Principles of regional anaesthesia

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Definition

Reversible block of signal conduction within nerves, nerve endings or nerve roots.

As a consequence cell membrane depolarisation in all excitable cells could be blocked.

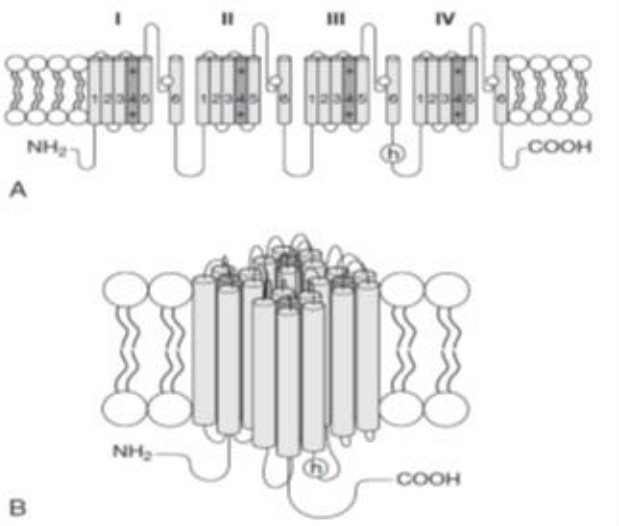
A bit of history

- 1880s, cocaine, Koller – ophthalmology, Hall - dentistry.
- 1885, Halsted, nerve blocks
- 1904, the first synthetic derivative of cocaine, procaine
- 1943, Lofgren developed lidocaine
- 1957, bupivacaine
- 1996, ropivacaine

Mechanism of action

Sodium Channel Block

Fast intracellular influx of Na+ ceases

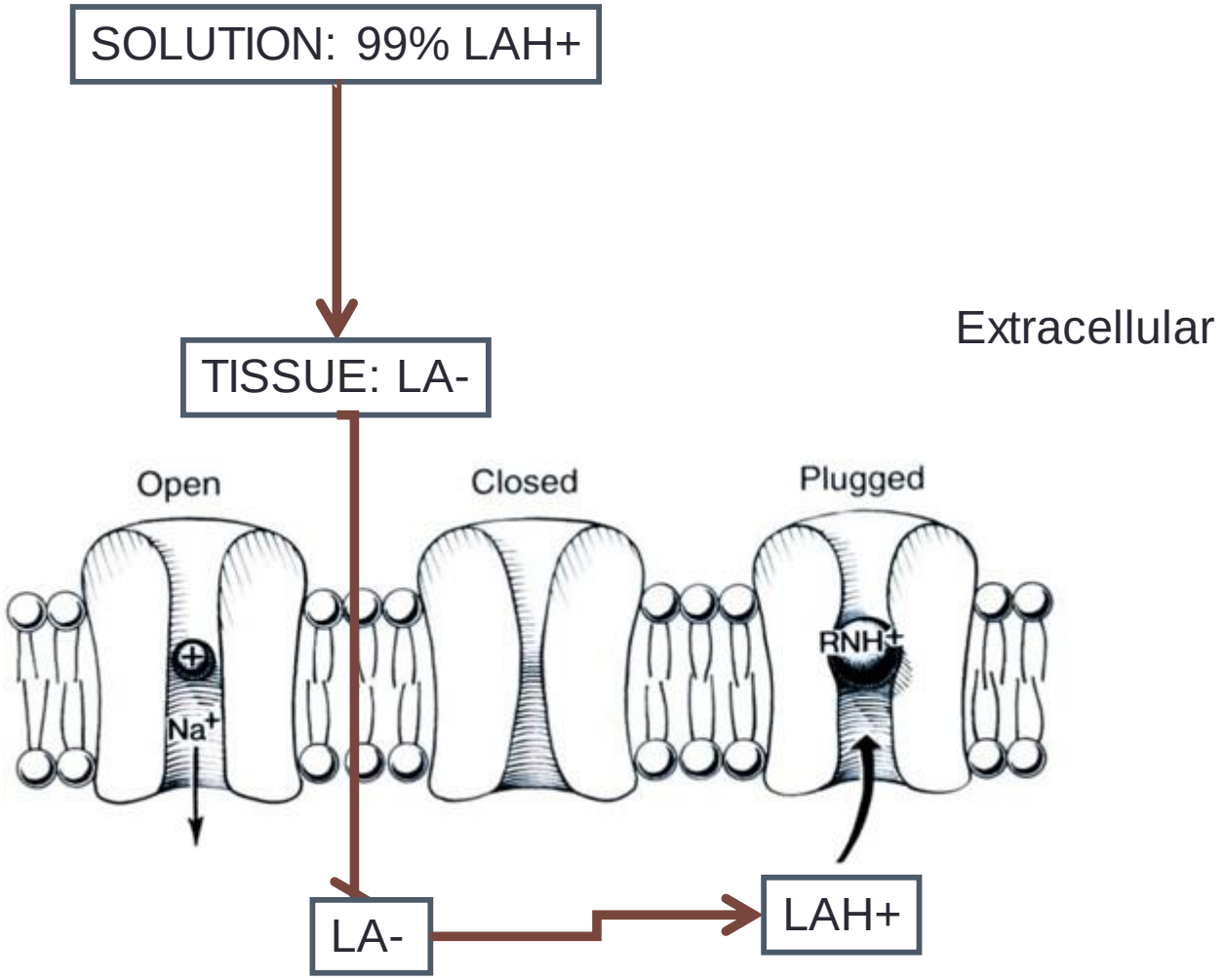


(Voltage-Gated Sodium Channel)

2 subunits:

α – transmembranous (4 of them)

β – modulatory function


SOLUTION: 99% LAH+
TISSUE: LA-
Extracellular
Open
Closed
Plugged
Na+
RNH+
LA-
LAH+
Intracellular

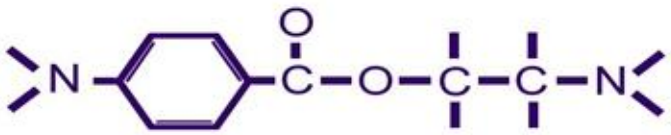
LA uses

- Regional anesthesia for surgical and other painful procedures
- Postoperative and general pain therapy
- Inhibition of reflexes (eg. cough)
- Antiarrhytmic

Chemistry

Chemical structure of local anesthetics

Aromatic lipophilic portion - Intermediate chain - Amine hydrophilic portion



AMINO ESTERS

AMINO AMIDES

- AMINOESTERS (-COO-)

- Unstable in solution
- Hydrolized through esterases in serum
- Short shelf-life
- Fast inactivation = low toxicity
- short acting

- TETRACAINE, PROCAINE, CHLORPROCAINE

- AMINOAMIDES (-NHCO-)

- Stable = more toxic
- Metabolized in liver
- Long shelf-life
- Long acting

- LIDOCAINE, PRILOCAINE, MEPIVACAINE, BUPIVACAINE, ROPIVACAINE

Profile

- LIPOPHILIC → strength and toxicity
- PROTEIN BINDING → duration of action, toxicity
- VASODILATORY → duration of action
- Dissociation constant (pKa) → free drug amount – origin of action

Block duration, strength and range

- Volume (ml), concentration (mg/ml lub %) or just dose?

- Vasoconstrictors
- Space of injection
- Tissue perfusion
- Temperature, pH
- Adjuvants
- Body homeostasis (eg.pregnancy)
- Drug properties (eg.protein binding)

Adiuvants

- ADRENALINE (max. 250mcg) 1:100,000-1:400,000

- Prolongs block duration
- Lowers peak systemic concetration
- Increases block intensity
- Reduces bleeding
- Tests intravascular injection

- CAUTION: distal body parts, dense vascularisation

Adiuvants

- Longer block duration:
- Opioids: buprenorphine, morphine
- Alfa-agonists: clonidine, dexmedetomidine
- Steroids: dexamethasone

- EFFECTIVE but NEUROTOXIC: ketamine, midazolam, high steroid doses (>4mg of dexamethasone)

TOXICITY

- Relative overdose (wrong space, wrong amount)

OR

- Absolute overdose (Elimination capacity exceeded)

Maximal doses

LIDOCAINE (w. ADRENALINE)	3-5mg/kg (7mg/kg) lub 200mg (500mg)
BUPIVACAINE	2mg/kg
ROPIVACAINE	3mg/kg
MEPIVACAINE	6mg/kg
PRILOCAINE	8mg/kg
CHLORPROCAINE	9mg/kg
LEVOBUPIVACAINE	2mg/kg

Toxicity

TABLE 2. ASSOCIATION BETWEEN PLASMA CONCENTRATION OF LIDOCAINE AND SIDE EFFECTS[29]

Plasma concentration	*Possible side effects*
4–6 μg/mL	Lightheadedness, numb tongue, metallic taste, increased blood pressure, dizziness
8 μg/mL	Visual and auditory disturbances, disassociation, muscle twitching, decreased blood pressure
12 μg/mL	Convulsions (very benzodiazepine-sensitive)
16 μg/mL	Coma
20 μg/mL	Respiratory arrest
24 μg/mL	Cardiovascular system depression/collapse

Toxicity Ferrini,2000

Modifiers of toxicity

- INCREASE:

- $CO_2 \uparrow$, acidosis, enzyme-inhibiting substances (eg. cimethide)

- DECREASE:

- barbiturates, benzodiazepines, inh.anestehetics, acidic alpha-1 glicoprotein (acute phase protein, eg.postoperative)

Symptoms of toxicity

- CNS: anxiety, numbness of lips and tongue, nausea, vertigo, tinnitus, difficulty in swallowing, convulsions, apnea, death.
- Circulation: arrhytmias, hypotension, cardiac arrest
- Digestive/urinary tract: nausea/vomiting, micturition disturbances
- Respiratory: wheezing, difficulty in breathing
- Skin: rash

Symptoms of toxicity

Early	Late
Tinnitus	Seizures
Metallic taste	Loss of consciousness
Diplopia	Further neurologic deterioration and cardiac toxicity leading to:
Circumoral paresthesia	Respiratory arrest
Agitation	Cardiovascular collapse
Confusion	Hypotension
	Arrhythmias
	Cardiac arrest

Data from Di Gregorio G, Neal JM, Rosenquist RW, et al. Clinical presentation of local anesthetic systemic toxicity: a review of published cases, 1979 to 2009. Reg Anesth Pain Med 2010;35(2):181–7.

