Regional Anesthesia for Extremity Surgery

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Disclosures

No financial disclosures or conflicts of interest

Objectives

- Discuss in brief the pharmacology of local anesthetics
- Discuss the anatomy of the brachial plexus
- Discuss the anatomy of the lumbar plexus
- Discuss the anatomy of the sacral plexus
- Discuss cutaneous sensory innervation of the arm
- Discuss distal cutaneous sensory innervation of the leg
- Discuss the different types of peripheral nerve blocks
- Discuss area of expected analgesia/anesthesia with each block

Local Anesthetic Pharmacology

Local anesthetics can be broadly classified into several groups

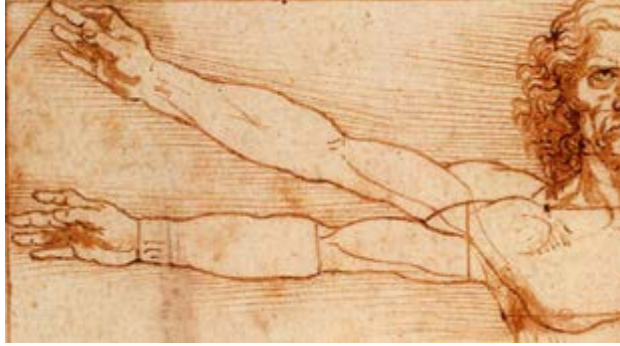
	Analgesic Concentration	Anesthetic Concentration
Long Acting	Bupivacaine 0.25% Ropivacaine 0.2%	Bupivacaine 0.5% Ropivacaine 0.5%
Intermediate Acting	Lidocaine 1% Mepivacaine 1%	Lidocaine 2% Mepivacaine 1.5%

Local Anesthetic Pharmacology

Drug (plain)	Onset	Duration of Action
Bupivacaine	20-30 mins	6 – 12 hrs
Ropivacaine	20-30 mins	6 – 12 hrs
Lidocaine	10-20 mins	2 – 4 hrs
Mepivacaine	10-20 mins	2 – 4 hrs

Local Anesthetic Pharmacology

- Adjuvants to local anesthetics
  - Vasoconstrictors: Epinephrine
    - Decreases vascular uptake
    - Improves depth and duration of anesthesia
    - Serves as an intravascular marker
  - Clonidine
    - May prolong duration of block
    - Has both vasoconstrictor and direct peripheral nerve effect
    - More pronounced increase in duration with intermediate acting local anesthetics
  - Dexamethasone
    - Improves analgesic duration.
  - Buprenorphine
    - Improves analgesic duration.
    - Possibly mediated via peripheral opioid receptors and possible intrinsic local-anesthetic-like ability to block voltage gated Na+ channels
    - Also has antihyperalgesic effects



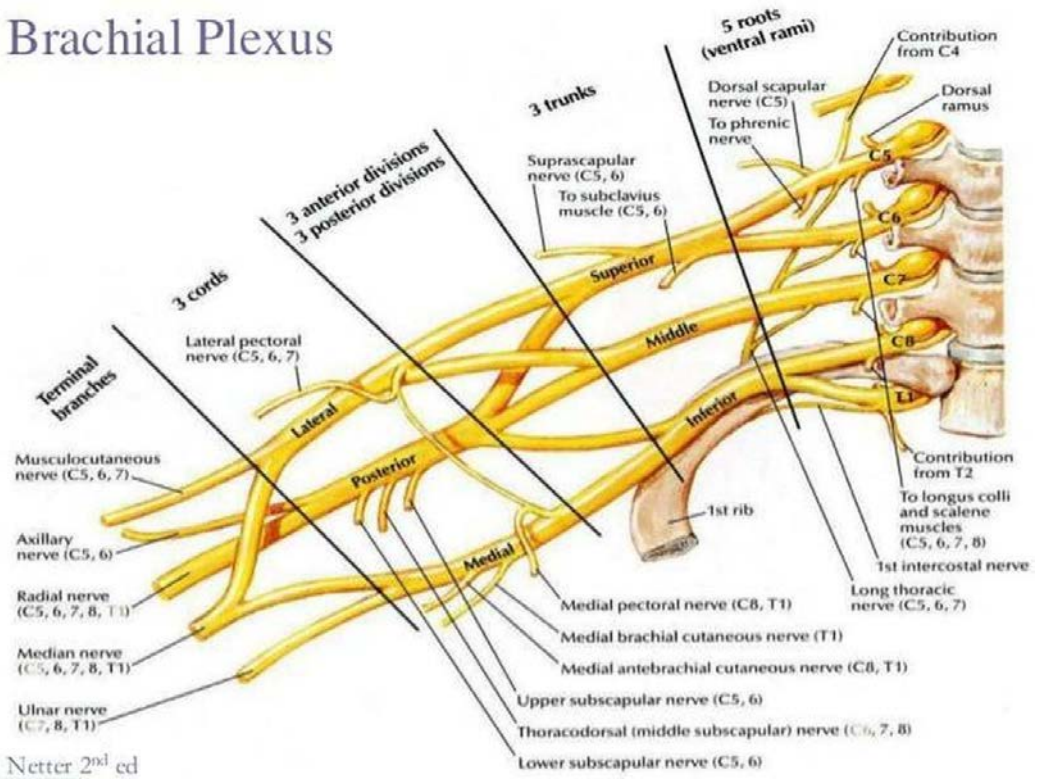
Upper Extremity Surgery

What is the location of the surgery

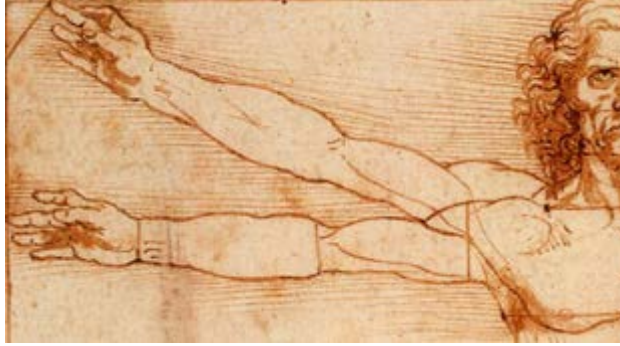
What skin, muscle, and bony components will be involved

Which nerves are involved when answering the above questions

Does my patient have any medical issues that would preclude “standard” blocks



“-Tomes”



Interscalene

Supraclavicular

Infraclavicular

Axillary

Sensory innervation of the human shoulder joint: the three bridges to break

Pierre Laumonerie [1], Yoann Dalmas [2], Meagan E Tibbo [3], Suzanne Robert [2], Marie Faruch [4], Patrick Chaynes [5], Nicolas Bonnevialle [2], Pierre Mansat [2]

Affiliations + expand

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Abstract

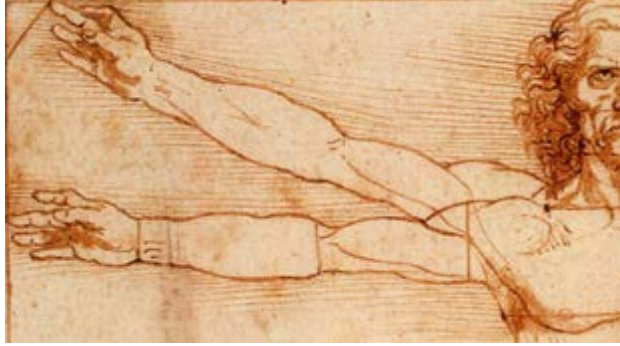
Background: Painful shoulders create a substantial socioeconomic burden and significant diagnostic challenge for shoulder surgeons. Consensus with respect to the anatomic location of sensory nerve branches is lacking. The aim of this literature review was to establish consensus with respect to the anatomic features of the articular branches (ABs) (1) innervating the shoulder joint and (2) the distribution of sensory receptors about its capsule and bursae.

Materials and methods: Four electronic databases were queried, between January 1945 and June 2019. Thirty original articles providing a detailed description of the distribution of sensory receptors about the shoulder joint capsule (13) and its ABs (22) were reviewed.

Results: The suprascapular, lateral pectoral, axillary, and lower subscapular nerves were found to provide ABs to the shoulder joint. The highest density of nociceptors was found in the subacromial bursa. The highest density of mechanoreceptors was identified within the insertion of the glenohumeral ligaments. The most frequently identified innervation pattern comprised 3 nerve bridges (consisting of ABs from suprascapular, axillary, and lateral pectoral nerves) connecting the trigger and the identified pain generator areas rich in nociceptors.

Conclusion: Current literature supports the presence of a common sensory innervation pattern for the human shoulder joint. Anatomic studies have demonstrated that the most common parent nerves supplying ABs to the shoulder joint are the suprascapular, lateral pectoral, and axillary nerves. Further studies are needed to assess both the safety and efficacy of selective denervation of the painful shoulders, while limiting the loss of proprioceptive function.

Keywords: Anatomy; denervation; joint innervation; nerve; pain; review; shoulder joint.



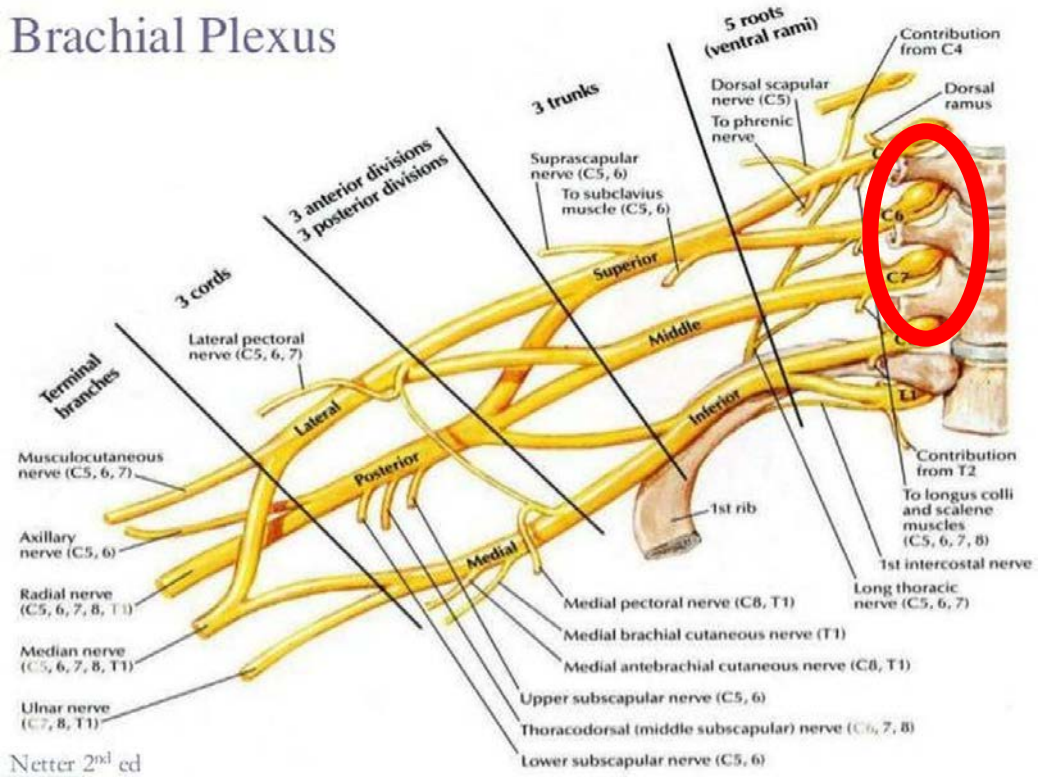
Shoulder Surgery: ISB

Indications: Rotator cuff repair, shoulder arthroscopy, total shoulder arthroplasty. Also applicable for proximal humerus operations

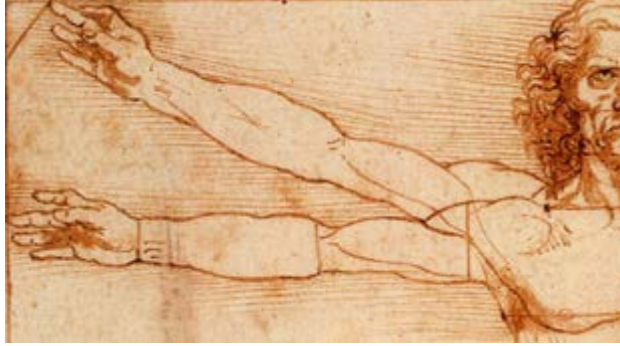
Contraindications: severe pulmonary cripple, contralateral phrenic nerve or RLN palsy, patient refusal, infection over site of block placement

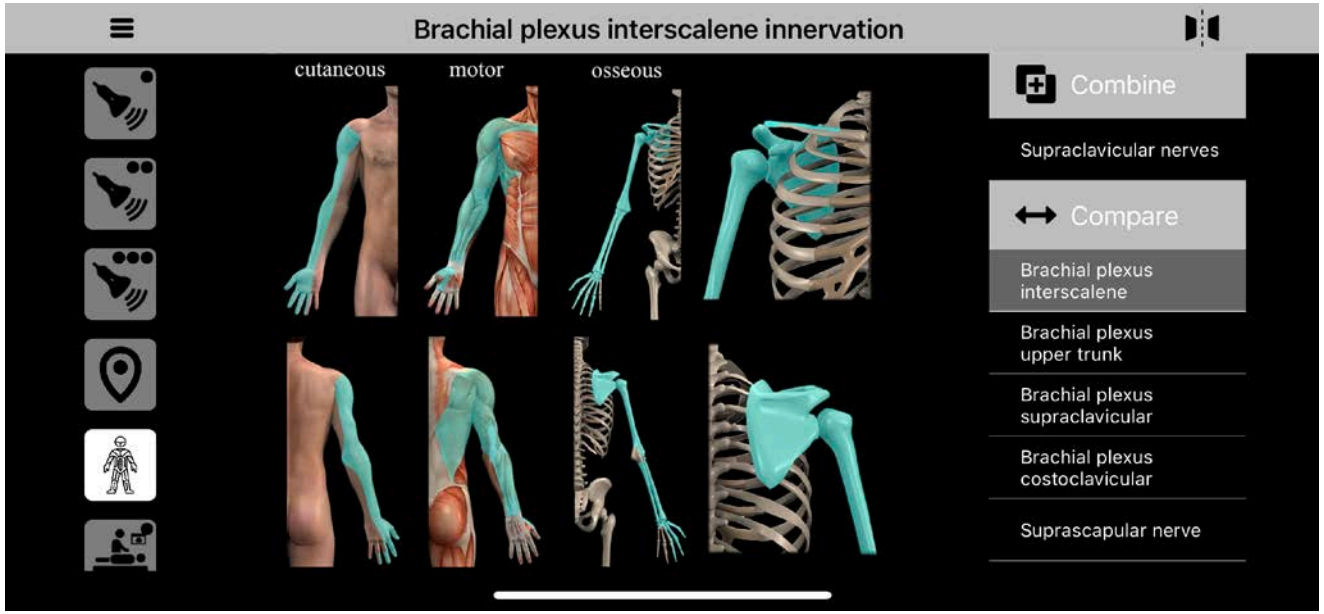
Considerations: 100% blockade of phrenic nerve, ptosis/Horner's syndrome, hoarseness (RLN)

Complications: dyspnea, vessel puncture, IV injection, intrathecal/epidural injection, motor weakness



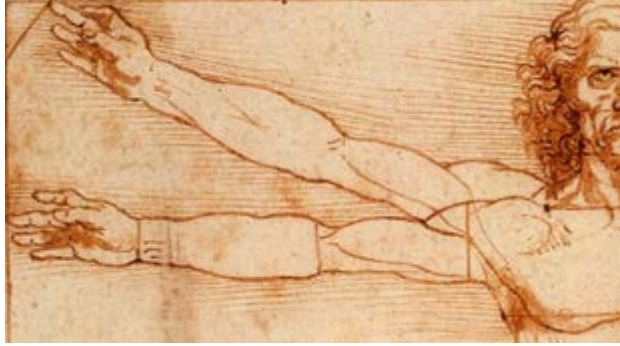
Shoulder Surgery: ISB





- Anatomic studies have demonstrated that the most common parent nerves supplying articular branches to the shoulder joint are the suprascapular (C5, 6), lateral pectoral (C5, 6, 7), and axillary (C5, 6) nerves, all of which are covered in an interscalene block.
- Coverage can be accomplished with single shot or catheter placement

