SPINAL ANAESTHESIA - A Practical Guide

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Spinal anaesthesia is induced by injecting small amounts of local anaesthetic into the cerebro-spinal fluid (CSF). The injection is usually made in the lumbar spine below the level at which the spinal cord ends (L2). Spinal anaesthesia is easy to perform and has the potential to provide excellent operating conditions for surgery below the umbilicus.

If the anaesthetist has an adequate knowledge of the relevant anatomy, physiology and pharmacology, safe and satisfactory anaesthesia can easily be obtained to the mutual satisfaction of the patient, surgeon and anaesthetist.

The Advantages of Spinal Anaesthesia

Cost. Anaesthetic drugs and gases are costly and the latter often difficult to transport. The costs associated with spinal anaesthesia are minimal.

Patient satisfaction. If a spinal anaesthetic and the ensuing surgery are performed skillfully, the majority of patients are very happy with the technique and appreciate the rapid recovery and absence of side-effects.

Respiratory disease. Spinal anaesthesia produces few adverse effects on the respiratory system as long as unduly high blocks are avoided.

Patent airway. As control of the airway is not compromised, there is a reduced risk of airway obstruction or the aspiration of gastric contents. This advantage may be lost with too much sedation.

Diabetic patients. There is little risk of unrecognised hypoglycaemia in an awake patient. Diabetic patients can usually return to their normal food and insulin regime soon after surgery as there is less sedation, nausea and vomiting.

Muscle relaxation. Spinal anaesthesia provides excellent muscle relaxation for lower abdominal and lower limb surgery.

Bleeding. Blood loss during operation is less than when the same operation is done under general anaesthesia. This is as a result of a decreased blood pressure and heart rate, and improved venous drainage which results in less oozing.

Splanchnic blood flow. Because of its effect on increasing blood flow to the gut, spinal anaesthesia reduces the incidence of anastomotic dehiscence.

Visceral tone. The bowel is contracted by spinal anaesthesia and sphincters relaxed although peristalsis continues. Normal gut function rapidly returns following surgery.

Coagulation. Post-operative deep vein thromboses and pulmonary emboli are less common following spinal anaesthesia.

Disadvantages of Spinal Anaesthesia

1. When an anaesthetist is learning a new technique, it will take longer to perform than when he is more practised, and it would be wise to let the surgeon know that induction of anaesthesia may be longer than usual. Once competent, however, spinal anaesthesia can be very swiftly performed.

2. Occasionally, it is impossible to locate the dural space and obtain CSF and the technique has to be abandoned. Rarely, despite an apparently faultless technique, anaesthesia is not obtained.

3. Hypotension may occur with higher blocks and the anaesthetist must know how to manage this situationsituation with the necessary resuscitative drugs and equipment immediately to hand. As with general anaesthesia, continuous, close monitoring of the patient is mandatory.

4. Some patients are not psychologically suited to be awake, even if sedated, during an operation. They should be identified during the preoperative assessment.

5. Even if a long-acting local anaesthetic is used, a spinal is not suitable for surgery lasting longer than approximately 2 hours. If an operation unexpectedly lasts longer than this, it may be necessary to convert to a general anaesthetic.

6. There is a theoretical risk of introducing infection into the subarachnoid space and causing meningitis. This should **never** happen if equipment is sterilised properly and an aseptic technique is used.

7. A postural headache may occur postoperatively. This should be rare: see later.

Indications for Spinal Anaesthesia

Spinal anaesthesia is best reserved for operations below the umbilicus e.g. hernia repairs, gynaecological and urological operations and any operation on the perineum or genitalia. All operations on the leg are possible, but an amputation, though painless, may be an unpleasant experience for an awake patient. In this situation it may be kinder to supplement the spinal with generous sedation or a light general anaesthetic.

Spinal anaesthesia is especially indicated for older patients and those with systemic disease such as chronic respiratory disease, hepatic, renal and endocrine disorders such as diabetes. Most patients with mild cardiac disease benefit from the vasodilation that accompanies spinal anaesthesia except those with stenotic valvular disease or uncontrolled hypertension.

It is suitable for managing patients with trauma if they have been adequately resuscitated and are not hypovolaemic. In obstetrics, it is ideal for manual removal of a retained placenta (again, provided there is no hypovolaemia). There are definite advantages for both mother and baby in using spinal anaesthesia for Caesarean section. However, special considerations apply to managing spinal anaesthesia in pregnant patients (see later) and it is best to become experienced in its use in the non-pregnant patient before using it for obstetrics.

Contra-indications to Spinal Anaesthesia

Most of the contra-indications to spinal anaesthesia apply equally to other forms of regional anaesthesia. These include:

Inadequate resuscitative drugs and equipment. No regional anaesthetic technique should be attempted if drugs and equipment for resuscitation are not immediately to hand.

Clotting disorders. If bleeding occurs into the epidural space because an epidural vein has been punctured by the spinal needle, a haematoma could form and compress the spinal cord. Patients with a low platelet count or receiving anticoagulant drugs such as heparin or warfarin are at risk. Remember that patients with liver disease may have abnormal clotting profiles whilst low platelet counts as well as abnormal clotting can occur in pre-eclampsia.

Hypovolaemia from whatever cause e.g. bleeding, dehydration due to vomiting, diarrhoea or bowel obstruction. Patients must be adequately rehydrated or resuscitated before spinal anaesthesia or they will become very hypotensive.

Any **sepsis** on the back near the site of lumbar puncture.

Patient refusal. Patients may be understandably apprehensive and initially state a preference for general anaesthesia, but if the advantages of spinal anaesthesia are explained they may then agree to the procedure and be pleasantly surprised at the outcome. If, despite adequate explanation, the patient still refuses spinal anaesthesia, their wishes should be respected.

Uncooperative patients. Although spinal anaesthesia is suitable for children, their cooperation is necessary and this must be carefully assessed at the pre-operative visit. Likewise, mentally handicapped patients and those with psychiatric problems need careful pre-operative assessment.

