

LUMBAR PUNCTURE

Cerebrospinal fluid drawn
from between two vertebrae (Lumbar)



ADAM.

Indication

- **Diagnosis :**
 - CNS infection, eg. meningitis, encephalitis and CNS syphilis
 - Subarachnoid hemorrhage (SAH)
 - Normal pressure hydrocephalus
- **Evaluation and diagnosis of demyelinating or inflammatory CNS processes**
 - Multiple sclerosis
 - Guillain-Barré syndrome
 - Paraneoplastic syndromes
- **Infusion of anesthetic, chemotherapy, or contrast agents into the spinal canal**
- **Treatment of idiopathic intracranial hypertension**

Contraindication

1. Idiopathic or Suspicion of **increased ICP** d/t cerebral mass

- Brain tumor
- Cerebral hemorrhage
- Abscesses
- Epidural or subdural hematomas

Signs of Increase ICP:

- Decreased levels of consciousness
- Focal neurological signs
- Papilloedema

– Rationale: LP in increased ICP may cause uncal herniation

– Exception: Therapeutic use of LP to reduce ICP

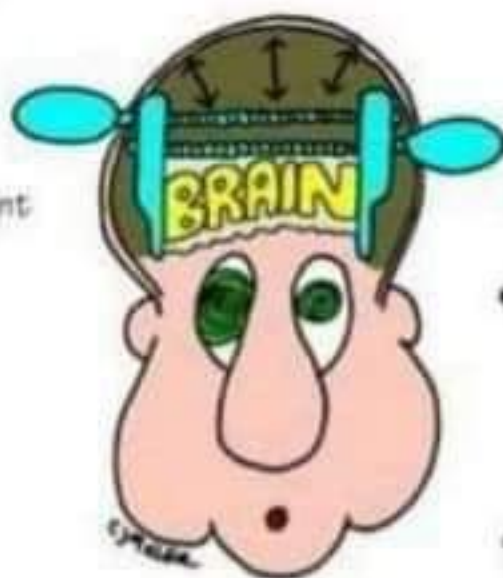
– Precaution

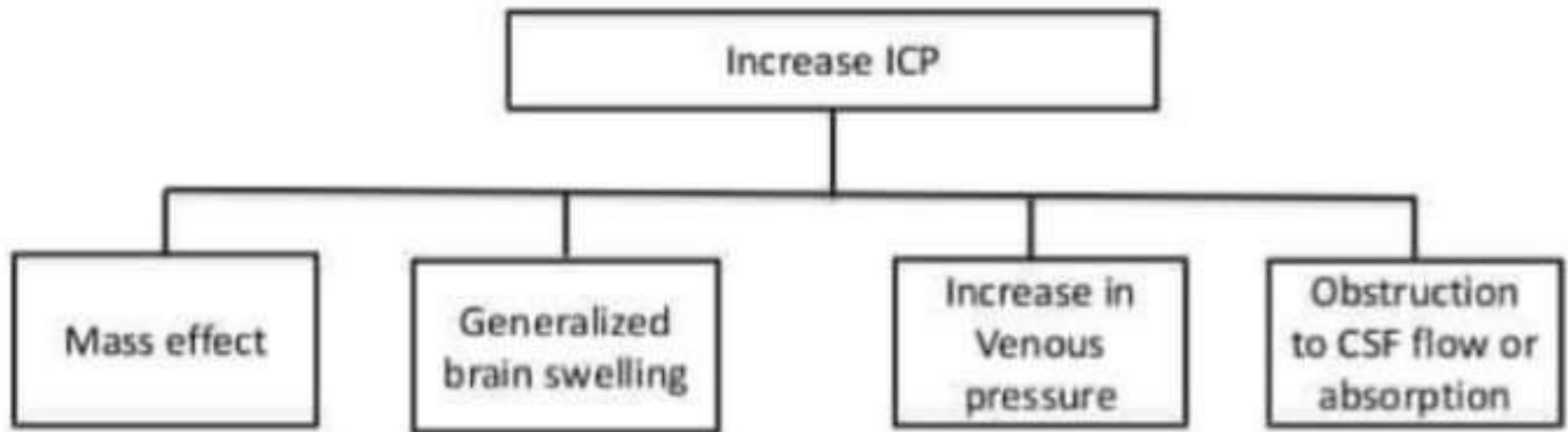
- CT brain is advocated by some, especially in the following situations
 - Age >65
 - Reduced GCS
 - Recent history of seizure
 - Focal neurological signs
- Ophthalmoscopy for papilledema

Low-pressure shunt is formed LP site where CSF can escape. As the CSF pressure drops in the spinal column, CSF and brain mass may then shift towards the low-pressure outlet (the LP site). This cause either **trans-tentorial or uncal herniation** & acute neurological deterioration.

