

How to do an LP

A guide for doctors in training

Key points

A calm environment

A trained nurse to assist

Careful explanation to patient of what to expect

Spend time on positioning the patient properly

Make sure you achieve cutaneous anaesthesia

Remember the 6 layers from skin to CSF

Loosen manometer tap and connect to manometer gauge before you insert needle

Collect adequate specimens (2mls per bottle)

Be confident - if your position and anatomical knowledge are correct you will succeed

Don't rush your patient afterwards, let them take their own time to get ready to leave

Introduction

Even today the word lumbar puncture still strikes fear in patients and practitioners. Like all fear, education will alleviate it! I've now done hundreds of LPs, teach about LPs and write LP guidelines. Here's how I go about it. The information here would be very useful when counselling your patients prior to the test. Any postgraduate physician in training would be expected to have a detailed knowledge of how to do an LP, and it is a core skill for emergency medicine and neurology.

Before you do an LP, make sure you have observed several successful and unsuccessful procedures. Make yourself aware of the anatomy of the lumbar spine and spinal canal, and the layers that your needle will traverse. An LP will be a lot easier in a calm environment e.g. side room, treatment room, day-case theatre/OR. I strongly advise that you have with you a nurse or nursing auxiliary who has assisted at many LPs before.

Equipment

An LP is usually performed on a hospital bed, or treatment couch or procedure table. The room should be well lit, warm and private. You will need, anti-septic (chlorhexidine or iodine-based), sterile drapes, sterile gloves. You will need a hypodermic needle and 5 ml syringe to draw up local anaesthetic, and another hypodermic needle to inject the local anaesthetic. You need a spinal needle (will discuss choice of needle later), and a manometer to measure opening pressure. Specimen containers are required – usually 4 are needed, and a fluoride oxalate tube if glucose is being measured in CSF. Blood bottles and venepuncture equipment for paired blood glucose, protein and serum oligoclonal bands are also needed. Most hospitals will already have pre-packed trays to which you need to add your own manometer - pre-packed spinal anaesthesia trays usually have atraumatic needles, and may not be suitable for diagnostic or therapeutic LP. Alternatively you can use an ordinary dressing pack and add your own choice of LP needle and manometer.

Choice of needle

There has been debate for years about use of atraumatic needles versus the classic bevelled tip needle. The difficulty with atraumatic needles is that the aperture in the needle is small and the needle is of fine bore making pressure recording (arguably) unreliable and sample collection slow. A bevelled needle will give a more reliable pressure reading and in some cases you actually want to create a dural tear – such as therapeutic LP in Idiopathic Intracranial Hypertension. There is consensus that atraumatic needles do reduce the incidence of post-LP headache, but I think they should be reserved for spinal anaesthesia. There is a technique described where oblique insertion of the bevelled needle can create a self-sealing hole (see the LP Directory). For diagnostic LP I prefer a 20 gauge bevelled tip needle of 8-9cm (3.5 inch) length. In obese subjects a 5.5 inch needle (or longer) may be required.

Anatomy review

The layers you pass en route to the CSF are: 1. Skin, 2 Subcutaneous fat, 3 Interspinous ligament, 4 Ligamentum flavum, 5 Epidural space, 6 Meninges to arrive at the subarachnoid space. The usual distance to the CSF space according to most studies is about 4 to 7 centimeters, i.e. before the needle is in to the hilt. In obese subjects the subcutaneous layer obscures the anatomy and increases the distance to the spinal canal. You need to have this layering in your mind as you do the LP. The ligamentum flavum can often be heavily calcified in older people and may give resistance, before the needle 'pops' gently into the epidural space. I would not say that a 'give' or 'pop' is felt in every case, but if you can learn to feel for this it will help you in some cases.

