



Regional Anesthesia

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Regional anesthesia - Definition

Rendering a specific area of the body, e.g. foot, arm, lower extremities, insensate to stimulus of surgery or other instrumentation

Regional anesthesia - Uses

- Provide anesthesia for a surgical procedure
- Provide analgesia post-operatively or during labor and delivery
- Diagnosis or therapy for patients with chronic pain syndromes



Advantages/Disadvantages of Regional and Local Anesthesia.

advantages

- patient remains conscious
- maintain his own airway
- aspiration of gastric contents unlikely
- smooth recovery requiring less skilled nursing care as compared to general anesthesia

advantages

- postoperative analgesia
- reduction in surgical stress
- earlier discharge for outpatients
- less expense

Disadvantages:

- patient may prefer to be asleep
- practice and skill is required for the best results
- some blocks require up to 30 minutes or more to be fully effective
- analgesia may not always be totally patient may require additional analgesics, IV sedation, or a light general anesthetic

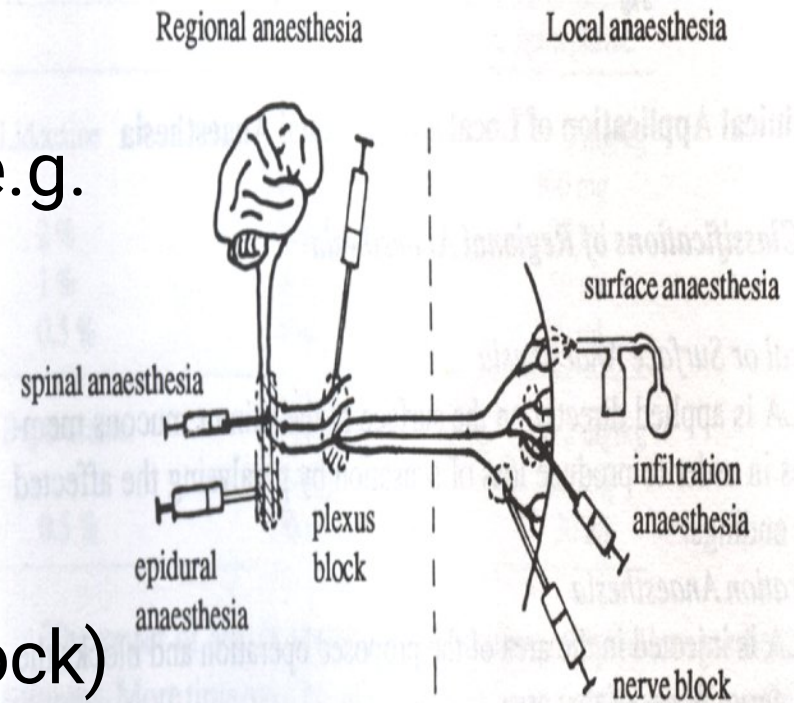
Disadvantages:

- toxicity may occur if the local anesthetic is given intravenously or if an overdose is injected
- some operations are unsuitable for local anesthetics, e.g., thoracotomies

Regional anesthesia - types

- Topical
- Local/Field
- Peripheral (named) nerve, e.g. radial n.
- Plexus - brachial, lumbar
- Central neuraxial - epidural, spinal, caudal
- Intravenous block ("Bier" block)

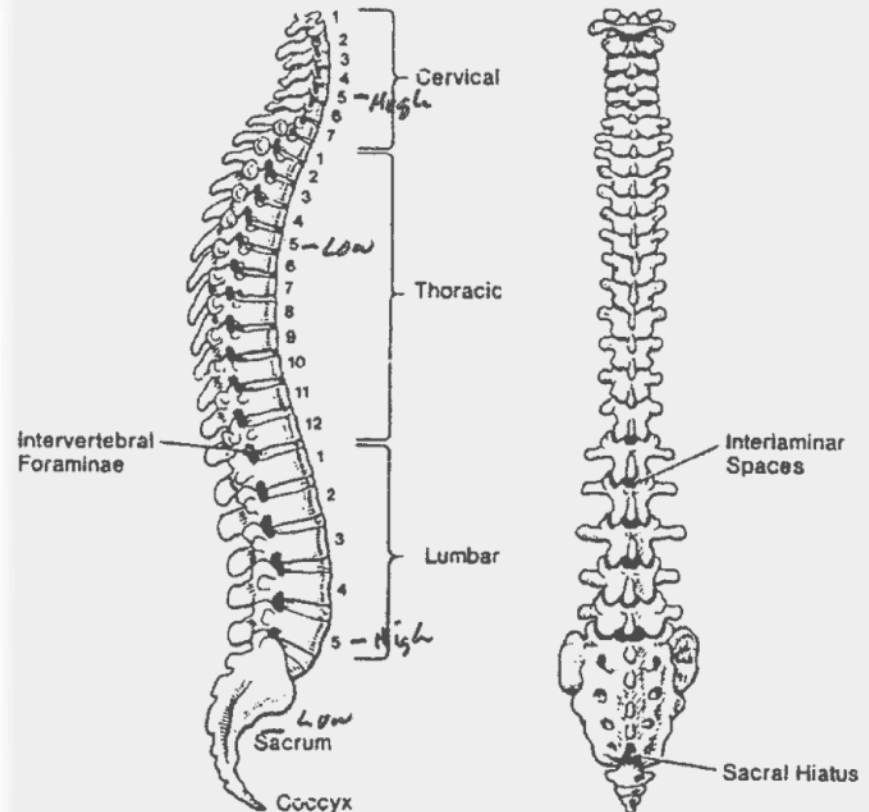
Fig. 13.2.1 Different types of local and regional anaesthetic techniques





Spinal Anatomy

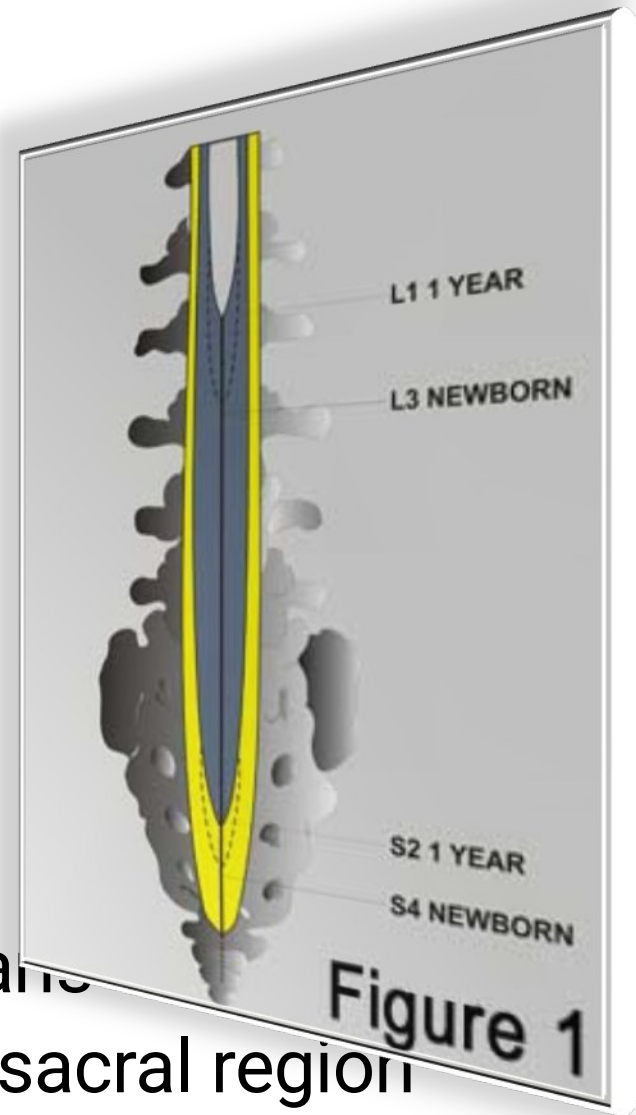
- 33 Vertebrae
 - 7 Cervical
 - 12 Thoracic
 - 5 Lumbar
 - 5 Sacral
 - 4 Coccygeal
- High Points: C5 & L5
- Low Points: T5 & S2



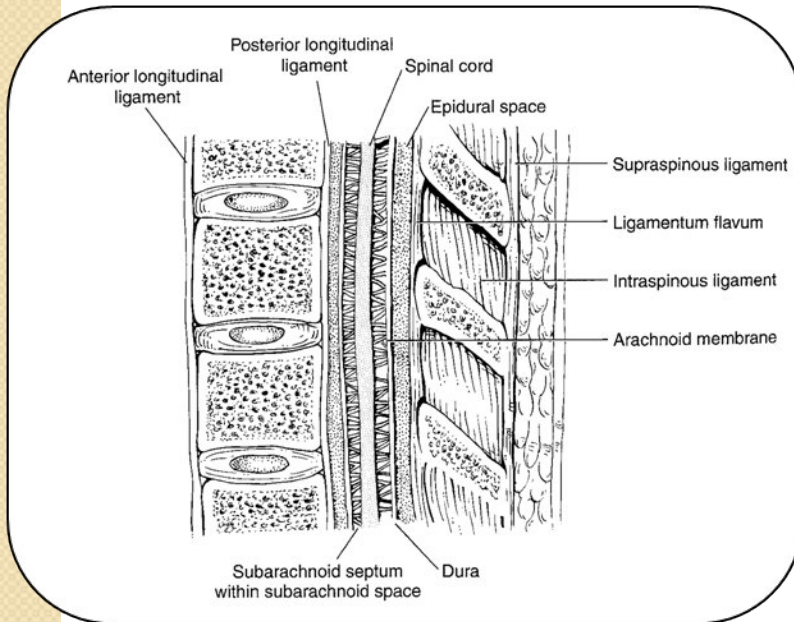
Vertebral Column Anatomy

Spinal Cord

- Adult
 - Begins: Foramen Magnum
 - Ends: **L1**
- Newborn
 - Begins: Foramen Magnum
 - Ends: **L3**
- Terminal End: Conus Medullaris
- Filum Terminale: Anchors in sacral region
- Cauda Equina: Nerve group of lower dural sac



Saggital Sections



- Supraspinous Ligament
 - Outer most layer
- Intraspinous Ligament
 - Middle layer
- Ligamentum Flavum
 - Inner most layer