Septicaemia. Due to the presence of infection in the blood there is a possiblity of such patients developing meningitis if a haematoma forms at the site of lumbar puncture and becomes infected.

Anatomical deformities of the patient's back. This is a relative contraindication, as it will probably only serve to make the dural puncture more difficult.

Neurological disease. The advantages and disadvantages of spinal anaesthesia in the presence of neurological disease need careful assessment. Any worsening of the disease postoperatively may be blamed erroneously on the spinal anaesthetic. Raised intracranial pressure, however, is an absolute contra-indication as a dural puncture may precipitate coning of the brain stem.

Reluctant surgeon. If a surgeon is unhappy operating on an awake patient or if he is relatively unskilled, spinal anaesthesia may be better avoided.

Physiology of Spinal Anaesthesia

Local anaesthetic solution injected into the subarachnoid space blocks conduction of impulses along all nerves with which it comes in contact, although some nerves are more easily blocked than others.

There are three classes of nerve: motor, sensory and autonomic. The motor convey messages for muscles to contract and when they are blocked, muscle paralysis results. Sensory nerves transmit sensations such as touch and pain to the spinal cord and from there to the brain, whilst autonomic nerves control the calibre of blood vessels, heart rate, gut contraction and other functions not under conscious control.

Generally, autonomic and pain fibres are blocked first and motor fibres last. This has several important consequences. For example, vasodilation and a drop in blood pressure may occur when the autonomic fibres are blocked and the patient may be aware of touch and yet feel no pain when surgery starts.

There are practical implications associated with these physiological phenomena.

- The patient should be well hydrated before the local anaesthetic is injected and should have an intravenous infusion in place so that further fluids or vasoconstrictors can be given if hypotension occurs.

- The site to be operated on should not be repeatedly touched and the patient asked "Can you feel this?" as this increases the patient's anxiety. Often some sensation of touch or movement remains and yet no pain is felt. It is better to pinch the skin gently either with artery forceps or fingers and ask if it is painful. If it is not then surgery can begin.

Anatomy

The spinal cord usually ends at the level of L2 in adults and L3 in children. Dural puncture above these levels is associated with a slight risk of damaging the spinal cord and is best avoided. **An important landmark to remember is that a line joining the top of the iliac crests is at L4 to L4/5**

Remember the structures that the needle will pierce before reaching the CSF (fig 1.).

The **skin**. It is wise to inject a small bleb of local anaesthetic into the skin before inserting the spinal needle.

Subcutaneous fat. This, of course, is of variable thickness. Identifying the intervertebral spaces is far easier in thin patients.

The **supraspinous ligament** which joins the tips of the spinous processes together.

The **interspinous ligament** which is a thin flat band of ligament running between the spinous processes.

The **ligamentum flavum** is quite thick, up to about 1cm in the middle and is mostly composed of elastic tissue. It runs vertically from lamina to lamina. When the needle is within the ligaments it will feel gripped and a distinct "give" can often be felt as it passes through and into the epidural space.

The **epidural space** contains fat and blood vessels. If blood comes out of the spinal needle instead of CSF when the stylet is removed, it is likely that an epidural vein has been punctured. The needle should simply be advanced a little further.

The **dura**. After feeling a "give" as the needle passes through the ligamentum flavum, a similar sensation may be felt when the needle is advanced a short distance further and pierces the dural sac.

The **subarachnoid space**. This contains the spinal cord and nerve roots surrounded by CSF. An injection of local anaesthetic will mix with the CSF and rapidly block the nerve roots with which it comes in contact.

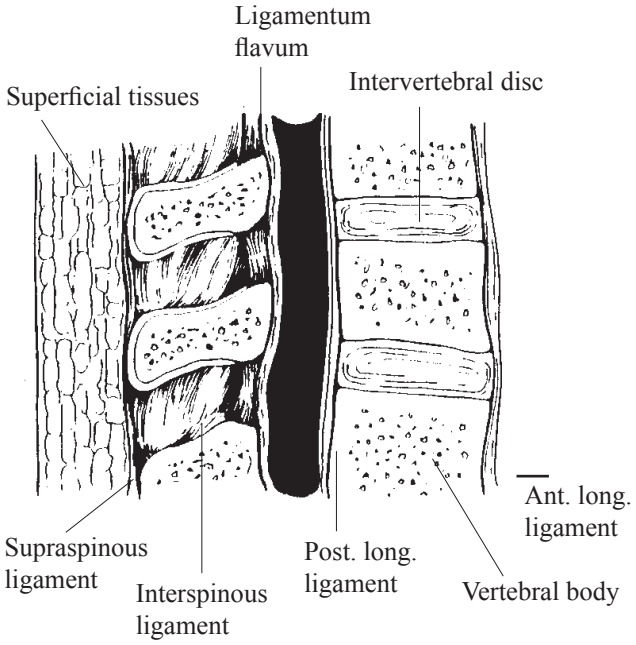


Figure 1. Section of lumbar vertebrae to show the ligaments.

Local Anaesthetics for Spinal Anaesthesia

Local anaesthetic agents are either heavier (hyperbaric), lighter (hypobaric), or have the same specific gravity (isobaric) as the CSF. Hyperbaric solutions tend to spread below the level of the injection, while isobaric solutions are not influenced in this way. It is easier to predict the spread of spinal anaesthesia when using a hyperbaric agent. Isobaric preparations may be made hyperbaric by the addition of dextrose. Hypobaric agents are not generally available. The other factors affecting the spread of local anaesthetic agents when used for spinal blocks are described later.

Bupivacaine (Marcaine). 0.5% hyperbaric (heavy) bupivacaine is the best agent to use if it is available. 0.5% plain bupivacaine is also popular. Bupivacaine lasts longer than most other spinal anaesthetics: usually 2-3 hours.

