

NEUROLOGICAL INVESTIGATIONS

Group C10

AGENDA

Cerebrospinal Fluid Analysis
Computed Tomography
Magnetic Resonance Imaging
Vascular Imaging Studies
Other Imaging Studies

CSF ANALYSIS

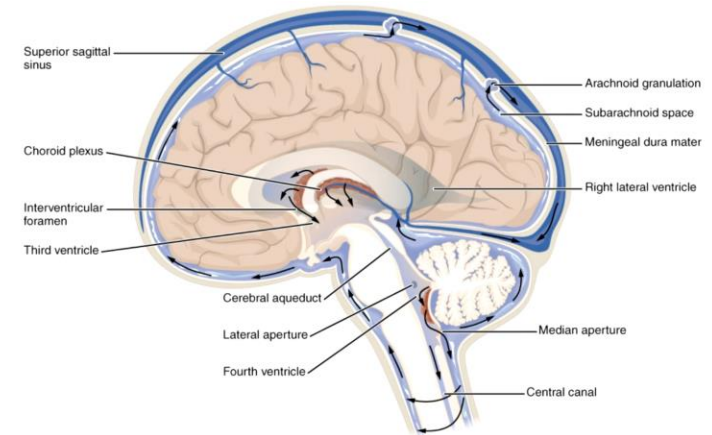
CSF is mainly: an ultrafiltrate or fluid of the spinal canal and the subarachnoid space (surrounding the brain and spinal cord).
a clear, colorless fluid formed in the ventricles of the brain mainly by choroid plexus.
reabsorbed into the blood through the arachnoid villi of dural venous sinuses
produced continually at a rate of about 0.5 mL per minute; the total volume is approximately 150 mL.

Functions of CSF: Protection, nutrition and removal of waste

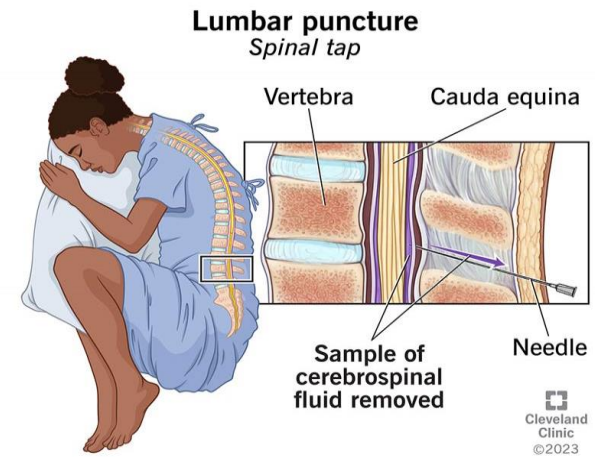
Collection of CSF ➡ Lumbar puncture (LP) at the **L3-L4 or L4-L5 interspace** (Remember that the spinal cord ends at the level of L1-L2).

Contraindications of LP:

- Presence of a space-occupying lesion that is causing mass effect in the CNS.
- Raised ICP.
- Local infection or inflammation at the puncture site > Risk of introducing the infection into the CSF+CNS (Meningitis).
- Significant coagulopathy > Risk of bleeding complications (Spinal hematoma, intracranial hemorrhage).



LP TECHNIQUE



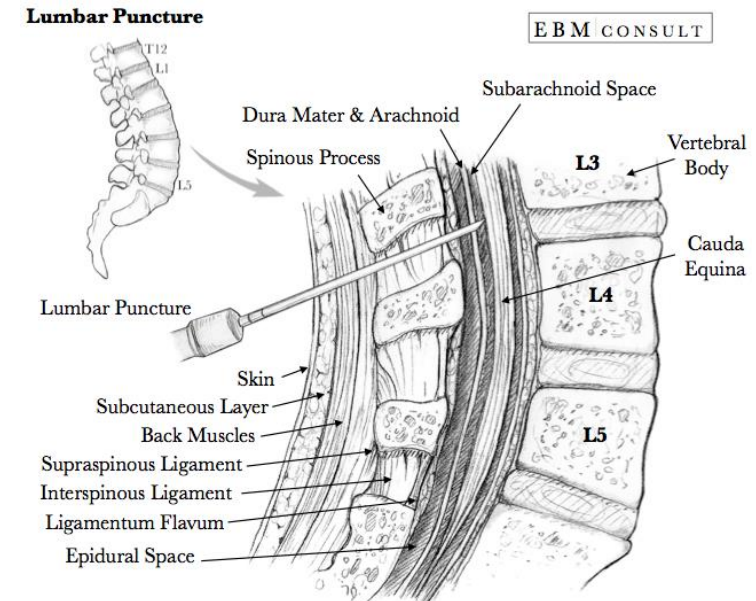
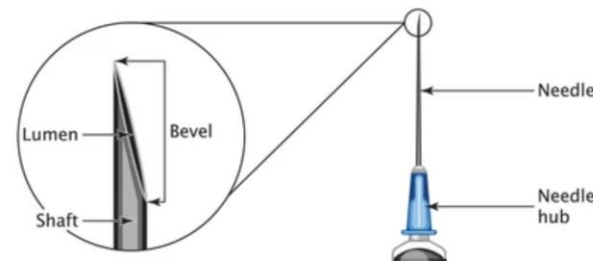
Optimal positioning is the key to a successful and atraumatic LP: lateral decubitus position with the legs flexed up over the abdomen.

