EPIDURAL ANAESTHESIA

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INTRODUCTION

Epidural anaesthesia is a central neuraxial block technique with many applications. The epidural space was first described by Corning in 1901, and Fidel Pages first used epidural anaesthesia in humans in 1921. In 1945 Tuohy introduced the needle which is still most commonly used for epidural anaesthesia. Improvements in equipment, drugs and technique have made it a popular and versatile anaesthetic technique, with applications in surgery, obstetrics and pain control. Both single injection and catheter techniques can be used. Its versatility means it can be used as an anaesthetic, as an analgesic adjuvant to general anaesthesia, and for postoperative analgesia in procedures involving the lower limbs, perineum, pelvis, abdomen and thorax.

INDICATIONS

General

Epidural anaesthesia can be used as sole anaesthetic for procedures involving the lower limbs, pelvis, perineum and lower abdomen. It is possible to perform upper abdominal and thoracic procedures under epidural anaesthesia alone, but the height of block required, with its attendant side effects, make it difficult to avoid significant patient discomfort and risk. The advantage of epidural over spinal anaesthesia is the ability to maintain continuous anaesthesia after placement of an epidural catheter, thus making it suitable for procedures of long duration. This feature also enables the use of this technique into the postoperative period for analgesia, using lower concentrations of local anaesthetic drugs or in combination with different agents.

Specific uses

- **Hip and knee surgery**. Internal fixation of a fractured hip is associated with less blood loss when central neuraxial block is used. The rate of deep venous thrombosis is reduced in patients undergoing total hip and knee replacement, when epidural anaesthesia is used.
- **Vascular reconstruction of the lower limbs**. Epidural anaesthesia improves distal blood flow in patients undergoing arterial reconstruction surgery.
- **Amputation.** Patients given epidural anaesthesia 48-72 hours prior to lower limb amputation may have a lower incidence of phantom limb pain following surgery, although this has not been substantiated.
- **Obstetrics.** Epidural analgesia is indicated in obstetric patients in difficult or high-risk labour, e.g. breech, twin pregnancy, pre-eclampsia and prolonged labour. Furthermore, Caesarean section performed under central neuraxial block is associated with a lower maternal mortality owing to anaesthetic factors than under general anaesthetic.
- **Low concentration local anaesthetics, opioids, or combinations of both** are effective in the control of postoperative pain in patients undergoing abdominal and thoracic procedures. Epidural analgesia has been shown to minimise the effects of surgery on cardiopulmonary reserve, i.e. diaphragmatic splinting and the inability to cough adequately, in patients with compromised respiratory function, such as those with chronic obstructive airway disease, morbid obesity and in the elderly. Epidural analgesia allows earlier mobilization, reduces the risk of deep venous thrombosis, and allows better cooperation with chest physiotherapy, preventing chest infections.
- **Thoracic trauma with rib or sternum fractures.** Adequate analgesia in patients with thoracic trauma improves respiratory function by allowing the patient to breathe adequately, cough and cooperate with chest physiotherapy.

CONTRAINDICATIONS

Absolute

- **Patient refusal**
- **Coagulopathy.** Insertion of an epidural needle or catheter into the epidural space may cause traumatic bleeding into the epidural space. Clotting abnormalities may lead to the development of a large haematoma leading to spinal cord compression.

- **Therapeutic anticoagulation**. As above

- **Skin infection at injection site**. Insertion of the epidural needle through an area of skin infection may introduce pathogenic bacteria into the epidural space, leading to serious complications such as meningitis or epidural abscess.

- **Raised intracranial pressure.** Accidental dural puncture in a patient with raised ICP may lead to brainstem herniation (coning).

- **Hypovolaemia.** The sympathetic blockade produced by epidurals, in combination with uncorrected hypovolaemia, may cause profound circulatory collapse.

Relative

- **Uncooperative patients** may be impossible to position correctly, and be unable to remain still enough to safely insert an epidural.

- **Pre-existing neurological disorders**, such as multiple sclerosis, may be a contraindication, because any new neurological symptoms may be ascribed to the epidural.

- **Fixed cardiac output states**. Probably relative rather than absolute. This includes aortic stenosis, hypertrophic obstructive cardiomyopathy (HOCM), mitral stenosis and complete heart block. Patients with these cardiovascular abnormalities are unable to increase their cardiac output in response to the peripheral vasodilatation caused by epidural blockade, and may develop profound circulatory collapse which is very difficult to treat.

- **Anatomical abnormalities of vertebral column** may make the placement of an epidural technically impossible.

- **Prophylactic low dose heparin** (see discussion below)

EPIDURALS AND ANTICOAGULANTS
(see also page 7)

- Full oral anticoagulation with warfarin or standard heparin (SH) are absolute contraindications to epidural blockade.

- Partial anticoagulation with low molecular weight heparin (LMWH) or low dose warfarin (INR <1.5) are relative contraindications.

- Minihep (low dose standard heparin (SH), 5,000units bd s/c is not associated with an increased risk of epidural haematoma. Wait for 4 hours after a dose before performing epidural. Minihep/SH should not be given until 1 hour following epidural injection. These guidelines also apply for removal of epidural catheters.

- LMWH (<40mg enoxaparin and dalteparin): allow 12hr interval between LMWH administration and epidural; this also applies to removal of epidural catheters.

- NSAID's (including aspirin) do not increase the risk of epidural haematoma.

- Intraoperative anticoagulation using 5000units i/v heparin following epidural/spinal injection appears safe, but careful postoperative observations are recommended. Bloody tap or blood in epidural catheter is controversial. Some teams delay surgery for 12hr, others (if pre-op coagulation normal) delay i/v bolus of heparin for 1hour.

- Fibrinolytic and thrombolytic drugs: avoid epidural block for 24 hrs, check clotting prior to insertion.

- Thrombocytopaenia: epidurals are relatively contraindicated below platelet count of 100,000/ mm^3.

- An epidural haematoma should be suspected in patients who complain of severe back pain a few hours/days following any central neuraxial block or with any prolonged or abnormal neurological deficit (including. sensory loss, paraesthesiae, muscle weakness and disturbance of bladder control and anal sphincter tone). A high index of suspicion is required, with early orthopaedic or neurosurgical referral for decompression of the haematoma. Even with early recognition, the morbidity of this condition is still very high.

