

Lumbar Puncture and CSF Analysis in Adults – An Update

What are the indications for CT scans of the brain prior to performing LP?

- Immunocompromised patients
- Recent history of head trauma
- Impaired level of consciousness
- Evidence of papilloedema or focal neurological deficits

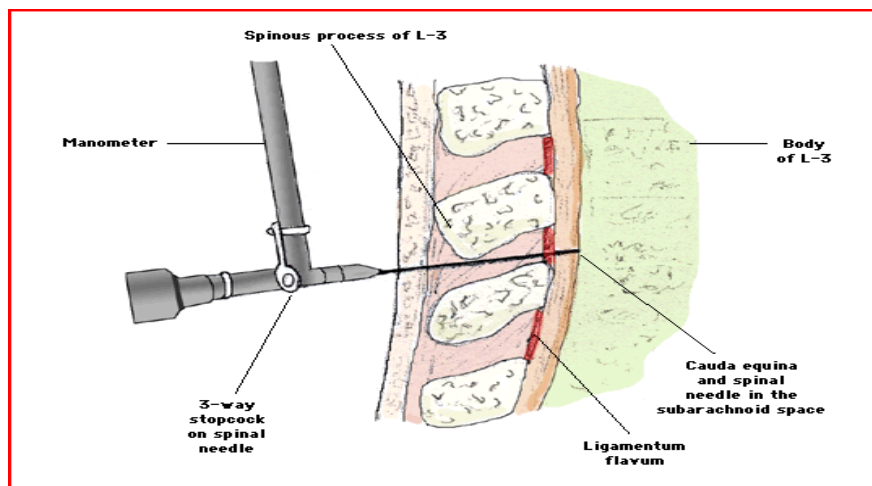
In an immunocompetent patient with no known recent history of head trauma, a normal level of consciousness, and no evidence of papilloedema or focal neurological deficits, it is safe to perform LP without prior neuroimaging. If LP is delayed to obtain neuroimaging studies, empirical antibiotic therapy should be initiated after blood cultures are obtained¹. Obviously it is paramount to perform LP if not contraindicated and commence antibiotics as soon as possible in the patient with suspected meningitis, as outcome relates to the time taken to initiate treatment.

What gauge needle should be used to collect CSF?

A 23 gauge, 9cm spinal needle is provided in all lumbar puncture kits. This needle should be used when performing lumbar punctures on adults.

What is the role of measuring opening pressure when performing an LP?

- Opening pressure should always be measured. It is usually elevated in cases of bacterial or cryptococcal meningitis²⁻⁶.
- Once CSF appears and begins to flow through the needle a manometer should be placed over the hub of the needle and the opening pressure should be measured and recorded, in cmH₂O.
- Normal CSF opening pressure is less than 20 cmH₂O when measured in the horizontal lateral decubitus position.



CSF manometry Midsagittal section through lumbar spinal column showing positioning for measurement of CSF opening pressure. The manometer is attached to the spinal needle hub with a three-way stop-cock. CSF is permitted to enter the manometer; opening pressure is recorded at the highest level attained by the CSF in the manometer column. Adapted from Dieckmann, RA, Fiser, DH, Selbst, SM, (Eds). Illustrated Textbook of Pediatric Emergency and Critical Care Procedures. Mosby, St. Louis, 1997.

When is it appropriate to order tests such as cryptococcal antigen, viral PCRs and TB PCR/culture?

- These tests should be requested in the correct clinical setting when the CSF differential cell count shows a predominance of lymphocytes⁷⁻⁹.
- Up to two-thirds of patients with enteroviral meningitis have a polymorphonuclear predominance in the CSF when examined early in the course of the illness. Repeat lumbar puncture after 12 to 24 hours, if performed, generally shows an evolution to a lymphocytic predominance. CSF PCR for enteroviruses yields a diagnosis in up to 75 percent of patients with culture-negative aseptic meningitis⁸.

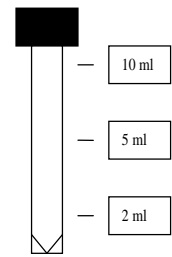
What are the physiological (i.e. normal) CSF differential cell counts in adults?

- Neutrophils: 0-3x10⁶/L
- Lymphocytes: <5x10⁶/L
- RBCs: <5x10⁶/L
- Note that newborns may have up to 25x10⁶/L WBC in the CSF¹⁰.

How much CSF is usually required by the laboratory, and how much can be safely collected at the time of LP?