INCREASED INTRACRANIAL PRESSURE

- Changes in LOC
- Headache
- Eyes
 - Papilledema
 - Pupillary Changes
 - Impaired Eye Movement
- Seizures
 - Impaired Sensory & Motor Function
- Posturing
 - Decerebrate
 - Decorticate
 - Flaccid
- Changes in Vital Signs:
 - Cushing's Triad:
 - ↑ Systolic B/P
 - ↓ Pulse
 - Altered Resp Pattern
- Decreased Motor Function
 - Change in Motor Ability
 - Posturing
- Vomiting
- Changes in Speech
- Infants:
 - Bulging Fontanel
 - Cranial Suture Separation
 - ↑ Head Circumference
 - High Pitched Cry





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2. Bleeding diathesis

- Uncorrected Coagulopathy
- Clotting defects such as disseminated intravascular coagulation, hemophilia or thrombocytopenia ($<50 \times 10^9/L$)
- Heparin, Warfarin
 - Reversal of warfarin with Vitamin K or fresh frozen plasma
 - Replacement of a hemophiliac's clotting factors
 - Transfusion of platelets to the thrombocytopenic patient

} Tr(x) for safe LP

3. Skin infection

- Skin infection near the site of the lumbar puncture > increases the risk of carrying the infection into the CSF with the LP needle > sepsis

4. Abnormal respiratory pattern

5. Hypertension with bradycardia and deteriorating consciousness.

6. Vertebral deformities (scoliosis or kyphosis),

7. Acute spinal trauma

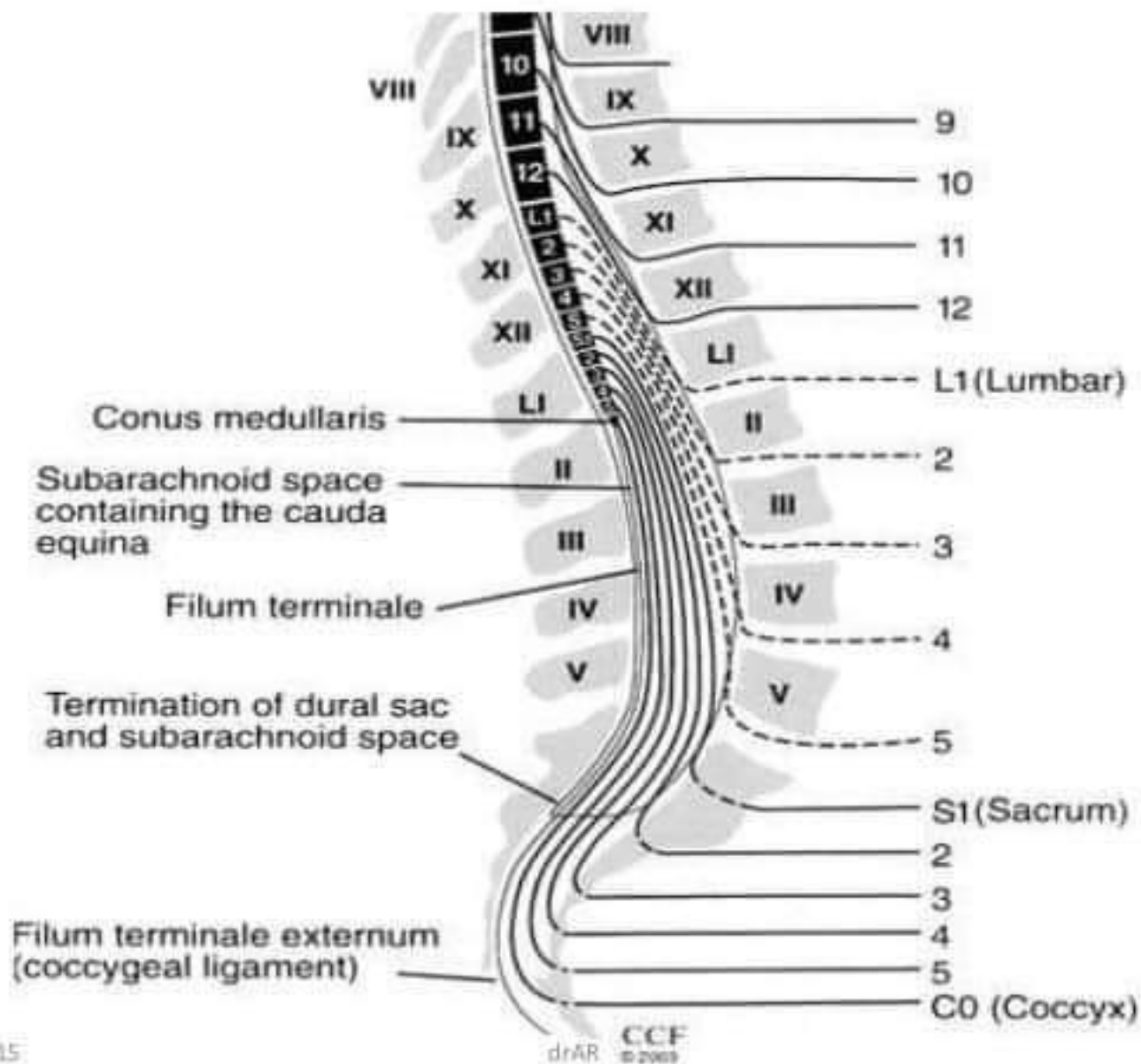
8. Obtunded state with poor peripheral perfusion or hypotension