ANATOMY OF THE EPIDURAL SPACE (figure 1)

The epidural space is that part of the vertebral canal not occupied by the dura mater and its contents. It is a potential space that lies between the dura and the periosteum lining the inside of the vertebral canal. It extends from the foramen magnum to the sacral hiatus. The anterior and posterior nerve roots in their dural covering pass across this potential space to

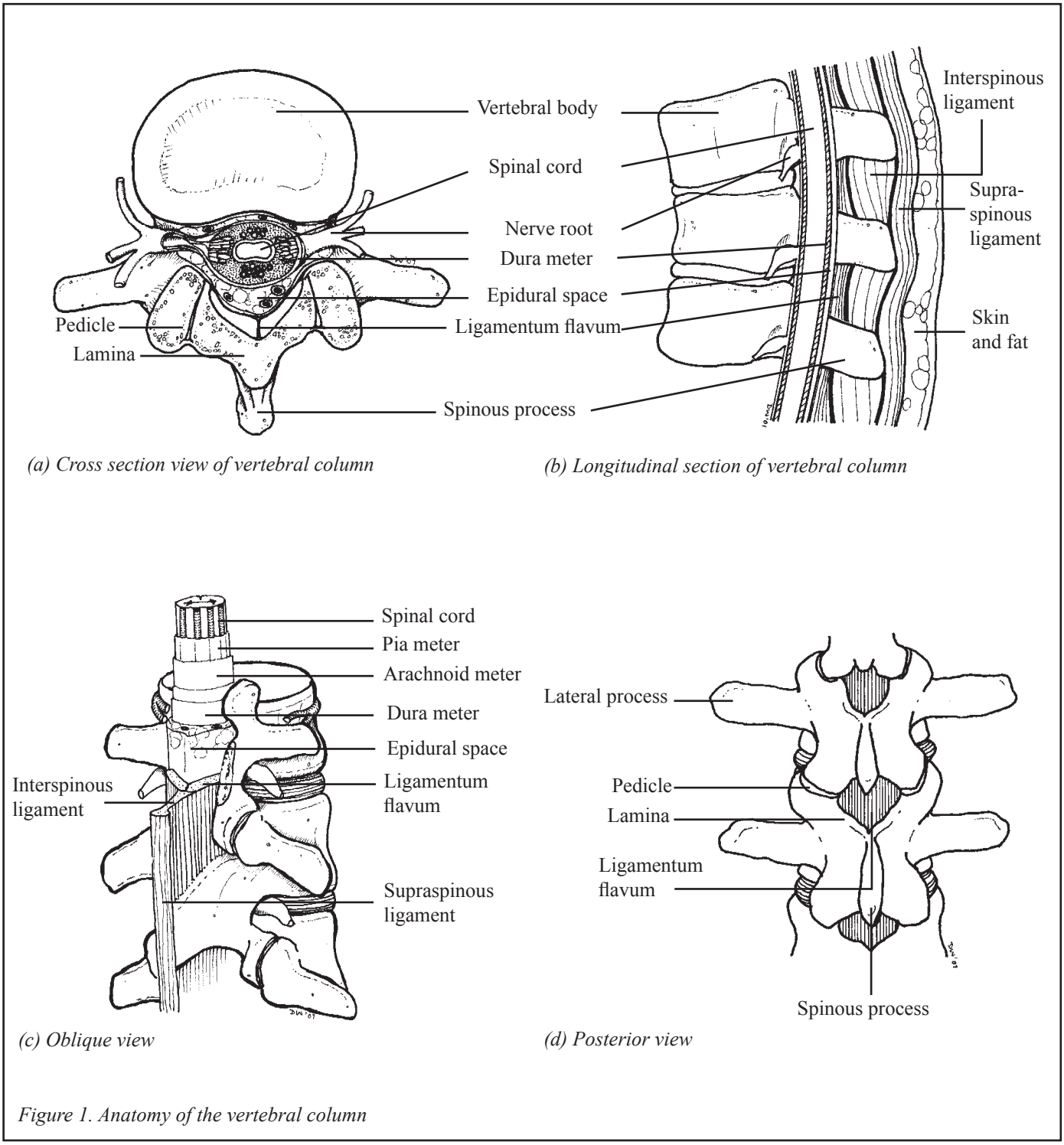


Figure 1. Anatomy of the vertebral column

unite in the intervertebral foramen to form segmental nerves. The anterior border consists of the posterior longitudinal ligament covering the vertebral bodies, and the intervertebral discs. Laterally, the epidural space is bordered by the periosteum of the vertebral pedicles, and the intervertebral foraminae. Posteriorly, the bordering stuctures are the periosteum of the anterior surface of the laminae and articular processes and their connecting ligaments, the periosteum of the root of the spines, and the interlaminar spaces filled by the ligamentum flavum. The space contains venous plexuses and fatty tissue which is continuous with the fat in the paravertebral space.

TECHNIQUE OF EPIDURAL ANAESTHESIA

Preparation

An epidural must be performed in a work area that is equipped for airway management and resuscitation. Facilities for monitoring blood pressure and heart rate must be available. It is advisable to obtain

informed consent prior to performing an epidural in the same way as before any other invasive procedure. The patient should be informed of the possible risks and complications associated with epidurals (see below). A formal pre-anaesthetic assessment should be carried out, and this should be no less rigorous than one carried out prior to general anaesthesia. Special attention should be given to the patient's cardiovascular status, with the emphasis on valvular lesions or other conditions that might impair the ability to increase cardiac output in response to the vasodilatation that inevitably follows sympathetic blockade. The back should be examined and any lesions or abnormalities noted. Laboratory assessment of the patient's coagulation status is necessary where there is any doubt regarding coagulopathy or anticoagulation therapy. INR (or prothrombin time), APTT and absolute platelet count should be within the normal range. Where there is doubt about platelet function in the presence of a normal platelet count, a haematologist's advice should be sought.

Prior to performing the block, all equipment should be checked. Intravenous access, preferably with a large bore cannula (e.g. 16G), is mandatory before the block is sited. The skin should be prepared with alcohol or iodine-containing sterilising solution. The back should be draped in a sterile fashion, and the operator should take full sterile precautions, including gown, mask and gloves.

