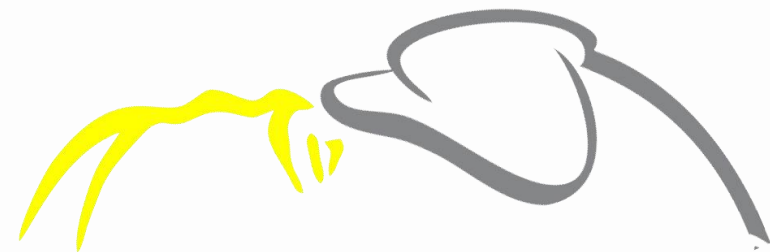


Neuraxial Blockade



433

ANAESTHESIA



Objectives:

- Relevant anatomy and surface landmark for Neuraxial block.
- Differences between spinal and epidural.
- Equipment and local anesthetics.
- Indication and contraindication.
- Side effects, complications and treatment.
- LAST

Vertebral column surrounds the spinal cord and is formed by:

- 7 cervical vertebrae (lordosis).
- 12 thoracic vertebrae (kyphosis).
- 5 lumbar vertebrae (lordosis)
- 5 fused Sacrum (kyphosis).
- 4 fused Coccyx.

Note: in anesthesia the patient should flex their back during the procedure why?

to convert lordosis into kyphosis giving a wider interlaminar space for needle insertion especially in pregnancy.

A. Vertebral joints:

1. intervertebral disks
2. 2 superior and 2 inferior articular processes.

B. vertebra bony parts:

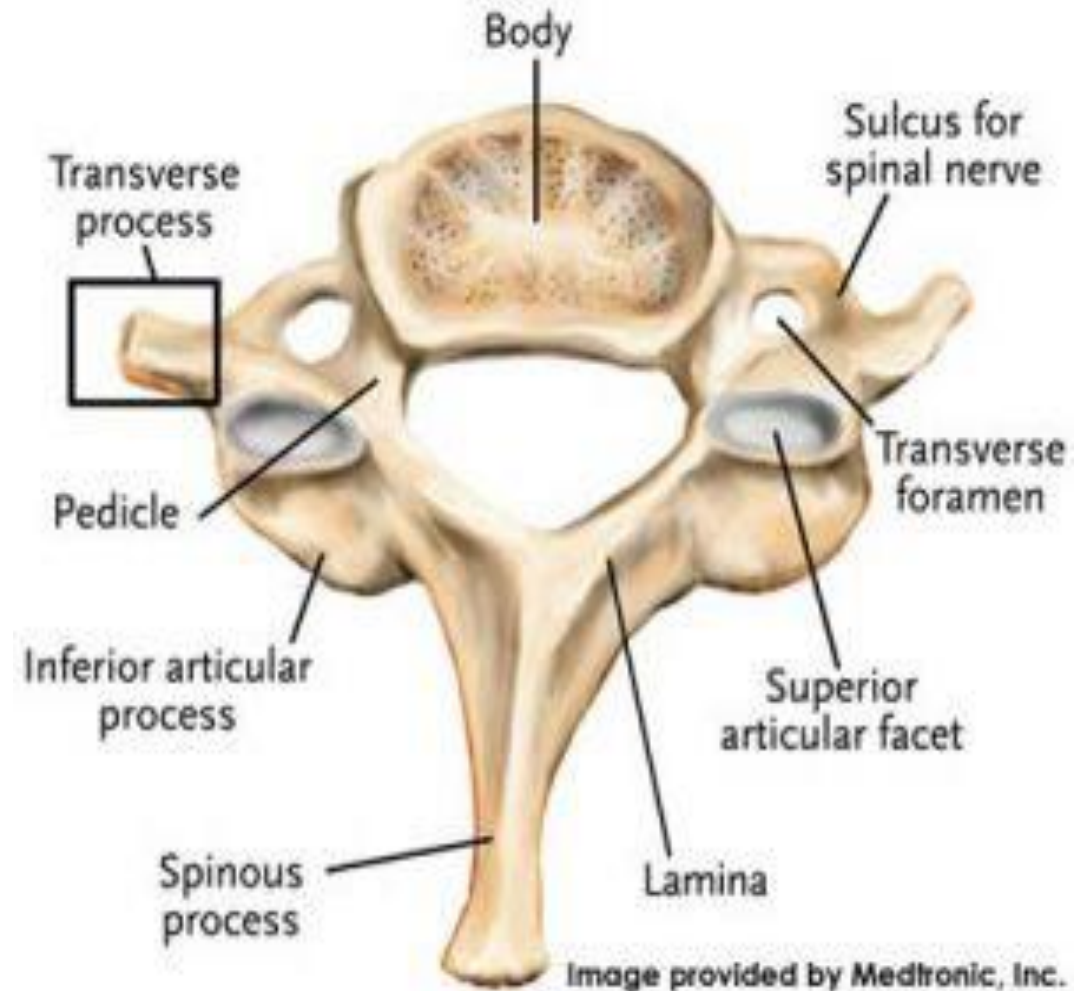
1. a pedicle: connects between transverse process and vertebral body. contain a notch superiorly and inferiorly for the spinal nerve root to exit.
2. lamina: connects transverse processes with spinous processes.
3. transverse process.
4. superior and inferior articular processes.
5. spinous process. gives you hint about midline.
6. vertebral body.