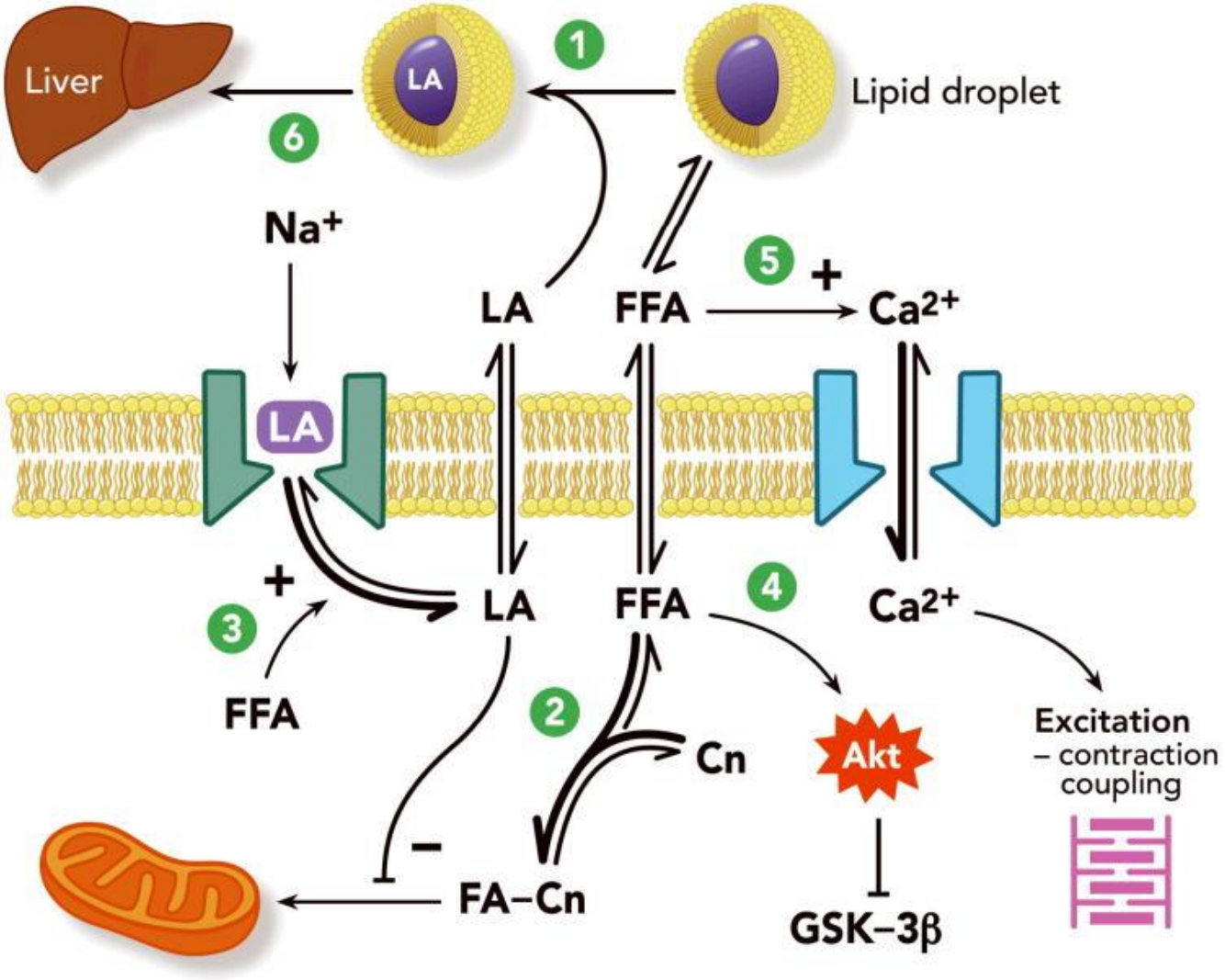
To do

1. STOP LA administration!

1. Treat symptoms

1. LIPID RESUSCITATION

http://www.lipidrescue.org



http://www.lipidrescue.org

- **Lipid Emulsion (20%) Therapy** (values in parenthesis are for 70kg patient)
  - **Bolus 1.5 mL/kg** (lean body mass) intravenously over 1 minute (~100mL)
  - **Continuous infusion 0.25 mL/kg/min** (~18 mL/min; adjust by roller clamp)
  - Repeat bolus once or twice for persistent cardiovascular collapse
  - Double the infusion rate to 0.5 mL/kg/min if blood pressure remains low
  - **Continue infusion** for at least10 minutes after attaining circulatory stability
  - Recommended upper limit: Approximately 10 mL/kg lipid emulsion over the first 30 minutes

LIDOCAINE

- Old and popular, relatively safe
- Antiarrhytmic (ALS drug)
- Usually 0,5-5%
- Short acting (45-60 minutes)
- Max.safe dose 300mg (3-5mg/kg) or 500mg (7mg/kg) with adrenaline

BUPIVACAINE

- About 4x more potent than lidocaine
- Long acting (6-30godzin)
- CARDIOTOXIC!
- No concetrations above 0,5%, no intravascular infusion!
- Max.dose 150mg (2mg/kg)
- Levobupivacaine – less toxic enantiomer

Techniques

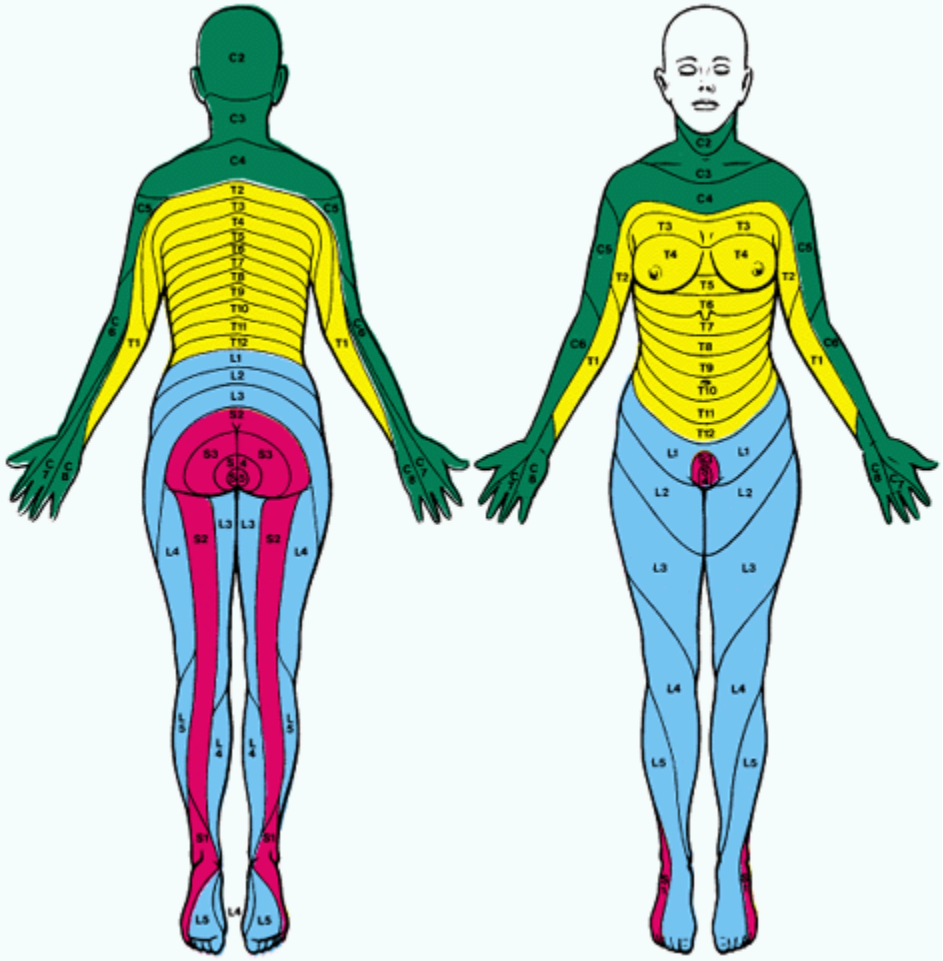
- Neuraxial
- Spinal, epidural, CSE/CSA

- Peripheral
- Roots, plexuses, nerves
- *Compartment blocks, infiltration, tumescent blocks*
- Transversus Abdominis Plane Block (TAP), Fascia iliaca, Quadratus Lumborum Block (QLB)