Positioning the patient

The aim of positioning is to create the widest possible gap between the L3 and L4 spinous processes for your needle, and to set the patient up as geometrically as possible to create easy reference points to allow you to plan the needle's trajectory. An LP is easiest performed in the sitting

position, with forward flexion of the trunk, as the midline of the spine is easy to see. However a seated patient has a 60cm column of pressure from the base of the neck to the entry point of the LP needle and manometer, so a high pressure is always measured! I am not a great fan of inserting the needle seated and then gently lowering the patient on to their side to measure pressure. I have done it, but the potential for neural injury must be present, and it is disquieting to withdraw a kinked needle. Usually, if pressure is needing to be measured (and it almost always does, especially in acute headache), lie the patient on their left hand side - the left lateral position, with knees flexed up towards the abdomen. The head should be supported by one pillow only, and your patient may feel more comfortable with another pillow between their knees. In a horizontal plane, make sure that your patient's back is parallel with the edge of the bed. In a vertical plane imagine that a plumb line suspended from the ceiling will touch both posterior iliac spines. If you take time to position in this way, you are most likely to have achieved adequate separation of the spinous processes between lumbar vertebrae L3 and L4, making the path for your needle as wide as possible. If you maintain the correct vertical orientation you are less likely to pass the needle to the left (too low) or right (too high) of the midline. Remember that if you can aim for the small target between spinous processes towards the small diamond of exposed ligamentum you could be well on your way to a near painless LP needle insertion! Most pain associated with LP is due to contact of the needle with periosteum of the spinous processes.

Confirming the L3/L4 intervertebral space

This can be very difficult, and some studies suggest that accuracy in identifying this space could be as low as 50%. Ultrasound can assist in identification of the interspinous space, especially if there is an excess of subcut tissue. Unfortunately Ultrasound is not widely used, but I expect to make this standard in my own practice shortly, especially if anatomical landmarks are indistinct. The line between the right (upper as you see it) and left (lower as you see it) posterior superior iliac spines - named Tuffiers Line - runs through closest to the L4/5 interspace i.e. too low. You want to go for the interspace immediately cephalad (towards the head) to Tuffiers Line. The L3/4 space is wider and easier to penetrate. L2/3 is wider still, but you are more likely to hit an abnormally low lying spinal cord tip at L2/3. Your needle wants to enter the skin at a point on the surface in the midline in horizontal and vertical planes. You can mark the skin with a pen, or indent the skin with a blunt marker (e.g. the cap of one of your hypodermic needles).

Preparing the skin

Use aseptic technique (and do not, under any circumstance, penetrate the skin through an obvious focus of cutaneous infection - you could cause meningitis), start at the proposed puncture site and in a circular motion move outwards until your field is covered. Wait for the solution to dry (takes 2-3 minutes - will feel like a long time) and apply another. While waiting for the second application to dry, draw up local anaesthetic, get your LP needle out of its cover, and connect up your manometer. When connecting your manometer make sure you test the 3-way tap at the bottom as it is usually very stiff and almost impossible to undo with one hand holding the manometer steady! In one of my earliest LPs I did not loosen the 3-way, and struggled to open it while trying to steady the manometer gauge with the same hand.

Local Anaesthetic

I normally use about 1 to 2ml of lidocaine 2%. My initial injection is a subdermal bleb, which almost immediately freezes the dermis (a tip taught me by a staff grade anaesthetist from Ninewells Hospital, Dundee - whose name I forget - sorry!). If you achieve immediate anaesthesia - test by pricking the skin with the needle over your bleb, then I usually go straight for the LP needle. If you do not achieve immediate anaesthesia, put 1-2 mls a bit deeper. I avoid using too much local as it can eventually distort the palpable anatomy. You may have been taught to put in 5 to 10mls, but I am letting you know I rarely use more than 2mls. Acute lidocaine toxicity can provoke a generalised tonic clonic seizure (I've seen it happen) and is another good reason to avoid too much LA.