Lignocaine (Lidocaine/Xylocaine). Best results are obtained with 5% hyperbaric (heavy) lignocaine which lasts 45-90 minutes. 2% lignocaine can also be used but it has a much shorter duration of action. If 0.2ml of adrenaline 1:1000 is added to the lignocaine, it will usefully prolong its duration of action. Lignocaine from multi-dose vials should not be used for intrathecal injection as it contains potentially harmful preservatives.

Cinchocaine (Nupercaine, Dibucaine, Percaine, Sovcaine). 0.5% hyperbaric (heavy) solution is similar to bupivacaine.

Amethocaine (Tetracaine, Pantocaine, Pontocaine, Decicain, Butethanol, Anethaine, Dikain). A 1% solution can be prepared with dextrose, saline or water for injection.

Mepivacaine (Scandicaine, Carbocaine, Meaverin). A 4% hyperbaric (heavy) solution is similar to lignocaine.

Spinal Anaesthesia and Common Medical

Conditions

Respiratory Disease. A low spinal block has no effect on the respiratory system and is therefore ideal for patients with respiratory disease unless they cough a lot. Frequent coughing results in less than ideal conditions for the surgeon. A high spinal block can produce intercostal muscle paralysis, but this does not usually create any problems, unless the patient is very limited by his respiratory disease.

Hypertension. Hypertension is not a contra-indication to spinal anaesthesia but, ideally, it should be controlled before any anaesthetic is administered. Hypertensive patients should have their blood pressure closely monitored during the anaesthetic and any episode of hypotension vigorously treated.

Sickle cell disease/trait. Spinal anaesthesia may be advantageous for patients with sickle cell disease. Follow the same rules as for general anaesthesia: ensure that the patient is well oxygenated, well hydrated and not allowed to become hypotensive. Consider warming the intravenous fluids and do not allow the patient to become cold. Avoid the use of tourniquets.

Pre-operative Visit

Patients should be told about their anaesthetic during the pre-operative visit. It is important to explain that although spinal anaesthesia abolishes pain, they may be aware of some sensation in the relevant area, but it will not be uncomfortable and is quite normal. It should also be explained that their legs

will become weak or feel as if they don't belong to them any more. They must be reassured that, if they feel pain they will be given a general anaesthetic.

Premedication is not always necessary, but if a patient is apprehensive, a benzodiazepine such as 5-10 mg of diazepam may be given orally 1 hour before the operation. Other sedative or narcotic agents may also be used. Anticholinergics such as atropine or scopolamine (hyoscine) are unnecessary.

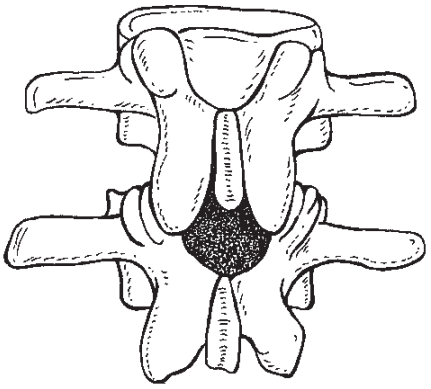
Pre-loading

All patients having spinal anaesthesia must have a large intravenous cannula inserted and be given intravenous fluids immediately before the spinal. The volume of fluid given will vary with the age of the patient and the extent of the proposed block. A young, fit man having a hernia repair may only need 500 mls. Older patients are not able to compensate as efficiently as the young for spinal-induced vasodilation and hypotension and may need 1000mls for a similar procedure. If a high block is planned, at least a 1000mls should be given to all patients. Caesarean section patients need at least 1500 mls.

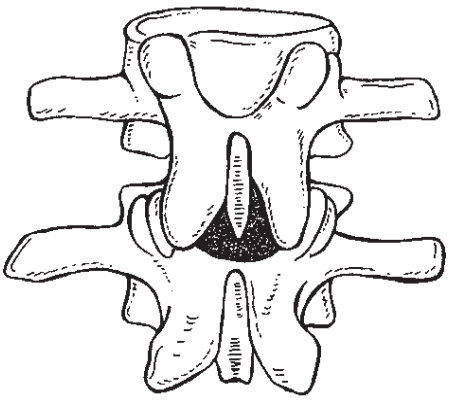
The fluid should preferably be normal saline or Hartmann's solution. 5% dextrose is readily metabolised and so is not effective in maintaining the blood pressure.

Positioning the Patient for Lumbar Puncture

Lumbar puncture is most easily performed when there is maximum flexion of the lumbar spine.



Flexion



Extension

Figure 2. Effect of flexion and extension on the lumbar intervertebral space in the lumbar region.

This can best be achieved by sitting the patient on the operating table and placing their feet on a stool. If they then rest their forearms on their thighs, they can maintain a stable and comfortable position.

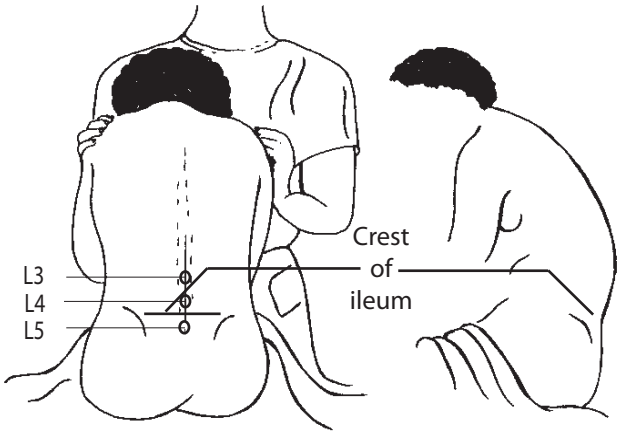


Figure 3. Ideal sitting position for spinal anaesthesia.

Alternatively, the procedure can be performed with the patient lying on their side with their hips and knees maximally flexed. An assistant may help to maintain the patient in a comfortable curled position. The sitting position is preferable in the obese whereas the lateral is better for uncooperative or sedated patients. The anaesthetist can either sit or kneel whilst performing the block.

