Plexus Blocks of the Lower Extremity
Ken Radford, PhD, CRNA
Uniformed Services University of the Health Sciences, Assistant Professor, Nurse Anesthesia Program

Disclosures
• I do not have any relevant relationships with any commercial interests.
• I may be discussing off-label uses of local anesthetics and adjuncts depending upon participant questions.

Learner Outcomes
1. Discuss pain pathways and current pain management priorities.
2. Identify the anatomy and peripheral nerves associated with the lumbar and sacral plexus.
3. Describe the landmarks used for the placement of lower extremity blocks.
4. Describe the use of ultrasound for the placement of lower extremity blocks.
5. Describe the indications and use of Truncal Blocks.
Pain Pathway
- Femoral
- Adductor Canal
- Sciatic
- iPACk
- Popliteal
- Fascia iliaca
- Ankle

Lower Trunk
- Paravertebral
- Erector Spinae
- PECS I/II
- TAP

PAIN PATHWAY REVIEW

Gate Control Theory - 1965
4 Stages of Pain Transmission

What we can do...

Multiple Inputs—“Sensitizing Soup”
Evolution of Anesthesia and Pain Management

- IV/PCA
- SAB/Epidural
- Nerve Block
- Local Infiltration

Recent Philosophical Shift

- Multi-modal analgesia
  - Below threshold for side effects
- More specific targeting
  - Peripheral block > regional > IV PCA > GA
- Preventative
  - Stay ahead of pain
- Avoid parenteral narcotics/ERAS protocols

Multi-Modal Therapy

- Anti-inflammatories:
  - Acetaminophen
  - NSAIDs (Celebrex/Ketorolac)
- Analgesics:
  - PO (oxycontin/oxycodeone)
  - IV as rescue
- Peripheral Nerve Blocks:
  - Continuous catheters

- Gabapentin/Pregabalin
- Ketamine
Acute Pain Service

- To reduce the incidence and severity of acute postoperative or posttraumatic pain.
- To educate patients about the need to communicate about their unrelieved pain.
- To enhance patient comfort and satisfaction.
- To reduce postoperative complications and in some cases, shorten stays after surgical procedures.
- To provide surgeons with a service for difficult patients who are not within their ability to effectively manage.
LOWER EXTREMITY

AANA Regional Anesthesia Course

- Femoral
- Adductor Canal
- Sciatic
- iPACK
- Popliteal
- Fascia Iliaca
- Ankle

Major Nerves of the Lower Extremity

Where to Block the Major Nerves of the Lower Extremity
LUMBAR PLEXUS
- Ventral rami of L1-L4
- Within Psoas muscle
- Major nerves:
  - Femoral (L2-4)
  - Lateral Femoral Cutaneous (L1-3)
  - Obturator (L2-4)
- Motor and Sensory to Hip/Anterior Thigh/Knee and Sensory to medial upper and lower leg/ankle

Femoral Nerve and Sensory Distribution
- Motor: Quadriceps and sartorius
- Sensory: Anterior thigh, anterior/medial knee, medial lower leg/ankle (saphenous n.)
- Indications:
  1. Surgery to anterior thigh
  2. Quadriceps muscle biopsy
  3. Knee arthroscopy/ACL
  4. Complete blockade of lower extremity when combined with sciatic nerve block

Femoral Nerve Block
- Disadvantage:
  - Loss of Quadriceps (motor) strength and control
  - Limits early postoperative ambulation and physical therapy (i.e. post knee replacement/reconstruction)
  - Falling out of favor in lieu of Adductor Canal Block.
- Contraindications:
  - Pre-existing femoral neuropathy
  - Local infection/Enlarged groin lymph nodes

Brown, Atlas of Regional Anesthesia
Femoral Nerve

Cousins, et al., Neural Blockade
Barrett, et al., Peripheral Nerve Blocks and Perioperative Pain Relief

Femoral Nerve Block

Nerve Stimulator

- 22g, 5cm B bevel needle
- 1 – 2 mA
- Directed Cephalad at 30-45 degree angle
- 1-2cm lateral to Femoral Artery, just below inguinal ligament.
- Depth: 1-3 cm
- Observe brisk "patellar snap" with current 0.5mA or less
- Local anesthetic volume: 20-30 mL
Femoral Nerve - Landmarks

- Probe: High Frequency 5-12 MHz, linear
- Placement: Inguinal crease
- Nerve: Hyper-echoic, triangular shape lateral to femoral artery.
- Advance needle in plane, lateral to medial
- Penetrate fascia lata and fascia iliaca
- Deposit local around entire nerve.

