NEURAXIAL BLOKADE

Dr: Ahmed Thallaj

Associate Professor, college of medicine, KSU

Head of regional Anesthesia division

Director, KSU Regional Anesthesia Fellowship Program

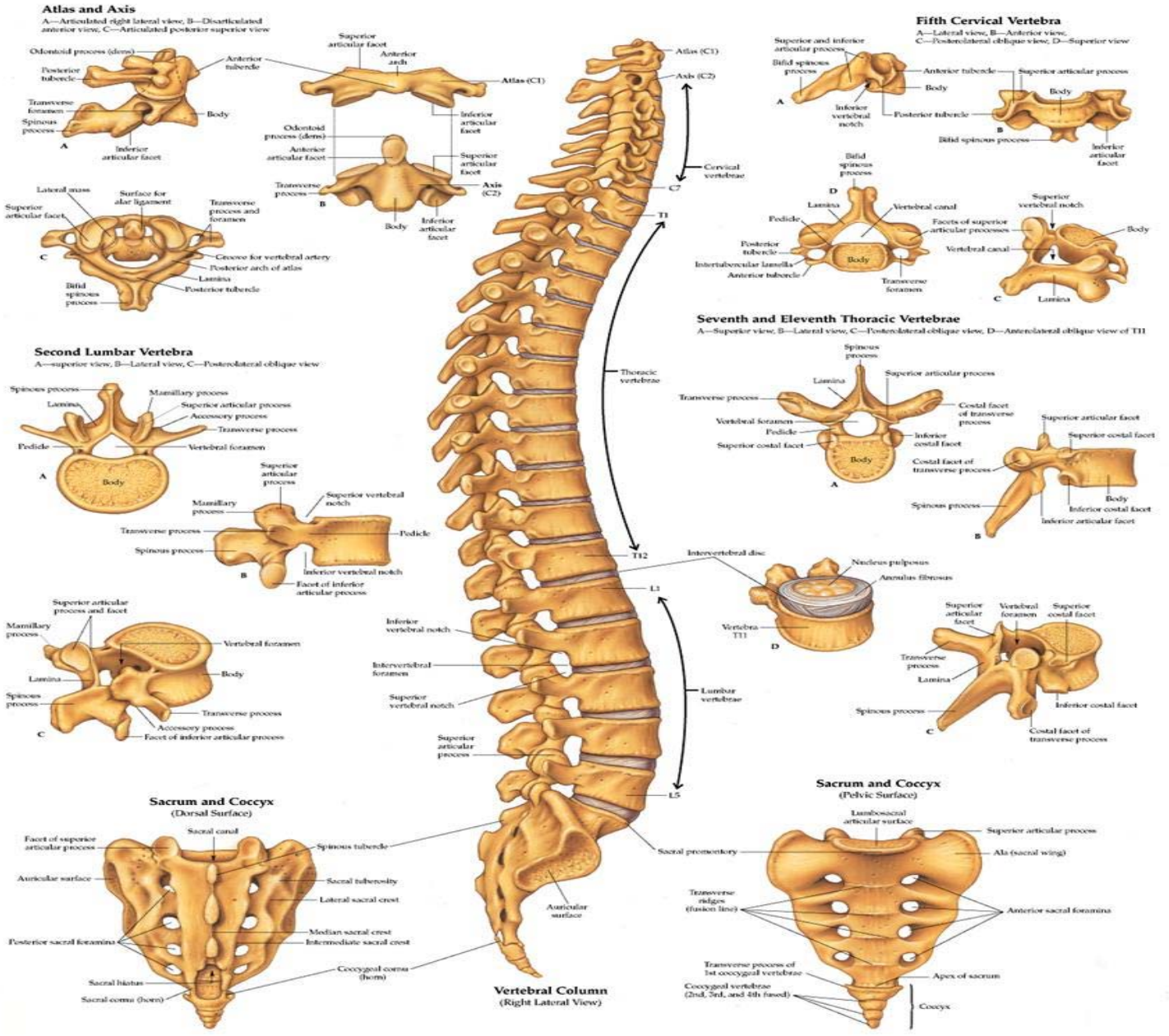
Objectives

- 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

Knowledge of anatomy for neuraxial blockade is essential!

- 7 cervical vertebrae
- 12 thoracic vertebrae
- 5 lumbar vertebrae
- Sacrum
- Coccyx

THE VERTEBRAL COLUMN



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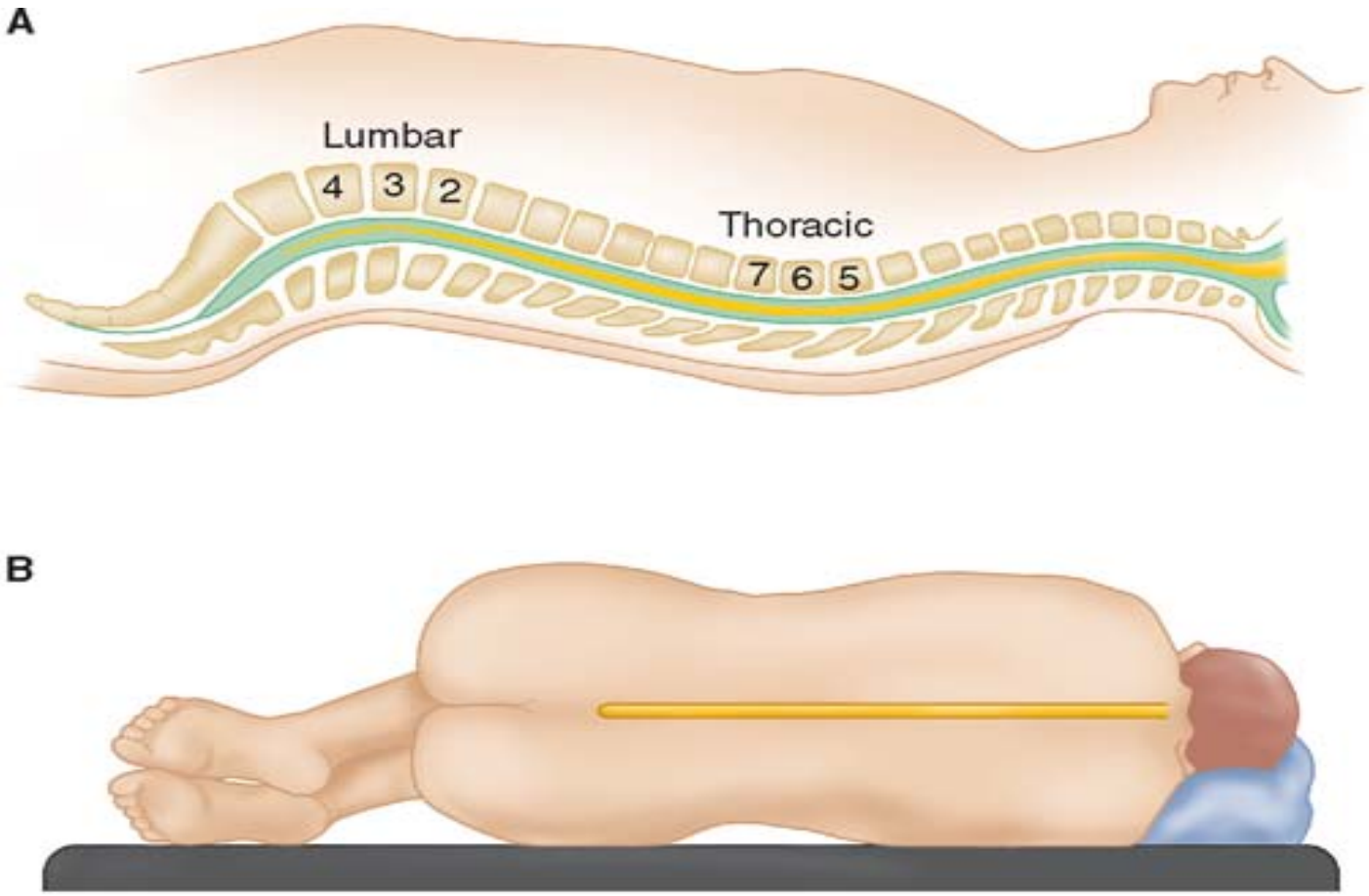


Source: Butterworth JF, Mackey DC, Wasnick JD: *Morgan & Mikhail's Clinical Anesthesiology*, 5th Edition: www.accessmedicine.com

Individual Vertebral Anatomy

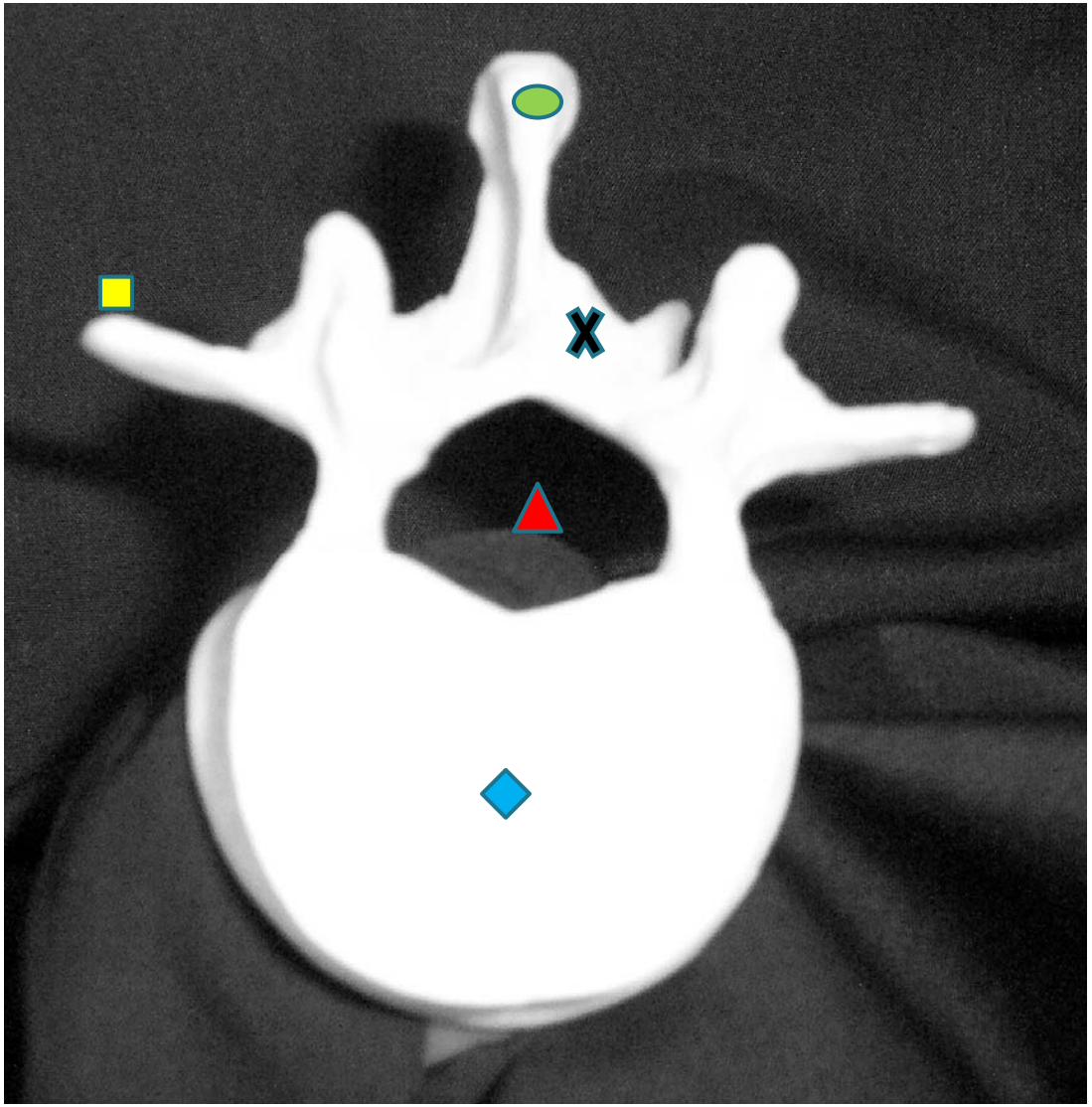
- Each vertebra consists of a pedicle, transverse process, superior and inferior articular processes, and a spinous process.
- Each vertebra is connected to the next by intervertebral disks.
- There are 2 superior and inferior articular processes (synovial joints) on each vertebra that allows for articulation.
- Pedicles contain a notch superiorly and inferiorly to allow the spinal nerve root to exit the vertebral column.