Factors Effecting the Spread of the Local Anaesthetic Solution

A number of factors effect the spread of the injected local anaesthetic solution within the CSF and the ultimate extent of the block obtained. Among these are:

- the baricity of the local anaesthetic solution
- the position of the patient
- the concentration and volume injected
- the level of injection
- the speed of injection

The specific gravity of the local anaesthetic solution can be altered by the addition of dextrose. Concentrations of 7.5% dextrose make the local anaesthetic hyperbaric (heavy) relative to CSF and also reduce the rate at which it diffuses and mixes with the CSF. Isobaric and hyperbaric solutions both produce reliable blocks. The most controllable blocks are probably produced by injecting hyperbaric solutions and then altering the patient's position.

If a patient is kept sitting for several minutes after the injection of a small volume of a hyperbaric solution of local anaesthetic, a classical saddle block of the perineum will result. The spinal column of patients lying on their side is rarely truly horizontal. Males tend to have wider shoulders than hips and so are in a slight "head up" position when lying on their sides, whilst for females with their wider hips, the opposite is true. Regardless of the position of the patient at the time of injection and whatever the initial extent of the block obtained, the level of the block may change if the patient's position is altered within twenty minutes of the injection.

The quantity of local anaesthetic (in milligrams) injected will determine the quality of the block obtained whilst its extent will also be determined by the volume in which it is injected. Large volumes of concentrated solutions will, thus, produce dense blockade over a large area.

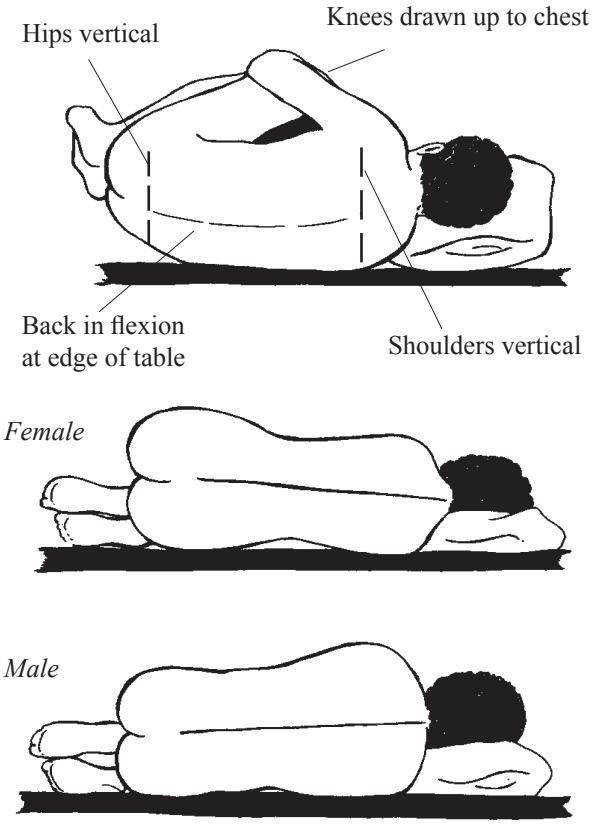


Figure 4. Note how the level of the subarachnoid space varies between male and female

Although the level of injection will obviously effect which dermatomes are blocked, spinal injections tend to be performed only in the lower lumbar region. The extent of the block is influenced more by the volume injected and the position of the patient than the actual interspace at which the injection occurs.

The speed of injection has a slight effect on the eventual extent of the block. Slow injections result in a more predictable spread while rapid injections produce eddy currents within the CSF and a somewhat less predictable outcome.

Finally, increased abdominal pressure from whatever cause (pregnancy, ascites etc) can lead to engorgement of the epidural veins, compression of the dura and hence a reduction in the volume of the CSF. A given quantity of local anaesthetic injected into the CSF might then be expected to produce a more extensive block.

Quantities of Local Anaesthetics to Use

The degree of spinal blockade needed, as measured by the height of the block, will depend on the operation to be performed.

Table 1.

Level	Surgical Procedure
T4-5 (Nipple)	Upper abdominal surgery
T6-8 (Xiphisternum)	Lower abdominal surgery incl. caesarean section, renal surgery, hernia
T10 (Umbilicus)	Prostatic and vaginal surgery incl. forceps delivery, hip surgery
L1 (Groin)	Lower limb surgery
S2 (Perineum)	Perineal and rectal surgery

For certain blocks, less local anaesthetic is needed when hyperbaric rather than plain solutions are used. Special considerations apply to obstetric patients and so the following chart does not apply to them (see later section).

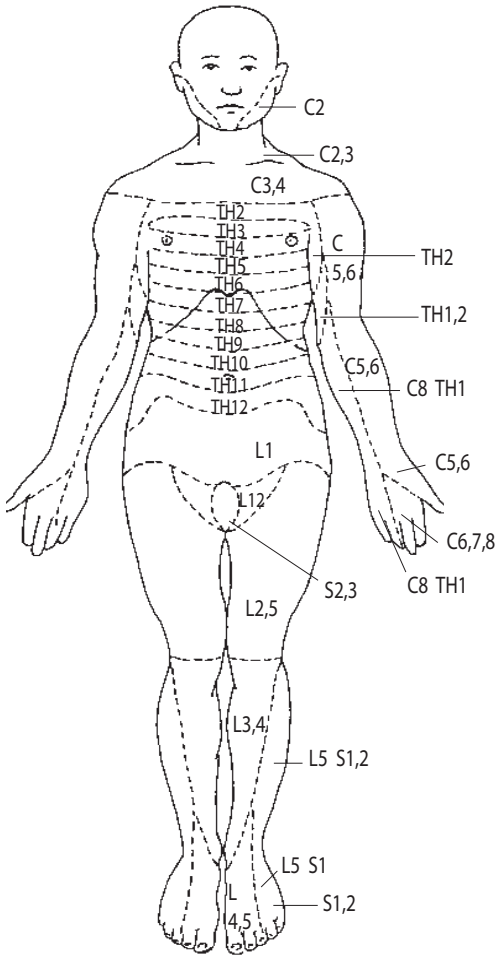


Figure 5. Diagram of dermatones

Table 2.