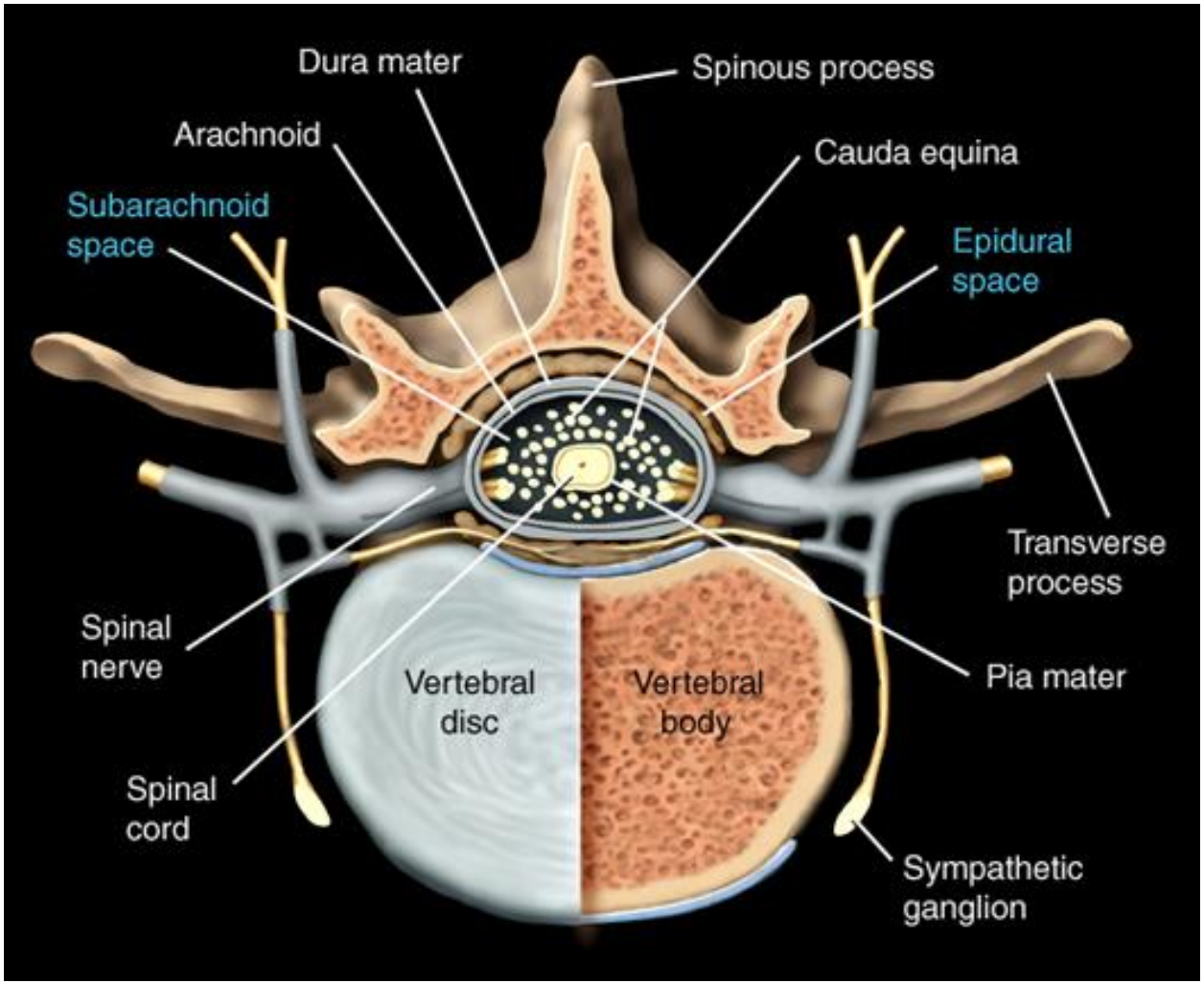
To block, or not to block...

- Indications
- Surgery with pain, or just pain…
- Obstetrics!
- Contraindications
- Lack of informed consent!
- Coagulopathy
- Shock and sepsis/infection
- Some neurologic disorders
- Some cardiologic disorders…