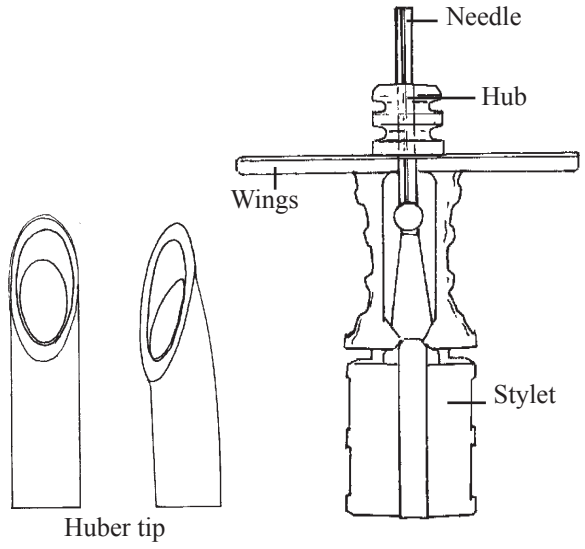


Figure 2. The Tuohy Needle

Equipment

Modern epidural kits are usually disposable and packed in a sterile fashion. All equipment and drugs used should be sterile, and drugs should be preservative free.

The epidural needle is typically 16-18G, 8cm long with surface markings at 1cm intervals, and has a blunt bevel with a 15-30 degree curve at the tip. The most commonly used version of this needle is the Tuohy needle, and the tip is referred to as the Huber tip. Most commercially available needles have the Tuohy/Huber configuration and have wings attached at the junction of the needle shaft with the hub, which allow better control of the needle as it is advanced. The original winged needle was called the Weiss needle (figure 2).

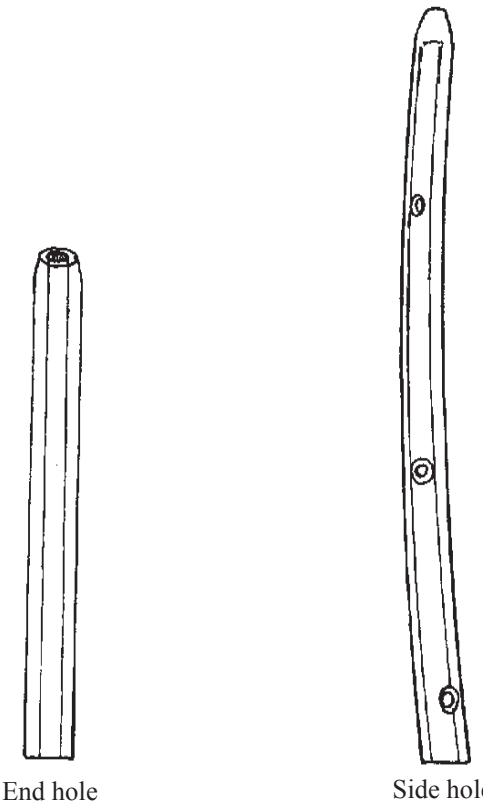


Figure 3. Epidural catheters

Traditionally, a glass syringe with a plunger, which slides very easily, has been used to identify the epidural space. Newer, commercially available disposable epidural packs contain a plastic syringe with a plunger that has very low resistance. Normal syringes should not be used because their greater resistance may make identification of the epidural space more difficult.

Epidural catheters are designed to pass through the lumen of the needle and are made of a durable but flexible plastic, and have either a single end-hole or a number of side holes at the distal end (figure 3). A filter is attached via Luer-Lok to a connector, which, when tightened, grips the proximal end of the catheter, and serves to prevent the inadvertent injection of particulate matter into the epidural space, and also acts as a bacterial filter. These filters are also usually included in disposable epidural packs.

Techniques to identify the epidural space

The epidural space is entered by the tip of the needle after it passes through the ligamentum flavum. The space is very narrow and is sometimes called a potential space, as the dura and the ligamentum flavum are usually closely adjacent. The space therefore has to be identified as the bevel of the needle exits the ligamentum flavum, as the dura will be penetrated shortly after if the needle is advanced any further. To identify this point, several techniques have been developed over the years, but currently most practitioners use a syringe to identify a loss of resistance when pressure is applied to the plunger. Some use saline in the syringe, and others use air. The two techniques are broadly similar, with some subtle differences in the way the syringe is advanced and the epidural space entered. Other techniques to identify the epidural space have been used in the past, e.g. the "hanging drop technique". With this technique, a drop of saline is placed at the hub of the needle and the needle (without syringe) is advanced. The epidural space is identified when the drop is "sucked" into the needle by the negative atmospheric pressure in the epidural space (equivalent to the intrapleural pressure). This technique is rarely used today.