Vertebral Anatomy- Top View

Transverse Process

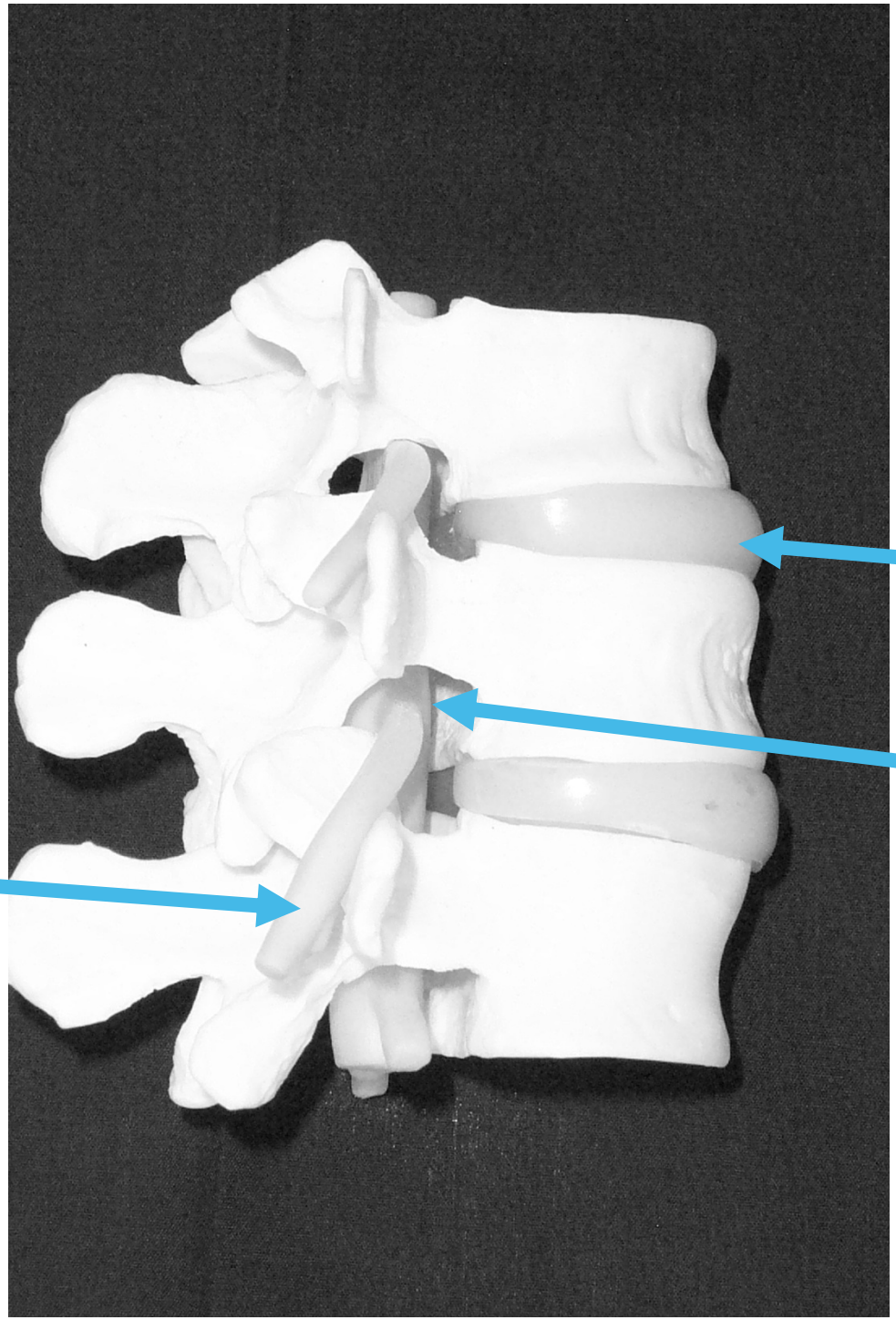
Spinal Canal

Vertebral Body

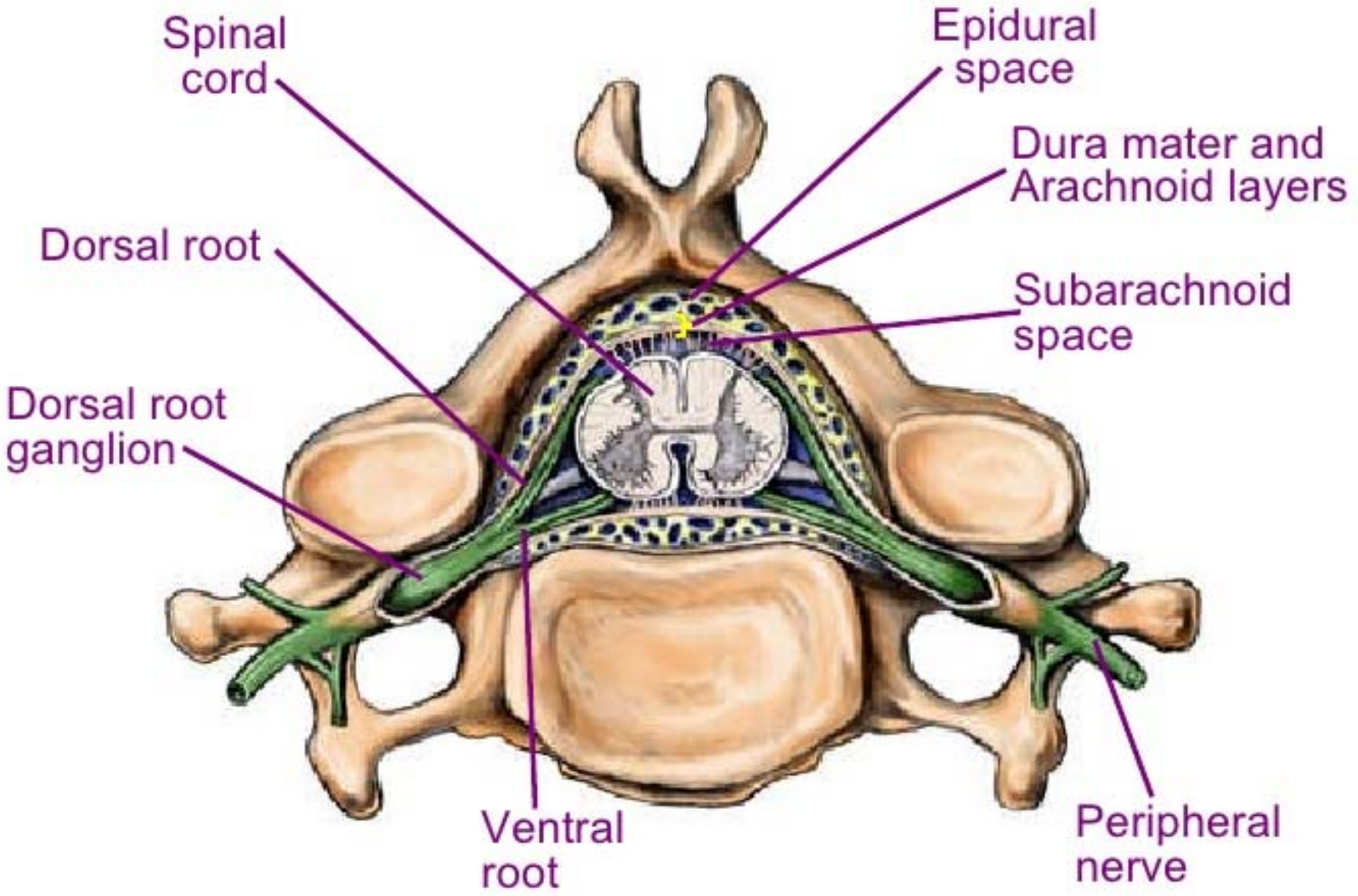


Spinous Process

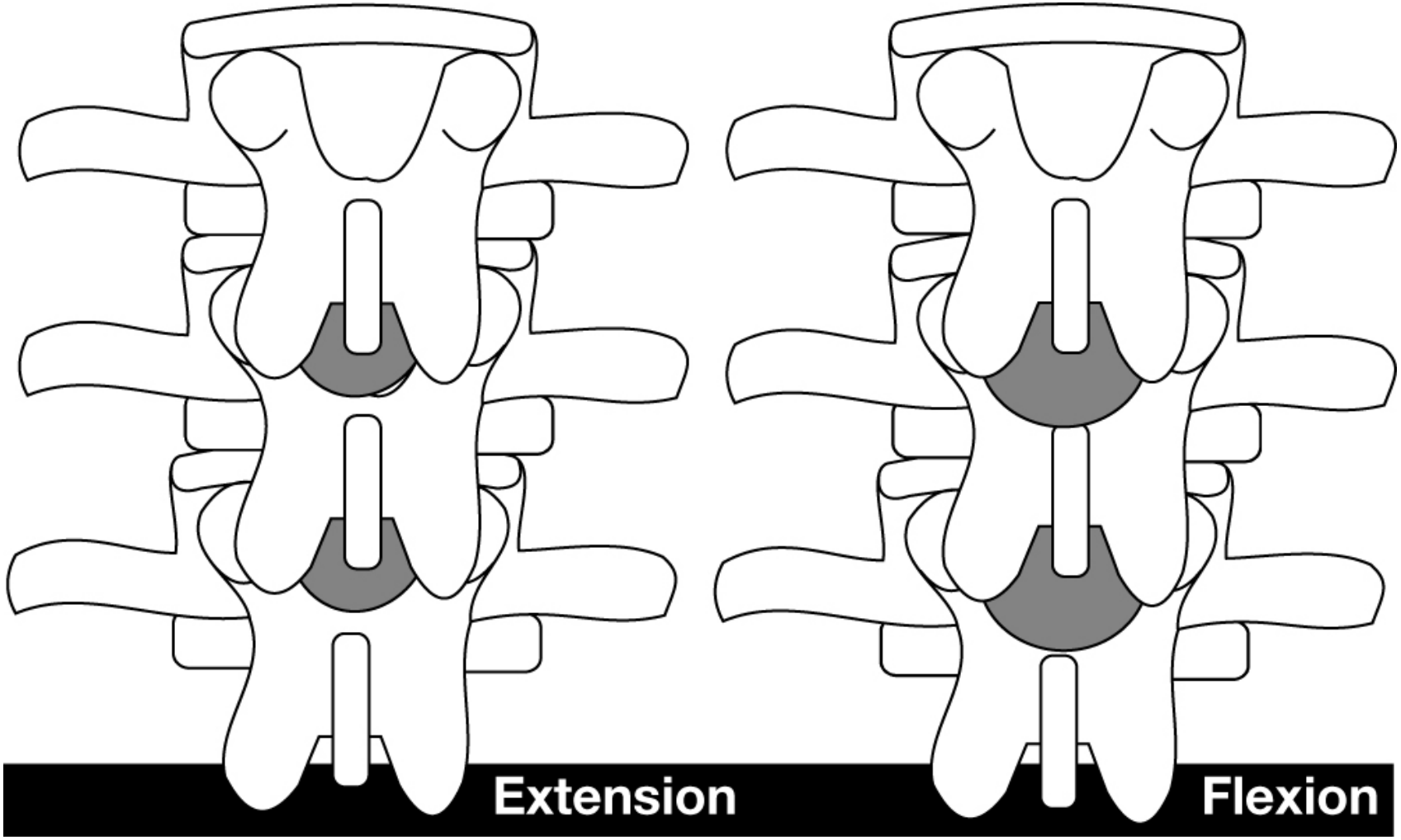
Lamina

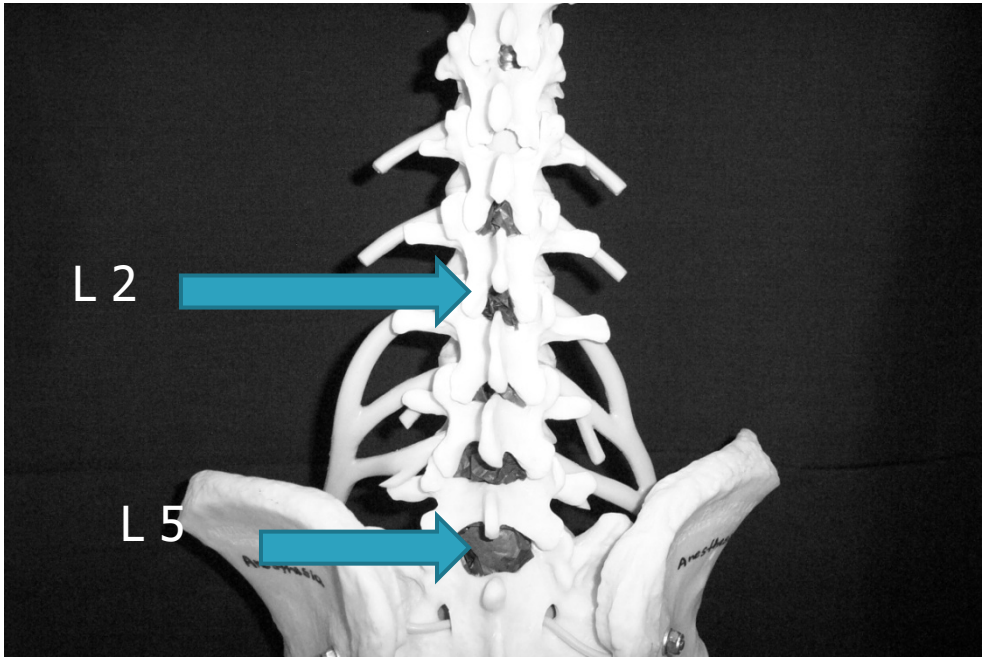

Intervertebral Disc
Intervertebral Foramina
Spinal Nerve Root

Spinal Nerves

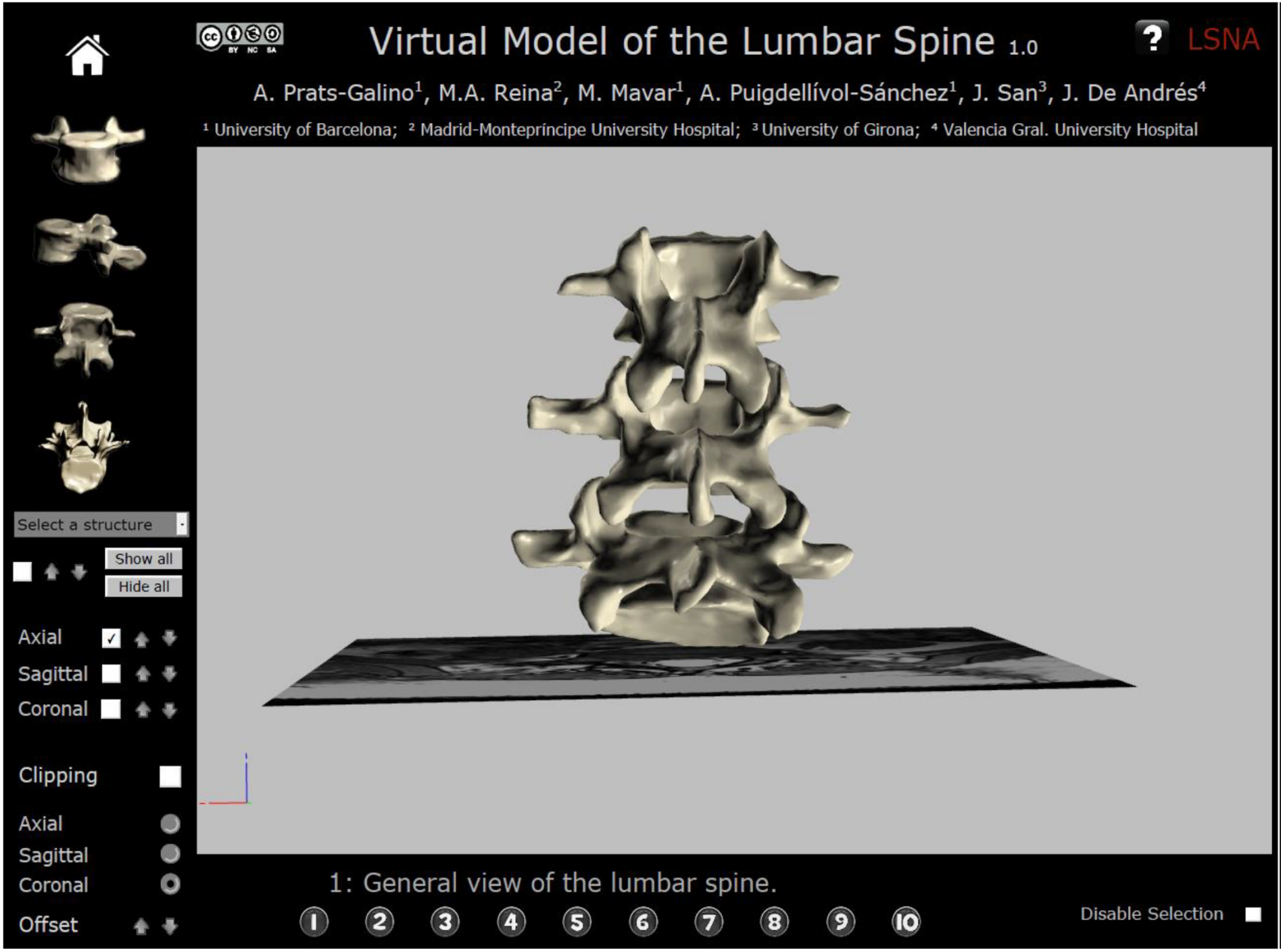


Lumbar Extension versus Flexion





Interlaminar spaces are larger in the lower lumbar region. If an anesthesia provider finds it challenging at one level it is important to remember that moving down one space may provide a larger space.


Virtual Model of the Lumbar Spine 1.0
LSNA
A. Prats-Galino[1], M.A. Reina[2], M. Mavar[1], A. Puigdellívol-Sánchez[1], J. San[3], J. De Andrés[4]
[1] University of Barcelona; [2] Madrid-Montepríncipe University Hospital; [3] University of Girona; [4] Valencia Gral. University Hospital
Select a structure
Show all
Hide all
Axial
Sagittal
Coronal
Clipping
Axial
Sagittal
Coronal
Offset
1: General view of the lumbar spine.
1 2 3 4 5 6 7 8 9 10
Disable Selection

Virtual Model of the Lumbar Spine 1.0

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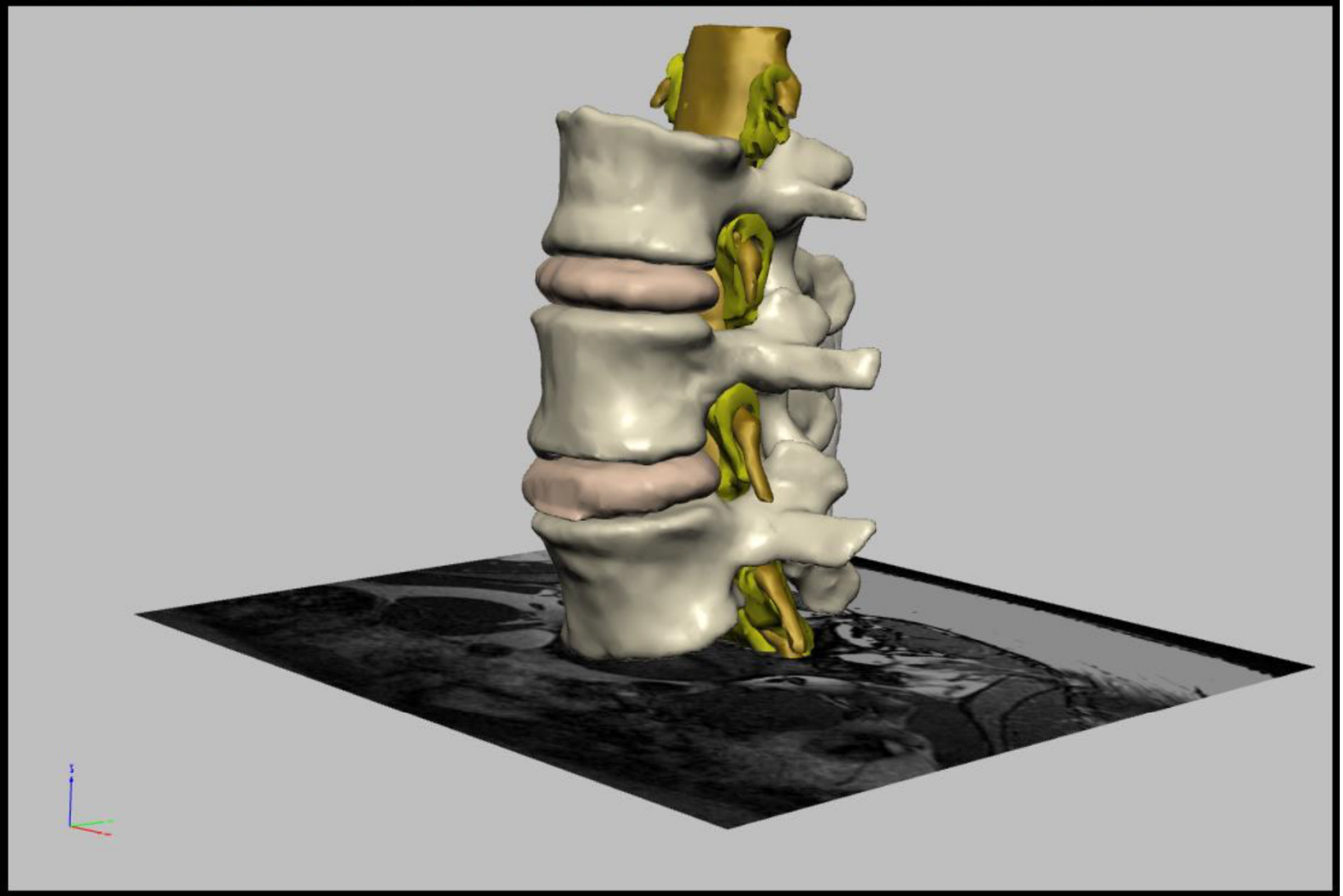


Select a structure

Show all

Hide all

Axial

Sagittal

Coronal

Clipping

Axial

Sagittal

Coronal

Offset

1: General view of the lumbar spine.

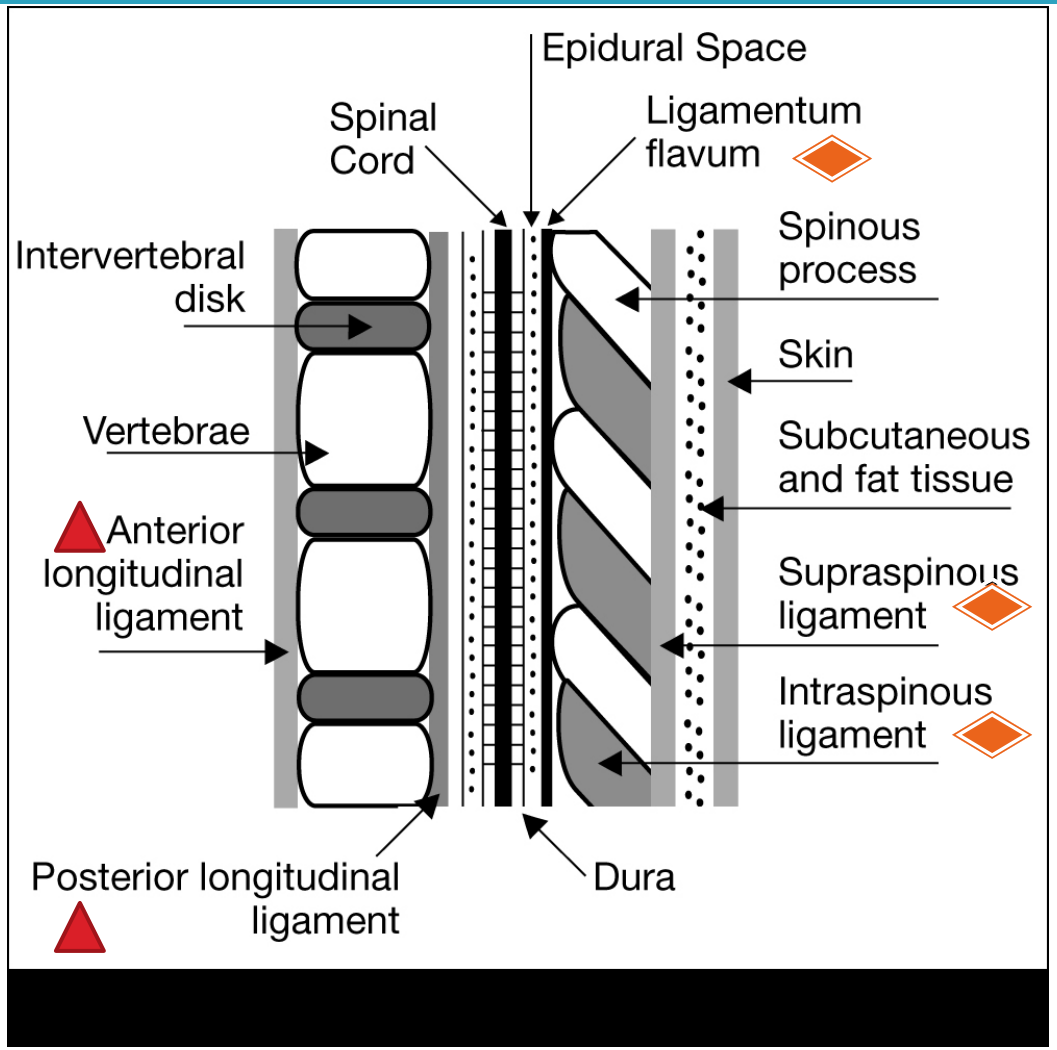
1 2 3 4 5 6 7 8 9 10

Disable Selection

Ligaments that support the vertebral column

Ventral side:

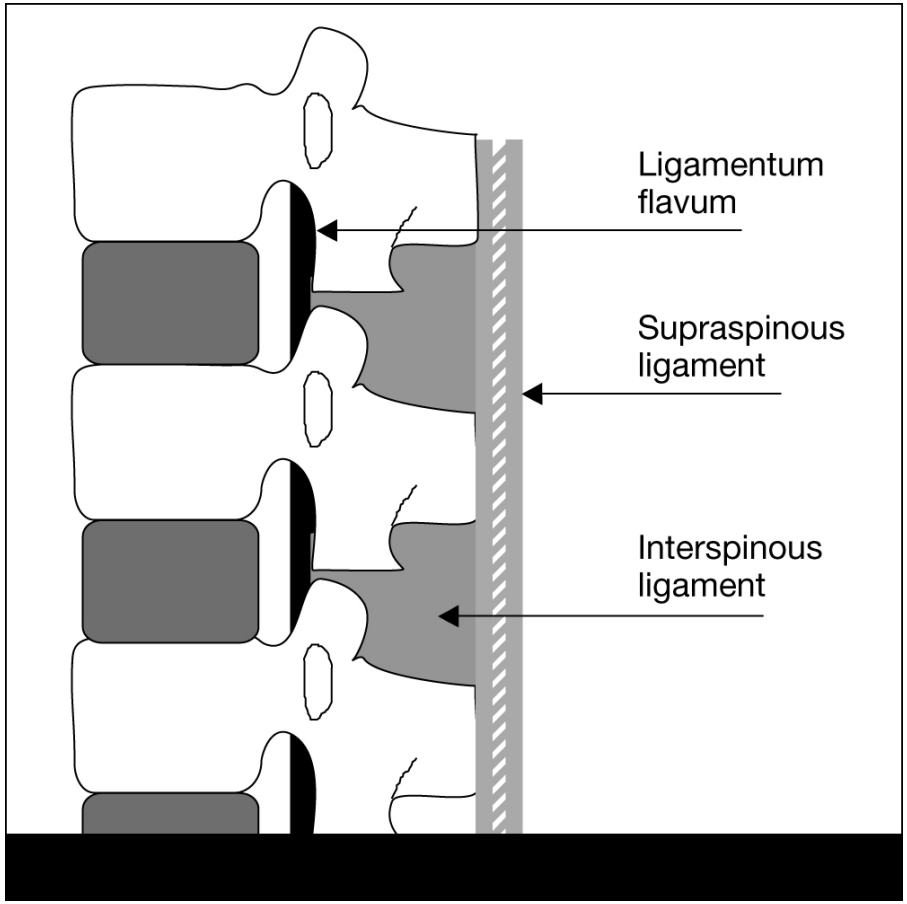
Anterior and posterior longitudinal ligaments



Dorsal side:

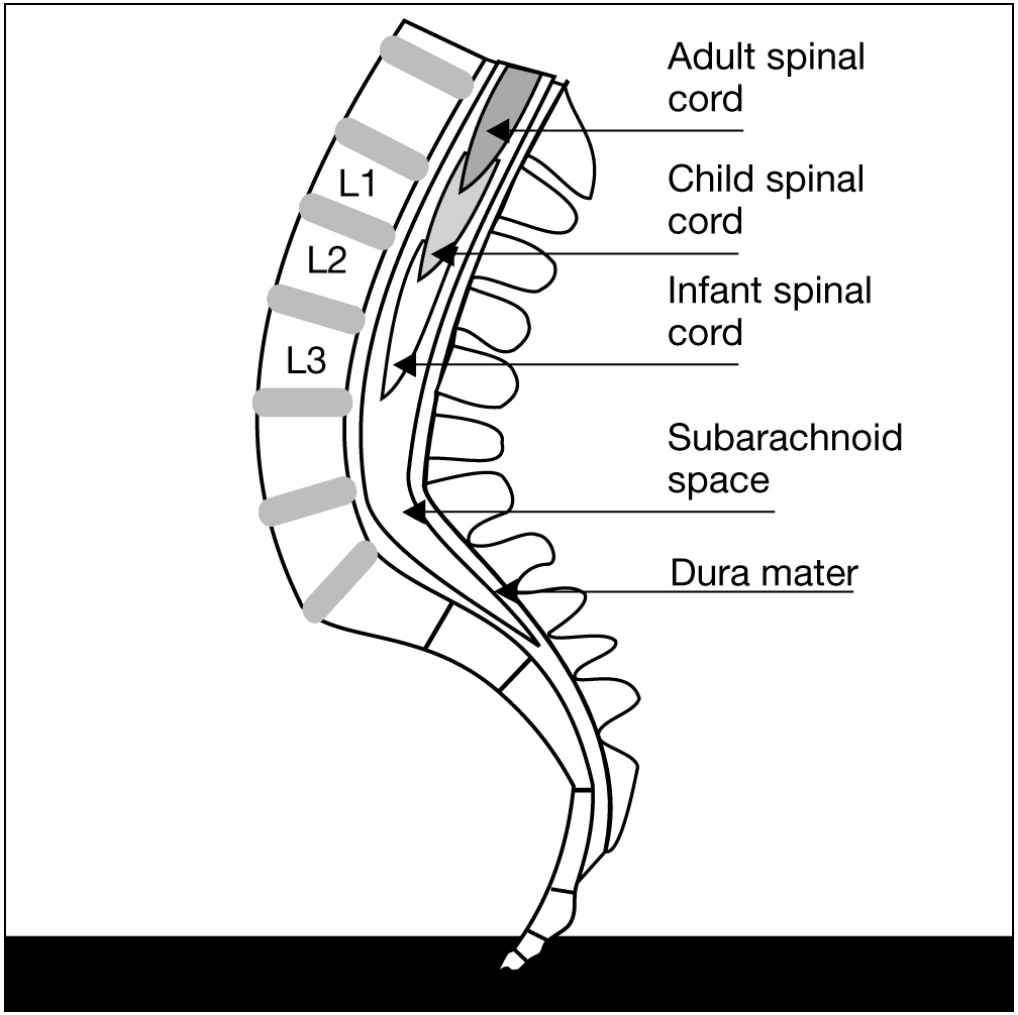
Important since these are the structures your needle will pass through!

Ligaments are identified by tactile sensation (feel)



Dorsal ligaments transversed during neuraxial blockade. With experience the anesthesia provider will be able to identify anatomical structures by "feel".

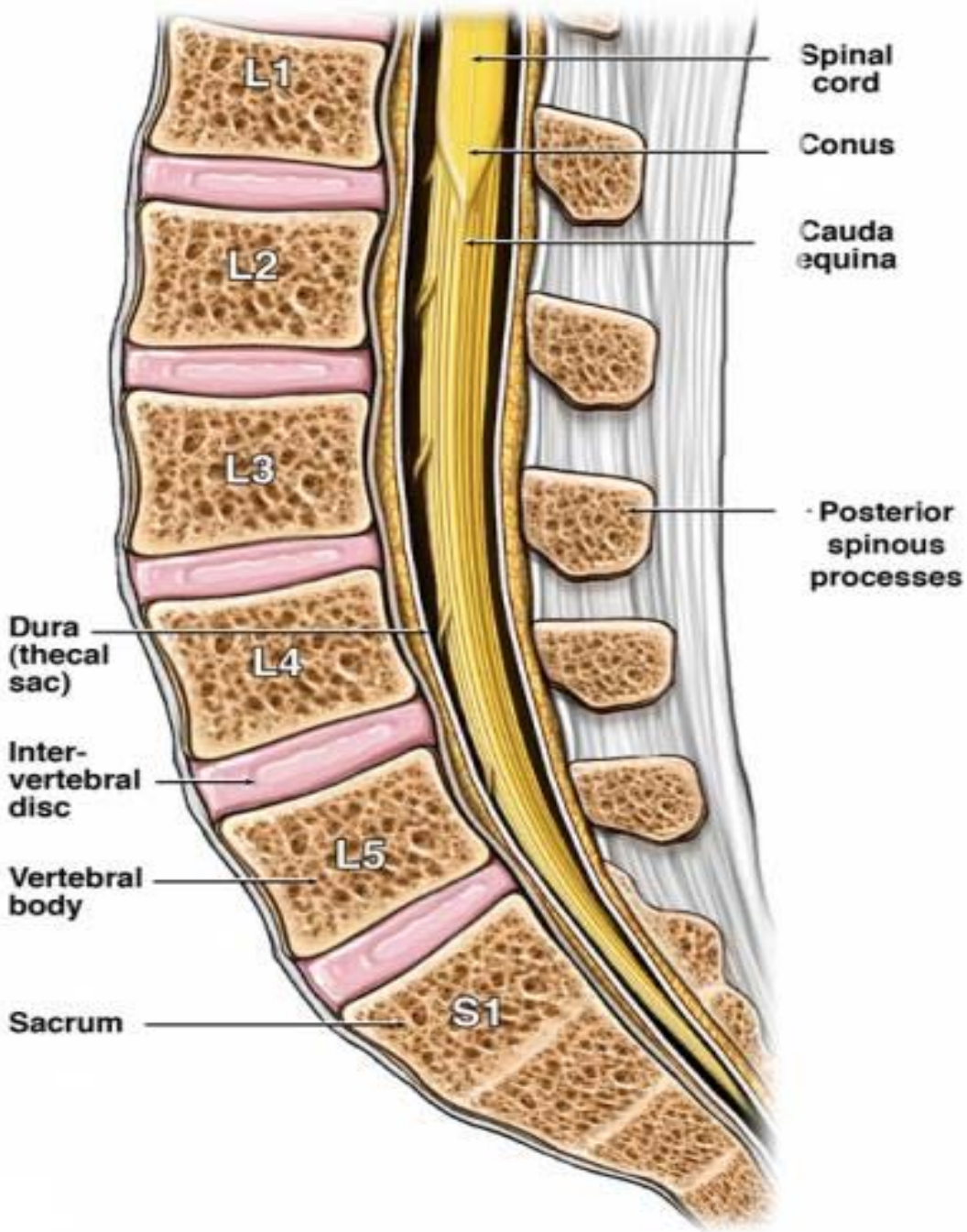
Termination of Spinal Cord



In adults usually ends at L1.

Infants L3

There are anatomical variations. For most adults it is generally safe to place a spinal needle below L2.

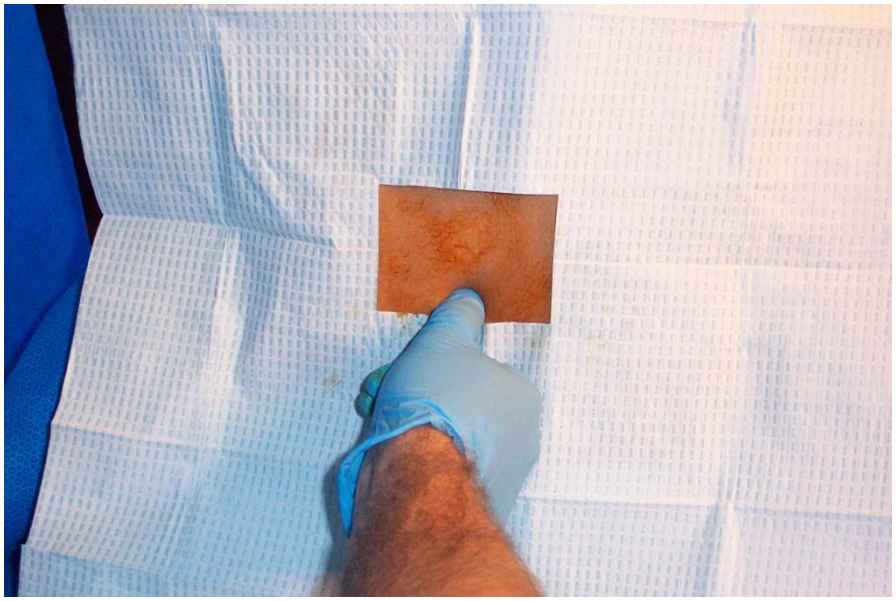

L1
L2
L3
L4
L5
S1
Spinal cord
Conus
Cauda equina
Posterior spinous processes
Dura (thecal sac)
Inter-vertebral disc
Vertebral body
Sacrum

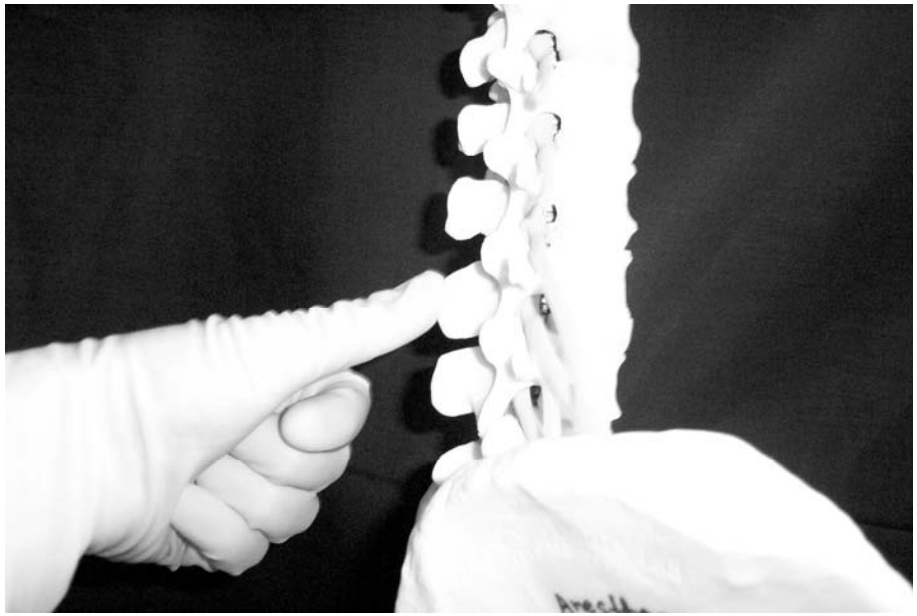
Surface Anatomy and Landmarks

Locating prominent cervical and thoracic vertebrae

- C2 is the first palpable vertebrae
- C7 is the most prominent cervical vertebrae
- With the patients arms at the side the tip of the scapula generally corresponds with T7

Palpation of Spinous Process



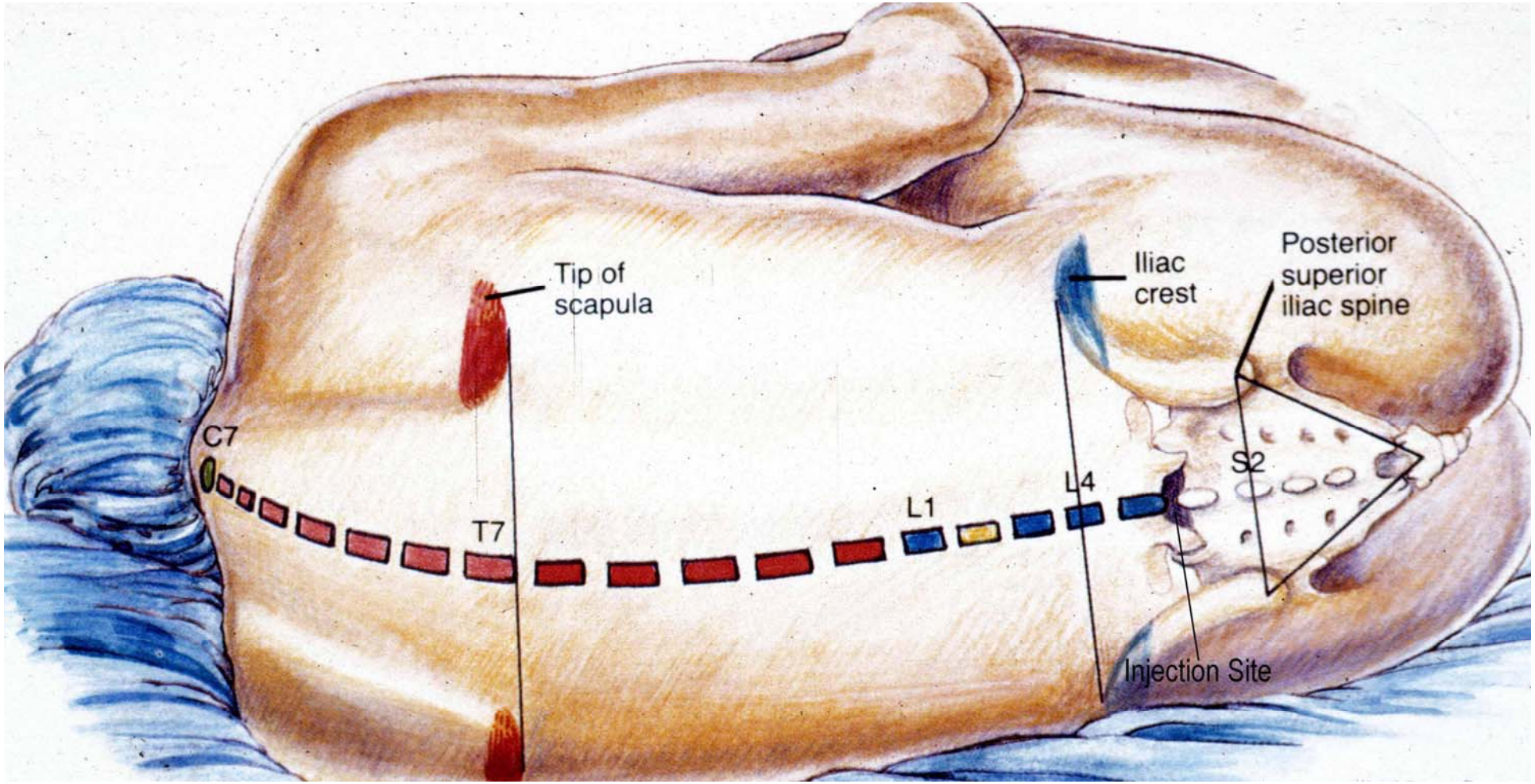


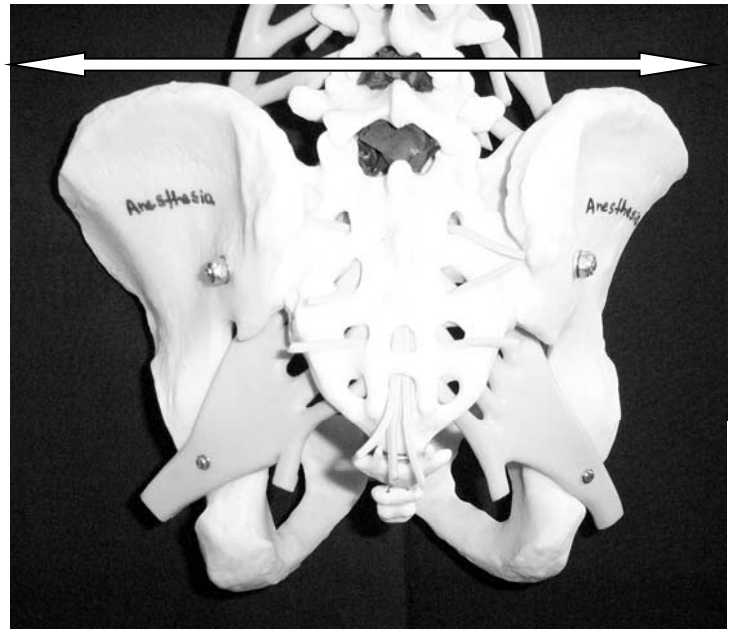
Spinous Processes

- Generally are palpable to help identify the midline
- If unable to palpate the spinous process one can look at the upper crease of the buttocks and line up the midline as long as there is no scoliosis or other deformities of the spine

What is Tuffier's Line?