Ideally, a pillow should be placed between the legs, and the patient should lie on the edge of the bed where there is better support to keep the back straight. The anterosuperior iliac spine is at the level of the LP.

The needle is: inserted with the bevel facing upward, so that it will enter parallel to the ligaments and dura that it pierces rather than cutting them transversely. directed slightly rostrally to coincide with the downward angulation of the spinous processes. advanced gently until CSF is obtained.

To measure the opening pressure reliably, the patient's legs should be extended slightly and note should be made of fluctuation of the CSF meniscus within the manometer with respiration.

Normally in the lateral recumbent position is about 60 to 150 mm H₂O



SAFETY, TOLERABILITY, AND COMPLICATIONS

Cerebral or cerebellar herniation may occur when LP is performed in the presence of either a supratentorial or infratentorial mass lesion.

A computed tomography (CT) scan should be performed prior to an LP when there are examination findings raising concern for increased ICP, focal neurologic findings, or severe encephalopathy.

Radiologic contraindications to LP include: closure of the fourth ventricle and quadrigeminal cistern.

COMPLICATIONS:

Low-pressure headache is the most common complication of LP. It is most effectively prevented by:

- Using smaller (higher gauge) LP needles. (22-gauge needle is thinner than an 18-gauge needle).
- Inserting the bevel of the LP needle parallel rather than perpendicular to the dural fibers.
- Replacing the stylet after obtaining CSF.

Should a post-LP headache develop, it is treated initially by having the patient lie flat and increase his or her intake of liquids and caffeine.

- In patients who do not respond to these conservative measures, it may be necessary to administer an epidural blood patch.

INTERPRETATION OF RESULTS

Normal CSF Analysis

Normal Physical Examination	
Appearance & Color	Clear ,Colorless
pH	7.4
Daily Secretion	450-500 ml
Specific Gravity	1.006-1.007
Normal Microscopic Examination	
Lymphocytes	1-5 /H.P.F
Normal Chemical Examination	
Protein	15-45 mg/dl
Glucose	50-80 mg /dl
Chloride	115-130 mmol /L
Calcium	1.0-1.40 mmol/L
Phosphorus	0.4-0.7 mmol/L
Magnesium	1.2-1.5 mmol/L
Potassium	2.6-3.0 mmol/L
Normal Microbiological Examination	
No pathogenic microorganisms	

INTERPRETATION OF RESULTS

TABLE 2-1. Interpretation of CSF Findings

Red Blood Cells	
No xanthochromia	Traumatic tap
Xanthochromia	Subarachnoid hemorrhage; hemorrhagic encephalitis
White Blood Cells	
Polymorphs	Bacterial or early viral infection
Lymphocytes	Infection (viral, fungal, mycobacterial); demyelination (MS, ADEM); CNS lymphoma
Elevated protein	Infection (fungal, mycobacterial); demyelination; tumor (e.g., meningioma, meningeal carcinomatosis); sarcoidosis; age
Low glucose	Bacterial infection; mycobacterial infection
Oligoclonal bands	Demyelination (MS); CNS infections (e.g., Lyme disease); noninfectious inflammatory processes (e.g., SLE)
Angiotensin-converting enzyme	May be elevated in neurosarcoidosis
ADEM, acute disseminated encephalomyelitis; CNS, central nervous system; CSF, cerebrospinal fluid; MS, multiple sclerosis; SLE, systemic lupus erythematosus	

INTERPRETATION OF RESULTS

TABLE 2-2. CSF Findings in Common Neurologic Diseases

Disease	Cells (Pleocytosis)	Protein	Glucose	Other
Bacterial meningitis	Polymorphs	High	Low	Culture and Gram stain may be positive
Viral meningitis/encephalitis	Lymphocytes	High	Normal	Viral PCR may be positive
Tuberculous meningitis	Lymphocytes	High	Very low	Positive for acid-fast bacilli
Guillain–Barré syndrome	None	High (degree depends on interval from symptom onset)	Normal	—
Multiple sclerosis	Several lymphocytes	Slightly high	Normal	OCBs usually present
ADEM	Lymphocytes or polymorphs	Usually high	Normal	OCBs usually absent
Subarachnoid hemorrhage	Lymphocytes and many RBCs	May be high	Normal	Xanthochromia
ADEM, acute disseminated encephalomyelitis; CSF, cerebrospinal fluid; OCB, oligoclonal bands; PCR, polymerase chain reaction; RBC, red blood cell.				