Shoulder Surgery: ISB



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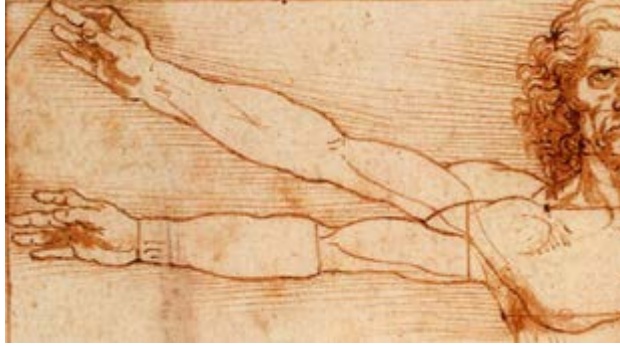
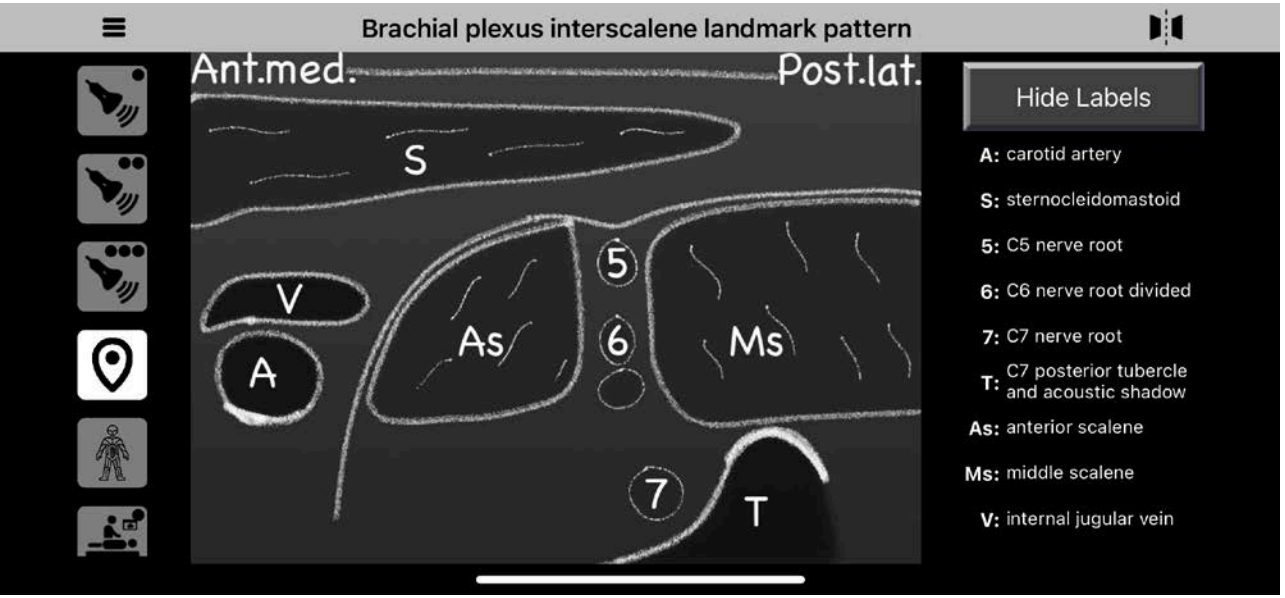
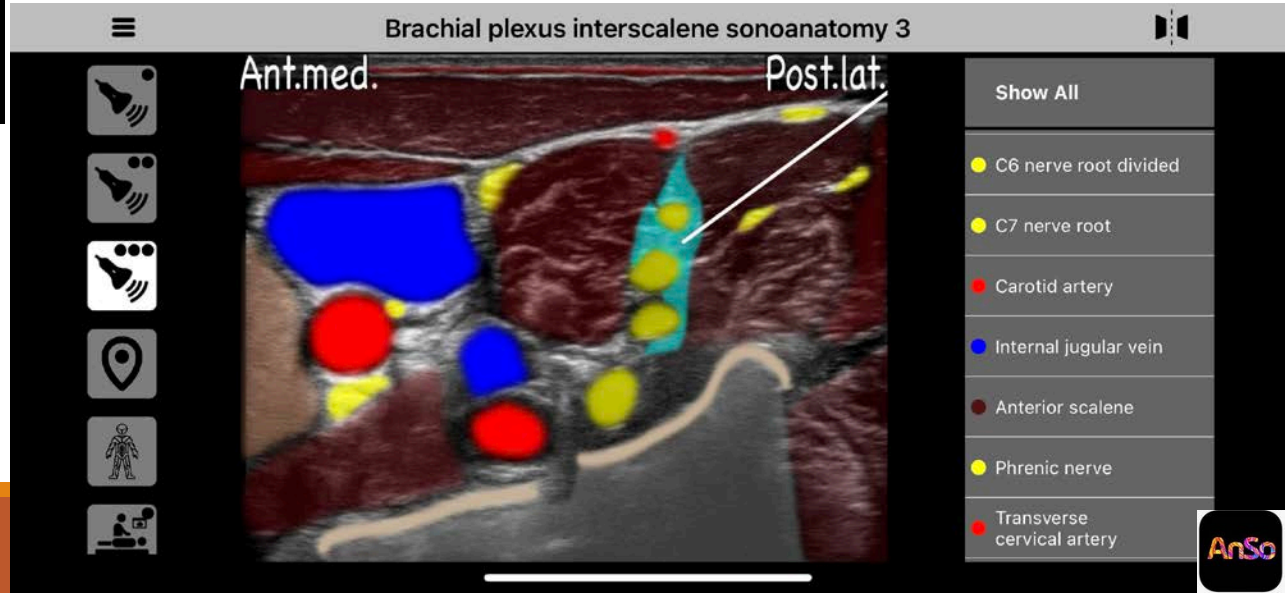
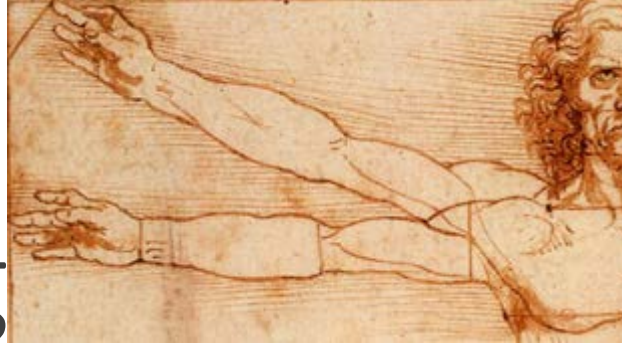
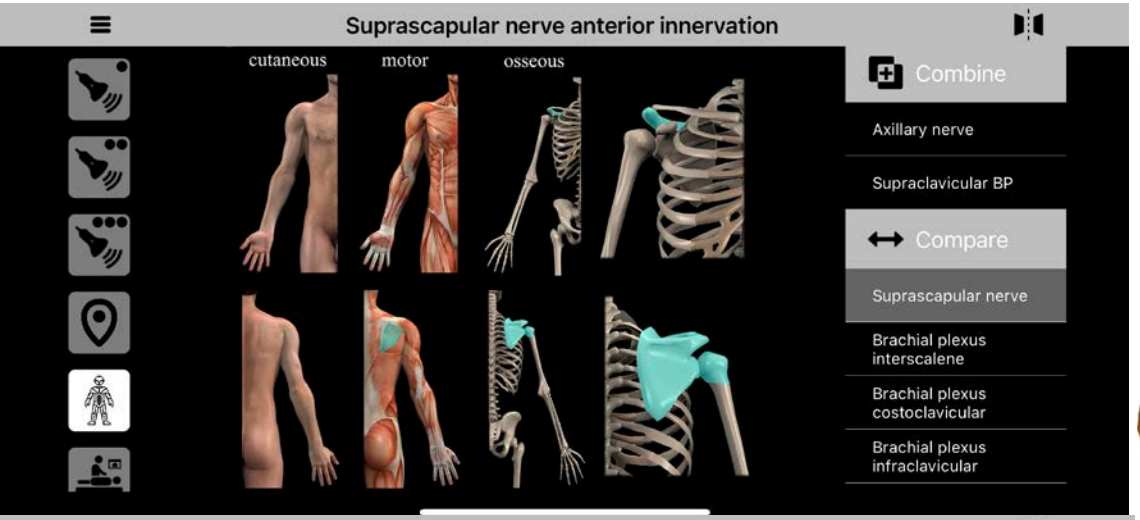


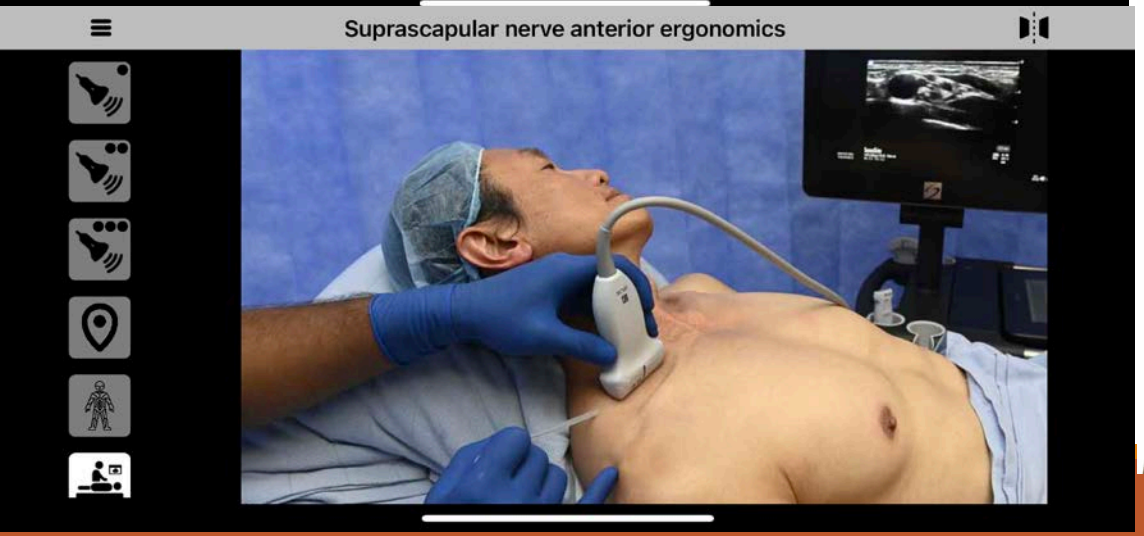


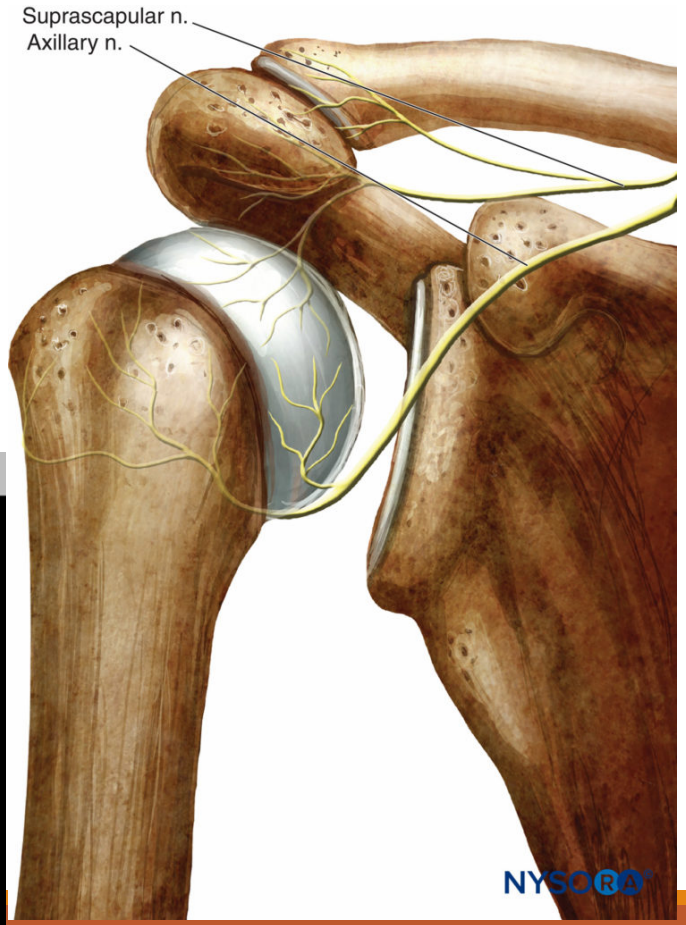


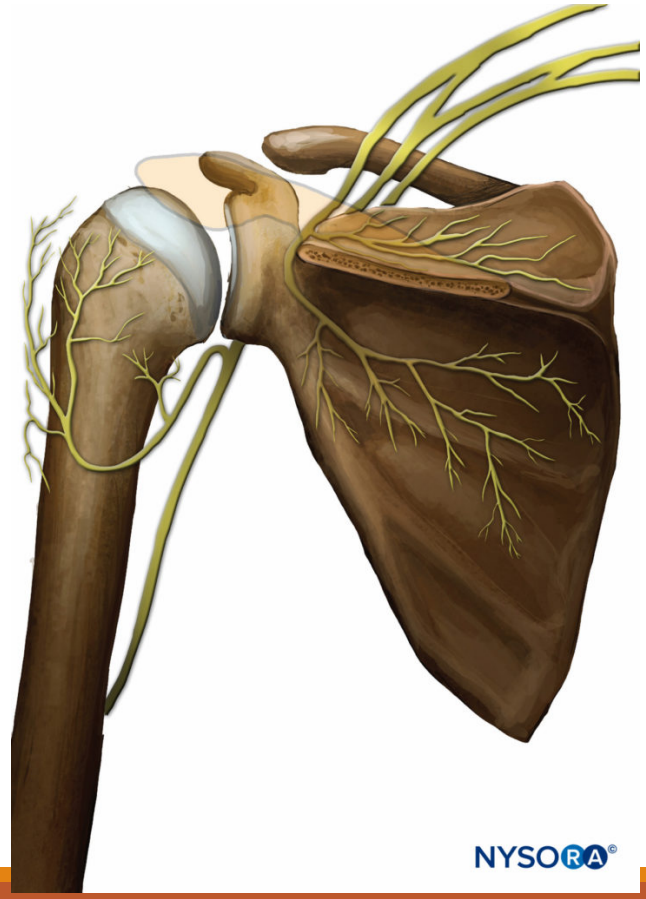
Shoulder Surgery: Phrenic Sparing











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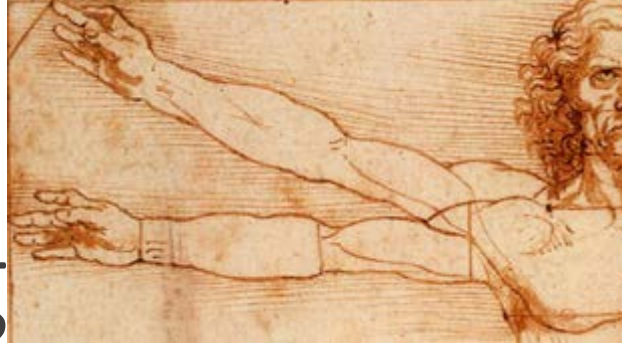

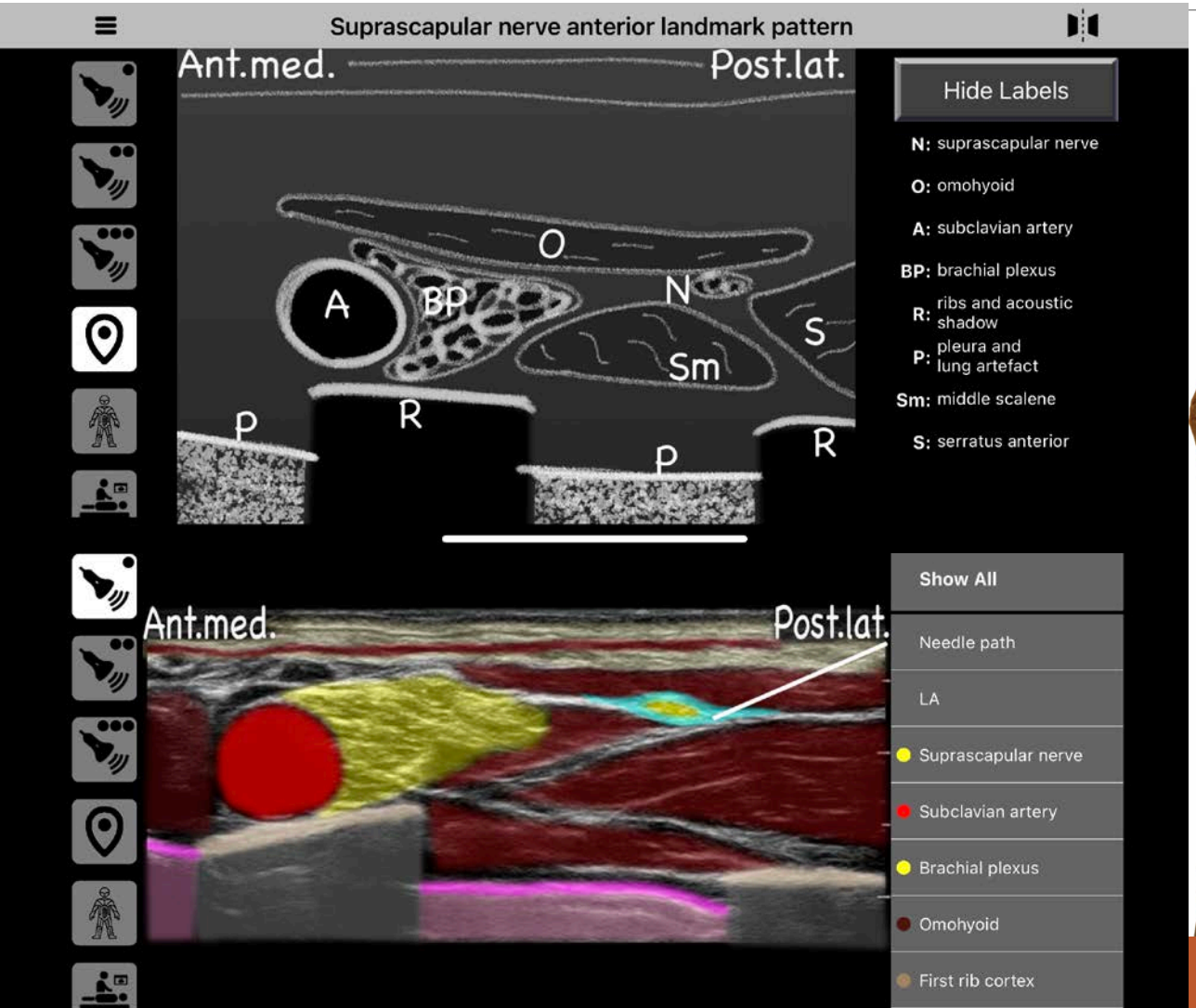

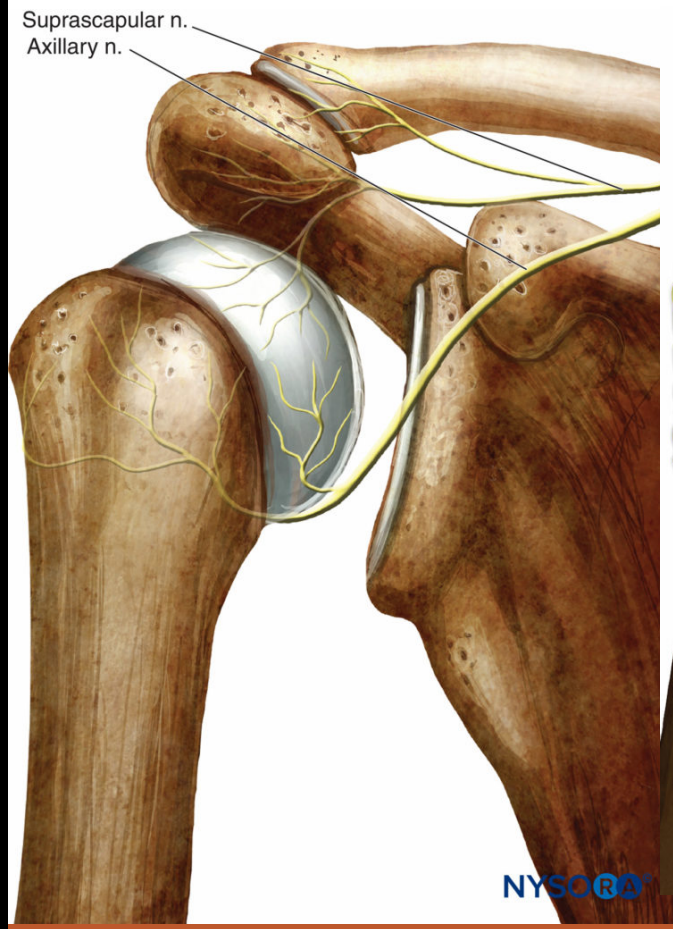

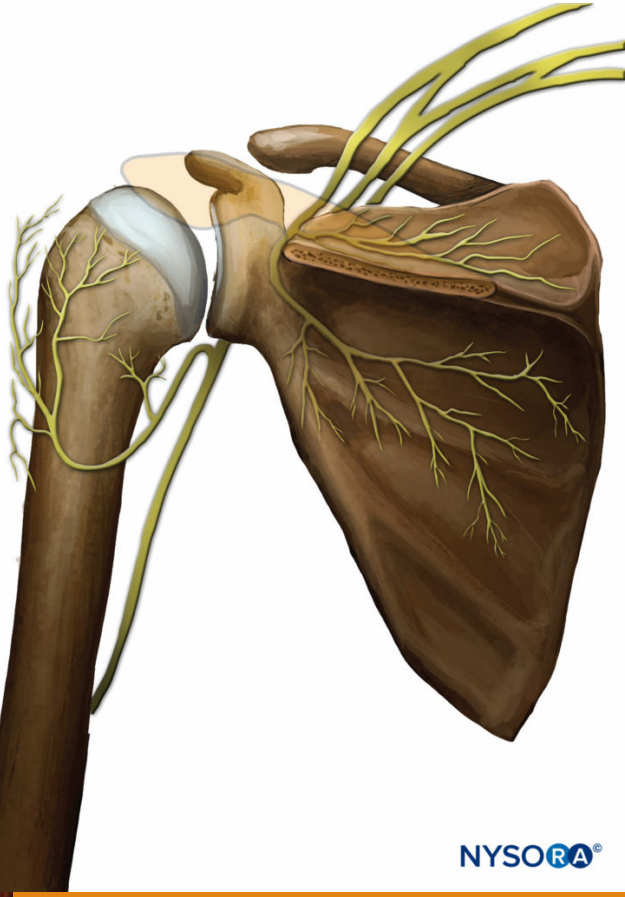

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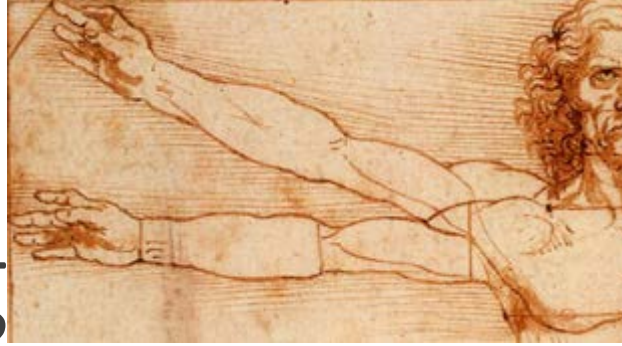