- A line drawn between the highest points of both iliac crests will yield either the body of L4 or the L4-L5 interspace.


Tip of scapula
Iliac crest
Posterior superior iliac spine
C7
T7
L1
L4
S2
Injection Site


Anesthesia

Anatomical Considerations of the Spinal Cord and Neuraxial Blockade.

The Subarachnoid Space is a continuous space that contains

- CSF
- Spinal cord & nerves

CSF

- Clear fluid that fills the subarachnoid space
- Total volume in adults is ~100-150 ml (2 ml/kg)
- Volume found in the subarachnoid space is ~45 ml
- Continually produced at a rate of 450 ml per 24 hour period replacing itself 3-4 times

CSF

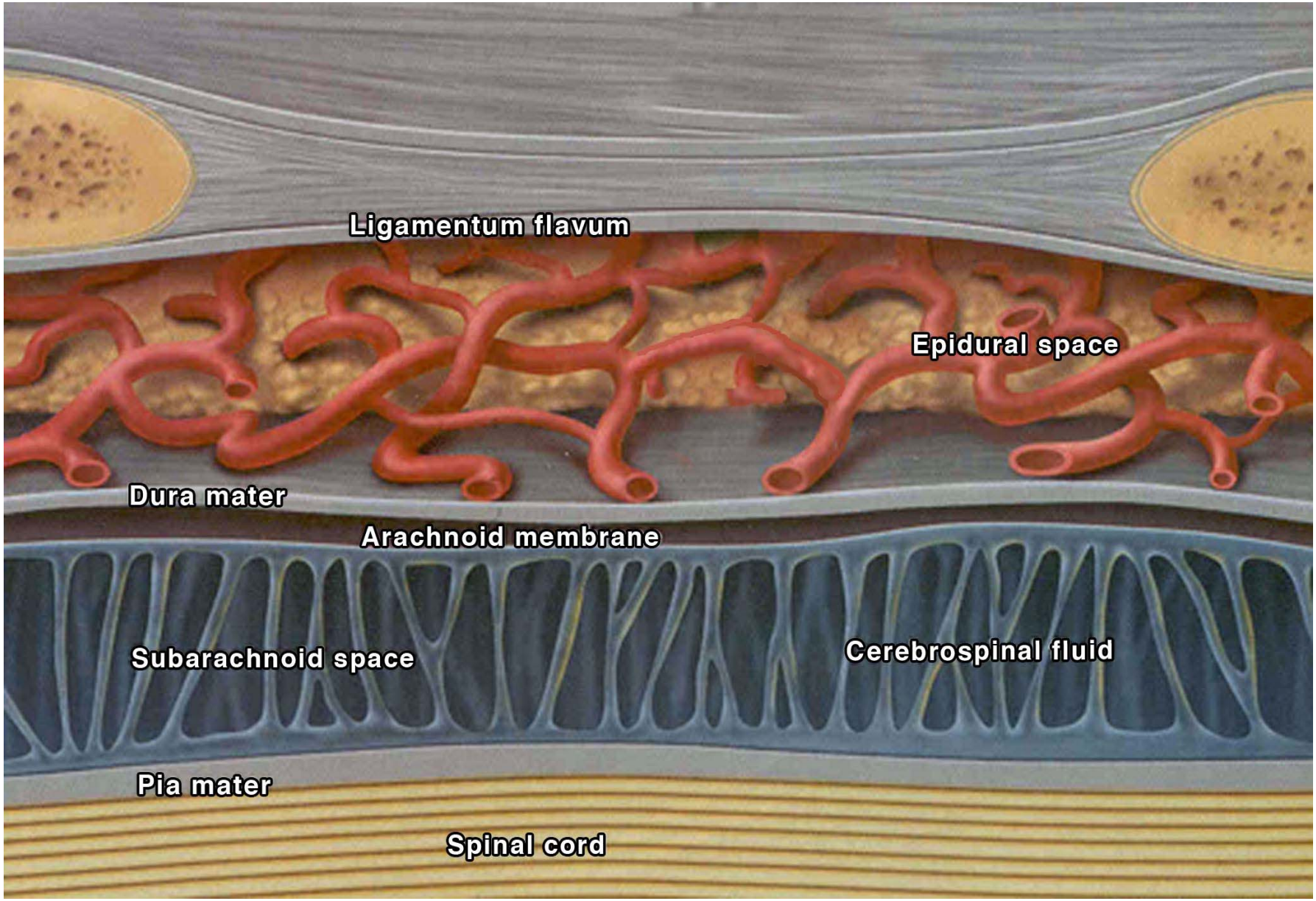
- Reabsorbed into the blood stream by arachnoid villi.
- Specific gravity is between 1.003-1.007 (this will play a crucial role in the baracity of local anesthetic that one chooses)
- CSF plays a role the patient to patient variability in relation to block height and sensory/motor regression (80% of the patient to patient variability)
- Body wt is the only measurement that coincides with CSF volume (this becomes important in the obese and pregnant).

Membranes that surround the spinal cord

- Pia mater- highly vascular, covers the spinal cord and brain, attaches to the periosteum of the coccyx (Filum terminalis)
- Arachnoid mater- non vascular and attached to the dura mater. Principal barrier to the migration of medications in and out of the CSF.
- Dura mater ("tough mother")- extension of the cranial dura mater, extends from the foramen magnum to S2.

Filum Terminale

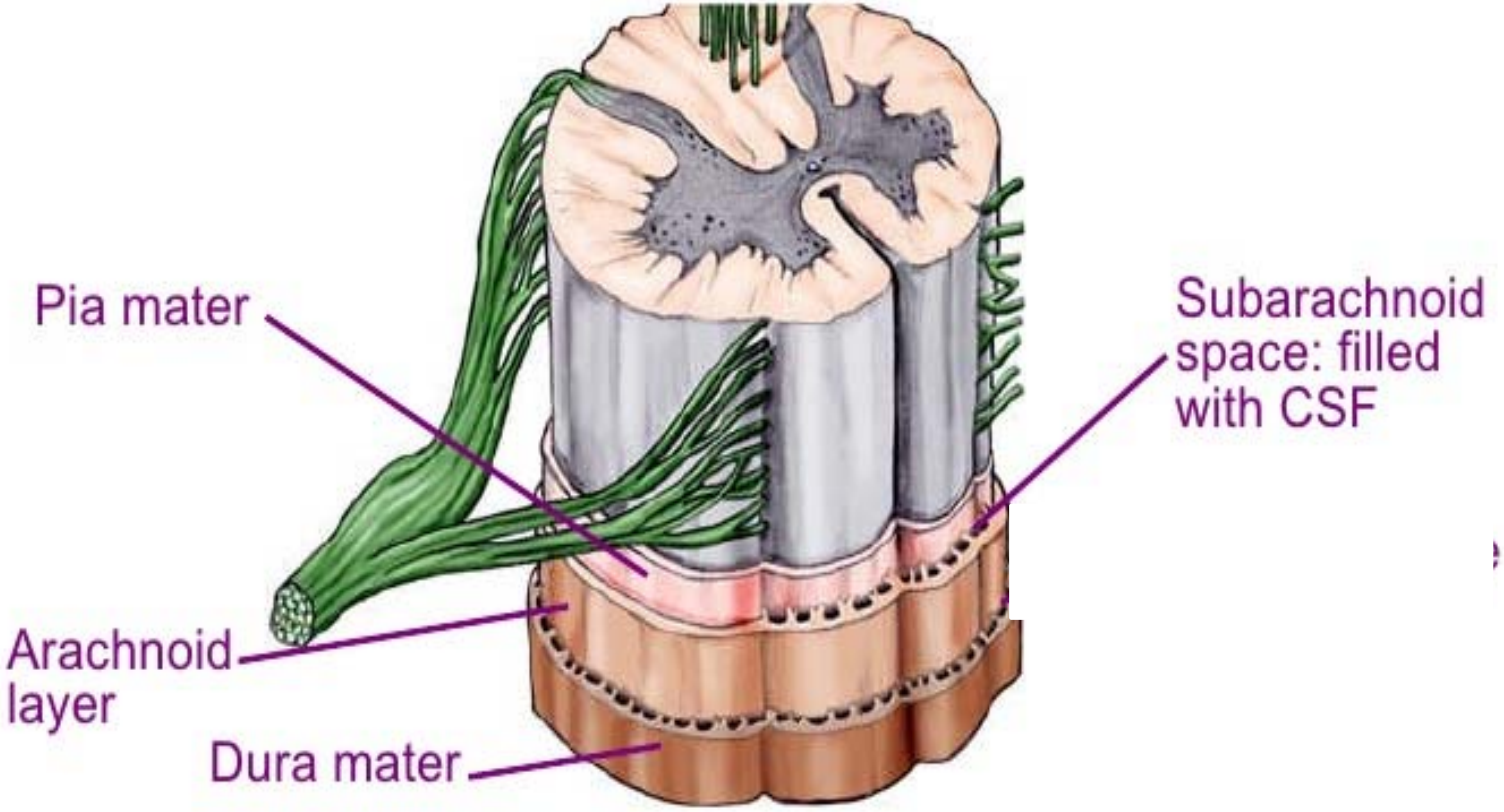
- An extension of the pia mater that attaches to the periosteum of the coccyx.


Ligamentum flavum
Epidural space
Dura mater
Arachnoid membrane
Subarachnoid space
Cerebrospinal fluid
Pia mater
Spinal cord

Meninges

Within the spinal canal, the spinal cord is surrounded by the EPIDURAL SPACE, filled with fatty tissue, veins, and arteries. The fatty tissue acts as a shock absorber.

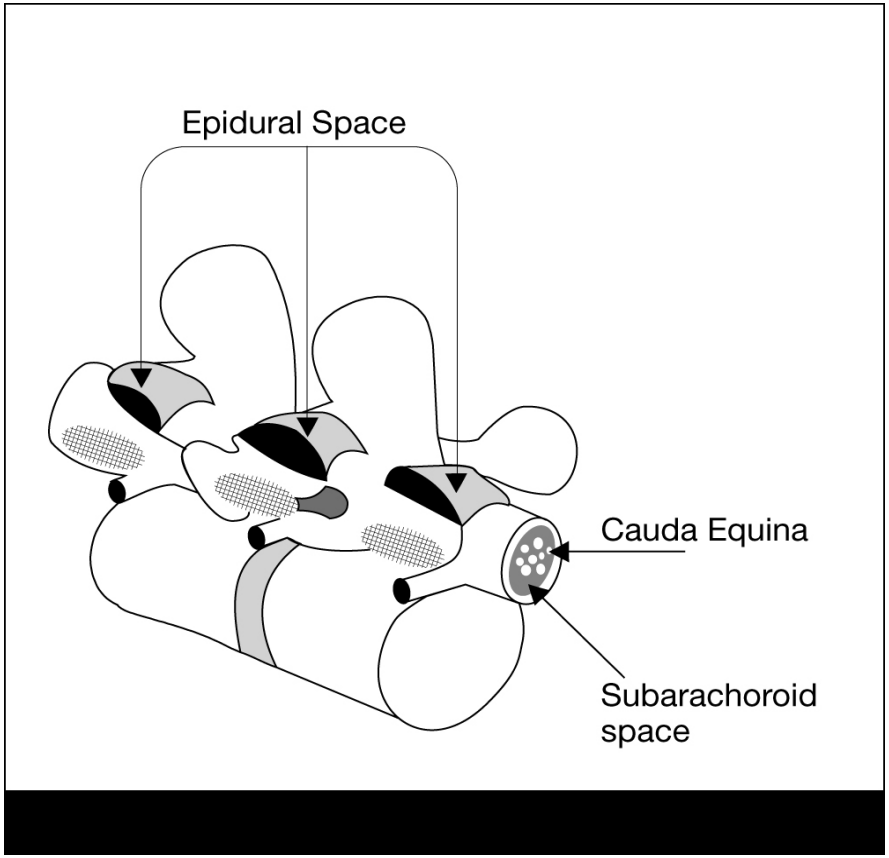
The spinal cord is covered by MENINGES which has three layers.



Epidural Space Anatomy

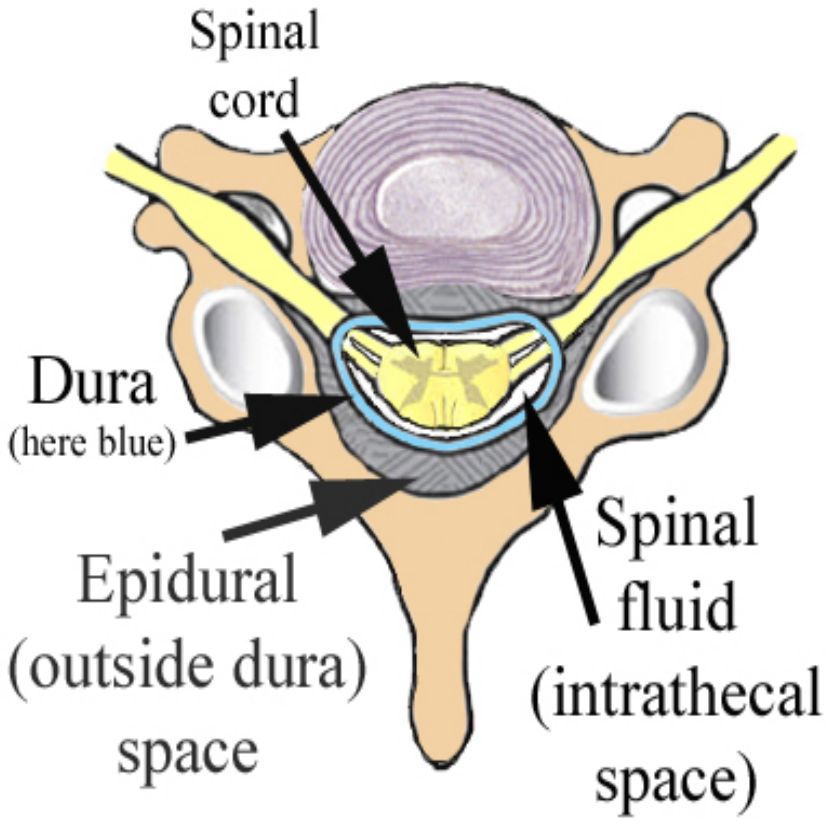
Epidural Space Anatomy

- Extends from the formen magnum to the sacral hiatus



Epidural Space Anatomy

- The epidural space surrounds the dura mater anteriorly, laterally, and most importantly to us posteriorly.

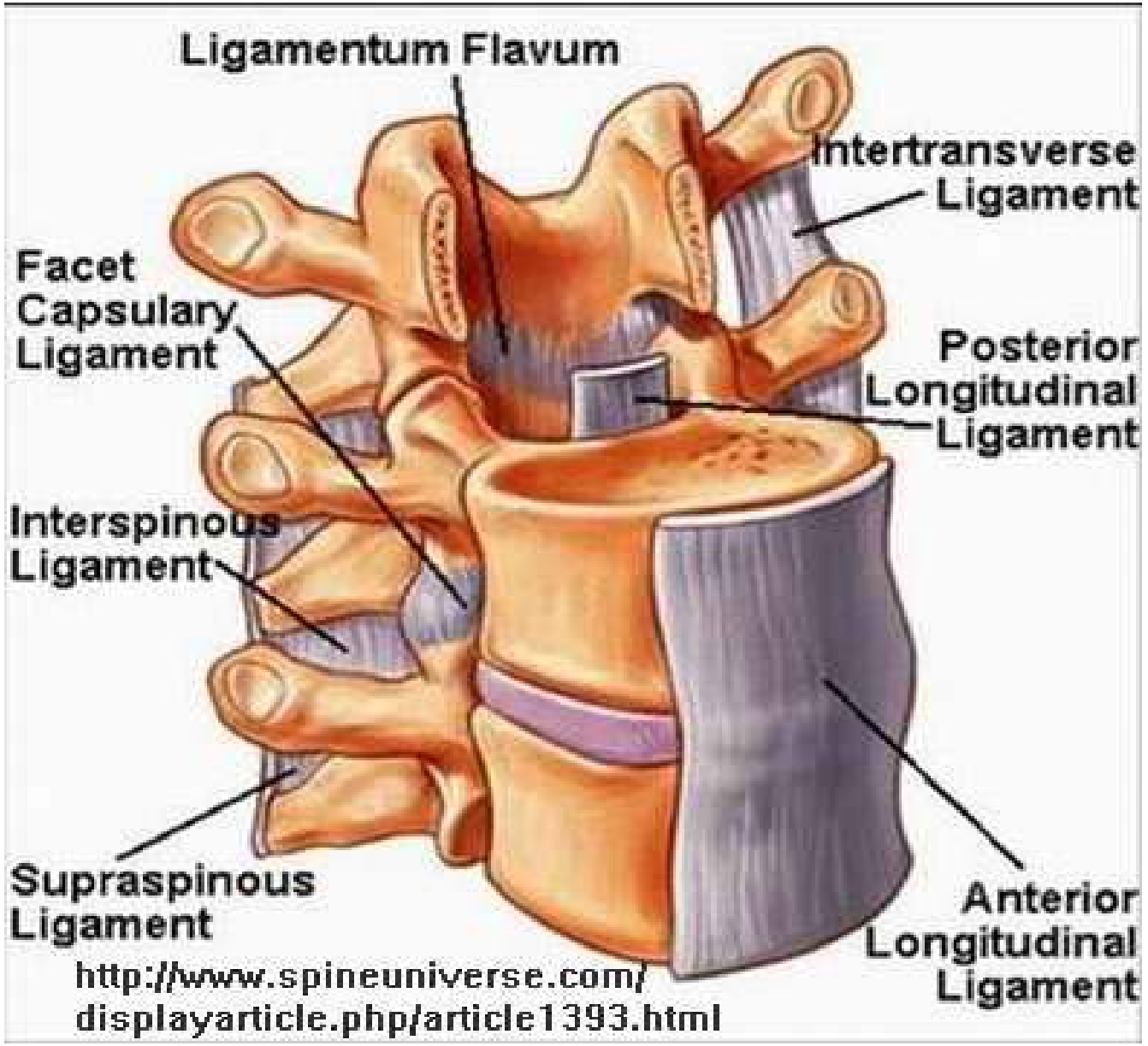


The Bounds of the Epidural Space are as follows:

- Anterior- posterior longitudinal ligament
- Lateral- pedicles and intervertebral ligaments
- Posterior- ligamentum flavum

