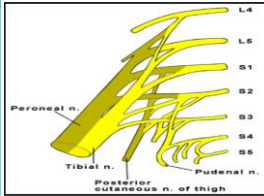
The saphenous nerve branches off from the femoral nerve in the thigh and travels down the length of the leg. It is the longest nerve in the body and is responsible for sensation in the medial aspect of the leg and foot. It is also responsible for the motor innervation of the muscles of the leg and foot.

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- Formed by the anterior rami of S1-S4 and the L4-L5 lumbosacral trunk
- Forms on the anterior portion of the piriformis muscle



One of these things are not like the other... QUIZ



- Each anterior ramus has a ventral and dorsal division. The anterior ramus of what sacral nerve has only a ventral division?
- What is the significance of this?

Sacral Plexus Branches

- Sciatic Nerve
- Gluteal Nerves
- Pudendal Nerve
- Numerous smaller branches supplying the pelvic wall, floor, and lower limbs
- We are primarily concerned with the sciatic nerve during this lecture.

Sciatic Nerve

- Originates from L4-S3
- Largest nerve in the body
- Function
 - Motor
 - Muscles in the posterior compartment of the thigh, leg, and foot
 - Sensory
 - Skin of foot and lateral leg

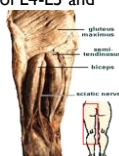
Do you remember?

- What nerve supplied sensory to the medial aspect of the leg?

Sciatic Nerve Branches

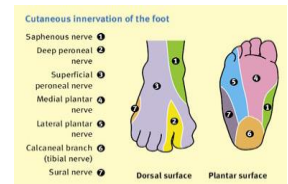
The Sciatic Nerve forms on the anterior surface of the piriformis and leaves the pelvis through the sciatic foramen. It passes through the gluteal region, to the thigh, and then divides into its two branches.

- 1. Common Peroneal Nerve
 - AKA: Common Fibular Nerve
 - Carries dorsal divisions of L4-L5 and S1-S2
- 2. Tibial Nerve
 - Carries ventral divisions of L4-L5 and S1-S3



Sciatic Nerve Branches

- Common Peroneal Nerve
 - Superficial peroneal nerve
 - Deep peroneal nerve
 - Sural nerve
- Tibial Nerve
 - Sural nerve
 - Posterior tibial nerve
 - Calcaneal
 - Plantar



SCIATIC NERVE BLOCK

Sciatic Nerve Block

- Often combined with a lumbar plexus block
- Despite sciatic nerve's large size, 20-25mL of LA adequate
 - Epinephrine use is not routine
- Contraindications
 - Local infection
 - Bed sores at injection site
 - Coagulopathy
 - Preexisting central or peripheral nervous system disorders
 - LA allergy

Sciatic Nerve Block Techniques

- Block may cause patient pain
 - Passes through the gluteus maximus
- First sign of block
 - foot feels "different" &/or can't wiggle toes
- 4 relevant approaches
 - 1. Classic posterior approach (Labat approach)
 - 2. Parasacral modification
 - 3. Subgluteal modification
 - 4. Anterior approach

Sciatic Block: Classic Posterior Approach

- Position: lateral decubitus with forward tilt
- Anatomic landmarks (outline w/pen)
 - 1. greater trochanter
 - 2. posterior superior iliac spine
 - Needle insertion: 4 cm distal to midpoint between 1 and 2
- 1st twitches from gluteal muscles
 - hamstring/calf/foot/toe twitches are the goal
 - usually depth of 5-8 cm

Sciatic Block: Parasacral Approach

- Position: lateral decubitus
- Landmarks
 - 1. Posterior-superior iliac spine (PSIS)
 - 2. Ischial tuberosity (IT)
 - 3. Needle insertion: found by drawing a line between 1 and 2 and inserting 6 cm caudal to PSIS
- Can provide anesthesia to obturator nerve