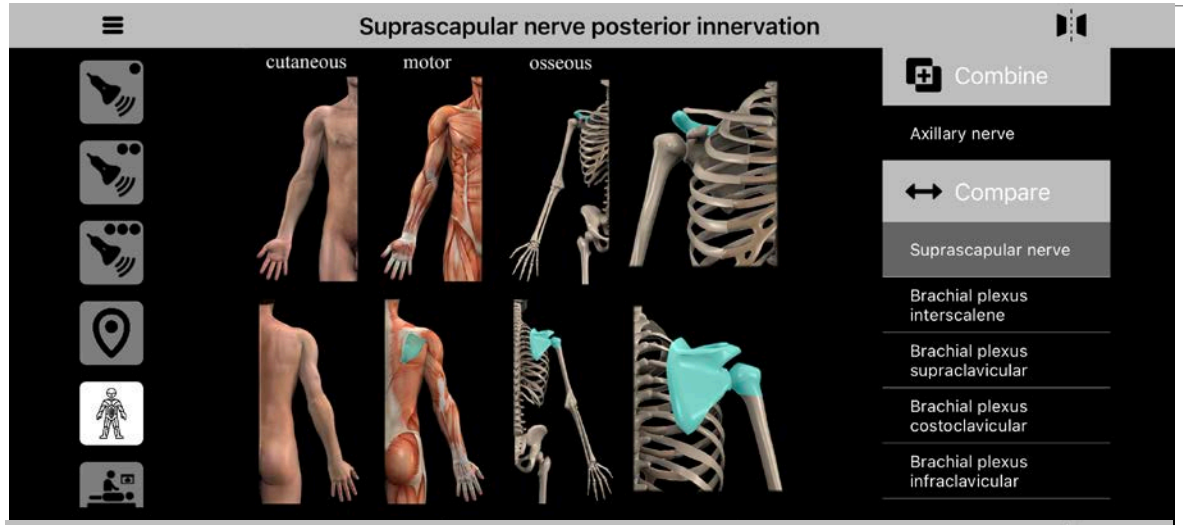

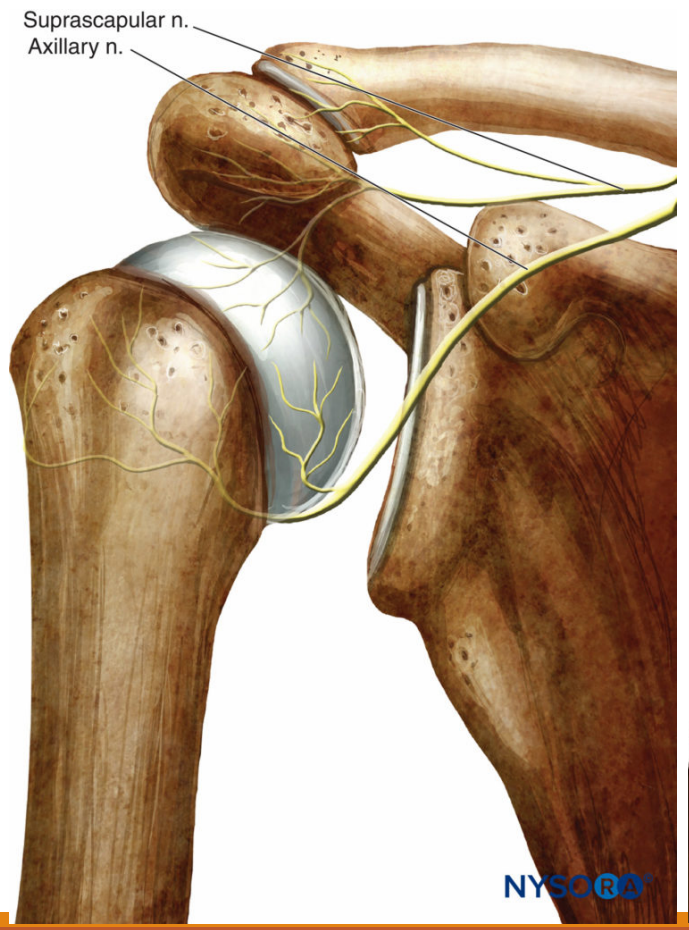

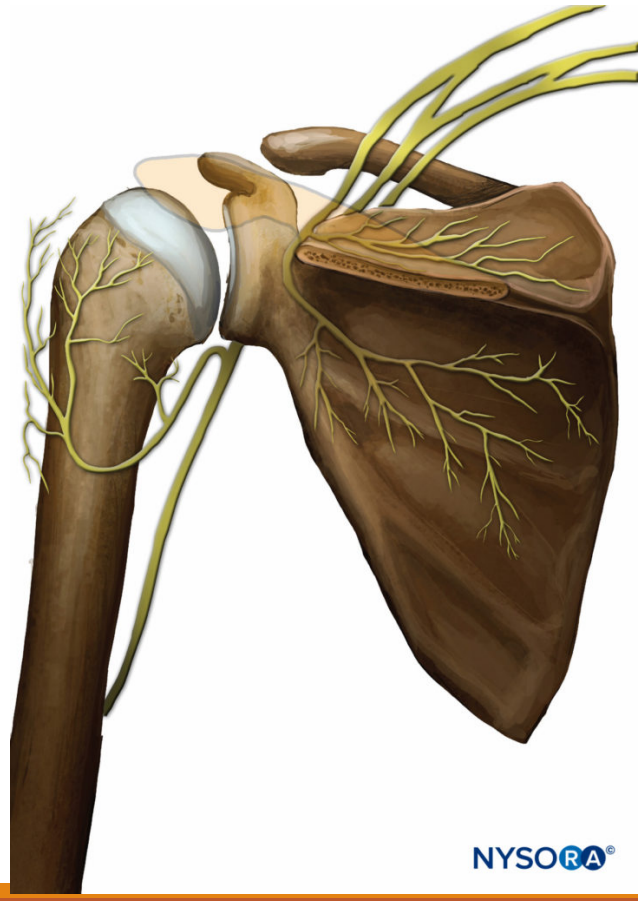

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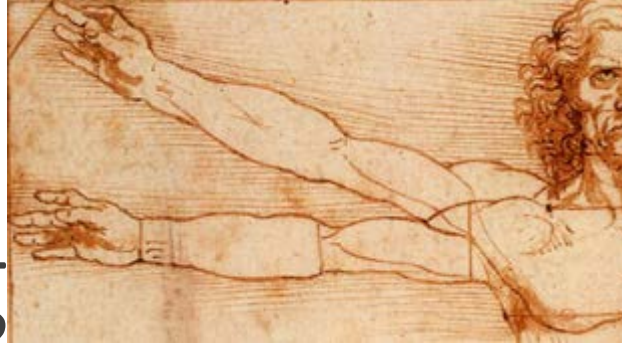

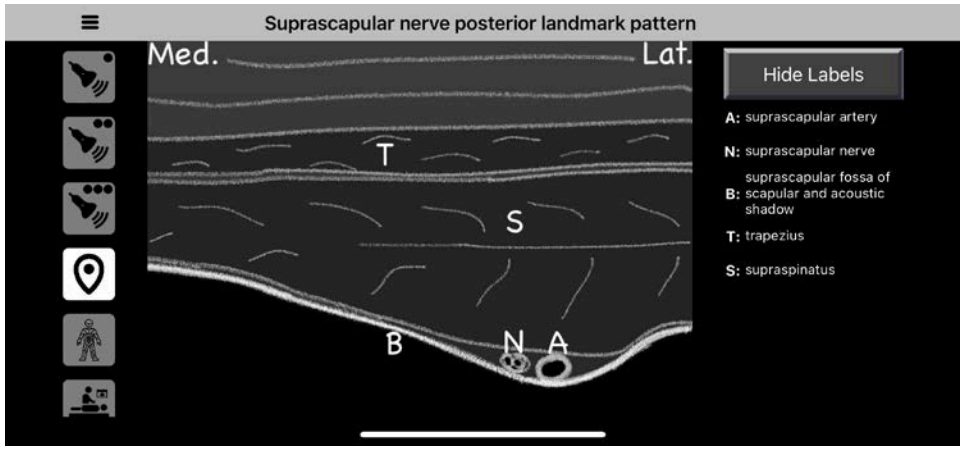

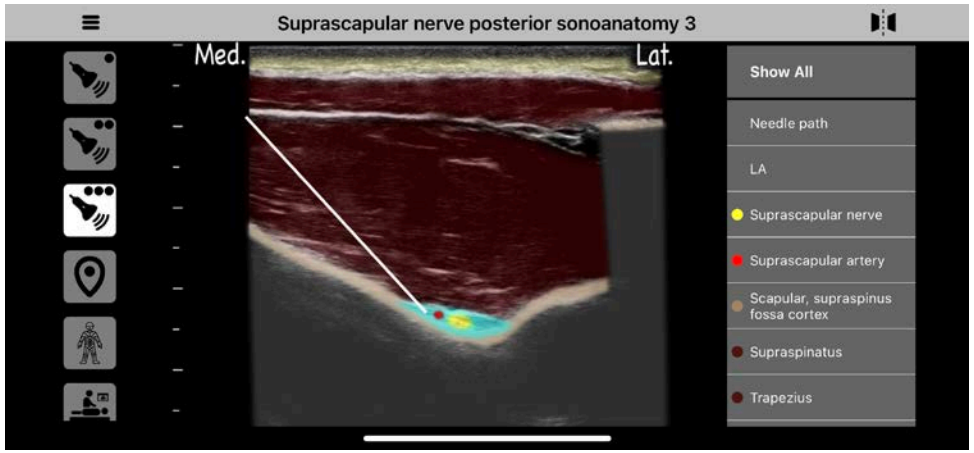

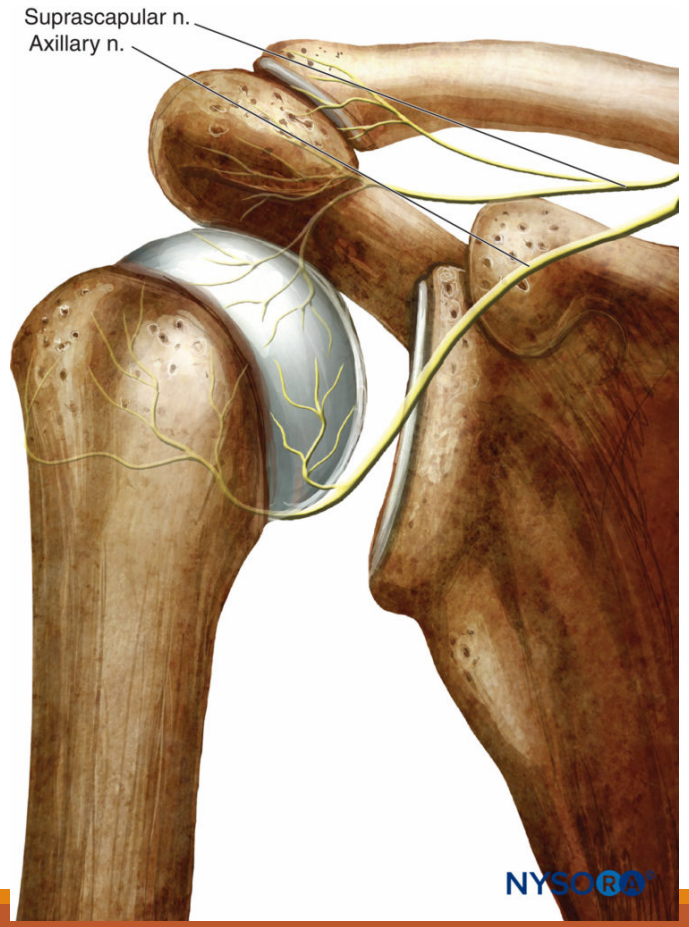

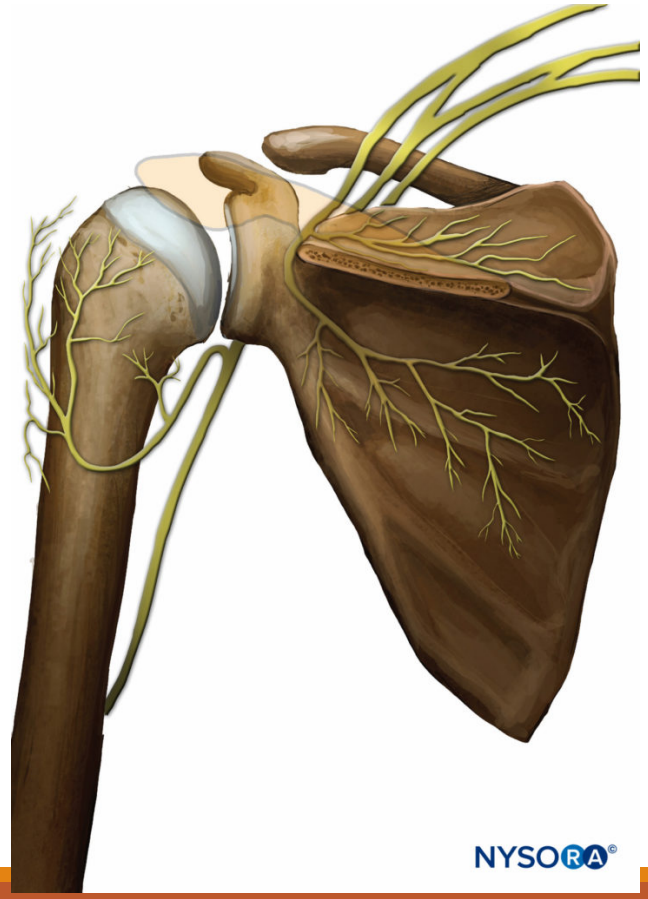

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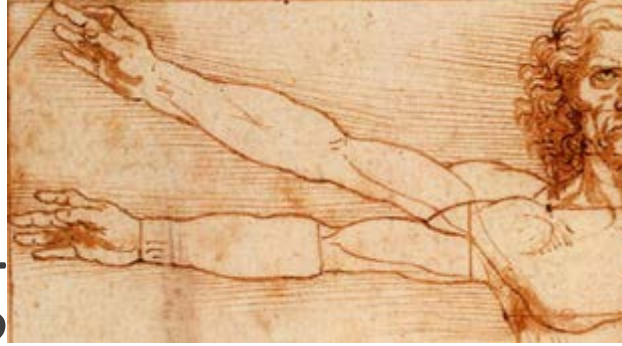
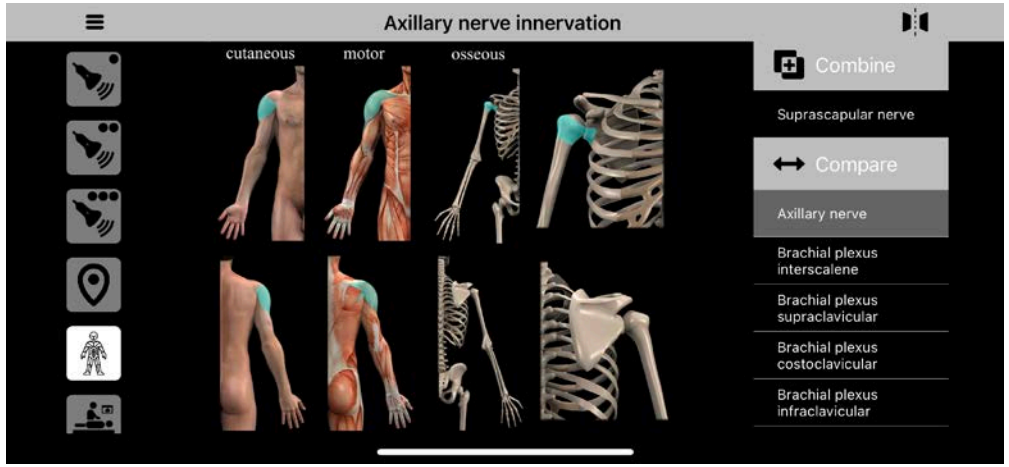
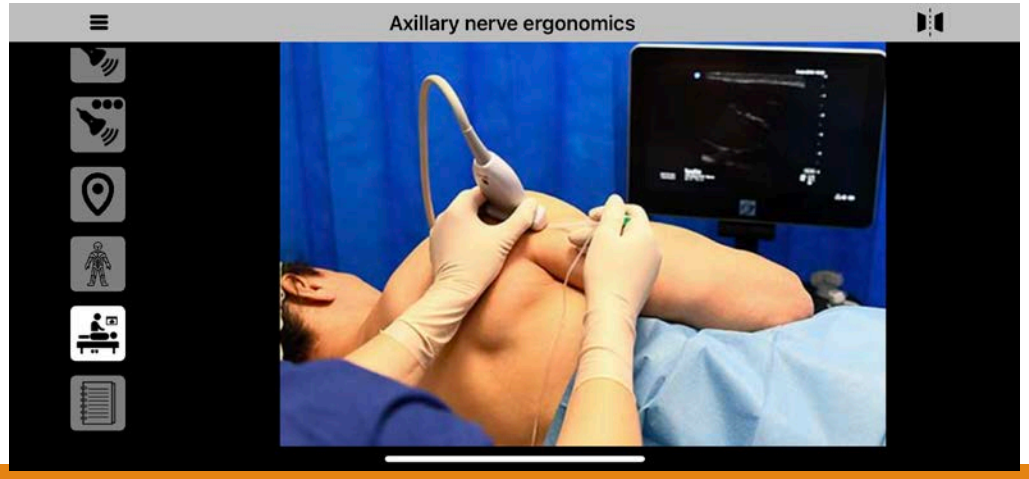
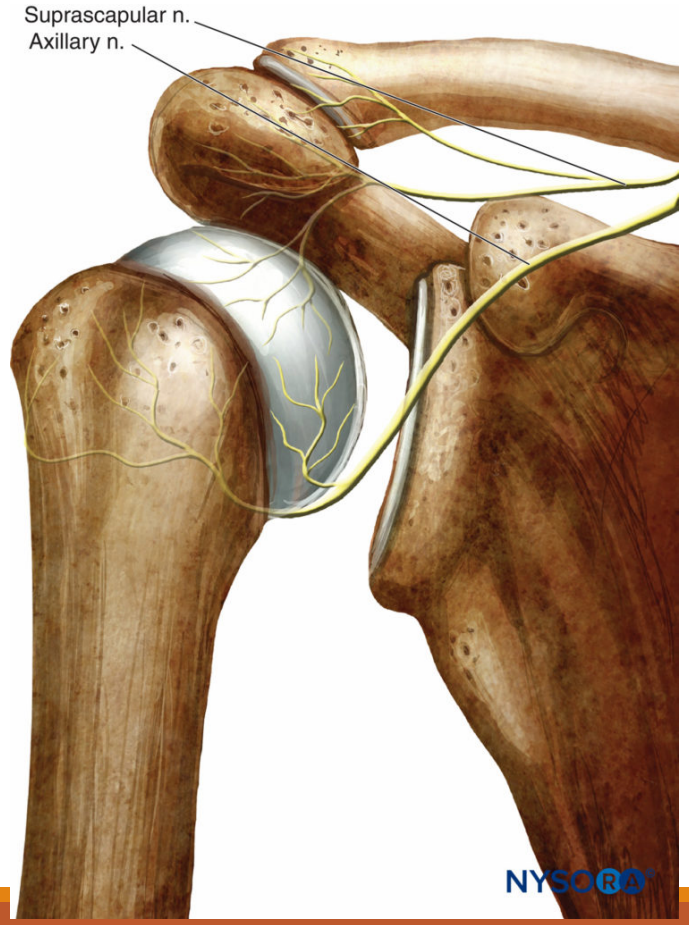
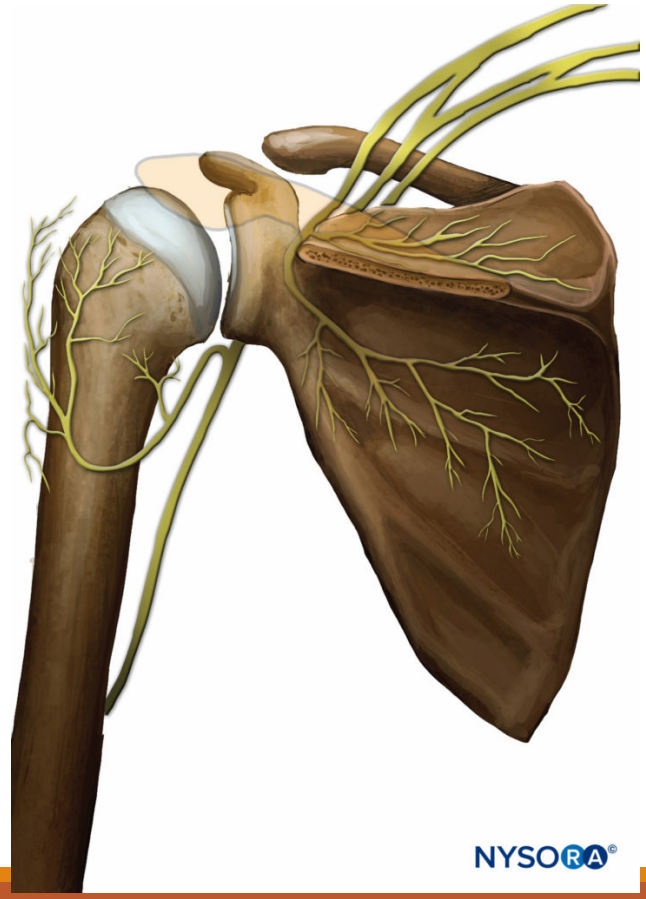