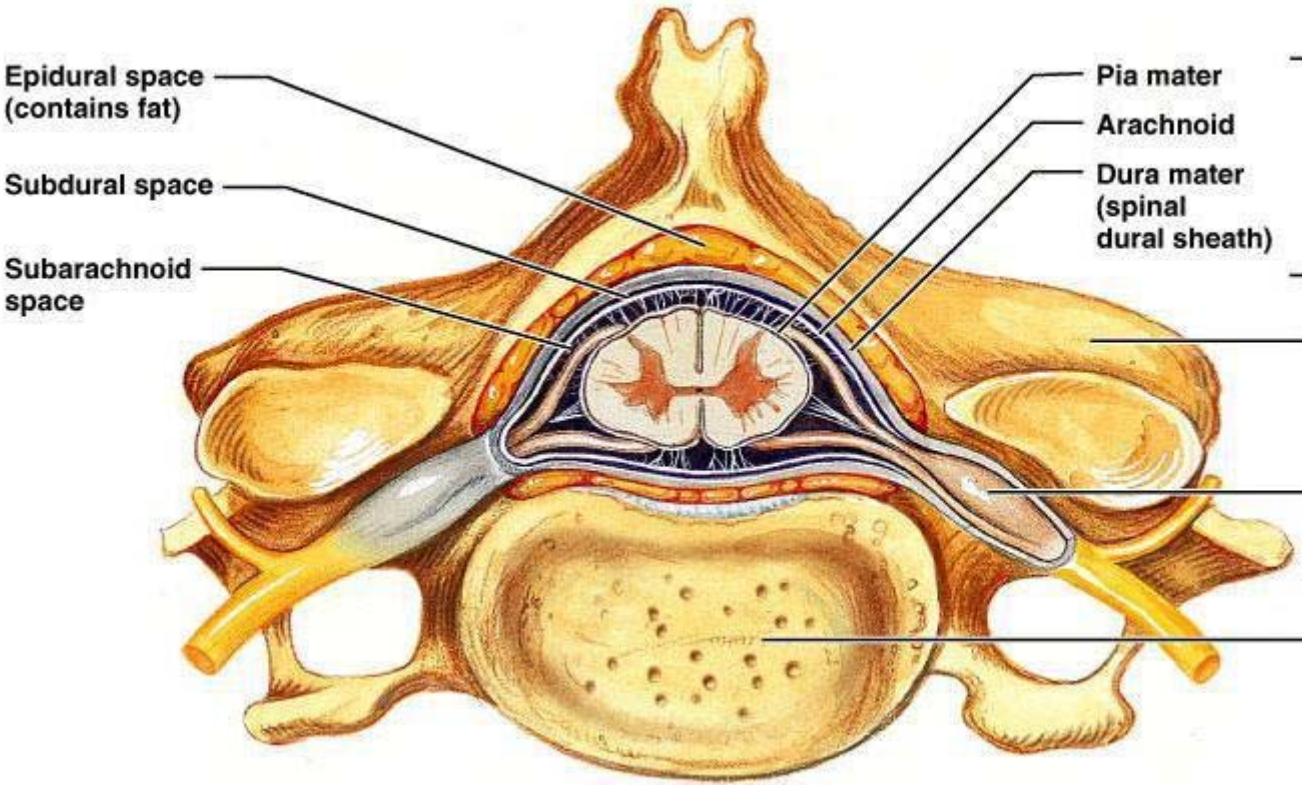
Ligamentum Flavum

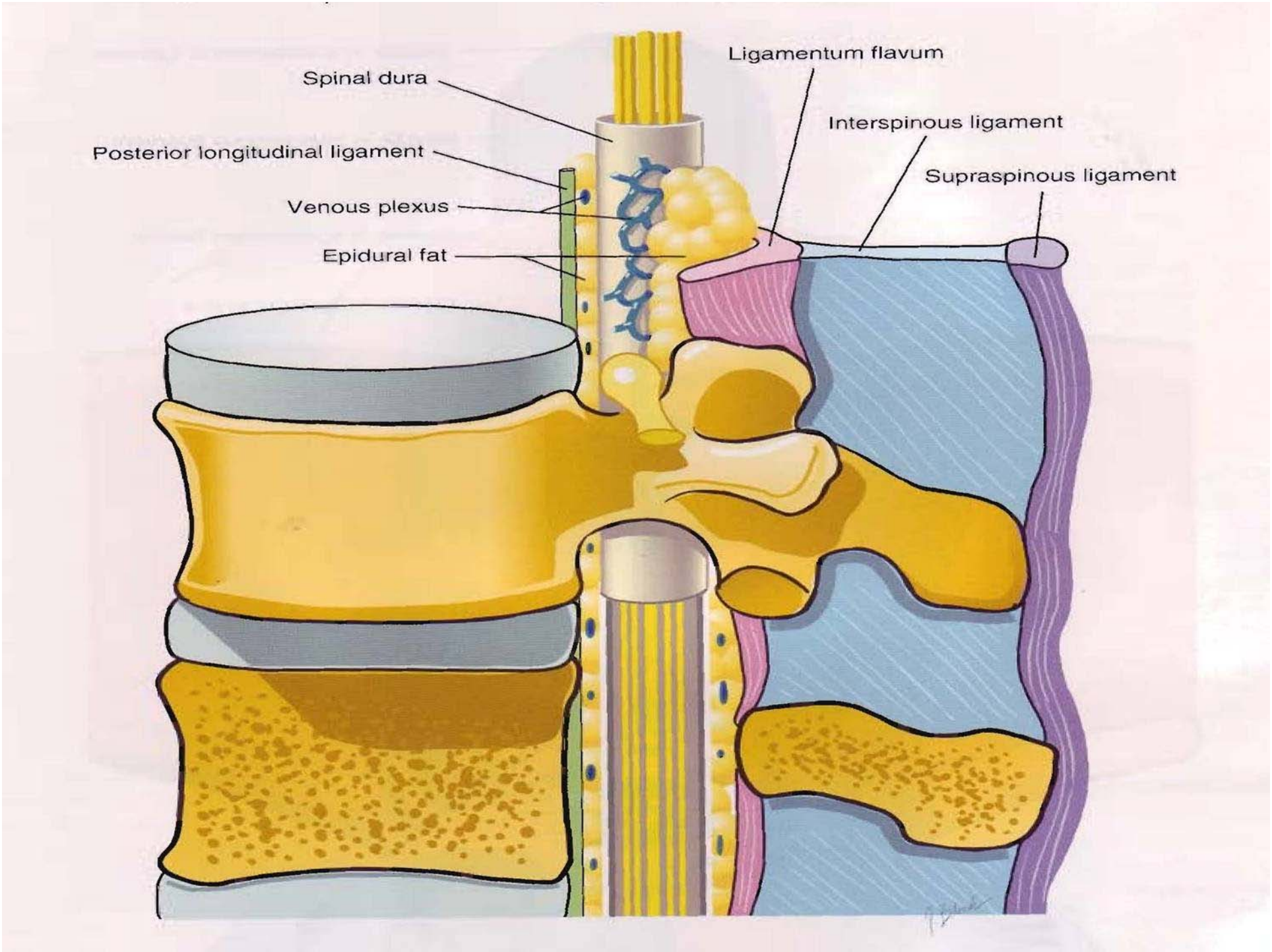
- Posterior to the epidural space
- Extends from the foramen magnum to the sacral hiatus
- Distance from skin to ligament varies from 3-8 cm in the lumbar area. It is 4 cm in 50% of the patients and 4-6 cm in 80% of the patients.
- Thickness of the ligamentum flavum also varies. In the thoracic area it can range from 3-5 mm and in the lumbar it can range from 5-6 mm

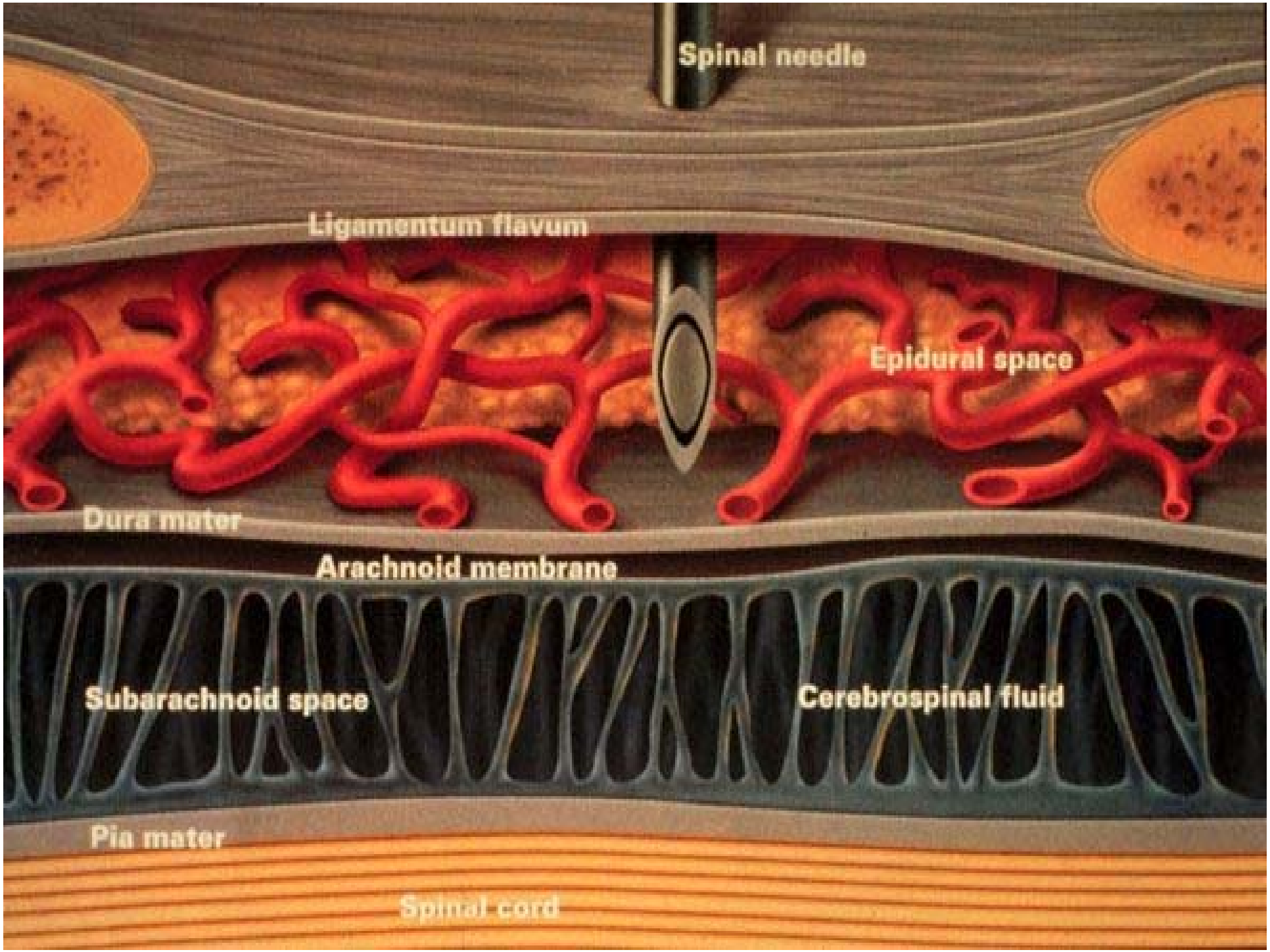

Ligamentum Flavum
Intertransverse Ligament
Facet Capsulary Ligament
Posterior Longitudinal Ligament
Interspinous Ligament
Supraspinous Ligament
Anterior Longitudinal Ligament
http://www.spineuniverse.com/displayarticle.php/article1393.html

Contents of the Epidural Space

- Fat
- Areolar tissue
- Lymphatics
- Blood vessels including the Batson venous plexus


Epidural space
(contains fat)
Subdural space
Subarachnoid
space
Pia mater
Arachnoid
Dura mater
(spinal
dural sheath)


Spinal dura
Posterior longitudinal ligament
Venous plexus
Epidural fat
Ligamentum flavum
Interspinous ligament
Supraspinous ligament


Spinal needle
Ligamentum flavum
Epidural space
Dura mater
Arachnoid membrane
Subarachnoid space
Cerebrospinal fluid
Pia mater
Spinal cord

Definition

Spinal anesthesia :

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

Indication

Operations below the umbilicus: hernia repairs, gynaecological, urological operation, orthopedics,

Any operation on the perineum or genitalia.

Spinal Anesthesia

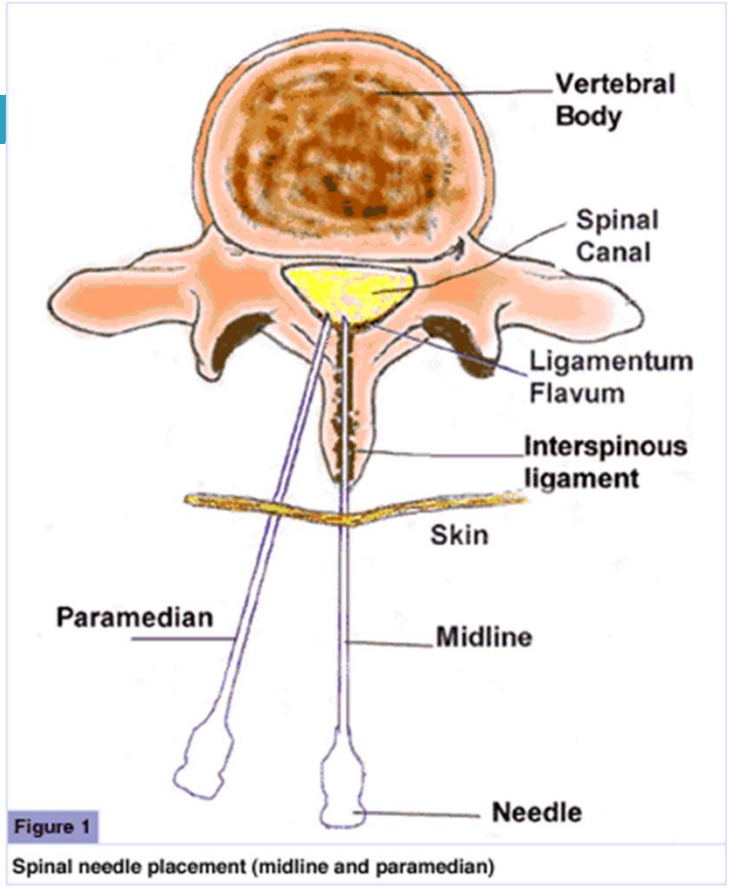
- Contraindications
  - Absolute:
    - Refusal
    - Infection
    - Coagulopathy & anticoagulated patient
    - Severe hypovolemia
    - Increased intracranial pressure
    - Severe aortic or mitral stenosis
  - Relative:
    - Use your best judgment