- The following table indicates the volume of CSF required by the laboratory to perform common investigations:

Test	Volume required (ml)
Cell count & differential WCC	0.5-1
Glucose and protein	0.5
Gram stain & bacterial culture	2-5
Viral PCR	1-2
Cytospin (cytology)	1
Flow cytometry	5-10
Mycobacterial &/or fungal cultures	5
PCR for mycobacteria	1-2
Cryptococcal antigen	0.5
RPR	0.5
Oligoclonal bands &/or serology	0.2 (plus 0.2ml accompanying serum)
CJD (protein 14-3-3)	1.0 ml non-bloodstained CSF (4 th tube)



- Up to 40 ml of CSF can be collected safely at the time of LP¹¹.

Which tube goes where within pathology?

- Tube one** (potentially the most contaminated and blood-stained) is sent to **biochemistry**, **tube two** is sent to **cytology** and **tube three** (the least likely to be contaminated or blood-stained) is sent to **microbiology**. By remembering this, it may be possible to collect more CSF in certain tubes, depending upon the clinical presentation. For example, in an adult with suspected meningitis:

Tube Number	Volume Required
1 (biochemistry)	0.5ml (10 drops)
2 (cytology)	1 ml (20 drops) (6 ml for flow cytometry)
3 (microbiology)	10ml (full tube)

- Always collect CSF into the tubes in the correct order (ie. tube 1 first; tube 3 last)
- If querying SAH, the number of RBCs in both tube 1 and tube 3 are counted in the laboratory. Therefore, consider collecting more CSF in tube 1 when investigating for suspected SAH.
- If querying CJD, the laboratory needs a fourth tube containing at least 1 ml of non-bloodstained CSF. An *orange CJD request form* must be used.
- When investigating for lymphoma/leptomeningeal metastatic disease, collect an adequate volume of CSF in tube 2 – up to 10ml is required and should be sent promptly to the laboratory for processing.
- Oligoclonal bands are found in 85-95% of patients with clinically definite multiple sclerosis. When testing for these, be sure that a serum sample accompanies the CSF to the laboratory.

Can microbial tests be added on to previously collected CSF that is being stored in the laboratory?

- Accurate results for most microbiology tests (eg. cryptococcal antigen, TB culture, viral PCR) can be obtained from CSF which has been correctly stored in the laboratory. The exceptions to this are differential cell counts and cytology, which must be performed promptly on fresh specimens. If sufficient CSF is collected, it should be possible to add appropriate tests without needing to collect more CSF.

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Performing a Diagnostic Lumbar Puncture

Indications

For diagnosis of:

- Subarachnoid haemorrhage
- Meningitis
- Neurological disorders
- Cerebral lymphoma / metastatic disease

Contra indications

- Coagulopathy (eg PT > 1.3, Platelet count < 80,000), recent heparin, LMWH or other anticoagulant
- Local sepsis such as cellulitis or abscess on back
- Raised intracranial pressure
- Note indications for CT scan prior to LP above
- Previous back surgery (relative)
- Prior history of back pain / pathology (relative)

Equipment / Requirements

- LP kit
- Includes 23 g 9cm spinal needle
- Mask, gown, gloves
- Assistant

Consent

- Patient consent must be obtained and an explanation of procedure given.
- Significant complications include post dural puncture headache
- Significant Back pain is unusual

Operator

For independent practice Registrars should have 3 to 5 successful LPs

Patient position

For right handed proceduralists patients should be left lateral. Sitting position can also be used. Patients should sit at the edge of the bed or trolley, with legs over side. An assistant can support patient. A pillow on the lap can help with the patient bent over it.

Aseptic Technique

The proceduralist should wear theatre mask and don a gown and gloves after a surgical scrub. The back is then prepped with betadine or similar antiseptic and allowed to dry.

Once the skin prep has dried the area is screened off using the plastic drape that accompanies the kit. Alternatively sterile green sheets can demarcate the prepped area.

The L3/4 interspace is identified using the intercrystal line as the surface marker (the line that is at the level of the iliac crests). The spinal cord usually ends at the lower border of L1; LPs should be done below this level.

A bleb of local anaesthetic is inserted into the skin and subcutaneous tissues. A 23g spinal needle and stylet is then inserted 90° to all planes at the L3/4 interspace. The needle is then advanced to the subarachnoid space. This can be felt as a small pop. The depth to space is approximately 5 cm but may be as shallow as 3 cm and as deep as 9 cm in large patients. If bone is contacted withdraw the needle almost to skin and try another approach, either more cephalad or caudad. Do not attempt to force needle as needles can bend or fracture. Replace the stylet with each advancement of the needle. Registrars should request help after 3 unsuccessful attempts.

Remove the stylet and examine for CSF flow.

If CSF is seen use the manometer to measure opening pressure taking into account the position of the patient when interpreting the measurement. Note that the CSF in the manometer is the first amount of CSF that emerges and should go into the first tube.

Collect CSF into the pre numbered tubes in correct order.

At completion of the collection take the needle out and use a suitable dressing. Many ED texts require the stylet to be replaced prior to removal of needle. Check to ensure that the needle is complete and intact.