Lumbar Puncture (s. Spinal Tap)

Last updated: April 10, 2019

INDICATIONS

1. Suspected meningitis overrides any contraindications

PROCEDURE DETAILS

1. SPINAL ANATOMY
2. EQUIPMENT
3. PATIENT POSITIONING
4. TECHNIQUE
5. OPENING PRESSURE
6. CSF COLLECTION
7. PROCEDURE END

POSTPROCEDURE

COMPLICATIONS

LUMBAR DRAIN (LUMBAR SUBARACHNOID DRAIN, SPINAL DRAIN)

When possible, CT is advised prior to lumbar puncture!

INDICATIONS

1. CSF collection for analysis:
   1) infection (menigitis, meningoecephalitis) – absolute indication overriding any other considerations!
      *exceptions – brain abscess, parameningial process examples: neonatal sepsis (25% will have meningitis, infection with no apparent source)
   2) subarachnoid hemorrhage (CT-neg case studies)
   3) carcinomatous meningitis
   4) inflammatory diseases (esp. Guillain-Barré syndrome, vasculitis, multiple sclerosis)
      • LP is no longer important in diagnosis of intracranial mass lesions (replaced by CT & MRI)!

2. Opening pressure measurement (but correlation with ICP is not always good) - pseudotumor cerebri diagnosis.

3. Therapeutic CSF drainage.

4. Intrathecal administration of medications (e.g. for meningeval malignancies, fungal meningitis), contrast (e.g. for myelography), radioisotopes (e.g. for CSF leak).

5. Preliminary step for spinal drain insertion.

CONTRAINDICATIONS

1. INTRACRANIAL MASS (known or suspected)
   - LP should not be used as sole criteria to determine if LP is safe
      - papilledema absence does not ensure normal ICP (papilledema takes 6-24 hours to develop).
      - papilledema presence (ICP) is not absolute contraindication to LP, because ICP may be due to diffuse process, not mass lesion (e.g. pseudotumor cerebri) – do CT before LP!
   - N.B. absolute contraindication is HEAD TRAUMA (LP adds no pertinent information ± LP is potentially lethal in case of intracranial hematoma!)

2. NONCOMMUNICATING (OBSTRUCTIVE) hydrocephalus (H: direct ventricular drainage of CSF; vs. in communicating hydrocephalus - LP may provide symptomatic relief.

3. INFECTION in LP region

4. COAGULOPATHY (risks of epidural hematoma or SAH)
   - platelet count should be > 50,000 (H: platelet transfusion)
   - PT / aPTT should be hemostatic
   - patient should not be on heparin or warfarin (H: Protamine or vit. K + FFP)
   - Aspirin should be discontinued for 48 hours before LP.

5. TETHERED spinal cord

6. COMPLETE spinal block (relative contraindication) – most commonly due to spinal tumor – LP may cause shifts of nervous tissue.

   - Spinal tumor is relative contraindication to LP! (except suspected leptomeningeal metastasis – CSF cytology is key diagnostic test)

   - Suspected meningitis overrides any contraindications - CSF examination is always indicated (imaging before LP is advisable); (if suspected pressure > 350 mmHg)
   - 1) use 24G needle.
   - 2) minimum required sample is obtained
   - 3) administer IV bolus of mannitol, 1 g/kg (Ideally 20 min before LP)
   - 4) Dexamethasone (unless contraindicated).

STUDIES before LP

1. Funduscopic for papilledema (if present → CT)
2. Blood studies:
   - thrombocyte count, coagulation studies
   - glucose (to compare with CSF glucose)

PROCEDE DETAILS

1. Anatomy
   - Wry lumbar spine
      1) spinal column grows faster than spinal cord – spinal cord (conus medularis) ends at L1: disc, (caudal sac ends at S3) – needle displaces freely floating roots of cauda equina.
      2) horizontal processus spinosi, in addition patient flexes lumbar spine.
   - Puncture at L4 or L5, or L4-L5 interspace
   - Puncture above L3, is absolutely contraindicated – in 1% people (esp. short) spinal cord ends at L3, interspace!
      • line between iliac crest (INNOCRAL LINE) goes through L3 or L4-5 interspace.
      • repeated taps are done at higher interspace.
      • midline is avascular!