Sciatic Block: Anterior Approach

- Position: Supine
- Landmarks
 - 1. Femoral crease
 - 2. Femoral artery pulse
 - 3. Needle insertion: 4-5cm distally on the line passing between 1 & 2
- Twitches of hamstrings shouldn't be accepted as reliable sign in this approach
- Best for surgery on leg below knee – especially foot & ankle

Sciatic Nerve Block Troubleshooting

Response Obtained	Interpretation	Problem	Action
Local twitch of gluteus	Direct stimulation of gluteus	Too shallow	Advance needle
Needle contacts bone but no gluteus twitch	Needle close to caudal aspect of iliac bone or lateral aspect of sacrum	Too superior to too medial	Slightly redirect needle caudal and lateral
Needle contacts bone and sciatic twitches elicited	Missed plane of sciatic nerve-- is at hip or ischial bone	Too lateral (hip joint) or medial (ischial bone)	Withdraw and redirect medially or laterally
Hamstring Twitch	Sciatic nerve	None	Accept and inject
The needle is deep (10 cm) but no twitches or bone contact	Needle has passed through sciatic notch	Too inferior	Withdraw and go slightly lateral or cephalad
Paresthesia of genital organs	Pudendal nerve	Too inferior and medial	Withdraw and go slightly cephalad and lateral

Sciatic Nerve Block Complications

- **Nerve Injury**
 - Unique predisposition for mechanical & pressure injury
 - Advise heel padding, frequent body repositioning
 - Advance needle slowly when gluteal muscle twitch ceases to prevent sciatic nerve impaling
- **Delayed onset of block**
 - 10-30min for full sensory-motor anesthesia
 - May need local infiltration at incision site
- **Perforation of Pelvic Organs**
 - Direct needle medially with care to avoid
- **Anesthesia of the Pudendal Nerve**
 - Transient
- **Tourniquet**
 - Avoid use to prevent ischemia of sciatic nerve

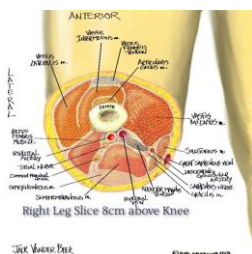
Pop Quiz

- A patient allergic to the sunscreen ingredient, PABA, may also be allergic to what type of local anesthetic?
- Give an example of this type of LA.

• SCIATIC NERVE BLOCK IN THE POPLITEAL FOSSA—AKA “POP BLOCK”

Popliteal Fossa Block

- The tibial and common peroneal branches of the sciatic nerve travel in the same sheath until the terminal division
 - Blocking these nerves provides pain relief to the lower extremity
 - There are multiple approaches



“Pop” Block- Posterior Approach

- Position: Prone with foot hanging off the bed
- Landmarks
 - 1. Popliteal fossa crease
 - 2. Tendon of biceps femoris
 - 3. Tendons of semitendinosus and semimembranosus
 - Needle insertion: 7 cm above the crease at the midpoint between 2 & 3
- First twitches are normally the sciatic nerve
 - Depth 3-4 cm
- If small needle movement result in changes from foot dorsiflexion to plantar flexion, the needle is above the sciatic nerve divergence

“Pop” Block- Posterior Approach



“Pop” Block- Lateral Approach

- Position: Supine
- Landmarks
 - 1. Popliteal fossa crease
 - 2. Vastus lateralis muscle
 - 3. Biceps femoris muscle
 - 4. Needle Insertion: groove between vastus lateralis and biceps femoris muscles
- Stimulation of common peroneal nerve usually occurs first (normally 5-7 cm)
 - More lateral and superficial than the tibial nerve



“Pop” Block Troubleshooting

Response	Interpretation	Problem	Action
Local twitch of biceps muscle	Stimulating biceps femoris muscle	Too lateral	Withdraw and redirect medially
Local twitch of semitendinosus/membranosus	Stimulating semitendinosus/membranosus muscle	Too medial	Withdraw and redirect laterally
Twitch of calf muscle without foot or toe twitch	Stimulation of muscular branch of sciatic nerve	Small branches outside of sciatic sheath	Disregard. Advance until foot/toe twitches are seen
Vascular puncture	Blood in syringe. Placement into popliteal artery or vein	Too medial	Withdraw and redirect laterally
Bone contact	The needle contacts the femur	Too deep. Nerve was missed or response not seen	Withdraw the needle slowly and watch for foot twitches