Needle Position

Femoral Nerve Block

Ultrasound
- Probe: High Frequency 5-12 MHz, linear
- Placement: Inguinal crease
- Nerve: Hyper-echoic, triangular shape lateral to femoral artery.
- Advance needle in plane, lateral to medial
- Penetrate fascia lata and fascia iliaca
- Deposit local around entire nerve.
Femoral Nerve Block
Ultrasound

Femoral Nerve Block – Rare Complications
- Hematoma -
- Vascular Puncture
- Nerve Injury
- Catheter Infection
  - Potential for Fall (Quad weakness!)

Pearls
- Use Ultrasound!
- Have a dedicated set of hands to control/retract the pannis (maybe two – sets of hands or pannis’)
- Use a doppler to find the pulse (in necessary)
- Location is variable
- Inject below facial layer
Adductor Canal Block

- Saphenous nerve (sensory) – branch of femoral
  - Anterior, medial knee
  - Medial lower leg and ankle
- Indications:
  - Knee analgesia (TKA, ACL, Foot/Ankle)
- Advantage:
  - Spares quadriceps (motor)
  - Allows for early ambulation/physical therapy

Adductor Canal Block Versus Femoral Nerve Block for Analgesia After Total Knee Arthroplasty: A Randomized, Double-blind Study

Conclusions: Adductor canal block preserved quadriceps muscle strength better than FNH, without a significant difference in postoperative pain.

(May Clin Proc 2013;88: 532–533)

More of the Same

The Effects of Ultrasound-Guided Adductor Canal Block Versus Femoral Nerve Block on Quadriceps Strength and Fall Risk

A Blinded, Randomized Trial of Volunteers

M. Kong Kang, MD, FACP; C. Chen, MD; C. Abberton, MD
However, be careful.....

---

Adductor Canal Block

- Medial aspect of the mid shaft of Femur (measure lateral aspect)
- ID artery
- Saphenous nerve is "typically" medial and above the artery
- Position needle underneath artery
- Want a "horseshoe" of LA around posterior side of artery

---

Cadaver Anatomy
Adductor Canal
Ultrasound

• 22g, 5-10 cm, b-bevel
• High Frequency, Linear
• Mid-thigh
• Anterior & lateral to femoral artery and vein
• Surrounded by:
  – Sartorius m. (SM)
  – Vastus Medialis m. (VM)
  – Adductor Magnus m. (AMM)

Adductor Canal
Ultrasound

• Supine Position
• External rotation of thigh
• In Plane
  – Mid-thigh
  – Lateral to Medial
• Penetrate facial plane
• Aspirate & Deposit 10-20 mL local anesthesia
  – Surround the artery

Sacral Plexus

• L4-5 + S1-4
• Posterior thigh (posterior femoral cutaneous n. S1-3)
• Posterior knee, lower leg and foot (sciatic n.)
Sciatic Nerve

- Nerve roots L4-5 + S1-3
- Exits the pelvis at greater sciatic foramen
- Travels under gluteus maximus
- Separates mid thigh into:
  - Tibial and Common Peroneal nerves
  - Mixed Motor and Sensory Nerve
    - Motor to posterior thigh, leg, and foot
    - Sensory to skin of posterior thigh/knee, lateral leg and foot
Sciatic Nerve Block

• Indications:
  – Anesthesia/analgesia to posterior distal thigh, posterior knee, lower leg/ankle/foot for surgery.
• Advantage:
  – Complete blockade of leg in combination with femoral nerve block
• Disadvantage:
  – Deep nerve structure, difficulty to identify
  – Motor blockade can limit post-operative ambulation/physical therapy

Sciatic Nerve
Anatomic Landmarks

• Labat's Approach:
  • Lateral Decubitus, knee flexed
  • First line: greater trochanter to posterior superior iliac spine (PSIS)
  • Second line: greater trochanter to sacral hiatus
  • Third line: perpendicular line from midpoint of first line to intersection with second line