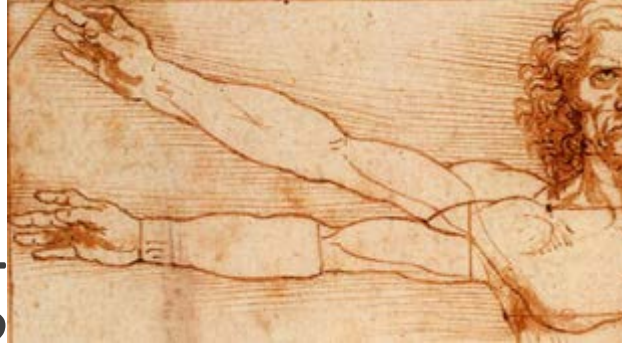


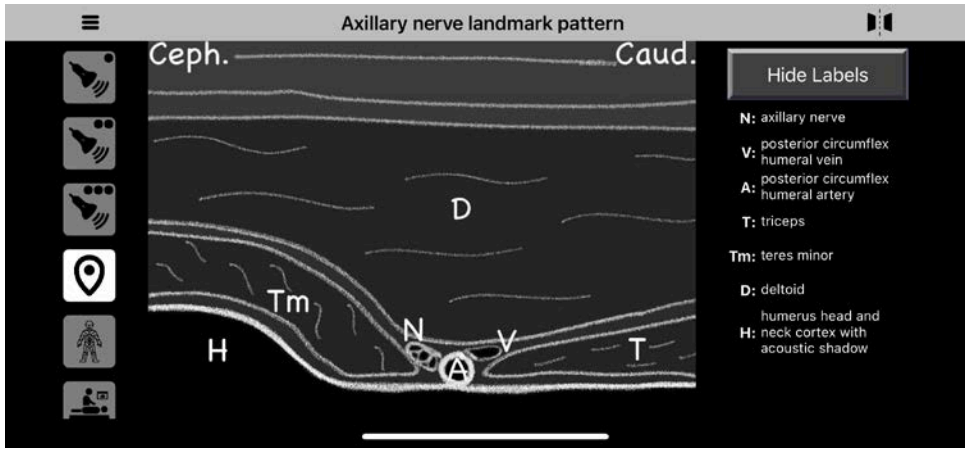


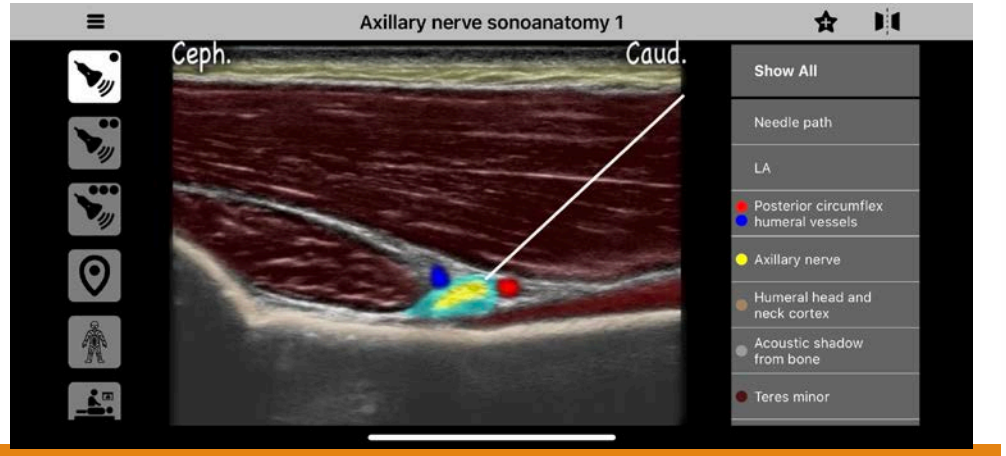


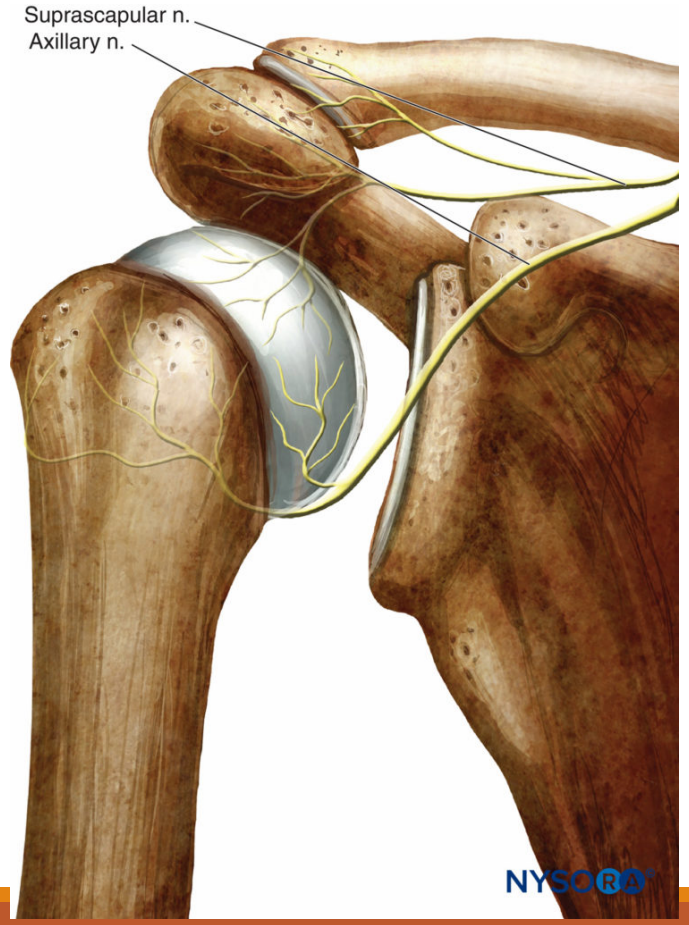


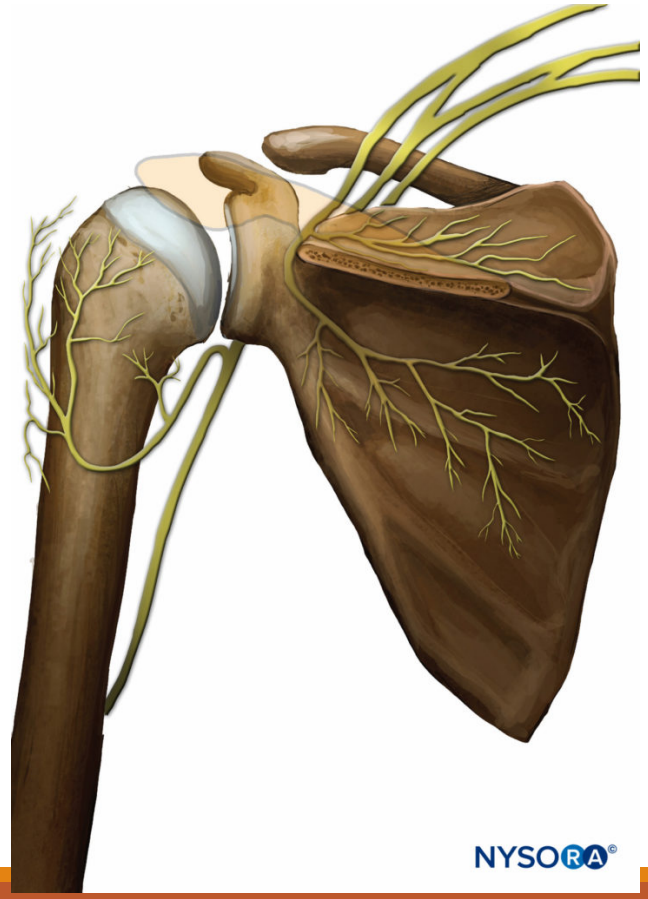
Shoulder Surgery: Phrenic Sparing

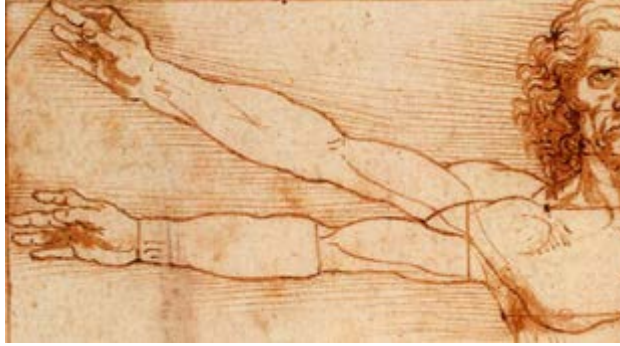






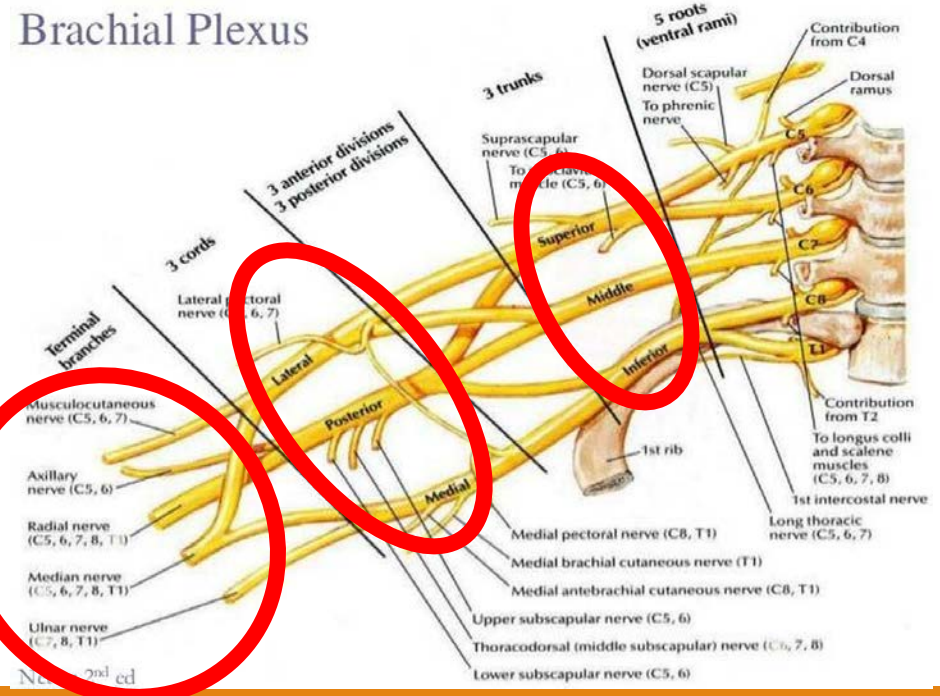






Elbow and below

Any BPB distal to the interscalene block can be performed for surgical or analgesic coverage for joint surgery elbow and below