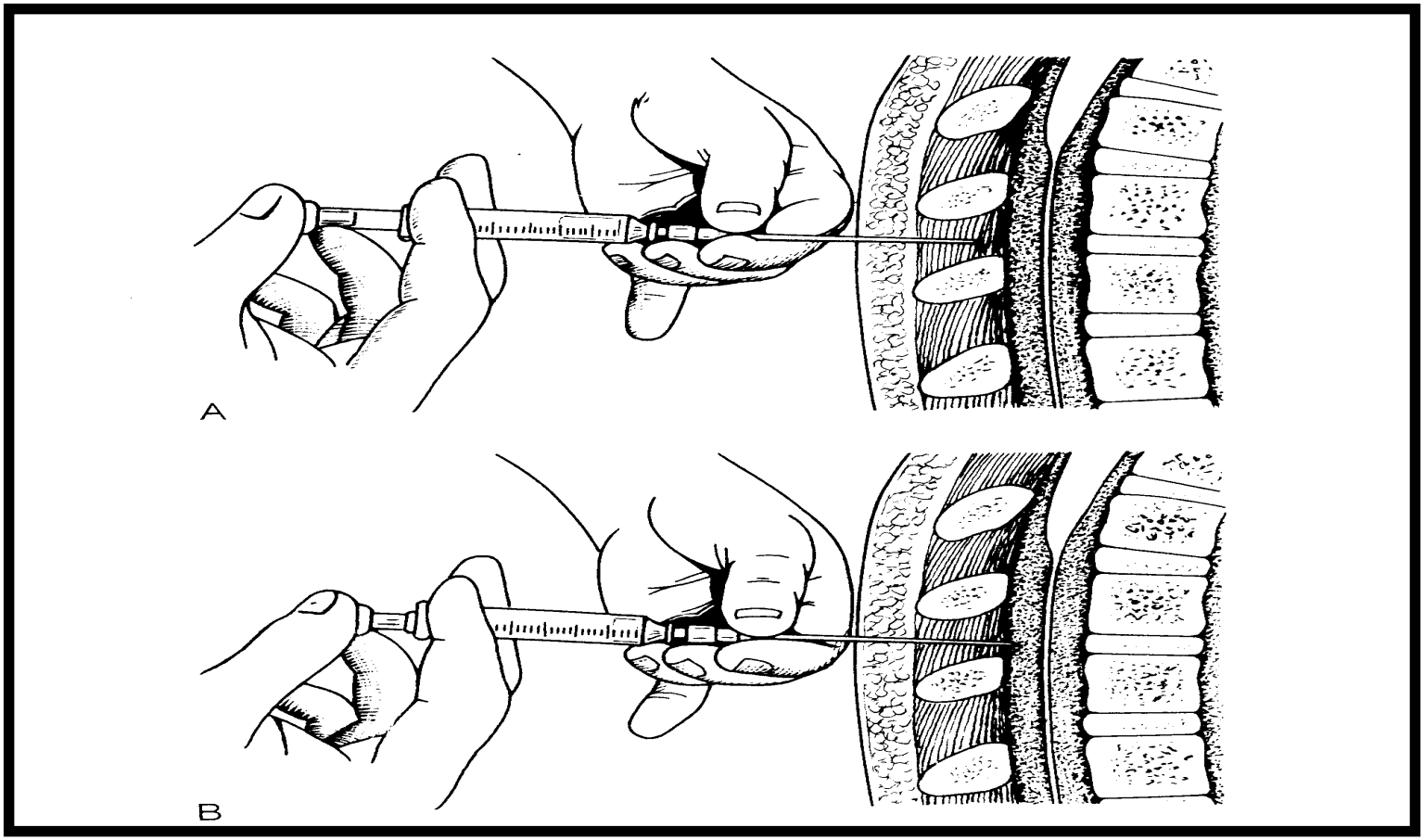
Neuraxial blocks



Neuraxial blocks



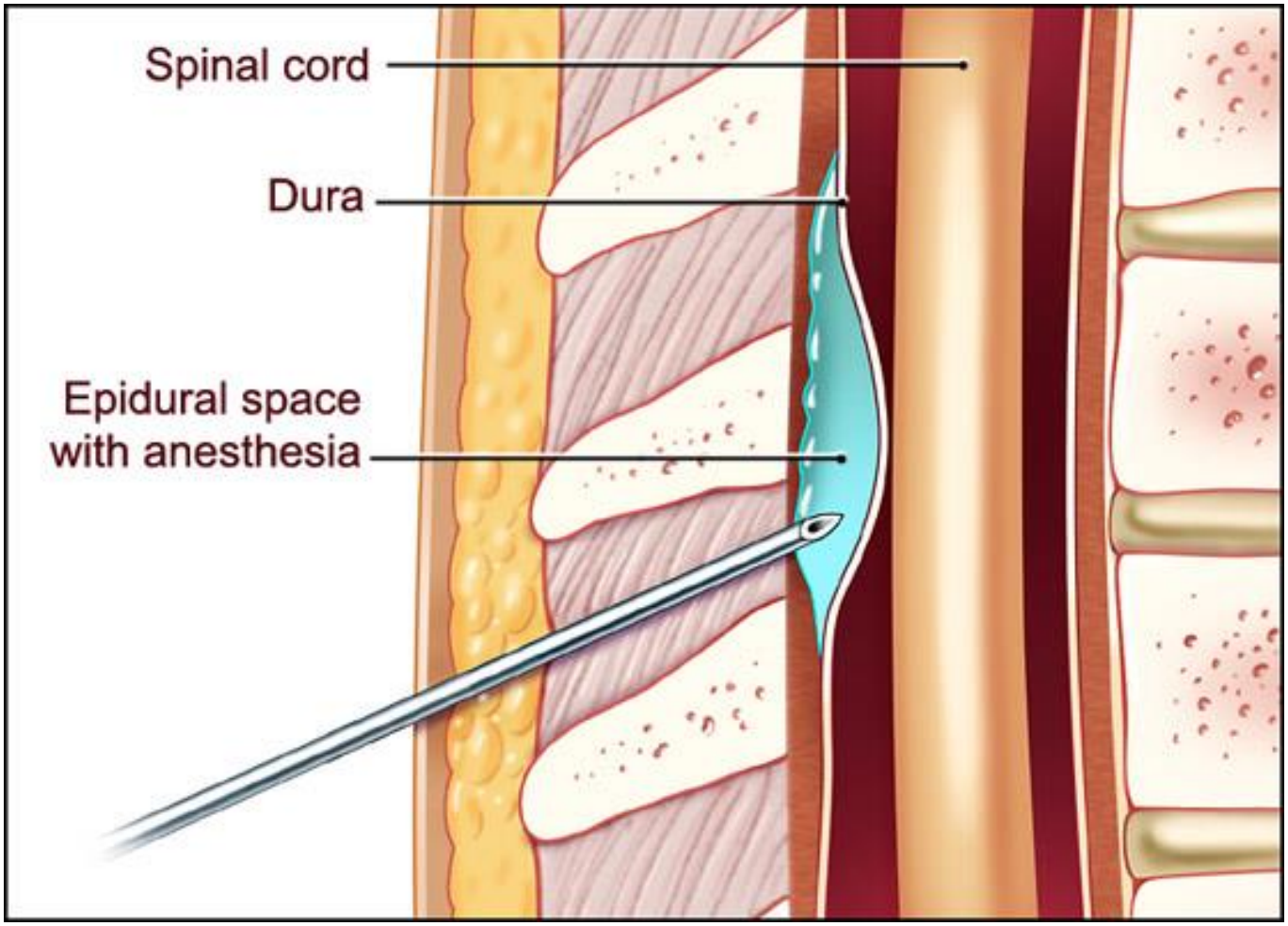
Spinal



Neuraxial blocks

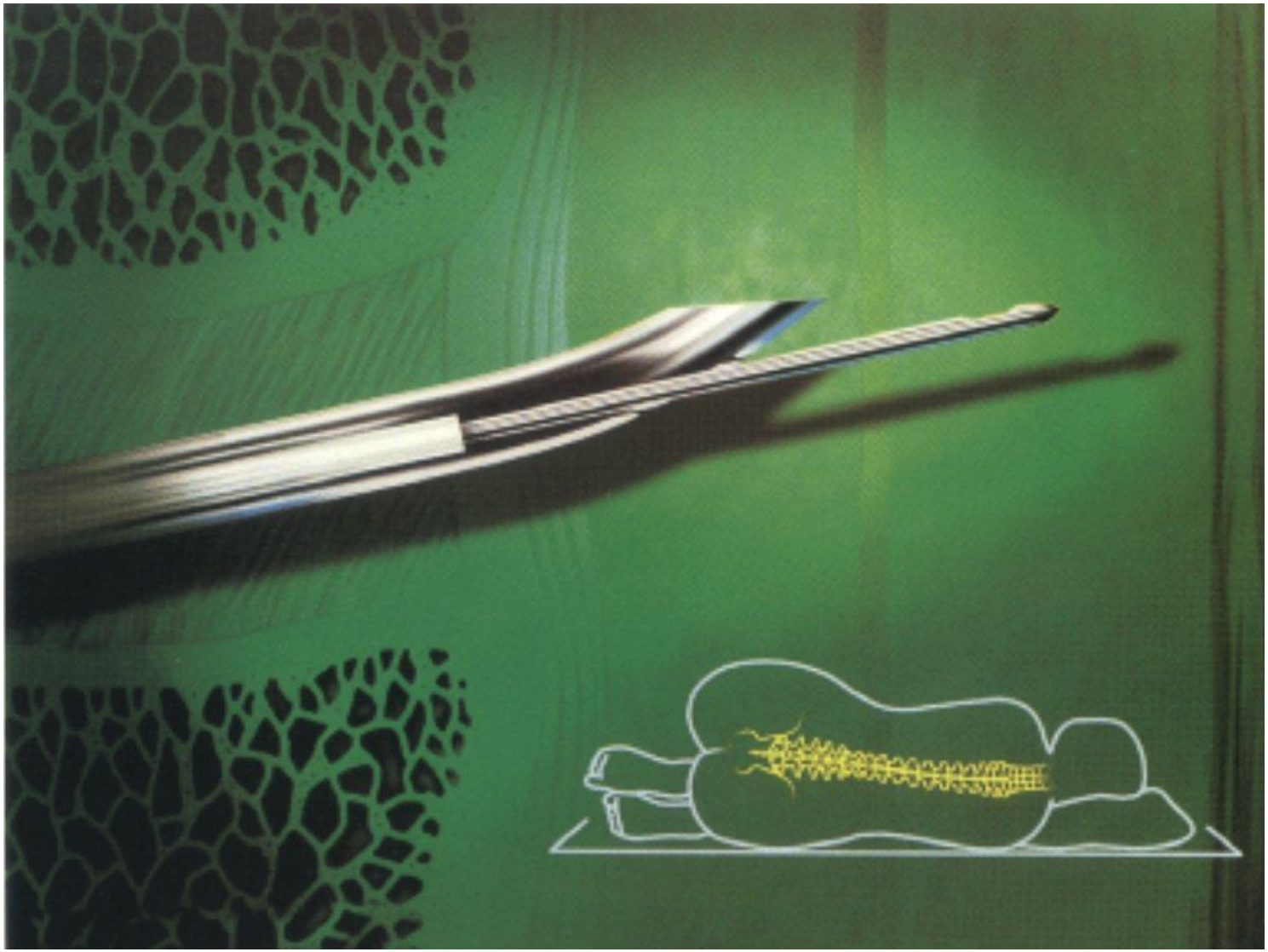
Needles

Epidural

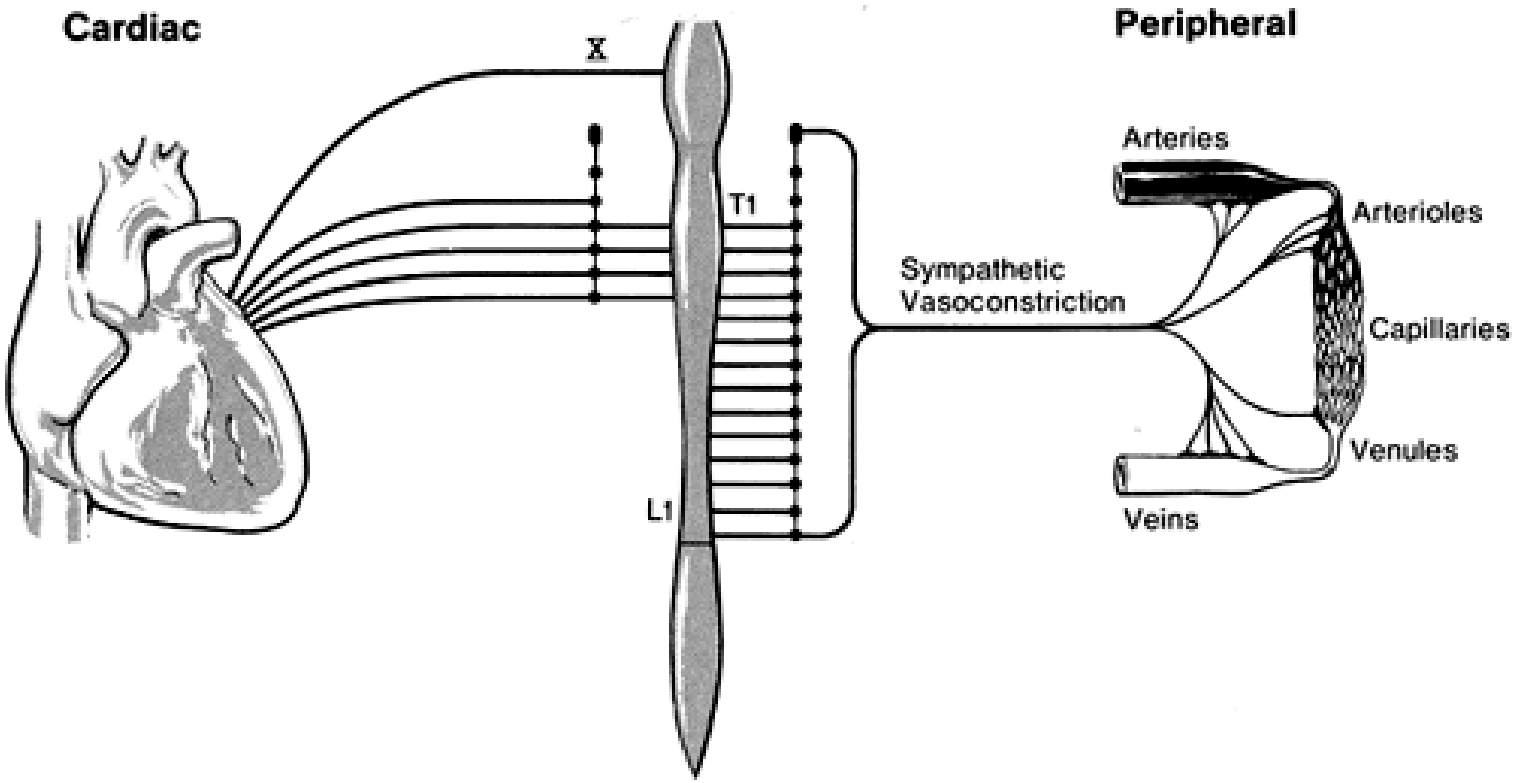


Epidural

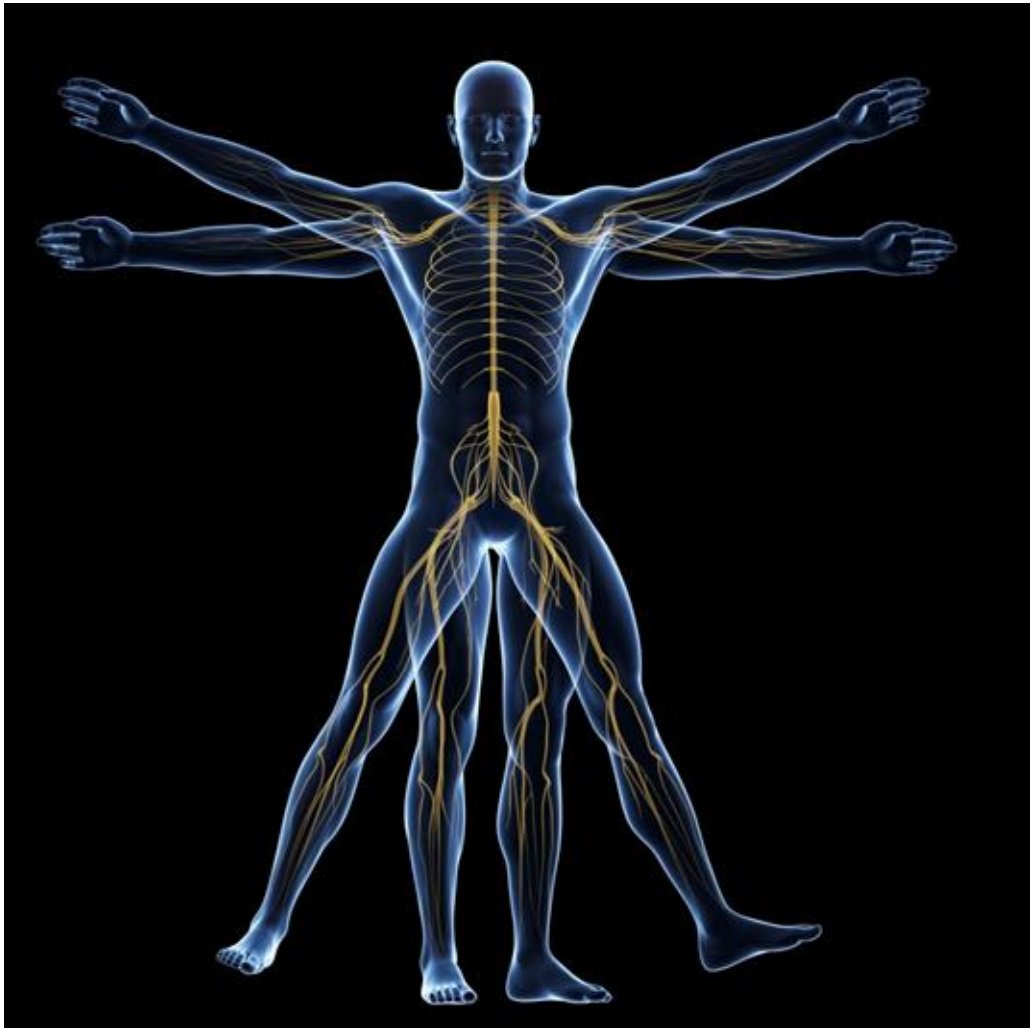
CSE

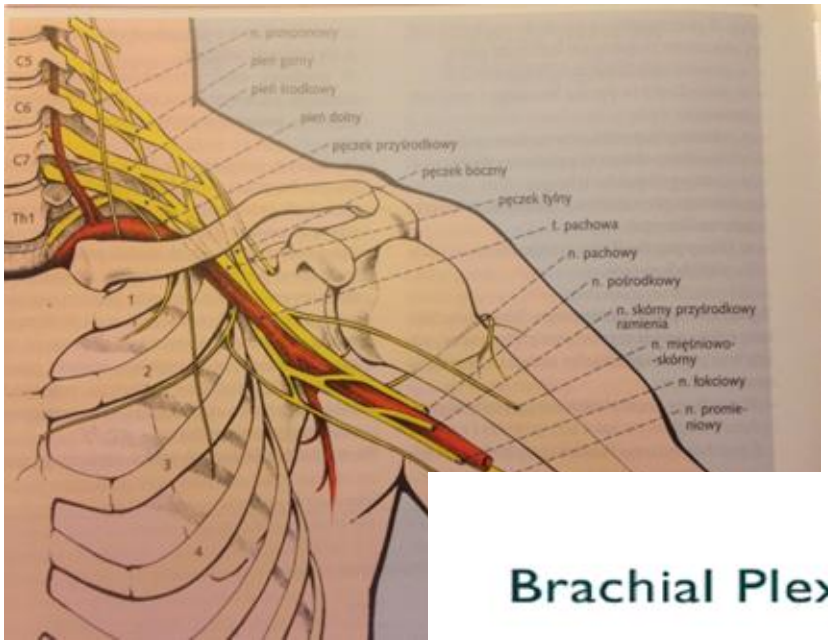


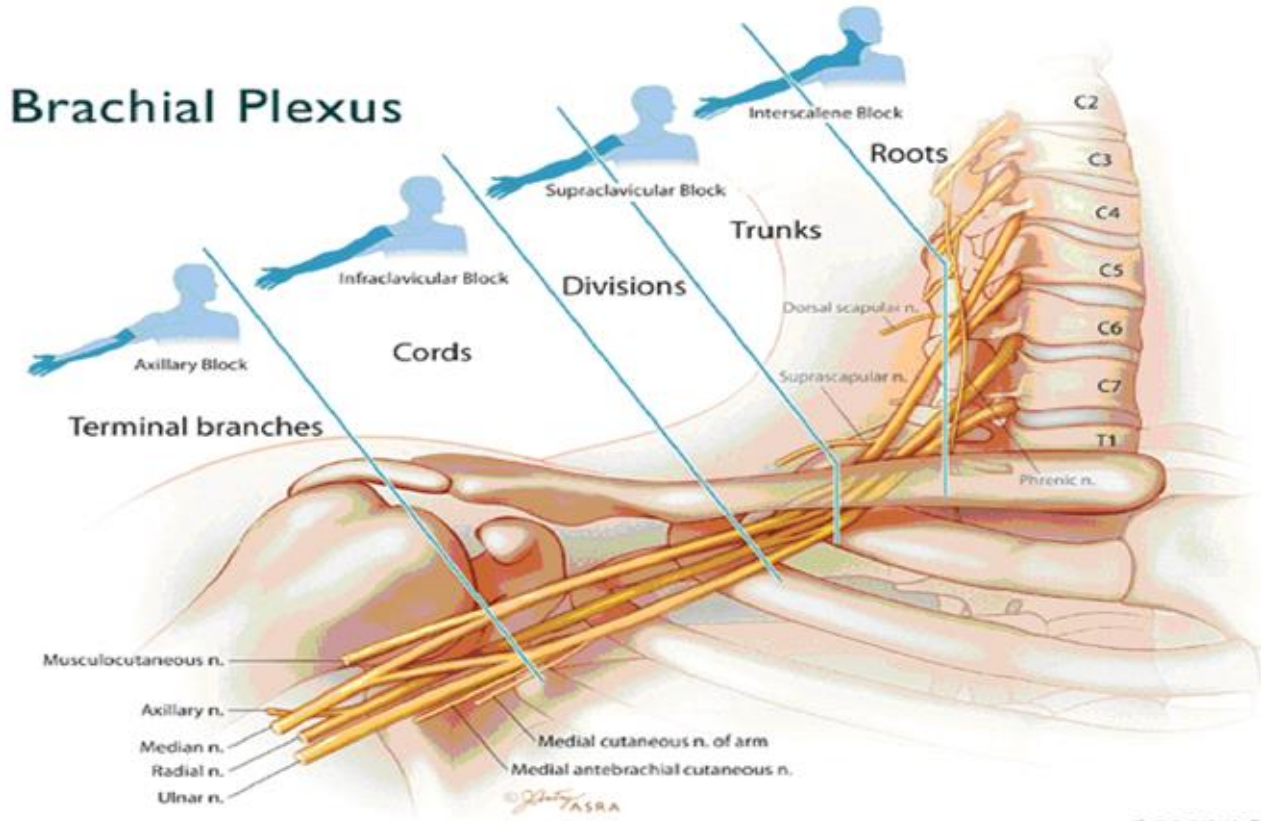
Circulation and neuraxial blocks



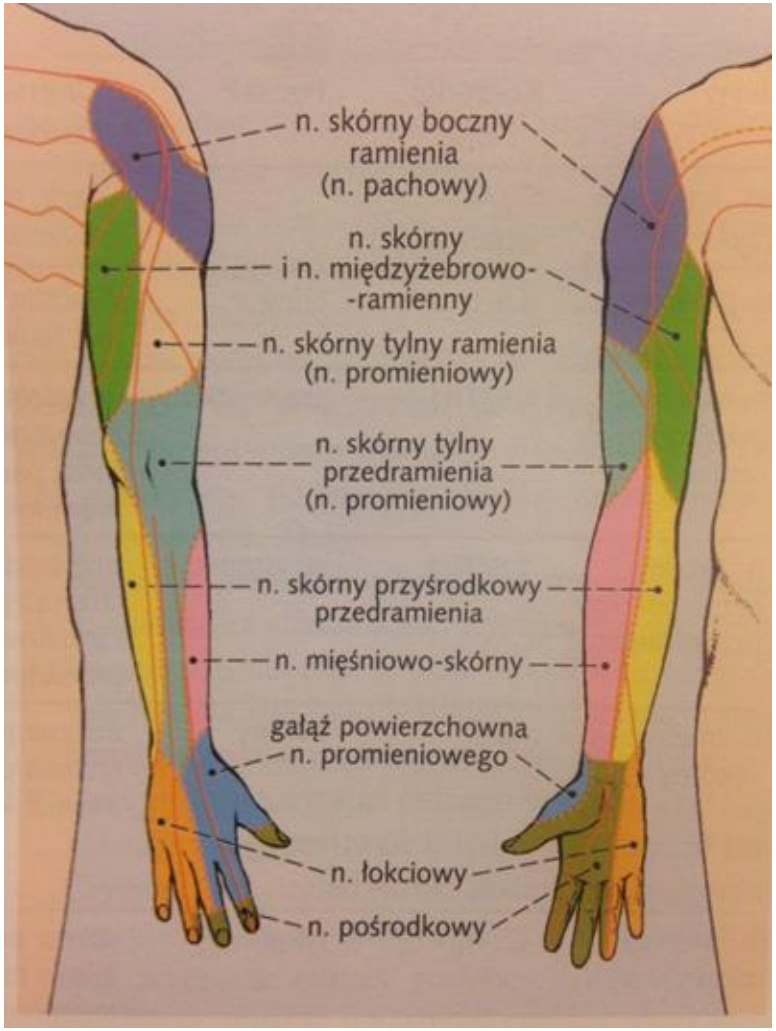
Peripheral blocks