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PATIENT POSITIONING

A. LEFT LATERSAL RECUMBENT FETAL POSITION (neck & knees brought to chest; craniocaudal axis parallel to floor; posterior aspect of pelvis at edge of table and perpendicular to floor; pillow under neck for comfort) - this flexes lumbar spine and opens spaces between spinous processes; assistant helps maintain patient as flexed as possible.

- avoid prolonged deep flexion in infant → airway obstruction; airway should be checked if infant suddenly stops crying.

B. SITTING WITH LEGS Dangling over bed side (head and arms rest on grasped pillow; patient leans forward as far as possible).

- indications:
  1) obesity
  2) difficult anatomy (incl. scoliosis)
  3) large volumes of CSF are to be collected.

- advantages:
  1) midline is much easier to determine
  2) more comfortable (than fetal position) for some patients
  3) gravity assists CSF flow.

If severe anatomical restrictions preclude LP (e.g. severe spondylosis, previous spinal surgery, morbid obesity) → obtain CSF under fluoroscopic/CPT guidance:

a) lumbar puncture
b) external puncture see p. Op5 >>
c) lateral cervical puncture see p. Op5 >>

TECHNIQUE

- first developed by Quincke in 1891.
- sterile prep (antiseptic solution is applied in circular motion - circumference of cleansed area should increase with each motion).
- sterile towel
- sterile gloves (± cap, mask)
- Sterile gloves
- Sterile prep solution
- Sterile prep is placed between patient's hip and bed; drape lumbar back (drapes extend over iliac crest).
- identify INTERCISTAL LINE and palpate in midline for spinous process (usually L5 and L4, i.e. interspace below it, mark puncture site by thumbul indentation to skin.
- puncture: anesthetized skin with spinal needle & stylet
  - needle is always advanced with stylet in place (to avoid introducing epidermal cells) → iatrogenic epidermoid tumor.
  - needle is held between thumb and index fingers.
  - needle is aimed slightly rostrally (± 15°; with umbilicus as target) - path approximately parallel to spinous processes.
  - needle bevel is turned parallel to length of spinal column i.e. parallel to longitudinally running fibers of dura* (to minimize post-LP headache); once in thecal sac, needle is turned craniad (to optimize CSF flow).
  - e.g. in sitting position, needle is inserted with bevel facing laterally, in decubitus position - bevel facing up.

- advance needle deeper, carefully maintaining midline trajectory; needle will encounter slight resistance, then “plop” will be felt (thecal sac penetration - patient experiences twinge of pain*).

- if “plop” is encountered, it is more often due to deviation from midline than to failure to aim correctly in rostral-caudal direction; needle direction cannot be changed - pull needle back to just beneath skin and redirect it.

- if bone is encountered, it is more often due to deviation from midline than to failure to aim correctly in rostral-caudal direction; needle direction cannot be changed - pull needle back to just beneath skin and redirect it.

- if no CSF is seen, reinsert stylet and advance needle little farther;
LUMBAR PUNCTURE

Op3 (3)

- if still no CSF is seen, withdraw needle to just below skin surface, reassess landmarks, and attempt another trajectory;
- failure to enter subarachnoid space after 2-3 trials → reposition patient to sitting position;
- if blood is seen, allow moment for blood to drain and see if it clears, because blood may represent traumatic tap; if it does not clear, withdraw needle and attempt another trajectory.

Causes of "dry tap":

a) improperly placed needle (most often)
b) pathologic obliteration of subarachnoid space (compressive lesion of spinal cord or chronic adhesive arachnoiditis)

LATERAL APPROACH

- used if supraspinal ligament is calcified in older persons.
- needle is directed slightly cephalad to miss lamina (lower lamina rises upward from midline) and slightly medially to compensate for lateral approach.
- needle bypasses supraspinal and interspinal ligaments.