COMPUTED TOMOGRAPHY (CT)

CT measures the degree of X-ray attenuation by tissue.

Attenuation: The removal (by absorption or scatter) of X-ray photons and is quantified on an arbitrary scale (in **Hounsfield units**) that is represented in shades of gray.
-Differences in the shades reflect the differences in the X-ray attenuation of different tissues → depends on their atomic number and physical density.

Images are usually obtained in either an **axial or a coronal plane**.

CT scans are used to look at things like: **Bones, stones, blood**, organs, lungs, cancer stages and abdominal emergencies.

Head CT is often the initial investigation used in a variety of neurologic disorders: (headache, trauma, seizures, subarachnoid hemorrhage, and stroke).

-**Contrast enhancement** indicates **local disruption of the blood-brain barrier**.

Sensitivity of CT scan:

-Depends on many factors (**Nature and duration** of the underlying disease process).

-Can be increased by: the administration of **intravenous contrast** (Detection of areas of inflammation, infection, or tumor).

↗ Iodine-based contrast

MAGNETIC RESONANCE IMAGING (MRI)

MRI is a type of scan that uses **strong magnetic fields and radio waves** to produce detailed images of the inside of the body.

- It **differs from CT** in its use of radiofrequency (RF) pulses rather than X-rays → **safe in pregnant women.**
- An MRI scanner is a large tube that contains powerful magnets. You lie inside the tube during the scan.

MRI is the gold standard for imaging **soft tissues**, including muscles, ligaments, and tendons.

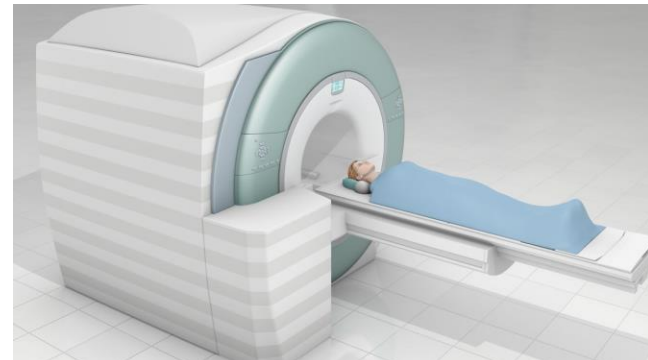
Contrast agents are typically **gadolinium-based**.

- It is **not safe** when **metal objects** (foreign bodies, plates, and screws) and **pacemaker and defibrillator devices** are present or **artificial joints**, unless those materials have been made MRI compatible.
- Some people with claustrophobia cannot tolerate MRI; under these circumstances, CT is preferred.
 - ↑ specific phobia of confined, tight, enclosed, or crowded spaces

MRI with gadolinium-based contrast is often preferred for patients with a history of **allergies to iodinated contrast agents** and for those at **risk of kidney damage**, due to the lower risk of allergic reactions and nephrotoxicity.

CT VS MRI

	CT	MRI
Technology	X-ray.	Magnets and radio waves.
Examples of uses	Bones, stones, blood, organs, lungs, cancer stages and abdominal emergencies.	Joints, nerves, brain and masses.
Risks	Potential for radiation exposure.	Not for people with some metal implants or who can't lie still for the procedure.
Procedure time	Less than a minute.	20 to 50 minutes. People must lie very still throughout.



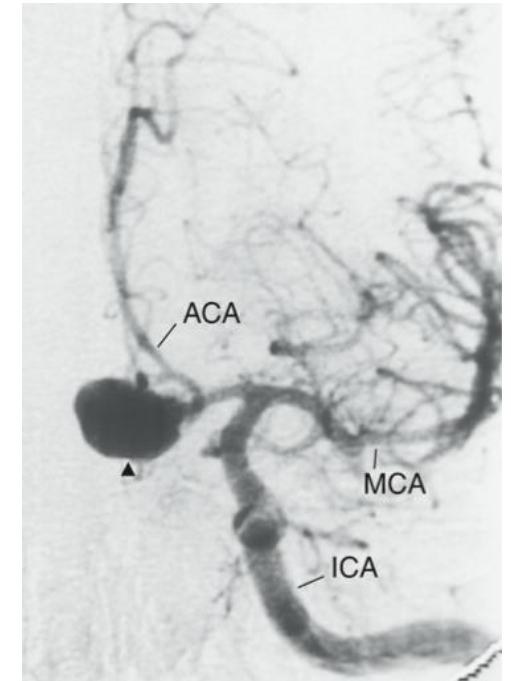
VASCULAR IMAGING STUDIES

❖ **Conventional angiography** involves cannulation of the great vessels and injection of contrast material to obtain an image of the vascular anatomy. This is the most sensitive and specific imaging study of the **intracranial and extracranial circulation**.