Type of block	Hyperbaric Bupivacaine	Plain Bupivacaine	Hyperbaric Lignocaine
Saddle block, eg operations on genitalia, perineum	2ml	3ml	1ml
Lumbar block, eg operations on legs	3-3.5ml	3-3.5ml	2ml
Mid-thoracic block, eg hernia, hysterectomy	3-4ml	3-4ml	2ml

The volumes of local anaesthetic shown in Table 2 should be considered only as a guideline. The lower volumes suggested should generally be injected in particularly small people. More may have to be given if the resultant block is not high enough for the proposed operation. Hyperbaric agents are more reliable when trying for a mid-thoracic block.

Preparation for Lumbar Puncture

Assemble the necessary equipment on a sterile surface. It will include:

A **spinal needle**. The ideal would be 24-25 gauge with a pencil point tip to minimise the risk of the patient developing a post-spinal headache.

An **introducer**, if using a fine gauge needle as they are thin and flexible, and therefore difficult to direct accurately. A standard 19 gauge (white) disposable needle is suitable for use as an introducer.

A **5ml syringe** for the spinal anaesthetic solution.

A **2 ml syringe** for local anaesthetic to be used for skin infiltration.

A **selection of needles** for drawing up the local anaesthetic solutions and for infiltrating the skin.

A **gallipot** with a suitable antiseptic for cleaning the skin, eg chlorhexidine, iodine, or methyl alcohol.

Sterile gauze swabs for skin cleansing.

A **sticking plaster** to cover the puncture site.

The local anaesthetic to be injected intrathecally should be in a single use ampoule. **Never use local anaesthetic from a multi-dose vial for intrathecal injection.** Spare equipment and drugs should be readily available if needed.

Performing the Spinal Injection

It is assumed that the patient has been adequately prepared, has had the procedure fully explained, has reliable intravenous access, is in a comfortable position and that resuscitation equipment is immediately available.

1. Scrub and glove up carefully.

2. Check the equipment on the sterile trolley.

3. Draw up the local anaesthetic to be injected intrathecally into the 5ml syringe, from the ampoule opened by your assistant. **Read the label**. Draw up the exact amount you intend to use, ensuring that your needle does not touch the outside of the ampoule (which is unsterile).

4 Draw up the local anaesthetic to be used for skin infiltration into the 2ml syringe. **Read the label.**

5. Clean the patient's back with the swabs and antiseptic ensuring that unsterile skin is not touched by your gloves. Swab radially outwards from the proposed injection site. Discard the swab and repeat several times making sure that a sufficiently large area is cleaned. Allow the solution to dry on the skin.

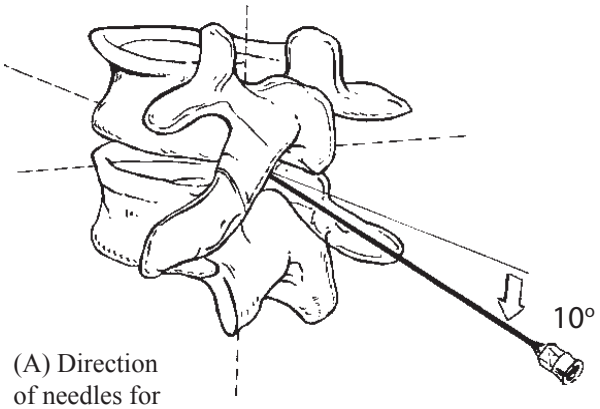
6. Locate a suitable interspinous space. You may have to press hard to feel the spinous processes in an obese patient.

7. Raise an intradermal wheal of local anaesthetic with a disposable 25 gauge needle at the proposed puncture site.

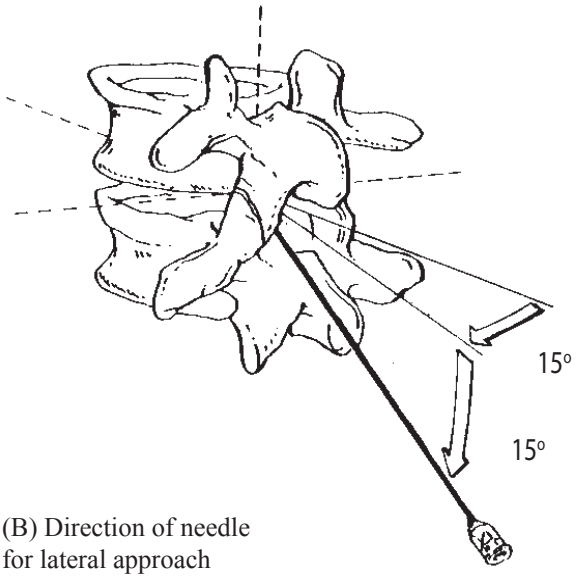
8. Insert the introducer if using a 24-25 gauge needle. Ideally it should be advanced into the interspinous ligament but care should be exercised in thin patients that an inadvertent dural puncture does not occur.

9. Insert the spinal needle (through the introducer, if applicable). Ensure that the stylet is in place so that the tip of the needle does not become blocked

by a tiny particle of tissue or clot. It is imperative that the needle is inserted **and stays** in the midline and that the bevel is directed laterally. It is angled slightly cephalad (towards the head) and slowly advanced. An increased resistance will be felt as the needle enters the ligamentum flavum, followed by a loss of resistance as the epidural space is entered. Another loss of resistance may be felt as the dura is pierced and CSF should flow from the needle when the stylet is removed. If bone is touched, the needle should be withdrawn a centimetre or so and then re-advanced in a slightly more cephalad direction again ensuring that it stays in the midline.



(A) Direction of needles for midline approach



(B) Direction of needle for lateral approach

10. If a 25 gauge spinal needle is being used, be prepared to wait 20-30 seconds for CSF to appear after the stylet has been withdrawn. If no CSF appears, replace the stylet and advance the needle a little further and try again.