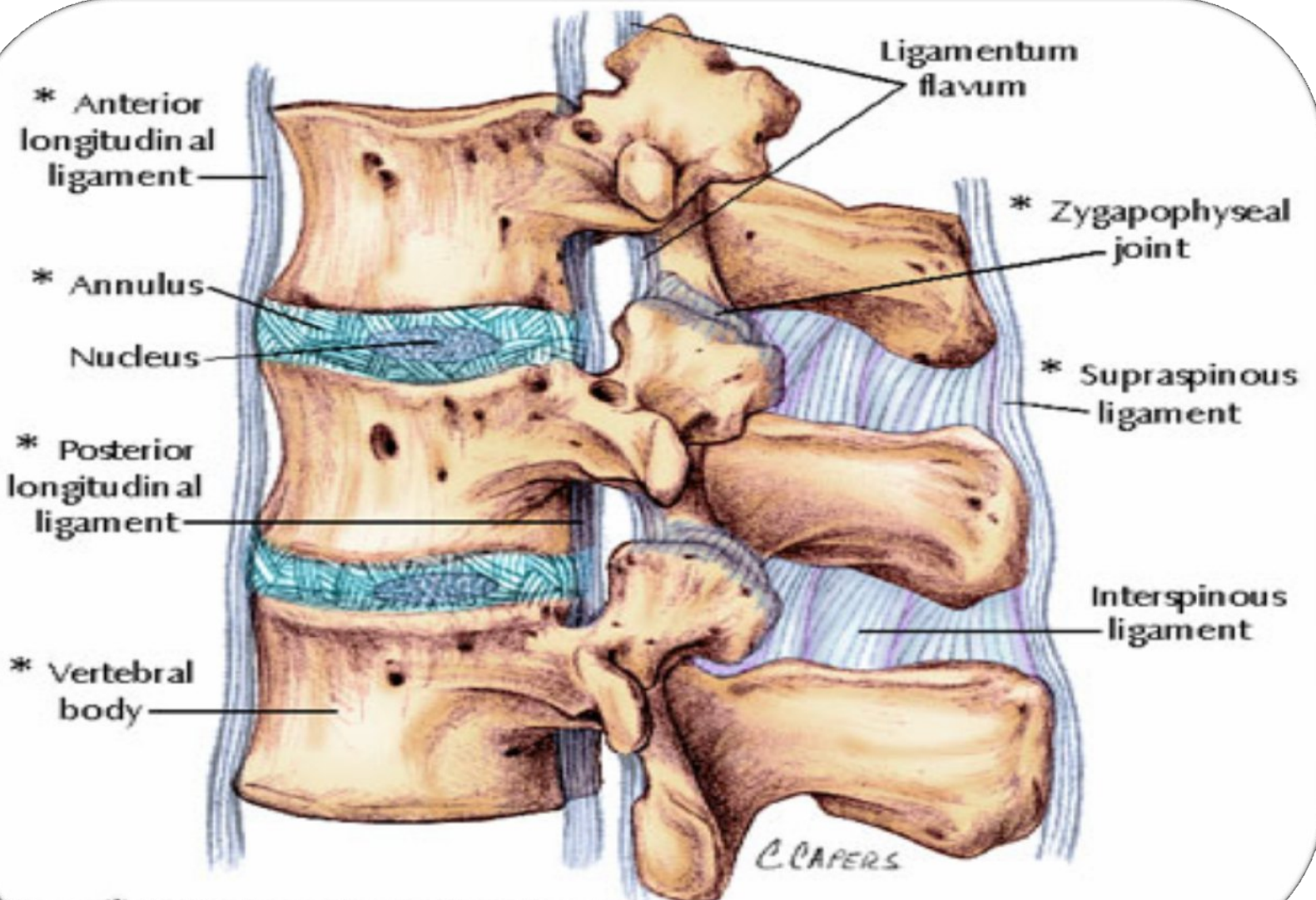
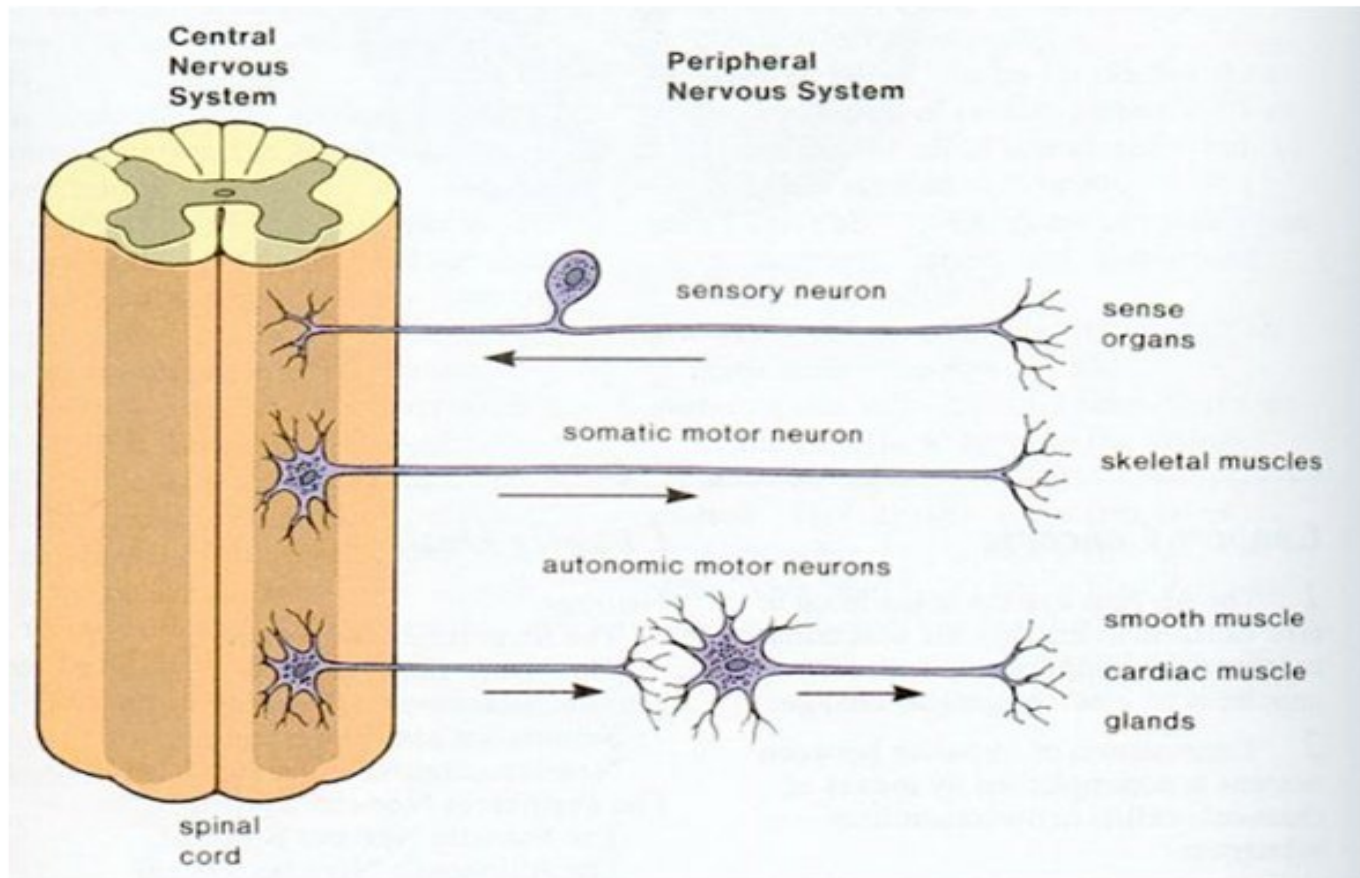