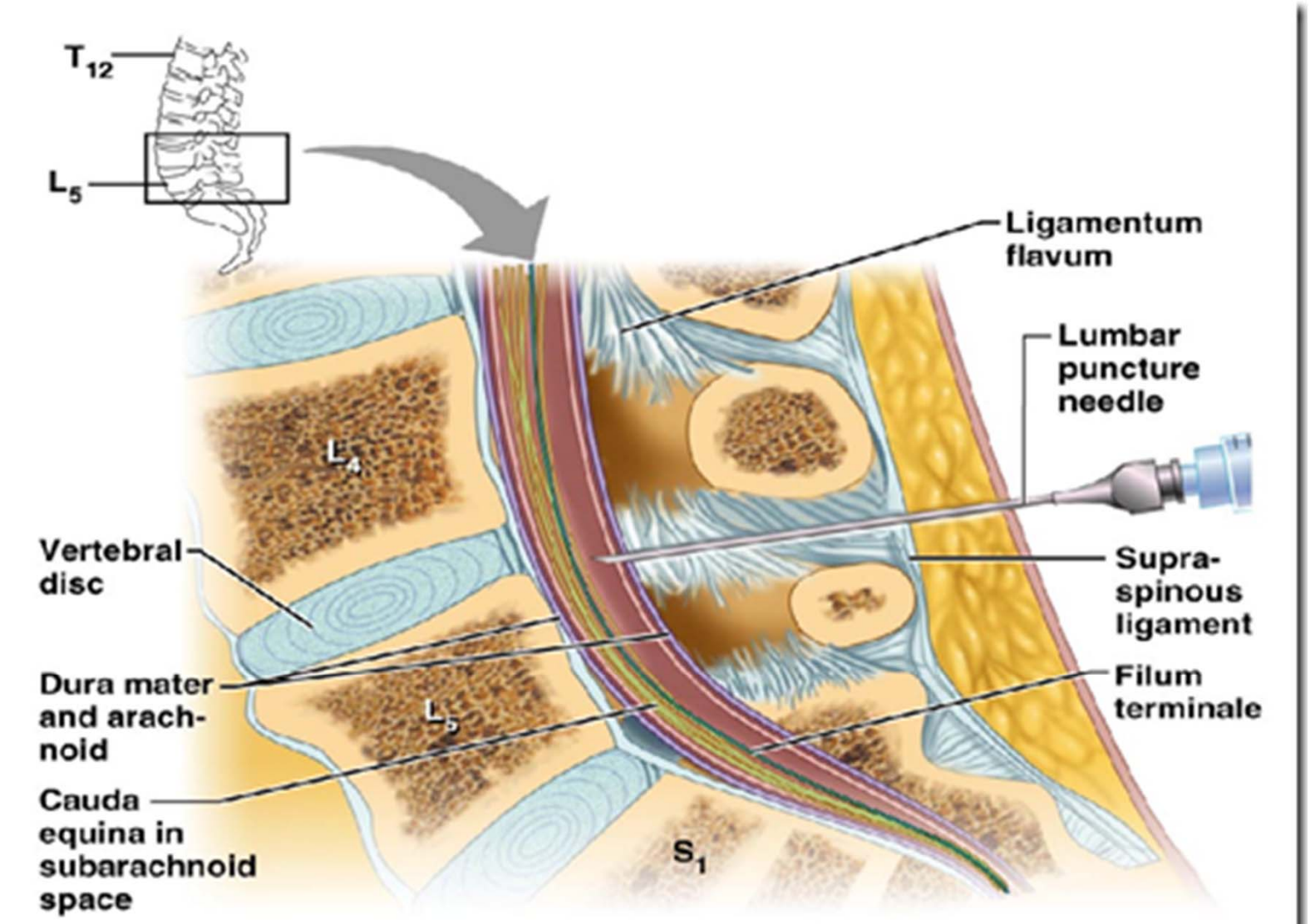
Sterility

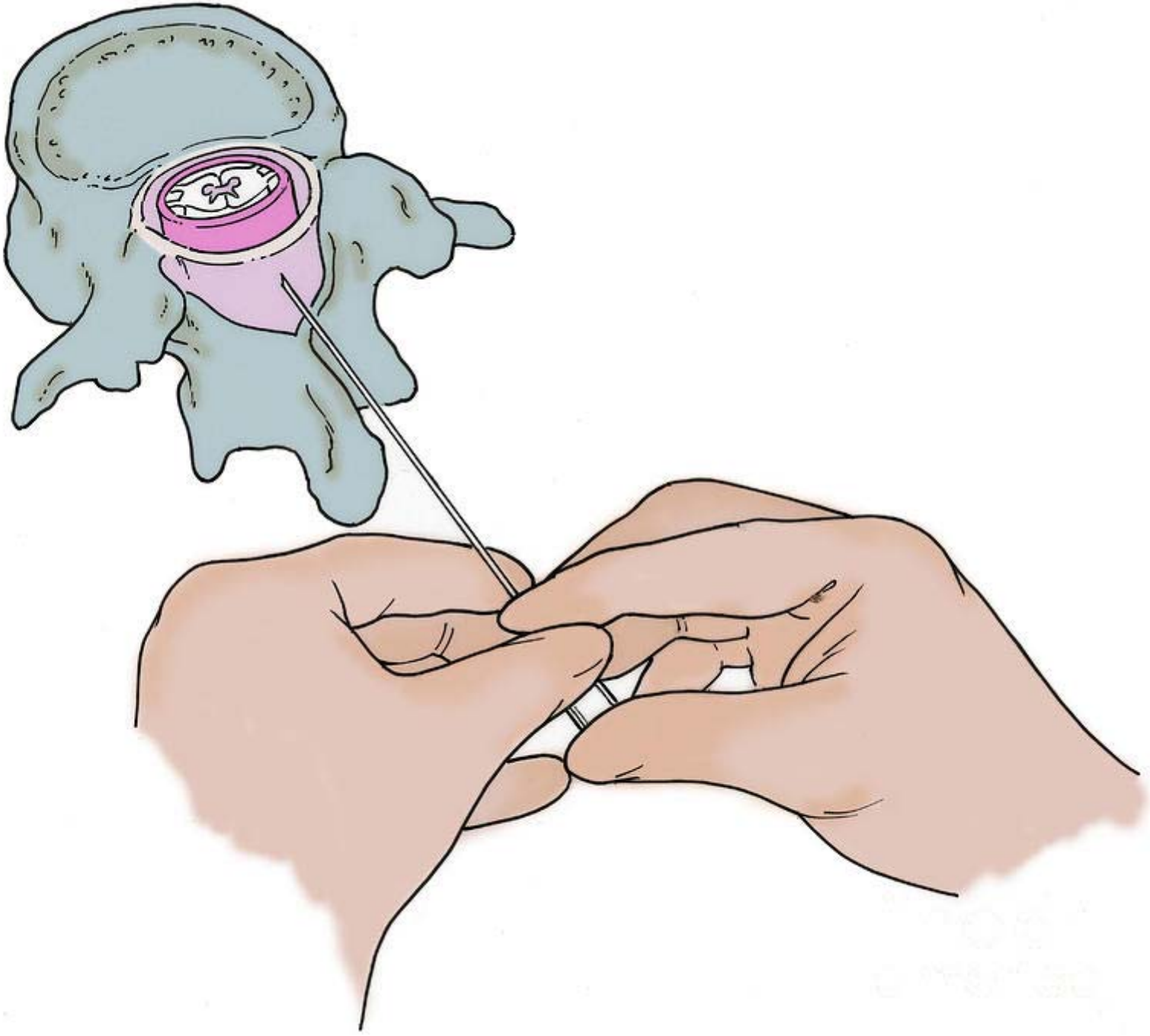
Sitting Vs. Lateral decobitus

Spinal Technique

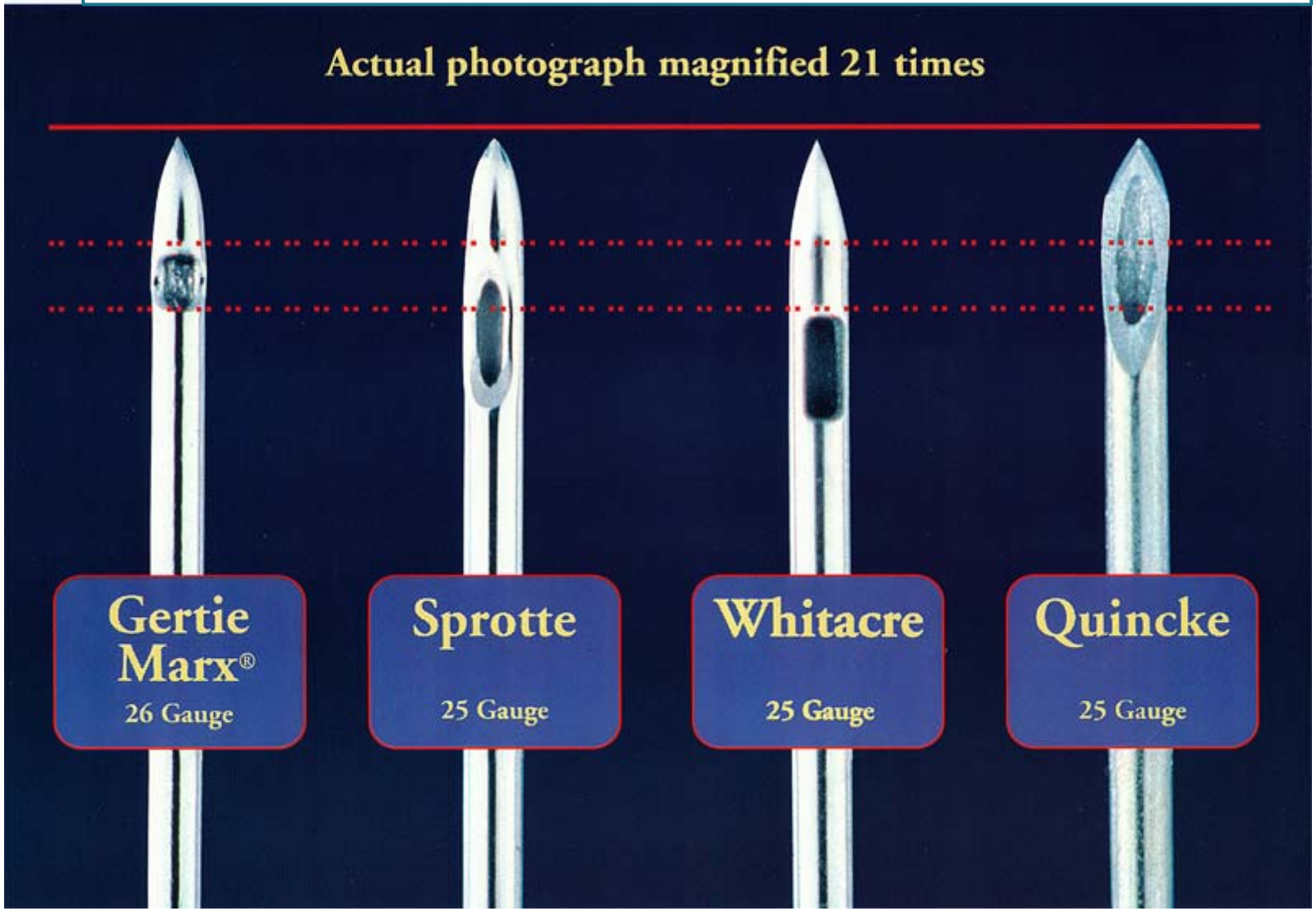
- Midline Approach
  - Skin
  - Subcutaneous tissue
  - Supraspinous ligament
  - Interspinous ligament
  - Ligamentum flavum
  - Epidural space
  - Dura mater
  - Arachnoid mater
- Paramedian or Lateral Approach
  - Same as midline excluding supraspinous & interspinous ligaments

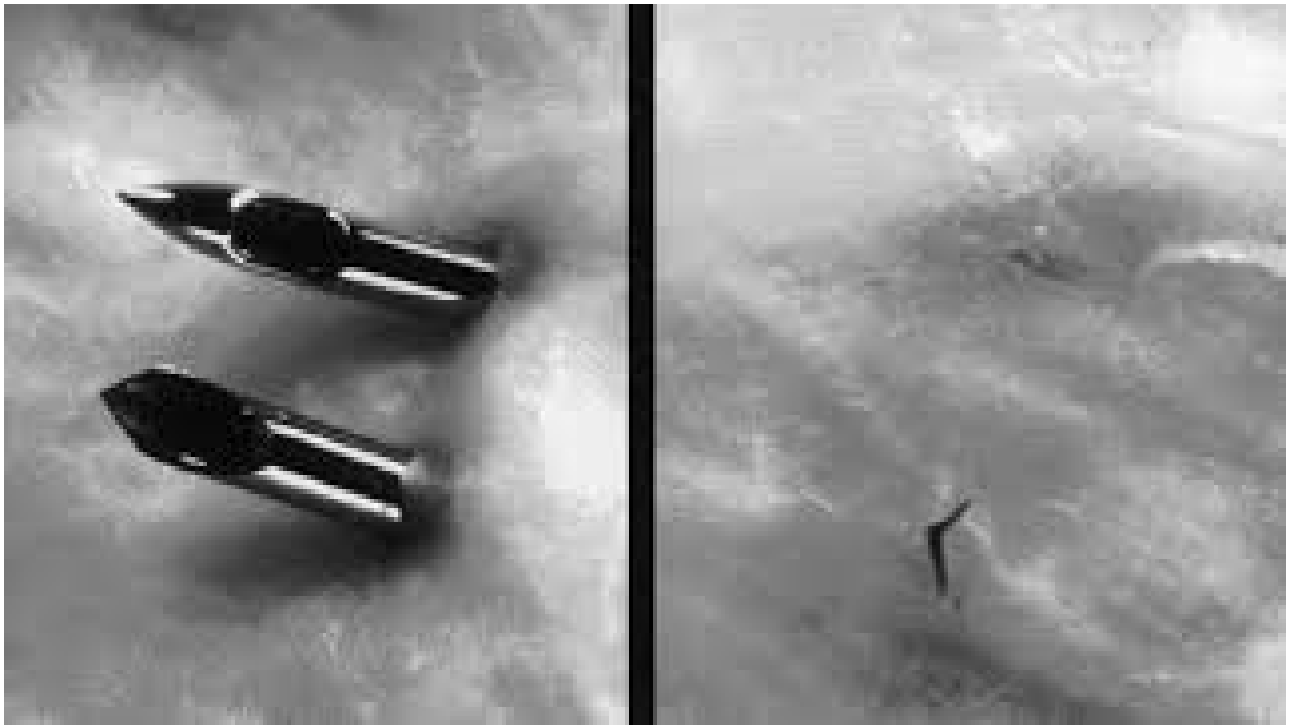


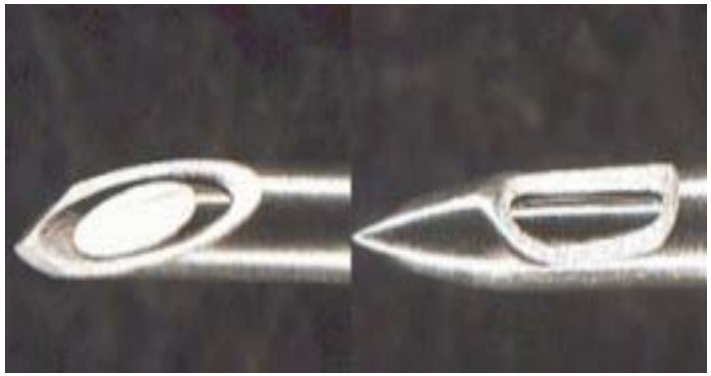




Spinal needles type

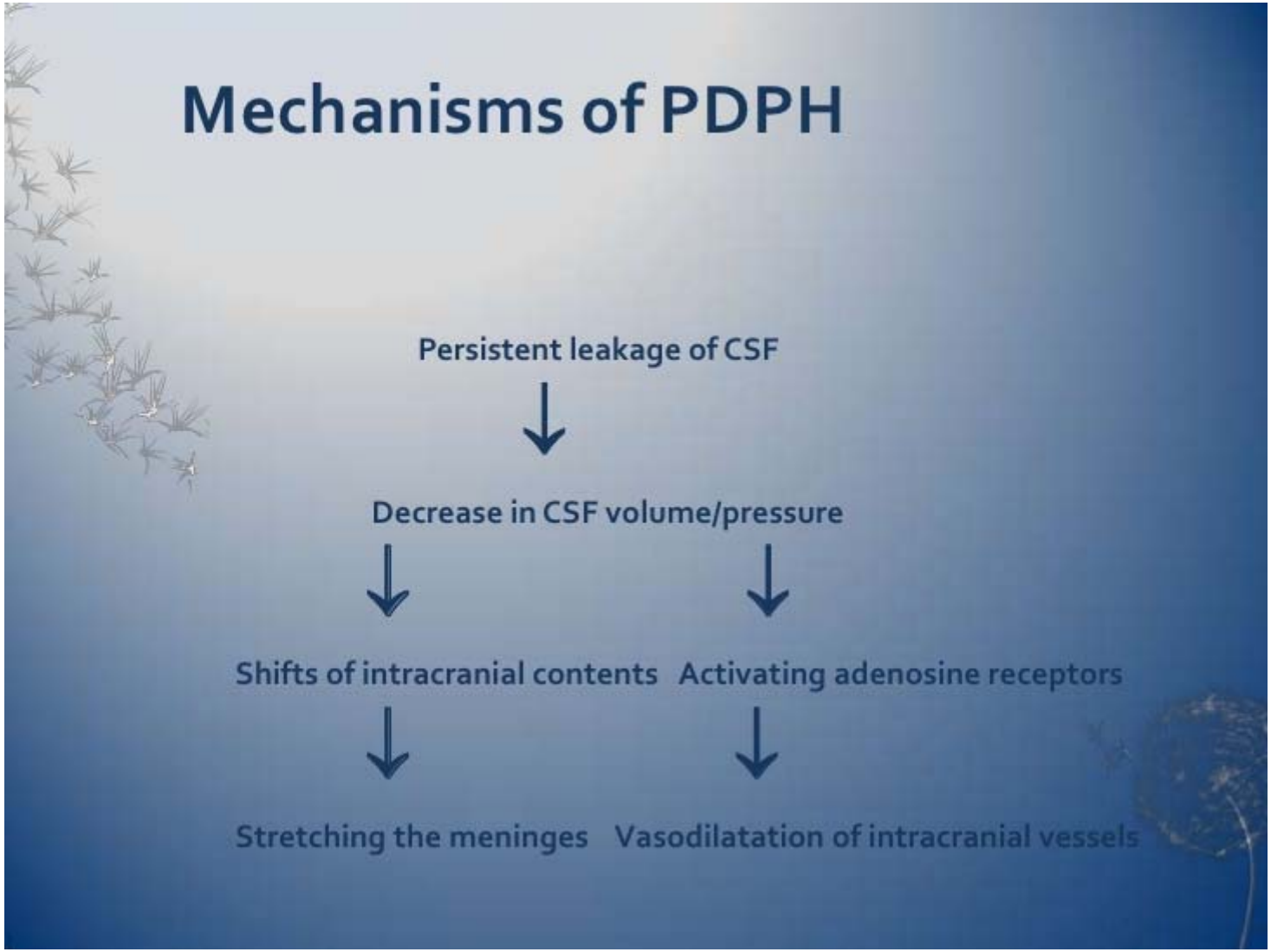






PDPH

- Develop 12-48 hours after spinal anesthesia.
- Headache improve when lying supine.


Mechanisms of PDPH
Persistent leakage of CSF
Decrease in CSF volume/pressure
Shifts of intracranial contents
Activating adenosine receptors
Stretching the meninges
Vasodilatation of intracranial vessels

Differential Diagnosis

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

PDPH; Treatment

- Conservative.
- Epidural blood patch.

Spinal anesthesia; single shot technique

Factors Affecting the Level of Spinal Anesthesia

Most Important Factors

- Baricity
- Position of the patient
  - During and immediately after injection
- Dosage
- Site of injection

Other Factors

- Age
- CSF
- Curvature of the spine
- Drug volume
- Intraabdominal pressure
- Needle direction
- Patient height
- Pregnancy

Baricity(a concern only in spinal anesthesia)

- Hyperbaric
  - Typically prepared by mixing local with dextrose
  - Flow is to most dependent area due to gravity
  - Very predictable spread
- 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
  - Increased dose has more effect on duration than dermatomal spread
- Note: Be cognizant of high & low regions of spinal column

Hyperbaric bupivacaine is prepared by mixing it with dextrose

Sterile, clear

Preservative free

3 ml ampoules

See the expiry date

Be sure it is bupivacaine??

Classification of nerve fibers

C. Classification of nerve fibers (in humans)

Fiber type	Function according to fiber type (Lloyd and Hunt types I–IV)	Diameter (μm)	Conduction rate (m/s)
Aα	Skeletal muscle efferent, afferents in muscle spindles (Ib) and tendon organs (Ib)	11 – 16	60 – 80
Aβ	Mechanoafferents of skin (II)	6 – 11	30 – 60
Aγ	Muscle spindle efferents	1 – 6	2 – 30
Aδ	Skin afferents (temperature and "fast" pain) (III)		
B	Sympathetic preganglionic; visceral afferents	3	3 – 15
C	Skin afferents ("slow" pain); sympathetic postganglionic afferents (IV)	0.5 – 1.5 (unmyelinated)	0.25 – 1.5

(After Erlanger and Gasser)