11. When CSF appears, take care not to alter the position of the spinal needle as the syringe of local anaesthetic is being attached. The needle is best immobilised by resting the back of the non-dominant hand firmly against the patient and by using the thumb and index finger to hold the hub of the needle. Be sure to attach the syringe firmly to the hub of the needle; hyperbaric solutions are viscous and resistance to injection will be high, especially through fine gauge needles. It is, therefore, easy to spill some of the local anaesthetic unless care is taken.

12. Aspirate gently to check the needle tip is still intrathecal and then slowly inject the local anaesthetic. When the injection is complete, withdraw the spinal needle, introducer and syringe as one and apply a sticking plaster to the puncture site.

Practical Problems

The spinal needle feels as if it is in the right position but no CSF flows. Wait at least 30 seconds, then try rotating the needle 90 degrees and wait again. If there is still no CSF, attach an empty 2ml syringe and inject 0.5-1ml of air to ensure the needle is not blocked then use the syringe to aspirate whilst slowly withdrawing the spinal needle. Stop as soon as CSF appears in the syringe.

Blood flows from the spinal needle. Wait a short time. If the blood becomes pinkish and finally clear, all is well. If blood only continues to drip, then it is likely that the needle tip is in an epidural vein and it should be advanced a little further or angled more medially to pierce the dura.

The patient complains of sharp, stabbing leg pain. The needle has hit a nerve root because it has deviated laterally. Withdraw the needle and redirect it more medially away from the affected side.

Wherever the needle is directed, it seems to strike bone. Make sure the patient is still properly positioned with as much lumbar flexion as possible and that the needle is still in the mid-line. If you think that you are not in the midline check with the patient which side they feel the needle. Alternatively, if the patient is elderly and cannot bend very much or has heavily calcified interspinous ligaments, it might bebetter to attempt a lateral approach to the dura.

This is performed by inserting the spinal needle about 1cm lateral to the mid line at the level of the upper border of a spinous process, then directing it both cephalad and medially. If bone is contacted it is likely to be the vertebral lamina. It should then be possible to "walk" the needle off the bone and into the epidural space, then advance through it to pierce the dura (fig. 6).

Assessing the Block

Some patients are very poor at describing what they do or do not feel, therefore, objective signs are valuable. If, for example, the patient is unable to lift his legs from the bed, the block is at least up to the mid-lumbar region.

It is unnecessary to test sensation with a sharp needle and leave the patient with a series of bleeding puncture wounds. It is better to test for a loss of temperature sensation using a swab soaked in either ether or alcohol. Do this by first touching the patient with the damp swab on the chest or arm (where sensation is normal), so that they appreciate that the swab feels cold. Then work up from the legs and lower abdomen until the patient again appreciates that the swab feels cold.

If the replies are inconsistent or equivocal, the patient can be **gently** pinched with artery forceps or fingers on blocked and unblocked segments and asked if they feel pain. Using this method, there is rarely any difficulty in ascertaining the extent of the block.

Surgeons should be dissuaded from prodding the patient and asking "can you feel this?". Surgeons and patients should be reminded that when a block is successful, a patient may still be aware of touch but will not feel pain.

Problems with the Block

No apparent block at all. If after 10 minutes the patient still has full power in the legs and normal sensation, then the block has failed probably because the injection was not intrathecal. Try again.

The block is one-sided or is not high enough on one side.

a). When using a hyperbaric solution, lie the patient on the side that is inadequately blocked for a few minutes and adjust the table so that the patient is slightly "head down".

b). When using an isobaric solution, lie the patient on the side that is blocked. (Moving a patient around in any way at all in the first 10-20 minutes following injection will tend to increase the height of the block).

Block not high enough.

a). When using a hyperbaric solution, tilt the patient head down whilst they are supine (lying on the back), so that the solution can run up the lumbar curvature. Flatten the lumbar curvature by raising the patients knees.

b). When using a plain solution turn the patient a complete circle from supine to prone (lying on the front) and back to supine again.

Block too high. The patient may complain of difficulty in breathing or tingling in the arms or hands. **Do not tilt the table "head up"**. (See later under 'Treatment of a total spinal.')

Nausea or vomiting. This may occur with high spinal blocks which may be associated with hypotension. Check the blood pressure and treat accordingly. (See later)

Shivering. This occurs occasionally. Reassure the patient and give oxygen by mask.

Monitoring

It is essential to monitor the respiration, pulse and blood pressure closely. The blood pressure can fall precipitously following induction of spinal anaesthesia, particularly in the elderly and those who have not been adequately preloaded with fluid. Warning signs of falling blood pressure include pallor, sweating or complaining of nausea or feeling generally unwell.

A moderate fall in systolic blood pressure to, say, 80mmHg in a young fit patient or 100mmHg in an older patient is acceptable, provided the patient looks and feels well and is adequately oxygenated.

Bradycardia is quite common during spinal anaesthesia particularly if the surgeon is manipulating the bowel or uterus. If the patient feels well, and the blood pressure is maintained, then it is not necessary to give atropine. If, however, the heart rate drops below 50 beats per minute or there is hypotension, then atropine 300-600mcg should be given intravenously.

It is generally considered good practice for all patients undergoing surgery under spinal anaesthesia to be given supplemental oxygen by face mask at a rate of 2-4 litres/minute, especially if sedation has also been given.

Treatment of Hypotension

Hypotension is due to vasodilation and a functional decrease in the effective circulating volume. The treatment is, therefore, to reverse the vasodilatation with vasoconstrictor drugs and increase the circulating volume by giving fluids. All hypotensive patients should be given OXYGEN by mask until the blood pressure is restored.

A simple and effective way of rapidly increasing the patient's circulating volume is by raising their legs thus increasing the return of venous blood to the heart. This can either be done manually by an assistant or by tilting the lower half of the operating table. Tilting the whole operating table head down will also achieve the same effect, but is unwise if a hyperbaric spinal anaesthetic has been injected in the preceding 15 minutes as it will result in the block spreading higher and the hypotension becoming more severe. If an isobaric spinal solution has been used, tilting the table at any time will have very little effect on the height of the block.