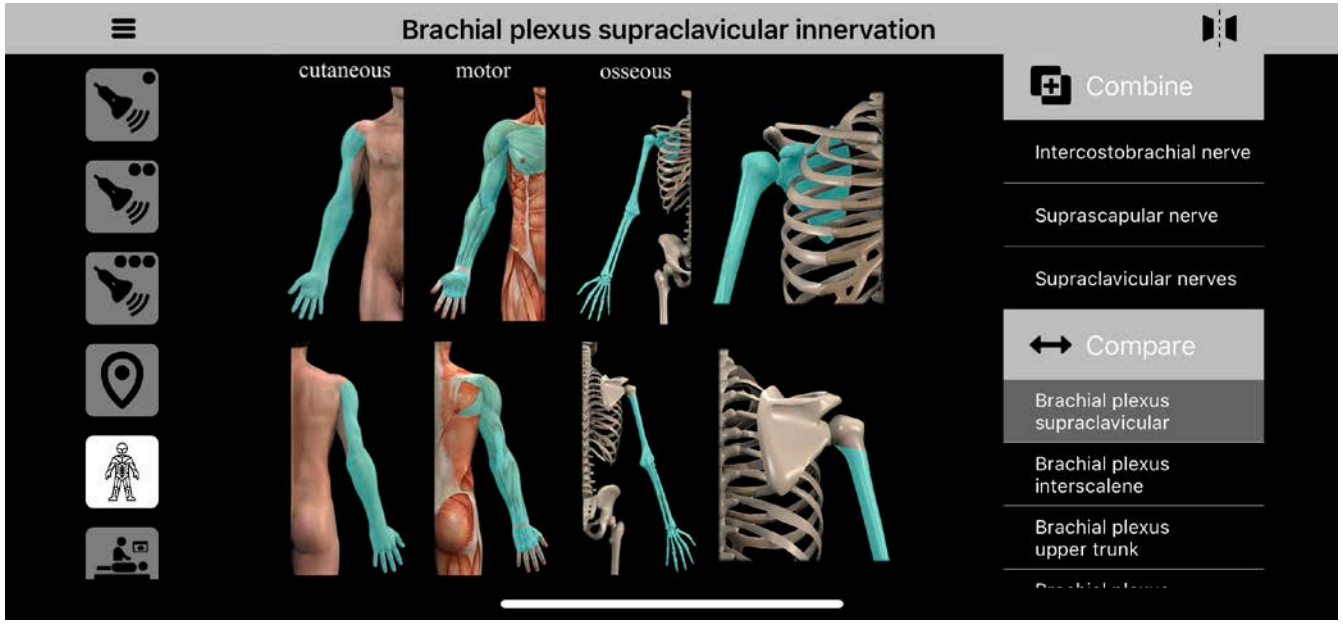
Interscalene

Supraclavicular

Infraclavicular

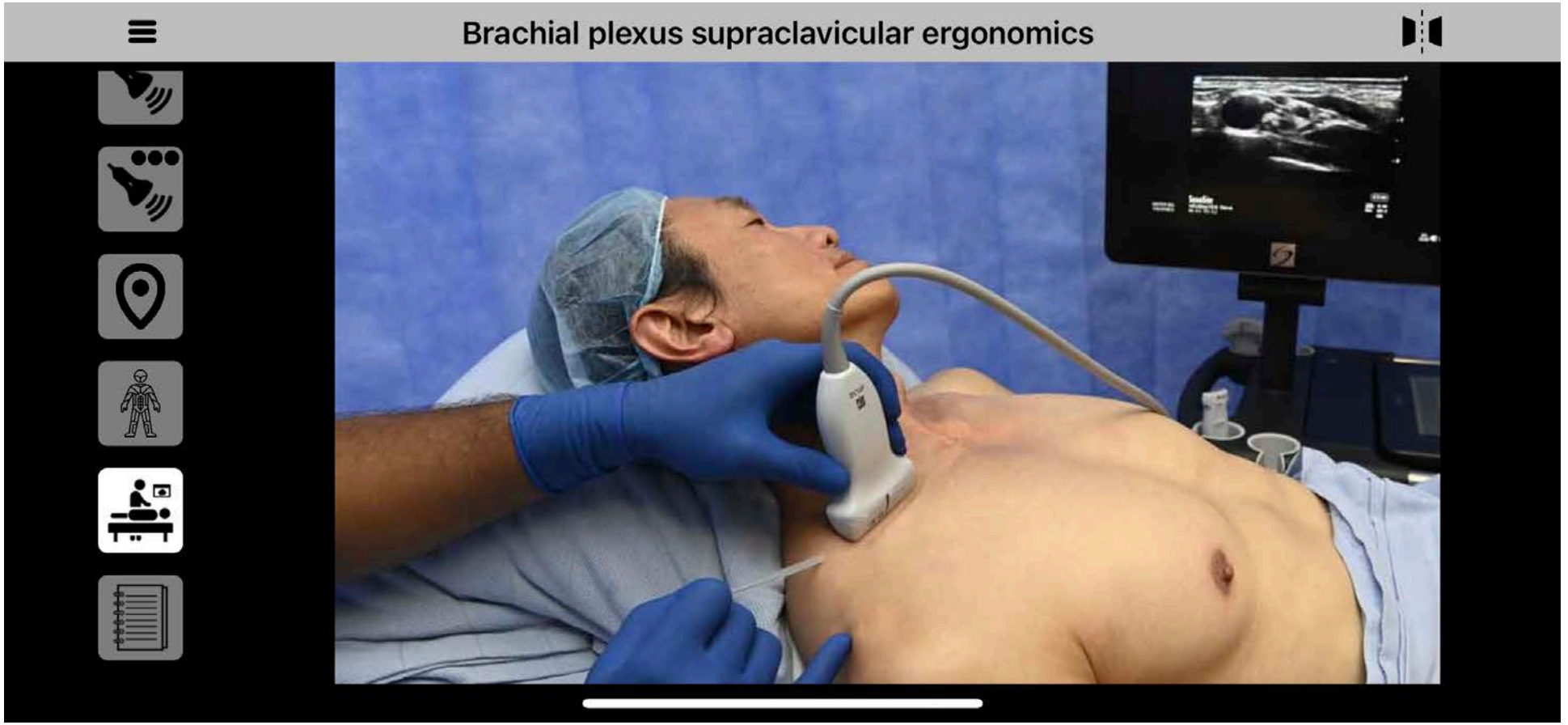
Axillary

Elbow and Below: Supraclavicular

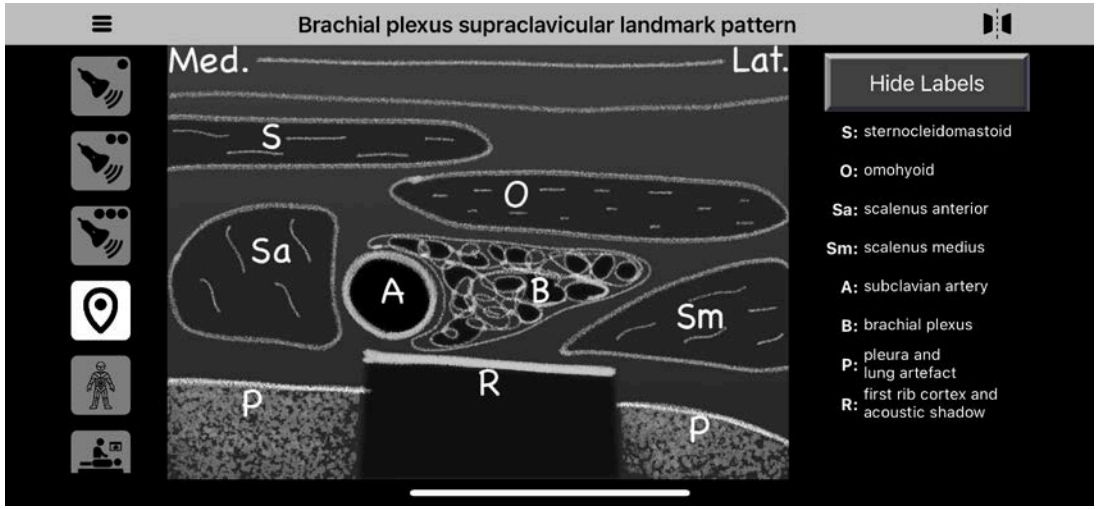


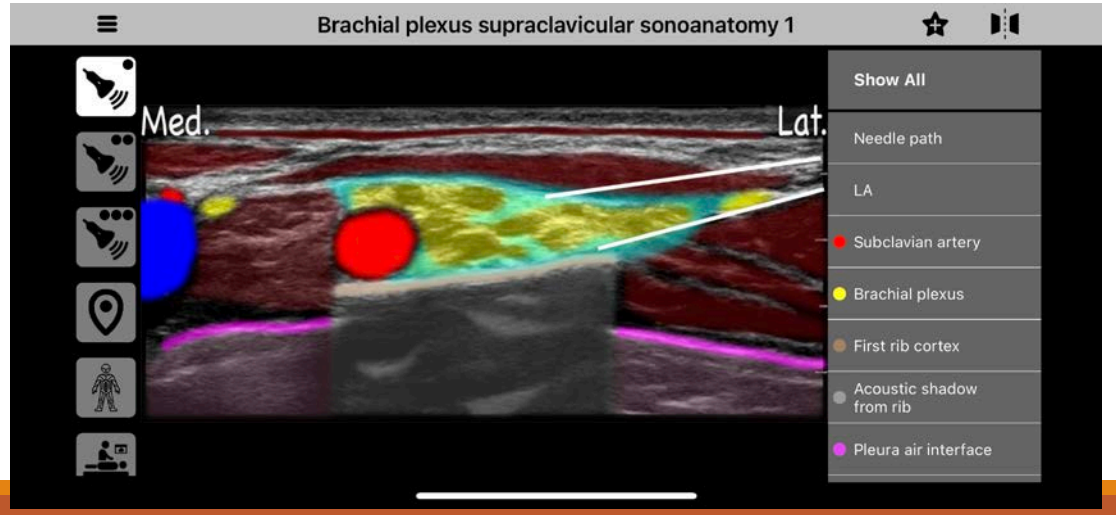
- Indications: anesthesia to forearm, wrist, or hand
  - Combine with intercostobrachial for anesthesia to elbow or distal humerus surgery; does provide analgesia to shoulder joint
- Side effects
  - Horner's syndrome (spread to cervical sympathetics)
  - Hoarseness
  - ~50% likelihood of phrenic nerve palsy
    - Caution in patient with COPD or contralateral hemidiaphragmatic paresis)
- Complications
  - Pneumothorax, vessel injury in non-compressible location (caution in patients on anticoagulation)

Elbow and Below: Supraclavicular

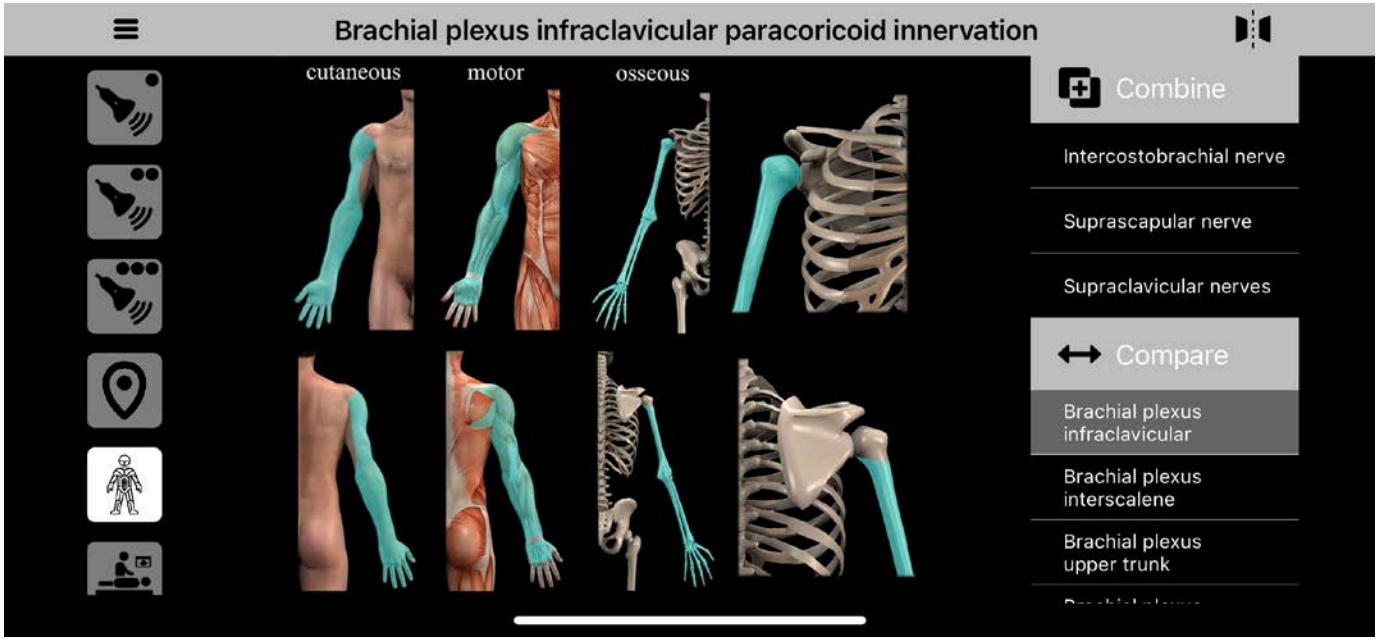


Elbow and Below: Supraclavicular





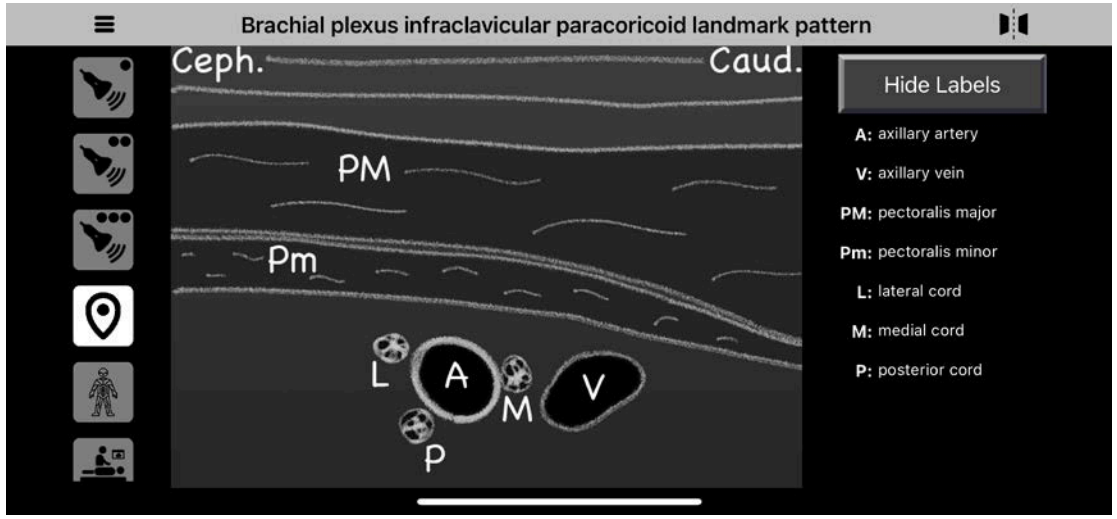
Elbow and Below: Infraclavicular

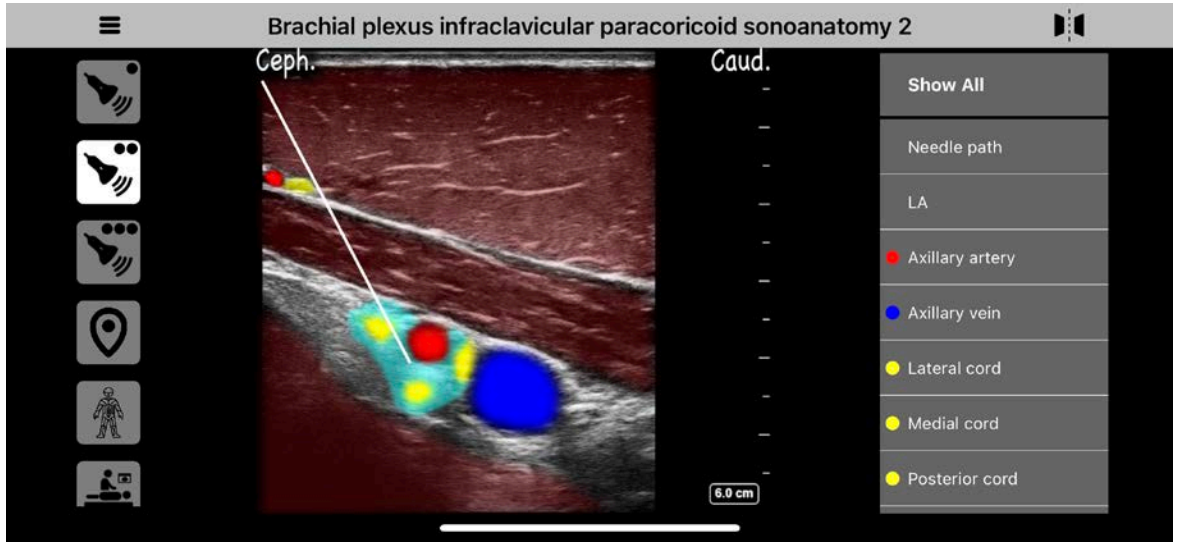


- Indications: anesthesia to forearm, wrist, or hand
  - Combine with intercostobrachial for anesthesia to elbow or distal humerus surgery; does NOT provide analgesia to shoulder joint
- Side effects
  - Muscle weakness in expected distribution
  - ~15% risk of phrenic nerve palsy
- Complications
  - Pneumothorax, vessel injury in non-compressible location (caution in patients on anticoagulation), IV injection

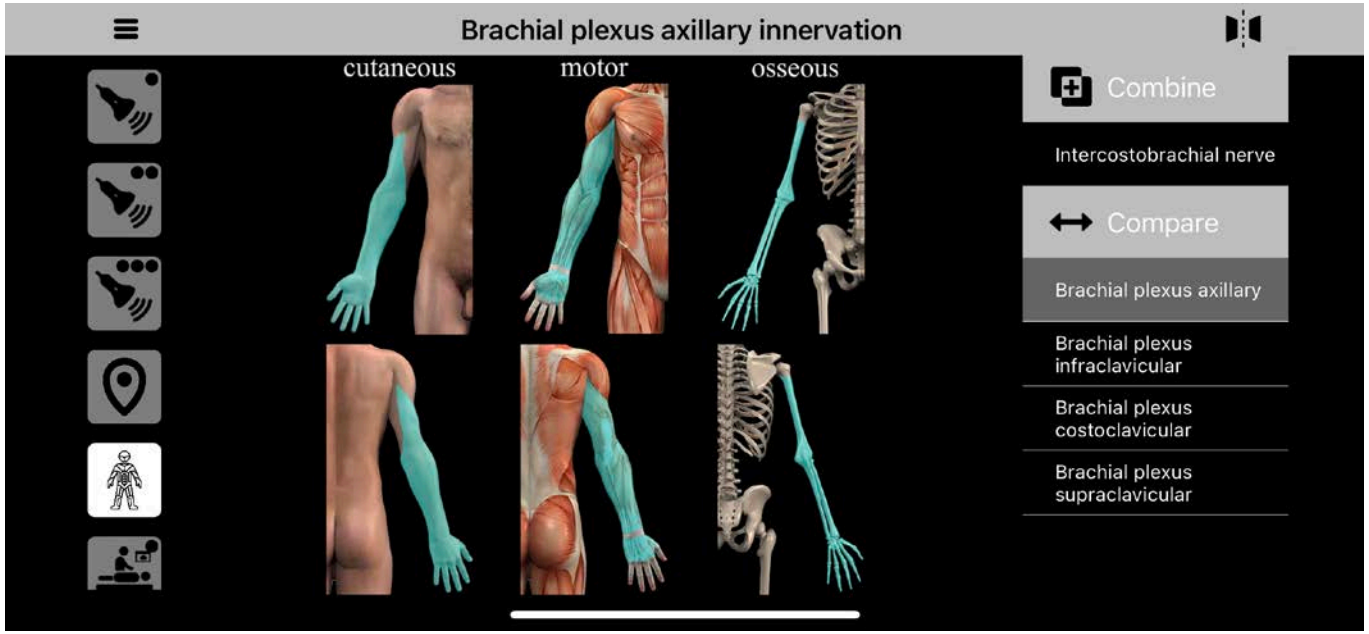
Elbow and Below: Infraclavicular

Elbow and Below: Infraclavicular



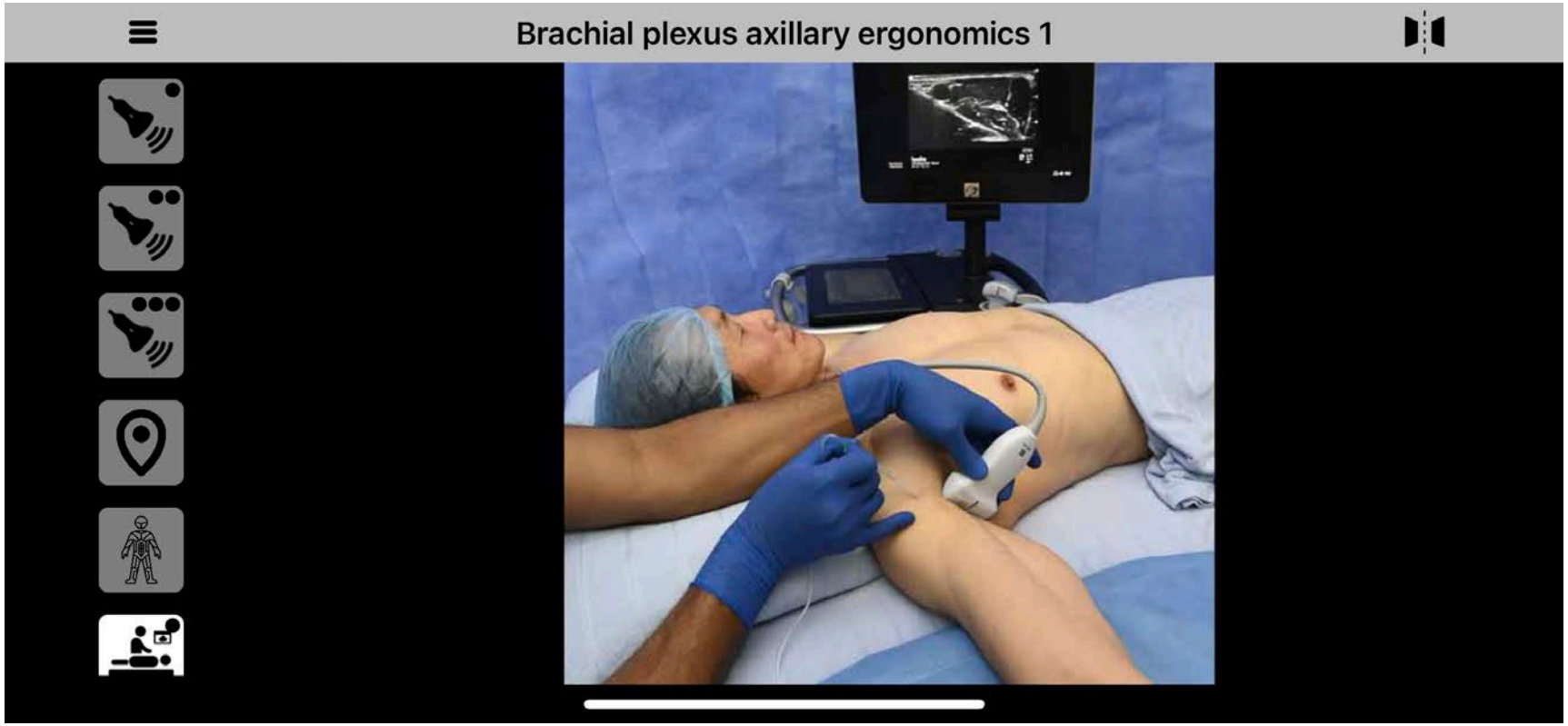


Elbow and Below: Axillary BPB

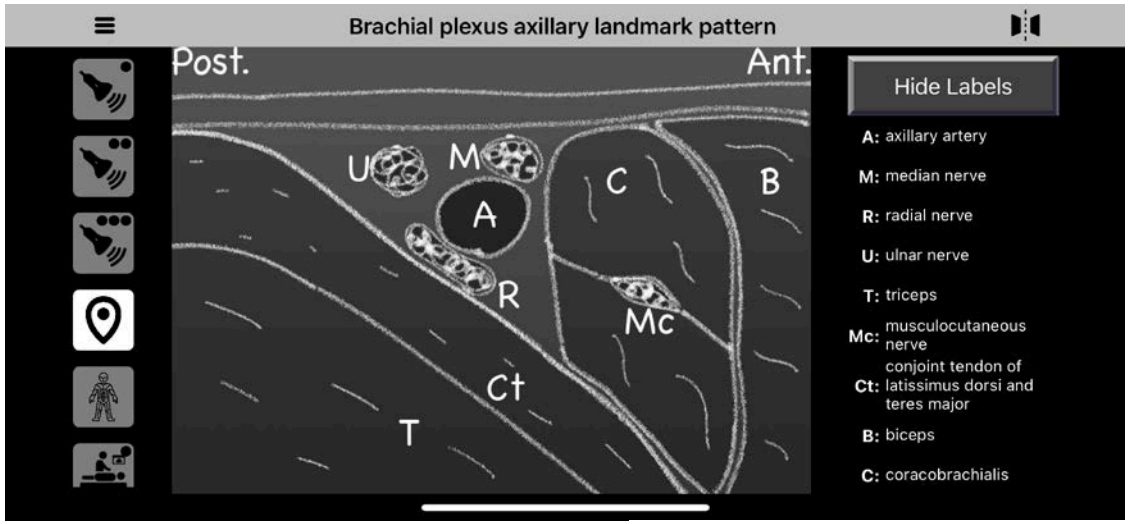


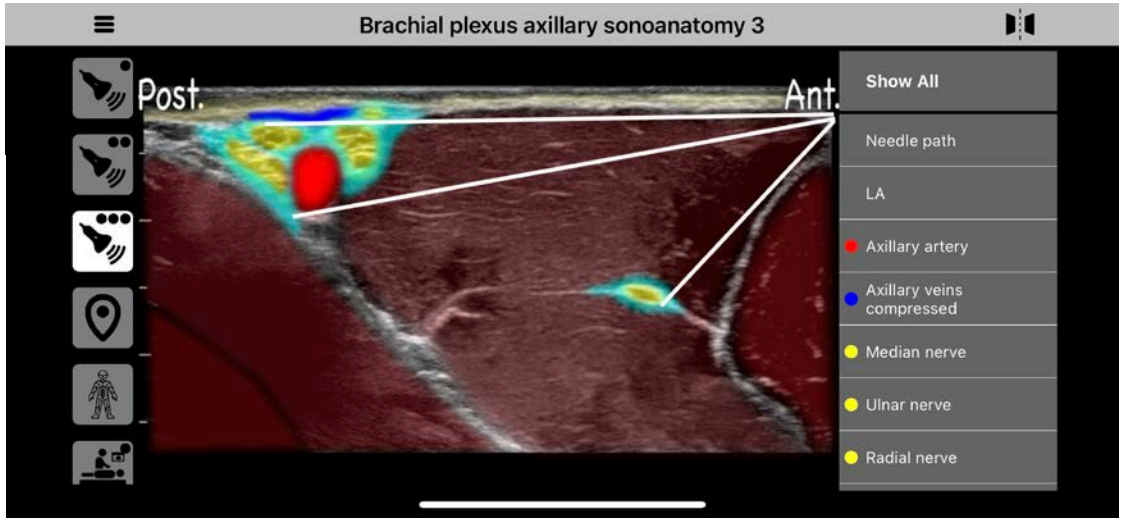
- Indications: anesthesia below the shoulder joint
  - Combine with intercostobrachial for anesthesia to elbow or distal humerus surgery; does NOT provide analgesia to shoulder joint
- Side effects
  - Muscle weakness in expected distribution
- Complications
  - Vessel injury, IV injection, LAST
  - No risk of phrenic nerve palsy