Insert the Needle

Insert the needle into your dermal bleb. Try to keep the needle parallel with the ceiling, and perpendicular to the inter-iliac line. Aim the needle slightly cephalad (meaning aim for the umbilicus area - mid anterior abdomen). After about 4 cm start to feel if you get a very slight give as you penetrate the 4th layer in the LP cake called ligamentum flavum. If you feel that give, you are nearly there. If you are slightly too high (right) or too low (left) you may make contact with a lumbar nerve root, which will produce sciatic-type pain into the thigh. Ask your patient to report any shooting pain as it can help you reposition the needle back towards the middle. Once you have felt the "give" advance the needle another 2-3mm and withdraw the central part of the needle called the stylet. Wait about 10 seconds to see if CSF appears. If you get venous blood you are most likely in the epidural space and are only a few mm from glory. In a non-obese subject you may find that you have advanced the needle almost up to the hilt (9cm / 3.5inches). If you do not have CSF, pull the needle back 3-5mm and remove the stylet to see if you get CSF. Check that you have not deviated from the midline and are still heading in the direction of the centre of the anterior abdomen.

Collecting CSF

If you get CSF (well done!), connect the 3-way tap and manometer tubing. The CSF will rise up the tube and once it has reached its peak you may see it rise and fall with respiration. Open the three way tap to drain the manometer into a CSF container (this will come out in a rush). Then you have the

option of removing the manometer completely and allowing CSF collection to proceed directly from the end of the open needle. Collect about 20 drops per container (I'm talking about adults), which will be about 2mls per container. This means you will never have to explain to your patient that despite all the trouble of getting an LP needle the lab report said insufficient sample (you must avoid this!). An adult makes about 500mls of CSF per day, and isotope studies suggest that CSF is replaced about 4 times daily. This means that your 8 ml CSF sample is replaced by the brain within about 20 minutes of LP completion. You have been warned.

Withdrawing the Needle and Skin Dressing

Before removing the needle, replace the stylet. If you don't there is the potential for a suction effect to draw soft tissues, such as a nerve root into contact with the LP needle, leading to nerve injury and pain for your patient. Please make sure you replace the stylet. An elastoplast is sufficient dressing after an LP. There is no need to bandage the patient up like they have had major surgery. (I've seen it done!).

Aftercare

Prolonged bed rest is not mandatory after an LP, as clinical trial evidence does not support its use to prevent post-LP headache. A short period of rest is of course kind and considerate, and I advise my patients to sit up once they feel comfortable to do so. Avoid driving home after an LP as your patient may develop an acute post-spinal headache which could impair driving ability. The dry skin dressing can be removed after 12-24 hours.

Complications

About 30-50% of people after LP will experience a new headache, worse with upright and better with supine posture. This is due to low pressure of CSF within the cranial cavity, caused by persistent leak of CSF through your dural tear into the lumbar canal. About 1-2% will develop a real stinker of a post-LP headache and may not be able to lift their head from the pillow without vomiting or experiencing extreme pain. I normally reserve epidural blood patching for the latter group. Most post-LP headaches will resolve with a mix of bed rest, additional 2 litres per day fluid intake and regular dosing with non-steroidals or paracetamol. Tangential needle insertion, is a skill that may be worth acquiring, as there is a logical, but not widely accepted, argument that this simple technique will reduce post-LP headache by creating a self-healing hole.

Pictures

Unfortunately I am waiting for pictures to illustrate an LP. There is a nice series posted on YouTube, annotated in Spanish. I have asked the author for permission to host these images here, and if he agrees will add them here to save you time.

Consent forms

All procedures require a patient's consent. In emergencies it may not be possible to obtain a patient's consent e.g. confusion or coma, and it is reasonable in that situation to record that consent is not possible (as a courtesy you should explain the procedure to next of kin). Your patient should be consented for the following: 1 Reason for LP, 2 initial pain of local anaesthesia, 3 potential for discomfort of inserting needle close to bone or nerve root 4 transient low back discomfort in the days after an LP, especially if it was difficult to obtain, 5 post-LP headache 30-50% rate, 1-2% are severe and may require additional intervention.

About the Author

Dr Forbes is a practising neurologist. His interests include educating people about neurological diseases. He lives in Northern Ireland and runs www.lumbarpuncture.net a website devoted to this commonly used medical test.

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