Fig. 1 * indicates pain-sensing structures



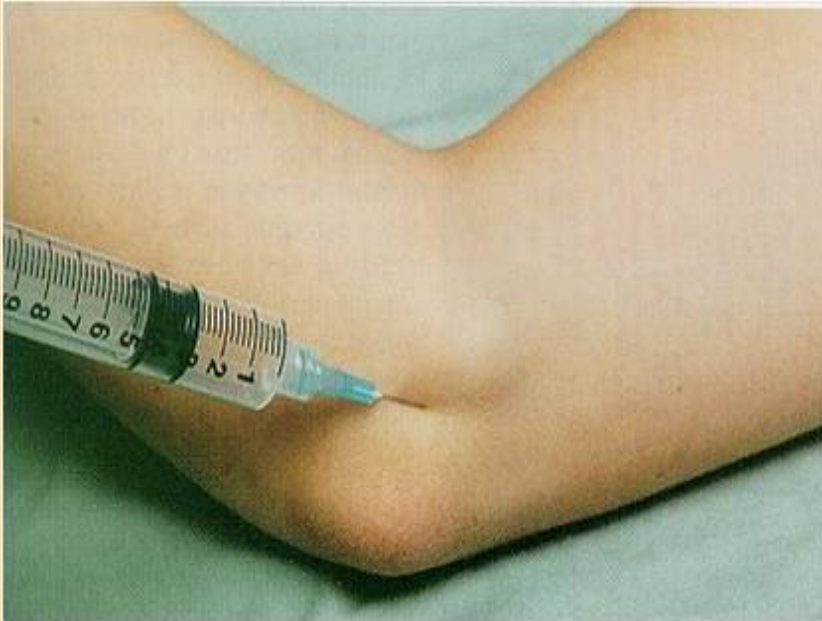
Topical Block



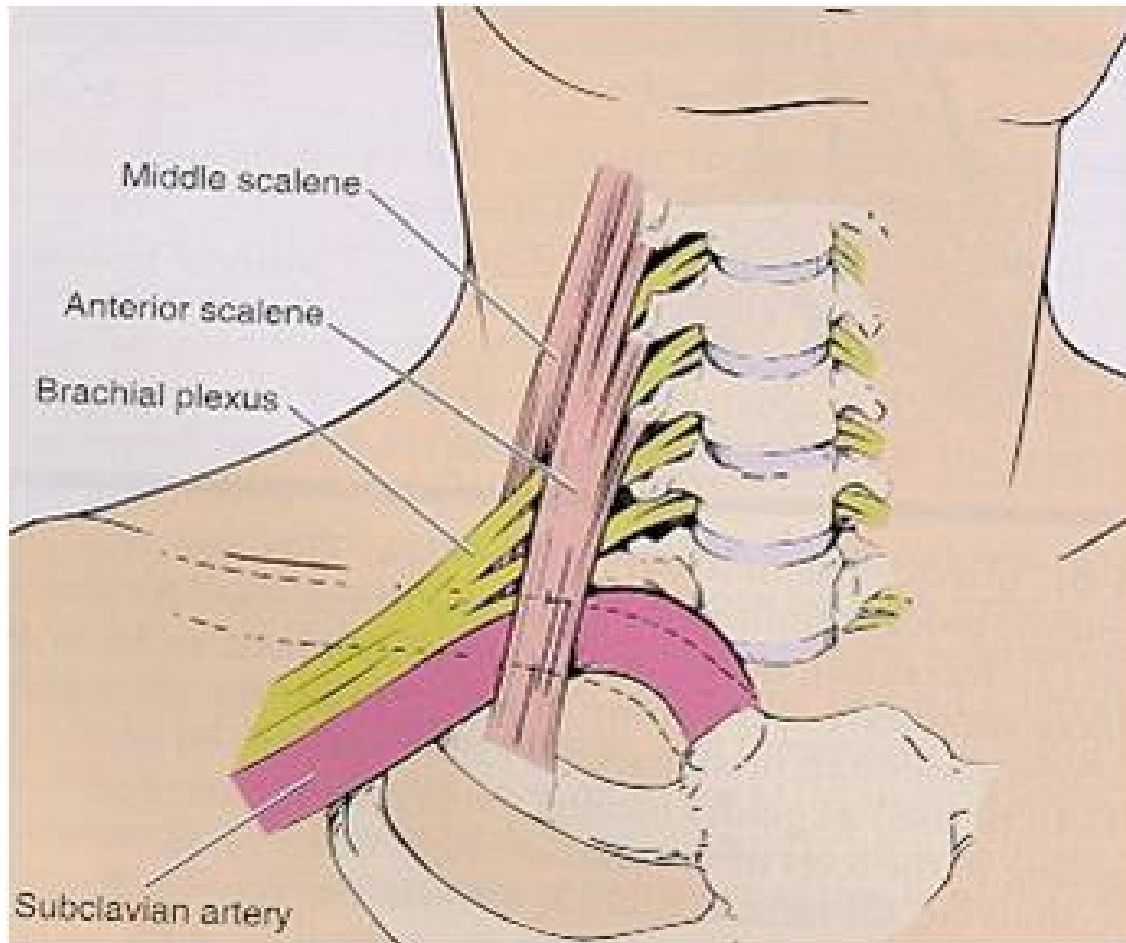
IV Block



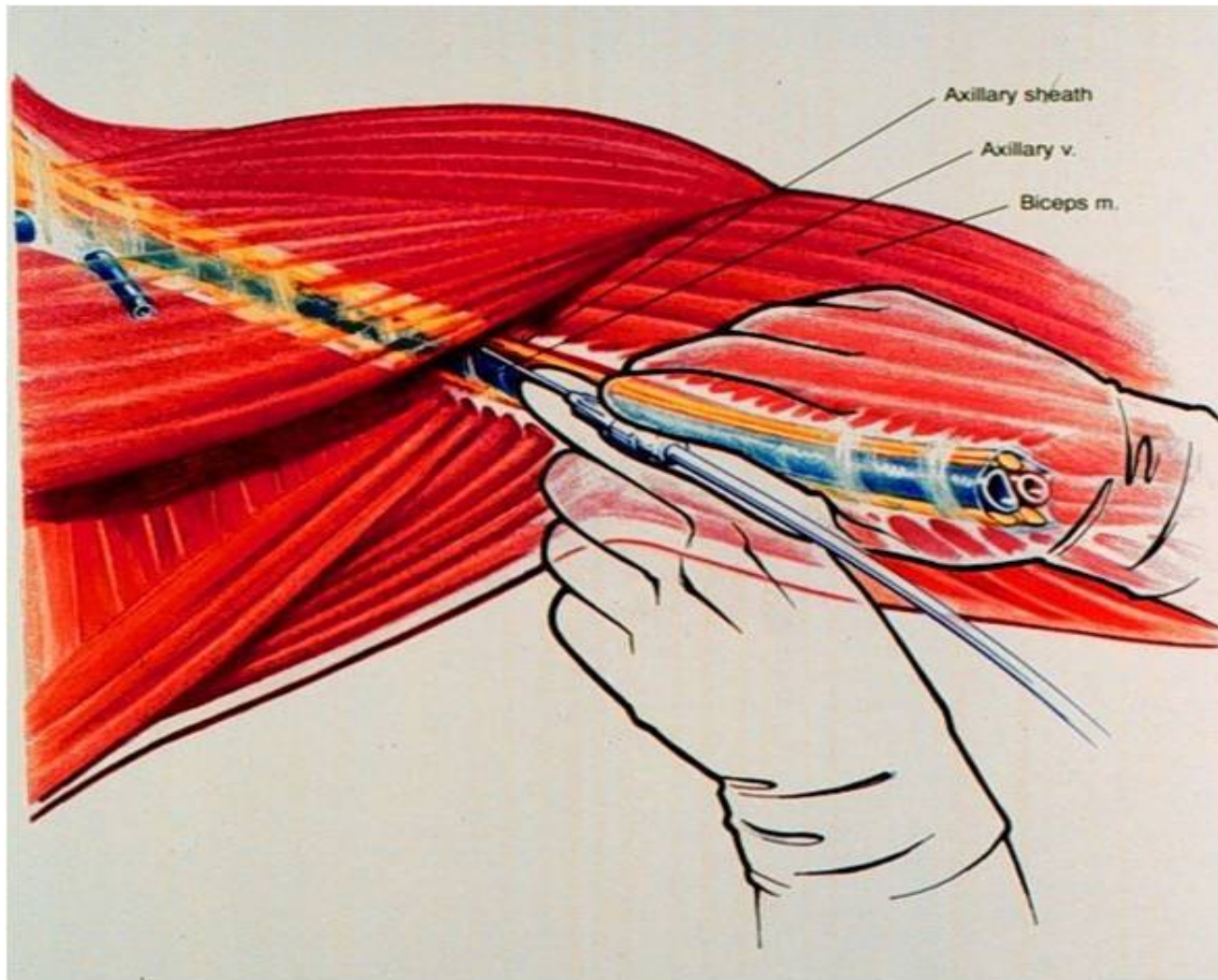
Infiltration Block



Plexus Block



Plexus Nerve Block

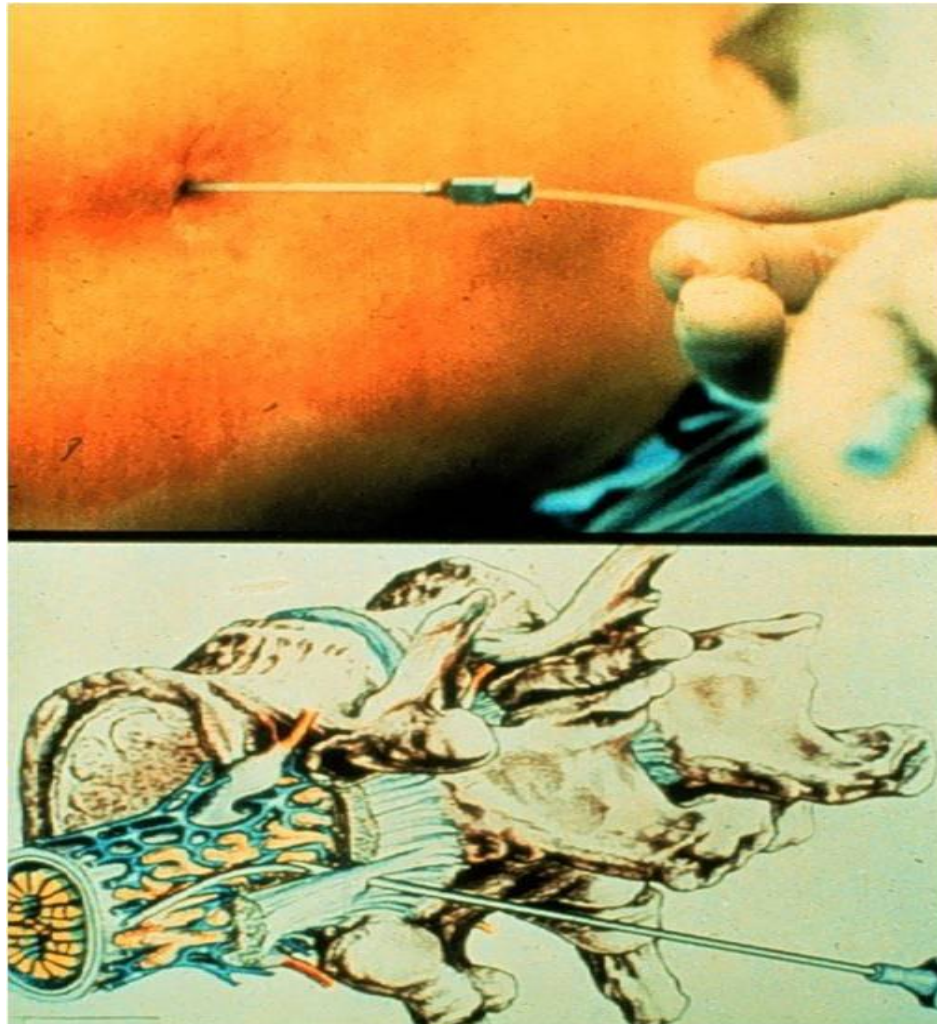




Epidural Space

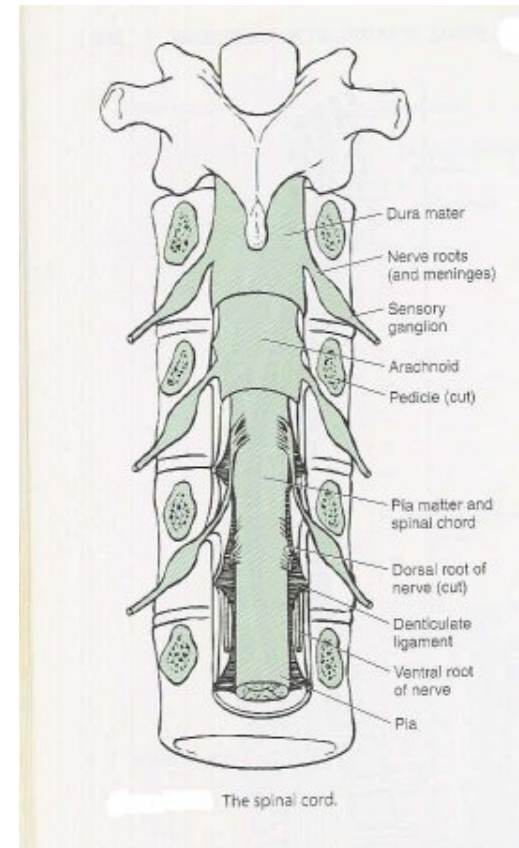
- Space that surrounds the spinal meninges
 - Potential space
- Ligamentum Flavum
 - Binds epidural space posteriorly
- Widest at Level L2 (5-6mm)
- Narrowest at Level C5 (1-1.5mm)

Epidural Block



Spinal Meninges

- Dura Mater
 - Outer most layer
 - Fibrous
- Arachnoid
 - Middle layer
 - Non-vascular
- Pia
 - Inner most layer
 - Highly vascular
- Sub Arachnoid Space
 - Lies between the arachnoid and pia



Cardiovascular Effects

- Blockade of Sympathetic Preganglionic Neurons
 - Send signals to both arteries and veins
 - Predominant action is venodilation
 - Reduces:
 - Venous return
 - Stroke volume
 - Cardiac output
 - Blood pressure
 - T1-T4 Blockade
 - Causes unopposed vagal stimulation
 - Bradycardia
 - Associated with decrease venous return & cardioaccelerator fibers blockade
 - Decreased venous return to right atrium causes decreased stretch receptor response

Hypotension

- Treatment
 - Best way to treat is physiologic not pharmacologic
 - Primary Treatment
 - Increase the cardiac preload
 - Large IV fluid bolus within 30 minutes prior to spinal placement, minimum 1 liter of crystalloids
 - Secondary Treatment Pharmacologic
 - Ephedrine is more effective than Phenylephrine

Respiratory System

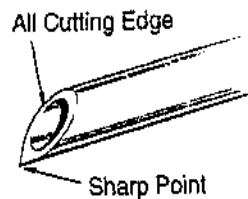
- Healthy Patients
 - Appropriate spinal blockade has little effect on ventilation
- High Spinal
 - Decrease functional residual capacity (FRC)
 - Paralysis of abdominal muscles
 - Intercostal muscle paralysis interferes with coughing and clearing secretions
 - Apnea is due to hypoperfusion of respiratory center

Spinal Anesthesia

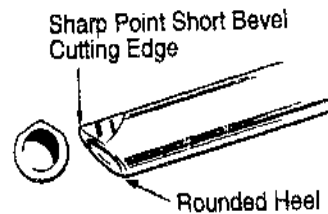
- Indications ;
 - Full stomach
 - Anatomic distortions of upper airway
 - TURP surgery
 - Obstetrical surgery
 - Decreased post-operative pain

Spinal Technique

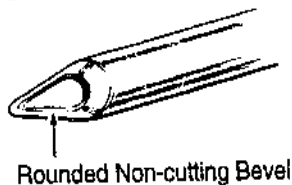
A. Quinke Badcock



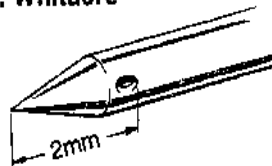
B. Pitkin



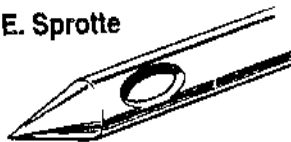
C. Greene



D. Whitacre



E. Sprotte



Spinal Needles

- Preparation & Monitoring
 - EKG
 - NBP
 - Pulse Oximeter
- Patient Positioning
 - Lateral decubitous
 - Sitting
 - Prone (hypobaric technique)

Position

- Sitting position

Sit straight first

Chin on chest

Arms resting on knees

Footstool/table to support feet

Back curving like banana or sh

- Lateral position

Shoulders perpendicular to bed

Positioned with hips on edge of bed

Knee chest



a The patient in a sitting position demonstrating a straight alignment of vertebrae and b in the lateral position showing distortion in alignment of the vertebrae.