Note :




Angle of transverse process will affect how the needle is orientated for epidural anesthesia or analgesia.

With flexion the spinous process in the lumbar region is almost horizontal. In the thoracic region the spinous process is angled in a slight caudal angle.

Interlaminar spaces are larger in the lower lumbar region especially between L5 and S1 (the largest). If an anesthesia provider finds it challenging (like spinal stenosis) at one level it is important to remember that moving down one space may provide a larger space. But notice the first option is L4- L5 in usual cases.



This is only for your knowledge to see differences in each level.
The important staff in red box

CHARACTERISTIC	CERVICAL	THORACIC	LUMBAR
Overall structure			
Size	Small.	Larger.	Largest.
Foramina	One vertebral and two transverse.	One vertebral.	One vertebral.
Spinous processes	Slender, often bifid (C2–C6).	Long, fairly thick (most project inferiorly).	Short, blunt (project posteriorly rather than inferiorly).
Transverse processes	Small.	Fairly large.	Large and blunt.
Articular facets for ribs	Absent.	Present.	Absent.
Direction of articular facets			
Superior	Posterosuperior.	Posterolateral.	Medial.
Inferior	Anteroinferior.	Anteromedial.	Lateral.
Size of intervertebral discs	Thick relative to size of vertebral bodies.	Thin relative to size of vertebral bodies.	Thickest.

C. Ligaments that support the vertebral column:

A. Dorsal ligaments:

- 1- Ligamentum nuchae: above C7 give continuity to Supraspinous ligament.
- 2- **Supraspinous ligament***: continuous ligament starts from C7 and down to L5.
- 3- **interspinous ligament***: interrupted ligament connects spinous processes above and below.
- 4- **ligamentum flavum***: interrupted ligament stops sacral hiatus **before S5**.

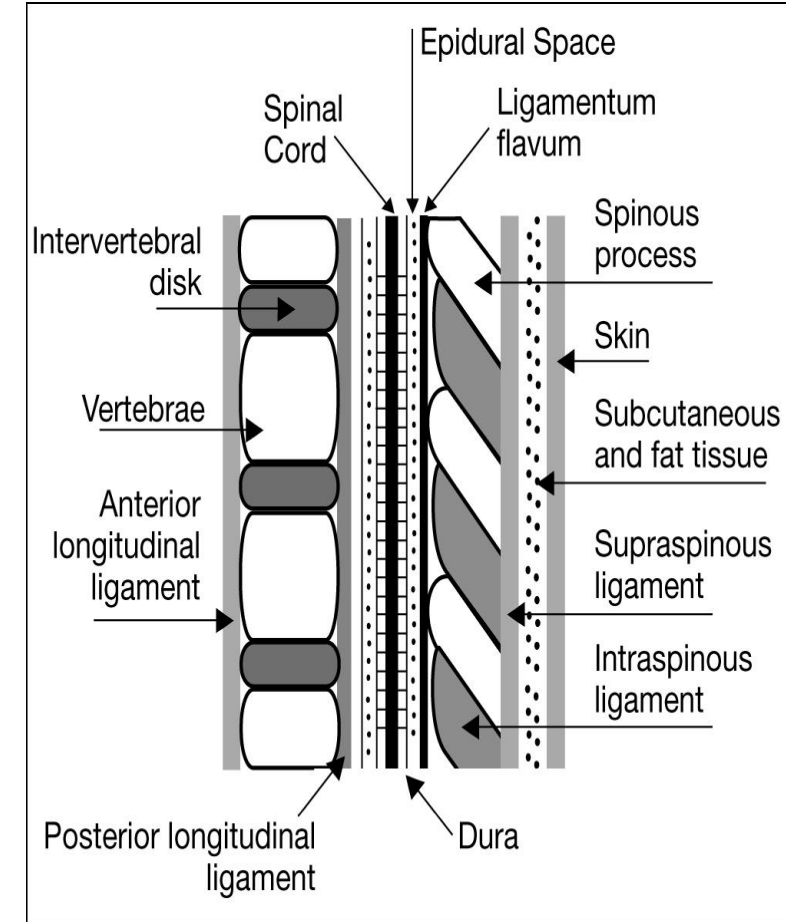
Note: Ligamentum flavum not penetrated in caudal anesthesia.

***Important since these are the structures your needle will pass through!**

B. Ventral ligaments:

- 1- Anterior longitudinal ligaments.
- 2- posterior longitudinal ligaments.

Give support to vertebrae. When disc herniation happen, it goes laterally.