OPENING PRESSURE

about causes of elevated / lowered opening pressure → see p. D40 >>

- once CSF flow is established (lose as little CSF as possible – this spuriously lowers pressure), place stopcock and attached manometer on end of needle.
- keep "zero" mark at level of spinal needle.
- adjust stopcock to allow CSF to flow up manometer – wait for steady state – record OPENING PRESSURE.
- Intermediate tubing may be used to minimize movement of needle while manipulating manometer and collecting CSF.
- patient should be lying down fully relaxed (not in forced fetal position - legs should be straightened when measuring open pressure or falsely elevated pressure will be obtained)!!!
- look for normal pressure oscillations with pulse and respirations.
**LUMBAR PUNCTURE**

Op 3 (4)

### Opening pressure is artificially elevated with patient in sitting position!

- Opening pressure of 500 mmH₂O is normal for sitting position.

  - if anatomy precludes LP in lateral decubitus but opening pressure is critical: spinal needle inserted in sitting position → needle withdrawn just out of thecal sac → patient placed in relaxed, lateral decubitus position → needle readvanced slightly into thecal sac.

If pressure is very high (esp. > 350 mmH₂O) – remove needle at once! (fluid in manometer is used for analysis?); although change in intracranial dynamics caused by LP has occurred already and premature needle removal changes nothing.

### Quicktest (seldom performed today – replaced by myelography and MRI) – demonstrates

1. **Spinal Block** (spinal subarachnoid space does not communicate with cranial subarachnoid space):
   - patient in lateral recumbent position.

2. **10-12 seconds of bilateral lateral jugular vein compression** (by assistant) → decreased venous return to heart → distended cerebral veins → (CVP rise → CSF pressure)?

   o **Normal**: CSF pressure rises 150 mmH₂O (or ≥ twice) over initial reading; CSF pressure returns to baseline in 10-12 seconds after release.

   o **Spinal Block**: delayed rise and fall (incomplete block) or no change (complete block) in CSF pressure at all.

   N.B. inject Pantopaque before needle removal - to facilitate subsequent myelogram (because lumbar dural sac may collapse, making it impossible to reenter canal).

   **Contraindications**: elevated opening pressure, suspected intracranial mass lesion.

   **Modifications**:
   - suspected *cervical cord disease* - test repeated with neck in neutral position, hypere xtended, and flexed.
   - suspected *lateral sinus obstruction* - unilateral jugular venous compression (TOREY-AYER test).

### CSF COLLECTION

Collect four tubes (extra tubes may be required for additional studies if indicated, e.g. cytology) – 5 ml each:

1. cell count
2. chemistry (glucose & protein)
3. bacteriologic studies (Gram stain, culture, ab/s sensitivities)
4. for future use (e.g. sample may be lost, unexpected chemistry value may require repeat determination, or new test may be wanted) or to compare cell count with first tube

N.B. if CSF is bloody, cells are counted in both 1st and 4th (clearest) tubes. See p. S50 >>

- remove only *minimum volume of CSF needed* for diagnostic studies (e.g. in aneurysmal SAH, excessive CSF pressure lowering increases transmural pressure across aneurysm wall → rebleed).

- 10-12 ml may be withdrawn from adult (3.5 ml from neonate);

- identification of tumor cells, TB, some fungi depends on large CSF volume examined or future use

- if CSF flow ceases (nerve root abutted against needle aperture), rotate needle 180°.

- if CSF pressure is too low for collection → elevate patients head, ask assistant to press on abdomen.

### PROCEDURE END

- rettach manometer to record **Closing Pressure** if indicated (e.g. therapeutic LP for increased ICP).

- replace stylet and withdraw needle.

- massage puncture region for a moment to break up needle tract.

- remove dressing or adhesive on puncture site.

- routinely observe for cord / spinal nerve compression from developing hematoma after traumatic taps.

### POSTPROCEDURE

*Prone bed rest for 6-24 hrs, hydration – see post-LP headache prevention!* see below >>

### COMPLICATIONS

1. **Post-LP headache** (5-35%; risk is greater in young females) – due to CSF leakage through dural puncture site:
   - onset 15 minutes + 4 days following LP.
   - usually lasts only few hours (untreated can last for 14 days).