Spinal Technique

- Midline Approach
 - Skin
 - Subcutaneous tissue
 - Supraspinous ligament
 - Interspinous ligament
 - Ligamentum flavum
 - Epidural space
 - Dura mater
 - Arachnoid mater
- Paramedian or Lateral Approach
 - Same as midline excluding supraspinous & interspinous ligaments

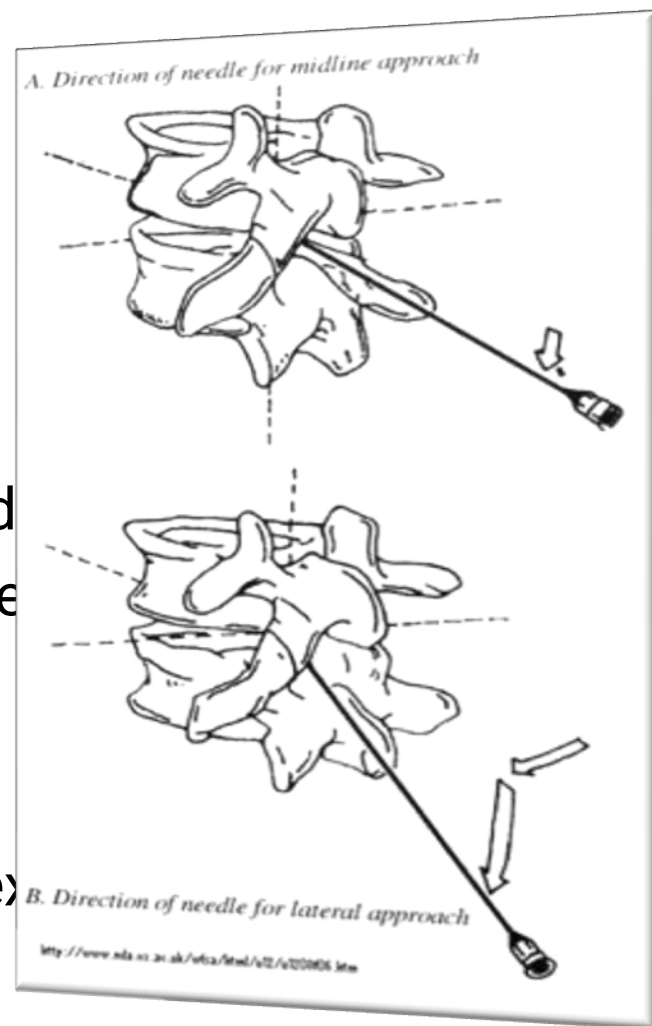
Approach

- Median approach

- Most common
- Needle or introducer is placed midline
- Perpendicular to spinous processes
- Slightly cephalad

- Paramedian approach

- For pts who cannot adequately flex
- Needle placed laterally (1.5cm)
- Needle aimed medially and slightly cephalad

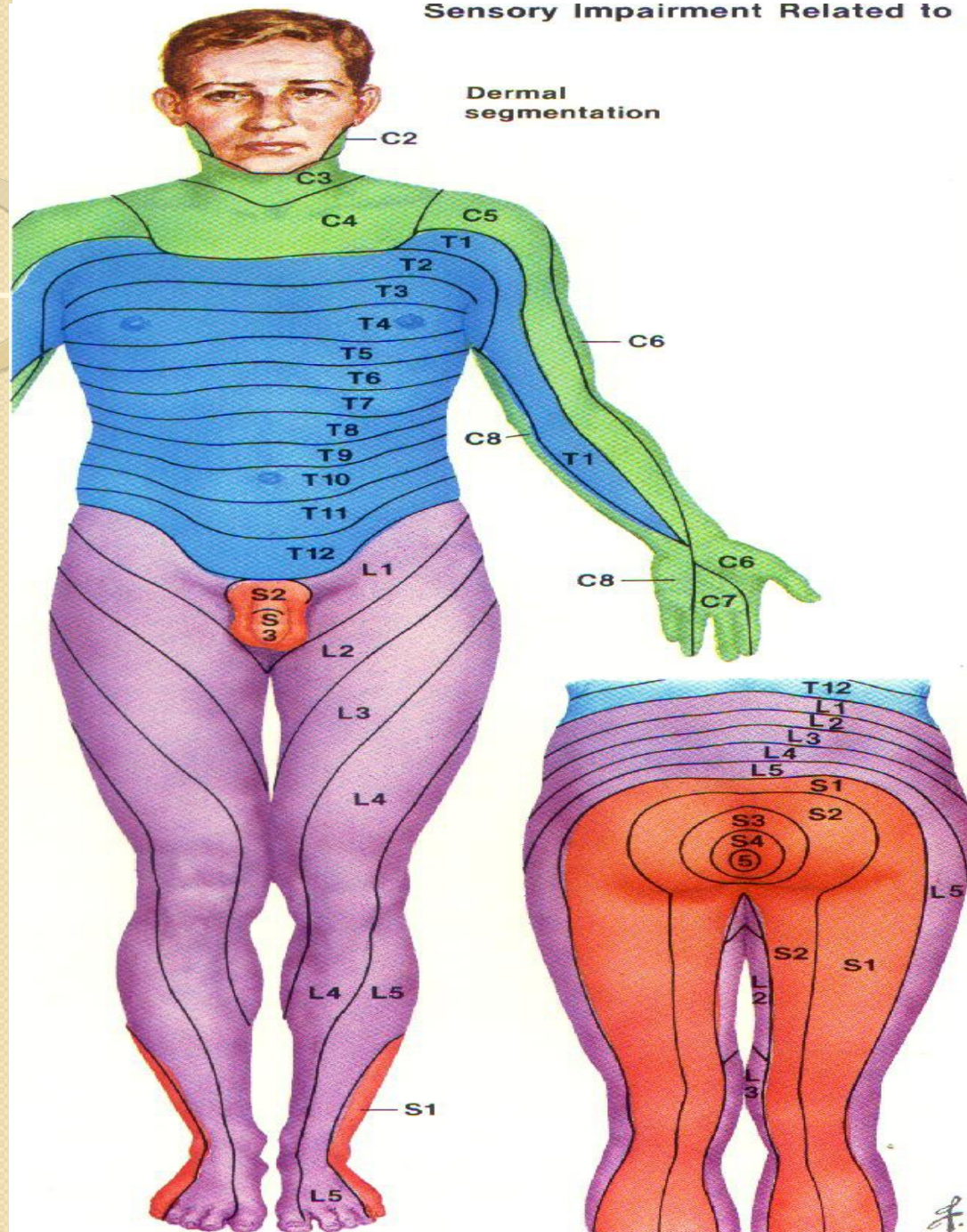


Spinal Anesthesia Levels

Spinal Anesthesia Levels (*You must know dermatomes*)

Dermatome	Application
C ₄ (clavicle)	Chest surgery
T ₄ - T ₅ (nipples)	upper abdominal surgery
T ₆ - T ₈ (xiphoid)	intestinal surgery, appendectomy, gynecologic pelvic surgery, and ureter and renal pelvic surgery
T ₈ (lower border of ribcage)	Abdominal surgery
T ₁₀ (umbilicus)	transurethral resection, obstetric vaginal delivery, and hip surgery
L ₁ (inguinal ligament)	transurethral resection, if no bladder distension, thigh surgery, lower limb amputation
L ₂ - L ₃ (knee and below)	foot surgery
S ₂ - S ₅ (perineal)	perineal surgery, hemorrhoidectomy, anal dilation

Sensory Impairment Related to Level of Spinal Cord Injury



Key indicators

Cervical segments

- C5-Anterolateral shoulder
- C6-Thumb
- C7-Middle finger
- C8-Little finger

Thoracic segments

- T1-Medial arm
- T3-3rd, 4th interspace
- T4-Nipple line, 4th, 5th interspace
- T6-Xiphoid process
- T10-Navel
- T12-Pubis

Lumbar segments

- L2-Medial thigh
- L3-Medial knee
- L4-Medial ankle, Great toe
- L5-Dorsum of foot

Sacral segments

- S1-Lateral foot
- S2-Posteromedial thigh
- S3, 4, 5-Perianal area

Spinal Anesthesia

Indication

- Lower abdominal, urogenital, lower
- Extrimity surgery
- Conjunction with general anesthesia

Spinal Anesthesia

- **Contraindications**
 - **Absolute:**
 - Refusal
 - Infection
 - Coagulopathy
 - Severe hypovolemia
 - Increased intracranial pressure
 - Severe aortic or mitral stenosis

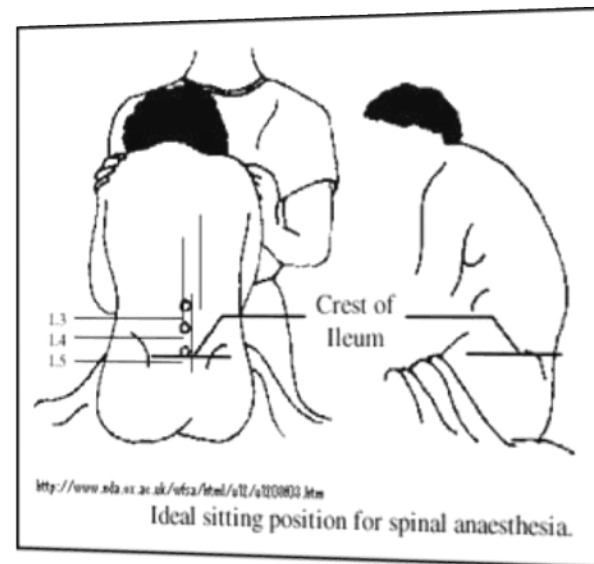
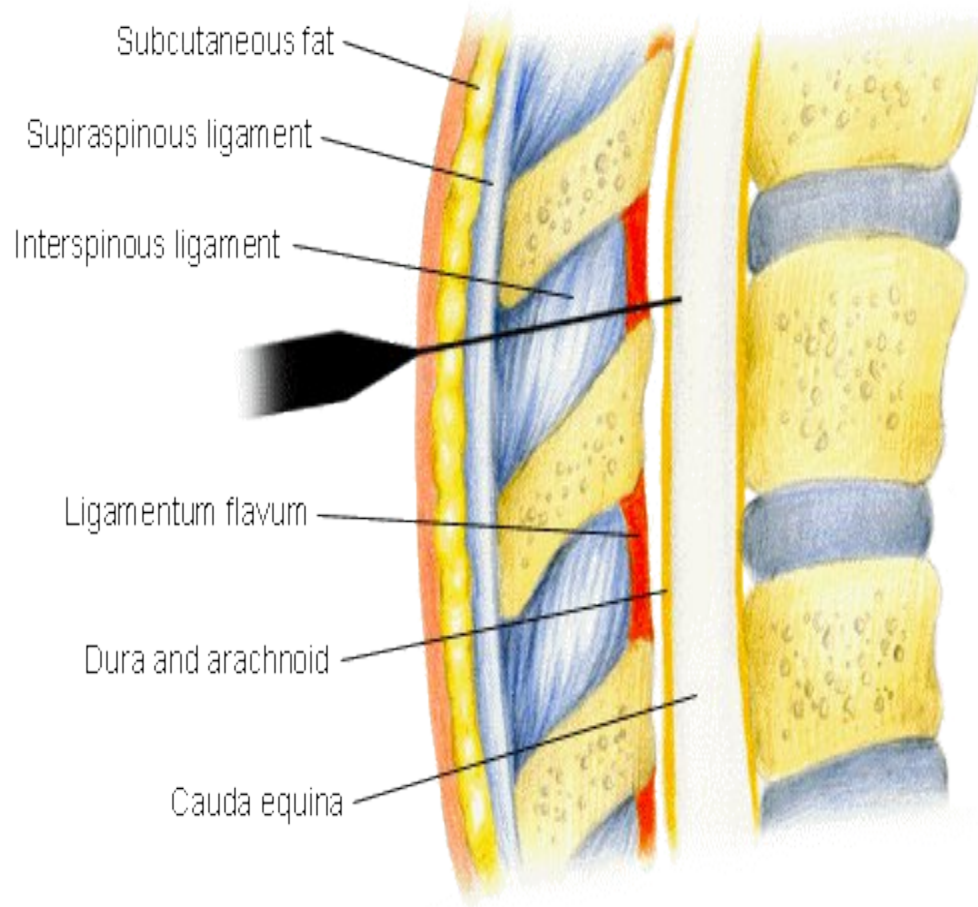
Contraindications

- Relative contraindications
 - Hypovolemia
 - Preexisting neurologic disorders
 - Chronic back pain
 - Localized infection peripheral to regional site
 - Patients taking ASA, NSAID