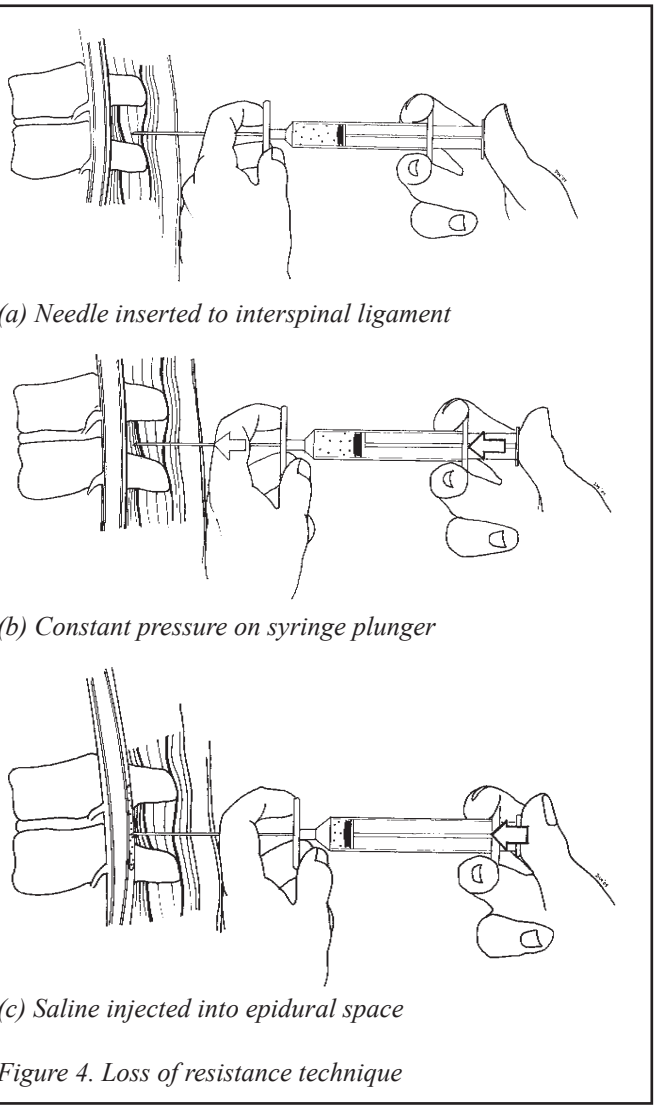
The block can be performed with the patient either in the sitting or lateral decubitus position. The patient should be encouraged to adopt a curled up position, as this tends to open the spaces between the spinous processes and facilitates the identification of the intervertebral spaces. After the back has been prepared with sterile solution and draped in sterile fashion, the desired level is selected (see below).

Midline approach (figure 4)

- Using local anaesthetic raise a subcutaneous wheal at the midpoint between two adjacent vertebrae. Inflitrate deeper in the midline and paraspinously to anaesthetise the posterior structures. At the planned puncture site make a small hole in the skin using a 19G needle.

- Insert epidural needle into the skin at this point, and advance through the supraspinous ligament, with the needle pointing in a slightly cephalad direction. Then advance the needle into the interspinous ligament, which is encountered at a depth of 2-3 cm.until distinct sensation of increased resistance is felt as the needle passes into the ligamentum flavum (most people pass the needle through the interspinous ligament and into the ligamentum flavum before attaching the LOR syringe)

- At this point, remove the needle stylet and attach the syringe to the hub of the needle. If loss of resistance to saline is to be used fill the syringe with 5-10ml of normal saline. Hold the syringe in the right hand (for a right handed operator) with the thumb on the plunger. The left hand grips the wing of the needle



(a) Needle inserted to interspinal ligament

(b) Constant pressure on syringe plunger

(c) Saline injected into epidural space

Figure 4. Loss of resistance technique

between thumb and forefinger, while the dorsum of the left hand rests against the back. The left hand acts to steady the needle and to serve as a "brake" to prevent the needle from advancing in an uncontrolled way. Using the thumb of the right hand to exert constant pressure on the plunger advance the needle through the interspinous ligament and then into the ligamentum flavum. While the tip of the needle is in the interspinous ligament there may be some loss of saline into the tissues as the tissue is not particularly dense, but there is usually significant resistance to pressure on the plunger. Occasionally, this false loss of resistance may cause some difficulty with placing an epidural. Once the needle enters the ligamentum flavum, there is usually a distinctive sensation of increased resistance, as this is a dense ligament with a leathery consistency. With continuous pressure on the plunger, advance the needle slowly until its tip exits the ligamentum flavum and the saline is easily injected into the epidural space, and the needle stops advancing.

- Remove the syringe and thread the catheter gently via the needle into the epidural space. The catheter has markings showing the distance from its tip, and should be advanced to 15-18cm at the hub of the needle, to ensure that a sufficient length of catheter has entered the epidural space. Remove the needle carefully, ensuring that the catheter is not drawn back with it. The markings on the needle will show the depth of the needle from the skin to the epidural space, and this distance will help determine the depth to which the catheter should be inserted at the skin. For example, if the needle entered the epidural space at a depth of 5cm, the catheter should be withdrawn so that the 10cm mark is at the skin, thus leaving approximately 5cm of the catheter inside the epidural space, which is an appropriate length.

- The technique when using loss of resistance to air is slightly different. With 5-10ml of air in the syringe, attach it to the hub of the needle once it has entered the interspinous ligament. Grip both wings of the needle between the thumb and forefinger of both hands. The plunger is gently pressed, and if there is resistance ("bounce"), the needle is very carefully advanced, with the dorsum of both hands resting against the back to provide stability. After 2-3mm, the plunger is again gently pressed, and this procedure is repeated as the needle is carefully advanced through the tissues. The distinctive increase in resistance when the needle enters the ligamentum flavum is felt, and the process is continued in 2mm increments. There is usually a distinctive "click" when the needle enters the epidural space, and provided great care is taken, and the needle only advanced in 2mm increments, the needle should stop before it reaches the dura. At this point air can be injected into the epidural space very easily. The syringe is removed and the catheter threaded as above.

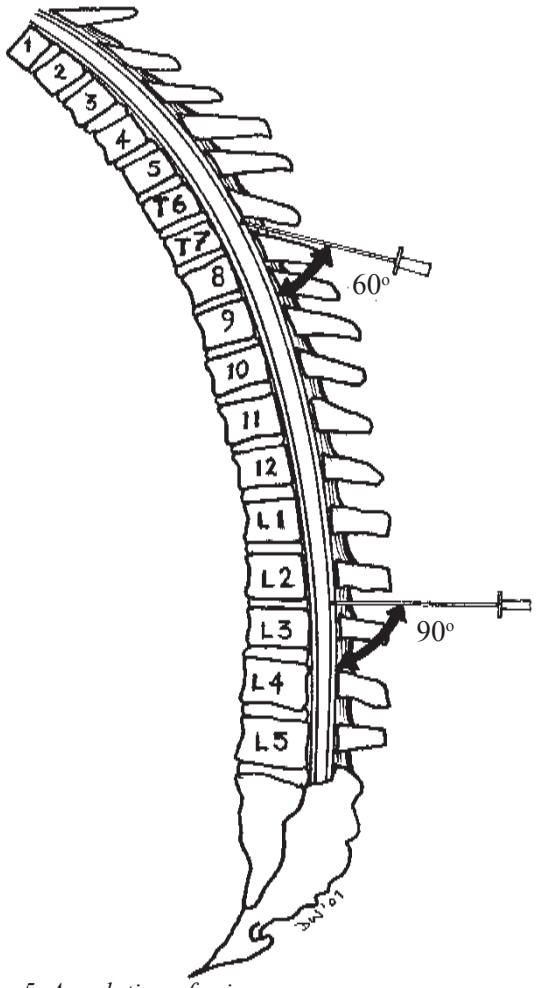


Figure 5. Angulation of spinous processes.