   - Prevention: see p. S58 >>

Source of picture: Paul W. Roberts “Useful Procedures in Medical Practice” (1986); Lea & Febiger; ISBN 0812109856 >>

*Norma: 65-200 mmH₂O* (5-15 mmHg) with patient lying down (or at level of foramen magnum in sitting position).

*30 mmH₂O in neonates, 85 mmH₂O in young children, 250 mmH₂O in extremely obese subjects.
1) use smaller-gauge spinal needles (20 or 22G, 25G for small children).
2) useatraumatic needle (vs. cutting type).
3) orient needle bevel parallel to longitudinally running dura fibers.
4) avoid multiple punctures.
5) remove as little CSF as possible.
6) turn patient prone (if LP is done in sitting position) before removing needle.
7) bed rest (better prone than supine) after procedure for 6-24 hrs (no studies support usefulness of this!!)
8) post-lumbar puncture hydration.
   - treatment: bed rest up to Trendeleburg), hydration, caffeine-containing analgetics, autologous epidural blood patch.

2. Herniation (1-2%) – TRANSSTEMONIAL or CEREBELLAR TONSILLAR:
   - inject 3 mL of NS and withdraw needle immediately ➔ elevate head of bed ➔ intubate & hyperventilate ➔ mannitol, steroids.
   - most important risk factor: signs of mass effect (hemiparesis and anosocoria).

   - withdraw needle immediately ➔ if pain persists ➔ start short course of dexmethylasone.

4. Spinal epidural / subdural hematoma (usually only with caudal/spinal).
   - heparin therapy should not commence for at least 1 hour after bloody tap!

5. Epidermoid tumor - pain in back and lower extremities developing years after LP.

6. Spinal meningits - leakage of blood containing bacteria into subarachnoid space.
   - Suspected bacteremia is not contraindication for LP!

7. Intracranial subdural hygroma or hematoma (extremely rare)

8. In aneurysmal SAH (when aneurysm is unsecured), excessive lowering of CSF pressure increases transmural pressure across wall of aneurysm ➔ rebleed (remove only minimum volume of CSF needed for diagnostic studies).

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**LUMBAR DRAIN (s. LUMBAR SUBARACHNOID DRAIN, SPINAL DRAIN)**

**INDICATIONS**
1. Intraoperative brain relaxation (e.g. for aneurysm or tumor exposure)
2. CSF leak prevention* or treatment
   - typically after posterior fossa or transsphenoidal procedures
3. Assessment of potential response to shunting in normal-pressure hydrocephalus

**DETAILS**
1. 14G Tuohy needle is inserted with bevel facing laterally.
   - *n needle with a lateral opening at the distal end, designed to cause a catheter passing through the needle's lumen to exit laterally at a 45° angle; used to place catheters into the subarachnoid or epidural space
   - lumbar drainage catheter (w/ wire stylet) is inserted until resistance is met (20-40 cm) to use catheters into the subarachnoid or epidural space
   - once brisk CSF flow is obtained, bevel is turned superiorly.
   - lumbar drainage catheter (w/ wire stylet) is inserted until resistance is met (20-40 cm)
   - *4 dots on the drain
   - pursestring suture is placed around the catheter exit on the skin while Tuohy needle is still in place (avoids injuring catheter).
   - Tuohy needle is withdrawn.
   - catheter stylet is withdrawn.
   - catheter is attached to supplied Luer-Lok connector and sutured to skin; coil rest of drain and cover with large Tegaderm / OpSite.
   - N.B. it is easy to kink he catheter or tie suture too tight – check CSF flow often!

**MAINTENANCE**
- keep drain clamped if patient is ambulatory.
- unclamp as needed to drain CSF (e.g. certain amount of CSF per hour), or keep drain open at shoulder level in recumbent patients for continuous drainage.
- drain is removed / changed every 5-7 days.

**COMPLICATIONS**
1. Infection
2. Overdrainage ➔ transfornaminal brain herniation (potentially lethal)

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* VIKTOR’S NOTES for the Neurosurgery Resident

For more visit website at www.NeurosurgeryResident.net