Elbow and Below: Axillary BPB



Elbow and Below: Axillary BPB





Anatomical Variation of the Brachial Plexus and Its Clinical Implications

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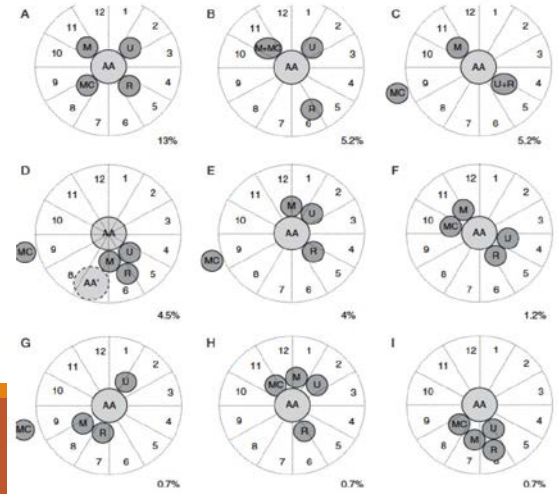
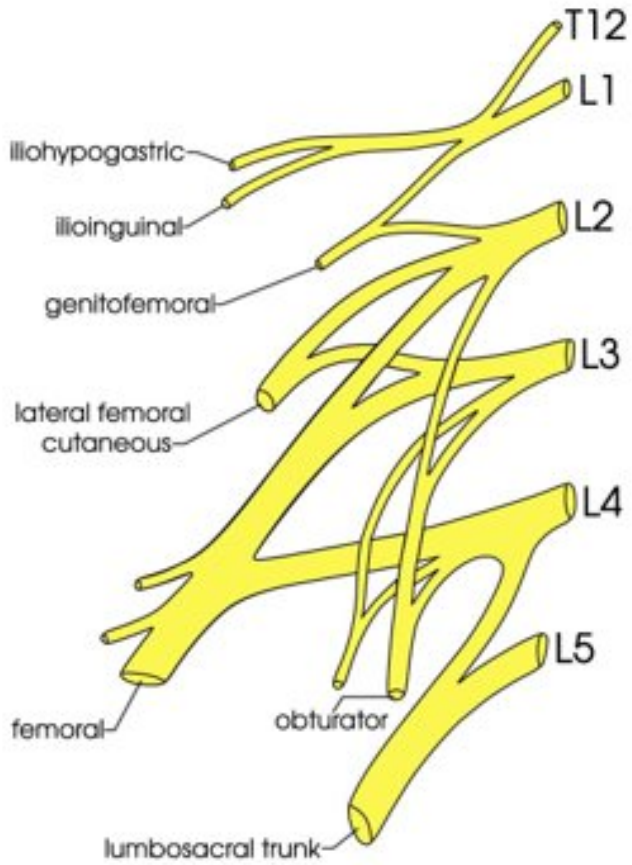
26th Dec 2017



Lumbar Plexus



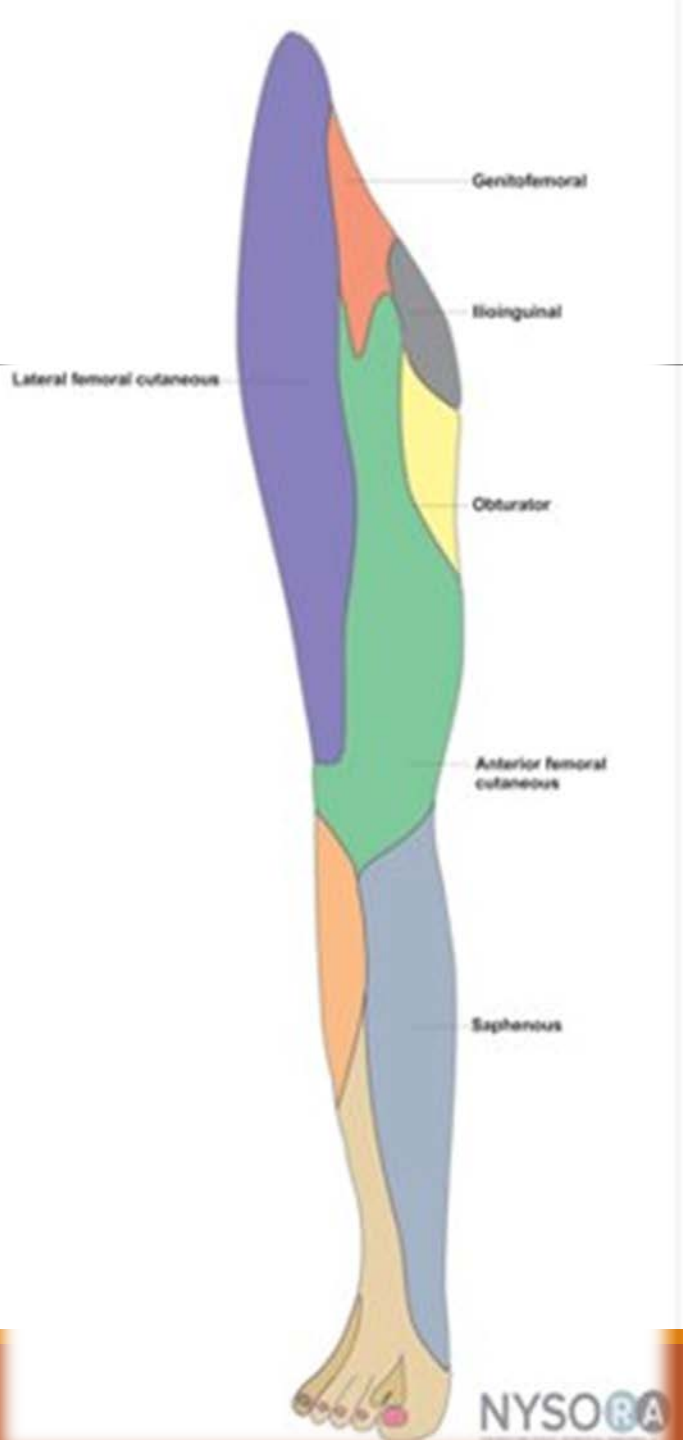
Lumbar plexus: T12-L4

Major branches:

1. Iliohypogastric (L1)
2. Ilioinguinal (L1)
3. Genitofemoral (L1/L2)
4. LFCN (L2,3,4)
5. Femoral (L2,3,4)
6. Obturator (L2,3,4)

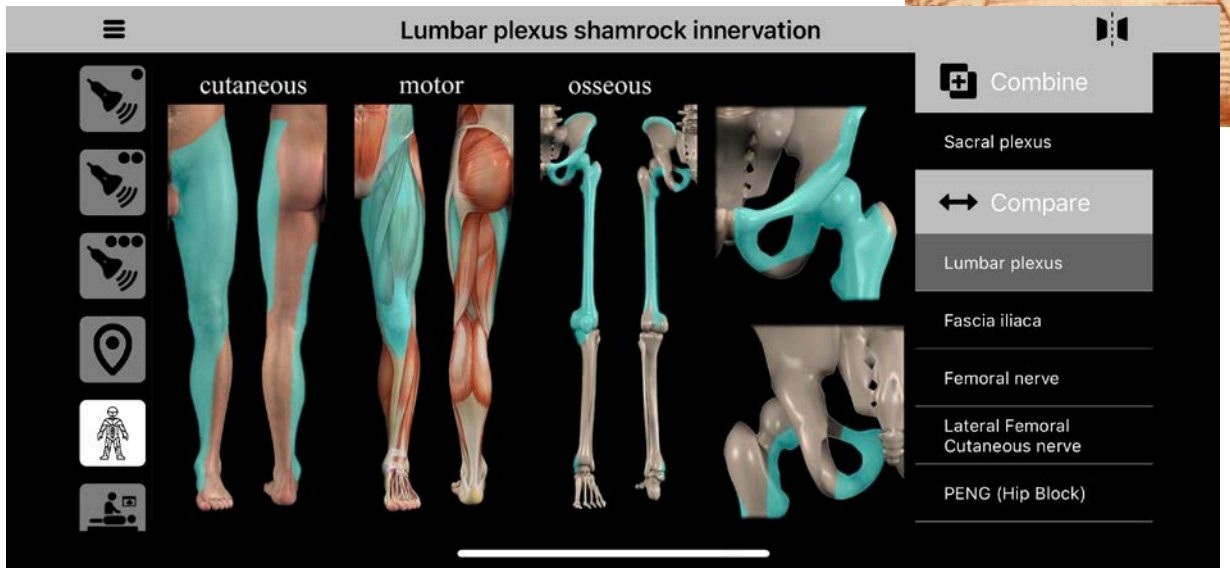
T12 contributes to iliohypogastric nerve 50% of cases

“Tomes”


Genitofemoral
Ilioinguinal
Lateral femoral cutaneous
Obturator
Anterior femoral cutaneous
Saphenous
NYSORA

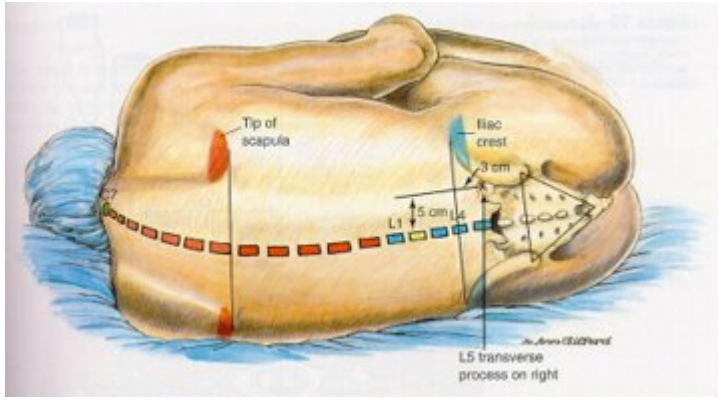
Total Hip: Lumbar Plexus Block

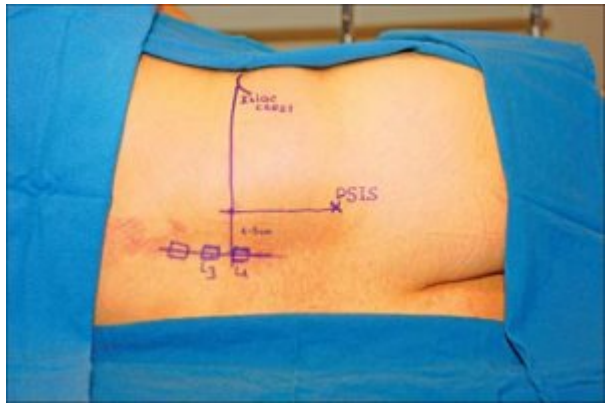
- Indications
  - Surgery of the anterolateral proximal leg/Knee (THA, TKA etc…)
- Expected coverage: LFCN, Femoral (Saph), and Obturator nerves
- Contraindications
  - Anticoagulation – considered a deep peripheral nerve block
  - Local infection
  - Desire to avoid quadriceps weakness
- Complications
  - Nerve injury
  - Hematoma
  - Vascular puncture
  - Local anesthetic toxicity
  - Sympathectomy – secondary to epidural spread – generally accept higher stimulation current threshold: 0.6 – 0.8mA
  - Block Failure

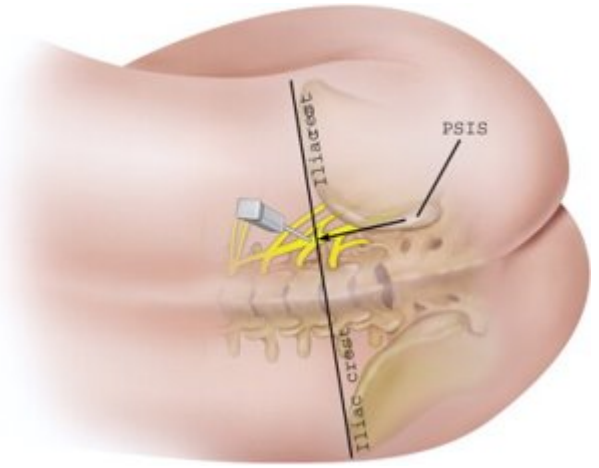


Total Hip: Lumbar Plexus Block

- TP is usually 4cm's in appropriately sized patients
- Plexus is 1.5 – 2cm's deep to TP
- Start with 5-6 cm passes to maximize chance of finding plexus
- Work caudal and medial first before cephalad / lateral

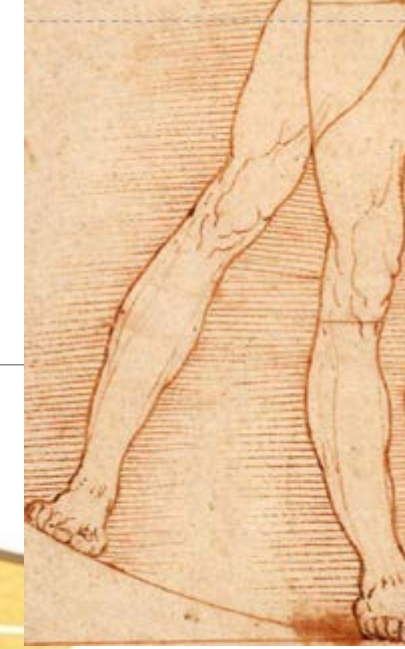


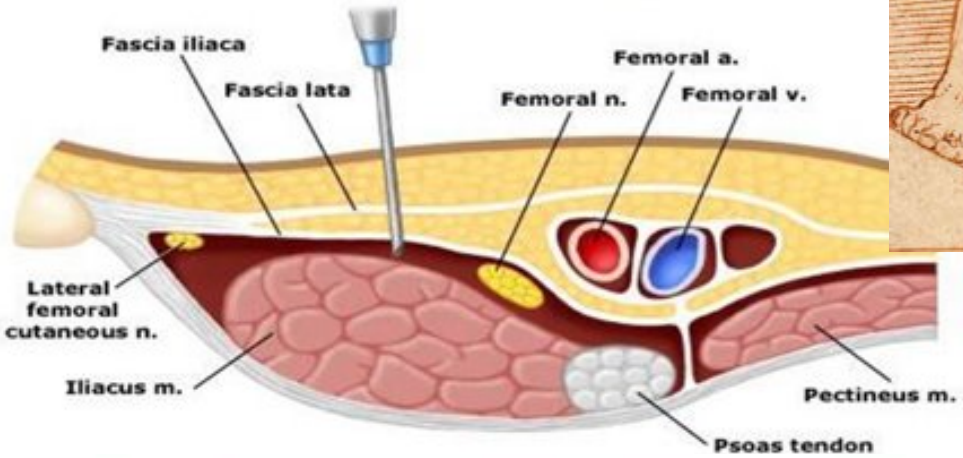


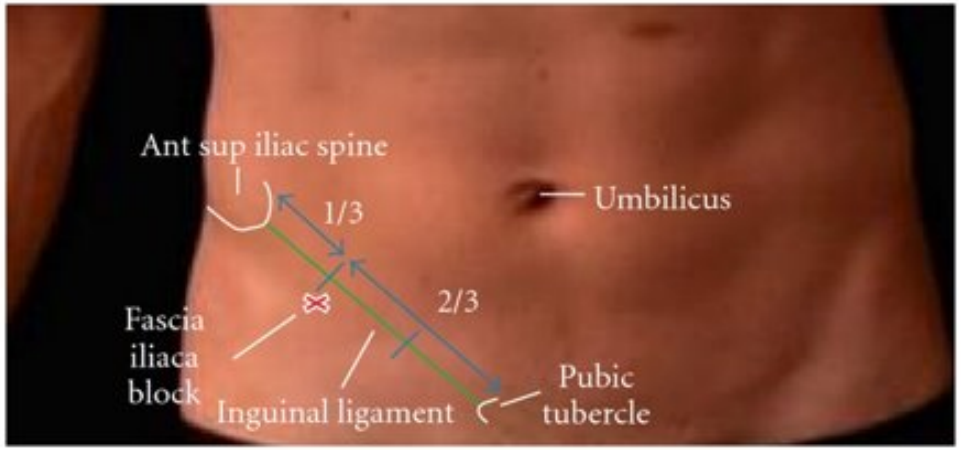


Total Hip: Fascia Iliaca Block

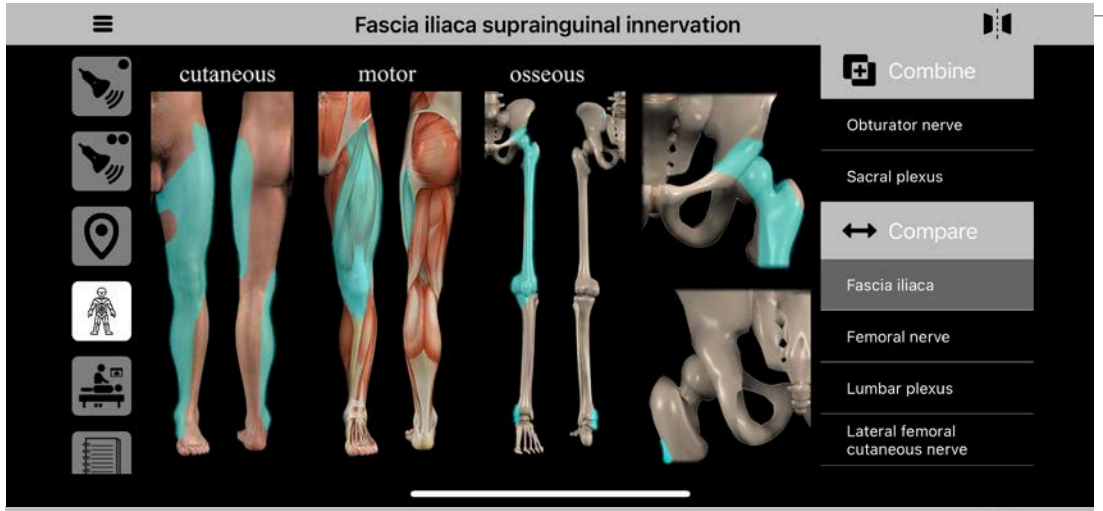
- Indications
  - Surgery of the anterolateral proximal leg/knee (ex….THA, Hip Fracture etc…)
- Expected coverage: LFCN, Femoral (saph), and possibly Obturator
- Contraindications
  - Local Infection
  - Desire to avoid quadriceps weakness
- Complications
  - Nerve Injury
  - Hematoma
  - Local Anesthetic Toxicity
  - Intra-abdominal injury
  - Block Failure