Paramedian approach

- Epidurals can be sited at any level along the lumbar and thoracic spine, enabling its use in procedures ranging from thoracic surgery to lower limb procedures. Due to the downward angulation of the spinous processes of the thoracic vertebrae, particularly in the mid-thoracic region, the needle has to be directed much more cephalad. to proceed through the ligamentous tissue and into the epidural space (figure 5). The ligaments in this area are also less dense and a false loss of resistance is not uncommon. Because of the oblique arrangement of the spinous

processes, the needle has to travel a longer distance before reaching the ligamentum flavum, and there is less space between the spinous processes. It is therefore much more common to encounter bony resistance during the placement of thoracic epidurals. For this reason, many practitioners prefer to use a paramedian approach in this region.

- Insert the needle, not in the midline in the space between the spinous processes, but 1-2cm lateral to the spinous process of the more cephalad vertebra.

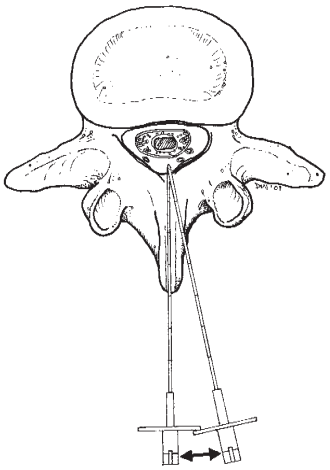


Figure 6. Midline vs. paramedian approach

- Advance the needle; perpendicular to the skin until the lamina or pedicle is encountered, and then redirect it approx 30° cephalad and 15° medially in an attempt to "walk the needle" off the lamina, at which point the needle should be in close proximity to the ligamentum flavum. The needle is then advanced further using a loss of resistance technique (figure 6).

Thoracic epidurals are technically more difficult to perform than lumbar epidurals, and should be attempted only once a practitioner is experienced and confident in the performance of lumbar epidural blocks.

Problem solving during performance of an epidural

- **Bony resistance everywhere** - try flexing more or changing position. If still unsuccessful, try paramedian approach (if using midline approach).

- **Unable to thread catheter** - try rotating the needle slightly so that the bevel changes direction. Most commercial epidural packs contain a catheter stabiliser, which attaches to the hub of the needle and may make feeding the catheter easier. If still unsuccessful, the needle is unlikely to be in the epidural space. Do not pull back the catheter through the needle as the tip may be cut off.

- **Fluid through needle** - if using saline, wait a few seconds to see if it stops flowing. If not, dural puncture is likely. Resite epidural at a different level. If fluid stops flowing, continue as before, but give small doses of local anaesthetic incrementally and observe carefully for signs of subarachnoid block.

- Fluid through catheter - *as above*

- **Pain on insertion of the catheter** - a brief sensation of "electric shock" on insertion of the catheter is not unusual, but if it persists, the needle or catheter may be up against a nerve root and should be withdrawn and resited.

- **Blood in catheter.** This indicates that the catheter has entered an epidural vein. Withdraw catheter by 1-2cm provided this will leave at least 2-3cm in the space and flush through with saline. Aspirate again to see if blood is still flowing through catheter. If blood has stopped, the catheter may be used, but with great care, making sure at all times that 1) catheter is aspirated prior to any subsequent doses of local anaesthetic 2) all doses are given in small increments 3) the patient is carefully monitored for any early signs of local anaesthetic toxicity.

FACTORS AFFECTING EPIDURAL ANAESTHESIA

Site of injection

- After lumbar injection, analgesia spreads both caudally and, to a greater extent, cranially, with a delay at the L5 and S1 segments, due to the large size of these nerve roots.

- After thoracic injection, analgesia spreads evenly from the site of injection. The upper thoracic and lower cervical roots are resistant to blockade due to their larger size. The epidural space in the thoracic region is usually smaller and a lower volume of local anaesthetic is needed.

Dosage

The dose required for analgesia or anaesthesia is determined by several factors but generally, 1-2ml of local anaesthetic is needed per segment to be blocked. The spread of local anaesthetic in the epidural space

is unpredictable as the size of the epidural space is variable, as is the amount of local anaesthetic that leaks into the paravertebral space.

The dose (in milligrams) is a function of the volume injected and the concentration of the solution, and the response is not necessarily the same if the same dose is used but in a different volume and concentration. A higher volume of a low concentration of local anaesthetic will result in a larger number of segments blocked but with less dense sensory block and less motor block. It is important to remember that sympathetic nerve fibres have the smallest diameter and are most easily blocked (see below), even with low concentrations of local anaesthetic, and the degree of sympathetic block is related to the number of segments blocked. With an epidural catheter, incremental dosing is possible and this is important in preventing excessively high sympathetic block with hypotension.

The need for repeat or "top-up" doses of local anaesthetic is dependent on the duration of action of the drug. Repeat doses should be given before the block regresses to the extent that the patient experiences pain. A useful concept is the "time to two-segment regression". This is the time from injection of the first dose of local anaesthetic to the point where maximum sensory level has receded by two segments. When two-segment regression has occurred, approximately one half of the original dose should be injected to maintain the block. The time to two-segment regression for lignocaine is 90-150 minutes, and for bupivacaine it is 200-260 minutes.

Age, height & weight

There is an age related decrease in the volume of local anaesthetic needed to achieve a given level of block, presumably due to a decrease in the size and compliance of the epidural space. The patient's height appears to correlate to some extent with the volume of local anaesthetic needed, so that an adult of 5ft should receive a volume of local anaesthetic at the lower end of the range (i.e. 1ml per segment blocked), while volumes up to 2ml per segment may be required for taller patients. The safest approach is to inject incremental doses and monitor the effect carefully. There is little correlation between the weight of a patient and the volume of local anaesthetic needed, although in morbidly obese patients the epidural space may be compressed due to the effect on intra-abdominal pressure, and a smaller volume of local anaesthetic is needed. Furthermore, venous engorgement of the epidural space due to compression of the azygos venous system may further reduce the volume of the epidural space, and increase the risk of puncture of an epidural vein. The same applies to patients with ascites, large intra-abdominal tumours and in the latter stages of pregnancy.