Membranes that surround the spinal cord

- a) **Pia mater**: highly vascular, covers the spinal cord and brain, attaches to the periosteum of the coccyx (Filum terminalis).
- b) **Arachnoid mater**: non vascular and attached to the dura mater (no potential space).
- c) **Dura mater** (“tough mother”): extension of the cranial dura mater, extends from the **foramen magnum to S2**.

The Subarachnoid Space is a continuous space that contains:

A.CSF:

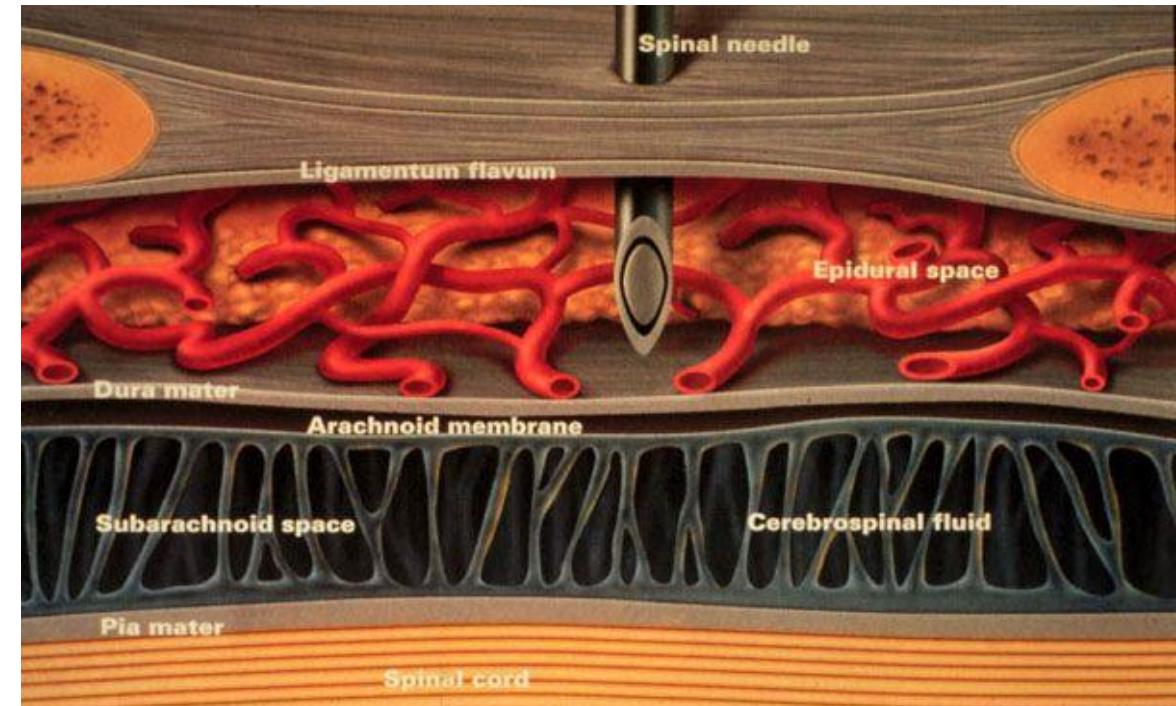
- Clear fluid that fills the subarachnoid space
- Total volume is ~**100-150 ml (2 ml/kg)** (75 for brain, 75 for spinal cord) but volume in the subarachnoid space is ~**35-45 ml**.
- Continually produced at a rate of 450 ml per 24 hour period replacing itself 3-4 times.
- Reabsorbed into the blood stream by **arachnoid villi**.
- **Specific gravity is between 1.003-1.007** (this will play a crucial role in the baricity of local anesthetic that one chooses)
- CSF plays a role the patient to patient variability in relation to block .
- Body wt is the only measurement that coincides with CSF volume(especially in the obese and pregnant).

B.Spinal cord & nerves

- Spinal cord ends at: **L3 in children but at L1-L2 in adults**.
- Spinal nerves exit from intervertebral foramina
- T1-L2 : sympathetic outflow (Thoracolumbar), CN3, CN7, CN9, CN10, S2, S3, S4: parasympathetic outflow (craniosacral).

Epidural Space Anatomy

- Extends from the foramen magnum to the sacral hiatus.
- The epidural space surrounds the dura mater anteriorly, laterally, and **most importantly to us posteriorly.**
- **The Bounds of the Epidural Space are as follows:**
 - Anterior: posterior longitudinal ligament
 - Lateral: pedicles and intervertebral ligaments
 - Posterior: ligamentum flavum
- **Contents of the Epidural Space:**
 1. Fat
 2. Areolar tissue
 3. Lymphatics
 4. Blood vessels including **the Batson venous plexus. Valveless gives you negative pressure**



Neuroaxial anesthesia includes:

- 1- spinal anesthesia (SA)
- 2- epidural anesthesia (EA)
- 3- combined spinal and epidural . Most commonly used
- 4- caudal block.

“**Baricity**”: the density (like specific gravity) of a drug compared to CSF density.