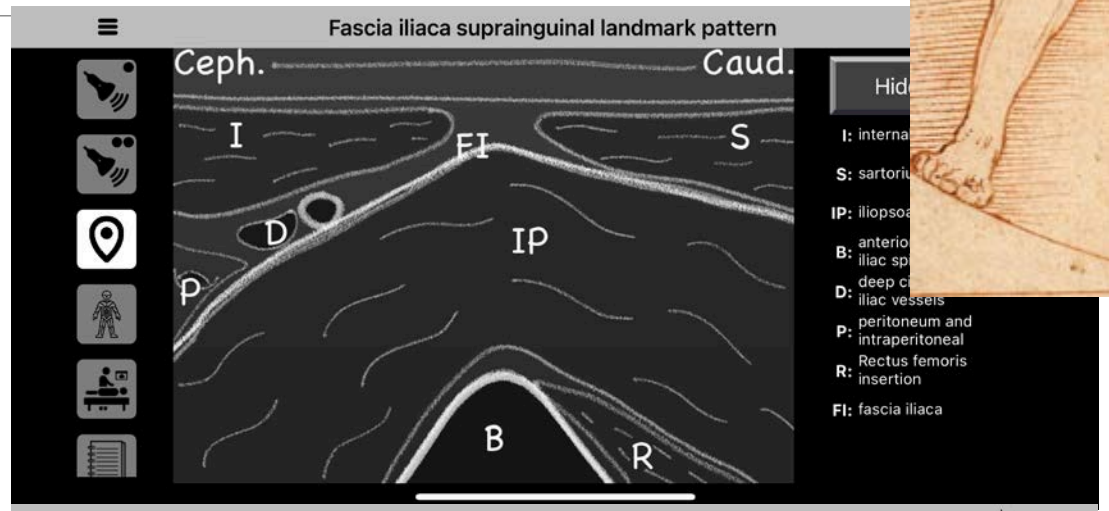






Total Hip: Fascia Iliaca Block





Total Hip: PENG Block

PEricapsular **N**erve **G**roup Block

Indications: analgesia to anterior hip capsule

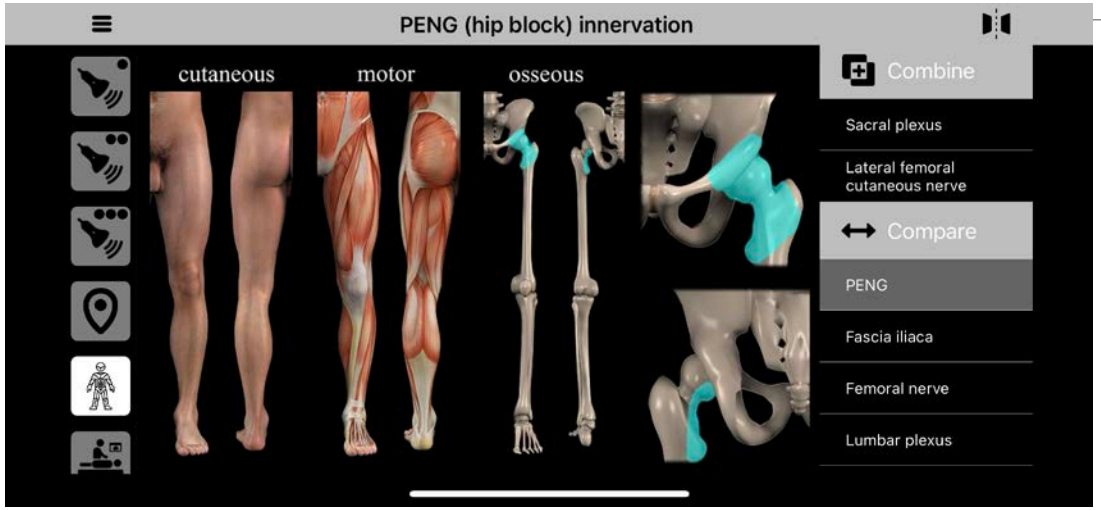
Side effects

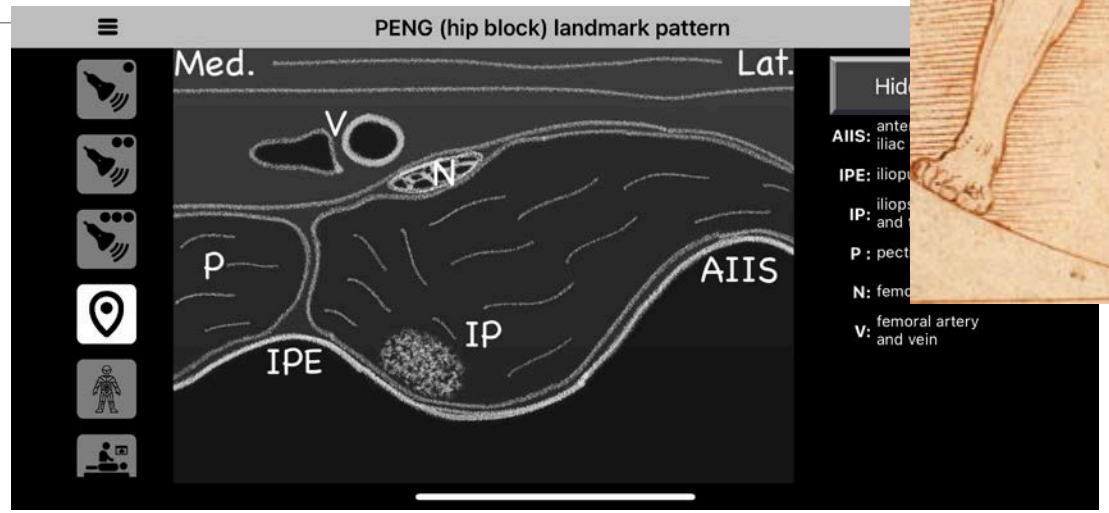
- Usually nothing
- Possible quad weakness of local spreads to femoral nerve

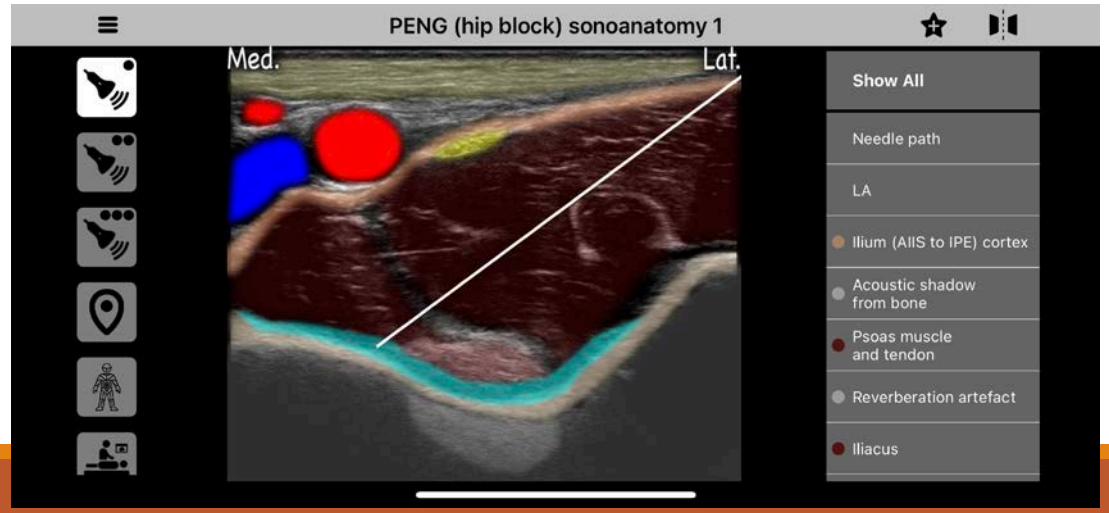
Complications

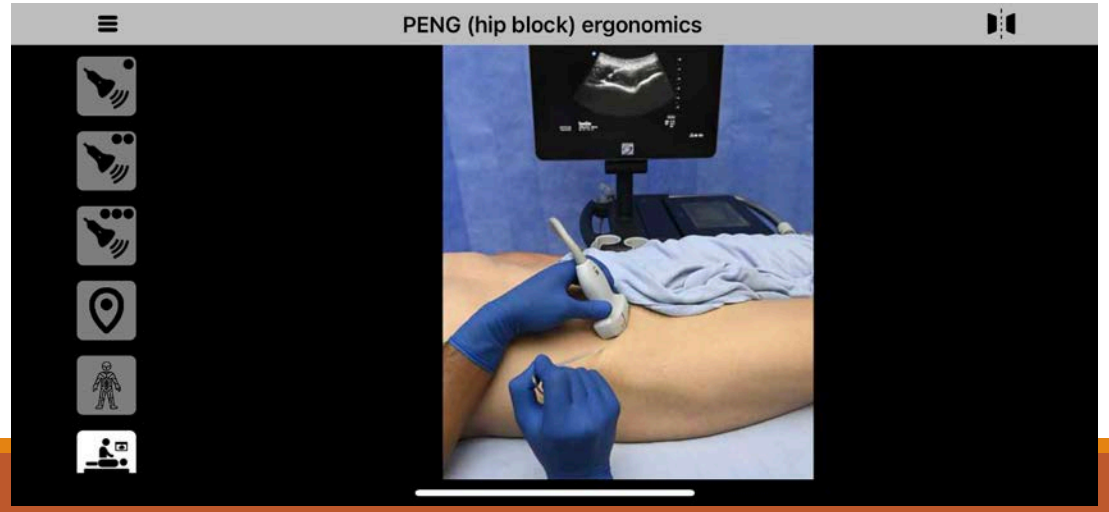
- Vessel puncture
- Femoral nerve injury

Total Hip: PENG Block









Total Knee Arthroplasty

Novel Regional Techniques for Total Knee Arthroplasty Promote Reduced Hospital Length of Stay: An Analysis of 106 Patients

Salman Thobhani, MD,[1] Lauren Scalercio, MD,[1] Clint E. Elliott, MD,[1,2] Bobby D. Nossaman, MD,[1,2] Leslie C. Thomas, MD,[1] Dane Yuratich, MD,[1] Kim Bland, MD,[1] Kristie Osteen, MD,[1,2] Matthew E. Patterson, MD[1,2]

[1]Department of Anesthesiology, Ochsner Clinic Foundation, New Orleans, LA [2]The University of Queensland School of Medicine, Ochsner Clinical School, New Orleans, LA

Results: We found no significant differences in the 3 groups with regard to baseline patient demographics. Although we observed no differences in pain scores between the 3 groups, opioid consumption was significantly reduced in the FNC with IPACK group. Physical therapy performance was significantly better on POD 1 in the ACB with IPACK group compared to the other 2 groups. Hospital length of stay was significantly shorter in the ACB with IPACK group.

Conclusion: This study demonstrated that an IPACK block reduced opioid consumption by providing effective supplemental analgesia following TKA compared to the FNC-only technique. ACB with IPACK provided equivalent analgesia and improved physical therapy performance, allowing earlier hospital discharge.

Total Knee: Adductor Canal Block

Indications

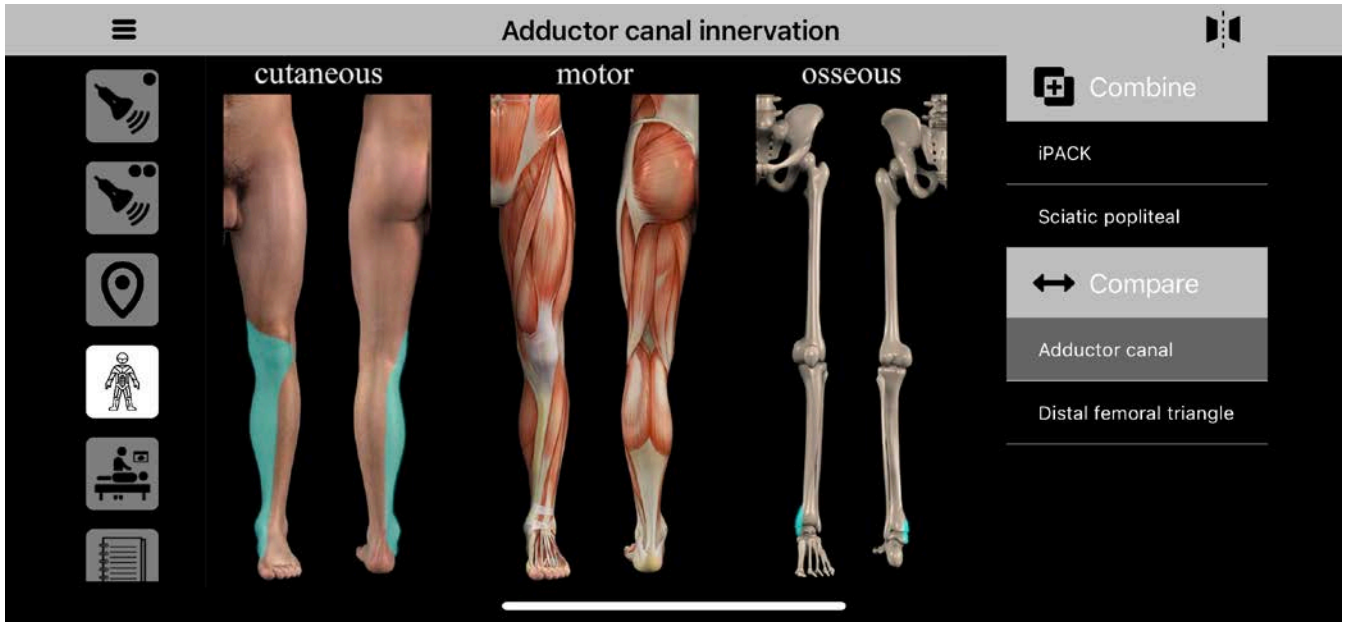
- Analgesia to anteromedial knee

Side effects

- Quadriceps weakness if LA spreads to motor branches of femoral nerve

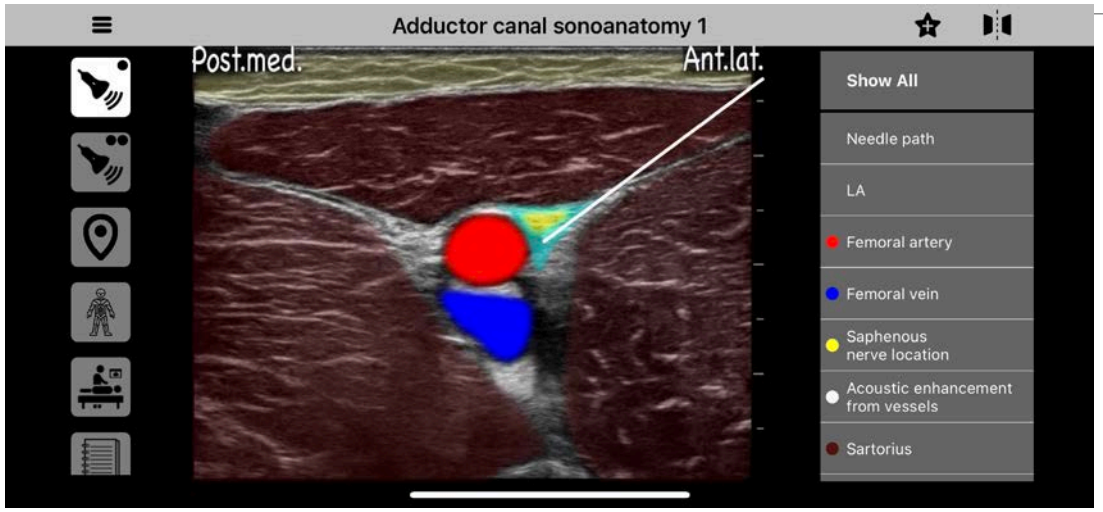
Complications

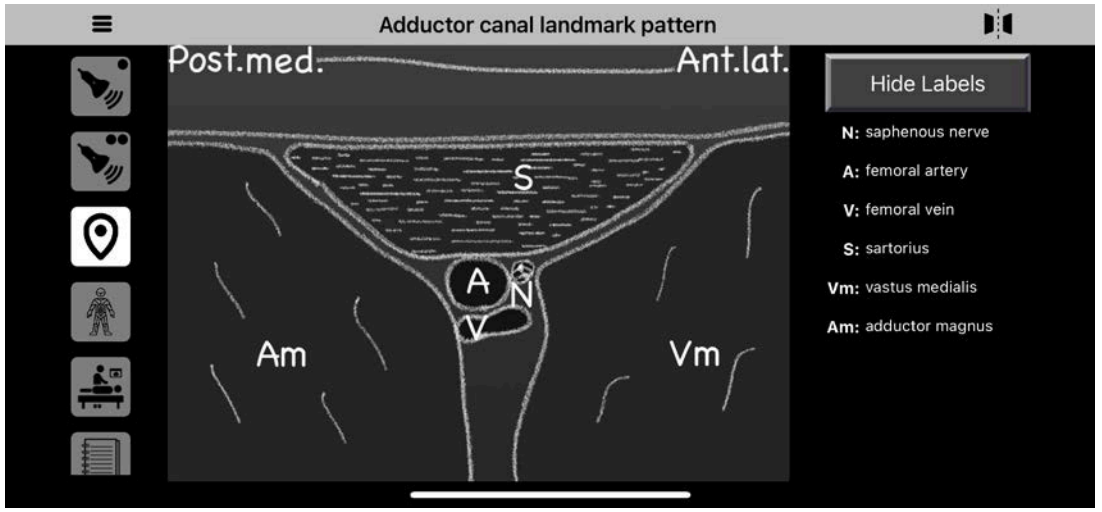
- Vascular injury
- Intravenous injection
- Nerve injury