Technique

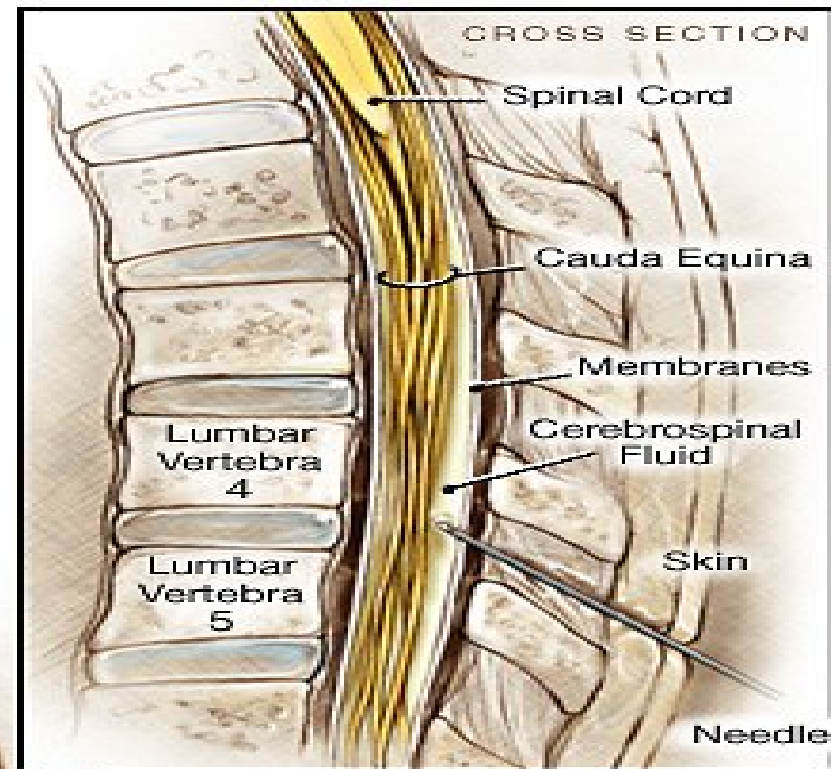
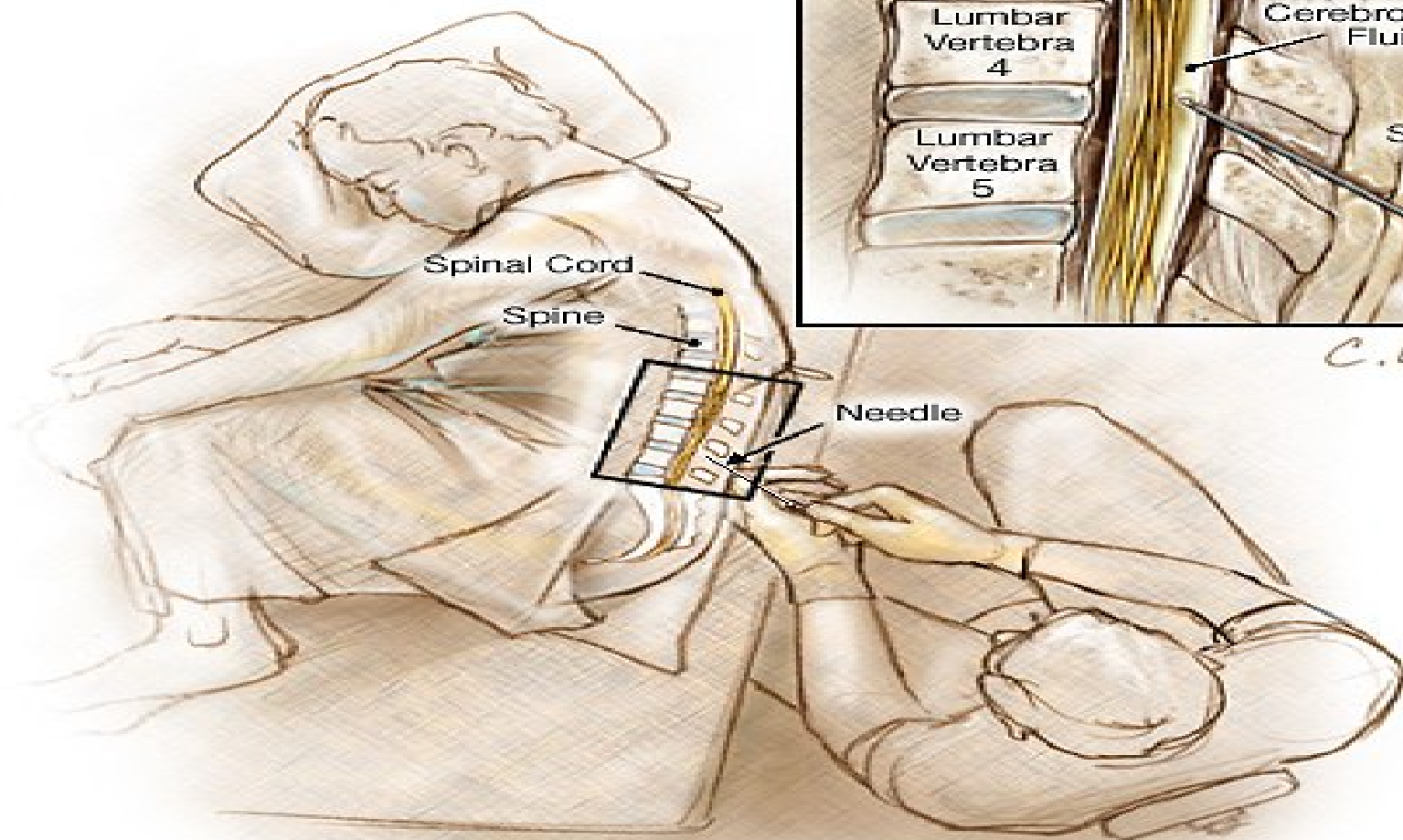
- Anatomic landmark identified
- Superior iliac crests at L4 level
- Spine is palpated
- A sterile field established
- Skin wheel with LA
- Introducer inserted and spinal needle passed
- CSF presence
- LA injection