Increase the speed of the intravenous infusion to maximum until the blood pressure is restored to acceptable levels and, if the pulse is slow, give atropine intravenously. Vasoconstrictors should be given immediately if the hypotension is severe, and to patients not responding to fluid therapy.

Vasopressors

Ephedrine is probably the vasopressor of choice. It causes peripheral blood vessels to constrict and raises the cardiac output by increasing the heart rate and the force of myocardial contraction. It is safe for use in pregnancy as it does not reduce placental blood flow.

Ephedrine is generally available in 25 or 30 mg ampoules. It is best diluted to 10mls with water for injections and then given in increments of 1-2ml (2.5-6mg) titrated against the blood pressure. Its effect generally lasts about 10 minutes and it may need repeating. Alternatively, the ampoule may be added to a bag of intravenous fluid and the rate of infusion altered to maintain the desired blood

It can also be given intramuscularly but its onset time is delayed although its duration is prolonged. Larger doses are necessary when it is given intramuscularly.

Other Vasopressors

Metaraminol (Aramine). It is supplied in 10mg ampoules and should be diluted and used incrementally (1-5mg) as with ephedrine. It has a slower onset time (at least 2 minutes after intravenous injection) but lasts longer (20-60 minutes)

Methoxamine (Vasoxine). It is available in 20mg ampoules and is best diluted before injection. Suitable adult doses are 2.5-5mg. It is a pure peripheral vasoconstrictor and reflex bradycardia, needing treatment with atropine can occur.

Phenylephrine. A pure peripheral vasoconstrictor which is available in 10mg ampoules. Dilute before use. Suitable adult doses for intravenous use are 100-200mcg which last about 15 minutes. A reflex bradycardia may occur.

Noradrenaline (Levophed). A powerful vasoconstrictor available in 2mg ampoules which must be diluted in 1000ml of intravenous fluid before use. It is then given at an initial rate of 2-3ml/minute and thereafter titrated against the blood pressure. Control the infusion with the utmost care.

Adrenaline/Epinephrine. Available as 1mg/ml (1:1,000) and 1mg/10ml (1:10,000) ampoules. Dilute 1ml of 1:1,000 adrenaline to at least 10ml with saline and give increments of 50mcg (0.5ml of 1:10,000) repeating as necessary. Monitor the effect of adrenaline closely - it is a very powerful drug but only lasts a few minutes.

Treatment of Total Spinal

Although rare, total spinals can occur with frightening rapidity and result in the death of the patient if not quickly recognised and treated. They are more likely to occur when a planned epidural injection is, inadvertently, given intrathecally. The warning signs that a total spinal block is developing are:

Hypotension - treat as detailed above. Remember that nausea may be the first sign of hypotension.

Bradycardia - give atropine

Increasing anxiety - reassure.

Numbness or weakness of the arms and hands, indicating that the block has reached the cervico-thoracic junction.

Difficulty breathing - as the intercostal nerves are blocked the patient may state that they can't take a deep breath. As the phrenic nerves (C 3,4,5) which supply the diaphragm become blocked, the patient will initially be unable to talk louder than a whisper and will then stop breathing.

Loss of consciousness.

Action:

Ask for help - several pairs of hands may be useful!

Intubate and ventilate the patient with 100% oxygen.

Treat hypotension and bradycardia with intravenous fluids, atropine and vasopressors as described earlier. If treatment is not started quickly the combination of hypoxia, bradycardia and hypotension may result in a cardiac arrest.

Ventilation will need to be continued until the spinal block recedes and the patient is able to breathe again unaided. The time this will take will depend on which local anaesthetic has been injected.

Once the airway has been controlled and the circulation restored, consider sedating the patient with a benzodiazepine as consciousness may return before muscle power.

General Postoperative Care

The patient should be admitted to the recovery room as with any other anaesthetised patient. In the event of hypotension in the recovery room, the nurses should know to elevate the legs, increase the rate at which intravenous fluids are being administered, give oxygen and summon the anaesthetist. Further doses of vasoconstrictors or fluids may be required, particularly if surgical bleeding continues.

Patients should be advised as to how long their spinal block will last and be told to remain in bed until full sensation and muscle power has returned.

Complications of Spinal Anaesthesia

Headache: a characteristic headache may occur following spinal anaesthesia. It begins within 12-24 hours and may last a week or more. It is postural, being made worse by raising the head and relieved by lying down. It is often occipital and may be associated with a stiff neck. It is frequently accompanied by nausea, vomiting, dizziness and photophobia.

It is more common in the young, in females and especially in obstetric patients. It is thought to be caused by the continuing loss of CSF through the hole made in the dura by the spinal needle. This results in descent of the brain and traction on its supporting structures.

The incidence of headache is related directly to the size of the needle used. A 16 gauge needle will cause headache in about 75% of patients, a 20 gauge needle in about 15% and a 25 gauge needle about 3%. It is, therefore, sensible to use the smallest needle available especially in high risk obstetric patients.

As the fibres of the dura run parallel to the long axis of the spine, if the bevel of the needle is parallel to them, it will part rather than cut them and therefore, leave a smaller hole. Make a mental note of which way the bevel lies in relation to the notch on the hub and then align it appropriately. It is widely considered that pencil-point needles (Whiteacre or Sprotte) make a smaller hole in the dura and are associated with a lower incidence of headache than conventional cutting-edged needles (Quincke).