C5
C6
C7
Th1
pęczek przyśrodkowy
pęczek boczny
pęczek tylny
t. pachowa
n. pachowy
n. pośrodkowy
n. skórny przyśrodkowy ramienia
n. mięśniowo-skórny
n. łokciowy
n. promieniowy

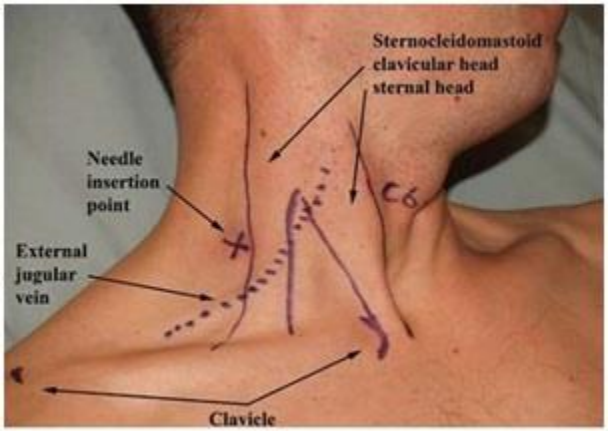

Brachial Plexus
Interscalene Block
Supraclavicular Block
Infraclavicular Block
Axillary Block
Roots
Trunks
Divisions
Cords
Terminal branches
C2
C3
C4
C5
C6
C7
T1
Dorsal scapular n.
Suprascapular n.
Phrenic n.
Musculocutaneous n.
Axillary n.
Median n.