Posture

The effect of gravity during placement of the block has traditionally been assumed to have an effect on the spread of local anaesthetic and thus the area blocked, i.e. in the sitting position the lower lumbar and sacral roots are preferentially blocked, while in the lateral decubitus position, the nerve roots on the dependent side are more densely anaesthetised. Although there is very little scientific evidence that this is the case, the clinical experience of most practitioners suggests that gravity may have some effect.

Vasoconstrictors

Although the addition of vasoconstrictors to local anaesthetic drugs has been shown to prolong anaesthesia with other regional techniques and local infiltration, their effect on epidural anaesthesia is less consistent. With bupivacaine, the addition of adrenaline has not been shown to prolong anaesthesia, while with lignocaine; the addition of adrenaline (usually 1:200 000) does prolong the duration of action. However, vasoconstriction does reduce the amount of systemic absorption of local anaesthetic drugs, and reduces the risk of toxicity.

Alkalinisation of local anaesthetics

Commercially available solutions of local anaesthetics have a pH between 3.5 and 5.5, for chemical stability and bacteriostasis. Most local anaesthetics are weak bases and exist in their ionised (hydrophilic) form at this pH. Since nerve blockade is dependent on penetration of the lipid nerve cell membranes, and the non-ionised (lipophilic) form crosses membranes more easily, it follows that raising the pH of the solution will increase the proportion of drug in the non-ionised form and thus enhance nerve membrane penetration and speed up the onset of blockade. The addition of 8.4% sodium bicarbonate (0.5ml per 10ml of local anaesthetic solution) has become popular in achieving more rapid onset of blockade with, for example, emergency Caesarean Section.

PHYSIOLOGICAL EFFECTS OF EPIDURAL BLOCKADE

The segmental nerves in the thoracic and lumbar region contain somatic sensory, motor and autonomic (sympathetic) nerve fibres. Sensory and autonomic fibres have a smaller diameter and are more easily blocked than larger, more rapidly-conducting motor fibres. The relationship between sensory and autonomic outflow is complex, but sympathetic block usually extends 1-2 levels higher than sensory block.

Effects on organ systems

- **Cardiovascular system.** Vasodilatation of resistance and capacitance vessels occurs, causing relative hypovolaemia and tachycardia, with a resultant drop in blood pressure. This is exacerbated by blockade of the sympathetic nerve supply to the adrenal glands, preventing the release of catecholamines. If blockade is as high as T2, sympathetic supply to the heart (T2-5) is also interrupted and may lead to bradycardia. The overall result may be inadequate perfusion of vital organs and measures are required to restore the blood pressure and cardiac output, such as fluid administration and the use of vasoconstrictors. Sympathetic outflow extends from T1 - L2 and blockade of nerve roots below this level, as with, for example, knee surgery, is less likely to cause significant sympathetic blockade, compared with procedures requiring blockade above the umbilicus.

- **Respiratory system.** Usually unaffected unless blockade is high enough to affect intercostal muscle nerve supply (thoracic nerve roots) leading to reliance on diaphragmatic breathing alone. This is likely to cause distress to the patient, as they may feel unable to breathe adequately.

- **Gastrointestinal system.** Blockade of sympathetic outflow (T5-L1) to the GI tract leads to predominance of parasympathetic (vagus and sacral parasympathetic outflow), leading to active peristalsis and relaxed sphincters, and a small, contracted gut, which enhances surgical access. Splenic enlargement (2-3 fold) occurs.

- **Endocrine system.** Nerve supply to the adrenals is blocked leading to a reduction in the release of catecholamines.

- **Genitourinary tract.** Urinary retention is a common problem with epidural anaesthesia. A severe drop in blood pressure may affect glomerular filtration in the kidney if sympathetic blockade extends high enough to cause significant vasodilatation.

- **Effects on cardiovascular physiology during pregnancy.** Aortocaval compression by the gravid uterus in the supine position leads to hypotension due to compression of the inferior vena cava, which results in diminished venous return and a drop in cardiac output. Epidural blockade, with its attendant sympathetic blockade, exacerbates the hypotension by causing peripheral vasodilatation. Compression of the aorta also reduces uterine blood flow, and it is thus clear that the combination of aortocaval compression and epidural blockade can have a profound effect on uterine and therefore placental blood flow. The supine position should be avoided in pregnant women undergoing epidural analgesia and anaesthesia, and the patient should be in a lateral (preferably left) or tilted position at all times. Hypotension should be corrected promptly with fluid replacement in the first instance. Alpha-adrenergic drugs, such as methoxamine or phenylephrine, have traditionally been avoided as they cause constriction of uterine vessels and may worsen uterine hypoperfusion. Ephedrine is the drug of choice, as it is primarily a ß-agonist and increases blood pressure by increasing cardiac output. However, should profound hypotension occur, a pure vasoconstrictor may be more effective in raising the blood pressure and therefore the uterine perfusion pressure.