Sciatic Nerve
Nerve Stimulator

• 22g, 10-cm, b-bevel needle
• Set at 1-1.5mA
• Insert perpendicular to all planes
• Advance through gluteus maximus stimulation
• Observe Plantar Flexion (tibial n.) or Dorsi-flexion (common peroneal n.)
• Dial to 0.5mA, aspirate, slowly inject LA
• Local Anesthesia: 20-30 mL (without epi)
Sciatic Nerve – Needle Position

- Low Frequency (2-8 MHz), Curvilinear Probe
- Sub-gluteal Approach
  - Midpoint between ischial tuberosity and greater trochanter.
  - Both bony structures visible with facial layer deep to gluteal muscles.
  - Sciatic nerve lies deep to this facial layer.
- Advance needle in plane or out of plane with nerve stim.

Sciatic Nerve Block

Subgluteal approach

IT = ischial tuberosity
ScN = Sciatic nerve
Sciatic – Rare Complications

- Infection
- Hematoma
- Nerve Injury
- Foot Drop

- Will need more sedation as you go through and deep to the gluteous muscles (and fat)

Pearls

- Need to use the long needle and may take up to 30 minutes to set up
- Sciatic is usually combined with femoral – remember the sensory distribution
- May/will need to cover the skin – despite sensory/motor anesthesia
- For distal surgery – go lower (popliteal or ankle)
- Don’t use Epi – greater risk of ischemic injury with tourniquet and positioning

iPACK block

- Goal:
  - Selectively block innervation of the posterior knee joint (sparing main trunks of tibial and common peroneal nerves)
  - Maintain sensorimotor function of the leg and foot.
- Indications:
  - Total knee arthroplasty
  - ACL repair
- Nerve innervation:
  - Articular branches (from main trunks of tibial and obturator nerves) travel to the posterior capsule of the knee.
iPACK Supplies

- 22 g, b-bevel, 100mm
- Local anesthetic
- Volume 20 mL
- Ultrasound: Low Frequency, Curvilinear probe

iPACK Technique

- Supine, “frog-leg”
- Probe – lower 1/3 medial thigh (Femur and femoral artery)
- Move caudal – watch artery dive to popliteal
- Slide posterior/inferior – femur and popliteal artery
- In plane – advance needle between femur and artery, stop 2 cm past artery
- Infiltrate in divided doses during withdrawal – 20mL

Popliteal Nerve Block

- Common and useful block
- Two nerves: Tibial and Common Peroneal together
- Indications:
  - Ankle and foot surgery
- Advantage:
  - Spares posterior thigh (hamstring) muscle
  - Facilitates early physical therapy, post-op ambulation
### Popliteal Fossa - Prone

**Nerve Stimulator Technique**
- 22g, 5-10 cm, b-bevel needle
- Prone position
- Lower leg/foot elevated to facilitate visible movement
- Identify:
  - popliteal fossa crease
  - Biceps femoris tendon (lateral)
  - Semitendinosus and Semimembranosus tendon (medial)
- Insertion point is 7-10 cm proximal to crease, between two tendons

### Landmarks – Posterior Popliteal Fossa
Popliteal Nerve Block

Nerve Stimulator Technique

- Set to 1.5mA
- Insert perpendicular to skin
- Advance needle
- Observe for plantar flexion (tibial-preferred) or dorsiflexion (common peroneal) – Depth 2-3 cm
- Decrease to 0.2-0.5 mA, observe movement
- Aspirate for blood, inject LA slowly
- Local anesthesia: 20-30 mL

Popliteal Nerve Block

Ultrasound Technique

- High Frequency (8-12 MHz), Linear Probe
- Patient position:
  - Prone, Supine, or Lateral
- Place probe in popliteal fossa, ID popliteal artery
  - Tibial n. is superficial to artery.
- Advance probe proximal (towards head) and observe common peroneal n. move from lateral to medial → joins with tibial n. to form sciatic n.
- In plane technique
  - Needle advances lateral to medial

Popliteal Nerve Block

Ultrasound Guided

CPN = Common Peroneal Nerve
TN = Tibial Nerve
PA = popliteal artery
Popliteal – Rare Complications