Risks of conventional angiography:

- ✓ Contrast reaction.
- ✓ Stroke caused by plaque dislodged by the catheter.
- ✓ Bleeding at the cannulation site.

Although the risks of the procedure and developments in magnetic resonance angiography (MRA) have decreased the use of conventional angiograms, it remains the **"gold standard"** in vascular imaging.



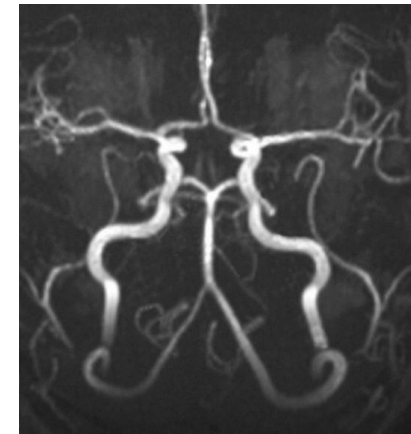
Conventional cerebral angiogram demonstrating aneurysm of the right middle cerebral artery (arrow)

VASCULAR IMAGING STUDIES

❖ Magnetic Resonance Angiography (MRA) → uses blood flow as a contrast agent and MR technique to define vascular anatomy.

Compared with conventional angiography, MRA is:

- ✓ Less invasive.
- ✓ Performed more quickly.
- ✓ Less expensively.
- ✓ Not as sensitive or specific for cerebrovascular disease.



MRA of the circle of Willis.

MRA is performed commonly on the intracranial circulation of stroke patients to look for evidence of vascular narrowing or occlusion.

Another type of MRA is "Fat-suppressed" MRA of the neck is useful for determining the presence of vertebral or carotid artery dissections.

VASCULAR IMAGING STUDIES

- ❖ Magnetic resonance venography (MRV) → used to demonstrate venous sinus thrombosis and other venous disease.
- ❖ CT angiography (CTA):
 - CTA of the head is most often used for patients determine whether there is a vascular occlusion that might be amenable to mechanical thrombectomy or intra-arterial tPA (tissue plasminogen activator).
 - CTA of the neck may identify carotid artery stenosis or dissection of the carotid or vertebral arteries.
- ❖ Extracranial Doppler sonography → measures blood flow by determining the difference between emitted and received ultrasound frequencies.
 - used commonly to detect stenosis or occlusion of the extracranial carotid circulation, especially in the planning stages for carotid endarterectomy.
- ❖ Transcranial Doppler (TCD) detects intracranial stenosis, emboli, and vasospasm occurring after subarachnoid hemorrhage.
 - Most of the intracranial circulation, however, is inaccessible to TCD.

Although somewhat less accurate than MRA or conventional angiography, Doppler studies are noninvasive and essentially without contraindication.

OTHER IMAGING STUDIES

❖ **18-fluorodeoxyglucose positron emission tomography (FDG-PET) scans** → measure regional brain metabolism.

-They are most often employed in the presurgical evaluation of epilepsy patients.

Hypermetabolism can be demonstrated during seizures (although obtaining the scan during a seizure is challenging), whereas hypometabolic regions may be evident interictally.

PET scans can also be useful in differentiating among the degenerative dementias: Hypometabolism is more prominent in the temporal and parietal lobes in Alzheimer disease patients, in the frontal and temporal regions in frontotemporal dementia patients, and in the occipital region in dementia with Lewy body patients.

❖ **Amyloid PET imaging:**

It is a molecular imaging technique which uses a radiotracer to detect elevated levels of β -amyloid in the brain in patients with Alzheimer.

-It can be used to distinguish between patients with Alzheimer disease, those with other dementias, and normal subjects.

OTHER IMAGING STUDIES

❖ Single-photon emission computed tomography (SPECT):

Uses a radioactive isotope to demonstrate increased blood flow during seizures or decreased blood flow in the degenerative dementias.

❖ Dopamine transporter SPECT (DaT scan):

A special kind of SPECT scan in which a radioisotope that binds to dopamine transporter in the striatum is injected.

-Helpful to distinguish Parkinson disease from other movement disorders.

❖ Magnetic resonance spectroscopy:

May be used to demonstrate areas of neuronal damage or dysfunction and has been studied in the assessment of brain tumors, demyelinating disease, and infections of the CNS.

❖ Peripheral nerve ultrasound:

Is being developed for the evaluation of focal and general neuropathic symptoms.

THANK YOU

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