Procedure



Lumbar Puncture

TOP VIEW

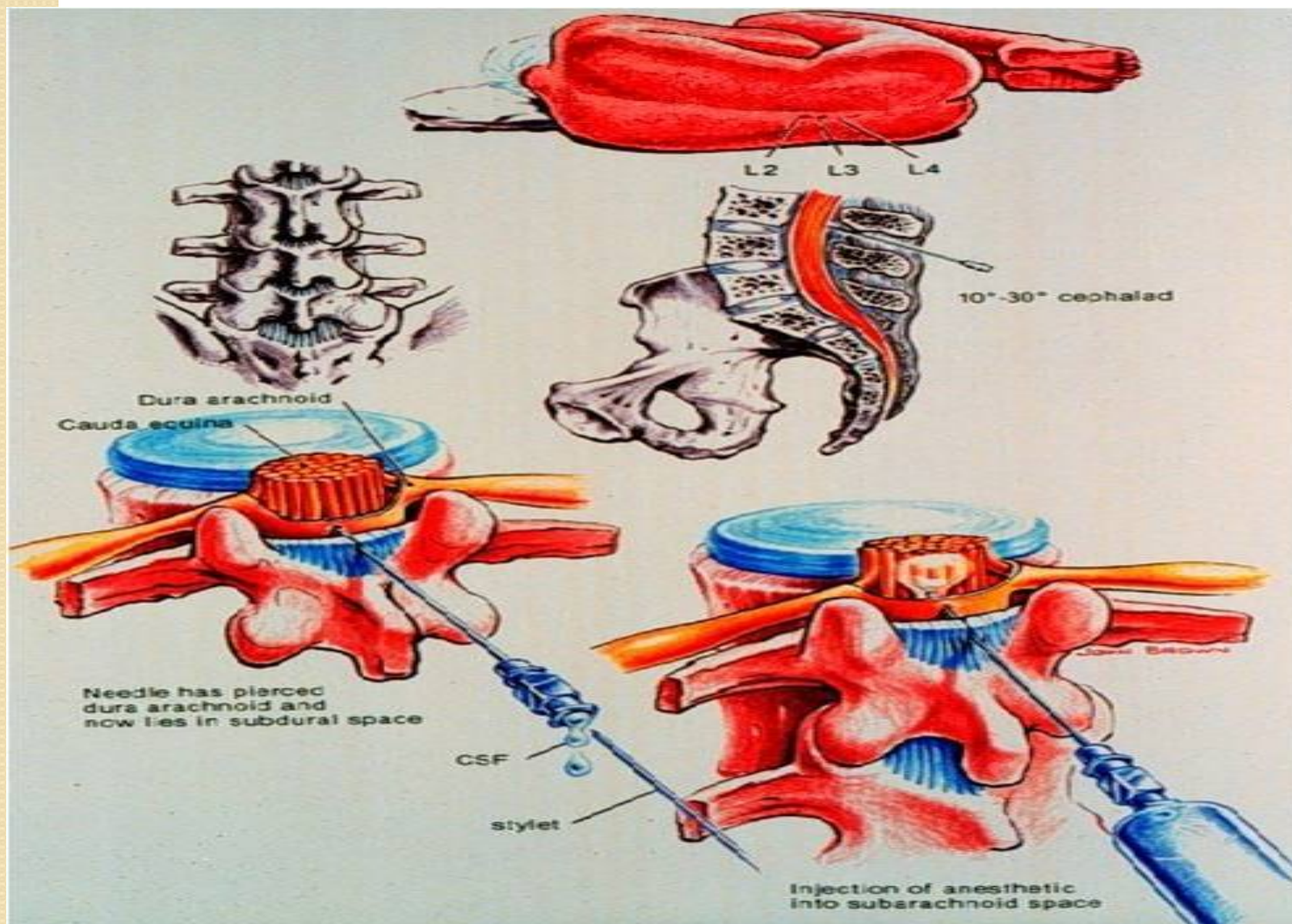


C. Lynn

Spinal Anesthesia

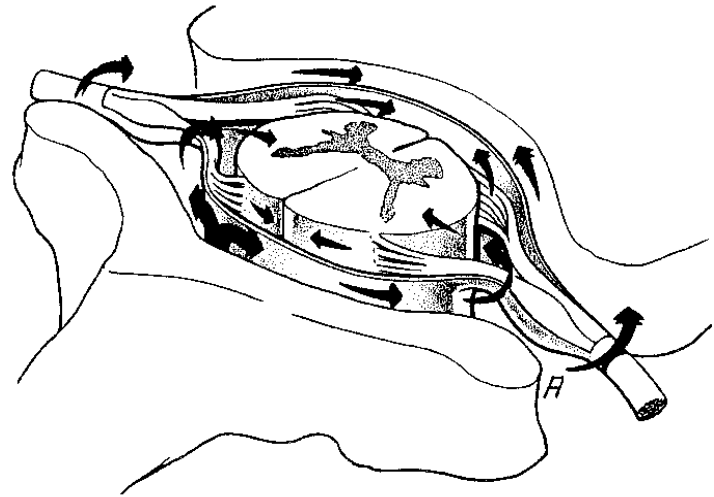
- Complications

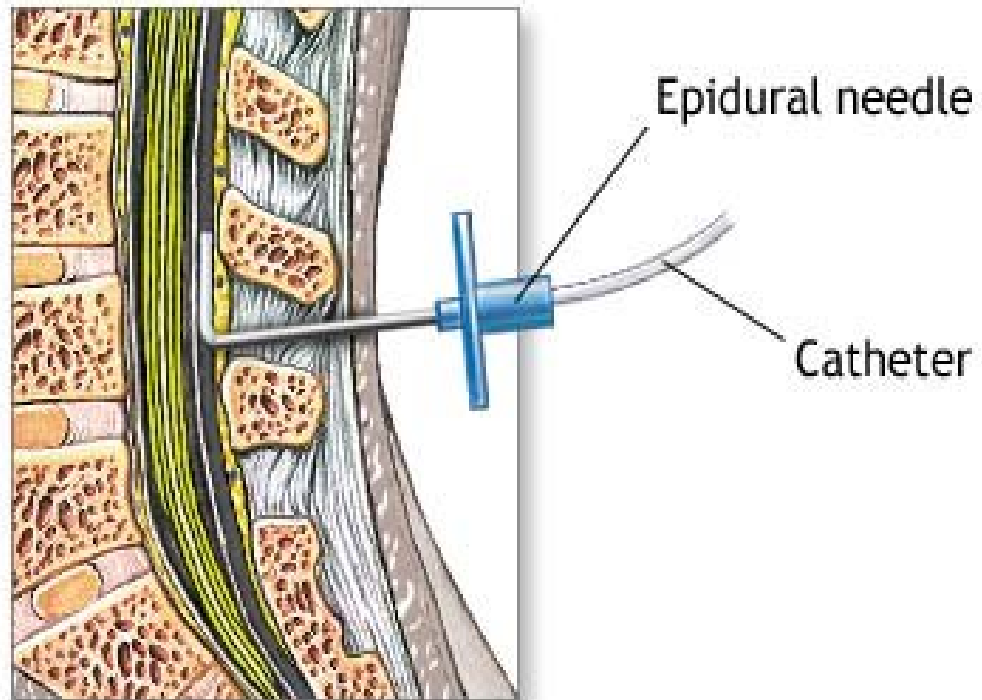
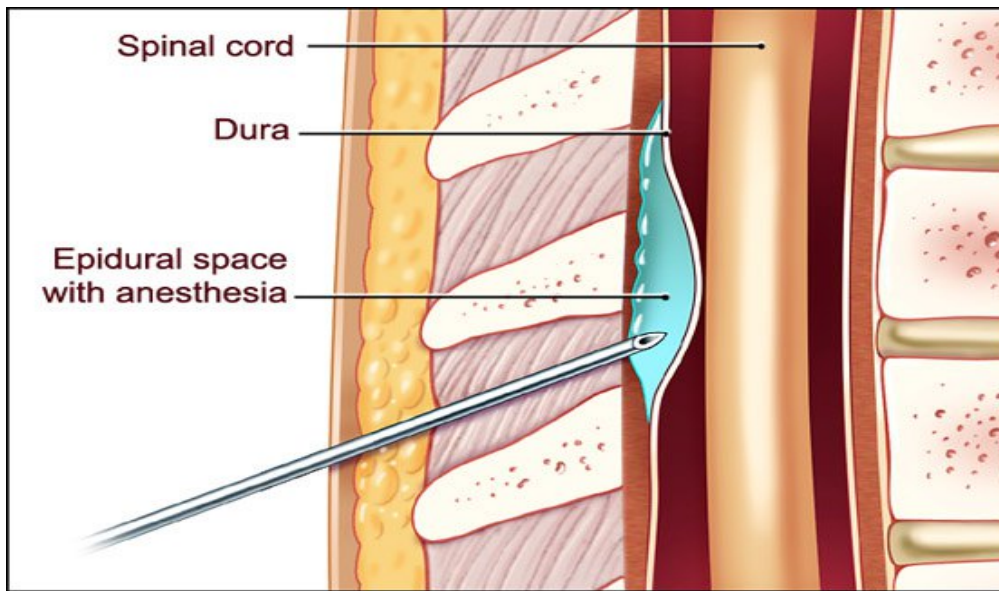
- Failed block
- Back pain (most common)
- Spinal headache
 - More common in women ages 13-40
 - Larger needle size increase severity
 - Onset typically occurs first or second day post-op
 - Treatment:
 - Bed rest
 - Fluids
 - Caffeine
 - Blood patch



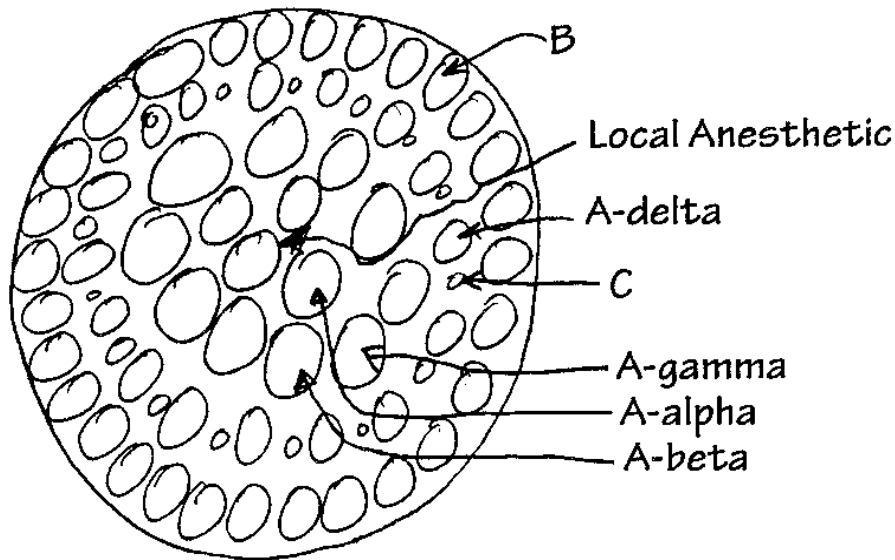
Epidural Anatomy

- Safest point of entry is midline lumbar
- Spread of epidural anesthesia parallels spinal anesthesia
 - Nerve rootlets
 - Nerve roots
 - Spinal cord





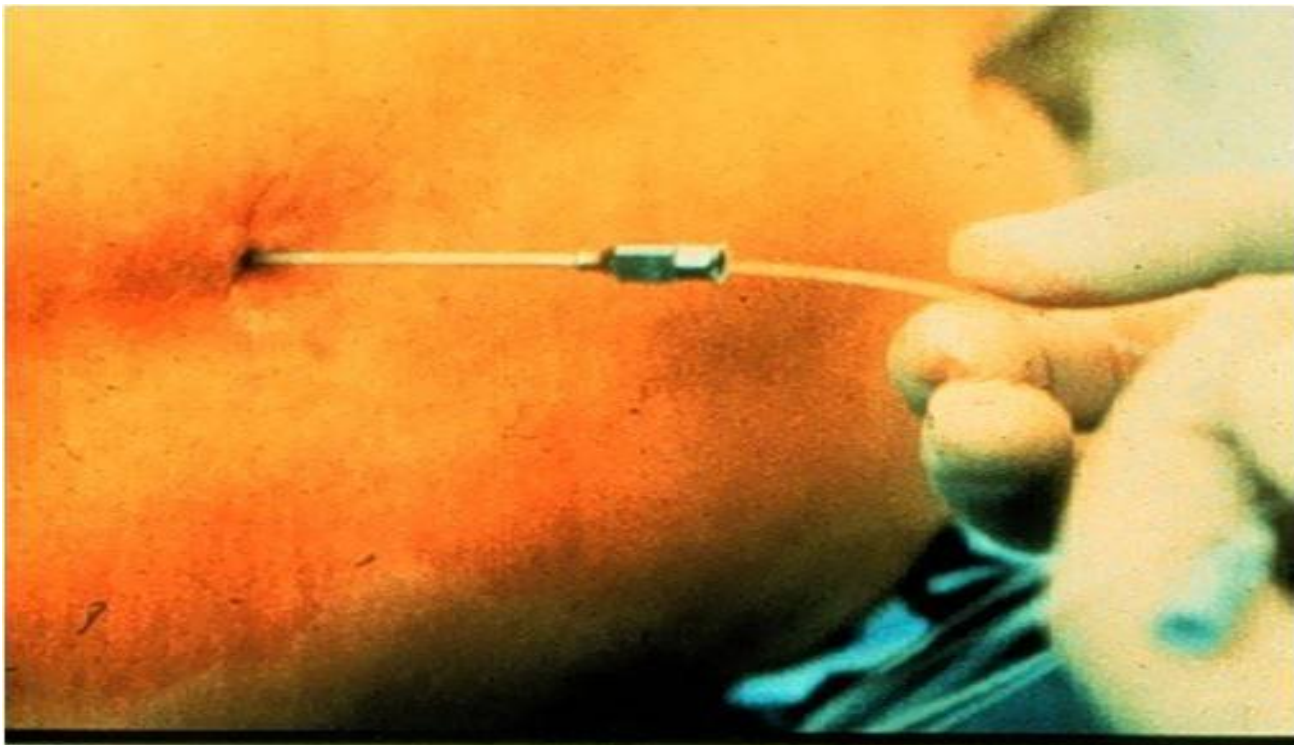
Epidural Anesthesia



- Order of Blockade
 - B fibers
 - C & A delta fibers
 - Pain
 - Temperature
 - Proprioception
 - A gamma fibers
 - A beta fibers
 - A alpha fibers

Epidural Anesthesia

- Test Dose: 1.5% Lido with Epi 1:200,000
 - Tachycardia (increase >30bpm over resting HR)
 - High blood pressure
 - Light headedness
 - Metallic taste in mouth
 - Ring in ears
 - Facial numbness
 - Note: if beta blocked will only see increase in BP not HR
- Bolus Dose: Preferred Local of Choice
 - 10 milliliters for labor pain
 - 20-30 milliliters for C-section

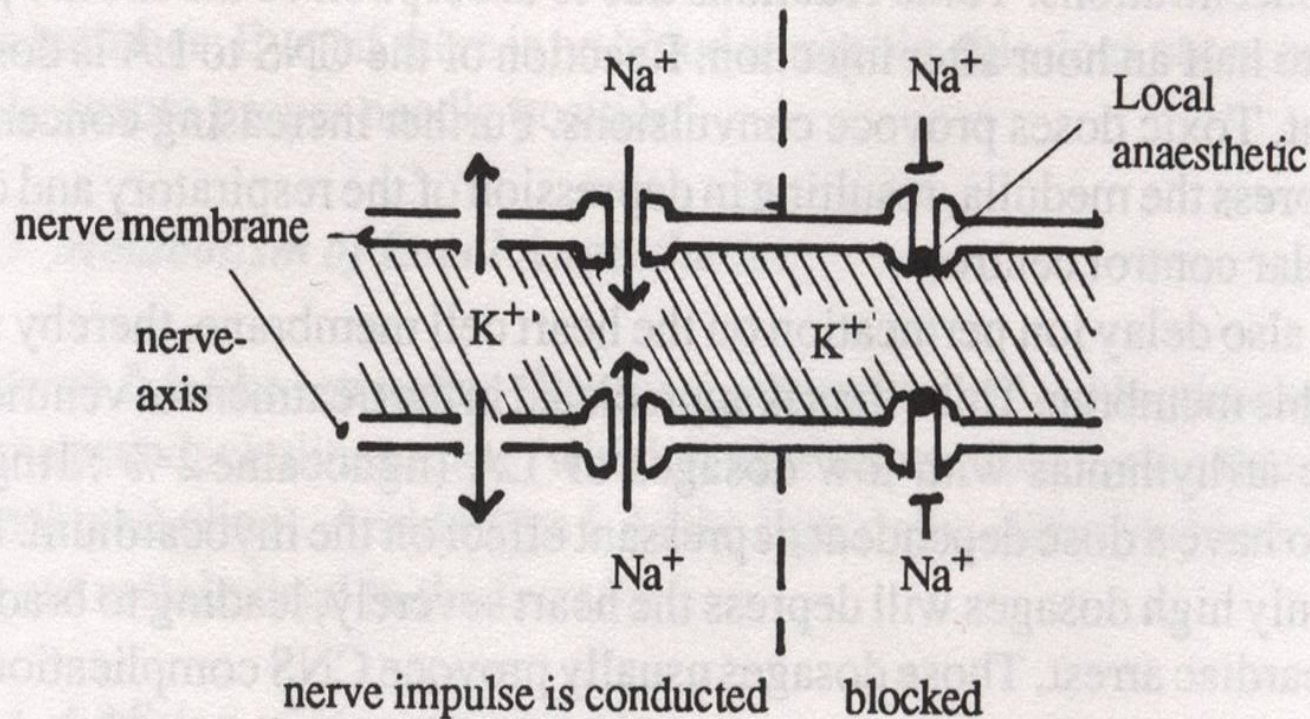






Local Anesthetics - Definition

A substance which reversibly inhibits nerve conduction when applied directly to tissues at non-toxic concentrations



This blocking effect lasts as long as the concentration is high enough. As soon as the concentration decreases, the nerve regains its normal function.

Local anesthetics - Classes (Rule of "i's")

Esters

Cocaine

Chloroprocaine

Procaine

Tetracaine

Am'i'des

Bupivacaine

Lidocaine

Ropivacaine

Etidocaine

Mepivacaine

Characteristics of Local Anesthetics

Potency

The higher the lipid solubility , the higher the potency .

Duration

The greater the protein binding , the longer the duration .

Onset time

the closer the P_{ka} of LA to tissue pH , the more rapid the onset time .