EPIDURAL MANAGEMENT AND CHOICE OF DRUGS

Single injection versus catheter techniques

Single shot epidurals, without the use of a catheter, is still widely used in various settings, and is effective in providing intraoperative anaesthesia and analgesia in the immediate postoperative period. The major disadvantages of single shot epidurals are 1) the duration of postoperative analgesia is limited to the duration of action of the drug given and cannot be topped up, and 2) the risk involved in injecting a full “anaesthetic” dose of local anaesthetic into the epidural space without a test dose and without the ability to give slow increments. This means that the risks of inadvertent high block, total spinal and local anaesthetic toxicity (see below) are much greater. For this reason it is difficult to justify the use of single shot

Examples of procedures, techniques and drug choice

	Labour analgesia	**LSCS**	**Hip / knee surgery**	**Laparotomy under general anaesthetic**	**Thoracotomy or fractured ribs**
Level of Insertion	L2-L4	L2-4	L2-4	T8-10	At relevant interspace – usually T5-7
Recommended height of block	T8-9	T6-7	T10	Upper abdo T7-8, lower abdo T10	Relevant area
Density of block	Minimal motor	Motor and sensory	Motor and sensory	Sensory + minimal motor	Sensory + minimal motor
Choice of Local Anaesthetic	0.1-0.25% bupivacaine	Lignocaine 2% + adrenaline 15-20mls or bupivacaine 0.5%	Bupivacaine 0.5%	Bupivacaine 0.25% -0.5% in theatre	Bupivacaine 0.25%- 0.5% in theatre or to establish block
Choice of Opioid	Fentanyl 50mcg	Fentanyl 100mcg	Morphine 1-2mg or diamorphine 2-3mg	Morphine 1-2mg or diamorphine 2-3mg	Morphine 1-2mg or diamorphine 2-3mg
Infusion	Bupivacaine 0.1% + fentanyl 2mcg/ml	Postoperative bupivacaine 0.166% + diamorphine 0.1mg/ml	Not usually necessary	Postoperative bupivacaine 0.166% + diamorphine 0.1mg/ml	Postoperative bupivacaine 0.166% + diamorphine 0.1mg/ml
Rate of infusion	0-12mls/hour	0-8mls/hour	-	0-12mls/hour	0-8mls/hour

Note: 0.166% bupivacaine is made by diluting 10mls of 0.5% with 20mls saline

techniques under any circumstances, and especially by inexperienced practitioners.

Once a catheter is placed, the filter and its connector are attached to the proximal end of the catheter. At this point, a test dose of local anaesthetic is injected to ensure that the catheter is not in fact in the subarachnoid space. A small dose, e.g. 0.5% bupivacaine 3.5ml, bearing in mind the volume of the filter, which is about 1ml, is injected and the response noted over the next few minutes. This dose, if injected into the subarachnoid space, will cause complete surgical anaesthesia below the level of injection, and will be accompanied by the drop in blood pressure usually seen in spinal anaesthesia. It is unlikely to cause significant sensory block or hypotension if correctly injected into the epidural space. Following the test dose, the procedure for the administration of further local anaesthetic will depend on the purpose of the epidural. The important principle is that any bolus injection of local anaesthetic should be given incrementally, and the response carefully monitored, so that the practitioner can react promptly to any adverse reaction. Once a satisfactory block is established, whether for surgical anaesthesia, analgesia in labour or any other indication, the block can be maintained either by intermittent bolus administration of local anaesthetic (with or without opioids) or as a continuous infusion, if the necessary equipment is available.

Choice of drugs

The choice of drugs administered epidurally depends on the indication for the epidural:

- **Surgical anaesthesia** - requires dense sensory block and usually moderate to dense motor block. To achieve this, concentrated local anaesthetic preparations are required. The most commonly used local anaesthetics in this setting are 2% lignocaine 10-20ml (with or without adrenaline 1:200 000) or 0.5% bupivacaine 10-20ml. The latter has a longer

duration of action, but a slower onset time, compared with lignocaine.

- For analgesia during labour, 0.1-0.25% bupivacaine 5-10ml is more popular, as it produces less motor block
- Postoperative analgesia, weaker concentrations of bupivacaine, e.g. 0.1-0.166% with or without added low dose opioids, by bolus, continuous infusion or PCEA (patient controlled epidural analgesia) has been shown to be safe and efficient when given by via a syringe pump.

Opioids in the epidural space

The addition of opioids to local anaesthetic solutions has gained popularity; as the opioids have a synergistic effect by acting directly on opioid receptors in the spinal cord. Various opioids, such as morphine (2-5mg), fentanyl (50-100mcg) and diamorphine (2-4mg), have been used successfully both alone and in combination with local anaesthetic drugs, during labour, for intraoperative use and for postoperative analgesia. The combination of low-concentration local anaesthetic and low-concentration mixtures of opioids, administered by slow infusion rather than as intermittent boluses, has, in particular, been shown to be very effective in the management of postoperative pain.

The amount of opioid, e.g. diamorphine in the examples above, should be reduced where there is an increased risk of respiratory depression, i.e. the elderly, the very frail or in patients with significant chronic obstructive airway disease.

Caution should be exercised when morphine is administered epidurally, as it is associated with delayed respiratory depression. This is thought to be as a result of its low lipid solubility, which means that instead of binding to opioid receptors in the spinal cord, some of the drug remains in solution in the CSF, and the circulation of CSF transports the remaining drug to the brainstem where it acts on the respiratory centre. This may occur many hours (up to 24 hours) after morphine has been administered epidurally.

Opioids have also been used on their own in the epidural space. Pethidine (meperidine) 25-75mg, in particular, has a structure similar to local anaesthetics and is effective in providing surgical anaesthesia and postoperative analgesia.

All opioids given by this route have the potential to cause respiratory depression, and this should be borne in mind when the patient is discharged from the care of the anaesthetist. Patients should be managed postoperatively in an area with a high nurse-to-patient ratio, and should be monitored carefully with special attention to their respiratory rate and level of consciousness. Epidural opioids should be avoided where there are inadequate resources for such careful monitoring. Other drugs used successfully via the epidural route include ketamine and alpha-2 receptor blockers such as clonidine.

COMPLICATIONS AND SIDE EFFECTS

Serious complications may occur with epidural anaesthesia. Facilities for resuscitation should always be available whenever epidural anaesthesia is performed.

Hypotension has been discussed and is the commonest side effect of successful therapeutic blockade for procedures above the umbilicus. It is especially common in pregnancy, both in labour and when used for Caesarean Section, and should be corrected promptly using fluid and vasopressors. The presenting symptom of hypotension is often nausea, which may occur before a change in blood pressure has even been detected.

Inadvertent high epidural block due to an excessively large dose of local anaesthetic in the epidural space may present with hypotension, nausea, sensory loss or paraesthesia of high thoracic or even cervical nerve roots (arms), or difficulty breathing due to blockade of nerve supply to the intercostal muscles. These symptoms can be very distressing to the patient and in the most severe cases may require induction of general anaesthesia with securing of the airway, while treating hypotension. If the patient has a clear airway and is breathing adequately they should be reassured and any hypotension immediately treated. Difficulty in talking (small tidal volumes due to phrenic block) and drowsiness are signs that the block is becoming excessively high and should be managed as an emergency - see total spinal.