Total Knee: Adductor Canal Block

Total Knee: Adductor Canal Block



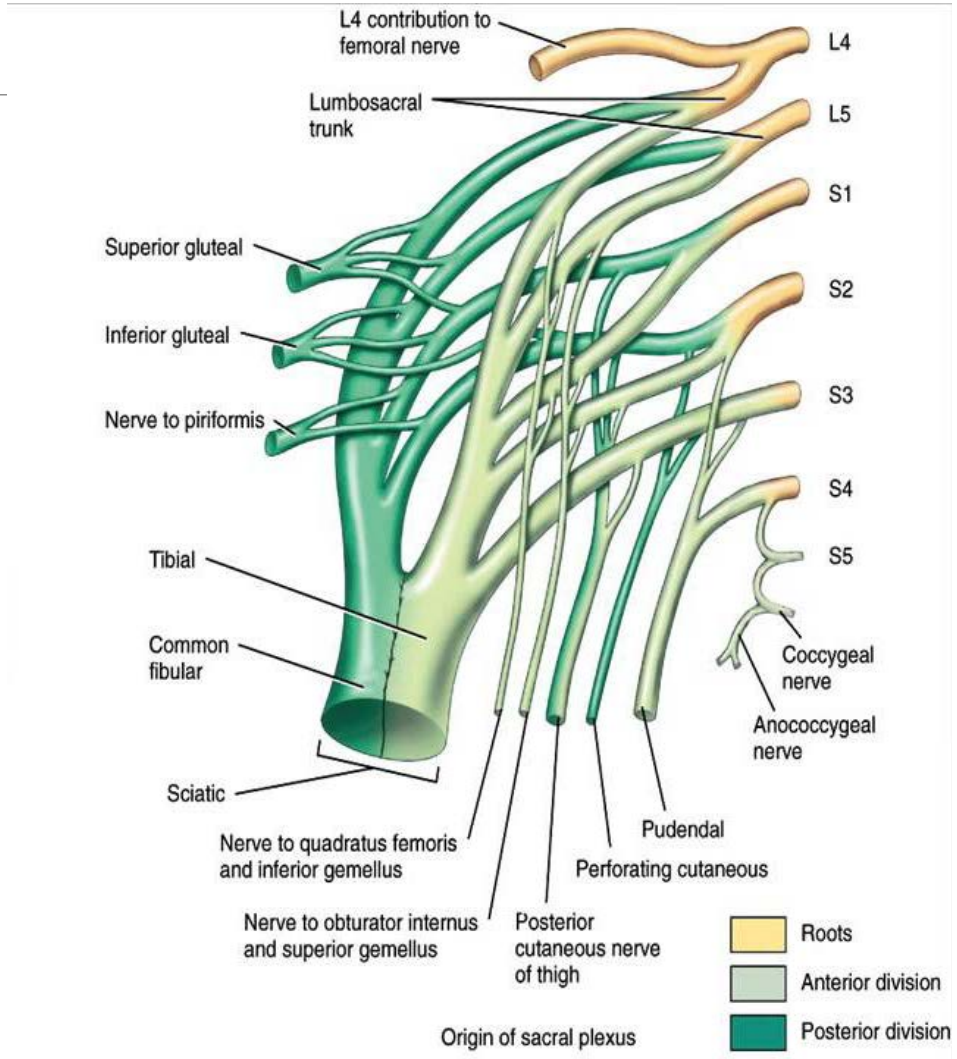


Sacral Plexus

Sacral plexus is formed by the lumbosacral trunk, and the ventral ramus of the first, second, and third sacral nerves

Sciatic block: Anesthesia of the skin of the posterior thigh, hamstring, and biceps femoris muscles; parts of the hip/knee joints and the entire leg below the knee with the exception of the saphenous nerve (medial distal lower extremity)

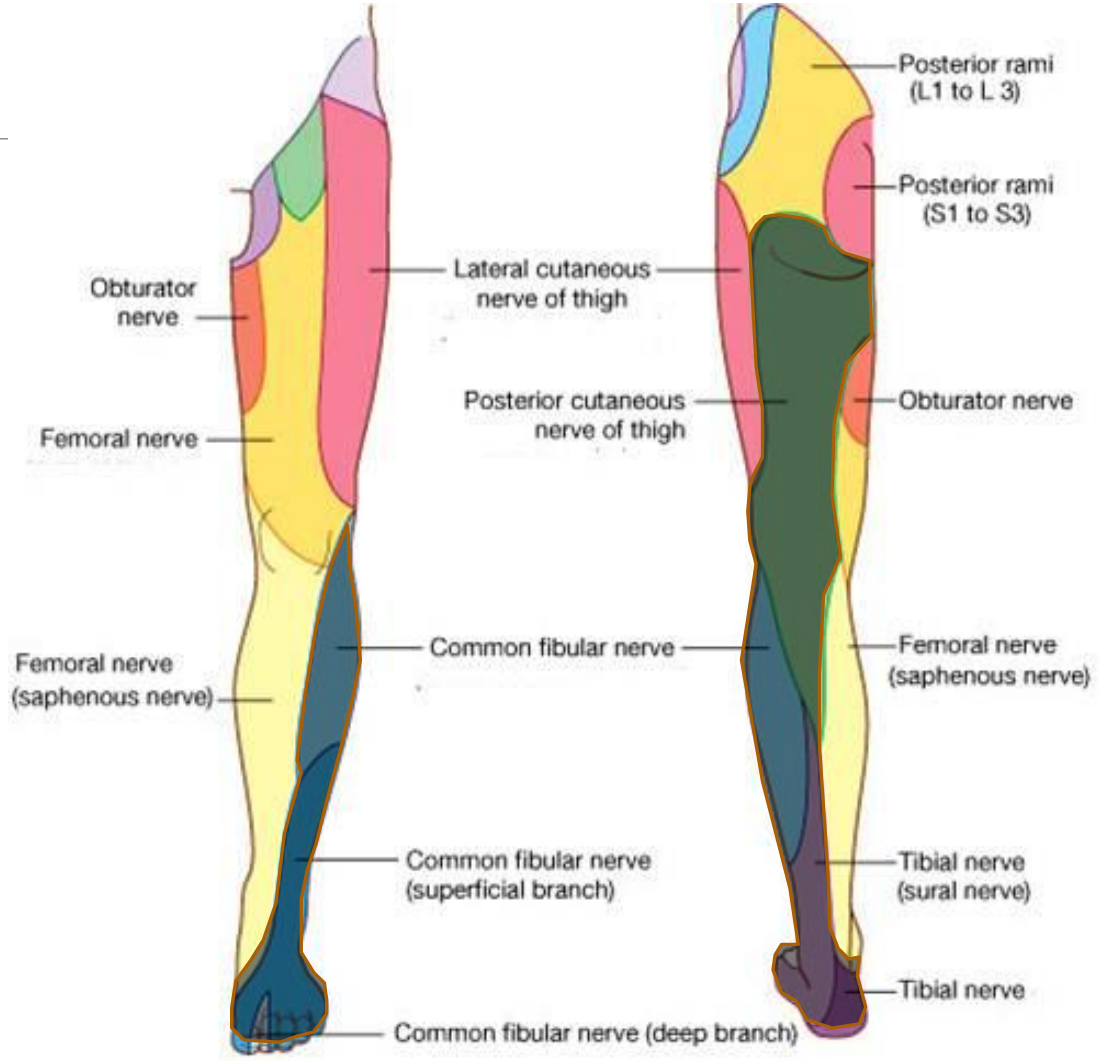
Knee Joint: Femoral nerve, obturator nerve, sciatic nerve



Sacral Plexus

Caution with very proximal sciatic blocks, such as Labat or subgluteal sciatic blocks, as those will take away muscle contraction in entire distribution of lower extremity

We'll focus on iPACK, motor sparing sciatic block specific to TKA



Total Knee: iPACK

Infiltration between the **P**opliteal **A**rtery and the **C**apsule of the **K**nee

Indications

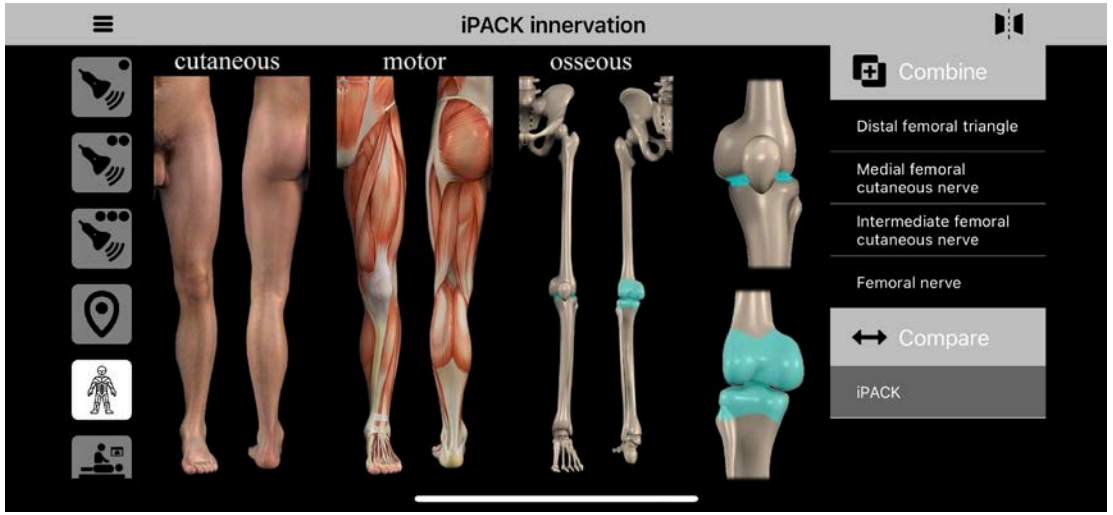
- Analgesia to the posterior capsule of the knee

Side effects

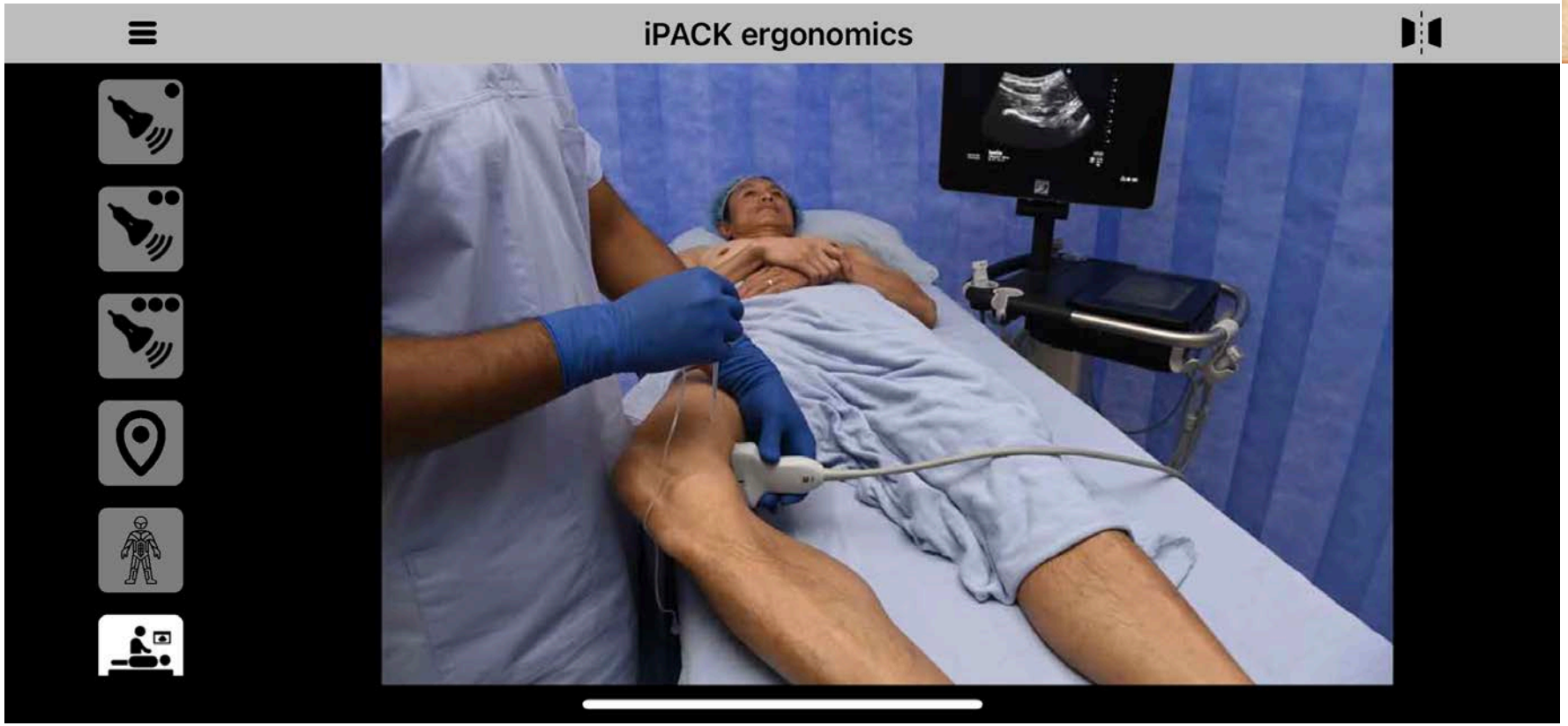
- None. Motor sparing, if local doesn't spread too far posteriorly to sciatic nerves (peroneal/tibial)

Complications

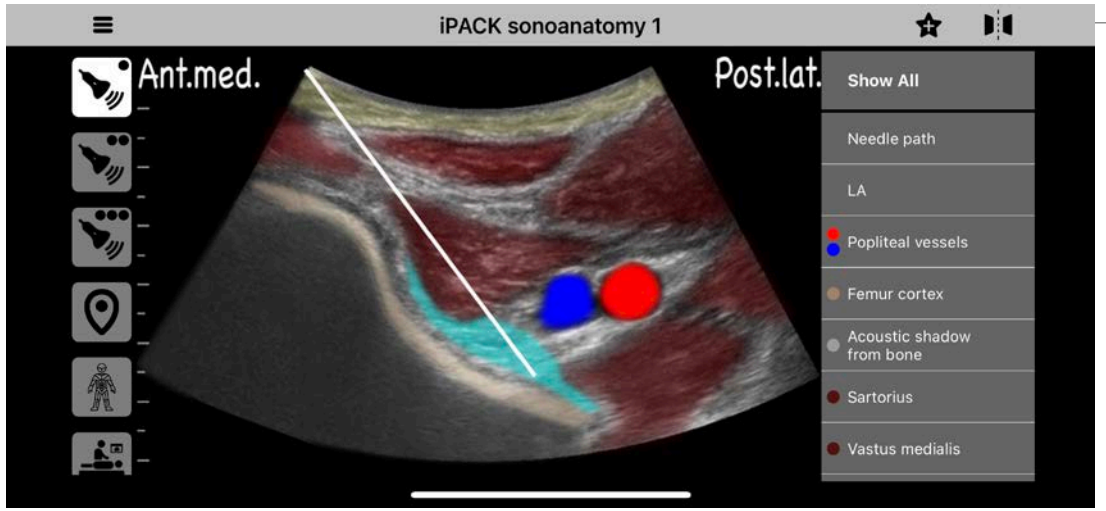
- Vascular injury, motor weakness with LA spread

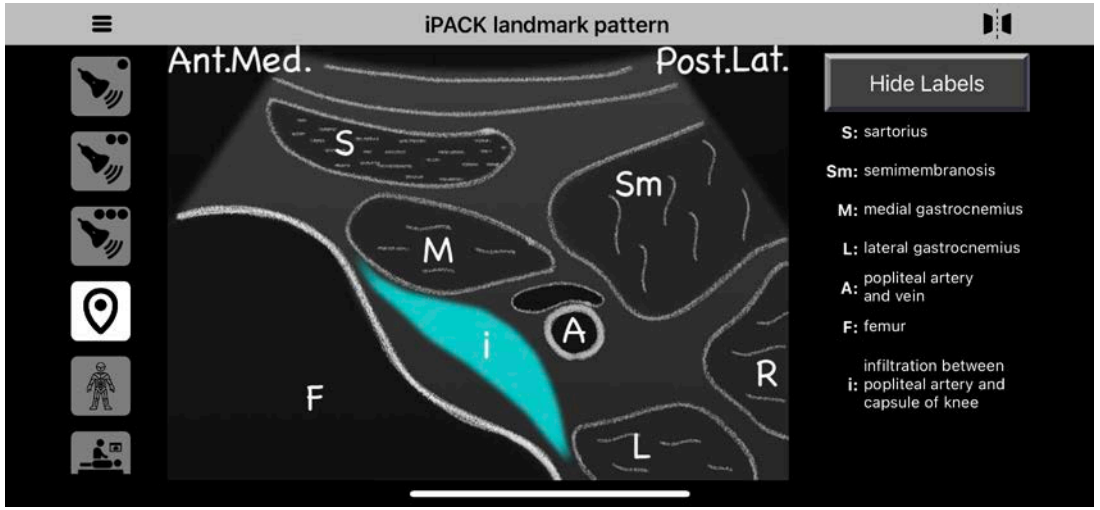


Total Knee: iPACK



Total Knee: iPACK





Example of Regional Anesthesia

Shoulder Surgery
- ISB + GA or surgical strength local anesthetic
- Phrenic sparing block + GA

Elbow Surgery
- BPB + intercostobrachial

Hip Surgery
- Lumbar Plexus block + Spinal Anesthetic (GA)
- Fascia Iliaca block + Spinal Anesthetic (GA)
- PENG + Spinal Anesthetic (GA)
- Combined Spinal Epidural or Lumbar Epidural + GA

Knee Surgery
- Adductor Canal block + Sciatic Block (IPACK) + Spinal (GA)
- Femoral block + Sciatic Block (IPACK) + Spinal (GA)
- Lumbar Plexus block + Sciatic Block (IPACK) + Spinal (GA)

Patient Education

- "Numbing Medicine" placed around the nerves that run down and innervating the area you're having surgery
- Similar to a numbing injection at the dentist
- We give you sedation while the block is being performed
  - Most people don't remember having the block placed because the sedation provides some amnesia around the time of administration
- Compared to a patient who had the same procedure, but no numbing block, patient's who have a block do much better from a pain-control perspective afterwards
- PNB are not required
- Sensation tends to return quickly after the block begins wearing off-take pain meds!
- Consider need for patient ambulation

References

Hadzic, Admir. *Hadzic's Peripheral Nerve Blocks and Anatomy for Ultrasound-Guided Regional Anesthesia.* New York: 2e McGraw-Hill, 2004. Print

Hadzic, Admir. *Hadzic's Textbook of Regional Anesthesia and Acute Pain Management*. New York: 2e McGraw-Hill, 2017. Print

Berde CB, et al. (2015). Local Anesthetics. In RD Miller et al., eds., Miller's Anesthesia, 8th ed., pp. 1028 – 1053

Kirksey, Meghan A. et al. Local Anesthetic Peripheral Nerve Block Adjuvants for Prolongation of Analgesia: A Systematic Qualitative Review. Ed. Christian Schwentner. *PLoS ONE* 10.9 (2015): e0137312. *PMC*. Web. 2 Apr. 2017.

Neal JM, Brull R, Horn JL, et al. The second American Society of Regional Anesthesia and Pain Medicine Evidence-Based Medicine Assessment of Ultrasound-Guided Regional Anesthesia: executive summary. *Reg Anesth Pain Med*. 2016; 41:181–194.

Henshaw DS, Jaffe JD, Reynolds JW, Dobson S, Russel GB, Weller RS. "An evaluation of ultrasound-guided adductor canal blockade for postoperative analgesia after medial unicondylar knee arthroplasty. *Anesth Analg*. 2016 Apr; 122(4):1192-201

Thobhani S, Scalercio L, Elliott CE, et al. Novel Regional Techniques for Total Knee Arthroplasty Promote Reduced Hospital Length of Stay: An Analysis of 106 Patients. The Ochsner Journal. 2017;17(3):233-238.

Calum R.K. Grant, Matthew R. Checketts; Analgesia for primary hip and knee arthroplasty: the role of regional anaesthesia, Continuing Education in Anaesthesia Critical Care & Pain, Volume 8, Issue 2, 1 April 2008, Pages 56–61, https://doi.org/10.1093/bjaceaccp/mkn007

Thobhani S, Scalercio L, Elliott CE, et al. Novel Regional Techniques for Total Knee Arthroplasty Promote Reduced Hospital Length of Stay: An Analysis of 106 Patients. *The Ochsner Journal. 2017;17(3):233-238*.

https://resources.wfsahq.org/atotw/anatomical-variation-of-the-brachial-plexus-and-its-clinical-implications/