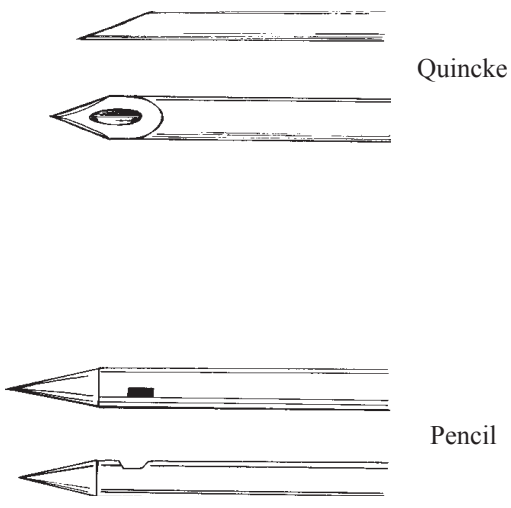


Figure 7. Patterns of spinal needle tips.

As the sacral autonomic fibres are among the last to recover following a spinal anaesthetic, urinary retention may occur. If fluid pre-loading has been excessive, a painful distended bladder may result and the patient may need to be catheterised.

Permanent neurological complications are extremely rare. Many of those that have been reported were due to the injection of inappropriate drugs or chemicals into the CSF producing meningitis, arachnoiditis, transverse myelitis or the cauda equina syndrome with varying patterns of neurological impairment and sphincter disturbances.

If inadequate sterile precautions are taken, bacterial meningitis or an epidural abscess may result although it is thought that most such abscesses are caused by the spread of infection in the blood.

Finally, permanent paralysis can occur due to the "anterior spinal artery syndrome". This is most likely to affect elderly patients who are subjected to prolonged periods of hypotension and may result in permanent paralysis of the lower limbs.

It used to be thought that bedrest for 24 hours following a spinal anaesthetic would help reduce the incidence of headache, but this is now no longer believed to be the case. Patients may get up once normal sensation has returned, if surgical considerations so allow.

Treatment of spinal headache : Pateints with spinal headaches prefer to remain lying flat in bed as this relieves the pain. They should be encouraged to drink freely or, if necessary, be given intravenous fluids to maintain adequate hydration. Simple analgesics such as paracetamol, aspirin or codeine may be helpful as may measures to increase intra-abdominal and hence epidural pressure such as lying prone. Caffeine containing drinks such as tea, coffee or Coca-Cola are often helpful. Prolonged or severe headaches may be treated with epidural blood patch performed by aseptically injecting 15-20ml of the pateint's own blood into the epidural space. This then clots and seals the hole and prevents further leakage of CSF.

Other Complications

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Spinal Anaesthesia in Obstetrics

There are several reasons for preferring spinal anaesthesia to general anaesthesia for caesarean sections. Babies born to mothers having spinal (or epidural) anaesthesia may be more alert and less sedated as they have not received any general anaesthestic agents through the placental circulation. As the mother's airway is not compromised, there is a reduced risk of aspiration of gastric contents causing chemical pneumonitis (Mendelson's syndrome).

Many mothers also welcome the opportunity of being awake during the delivery and being able to feed their child as soon as the operation is complete.

There are, however, also disadvantages. It may be difficult to perform the spinal injection as lumbar flexion may be impeded by the pregnant uterus and, if labour has started, the mother may be unable to remain still when having contractions. Unless small gauge needles (25 gauge) are used, the incidence of post-spinal headache may be unacceptably high. Spinal anaesthetics for caesarean section should not be performed until the anaesthetist has accumulated sufficient experience in their performance with non-pregnant patients.

In the absence of hypovolaemia due to bleeding, spinal anaesthesia is a simple and safe alternative to general anaesthesia for manual removal of a retained placenta. It does not produce uterine relaxation and if this is required, a general anaesthetic with a volatile agent may be preferred.

Technique

Spinal anaesthesia is performed and managed in pregnant patients in the same way as in non-pregnant patients but with a number of special considerations.

It is generally recommended that obstetric patients should be pre-loaded with not less than 1500 mls of a crystalloid solution before the dural puncture is performed.

Although spinal anaesthesia is not contra-indicated in the presence of mild pre-eclampsia, remember that such patients may have altered clotting function and are relatively hypovolaemic. There is always a chance that a pre-eclamptic patient may suddenly fit and anticonvulsant drugs (diazepam or thiopentone) must be immediately available. The advantages and disadvantages of spinal versus general anaesthesia will have to be carefully considered for each patient.

Pregnant women need smaller volumes of spinal anaesthetic solution than non-pregnant women in order to obtain a given height of block. For a caesarean section, anaesthesia should extend to T6 (about the bottom of the sternum) to be completely successful. This can usually be achieved with the following regimes, although the hyperbaric agents are more predictable:

2.0-2.5 ml of a hyperbaric solution of 0.5% bupivacaine or

2.0-2.5 ml of an isobaric solution of 0.5% bupivacaine or

1.4-1.6 ml of a hyperbaric solution of 5% lignocaine or

2.0-2.5 ml of an isobaric solution of 2% lignocaine with added adrenaline (0.2 ml of 1:1000)

If anaesthesia is required for a forceps delivery, 1.0ml of a hyperbaric solution injected with the mother in the sitting position is usually adequate.

Anaesthesia to T10 is needed for removal of a retained placenta. This can be obtained by injecting 1.5mls of a hyperbaric solution with the patient sitting and then lying her down.

Positioning of the Pregnant Patient

Pregnant patients should never lie supine as the gravid uterus will compress the vena cava and, to a lesser extent the aorta (aorto-caval compression) resulting in hypotension. They should, instead, always lie with a lateral tilt. This can be achieved either by tilting the whole table or by inserting a wedge under the patients right hip. The uterus is displaced slightly to the left and the vena cava is not compressed (see Update No. 2).

As with all patients undergoing surgery under spinal anaesthesia, oxygen should be given during the operation. As hypotension commonly occurs despite fluid preloading, many anaesthetists routinely give a dose of vasoconstrictor intravenously. Ephedrine is the favoured vasoconstrictor as it does not cause constriction of the uterine blood vessels. If it is not available, one of the other vasoconstrictors discussed previously should be used as untreated hypotension can seriously damage the unborn infant.

After delivery of the baby, syntocinon is the oxytocic of choice as it is less likely to produce maternal nausea and vomiting than ergometrine.