- **Hyperbaric** descends in the intrathecal space. So used for spinal.
 - Typically prepared by **mixing local with dextrose**.
 - Flow is to most dependent area due to **gravity**.
 - Very predictable spread.
- **Hypobaric** Used in epidural anesthesia. If you use it in spinal it will go to brain directly with no barrier
 - Prepared by mixing local with sterile water.
 - Flow is to highest part of CSF column.
- **Isobaric**
 - Neutral flow that can be manipulated **by positioning**.
 - Increased dose has **more effect on duration** than dermatomal spread.
- **Note:**
 - **a concern only in spinal anesthesia?** Because if you give hypobaric it will go to the brain.
 - Recognized of high & low regions of spinal column
 - **Preservative free in drugs** to not cause CNS toxicity.



A.Epidural anesthesia:

1- **catheter technique**. Epidural catheter has series of special markings to guide the anesthetist on the length inserted into epidural space. > 2 dashes = 10 cm / 3 dashes = 15 cm / 4 dashes = 20cm.

The catheter should be advanced 3-5 cm in addition to skin to epidural space distance. For example skin to epidural space = 5 cm, catheter should be inserted = 8-10 cm.

2- used **Isobaric** bupivacaine (20 ml).

3- **Slow onset (30 min)**

4- **less dense block**.

5- the needle that is used called "**Touhy needle**" its tip is facing up with 8 cm length , it has wings that used to oriented your needle precisely.

6- we have to do **loss of resistance technique**. To get some space,using saline or air .

7- preferred to use in vaginal delivery anesthesia.

8- give urinary catheter due to block of sympathetic and activated of parasympathetic cause urination.



Epidural Test dose To avoid systemic local anesthetic toxicity

- After checking the catheter
- **Careful aspiration, NO blood or CSF > no danger.**
- 3 ml lidocaine 1.5% + epinephrine 15 micrograms = 5 micrograms epinephrine / 1 ml lidocaine. **check mointor if there is a tachycardia the cath is intravascular.**
- With careful monitoring, give the epidural injection 15-20 ml bupivacaine in allequete.
- After 2-3min tell the patient to move his legs> if he can that means it is not spinal because faster effects.

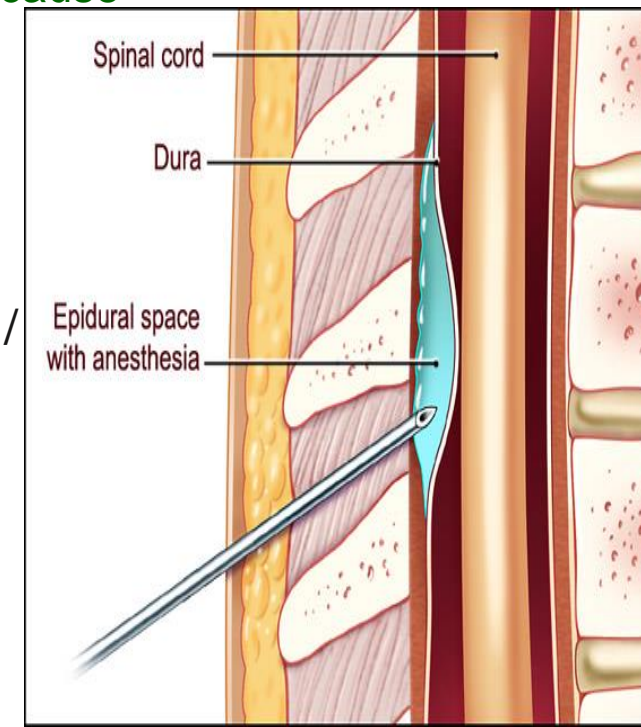


Table 3: Types of neurons blocked with local anesthetics

Neuron type	Function	Myelination	Order of Blockade	Signs of Blockade
A alpha	Motor -skeletal muscle	Myelinated	Fifth *	Loss of motor function
A beta	Sensory – touch, pressure	Myelinated	Fourth	Loss of sensation to touch and pressure
A gamma	Motor - muscle spindles proprioception	Myelinated	Third	Loss of proprioception
A delta	Fast pain temperature	Myelinated	Second	Pain relief, loss of temperature sensation
B	Autonomic, Pre-ganglionic sympathetic	Myelinated	First	Increased skin temperature
C	Slow pain, autonomic, postganglionic sympathetic, polymodal nociceptors	Unmyelinated	Second	Pain relief, loss of temperature sensation

* Last one get blocked and first one get back.

B. Spinal anesthesia :

Definition:

- 1- **single hyperbaric*** Injection of **small amounts (2-3 ml)** of local anaesthetics into the CSF.
- 2- at the level **below (L2)** ,where the spinal cord ends.
- 3- anesthesia of the lower body part below the umbilicus is achieved.