Common LA for Epidural Anesthesia

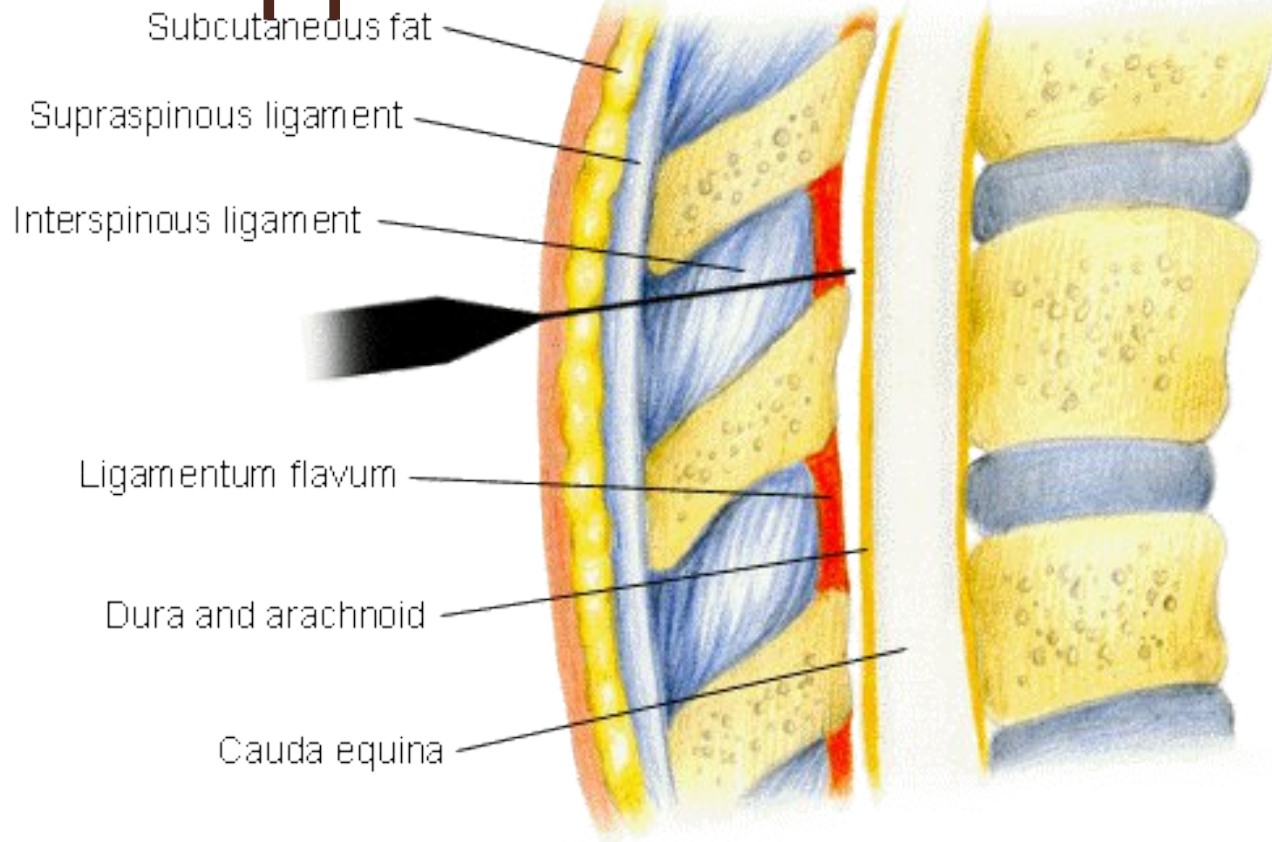
- Bupivacaine:
0.125-0.25% for analgesia
0.5% for anesthesia
- Ropivacaine:
0.2% for analgesia
0.5-1% for anesthesia
- Lidocaine:
2% for anesthesia

%

Epidural Anesthesia

- Distances from Skin to Epidural Space
 - Average adult: 4-6cm
 - Obese adult: up to 8cm
 - Thin adult: 3cm
- Assessment of Sensory Blockade
 - Alcohol swab
 - Most sensitive initial indicator to assess loss of temperature
 - Pin prick
 - Most accurate assessment of overall sensory block

Epidural Approach



Epidural Anesthesia Kit



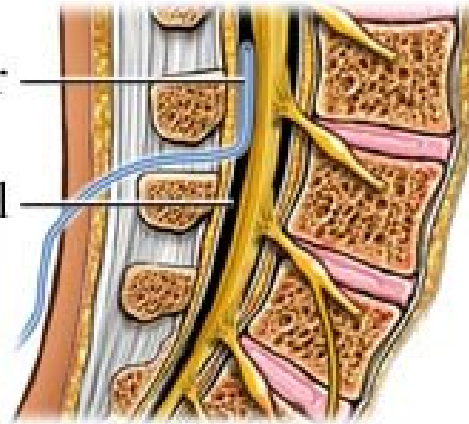
Loss of resistance technique

Epidural Catheter Placement

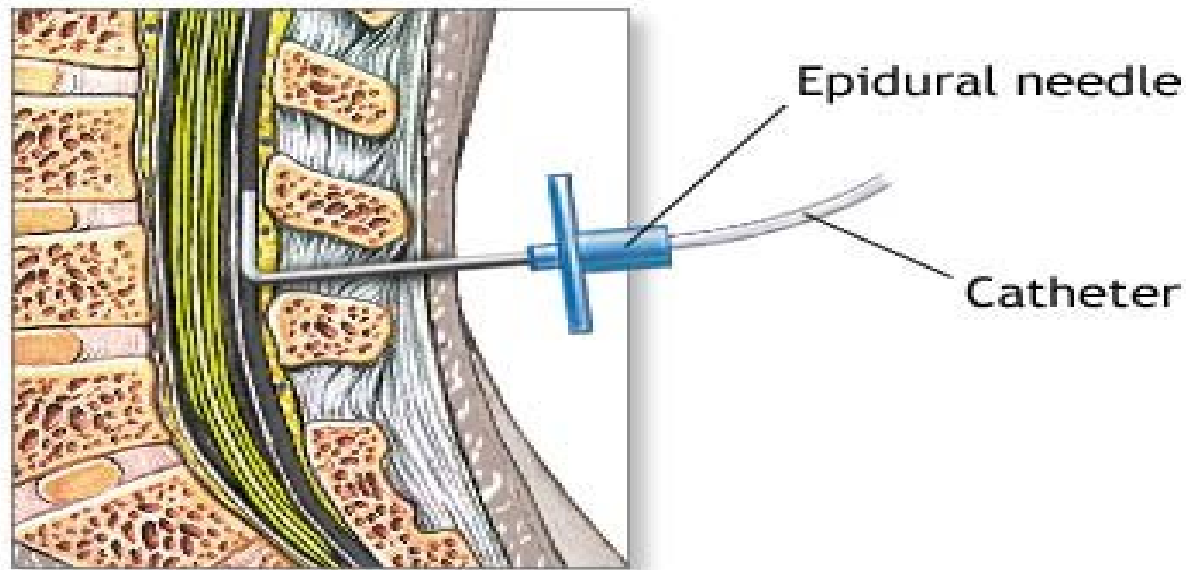


Catheter

Epidural
space



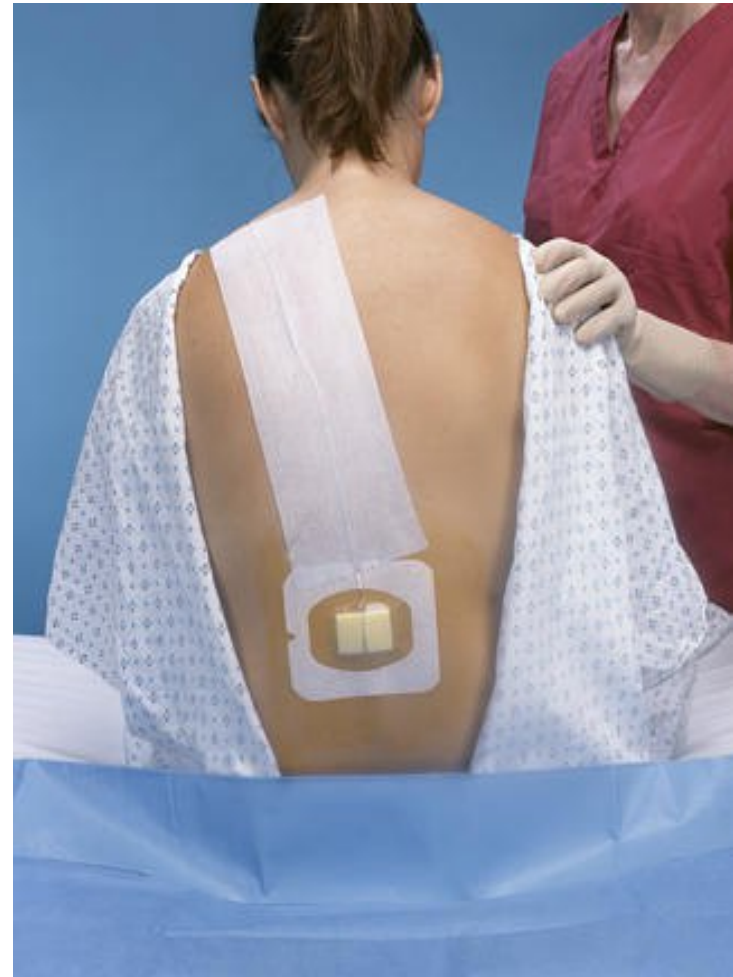
Epidural Catheter Placement



Epidural Catheter placement



Epidural Catheter Placement



Epidural Anesthesia

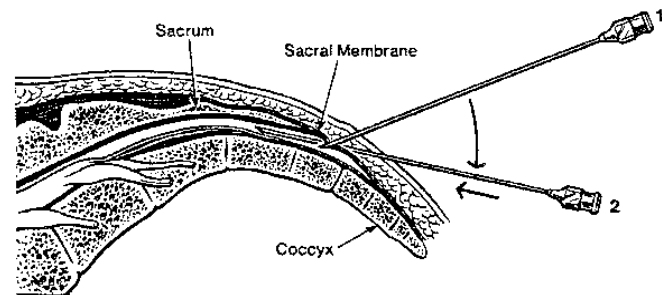
- Complications
 - Penetration of a blood vessel
 - Hypotension (nausea & vomiting)
 - Headache
 - Back pain
 - Intravascular catheterization
 - Wet tap
 - Infection

Blood Patch

- Increase pressure of CSF by placing blood in epidural space
- If more than one puncture site use lowest site due to rostral spread
- May do no more than two
- 95% success with first patch
- Second patch may be done 24 hours after first

Caudal Anesthesia

- Anatomy
 - Sacrum
 - Triangular bone
 - 5 fused sacral vertebrae
- Needle Insertion
 - Sacrococcygeal membrane
 - No subcutaneous bulge or crepitous at site of injection after 2-3ml