- Infection
- Hematoma
- Vascular Puncture
- Nerve Injury
- Pressure necrosis of heel – particularly with long acting local anesthetics

Fascia Iliaca Block

- Coverage:
  - Hip, anterolateral thigh, and potential anterior knee
- Indications:
  - Analgesia for hip fractures, total hip replacement, hip arthroscopy

Fascia Iliaca - Anatomy

- Iliacus (lateral) and psoas muscle (medial) pass through the pelvis.
- Fascia iliaca covers the iliacus and psoas muscles
- Lateral femoral cutaneous and femoral nerves run along anterior surface of iliacus muscles and deep to fascia iliaca.
Fascia iliaca

- Supplies
  - 100 mm, 22 g, b bevel
  - 40-60 mL local anesthetic
  - High frequency probe, linear
  - Skin disinfectant
  - Gloves

Fascia iliaca - Technique

- Supine position
- Probe in parasagittal plane over the ASIS.
- Slide medial, along inguinal ligament.
- ID the IOM and superior border of SM ("bow-tie")
- Deep is the iliacus muscle, the fascia iliaca is hyperechoic layer over the iliacus.
- Rotate toward umbilicus, advance in plane, caudal to cephalad.
- Pass needle through fascia iliaca, may feel "pop"
- Aspirate and inject 1-2 mL to hydrodissect iliacus from fascial layer.
- Layers should peel, inject 5 mL increments to 40-60 mL.

Fascia iliaca block
Ankle Block

- Indications:
  - Procedures that involve the foot/toes

- 5 major nerves:
  - Posterior Tibial
  - Deep Peroneal
  - Superficial Peroneal
  - Sural
  - Saphenous

Landmarks

Ankle Block
Ankle Block - Technique

• Posterior Tibial Nerve
  – Inject LA behind medial malleolus
  – Deep to superficial fascia
  – Contact bone, withdraw 1-2 mm, inject 3 mL

• Deep Peroneal
  – Palpate groove just lateral to extensor hallucis longus (flex big toe helps)
  – Contact bone, withdraw 1-2 mm, inject 2-3 mL

• Saphenous Nerve
  – At level of medial malleolus
  – Inject a “ring” of LA from:
    • injection site to Achilles tendon.
    • Injection site to tibial ridge
**Ankle Block - Technique**

- **Superficial Peroneal**
  - Inject a “ring” of LA from:
    - Tibial ridge toward lateral malleolus
  - 5 mL of LA
  - 1.5 inch, 25 g needle

- **Sural Nerve**
  - At level of lateral malleolus
  - LA is injected towards the Achilles tendon, subcutaneous fan like spread

**Evaluation of the Lower Extremity**

- **Femoral Nerve** = “punt the ball”
- **Sciatic Nerve** = “push on the gas”
TRUNK BLOCKADE

- Paravertebral
- Erector Spinae
- PECS I/II
- TAP

Landmark Article

Reg Anesth Pain Med 2014;39, 289-298

TransPlex Paravertebral Block and Its Effects on Chronic Pain and Health-Related Quality of Life After Modified Radical Mastectomy

A prospective, randomized, controlled trial comparing the effect of transPlex paravertebral block on pain and HRQoL after modified radical mastectomy was conducted in 2014.

The study involved 100 patients who were randomized to receive either transPlex paravertebral block or standard anesthesia.

Results showed significant differences in pain reduction and HRQoL improvement in favor of transPlex paravertebral block.

This landmark study provided valuable insights into the benefits of transPlex paravertebral block for managing chronic pain and improving HRQoL.
Paravertebral

- Paravertebral space extends from the cervical spine to the sacrum
- Can be as effective as a thoracic epidural for postoperative analgesia
- Can be placed (carefully) in anticoagulated patients
- Used primarily for breast procedures
- Can be used for VATS or minimally invasive thoracic procedures, particularly in pediatric patients
Erector Spinae Block

- Coverage:
  - Analgesia of anterior, lateral, posterior chest wall at T5
  - Analgesia of anterior, lateral, posterior abdominal wall at T8

- Indications:
  - Chronic neuropathic pain
  - Rib Fracture
  - Thoracic surgical procedures: VATS or breast surgery
  - Abdominal procedures
  - Less risk for pneumothorax vs paravertebral
  - Probably (absolutely) a bit easier...