Spinal anasethsia is faster and heavier due to the drug is dealing with nerves directly with no barrier (necked)

MCQ: the hyperbaric Bupivacaine used for : Local block, spinal block, epidural block

- Spinal needles types :

- Quincke needle is the first needle used. But now it is not used due to large diameter and sharp edge that leads to Post-dural-puncture headache (PDPH)
- **Pencil point needle** first three in pic is the best because it has blunt end, small diameter 27G and the orifice is not at the tip, and it separates dura not puncture it .

Post-dural-puncture headache (PDPH)

This complication does not occur in epidural anesthesia because the dura should not be penetrated, unless it is mistakenly punctured!

- Develop **12-48 hours** after spinal anesthesia. Mostly occurs in young female or pregnant.
- **Critical symptoms:**
 1. Headache improve when lying supine.
 2. Increase when standing up.
 3. Hx of puncture.

Treatment:

- Conservative. Paracetamol, caffeine, abdominal binders and bed rest.
- Epidural blood patch. is a surgical procedure that uses autologous blood in order to close one or many holes in the dura mater of the spinal cord,

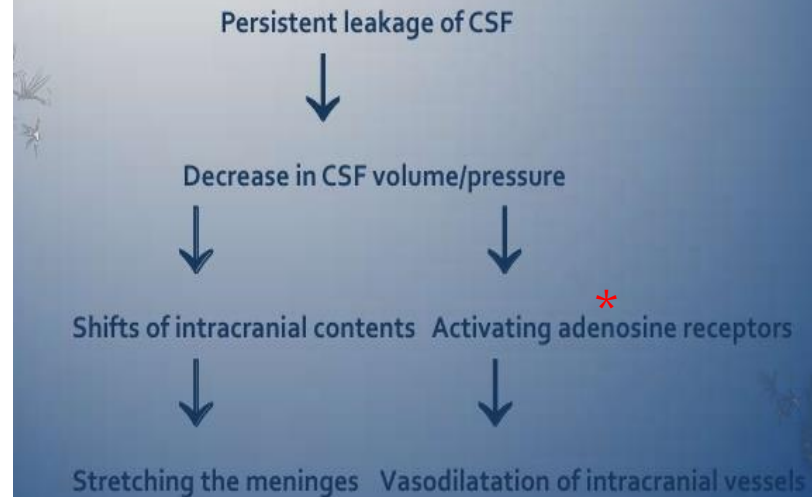
Differential Diagnosis

- Meningitis
- Sinusitis
- Migraine
- Pregnancy related hypertension
- Intracranial Pathology (sol)
- Dural Venous thrombosis,
- Pneumocephalus,
- Spontaneous intracranial hypotension.

*Monro-Kellie doctrine:

The pressure-volume relationship between ICP, volume of CSF, blood, and brain tissue, and cerebral perfusion pressure (CPP). If any changes in one volume it will change the others to get the balance. So if CSF volume becomes low that means(the brain cannot increase its volume) the intervascular volume increases and causes vasodilation which gives the pain.

Mechanisms of PDPH



Sympathetic, Sensory & Motor Blockade

- Spinal Injection from previous table of nerve types you can figure out
 - Sympathetic block is 2 dermatomes higher than sensory block
 - Motor block is 2 dermatomes lower than sensory block
 - Detect the sensory level by cold sensation test(Ice cubes).

MCQs: 56 y.o male got spinal block. In sensory level examination it shown T10:

What is the level of sympathetic block? T8

What is the level of motor block? T12

■ Factors effecting of spinal level anesthesia:

■ Most important factors:

1. Baricity of anesthetic solution (relative to CSF)
2. Patient positioning (during and immediately after injection)
3. Drug dosage
4. Site of injection.

■ Other factors:

1. Age: elderly patients tend to have decreased CSF volume and are prone to higher blocks
2. CSF: volume correlates inversely with level of anesthesia (i.e., increased intraabdominal pressure or conditions that cause engorgement of epidural veins (pregnancy, ascites, large abdominal tumors) decrease CSF volume and are associated with higher blocks)