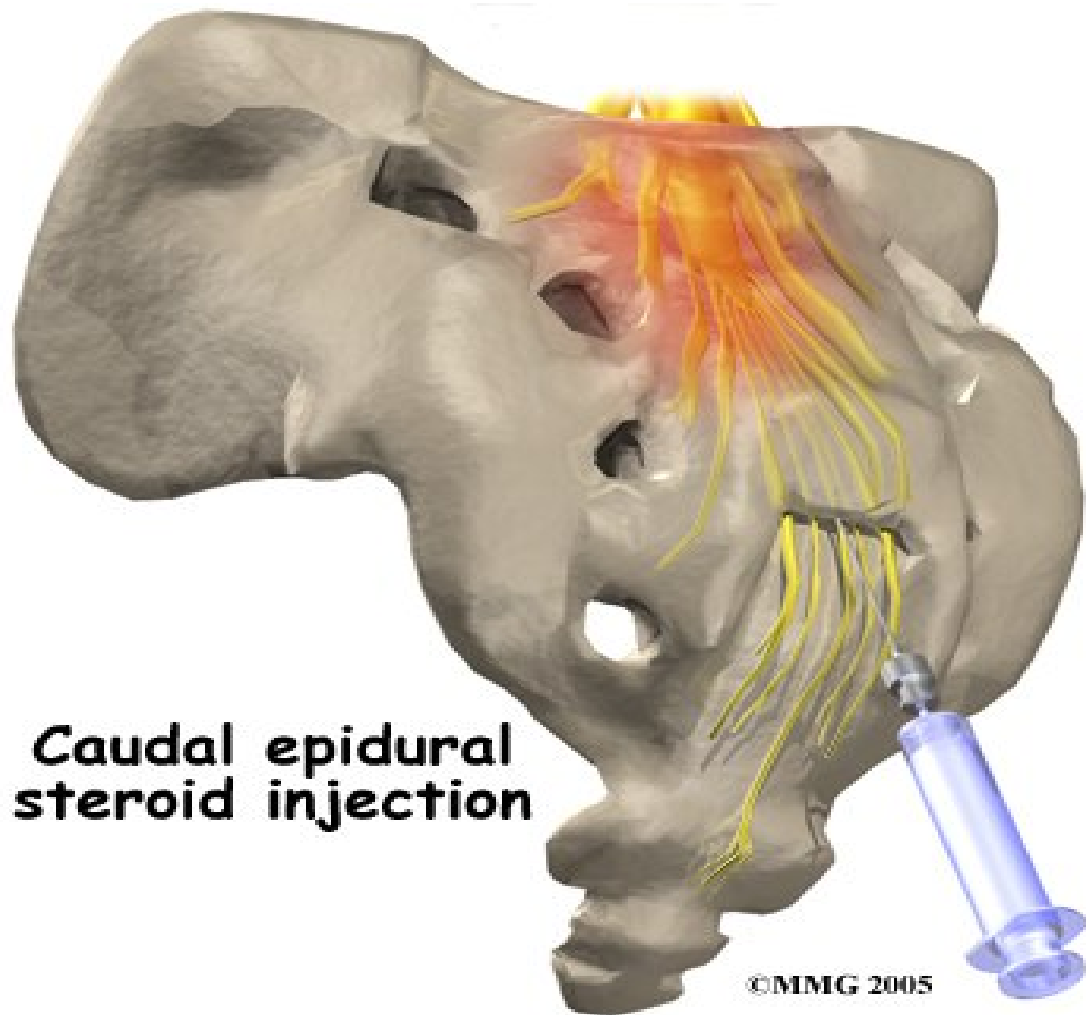


Caudal Epidural Block

Caudal Anesthesia

- Post Operative Problems
 - Pain at injection site is most common
 - Slight risk of neurological complications
 - Risk of infection
- Dosages
 - S5-L2: 15-20ml

Caudal Technique



Caudal Anesthesia



Fig 1

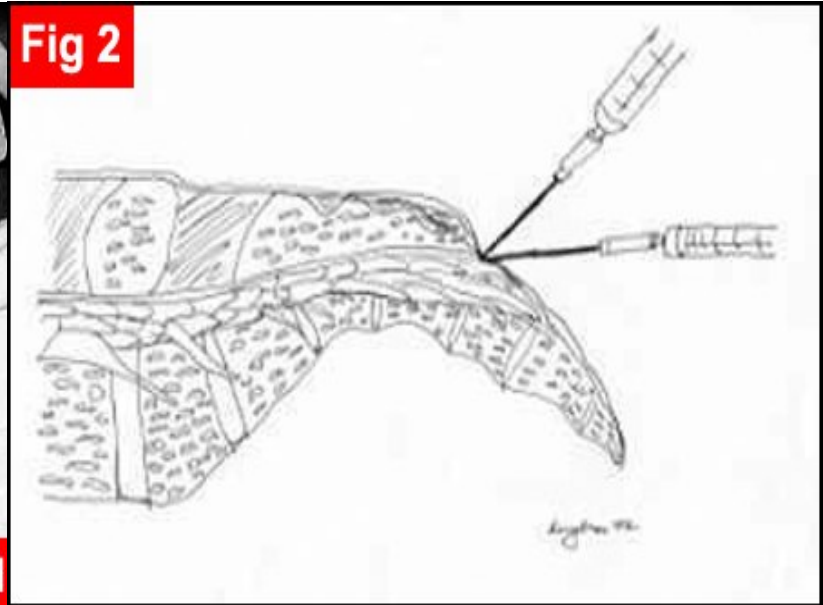


Fig 2



Fig 4



Questions

Local Anesthetics

- Objectives

- Classify each local as an ester or amide
- State the mechanism of action for local anesthetics
- State the metabolism for esters & amides
- Identify ranking of absorption by arterial flow for give anatomic regions
- Discuss how lipid solubility and vasoconstriction affect the potency and duration of locals
- Discuss the etiology of an allergic reaction to local anesthetics
- Understand how pKa effects speed of onset of locals

Local Anesthetics

- Speed of Onset
 - Based on pKa
 - Lower pKa equals more un-ionized at pH 7.4
 - Un-ionized drug penetrates lipid bilayer of nerve
 - More un-ionized form of local equals faster penetration, which equals quicker onset of action
- Local anesthetics + NaHCO₃ (High pH) = more un-ionized

Local Anesthetics

Agent	pK _a	% Un-ionized at pH = 7.4	Relative Onset Time
Procaine	8.9	3	Slow
Tetracaine	8.6	14	Slow
Bupivacaine	8.1	17	Moderate
Ropivacaine	8.1	—	—
Chloroprocaine	9.1	2	Fast*
Lidocaine	7.7	24	Fast
Etidocaine	7.7	33	Fast
Mepivacaine	7.6	39	Fast

Local Anesthetics

- Esters

- Procaine
- Chloroprocaine
- Tetracaine
- Cocaine

- Metabolism

- Hydrolysis by pseudo-cholinesterase enzyme

- Amides

- Lidocaine
- Mepivacaine
- Bupivacaine
- Etidocaine
- Prilocaine
- Ropivacaine

- Metabolism

- Liver

Local Anesthetics

- Toxicity & Allergies
 - Esters: Increase risk for allergic reaction due to para-aminobenzoic acid produced through ester-hydralysis
 - Amides: Greater risk of plasma toxicity due to slower metabolism in liver

Local Anesthetics

AGENT	RELATIVE CLINICAL POTENCY	OIL:WATER PARTITION COEFFICIENT
Chloroprocaine	1	1
Mepivacaine	2	1
Lidocaine	2	4.0
Tetracaine	8	80
Bupivacaine	8	30
Ropivacaine	—	<<30*
Etidocaine	6	140

- Potency
 - The greater the oil/water partition coefficient the greater the lipid solubility
 - The more lipid soluble the greater the potency

Local Anesthetics

- Duration of Action
 - The degree of protein binding is the most important factor
 - Lipid solubility is the second leading determining factor
 - Greater protein bound + increase lipid solubility = longer duration of action

Characteristics of Local Anesthetic Agents

Agent	Lipid Solubility	Protein Binding	Anesthetic Duration
Procaine	1	5	Short
Chloroprocaine	1	7	Short
Lidocaine	4	65	Moderate
Mepivacaine	1	75	Moderate
Tetracaine	80	85	Long
Etidocaine	140	95	Long
Bupivacaine	30	95	Long
Ropivacaine	<< 30*	94	Long

*The oil:water partition coefficient for ropivacaine is considerably less than that for bupivacaine.

Local Anesthetics

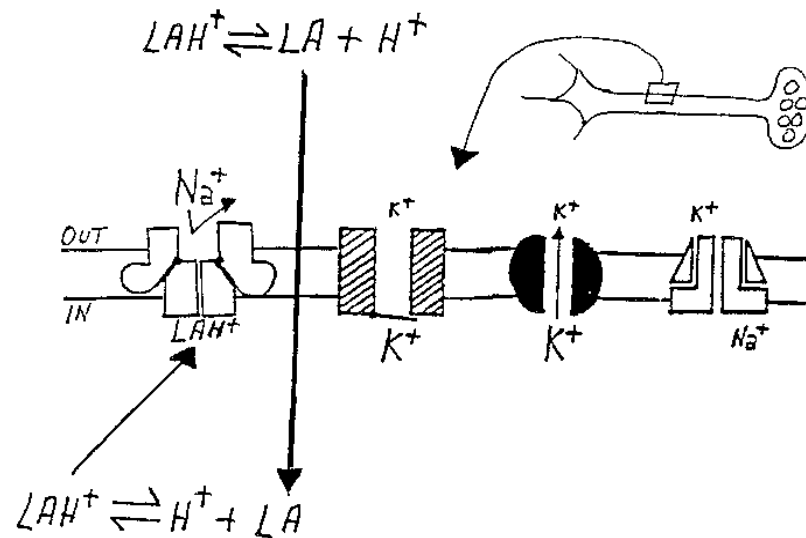
- Determinants of Blood Concentrations
- Loss of local anesthetic is primarily through vascular absorption
 - Vasoconstrictors decrease the rate of absorption & increase duration of action
 - Ranking rate of absorption by arterial blood flow
 - Highest to lowest
 - Tracheal
 - Intercostal muscles
 - Caudal
 - Paracervical
 - Epidural
 - Brachial plexus
 - Subarachnoid
 - Subcutaneous

Local Anesthetics & Baricity

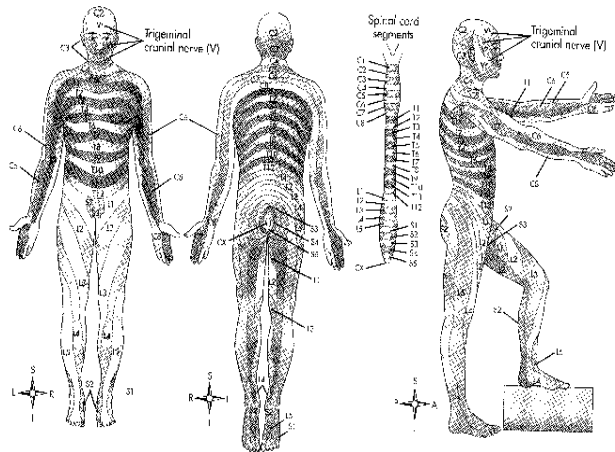
- Hyperbaric
 - Typically prepared by mixing local with dextrose
 - Flow is to most dependent area due to gravity
- Hypobaric
 - Prepared by mixing local with sterile water
 - Flow is to highest part of CSF column
- Isobaric
 - Neutral flow that can be manipulated by positioning
 - Very predictable spread
 - Increased dose has more effect on duration than dermatomal spread
- Note: Be cognizant of high & low regions of spinal column

Mechanism of Action

- Un-ionized local anesthetic diffuses into nerve axon & the ionized form binds the receptors of the Na channel in the inactivated state



Dermatomes of the Body



Dermatome distribution of spinal nerves.

- Key Dermatomes & Levels
 - C1-C2: Oops...
 - C3,4,5: Keep the diaphragm alive...
 - T1-T4: Cardioaccelerator
 - T4: Nipple line
 - T6: Xyphoid process
 - T10: Umbilicus
 - S2,3,4: Keep the penis off the floor...

Sensory vs. Motor Blockade

- Spinal Injection
 - Sympathetic block is 2-6 dermatomes higher than sensory block
 - Motor block is 2 dermatomes lower than sensory block

Metabolism & Toxicity

- Metabolism
 - Ester locals are metabolized by plasma psuedocholinesterase
 - Amide locals are metabolized by the liver
- Toxicity
 - Determined by blood concentration of local anesthetics

Manifestation of Lidocaine Toxicity

Plasma Concentration of Lidocaine	Order of Toxic Manifestations for <i>any</i> Local Anesthetic
3 $\mu\text{g/ml}$	Circumoral and tongue numbness
4 $\mu\text{g/ml}$	Lightheadedness and tinnitus
6 $\mu\text{g/ml}$	Visual disturbances
8 $\mu\text{g/ml}$	Muscular twitching
10 $\mu\text{g/ml}$	Unconsciousness
12 $\mu\text{g/ml}$	Convulsions
15 $\mu\text{g/ml}$	Coma
20 $\mu\text{g/ml}$	Respiratory arrest
26 $\mu\text{g/ml}$	Cardiovascular collapse