Radial n.
Ulnar n.
Medial cutaneous n. of arm
Medial antebrachial cutaneous n.
ASRA

Upper limb innervation



Intrascalene block

- Shoulder surgery, clavicular or humeral fractures

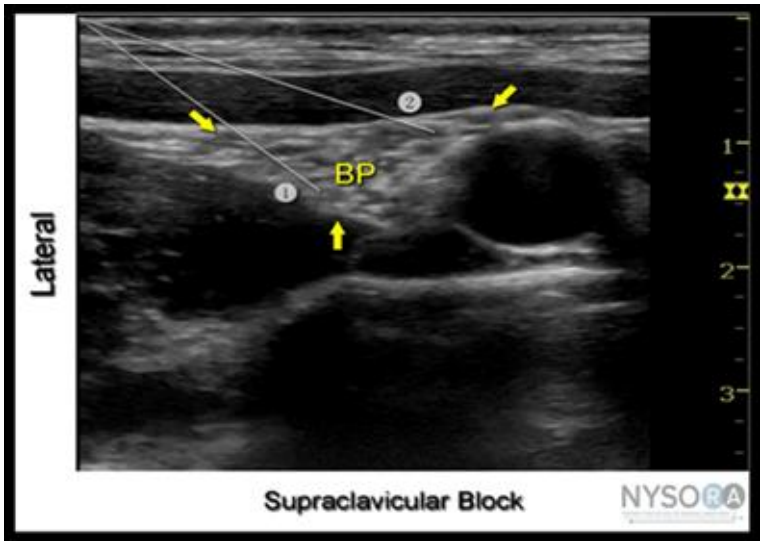


- <u>Complications:</u> phrenic nerve, pneumothorax, intravascular injection, „total spinal”

Supraclavicular block

- "Spinal of the arm"

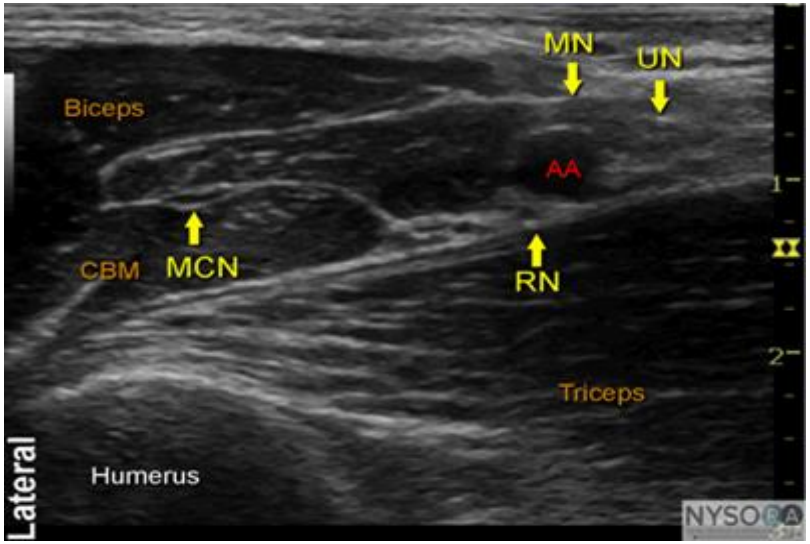
- Complications: pneumothorax, intravascular injection or vascular injury