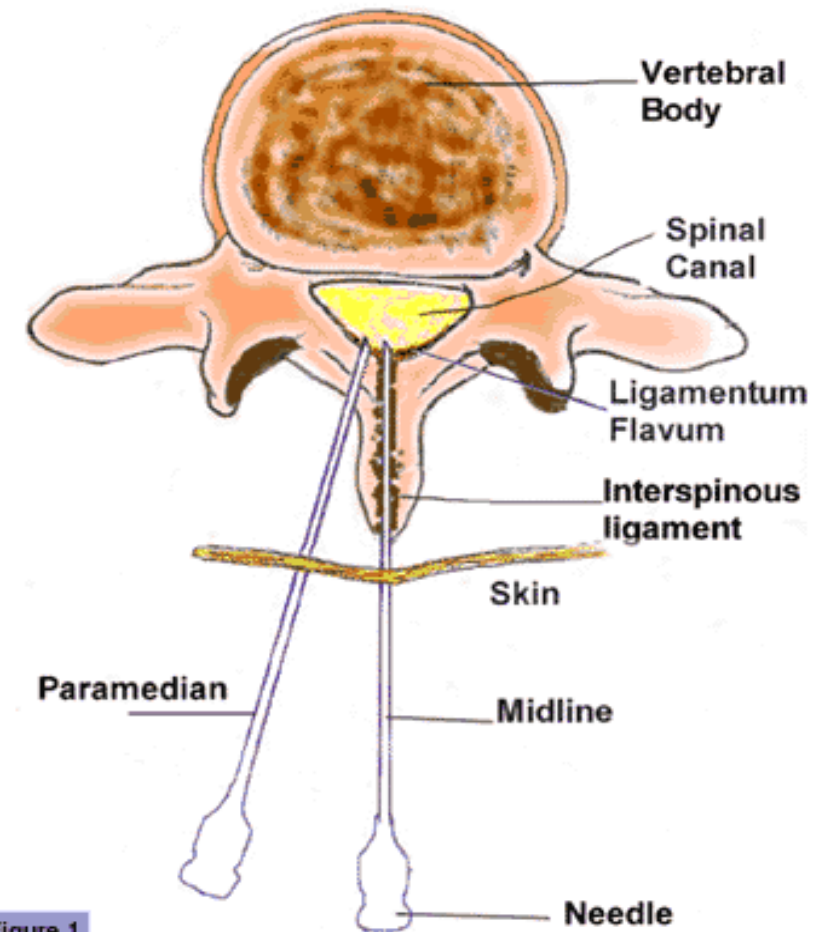


Figure 1

Spinal needle placement (midline and paramedian)

■ Factors effecting of spinal level anesthesia:

Other factors:

3. Curvature of spine
4. Drug volume
5. Intraabdominal pressure: (see CSF section)
6. Needle direction: higher levels are achieved if injection directed cephalad
7. Patient height: taller patients require more drug to achieve a given level
8. Pregnancy: (see CSF section), Progesterone increases local anesthetic sensitivity too. also decreased dosage requirements for term parturient

Sympathetic, Sensory & Motor Blockade

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

Spinal Anesthesia

■ Indications

Any operations below the umbilicus and surgery duration 2-3 hrs:

- 1- C/S (most commonly because it is fast and heavier).
- 2- hernia repairs
- 3- gynaecological, urological operation.
- 4- orthopedics.
- 5- any operation on the perineum or genitalia

■ Contraindications same for epidural

- Absolute:

1. Refusal
2. Infection seen in immobilized patients who develop bed sores
3. Coagulopathy & anticoagulated patient aspirin use is not a contraindication for spinal anesthesia according to guidelines.
4. Severe hypovolemia. Because the drug cause hypotension and that will worsen the situation.
5. Increased intracranial pressure. To not cause brain herniation.
6. Severe aortic or mitral stenosis. Not hemodynamically stable.

- Relative:

- Use your best judgment

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
- Lateral approach used in thoracic epidural anesthesia or when there is ossifications that difficult midline approach.

Note :

- don't forget to sterile and maintaining the sterility.
- **The patient positions can be:**
 1. Sitting (c-shaped position : raising his legs and flexing his back to increase the interlaminar space)
 2. Lateral decubitus

■ **Complications** same for epidural

1. Failed block
2. Back pain (most common)
3. Spinal head ache
 - More common in women ages 13-40
 - Larger needle size increase severity
 - Onset typically occurs first or second day
 - **Treatment:**
 - ✓ Bed rest
 - ✓ Fluids
 - ✓ Caffeine to cause vasoconstriction.
 - ✓ Blood patch
3. Epidural hematoma
4. Epidural abscess
5. Meningitis using unsterile technique or in immunocompromised patients
6. Cauda equina injected into the nerve itself.
7. Neurological deficit
8. TNS transient neurologic symptoms
9. Bradycardia--- Cardiac arrest

• **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 **when the primary failed**
 - Pharmacologic vasopressor
 - ☐ Ephedrine have alpha + beta effects used in bradycardiac pt.
 - ☐ Phenylephrine have only alpha effects used in tachycardiac pt.

D. Local anesthetics:

the first drug discovered was cocaine.