Supplies:

- 50-80 mm, 22g, b bevel needle
- 20-60 mL local anesthetic
- High Frequency Transducer
- Skin disinfectant
- Gloves

Technique:

- Sitting, lateral, or prone position
- Probe placed in longitudinal plane, 2-3 cm lateral to the spinous process at either T5 or T8 level.
- Use transverse process as "backstop"
- Drive needle "in plane" cephalad to caudal direction.
- Aim for TP apex, below erector spinae muscle layer, inject.

**ERECTOR SPINAE BLOCK**

Sonanatomy
PECS I and PECS II

- **Targets:**
  - PECS I: Lateral and Medial Pectoral Nerves
  - PECS II: Intercostal nerves T2-6 and Long Thoracic Nerve

- **Indications:**
  - PECS I: Anesthesia to the Pec Major and Pec Minor muscles
  - PECS II: Skin of the anteriolateral chest, axilla, and medial aspect of upper arm, serratus anterior

PECS I and II

- **Supplies**
  - 22g, 80-100 mm b bevel
  - 30-40 mL local anesthetic
  - High frequency probe (6-13 mHz)
  - Skin disinfectant
  - Gloves
Anatomy

- Lateral and Medial Pectoral nerves are in the facial plane between Pec Major and Minor (PECS I)
- Long Thoracic Nerve is in the facial plane between Serratus anterior and Pec Minor (PECS II)

PECS I and II

- Supine or Semi-recumbent position; head turned away from side being blocked
- Arm abducted 30-90 degrees
- Probe in parasagittal plane, just inferior to clavical and medial to coracoid process (deltopectoral groove)
- Identify 3rd and 4th ribs
- Rotate 30-45 degrees, slide laterally toward axilla
PECS II

- Insert and advance needle in plane in medial to lateral direction
- Advance needle to within facial plane between pec minor and serratus anterior muscles.
- Aspirate and inject 1-2 mL, verify hydrodissection
- Administer 3-5 mL increments to 20 mL volume

PECS I

- Withdraw needle until tip is between facial plane between pec major and minor.
- Aspirate and inject 1-2 mL to verify hydrodissection.
- Administer 3-5 mL increments to total volume of 10 mL

Transversus Abdominis Plane Block

- Indications:
  - Analgesia for lower abdominal wall procedures
  - Inguinal hernia (both open and laparoscopic)
  - Appendectomy
    - Analgesia for cesarean section*
    - Analgesia for hysterectomy*

*Requires bilateral blocks
Transversus Abdominis Plane Block

Transverse Abdominis Plane (TAP)

- Indications:
  - Somatic sensation of anterior abdominal wall.
  - Dermatomes T6-T9 (Subcostal TAP - upper abd)
  - Dermatomes T10-T12 (Lateral TAP - lower abd)
  - Open Abdominal Surgeries
  - C-Section, Total Abdominal Hysterectomy
  - Renal Transplant, nephrectomy
  - Ileostomy
  - Exploratory laparotomy
Subcostal TAP

- **Technique**
  - Linear Probe – medial - lower margin of rib cage
  - Rectus Abdominis and its posterior rectus sheath are visualized – transverse abdominis muscle is deep to this sheath.
  - Target: Fascial plane between the posterior rectus sheath and the transverse abdominis muscle.
  - Needle – medial to lateral (or lateral to medial) to target (50 or 100mm)
  - Local – 20 mL per side

---

Transversus Abdominis Plane Block

---
Lateral TAP

- Technique
  - Linear Probe – midaxillary line between subcostal margin and iliac crest.
  - Visualize 3 muscles: External Oblique, Internal Oblique, Transverse Abdominis.
  - Target: Fascial Plane between IO and TA.
  - Needle: Anterior to midaxillary line, Medial to Lateral.
  - Local: 20-30 mL per side.

TAP Block – Ultrasound Image

Perioperative Interactive Education, Mount Sinai Hospital, University of Toronto (http://pie.med.utoronto.ca)
References

References, continued

• NYSORA – www.nysora.com