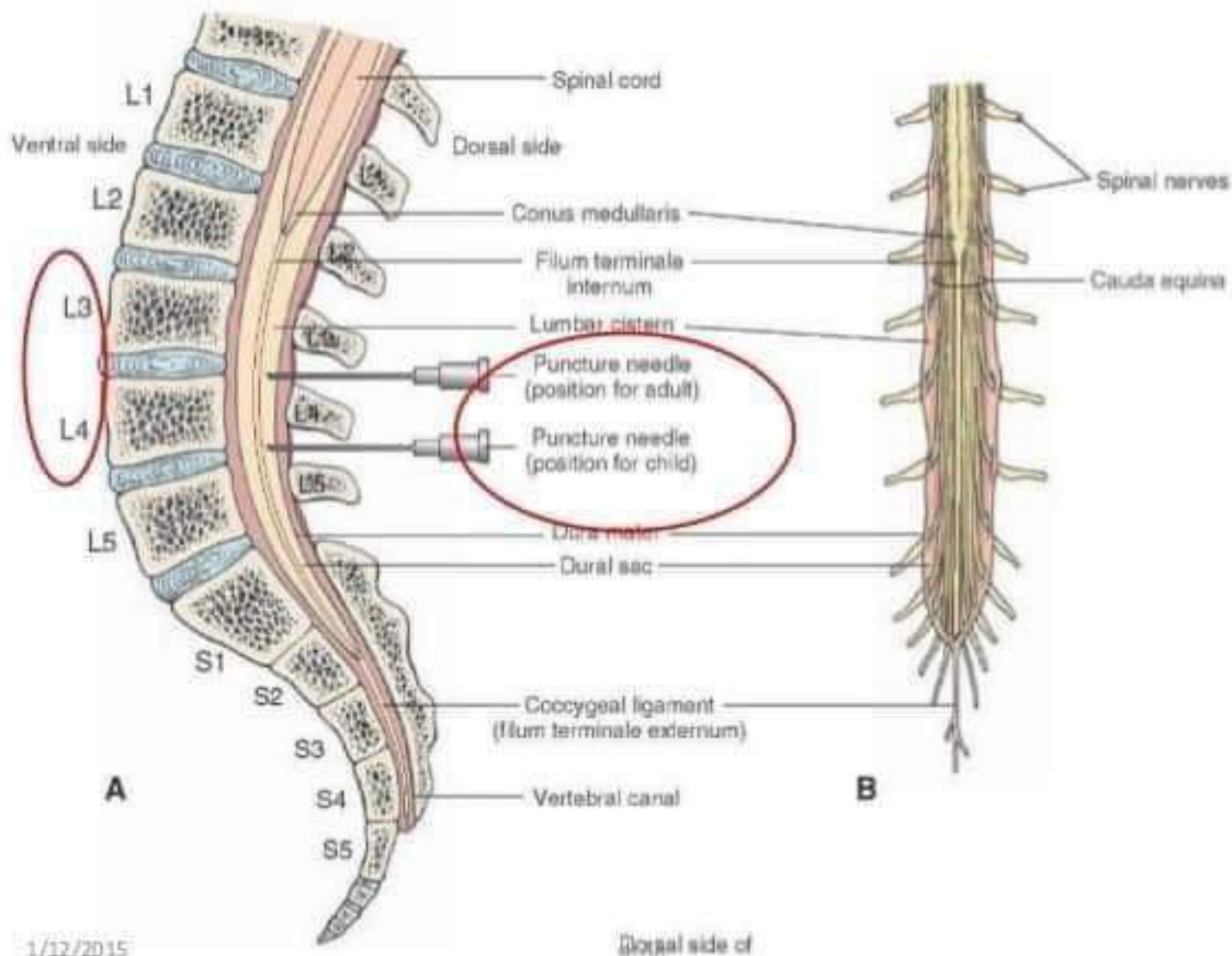
9. Seizures-prolonged or recent (within 30 minutes)