Axillary block

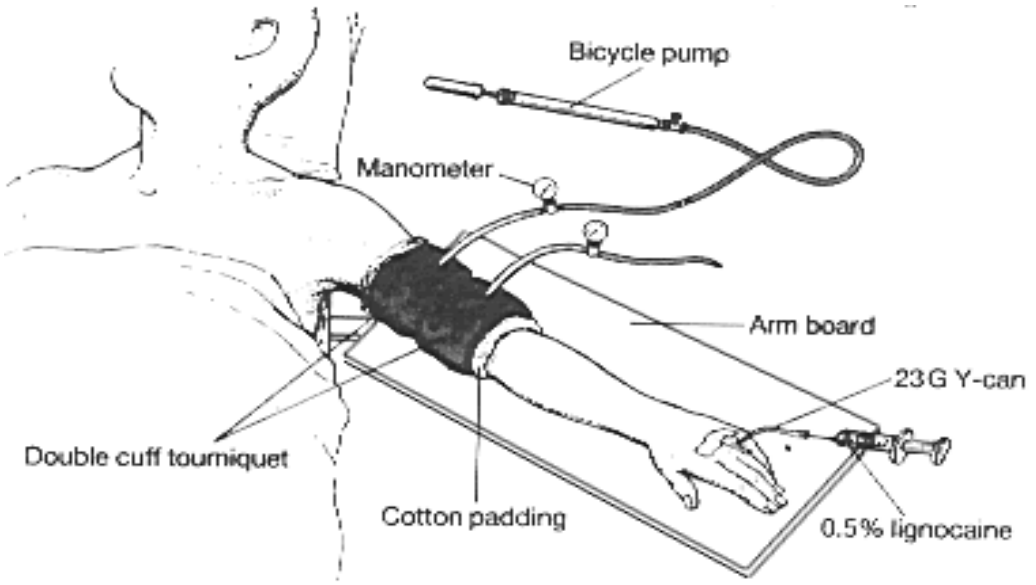
- Hand and forearm surgery

- Complications: intravascular injection, vascular injury

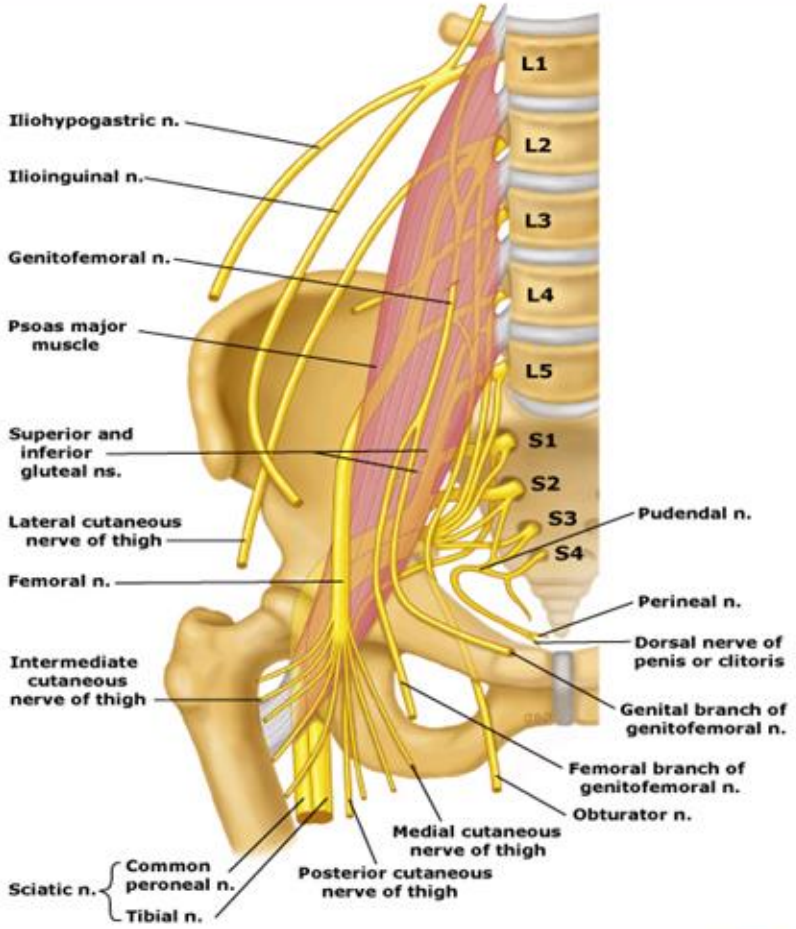


Bier's block

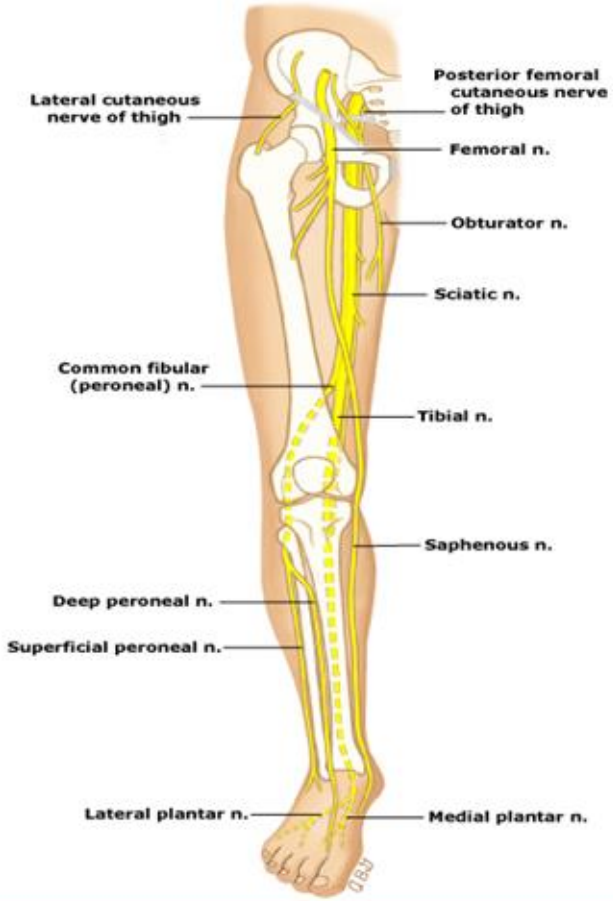
- 2 tourniquets
- LA – 0,5% Lignocaine or prilocaine
- Limited duration



Anatomy of the lumbosacral plexus



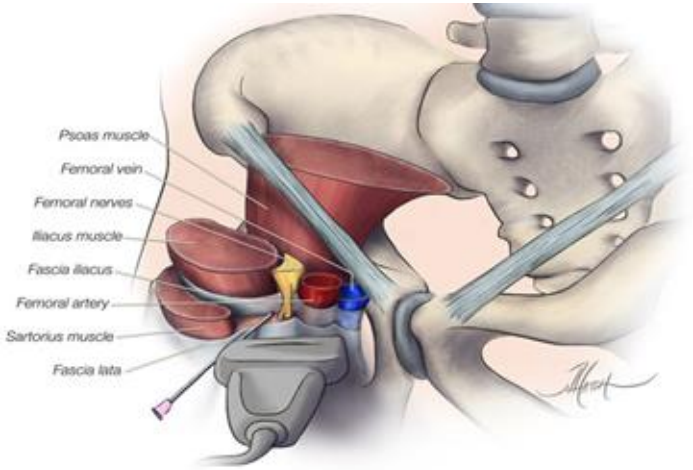
Nerves of the lower extremity

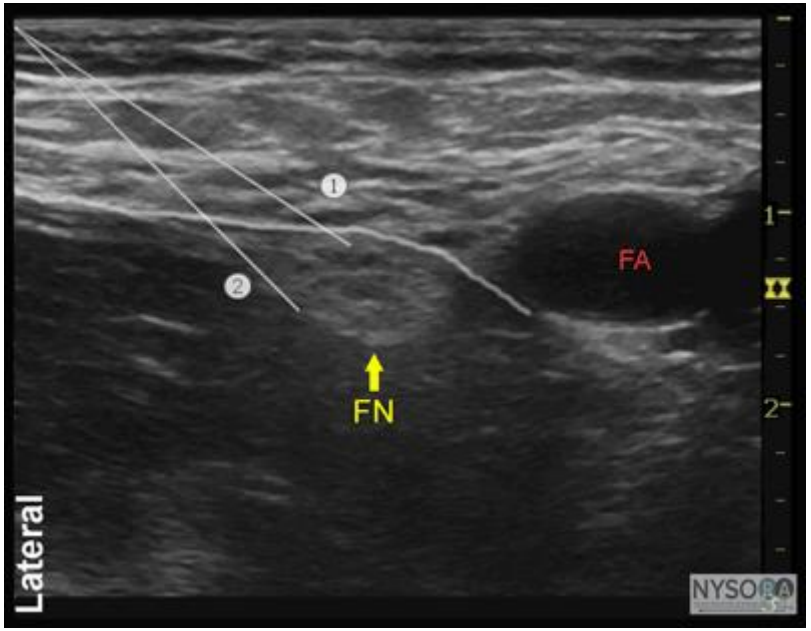


n.: nerve.