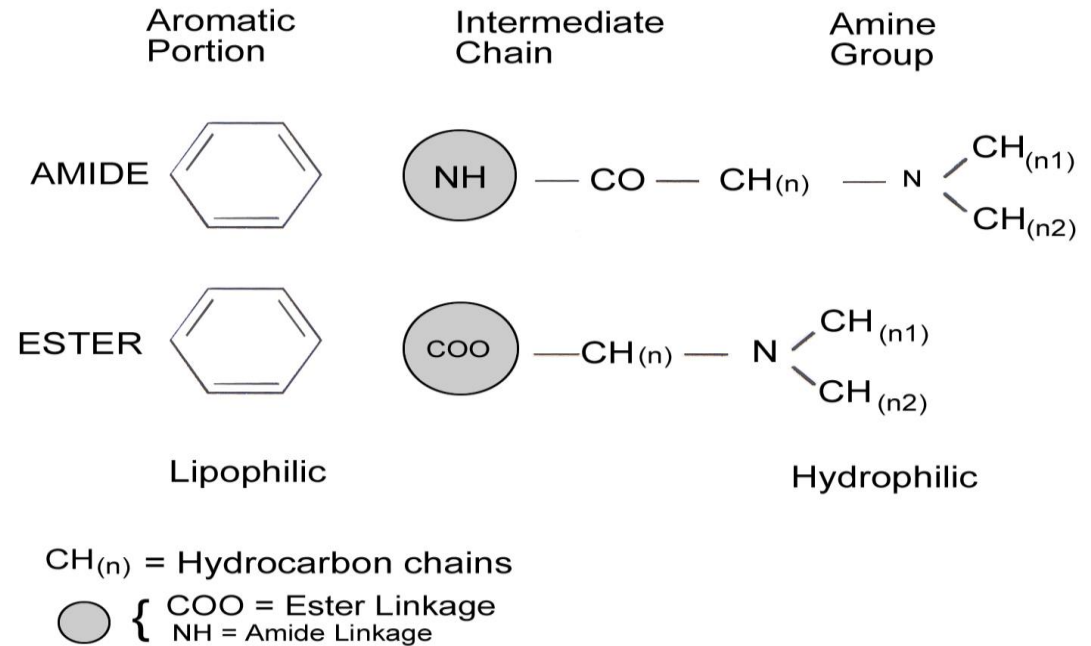
There are two types:

1- amides(more common): remember always the drug names have two i latter. Metabolized by liver.

2- esters: metabolized by acetylcholine esterase not by liver.

TABLE 2. Local anesthetics

AMIDE GROUP	ESTER GROUP
Lidocaine	Cocaine
Mepivacaine	Procaine
Bupivacaine	Chlorprocaine
Etidocaine	Tetracaine
Prilocaine	



2

All local anesthetics consist of an aromatic ring (giving the lipophilic property) + intermediate chain + amine group (giving hydrophilic property).

■ Mechanism of Action:

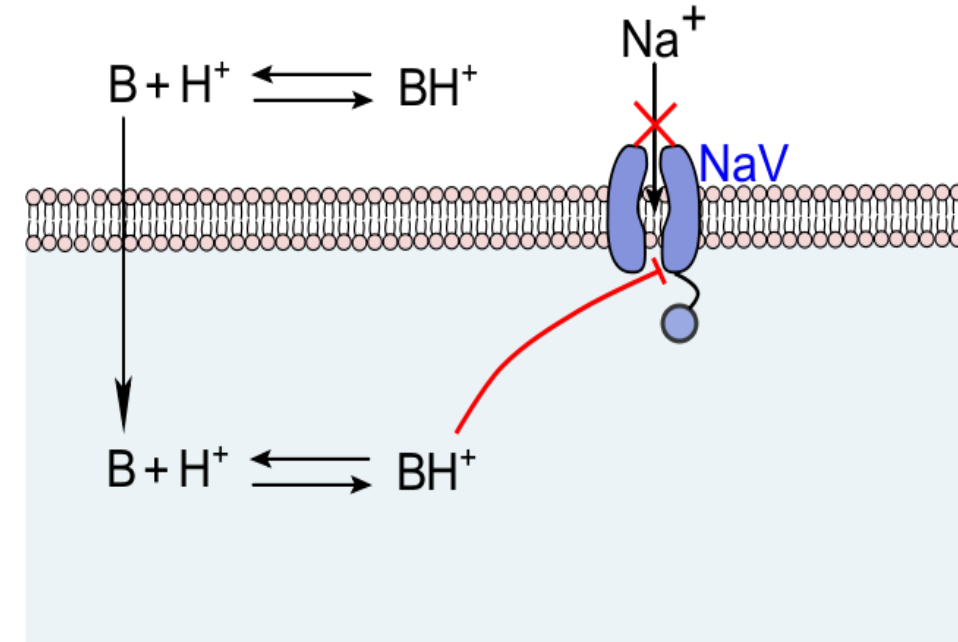
Un-ionized (lipophilic, not depend on PH) local anesthetic diffuses into nerve axon > become ionized > binds the receptors of the Na channel in the inactivated state. **Inhibit the nerve conduction.**

■ Duration of Action:

1. The degree of protein binding is the most important factor
2. Lipid solubility is the second leading determining factor
3. Greater protein bound + increase lipid solubility = longer duration of action

■ 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



LAST

❖ Causes:

- Exceeding the maximum safe dose(Bupivacaine 2mg/kg), Lidocaine (5mg/kg)
- Intravascular injection

❖ Manifestations:

1. CNS

BOX 1 *Manifestations of Systemic Toxicity*

Minor (Associated With Low Plasma Levels)

- Perioral numbness
- Facial tingling
- Restlessness
- Tinnitus
- Metallic taste
- Vertigo
- Slurred speech