10. Inexperienced physician

Anatomy

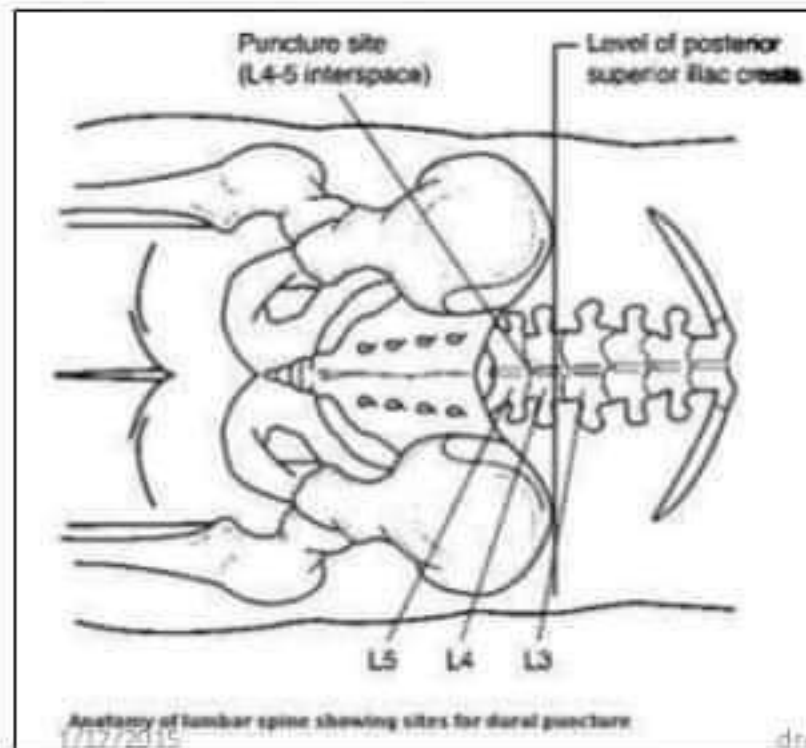
- At birth → inferior end of the spinal cord is opposite the body of the third lumbar vertebrae (L3)
- As the child grows, the vertebral column grows much faster than the spinal cord itself.
- **Adulthood** → the spinal cord only reaches the **inferior border of the L1 vertebra**, or the superior aspect of L2. In order to avoid transfixing the spinal cord during LP, the needle is placed **distal to L2**. This means the needle enters the subarachnoid space at the level of the mobile cauda equina.