Femoral nerve block

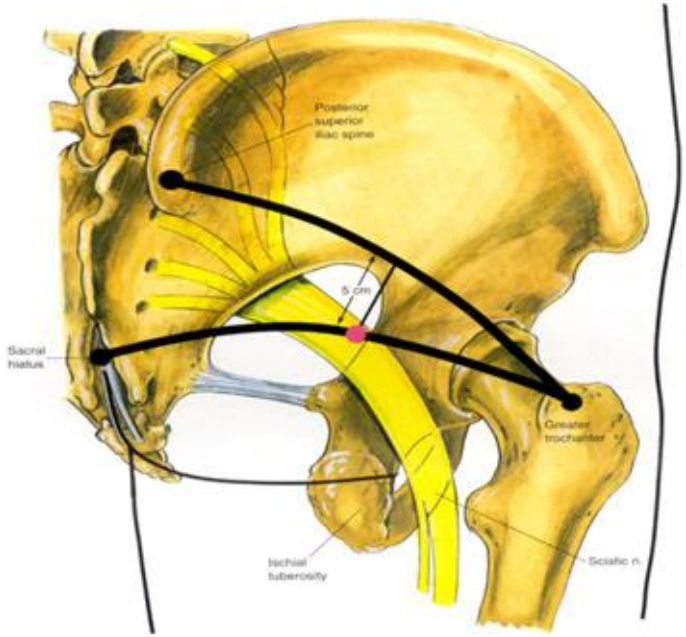
- Hip and femur surgery
- Knee surgery – supplementary block



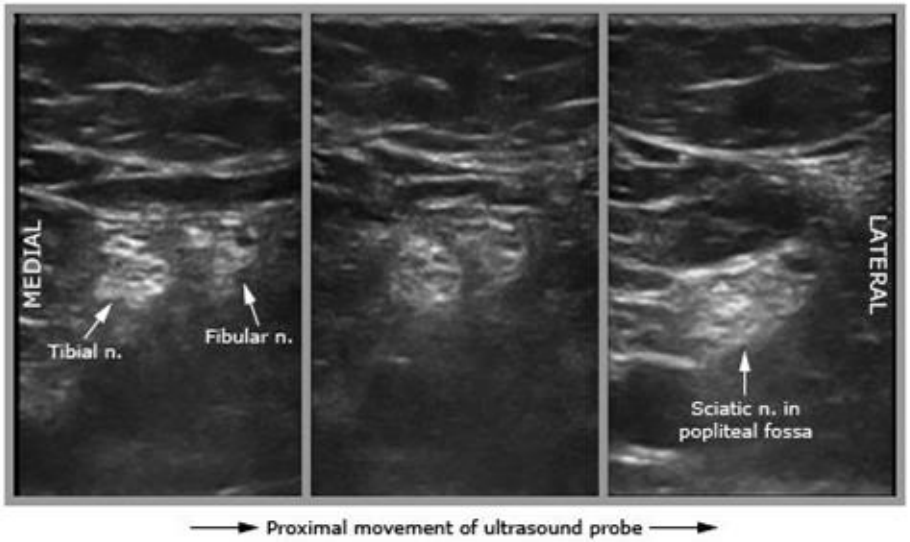


Sciatic nerve block

- Foot and shank surgery

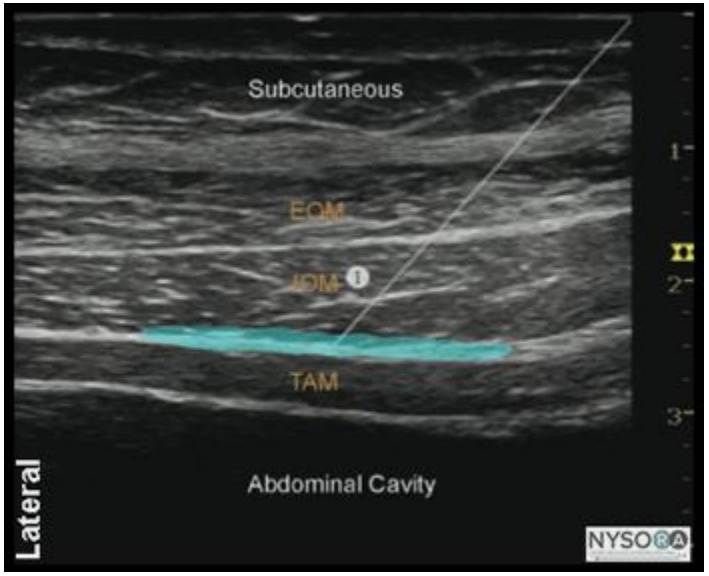


Sciatic nerve



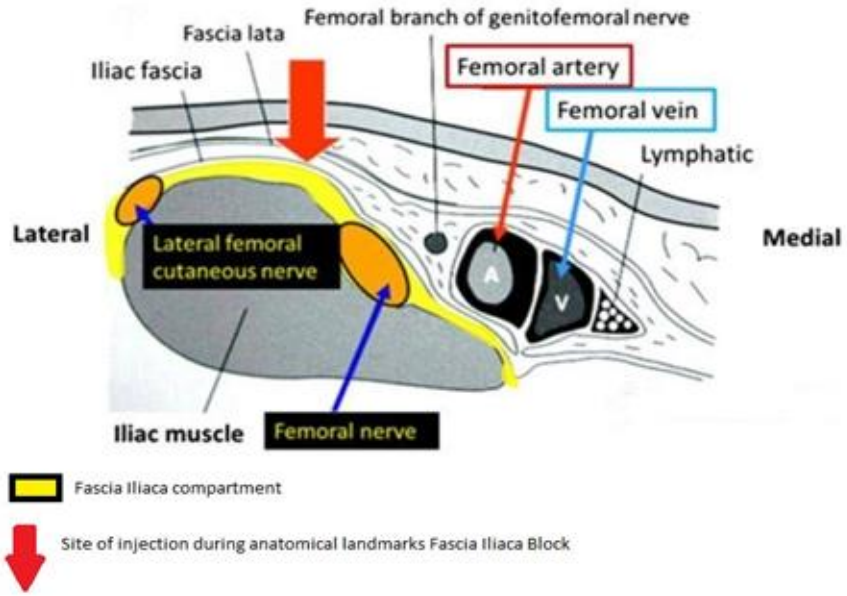
TAP block

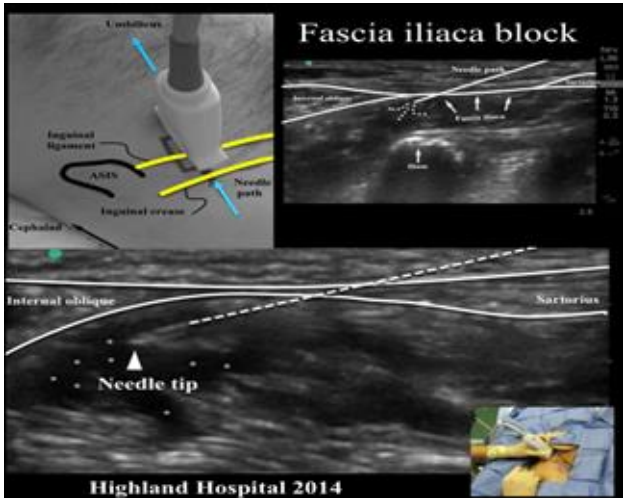
- *Transversus Abdominis Plane Block*
- As a part of multimodal anesthesia for abdominal and obstetric surgery



Fascia illiaca block

- Alternative for lumbar plexus block





Complications - neuraxial

Table 3. Aggregate Estimated Rate of Occurrence of Neurological Complications After Neuraxial Blockade

	Estimated rate of occurrence (n = 10,000)	Lower CI (n = 10,000)	Upper CI (n = 10,000)	Heterogeneity (Q value)	
Spinal anesthesia					
Radiculopathy/neuropathy (6 studies)	3.78	1.06	13.50	168.70	$P < 0.01$
Cauda equina syndrome (4 studies)	0.11	0.03	0.37	20.59	$P < 0.01$
Intracranial event (2 studies)	0.03	0.00	0.20	1.66	NS
Paraplegia (4 studies)	0.06	0.02	0.20	5.38	NS
Epidural anesthesia					
Radiculopathy/neuropathy (9 studies)	2.19	0.88	5.44	142.30	$P < 0.01$
Cauda equina syndrome (4 studies)	0.23	0.14	0.39	2.30	NS
Intracranial event (2 studies)	0.07	0.03	0.21	0.24	NS
Paraplegia (4 studies)	0.09	0.04	0.22	2.23	NS

The estimated rate of occurrence was calculated using a random effects general linear model (see text).

CI = 95% confidence interval; NS = nonsignificant (nonsignificance indicates the absence of heterogeneity between studies).

(Anesth Analg 2007;104:965-74)

Complications - peripheral

Table 4. Aggregate Estimated Rate of Occurrence of Neuropathy After Peripheral Nerve Blockade

	Estimated rate of occurrence ($n = 100$)	Lower CI ($n = 100$)	Upper CI ($n = 100$)	Heterogeneity (Q value)	
Brachial plexus blockade					
Interscalene block (7 studies)	2.84	1.33	5.98	90.71	$P < 0.01$
Supraclavicular block (1 study)	0.03	0.00	0.42	NA	NA
Axillary block (10 studies)	1.48	0.52	4.11	315.57	$P < 0.01$
Midhumeral block (2 studies)	0.02	0.00	0.09	0.28	NS
Lumbar plexus blockade					
Lumbar plexus block (3 studies)	0.19	0.02	1.93	6.18	$P < 0.05$
Femoral nerve block (4 studies)	0.34	0.04	2.81	57.51	$P < 0.01$
Sacral plexus blockade					
Sciatic nerve block (3 studies)	0.41	0.02	9.96	38.71	$P < 0.01$
Popliteal nerve block (4 studies)	0.24	0.10	0.61	0.96	NS

The estimated rate of occurrence was calculated using a random effects general linear model (see text).

CI = 95% confidence interval; NA = not applicable; NS = nonsignificant (nonsignificance indicates the absence of heterogeneity between studies).

(Anesth Analg 2007;104:965-74)