ANKLE BLOCK

Ankle Block

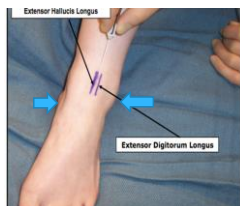
- Blocks the five peripheral nerves of the foot
- No motor block-- patients can ambulate
- Contraindications
 - infection, burn, soft tissue trauma, or distorted anatomy in the area
 - If severe coagulopathy, a more distal approach allows vessels to be more easily compressed
 - Vascular compromise due to compartment syndrome

Ankle Block Anatomy

Nerve	Innervates	Arises from
Saphenous nerve	Medial aspect	Femoral
Sural nerve	Lateral aspect	Tibial & communicating superficial peroneal branches
Posterior tibial nerve - Largest of the 5	Deep plantar structures, muscles, sole	Tibial
Superficial peroneal nerve	Dorsum of the foot	Common peroneal
Deep peroneal nerve	Deep dorsal structures, web space between 1 st & 2 nd toes	Common peroneal

Ankle Block Landmarks

- 1. Medial & lateral malleoli
- 2. Achilles tendon
- 3. Extensor hallucis longus tendon
- 4. Posterior tibial & dorsalis pedis arteries
- 5. Sustentaculum tali



Ankle Block Techniques

- Can be performed at the level of the Malleoli or Midtarsal
- Block all nerves, especially with tourniquet use
 - ONE exception: a purely cutaneous surgery without tourniquet in the distribution of the sural, saphenous or superficial peroneal nerves
 - More post-op pain is seen with selective blocks when compared to complete
- Block deep peroneal & post tibial nerves distally where they are more superficial whenever possible

Ankle Block Complications

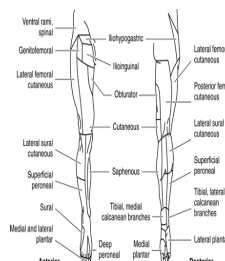
- **Tourniquet**
 - >250mmHg NOT necessary
 - Pad ankle if tourniquet required to maximize comfort, minimize sedation & prevent GA
- **Transient parasthesia**
 - most common & almost always resolve
- **Nerve Injury**
 - Ensure normal anatomy before injection & avoid injecting in scarred/swollen areas.
 - Avoid large volume injection
 - most ankle blocks performed w/<30mL of LA

General Considerations of PNBs

- **Peripheral Nerve Stimulation**
 - Upon obtaining the desired twitch, mA should be reduced to 0.2-0.5 to ensure best lower extremity block
 - This is true except for the lumbar plexus block: 0.5-1 mA accepted
 - May use 1 mA for patients with Diabetes, sepsis, neuropathy, and PVD
- **Complications**
 - Hematoma
 - Avoid multiple needle insertions
 - Caution in anticoagulated patients
 - Nerve Injury
 - Avoid injecting with high pressure and when patient c/o pain
 - Infection
 - Use aseptic technique
 - LA toxicity
 - Use small volumes when possible
 - Negative aspiration

ASSESSING LOWER EXTREMITY NERVE BLOCKS

Cutaneous Distribution



- An understanding of the nerves which supply sensory innervation to the lower extremity is necessary to determine the best block and to determine the success of the block.

Pop Quiz

- Based on your knowledge of regional anesthesia, what do you suspect to be the earliest sign that a femoral nerve block is setting in?
- Which nerve fibers carry this sign?

**When assessing the lower extremity blocks think
*push, pull, pinch, & punt!***

Pop Quiz

- You have performed a successful femoral block for a patient undergoing knee surgery. Following the case, the patient complains of severe pain behind the knee. Why?

References

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And

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