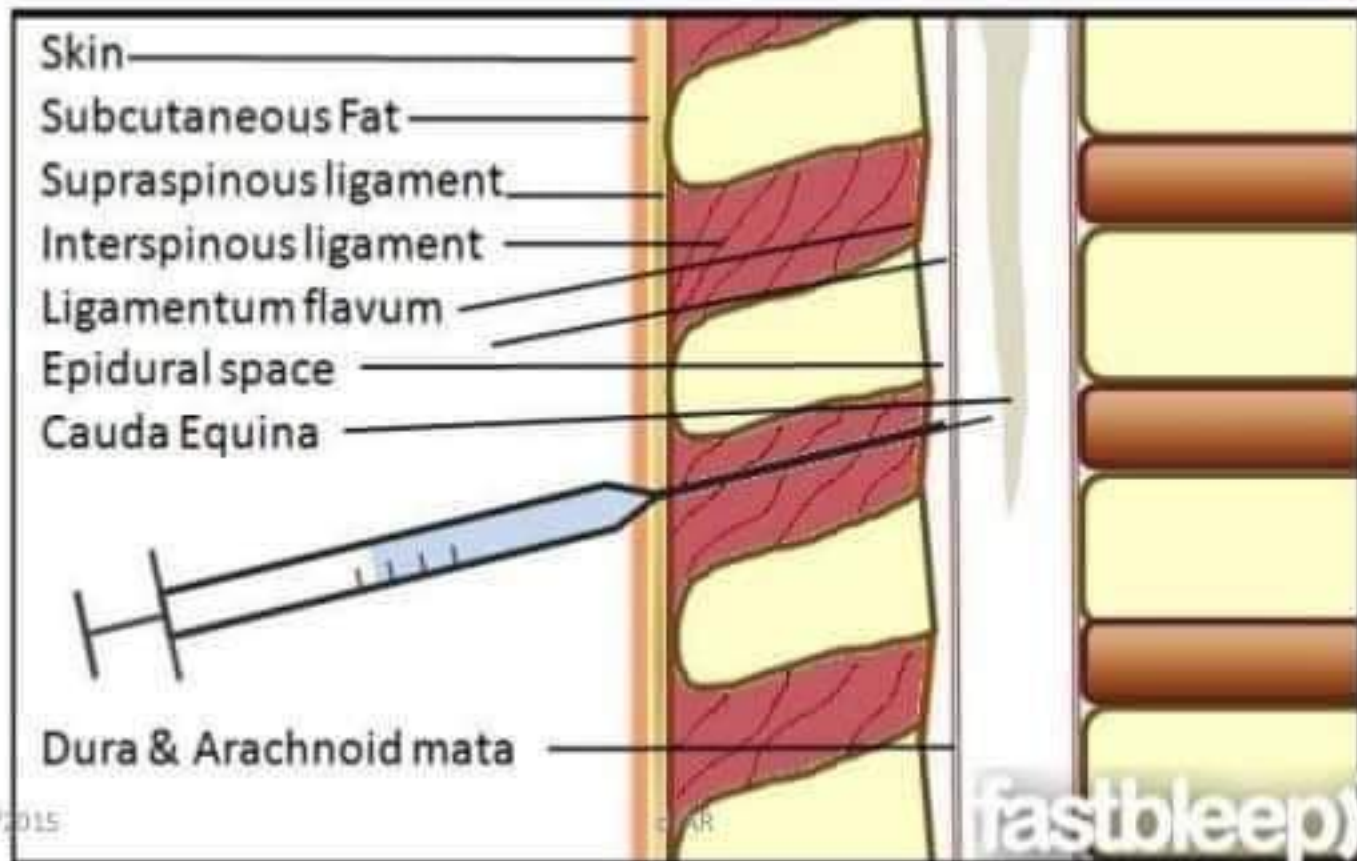


WHERE TO INSERT THE NEEDLE ??

- The **imaginary line** that crosses the lumbar region of the back **joining the posterior superior iliac crests** will cross the **L3-L4 interspace**



- The tissues pierced are (in order): skin, subcutaneous tissue, supraspinal ligament, interspinal ligament, ligamentum flavum, dura mater, the arachnoid mater and into the subarachnoid space.



THE LP KIT

- three cleaning sponges
- a 20 gauge spinal needle
- a 25 gauge and a 20 gauge needle for anesthetic infiltration
- a 3cc syringe
- a vial of 1% lidocaine for anesthesia
- a pressure manometer with tubing
- four collection vials and a Band-Aid.

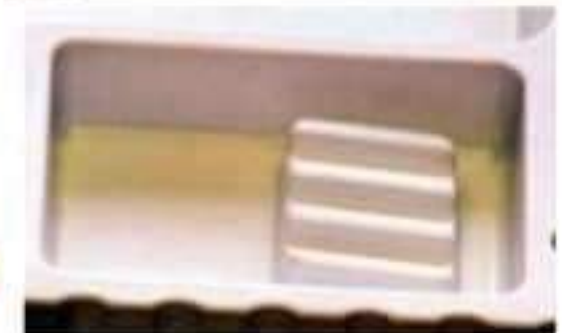
The other tools you may need include sterile gloves, gown, providine cleaning solution

Equipments



A spinal or lumbar puncture tray should include the following items:

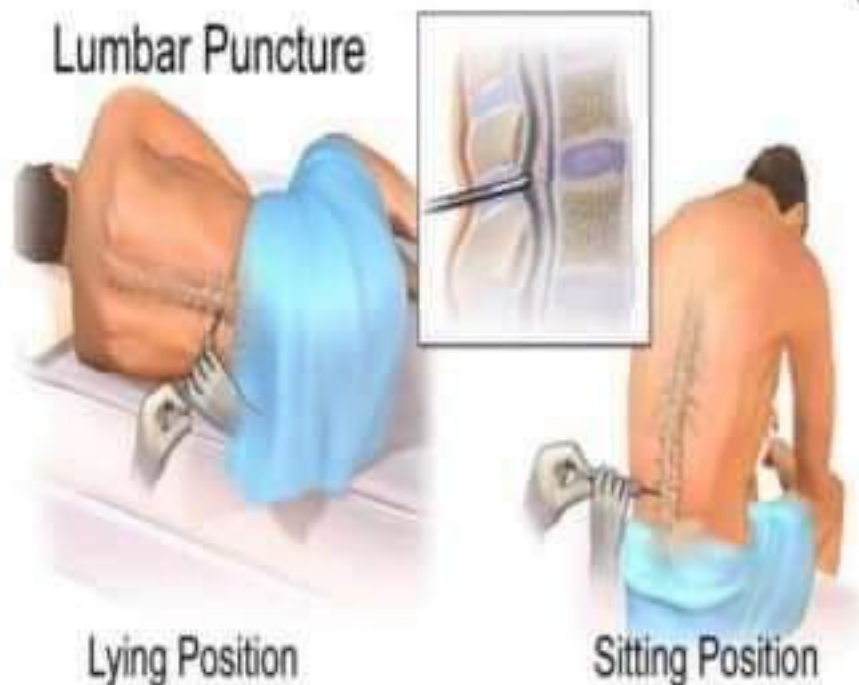
- Sterile dressing
- Sterile gloves
- Sterile drape
- Antiseptic solution with skin swabs
- Lidocaine 1% without epinephrine
- Syringe, 3 mL
- Needles, 20 and 25 gauge
- Spinal needles, 20 and 22 gauge
- Three-way stopcock
- Manometer
- Four plastic test tubes, numbered 1-4, with caps
- Syringe, 10 mL (optional)



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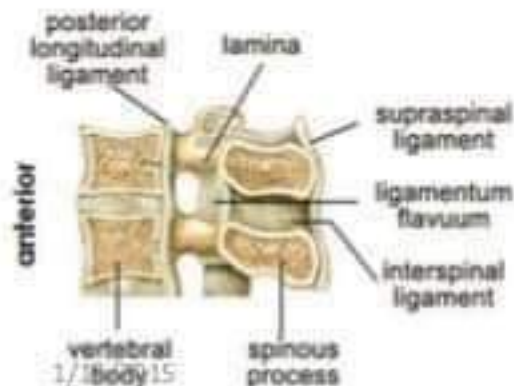
Patient Preparation

Lumbar Puncture



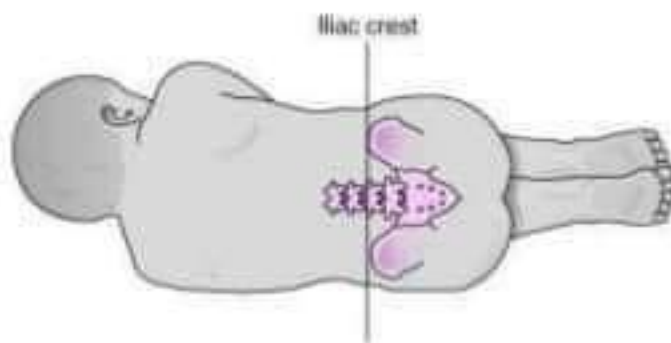
Lying Position

Sitting Position



- Local anesthesia is employed for lumbar puncture
- The patient is placed in the lateral recumbent position with the hips, knees, and chin flexed toward the chest so as to open the inter-laminar spaces or interspinous distance
- A pillow may be used to support the head
- Inter-laminar space
- Inter-spinous diameter

Lateral Decubitus Position



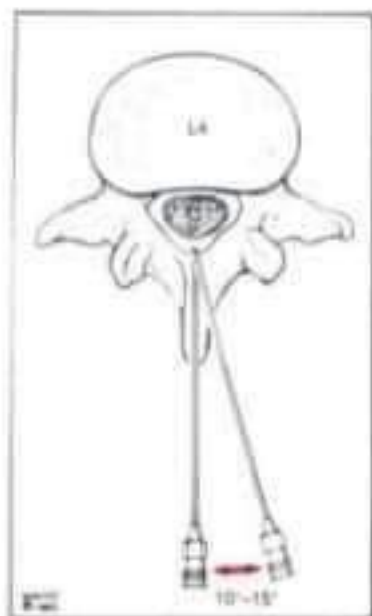
- Apply topical anesthetic 30-45 min prior to procedure
- Spinal cord ends at L1-L2, so sites for puncture are located at L3-L4 or L4-L5
- Restrain patient in lateral decubitus position
 - Maximally flex spine without compromising airway
 - Keep alignment of feet, knees and hips
 - Position head to left if right handed or vice versa