Local anaesthetic toxicity can also occur as a result of an excessive dose of local anaesthetic in the epidural space. Even a moderate dose of local anaesthetic, when injected directly into a blood vessel, can cause toxicity. This is especially possible when an epidural

catheter is inadvertently advanced into one of the many epidural veins. It is therefore vital to aspirate from the epidural catheter prior to injecting local anaesthetic. Symptoms usually follow a sequence of light-headedness, tinnitus, circumoral tingling or numbness and a feeling of anxiety or "impending doom", followed by confusion, tremor, convulsions, coma and cardio-respiratory arrest. It is important to recognise these symptoms early, and discontinue the further administration of local anaesthetic drugs. Treatment should be supportive, with the use of sedative/anticonvulsants (thiopentone, diazepam) where necessary, and cardiopulmonary resuscitation if required.

Total spinal is a rare complication occurring when the epidural needle, or epidural catheter, is advanced into the subarachnoid space without the operator's knowledge, and an "epidural dose" e.g. 10-20 ml of local anaesthetic is injected directly into the CSF. The result is profound hypotension, apnoea, unconsciousness and dilated pupils as a result of the action of local anaesthetic on the brainstem. The use of a test dose should prevent most cases of total spinal, but cases have been described where the epidural initially appeared to be correctly sited, but subsequent top-up doses caused the symptoms of total spinal. This has been ascribed to migration of the epidural catheter into the subarachnoid space, although the precise mechanism is uncertain.

Management of total spinal

- Airway - secure airway and administer100% oxygen
- Breathing - ventilate by facemask and intubate.
- Circulation - treat with i/v fluids and vasopressor e.g. ephedrine 3-6mg or metaraminol 2mg increments or 0.5-1ml adrenaline 1:10 000 as required
- Continue to ventilate until the block wears off (2 - 4 hours)
- As the block recedes the patient will begin recovering consciousness followed by breathing and then movement of the arms and finally legs. Consider some sedation (diazepam 5 - 10mg i/v) when the patient begins to recover consciousness but is still intubated and requiring ventilation.

Accidental dural puncture is usually easily recognised by the immediate loss of CSF through the epidural needle. This complication occurs in 1-2% of epidural blocks, although it is more common in inexperienced hands. It leads to a high incidence of post dural puncture headache, which is severe and associated with a number of characteristic features. The headache is typically frontal, exacerbated by movement or sitting upright, associated with photophobia, nausea and vomiting, and relieved when lying flat. Young patients, especially obstetric patients, are more susceptible than the elderly. The headache is thought to be due to the leakage of CSF through the puncture site. Basic measures, such as simple analgesics, caffeine, bed rest, fluid rehydration and reassurance are indicated in the first instance, and are often sufficient to treat the headache. Where the headache is severe, or unresponsive to conservative measures, an epidural blood patch may be used to treat the headache. This procedure is effective in treating approximately 90% of post dural puncture headaches. If unsuccessful, the blood patch may be repeated, and the success rate increases to 96% on the second attempt. The blood injected into the epidural space is thought to seal the hole in the dura.

Procedure for epidural blood patch

Indications

- Clinical diagnosis of post dural puncture headache.
- Sufficiently severe so as to be incapacitating.
- Unrelieved by 2-3 days of conservative management

Contraindications

- Unexplained neurological symptoms
- Active neurological disease
- Localised sepsis in lumbar area
- Generalised sepsis
- Coagulopathy

Technique

- Obtain informed consent following full explanation of technique, potential hazards and anticipated success rate

- Move patient to fully equipped work area
- Two operators required, both taking full sterile precautions (gloves, gown, mask)
- Position patient in lateral position or sitting
- Operator 1: sterilise skin over back, drape and perform epidural puncture at the same level as previous puncture or one level below
- Operator 2: simultaneously sterilise skin over antecubital fossa, drape and perform venepuncture withdrawing 20ml of blood.
- Blood is handed to operator 1 who injects blood via epidural needle until either the patient complains of a tightness in the buttocks or lower back, or until 20ml is injected
- Inject remaining blood into blood culture bottles for culture and sensitivity
- Nurse patient supine for 1hour followed by careful mobilisation.

Epidural haematoma is a rare but potentially catastrophic complication of epidural anaesthesia. The epidural space is filled with a rich network of venous plexuses, and puncture of these veins, with bleeding into the confined epidural space, may lead to the rapid development of a haematoma which may lead to compression of the spinal cord, and can have disastrous consequences for the patient including paraplegia. For this reason, coagulopathy or therapeutic anticoagulation with heparin or oral anticoagulants has long been an absolute contraindication to epidural blockade.

Infection is another rare but potentially serious complication. Pathogenic organisms can be introduced into the epidural space if strict asepsis is not observed during the performance of the block. The commonest pathogens are Staphylococcus aureus and streptococci. Meningitis has been described, as has epidural abscess. In addition to the symptoms of spinal cord compression described above, the patient may exhibit signs of infection such as pyrexia and a raised white cell count. Once again, a high index of suspicion is needed, and surgical decompression of an abscess should be performed without delay.

Failure of block can occur as a result of many factors, the most important being the experience of the operator. False loss of resistance during performance of the block may lead to insertion of the epidural catheter into an area other than the epidural space, with failure to establish anaesthesia. Segmental sparing occurs occasionally for reasons that are unclear, but are assumed to be the result of anatomic variation of the epidural space, so that local anaesthetic fails to spread evenly throughout the space. The result is that some nerve roots are inadequately soaked with local anaesthetic, leaving the dermatomes of these nerve roots poorly anaesthetised. Unilateral blockade occurs occasionally, and this is thought to be the result of a septated epidural space, with failure of the local anaesthetic solution to spread to one half of the epidural space. Positioning the patient on his side with the unblocked side down is sometimes successful in allowing spread of the local anaesthetic to the dependent side, giving bilateral anaesthesia.

Further reading:

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