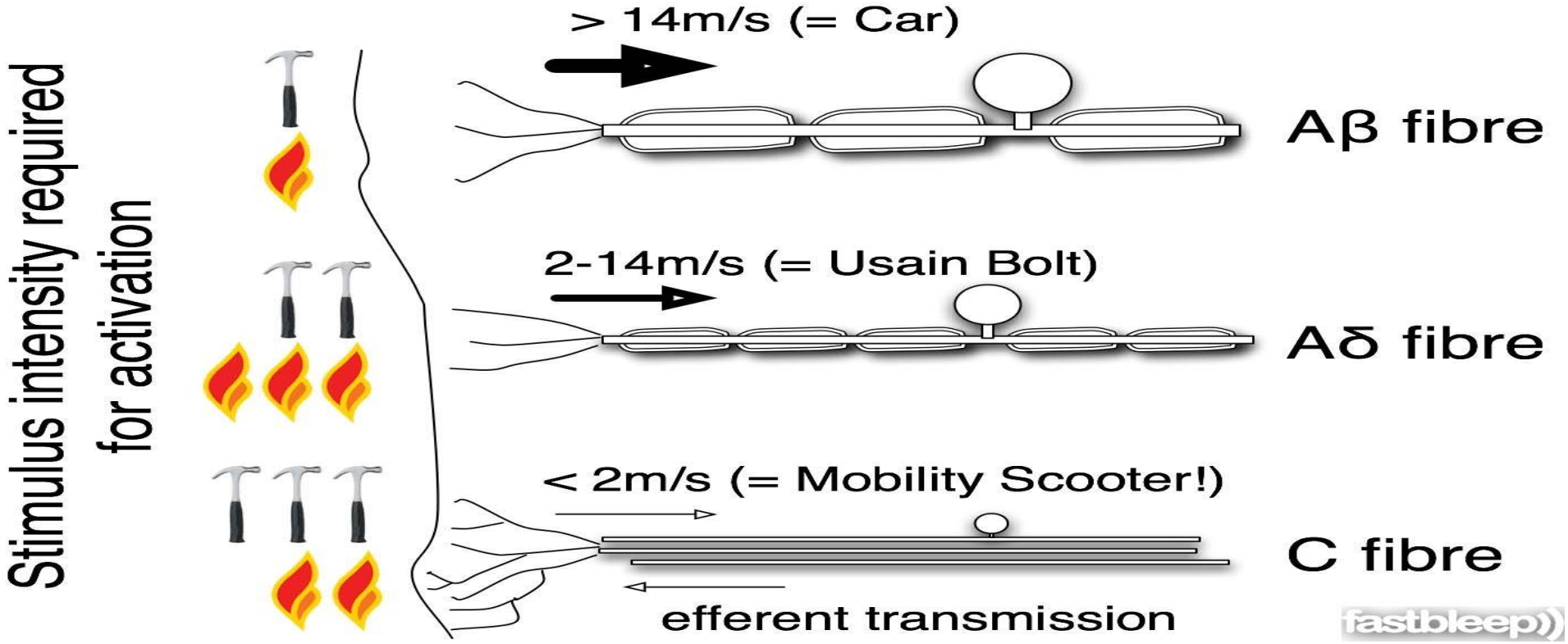
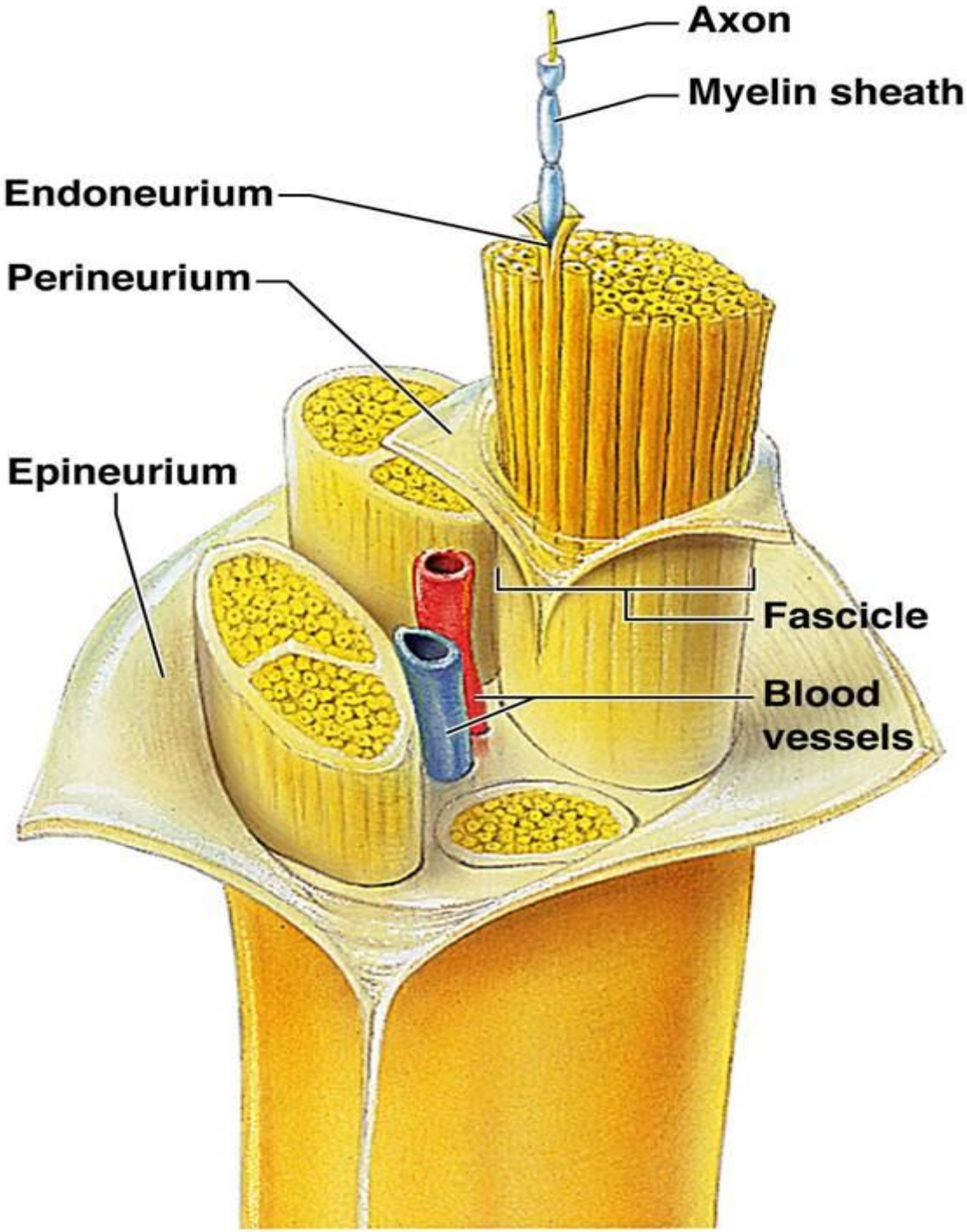


Table 3: Types of neurons blocked with local anesthetics

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**


Axon
Myelin sheath
Endoneurium
Perineurium
Epineurium
Fascicle
Blood vessels

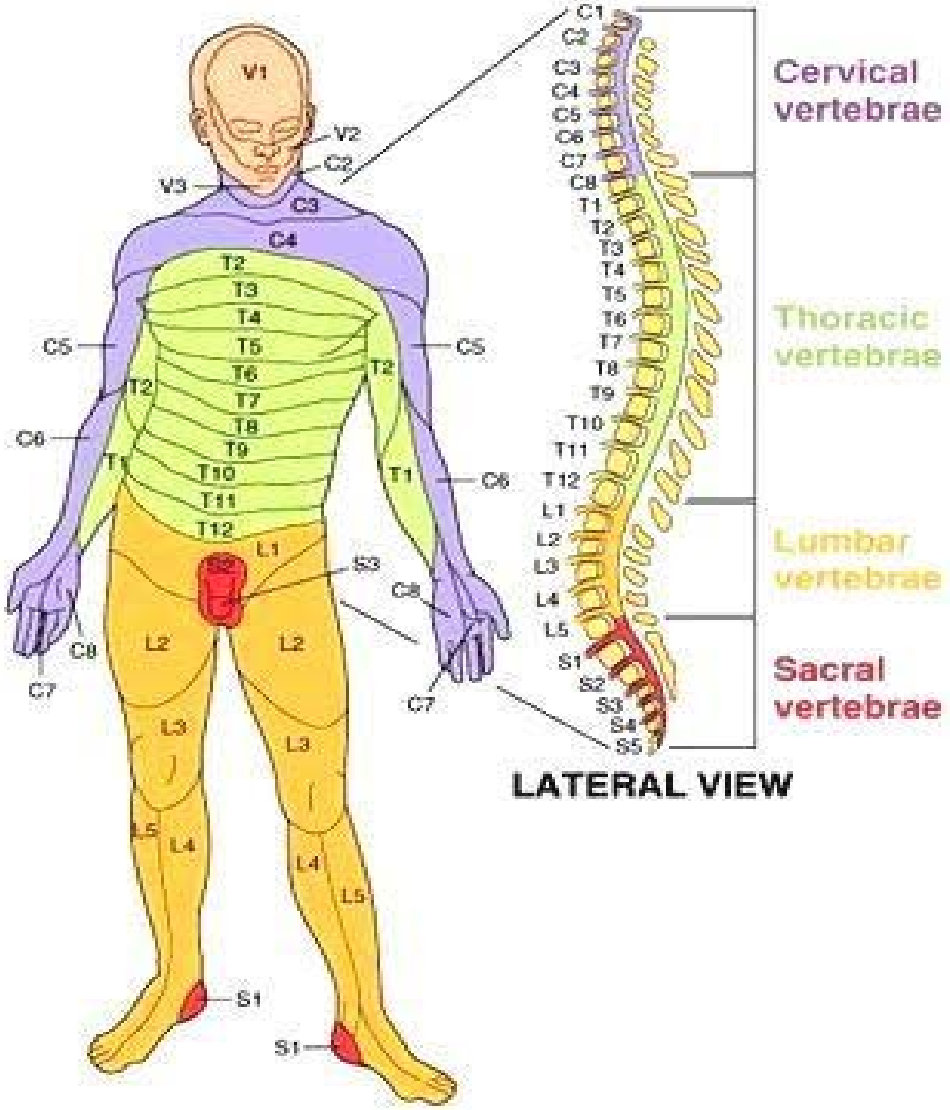
Sympathetic, Sensory & Motor Blockade

- Spinal Injection
  - 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).

  Block order B> C=A delta> A beta>A alfa

Dermatomes of the Body



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

Spinal Anesthesia

- Complications
  - Failed block
  - Back pain (most common)
  - Spinal head ache
    - 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

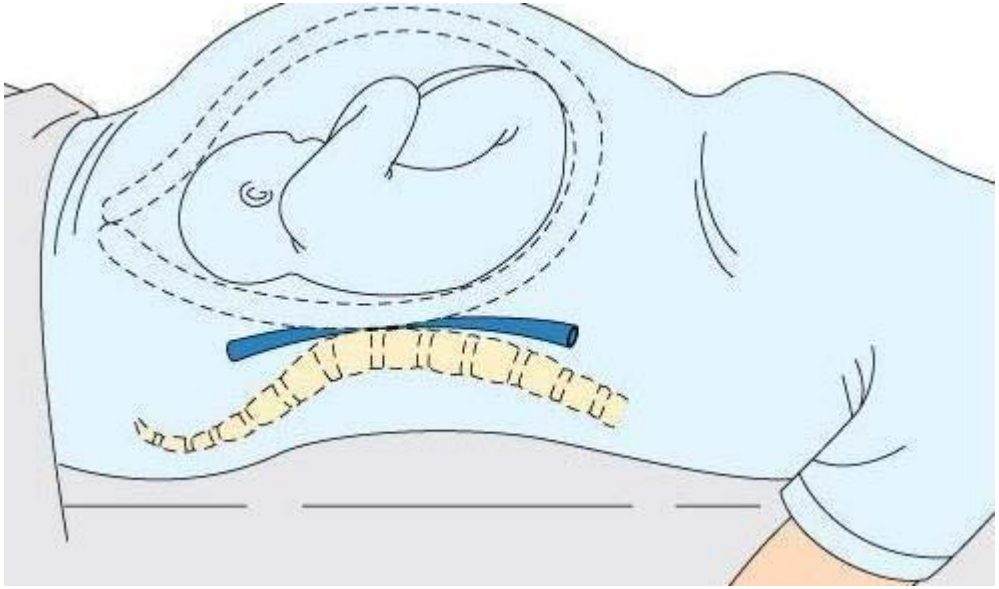
Spinal Anesthesia

- Complications
  - Epidural hematoma
  - Epidural abscess
  - Meningitis
  - Cauda equina
  - Neurological deficit
  - TNS
  - Bradycardia--- Cardiac arrest

Hypotension

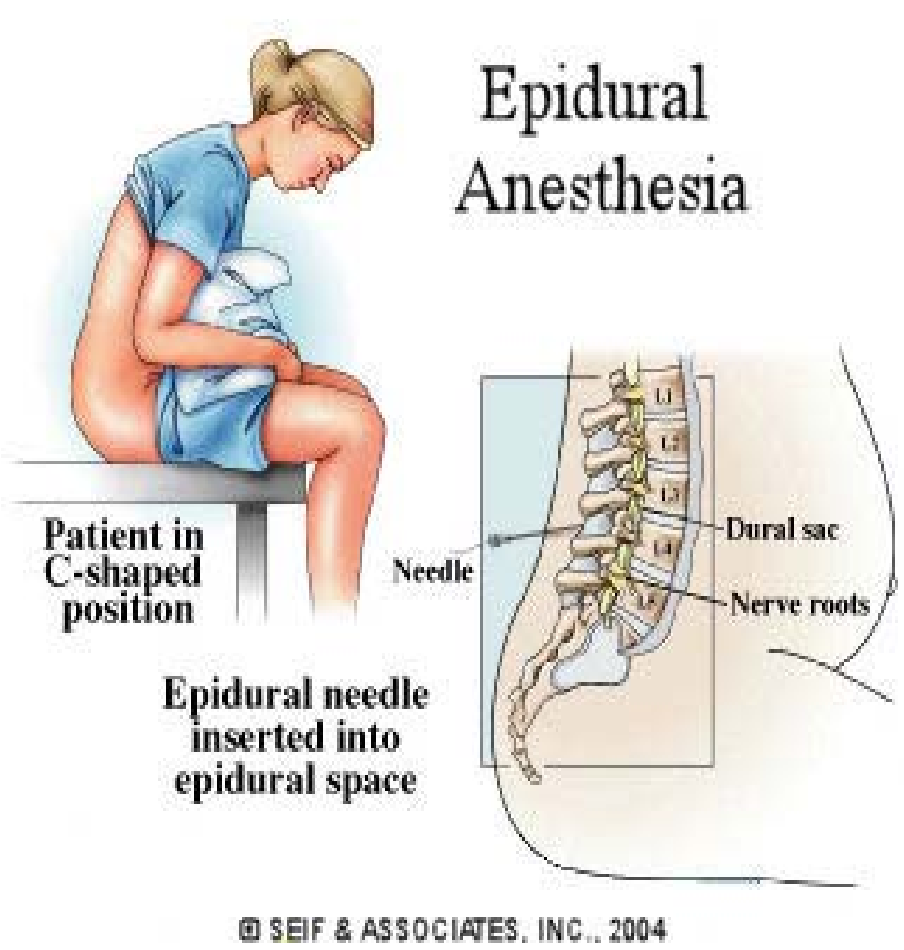
- Treatment
  - Best way to treat is physiologic not pharmacologic
  - Primary Treatment
    - Increase the cardiac preload
      - Large IV fluid bolus within 30 minutes prior to spinal placement, minimum 1 liter of crystalloids
  - Secondary Treatment
    - Pharmacologic
      - Ephedrine

IVC syndrome (pregnancy)