Sitting Position



- Restrain infant in the seated position with maximal spinal flexion
 - Hold infant's hands between flexed legs with one hand and flex head with the other hand
- Drape patient below buttocks and fenestrated drape opening over puncture site
- Insert needle so bevel is parallel to spinal cord (Bevel left or right)
- Cannot measure pressure accurately in this position

Paramedian (Lateral) Approach



- Use for patients who have calcifications from repeated LPs or anatomic abnormalities
- Needle passes through erector spinae muscles, and ligamentum flavum
 - Bypasses supraspinal and interspinal ligaments
- Less incidence of spinal headache

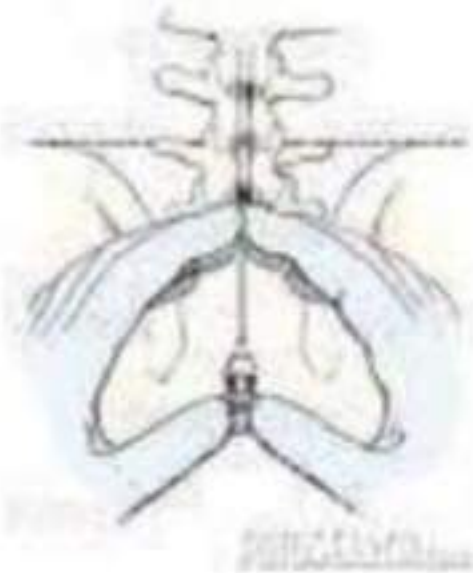
Procedure

- Cleanse skin with povidone iodine from puncture site radially out to 10 cm and ALLOW TO DRY
- Drape below patient and around site with fenestrated drape
- Anesthetize with lidocaine if topical not used by:
 - Intradermally raising a wheal at needle insertion site
 - Advance needle through wheal to desired interspace
 - Careful not to inject into a blood vessel or spinal canal
- Insert spinal needle with stylet with bevel up to keep cutting edge parallel with nerve and ligament fibers

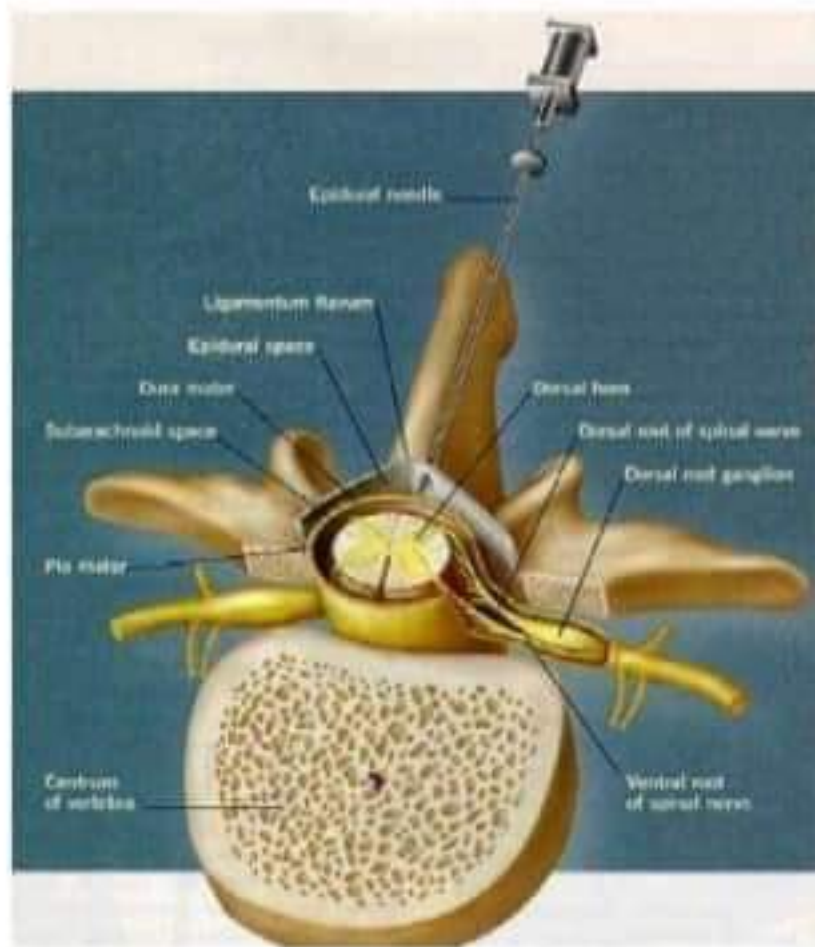
Procedure



- Aim towards umbilicus directing needle slightly cephalad
- Hold needle firmly



Procedure



- A “pop” of sudden decrease in resistance indicates that ligamentum flavum and dura are punctured
- Remove stylet and check for flow of spinal fluid