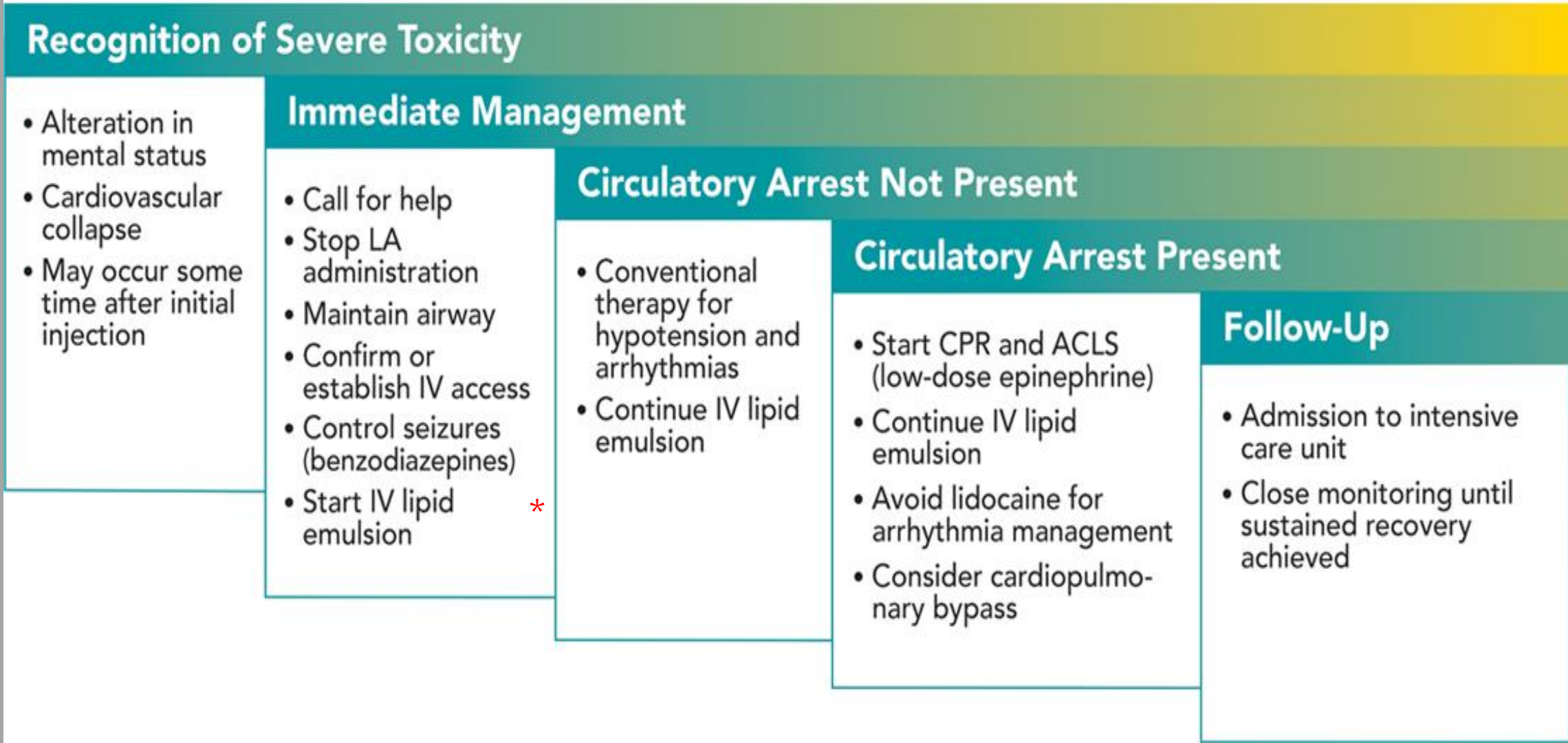
Major (Associated With High Plasma Levels)

- Sudden loss of consciousness
- Tonic-clonic seizures
- Cardiovascular collapse
- Cardiac arrest

Then CVS:

- Tachycardia & Hypertension
- Hypotension
- Wide QRS
- VF
- Cardiac arrest

LAST: Management



* We give lipids to make the blood in lipid phase that makes the blood detached from the active site.

Summary

	Spinal anesthesia	Epidural anesthesia
Vol.	2- 3 ml	20 ml
Degree	Fast and Heavier	Lighter
Onset	2-5min	Up to 30 min
confirmatory	CSF	Loss of resistance
Type of injection	Single	Continuous (cath)
Degree of penetration	Up to arachnoid	Up to Ligamentum flavum
Barcity	Hyperbaric	Isobaric
Duration	2-3hrs	Longer
Test dose	Not required	Required
Needle	Pencil point	Tuohy

Done and
Reviewed
by:

Maha Saeed Alzeheary

Leader

Yasmine Alshehri

Color reference:

Black-slids

Green-Notes

Blue-Book

Red-important

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