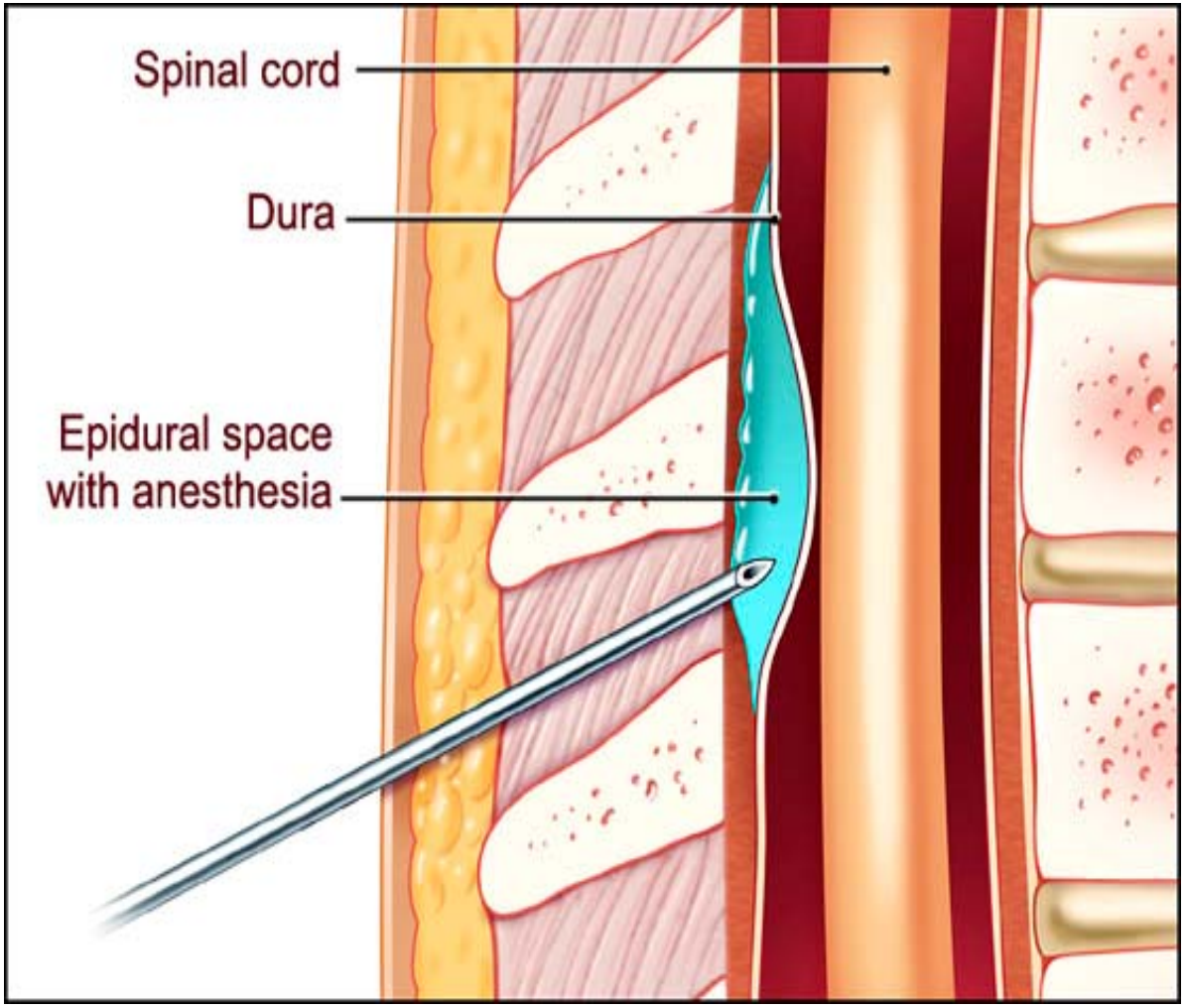
EPIDURAL ANESTHESIA

Epidural anesthesia; catheter technique

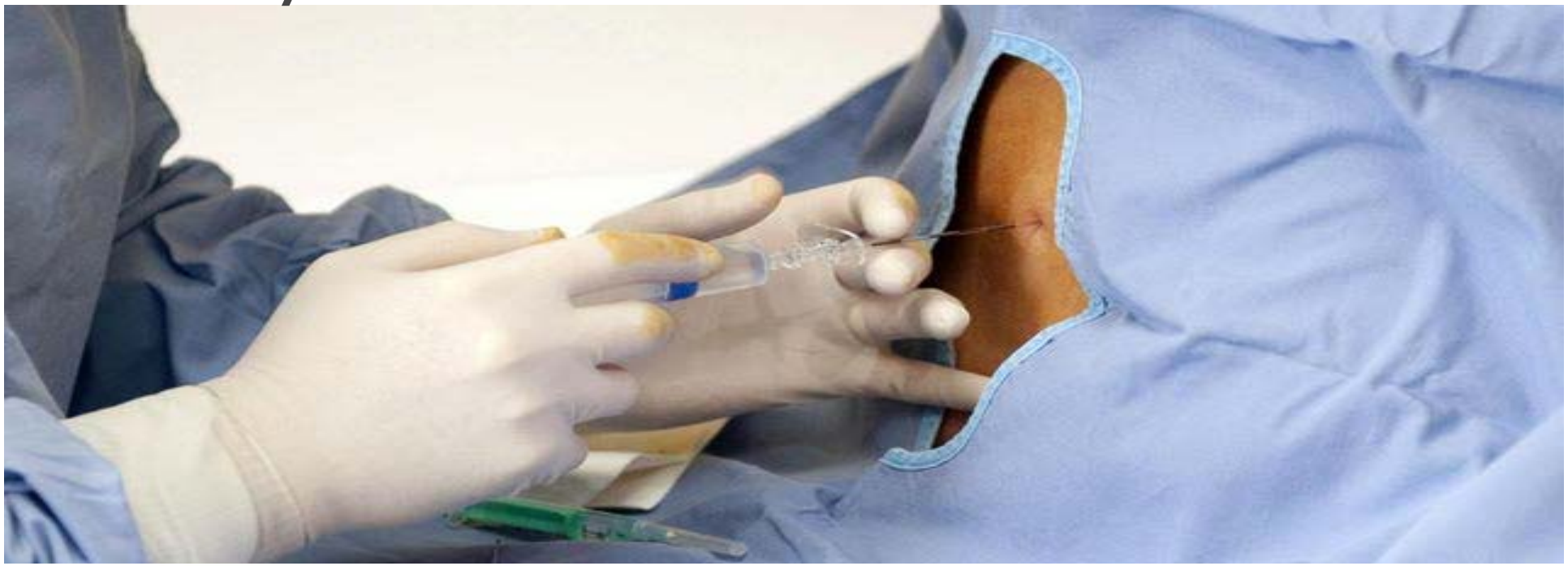


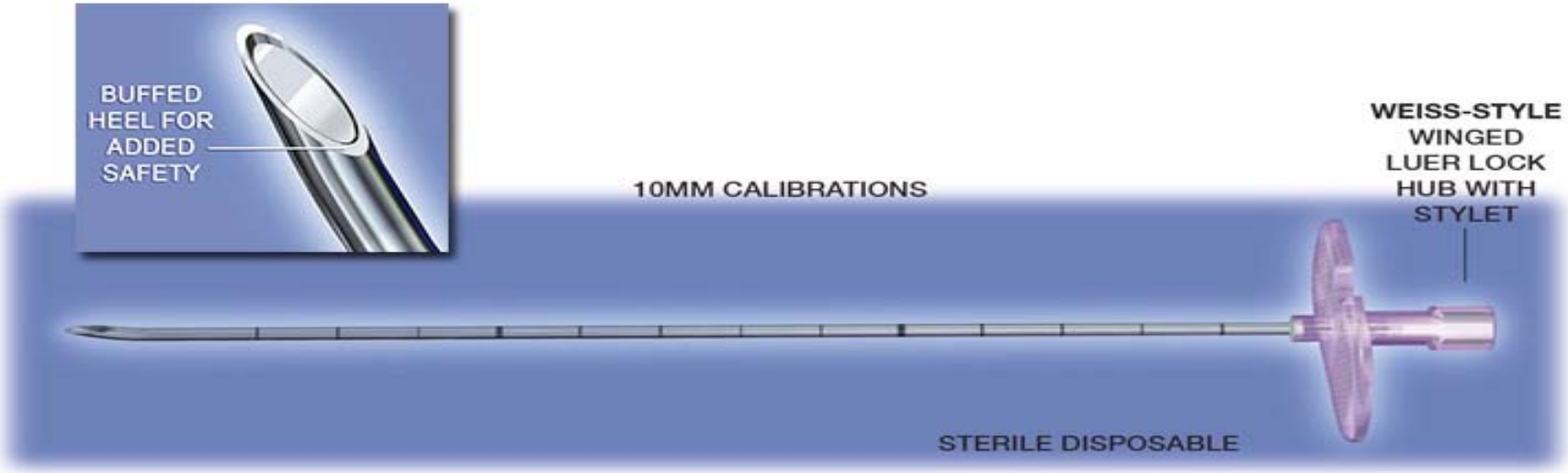
Isobaric bupivacaine (20 ml)

Slow onset (30 min), less dense block



Touhy needle





Loss of resistance technique

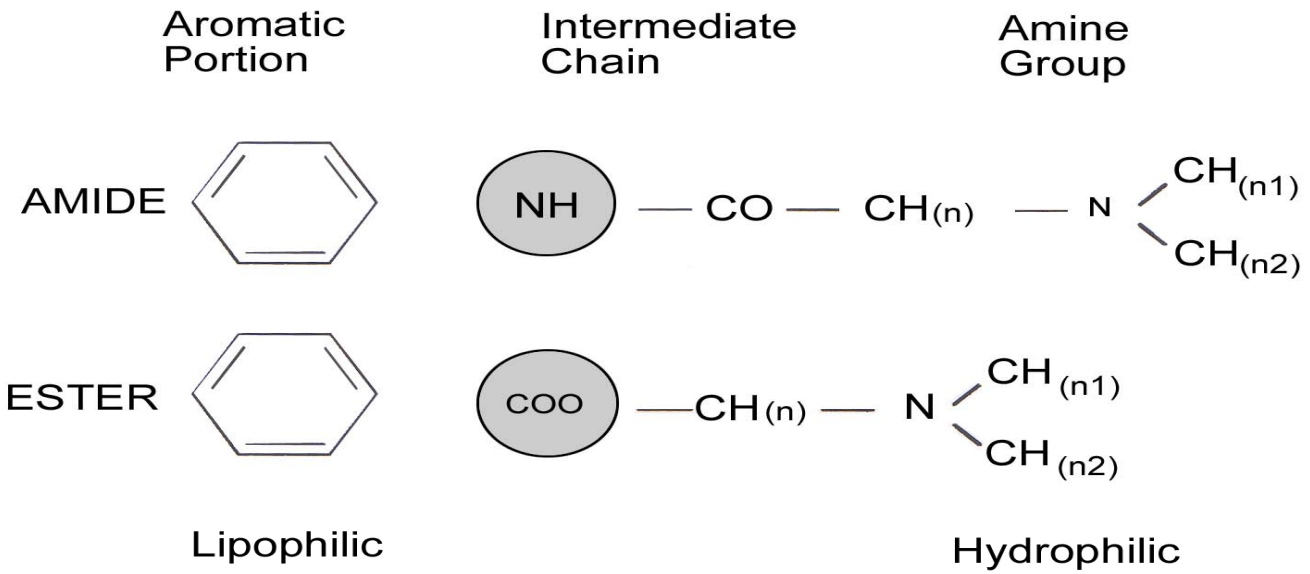
Catheter technique

Epidural Test dose

- After checking the catheter
- Careful aspiration, NO blood or CSF
- 3 ml Lidocaine 1.5% mixed with epinephrine 5 micg/ml
- With careful monitoring, give the epidural injection15-20 ml bupivacaine in allequete.


YOU ARE LEAVING
PAIN
ENJOY THE JOURNEY!

Local anesthetics

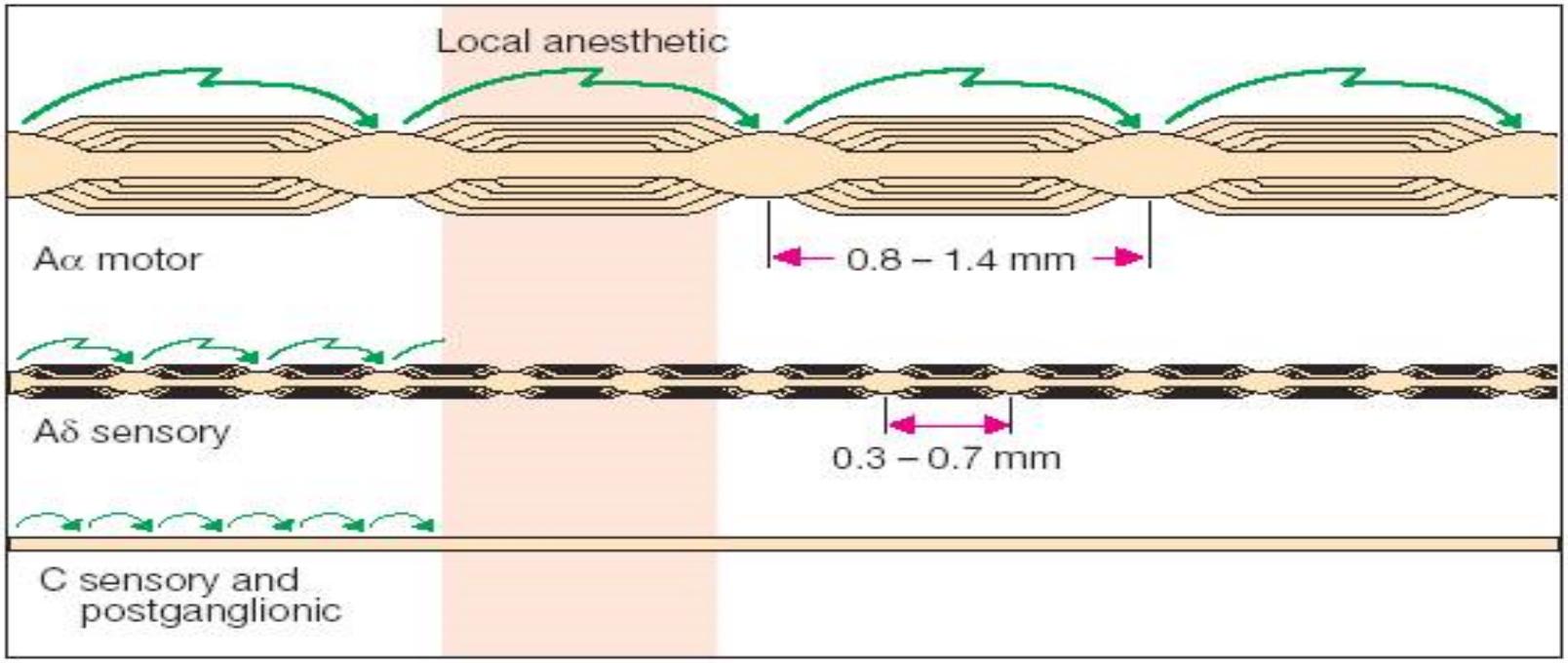


$CH_{(n)}$ = Hydrocarbon chains

{ COO = Ester Linkage
NH = Amide Linkage

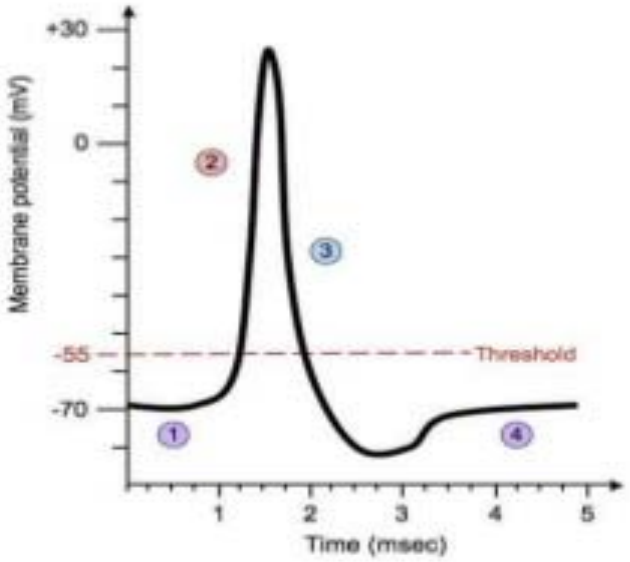
TABLE 2. Local anesthetics

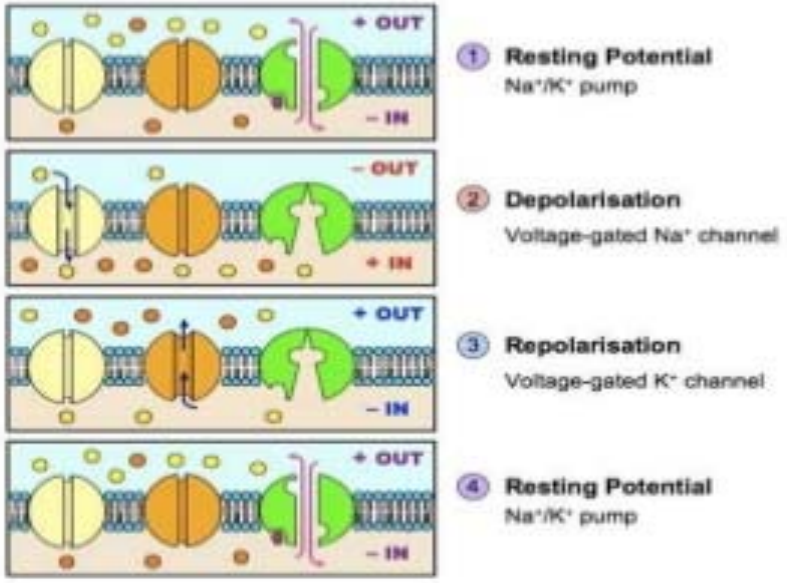
AMIDE GROUP	ESTER GROUP
Lidocaine	Cocaine
Mepivacaine	Procaine
Bupivacaine	Chloroprocaine
Etidocaine	Tetracaine
Prilocaine	



B. Inhibition of impulse conduction in different types of nerve fibers

Nerve impulse





1 **Resting Potential**
Na^+/K^+ pump

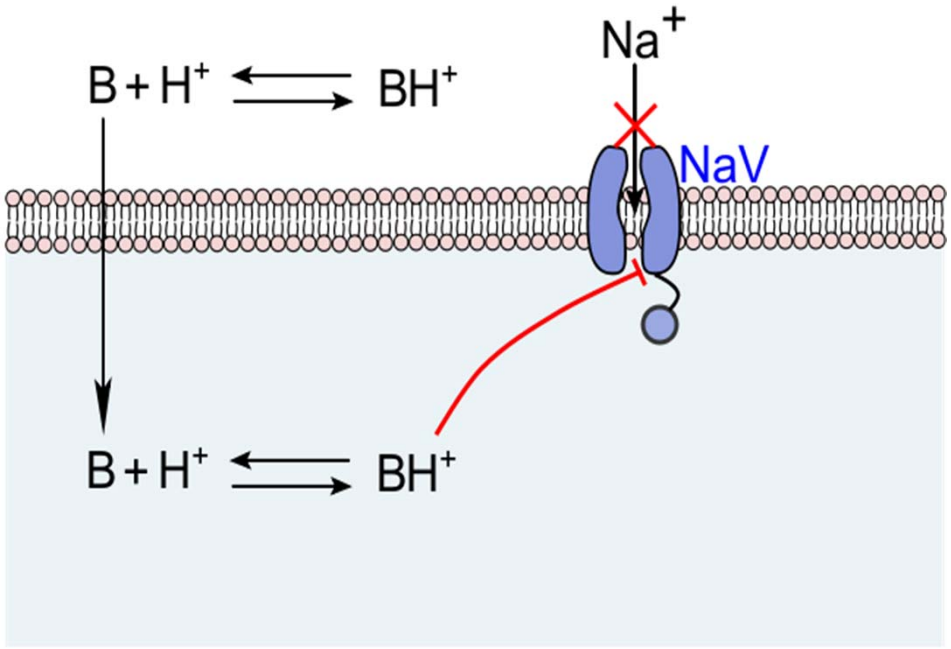
2 **Depolarisation**
Voltage-gated Na^+ channel

3 **Repolarisation**
Voltage-gated K^+ channel

4 **Resting Potential**
Na^+/K^+ pump

Mechanism of Action

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



- 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

- 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

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

LAST(CNS)

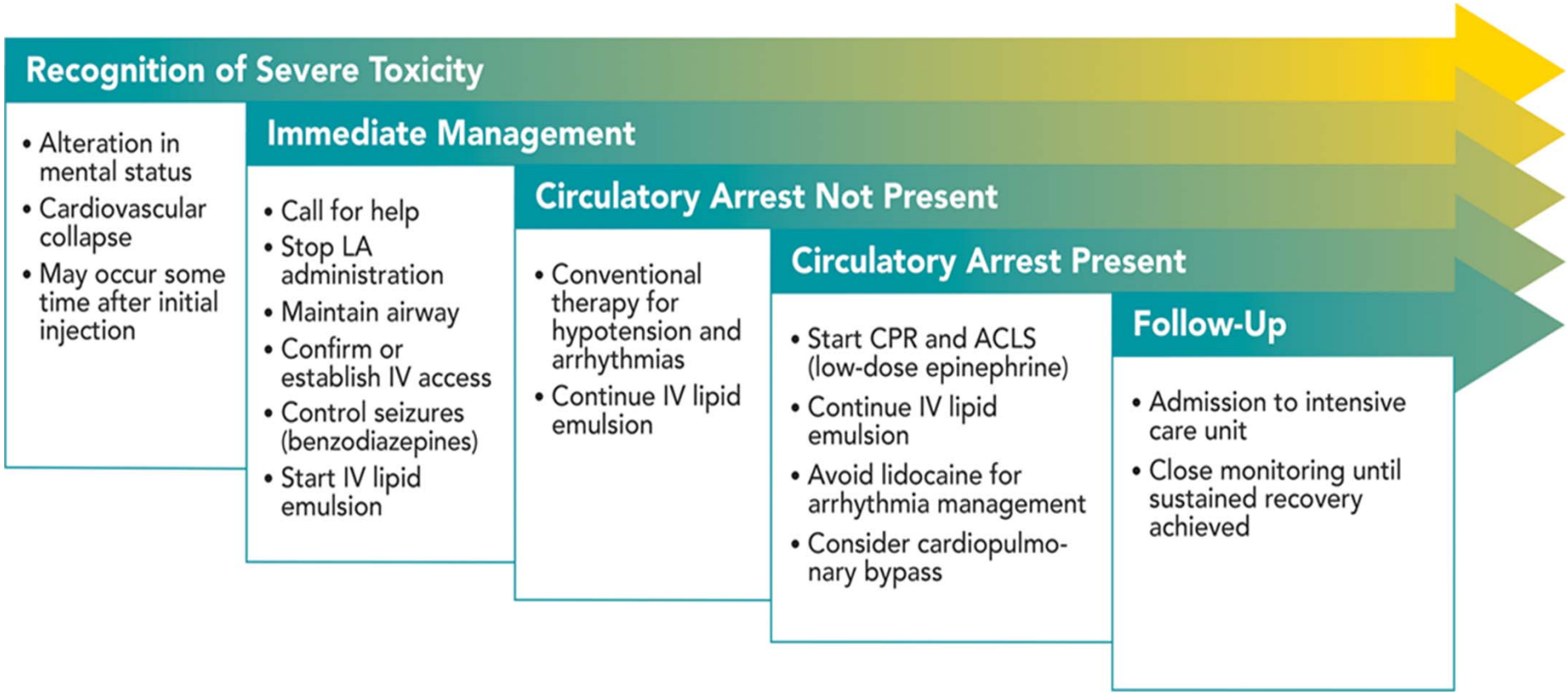
BOX 1 *Manifestations of Systemic Toxicity*

Minor (Associated With Low Plasma Levels)	Major (Associated With High Plasma Levels)
■ Perioral numbness	■ Sudden loss of consciousness
■ Facial tingling	■ Tonic-clonic seizures
■ Restlessness	■ Cardiovascular collapse
■ Tinnitus	■ Cardiac arrest
■ Metallic taste	
■ Vertigo	
■ Slurred speech	

LAST (CVS)

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

LAST; Management



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