Procedure

- If no fluid, then:
 - Rotate needle 90°
 - Reinsert stylet and advance needle slowly checking frequently for CSF
- Jugular vein compression can increase CSF pressure in low flow situations
- If bony resistance is felt immediately then you are not in the spinal interspace
- If bony resistance is felt deeply, then withdraw needle to the skin surface and redirect more cephalad and increase patient flexion
- If bloody fluid that does not clear or that clots results, then withdraw needle and reattempt at a different interspace

PROCEDURE



Normal CSF Parameter

Opening pressure	90-180 mm H ₂ O / 6.6 – 13.2 mmHg (with patient lying in lateral position)
Appearance and color	Clear, colorless
Blood cell count and differential	<ul style="list-style-type: none">• White blood cells: < 5 (all mononuclear)• Red blood cells: 0
Glucose	2.8 – 4.4 mmol/L, 50 - 80 mg/dL (or greater than two-thirds of blood glucose)
Total protein	15-45 mg/dL
Bacteria (Gram stain, culture, VDRL)	Negative
pH	7.28-7.32
Antibodies, viral DNA	None
Lactate dehydrogenase (LDH)	< 2.0-7.2 U/mL
Lactate	<ul style="list-style-type: none">• Newborns 10-40 mg/dL• Older children and adults 10-25 mg/dL
Chloride	110-125 mmol/L
Cancerous cells	None
Cryptococcal antigen	None
Glutamine	6-15 mg/dL

Test	Appearance	Pressure	WBC/ μ L	Protein mg/dL	Glucose mg/dL	Chloride
Normal CSF	Clear	90 – 180 mm	0-8 lymph.	15-45	50-80	115-130 mEq/L
Acute bacterial meningitis	Turbid	Increased	1000 -10000	100 – 500	< 40	Decreased
Viral meningitis	Clear	Normal to moderate increase	5-300, rarely >1000	Normal to mild increased	Normal	Normal
Tubercular meningitis	Slightly opaque cobweb formation	Increased/ decreased, spinal block	100-600 mixed or lymph.	50-300 due to spinal block	Decreased	Decreased
Fungal meningitis	Clear	Increased	40-400 mixed	50-300	Decreased	Decreased
Acute syphilitic	Clear	Increased	About 500 lymph	Increased but <100	Normal	normal

Conditions associated with a **reactive CSF lymphocytosis** include the following:

- Meningitis
- Syphilitic meningoencephalitis
- Parasitic CNS infection
- Multiple sclerosis
- Guillain-Barré syndrome
- Polyneuritis

Conditions associated with **CSF monocytosis** include the following:

- Chronic or treated bacterial meningitis
- Syphilitic, viral, fungal, amebic meningitis
- Intracranial hemorrhage
- Cerebral infarct
- CNS malignancy

Conditions associated with increased CSF polymorphonuclear neutrophils include the following:

- Bacterial meningitis
- Acute viral meningitis
- Tuberculous and fungal meningitis
- Amebic encephalomyelitis
- Brain abscess
- Subdural empyema
- CNS hemorrhage
- Cerebral infarct
- Malignancies
- Previous lumbar puncture
- Intrathecal chemotherapy
- Seizure

Complication of Lumbar Puncture

1. Post LP headache (most common)

- Usually begins 24-48 hours after the procedure
- Probable etiology is continued leakage of CSF
- Bilateral pressure or throbbing that is intensified in the upright position
- Self-limited (≤ 7 days), uncommon less than 10 yo

2. Post LP back pain

- Occasionally with short-lived referred limp
- Disc herniation if needle advanced too far

3. Bloody tap / Dry tap

- Bloody: Micro-trauma caused by spinal needle
- Dry: misplacement, dehydrated patient (low csf)

4. Infection to the CSF

- Can occur with breaks in sterile technique, use of contaminated equipment and placement of the needle through infected skin
- Cellulitis, skin abscesses, epidural abscesses, spinal abscesses

5. Hemorrhage (low platelets counts /coagulopathies)

6. Dysesthesia (impairment of sensation)

7. Post-dural puncture cerebral herniation (most serious but very rare)

- risk of herniation is 0 –5 % in those patients who are known to have intracranial masses

Herniation

- Manifests initially as altered mental status, followed by cranial nerve abnormalities and Cushing triad
- May be rapidly fatal.
- Immediately remove needle and raise the head of bed to 30-45° improve venous return from the brain.
- Mannitol or 3% Saline
- Intubate patient and hyperventilate
- Emergent neurosurgical consult